

**APACHE CANADA  
LIMITED**

**HAMBURG 2-6  
COMPRESSOR STATION**

**SO# 99404**

LSD: 02-06-097-11 W6M

SEPTEMBER, 2000

OPERATING MANUAL

**VOLUME 2**

PROPAK C  
PLEASE DO NOT REMOVE

# **APACHE CANADA LIMITED**

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**LSD: 02-06-097-11 W6M**

**2-6 Hamburg 1478 hp Compressor Package**

**Propak Systems Unit #99404**

**Waukesha L7042GL / Dresser-Rand 6HOS-3**

**Operations and Maintenance Manual**



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KD-200

*Waukesha*

**DSM**

Custom Engine Control<sup>®</sup>  
Detonation Sensing Module  
Installation, Operation &  
Maintenance

First Edition

Software Version 6 Series



Form 6278

Serial No.

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Specification No.

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# **Waukesha**

# **DSM**

## Custom Engine Control<sup>®</sup>

## Detonation Sensing Module

## Installation, Operation &

## Maintenance

First Edition

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Dresser Equipment Group, Inc.  
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Printed on Recycled Paper



## HOW TO USE THIS MANUAL

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Your purchase of a Custom Engine Control® (CEC) Detonation Sensing Module (DSM) system was a wise investment. In the industrial engine field the name, Waukesha Engine, stands for quality and durability. With normal care and maintenance this equipment will provide many years of reliable service.

Before placing the Detonation Sensing Module system in service read Chapter 1 very carefully. This chapter covers Safety and General Information.

Section 1.00 - Safety Section - Provides a list of warnings and cautions to make you aware of the dangers present during operation and maintenance of the engine. - **READ THEM CAREFULLY AND FOLLOW THEM COMPLETELY -**

Section 1.05 - General Information - Provides conversion data, intake manifold calculations, wiring information, and grounding information.

Section 1.10 - Description of Operation - Provides basic data on the Detonation Sensing Module system such as: system description, theory of operation, and definitions.

**ALWAYS BE ALERT FOR THE SPECIAL WARNINGS WITHIN THE MANUAL TEXT. THESE WARNINGS PRECEDE INFORMATION THAT IS CRUCIAL TO YOUR SAFETY AS WELL AS OTHER PERSONNEL WORKING ON OR NEAR THE ENGINE. CAUTIONS OR NOTES IN THE MANUAL CONTAIN INFORMATION THAT RELATES TO POSSIBLE DAMAGE TO THE ENGINE OR ITS COMPONENTS DURING ENGINE OPERATION OR MAINTENANCE PROCEDURES.**

This manual contains installation, operation, and maintenance instructions for the Detonation Sensing Module system. There are four chapters within the manual and each chapter contains one or more sections. The title of each chapter or section appears at the top of each page. To locate information on a specific topic, refer to the Table of Contents at the front of the manual or the Index at the back of the manual.

Recommendations and data contained in the manual are the latest information available at the time of this printing and are subject to change without notice. Since engine accessories may vary due to customer specifications consult your local distributor or Waukesha Engine Division Service Operations Department for any information on subjects beyond the scope of this manual.

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# SECTION 1.00

## SAFETY

### SAFETY INTRODUCTION

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

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

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

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

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

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

 **DANGER**

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

### SAFETY TAGS AND DECALS

 **WARNING**

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

### EQUIPMENT REPAIR AND SERVICE

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

 **WARNING**

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

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

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

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

## SAFETY

### WARNING

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

### WARNING

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

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

## ACIDS

### WARNING

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

## BATTERIES

### WARNING

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

## BODY PROTECTION

### WARNING

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

## CHEMICALS

### GENERAL

### WARNING

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

### CLEANING SOLVENTS

### WARNING

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

### LIQUID NITROGEN/DRY ICE

### WARNING

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

## COMPONENTS

### HEATED OR FROZEN

### WARNING

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

### INTERFERENCE FIT

### WARNING

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

**COOLING SYSTEM****⚠ WARNING**

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

**⚠ WARNING**

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

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

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

**⚠ WARNING**

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

**IGNITION****⚠ WARNING**

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

**⚠ WARNING**

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

**EXHAUST****⚠ WARNING**

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

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

**⚠ WARNING**

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

**FIRE PROTECTION****⚠ WARNING**

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

## SAFETY

### FUELS

#### GENERAL

#### WARNING

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

#### GASEOUS

#### WARNING

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

#### WARNING

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

#### LIQUID

#### WARNING

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

#### WARNING

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

### INTOXICANTS AND NARCOTICS

#### WARNING

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

### PRESSURIZED FLUIDS/GAS/AIR

#### WARNING

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

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

### PROTECTIVE GUARDS

#### WARNING

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

It is the responsibility of the engine owner to specify and provide guarding.

### SPRINGS

#### WARNING

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



## TOOLS

## ELECTRICAL

**⚠ WARNING**

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

## HYDRAULIC

**⚠ WARNING**

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

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

## PNEUMATIC

**⚠ WARNING**

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

## WEIGHT

**⚠ WARNING**

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

**⚠ WARNING**

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

## WELDING

## GENERAL

**⚠ WARNING**

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

## ON ENGINE

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

**⚠ CAUTION** Disconnect the ignition harness before welding on or near an engine to eliminate charging of an ignition system capacitor. Failure to disconnect the ignition harness could result in severe engine damage.

**SAFETY**

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# SECTION 1.05

## GENERAL INFORMATION

**Table 1.05-1. English To Metric Formula Conversion Table**

CONVERSION	FORMULA	EXAMPLE
Inches to Millimeters	Inches and any fraction in decimal equivalent multiplied by 25.4 equals millimeters.	2-5/8 in. = $2.625 \times 25.4 = 66.7$ mm
Cubic Inches to Litres	Cubic inches multiplied by 0.01639 equals litres.	9388 cu. in. = $9388 \times 0.01639 = 153.9$ L
Ounces to Grams	Ounces multiplied by 28.35 equals grams.	21 oz. = $21 \times 28.35 = 595$ g
Pounds to Kilograms	Pounds multiplied by 0.4536 equals kilograms.	22,550 lb. = $22,550 \times 0.4536 = 10,229$ kg
Inch Pounds to Newton-meters	Inch pounds multiplied by 0.113 equals Newton-meters.	360 in-lb = $360 \times 0.113 = 40.7$ N·m
Foot Pounds to Newton-meters	Foot pounds multiplied by 1.3558 equals Newton-meters.	145 ft-lb = $145 \times 1.3558 = 197$ N·m
Pounds per Square Inch to Bars	Pounds per square inch multiplied by 0.0690 equals bars.	9933 psi = $9933 \times 0.0690 = 685$ Bar
Pounds per Square Inch to Kilograms per Square Centimeter	Pounds per square inch multiplied by 0.0703 equals kilograms per square centimeter.	45 psi = $45 \times 0.0703 = 3.2$ kg/cm <sup>2</sup>
Pounds per Square Inch to Kilopascals	Pounds per square inch multiplied by 6.8947 equals kilopascals.	45 psi = $45 \times 6.8947 = 310$ kPa
Fluid Ounces to Cubic Centimeters	Fluid ounces multiplied by 29.57 equals cubic centimeters.	8 oz. = $8 \times 29.57 = 237$ cc
Gallons to Litres	Gallons multiplied by 3.7853 equals litres.	148 gal. = $148 \times 3.7853 = 560$ L
Degrees Fahrenheit to Degrees Centigrade	Degrees Fahrenheit minus 32 divided by 1.8 equals degrees Centigrade.	$212^\circ \text{ F} - 32 + 1.8 = 100^\circ \text{ C}$

**Table 1.05-2. Metric To English Formula Conversion Table**

CONVERSION	FORMULA	EXAMPLE
Millimeters to Inches	Millimeters multiplied by 0.03937 equals inches.	67 mm = $67 \times 0.03937 = 2.6$ in.
Litres to Cubic Inches	Litres multiplied by 61.02 equals cubic inches.	153.8 L = $153.8 \times 61.02 = 9385$ cu. in.
Grams to Ounces	Grams multiplied by 0.03527 equals ounces.	595 g = $595 \times 0.03527 = 21.0$ oz.
Kilograms to Pounds	Kilograms multiplied by 2.205 equals pounds.	10,228 kg = $10,228 \times 2.205 = 22,553$ lb.
Newton-meters to Inch Pounds	Newton-meters multiplied by 8.85 equals inch pounds.	40.7 N·m = $40.7 \times 8.85 = 360$ in-lb
Newton-meters to Foot Pounds	Newton-meters multiplied by 0.7375 equals foot pounds.	197 N·m = $197 \times 0.7375 = 145$ ft-lb
Bars to Pounds per Square Inch	Bars multiplied by 14.5 equals pounds per square inch.	685 Bar = $685 \times 14.5 = 9933$ psi
Kilograms per Square Centimeter to Pounds per Square Inch (psi)	Kilograms per square centimeter multiplied by 14.22 equals pounds per square inch.	$3.2 \text{ kg/cm}^2 = 3.2 \times 14.22 = 46$ psi
Kilopascals to Pounds per Square Inch (psi)	Kilopascals multiplied by 0.145 equals pounds per square inch.	310 kPa = $310 \times 0.145 = 45.0$ psi
Cubic Centimeters to Fluid Ounces	Cubic centimeters multiplied by 0.0338 equals fluid ounces.	236 cc = $236 \times 0.0338 = 7.98$ oz.
Litres to Gallons	Litres multiplied by 0.264 equals gallons.	560 L = $560 \times 0.264 = 148$ gal.
Degrees Centigrade to Degrees Fahrenheit	Degrees Centigrade multiplied by 1.8 plus 32 equals Degrees Fahrenheit.	$100^\circ \text{ C} = 100 \times 1.8 + 32 = 212^\circ \text{ F}$

## GENERAL INFORMATION

### INTAKE MANIFOLD PRESSURE CALCULATIONS

The only way to know for sure how much power the engine is producing is to know the intake manifold charge density. For a constant horsepower, the intake manifold charge density must remain constant. In addition, it is important to remember that at different altitudes the atmospheric pressure will be different which, in turn, will produce different charge densities for the same power output. Understanding this, intake manifold pressure can be calculated for various altitudes and intake manifold temperatures. Given below is a sample calculation you can model to determine intake manifold pressure at your site.

$$P_2 = \frac{P_1 \times T_2}{T_1}$$

where:  $P_1$  = full load intake manifold pressure at Waukesha  
 $T_1$  = full load intake manifold temperature at Waukesha  
 $T_2$  = intake manifold temperature at site

Because the above equation is based on the Ideal Gas Law, it is required that all of the values be corrected to "absolute." To do this, add the atmospheric pressure (in the same units) to the pressures, and 460 to the temperatures if using degrees Fahrenheit or 273 to the temperature if using degrees Celsius.

For example, for a 12V-AT25GL operating at Waukesha with 41" Hg intake manifold pressure and 120° F intake manifold temperature, the full load absolute intake manifold pressure equals the manifold gauge pressure plus the atmospheric pressure:

$$P_1 = 41" \text{ Hg} + 29.5" \text{ Hg} = 70.5" \text{ Hg}$$

The absolute intake manifold temperature equals:

$$T_1 = 120^\circ \text{ F} + 460 = 580^\circ \text{ R}$$

At a particular 12V-AT25GL operating site, the intake manifold temperature is:

$$T_2 = 105^\circ \text{ F} + 460 = 565^\circ \text{ R}$$

The full load absolute intake manifold pressure is found by:

$$P_2 = \frac{70.5 \times 565}{580}$$

$$P_2 = 68.7" \text{ Hg}$$

The atmospheric pressure at this site is an average 24.7" Hg., therefore the full load intake manifold gauge pressure is:

$$68.7" \text{ Hg} - 24.7" \text{ Hg} = 44" \text{ Hg}$$

If site atmospheric pressure is unavailable, Table 1.05-3 can be used as an alternative; however, you will need to know site elevation. **Do not call the local weather service for atmospheric pressure because they may be located at a different altitude.**

Table 1.05-3. Atmospheric Pressure Table

SITE ALTITUDE (feet)	PRESSURE (In-hg)
0	29.92
1,000	28.86
2,000	27.82
3,000	26.81
4,000	25.84
5,000	24.89
6,000	23.98
7,000	23.09
8,000	22.22
9,000	21.38
10,000	20.58
11,000	19.79
12,000	19.03
13,000	18.29
14,000	17.57
15,000	16.88
16,000	16.21
17,000	15.56
18,000	14.94
19,000	14.33
20,000	13.75
21,000	13.18
22,000	12.63
23,000	12.10
24,000	11.59
25,000	11.10
26,000	10.62
27,000	10.16
28,000	9.72
29,000	9.29
30,000	8.88
31,000	8.48
32,000	8.10
33,000	7.73
34,000	7.38
35,000	7.04
36,000	6.71
37,000	6.39
38,000	6.10
39,000	5.81
40,000	5.54

## WIRING REQUIREMENTS

All electrical equipment and wiring shall comply with applicable local codes. This Waukesha standard defines additional requirements for Waukesha engines.

### WARNING

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

### WARNING

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

1. Whenever two or more wires run together, they should be fastened together at no more than four (4) to six (6) inch intervals, closer where necessary, with tie wraps. Power wires (24 volts or greater) should never be run together with any other instrument or control wires. Spacing for these types of wires should be six (6) inches minimum to eliminate electrical "noise" problems in the instrument or control wires.
2. All wires should be mounted off hot areas of the engine with insulated clips, at intervals of no more than twelve (12) inches, closer where necessary. Wires must never be run closer than six (6) inches to exhaust manifolds, turbochargers, or exhaust pipes.
3. In cases where wires do not run over the engine, they should be fastened to rigid, non-moving bodies with insulated clips when possible or tie wraps. Fasteners should be spaced at no more than twelve (12) inch intervals.
4. When wires run through holes, rubber grommets should be installed in holes to protect the wires. Wires should never be run over rough surfaces or sharp edges without protection (see Item 11).

 **CAUTION** Do not use non-electrical grade RTVs. Non-electrical RTVs can emit corrosive gases that can damage electrical connectors.

5. An electrical grade RTV should be applied around the wires entering all electrical devices such as Murphy Junction Boxes and gas valves, Syncro Start speed switches, microswitch boxes used in conjunction with safety equipment, solenoids, etc. An electrical grade RTV is to be applied immediately after wire installation and prior to the engine entering the test room.

6. A small "drip loop" should be formed in all wires before entering the electrical devices. This drip loop will reduce the amount of moisture entering electrical device via the wires if an electrical grade RTV does not seal completely.

7. The following procedures should be followed for wires entering engine junction boxes:

- Bottom entrance best and side entrance second best.
  - Insert grommet in opening to protect wires.
  - Wires to contain "drip loop" before entering box, except where using bottom entrance.
  - When installing flexible conduit, use straight connector for side entrance. If top entrance is required, use elbow connector.
8. If wire harness has a covering, clamp harness so openings of covering are downward.
9. The routing of wires should be determined for reliability and appearance and not by shortest distance.
10. Installation connection wire must be coiled and secured to provide protection during shipment.
11. Each end of flexible metal conduit *must* have an insulating sleeve to protect wires from chafing.

### WARNING

Always label "HIGH VOLTAGE" on engine mounted equipment over 24 volts. Failure to adhere to this warning could result in personal injury or death.

12. All engine mounted electrical equipment over 24 volts shall have "HIGH VOLTAGE" warning decal. Decal to be attached to all the equipment and junction boxes on visible surface (vertical surface whenever possible).

13. Wiring that is routed in rigid or flexible conduit shall have all wire splices made only in junction boxes, outlet boxes, or equipment boxes. Wire splices shall not be located in the run of any conduit.

## GENERAL INFORMATION

### POWER REQUIREMENTS FOR CUSTOM ENGINE CONTROL® PRODUCTS

Table 1.05-4 provides you with the power requirements for Waukesha's Custom Engine Control® (CEC) products. An oscilloscope must be used to verify ripple limitations. All power connections must be in accordance with the applicable electrical codes.

**NOTE:** To power the CEC Ignition Module, a nominal supply of 24 VDC with less than a 2 volt peak-to-peak ripple is recommended for compatibility with other CEC products.

### CAPACITIVE DISCHARGE AND GROUNDING

A Capacitive Discharge (CD) ignition system, such as the CEC Ignition Module, requires an external power source and special wiring requirements.

This ignition system contains several large energy storage capacitors. When firing a spark plug, the energy stored in one of these capacitors is rapidly discharged into an ignition coil which converts it to the high tension ignition voltage. Having been discharged, the energy storage capacitor must then be recharged to be ready to fire again. The storage capacitor is typically recharged

by drawing energy from the power supply as quickly as possible, resulting in a high current flow (typically 30 amps or more) in the power supply wiring for a short period of time.

The average ignition system current remains low (1 or 2 amps depending on the number of cylinders, engine speed, and supply voltage) since the high current only flows for the short period of time and virtually no current flows the rest of the time. However, the wiring must be sized for the high instantaneous currents. In addition, the grounding, particularly where the ground is "referenced," becomes more critical when electronic controls are used on engines having this type of CD ignition system.

With ignition power supply currents of approximately 30 amps, the resistive voltage drop of the wiring can easily reach a volt or two. As a result, it is necessary to reference all of the grounds to the same point. Since many electronic sensors are internally grounded, the engine crankcase has been chosen as THE GROUND reference to minimize problems with sensor signals. By following the recommended wiring and grounding procedures, the concerns associated with the ignition power supply wiring voltage drops can be greatly reduced or eliminated.

**Table 1.05-4. Power Requirements For Waukesha Custom Engine Control® Products**

CEC PRODUCT	NOMINAL VOLTAGE (volts DC)	TOLERANCE	OPERATING RANGE (volts DC)	PEAK-TO-PEAK RIPPLE (volts AC)	OPERATING CURRENT (amps)
Ignition Module (IM)	24	+33%, -58%	10.0 - 32.0**	less than 2**	2 (typical)
Detonation Sensing Module (DSM) System	24	+25%, -10%	21.6 - 30.0	less than 2	1.5
Air/Fuel Module (AFM) System	24	+25%, -10%	21.6 - 30.0	less than 2	2.5 (all rich burn applications) 18.0 (lean burn applications on VHP 6 cylinder and all VGF engines) 32.0 (lean burn applications on all AT and VHP 12 & 16 cylinder engines)
Turbocharger Control Module (TCM) System	24	+25%, -10%	21.6 - 30.0	less than 2	1.5

**NOTE:** \*The voltage specifications provided in this table apply to the power that is to be supplied to the the CEC modules. The CEC modules will supply the correct voltage specification(s) to other system components if required, such as oxygen sensors used in the AFM system.  
\*\*For compatibility with other CEC products, a nominal supply of 24 VDC with less than a 2 volt peak-to-peak ripple is recommended to power the IM.

## SECTION 1.10

### DESCRIPTION OF OPERATION

#### CUSTOM ENGINE CONTROL® DETONATION SENSING MODULE SYSTEM

##### SYSTEM DESCRIPTION

Detonation is the autoignition of end gas after the spark plug has fired that is not being consumed in normal flame-front reaction in an engine's combustion chamber. When this happens, two pressure waves, created by the two flame-fronts, slam together creating a high pressure pulse which causes an audible "ping" or "knock" known as detonation. Avoiding detonation conditions is critical since detonation is typically destructive to engine components.

Detonation is caused by site conditions and/or engine misadjustment, not the engine. The conditions that promote detonation are extremely complex. See "Detonation Theory" in this section for a definition of detonation and examples of detonation promoters and reducers.

To prevent detonation from occurring, Waukesha Engine has developed an electronic Custom Engine Control® Detonation Sensing Module (DSM) system that is designed to function with spark ignited Waukesha AT, VGF (12 and 16 cylinders), and VHP engines (see Figure 1.10-1). The DSM system protects Waukesha spark ignited gas engines from damage due to detonation.

**NOTE:** For maximum engine protection, the DSM system must be connected to a safety shutdown.

##### COMPONENTS

The DSM, and its related system, are designed to function with the CEC Ignition Module through a 14 pin DSM expansion port (see Figure 1.10-2). The DSM system also includes a Waukesha designed electronic filter, knock sensors, and a number of interconnecting cables and harnesses that may vary depending on the application (see Figure 1.10-1).

The DSM system is customized for each application with a personal computer. Minimum requirements include an 80286-12 Mhz microprocessor, a 3.5 inch high density (1.44 MB) floppy disk drive, an RS-232 serial port, and MS-DOS 3.3 or higher. However, a 386 or 486 based computer with both hard and floppy drives and a printer port is strongly recommended.

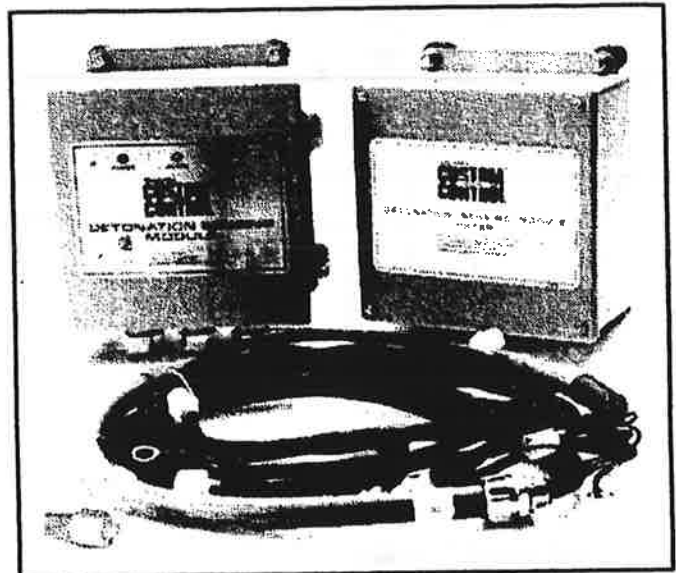


Figure 1.10-1. CEC Detonation Sensing Module System

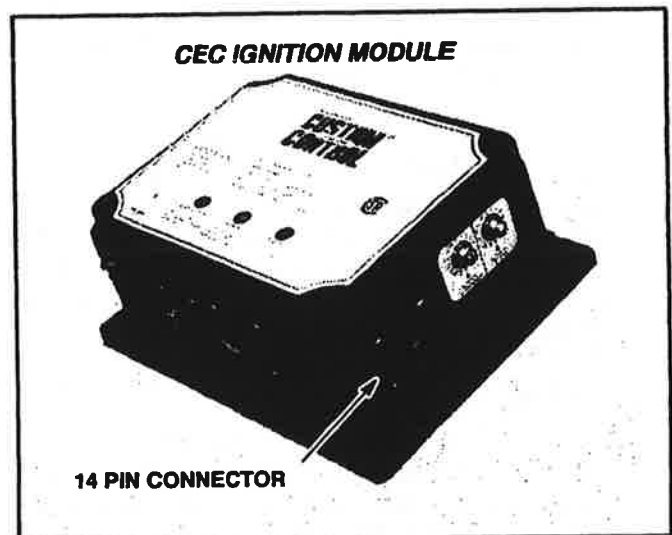


Figure 1.10-2. CEC Ignition Module With 14 Pin DSM Expansion Port

The schematic in Figure 1.10-3 illustrates the electronic route of the DSM system.

## DESCRIPTION OF OPERATION

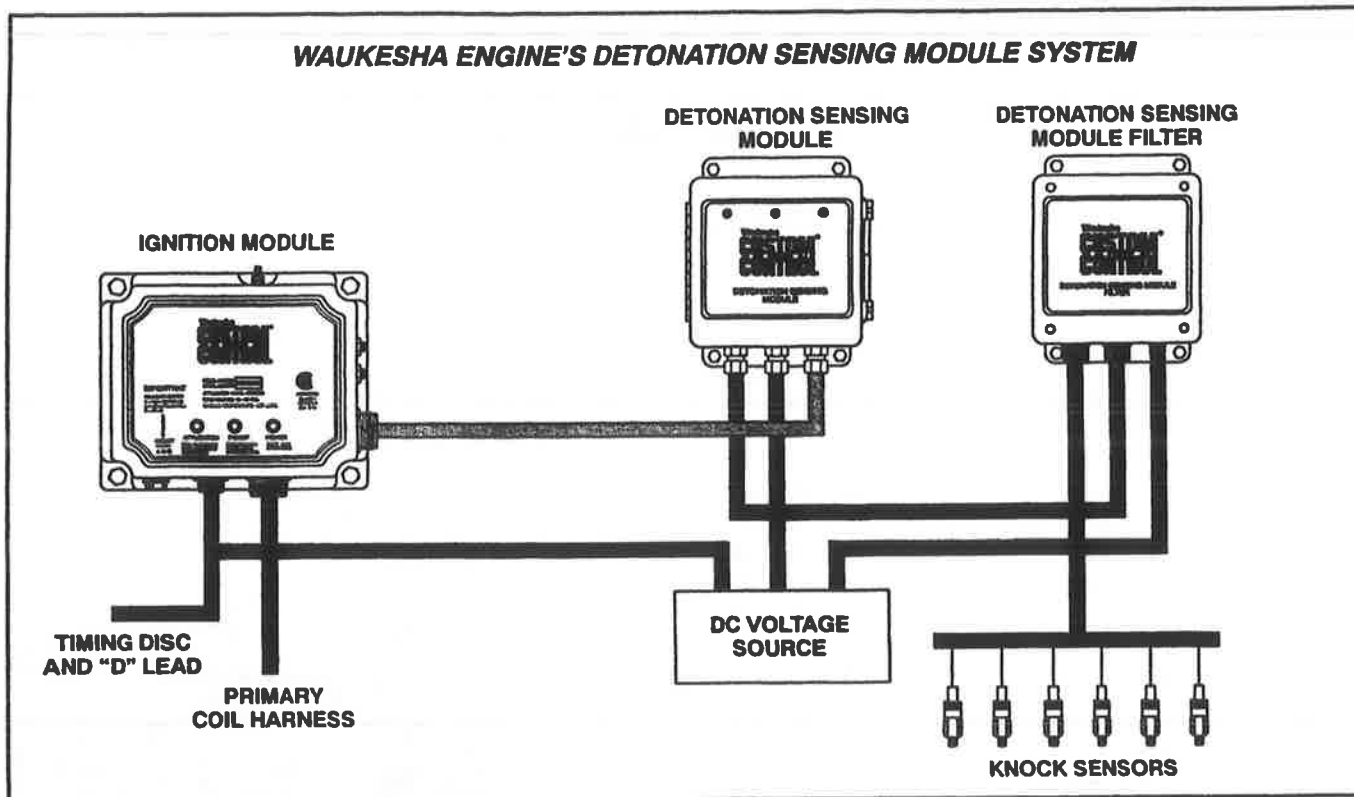


Figure 1.10-3. Detonation Sensing Module System Layout

### CANADIAN STANDARDS ASSOCIATION (CSA)

The DSM system meets North American Canadian Standards Association (CSA) Class I, Division 2, Group D Hazardous Location requirements. Under this classification, the DSM system can operate safely in locations where there is danger of explosion due to the presence of flammable gases.

**CAUTION** Never substitute any components of the CSA certified DSM system. Substitution of components may impair suitability for Class I, Division 2 Group D Hazardous Location requirements. Disregarding this information could result in product damage and/or personal injury.

### ENGINES SERVED

Currently, the DSM system is designed to function with spark ignited Waukesha AT, VGF (12 and 16 cylinders), and VHP engines. All information about the engine model and application is programmed to the DSM module using a personal computer.

### IGNITION TIMING ADJUSTMENTS

The DSM system functions by monitoring vibrations at each cylinder with knock sensors. When a signal exceeds a detonation threshold, the DSM system, through the CEC Ignition Module, retards ignition timing incrementally. Ignition timing is adjusted on an individual cylinder basis or in "cylinder pairs." The descriptions that follow describe the adjustment made on the different engines.

- On 6 and 12 cylinder VHP engines, one knock sensor is mounted below each cylinder head. When detonation is detected with the DSM system, ignition timing is adjusted on an individual cylinder basis.
- On 8 and 12 cylinder AT engines, one knock sensor is mounted on each cylinder head. When detonation is detected with the DSM system, ignition timing is adjusted on an individual cylinder basis.
- On 12 cylinder VGF engines, one sensor is mounted for two adjacent cylinders (6 sensors total); however, when detonation is detected ignition timing is still adjusted on an individual cylinder basis. Individual timing is possible because the engine alternately fires a cylinder on each engine bank but the knock sensor works for adjacent cylinders on the *same* engine bank.



- On 16 cylinder VHP engines, one sensor is mounted below each cylinder head but ignition timing is adjusted in "cylinder pairs." Timing adjusts for two cylinders (one on each bank) at once when detonation is detected by either sensor of the paired cylinders.
- On 16 cylinder AT engines, one sensor is mounted on each cylinder head but ignition timing is adjusted in "cylinder pairs." Timing adjusts for two cylinders (one on each bank) at once when detonation is detected by either sensor of the paired cylinders.
- On 16 cylinder VGF engines, one sensor is mounted for two adjacent cylinders (8 sensors total). Ignition timing is adjusted in "cylinder pairs." Timing adjusts for two cylinders (one on each bank) at once when detonation is detected by either sensor of the paired cylinders.

## OPERATOR INTERFACE

The DSM module is equipped with several features to inform site personnel of system status. These features include:

- "Power," "Alarm," and "Shutdown" lights (LEDs) on the front panel of the DSM module (see Figure 1.10-4)
- a liquid crystal display (LCD) located inside the DSM module which continually shows the current status of the system through diagnostic codes (see Figure 1.10-5)
- the capability to drive remote alarms or lights

**Example:** For 6, 8, and 12 cylinder engines the DSM module can detect if a sensor has been damaged or disconnected. In either event, a default timing value is imposed for the cylinder associated with the lost signal. In addition to imposing the default timing, the DSM module will also illuminate the yellow alarm LED on the front cover, provide a signal for a remote alarm, and will display the error code on the LCD within the DSM module.

**NOTE:** For 16 cylinder engines a sensor test must be performed to detect a lost sensor. The lost sensor check procedure is explained in Section 4.10, Lost Sensor Check Test On 16 Cylinder Engines. A test for lost sensors should be performed whenever the safety controls and alarms are tested on the engine.

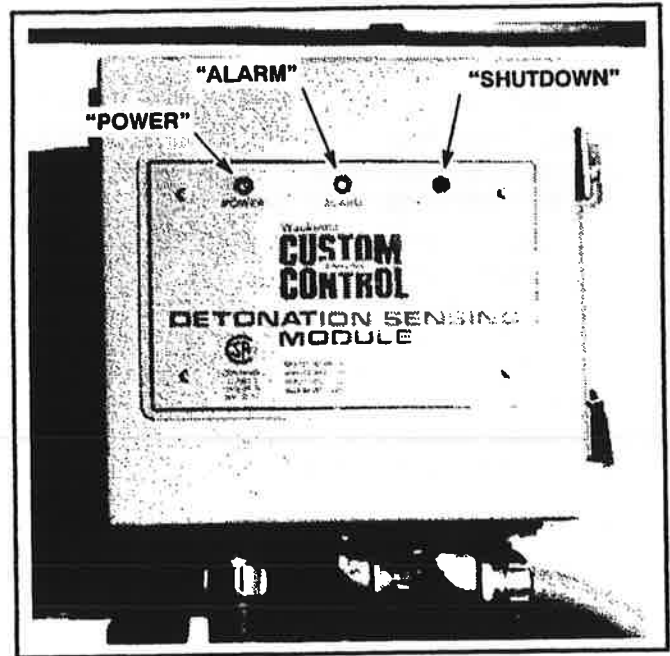


Figure 1.10-4. Detonation Sensing Module Front Panel

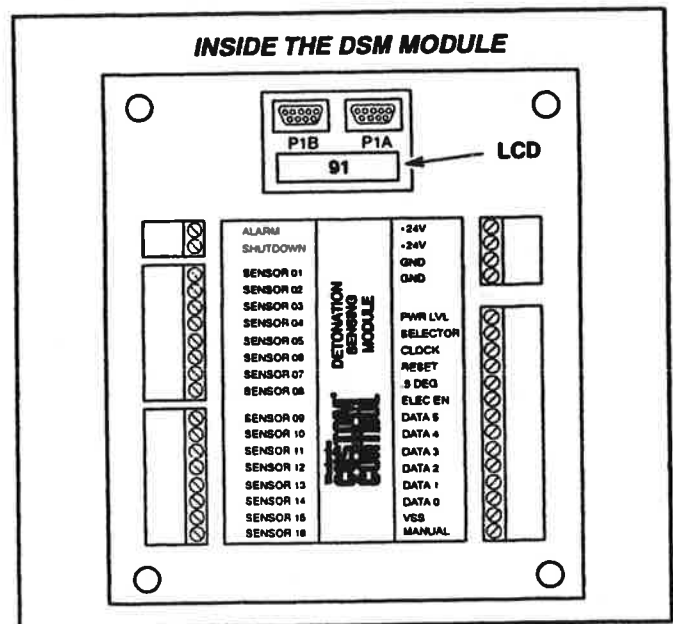


Figure 1.10-5. Detonation Sensing Module LCD

## ⚠ WARNING

For maximum engine protection, the DSM system must be connected to a safety shutdown. The DSM system is considered a safety system and, as such, must be connected to shut down the engine if the engine cannot be brought out of detonation. Disregarding this information could result in severe personal injury or death.

**NOTE:** Refer to Section 2.10 DSM System Power And Alarm Connections for installation.

## DESCRIPTION OF OPERATION

### THEORY OF OPERATION

The DSM system senses detonation with a technique called "windowing." This technique allows the DSM system to look for detonation only during the combustion time when detonation could be present.

The "window" opens shortly after the spark plug fires to eliminate the effects of ignition noise. This noise is caused from the firing of the spark plug and subsequent "ring-out" of coils. The "end of sample window" is closed near the end of the combustion event. This is a predetermined angle after top dead center (ATDC) in crankshaft degrees at which the "window" is closed (programmable) (see Figure 1.10-6).

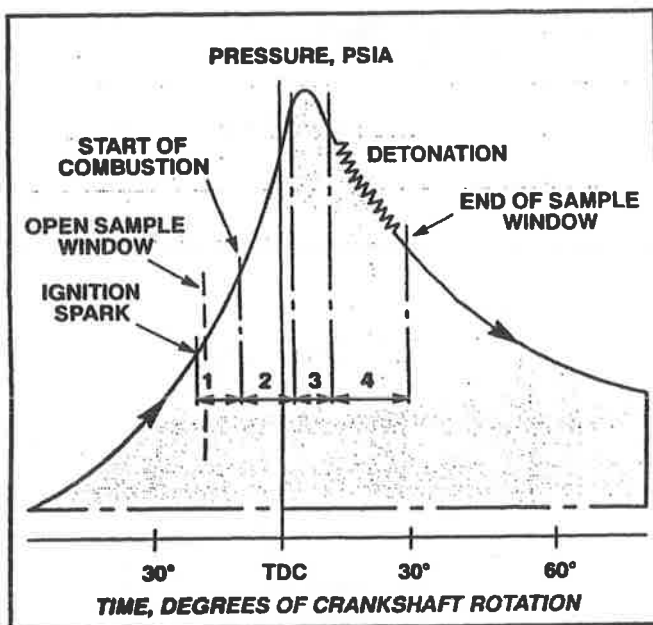


Figure 1.10-6. Windowing Chart

For 16 cylinder engines, the window opens after a short delay following the firing of the first cylinder in the cylinder pair just as it does in the other applications, but the window closes temporarily during the firing of the second cylinder in the pair. The window is opened again to look at the second cylinder during its combustion process. The DSM then closes the "window" after the programmed delay relative to the second cylinder in the "pair."

The DSM module monitors for detonation using the frequency output of each cylinder with engine mounted knock sensors.

During detonation a unique vibration called "knock" frequency is produced. Knock frequency is just one of many frequencies created in a cylinder during engine operation. The knock sensors mounted at each cylinder convert engine vibrations to electrical signals which are routed through a Waukesha designed electronic filter (electronic filters are engine model specific) (see Figure 1.10-7). This filter removes the electrical signals that are not associated with detonation and routes the knock signal to the DSM module. When the filtered signal exceeds a predetermined limit (detonation threshold), the DSM module, in conjunction with the Ignition Module, retards the ignition timing for the cylinder (or cylinder pair in 16 cylinder applications) associated with that sensor. The predetermined limit or detonation threshold can be reprogrammed using the DSM system software and a personal computer.

The DSM system controls timing between two predetermined limits. The maximum advanced timing (nameplate timing) at which the system will allow the engine to operate is the Most Advanced Timing (programmable). The minimum advanced timing at which the system will allow the engine to operate is the Most Retarded Timing (programmable). Several factors go into the selection of the retard limit, including exhaust temperature and emission considerations.

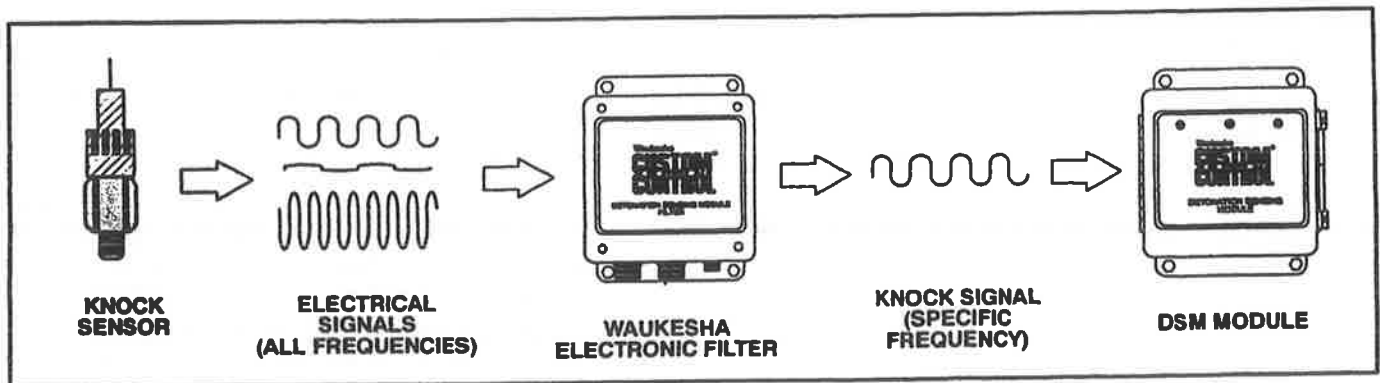


Figure 1.10-7. DSM Electronic Filter Operation

In the event that the DSM system senses detonation, the ignition timing will be retarded at a predetermined rate (programmable) until either the signal from the sensor falls below the "detonation threshold" or the Most Retarded Timing position is reached. Should detonation continue once the Most Retarded Timing is reached, the DSM module will illuminate the "Shutdown" light on the module's cover after a predetermined period of time (programmable), and provide an output that can be used to shut the engine off or activate other warning devices. As soon as conditions permit, the DSM system will advance spark timing to the original set-point at a predetermined rate (programmable).

For 6, 8, and 12 cylinder applications, the DSM system, in conjunction with the Ignition Module, is capable of varying engine timing a total of 35 crankshaft degrees. Twenty-five degrees of authority are available when the "D" lead of the Ignition Module is grounded, and 31 degrees of authority are available when the "D" lead is ungrounded. However, these two separate ranges of adjustment overlap by 21 degrees so a total span of 35 degrees is available.

On 16 cylinder VGF and VHP applications, 20 degrees of authority are available when the "D" lead of the Ignition Module is grounded, and 25 degrees of authority are available when the "D" lead is ungrounded. However, these two separate ranges of adjustment overlap by 16 degrees so a total span of 29 degrees is available.

On 16 cylinder AT applications, 20 degrees of authority are available when the "D" lead of the Ignition Module is grounded, and 19 degrees of authority are available when the "D" lead is ungrounded. However, these two separate ranges of adjustment overlap by 16 degrees so a total span of 23 degrees is available.

**NOTE:** Ignition timing varies for each engine application. Refer to the engine nameplate for engine timing ("BTDC) or the Custom Engine Control® Ignition Module Installation, Operation, And Maintenance Manual Form 6253 or Form 6272 (for Models 811, 1211, and 1611) for more information.

The system also has a predetermined default timing value (programmable) that is used during a predetermined warm-up time period (programmable) and when a low sensor output is detected. During engine warm-up, the DSM system is disabled and is not protecting the engine so the default timing value is active. The purpose of this delay is to prevent misleading vibration signals, that may exist during the time that the engine is warming up, from being incorrectly detected as detonation signals. With careful selection of the default timing value and the warm-up time period, it may be possible to improve synchronization characteristics because the engine should have better speed stability at the retarded (from nameplate) default timing.

## DETONATION THEORY

Detonation has been a known adversary of engine operation for many years. Avoiding detonation conditions is critical since detonation is typically destructive to engine components. Severe detonation often damages pistons, cylinder heads, valves, and piston rings. Damage from detonation will eventually lead to complete failure of the affected part. Detonation is preventable; however, the conditions which promote detonation are extremely complex and many variables can promote detonation at any one time. This section defines detonation and gives examples of detonation promoters and reducers.

In normal combustion, the forward boundary of the burning fuel is called the "flame-front." Research has shown that combustion in a gaseous air/fuel homogeneous mixture ignited by a spark is characterized by the more or less rapid development of a flame that starts from the ignition point and spreads continually outward in the manner of a grass fire. When this spread continues to the end of the chamber without abrupt change in its speed or shape, combustion is called "normal." When analyzing detonation, however, combustion is never normal.

Detonation is due to the autoignition of the end gas after spark ignition has occurred which is that part of the air/fuel charge which has not yet been consumed in the normal flame-front reaction. When detonation occurs, it is because compression of the end gas by expansion of the burned part of the charge raises its temperature and pressure to the point where the end gas autoignites. If the reaction of autoignition is sufficiently rapid and a sufficient amount of end gas is involved, the two flame-fronts will collide with sufficient force to be heard. This is referred to as audible "ping" or "knock."

The tendency to detonate will depend chiefly on the temperature and pressure of the end gas in the combustion chamber. Any change in engine operating characteristics which affects end gas temperature will determine whether combustion will result with or without detonation. The greater the end gas pressure and temperature and the time to which the end gas is exposed to this severe stress, the greater will be the tendency for the fuel to detonate.

## DESCRIPTION OF OPERATION

Detonation is an extremely complex subject when dealing with internal combustion engines. The number of unpredictable variables in actual field running engines can be enormous. Table 1.10-1 lists the promoters and reducers of detonation.

**Table 1.10-1. Detonation Promoters And Reducers**

PROMOTERS	REDUCERS
Higher Cylinder Temperature	Lower Cylinder Temperatures
Lower Octane Fuels	Higher Octane Fuels
More Advanced Spark Timing	Less Advanced Spark Timing
Higher Compression Ratios	Lower Compression Ratios
Higher Inlet Pressure	Lower Inlet Pressure
Higher Coolant Temperatures	Lower Coolant Temperatures
Lower Engine Speeds	Higher Engine Speeds
Lower Atmospheric Humidity	Higher Atmospheric Humidity
Higher Engine Load	Lighter Engine Load
Stoichiometric Air/Fuel Ratio (Rich Burn Engine)	Lean or Rich Air/Fuel Ratios (Without Engine Overload)
Rich Air/Fuel Ratio (Lean Burn Engine)	Lean Air/Fuel Ratios

## DEFINITIONS

**AutoCal:** Automatic calibration of the detonation threshold by the DSM Terminal Program.

**NOTE:** After doing any removal, repair, or replacement of engine cylinder heads, cylinder liners, cylinder gaskets, pistons, or knock sensors, the DSM system must be re-AutoCaled using the DSM Terminal Program and a personal computer.

**Data-Set:** A data-set is a group of site specific data points that are created and then stored within the DSM module. The DSM data-set includes values for: Most Advanced Timing, Most Retarded Timing, End of Sample Window angle, retard and advanced timing values, warm-up delay time, and shutdown delay time.

**Default Timing:** The default timing is the retarded ignition timing imposed by the DSM system when it is not protecting against detonation. The DSM system activates default timing for a cylinder when the cylinder's sensor is disabled, when the sensor fails, and during engine warm-up delay. (PC programmable)

**Detonation:** Detonation occurs when part of the air/fuel charge cannot wait for the normal flame-front, which was started by the spark plug, to pass completely through the combustion chamber. The advancing flame-front heats and squeezes the unburned mixture until it explodes or autoignites. A good comparison is a grass fire. Normal combustion is similar to a grass fire. It begins at one end of a field, and the flame-front progresses in an orderly manner through the field. When all of the grass is burned, the combustion stops. During "grass-detonation," the grass would begin burning normally, but before the flames could sweep through the length of the field, some portion of the unburned grass would burst into flames. When this happens in the combustion chamber of an engine, two pressure waves, associated with the two flame-fronts, slam together and cause the audible "ping" or "knock."

**Detonation Level:** Voltage that a detonation signal must exceed before the engine is considered to be in detonation and individual cylinder timing is retarded.

**End of Sample Window:** This is a predetermined angle after top dead center (ATDC) in crankshaft degrees at which the window is closed. The window is used so that detonation is only looked for during the combustion event. (PC programmable)

**EPROM:** Erasable Programmable Read Only Memory. This is the same as ROM (permanent memory) when speaking about programming the DSM module. The term EPROM is used to describe the electrical chip that resides in the DSM module.

**Filter:** The filter isolates the "knock" frequency from background engine noise and other frequencies.

**Interface Program:** The personal computer program that is used to create data-sets and communicate with the DSM system.

**Knock Frequency:** The unique vibration or frequency that an engine exhibits while in detonation.

**Knock:** Engine detonation.

**Knock Sensor:** Converts engine vibration to an electrical signal to be used by the DSM filter to isolate the "knock" frequency.

**LCD:** Liquid Crystal Display. Numerical display located inside the DSM module, that informs the system operator of current DSM system status via coded messages.

**LED: Light Emitting Diode.** A semiconductor that emits light (not a light bulb) and is used as power, alarm, and shutdown indicators, located on the front of the DSM module.

**Most Advanced Timing:** The maximum advanced timing at which the DSM system will allow the engine to operate (nameplate timing). (PC programmable)

**Most Retarded Timing:** The minimum timing at which the DSM system will allow a cylinder to retard in order to control detonation (PC programmable)

**Pre-ignition:** Pre-ignition is autoignition that occurs prior to the timed spark ignition. It is caused by an overheated surface in the combustion chamber. Pre-ignition may lead to detonation because during pre-ignition the combustion event is not initiated by the Ignition System's spark. Therefore, it is not possible to control pre-ignition with the DSM system.

**RAM: Random Access Memory.** RAM, temporary DSM system memory, is used to evaluate "test" data-sets before storing to ROM. The contents of RAM are lost whenever power to the DSM module is removed.

**ROM: Read Only Memory.** When the DSM module configures data-sets to ROM, or permanent memory, the data-set information is not lost when power to the DSM module is removed. The DSM module allows a limited number of saves to ROM (25 saves to ROM are possible). Once ROM has been fully configured, the EPROM chip in the DSM module must be replaced to permit further saves to permanent memory.

**Shutdown Delay:** Amount of delay between the moment when the cylinder reaches the Most Retarded Timing during detonation and the time the shutdown warning becomes active while still in detonation. (PC programmable)

**Sinking Circuit:** An electronic switching circuit with a single output terminal used to provide a path to ground. This mechanism can be used as a trigger to drive remote devices such as alarms, lights, and relays. When the DSM system is operating correctly it is an OPEN device. Any system fault will CLOSE the circuit. The circuit is designed to handle a maximum current rating of 1 amp and a maximum voltage rating of 50 VDC (no AC voltages are allowed).

**Timing Disk Reference:** The angular relationship between the magnet for the first cylinder to fire and top dead center (TDC). Example: 25° BTDC

**Warm-Up Delay:** Amount of delay between the time the engine begins rotating and when the DSM system takes control of ignition timing. While this delay is active, the cylinders are operating at the default timing. The purpose of this delay is to prevent misleading vibration signals, that may exist during the time the engine is warming up, from being incorrectly construed as "knock" signals. During the Warm-Up Delay time, the DSM system is not protecting against detonation. (PC programmable)

**Windowing:** This technique allows the DSM system to look for detonation only during the combustion time when detonation could be present.

# DESCRIPTION OF OPERATION

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**CONTENTS**

**SECTION 2.00 - MOUNTING DSM SYSTEM COMPONENTS**

**SECTION 2.05 - DSM SYSTEM COMPONENT CONNECTIONS**

**SECTION 2.10 - DSM SYSTEM POWER, ALARM, AND  
GROUND CONNECTIONS**

**SECTION 2.15 - DSM SYSTEM WIRING DIAGRAMS**





## SECTION 2.00

### MOUNTING DSM SYSTEM COMPONENTS

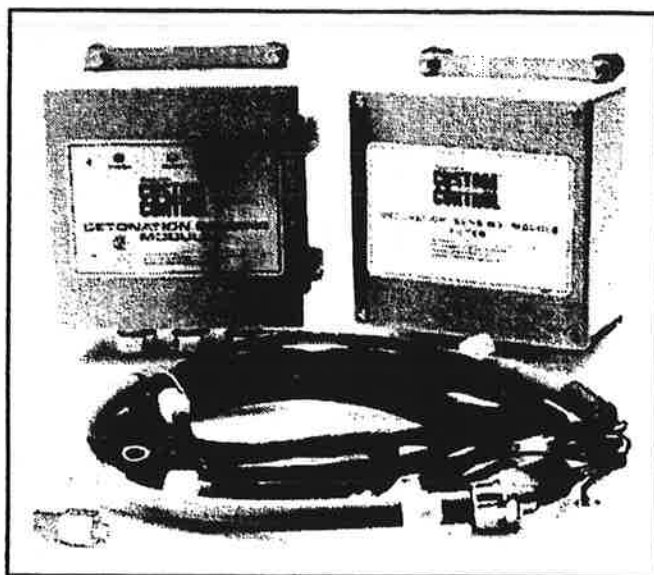
#### SYSTEM COMPONENTS

The DSM system includes a DSM module, a Waukesha designed electronic filter, detonation knock sensors, and harnesses that vary depending on the application (see Figure 2.00-1). Table 2.00-1 lists the part numbers for the components of the DSM system.

**NOTE:** Unless otherwise shown in Table 2.00-1, DSM retrofit kit part numbers are same as production part numbers.

**NOTE:** The filters used with the DSM system are engine specific. If an incorrect filter is installed, the DSM system will appear to work but will not protect against detonation. Detonation can cause severe engine damage.

This chapter, Chapter 2 *Detonation Sensing Module System Installation*, explains how to mount the components of the DSM system (Section 2.00), make wire harness connections (Section 2.05), make power connections to the DSM module and filter (Section 2.10), make shutdown/alarm connections (Section 2.10), and make ground connections (Section 2.10). DSM system wiring diagrams for AT, VHP, and VGF engines are provided in Section 2.15.



**Figure 2.00-1. Detonation Sensing Module System**

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

**Table 2.00-1. Current DSM System Components**

DESCRIPTION <sup>1</sup>		PART NUMBER	
CEC Detonation Sensing Module		D740401 (EPROM Ver. 6.0)	—
DSM Interface Program and Installation, Operation, & Maintenance Manual		A740014A (Ver. 6.0)	—
Knock Sensor		A740110A A740110B <sup>2</sup>	— —
Filter	AT-25	A740412B	—
	AT-27	A740412A	—
	AT-27 16 Cylinder	D740412H	—
	VHP 9-3/8	A740412C	—
	VHP 8-1/2	A740412G	—
	VHP 16 Cylinder	C740412H	—
	VGF GL 12 Cylinder	A740412J	—
	VGF GL 16 Cylinder	A740412K	—

(Continued)

# MOUNTING DSM SYSTEM COMPONENTS

DESCRIPTION <sup>1</sup>		PART NUMBER		
Harnesses	ATGL 8 Cylinder	"Sensor to Filter" Harness	AD740222	AJ740222 (Retrofit) <sup>3</sup>
		"Filter to DSM" Harness	C740225A	F740225 (Retrofit) <sup>3</sup>
		"Filter Power" Harness	C740230A	740230B (Retrofit) <sup>3</sup>
		"DSM to Ignition" Harness	740221B	7402221 (Retrofit) <sup>3</sup>
	ATGL 12 Cylinder	"Sensor to Filter" Harness	AE740222 (OEM)	AH740222 (Retrofit) <sup>3</sup>
		"Filter to DSM" Harness	C740225 (OEM)	D740225 (Retrofit) <sup>3</sup>
		"Filter Power" Harness	740230 (OEM)	740230B (Retrofit) <sup>3</sup>
		"DSM to Ignition" Harness	740221A	7402221 (Retrofit) <sup>3</sup>
	ATGL 16 Cylinder	"Sensor to Filter" Harness	AA740222H	—
		"Filter to DSM" Harness	A740225E	—
		"Filter Power" Harness	G740230A	—
		"DSM to Ignition" Harness	740221A	—
	VHP 6 Cylinder	"Sensor to J-Box" Harness	AG740222	G740222 (Retrofit) <sup>3</sup>
		"J-Box to Filter" Harness	740232	740232 (Retrofit) <sup>3</sup>
		"Filter to DSM" Harness	E740225	E740225 (Retrofit) <sup>3</sup>
		"Filter Power" Harness	740230B	740230B (Retrofit) <sup>3</sup>
		"DSM to Ignition" Harness	740221	740221 (Retrofit) <sup>3</sup>
	VHP 12 Cylinder	"Sensor to J-Box" Harness	AA740222	A740222 (Retrofit) <sup>3</sup>
		"J-Box to Filter" Harness	740231	740231 (Retrofit) <sup>3</sup>
		"Filter to DSM" Harness	D740225	D740225 (Retrofit) <sup>3</sup>
		"Filter Power" Harness	740230B	740230B (Retrofit) <sup>3</sup>
		"DSM to Ignition" Harness	740221	740221 (Retrofit) <sup>3</sup>
	VHP 16 Cylinder	"Sensor to J-Box" Harness	AA740222C	A740222C (Retrofit) <sup>3</sup>
		"J-Box to Filter" Harness	740231A	740231A (Retrofit) <sup>3</sup>
		"Filter to DSM" Harness	G740225	G740225 (Retrofit) <sup>3</sup>
		"Filter Power" Harness	740230B	740230B (Retrofit) <sup>3</sup>
		"DSM to Ignition" Harness	740221	740221 (Retrofit) <sup>3</sup>
	VGF 12 Cylinder	"Sensor to Filter" Harness	AM740222	T740222 (Retrofit) <sup>3</sup>
		"Filter to DSM" Harness	A740225C	740225C (Retrofit) <sup>3</sup>
		"Filter Power" Harness	F740230A	740230B (Retrofit) <sup>3</sup>
		"DSM to Ignition" Harness	A740221D	740221 (Retrofit) <sup>3</sup>
	VGF 16 Cylinder	"Sensor to Filter" Harness	AK740222	N740222 (Retrofit) <sup>3</sup>
"Filter to DSM" Harness		A740225B	740225B (Retrofit) <sup>3</sup>	
"Filter Power" Harness		E740230A	740230B (Retrofit) <sup>3</sup>	
"DSM to Ignition" Harness		A740221E	740221 (Retrofit) <sup>3</sup>	

**NOTE:** <sup>1</sup> These are not all of the components required for installation of the DSM system. The customer must supply junction boxes, terminal blocks, brackets, conduit assemblies, and other components depending on engine configuration. DSM system retrofit kits are available (see Table 2.00-2). Please contact your Waukesha Engine Distributor for more information.

<sup>2</sup> The knock sensor (P/N A740110B) will become standard as remaining stock of the other knock sensor (P/N A740110A) is used. If you have a knock sensor (P/N A740110A) that needs to be replaced, it is possible to replace it with the new knock sensor using a pigtail adaptor (P/N 740225D). The pigtail allows you to install the new sensor to the existing wire harness. Please contact your Waukesha Engine Distributor for more information.

<sup>3</sup> The P/N given is for the harness included in a retrofit kit. Harnesses for retrofit kits are different lengths than the harnesses that come with an engine in a non-retrofit installation.

**WARNING**

For maximum engine protection, the DSM system must be connected to a safety shutdown. The DSM system is considered a safety system and, as such, must be connected to shut down the engine if the engine cannot be brought out of detonation. Disregarding this information could result in SEVERE PERSONAL INJURY OR DEATH.

*NOTE: Refer to Section 2.10, DSM System Power, Alarm, And Ground Connections, for installation.*

Table 2.00-2 lists the DSM retrofit kit part numbers for AT, VHP, and VGF engines.

*NOTE: DSM system retrofit kits are available. Please contact your Waukesha Engine Distributor for more information.*

**Table 2.00-2. DSM System Retrofit Kit P/Ns**

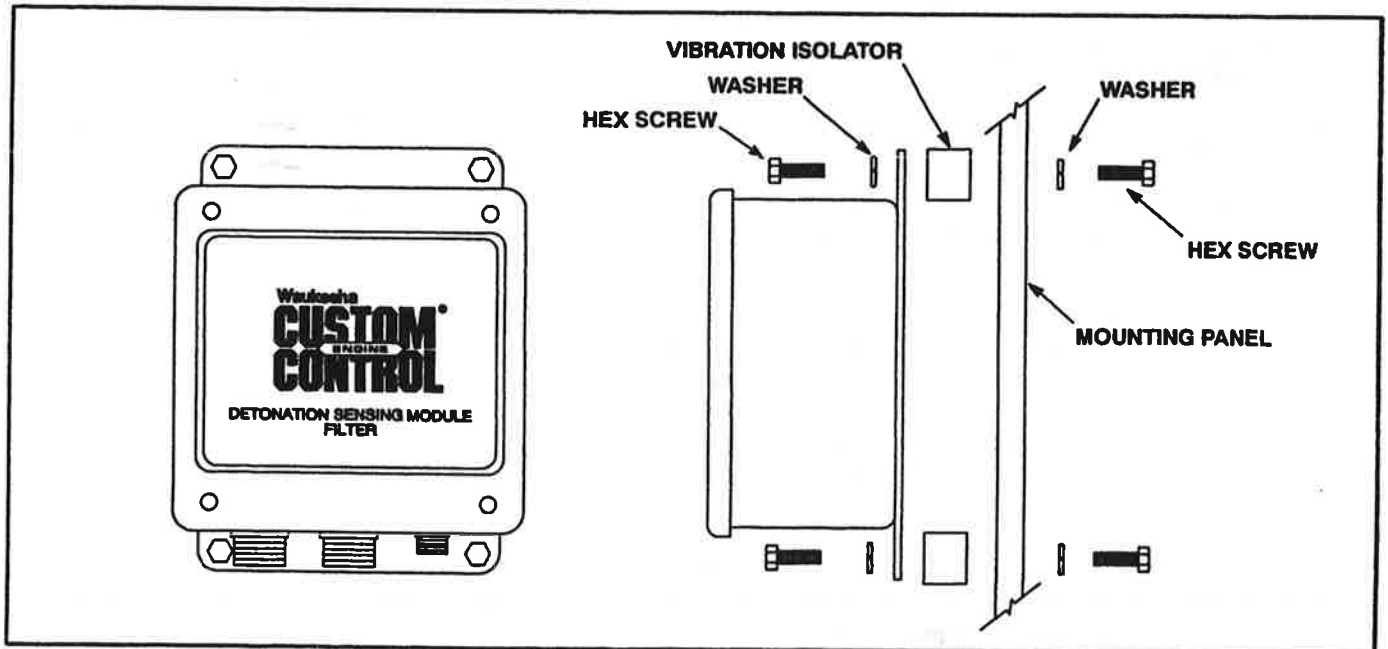
DESCRIPTION	RETROFIT KIT P/N
ATGL 8 Cylinder	G-962-1557
ATGL 12 Cylinder	G-962-1551
VHP 6 Cylinder	G-962-1552
VHP 12 Cylinder	G-962-1553
VHP 16 Cylinder	G-962-1558
VGF 12 Cylinder	G-962-1559
VGF 16 Cylinder	G-962-1560

**MOUNTING THE DSM FILTER**

Mount the DSM filter upright in an on or off engine location using the vibration isolators supplied with the filter (see Figure 2.00-2). Note the following concerning filter installation:

- The filter must be mounted within approximately 15 feet (4.5 meters) of the engine (or knock sensor junction box on VHP engines) due to wire length.
- The filter must also be mounted within approximately 15 feet (4.5 meters) of the DSM module due to wire length.
- Ambient temperature may vary from -40° F (-40° C) to 150° F (65° C).
- Although the filter is "splash-proof," exposure to direct sprays of water should be avoided.

**CAUTION** The DSM filter must be mounted with the entry ports down. Improper mounting of the DSM filter could result in water entering the DSM filter enclosure resulting in product damage.



**Figure 2.00-2. Mounting The DSM Filter**

## MOUNTING DSM SYSTEM COMPONENTS

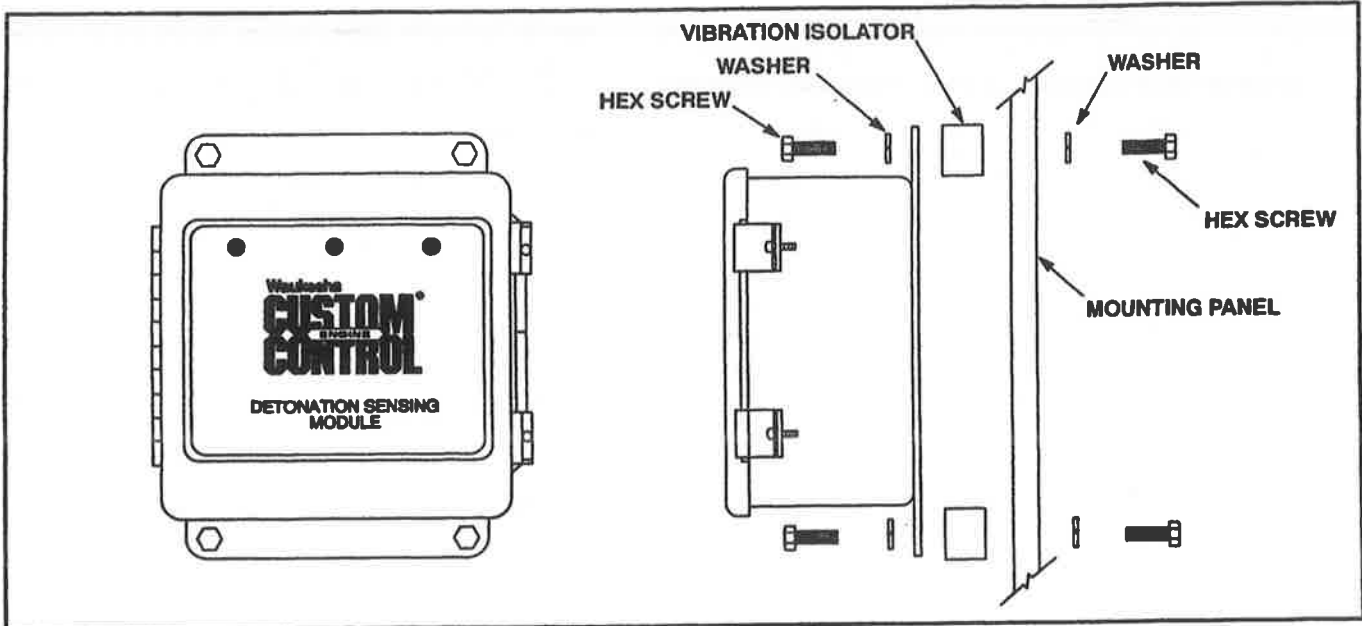


Figure 2.00-3. Mounting The DSM Module

### MOUNTING THE DSM MODULE

Mount the DSM module upright in an on or off engine location using the vibration isolators supplied with the DSM module (see Figure 2.00-3). Note the following concerning DSM module mounting:

- The DSM module must be mounted within approximately 15 feet (4.5 meters) of the CEC Ignition Module due to wire length (a wire harness connects the DSM module directly to the Ignition Module).
- Ambient temperature may vary from  $-40^{\circ}\text{F}$  ( $-40^{\circ}\text{C}$ ) to  $150^{\circ}\text{F}$  ( $65^{\circ}\text{C}$ ).
- Although the DSM module is "splash-proof," exposure to direct sprays of water should be avoided.
- Do not cut any new holes in the DSM module. Wire routing is important. The wires must be directed through the holes provided in the bottom of the DSM module as shown in Figure 2.00-4.

**CAUTION** Route the DSM system wires through the correct port on the DSM module. The wires must be directed through the holes provided in the bottom of the DSM module. If the wires are routed through the wrong port, electrical interference may result, affecting the performance of the DSM system.

**CAUTION** The DSM module must be mounted with the entry ports down. Improper mounting of the DSM module could result in water entering the DSM module enclosure resulting in product damage.

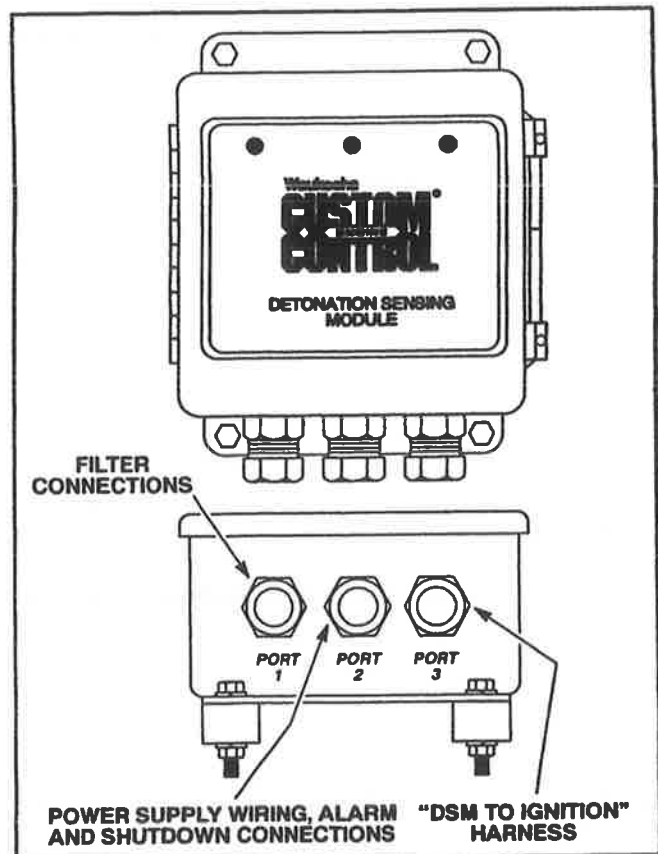


Figure 2.00-4. DSM Module Conduit Ports

## MOUNTING THE KNOCK SENSORS

Knock sensors convert engine vibration to an electrical signal that is sent to the DSM filter. The number, location, and mounting procedure of the knock sensors are dependant on the series and age of your engine. On AT engines, knock sensors are installed on the horizontal or top cylinder head location. On VHP and VGF engines, knock sensors are installed just below the intake port on the side of the engine crankcase. Continue with the section "AT Series Engines," "VHP Series Engines," or "VGF Series Engines" to mount the DSM knock sensors on your engine.

### AT SERIES ENGINES

The following items are needed for field installation of the knock sensors on AT cylinder heads without predrilled knock sensor mounting holes:

- Drill/Tap Fixture (Tool P/N 473011)
- 1/4" Drill bit
- 7/16" Drill bit
- 5/8" Drill bit
- Tap and Bottoming Tap, 12 mm x 1.25

### AT Knock Sensor Mounting Steps

The knock sensors are installed on the left horizontal or top cylinder head locations (see Figure 2.00-5). As of May 1994, all AT cylinder heads are drilled at the factory to accommodate the installation of the knock sensors. If the cylinder heads are predrilled, continue with Step 16. If the cylinder heads are not predrilled, continue with Step 1.

**NOTE:** A knock sensor with its connector will extend about two inches away from the surface of the cylinder head. There should be at least three inches of clearance perpendicular to the knock sensor surface.

**CAUTION** All harnesses must be routed at least four inches away from ignition or other high voltage wiring (including ignition coil primary wiring). If knock sensor wires are bundled with other wires, electrical interference may result, affecting the performance of the DSM system.

1. Examine the cylinder head surface to the left of the valve cover. This area must be free of obstruction and paint. Secure any loose wires or tubes that may be in the area.

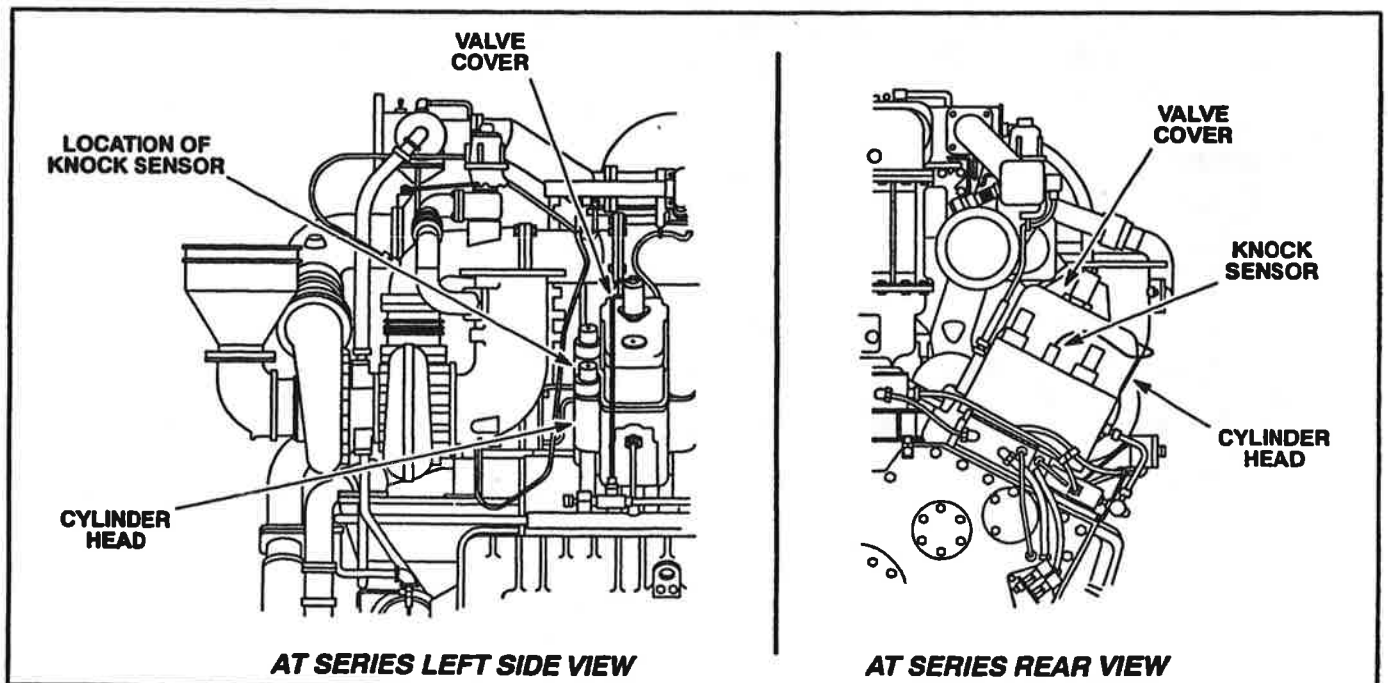


Figure 2.00-5. Knock Sensor Location On AT Series Engines

## MOUNTING DSM SYSTEM COMPONENTS

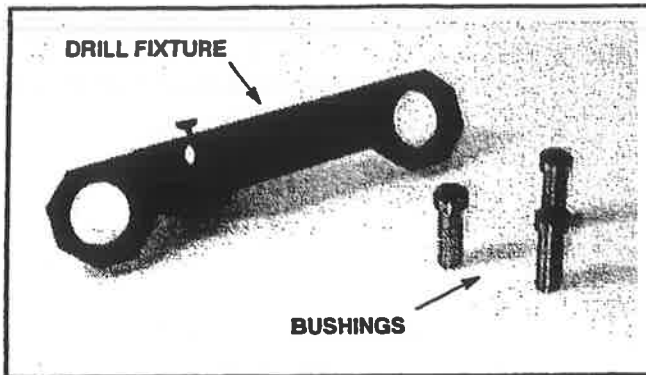


Figure 2.00-6. Drill/Tap Fixtures For Mounting Knock Sensors - AT Series (Tool P/N 473011)

2. Clean the top surface area on the left side of the cylinder head.
3. Place the drill fixture over the two left studs of the cylinder head (as viewed from the pre-chamber hole side) (see Figure 2.00-6 and Figure 2.00-7).
4. Place the 1/4" bushing into the drill fixture.

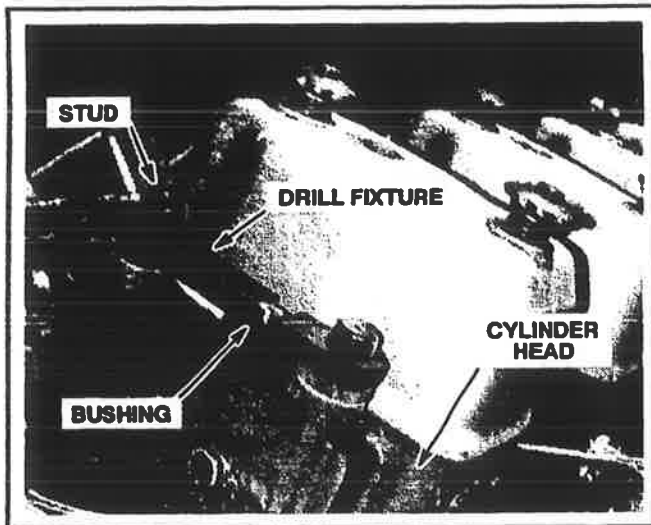


Figure 2.00-7. Drill Fixture Mounting - AT Series

5. Secure the drill fixture to the cylinder head studs with two nuts from an AT cylinder head shipping plate.
6. Oil the bushing hole and drill a 1/4" hole 3/4" (19 mm) deep using the bushing as a guide. Oil the drill bit as necessary while drilling.
7. Remove the 1/4" bushing from the drill fixture. Place the 7/16" bushing into the drill fixture. Oil the bushing hole and drill a 7/16" hole 3/4" (19 mm) deep using the bushing as a guide. Oil the drill bit as necessary while drilling.

8. Remove the 7/16" bushing from the drill fixture.
9. Use a 5/8" drill bit to put a slight chamfer on the 7/16" drilled hole.
10. Clean debris from the hole.
11. Place the 31/64" bushing into the drill fixture.
12. Oil tap and place tap into bushing on drill fixture. Tap hole until tap just touches bottom. Oil as necessary while tapping. Remove the tap and clean threaded hole.

**NOTE:** To prevent tap breakage, do not force tap against bottom of blind hole.

13. Use bottoming tap to finish tapping hole. Remove tap.
14. Remove the 31/64" bushing from the drill fixture.
15. Remove the drill fixture from the studs.
16. Thoroughly clean hole and area around tapped hole. Make sure knock sensor mounting surface is free of paint.

**CAUTION** Drilled and tapped hole (knock sensor surface) must be flat, smooth (RMS 125), and be perpendicular to the drilled hole. Make sure knock sensor mounting surface is free of paint. If the knock sensor is not mounted flush with the cylinder head surface or if the cylinder head surface is not within RMS 125, the knock sensor WILL provide incorrect signals to the DSM system.

**CAUTION** Do not drop or mishandle knock sensor. Knock sensor damage may occur if knock sensor is mishandled.

17. Install knock sensor into the threaded hole. Torque knock sensor to 20 - 25 ft-lb (27 - 34 N·m). Verify that the knock sensor is seated flat against the head surface. Knock sensor **MUST** have full-face contact with mounting surface. Imperfections in the surface that the sensor mounts against can cause higher sensor output.

**CAUTION** Do not over-tighten knock sensor. Over-tightening will cause damage to the knock sensor.

18. Repeat this mounting procedure for each cylinder head.

## VHP SERIES ENGINES

The following items are needed for field installation of the knock sensors on an engine crankcase without predrilled knock sensor mounting holes:

- Drill/Tap Fixture (Tool P/N 474021)
- 1-1/4" Spot face
- 1/4" Drill bit
- 7/16" Drill bit
- 5/8" Drill bit
- 1/2"-13 x 2-1/4" Capscrews (2)
- Tap and Bottoming Tap, 12 mm x 1.25

### VHP Knock Sensor Mounting Steps

The knock sensors are installed just below the intake ports on the sides of the engine crankcase (see Figure 2.00-8 and Figure 2.00-9). As of April 1994, all VHP crankcases are drilled at the factory to accommodate the installation of the knock sensors. If the knock sensor holes are predrilled, continue with Step 18. If the knock sensor holes are not predrilled, continue with Step 1.

**NOTE:** A knock sensor with its connector will extend about two inches away from the surface of the crankcase. There should be at least three inches of clearance perpendicular to the knock sensor surface.

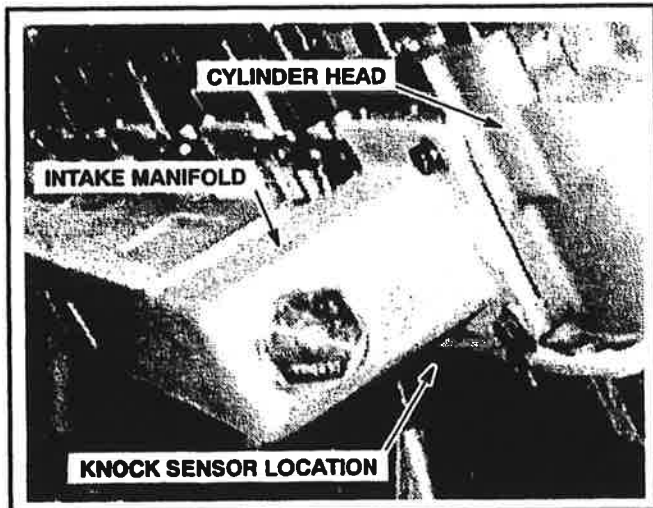


Figure 2.00-8. Knock Sensor Location - VHP Series

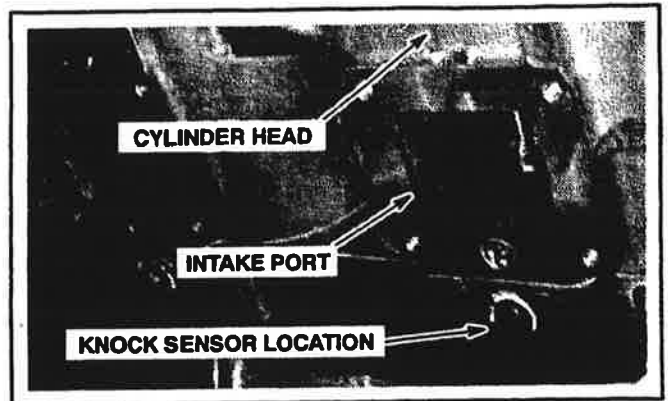


Figure 2.00-9. Pre-Drilled Knock Sensor Location With Intake Manifold Removed - VHP Series

1. Remove the lower two capscrews that secure the intake manifold to the cylinder head. Secure any brackets, tubing, or wiring that may be connected to these capscrews.
2. Examine the crankcase area directly below the intake manifold connection. This area must be free of obstruction and paint. Secure any loose wires or tubes that may be in the area.

**CAUTION** All harnesses must be routed at least four inches away from ignition or other high voltage wiring (including ignition coil primary wiring). If knock sensor wires are bundled with other wires, electrical interference may result, affecting the performance of the DSM system.

3. Using the two 1/2"-13 x 2-1/4" capscrews, secure the drill fixture onto the intake manifold flange using the two lower bolt holes (see Figure 2.00-10 and Figure 2.00-11). Tighten capscrews.

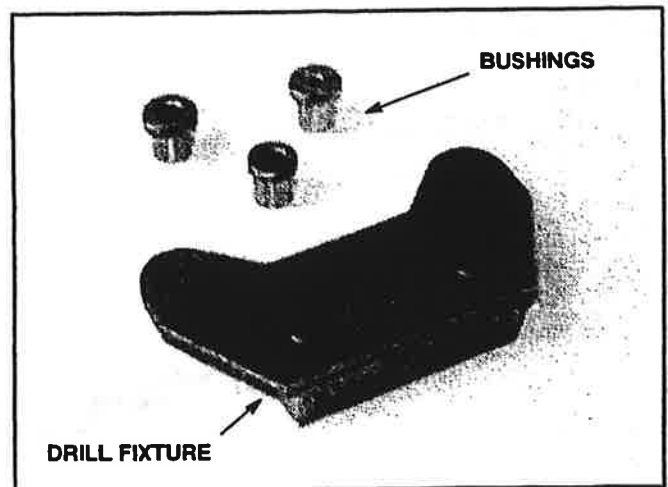


Figure 2.00-10. Drill/Tap Fixtures For Mounting Knock Sensors - VHP Series (Tool P/N 474021)

## MOUNTING DSM SYSTEM COMPONENTS

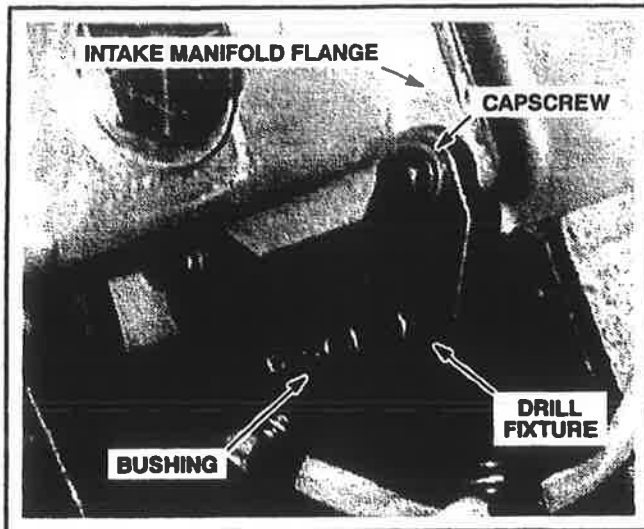


Figure 2.00-11. Drill Fixture Mounting - VHP Series

4. Place the 1/4" bushing into the drill fixture.

**CAUTION** Do not drill deeper than 3/4" (20 mm) deep or the drill bit will break through the water jacket.

5. Oil the bushing hole and drill a 1/4" hole 3/4" (20 mm) deep using the bushing as a guide. Oil drill bit as necessary while drilling.

6. Remove the 1/4" bushing from the drill fixture. Place the 7/16" bushing into the drill fixture. Oil the bushing hole and drill a 7/16" hole 3/4" (20 mm) deep using the bushing as a guide. Oil drill bit as necessary while drilling.

7. Remove the 7/16" bushing from the drill fixture.

8. Use a 5/8" drill bit to put a slight chamfer on the 7/16" drilled hole.

9. Clean debris from the drilled hole.

10. Using a 1-1/4" spot face, carefully spot face the area around the 7/16" hole until the area is smooth and free from paint. This surface must be free of burrs, have a finish of RMS 125 or better, and be perpendicular to the drilled hole.

**NOTE:** If the spot face in Step 10 has removed the slight chamfer on the drilled hole, reapply chamfer using the 5/8" drill bit.

11. Clean debris from the drilled hole.
12. Place the 31/64" bushing into the drill fixture.

13. Oil tap and place tap into bushing. Tap hole until tap just touches bottom. Oil as necessary while tapping. Remove the tap and clean threaded hole.

**NOTE:** To prevent tap breakage, do not force tap against bottom of blind hole.

14. Use bottoming tap to finish tapping hole. Remove tap.

15. Remove the 31/64" bushing from drill fixture.

16. Remove the drill fixture from the intake manifold flange.

17. Reconnect intake manifold flange to cylinder head using the two 1/2"-13 capscrews removed in Step 1.

18. Thoroughly clean hole and area around tapped hole. Make sure knock sensor mounting surface is free of paint.

**CAUTION** Drilled and tapped hole (knock sensor surface) must be flat, smooth (RMS 125), and be perpendicular to the drilled hole. Make sure knock sensor mounting surface is free of paint. If the knock sensor is not mounted flush with the cylinder head surface or if the cylinder head surface is not within RMS 125, the knock sensor WILL provide incorrect signals to the DSM system.

**CAUTION** Do not drop or mishandle knock sensor. Knock sensor damage may occur if knock sensor is mishandled.

19. Install knock sensor into the threaded hole. Torque knock sensor to 20 - 25 ft-lb (27 - 34 N·m). Verify that the knock sensor is seated flat against the spot face. Knock sensor **MUST** have full-face contact with mounting surface. Imperfections in the surface that the sensor mounts against can cause higher sensor output.

**CAUTION** Do not over-tighten knock sensor. Over-tightening will cause damage to the knock sensor.

20. Repeat this mounting procedure for each cylinder.



### VGF SERIES ENGINES - 12 AND 16 CYLINDER

The following items are needed for field installation of the knock sensors on an engine crankcase without predrilled knock sensor mounting holes:

- Drill/Tap Fixture (Tool P/N 472070)
- 1/4" Drill bit
- 7/16" Drill bit
- 5/8" Drill bit
- 10 mm Capscrews (2)
- 12 mm Capscrew (1)

### VGF Knock Sensor Mounting Steps

The knock sensors are installed between every other cylinder just below the intake port on the side of the engine crankcase (see Figure 2.00-12). On VGF engines, one knock sensor is mounted for two adjacent cylinders (see Figure 2.00-14). On 12 cylinder VGF engines there are a total of 6 knock sensors; 8 knock sensors on 16 cylinder engines. As of April 1997, all 12 and 16 cylinder VGF crankcases are drilled at the factory to accommodate the installation of the knock sensors. If the knock sensor holes are predrilled, continue with Step 20. If the knock sensor holes are not predrilled, continue with Step 1.

**NOTE:** Although there is one knock sensor installed for adjacent cylinders, when detonation is detected ignition timing is still adjusted on an individual cylinder basis. Individual timing is possible because the engine alternately fires a cylinder on each engine bank but the knock sensor works for adjacent cylinders on the same engine bank. On 16 cylinder VGF engines, two cylinders will always retard together due to DSM system design.

**NOTE:** One knock sensor is mounted for two adjacent cylinders. Refer to Figure 2.00-14 for location of knock sensors on crankcase.

1. Remove the upper right and upper left capscrews of the two adjacent camshaft access covers. Secure any brackets, tubing, or wiring that may be connected to these capscrews.
2. Examine the crankcase area directly above the auxiliary rocker arm locknut. Secure any loose wires or tubes that may be in the area.

**CAUTION** All harnesses must be routed at least four inches away from ignition or other high voltage wiring (including ignition coil primary wiring). If knock sensor wires are bundled with other wires, electrical interference may result, affecting the performance of the DSM system.

3. Hold the drill fixture against the bolt holes to determine the location where the drill fixture will rest against the engine crankcase (see Figure 2.00-13). Mark the area and remove drill fixture.

4. Using a stiff scraper, remove the paint in the area marked in Step 3. The drill fixture must rest against the crankcase free of paint.

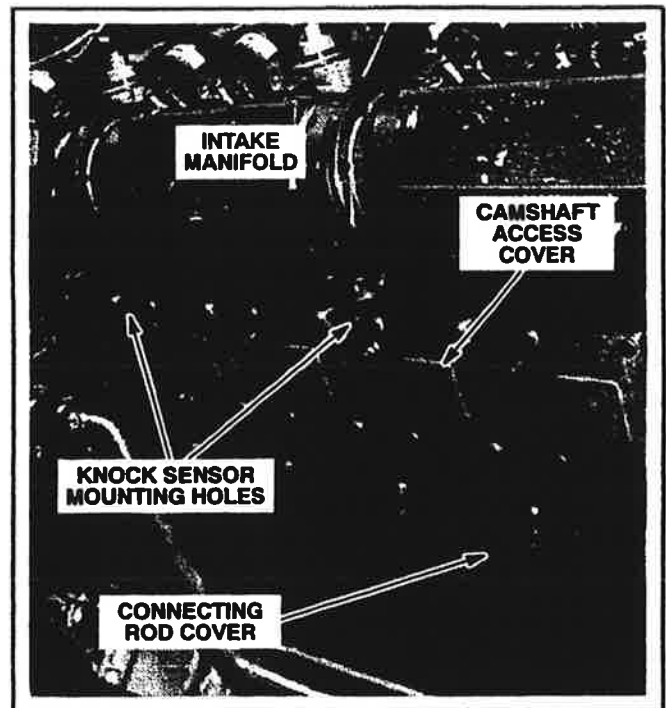


Figure 2.00-12. Knock Sensor Locations - VGF Series

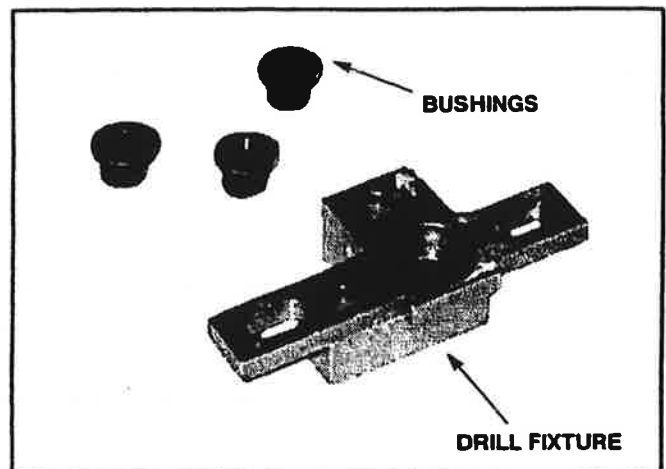


Figure 2.00-13. Drill/Tap Fixtures For Mounting Knock Sensors - VGF Series (Tool P/N 472070)

# MOUNTING DSM SYSTEM COMPONENTS

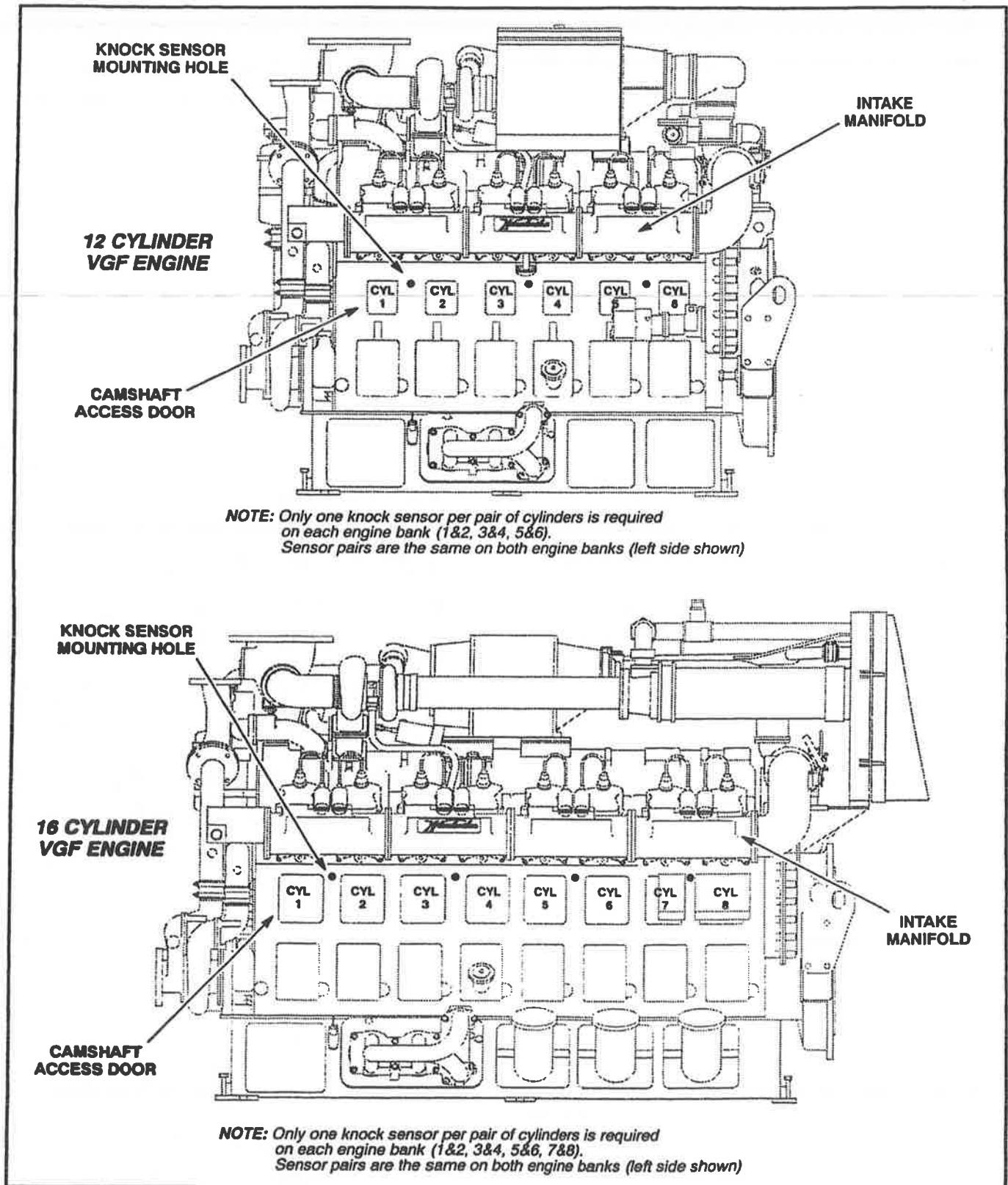


Figure 2.00-14. Knock Sensor Locations On VGF Engines

**CAUTION** Ensure that the drill fixture is properly aligned on the crankcase with the auxiliary rocker arm locknut **BEFORE** drilling knock sensor mounting hole. Misalignment of the drill fixture could cause damage to the crankcase when drilling and/or provide incorrect signals to the DSM system.

5. Place drill fixture against the bolt holes of the camshaft access cover and align drill fixture with the auxiliary rocker arm locknut. The sensor mounting hole to be drilled must be inline with the center of the auxiliary rocker arm locknut as shown in Figure 2.00-15.

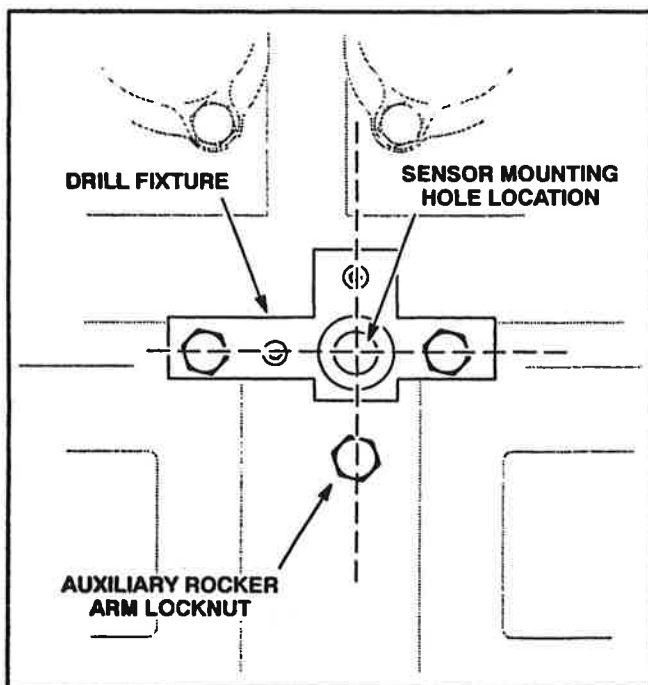


Figure 2.00-15. Drill Fixture Alignment - VGF Engines

6. Using the two 10 mm capscrews, secure the drill fixture onto the adjacent door bolt holes of the camshaft access covers (see Figure 2.00-16). Tighten capscrews.

**NOTE:** On crankcases built before 1995, use the 12 mm capscrew to secure the drill fixture to the fifth camshaft access cover bolt hole on a 16 cylinder engine and the fourth cover bolt hole on a 12 cylinder engine. These camshaft access covers on pre-1995 crankcases vary in design and require the larger capscrew when using the drill fixture.

7. Place the 1/4" bushing into the drill fixture.

8. Oil the bushing hole and drill a 1/4" hole 3/4" (20 mm) deep using the bushing as a guide. Oil drill bit as necessary while drilling.

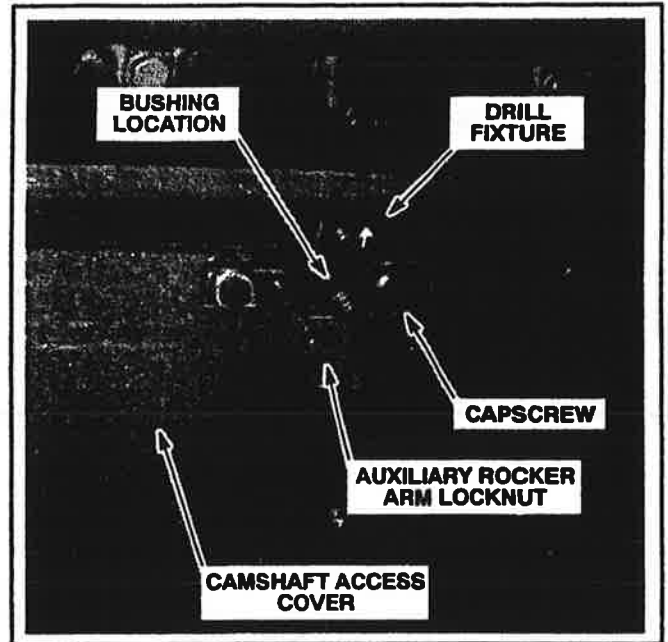


Figure 2.00-16. Drill Fixture Mounting - VGF Series

**CAUTION** Do not drill deeper than 3/4" (20 mm) deep or the drill bit will break through the crankcase.

9. Remove the 1/4" bushing from the drill fixture. Place the 7/16" bushing into the drill fixture. Oil the bushing hole and drill a 7/16" hole 3/4" (20 mm) deep using the bushing as a guide. Oil drill bit as necessary while drilling.

10. Remove the 7/16" bushing from the drill fixture.

11. Use a 5/8" drill bit to put a slight chamfer on the 7/16" drilled hole.

12. Clean debris from the drilled hole.

13. Closely examine the surface. This surface must be free of burrs and have a finish of RMS 125 or better.

14. Place the 31/64" bushing into the drill fixture.

15. Oil tap and place tap into bushing. Tap hole until tap just touches bottom. Oil as necessary while tapping. Remove the tap and clean threaded hole.

**NOTE:** To prevent tap breakage, do not force tap against bottom of blind hole.

16. Use bottoming tap to finish tapping hole. Remove tap.

17. Remove the 31/64" bushing from drill fixture.

18. Remove the drill fixture from the crankcase.

## MOUNTING DSM SYSTEM COMPONENTS

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19. Refasten the camshaft access doors using the capscrews removed in Step 1.

20. Thoroughly clean hole and area around mounting hole.

**CAUTION** Drilled and tapped hole (knock sensor surface) must be flat, smooth (RMS 125), and be perpendicular to the drilled hole. Make sure knock sensor mounting surface is free of paint. If the knock sensor is not mounted flush with the cylinder head surface or if the cylinder head surface is not within RMS 125, the knock sensor WILL provide incorrect signals to the DSM system.

**CAUTION** Do not drop or mishandle knock sensor. Knock sensor damage may occur if knock sensor is mishandled.

**CAUTION** Do not over-tighten knock sensor. Over-tightening will cause damage to the knock sensor.

*NOTE: A knock sensor with its connector will extend about two inches away from the surface of the crankcase. There should be at least three inches of clearance perpendicular to the knock sensor surface.*

21. Install knock sensor into the threaded hole. Torque knock sensor to 20 - 25 ft-lb (27 - 34 N·m). Verify that the knock sensor is seated flat against the crankcase surface. Knock sensor **MUST** have full-face contact with mounting surface. Imperfections in the surface that the sensor mounts against can cause higher sensor output.

22. Repeat this mounting procedure for each knock sensor mounting location.

## SECTION 2.05

### DSM SYSTEM COMPONENT CONNECTIONS

#### COMPONENT CONNECTIONS

In this section, you will be interconnecting the DSM system components with the various DSM harnesses. This section includes the steps required to connect the knock sensors, DSM filter, and DSM module. Power connections are completed in Section 2.10, *DSM System Power, Alarm, And Ground Connections*.

Figure 2.05-1 and Figure 2.05-2 illustrate the DSM system connections that will be completed following the steps in this section.

Continue with "Knock Sensor And Filter Connections" on the next page.

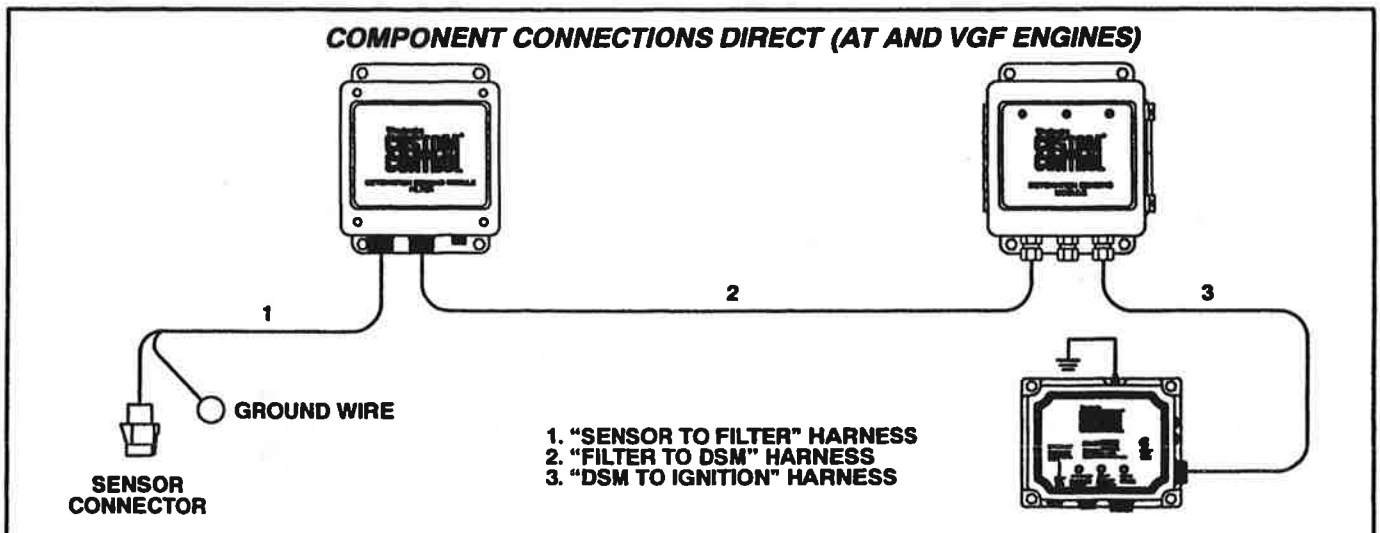


Figure 2.05-1. Component Connections Direct - AT And VGF Engines

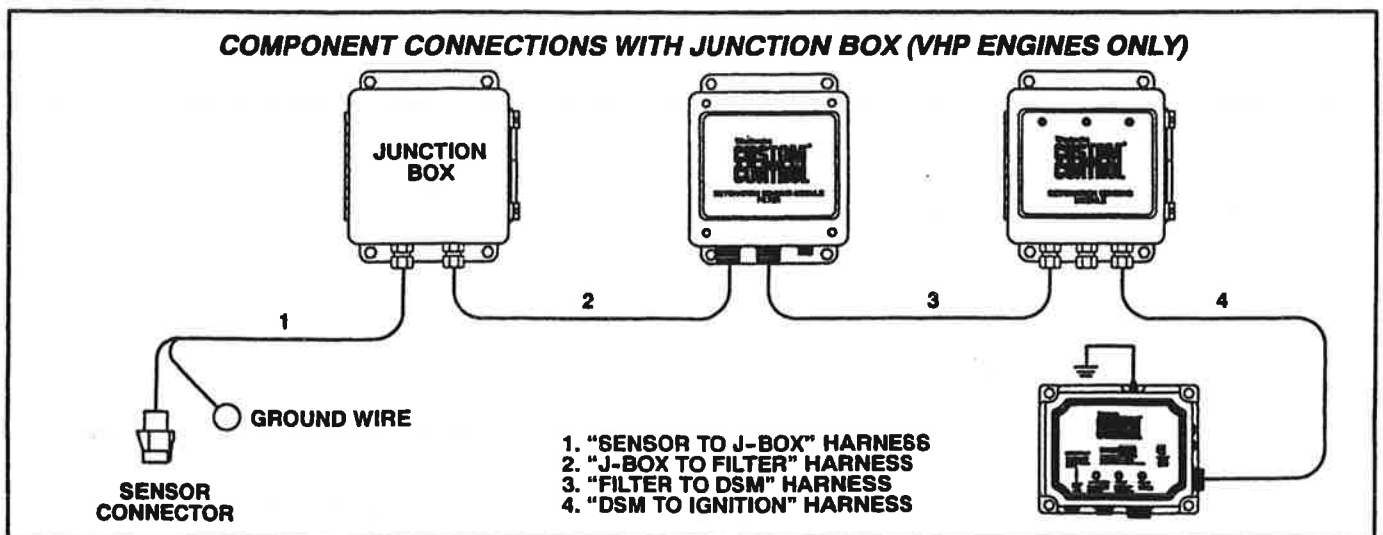


Figure 2.05-2. Component Connections With Junction Box - VHP Engines Only

## DSM SYSTEM COMPONENT CONNECTIONS

### KNOCK SENSOR AND FILTER CONNECTIONS

#### COMPLETING THE KNOCK SENSOR AND FILTER CONNECTIONS

On AT and VGF engines, individual sensor wires are routed directly to the DSM filter. Complete the steps in "Connections Routed Directly To The DSM Filter - AT And VGF Engines."

On VHP engines, individual sensor wires are routed through an engine mounted junction box and then to the DSM filter. Complete the steps in the section entitled, "Connections Routed Through An Engine Mounted Junction Box - VHP Engines."

The components of the DSM system are connected with several different wire harnesses. In the steps that follow, the harness name is enclosed in quotation marks (Example: "sensor to J-box" harness).

#### Connections Routed Directly To The DSM Filter - AT And VGF Engines

**CAUTION** All harnesses must be routed at least four inches away from ignition or other high voltage wiring including ignition coil primary wiring. If knock sensor wires are bundled with other wires, electrical interference may result, affecting the performance of the DSM system.

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

1. Verify that the knock sensors are mounted and installed properly. The sensors must be torqued to the correct specification. Refer to Section 2.00 *Mounting DSM System Components* "Mounting The Knock Sensors" for mounting instructions and specifications.

2. Locate the "sensor to filter" harness (see Figure 2.05-3).

**NOTE:** Actual shape (elbow or straight) of the 19 pin connector varies due to engine configuration and DSM installation requirements.

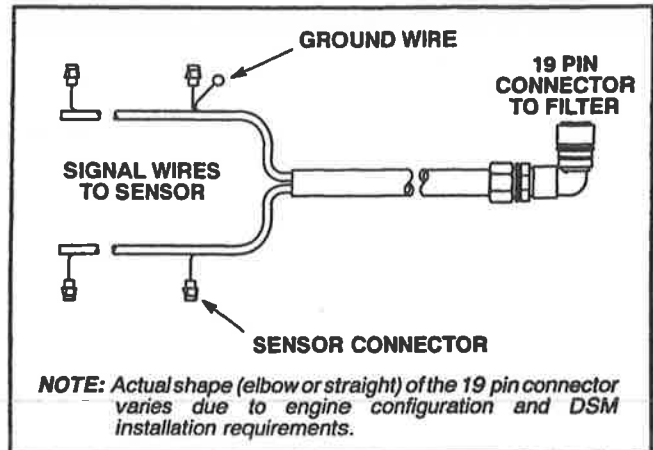


Figure 2.05-3. "Sensor To Filter" Harness

3. Attach each sensor connector of the "sensor to filter" harness to the sensor of its corresponding cylinder (or corresponding cylinder pair on VGF engines) (see Figure 2.05-3). The signal wires from the "sensor to filter" harness are labeled for their corresponding cylinders or cylinder pairs and have plastic connectors that attach to each sensor. There are also labeled ground wires.

4. Attach each labeled ground wire of the "sensor to filter" harness to the engine crankcase. Each ground wire must be securely attached to the engine crankcase at a place where surface paint has been removed.

5. Attach the 19 pin connector of the "sensor to filter" harness to the input connector on the DSM filter (see Figure 2.05-4). The input connector is the only 19 pin metal connector on the filter. The length of this harness must not be altered.

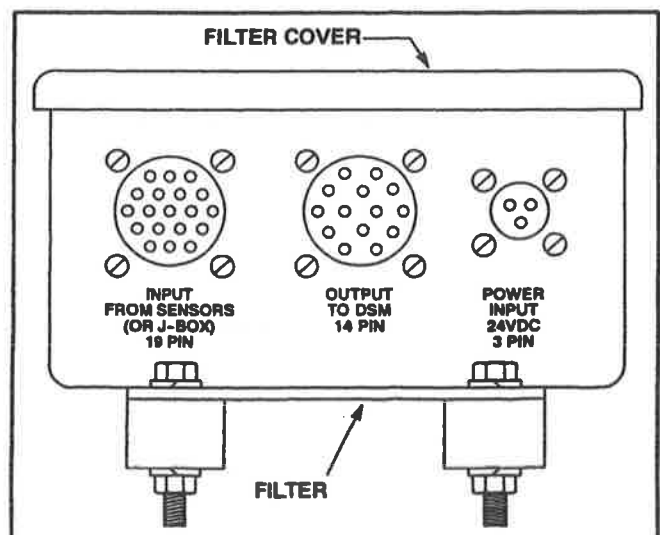


Figure 2.05-4. DSM's Filter Input Connectors

6. Locate the "filter to DSM" harness (see Figure 2.05-5).

**NOTE:** Actual shape (elbow or straight) of the 14 pin connector varies due to engine configuration and DSM installation requirements.

7. Attach the 14 pin cylindrical connector of the "filter to DSM" harness to the output connector on the filter (see Figure 2.05-4 and Figure 2.05-5). The output connector is the only 14 pin metal connector on the filter.

8. Continue with the next section "DSM Module Connections."

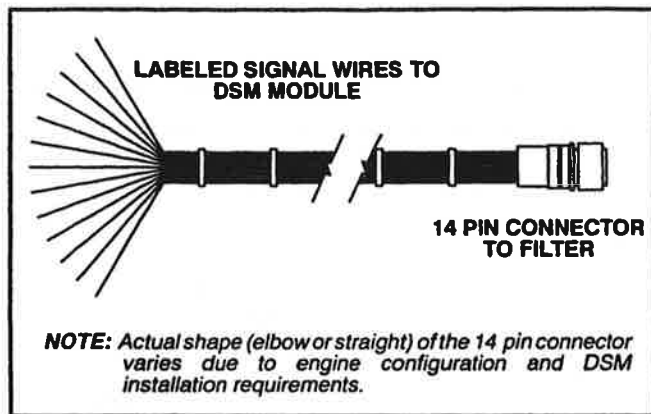


Figure 2.05-5. "Filter To DSM" Harness

### Connections Routed Through An Engine Mounted Junction Box - VHP Engines

On VHP engines, individual sensor wires are routed through an engine mounted junction box and then to the DSM filter.

**CAUTION** All harnesses must be routed at least four inches away from ignition or other high voltage wiring including ignition coil primary wiring. If knock sensor wires are bundled with other wires, electrical interference may result, affecting the performance of the DSM system.

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

1. Locate the "sensor to J-box" harness (see Figure 2.05-6).

2. Attach each plastic connector of the "sensor to J-box" harness to the knock sensor of its corresponding cylinder as labeled (see Figure 2.05-6). The signal wires of the "sensor to J-box" harness are labeled with their corresponding cylinder numbers and have plastic connectors that attach to each sensor. There are also labeled ground wires.

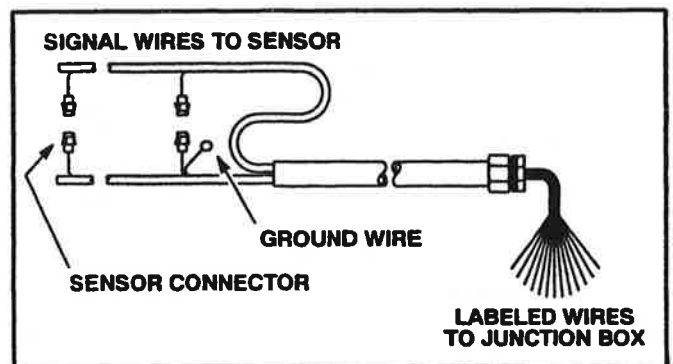


Figure 2.05-6. "Sensor To J-Box" Harness

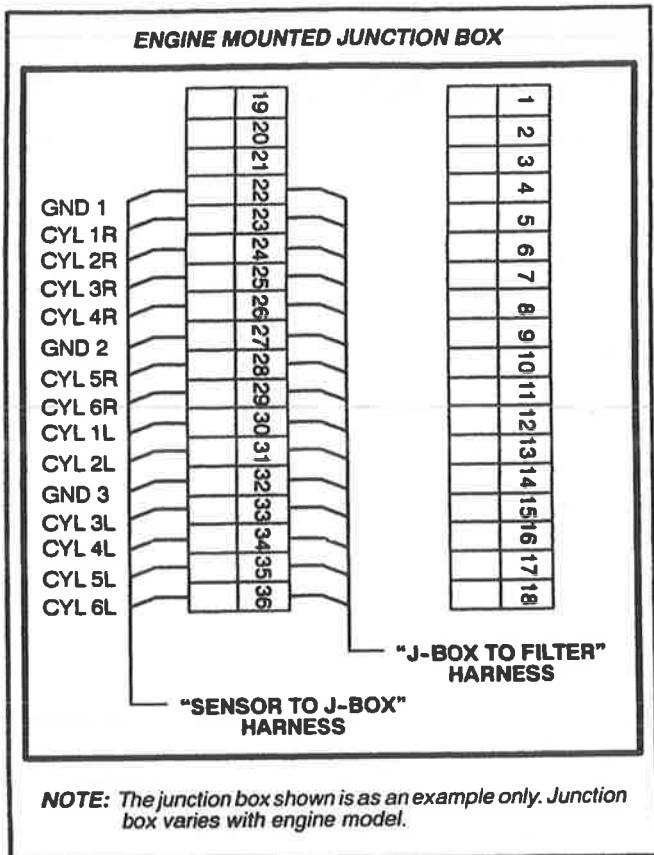
3. Attach each labeled ground wire of the "sensor to J-box" harness to the engine crankcase. Each ground wire must be securely attached to the engine crankcase at a place where surface paint has been removed.

4. Attach the individual sensor and ground wires of the "sensor to J-box" harness in the engine mounted junction box (see Figure 2.05-7). Connect these wires to a terminal strip in numerical order with the ground wires dispersed evenly between the sensor wires.

**NOTE:** The junction box in Figure 2.05-7 is shown as an example only. Junction box varies with engine model.

**NOTE:** The individual sensor and ground wires of the "sensor to J-box" harness may be shortened if necessary.

# DSM SYSTEM COMPONENT CONNECTIONS



**Figure 2.05-7. "Sensor To J-Box" Harness Connections In Junction Box**

5. Locate the "J-box to filter" harness (see Figure 2.05-8).

**NOTE:** Actual shape (elbow or straight) of the 19 pin connector varies due to engine configuration and DSM installation requirements.

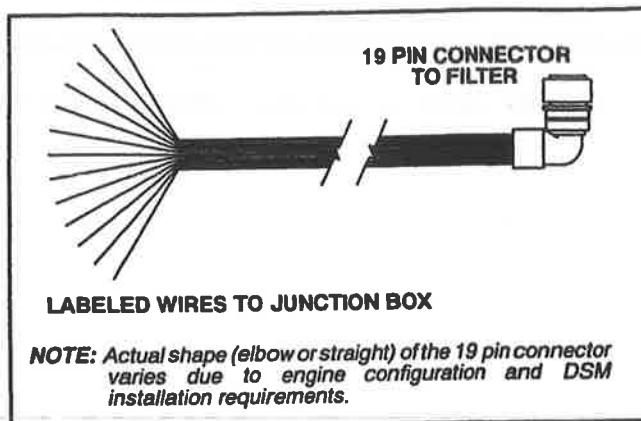
**NOTE:** The wires of the "J-box to filter" harness may be shortened if necessary. The wires of the "J-box to filter" harness **MUST** be run through conduit.

6. Attach the wires of the "J-box to filter" harness to the corresponding inputs inside the engine mounted junction box (see Figure 2.05-7 and Figure 2.05-8). For example, CYL 1R on the "sensor to J-box" harness corresponds to CYL 1R on the "J-box to filter" harness.

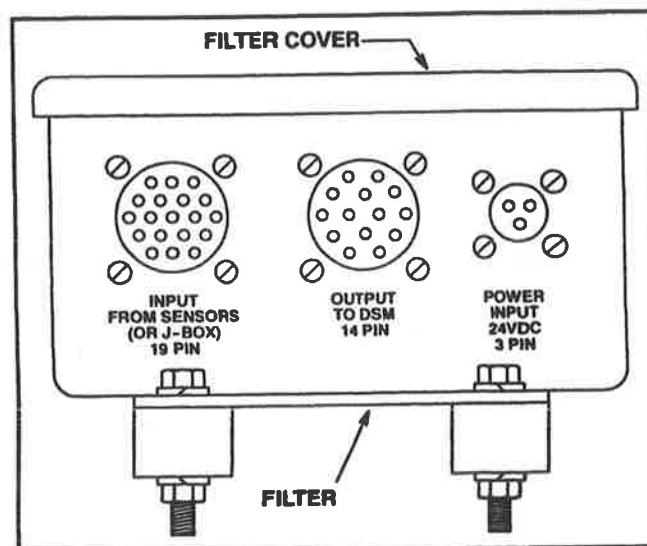
7. Attach the 19 pin cylindrical connector of the "J-box to filter" harness to the input connector on the DSM filter (see Figure 2.05-9). The input connector is the only 19 pin metal connector on the filter.

8. Locate the "filter to DSM" harness (see Figure 2.05-10).

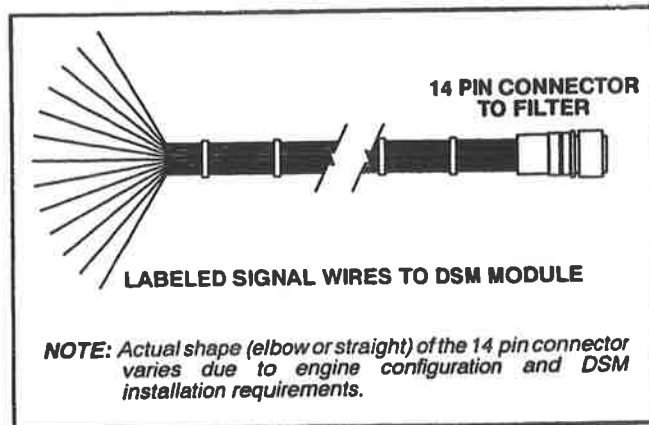
**NOTE:** Actual shape (elbow or straight) of the 14 pin connector varies due to engine configuration and DSM installation requirements.



**Figure 2.05-8. "J-Box To Filter" Harness**



**Figure 2.05-9. DSM's Filter Input Connectors**



**Figure 2.05-10. "Filter To DSM" Harness**

9. Attach the 14 pin cylindrical connector of the "filter to DSM" harness to the output connector on the DSM filter (see Figure 2.05-9 and Figure 2.05-10). The output connector is the only 14 pin metal connector on the filter.

10. Continue with "DSM Module Connections" in this section.



DSM MODULE CONNECTIONS

**CAUTION** All harnesses must be routed at least four inches away from ignition or other high voltage wiring including ignition coil primary wiring. If sensor wires are bundled with other wires, electrical interference may result, affecting the performance of the DSM system.

**CAUTION** Do not cut any new holes in the DSM module. The wires must be directed through the holes provided in the bottom of the DSM module. If the wires are routed through the wrong port, electrical interference may result, affecting the performance of the DSM system.

*NOTE: See Figure 2.05-11 for proper wire routing of the DSM module.*

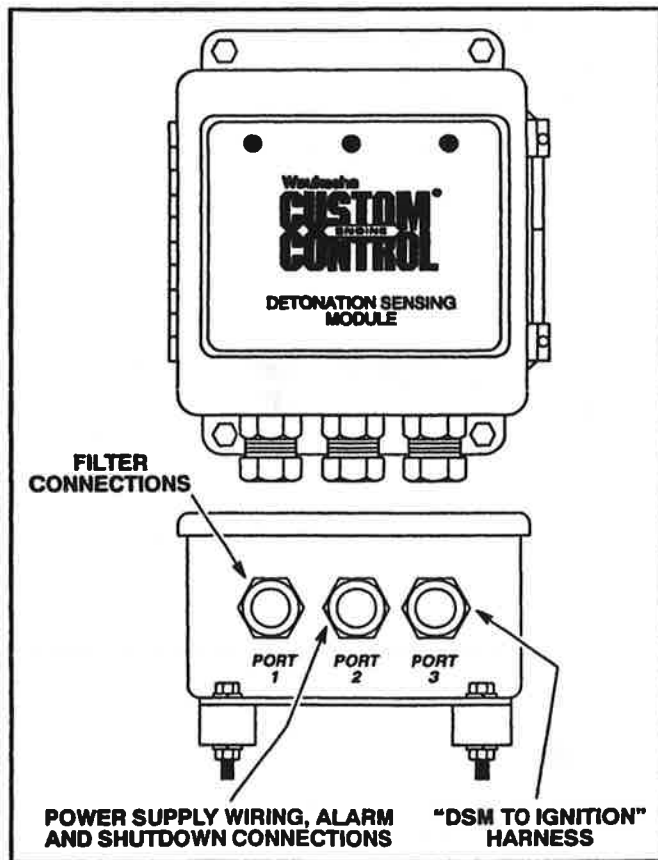


Figure 2.05-11. DSM Module Conduit Ports

DSM MODULE TO IGNITION MODULE

1. Locate the "DSM to ignition" harness (see Figure 2.05-12).

*NOTE: Actual shape (elbow or straight) of the 14 pin connector varies due to engine configuration and DSM installation requirements.*

2. Route the "DSM to ignition" harness to the Ignition Module (see Figure 2.05-12 and Figure 2.05-13).

*NOTE: Do not connect the "DSM to ignition" harness to the Ignition Module at this time. The "DSM to ignition" harness will be connected to the Ignition Module when programming the DSM system following the steps in Chapter 3 Detonation Sensing Module System Programming.*

3. Route conduit and the wires of the "DSM to ignition" harness from the Ignition Module to the DSM module.

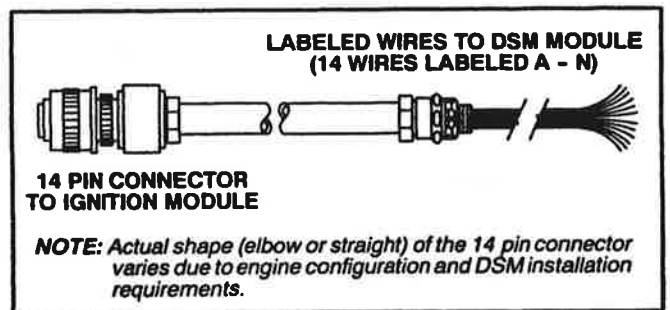


Figure 2.05-12. "DSM To Ignition" Harness

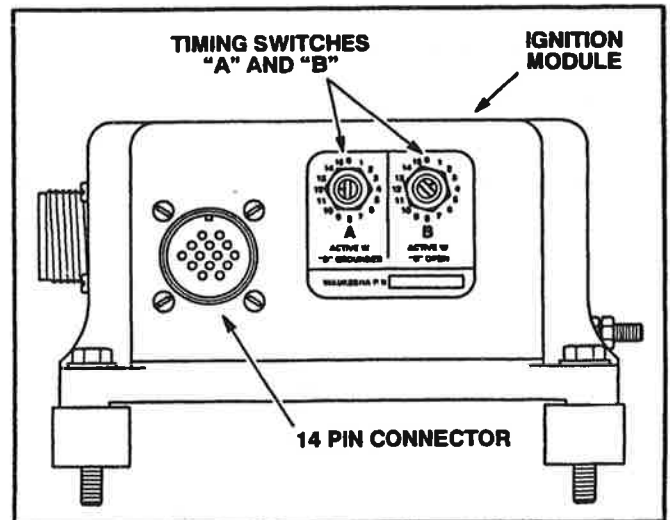


Figure 2.05-13. "DSM To Ignition" Harness Connection To Ignition Module

## DSM SYSTEM COMPONENT CONNECTIONS

**CAUTION** Route the DSM system wires through the correct port on the DSM module. The wires must be directed through the holes provided in the bottom of the DSM module. If the wires are routed through the wrong port, electrical interference may result, affecting the performance of the DSM system.

4. Direct the wires of the "DSM to ignition" harness through port 3 on the DSM module (see Figure 2.05-14).

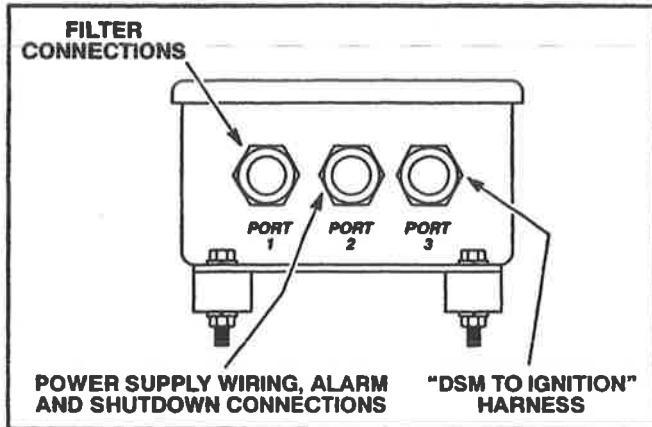


Figure 2.05-14. DSM Module Conduit Ports

5. Attach the conduit to the conduit connector attached to port 3. Secure the loose conduit.

6. Cut the wires to length and connect them to the Ignition Module terminal strip inside of the DSM module as shown in Figure 2.05-15.

### FILTER TO DSM MODULE

1. Locate the "filter to DSM" harness (see Figure 2.05-16).

**NOTE:** The signal wires of the "filter to DSM" harness are labeled for their corresponding cylinders/cylinder pairs and ground wires.

**NOTE:** The wires of the "filter to DSM" harness must be run through conduit.

2. Route the "filter to DSM" harness wires to the DSM module.

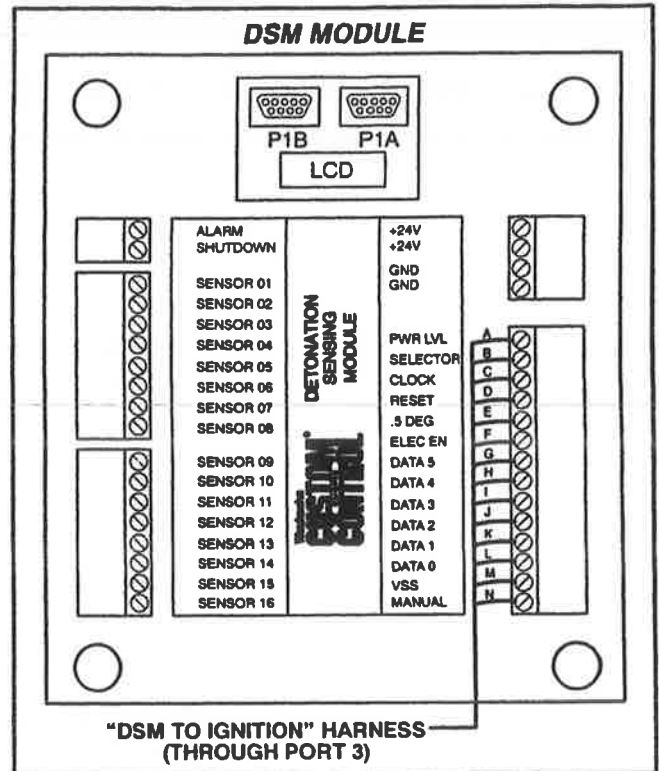


Figure 2.05-15. "DSM To Ignition" Harness Connections In DSM Module

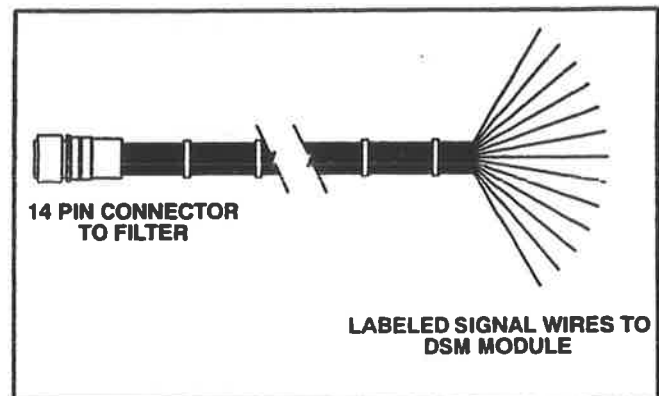


Figure 2.05-16. "Filter To DSM" Harness

**CAUTION** Route the DSM system wires through the correct port on the DSM module. The wires must be directed through the holes provided in the bottom of the DSM module. If the wires are routed through the wrong port, electrical interference may result, affecting the performance of the DSM system.

3. Direct the wires through port 1 on the DSM module (see Figure 2.05-14).

## DSM SYSTEM COMPONENT CONNECTIONS

4. Attach the conduit to the connector attached to port 1. Secure the loose conduit.

5. Determine the firing order of your engine (see Table 2.05-1).

6. Measure and cut the signal wires of the "filter to DSM" harness to length. The signal wires are connected to the terminal strips inside the DSM module.

7. Attach the signal wires from the "filter to DSM" harness to the appropriate SENSOR input as determined by the firing order given in Table 2.05-1. Note the following:

- For 6, 8, and 12 cylinder AT and VHP engines, sensors must be wired individually. See the sample wiring diagram in Figure 2.05-17.
- For 12 cylinder VGF engines, sensors must be jumpered in adjacent cylinder pairs as shown in Figure 2.05-18.

- For 16 cylinder AT, VHP, and VGF engines, sensors must be jumpered in pairs as shown in Figure 2.05-19.

Refer to Section 2.15 *DSM System Wiring Diagrams* for wiring diagrams for AT, VHP, and VGF engines.

**NOTE:** Within the DSM module the sensor inputs are labeled *SENSOR 01*, *SENSOR 02*, *SENSOR 03*. The *SENSOR* number corresponds to the sensor's position in the firing order. For example, the firing order of a 6 cylinder VHP engine is 1-5-3-6-2-4 (from Table 2.05-1). Therefore, the signal wire labeled *CYL 1* is connected to *SENSOR 01* and the signal wire labeled *CYL 5* is connected to *SENSOR 02*, etc.

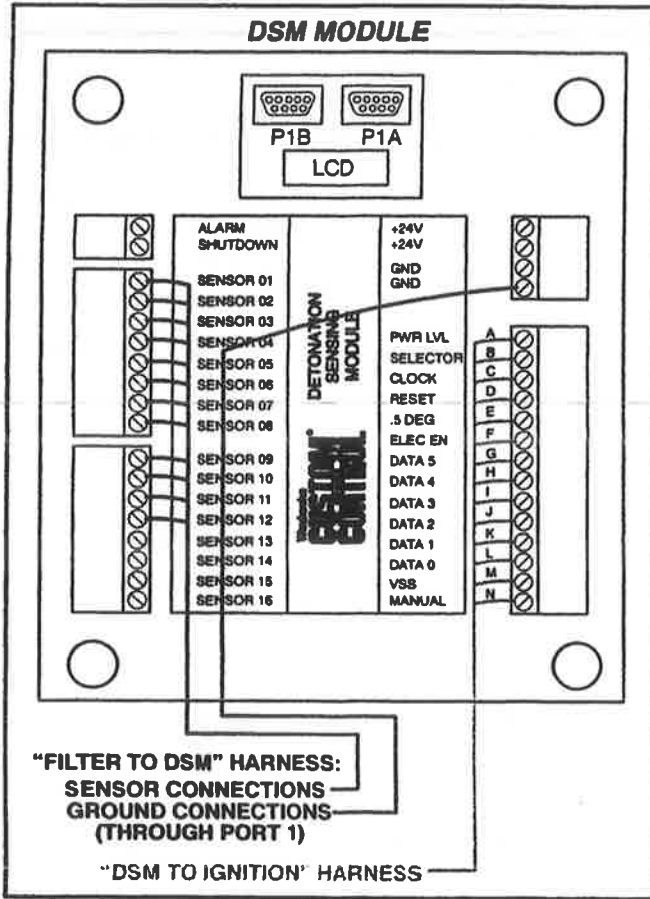
8. Cut to length and attach the ground wires. Each labeled ground wire must be connected to a GND (ground) terminal inside the DSM module.

9. Continue with Section 2.10 *DSM System Power And Alarm Connections*.

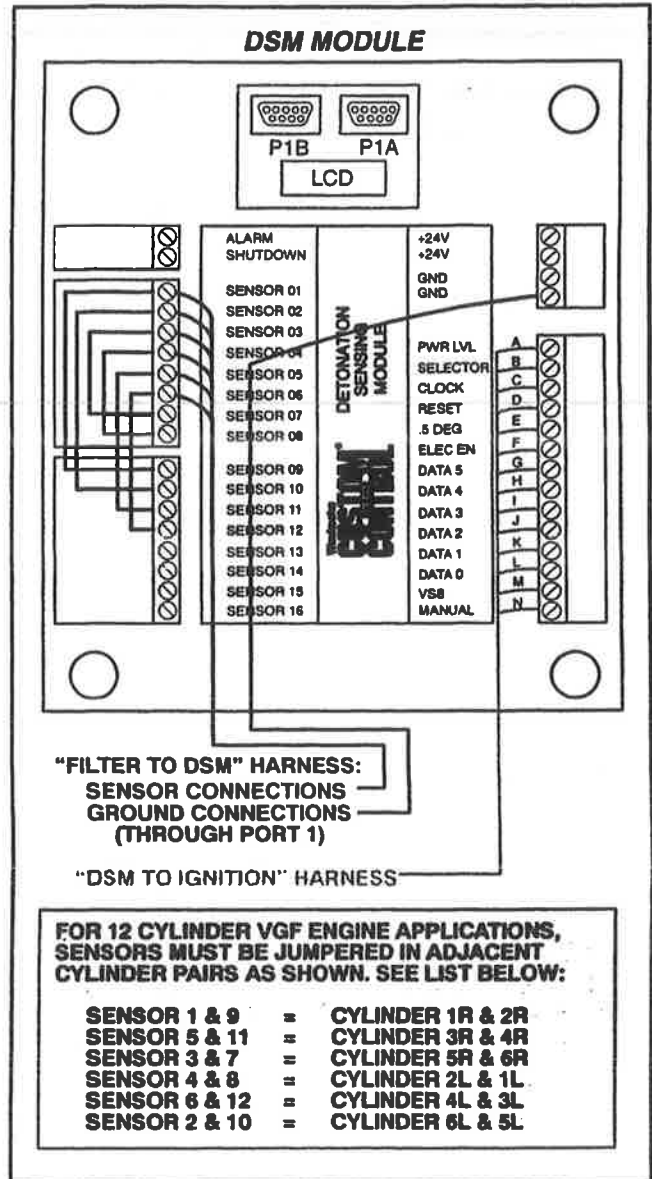
**Table 2.05-1. Cylinder Firing Order**

SENSOR	SENSOR WIRE							
	AT25/27			VHP			VGF	
	8L	12V	16V	6V	12V	16V	12V	16V
1	CYL 1	CYL 1R	CYL 1L	CYL 1	CYL 1R	CYL 1L	CYL 1R	CYL 1L
2	CYL 4	CYL 1L	CYL 4R	CYL 5	CYL 6L	CYL 3R	CYL 6L	CYL 4R
3	CYL 7	CYL 5R	CYL 4L	CYL 3	CYL 5R	CYL 3L	CYL 5R	CYL 4L
4	CYL 6	CYL 5L	CYL 7R	CYL 6	CYL 2L	CYL 7R	CYL 2L	CYL 2R
5	CYL 8	CYL 3R	CYL 7L	CYL 2	CYL 3R	CYL 7L	CYL 3R	CYL 2L
6	CYL 5	CYL 3L	CYL 6R	CYL 4	CYL 4L	CYL 5R	CYL 4L	CYL 6R
7	CYL 2	CYL 6R	CYL 6L		CYL 6R	CYL 5L	CYL 6R	CYL 6L
8	CYL 3	CYL 6L	CYL 8R		CYL 1L	CYL 8R	CYL 1L	CYL 8R
9		CYL 2R	CYL 8L		CYL 2R	CYL 8L	CYL 2R	CYL 8L
10		CYL 2L	CYL 5R		CYL 5L	CYL 6R	CYL 5L	CYL 5R
11		CYL 4R	CYL 5L		CYL 4R	CYL 6L	CYL 4R	CYL 5L
12		CYL 4L	CYL 2R		CYL 3L	CYL 2R	CYL 3L	CYL 7R
13			CYL 2L			CYL 2L		CYL 7L
14			CYL 3R			CYL 4R		CYL 3R
15			CYL 3L			CYL 4L		CYL 3L
16			CYL 1R			CYL 1R		CYL 1R

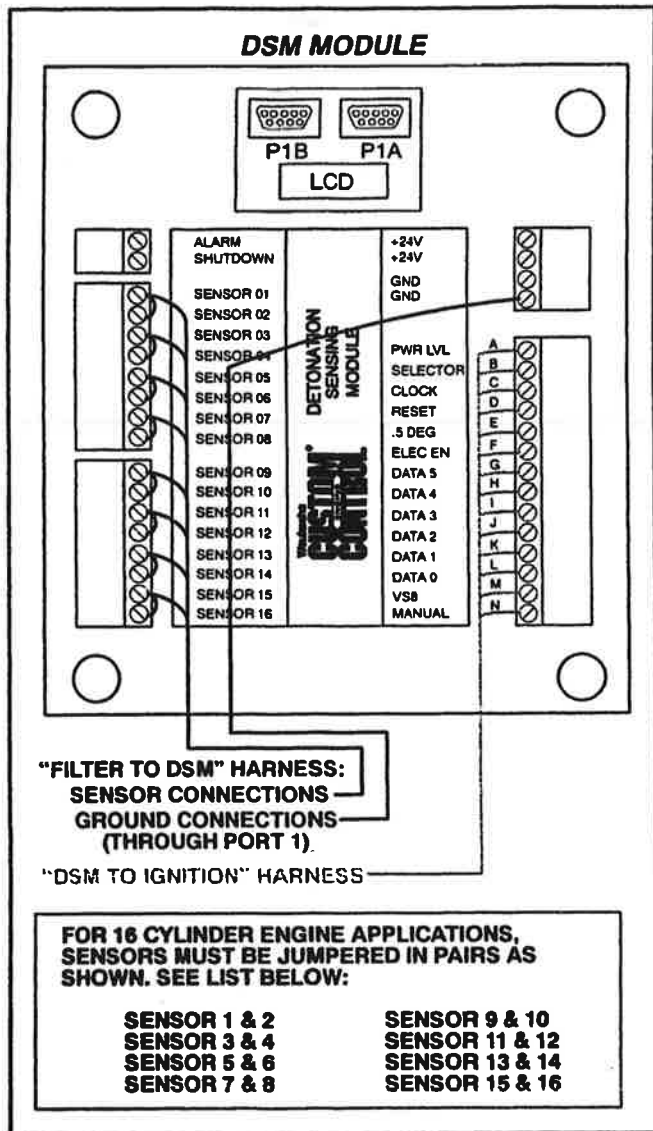
# DSM SYSTEM COMPONENT CONNECTIONS



**Figure 2.05-17. "Filter To DSM" Harness Connections In DSM Module - 6, 8, And 12 Cylinder VHP And AT Engines**



**Figure 2.05-18. "Filter To DSM" Harness Connections In DSM Module - 12 Cylinder VGF Engines**



**Figure 2.05-19. "Filter To DSM" Harness Connections  
In DSM Module - 16 Cylinder AT, VHP, VGF Engines**

# DSM SYSTEM COMPONENT CONNECTIONS

---

## SECTION 2.10

# DSM SYSTEM POWER, ALARM, AND GROUND CONNECTIONS

### POWER CONNECTIONS

In this section, you will be making power connections to the DSM filter and module with various DSM harnesses. Additionally, you will be making alarm and shutdown connections. DSM component connections are completed in Section 2.05 *DSM System Component Connections*.

Figure 2.10-1 and Figure 2.10-2 illustrate the connections of the DSM harnesses made after completing the power connections in this section.

Continue with "Filter Power Connections" on the next page.

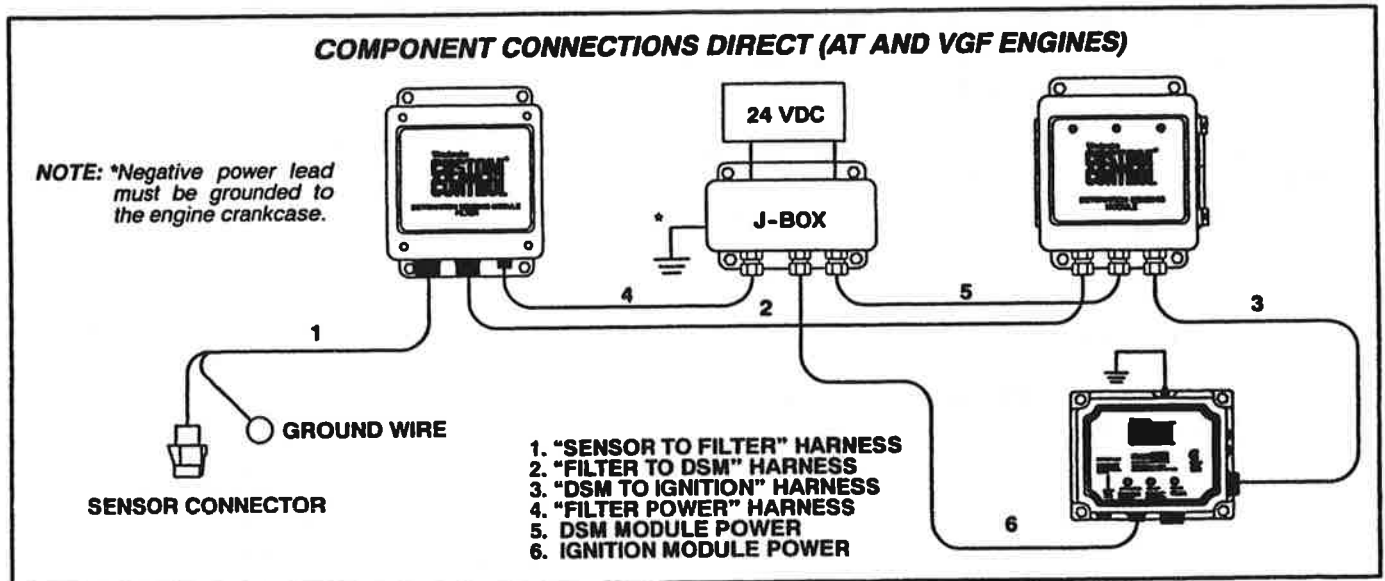


Figure 2.10-1. Component And Power Connections Direct - AT And VGF Engines

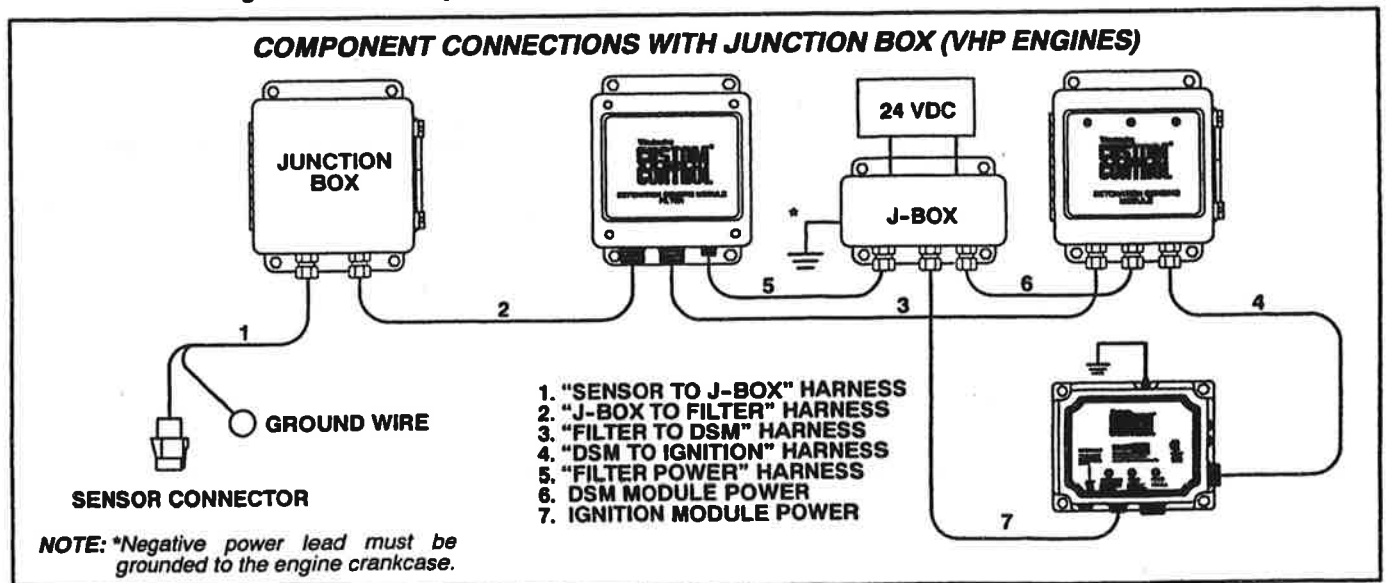


Figure 2.10-2. Component And Power Connections With Junction Box - VHP Engines

# DSM SYSTEM POWER, ALARM, AND GROUND CONNECTIONS

## FILTER POWER CONNECTIONS

The power connections to the DSM system filter must be in accordance with the applicable electrical codes. The DSM is suitable for installation in Canadian Standards Association (CSA) Class I, Group D, Division 2 locations. All wire sizing must be in accordance with Figure 2.10-5, Waukesha CEC Products Power Wiring Requirements.

See Table 2.10-1 for DSM filter power requirements. An oscilloscope must be used to verify that the ripple meets the listed requirement.

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

Refer to Section 2.15, *DSM System Wiring Diagrams*, for wiring diagrams for AT, VHP, and VGF engines.

### WARNING

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

1. Locate the "filter power" harness (see Figure 2.10-3).

**NOTE:** The wires of the "filter power" harness must be run through conduit.

**NOTE:** Actual shape (elbow or straight) of the 3 pin connector varies due to engine configuration and DSM installation requirements.

2. With power supply off, connect the "filter power" harness to the customer supplied power supply through an engine mounted junction box (see Figure 2.10-3). The negative power lead must be grounded to the engine crankcase at the engine mounted junction box. The harness wires are labeled for the appropriate connection.

3. Attach the 3 pin cylindrical connector of the "filter power" harness to the power connector on the filter (see Figure 2.10-3 and Figure 2.10-4). The power connector is the only 3 pin metal connector on the filter.

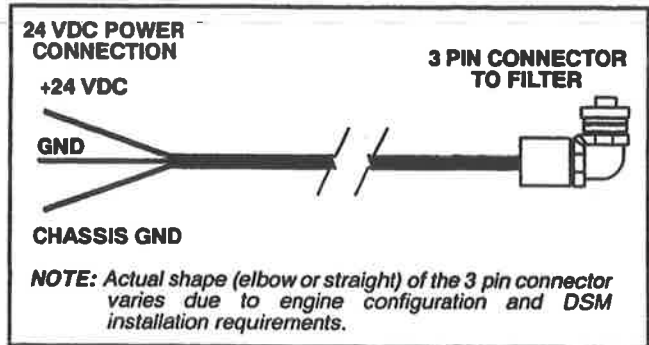


Figure 2.10-3. "Filter Power" Harness

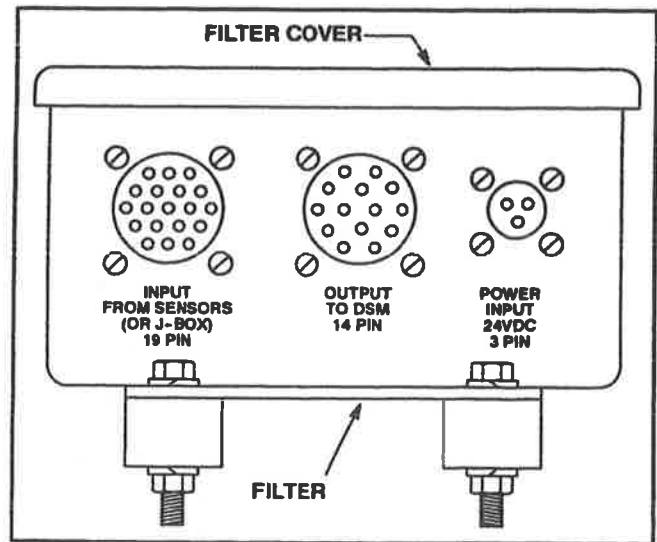


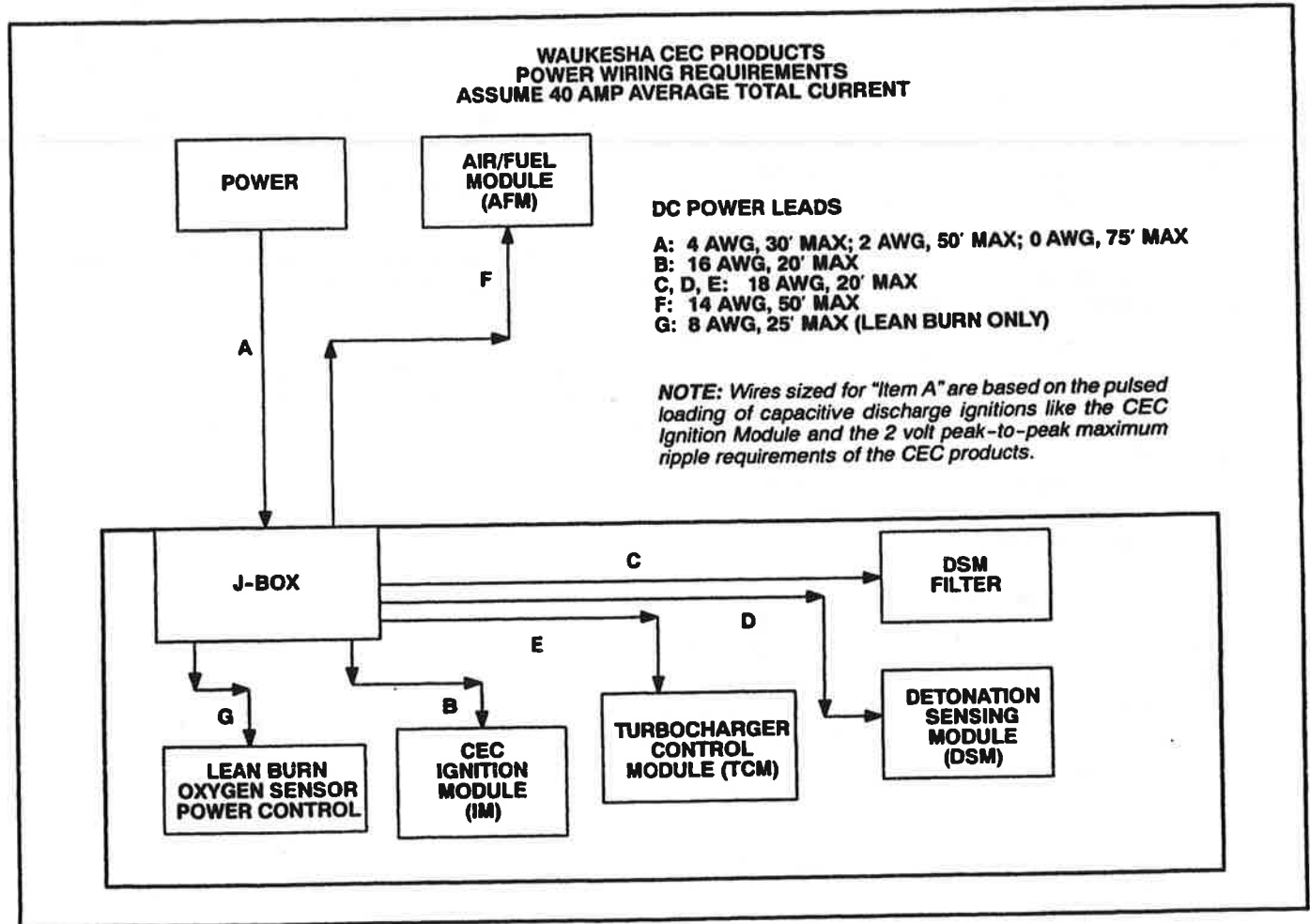
Figure 2.10-4. DSM System's Filter Input Connectors



# DSM SYSTEM POWER, ALARM, AND GROUND CONNECTIONS

**Table 2.10-1. Power Requirements For The DSM System**

CEC PRODUCT	NOMINAL VOLTAGE (volts DC)	TOLERANCE	OPERATING RANGE (volts DC)	PEAK-TO-PEAK RIPPLE (volts AC)	OPERATING CURRENT (amps)
DSM Filter	24	+25%, -10%	21.6 - 30	less than 2	1.0 (typical)
DSM Module	24	+25%, -10%	21.6 - 30	less than 2	0.5 (typical)



**Figure 2.10-5. Waukesha CEC Products Power Wiring Requirements**

## DSM SYSTEM POWER, ALARM, AND GROUND CONNECTIONS

### DSM MODULE POWER CONNECTIONS

The power connections to the DSM module must be in accordance with the applicable electrical codes. The DSM is suitable for installation in Canadian Standards Association (CSA) Class I, Group D, Division 2 locations. All power sizing must be in accordance with Figure 2.10-5, Waukesha CEC Products Power Wiring Requirements.


See Table 2.10-1 for DSM module power requirements. An oscilloscope must be used to verify that the ripple meets the listed requirement.

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

Refer to Section 2.15, *DSM System Wiring Diagrams*, for wiring diagrams for AT, VHP, and VGF engines.

### WARNING

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

** CAUTION** Route the DSM system wires through the correct port on the DSM module. The wires must be directed through the holes provided in the bottom of the DSM module. If the wires are routed through the wrong port, electrical interference may result, affecting the performance of the DSM system.

1. With power off, install an input power wire from the 24 VDC supply through the center conduit entry (port 2) of the DSM module (see Figure 2.10-6).

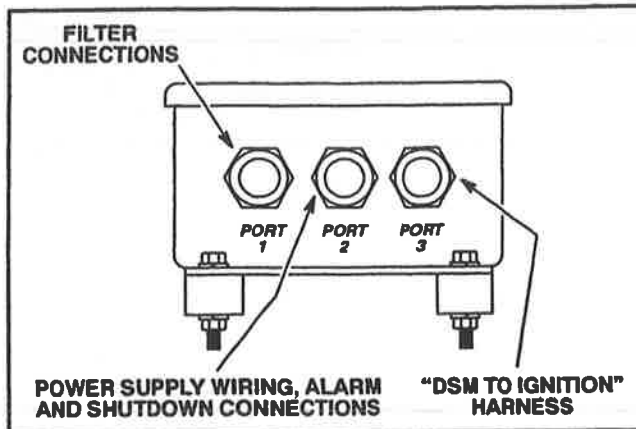


Figure 2.10-6. DSM Module Conduit Ports

2. Connect the power wire to the terminal block labeled +24V (see Figure 2.10-7).

3. Connect a wire from the crankcase to the same terminal block at the point labeled GND (ground). Run the ground wire through the center conduit entry of the DSM module to the engine mounted junction box.

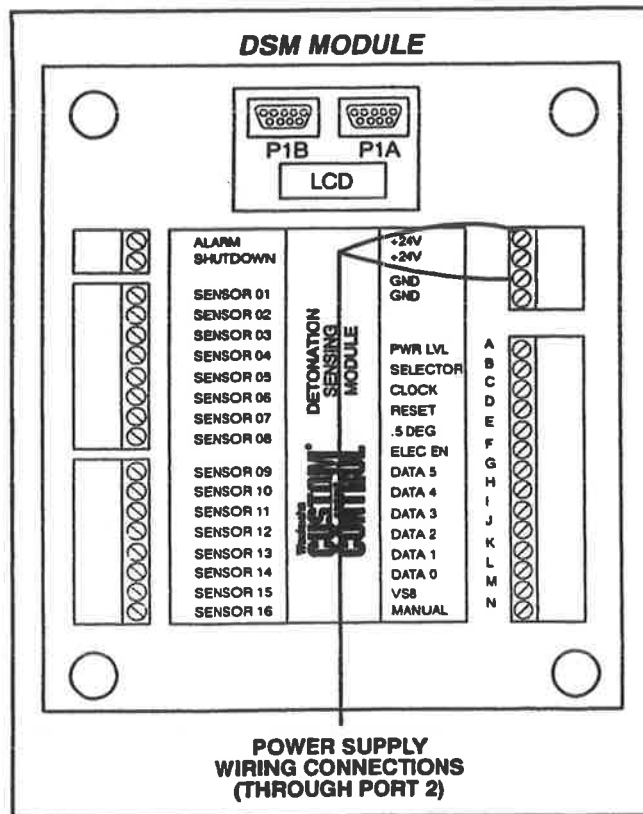


Figure 2.10-7. Power Connections in DSM Module

# DSM SYSTEM POWER, ALARM, AND GROUND CONNECTIONS

## ALARM AND SHUTDOWN CONNECTIONS

### ⚠ WARNING

Connect the DSM system to a safety engine shutdown for maximum engine protection. Failure to connect a safety engine shutdown could cause personal injury, death or engine damage.

**⚠ CAUTION** Route the DSM system wires through the correct port on the DSM module. The wires must be directed through the holes provided in the bottom of the DSM module. If the wires are routed through the wrong port, electrical interference may result, affecting the performance of the DSM system.

The alarm and shutdown terminals are sinking devices. A sinking device is an electronic switching device with a single terminal used to complete an electrical circuit connection that can be used to control (through a relay) remote devices such as alarms and lights. A sinking device completes the electrical path to ground.

The alarm and shutdown terminals are auxiliary connections that can be used to interface the DSM system to external electrical devices (see Figure 2.10-8). The alarm terminal is a sinking device with an internal circuit limit of 1 amp, 50 VDC. The alarm terminal can be used to control (through a relay) remote devices such as alarms and lights. When the DSM system is operating correctly it is in an OPEN state. Any system fault will "close" the alarm circuit. The alarm terminal will be CLOSED (connected to ground) whenever the "Alarm" LED (yellow light) on the front of the DSM module is on. The shutdown terminal operates the same as the alarm terminal and will only be activated when the "Shutdown" LED (red light) on the front of the DSM module is on. The alarm and shutdown wires must be routed through port 2 of the DSM module (see Figure 2.10-6).

You may use a relay with normally open and/or normally closed contacts as long as the logic is compatible with the devices being controlled. A separate supply for the relays may be used as long as the negative of the 24 VDC power source is grounded at the same point as the negative of the 24 VDC power source of the DSM module.

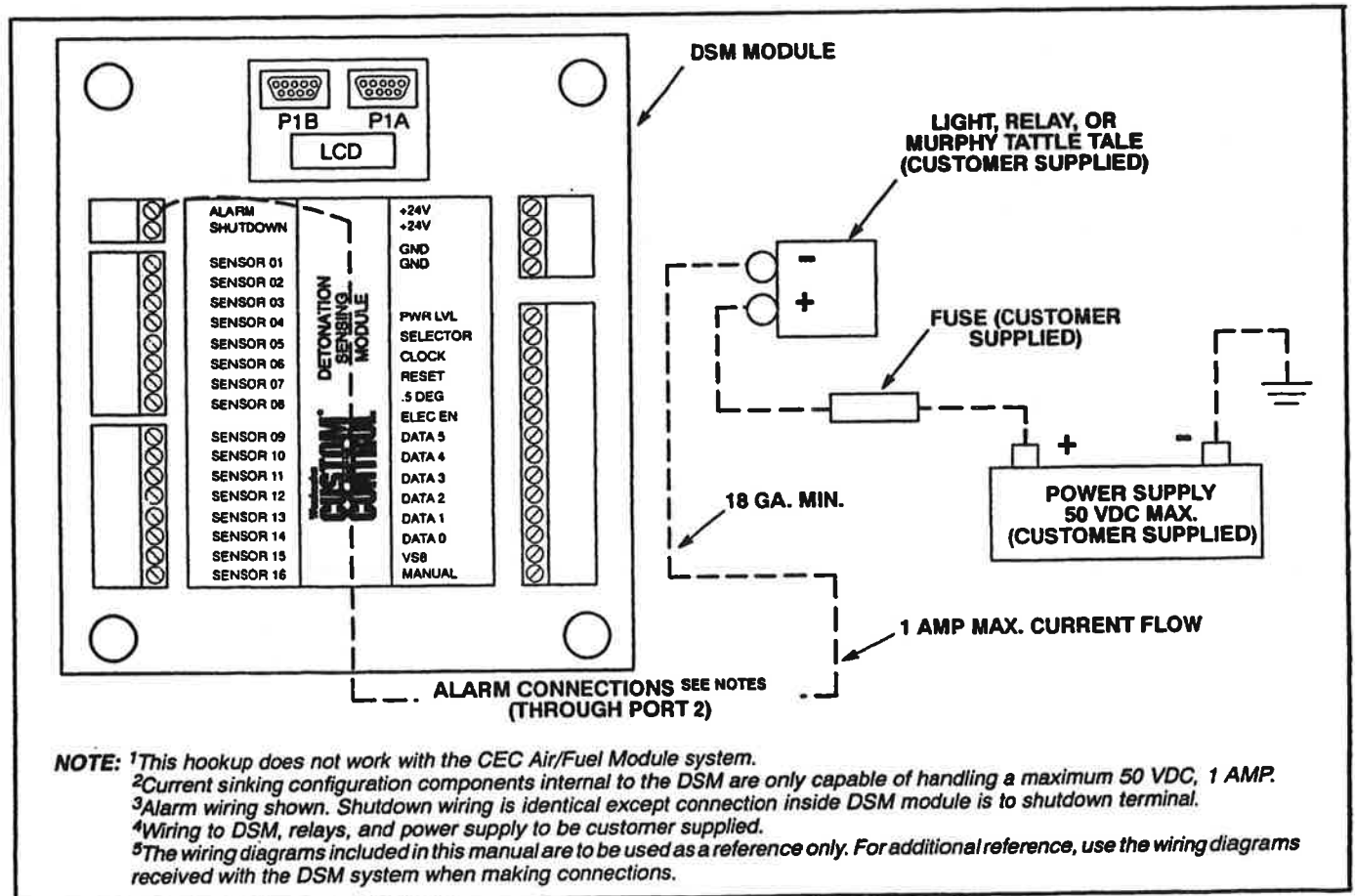


Figure 2.10-8. Alarm Wiring Schematic

## DSM SYSTEM POWER, ALARM, AND GROUND CONNECTIONS

### GROUND CONNECTIONS

To prevent electrical interference with the DSM system from other components (especially high current devices such as solenoid valves, ignition systems, and motors), complete the following grounding procedure.

- **Non-Junction Box Applications:** The negative side of the power source and the chassis ground of the filter must be securely attached to a clean, dry, unpainted engine crankcase surface (see Figure 2.10-9). The surface of the "Sensor to Filter" harness ground connection(s) must also be connected to a clean, dry, unpainted engine crankcase surface.

- **Junction Box Applications:** On engines using a Waukesha supplied junction box, the filter chassis ground and the negative side of the power source, for both the DSM module and filter, must be connected together in the junction box (see Figure 2.10-10). Then, this connection must be grounded to a clean, dry, unpainted engine crankcase surface.

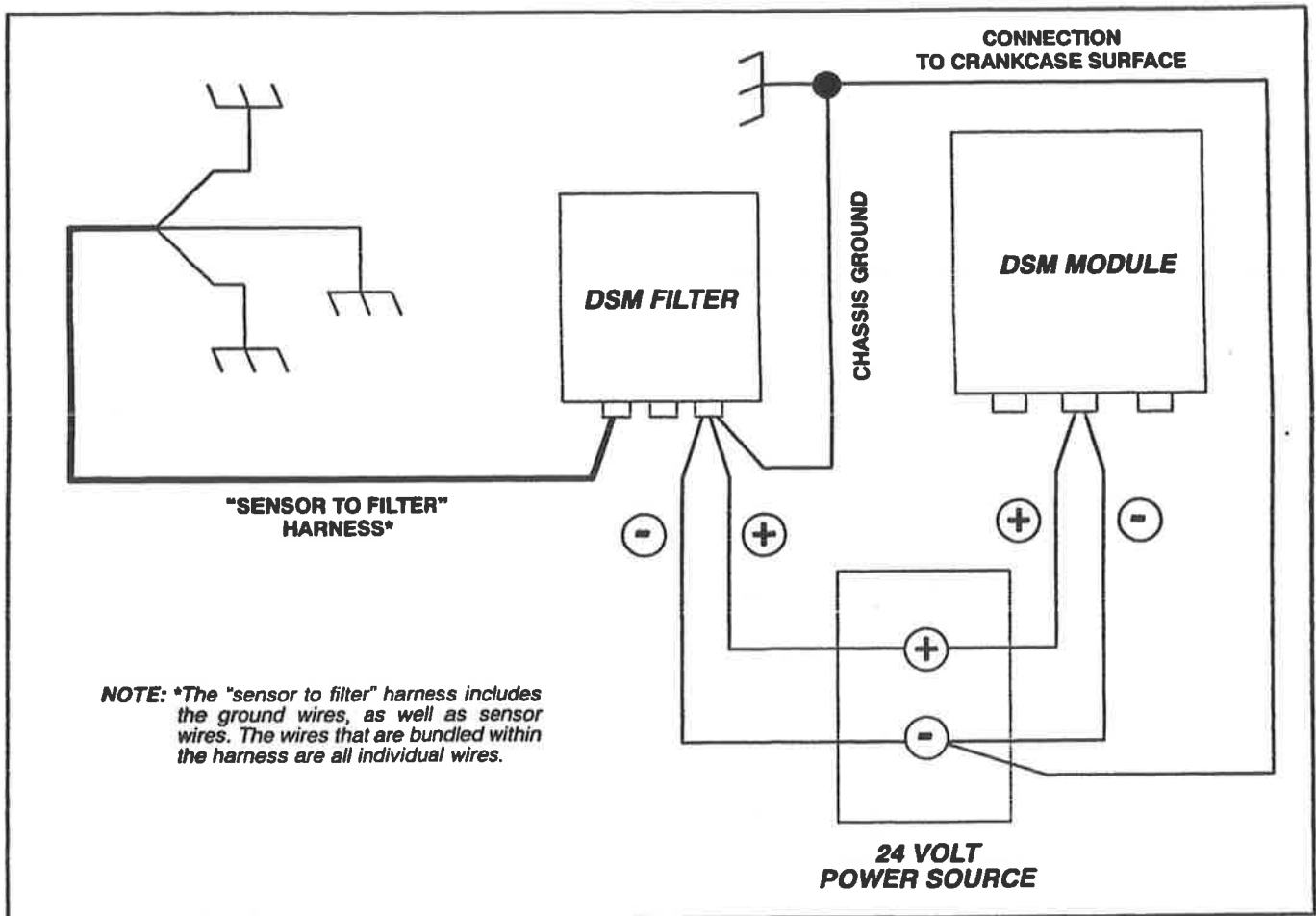


Figure 2.10-9. Ground Connections For Non-Junction Box Applications

# DSM SYSTEM POWER, ALARM, AND GROUND CONNECTIONS

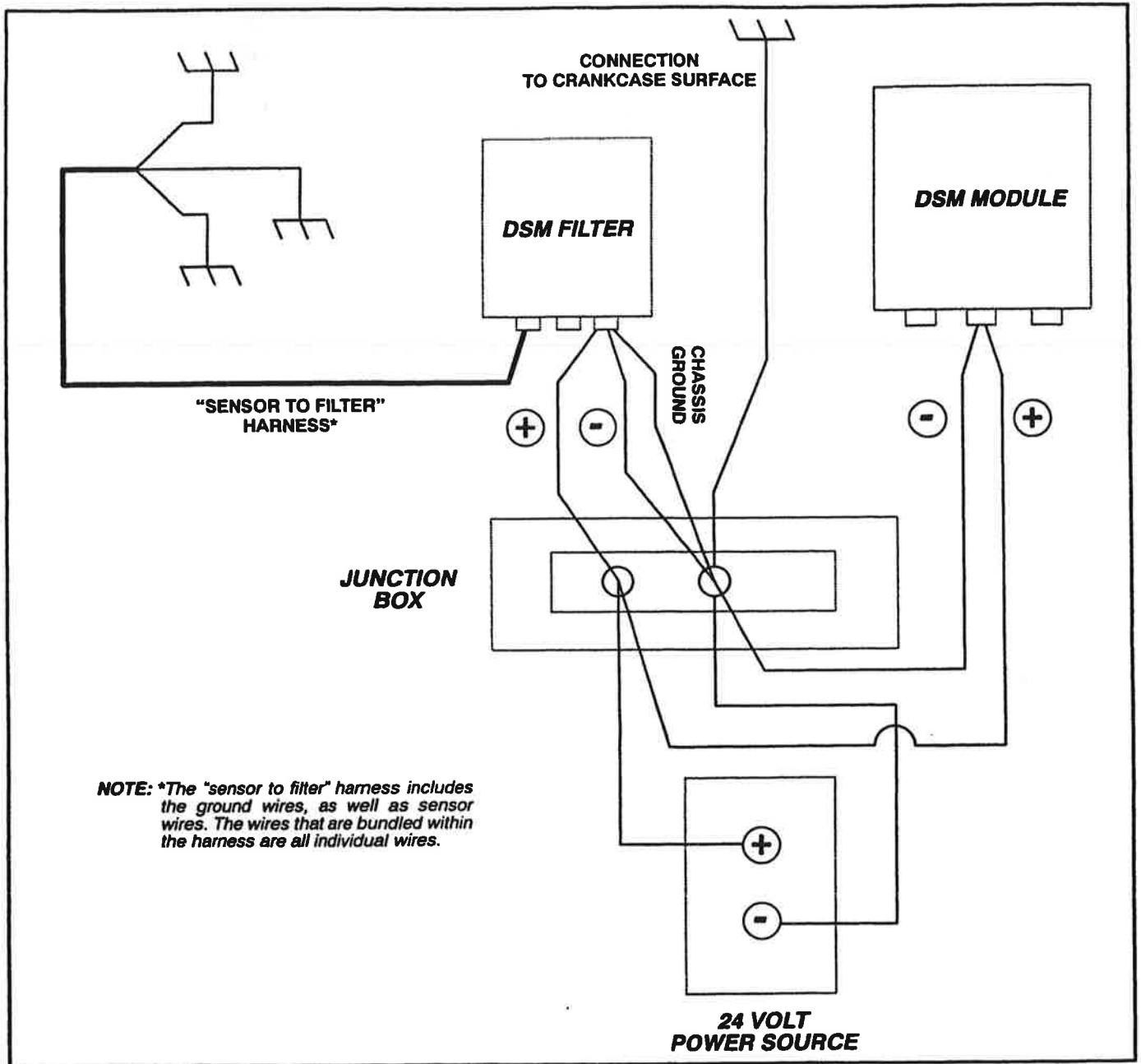


Figure 2.10-10. Ground Connections For Waukesha Supplied Junction Box Applications

# DSM SYSTEM POWER, ALARM, AND GROUND CONNECTIONS

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## SECTION 2.15

### DSM SYSTEM WIRING DIAGRAMS

#### DSM SYSTEM WIRING DIAGRAMS


WARNING

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

This section contains wiring diagrams for AT, VHP, and VGF engines. Figure 2.15-2 and Figure 2.15-3 illustrate the connections of the DSM harnesses.


Refer to Figure 2.15-4 through Figure 2.15-11 for DSM system wiring diagrams. Table 2.15-1 lists the page numbers of the wiring diagrams for AT, VHP, and VGF engines.

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

**Table 2.15-1. Page Locations Of DSM Wiring Diagrams**

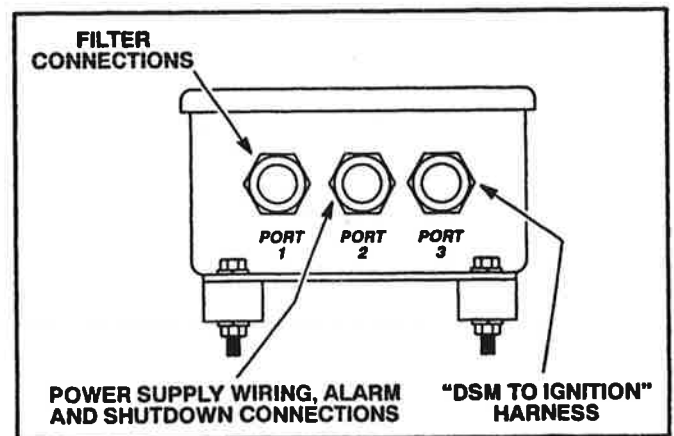
WIRING DIAGRAM	PAGE NUMBER
Figure 2.15-3. 8L-ATGL Wiring Diagram	2.15-3
Figure 2.15-4. 12V-ATGL Wiring Diagram	2.15-4
Figure 2.15-5. 16V-ATGL Wiring Diagram	2.15-5
Figure 2.15-6. 6 Cyl. VHP Wiring Diagram	2.15-6
Figure 2.15-7. 12 Cyl. VHP Wiring Diagram	2.15-7
Figure 2.15-8. 16 Cyl. VHP Wiring Diagram	2.15-8
Figure 2.15-9. 12 Cyl. VGF Wiring Diagram	2.15-9
Figure 2.15-10. 16 Cyl. VGF Wiring Diagram	2.15-10

Refer to Section 2.00, *Mounting DSM System Components*, to mount DSM system components. Refer to Section 2.05, *DSM System Component Connections*, to make wire harness connections. Refer to Section 2.10, *DSM System Power, Alarm, And Ground Connections*, to make power connections.


CAUTION

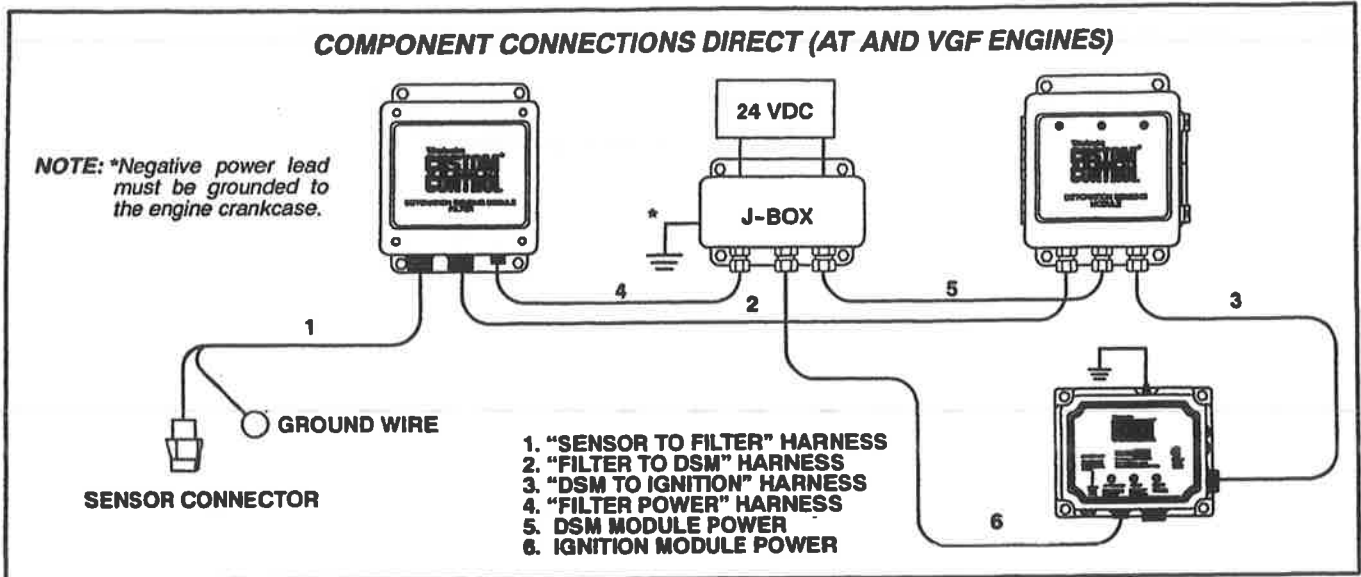
Route the DSM system wires through the correct port on the DSM module. The wires must be directed through the holes provided in the bottom of the DSM module. If the wires are routed through the wrong port, electrical interference may result, affecting the performance of the DSM system.

**NOTE:** See Figure 2.15-1 for proper wire routing of the DSM module.

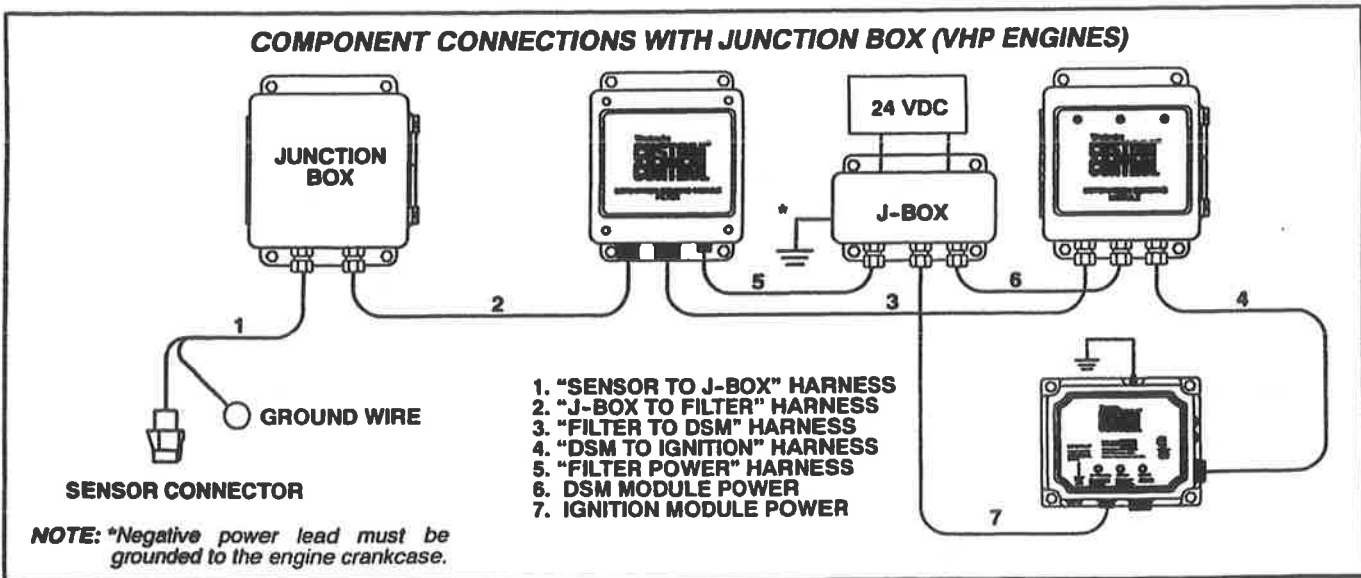


**Figure 2.15-1. DSM Module Conduit Ports**

# DSM SYSTEM WIRING DIAGRAMS



**Figure 2.15-2. Component And Power Connections Direct - AT And VGF Engines**



**Figure 2.15-3. Component And Power Connections With Junction Box - VHP Engines**



# DSM SYSTEM POWER AND ALARM CONNECTIONS

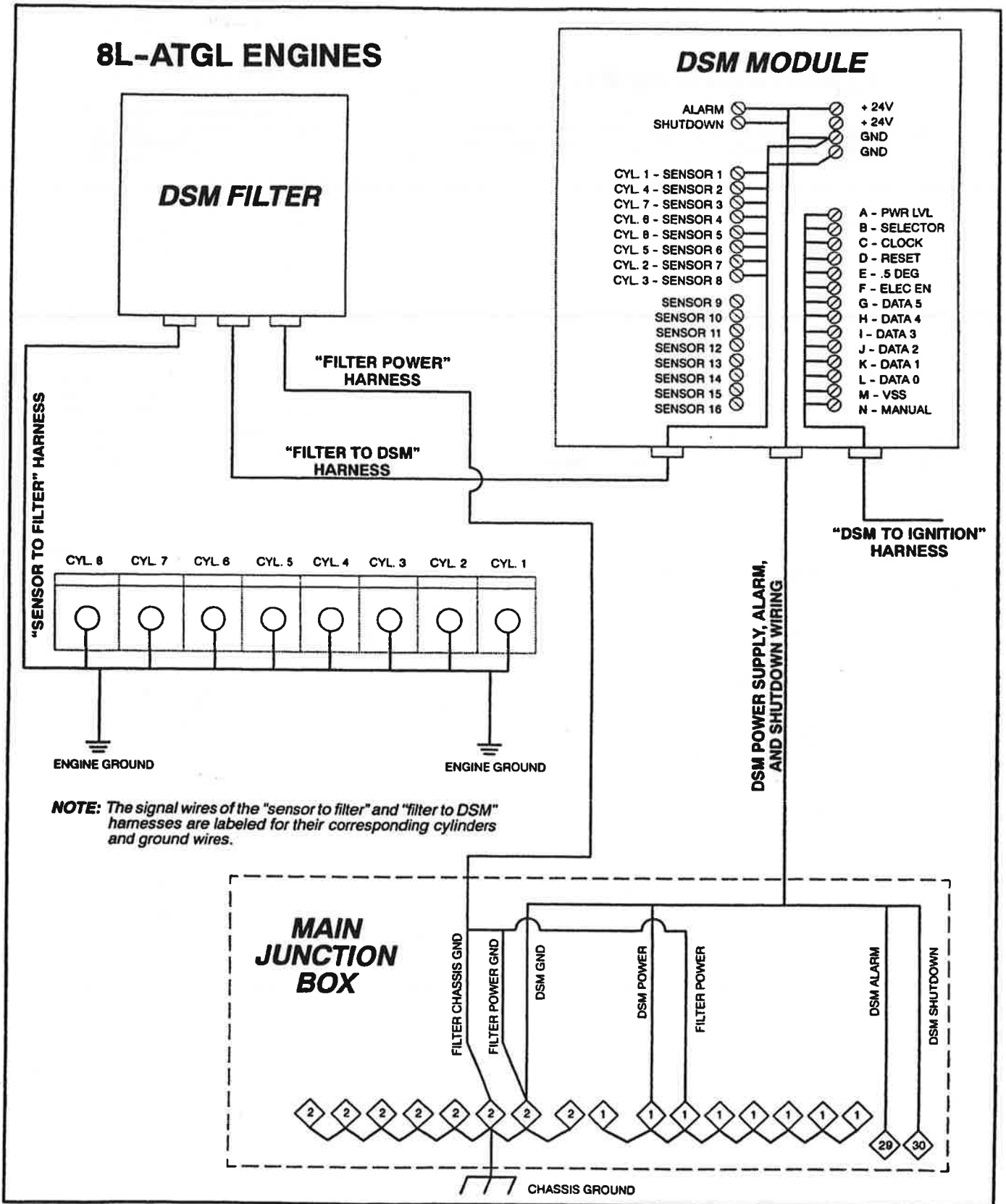


Figure 2.15-4. AT DSM System Wiring Diagram - 8L-ATGL

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

# DSM SYSTEM WIRING DIAGRAMS

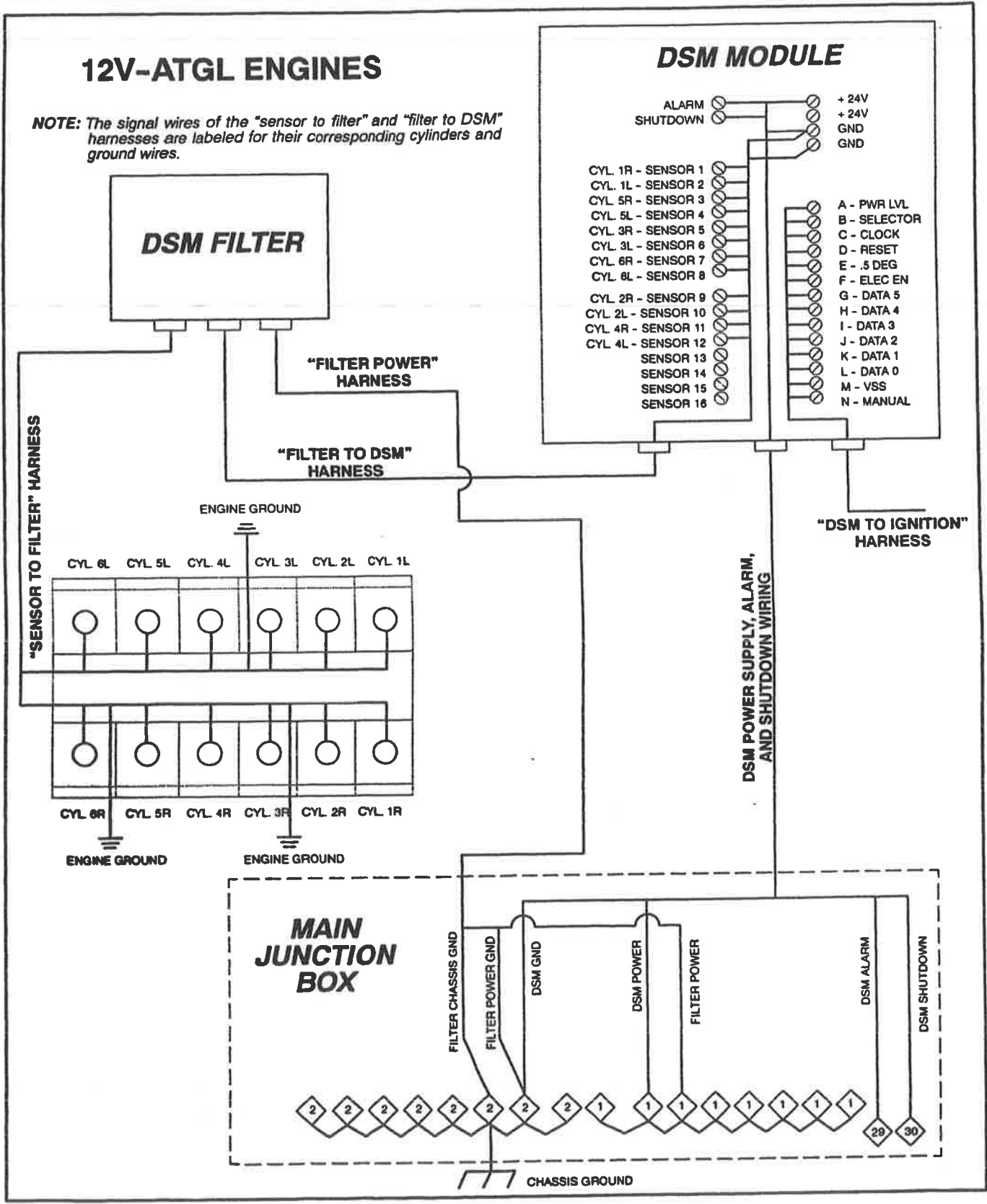


Figure 2.15-5. AT DSM System Wiring Diagram - 12V-ATGL

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

# DSM SYSTEM POWER AND ALARM CONNECTIONS

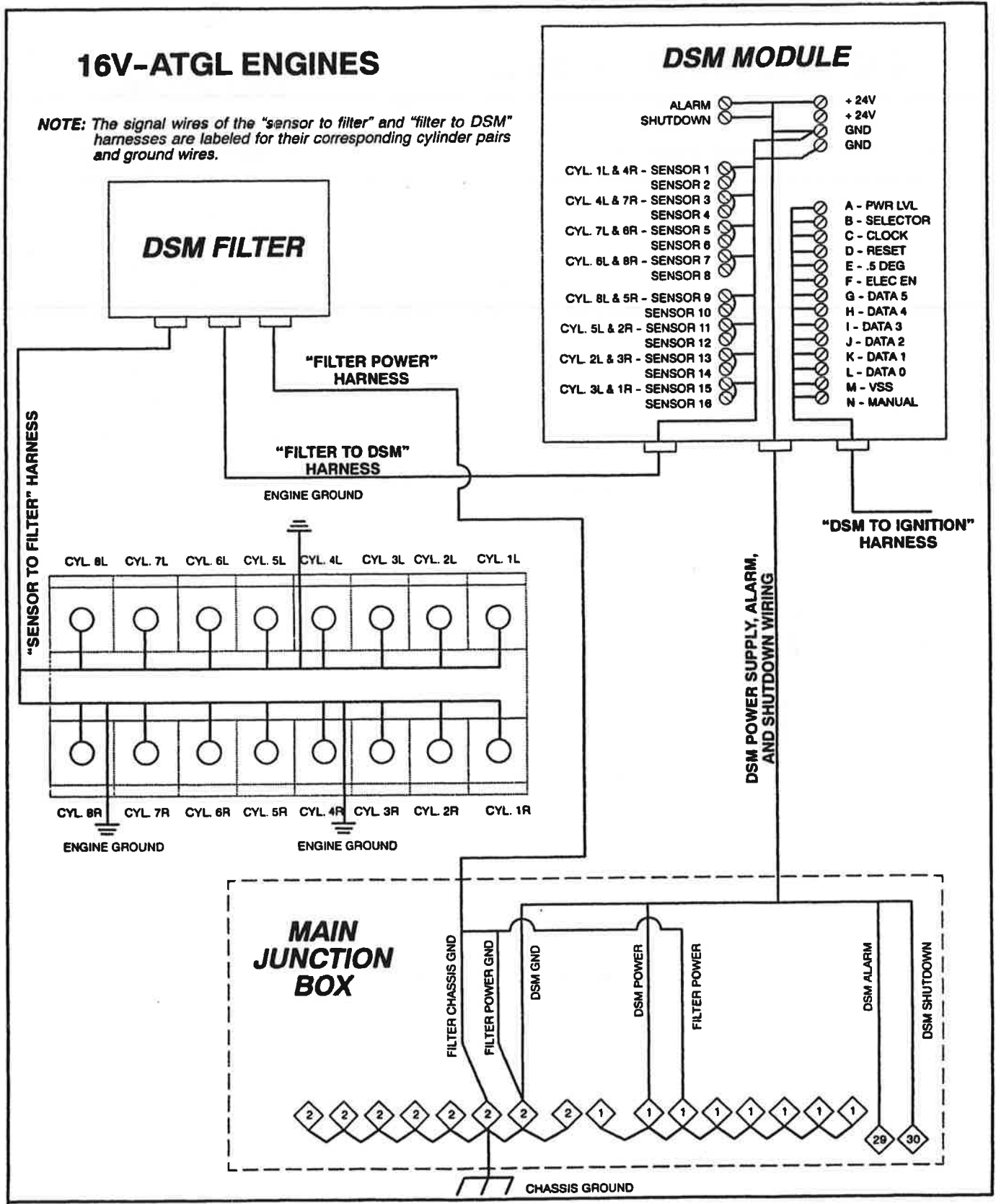


Figure 2.15-6. DSM System Wiring Diagram - 16V-ATGL

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

# DSM SYSTEM WIRING DIAGRAMS

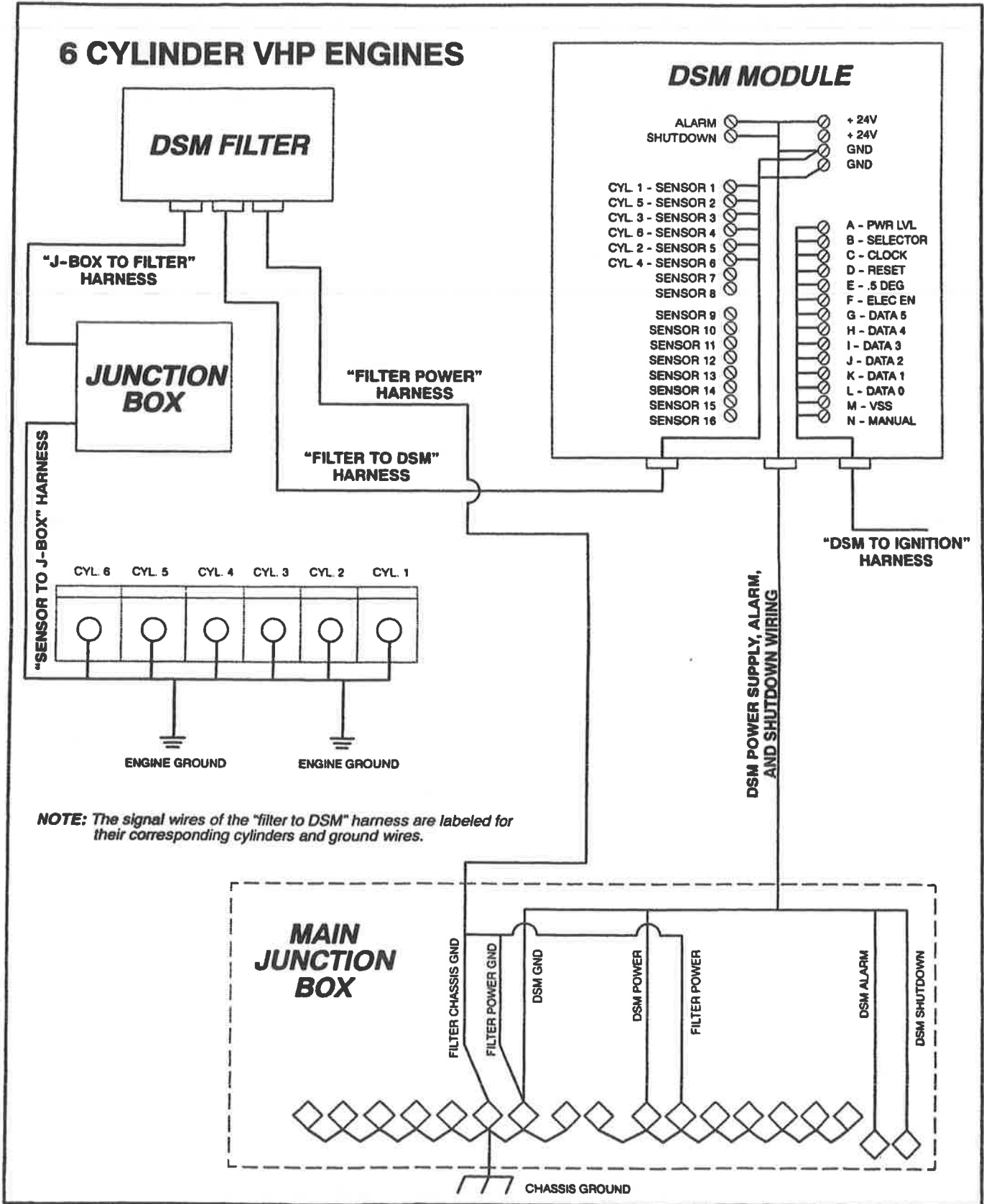


Figure 2.15-7. VHP DSM System Wiring Diagram - 6 Cylinder

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

# DSM SYSTEM POWER AND ALARM CONNECTIONS

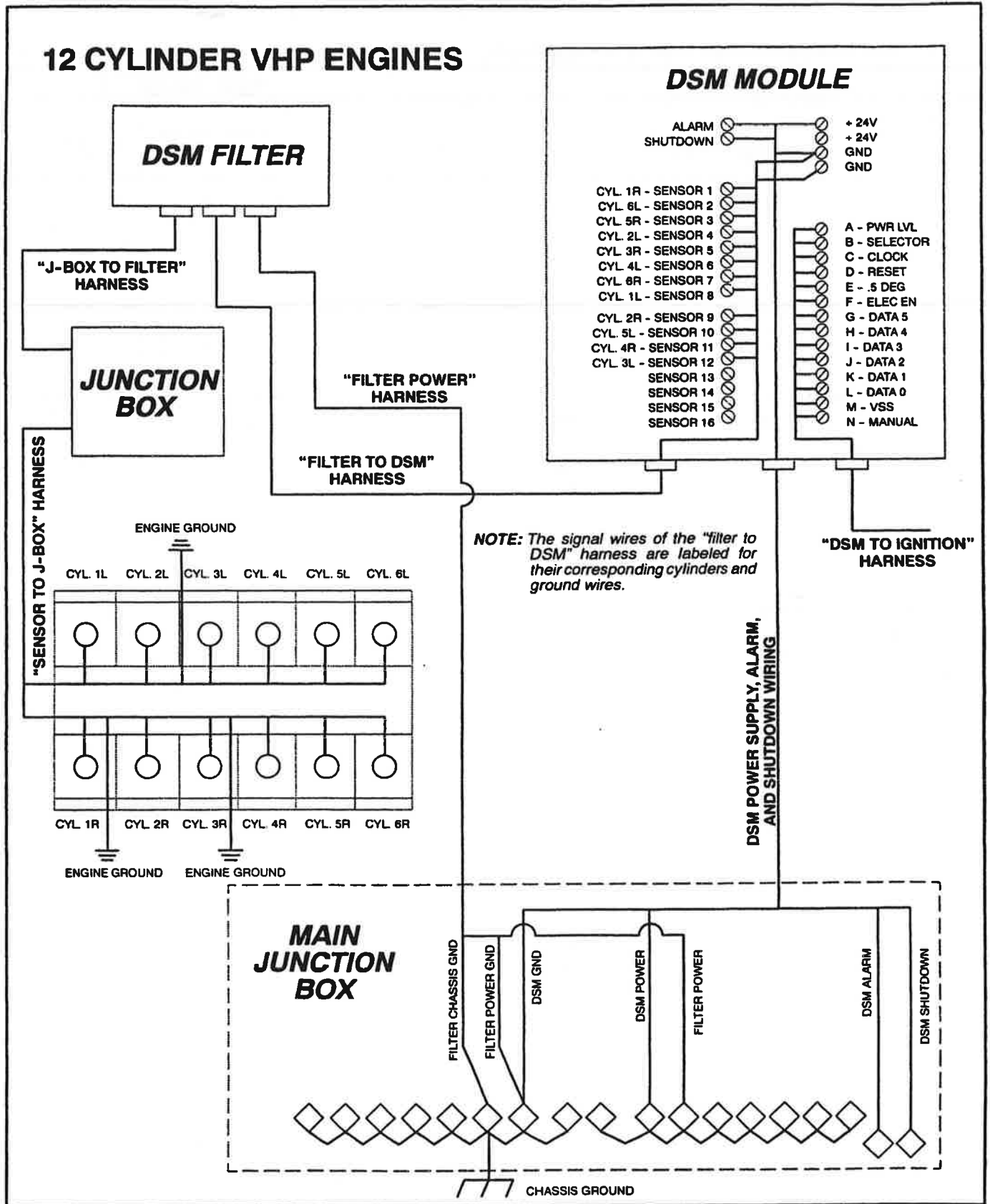


Figure 2.15-8. VHP DSM System Wiring Diagram - 12 Cylinder

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

# DSM SYSTEM WIRING DIAGRAMS

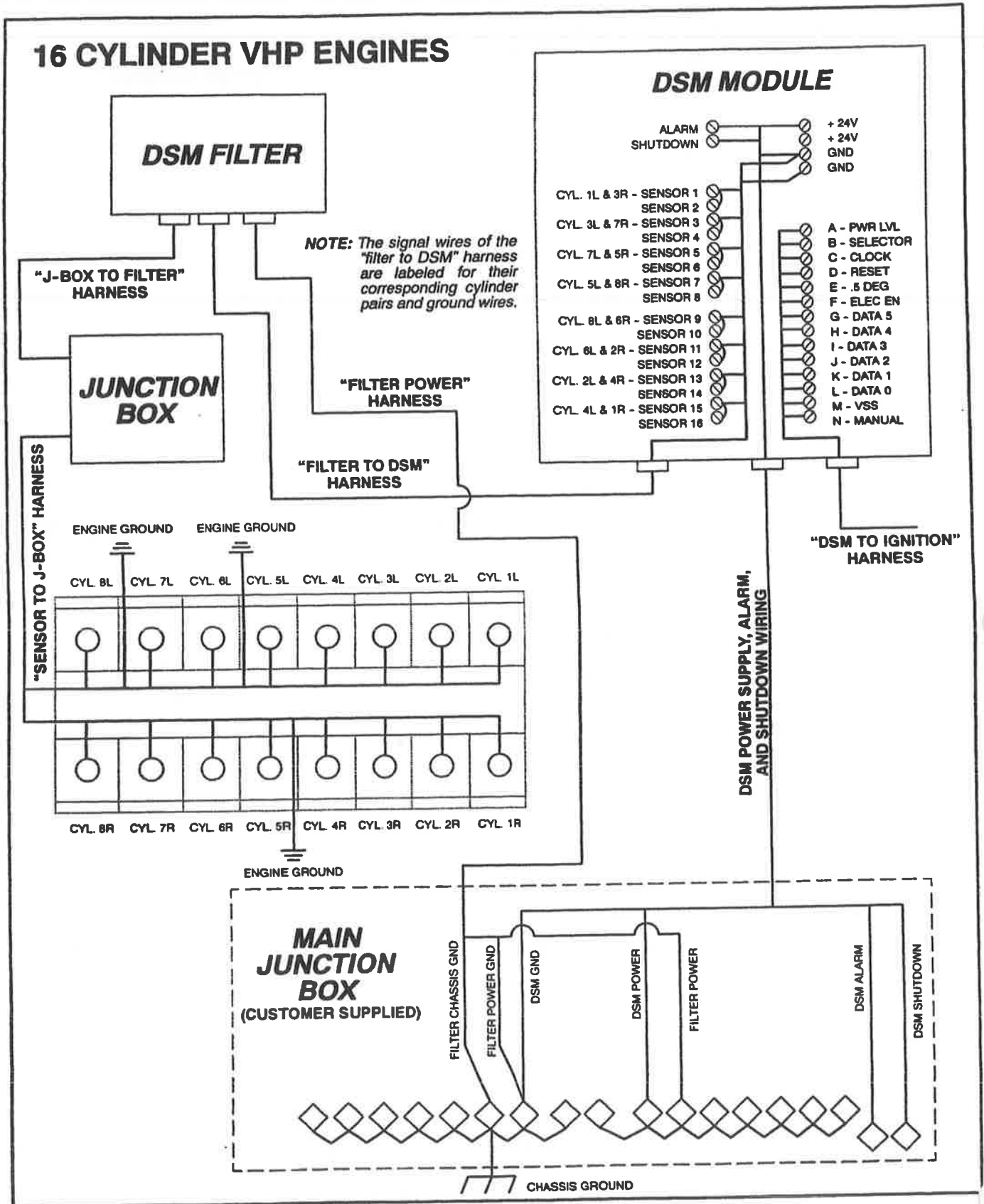


Figure 2.15-9. VHP DSM System Wiring Diagram - 16 Cylinder

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

# DSM SYSTEM POWER AND ALARM CONNECTIONS

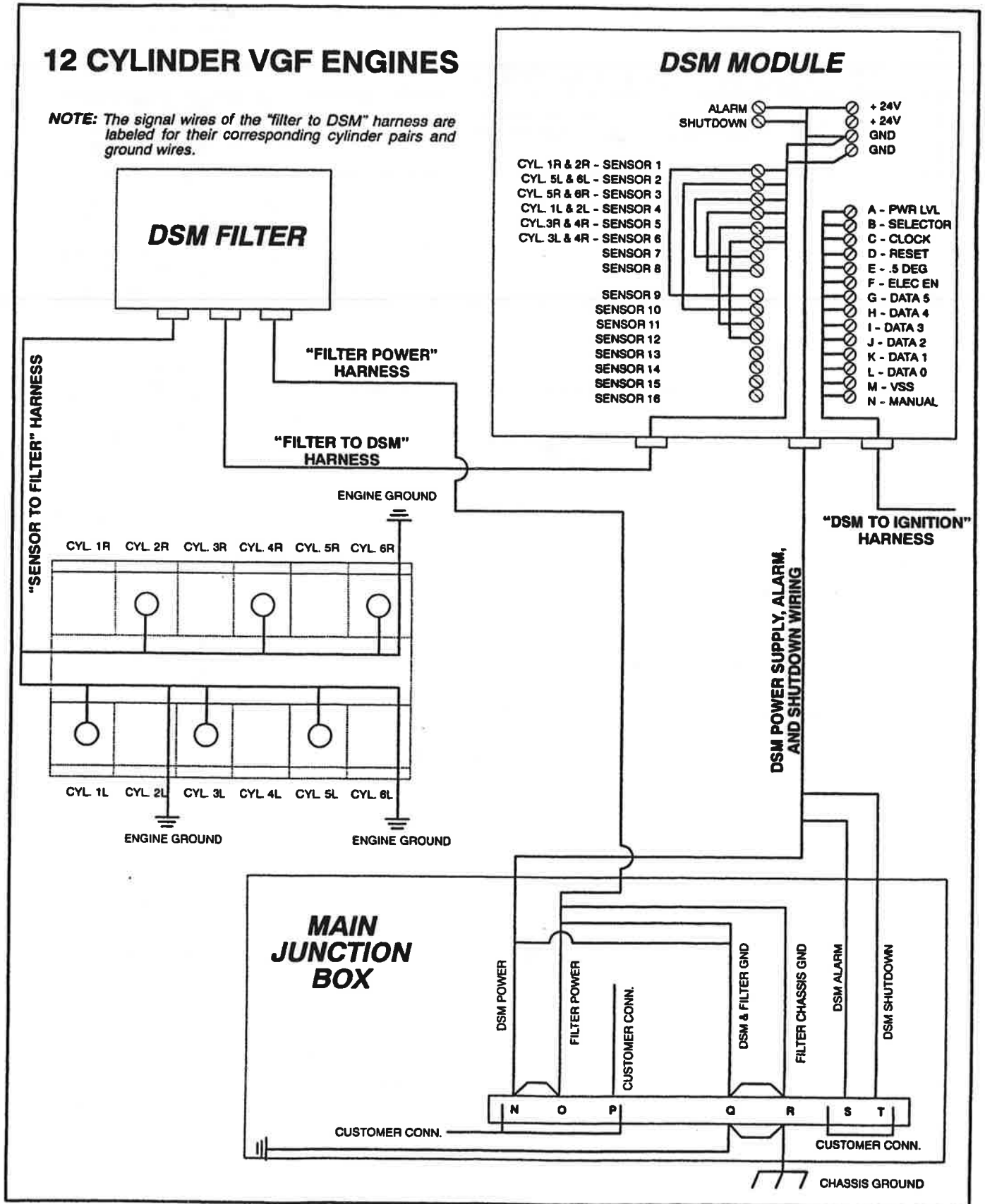


Figure 2.15-10. VGF DSM System Wiring Diagram - 12 Cylinder

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.

# DSM SYSTEM WIRING DIAGRAMS

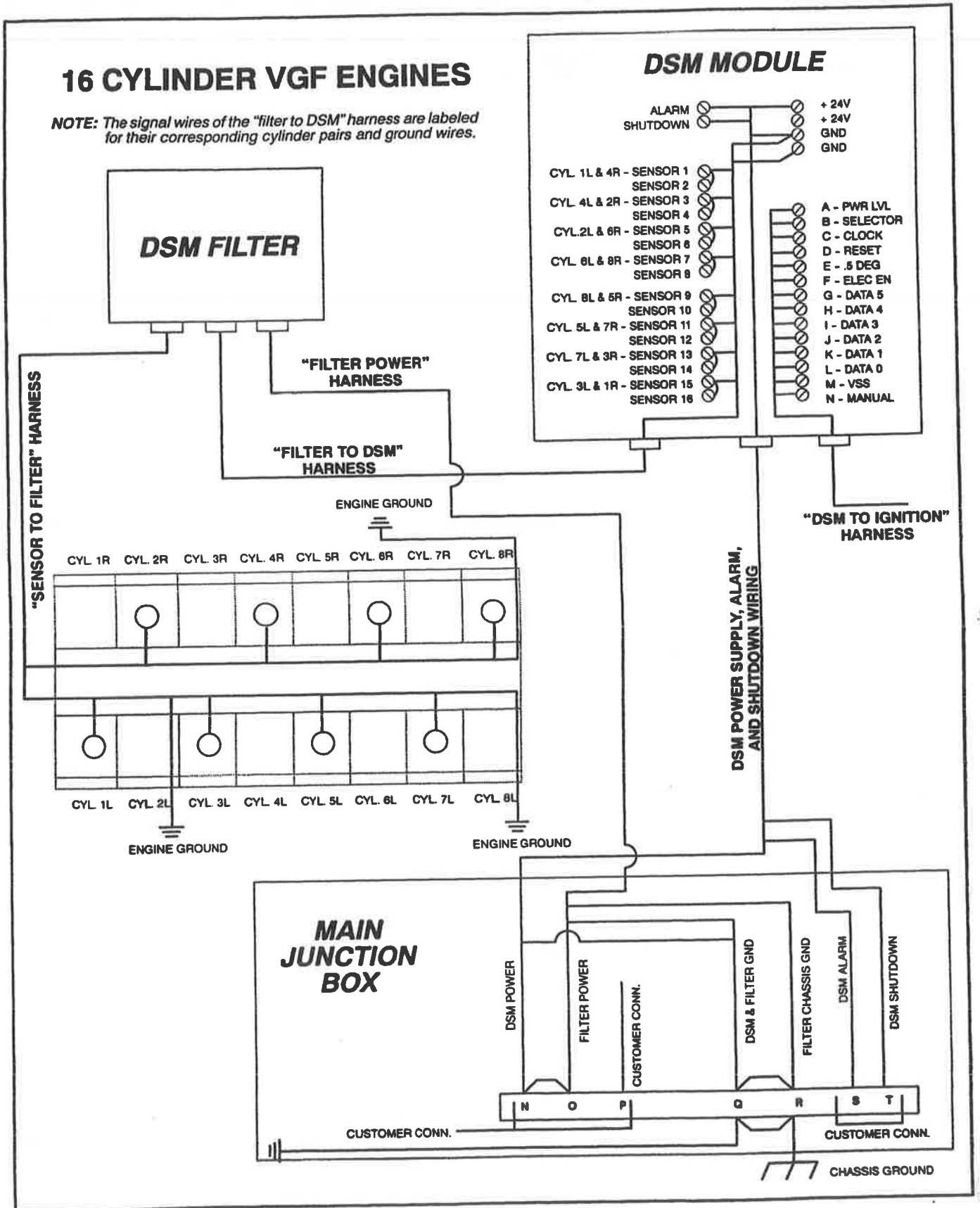


Figure 2.15-11. VGF DSM System Wiring Diagram - 16 Cylinder

**NOTE:** The wiring diagrams included in this manual are to be used as a reference only. For additional reference, use the wiring diagrams received with the DSM system when making connections.



**CONTENTS**

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**SECTION 3.00 - DSM INTERFACE PROGRAM OPERATION**

**SECTION 3.05 - EDITING AN EXISTING DSM DATA-SET**

**SECTION 3.10 - PROGRAMMING THE DSM SYSTEM  
FOR A NEW APPLICATION**

**SECTION 3.15 - DSM COMPUTER SCREEN AND  
DATA RETRIEVAL**

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## SECTION 3.00

### DSM INTERFACE PROGRAM OPERATION

#### PROGRAMMING INFORMATION

##### MINIMUM RECOMMENDED COMPUTER FOR DSM SYSTEM EQUIPMENT PROGRAMMING

The DSM system is customized for each engine application based on site specific information with a personal computer (PC). The following is a list of the minimum recommended computer equipment for DSM system programming:

- Portable IBM PC or Compatible Computer
- Intel 80286-12 MHz Microprocessor
- 640K RAM (512K RAM free)
- Single 3.5" High Density (1.44 MB) Floppy Drive
- RS-232 Serial Port
- Microsoft MS-DOS 3.3
- DB-9 Serial Cable (male to female)
- Optional: Printer Port (Centronics Type Parallel Port)
- Optional: Portable Printer with IBM Proprinter Emulation Mouse (Print-outs of computer screens can be used to aid in troubleshooting and filed for future reference.)

##### CONVENTIONS USED WITH DSM PROGRAMMING

The following is a list of conventions used in the DSM system software and documentation:

- All commands enclosed in brackets, [ ], are to be executed from the PC keyboard.
- In most cases, if an errant keystroke is made with the PC, simply press [Esc] to return to the previous menu.
- You can highlight menu options by using the arrow keys.
- Highlighting and then pressing [Enter] accesses a screen menu choice.

- If you have a portable printer connected to your PC, press [Print Screen] to make a copy of the screen you are viewing for reference.
- The [Return] key is the same as the [Enter] key (on some keyboards [Return] is used instead of [Enter]).

**NOTE:** This manual assumes you are already familiar with basic MS-DOS commands for viewing directories, copying files, and other MS-DOS concepts. If you need more information on these subjects, refer to a MS-DOS instruction manual.

#### OPERATOR INTERFACE

The DSM module is equipped with diagnostic features to inform site personnel of system status at any time. These diagnostic features include:

- "Power," "Alarm," and "Shutdown" lights (LED) on the front panel of the DSM module (see Figure 3.00-1)
  - The green "Power" LED is lit any time power is applied to the DSM module.

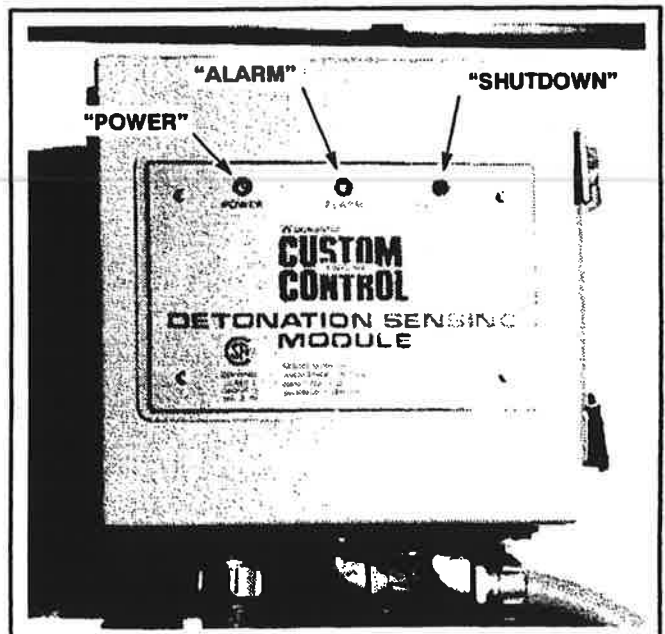


Figure 3.00-1. Detonation Sensing Module Front Panel

## DSM INTERFACE PROGRAM OPERATION

- The yellow "Alarm" LED is lit when power is applied to the DSM and the engine is not running (not due to shutdown mode). The "Alarm" LED lights any time a sensor output is lost or disconnected (6, 8, and 12 cylinder engines). Additionally, the alarm LED lights when the timing is retarded to the most retarded limit (uncontrollable detonation). The alarm LED flashes when the shutdown delay expires and detonation is still present.

**NOTE:** For 16 cylinder engines a sensor test must be performed to detect a lost sensor. The lost sensor check procedure is explained in Section 4.10, Lost Sensor Check Test On 16 Cylinder Engines. A test for lost sensors should be performed whenever the safety controls and alarms are tested on the engine.

- The red "Shutdown" LED lights when the DSM system has reached the most retarded timing, the shutdown delay has timed out, and the engine is still in detonation.
- a liquid crystal display (LCD) located inside the DSM module which continually shows the current status of the system through specific diagnostic codes for all conditions (see Figure 3.00-2 and Table 3.00-1)

Refer to Section 4.00, *DSM System Diagnostics And Troubleshooting*, for more diagnostic and troubleshooting information.

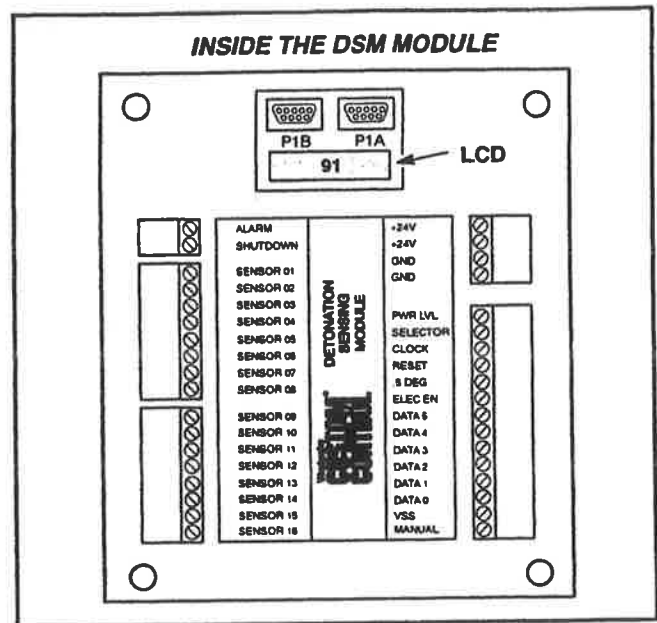


Figure 3.00-2. Detonation Sensing Module LCD

Table 3.00-1. Description Of Diagnostic Codes

OPERATIONAL CODES		
Code	Status	Description of Condition
Blank	No Power	The DSM module is not powered, system not operating.
(00)	Loss of Rotation	DSM module has sensed that the engine has stopped running.
(75)	Shutdown Active	Uncontrolled detonation present, shutdown output activated by the DSM module.
(90)	Ready to Start	DSM module is waiting for engine to be started.
(81)	Error Present	Sensor error code detected by DSM module. Sensor error for Maximum Retard or failed sensor will follow.
(91)	Normal Operation	The DSM system is running properly. Detonation is being controlled and no errors are present.
(95)	Warm-up Cycle	Warm-up delay time has not elapsed, therefore, engine is running at default timing.
PGM (PROGRAM) INTERRUPT CODES		
Code	Status	Description of Condition
(66)	Configuration Error	Configuration data or application problem if present. (Example: DSM module has been programmed for the wrong engine.)
(86)	Executing AutoCal	DSM module is establishing detonation threshold.
(97)	Serial Transfer	DSM module is communicating with the PC through serial cable.
(99)	No data	The DSM module has not yet been programmed and should not be connected to the Ignition Module while this code is active.
SENSOR CODES		
Code	Status	Description of Condition
(01-16)	Failed Sensor	The DSM module no longer senses a signal from the filter.
(21-36)	Maximum Retard	The cylinder timing for the corresponding sensor has been retarded to its most retarded timing.
(41-56)	Disabled Sensor	The DSM module has been programmed to not control the timing on the corresponding sensor. The cylinder is at default timing.

### PROGRAMMING THE DSM SYSTEM

In this manual, programming is divided into three sections: Section 3.05, Section 3.10, and Section 3.15. Follow the programming steps in the section described below that meet your programming requirements:

- **Section 3.05 Editing An Existing DSM Data-Set**

The programming steps in this section should be completed when an existing data-set saved to ROM requires editing.

Engines shipped from the factory with the DSM system are initially setup at the factory. A data-set is created at the factory for testing the DSM system on the engine. If your DSM was installed and shipped from the factory, it will only be necessary to edit the data-set since the DSM system was tested on the engine at the factory.

**NOTE:** An AutoCal program, as explained in Section 4.05, must be run the first time the DSM is programmed for an engine (including engines shipped from the factory with the DSM system).

If your DSM was installed as a retrofit or was used on a different engine model, complete the steps in Section 3.10 to program the DSM for a new application.

**NOTE:** If the internally mounted LCD display inside the DSM module reads "99" (no data), the DSM module is sensing that a new EPROM chip is installed and no data-set exists. You will need to complete the programming steps in Section 3.10, Programming The DSM System For A New Application.

- **Section 3.10 Programming The DSM System For A New Application**

The programming steps and post-programming checks in this section must be completed in retrofit applications and whenever a DSM module is removed from one engine and installed on another engine model.

If the internally mounted LCD inside the DSM module reads "99" (no data), the DSM module is sensing that a new EPROM chip is installed and no data-set exists. You will need to complete the programming steps in Section 3.10.

- **Section 3.15 DSM System Computer Screen And Data Retrieval**

This section is to provide the steps needed to retrieve DSM computer screens to view engine performance. No programming or editing procedures are included in this section. This section explains the steps necessary to view data-sets and computer screens.

### INFORMATION ON SAVING DATA-SETS TO RAM AND ROM MEMORY

The DSM system is designed to be used with many engine families of various configurations. Consequently, it must be tailored to work with site specific information. This is achieved by creating and installing a "data-set" that is appropriate for your specific site application.

Data-sets are developed on the PC with the DSM Interface Program. Once a data-set is created, the data-set can be saved to a computer disk, tested on the DSM system in RAM (temporary DSM memory), or used to configure DSM ROM (permanent DSM memory).

RAM is used to evaluate "test" data-sets before storing to ROM. The contents of RAM are lost whenever power to the DSM module is removed. Be sure to save values to ROM after a test data-set is evaluated and is found acceptable.

When saving to ROM (permanent memory), 25 data-sets can be saved before the EPROM chip must be replaced. Once a data-set is stored to ROM, the previous save to ROM is not accessible/retrievable. The DSM module can only access the most recently saved data-set. When the DSM module saves a data-set to ROM, the data-set information is not lost when power to the DSM module is removed.

**NOTE:** The term EPROM is used to describe the electrical chip that resides in the DSM module. The EPROM chip houses ROM memory.

### DATA ACQUISITION MONITORING CAPABILITY

It is possible to acquire continuous streams of data about the DSM system using data acquisition software (software provided by customer). The DSM Terminal Program provides information on sensor status, diagnostic codes, and cylinder timing through the use of a PC. In addition to the information already provided by the DSM system, data serial streams are transmitted continuously from the DSM system that can be used to trend data for DSM and engine diagnostics information. The DSM serial streams are specified in Waukesha Engine specification sheet S-8484-1. Contact Waukesha Product Support for more information.

# DSM INTERFACE PROGRAM OPERATION

## DSM INTERFACE PROGRAM LAYOUT AND DESCRIPTION

Refer to Figure 3.00-3 for an illustrated menu layout of the DSM Interface Program.

### 1. COMMUNICATIONS MENU

Asks user to identify which communication port the DSM module is connected to on the PC by a DB-9 serial cable.

### 2. MAIN MENU

#### A. Edit/Create Setup

##### 1) Retrieve from DSM

Retrieves program currently running in the DSM module to the View/Edit Control Values Screen. The memory location where the data is stored will be indicated on the PC screen (RAM or ROM# location).

##### 2) Retrieve from Filename

Displays a list of DSM system data-sets previously saved to the same directory as the DSM Interface Program. Permits user to select a file to be retrieved into the View/Edit Control Values Screen.

##### 3) Create New Data-Set

Allows user to create a data-set from "scratch." The data-set is blank allowing the user to create a new data-set.

**NOTE:** Whenever it is necessary to create a new data-set, it is recommended that the programming steps described in Section 3.10, Programming The DSM System For A New Application, be completed instead of using the "Create New Data-Set" option from the Edit/Create Setup Menu. Whenever it is necessary to edit an existing data-set, it is recommended that the programming steps described in Section 3.05, Editing An Existing Data-Set, be completed.

#### B. View/Edit Control Values Screen

After selecting "Retrieve from DSM," "Retrieve from Filename," or "Create New Data-Set" from the Edit/Create Setup Menu, the appropriate data-set will be displayed on the View/Edit Control Values Screen. This allows the user to view and edit the system parameters. Press [F10] to display the Save Menu.

**NOTE:** Editing values on the View/Edit Control Values Screen will not affect the performance of the DSM system. The edited data-set must be saved to RAM or ROM to change the DSM system operating parameters.

##### 1) AutoCal [F5]

The AutoCal program is used to establish detonation threshold.

##### 2) Save Menu [F10]

###### a) Save to Filename

Saves the data-set displayed on the View/Edit Control Values Screen to disk. The filename can be up to eight characters and is saved to the drive and directory where the DSM Interface Program is located.

###### b) Test Data on DSM

Allows user to save data-set to RAM (temporary memory within the DSM module). This enables the user to temporarily evaluate data-sets on the DSM module before saving them to ROM (permanent memory within the DSM module). The contents of RAM are lost when power is disconnected from the DSM module. Make sure to save your final data-set to ROM.

###### c) Configure DSM Memory

Allows user to save the data-set to ROM (permanent memory within the DSM). The previous data-set configured to ROM will be "replaced" with the new data-set. The contents of ROM are not lost when power is disconnected from the DSM module.

###### d) View Wiring Data

Displays the wiring data for the chosen engine application.

#### C. New Application Setup

This setup is used the first time the DSM system is programmed for an engine (typically retrofit installations). Using this setup procedure will overwrite any existing data-set.

##### a) Engine Model Information

Allows user to customize a DSM system for a specific application by indicating engine family, engine model, and fuel type(s). Creates "skeleton" data-set to aid in programming.

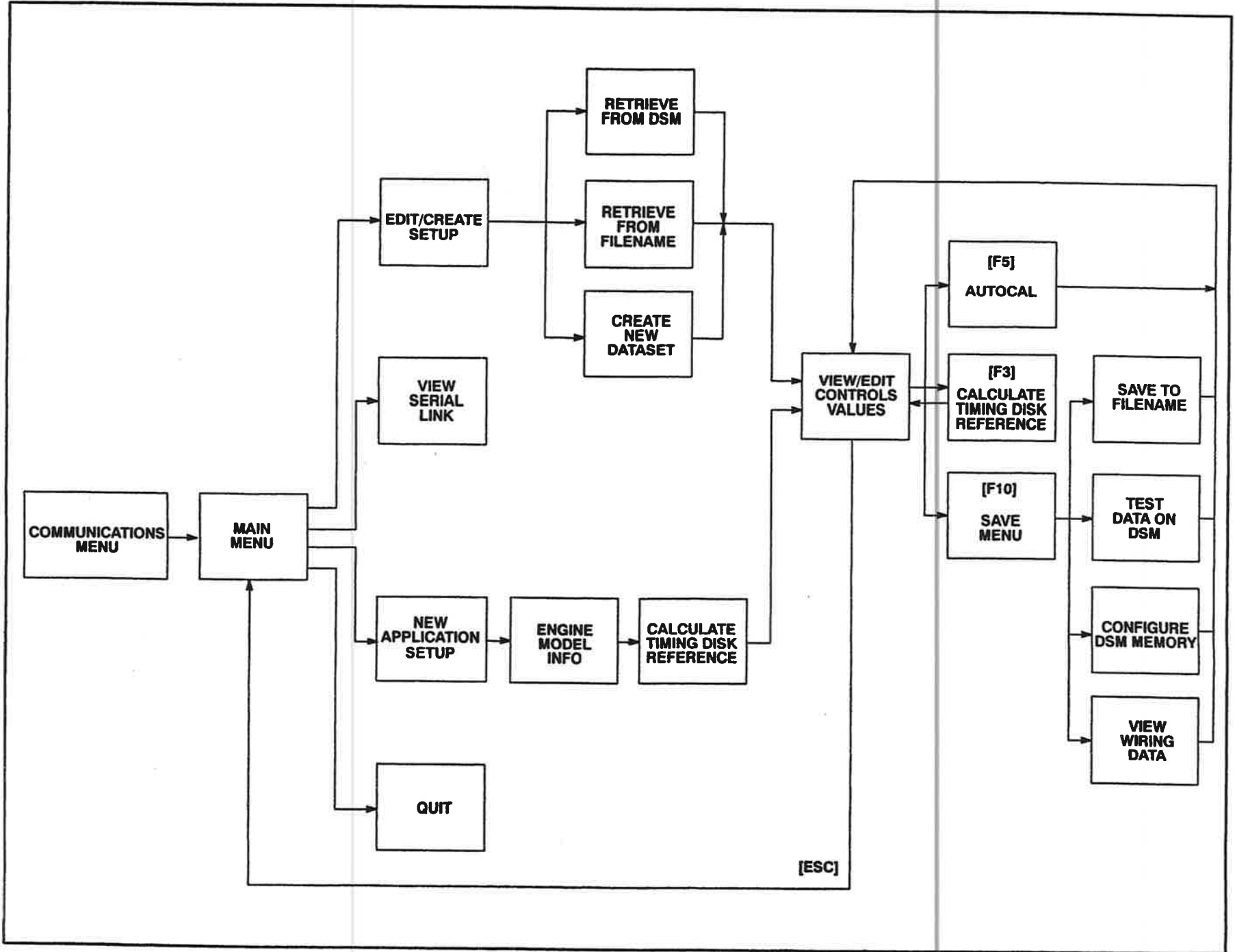
##### b) Calculate Timing Disk Reference

The position of the Ignition Module's timing disk is not the same on all engines. TDR is the angular relationship between the magnet for the first cylinder to fire and top dead center (example: 25° BTDC). This position has to be calculated for the DSM module to accurately control timing.

#### D. View Serial Link

Allows operator to monitor current system performance. Aids in troubleshooting.

Figure 3.00-3. DSM Interface Program Layout



# DSM INTERFACE PROGRAM OPERATION

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## SECTION 3.05

### EDITING AN EXISTING DSM DATA-SET

#### EDITING INFORMATION

This section, Section 3.05 *Editing An Existing DSM Data-Set*, explains the steps required to edit an existing DSM data-set. The data-set that is edited following the procedures in this section is engine specific. Complete all the programming steps provided in this section.

**NOTE:** Engines shipped from the factory with the DSM system are initially setup at the factory. A data-set is created at the factory for testing the DSM system on the engine. Since a data-set already exists, complete the steps in this section.

**NOTE:** An AutoCal program, as explained in Section 4.05, must be run the first time the DSM is programmed for an engine (including engines shipped from the factory with the DSM system).

**NOTE:** If the internally mounted LCD inside the DSM module reads "99" (no data), the DSM module is sensing that a new EPROM chip is installed and no data-set exists. You will need to complete the programming steps in Section 3.10, Programming The DSM System For A New Application.

Section 3.10, *Programming The DSM System For A New Application*, explains the programming steps and post-programming checks to be completed in retrofit applications or whenever a DSM module is removed from one engine and installed on another engine model. By completing the programming steps in this section, any existing data-set is overwritten and an entirely new data-set is programmed.

Section 3.15, *DSM System Computer Screen And Data Retrieval*, explains the procedures necessary to access DSM system information from the DSM Interface Program using a PC. Section 3.15 does not include any programming procedures.

**NOTE:** This manual assumes you are already familiar with basic MS-DOS commands for viewing directories, copying files, and other MS-DOS concepts. If you need more information on these subjects, refer to a MS-DOS instruction manual.

#### PRE-PROGRAMMING INSTALLATION CHECKLIST

Complete the preprogramming installation checklist only if you are editing the data-set at initial engine and DSM system startup. If your engine is running with the DSM system and you are editing a saved data-set, it is not necessary to complete the preprogramming installation checklist.

Before applying power to the DSM system:

- A. **Disconnect the DSM module from the Ignition Module** by removing the "DSM to ignition" harness from the 14 pin connector on the side of the Ignition Module (see Figure 3.05-1).

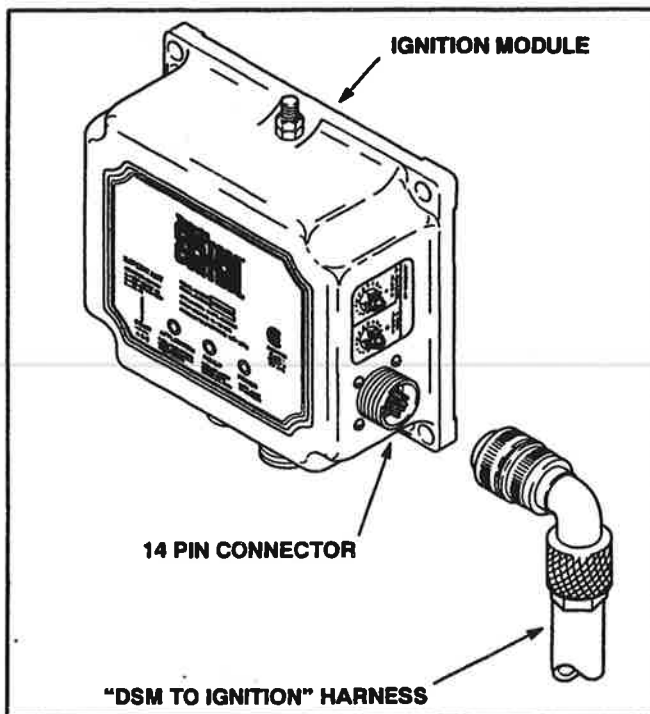


Figure 3.05-1. Disconnecting The "DSM To Ignition" Harness

## EDITING AN EXISTING DSM DATA-SET

- B. Visually inspect the installation to be sure that all wiring conforms to the requirements of this manual, local codes, and regulatory bodies. Verify that each connection to the DSM module is routed through the correct conduit (see Figure 3.05-2).

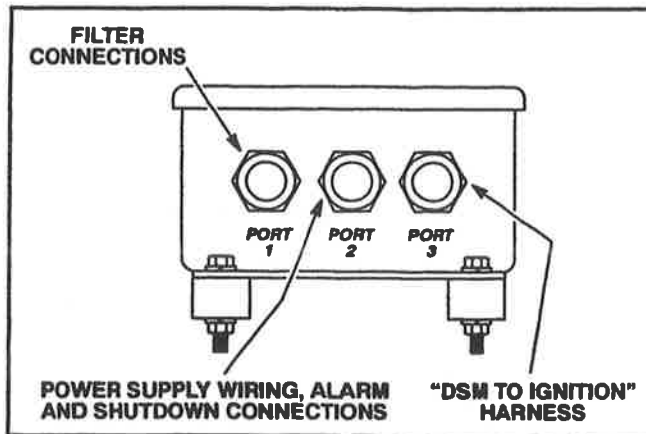


Figure 3.05-2. DSM Module Conduit Ports

- C. Verify that the power supply is within specification. Refer to Section 2.10, *DSM System Power, Alarm, And Ground Connections*, for power specifications to the DSM module. Make this measurement with an oscilloscope at the supply wires to the DSM module with the engine running.

## EDITING THE DSM DATA-SET

### ESTABLISHING COMMUNICATION WITH THE DSM

1. If you are editing the data-set at initial engine and DSM system startup, verify that the DSM module is disconnected from the Ignition Module before applying power. If the DSM module is not disconnected from the Ignition Module, disconnect the "DSM to ignition" harness from the 14 pin DSM connector on the side of the Ignition Module (see Figure 3.05-1).

**NOTE:** It is not necessary to disconnect the DSM from the Ignition Module in Step 1 when editing a data-set for an engine that has been running with the DSM system.

2. If no power is applied to the DSM module, apply power. The "Power," "Alarm," and "Shutdown" LEDs on the front cover will light for approximately five seconds. The green power LED will remain on when the alarm and shutdown LEDs go off. The internally mounted LCD display will read "90" (system OK - ready and waiting for engine to start).

**NOTE:** If the internally mounted LCD reads "99" (no data) instead of "90," the DSM module is sensing that a new EPROM chip is installed in the DSM module. Complete the programming steps in Section 3.10, *Programming The DSM System For A New Application*.

**NOTE:** If any of the alarm or shutdown LEDs come on any time during DSM system operation, see Section 4.00, *DSM System Diagnostics And Troubleshooting*.

3. The DSM module must be programmed to work with site specific information in order for the DSM system to function properly. To program the DSM module, connect a standard DB-9 serial cable (male to female) to the communications port (labeled P1A) within the DSM module. This is the communications port on the right (see Figure 3.05-3). Connect the other end of the cable to the PC's communications port. Typically, this is port 1 (also referred to as COM 1, serial A, or serial 1).

**CAUTION** Verify that the DB-9 serial cable is securely connected to the appropriate computer port. If the serial cable is disturbed or disconnected during the saving process, the EPROM chip in the DSM module will become corrupted and will need to be replaced.

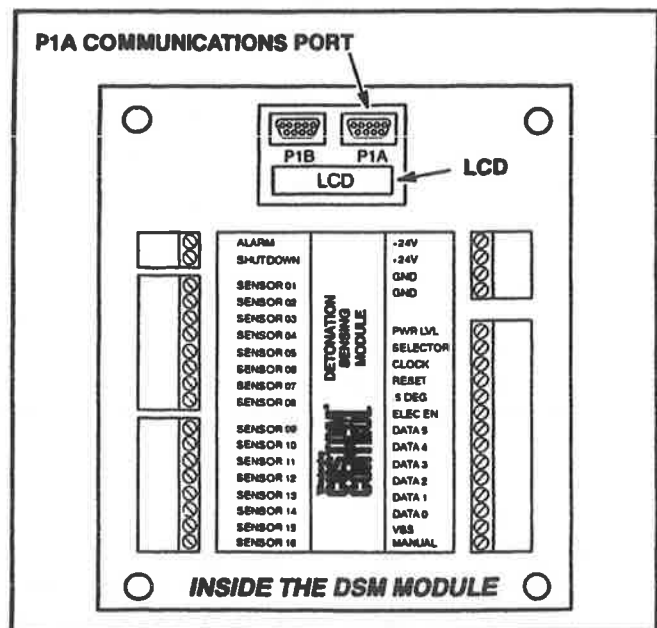


Figure 3.05-3. DB-9 Serial Cable Connection Inside DSM Module

4. Start the DSM Interface Program on your PC.

**NOTE:** For information on installing and/or accessing the DSM Interface Program, refer to the page at the back of this manual which holds the 3-1/2" diskette for installation and accessing instructions.

5. The "Genuine Waukesha Parts" logo screen appears briefly, followed by the screen shown in Figure 3.05-4. The bottom line of this screen indicates what version of the DSM Interface Program you are using.

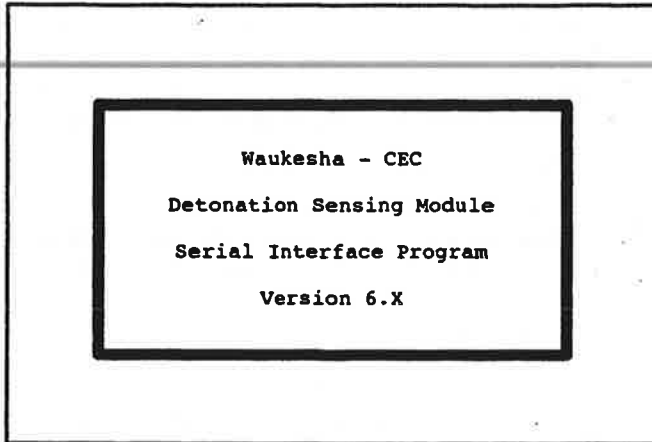


Figure 3.05-4. Software Version Identification

6. Automatically the Communications Menu appears (see Figure 3.05-5). A black dot is located in a circle next to "1" which indicates that the selected communications port on your computer is port 1. Press [Enter] to select communications port 1. If the DB-9 cable is connected to a different port on your PC, use the arrow keys on the keyboard to select the corresponding port from the Communications Menu and press [Enter] (typically: port 1 is correct).

7. The DSM Interface Program's Main Menu appears showing various program options available (see Figure 3.05-6). Highlight "Edit/Create Setup" and press [Enter]. This option allows you to view and edit the DSM system data-set that is already programmed.

8. The menu shown in Figure 3.05-7 appears. Highlight "Retrieve from DSM" from this menu and press [Enter].

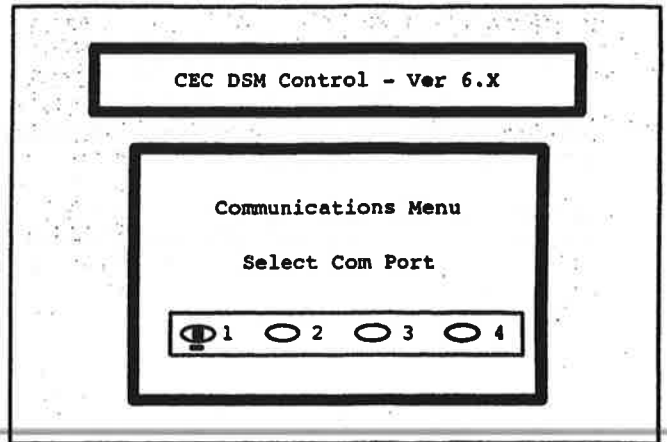


Figure 3.05-5. Communications Menu

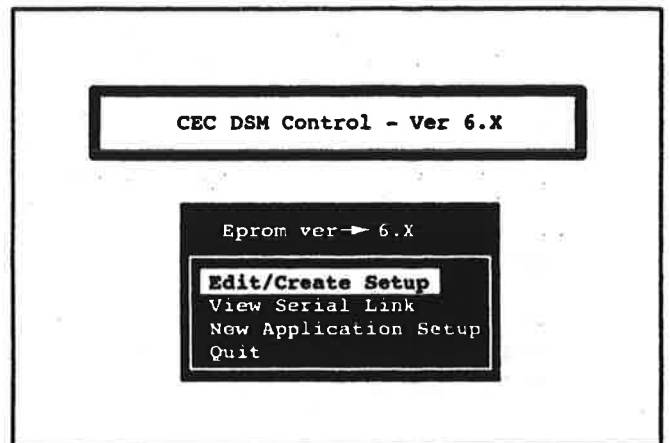


Figure 3.05-6. DSM Interface Program Main Menu

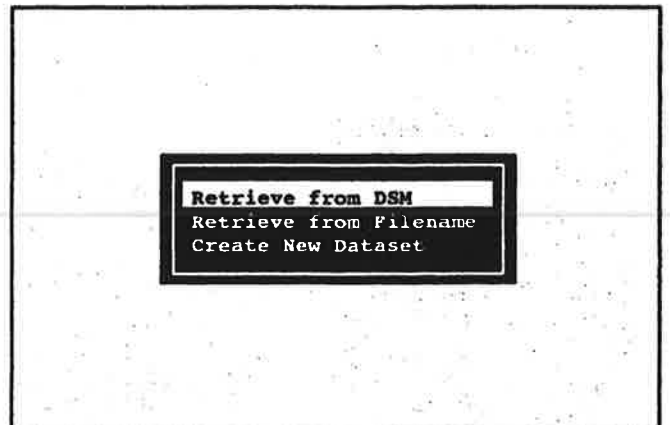


Figure 3.05-7. Edit/Create Setup Menu

## EDITING AN EXISTING DSM DATA-SET

9. Several screens will appear indicating that the data is being retrieved from the DSM module. The screen shown in Figure 3.05-8 indicates what data source is being retrieved. For example, Figure 3.05-8 indicates that the data source is ROM 11.

**NOTE:** You can save 25 times to ROM memory (permanent memory) before replacing the EPROM chip in the DSM module.

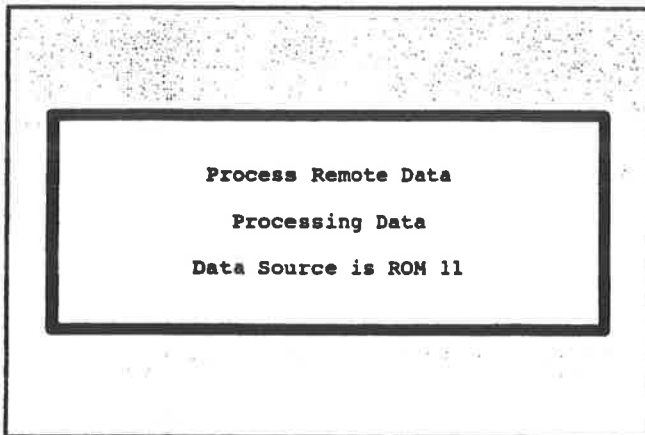


Figure 3.05-8. Processing Data Verification Screen

10. Then the View/Edit Control Data Values Screen appears (see Figure 3.05-9). This screen shows the engine data-set parameters. The information shown on the screen is stored on the DSM EPROM chip (ROM or permanent memory).

You can change data-set information on the View/Edit Control Data Values Screen by entering data as desired. To change data-set information, continue with "Editing The DSM Data-Set."

**NOTE:** For the purposes of this manual, the DSM module will be programmed for a 12 cylinder VHP L7042 engine. The programming steps taken in this manual are the same for whatever engine family you choose (exceptions are noted).

### EDITING THE DSM DATA-SET

A data-set is a group of site specific data points that are created and then stored within the DSM module. The DSM data-set includes values for: Most Advanced Timing, Most Retarded Timing, End of Sample Window angle, retard and advanced timing values, warm-up delay time, and shutdown delay time (see Figure 3.05-9). Complete the steps that follow to edit the data-set for the engine you are programming.

**NOTE:** Editing values on the View/Edit Control Data Values Screen will not affect the performance of the DSM system. The edited data-set must be saved to RAM or ROM to change the DSM system's operating parameters.

**NOTE:** If the values in the Detonation Level Select table in the View/Edit Control Data Values Screen are above 2400 mV, the knock sensors are disabled and may indicate the knock sensors are not calibrated. Run the AutoCal program to calibrate the knock sensors. Complete the steps in Section 4.05, Running The DSM AutoCal Program, to calibrate the sensors.

You can change data points on the View/Edit Control Data Values Screen by moving the cursor with the arrow keys and entering data as desired.

View/Edit Control Data Values

Engine Family : VHP GAS ENGINE	
Engine Model : L7042 V-12	
# of Cylinders: 12	
Primary Fuel : NATURAL GAS PIPELINE QUALITY	
Secondary Fuel: DIGESTER GAS	
Comments:	
Timing Disk Reference	26 °BTDC
<F3> To Calculate TDR	
D-Lead Position - - ->	Grounded                      Open
Most Advanced Timing	10 °BTDC                      10 °BTDC
Most Retarded Timing	4 °BTDC                        4 °BTDC
Default Timing	8 °BTDC                        8 °BTDC
End of Sample Window	30 °ATDC
Retard 1°	Every 1 Knock Sample(s)
Advance 1°	Every 5 No-Knock Sample(s)
Warm-Up Delay Time	300 Seconds
Shutdown Delay Time	15 Seconds

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Detonation Level Select

Sensor 1	656	mV
Sensor 2	882	mV
Sensor 3	705	mV
Sensor 4	617	mV
Sensor 5	705	mV
Sensor 6	705	mV
Sensor 7	833	mV
Sensor 8	793	mV
Sensor 9	656	mV
Sensor 10	882	mV
Sensor 11	617	mV
Sensor 12	744	mV

**NOTE:** Entries above 2400mV result in a Disabled Sensor.

Figure 3.05-9. View/Edit Control Data Values Screen

1. If disconnected, reconnect the DSM module ("DSM to ignition" harness) to the Ignition Module. After reconnecting the DSM module to the Ignition Module, ignition timing is being controlled by the DSM system so the data-set for the engine can be completed.

**NOTE:** It is not necessary to verify Timing Disk Reference (TDR) in Step 2 when editing a data-set for an engine that has been running with the DSM system. If you are editing the data-set at initial engine and DSM system startup, perform the TDR verification in Step 2.

2. Using a timing light, verify that the correct Timing Disk Reference (TDR) value is programmed. The TDR value is shown on the View/Edit Control Data Values Screen. Complete the following:

- A. Press [Esc] to return to the Main Menu. Highlight "View Serial Link" and press [Enter] (see Figure 3.05-10).

**NOTE:** If changes were made to the data-set and were not saved before pressing [Esc], the DSM program will give you an option to save BEFORE returning to the Main Menu. Save changes if desired.

- B. If engine timing does match the Timing (°BTDC) shown on the Display Serial Port Screen, continue with Step 3. If the engine timing does not match, the TDR value needs to be adjusted.
- C. If engine timing is lower than the timing shown, then decrease the TDR value by that amount. For example, if timing is set at 11° but the engine is running at 10°, then decrease the TDR value by 1°.

D. If engine timing is higher than the timing shown, then increase the TDR value by that amount. For example, if timing is set at 11° but the engine is running at 12°, then increase the TDR value by 1°.

E. Press [Esc] to return to the Main Menu. Highlight "Retrieve from DSM" and press [Enter] to return to the View/Edit Control Data Values Screen.

F. Use the arrow keys to position the cursor in the "Timing Disk Reference" field on the View/Edit Control Data Values Screen.

G. Enter the adjusted TDR value and press [Enter].

H. Press [F10] to test the new TDR value. Highlight "Test Data on DSM" on the next menu and press [Enter]. The new information is now saved to RAM (temporary memory). Press any key to continue.

**NOTE:** The "Test Data on DSM" option from the Save Options Menu allows a program to be run in the DSM module's temporary memory (RAM). The contents of RAM are lost whenever power to the DSM module is removed.

I. Using a timing light, verify that the engine timing is running at the timing shown on the Display Serial Port Screen. If engine timing does match continue with Step 3. If the engine timing does not match, repeat Steps A - H. If repeating these steps does not correct engine timing, contact Waukesha Product Support.

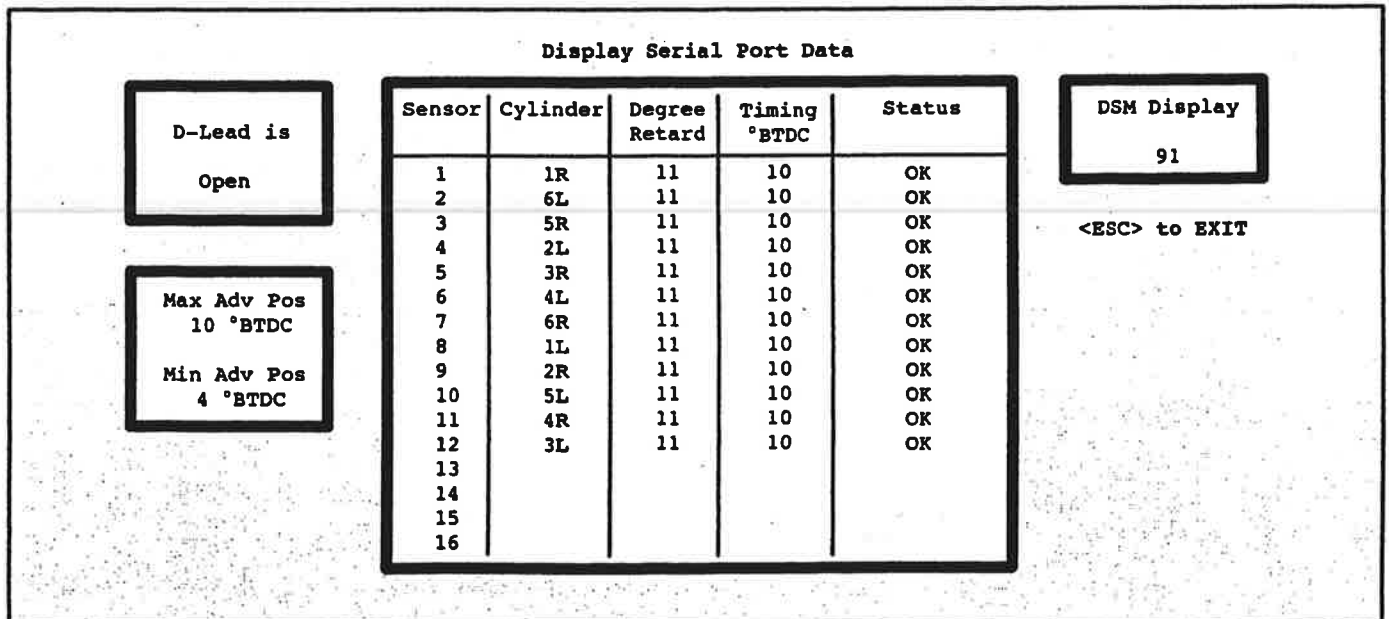
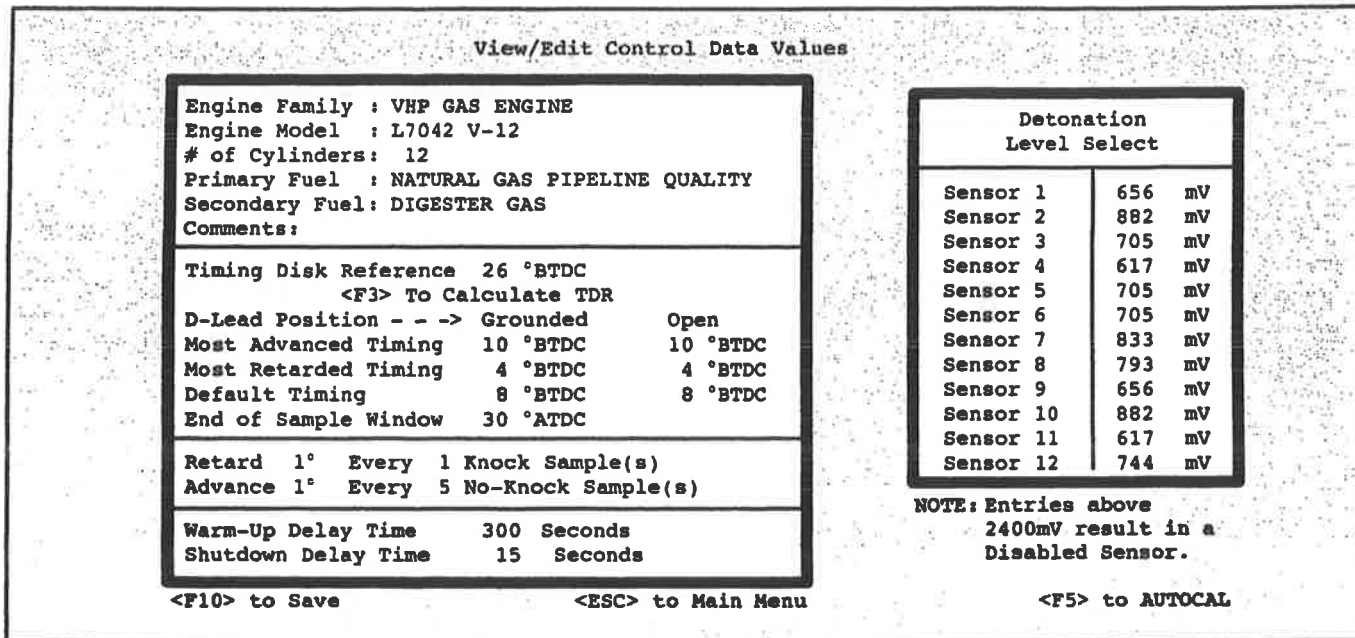


Figure 3.05-10. Display Serial Port Data Screen

# EDITING AN EXISTING DSM DATA-SET



**Figure 3.05-11. View/Edit Control Data Values Screen**

3. The DSM parameters include: default timing values, retard and advance timing values and rates of change, and delay times. To edit any of the values in the data-set, position the cursor in the field for the parameter you want to edit. Then enter the new value.

Refer to Figure 3.05-11 and the correct table while editing the data-set. The values provided in the tables are the recommended data-set parameters for the DSM system. Modifications may be made based on site conditions.

- Table 3.05-1 on page 7 provides the data-set parameters for 8L-AT27GL engines.
- Table 3.05-2 on page 8 provides the data-set parameters for 12V-AT27GL engines.
- Table 3.05-3 on page 8 provides the data-set parameters for 12V-AT25GL engines.
- Table 3.05-4 on page 8 provides the data-set parameters for VHP engines.
- Table 3.05-5 on page 8 provides the data-set parameters for VGF engines.

Listed are definitions of each of the data-set parameters found on the View/Edit Control Data Values Screen.

**Comments:** Type in any comments regarding DSM programming or revise existing comments. Typically, comments include site, engine number, and date information.

**Most Advanced Timing:** The maximum advanced timing at which the system will allow the engine to operate. Enter the most advanced timing for the Ignition Module's "D" lead grounded and the most advanced timing for the "D" lead open.

**NOTE:** "Most Advanced Timing" may not be greater than nameplate timing.

**Most Retarded Timing:** The minimum timing at which the DSM system will allow a cylinder to retard in order to control detonation. Enter the most retarded timing for the Ignition Module's "D" lead grounded and the most retarded timing for the "D" lead open.

**Default Timing:** Default timing is the retarded ignition timing imposed by the DSM system when it is not protecting against detonation. The DSM system activates default timing for a cylinder when the cylinder's sensor is disabled, when the sensor fails, and during engine warm-up delay.

**End of Sample Window:** The end of sample window is a predetermined angle after top dead center (ATDC) in crankshaft degrees at which the DSM system stops looking for detonation.

**Retard X° Every Y Knock Sample(s):** Allows you to select how fast the timing retards by changing the "X" and "Y" values. When an individual cylinder is in detonation, the timing retards "X" degrees for every "Y" consecutive times detonation is found.

**Advance X° Every Y No-Knock Sample(s):** Allows you to select how fast the timing advances by changing the "X" and "Y" values. Once an individual cylinder is no longer in detonation, the timing advances "X" degrees for every "Y" consecutive times the cylinder is not found to be detonating.

**Warm-Up Delay Time:** Allows you to select the amount of delay between the time the engine begins rotating and when the DSM system takes control. While this delay is active, the cylinders are operating at the default timing. The purpose of this delay is to prevent misleading vibration signals, that may exist during the time the engine is warming up, from being incorrectly construed as "knock" signals. During the Warm-Up Delay Time, the DSM system is not protecting against detonation.

**Shutdown Delay Time:** Allows you to select the amount of delay between the moment when the cylinder reaches the Most Retarded Timing during detonation and the time the shutdown warning becomes active while still in detonation.

**NOTE:** Make sure to program the Shutdown Delay Time long enough to avoid unnecessary shutdowns. For example: If engine timing reaches the Maximum Retard limit AND the Shutdown Delay Time is shorter than the Advance Rate, shutdown may occur before the engine is allowed to advance at the programmed Advance Rate.

4. If you are editing the data-set at initial engine and DSM system startup (engines shipped from the factory with the DSM system), complete an AutoCal program. The AutoCal program is the automatic calibration of the detonation threshold levels by the DSM Interface Program. Complete the programming steps in Section 4.05, *Running The DSM AutoCal Program*, to run the AutoCal program.

**NOTE:** If the values in the Detonation Level Select table in the View/Edit Control Data Values Screen are above 2400 mV, the knock sensors are disabled and may indicate the knock sensors are not calibrated. Run the AutoCal program to calibrate the knock sensors. Complete the steps in Section 4.05, *Running The DSM AutoCal Program*, to calibrate the knock sensors. An AutoCal should be run the first time the DSM is programmed for an engine or whenever a DSM is programmed for a new application. Additionally, the DSM system must be re-AutoCaled using the DSM Interface Program and a PC after doing any removal, repair, or replacement of engine cylinder heads, cylinder liners, cylinder gaskets, pistons, or knock sensors. This calibration **MUST BE** done using the AutoCal program.

5. Continue with the next section, "Saving Data-Set To ROM," to permanently save the edited data-set. Make sure to complete the next section. Data-sets NOT saved to ROM are lost when power is disconnected from the DSM module.

Table 3.05-1. 8L-AT27GL DSM Data-Set Parameters<sup>1</sup>

FUEL	AIR/FUEL RATIO (% EXHAUST O <sub>2</sub> )	DEFAULT TIMING VALUES (°BTDC)	MAX. ADVANCE <sup>2</sup> (°BTDC)	MAX. RETARD (°BTDC)	END OF SAMPLE WINDOW	"D" LEAD
Natural Gas	28:1 (9.8)	6°	8°	2°	30°	OPEN
	32:1 (11.4)	18°	20°	8°	30°	GROUND
Field Gas (115 Octane)	32:1 (11.4)	8°	10°	4°	30°	OPEN
Digester Gas	30:1 (10.5)	18°	20°	12°	30°	GROUND
Landfill Gas	30:1 (10.5)	18°	22°	14°	30°	GROUND
<b>FUEL QUALITY:</b>		<b>64 WKI™ AND BELOW</b>		<b>64 WKI™ +</b>		
Retard Rate		4° Every 1 Knock Sample(s)		1° Every 1 Knock Sample(s)		
Advance Rate		1° Every 5 No-Knock Sample(s)		1° Every 5 No-Knock Sample(s)		
Warm-Up Delay Time		300 Second(s)		300 Second(s)		
Shutdown Delay Time		5 Second(s)		15 Second(s)		

**NOTE:** <sup>1</sup> The timing values listed apply to engines with the six hole prechamber cups.  
<sup>2</sup> "Max. Advance" should never exceed nameplate timing.

# EDITING AN EXISTING DSM DATA-SET

**Table 3.05-2. 12V-AT27GL DSM Data-Set Parameters<sup>1</sup>**

FUEL	AIR/FUEL RATIO (% EXHAUST O <sub>2</sub> )	DEFAULT TIMING VALUES (°BTDC)	MAX. ADVANCE <sup>2</sup> (°BTDC)	MAX. RETARD (°BTDC)	END OF SAMPLE WINDOW	"D" LEAD
Natural Gas	28:1 (9.8)	6°	8°	2°	30°	OPEN
	32:1 (11.4)	16°	18°	8°	30°	GROUNDED
Field Gas (115 Octane)	32:1 (11.4)	8°	10°	4°	30°	OPEN
Digester Gas	30:1 (10.5)	16°	18°	10°	30°	GROUNDED
Landfill Gas	30:1 (10.5)	16°	20°	12°	30°	GROUNDED
<b>FUEL QUALITY:</b>		<b>64 WKI™ AND BELOW</b>		<b>64 WKI™ +</b>		
Retard Rate		4° Every 1 Knock Sample(s)		1° Every 1 Knock Sample(s)		
Advance Rate		1° Every 5 No-Knock Sample(s)		1° Every 5 No-Knock Sample(s)		
Warm-Up Delay Time		300 Second(s)		300 Second(s)		
Shutdown Delay Time		5 Second(s)		15 Second(s)		

**NOTE:** <sup>1</sup> The timing values listed apply to engines with the six hole prechamber cups.  
<sup>2</sup> "Max. Advance" should never exceed nameplate timing.

**Table 3.05-3. 12V-AT25GL DSM Data-Set Parameters**

FUEL	AIR/FUEL RATIO (% EXHAUST O <sub>2</sub> )	DEFAULT TIMING VALUES (°BTDC)	MAX. ADVANCE <sup>1</sup> (°BTDC)	MAX. RETARD (°BTDC)	END OF SAMPLE WINDOW	"D" LEAD
Natural Gas	28:1 (9.8)	8°	10°	4°	30°	OPEN
Digester Gas	26:1 (8.8)	12°	14°	8°	30°	OPEN
Landfill Gas	26:1 (8.8)	15°	17°	11°	30°	GROUNDED
<b>FUEL QUALITY:</b>		<b>64 WKI™ AND BELOW</b>		<b>64 WKI™ +</b>		
Retard Rate		3° Every 1 Knock Sample(s)		1° Every 1 Knock Sample(s)		
Advance Rate		1° Every 5 No-Knock Sample(s)		1° Every 5 No-Knock Sample(s)		
Warm-Up Delay Time		300 Second(s)		300 Second(s)		
Shutdown Delay Time		5 Second(s)		15 Second(s)		

**NOTE:** <sup>1</sup> "Max. Advance" should never exceed nameplate timing.

**Table 3.05-4. VHP DSM Data-Set Parameters**

<b>Most Advanced Timing</b>	Nameplate Timing
<b>Most Retarded Timing</b>	Nameplate Timing - 6°
<b>Default Timing</b>	Nameplate Timing - 2°
<b>End of Sample Window</b>	30°
<b>Retard X° Every Y Knock Sample(s)</b>	Retard 1° Every 1 Sample Propane Only = Retard 3° Every 1 Sample
<b>Advance X° Every Y No-Knock Sample(s)</b>	1° Every 5 Samples
<b>Warm-Up Delay Time</b>	300 Seconds
<b>Shutdown Delay Time</b>	15 Seconds

**Table 3.05-5. VGF DSM Data-Set Parameters**

<b>Most Advanced Timing</b>	Nameplate Timing
<b>Most Retarded Timing</b>	Nameplate Timing - 6°
<b>Default Timing</b>	Nameplate Timing - 2°
<b>End of Sample Window</b>	30°
<b>Retard X° Every Y Knock Sample(s)</b>	Retard 2° Every 1 Sample Propane Only = Retard 3° Every 1 Sample
<b>Advance X° Every Y No-Knock Sample(s)</b>	1° Every 5 Samples
<b>Warm-Up Delay Time</b>	300 Seconds
<b>Shutdown Delay Time</b>	15 Seconds



# EDITING AN EXISTING DSM DATA-SET

## SAVING DATA-SET TO ROM

1. Save the edited data-set to ROM (permanent memory) on the EPROM chip in the DSM module. Press [F10] for the Saving Options Menu.
2. Highlight "Configure DSM Memory" on the menu and press [Enter] (see Figure 3.05-12).

**NOTE:** The "Test Data on DSM" option from the Save Options Menu allows a program to be run in the DSM module's temporary memory (RAM). This may be used for troubleshooting so that the ROM memory space is

preserved. The contents of RAM are lost whenever power to the DSM module is removed.

3. When the Verification Screen appears as shown in Figure 3.05-13, press [Y].

**CAUTION** Do not disturb the serial cable or interrupt computer power while programming. If the serial cable is disturbed or disconnected during the saving process, the EPROM chip in the DSM module will become corrupted and will need to be replaced.

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE                  Engine Model : L7042 V-12                  # of Cylinders: 12                  Primary Fuel : NATURAL                  Secondary Fuel: DIGESTED                  Comments:</p> <p>Timing Disk Reference                  &lt;F3&gt; To Calculate IAK</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">D-Lead Position - - -&gt;</td> <td style="width: 30%;">Grounded</td> <td style="width: 30%;">Open</td> </tr> <tr> <td>Most Advanced Timing</td> <td>10 °BTDC</td> <td>10 °BTDC</td> </tr> <tr> <td>Most Retarded Timing</td> <td>4 °BTDC</td> <td>4 °BTDC</td> </tr> <tr> <td>Default Timing</td> <td>8 °BTDC</td> <td>8 °BTDC</td> </tr> <tr> <td>End of Sample Window</td> <td>30 °ATDC</td> <td></td> </tr> </table> <p>Retard 1° Every 1 Knock Sample(s)                  Advance 1° Every 5 No-Knock Sample(s)</p> <p>Warm-Up Delay Time 300 Seconds                  Shutdown Delay Time 15 Seconds</p>	D-Lead Position - - ->	Grounded	Open	Most Advanced Timing	10 °BTDC	10 °BTDC	Most Retarded Timing	4 °BTDC	4 °BTDC	Default Timing	8 °BTDC	8 °BTDC	End of Sample Window	30 °ATDC		<p style="text-align: center;">Detonation Level Select</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>Sensor 1</td><td>656 mV</td></tr> <tr><td>Sensor 2</td><td>882 mV</td></tr> <tr><td>Sensor 3</td><td>705 mV</td></tr> <tr><td>Sensor 4</td><td>617 mV</td></tr> <tr><td>Sensor 5</td><td>705 mV</td></tr> <tr><td>Sensor 6</td><td>705 mV</td></tr> <tr><td>Sensor 7</td><td>833 mV</td></tr> <tr><td>Sensor 8</td><td>793 mV</td></tr> <tr><td>Sensor 9</td><td>656 mV</td></tr> <tr><td>Sensor 10</td><td>882 mV</td></tr> <tr><td>Sensor 11</td><td>617 mV</td></tr> <tr><td>Sensor 12</td><td>744 mV</td></tr> </table> <p><b>NOTE:</b> Entries above 2400mV result in a Disabled Sensor.</p>	Sensor 1	656 mV	Sensor 2	882 mV	Sensor 3	705 mV	Sensor 4	617 mV	Sensor 5	705 mV	Sensor 6	705 mV	Sensor 7	833 mV	Sensor 8	793 mV	Sensor 9	656 mV	Sensor 10	882 mV	Sensor 11	617 mV	Sensor 12	744 mV
D-Lead Position - - ->	Grounded	Open																																						
Most Advanced Timing	10 °BTDC	10 °BTDC																																						
Most Retarded Timing	4 °BTDC	4 °BTDC																																						
Default Timing	8 °BTDC	8 °BTDC																																						
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Sensor 9	656 mV																																							
Sensor 10	882 mV																																							
Sensor 11	617 mV																																							
Sensor 12	744 mV																																							

Save Data to Filename  
 Test Data on DSM  
**Configure DSM Memory**  
 View Wiring Data

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Figure 3.05-12. Saving Options Menu

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE                  Engine Model : L7042 V-12                  # of Cylinders: 12                  Primary Fuel : NATURAL GAS PIPELINE QUALITY                  Secondary Fuel:                  Comments:</p> <p>Timing Disk Reference                  &lt;F3&gt;</p> <p>D-Lead Position                  Most Advanced Timing                  Most Retarded Timing                  Default Timing                  End of Sample Window</p> <p>Retard 1° Every                  Advance 1° Every</p> <p>Warm-Up Delay Time 300 Seconds                  Shutdown Delay Time 15 Seconds</p>	<p style="text-align: center;">Detonation Level Select</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>Sensor 1</td><td>656 mV</td></tr> <tr><td>Sensor 2</td><td>882 mV</td></tr> <tr><td>Sensor 3</td><td>705 mV</td></tr> <tr><td>Sensor 4</td><td>617 mV</td></tr> <tr><td>Sensor 5</td><td>705 mV</td></tr> <tr><td>Sensor 6</td><td>705 mV</td></tr> <tr><td>Sensor 7</td><td>833 mV</td></tr> <tr><td>Sensor 8</td><td>793 mV</td></tr> <tr><td>Sensor 9</td><td>656 mV</td></tr> <tr><td>Sensor 10</td><td>882 mV</td></tr> <tr><td>Sensor 11</td><td>617 mV</td></tr> <tr><td>Sensor 12</td><td>744 mV</td></tr> </table> <p><b>NOTE:</b> Entries above 2400mV result in a Disabled Sensor.</p>	Sensor 1	656 mV	Sensor 2	882 mV	Sensor 3	705 mV	Sensor 4	617 mV	Sensor 5	705 mV	Sensor 6	705 mV	Sensor 7	833 mV	Sensor 8	793 mV	Sensor 9	656 mV	Sensor 10	882 mV	Sensor 11	617 mV	Sensor 12	744 mV
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Sensor 9	656 mV																								
Sensor 10	882 mV																								
Sensor 11	617 mV																								
Sensor 12	744 mV																								

OK to Store New Values?

Yes
No esc

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Figure 3.05-13. Verification Screen

## EDITING AN EXISTING DSM DATA-SET

4. Several screens will appear indicating that the data-set is being saved to ROM, permanent memory on the EPROM chip inside the DSM module. Once the data-set has been saved to ROM, the message shown in Figure 3.05-14 appears.

**NOTE:** The DSM allows 25 saves to ROM. Once ROM has been fully configured, the EPROM chip in the DSM module must be replaced to permit further saves to permanent memory.

5. Press any key to continue and the View/Edit Control Data Values Screen appears (see Figure 3.05-15).

**NOTE:** Make copies of your data-set for future reference. If a printer is connected to your PC, press [Print Screen] on the keyboard.

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE                  Engine Model : L7042 V-12                  # of Cylinders : 12                  Primary Fuel :                  Secondary Fuel :                  Comments:</p> <p>Timing Disk Reference                  &lt;F3&gt;                  D-Lead Position                  Most Advanced Timing                  Most Retarded Timing                  Default Timing                  End of Sample Window</p> <p>Retard 1° Every                  Advance 1° Every 5 No-Knock Sample(s)</p> <p>Warm-Up Delay Time 300 Seconds                  Shutdown Delay Time 15 Seconds</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td>r 1</td><td>656 mV</td></tr> <tr><td>r 2</td><td>882 mV</td></tr> <tr><td>r 3</td><td>705 mV</td></tr> <tr><td>r 4</td><td>617 mV</td></tr> <tr><td>r 5</td><td>705 mV</td></tr> <tr><td>r 6</td><td>705 mV</td></tr> <tr><td>r 7</td><td>833 mV</td></tr> <tr><td>r 8</td><td>793 mV</td></tr> <tr><td>r 9</td><td>656 mV</td></tr> <tr><td>r 10</td><td>882 mV</td></tr> <tr><td>r 11</td><td>617 mV</td></tr> <tr><td>r 12</td><td>744 mV</td></tr> </tbody> </table> <p style="font-size: small;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select		r 1	656 mV	r 2	882 mV	r 3	705 mV	r 4	617 mV	r 5	705 mV	r 6	705 mV	r 7	833 mV	r 8	793 mV	r 9	656 mV	r 10	882 mV	r 11	617 mV	r 12	744 mV
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r 8	793 mV																										
r 9	656 mV																										
r 10	882 mV																										
r 11	617 mV																										
r 12	744 mV																										

Starting ROM12 Program  
 DSM Memory has been Configured.  
 Program Is Running.  
 Press ANY KEY to Continue

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Figure 3.05-14. Verification Screen Of Save To ROM

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE                  Engine Model : L7042 V-12                  # of Cylinders : 12                  Primary Fuel : NATURAL GAS PIPELINE QUALITY                  Secondary Fuel : DIGESTER GAS                  Comments:</p> <p>Timing Disk Reference 26 °BTDC                  &lt;F3&gt; To Calculate TDR</p> <p>D-Lead Position - - -&gt; Grounded Open</p> <p>Most Advanced Timing 10 °BTDC 10 °BTDC</p> <p>Most Retarded Timing 4 °BTDC 4 °BTDC</p> <p>Default Timing 8 °BTDC 8 °BTDC</p> <p>End of Sample Window 30 °ATDC</p> <p>Retard 1° Every 1 Knock Sample(s)                  Advance 1° Every 5 No-Knock Sample(s)</p> <p>Warm-Up Delay Time 300 Seconds                  Shutdown Delay Time 15 Seconds</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td>Sensor 1</td><td>656 mV</td></tr> <tr><td>Sensor 2</td><td>882 mV</td></tr> <tr><td>Sensor 3</td><td>705 mV</td></tr> <tr><td>Sensor 4</td><td>617 mV</td></tr> <tr><td>Sensor 5</td><td>705 mV</td></tr> <tr><td>Sensor 6</td><td>705 mV</td></tr> <tr><td>Sensor 7</td><td>833 mV</td></tr> <tr><td>Sensor 8</td><td>793 mV</td></tr> <tr><td>Sensor 9</td><td>656 mV</td></tr> <tr><td>Sensor 10</td><td>882 mV</td></tr> <tr><td>Sensor 11</td><td>617 mV</td></tr> <tr><td>Sensor 12</td><td>744 mV</td></tr> </tbody> </table> <p style="font-size: small;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select		Sensor 1	656 mV	Sensor 2	882 mV	Sensor 3	705 mV	Sensor 4	617 mV	Sensor 5	705 mV	Sensor 6	705 mV	Sensor 7	833 mV	Sensor 8	793 mV	Sensor 9	656 mV	Sensor 10	882 mV	Sensor 11	617 mV	Sensor 12	744 mV
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Sensor 12	744 mV																										

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Figure 3.05-15. View/Edit Control Data Values Screen

# EDITING AN EXISTING DSM DATA-SET

## SAVING DATA-SET TO DISK

Data-sets are assigned filenames and saved on disk so the user can retain the data-set for future reference. Each time a new program is saved to ROM, the previous program can no longer be retrieved. The only way to keep track of old data-sets is to save to disk.

**NOTE:** When saving to disk, the data-set will be saved to the drive and directory where the DSM Interface Program is located.

1. Save a data-set to disk by pressing [F10] (see Figure 3.05-16).

2. Highlight "Save Data to Filename" from the menu and press [Enter].

3. Enter a filename according to the following procedure (see Figure 3.05-17). Read all three steps prior to saving the file to the disk.

A. Locate the engine's serial number on the name-plate.

View/Edit Control Data Values

Engine Family : VHP GAS ENGINE Engine Model : L7042 V-12 # of Cylinders: 12 Primary Fuel : NATURAL Secondary Fuel: DIGESTED Comments: <hr/> Timing Disk Reference <F3> To Calculate D-Lead Position - - -> Grounded      Open Most Advanced Timing    10 °BTDC      10 °BTDC Most Retarded Timing    4 °BTDC      4 °BTDC Default Timing          8 °BTDC      8 °BTDC End of Sample Window    30 °ATDC <hr/> Retard 1° Every 1 Knock Sample(s) Advance 1° Every 5 No-Knock Sample(s) <hr/> Warm-Up Delay Time      300 Seconds Shutdown Delay Time     15 Seconds	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td>Sensor 1</td><td style="text-align: right;">656 mV</td></tr> <tr><td>Sensor 2</td><td style="text-align: right;">882 mV</td></tr> <tr><td>Sensor 3</td><td style="text-align: right;">705 mV</td></tr> <tr><td>Sensor 4</td><td style="text-align: right;">617 mV</td></tr> <tr><td>Sensor 5</td><td style="text-align: right;">705 mV</td></tr> <tr><td>Sensor 6</td><td style="text-align: right;">705 mV</td></tr> <tr><td>Sensor 7</td><td style="text-align: right;">833 mV</td></tr> <tr><td>Sensor 8</td><td style="text-align: right;">793 mV</td></tr> <tr><td>Sensor 9</td><td style="text-align: right;">656 mV</td></tr> <tr><td>Sensor 10</td><td style="text-align: right;">882 mV</td></tr> <tr><td>Sensor 11</td><td style="text-align: right;">617 mV</td></tr> <tr><td>Sensor 12</td><td style="text-align: right;">744 mV</td></tr> </tbody> </table> <p style="font-size: small; margin-top: 5px;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select		Sensor 1	656 mV	Sensor 2	882 mV	Sensor 3	705 mV	Sensor 4	617 mV	Sensor 5	705 mV	Sensor 6	705 mV	Sensor 7	833 mV	Sensor 8	793 mV	Sensor 9	656 mV	Sensor 10	882 mV	Sensor 11	617 mV	Sensor 12	744 mV
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Sensor 10	882 mV																										
Sensor 11	617 mV																										
Sensor 12	744 mV																										

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Figure 3.05-16. Saving Options Menu

View/Edit Control Data Values

Engine Family : VHP GAS ENGINE Engine Model : L7042 V-12 # of Cylinders: 12 Primary Fuel : Secondary Fuel: Comments: <hr/> Timing Disk Refe <F3> D-Lead Position Most Advanced Ti Most Retarded Ti Default Timing End of Sample W <hr/> Retard 1° Eve Advance 1° Every 5 No-Knock Sample(s) <hr/> Warm-Up Delay Time      300 Seconds Shutdown Delay Time     15 Seconds	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td>r 1</td><td style="text-align: right;">656 mV</td></tr> <tr><td>r 2</td><td style="text-align: right;">882 mV</td></tr> <tr><td>r 3</td><td style="text-align: right;">705 mV</td></tr> <tr><td>r 4</td><td style="text-align: right;">617 mV</td></tr> <tr><td>r 5</td><td style="text-align: right;">705 mV</td></tr> <tr><td>r 6</td><td style="text-align: right;">705 mV</td></tr> <tr><td>r 7</td><td style="text-align: right;">833 mV</td></tr> <tr><td>r 8</td><td style="text-align: right;">793 mV</td></tr> <tr><td>r 9</td><td style="text-align: right;">656 mV</td></tr> <tr><td>r 10</td><td style="text-align: right;">882 mV</td></tr> <tr><td>r 11</td><td style="text-align: right;">617 mV</td></tr> <tr><td>r 12</td><td style="text-align: right;">744 mV</td></tr> </tbody> </table> <p style="font-size: small; margin-top: 5px;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select		r 1	656 mV	r 2	882 mV	r 3	705 mV	r 4	617 mV	r 5	705 mV	r 6	705 mV	r 7	833 mV	r 8	793 mV	r 9	656 mV	r 10	882 mV	r 11	617 mV	r 12	744 mV
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r 8	793 mV																										
r 9	656 mV																										
r 10	882 mV																										
r 11	617 mV																										
r 12	744 mV																										

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Figure 3.05-17. Entering Filename Of Data-Set

## EDITING AN EXISTING DSM DATA-SET

- B. If the engine has a "C-" number, remove the "C-" and the "/" from the number. Example: C-10768/01 would give a root file name of "1076801." If the engine does not have a "C-" number use all six digits in the serial number for the filename.
- C. The first time the configuration is saved to the disk add an "A" to the end. This is to indicate that this is the first save of this configuration. If changes are made to the configuration, save the next file with the same numerical information and change the suffix letter to "B." Continue in this manner for each revision to the file.

Once eight characters have been entered, the file will automatically be saved to the PC disk where the DSM program resides. If the filename is less than eight characters, press [Enter] to save.

4. Press [ESC] to return to the Main Menu.

5. If the data-set for your engine has been saved to ROM and a file on disk, confirm the exit to the Main Menu by pressing [Y] (see Figure 3.05-18). The Main Menu appears. If you have not saved the data-set to ROM (permanent memory), press [N] and refer to "Saving Data-Set To ROM" in this section.

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE          Engine Model : L7042 V-12          # of Cylinders: 12          Primary Fuel :          Secondary Fuel:          Comments:</p> <p>Timing Disk Refe          &lt;F3&gt;</p> <p>D-Lead Position          Most Advanced T          Most Retarded T          Default Timing          End of Sample W</p> <p>Retard 1° Eve          Advance 1° Every 5 No-Knock Sample(s)</p> <p>Warm-Up Delay Time 300 Seconds          Shutdown Delay Time 15 Seconds</p> <p>&lt;F10&gt; to Save</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td>r 1</td><td>656 mV</td></tr> <tr><td>r 2</td><td>882 mV</td></tr> <tr><td>r 3</td><td>705 mV</td></tr> <tr><td>r 4</td><td>617 mV</td></tr> <tr><td>r 5</td><td>705 mV</td></tr> <tr><td>r 6</td><td>705 mV</td></tr> <tr><td>r 7</td><td>833 mV</td></tr> <tr><td>r 8</td><td>793 mV</td></tr> <tr><td>r 9</td><td>656 mV</td></tr> <tr><td>r 10</td><td>882 mV</td></tr> <tr><td>r 11</td><td>617 mV</td></tr> <tr><td>r 12</td><td>744 mV</td></tr> </tbody> </table> <p style="font-size: small;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p> <p style="text-align: right;">&lt;F5&gt; to AUTOCAL</p>	Detonation Level Select		r 1	656 mV	r 2	882 mV	r 3	705 mV	r 4	617 mV	r 5	705 mV	r 6	705 mV	r 7	833 mV	r 8	793 mV	r 9	656 mV	r 10	882 mV	r 11	617 mV	r 12	744 mV
Detonation Level Select																											
r 1	656 mV																										
r 2	882 mV																										
r 3	705 mV																										
r 4	617 mV																										
r 5	705 mV																										
r 6	705 mV																										
r 7	833 mV																										
r 8	793 mV																										
r 9	656 mV																										
r 10	882 mV																										
r 11	617 mV																										
r 12	744 mV																										

Exit to Main Menu

Changes Will be Lost if  
you Have Not Saved Them.

Do You REALLY Want to EXIT?

Yes
No    esc

<ESC> to Main Menu

Figure 3.05-18. Confirmation Of Exit

5. The "Genuine Waukesha Parts" logo screen appears briefly, followed by the screen shown in Figure 3.10-4. The bottom line of this screen indicates what version of the DSM Interface Program you are using.

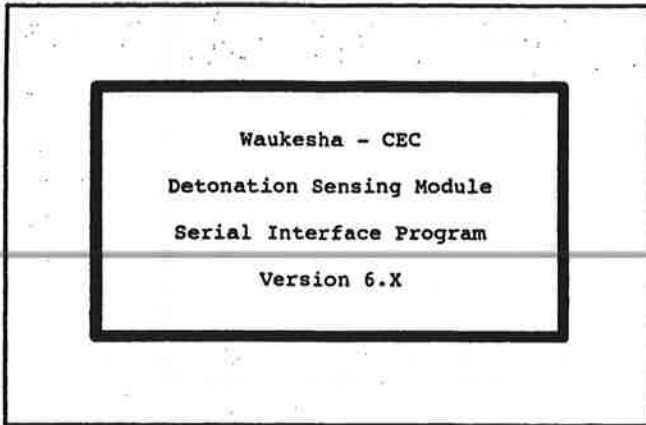


Figure 3.10-4. Software Version Identification

6. Automatically the Communications Menu appears (see Figure 3.10-5). A black dot is located in a circle next to "1" which indicates that the selected communications port on your computer is port 1. Press [Enter] to select communications port 1. If the DB-9 cable is connected to a different port on your PC, use the arrow keys on the keyboard to select the corresponding port from the Communications Menu and press [Enter] (typically: port 1 is correct).

The DSM Interface Program's Main Menu appears showing various program options available (see Figure 3.10-6).

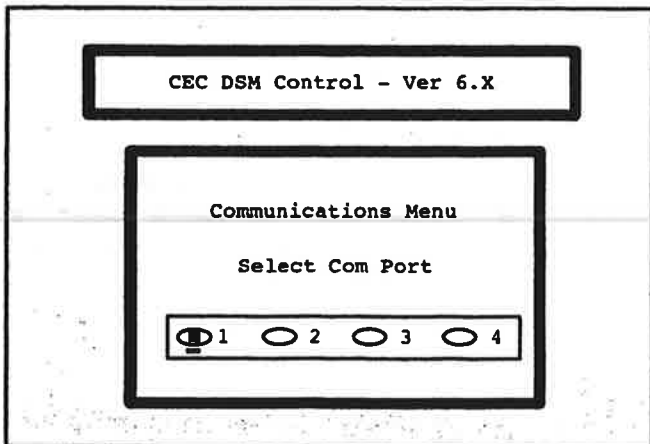


Figure 3.10-5. Communications Menu

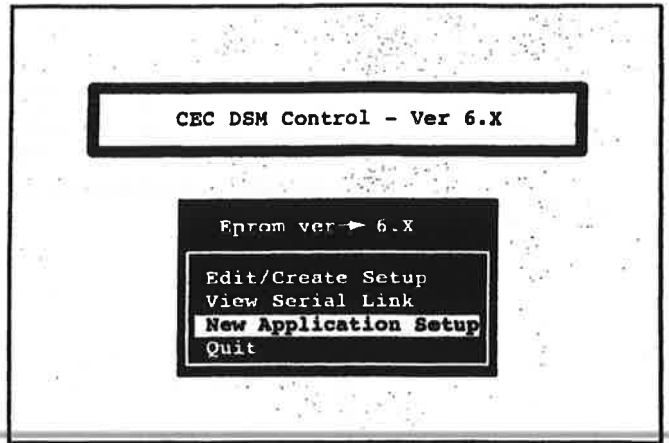


Figure 3.10-6. DSM Interface Program Main Menu

### NEW APPLICATION SETUP

1. Highlight "New Application Setup" on the DSM Interface Program's Main Menu (see Figure 3.05-6) and press [Enter].

2. The DSM system will then scan the EPROM chip for a saved data-set. Several screens appear indicating the scan of the EPROM chip.

- If the DSM finds a saved data-set on the EPROM chip, the New Application Setup Verification Screen appears (see Figure 3.10-7). Because creating a new data-set will overwrite an existing data-set, the DSM Interface Program verifies that you want to continue with a new application.

If you want to setup the DSM system for a new application, highlight the "Continue" button and press [Enter]. The Engine Family Menu appears. Continue with Step 3.

If you do not want to setup the DSM system for a new application, highlight the "Cancel" button and press [Enter].

- If the DSM does not find a saved data-set on the EPROM chip, the Engine Family Menu appears. Continue with Step 3. The internally mounted LCD reads "99" (no data) when the DSM module senses a new EPROM chip is installed.

**NOTE:** If you simply want to edit an existing data-set, complete the steps in Section 3.05, Editing An Existing DSM Data-Set.

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

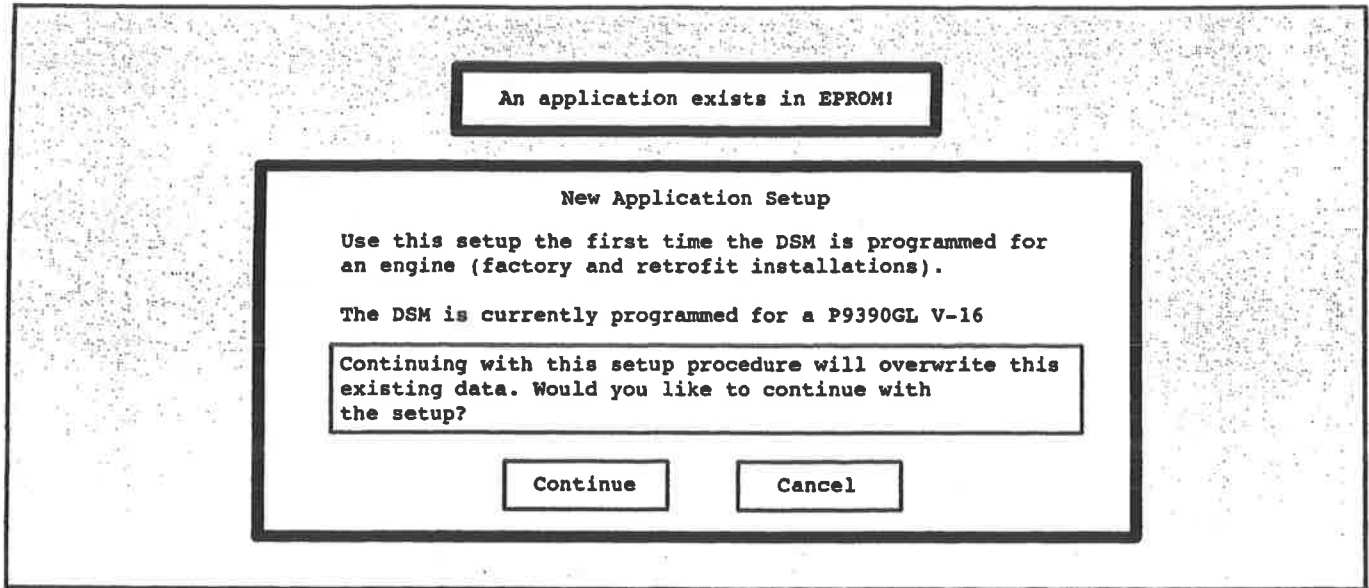


Figure 3.10-7. New Application Setup Screen

**NOTE:** Some DSM system programming will require you to enter engine specific information. Read these steps carefully so you enter the information that applies to the engine and DSM system you are programming.

**NOTE:** The filters used with the DSM system are engine specific. If an incorrect filter is installed, the DSM system will appear to work but will not protect against detonation. Detonation can cause severe engine damage.

**NOTE:** For the purposes of this manual, the DSM module will be programmed for a 12 cylinder VHP L7042 engine. For example, in Step 3 "VHP Gas Engines" is selected from the Engine Family Menu. The programming steps taken in this manual are the same for whatever engine family you choose (exceptions are noted).

3. A listing of various Waukesha Engine families appears on the screen (see Figure 3.10-8). The DSM module must be customized for each application. Highlight the appropriate engine family for your application and press [Enter].

4. On the next screen, a selection of specific engine models available for the engine family previously selected appears (see Figure 3.10-9). Highlight the applicable engine model and press [Enter].

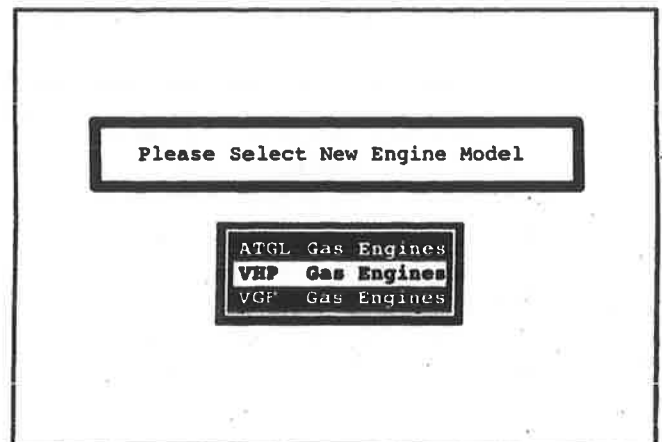


Figure 3.10-8. Engine Family Menu

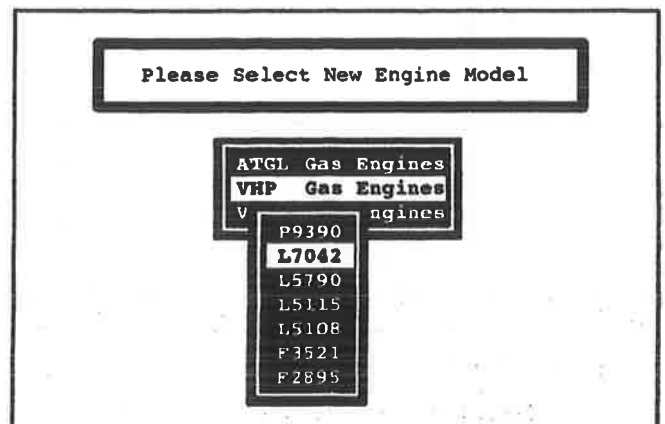


Figure 3.10-9. Engine Model Menu

## SECTION 3.10

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

### PROGRAMMING INFORMATION

This section, Section 3.10, *Programming The DSM System For A New Application*, explains the programming steps and post-programming checks to be completed for a "new application." A new application includes retrofit applications or whenever a DSM module is removed from one engine and installed on another engine model. By completing the programming steps in this section, any existing data-set is overwritten and an entirely new data-set is programmed. The data-set that is created following the procedures in this section is engine specific. Complete all the procedures and post-programming checks provided in this section to program the DSM system for a new application.

**NOTE:** If the internally mounted LCD inside the DSM module reads "99" (no data), the DSM module is sensing that a new EPROM chip is installed and no data-set exists. You will need to complete the programming steps in this section.

Section 3.05, *Editing An Existing DSM Data-Set*, explains the steps required to edit an existing DSM data-set. The data-set that is edited following the procedures in Section 3.05 is engine specific.

**NOTE:** Engines shipped from the factory with the DSM system are initially setup at the factory. A data-set is created at the factory for testing the DSM system on the engine. Since a data-set already exists, complete the programming steps in Section 3.05, *Editing An Existing DSM Data-Set*.

Section 3.15, *DSM System Computer Screen And Data Retrieval*, explains the procedures necessary to access DSM system information from the DSM Interface Program using a PC. Section 3.15 does not include any programming procedures.

**NOTE:** This manual assumes you are already familiar with basic MS-DOS commands for viewing directories, copying files, and other MS-DOS concepts. If you need more information on these subjects, refer to a MS-DOS instruction manual.

### PRE-PROGRAMMING INSTALLATION CHECKLIST

Before applying power to the DSM system:

- A. **Disconnect the DSM module from the Ignition Module** by removing the "DSM to ignition" harness from the 14 pin connector on the side of the Ignition Module (see Figure 3.10-1).

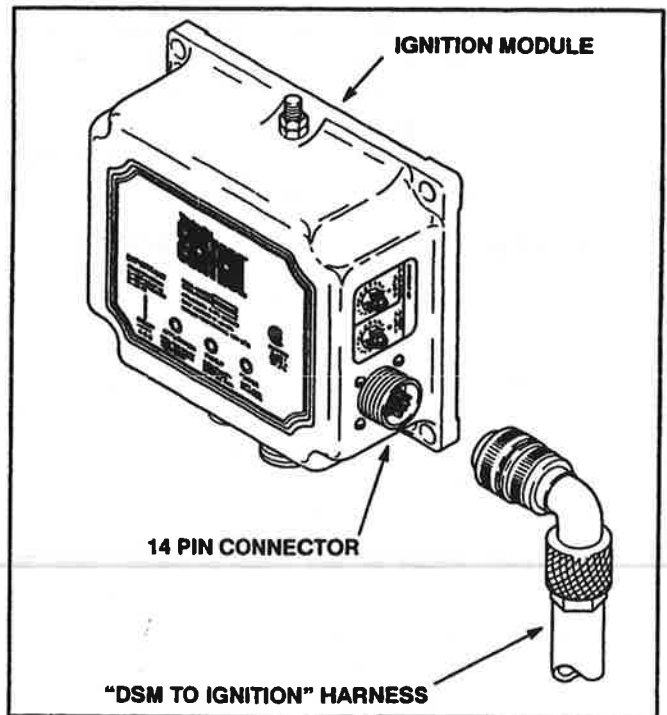


Figure 3.10-1. Disconnecting The "DSM To Ignition" Harness

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

- B. Visually inspect the installation to be sure that all wiring conforms to the requirements of this manual, local codes, and regulatory bodies. Verify that each connection to the DSM module is routed through the correct conduit (see Figure 3.10-2).

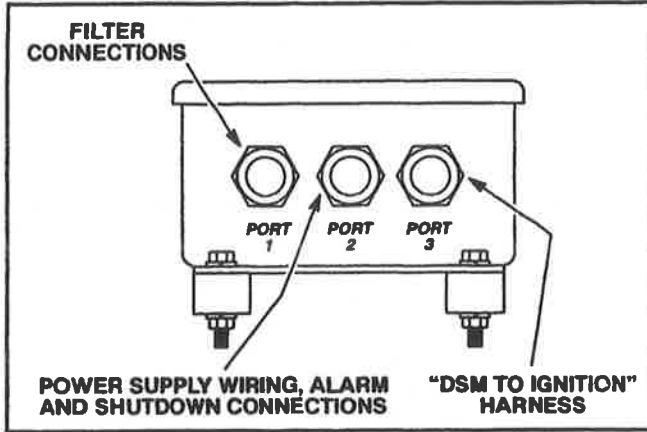


Figure 3.10-2. DSM Module Conduit Ports

- C. Verify that the power supply is within specification. Refer to Section 2.10, *DSM System Power, Alarm, And Ground Connections*, for power specifications to DSM module. Make this measurement with an oscilloscope at the supply wires to the DSM module with the engine running.

## DSM INTERFACE PROGRAMMING STEPS

### ESTABLISHING COMMUNICATION WITH THE DSM

1. Verify that the DSM module is disconnected from the Ignition Module before applying power. If the DSM module is not disconnected from the Ignition Module, disconnect the "DSM to ignition" harness from the 14 pin DSM connector on the side of the Ignition Module (see Figure 3.10-1).

2. Apply power to the DSM module. The "Power," "Alarm," and "Shutdown" LEDs on the front cover will light for approximately five seconds. The green power LED will remain on when the alarm and shutdown LEDs go off. The internally mounted LCD display will read "90" (system OK - ready and waiting for engine to start).

**NOTE:** If the internally mounted LCD reads "99" (no data) instead of "90", the DSM module is sensing that a new EPROM chip is installed in the DSM module. Continue with the DSM module programming.

**NOTE:** If any of the alarm or shutdown LEDs come on any time during DSM system operation, see Section 4.00, *DSM System Diagnostics And Troubleshooting*.

3. The DSM module must be programmed to work with site specific information in order for the DSM system to function properly. To program the DSM module, connect a standard DB-9 serial cable (male to female) to the communications port (labeled P1A) within the DSM module. This is the communications port on the right (see Figure 3.10-3). Connect the other end of the cable to the PC's communications port. Typically, this is port 1 (also referred to as COM 1, serial A, or serial 1).

**CAUTION** Verify that the DB-9 serial cable is securely connected to the appropriate computer port. If the serial cable is disturbed or disconnected during the saving process, the EPROM chip in the DSM module will become corrupted and will need to be replaced.

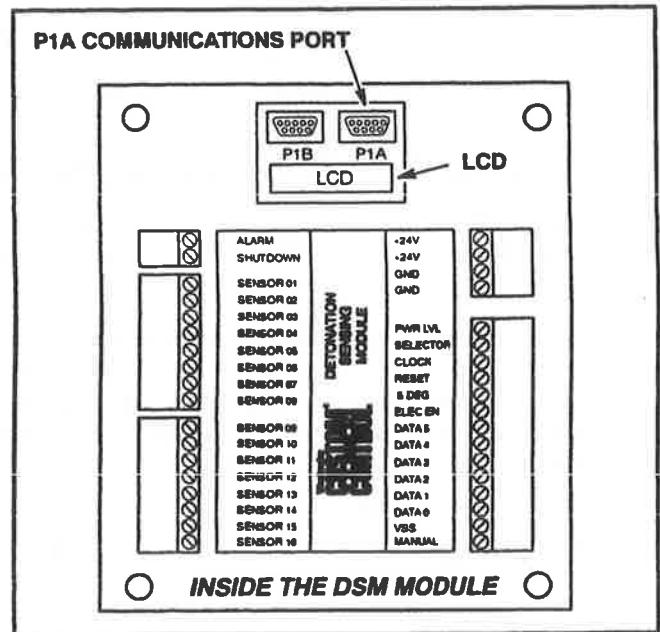


Figure 3.10-3. DB-9 Serial Cable Connection Inside DSM Module

4. Start the DSM Interface Program on your PC.

**NOTE:** For information on installing and/or accessing the DSM Interface Program, refer to the white card at the back of this manual which holds the 3-1/2" diskette for installation and accessing instructions.



# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

5. A selection of fuel types for the engine is listed (see Figure 3.10-10). Highlight the type of primary fuel the engine is using on the Primary Fuel Selection Menu and press [Enter].

6. A selection of fuel types for the engine is listed (see Figure 3.10-11). Highlight the type of secondary fuel the engine is using on the Secondary Fuel Selection Menu and press [Enter]. If no secondary fuel is being used or will be used, highlight "NONE" and press [Enter].

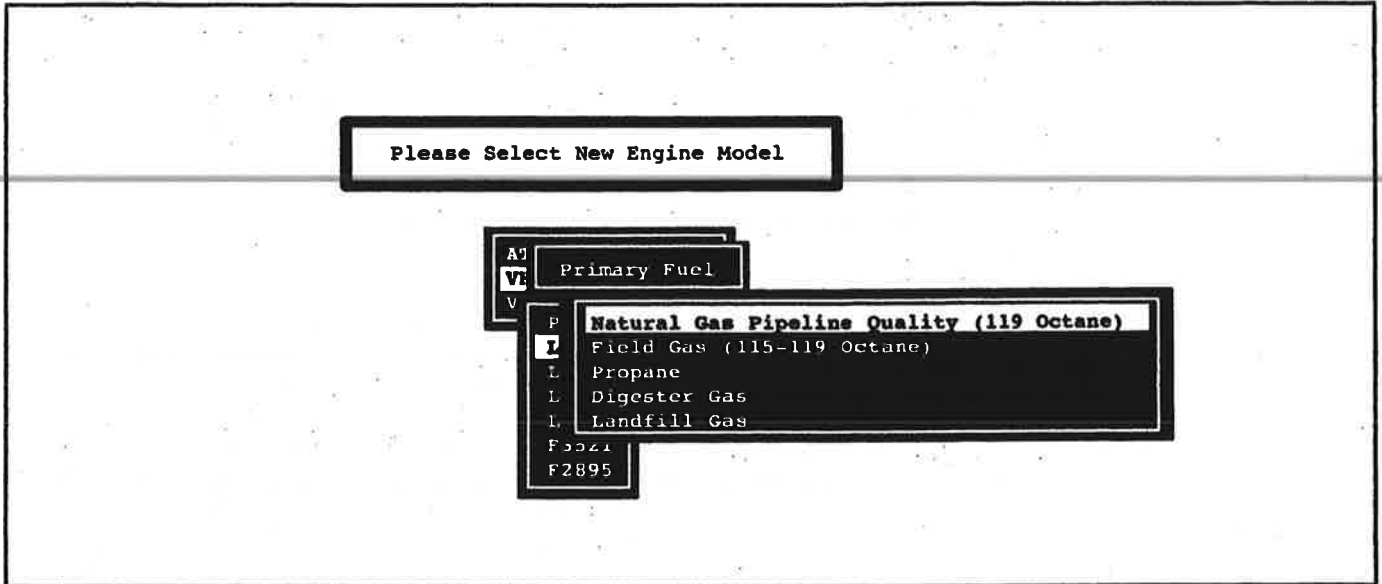


Figure 3.10-10. Primary Fuel Selection Menu

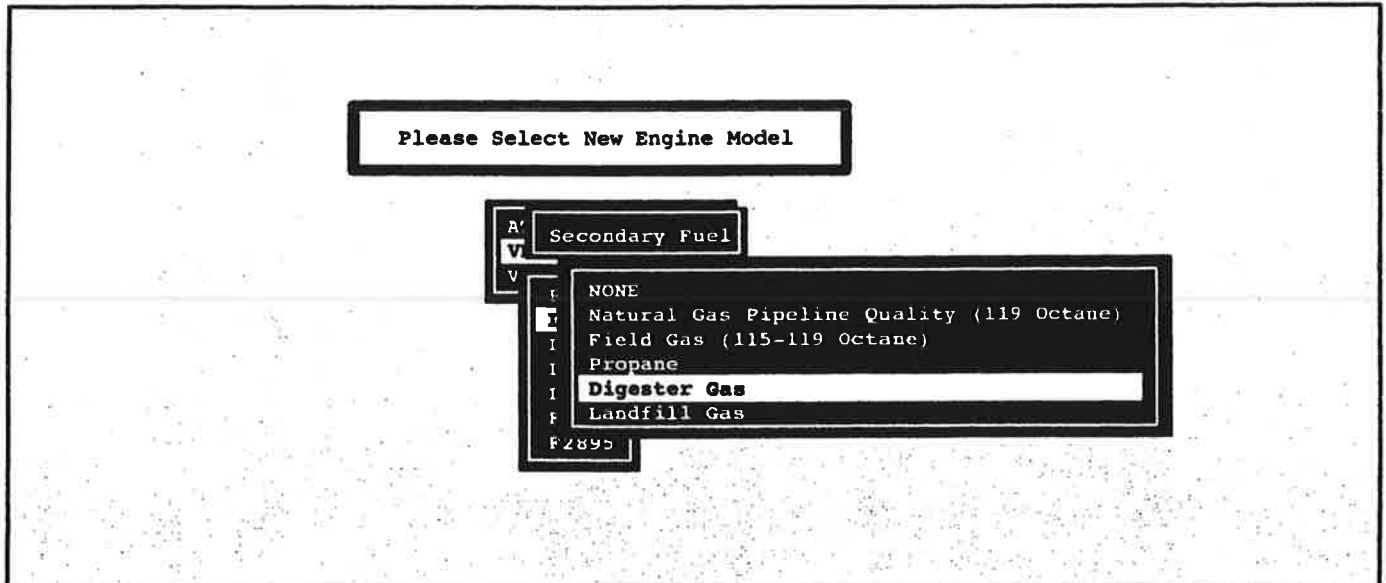


Figure 3.10-11. Secondary Fuel Selection Menu

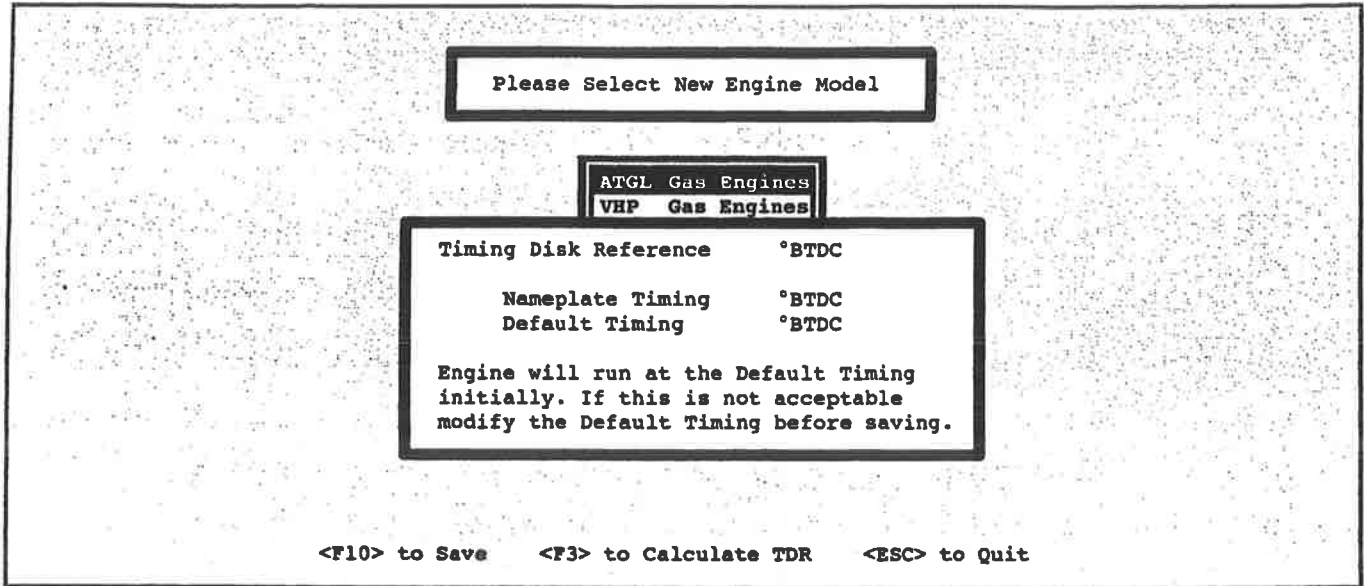


Figure 3.10-12. Entering Timing Disk And Nameplate Timing Values

7. After the engine family, model, and fuel types are selected, a screen appears requiring Timing Disk Reference (TDR) and nameplate timing values (see Figure 3.10-12). The proper TDR is required so that the DSM system can control timing.

- If you know these values, enter the TDR value and press [Enter]. Then enter nameplate timing and press [Enter]. The default timing value is automatically calculated (based on the formula: Nameplate Timing - 2° = Default Timing). Default timing is the retarded ignition timing imposed by the DSM system when it is not protecting against detonation. The DSM system activates default timing for a cylinder when the cylinder's sensor is disabled, when the sensor fails, and during engine warm-up delay. You may modify the default timing if the calculated value is not acceptable. To modify the default timing, enter the new value in the "Default Timing" field. Continue with "Saving Engine Parameters" in this section.
- If you do not know the TDR, continue with the next section, "Calculating Timing Disk Reference."

**CALCULATING TIMING DISK REFERENCE**

The proper Timing Disk Reference (TDR) is required so that the DSM system can accurately control timing. TDR is the angular relationship between the first cylinder to fire and top dead center (TDC) (example: 25° BTDC). The position of the Ignition Module's timing disk is not the same on all engines. Complete this section to calculate the TDR for the specific engine model you are programming.

1. To calculate the Timing Disk Reference press [F3].

**CAUTION** The Timing Disk Reference (TDR) will be calculated incorrectly if the DSM module is not disconnected from the Ignition Module. The TDR is essential for proper DSM system performance.

2. After pressing [F3], a message appears asking you to verify that the DSM module is disconnected from the Ignition Module (see Figure 3.10-14). If the DSM module is disconnected from the Ignition Module press [Y]. If the DSM module is not disconnected from the Ignition Module, disconnect the "DSM to Ignition" harness from the 14 pin connector on the side of the Ignition Module (see Figure 3.10-13) and press [Y].

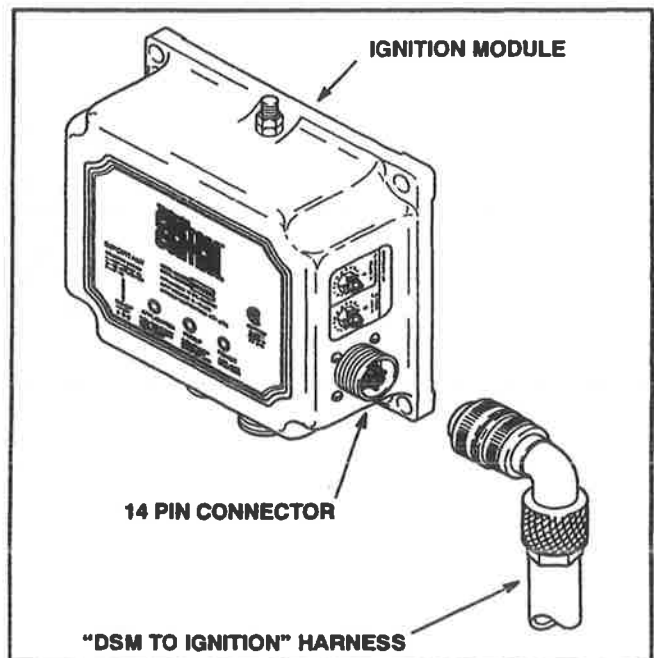
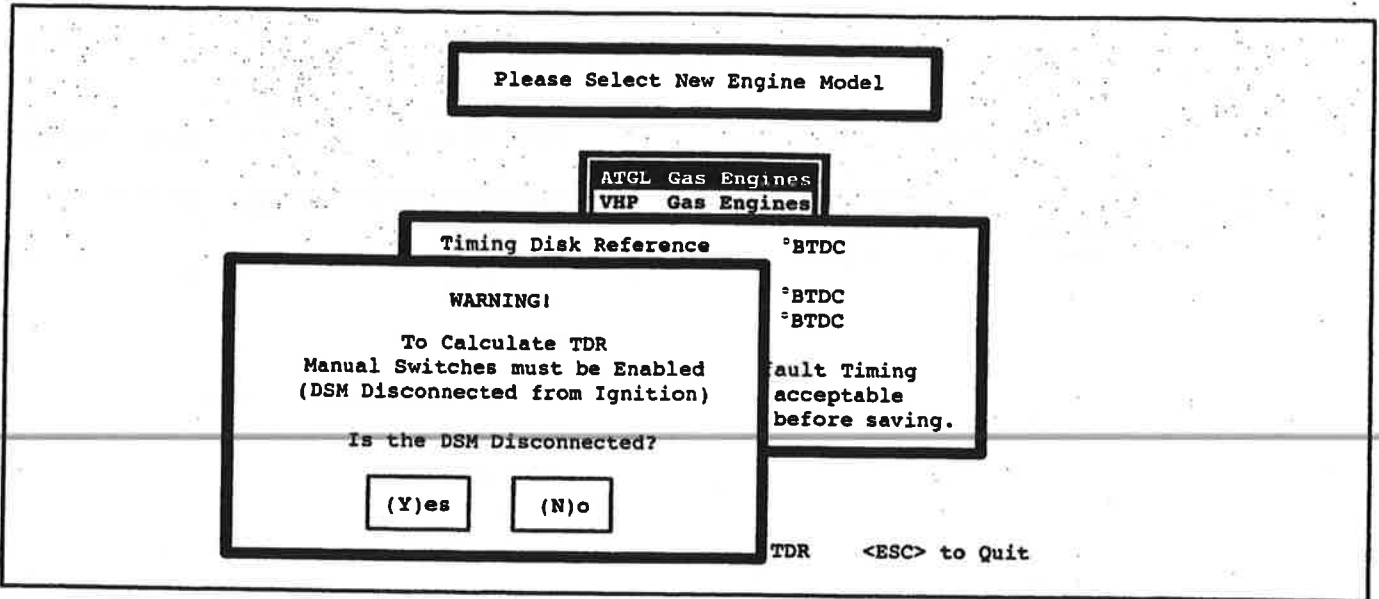


Figure 3.10-13. Disconnecting The "DSM To Ignition" Harness

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION



**Figure 3.10-14. Verification Screen**

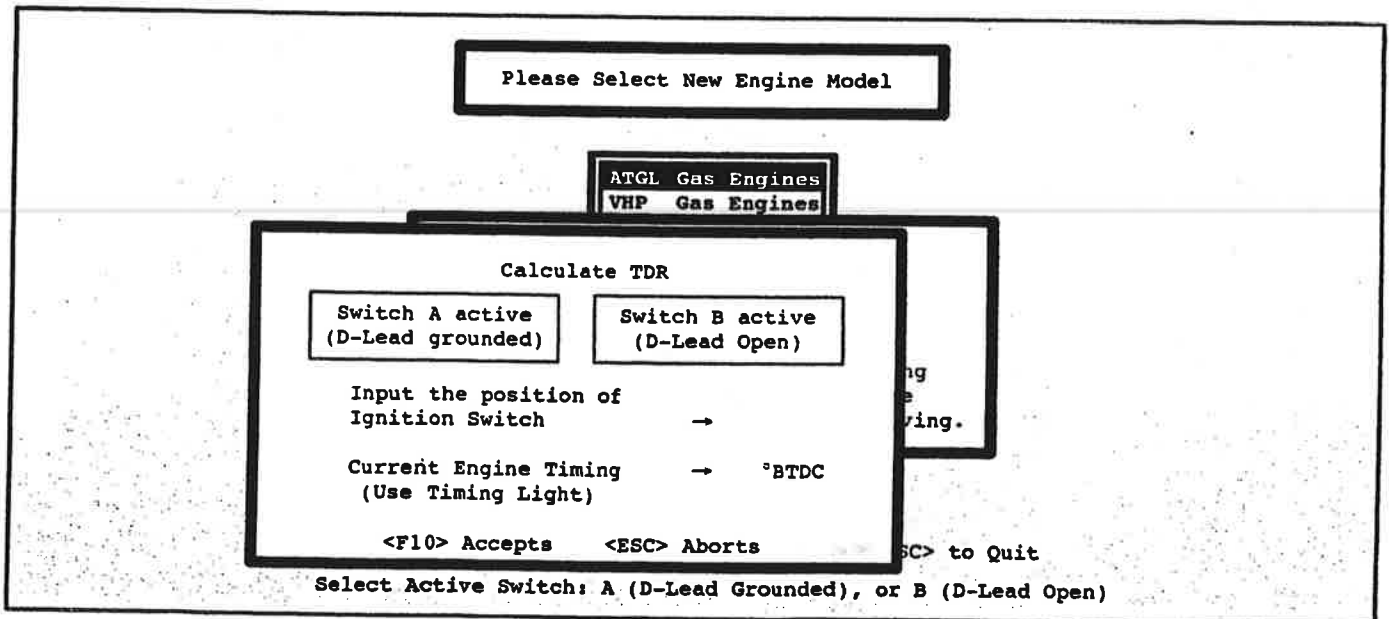
3. To have the DSM system calculate TDR, you must enter data about engine timing on the Timing Disk Reference (TDR) Calculation Screen (see Figure 3.10-15). First, determine whether "A" or "B" is the active timing switch on the Ignition Module. When the "D" lead of the Ignition Module is grounded, timing switch "A" is the active switch. When the "D" lead is open, timing switch "B" is active.

To determine which is the active timing switch, follow the steps below.

A. Check engine timing with a timing light and record the engine timing value.

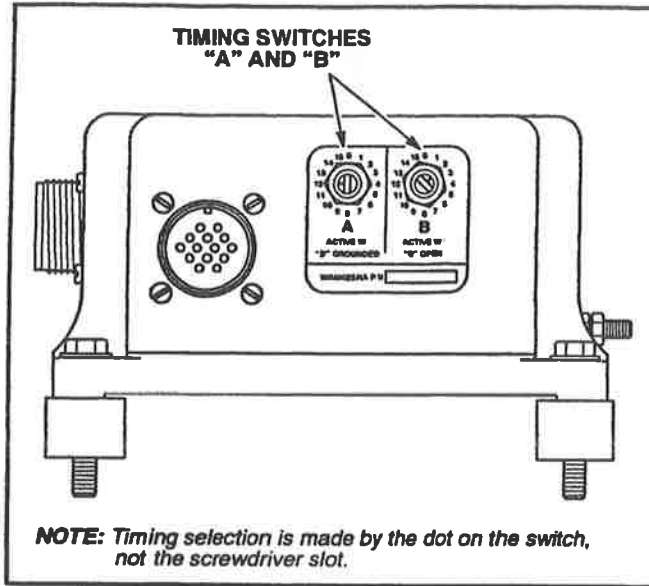
B. On the side of the Ignition Module, turn the "A" timing switch one degree (place) (see Figure 2.05-13).

C. Re-check engine timing with a timing light. If engine timing has changed one degree, the "D" lead is grounded and "A" is the active timing switch. Turn the "A" timing switch back to its previous setting and continue with Step 4. If engine timing has not changed one degree, turn the "A" timing switch back to its previous setting and continue with Step D.



**Figure 3.10-15. Timing Disk Reference Calculation Screen**

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION



**Figure 3.10-16. CEC Ignition Module Timing Switches**

- D. On the side of the Ignition Module, turn the "B" timing switch one degree (place) (see Figure 3.10-16).
- E. Re-check engine timing with a timing light. If engine timing has changed one degree, the "D" lead is open and "B" is the active timing switch. Turn the "B" timing switch back to its previous setting. Continue with Step 4.

**NOTE:** If timing did not change when either timing switch "A" or "B" was changed, verify that the DSM module is disconnected from the Ignition Module. If the DSM module is not disconnected from the Ignition Module, disconnect the "DSM to ignition" harness from the 14 pin DSM connector on the side of the Ignition Module and repeat the TDR calculation with Step 1. If disconnected, contact Waukesha Product Support.

4. If "A" is the active timing switch on the Ignition Module, highlight the "Switch A active" button on the Timing Disk Reference Calculation Screen using the [Tab] or arrow key (see Figure 3.10-15) and press [Enter]. If "B" is the active timing switch, highlight the "Switch B active" button and press [Enter].

5. Enter the position (0 - 15) of the active timing switch (found on the side of the Ignition Module) and press [Enter]. Timing selection is made by the dot on the timing switch, not the screwdriver slot.

6. Check engine timing using a timing light.

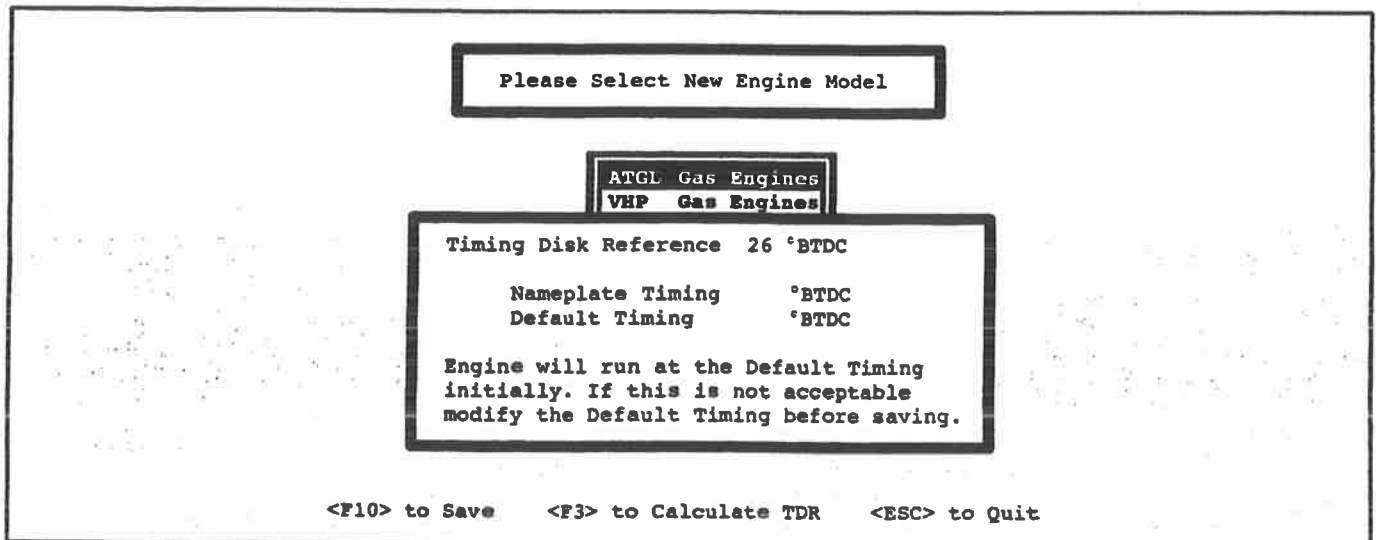
7. Verify that engine timing from Step 6 is the same as nameplate timing. If the two timings do not match, contact Waukesha Product Support.

8. Enter engine timing on the Timing Disk Reference Calculation Screen and press [F10].

9. The Timing Disk Reference (TDR) angle is automatically calculated and entered for the application based on the switch position and timing values just entered. Press [Enter] to accept the calculated TDR angle (see Figure 3.10-17).

10. Enter nameplate timing and press [Enter]. The default timing value is automatically calculated (based on the formula: Nameplate Timing - 2° = Default Timing) (see Figure 3.10-18). Default timing is the retarded ignition timing imposed by the DSM system when it is not protecting against detonation. The DSM system activates default timing for a cylinder when the cylinder's sensor is disabled, when the sensor fails, and during engine warm-up delay. You may modify the default timing if the calculated value is not acceptable. To modify the default timing, enter the new value in the "Default Timing" field.

11. Continue with the next section, "Saving Engine Parameters."



**Figure 3.10-17. Entering Timing Disk And Default Timing Values**

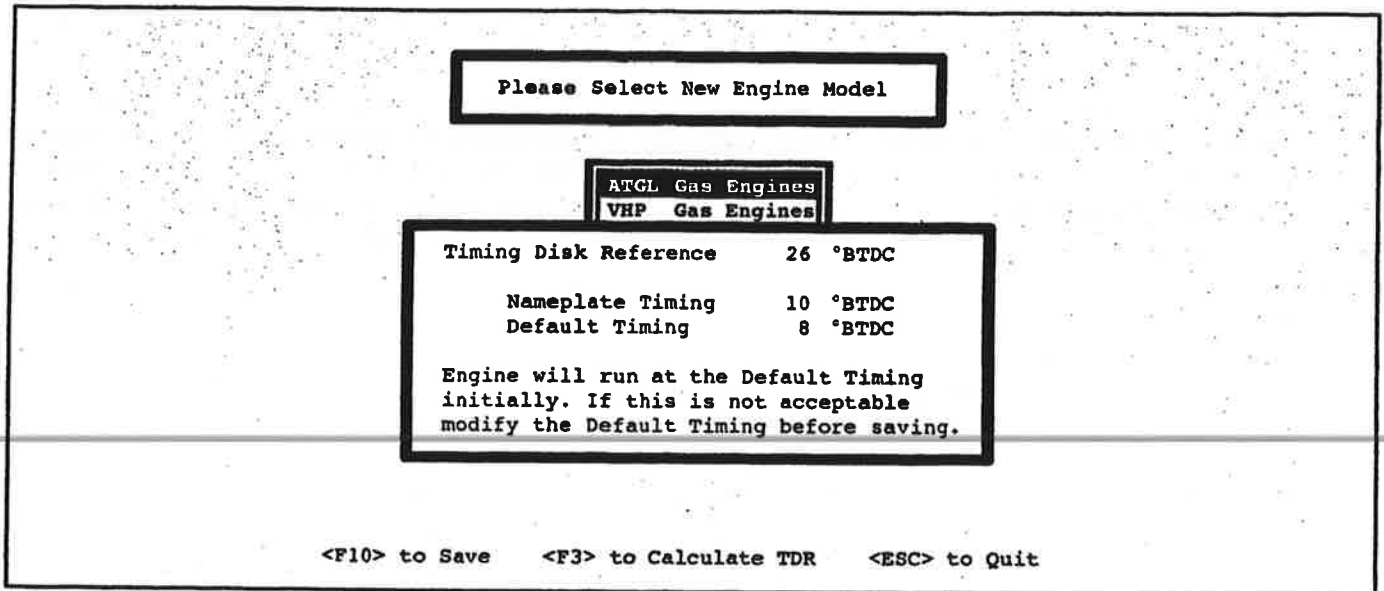


Figure 3.10-18. Calculated TDR And Default Timing Values

**SAVING ENGINE PARAMETERS**

Complete the following steps to save the engine model information, Timing Disk Reference value, and default timing value to read only memory (ROM), permanent memory within the DSM module (EPROM chip).

1. After the engine model information, Timing Disk Reference value, and default timing are entered, press [F10] to save the engine parameters to ROM (permanent memory). The Saving Options Menu appears.
2. Highlight "Configure DSM Memory" on the Saving Options Menu and press [Enter].

3. A screen appears confirming the save of the engine parameters to ROM (see Figure 3.10-19). Press [Y].

**CAUTION** Do not disturb the serial cable or interrupt computer power while programming. If the serial cable is disturbed or disconnected during the saving process, the EPROM chip in the DSM module will become corrupted and will need to be replaced.

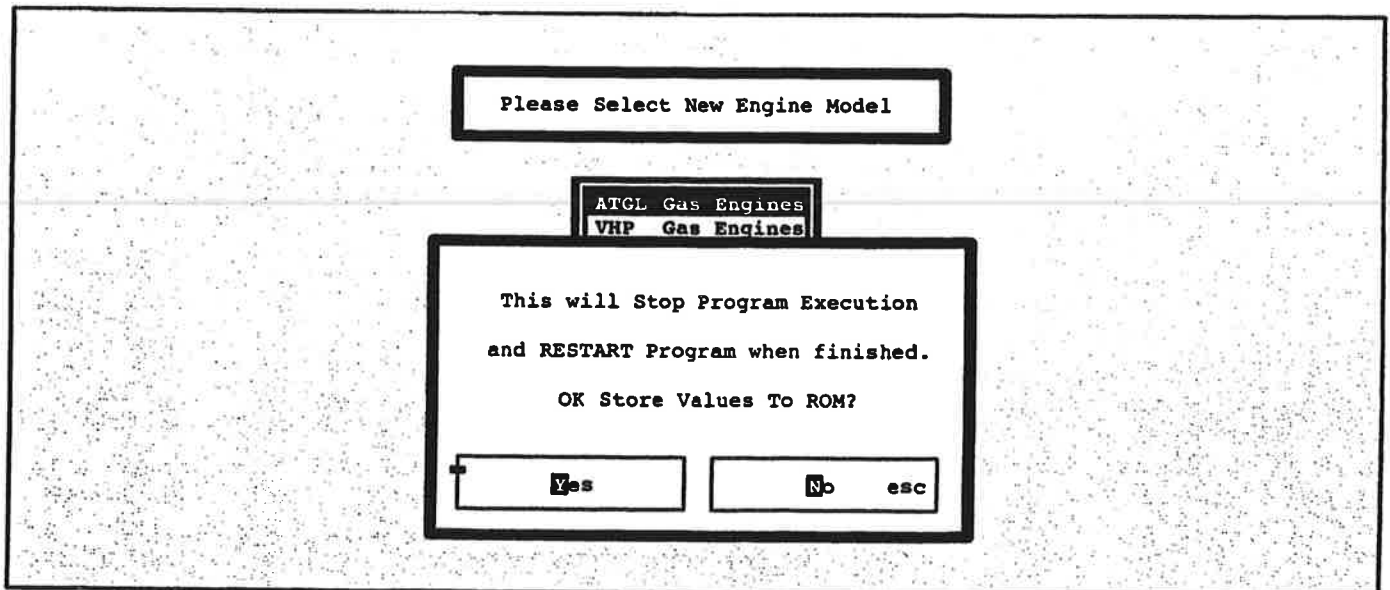


Figure 3.10-19. Saving Engine Parameters To Read Only Memory (ROM)

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

4. Several screens appear indicating that the engine parameters are being saved to ROM. A screen appears indicating that the engine parameters have been saved (see Figure 3.10-20). The ROM number (ROM##) shows you which ROM location the engine parameter data has been saved to.

**NOTE:** Record the ROM number (ROM##) of your save so you can keep track of how many saves to ROM are still available.

**NOTE:** The DSM allows 25 saves to ROM. Once ROM has been fully configured, the EPROM chip in the DSM module must be replaced to permit further saves to permanent memory.

5. Press any key to continue.

6. After the engine parameters are saved to ROM, the View/Edit Control Data Values Screen appears (see Figure 3.10-21). Verify that the engine family, engine model, Timing Disk Reference value, and default timing agree with the values you entered.

7. Continue with the next section, "Editing The DSM Data-Set."

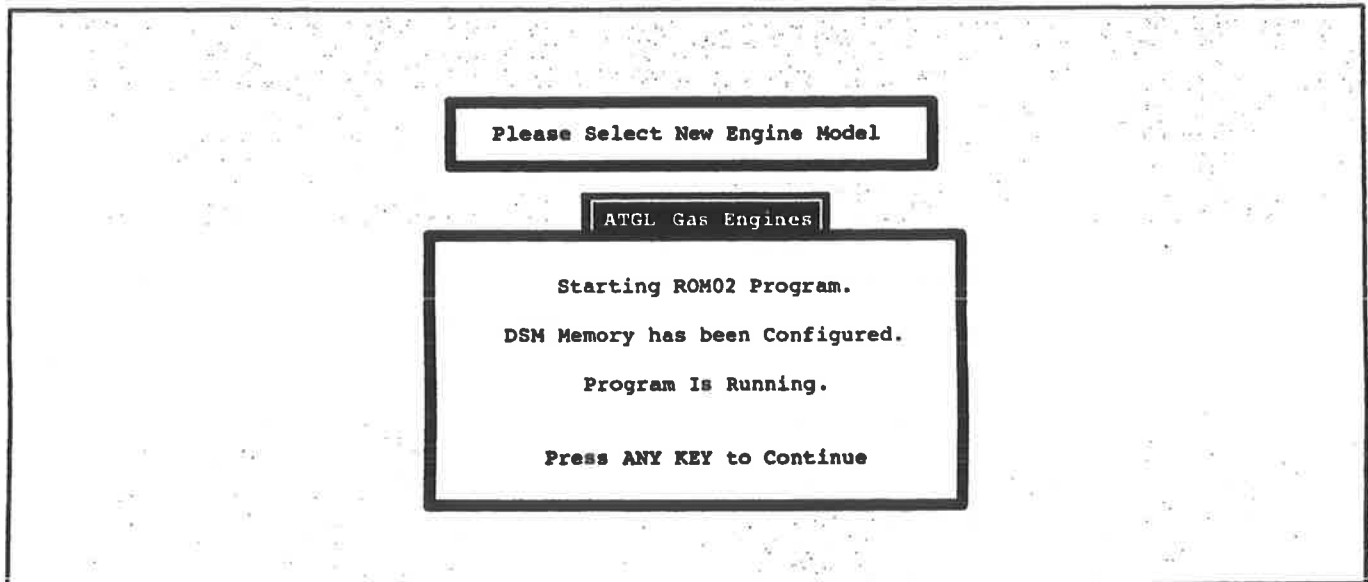


Figure 3.10-20. Confirmation Of Save To Read Only Memory (ROM)

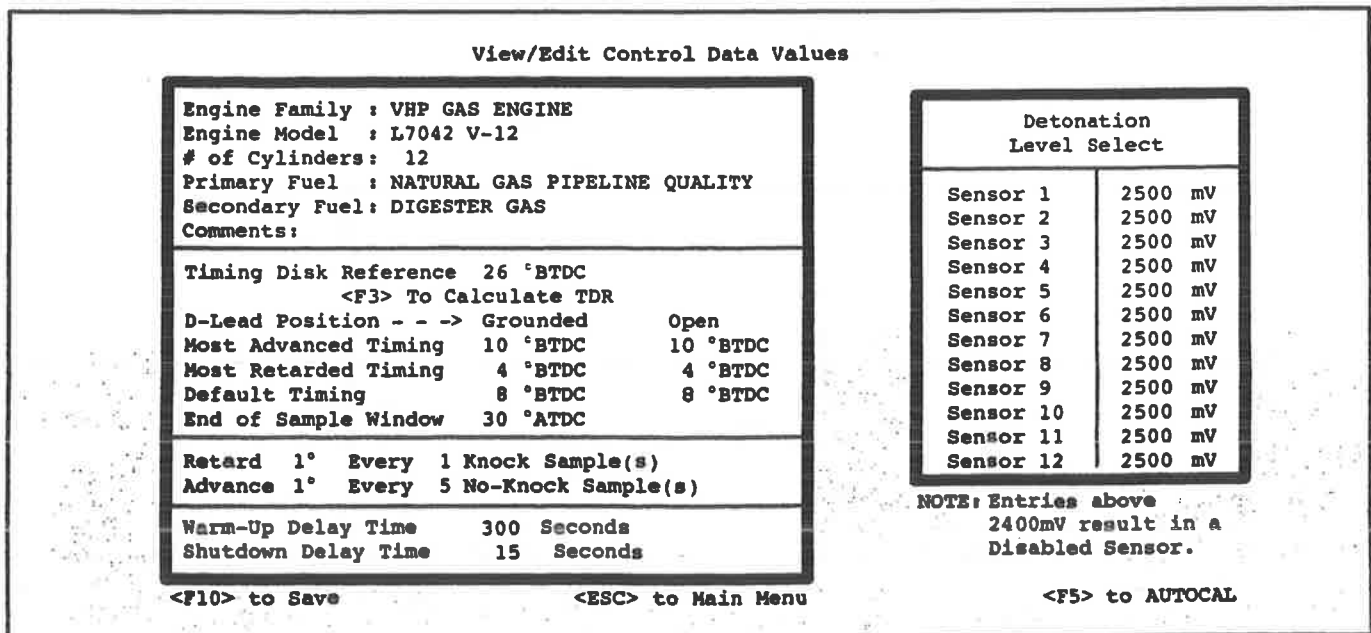


Figure 3.10-21. View/Edit Control Data Values Screen

## EDITING THE DSM DATA-SET

A data-set is a group of site specific data points that are created and then stored in ROM within the DSM module. The DSM data-set includes values for: Most Advanced Timing, Most Retarded Timing, End of Sample Window angle, retard and advanced timing values, warm-up delay time, and shutdown delay time. Complete the steps that follow to edit the data-set for the engine you are programming.

**NOTE:** *Editing values on the View/Edit Control Data Values Screen will not affect the performance of the DSM system. The edited data-set must be saved to RAM or ROM to change the DSM system's operating parameters.*

You can change data points on the View/Edit Control Data Values Screen by moving the cursor with the arrow keys and entering data as desired.

1. Reconnect the DSM module ("DSM to ignition" harness) to the Ignition Module. After reconnecting the DSM module to the Ignition Module, ignition timing is being controlled by the DSM system so the data-set for the engine can be completed.

**NOTE:** *Knock sensors above 2400 mV are disabled and do not protect against detonation. Engine timing runs at the default timing. The knock sensors remain disabled until the AutoCal program is completed and new voltages are entered on the View/Edit Data Control Values Screen and saved to ROM.*

2. Using a timing light, verify that the correct Timing Disk Reference (TDR) value is programmed. The TDR value is shown on the View/Edit Control Data Values Screen (see Figure 3.10-21). Complete the following:

- A. If engine timing does match the Default Timing ( $^{\circ}$ BTDC), continue with Step 3. If the engine timing does not match, the TDR value needs to be adjusted.
- B. If engine timing is lower than the default timing shown, then decrease the TDR value by that amount. For example, if timing is set at  $11^{\circ}$  but the engine is running at  $10^{\circ}$ , then decrease the TDR value by  $1^{\circ}$ .

- C. If engine timing is higher than the default timing shown, then increase the TDR value by that amount. For example, if timing is set at  $11^{\circ}$  but the engine is running at  $12^{\circ}$ , then increase the TDR value by  $1^{\circ}$ .
- D. Use the arrow keys to position the cursor in the "Timing Disk Reference" field on the View/Edit Control Data Values Screen.
- E. Enter the adjusted TDR value and press [Enter].
- F. Press [F10] to test the new TDR value. Highlight "Test Data on DSM" on the next menu and press [Enter]. The new information is now saved to RAM (temporary memory). Press any key to continue.

**NOTE:** *The "Test Data on DSM" option from the Save Options Menu allows a program to be run in the DSM module's temporary memory (RAM). The contents of RAM are lost whenever power to the DSM module is removed.*

- G. Using a timing light, verify that the engine timing is running at the default timing. If engine timing does match continue with Step 3. If the engine timing does not match, repeat Steps A - F. If repeating these steps does not correct engine timing, contact Waukesha Product Support.
- H. Once verified, the new TDR value must be saved to ROM. Press [F10] to save the new TDR value. Highlight "Configure DSM Memory" on the next menu and press [Enter]. When the Verification Screen appears press [Y]. Several screens will appear indicating that the data-set is being saved to ROM, permanent memory on the EPROM chip inside the DSM module. Once the data-set has been saved to ROM, a message will state that the DSM memory has been configured to ROM. Press any key to continue.

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

View/Edit Control Data Values

Engine Family : VHP GAS ENGINE Engine Model : L7042 V-12 # of Cylinders : 12 Primary Fuel : NATURAL GAS PIPELINE QUALITY Secondary Fuel: DIGESTER GAS Comments:	
Timing Disk Reference 26 °BTDC <F3> To Calculate TDR D-Lead Position - - -> Grounded      Open Most Advanced Timing    10 °BTDC      10 °BTDC Most Retarded Timing    4 °BTDC      4 °BTDC Default Timing            8 °BTDC      8 °BTDC End of Sample Window   30 °ATDC	
Retard 1° Every 1 Knock Sample(s) Advance 1° Every 5 No-Knock Sample(s)	
Warm-Up Delay Time      300 Seconds Shutdown Delay Time      15 Seconds	

Detonation  
Level Select

Sensor 1	2500 mV
Sensor 2	2500 mV
Sensor 3	2500 mV
Sensor 4	2500 mV
Sensor 5	2500 mV
Sensor 6	2500 mV
Sensor 7	2500 mV
Sensor 8	2500 mV
Sensor 9	2500 mV
Sensor 10	2500 mV
Sensor 11	2500 mV
Sensor 12	2500 mV

NOTE: Entries above 2400mV result in a Disabled Sensor.

<F10> to Save                      <ESC> to Main Menu                      <F5> to AUTOCAL

**Figure 3.10-22. View/Edit Control Data Values Screen**

3. The DSM parameters include: default timing values, retard and advance timing values and rates of change, and delay times. To edit any of the values in the data-set, position the cursor in the field for the parameter you want to edit. Then enter the new value.

Refer to Figure 3.10-22 and the correct table while editing the data-set. The values provided in the tables are the recommended data-set parameters for the DSM system. Modifications may be made based on site conditions.

- Table 3.10-1 on page 13 provides the data-set parameters for 8L-AT27GL engines.
- Table 3.10-2 on page 14 provides the data-set parameters for 12V-AT27GL engines.
- Table 3.10-3 on page 14 provides the data-set parameters for 12V-AT25GL engines.
- Table 3.10-4 on page 14 provides the data-set parameters for VHP engines.
- Table 3.10-5 on page 14 provides the data-set parameters for VGF engines.

Listed are definitions of each of the data-set parameters found on the View/Edit Control Data Values Screen.

**Comments:** Type in any comments regarding DSM programming or revise existing comments. Typically, comments include site, engine number, and date information.

**Most Advanced Timing:** The maximum advanced timing at which the system will allow the engine to operate. Enter the most advanced timing for the Ignition Module's "D" lead grounded and the most advanced timing for the "D" lead open.

**NOTE:** "Most Advanced Timing" may not be greater than nameplate timing.

**Most Retarded Timing:** The minimum timing at which the DSM system will allow a cylinder to retard in order to control detonation. Enter the most retarded timing for the Ignition Module's "D" lead grounded and the most retarded timing for the "D" lead open.

**Default Timing:** Default timing is the retarded ignition timing imposed by the DSM system when it is not protecting against detonation. The DSM system activates default timing for a cylinder when the cylinder's sensor is disabled, when the sensor fails, and during engine warm-up delay.



# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

**End of Sample Window:** The end of sample window is a predetermined angle after top dead center (ATDC) in crankshaft degrees at which the DSM system stops looking for detonation.

**Retard X° Every Y Knock Sample(s):** Allows you to select how fast the timing retards by changing the "X" and "Y" values. When an individual cylinder is in detonation, the timing retards "X" degrees for every "Y" consecutive times detonation is found.

**Advance X° Every Y No-Knock Sample(s):** Allows you to select how fast the timing advances by changing the "X" and "Y" values. Once an individual cylinder is no longer in detonation, the timing advances "X" degrees for every "Y" consecutive times the cylinder is not found to be detonating.

**Warm-Up Delay Time:** Allows you to select the amount of delay between the time the engine begins rotating and when the DSM system takes control. While this delay is active, the cylinders are operating at the default timing. The purpose of this delay is to prevent misleading

vibration signals, that may exist during the time the engine is warming up, from being incorrectly construed as "knock" signals. During the Warm-Up Delay Time, the DSM system is not protecting against detonation.

**Shutdown Delay Time:** Allows you to select the amount of delay between the moment when the cylinder reaches the Most Retarded Timing during detonation and the time the shutdown warning becomes active while still in detonation.

**NOTE:** Make sure to program the Shutdown Delay Time long enough to avoid unnecessary shutdowns. For example: If engine timing reaches the Maximum Retard limit AND the Shutdown Delay Time is shorter than the Advance Rate, shutdown may occur before the engine is allowed to advance at the programmed Advance Rate.

4. Continue with the next section, "Running The AutoCal Program," to establish detonation threshold so that the DSM system can operate properly.

**Table 3.10-1. 8L-AT27GL DSM Data-Set Parameters<sup>1</sup>**

FUEL	AIR/FUEL RATIO (% EXHAUST O <sub>2</sub> )	DEFAULT TIMING VALUES (°BTDC)	MAX. ADVANCE <sup>2</sup> (°BTDC)	MAX. RETARD (°BTDC)	END OF SAMPLE WINDOW	"D" LEAD
Natural Gas	28:1 (9.8)	6°	8°	2°	30°	OPEN
	32:1 (11.4)	18°	20°	8°	30°	GROUNDED
Field Gas (115 Octane)	32:1 (11.4)	8°	10°	4°	30°	OPEN
Digester Gas	30:1 (10.5)	18°	20°	12°	30°	GROUNDED
Landfill Gas	30:1 (10.5)	18°	22°	14°	30°	GROUNDED
<b>FUEL QUALITY:</b>		<b>64 WKI™ AND BELOW</b>		<b>64 WKI™ +</b>		
Retard Rate		4° Every 1 Knock Sample(s)		1° Every 1 Knock Sample(s)		
Advance Rate		1° Every 5 No-Knock Sample(s)		1° Every 5 No-Knock Sample(s)		
Warm-Up Delay Time		300 Second(s)		300 Second(s)		
Shutdown Delay Time		5 Second(s)		15 Second(s)		

**NOTE:** <sup>1</sup> The timing values listed apply to engines with the six hole prechamber cups.

<sup>2</sup> "Max. Advance" should never exceed nameplate timing.

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

**Table 3.10-2. 12V-AT27GL DSM Data-Set Parameters<sup>1</sup>**

FUEL	AIR/FUEL RATIO (% EXHAUST O <sub>2</sub> )	DEFAULT TIMING VALUES (°BTDC)	MAX. ADVANCE <sup>2</sup> (°BTDC)	MAX. RETARD (°BTDC)	END OF SAMPLE WINDOW	"D" LEAD
Natural Gas	28:1 (9.8)	6°	8°	2°	30°	OPEN
	32:1 (11.4)	16°	18°	8°	30°	GROUNDED
Field Gas (115 Octane)	32:1 (11.4)	8°	10°	4°	30°	OPEN
Digester Gas	30:1 (10.5)	16°	18°	10°	30°	GROUNDED
Landfill Gas	30:1 (10.5)	16°	20°	12°	30°	GROUNDED
<b>FUEL QUALITY:</b>		<b>64 WKI™ AND BELOW</b>		<b>64 WKI™ +</b>		
Retard Rate		4° Every 1 Knock Sample(s)		1° Every 1 Knock Sample(s)		
Advance Rate		1° Every 5 No-Knock Sample(s)		1° Every 5 No-Knock Sample(s)		
Warm-Up Delay Time		300 Second(s)		300 Second(s)		
Shutdown Delay Time		5 Second(s)		15 Second(s)		

**NOTE:** <sup>1</sup> The timing values listed apply to engines with the six hole prechamber cups.  
<sup>2</sup> "Max. Advance" should never exceed nameplate timing.

**Table 3.10-3. 12V-AT25GL DSM Data-Set Parameters**

FUEL	AIR/FUEL RATIO (% EXHAUST O <sub>2</sub> )	DEFAULT TIMING VALUES (°BTDC)	MAX. ADVANCE <sup>1</sup> (°BTDC)	MAX. RETARD (°BTDC)	END OF SAMPLE WINDOW	"D" LEAD
Natural Gas	28:1 (9.8)	8°	10°	4°	30°	OPEN
Digester Gas	28:1 (8.8)	12°	14°	8°	30°	OPEN
Landfill Gas	26:1 (8.8)	15°	17°	11°	30°	GROUNDED
<b>FUEL QUALITY:</b>		<b>64 WKI™ AND BELOW</b>		<b>64 WKI™ +</b>		
Retard Rate		3° Every 1 Knock Sample(s)		1° Every 1 Knock Sample(s)		
Advance Rate		1° Every 5 No-Knock Sample(s)		1° Every 5 No-Knock Sample(s)		
Warm-Up Delay Time		300 Second(s)		300 Second(s)		
Shutdown Delay Time		5 Second(s)		15 Second(s)		

**NOTE:** <sup>1</sup> "Max. Advance" should never exceed nameplate timing.

**Table 3.10-4. VHP DSM Data-Set Parameters**

<b>Most Advanced Timing</b>	Nameplate Timing
<b>Most Retarded Timing</b>	Nameplate Timing - 6°
<b>Default Timing</b>	Nameplate Timing - 2°
<b>End of Sample Window</b>	30°
<b>Retard X° Every Y Knock Sample(s)</b>	Retard 1° Every 1 Sample Propane Only = Retard 3° Every 1 Sample
<b>Advance X° Every Y No-Knock Sample(s)</b>	1° Every 5 Samples
<b>Warm-Up Delay Time</b>	300 Seconds
<b>Shutdown Delay Time</b>	15 Seconds

**Table 3.10-5. VGF DSM Data-Set Parameters**

<b>Most Advanced Timing</b>	Nameplate Timing
<b>Most Retarded Timing</b>	Nameplate Timing - 6°
<b>Default Timing</b>	Nameplate Timing - 2°
<b>End of Sample Window</b>	30°
<b>Retard X° Every Y Knock Sample(s)</b>	Retard 2° Every 1 Sample Propane Only = Retard 3° Every 1 Sample
<b>Advance X° Every Y No-Knock Sample(s)</b>	1° Every 5 Samples
<b>Warm-Up Delay Time</b>	300 Seconds
<b>Shutdown Delay Time</b>	15 Seconds

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

## RUNNING THE AUTOCAL PROGRAM

The DSM AutoCal program is the automatic calibration of the detonation threshold levels by the DSM Interface Program. The DSM module monitors for detonation using the frequency output of each cylinder with engine mounted knock sensors. These knock sensors must be calibrated or "AutoCaled." During AutoCal, the knock sensors are calibrated so that the DSM system can operate properly.

An AutoCal should be run the first time the DSM is programmed for an engine or whenever a DSM is programmed for a new application. Additionally, the DSM system must be re-AutoCaled using the DSM Interface Program and a PC after doing any removal, repair, or replacement of engine cylinder heads, cylinder liners, cylinder gaskets, pistons, or knock sensors. This calibration **MUST BE** done using the AutoCal program as explained in this section.

**CAUTION** The sensors give an output even when the engine is not in detonation. The sensor output increases with load, so the engine must be at its **HIGHEST LOAD** during AutoCal. If the AutoCal program is run while the engine is at a lower load, an increase in load may be mistaken for detonation. The engine must be running at the maximum load and speed anticipated during normal operation.

**NOTE:** At light loads, engine characteristics are very different than at higher loads. Typically, this results in lower output from the knock sensors which, if low enough, will result in a "lost sensor" error even when the system is working properly. Errors may result at low loads after engine warm up. These errors go away once the engine is fully loaded. If "lost sensor" errors are experienced at low loads and do not correct themselves as the engine is fully loaded, refer to Section 4.00, DSM System Diagnostics And Troubleshooting.

1. Verify that the engine is running at the maximum load and speed anticipated during normal engine operation.

**CAUTION** Detonation must not be present while running AutoCal. If detonation occurs at any time during the calibration program, the AutoCal results must be discarded and the AutoCal program must be rerun.

2. Detach or copy the applicable AutoCal Worksheet from the back of this manual. The blue AutoCal Worksheet applies to 6, 8, and 12 cylinder engines (see Table 3.10-6 for sample worksheet). The yellow AutoCal Worksheet applies to 16 cylinder engines (see Table 3.10-7 for sample worksheet). Be sure to detach or copy the worksheet applicable to your engine application.

3. Verify that the View/Edit Control Data Values Screen is showing.

**Table 3.10-6. AutoCal Worksheet For 6, 8, And 12 Cylinder Engines**

SENSOR	SET-POINT "S" COLUMN RESULTS										HIGHEST "S" VALUE
	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

Table 3.10-7. AutoCal Worksheet For 16 Cylinder Engines

SENSOR PAIRS	SET-POINT "S" COLUMN RESULTS										HIGHEST "S" VALUE
	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	
1 & 2											
3 & 4											
5 & 6											
7 & 8											
9 & 10											
11 & 12											
13 & 14											
15 & 16											

4. To begin AutoCal, press [F5] while viewing the View/Edit Control Data Values Screen. The AutoCal Screen appears. Figure 4.05-3 shows the AutoCal Screen for 6, 8, and 12 cylinder engine applications. Figure 4.05-4 shows the AutoCal Screen for 16 cylinder engine applications.

**NOTE:** The AutoCal results shown in the figures and tables provided in this manual are for example only. Actual AutoCal values will vary depending on the application.

**NOTE:** "L" = Low, "M" = Medium, "H" = High, "S" = Set-Point in Figure 3.10-23 and Figure 4.05-4.

5. Verify that the "AutoCal Test Timing" on the AutoCal Screen (see Figure 3.10-23 or Figure 3.10-24) is the same as that fuel's "Most Advanced Timing" (grounded or open, whichever is applicable) on the View/Edit Control Data Values Screen (see Figure 3.10-25). If the "AutoCal Test Timing" is not the same as "Most Advanced Timing," enter the "Most Advanced Timing" on the AutoCal Screen.

**NOTE:** AutoCal will default to the "D" lead grounded ignition setting which is "Most Advanced Timing." For secondary fuel (or "D" lead open), the AutoCal Screen test timing value may need to be edited as explained in Step 5.

**AUTOCAL TEST TIMING**

Automatic Calibration of Detonation Sensor Threshold Voltages

AutoCal Test Timing 10 °BTDC

Messages:

AutoCal	L	M	H	S
Sensor 1				
Sensor 2				
Sensor 3				
Sensor 4				
Sensor 5				
Sensor 6				
Sensor 7				
Sensor 8				
Sensor 9				
Sensor 10				
Sensor 11				
Sensor 12				

Engine Timing for Autocal Program. <F10> Accepts, <ESC> Aborts

Figure 3.10-23. AutoCal Screen For 6, 8, And 12 Cylinder Engines

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

**AUTOCAL TEST TIMING** Automatic Calibration of Detonation Sensor Threshold Voltages

AutoCal Test Timing 10 °BTDC

Messages:

AutoCal	L	M	H	S
Sensors 1 & 2				
Sensors 3 & 4				
Sensors 5 & 6				
Sensors 7 & 8				
Sensors 9 & 10				
Sensors 11 & 12				
Sensors 13 & 14				
Sensors 15 & 16				

Engine Timing for Autocal Program. <F10> Accepts, <ESC> Aborts

**Figure 3.10-24. AutoCal Screen For 16 Cylinder Engines**

**MOST ADVANCED TIMING** View/Edit Control Data Values

Engine Family : V-12 GAS ENGINE  
 Engine Model : L70 V-12  
 # of Cylinders : 12  
 Primary Fuel : NATURAL GAS PIPELINE QUALITY  
 Secondary Fuel : DIESTER GAS  
 Comments:

Timing Disk Reference 26 °BTDC  
 <F3> To Calculate TDR

D-Lead Position - - -> Grounded      Open

Most Advanced Timing 10 °BTDC      10 °BTDC  
 Most Retarded Timing 4 °BTDC      4 °BTDC  
 Default Timing 8 °BTDC      8 °BTDC  
 End of Sample Window 30 °ATDC

Retard 1° Every 1 Knock Sample(s)  
 Advance 1° Every 5 No-Knock Sample(s)

Warm-Up Delay Time 300 Seconds  
 Shutdown Delay Time 15 Seconds

**Detonation Level Select**

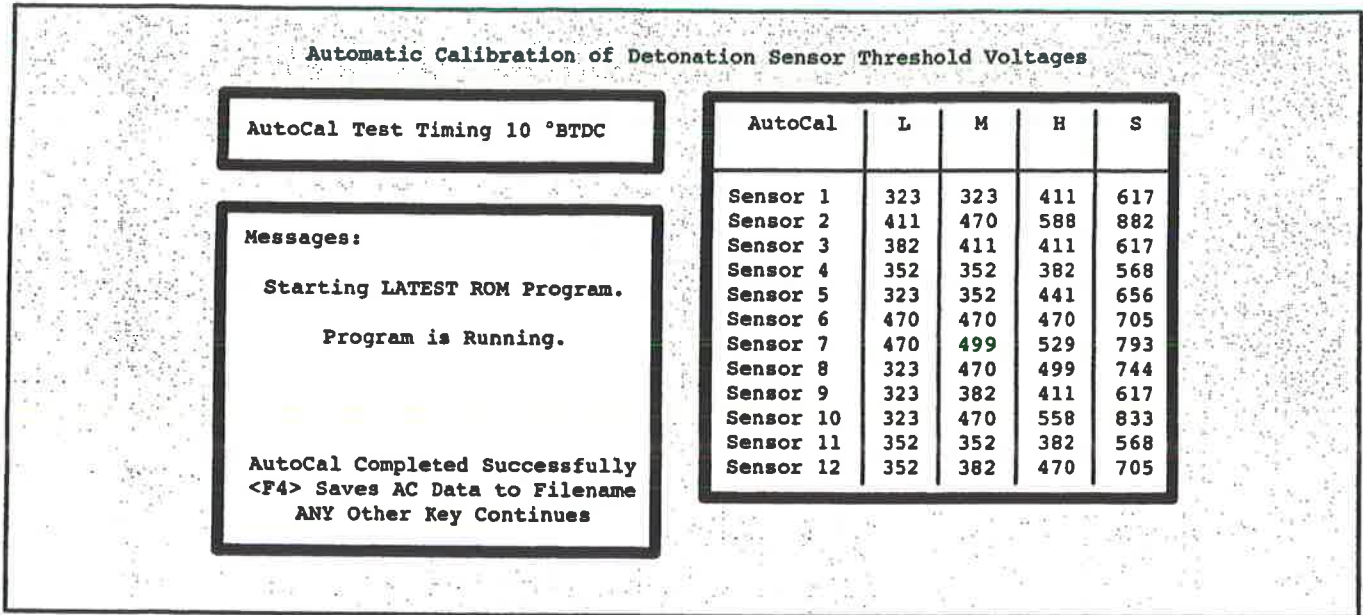
Sensor 1	2500 mV
Sensor 2	2500 mV
Sensor 3	2500 mV
Sensor 4	2500 mV
Sensor 5	2500 mV
Sensor 6	2500 mV
Sensor 7	2500 mV
Sensor 8	2500 mV
Sensor 9	2500 mV
Sensor 10	2500 mV
Sensor 11	2500 mV
Sensor 12	2500 mV

NOTE: Entries above 2400mV result in a Disabled Sensor.

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

**Figure 3.10-25. View/Edit Control Data Values Screen**

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION



**Figure 3.10-26. Completion Of AutoCal Program**

6. Press [F10] to accept the "AutoCal Test Timing" value and begin the AutoCal program. Calibration numbers for each sensor will begin appearing in the "S" or Set-Point column. When the calibration process is completed your screen will resemble the screen shown in Figure 3.10-26.

**NOTE:** If any errors occur during the AutoCal program they will be displayed as LOW, STAL, or HISP in the Set-Point column on the AutoCal Screen. Additionally, an error message will be provided in the "Messages" box on the AutoCal Screen stating, "AutoCal Completed With ERRORS." See Section 4.00, DSM System Diagnostics And Troubleshooting, to correct problem. Once the problem is corrected, rerun AutoCal.

**NOTE:** If an HISP or STAL error occurs, the AutoCal Program will stop as soon as the error is detected. If a LOW error occurs, the AutoCal program will continue but the AutoCal results on the View/Edit Control Data Values Screen will NOT be updated.

**NOTE:** To save your AutoCal results to a file, press [F4] after running the AutoCal program. Follow the instructions on the screens that follow. The file will be saved to the drive and directory where the DSM Interface Program is located. This file is NOT retrievable through

the DSM but can be opened outside of the DSM program in Microsoft® Notepad® or a word processing program and then printed. **Saving the AutoCal results to a file is NOT a substitute for saving to ROM. Be sure to save the FINAL AutoCal results to ROM as explained in the following section, "Saving Data-Set to ROM."**

7. In a "RUN #" column on your AutoCal Worksheet, record the values listed in the "S" or Set-Point column on the AutoCal Screen. For example, the values in the "S" or Set-Point column on the AutoCal Screen in Figure 3.10-26 are recorded in the sample AutoCal Worksheet shown in Table 3.10-8.

**NOTE:** If you have a portable printer connected to your PC, press the [Print Screen] button for a printout of the AutoCal Screen.

8. Press any key to continue. You will return to the View/Edit Control Data Values Screen. The "S" or Set-Point values just determined during the AutoCal program appears in the "Detonation Level Select" table on the right hand side of the View/Edit Control Data Values Screen (see Figure 3.10-27).

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

**Table 3.10-8. AutoCal Worksheet Example - Run # 1 Results**

SENSOR	SET-POINT "S" COLUMN RESULTS										HIGHEST "S" VALUE
	RUN # 1	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	
1	617										
2	882										
3	617										
4	568										
5	656										
6	705										
7	793										
8	744										
9	617										
10	833										
11	568										
12	705										

*NOTE: The AutoCal results shown in the figures and tables provided in this manual are for example only. Actual AutoCal values will vary depending on the application.*

View/Edit Control Data Values

Engine Family : VHP GAS ENGINE  
 Engine Model : L7042 V-12  
 # of Cylinders: 12  
 Primary Fuel : NATURAL GAS PIPELINE QUALITY  
 Secondary Fuel: DIGESTER GAS  
 Comments:

---

Timing Disk Reference 26 °BTDC  
 <F3> To Calculate TDR  
 D-Lead Position - - -> Grounded          Open  
 Most Advanced Timing 10 °BTDC          10 °BTDC  
 Most Retarded Timing 4 °BTDC          4 °BTDC  
 Default Timing 8 °BTDC          8 °BTDC  
 End of Sample Window 30 °ATDC

---

Retard 1" Every 1 Knock Sample(s)  
 Advance 1" Every 5 No-Knock Sample(s)

---

Warm-Up Delay Time 300 Seconds  
 Shutdown Delay Time 15 Seconds

Detonation  
Level Select

Sensor 1	617	mV
Sensor 2	882	mV
Sensor 3	617	mV
Sensor 4	568	mV
Sensor 5	656	mV
Sensor 6	705	mV
Sensor 7	793	mV
Sensor 8	744	mV
Sensor 9	617	mV
Sensor 10	833	mV
Sensor 11	568	mV
Sensor 12	705	mV

NOTE: Entries above 2400mV result in a Disabled Sensor.

<F10> to Save
<ESC> to Main Menu
<F5> to AUTO CAL

**Figure 3.10-27. View/Edit Control Data Values Screen With Preliminary AutoCal Results**

## PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

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9. Rerun the AutoCal program two additional times following Steps 4 - 8. Be sure to record the "S" or Set-Point column results for each AutoCal you run on the AutoCal Worksheet.
10. Press any key to continue. You will return to the View/Edit Control Data Values Screen. The values determined by the last AutoCal program you ran appears in the "Detonation Level Select" table on the right hand side of the View/Edit Control Data Values Screen.
11. If this is a dual fuel application and if possible, change fuels going to the engine and repeat Steps 3 - 10 to run the AutoCal program while running on the secondary fuel and timing. Record all "S" or Set-Point values determined by the AutoCal program for each sensor on the AutoCal Worksheet.
12. After running the AutoCal programs, circle the highest "S" or Set-Point value calibrated during all the AutoCals for each sensor on the worksheet (see Table 3.10-9).
13. Record the circled (highest) "S" or Set-Point value in the "Highest 'S' Value" column on the worksheet (see Table 3.10-9).
14. Compare the "S" or Set-Point values for each sensor recorded in the "Highest 'S' Value" column on your worksheet. If the results determined for each sensor vary by more than 500 from one sensor to another, refer to Table 4.00-4 in Section 4.00, *DSM System Diagnostics And Troubleshooting*. If the values do vary by more than 500 from sensor to sensor it may indicate 1) engine detonation, 2) sensor mounting imperfections, 3) unattached or incorrectly routed wire harnesses and/or ground wiring, or 4) other engine related problems. The troubleshooting table in Section 4.00 provides you with remedies.
15. With the View/Edit Control Data Values Screen showing, position the cursor in the "Detonation Level Select" table on the screen.
16. Enter the highest set-point value calibrated for each sensor in the "Detonation Level Select" table on the View/Edit Control Data Values Screen (see Figure 4.05-8). These values are recorded on your AutoCal Worksheet in the "Highest 'S' Value" column. For example, in Figure 3.10-28, "656" was entered since it was the highest detonation level calibrated for Sensor 1 during all AutoCal programs completed.
17. Continue with the next section, "Saving Data-Set To ROM." **Make sure to complete the next section. Data-sets NOT saved to ROM are lost when power is disconnected from the DSM module.**



# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

**Table 3.10-9. AutoCal Worksheet Example - Completed Results**

SENSOR	SET-POINT "S" COLUMN RESULTS										HIGHEST "S" VALUE
	RUN # 1	RUN # 2	RUN # 3	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	
1	617	617	656								656
2	882	833	793								882
3	617	705	656								705
4	568	568	617								617
5	656	656	705								705
6	705	656	617								705
7	793	744	833								833
8	744	793	793								793
9	617	656	656								656
10	833	793	882								882
11	568	568	617								617
12	705	744	705								744

*NOTE: The AutoCal results shown in the figures and tables provided in this manual are for example only. Actual AutoCal values will vary depending on the application.*

**View/Edit Control Data Values**

<p>Engine Family : VHP GAS ENGINE                  Engine Model : L7042 V-12                  # of Cylinders: 12                  Primary Fuel : NATURAL GAS PIPELINE QUALITY                  Secondary Fuel: DIGESTER GAS                  Comments:</p> <hr/> <p>Timing Disk Reference 26 °BTDC                  &lt;F3&gt; To Calculate TDR                  D-Lead Position - - -&gt; Grounded      Open                  Most Advanced Timing 10 °BTDC      10 °BTDC                  Most Retarded Timing 4 °BTDC      4 °BTDC                  Default Timing 8 °BTDC      8 °BTDC                  End of Sample Window 30 °ATDC</p> <hr/> <p>Retard 1° Every 1 Knock Sample(s)                  Advance 1° Every 5 No-Knock Sample(s)</p> <hr/> <p>Warm-Up Delay Time 300 Seconds                  Shutdown Delay Time 15 Seconds</p>	<p><b>Detonation Level Select</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr><td>Sensor 1</td><td>656</td><td>mV</td></tr> <tr><td>Sensor 2</td><td>882</td><td>mV</td></tr> <tr><td>Sensor 3</td><td>705</td><td>mV</td></tr> <tr><td>Sensor 4</td><td>617</td><td>mV</td></tr> <tr><td>Sensor 5</td><td>705</td><td>mV</td></tr> <tr><td>Sensor 6</td><td>705</td><td>mV</td></tr> <tr><td>Sensor 7</td><td>833</td><td>mV</td></tr> <tr><td>Sensor 8</td><td>793</td><td>mV</td></tr> <tr><td>Sensor 9</td><td>656</td><td>mV</td></tr> <tr><td>Sensor 10</td><td>882</td><td>mV</td></tr> <tr><td>Sensor 11</td><td>617</td><td>mV</td></tr> <tr><td>Sensor 12</td><td>744</td><td>mV</td></tr> </table>	Sensor 1	656	mV	Sensor 2	882	mV	Sensor 3	705	mV	Sensor 4	617	mV	Sensor 5	705	mV	Sensor 6	705	mV	Sensor 7	833	mV	Sensor 8	793	mV	Sensor 9	656	mV	Sensor 10	882	mV	Sensor 11	617	mV	Sensor 12	744	mV
Sensor 1	656	mV																																			
Sensor 2	882	mV																																			
Sensor 3	705	mV																																			
Sensor 4	617	mV																																			
Sensor 5	705	mV																																			
Sensor 6	705	mV																																			
Sensor 7	833	mV																																			
Sensor 8	793	mV																																			
Sensor 9	656	mV																																			
Sensor 10	882	mV																																			
Sensor 11	617	mV																																			
Sensor 12	744	mV																																			

*NOTE: Entries above 2400mV result in a Disabled Sensor.*

<F10> to Save      <ESC> to Main Menu      <F5> to AUTOCAL

**Figure 3.10-28. View/Edit Control Data Values Screen With Completed AutoCal Results**

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

## SAVING DATA-SET TO ROM

1. Save the edited data-set to ROM (permanent memory) on the EPROM chip in the DSM module. Press [F10] for the Saving Options Menu.
2. Highlight "Configure DSM Memory" on the menu and press [Enter] (see Figure 3.10-29).

**NOTE:** The "Test Data on DSM" option from the Save Options Menu allows a program to be run in the DSM module's temporary memory (RAM). This may be used for troubleshooting so that the ROM memory space is

preserved. The contents of RAM are lost whenever power to the DSM module is removed.

3. When the Verification Screen appears as shown in Figure 3.10-30, press [Y].

**CAUTION** Do not disturb the serial cable or interrupt computer power while programming. If the serial cable is disturbed or disconnected during the saving process, the EPROM chip in the DSM module will become corrupted and will need to be replaced.

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE                  Engine Model : L7042 V-12                  # of Cylinders: 12                  Primary Fuel : NATURAL                  Secondary Fuel: DIGESTED                  Comments:</p> <p>Timing Disk Reference                  &lt;F3&gt; To Calculate IDK</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">D-Lead Position - - -&gt;</td> <td style="width: 30%;">Grounded</td> <td style="width: 30%;">Open</td> </tr> <tr> <td>Most Advanced Timing</td> <td>10 °BTDC</td> <td>10 °BTDC</td> </tr> <tr> <td>Most Retarded Timing</td> <td>4 °BTDC</td> <td>4 °BTDC</td> </tr> <tr> <td>Default Timing</td> <td>8 °BTDC</td> <td>8 °BTDC</td> </tr> <tr> <td>End of Sample Window</td> <td>30 °ATDC</td> <td></td> </tr> </table> <p>Retard 1° Every 1 Knock Sample(s)                  Advance 1° Every 5 No-Knock Sample(s)</p> <p>Warm-Up Delay Time 300 Seconds                  Shutdown Delay Time 15 Seconds</p>	D-Lead Position - - ->	Grounded	Open	Most Advanced Timing	10 °BTDC	10 °BTDC	Most Retarded Timing	4 °BTDC	4 °BTDC	Default Timing	8 °BTDC	8 °BTDC	End of Sample Window	30 °ATDC		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td>Sensor 1</td><td>656 mV</td></tr> <tr><td>Sensor 2</td><td>882 mV</td></tr> <tr><td>Sensor 3</td><td>705 mV</td></tr> <tr><td>Sensor 4</td><td>617 mV</td></tr> <tr><td>Sensor 5</td><td>705 mV</td></tr> <tr><td>Sensor 6</td><td>705 mV</td></tr> <tr><td>Sensor 7</td><td>833 mV</td></tr> <tr><td>Sensor 8</td><td>793 mV</td></tr> <tr><td>Sensor 9</td><td>656 mV</td></tr> <tr><td>Sensor 10</td><td>882 mV</td></tr> <tr><td>Sensor 11</td><td>617 mV</td></tr> <tr><td>Sensor 12</td><td>744 mV</td></tr> </tbody> </table> <p style="font-size: small;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select		Sensor 1	656 mV	Sensor 2	882 mV	Sensor 3	705 mV	Sensor 4	617 mV	Sensor 5	705 mV	Sensor 6	705 mV	Sensor 7	833 mV	Sensor 8	793 mV	Sensor 9	656 mV	Sensor 10	882 mV	Sensor 11	617 mV	Sensor 12	744 mV
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Sensor 12	744 mV																																									

<F10> to Save	<ESC> to Main Menu	<F5> to AUTOCAL
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Figure 3.10-29. Saving Options Menu

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE                  Engine Model : L7042 V-12                  # of Cylinders: 12                  Primary Fuel : NATURAL GAS PIPELINE QUALITY                  Secondary Fuel:                  Comments:</p> <p>Timing Disk Refe                  &lt;F3&gt;</p> <p>D-Lead Position                  Most Advanced Ti                  Most Retarded Ti                  Default Timing                  End of Sample W</p> <p>Retard 1° Eve                  Advance 1° Eve</p> <p>Warm-Up Delay Time 300 Seconds                  Shutdown Delay Time 15 Seconds</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td>Sensor 1</td><td>656 mV</td></tr> <tr><td>Sensor 2</td><td>882 mV</td></tr> <tr><td>Sensor 3</td><td>705 mV</td></tr> <tr><td>Sensor 4</td><td>617 mV</td></tr> <tr><td>Sensor 5</td><td>705 mV</td></tr> <tr><td>Sensor 6</td><td>705 mV</td></tr> <tr><td>Sensor 7</td><td>833 mV</td></tr> <tr><td>Sensor 8</td><td>793 mV</td></tr> <tr><td>Sensor 9</td><td>656 mV</td></tr> <tr><td>Sensor 10</td><td>882 mV</td></tr> <tr><td>Sensor 11</td><td>617 mV</td></tr> <tr><td>Sensor 12</td><td>744 mV</td></tr> </tbody> </table> <p style="font-size: small;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select		Sensor 1	656 mV	Sensor 2	882 mV	Sensor 3	705 mV	Sensor 4	617 mV	Sensor 5	705 mV	Sensor 6	705 mV	Sensor 7	833 mV	Sensor 8	793 mV	Sensor 9	656 mV	Sensor 10	882 mV	Sensor 11	617 mV	Sensor 12	744 mV
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Sensor 8	793 mV																										
Sensor 9	656 mV																										
Sensor 10	882 mV																										
Sensor 11	617 mV																										
Sensor 12	744 mV																										

OK to Store New Values?	
Yes	No esc

<F10> to Save	<ESC> to Main Menu	<F5> to AUTOCAL
---------------	--------------------	-----------------

Figure 3.10-30. Verification Screen

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

4. Several screens will appear indicating that the data-set is being saved to ROM, permanent memory on the EPROM chip inside the DSM module. Once the data-set has been saved to ROM, the message shown in Figure 3.10-31 appears.

**NOTE:** The DSM allows 25 saves to ROM. Once ROM has been fully configured, the EPROM chip in the DSM module must be replaced to permit further saves to permanent memory.

5. Press any key to continue and the View/Edit Control Data Values Screen appears (see Figure 3.10-32).

**NOTE:** Make copies of your data-set for future reference. If a printer is connected to your PC, press [Print Screen] on the keyboard.

**View/Edit Control Data Values**

Engine Family : VHP GAS ENGINE Engine Model : L7042 V-12 # of Cylinders: 12 Primary Fuel : Secondary Fuel: Comments: <hr/> Timing Disk Reference : <F3> D-Lead Position Most Advanced Timing Most Retarded Timing Default Timing End of Sample Window <hr/> Retard 1° Every Advance 1° Every 5 No-Knock Sample(s) <hr/> Warm-Up Delay Time 300 Seconds Shutdown Delay Time 15 Seconds	<table style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="3" style="text-align: center; padding: 5px;">Detonation Level Select</th> </tr> <tr><td style="text-align: center;">r 1</td><td style="text-align: right;">656</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 2</td><td style="text-align: right;">882</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 3</td><td style="text-align: right;">705</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 4</td><td style="text-align: right;">617</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 5</td><td style="text-align: right;">705</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 6</td><td style="text-align: right;">705</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 7</td><td style="text-align: right;">833</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 8</td><td style="text-align: right;">793</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 9</td><td style="text-align: right;">656</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 10</td><td style="text-align: right;">882</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 11</td><td style="text-align: right;">617</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">r 12</td><td style="text-align: right;">744</td><td style="text-align: left;">mV</td></tr> </table> <p style="font-size: small; margin-top: 5px;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select			r 1	656	mV	r 2	882	mV	r 3	705	mV	r 4	617	mV	r 5	705	mV	r 6	705	mV	r 7	833	mV	r 8	793	mV	r 9	656	mV	r 10	882	mV	r 11	617	mV	r 12	744	mV
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r 9	656	mV																																						
r 10	882	mV																																						
r 11	617	mV																																						
r 12	744	mV																																						

Starting ROM03 Program		
DSM Memory has been Configured.		
Program Is Running.		
Press ANY KEY to Continue		

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

**Figure 3.10-31. Verification Screen Of Save To ROM**

**View/Edit Control Data Values**

Engine Family : VHP GAS ENGINE Engine Model : L7042 V-12 # of Cylinders: 12 Primary Fuel : NATURAL GAS PIPELINE QUALITY Secondary Fuel: DIGESTER GAS Comments: <hr/> Timing Disk Reference 26 °BTDC <F3> To Calculate TDR D-Lead Position -- -> Grounded      Open Most Advanced Timing 10 °BTDC      10 °BTDC Most Retarded Timing 4 °BTDC      4 °BTDC Default Timing 8 °BTDC      8 °BTDC End of Sample Window 30 °ATDC <hr/> Retard 1° Every 1 Knock Sample(s) Advance 1° Every 5 No-Knock Sample(s) <hr/> Warm-Up Delay Time 300 Seconds Shutdown Delay Time 15 Seconds	<table style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="3" style="text-align: center; padding: 5px;">Detonation Level Select</th> </tr> <tr><td style="text-align: center;">Sensor 1</td><td style="text-align: right;">656</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 2</td><td style="text-align: right;">882</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 3</td><td style="text-align: right;">705</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 4</td><td style="text-align: right;">617</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 5</td><td style="text-align: right;">705</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 6</td><td style="text-align: right;">705</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 7</td><td style="text-align: right;">833</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 8</td><td style="text-align: right;">793</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 9</td><td style="text-align: right;">656</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 10</td><td style="text-align: right;">882</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 11</td><td style="text-align: right;">617</td><td style="text-align: left;">mV</td></tr> <tr><td style="text-align: center;">Sensor 12</td><td style="text-align: right;">744</td><td style="text-align: left;">mV</td></tr> </table> <p style="font-size: small; margin-top: 5px;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select			Sensor 1	656	mV	Sensor 2	882	mV	Sensor 3	705	mV	Sensor 4	617	mV	Sensor 5	705	mV	Sensor 6	705	mV	Sensor 7	833	mV	Sensor 8	793	mV	Sensor 9	656	mV	Sensor 10	882	mV	Sensor 11	617	mV	Sensor 12	744	mV
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<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

**Figure 3.10-32. View/Edit Control Data Values Screen**

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

## SAVING DATA-SET TO DISK

Data-sets are assigned filenames and saved on disk so the user can retain the data-set for future reference. Each time a new program is saved to ROM, the previous program can no longer be retrieved. The only way to keep track of old data-sets is to save to disk.

**NOTE:** When saving to disk, the data-set will be saved to the drive and directory where the DSM Interface Program is located.

1. Save this program to disk by pressing [F10] (see Figure 3.10-33).
2. Highlight "Save Data to Filename" from the menu and press [Enter].
3. Enter a filename according to the following procedure (see Figure 3.10-34). Read all three steps prior to saving the file to the disk.
  - A. Locate the engine's serial number on the nameplate.
  - B. If the engine has a "C-" number, remove the "C-" and the "/" from the number.

Example: C-10768/01 would give a root file name of "1076801". If the engine does not have a "C-" number use all six digits in the serial number for the filename.

- C. The first time the configuration is saved to the disk add an "A" to the end. This is to indicate that this is the first save of this configuration. If changes are made to the configuration, save the next file with the same numerical information and change the suffix letter to "B". Continue in this manner for each revision to the file.

Once eight characters have been entered, the file will automatically be saved to the PC disk where the DSM program resides. If the filename is less than eight characters, press [Enter] to save.

4. Press [ESC] to return to the Main Menu.
5. If the data-set for your engine has been saved to ROM and a file on disk, confirm the exit to the Main Menu by pressing [Y] (see Figure 3.10-35) and the Main Menu appears. If you have not saved the data-set to ROM (permanent memory), press [N] and refer to "Saving Data-Set To ROM" in this section.

View/Edit Control Data Values

Engine Family : VHP GAS ENGINE Engine Model : L7042 V-12 # of Cylinders : 12 Primary Fuel : NATURAL Secondary Fuel : DIGESTED Comments :		
<F3> To Calculate ROM		
D-Lead Position - - ->	Grounded	Open
Most Advanced Timing	10 °BTDC	10 °BTDC
Most Retarded Timing	4 °BTDC	4 °BTDC
Default Timing	8 °BTDC	8 °BTDC
End of Sample Window	30 °ATDC	
Retard 1° Every 1	Knock Sample(s)	
Advance 1° Every 5	No-Knock Sample(s)	
Warm-Up Delay Time	300	Seconds
Shutdown Delay Time	15	Seconds

Save Data to Filename

Test Data on DSM

Configure DSM Memory

View Wiring Data

Detonation Level Select	
Sensor 1	656 mV
Sensor 2	882 mV
Sensor 3	705 mV
Sensor 4	617 mV
Sensor 5	705 mV
Sensor 6	705 mV
Sensor 7	833 mV
Sensor 8	793 mV
Sensor 9	656 mV
Sensor 10	882 mV
Sensor 11	617 mV
Sensor 12	744 mV

NOTE: Entries above 240mV result in a Disabled Sensor.

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Figure 3.10-33. Saving Options Menu

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE                  Engine Model : L7042 V-12                  # of Cylinders: 12                  Primary Fuel :                  Secondary Fuel:                  Comments:</p> <p>Timing Disk Refe                  &lt;F3&gt;</p> <p>D-Lead Position                  Most Advanced T                  Most Retarded T                  Default Timing                  End of Sample W</p> <p>Retard 1° Eve                  Advance 1° Every 5 No-Knock Sample(s)</p> <p>Warm-Up Delay Time      300 Seconds                  Shutdown Delay Time    15 Seconds</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td style="text-align: center;">r 1</td><td style="text-align: center;">656</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 2</td><td style="text-align: center;">882</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 3</td><td style="text-align: center;">705</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 4</td><td style="text-align: center;">617</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 5</td><td style="text-align: center;">705</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 6</td><td style="text-align: center;">705</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 7</td><td style="text-align: center;">833</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 8</td><td style="text-align: center;">793</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 9</td><td style="text-align: center;">656</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 10</td><td style="text-align: center;">882</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 11</td><td style="text-align: center;">617</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 12</td><td style="text-align: center;">744</td><td style="text-align: center;">mV</td></tr> </tbody> </table> <p style="font-size: small;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select			r 1	656	mV	r 2	882	mV	r 3	705	mV	r 4	617	mV	r 5	705	mV	r 6	705	mV	r 7	833	mV	r 8	793	mV	r 9	656	mV	r 10	882	mV	r 11	617	mV	r 12	744	mV
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r 8	793	mV																																						
r 9	656	mV																																						
r 10	882	mV																																						
r 11	617	mV																																						
r 12	744	mV																																						

Save Choices to Disk

Input DataFile Name

<F10> to Save                                  <ESC> to Main Menu                                  <F5> to AUTOCAL

**Figure 3.10-34. Entering Filename Of Data-Set**

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE                  Engine Model : L7042 V-12                  # of Cylinders: 12                  Primary Fuel :                  Secondary Fuel:                  Comments:</p> <p>Timing Disk Refe                  &lt;F3&gt;</p> <p>D-Lead Position                  Most Advanced T                  Most Retarded T                  Default Timing                  End of Sample W</p> <p>Retard 1° Eve                  Advance 1° Every 5 No-Knock Sample(s)</p> <p>Warm-Up Delay Time      300 Seconds                  Shutdown Delay Time    15 Seconds</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td style="text-align: center;">r 1</td><td style="text-align: center;">656</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 2</td><td style="text-align: center;">882</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 3</td><td style="text-align: center;">705</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 4</td><td style="text-align: center;">617</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 5</td><td style="text-align: center;">705</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 6</td><td style="text-align: center;">705</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 7</td><td style="text-align: center;">833</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 8</td><td style="text-align: center;">793</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 9</td><td style="text-align: center;">656</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 10</td><td style="text-align: center;">882</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 11</td><td style="text-align: center;">617</td><td style="text-align: center;">mV</td></tr> <tr><td style="text-align: center;">r 12</td><td style="text-align: center;">744</td><td style="text-align: center;">mV</td></tr> </tbody> </table> <p style="font-size: small;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select			r 1	656	mV	r 2	882	mV	r 3	705	mV	r 4	617	mV	r 5	705	mV	r 6	705	mV	r 7	833	mV	r 8	793	mV	r 9	656	mV	r 10	882	mV	r 11	617	mV	r 12	744	mV
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r 8	793	mV																																						
r 9	656	mV																																						
r 10	882	mV																																						
r 11	617	mV																																						
r 12	744	mV																																						

Exit to Main Menu

Changes Will be Lost if  
 you Have Not Saved Them.

Do You REALLY Want to EXIT?

Yes
No    esc

<F10> to Save                                  <ESC> to Main Menu                                  <F5> to AUTOCAL

**Figure 3.10-35. Confirmation Of Exit**

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

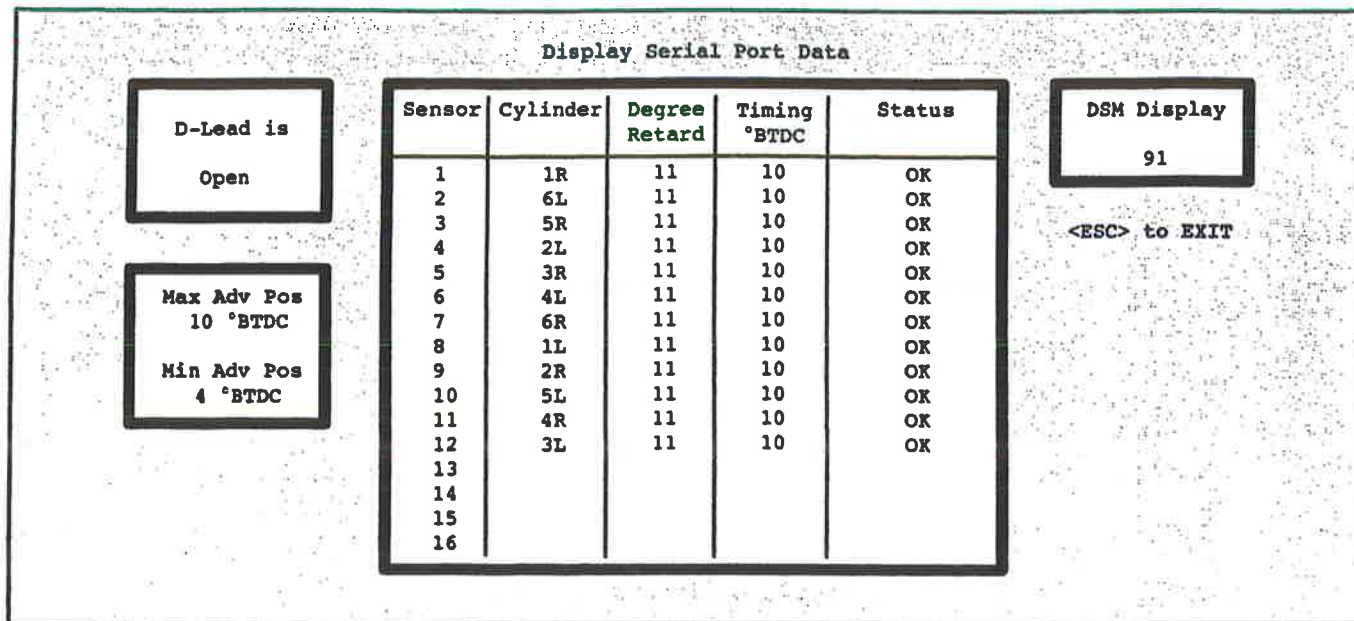


Figure 3.10-36. Display Serial Port Data Screen

## POST-PROGRAMMING CHECKS

After the engine has been successfully started, the engine timing verified, and the AutoCal program completed, you need to complete a check of the system to verify that the DSM system is working properly.

Several programming checks must be completed. The procedures that follow take you step-by-step through the programming checks. Make copies of your data-set or save your data-set to a file for future reference.

### CHECK 1: CHECKING FOR PROPER SENSOR CONNECTION

#### Viewing Display Serial Port Data Screen

1. Highlight "View Serial Link" on the Main Menu and press [Enter] (see Figure 3.10-37). The Display Serial Port Data Screen appears (see Figure 3.10-36). Information such as engine timing will vary depending on the application.

**NOTE:** If the engine is not running and the "D" lead is switched on the CEC Ignition Module (Models 811, 1211, 1611), the "D" lead status will not update immediately on the Display Serial Port Data Screen. The engine must rotate before the status of the "D" lead is updated.

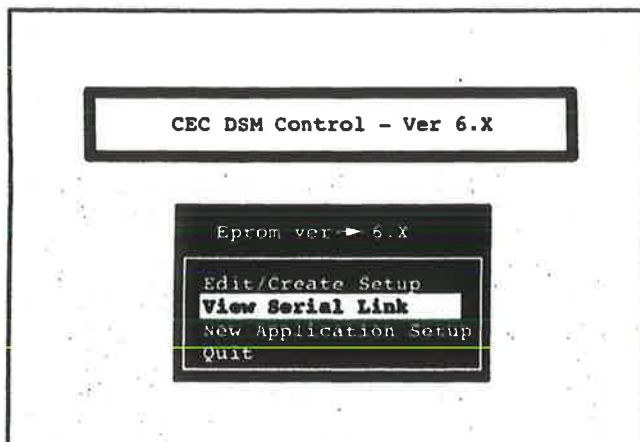


Figure 3.10-37. DSM Interface Program Main Menu

The following information can be obtained from the Display Serial Port Data Screen (see Figure 3.10-36):

- Status of "D" lead
- Programmed limits for minimum and maximum timing
- Current sensor status and timing information
- LCD, alarm, and shutdown status
- Error messages appear on the right side of the screen and flash

This makes the Display Serial Port Data Screen in the View Serial Link option from the Main Menu useful for troubleshooting and checking proper sensor connection.

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

## Checking Individual Sensors On 6, 8, And 12 Cylinder Engines

The "Sensor #" corresponds to the cylinder's position in the firing order. Use the following procedure to check proper sensor connection.

**CAUTION** Make sure the engine is at full load during this check. At light loads, engine characteristics are very different than at higher loads. Typically, this results in lower output from the knock sensors which, if low enough, will result in a "lost sensor" error even when the system is working properly. Errors may result at low loads after engine warm up. These errors go away once the engine is fully loaded.

**NOTE:** If "lost sensor" errors are experienced at low loads and do not correct themselves as the engine is fully loaded, refer to Section 4.00, DSM System Diagnostics And Troubleshooting.

1. Access the Display Serial Port Data Screen by selecting "View Serial Link" from the DSM program's Main Menu.
2. Disconnect a plastic connector from a sensor.
3. On the Display Serial Port Data Screen, verify that "Sensor Low" appears in the "Status" column of the

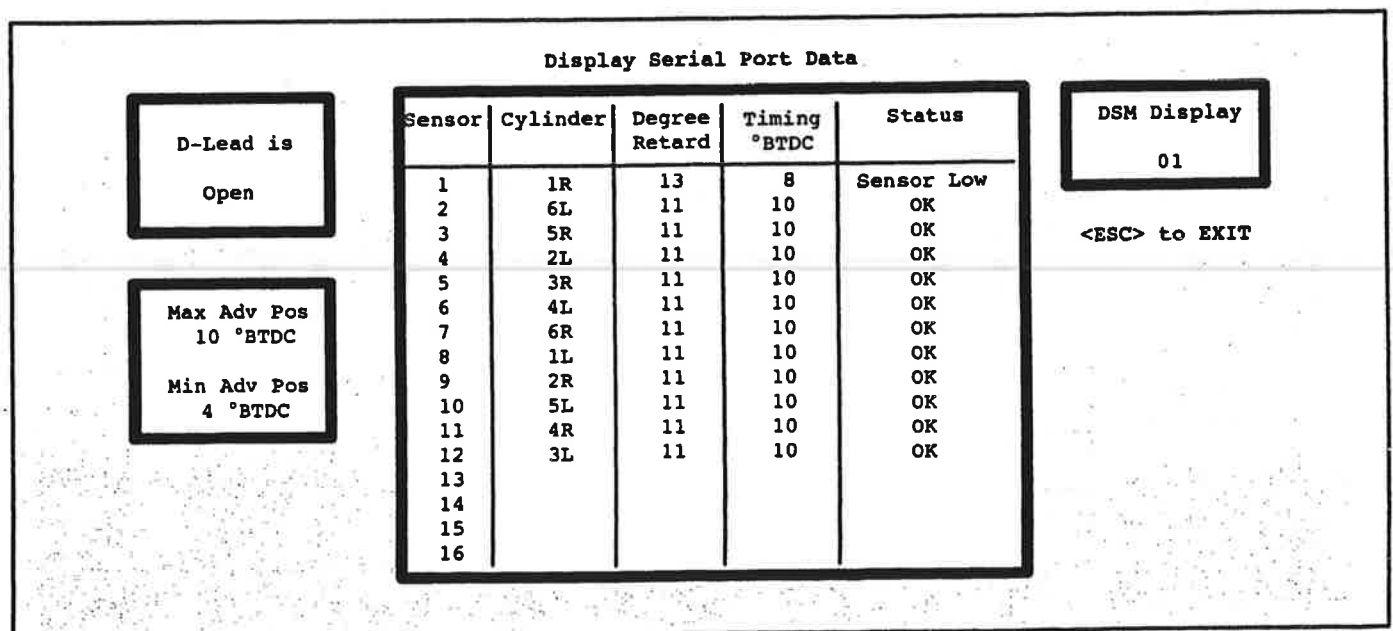
disconnected sensor (see Figure 3.10-38). This may take up to 3 minutes to appear.

**NOTE:** If a bad or disconnected sensor is detected, the DSM module also displays a message on the LCD display inside the DSM module.

**NOTE:** After removing the plastic connector from a cylinder, use a timing light and verify that the timing has been retarded to the default you set. If it has not, refer to Section 4.00, DSM System Diagnostics And Troubleshooting.

Step 3 is important because during normal operation you want the DSM system to retard the timing of a cylinder to the default value if a sensor goes bad or a wire is broken. The DSM system will retard the timing to the default timing value when a sensor goes bad or a wire is broken since the DSM system is not protecting that cylinder.

4. Reconnect the plastic connector. The sensor status will change from "Sensor Low" to "OK" in less than 3 minutes.
5. Repeat Steps 2 - 4 until all sensor connections have been checked. This checking process should take approximately 10 minutes for each sensor.
6. Press [ESC] to return to the Main Menu.



**Figure 3.10-38. Display Serial Port Data Screen With Low Sensor**

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

## Performing Lost Sensor Check Test On 16 Cylinder Engines

The 16 cylinder DSM system checks for detonation in cylinder pairs and not individually (like the 6, 8, and 12 cylinder engines). Because of cylinder pairs, the DSM system does not automatically display lost sensor alarms on the Display Serial Port Data Screen. To display lost sensors, a lost sensor check must be performed. Complete the steps in this section to perform a lost sensor check for 16 cylinder engines.

A test for lost sensors on 16 cylinder engines should be performed whenever the safety controls and alarms are tested on the engine.

**CAUTION** Make sure the engine is at full load during this check. At light loads, engine characteristics are very different than at higher loads. Typically, this results in lower output from the knock sensors which, if low enough, will result in a "lost sensor" error even when the system is working properly. Errors may result at low loads after engine warm up. These errors go away once the engine is fully loaded.

**NOTE:** If "lost sensor" errors are experienced at low loads and do not correct themselves as the engine is fully loaded, refer to Section 4.00, DSM System Diagnostics And Troubleshooting.

1. Access the Display Serial Port Data Screen (see Figure 3.10-40) by selecting "View Serial Link" from the DSM program's Main Menu. Although sensor

status is displayed in the "Status" column, a sensor check must be manually completed to indicate a bad or disconnected sensor on the Display Serial Port Data Screen. A bad or disconnected sensor will be indicated on the Display Serial Port Data Screen during Steps 3 and 5 that follow.

**NOTE:** If a bad or disconnected sensor is detected, the DSM module also displays a message on the LCD display inside the DSM module.

2. Press the SENSOR CHECK button on the DSM filter once, the red Right Bank LED on the DSM filter will be illuminated (see Figure 3.10-39).

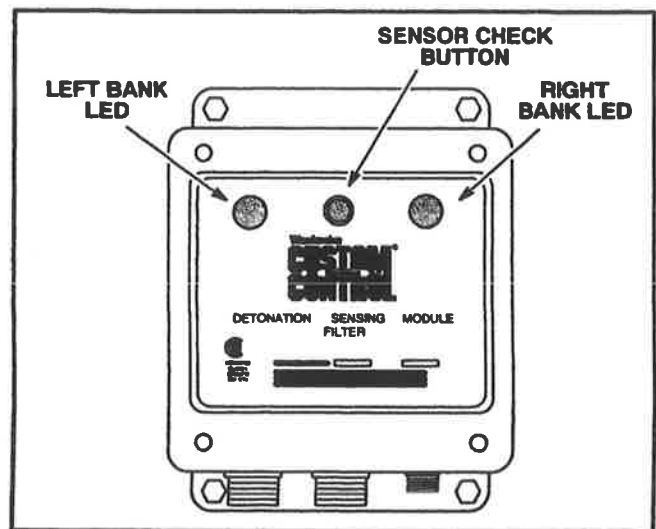


Figure 3.10-39. DSM Filter For 16 Cylinder Engines

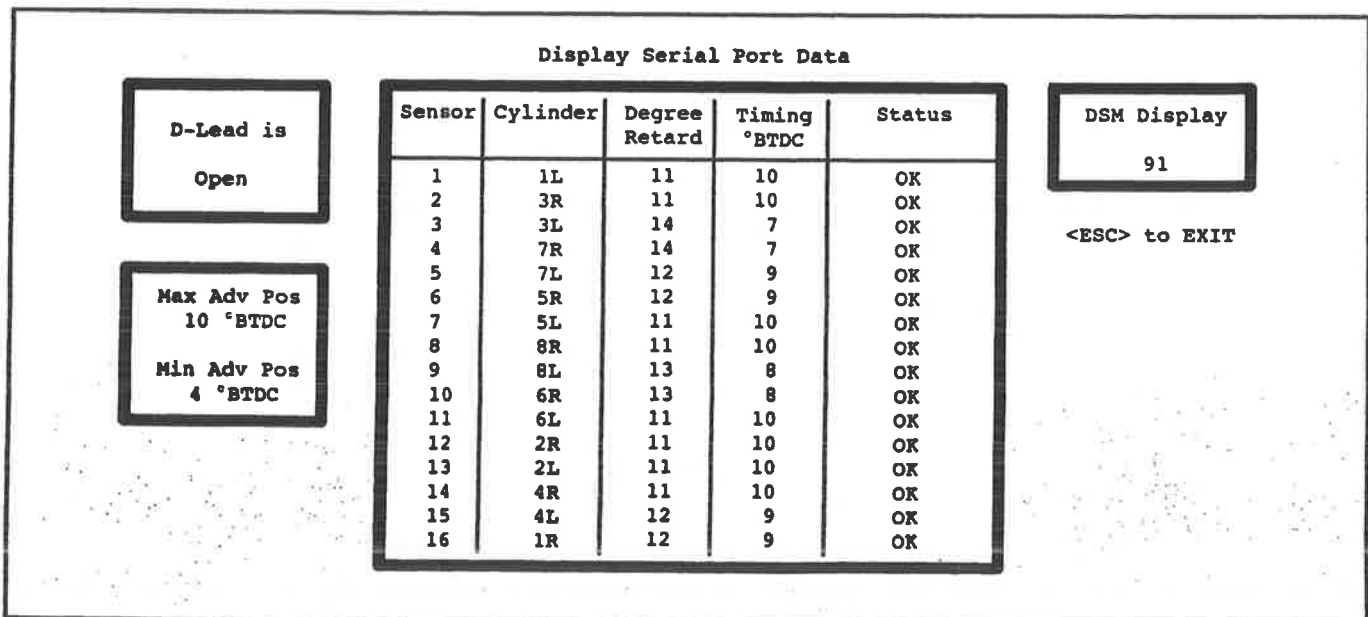
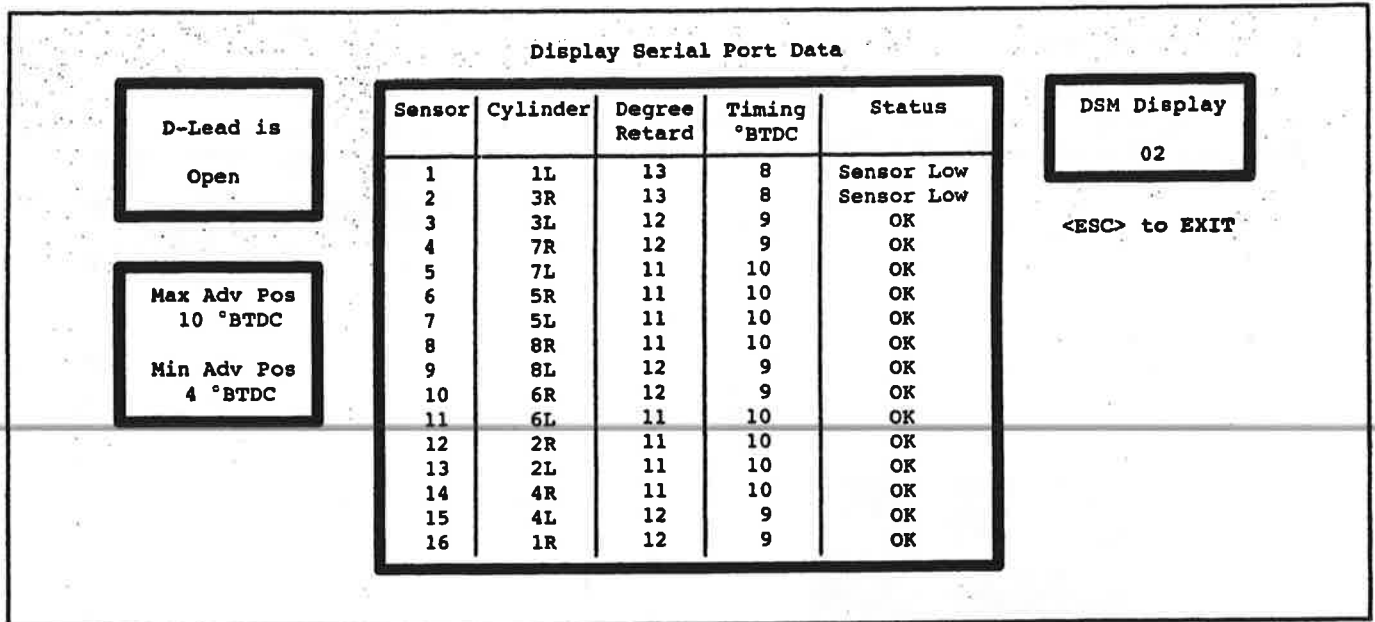


Figure 3.10-40. Display Serial Port Data Screen



# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION



**Figure 3.10-41. Display Serial Port Data Screen**

3. If there are any bad or disconnected sensors on the right bank of the engine, the status shown on the Display Serial Port Data Screen will change from "OK" to "Sensor Low" for both cylinders in the pair within three minutes (see Figure 3.10-41).

4. After three minutes, press the SENSOR CHECK button again to perform the sensor test on the left bank of the engine.

5. If there are any bad or disconnected sensors on the left bank of the engine, the status shown on the Display Serial Port Data Screen will change from "OK" to "Sensor Low" for both cylinders in the pair within three minutes.

6. After three minutes, press the SENSOR CHECK button again to exit the lost sensor check test. The LEDs will turn off.

**NOTE:** The DSM system will automatically exit the "sensor check" mode after five minutes and the LEDs will turn off, returning the DSM system to normal operation.

7. Perform a sensor check whenever the safety controls and alarms are tested on the engine.

Individual sensor connections can be checked on the engine by disconnecting a sensor and running the lost sensor check. A disconnected sensor signal for a cylinder pair will appear on the Display Serial Data Port Screen. The status on the Display Serial Port Data Screen will indicate which "cylinder pair" has a low signal and the RIGHT BANK or LEFT BANK LED on the DSM filter will determine which bank has the low signal.

# PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

## Viewing Wiring Data

The "Sensor #" corresponds to the cylinder's position in the firing order. This information can be obtained from the DSM Interface Program using the following procedure.

1. Highlight "Edit/Create Setup" from the Main Menu and press [Enter] (see Figure 3.10-42).

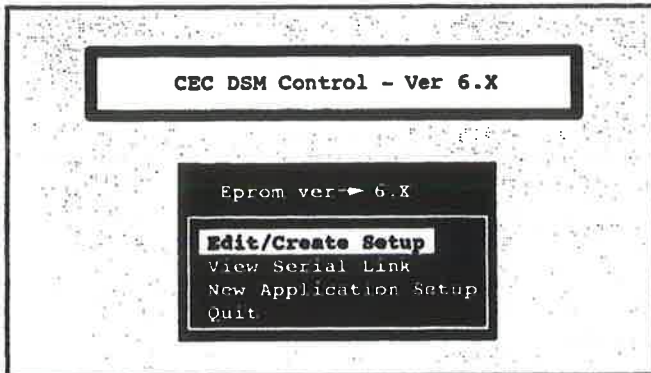


Figure 3.10-42. DSM Interface Program Main Menu

2. Highlight "Retrieve from DSM" on the next menu and press [Enter] (see Figure 3.10-43).



Figure 3.10-43. Selecting Next Menu Choice

3. Press [F10] when the View/Edit Control Data Values Screen appears.

4. Highlight "View Wiring Data" and press [Enter] (see Figure 3.10-44).



Figure 3.10-44. Selecting Next Menu Choice

5. The Display Wiring Data Screen appears (see Figure 3.10-45). Record the wiring data for future reference or print-out a copy of the screen if a printer is available.

6. Press [Esc] and return to the View/Edit Control Data Screen.

7. Press [Esc] to return to the Main Menu.

8. Continue with Check 2: Confirming DSM System Configuration.

Display Wiring Data

Sensor	Cylinder	Ignition Lead
1	1R	A
2	6L	B
3	5R	C
4	2L	D
5	3R	E
6	4L	F
7	6R	K
8	1L	L
9	2R	M
10	5L	N
11	4R	P
12	3L	R
13		
14		
15		
16		
--	--	J/GND

Engine Data

Family : VHP GAS ENGINE

Model : L7042 V-12

CEC Ignition Module

Model 1201 or 1211

<ESC> TO EXIT

Figure 3.10-45. Display Wiring Data Screen

**CHECK 2: CONFIRMING DSM SYSTEM CONFIGURATION**

Use the following procedure to confirm that the DSM module has been configured with the latest data-set.

**NOTE:** If the current data-set has not been saved to a filename, save it before continuing using the procedure in the section "Saving Data-Set To Disk" in this section.

1. Highlight "Quit" on the Main Menu and press [Enter] (see Figure 3.10-46).

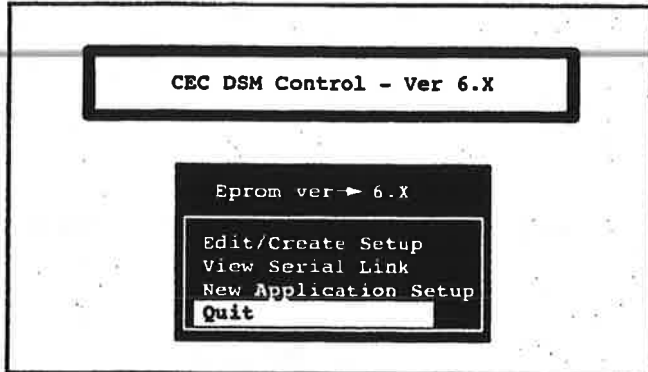


Figure 3.10-46. DSM Interface Program Main Menu

2. Press "Y" to confirm that the program is to be exited.

**CAUTION** Perform the proceeding steps exactly as stated. A small amount of voltage is supplied to the DSM module from the Ignition Module through the harness. This voltage could corrupt the EPROM chip in the DSM module if the harness is not disconnected first.

**NOTE:** When the DSM module is disconnected from the Ignition Module, the engine timing will be determined by the switch positions on the Ignition Module.

3. Disconnect the DSM module from the Ignition Module. Remove the "DSM to ignition" harness from the 14 pin connector on the side of the Ignition Module.

4. Disconnect power from the DSM module for 15 minutes.

5. Restore power to the DSM module.

6. Start the DSM Interface Program on your PC.

**NOTE:** For information on installing and/or accessing the DSM Interface Program, refer to the white card at the back of this manual which holds the 3-1/2" diskette for installation and accessing instructions.

7. The Communications Menu appears on the screen after the Software Identification Screen (see Figure 3.10-47 and Figure 3.10-48). A black dot is located in a circle next to "1" which indicates that the selected communications port on your computer is port 1. Press [Enter] to select communications port 1. If the DB-9 cable is connected to a different port on your PC, use the arrow keys on the keyboard to select the corresponding port from the Communications Menu and press [Enter] (typically: port 1 is correct).

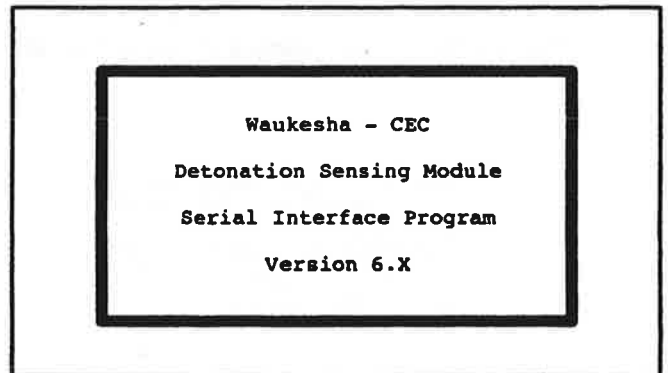


Figure 3.10-47. Software Version Identification

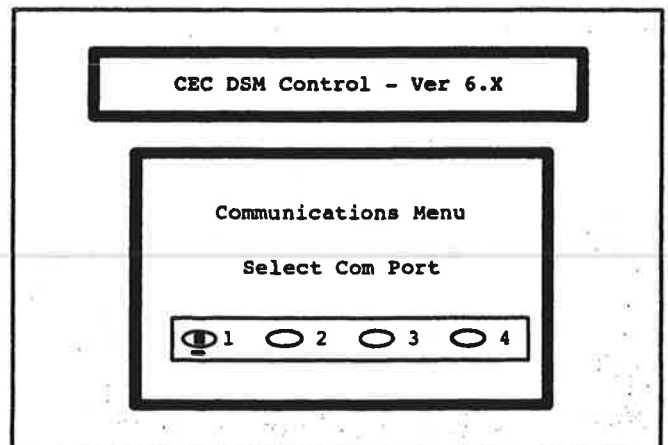


Figure 3.10-48. Communications Menu

## PROGRAMMING THE DSM SYSTEM FOR A NEW APPLICATION

8. The Main Menu will now appear (see Figure 3.10-49). Highlight "Edit/Create Setup" and press [Enter].

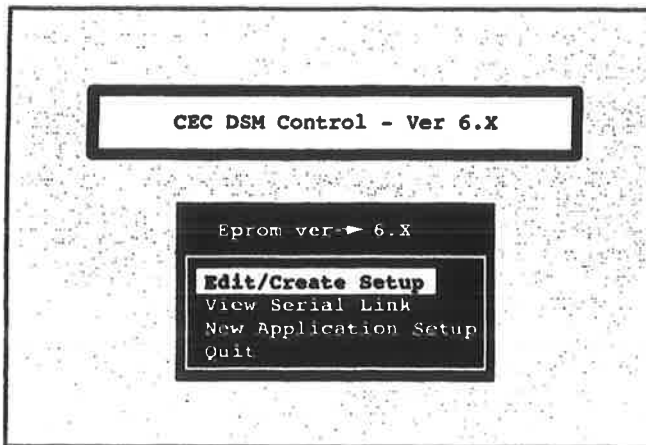


Figure 3.10-49. DSM Interface Program Main Menu



Figure 3.10-50. Selecting Next Menu Choice

9. Highlight "Retrieve from DSM" from the Edit/Create Setup Menu and press [Enter] (see Figure 3.10-50).

10. The program will be retrieved from the DSM. The View/Edit Control Data Values Screen will appear on the screen (see Figure 3.10-51). Verify that these are the values that were entered earlier. If the correct data does not appear, check to see that the serial cable is not faulty and that the power to the DSM module is within specification. Refer to Section 2.10, *DSM System Power, Alarm, And Ground Connections*, for correct power specifications. Retrieve the correct data-set from disk and attempt a second "store." If difficulty continues, refer to Section 4.00, *DSM System Diagnostics And Troubleshooting*.

**NOTE:** Programs saved to the EPROM chip will be retained even if power to the DSM module is interrupted. Programs saved to RAM will be lost when power to the DSM module is disconnected. The DSM module will not allow the DSM Interface Program to be exited while a program is running in RAM. If you attempt to leave the DSM Interface Program without saving the evaluation data to ROM, a warning will be displayed. You must verify that it is OK to restart the last ROM program.

11. Reconnect the DSM module to the Ignition Module.

12. Press [Esc] to return to the Main Menu.

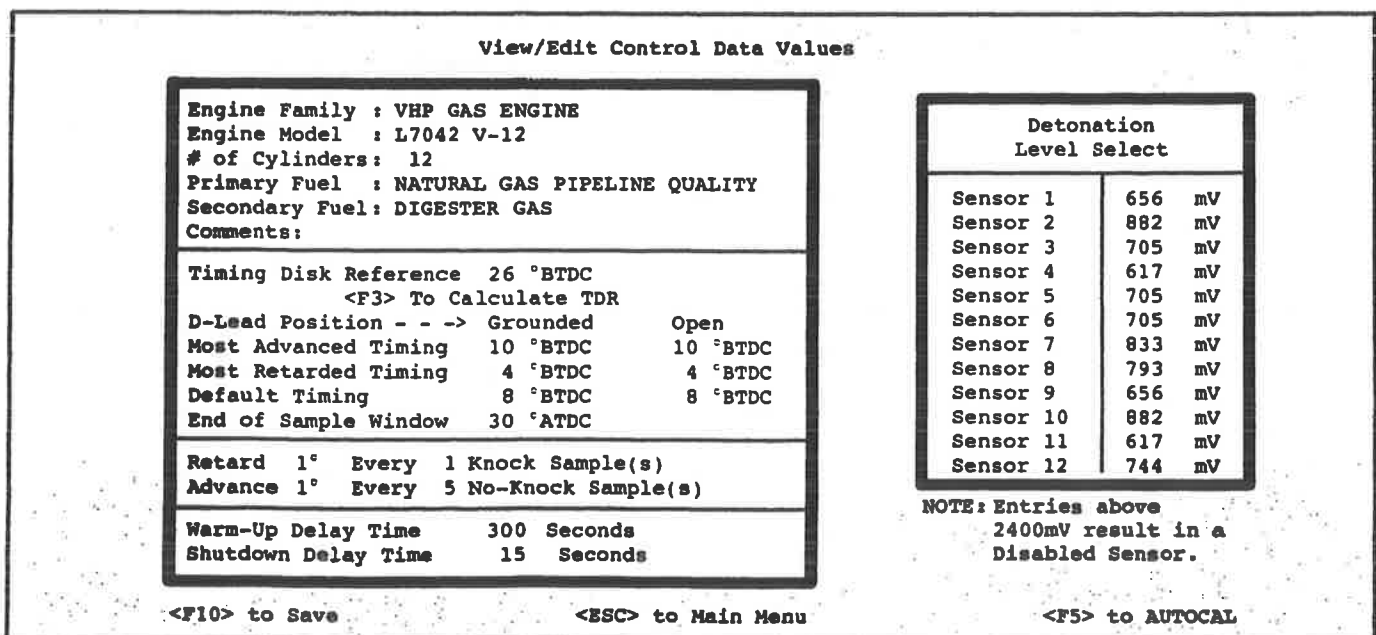


Figure 3.10-51. View/Edit Control Data Values Screen

## SECTION 3.15

### DSM COMPUTER SCREEN AND DATA RETRIEVAL

#### SCREEN AND DATA RETRIEVAL

Once a DSM module is programmed for an engine, computer screens can be retrieved to view engine performance. The DSM Interface Program allows you to retrieve saved data-sets, change settings, and view engine performance. Section 3.15 explains the steps necessary to view data-sets and computer screens. **No programming or editing procedures are included in this section.** Data-sets can be retrieved from the DSM module EPROM chip or saved DSM data-set files.

Section 3.05, *Editing An Existing DSM Data-Set*, explains the steps required to edit an existing DSM data-set. The data-set that is edited following the procedures in this section is engine specific. Complete all the programming steps provided in this section.

Section 3.10, *Programming The DSM System For A New Application*, explains the programming steps and post-programming checks to be completed in retrofit applications or whenever a DSM module is removed from one engine and installed on another engine model. By completing the programming steps in this section, any existing data-set is overwritten and an entirely new data-set is programmed.

**NOTE:** If the internally mounted LCD inside the DSM module reads "99" (no data), the DSM module is sensing that a new EPROM chip is installed and no data-set exists. You will need to complete the programming steps in Section 3.10, *Programming The DSM System For A New Application*.

#### DSM PROGRAM STARTUP FOR SCREEN AND DATA RETRIEVAL

**NOTE:** If any of the alarm or shutdown LEDs come on any time during DSM system operation, see Section 4.00, *DSM System Diagnostics And Troubleshooting*.

1. To access the DSM interface Program, connect a standard DB-9 serial cable (male to female) to the communications port (labeled P1A) within the DSM module. This is the communications port on the right (see Figure 3.15-1). Connect the other end of the cable to the PC's communications port. Typically, this is port 1 (also referred to as COM 1, serial A, or serial 1).

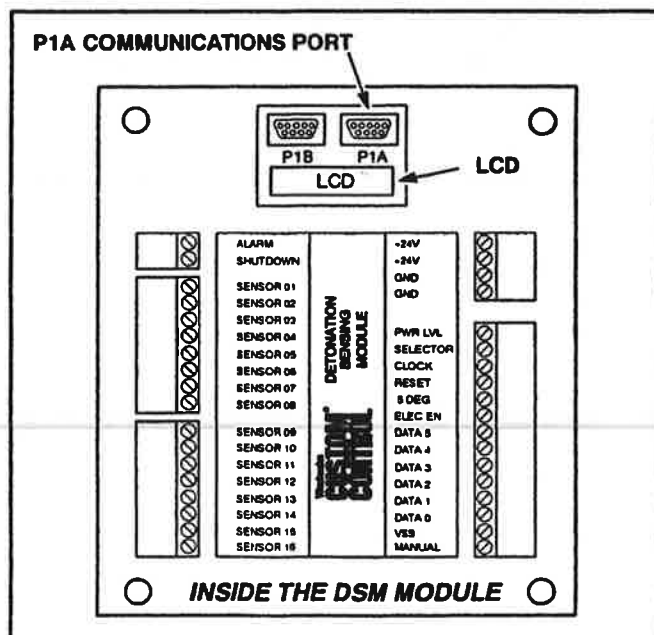


Figure 3.15-1. DB-9 Serial Cable Connection Inside DSM Module

# DSM COMPUTER SCREEN AND DATA RETRIEVAL

2. Start the DSM Interface Program on your PC.

**NOTE:** For information on installing and/or accessing the DSM Interface Program, refer to the white card at the back of this manual which holds the 3-1/2" diskette for installation and accessing instructions.

**NOTE:** This manual assumes you are already familiar with basic MS-DOS commands for viewing directories, copying files, and other MS-DOS concepts. If you need more information on these subjects, refer to a MS-DOS instruction manual.

3. Once the DSM Interface Program is open, the screen shown in Figure 3.15-2 appears. The bottom line of this screen indicates what software version of the DSM program you are using.

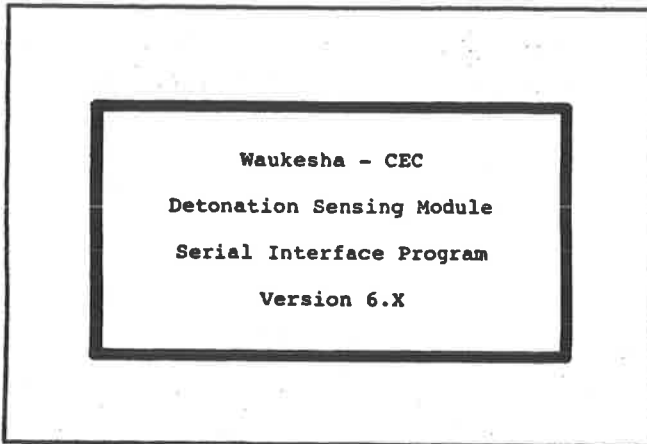


Figure 3.15-2. Software Version Identification

**CAUTION** Verify that the DB-9 serial cable is securely connected to the appropriate computer port. If the serial cable is disturbed or disconnected during the saving process, the EPROM chip in the DSM module will become corrupted and will need to be replaced.

4. Automatically the Communications Menu appears (see Figure 3.15-3). A black dot is located in a circle next to "1" which indicates that the selected communications port on your computer is port 1. Press [Enter] to select communications port 1. If the DB-9 cable is connected to a different port on your PC, use the arrow keys on the keyboard to select the corresponding port from the Communications Menu and press [Enter] (typically: port 1 is correct).

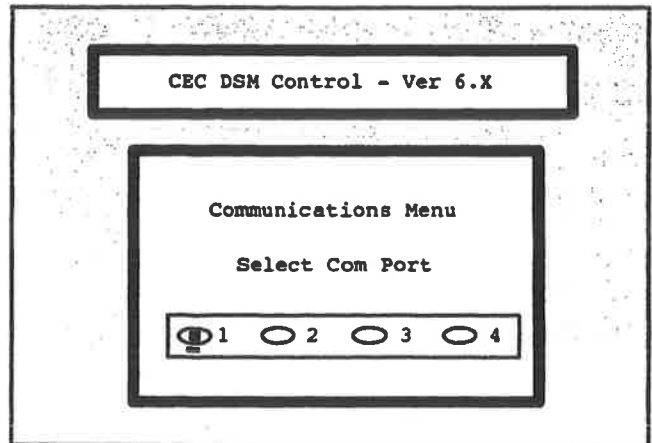


Figure 3.15-3. Communications Menu

5. The DSM Interface Program's Main Menu appears showing various program options available (see Figure 3.15-4).

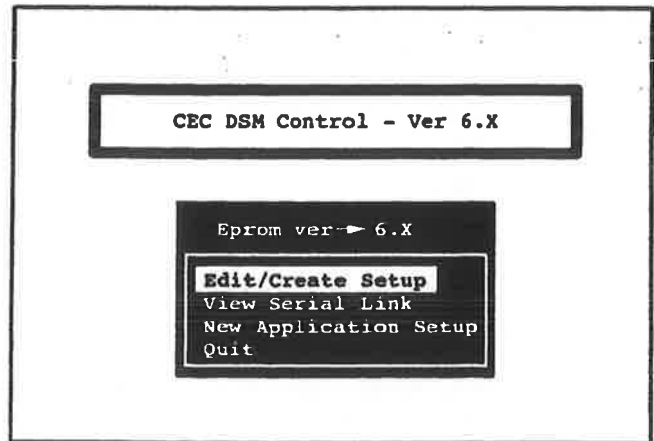


Figure 3.15-4. DSM Interface Program Main Menu

## RETRIEVING THE VIEW/EDIT CONTROL DATA VALUES SCREEN

The View/Edit Control Data Values Screen allows you to view and edit data-set parameters. The data-set being retrieved following the steps below is the data-set saved on the EPROM chip located inside the DSM module.

1. With the DSM Interface Program's Main Menu showing on your screen, highlight "Edit/Create Setup" and press [Enter] (see Figure 3.15-4).

**NOTE:** For information on installing and/or accessing the DSM Interface Program, refer to the white card at the back of this manual which holds the 3-1/2" diskette for installation and accessing instructions.

2. The menu shown in Figure 3.15-5 appears. Highlight "Retrieve from DSM" from this menu and press [Enter].

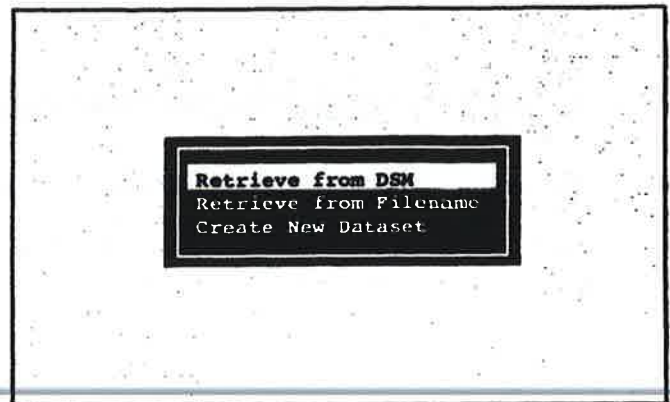
3. Several screens will appear indicating that the data is being retrieved from the DSM module. The screen shown in Figure 3.15-6 indicates what data source is being retrieved. For example, Figure 3.15-6 indicates that the data source is ROM 11.

4. Then the View/Edit Control Data Values Screen appears (see Figure 3.15-7). This screen shows the engine data-set parameters.

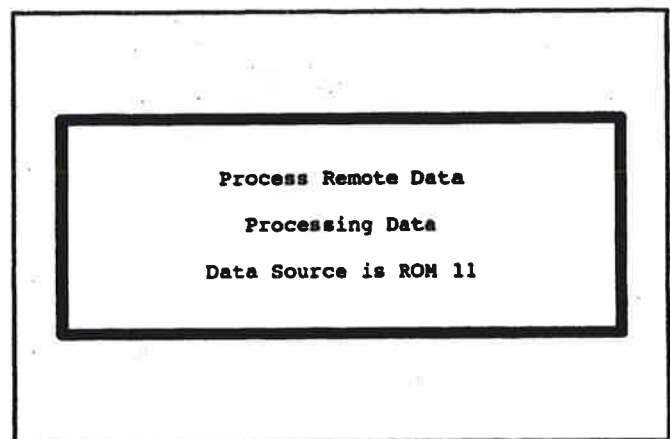
To change data-set information, refer to Section 3.05, *Editing An Existing Data-Set*.

After you are finished reviewing the View/Edit Control Data Values Screen, exit the screen by pressing [Esc].

After confirming the exit, the DSM Main Menu appears.



**Figure 3.15-5. Edit/Create Setup Menu**



**Figure 3.15-6. Processing Data Verification Screen**

View/Edit Control Data Values

Engine Family : VHP GAS ENGINE		
Engine Model : L7042 V-12		
# of Cylinders: 12		
Primary Fuel : NATURAL GAS PIPELINE QUALITY		
Secondary Fuel: DIGESTER GAS		
Comments:		
Timing Disk Reference	26 °BTDC	
<F3> To Calculate TDR		
D-Lead Position - - ->	Grounded	Open
Most Advanced Timing	10 °BTDC	10 °BTDC
Most Retarded Timing	4 °BTDC	4 °BTDC
Default Timing	8 °BTDC	8 °BTDC
End of Sample Window	30 °ATDC	
Retard 1°	Every 1	Knock Sample(s)
Advance 1°	Every 5	No-Knock Sample(s)
Warm-Up Delay Time	300	Seconds
Shutdown Delay Time	15	Seconds

Detonation Level Select		
Sensor 1	529	mV
Sensor 2	441	mV
Sensor 3	441	mV
Sensor 4	392	mV
Sensor 5	656	mV
Sensor 6	480	mV
Sensor 7	459	mV
Sensor 8	534	mV
Sensor 9	391	mV
Sensor 10	492	mV
Sensor 11	355	mV
Sensor 12	624	mV

NOTE: Entries above 2400mV result in a Disabled Sensor.

<F10> to Save                      <ESC> to Main Menu                      <F5> to AUTOCAL

**Figure 3.15-7. View/Edit Control Data Values Screen**

## DSM COMPUTER SCREEN AND DATA RETRIEVAL

### RETRIEVING THE DISPLAY SERIAL PORT DATA SCREEN

With the DSM Interface Program's Main Menu showing on your screen, highlight "View Serial Link" and press [Enter] (see Figure 3.15-8).

**NOTE:** For information on installing and/or accessing the DSM Interface Program, refer to the white card at the back of this manual which holds the 3-1/2" diskette for installation and accessing instructions.

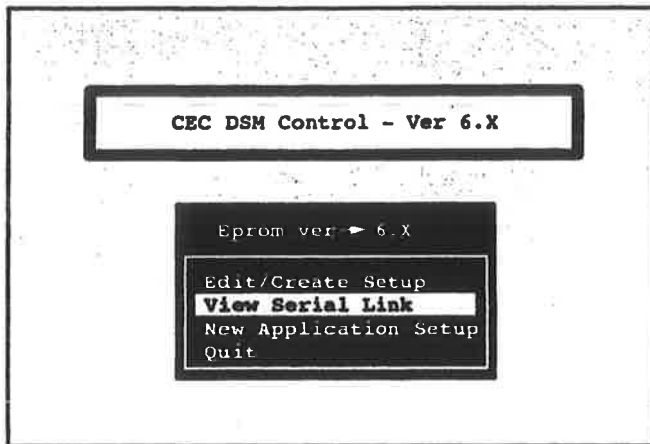


Figure 3.15-8. DSM Interface Program Main Menu

A screen similar to Figure 3.15-9 appears. Information such as "D" lead status and engine timing will vary depending on the application.

The following information can be obtained from the Display Serial Port Data Screen (see Figure 3.15-9):

- Status of "D" lead
- Programmed limits for minimum and maximum timing
- Current sensor status and timing information
- LCD, alarm, and shutdown status
- Error messages appear on the right side of the screen and flash

This makes the Display Serial Port Data Screen in the View Serial Link option from the Main Menu useful for troubleshooting and checking proper sensor connection.

**NOTE:** If the engine is not running and the "D" lead is switched on the CEC Ignition Module (Models 811, 1211, 1611), the "D" lead status will not update automatically on the Display Serial Port Data Screen. The engine must rotate before the status of the "D" lead is updated.

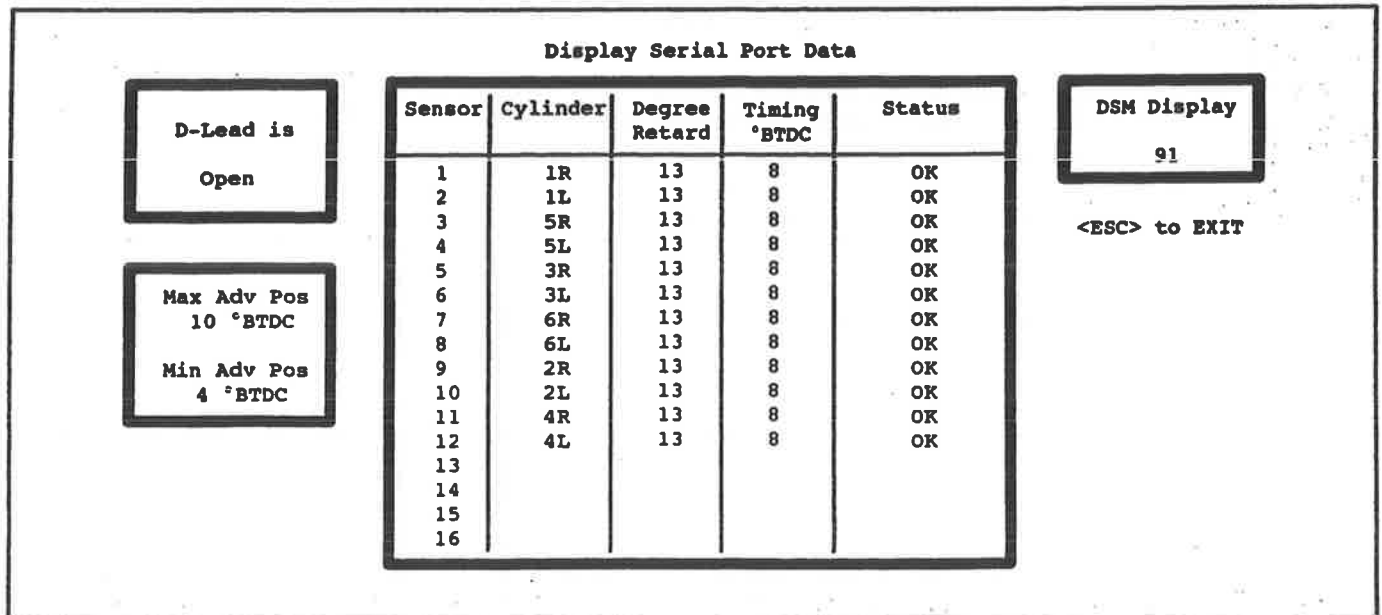


Figure 3.15-9. Display Serial Port Data Screen



**RETRIEVING A SAVED DATA-SET**

1. With the DSM Interface Program's Main Menu showing on your screen, highlight "Edit/Create Setup" and press [Enter] (see Figure 3.15-10).

*NOTE: For information on Installing and/or accessing the DSM Interface Program, refer to the white card at the back of this manual which holds the 3-1/2" diskette for installation and accessing instructions.*

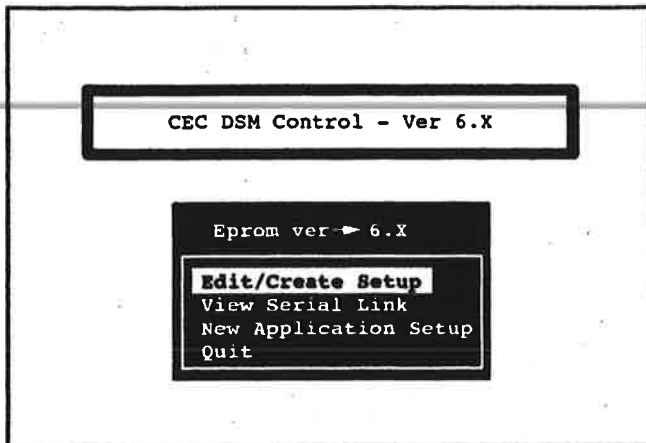


Figure 3.15-10. DSM Interface Program Main Menu

*NOTE: If you want to save an opened file to ROM (permanent memory), refer to Section 3.05, Editing An Existing Data-Set.*

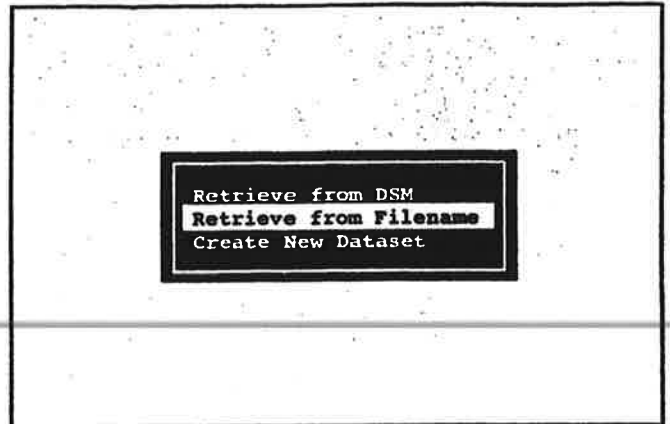


Figure 3.15-11. Edit/Create Setup Menu

2. On the next menu highlight "Retrieve from Filename" and press [Enter] (see Figure 3.15-11).

3. Highlight the file name (serial number) you want to open and press [Enter] (see Figure 3.15-12). The information that is shown on the View/Edit Control Data Values Screen is information that has been saved in a file and not what is stored on the DSM module's EPROM chip (permanent memory) (see Figure 3.15-13).

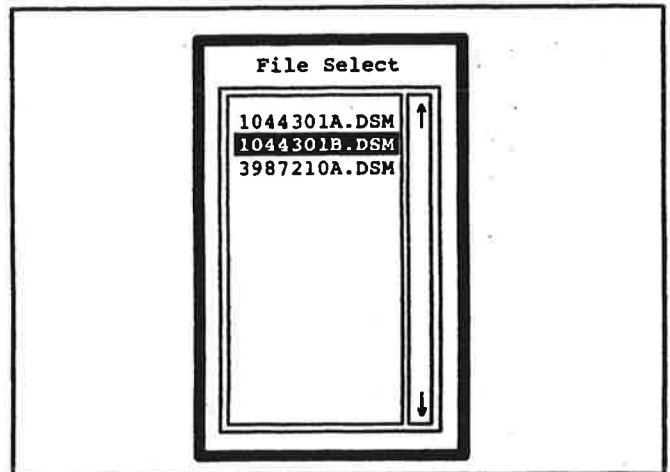


Figure 3.15-12. Selecting File Name Of Saved Data-Set

View/Edit Control Data Values

Engine Family : VHP GAS ENGINE Engine Model : L7042 V-12 # of Cylinders: 12 Primary Fuel : NATURAL GAS PIPELINE QUALITY Secondary Fuel: DIGESTER GAS Comments:			<b>Detonation Level Select</b>																																						
Timing Disk Reference 26 °BTDC <F3> To Calculate TDR D-Lead Position - - -> Grounded           Open Most Advanced Timing 10 °BTDC           10 °BTDC Most Retarded Timing 4 °BTDC           4 °BTDC Default Timing 8 °BTDC               8 °BTDC End of Sample Window 30 °ATDC			<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>Sensor 1</td><td>529</td><td>mV</td></tr> <tr><td>Sensor 2</td><td>441</td><td>mV</td></tr> <tr><td>Sensor 3</td><td>441</td><td>mV</td></tr> <tr><td>Sensor 4</td><td>392</td><td>mV</td></tr> <tr><td>Sensor 5</td><td>656</td><td>mV</td></tr> <tr><td>Sensor 6</td><td>480</td><td>mV</td></tr> <tr><td>Sensor 7</td><td>459</td><td>mV</td></tr> <tr><td>Sensor 8</td><td>534</td><td>mV</td></tr> <tr><td>Sensor 9</td><td>391</td><td>mV</td></tr> <tr><td>Sensor 10</td><td>492</td><td>mV</td></tr> <tr><td>Sensor 11</td><td>355</td><td>mV</td></tr> <tr><td>Sensor 12</td><td>624</td><td>mV</td></tr> </table>			Sensor 1	529	mV	Sensor 2	441	mV	Sensor 3	441	mV	Sensor 4	392	mV	Sensor 5	656	mV	Sensor 6	480	mV	Sensor 7	459	mV	Sensor 8	534	mV	Sensor 9	391	mV	Sensor 10	492	mV	Sensor 11	355	mV	Sensor 12	624	mV
Sensor 1	529	mV																																							
Sensor 2	441	mV																																							
Sensor 3	441	mV																																							
Sensor 4	392	mV																																							
Sensor 5	656	mV																																							
Sensor 6	480	mV																																							
Sensor 7	459	mV																																							
Sensor 8	534	mV																																							
Sensor 9	391	mV																																							
Sensor 10	492	mV																																							
Sensor 11	355	mV																																							
Sensor 12	624	mV																																							
Retard 1° Every 1 Knock Sample(s) Advance 1° Every 5 No-Knock Sample(s)			NOTE: Entries above 2400mV result in a Disabled Sensor.																																						
Warm-Up Delay Time 300 Seconds Shutdown Delay Time 15 Seconds			<F5> to AUTOCAL																																						
<F10> to Save		<ESC> to Main Menu																																							

Figure 3.15-13. View/Edit Control Data Values Screen

**DSM COMPUTER SCREEN AND DATA RETRIEVAL**

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**CONTENTS**

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**SECTION 4.00 - DSM SYSTEM DIAGNOSTICS  
AND TROUBLESHOOTING**

**SECTION 4.05 - RUNNING THE DSM AUTOCAL PROGRAM**

**SECTION 4.10 - LOST SENSOR CHECK ON  
16 CYLINDER ENGINES**

**SECTION 4.15 - EPROM CHIP REPLACEMENT**



## SECTION 4.00

# DSM SYSTEM DIAGNOSTICS AND TROUBLESHOOTING

### DIAGNOSTICS

#### DSM SYSTEM DIAGNOSTICS

This section is provided to determine diagnostic codes of the DSM system, as well as, possible corrective actions that may remedy diagnostic problems.

Inside the DSM module is a liquid crystal display (LCD) that gives a numerical read-out on what is happening within the DSM system (see Figure 4.00-1). The LCD continually shows the current status of the DSM system through diagnostic codes.

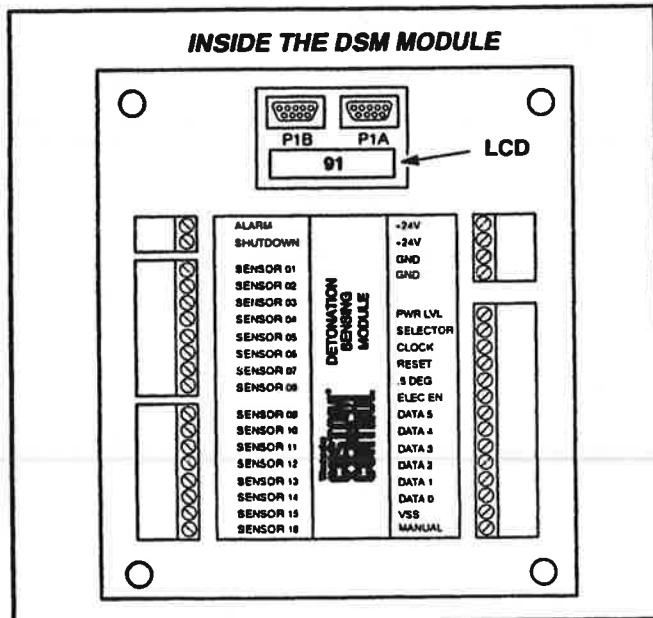


Figure 4.00-1. Detonation Sensing Module LCD

DSM system diagnostics are handled with three light emitting diodes (LEDs) on the front of the DSM module (see Figure 4.00-2).

- The green "Power" LED is lit any time power is applied to the DSM module.

- The yellow "Alarm" LED is lit when power is applied to the DSM and the engine is not running (not due to shutdown mode). The "Alarm" LED lights any time a sensor output is lost or disconnected (6, 8, and 12 cylinder engines). Additionally, the alarm LED lights when the timing is retarded to the most retarded limit (uncontrollable detonation). The alarm LED flashes when the shutdown delay expires and detonation is still present.

**NOTE:** For 16 cylinder engines a sensor test must be performed to detect a lost sensor. The lost sensor check procedure is explained in Section 4.10, Lost Sensor Check Test For 16 Cylinder Engines. A test for lost sensors should be performed whenever the safety controls and alarms are tested on the engine.

- The red "Shutdown" LED illuminates when the DSM system has reached the most retarded timing, the shutdown delay has timed out, and the engine is still in detonation.

If the "Alarm" (yellow) or "Shutdown" (red) LED is lit on the front panel of the DSM module, refer to the LCD inside the DSM module for the diagnostic code.

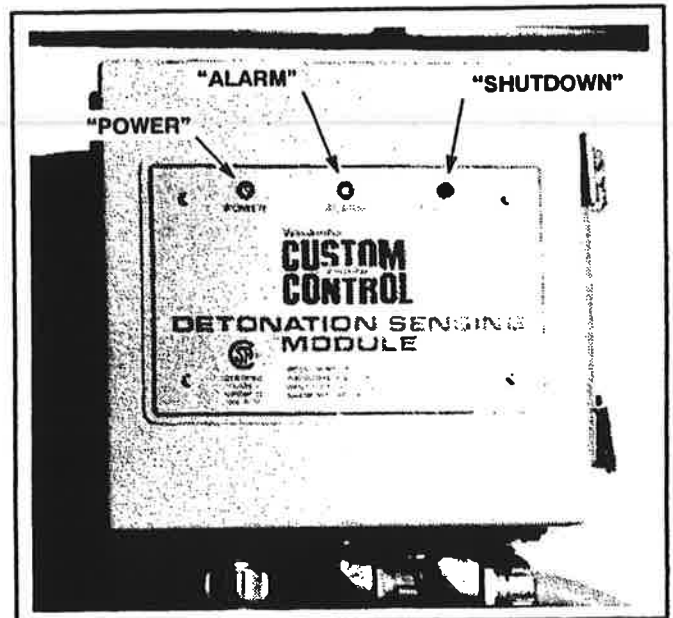


Figure 4.00-2. Detonation Sensing Module Front Panel

# DSM SYSTEM DIAGNOSTICS AND TROUBLESHOOTING

The following diagnostic tables are provided to assist you in diagnosing the DSM system.

- Table 4.00-1 provides a description of the DSM system's diagnostic codes.
- Table 4.00-2 provides a description of the condition the DSM system is sensing based on the diagnostic code.
- Table 4.00-3 provides troubleshooting suggestions to remedy the situation.

**CAUTION** Do not mishandle or drop a DSM knock sensor if a sensor is removed. Improper handling of the sensor could result in permanent damage to the sensor crystal.

**CAUTION** Do not overtighten sensor. Over-tightening will cause sensor damage.

**NOTE:** To install a sensor, the sensor must be free of oil and torqued to a value of 20 - 25 ft-lb (27 - 35 N-m). The mounting surface must be flat, smooth (RMS 125), and be perpendicular within 0.008" (1/2 degree).

**CAUTION** After doing any removal, repair, or replacement of engine cylinder heads, cylinder head gaskets, cylinder liners, pistons, or knock sensors, the DSM system must be AutoCaled using the DSM Terminal Program and a personal computer. Disregarding this information could result in product damage.

**NOTE:** Refer to Section 4.05, Running The DSM AutoCal Program.

**Table 4.00-1. Description Of Diagnostic LCD Codes**

OPERATIONAL CODES		
Code	Status	Description of Condition
Blank	No Power	The DSM module is not powered, system not operating.
(00)	Loss of Rotation	DSM module has sensed that the engine has stopped running.
(75)	Shutdown Active	Uncontrolled detonation present, shutdown output activated by the DSM module.
(90)	Ready to Start	DSM module is waiting for engine to be started.
(81)	Error Present	Sensor error code detected by DSM module. Sensor error for Maximum Retard or failed sensor will follow.
(91)	Normal Operation	The DSM system is running properly. Detonation is being controlled and no errors are present.
(95)	Warm-up Cycle	Warm-up delay time has not elapsed, therefore, engine is running at default timing.
PGM (PROGRAM) INTERRUPT CODES		
Code	Status	Description of Condition
(66)	Configuration Error	Configuration data or application problem if present. (Example: DSM module has been programmed for the wrong engine.)
(86)	Executing AutoCal	DSM module is establishing detonation threshold.
(97)	Serial Transfer	DSM module is communicating with the PC through serial cable.
(99)	No data	The DSM module has not yet been programmed and should not be connected to the Ignition Module while this code is active.
SENSOR CODES		
Code	Status	Description of Condition
(01-16)	Failed Sensor	The DSM module no longer senses a signal from the filter.
(21-36)	Maximum Retard	The cylinder timing for the corresponding sensor has been retarded to its most retarded timing.
(41-56)	Disabled Sensor	The DSM module has been programmed to not control the timing on the corresponding sensor. The cylinder is at default timing.

# DSM SYSTEM DIAGNOSTICS AND TROUBLESHOOTING

**Table 4.00-2. DSM LCD Message Display Diagnostic Codes**

LCD CODE	LED LIGHTS	DESCRIPTION OF CONDITIONS	IGNITION TIMING IN USE
—	— — —	No Power: System Not Operating	CEC Ignition Switch Timing
—	G Y R	No Program: System Has Power But Is Not Executing Code	CEC Ignition Switch Timing
00	G Y -	No Rotation: Engine Stopped Running	CEC Ignition Switch Timing
01	G Y -	Sensor #1: Failed Diagnostic Test	Cylinder Default Timing
02	G Y -	Sensor #2: Failed Diagnostic Test	Cylinder Default Timing
03	G Y -	Sensor #3: Failed Diagnostic Test	Cylinder Default Timing
04	G Y -	Sensor #4: Failed Diagnostic Test	Cylinder Default Timing
05	G Y -	Sensor #5: Failed Diagnostic Test	Cylinder Default Timing
06	G Y -	Sensor #6: Failed Diagnostic Test	Cylinder Default Timing
07	G Y -	Sensor #7: Failed Diagnostic Test	Cylinder Default Timing
08	G Y -	Sensor #8: Failed Diagnostic Test	Cylinder Default Timing
09	G Y -	Sensor #9: Failed Diagnostic Test	Cylinder Default Timing
10	G Y -	Sensor #10: Failed Diagnostic Test	Cylinder Default Timing
11	G Y -	Sensor #11: Failed Diagnostic Test	Cylinder Default Timing
12	G Y -	Sensor #12: Failed Diagnostic Test	Cylinder Default Timing
13	G Y -	Sensor #13: Failed Diagnostic Test	Cylinder Default Timing
14	G Y -	Sensor #14: Failed Diagnostic Test	Cylinder Default Timing
15	G Y -	Sensor #15: Failed Diagnostic Test	Cylinder Default Timing
16	G Y -	Sensor #16: Failed Diagnostic Test	Cylinder Default Timing
21	G Y -	Sensor #1: Uncontrolled Detonation	Cylinder Maximum Retard
22	G Y -	Sensor #2: Uncontrolled Detonation	Cylinder Maximum Retard
23	G Y -	Sensor #3: Uncontrolled Detonation	Cylinder Maximum Retard
24	G Y -	Sensor #4: Uncontrolled Detonation	Cylinder Maximum Retard
25	G Y -	Sensor #5: Uncontrolled Detonation	Cylinder Maximum Retard
26	G Y -	Sensor #6: Uncontrolled Detonation	Cylinder Maximum Retard
27	G Y -	Sensor #7: Uncontrolled Detonation	Cylinder Maximum Retard
28	G Y -	Sensor #8: Uncontrolled Detonation	Cylinder Maximum Retard
29	G Y -	Sensor #9: Uncontrolled Detonation	Cylinder Maximum Retard
30	G Y -	Sensor #10: Uncontrolled Detonation	Cylinder Maximum Retard
31	G Y -	Sensor #11: Uncontrolled Detonation	Cylinder Maximum Retard
32	G Y -	Sensor #12: Uncontrolled Detonation	Cylinder Maximum Retard
33	G Y -	Sensor #13: Uncontrolled Detonation	Cylinder Maximum Retard
34	G Y -	Sensor #14: Uncontrolled Detonation	Cylinder Maximum Retard
35	G Y -	Sensor #15: Uncontrolled Detonation	Cylinder Maximum Retard
36	G Y -	Sensor #16: Uncontrolled Detonation	Cylinder Maximum Retard
41	G - -	Sensor #1: Automatic Timing Control Disabled	Cylinder Default Timing
42	G - -	Sensor #2: Automatic Timing Control Disabled	Cylinder Default Timing
43	G - -	Sensor #3: Automatic Timing Control Disabled	Cylinder Default Timing
44	G - -	Sensor #4: Automatic Timing Control Disabled	Cylinder Default Timing

(Continued)

## DSM SYSTEM DIAGNOSTICS AND TROUBLESHOOTING

LCD CODE	LED LIGHTS	DESCRIPTION OF CONDITIONS	IGNITION TIMING IN USE
45	G - -	Sensor #5: Automatic Timing Control Disabled	Cylinder Default Timing
46	G - -	Sensor #6: Automatic Timing Control Disabled	Cylinder Default Timing
47	G - -	Sensor #7: Automatic Timing Control Disabled	Cylinder Default Timing
48	G - -	Sensor #8: Automatic Timing Control Disabled	Cylinder Default Timing
49	G - -	Sensor #9: Automatic Timing Control Disabled	Cylinder Default Timing
50	G - -	Sensor #10: Automatic Timing Control Disabled	Cylinder Default Timing
51	G - -	Sensor #11: Automatic Timing Control Disabled	Cylinder Default Timing
52	G - -	Sensor #12: Automatic Timing Control Disabled	Cylinder Default Timing
53	G - -	Sensor #13: Automatic Timing Control Disabled	Cylinder Default Timing
54	G - -	Sensor #14: Automatic Timing Control Disabled	Cylinder Default Timing
55	G - -	Sensor #15: Automatic Timing Control Disabled	Cylinder Default Timing
56	G - -	Sensor #16: Automatic Timing Control Disabled	Cylinder Default Timing
66	G Y -	Sample Error: Configuration Data or Application Problem	Cylinder Default Timing
75	G y R	Shutdown: Uncontrolled Detonation Present Shutdown Activated	Timing Control
	G Y -	Shutdown: Engine Has Stopped Running Due to Detonation/Shutdown	Cylinder Default Timing
81	G Y -	System Error: Some Cylinders Are OK-Wait for Sensor Error Code	Timing Control
86	G - -	AutoCal: Executing AutoCal Routine	AutoCal Timing
90	G - -	System OK: Ready and Waiting for Engine to Start	Cylinder Default Timing
91	G - -	System OK: Normal Operation	Timing Control
95	G - -	System OK: Delaying Engine Warm-Up	Cylinder Default Timing
97	G - -	Serial Mode: Communication Transfer Mode	Last Active Timing
99	G Y -	No Data: Configuration Data Must Be Down Loaded	30° Retard from Timing Disk Reference Angle

**NOTE:** The diagnostic codes given in the LCD READ-OUT column are shown on the LCD inside the DSM module. Letters in the LED STATUS column represent the LED lights on the DSM module's front panel that are lit under the given condition: G = Green/Power, Y = Yellow/Alarm, y = Yellow/Alarm Flashing, R = Red/Shutdown



# DSM SYSTEM DIAGNOSTICS AND TROUBLESHOOTING

**Table 4.00-3. DSM Diagnostic Codes Troubleshooting**

IF DIAGNOSTIC CODE ON LED DISPLAY READS:	THEN
Code 00 (No Rotation)	<ul style="list-style-type: none"> <li>a. Engine is not running.</li> <li>b. Ignition Module has lost power.</li> <li>c. "DSM to Ignition" harness is disconnected.</li> </ul>
Codes 1 - 16 (Failed Diagnostic Test)	<ul style="list-style-type: none"> <li>a. Verify that the engine is running at the maximum load and speed anticipated during normal engine operation. A faulty sensor code may be activated at low engine loads after warmup. At light loads, engine characteristics are very different than at higher loads. Typically, this results in lower output from the knock sensors which, if low enough, will result in a "lost sensor" error even when the system is working properly. Errors may result at low loads after engine warmup. These errors go away once the engine is fully loaded.</li> <li>b. Check wiring from sensor to DSM for damage. Check that all ground wires ("sensor to DSM" harness and DSM filter grounds) are attached properly. Refer to Chapter 2 <i>Detonation Sensing Module Installation</i>. Repair/replace wiring as required. Once problem is corrected, rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</li> <li>c. Check Spark plug for misfiring. Replace as required.</li> <li>d. Check admission valves in cylinder head for correct operation. Replace or clean as required.</li> <li>e. Replace sensor. (Refer to Section 2.00 <i>Mounting DSM System Components "Mounting The Knock Sensors"</i>. Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</li> </ul>
Codes 21 - 36 (Uncontrolled Detonation)	<ul style="list-style-type: none"> <li>a. Shutdown engine.</li> <li>b. Determine if any "hot" or unprocessed gas has gone through the engine that could cause detonation damage. Refer to "Detonation Theory" in Section 1.10 <i>Description Of Operation</i> for detonation theory and a list of detonation promoters/reducers.</li> <li>c. Check gas/air supply.</li> <li>d. Borescope the cylinder to check for detonation damage.</li> <li>e. Review programmed AutoCal values. If calibrated detonation levels vary more than 500 from sensor to sensor, refer to Table 4.00-4, DSM System Troubleshooting.</li> </ul>
Codes 41 - 56 (Automatic Timing Control Disabled)	<ul style="list-style-type: none"> <li>a. The sensor was disabled through the DSM Interface Program. Entries above 2400 mV in the Detonation Level Select table on the View/Edit Control Data Values Screen result in a disabled sensor. An AutoCal program must be run to obtain the detonation levels for your application. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</li> <li>b. If all sensors are disabled, the installed EPROM chip may never have been programmed. New EPROM chips are configured to keep the sensors and/or controls disabled until AutoCal values are programmed and saved to ROM. It is possible that AutoCal values were not successfully saved to ROM. Run the AutoCal program and save values to ROM. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</li> </ul>
Code 81 (System Error)	<ul style="list-style-type: none"> <li>a. Sensor error code detected by DSM module. Read the LCD inside the DSM until the sensor error for Maximum Retard or failed sensor is displayed. Or view the Display Serial Port Data Screen using the DSM Interface Program and PC to see status of all the sensors.</li> </ul>
All Other Codes	<ul style="list-style-type: none"> <li>a. See Table 4.00-2 for code description and Table 4.00-4 for DSM system troubleshooting.</li> </ul>

**NOTE:** If these diagnostic troubleshooting suggestions do not remedy the problem, refer to Table 4.00-4, "DSM System Troubleshooting."

# DSM SYSTEM DIAGNOSTICS AND TROUBLESHOOTING

## TROUBLESHOOTING

Table 4.00-4 is provided to assist the user in determining the possible causes of unsatisfactory system operation, as well as point out the corrective action that may be undertaken to remedy the problem.

If problems persist, contact your local Waukesha Engine Distributor or Waukesha Engine Product Support for assistance.

Troubleshooting the DSM can involve some disassembly of circuit board pairs, removal and replacement of multi-pin components (chips), and other work of similar nature. Only "qualified technicians" should undertake these activities. Improper handling of circuit boards and electronic components can cause damage that may render them unusable.

**NOTE:** Table 4.00-4 is only provided as a service to our customers. It should not be viewed as a reflection of Waukesha Engine's actual experience with this product.

**NOTE:** If you completed the diagnostics in Table 4.00-3, some of the troubleshooting checks listed in Table 4.00-4 may have already been completed.

**Table 4.00-4. DSM System Troubleshooting**

SYMPTOM	PROBABLE CAUSE	REMEDY
"COM Port Failed" message is displayed on the PC.	Communications between the PC and the DSM module cannot be established.	<p>a. Check to see that the DB-9 serial cable is connected to the correct communications port on your PC. Verify that the communications port chosen is enabled in the PC system's setup. Verify that the port chosen from the Communications Menu (when beginning the programming procedure) corresponds to the port the DB-9 serial cable is connected to on the PC.</p> <p>b. Verify that the serial cable is connected to the correct communications port (labeled P1A) within the DSM module.</p> <p>c. Replace DB-9 serial cable.</p> <p>d. Verify that the power supply to the DSM module is within specification. Refer to Section 2.10 <i>DSM System Power, Alarm, And Ground Connections</i> "DSM Module Power Connections" for correct power specifications.</p> <p>e. Remove power from the DSM module and disconnect the "DSM to ignition" harness from the 14 pin connector on the side of the Ignition Module. Wait for one minute before repowering and reconnecting the DSM module to the Ignition Module. Restart programming procedure.</p> <p>f. If the problem persists, then replace the EPROM chip inside the DSM module. Refer to Section 4.15 <i>EPROM Chip Replacement</i>.</p>
"Com Device I/O Error Occurred" message is displayed on the PC after trying to program a new application.	Previous version of the DSM Interface Program software (version 5.3c) is being accessed by a PC with a high speed (MHz) processor.	a. Verify that current DSM Interface Software (version 6.X) is being accessed. PCs with a high speed processor may cause communication device input/output errors with the previous version of the DSM Interface Program (version 5.3c). DSM Interface Program, version 6.X, has been upgraded to run on high speed PCs.

(Continued)

### WARNING

Always use caution when servicing or repairing an engine and installed CEC systems. Engine components or fluids can be extremely hot and can cause severe personal injury or death.

### WARNING

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

Before referring to the troubleshooting procedures in Table 4.00-4, check the DSM LCD inside the DSM module. During normal operation the LCD code displayed inside the DSM module is 91. If any other codes are displayed, complete the diagnostic checks provided in Table 4.00-1 through Table 4.00-3.

# DSM SYSTEM DIAGNOSTICS AND TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
<p>DSM system loses the program's data-set whenever the power is disconnected.</p>	<p>The data-set created was only stored in RAM using the "Test Data on DSM" selection of the Save Menu. Any program stored in RAM will be lost when the power is disconnected from the DSM module. The "Configure DSM Memory" should be used to save the data to ROM (permanent memory on the EPROM chip).</p>	<p>a. The data-set you created has been lost. If the data-set has been stored to disk it can be retrieved and then saved to the EPROM chip (see Section 3.15 <i>DSM System Computer Screen And Data Retrieval</i> "Retrieving A Saved Data-Set"). If the data was not saved to disk, reprogram the DSM module following the programming steps in Section 3.05 <i>Editing An Existing DSM Data-Set</i> and save the data-set to ROM (permanent memory).</p> <p>b. Check power supply to the DSM module during save to ROM to verify power supply continues to meet specification. Refer to Section 2.10 <i>DSM System Power, Alarm, And Ground Connections</i> "DSM Module Power Connections" for correct power specifications. If power supply does not continue to meet specification, correct power supply. Resave data-set and during the save re-verify power supply continues to be within specification.</p> <p>c. If the problem persists, replace the EPROM chip inside the DSM module. Refer to Section 4.15 <i>EPROM Chip Replacement</i>.</p>
<p>The DSM module cannot be programmed.</p>	<p>The EPROM chip may have been damaged.</p>	<p>a. Verify that the power supply to the DSM module and DSM filter is within specification. Refer to Section 2.10 <i>DSM System Power, Alarm, And Ground Connections</i> "DSM Module Power Connections" for correct power specifications.</p> <p>b. Check to see that the DB-9 serial cable is connected to the correct communications port on your PC. Verify that the communications port chosen is enabled in the PC system's setup. Verify that the port chosen from the Communications Menu (when beginning the programming procedure) corresponds to the port the DB-9 serial cable is connected to on the PC.</p> <p>c. Verify that the serial cable is connected to the correct communications port (labeled P1A) within the DSM module.</p> <p>d. Replace DB-9 serial cable.</p> <p>e. Check that all wire harnesses and ground wires are attached and routed properly. Refer to Chapter 2 <i>Detonation Sensing Module Installation</i>.</p> <p>f. Check if the EPROM chip has the maximum allowed 25 saves. The screen will indicate the ROM location (or number of saves already made to the EPROM chip) when you retrieve a data-set from ROM or enter the View Serial Link Screen. For example: When you choose "Edit/Create Setup" from the Main Menu and then "Retrieve from DSM," the screen will indicate whether the data-set is in RAM or ROM; and if in ROM, from which ROM location. A message like "Data Source is ROM 5" indicates that there are 20 saves still available to ROM. If the EPROM chip is full (25 saves), replace the EPROM chip inside the DSM module. Refer to Section 4.15 <i>EPROM Chip Replacement</i>.</p> <p>g. Verify that current DSM Interface Software (version 6.X) is being accessed. PCs with a high speed processor may cause communication device input/output errors with the previous version of the DSM Interface Program (version 5.3c). DSM Interface Program, version 6.X, has been upgraded to run on high speed PCs (speeds greater than 100 Mhz).</p> <p>h. If the problem persists, replace the EPROM chip inside the DSM module. Refer to Section 4.15 <i>EPROM Chip Replacement</i>.</p>

(Continued)

# DSM SYSTEM DIAGNOSTICS AND TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
<p>Unable to run the AutoCal program.</p>	<p>1) Communications problem between the PC and the DSM module.</p> <p>2) Previous version of the DSM Interface Program software (version 5.3c) is being accessed by a PC.</p>	<p>a. Retry running the AutoCal Program.</p> <p>b. Check to see that the DB-9 serial cable is connected to the correct communications port on your PC. Verify that the communications port chosen is enabled in the PC system's setup. Verify that the port chosen from the Communications Menu (when beginning the programming procedure) corresponds to the port the DB-9 serial cable is connected to on the PC.</p> <p>c. Verify that the serial cable is connected to the correct communications port (labeled P1A) within the DSM module.</p> <p>c. Replace DB-9 serial cable. Retry running the AutoCal Program.</p> <p>d. Check that all wire harnesses and ground wires are attached and routed properly. Refer to Chapter 2 <i>Detonation Sensing Module Installation</i>. Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p> <p>e. Verify that current DSM Interface Software (version 6.X) is being accessed. PCs with a high speed processor (speeds greater than 100 Mhz) may cause communication device input/output errors with the previous version of the DSM Interface Program (version 5.3c). DSM Interface Program, version 6.X, has been upgraded to run on high speed PCs.</p>
<p>Calibrated detonation levels determined from the AutoCal program vary by more than 500 from sensor to sensor.</p>	<p>1) Sensor mounting surface imperfections.</p> <p>2) Wire harnesses and/or ground wiring are not attached or routed properly.</p> <p>3) Engine is in detonation.</p> <p>4) Other engine related problems.</p>	<p>a. Verify that the sensors are mounted and installed properly. Sensor MUST have full-face contact with mounting surface. Imperfections in the surface that the sensor mounts against can cause higher sensor output. The sensors must be torqued to the correct specification. Refer to Section 2.00 <i>Mounting DSM System Components "Mounting The Knock Sensors"</i>. Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p> <p>b. Check that all wire harnesses and ground wires are attached and routed properly. Refer to Chapter 2 <i>Detonation Sensing Module Installation</i>. Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p> <p>c. Verify that the power supply to the DSM module and DSM filter is within specification. Refer to Section 2.10 <i>DSM System Power, Alarm, And Ground Connections</i>: "DSM Module Power Connections" for correct power specifications.</p> <p><b>CAUTION</b> Detonation must not be present while running AutoCal. If detonation occurs at any time during the calibration program, the AutoCal results must be discarded and the AutoCal program must be rerun.</p> <p>d. Determine if the engine is in detonation. Change timing by backing off 2 degrees from the current timing setting. Rerun AutoCal. If after backing off the timing by 2 degrees the AutoCal results are within the acceptable 500 range it may indicate inaudible detonation is occurring. Check the following:</p> <ol style="list-style-type: none"> <li>1. Check engine timing, the air/fuel ratio, and load.</li> <li>2. Check for any conditions that may cause detonation such as a change in fuel quality. Refer to "Detonation Theory" in Section 1.10 <i>Description Of Operation</i> for detonation theory and a list of detonation promoters/reducers.</li> <li>3. Borescope the engine to look for signs of detonation or signs of general engine wear.</li> </ol> <p>Once the engine is not detonating, rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p> <p>e. Check other possible engine problems such as: valves hitting liners, valves hitting piston, main bearings, cylinder head torque, piston cooling jets, etc.</p> <p>f. Replace the sensor and rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p>

(Continued)

## DSM SYSTEM DIAGNOSTICS AND TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
A LOW error (low setpoint) occurs during the AutoCal program and is displayed in the Set-Point column of the AutoCal Screen.	The AutoCal value determined is considered too low.	<p>a. Verify that the engine is running at the maximum load and speed anticipated during normal engine operation.</p> <p><b>CAUTION</b> The sensors give an output even when the engine is not in detonation. The sensor output increases with load, so the engine must be at its highest load during AutoCal. If the AutoCal program is run while the engine is at a lower load, an increase in load may be mistaken for detonation. The engine must be running at the maximum load and speed anticipated during normal operation.</p> <p>b. Check that all wire harnesses and ground wires are attached and routed properly. Verify that the "DSM to Ignition" harness is connected. Refer to Chapter 2 <i>Detonation Sensing Module Installation</i>. Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p> <p>c. Replace the sensor and rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p>
A STAL error (stall error) occurs during the AutoCal program and is displayed in the Set-Point column of the AutoCal Screen.	During AutoCal, the DSM system senses the engine is not running.	<p>a. Verify engine rotation.</p> <p>b. Check that the "DSM to ignition" harness is connected and routed properly. Refer to Chapter 2 <i>Detonation Sensing Module Installation</i>. Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p>
An HISP error (high setpoint error) occurs during the AutoCal program and is displayed in the Set-Point column of the AutoCal Screen.	The AutoCal value is higher than the maximum 2400 mV value.	<p>a. Determine if the engine is in detonation. Once the engine is not detonating, rerun AutoCal. (Refer to "Detonation Theory" in Section 1.10 <i>Description Of Operation</i> for detonation theory and a list of detonation promoters/reducers.) (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p> <p>b. Check that all wire harnesses and ground wires are attached and routed properly. Refer to Chapter 2 <i>Detonation Sensing Module Installation</i>. Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p> <p>c. Verify that the sensors are mounted and installed properly. Sensor MUST have full-face contact with mounting surface. Imperfections in the surface that the sensor mounts to can cause higher sensor output. The sensors must be torqued to the correct specification. Refer to Section 2.00 <i>Mounting DSM System Components</i> "Mounting The Knock Sensors". Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p> <p>d. Check other possible engine problems such as: valves hitting liners, valves hitting piston, main bearings, cylinder head torque, piston cooling jets, etc.</p> <p>e. Replace the sensor and rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p>
The Display Serial Port Data Screen (View Serial Link) is showing the incorrect "D" lead status.	When the engine is not running and the "D" lead is switched on the CEC Ignition Module (Models 811, 1211, 1611), the "D" lead status does not immediately update.	<p>a. If the engine is not running and the "D" lead is switched on the CEC Ignition Module (Models 811, 1211, 1611), the "D" lead status will not update immediately on the Display Serial Port Data Screen. The engine must rotate before the status of the "D" lead is updated on the screen.</p> <p>b. If the "D" lead status is not updated on the Display Serial Port Data Screen after the engine is started, contact Waukesha Product Support.</p>
When more than one sensor indicates "Low Sensor" on the Display Serial Port Data Screen, the status on the PC display will continue to read "Low Sensor" even though cylinder is at max. advanced timing.	Error is corrected for some but not all sensors displaying "Low Sensor."	<p>a. The status column will not clear the fault "Low Sensor" and change the indication to OK for any of the cylinders until all of the cylinder sensors are corrected. The status can be updated by exiting and then re-entering the View Serial Link Data Screen. DSM system is functioning correctly, the only error will be on the PC display.</p>

(Continued)

# DSM SYSTEM DIAGNOSTICS AND TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
Unable to retrieve data.	<p>1) Defective or improperly connected DB-9 serial cable.</p> <p>2) Corrupt EPROM chip.</p>	<p>a. Check to see that the DB-9 serial cable is connected to the correct communications port on your PC. Verify that the communications port chosen is enabled in the PC system's setup. Verify that the port chosen from the Communications Menu (when beginning the programming procedure) corresponds to the port the DB-9 serial cable is connected to on the PC.</p> <p>b. Verify that the serial cable is connected to the correct communications port (labeled P1A) within the DSM module.</p> <p>c. Replace DB-9 serial cable.</p> <p>d. Remove power from the DSM module by disconnecting all terminal blocks inside the module for 1 minute. Reconnect and try to retrieve data.</p> <p>e. If the problem persists, then replace the EPROM chip inside the DSM module. Refer to Section 4.15 <i>EPROM Chip Replacement</i>.</p>
The DSM system continually reduces ignition timing and/or displays the shutdown error when detonation is not present.	Some sensors are exceeding the detonation threshold settings for each individual cylinder.	<p>a. Find out if the engine has been overhauled recently. If so, rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.) Whenever major power cylinder components are removed, switched, or replaced, AutoCal must be rerun.</p> <p>b. Verify that the sensors are installed properly. Sensor MUST have full-face contact with mounting surface. Imperfections in the surface that the sensor mounts to can cause higher sensor output. Refer to Section 2.00 <i>Mounting DSM System Components "Mounting The Knock Sensors"</i>. Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p> <p>c. Check that all wire harnesses and ground wires are attached and routed properly. Refer to Chapter 2 <i>Detonation Sensing Module Installation</i>. Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i>.)</p> <p>d. Check other possible engine problems such as: valves hitting liners, valves hitting piston, main bearings, cylinder head torque, piston cooling jets, etc.</p> <p>e. If this condition only occurs at low load, a load sensing feature may be required. Contact Waukesha Product Support for assistance.</p>
Engine timing does not agree with the program values.	Timing Disk Reference has been programmed incorrectly.	a. Timing Disk Reference (TDR) must be recalculated. Refer to Section 3.05 <i>Editing An Existing DSM Data-Set</i> .
Shutdown warning lights are on and the DSM LCD displays Code 91 (System OK: Normal Operation).	Alarm and/or shutdown connections are not wired or routed properly.	a. Check that alarm and shutdown connections are wired and routed properly. The alarm and shutdown terminals are sinking devices. Refer to "Alarm And Shutdown Connections" in Section 2.10 <i>DSM System Power, Alarm, And Ground Connections</i> .
After the DSM module is powered up, the green power LED lights up, but the LCD inside the DSM module is blank and the DSM does not function.	<p>1) Input voltages are insufficient.</p> <p>2) DSM module was powered up with Ignition Module connected.</p> <p>3) EPROM chip is corrupt.</p>	<p>a. Verify that the power supply to the DSM module is within specification. Refer to Section 2.10 <i>DSM System Power, Alarm, And Ground Connections</i> "DSM Module Power Connections" for correct power specifications.</p> <p>b. Disconnect the "DSM to ignition" harness from the DSM module. Turn off power to DSM module. Reapply power to DSM module. Connect PC and retrieve data-set from DSM module.</p> <p>c. If the problem persists, replace the EPROM chip inside the DSM module. Refer to Section 4.15 <i>EPROM Chip Replacement</i>.</p>
When power to DSM system is removed, the engine stops running.	Ignition Module negative power path is through the DSM.	<p>a. Check the Ignition Module's negative power connections and wiring. Refer to <i>Custom Engine Control<sup>®</sup> Ignition Module Installation, Operation, And Maintenance Manual</i> Form 6253 or Form 6272 (Models 811, 1211, 1611).</p> <p>b. Replace Ignition Module.</p>
The DSM system does not detect a lost sensor.	Electrical noise is being seen by the DSM system.	a. Check that all wire harnesses and ground wires are attached and routed properly. Refer to Chapter 2 <i>Detonation Sensing Module Installation</i> . Rerun AutoCal. (Refer to Section 4.05 <i>Running The DSM AutoCal Program</i> .)

**NOTE: If these troubleshooting suggestions do not remedy the problem, please contact Waukesha Engine Product Support.**

## SECTION 4.05

### RUNNING THE DSM AUTOCAL PROGRAM

#### RUNNING THE AUTOCAL PROGRAM

The DSM AutoCal program is the automatic calibration of the detonation threshold levels by the DSM Interface Program. The DSM module monitors for detonation using the frequency output of each cylinder with engine mounted knock sensors. These knock sensors must be calibrated or "AutoCaled." During AutoCal, the knock sensors are calibrated so that the DSM system can operate properly.

An AutoCal should be run the first time the DSM is programmed for an engine or whenever a DSM is programmed for a new application. Additionally, the DSM system must be re-AutoCaled using the DSM Interface Program and a PC after doing any removal, repair, or replacement of engine cylinder heads, cylinder liners, cylinder gaskets, pistons, or knock sensors. This calibration **MUST BE** done using the AutoCal program as explained in this section.

**CAUTION** Detonation must not be present while running AutoCal. If detonation occurs at any time during the calibration program, the AutoCal results must be discarded and the AutoCal program must be rerun.

**CAUTION** The sensors give an output even when the engine is not in detonation. The sensor output increases with load, so the engine must be at its **HIGHEST LOAD** during AutoCal. If the AutoCal program is run while the engine is at a lower load, an increase in load may be mistaken for detonation. The engine must be running at the maximum load and speed anticipated during normal operation.

*NOTE: At light loads, engine characteristics are very different than at higher loads. Typically, this results in lower output from the knock sensors which, if low enough, will result in a "lost sensor" error even when the system is working properly. Errors may result at low loads after engine warm up. These errors go away once the engine is fully loaded. If "lost sensor" errors are experienced at low loads and do not correct themselves as the engine is fully loaded, refer to Section 4.00, DSM System Diagnostics And Troubleshooting.*

1. Verify that the engine is running at the maximum load and speed anticipated during normal engine operation.
2. With the DSM Interface Program's Main Menu showing on your screen, highlight "Edit/Create Setup" and press [Enter] (see Figure 4.05-1).

*NOTE: For information on installing and/or accessing the DSM Interface Program, refer to the white card at the back of this manual which holds the 3-1/2" diskette for installation and accessing instructions.*

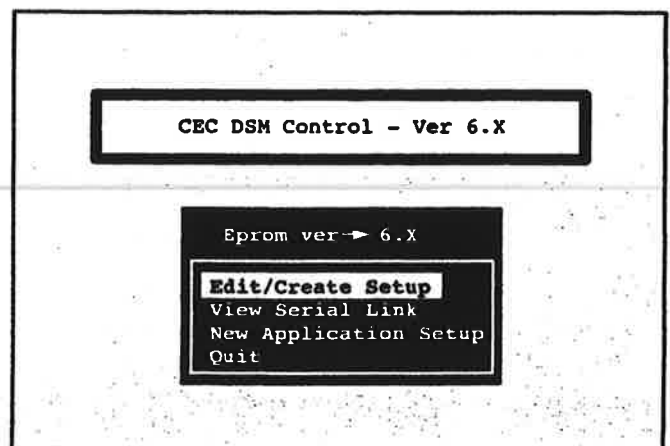


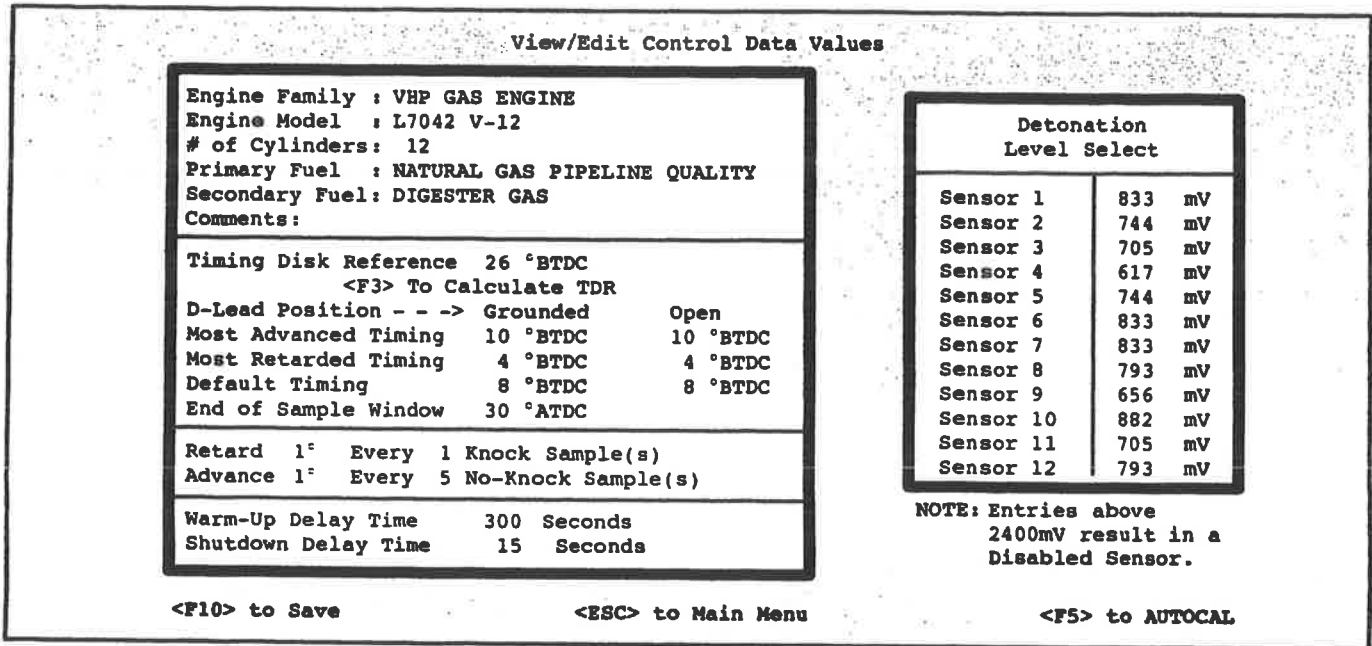
Figure 4.05-1. DSM Interface Program Main Menu

# RUNNING THE DSM AUTOCAL PROGRAM

3. On the Edit/Create Setup Menu, highlight "Retrieve from DSM" from this menu and press [Enter].

4. Several screens will appear indicating that the data is being retrieved from the DSM module. Then the View/Edit Control Data Values Screen appears (see Figure 4.05-2). This screen shows the data-set parameters. The information shown on the screen is stored in the DSM.

5. Detach or copy the applicable AutoCal Worksheet from the back of this manual. The blue AutoCal Worksheet applies to 6, 8, and 12 cylinder engines (see Table 4.05-1 for sample worksheet). The yellow AutoCal Worksheet applies to 16 cylinder engines (see Table 4.05-2 for sample worksheet). Be sure to detach or copy the worksheet applicable to your engine application.



**Figure 4.05-2. View/Edit Control Data Values Screen**

**Table 4.05-1. AutoCal Worksheet For 6, 8, And 12 Cylinder Engines**

SENSOR	SET-POINT "S" COLUMN RESULTS										HIGHEST "S" VALUE
	RUN #___	RUN #___	RUN #___	RUN #___	RUN #___	RUN #___	RUN #___	RUN #___	RUN #___	RUN #___	
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											



**Table 4.05-2. AutoCal Worksheet For 16 Cylinder Engines**

SENSOR PAIRS	SET-POINT "S" COLUMN RESULTS										HIGHEST "S" VALUE
	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	
1 & 2											
3 & 4											
5 & 6											
7 & 8											
9 & 10											
11 & 12											
13 & 14											
15 & 16											

6. To begin AutoCal, press [F5] while viewing the View/Edit Control Data Values Screen. The AutoCal Screen appears. Figure 4.05-3 shows the AutoCal Screen for 6, 8, and 12 cylinder engine applications. Figure 4.05-4 shows the AutoCal Screen for 16 cylinder engine applications.

*NOTE: The AutoCal results shown in the figures and tables provided in this manual are for example only. Actual AutoCal values will vary depending on the application.*

*NOTE: "L" = Low, "M" = Medium, "H" = High, "S" = Set-Point in Figure 4.05-3 and Figure 4.05-4.*

**AUTOCAL TEST TIMING**

Automatic Calibration of Detonation Sensor Threshold Voltages

AutoCal Test Timing 10 °BTDC

---

Messages:

AutoCal	L	M	H	S
Sensor 1				
Sensor 2				
Sensor 3				
Sensor 4				
Sensor 5				
Sensor 6				
Sensor 7				
Sensor 8				
Sensor 9				
Sensor 10				
Sensor 11				
Sensor 12				

Engine Timing for Autocal Program. <F10> Accepts, <ESC> Aborts

**Figure 4.05-3. AutoCal Screen For 6, 8, And 12 Cylinder Engines**

# RUNNING THE DSM AUTOCAL PROGRAM

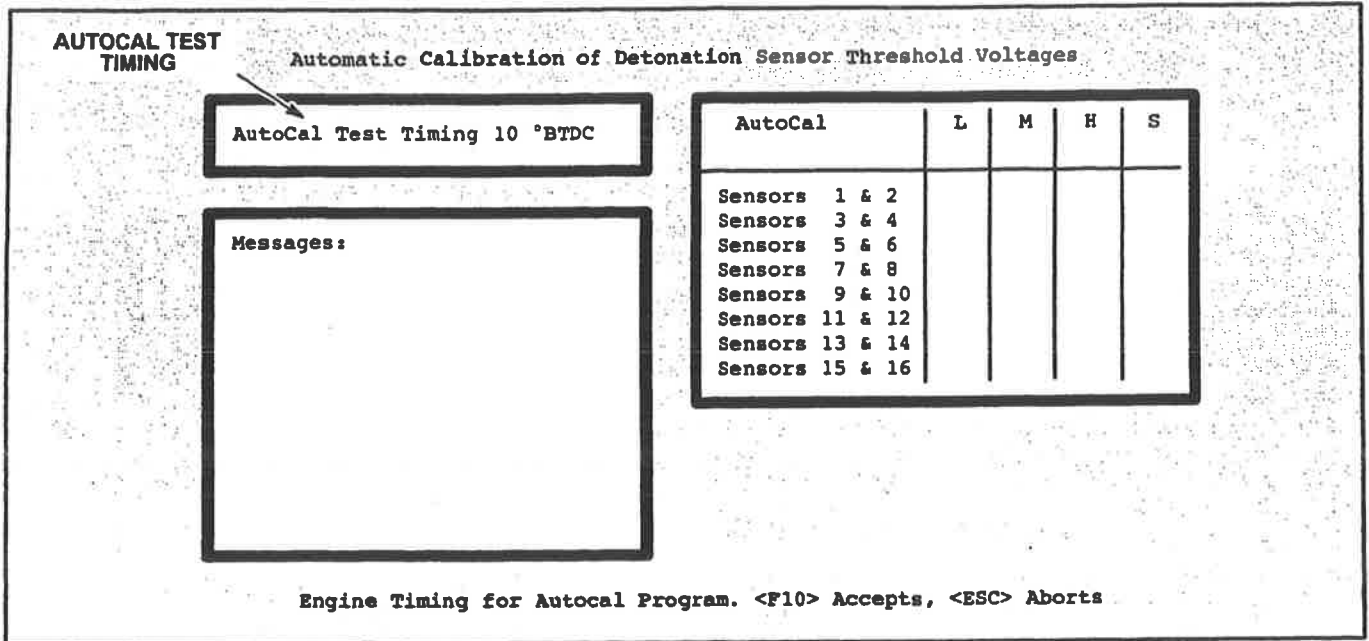


Figure 4.05-4. AutoCal Screen For 16 Cylinder Engines

7. Verify that the "AutoCal Test Timing" on the AutoCal Screen (see Figure 4.05-3 or Figure 4.05-4) is the same as that fuel's "Most Advanced Timing" (grounded or open, whichever is applicable) on the View/Edit Control Data Values Screen (see Figure 4.05-5). If the "AutoCal Test Timing" is not the same as "Most Advanced Timing," enter the "Most Advanced Timing" on the AutoCal Screen.

**NOTE:** AutoCal will default to the "D" lead grounded ignition setting which is "Most Advanced Timing." For secondary fuel (or "D" lead open), the AutoCal Screen test timing value may need to be edited as explained in Step 7.

8. Press [F10] to accept the "AutoCal Test Timing" value and begin AutoCal. Calibration numbers for each sensor will begin appearing in the "S" or Set-Point column. When the calibration process is completed your screen will resemble the screen shown in Figure 4.05-6.

**NOTE:** If any errors occur during the AutoCal program they will be displayed as LOW, STAL, or HISP in the

Set-Point column on the AutoCal Screen. Additionally, an error message will be provided in the "Messages" box on the AutoCal Screen stating, "AutoCal Completed With ERRORS." See Section 4.00, DSM System Diagnostics And Troubleshooting, to correct problem. Once the problem is corrected, rerun AutoCal.

**NOTE:** If an HISP or STAL error occurs, the AutoCal Program will stop as soon as the error is detected. If a LOW error occurs, the AutoCal program will continue but the AutoCal results on the View/Edit Control Data Values Screen will NOT be updated.

**NOTE:** To save your AutoCal results to a file, press [F4] after running the AutoCal program. Follow the instructions on the screens that follow. The file will be saved to the drive and directory where the DSM Interface Program is located. This file is NOT retrievable through the DSM but can be opened outside of the DSM program in Microsoft® Notepad® or a word processing program and then printed. **Saving the AutoCal results to a file is NOT a substitute for saving to ROM. Be sure to save the AutoCal results to ROM.**

**MOST ADVANCED TIMING** View/Edit Control Data Values

Engine Family : VPP GAS ENGINE Engine Model : L7002 V-12 # of Cylinders : 12 Primary Fuel : NATURAL GAS PIPELINE QUALITY Secondary Fuel : DIESTER GAS Comments:	
Timing Disk Reference	26 °BTDC <F3> To Calculate TDR
D-Lead Position	Grounded <span style="margin-left: 100px;">Open</span>
Most Advanced Timing	10 °BTDC <span style="margin-left: 100px;">10 °BTDC</span>
Most Retarded Timing	4 °BTDC <span style="margin-left: 100px;">4 °BTDC</span>
Default Timing	8 °BTDC <span style="margin-left: 100px;">8 °BTDC</span>
End of Sample Window	30 °ATDC
Retard 1°	Every 1 Knock Sample(s)
Advance 1°	Every 5 No-Knock Sample(s)
Warm-Up Delay Time	300 Seconds
Shutdown Delay Time	15 Seconds

Detonation Level Select		
Sensor 1	833	mV
Sensor 2	744	mV
Sensor 3	705	mV
Sensor 4	617	mV
Sensor 5	744	mV
Sensor 6	833	mV
Sensor 7	833	mV
Sensor 8	793	mV
Sensor 9	656	mV
Sensor 10	882	mV
Sensor 11	705	mV
Sensor 12	793	mV

NOTE: Entries above 2400mV result in a Disabled Sensor.

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Figure 4.05-5. View/Edit Control Data Values Screen

Automatic Calibration of Detonation Sensor Threshold Voltages

AutoCal Test Timing 10 °BTDC

---

Messages:

Starting LATEST ROM Program.

Program is Running.

AutoCal Completed Successfully  
 <F4> Saves AC Data to Filename  
 ANY Other Key Continues

AutoCal	L	M	H	S
Sensor 1	323	323	411	617
Sensor 2	411	470	588	882
Sensor 3	382	411	411	617
Sensor 4	352	352	382	568
Sensor 5	323	352	441	656
Sensor 6	470	470	470	705
Sensor 7	470	499	529	793
Sensor 8	323	470	499	744
Sensor 9	323	382	411	617
Sensor 10	323	470	558	833
Sensor 11	352	352	382	568
Sensor 12	352	382	470	705

Figure 4.05-6. Completion Of AutoCal Program

# RUNNING THE DSM AUTOCAL PROGRAM

Table 4.05-3. AutoCal Worksheet Example - Run # 1 Results

SENSOR	SET-POINT "S" COLUMN RESULTS										HIGHEST "S" VALUE
	RUN # 1	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	
1	617										
2	882										
3	617										
4	568										
5	656										
6	705										
7	793										
8	744										
9	617										
10	833										
11	568										
12	705										

NOTE: The AutoCal results shown in the figures and tables provided in this manual are for example only. Actual AutoCal values will vary depending on the application.

**View/Edit Control Data Values**

Engine Family : VHP GAS ENGINE  
 Engine Model : L7042 V-12  
 # of Cylinders: 12  
 Primary Fuel : NATURAL GAS PIPELINE QUALITY  
 Secondary Fuel: DIGESTER GAS  
 Comments:

Timing Disk Reference 26 °BTDC  
     <F3> To Calculate TDR

D-Lead Position - - -> Grounded          Open

Most Advanced Timing 10 °BTDC          10 °BTDC  
 Most Retarded Timing 4 °BTDC          4 °BTDC  
 Default Timing 8 °BTDC            8 °BTDC  
 End of Sample Window 30 °ATDC

Retard 1° Every 1 Knock Sample(s)  
 Advance 1° Every 5 No-Knock Sample(s)

Warm-Up Delay Time 300 Seconds  
 Shutdown Delay Time 15 Seconds

**Detonation  
Level Select**

Sensor 1	617
Sensor 2	882
Sensor 3	617
Sensor 4	568
Sensor 5	656
Sensor 6	705
Sensor 7	793
Sensor 8	744
Sensor 9	617
Sensor 10	833
Sensor 11	568
Sensor 12	705

NOTE: Entries above  
2400mV result in a  
Disabled Sensor.

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Figure 4.05-7. View/Edit Control Data Values Screen With Preliminary AutoCal Results

9. In a "RUN #" column on your AutoCal Worksheet, record the values listed in the "S" or Set-Point column on the AutoCal Screen. For example, the values in the "S" or Set-Point column on the AutoCal Screen in Figure 4.05-6 are recorded in the sample AutoCal Worksheet shown in Table 4.05-3.

**NOTE:** If you have a portable printer connected to your PC, press the [Print Screen] button for a printout of the AutoCal Screen.

10. Press any key to continue. You will return to the View/Edit Control Data Values Screen. The "S" or Set-Point values just determined during the AutoCal program appears in the "Detonation Level Select" table on the right hand side of the View/Edit Control Data Values Screen (see Figure 4.05-7).

11. Rerun the AutoCal program two additional times following Steps 6 - 10. Be sure to record the "S" or Set-Point column results for each AutoCal you run on the AutoCal Worksheet.

12. Press any key to continue. You will return to the View/Edit Control Data Values Screen. The values determined by the last AutoCal program you ran appears in the "Detonation Level Select" table on the right hand side of the View/Edit Control Data Values Screen.

13. If this is a dual fuel application and if possible, change fuels going to the engine and repeat Steps 5 - 12 to run the AutoCal program while running on the secondary fuel and timing. Record all "S" or Set-Point values determined by the AutoCal program for each sensor on the AutoCal Worksheet.

14. After running the AutoCal programs, circle the highest "S" or Set-Point value calibrated during all the AutoCals for each sensor on the worksheet (see Table 4.05-4).

15. Record the circled (highest) "S" or Set-Point value in the "Highest 'S' Value" column on the worksheet (see Table 4.05-4).

16. Compare the "S" or Set-Point values for each sensor recorded in the "Highest 'S' Value" column on your worksheet. If the results determined for each sensor vary by more than 500 from one sensor to another, refer to Table 4.00-4 in Section 4.00, *DSM System Diagnostics And Troubleshooting*. If the values do vary by more than 500 from sensor to sensor it may indicate 1) engine detonation, 2) sensor mounting imperfections, 3) unattached or incorrectly routed wire harnesses and/or ground wiring, or 4) other engine related problems. The troubleshooting table in Section 4.00 provides you with remedies.

17. With the View/Edit Control Data Values Screen showing, position the cursor in the first field of the "Detonation Level Select" table on the screen.

18. Enter the highest set-point value calibrated for each sensor (see Figure 4.05-8). These values are recorded on your AutoCal Worksheet in the "Highest 'S' Value" column. For example, in Figure 4.05-8, "656" was entered since it was the highest detonation level calibrated for Sensor 1 during all AutoCal programs completed.

19. Once all the set-point values are entered in the "Detonation Level Select" table, the edited data-set must be saved to ROM. Press [F10] to save the edited data-set. Highlight "Configure DSM Memory" on the next menu and press [Enter]. When the Verification Screen appears press [Y]. Several screens will appear indicating that the data-set is being saved to ROM, permanent memory on the EPROM chip inside the DSM module. Once the data-set has been saved to ROM, a message will state that the DSM memory has been configured to ROM. Press any key to continue.

# RUNNING THE DSM AUTOCAL PROGRAM

Table 4.05-4. AutoCal Worksheet Example - Completed Results

SENSOR	SET-POINT "S" COLUMN RESULTS										HIGHEST "S" VALUE
	RUN # 1	RUN # 2	RUN # 3	RUN # 4	RUN # 5	RUN # ___	RUN # ___	RUN # ___	RUN # ___	RUN # ___	
1	617	617	656								656
2	882	833	793								882
3	617	705	656								705
4	568	568	617								617
5	656	656	705								705
6	705	656	617								705
7	793	744	833								833
8	744	793	793								793
9	617	656	656								656
10	833	793	882								882
11	568	568	617								617
12	705	744	705								744

NOTE: The AutoCal results shown in the figures and tables provided in this manual are for example only. Actual AutoCal values will vary depending on the application.

View/Edit Control Data Values

<b>Engine Family : VHP GAS ENGINE</b> <b>Engine Model : L7042 V-12</b> <b># of Cylinders: 12</b> <b>Primary Fuel : NATURAL GAS PIPELINE QUALITY</b> <b>Secondary Fuel: DIGESTER GAS</b> <b>Comments:</b>		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td>Sensor 1</td><td>656</td><td>mV</td></tr> <tr><td>Sensor 2</td><td>882</td><td>mV</td></tr> <tr><td>Sensor 3</td><td>705</td><td>mV</td></tr> <tr><td>Sensor 4</td><td>617</td><td>mV</td></tr> <tr><td>Sensor 5</td><td>705</td><td>mV</td></tr> <tr><td>Sensor 6</td><td>705</td><td>mV</td></tr> <tr><td>Sensor 7</td><td>833</td><td>mV</td></tr> <tr><td>Sensor 8</td><td>793</td><td>mV</td></tr> <tr><td>Sensor 9</td><td>656</td><td>mV</td></tr> <tr><td>Sensor 10</td><td>882</td><td>mV</td></tr> <tr><td>Sensor 11</td><td>617</td><td>mV</td></tr> <tr><td>Sensor 12</td><td>744</td><td>mV</td></tr> </tbody> </table> <p style="font-size: small;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select			Sensor 1	656	mV	Sensor 2	882	mV	Sensor 3	705	mV	Sensor 4	617	mV	Sensor 5	705	mV	Sensor 6	705	mV	Sensor 7	833	mV	Sensor 8	793	mV	Sensor 9	656	mV	Sensor 10	882	mV	Sensor 11	617	mV	Sensor 12	744	mV
Detonation Level Select																																									
Sensor 1	656		mV																																						
Sensor 2	882		mV																																						
Sensor 3	705	mV																																							
Sensor 4	617	mV																																							
Sensor 5	705	mV																																							
Sensor 6	705	mV																																							
Sensor 7	833	mV																																							
Sensor 8	793	mV																																							
Sensor 9	656	mV																																							
Sensor 10	882	mV																																							
Sensor 11	617	mV																																							
Sensor 12	744	mV																																							
<b>Timing Disk Reference 26 °BTDC</b> <b>&lt;F3&gt; To Calculate TDR</b> <b>D-Lead Position - - -&gt; Grounded      Open</b> <b>Most Advanced Timing 10 °BTDC      10 °BTDC</b> <b>Most Retarded Timing 4 °BTDC      4 °BTDC</b> <b>Default Timing 8 °BTDC      8 °BTDC</b> <b>End of Sample Window 30 °ATDC</b>																																									
<b>Retard 1° Every 1 Knock Sample(s)</b> <b>Advance 1° Every 5 No-Knock Sample(s)</b>																																									
<b>Warm-Up Delay Time 300 Seconds</b> <b>Shutdown Delay Time 15 Seconds</b>																																									

<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

Figure 4.05-8. View/Edit Control Data Values Screen With Completed AutoCal Results

## SECTION 4.10

### LOST SENSOR CHECK TEST ON 16 CYLINDER ENGINES

#### PERFORMING LOST SENSOR CHECK TEST ON 16 CYLINDER ENGINES

The 16 cylinder DSM system checks for detonation in cylinder pairs and not individually like 6, 8, and 12 cylinder engines. Because of cylinder pairs, the DSM system does not automatically display lost sensor alarms on the Display Serial Port Data Screen. To display lost sensors, a lost sensor check must be performed. Complete the steps in this section to perform a lost sensor check for 16 cylinder engines.

**A TEST FOR LOST SENSORS ON 16 CYLINDER ENGINES SHOULD BE PERFORMED WHENEVER THE SAFETY CONTROLS AND ALARMS ARE TESTED ON THE ENGINE.**

**CAUTION** Make sure the engine is at full load during this check. At light loads, engine characteristics are very different than at higher loads. Typically, this results in lower output from the knock sensors which, if low enough, will result in a "lost sensor" error even when the system is working properly. Errors may result at low loads after engine warmup. These errors go away once the engine is fully loaded.

**NOTE:** If "lost sensor" errors are experienced at low loads and do not correct themselves as the engine is fully loaded, refer to Section 4.00, DSM System Diagnostics And Troubleshooting.

1. Access the Display Serial Port Data Screen (see Figure 4.10-2) by selecting "View Serial Link" from the DSM program's Main Menu. Although sensor status is displayed in the "Status" column, a sensor check must be manually completed to indicate a bad or disconnected sensor on the Display Serial Port Data Screen. A bad or disconnected sensor will be indicated on the Display Serial Port Data Screen during Steps 3 and 5 that follow.

**NOTE:** If a bad or disconnected sensor is detected, the DSM module also displays a message on the LCD display inside the DSM module.

2. Press the SENSOR CHECK button on the DSM filter once, the red Right Bank LED on the DSM filter will be illuminated (see Figure 4.10-1).

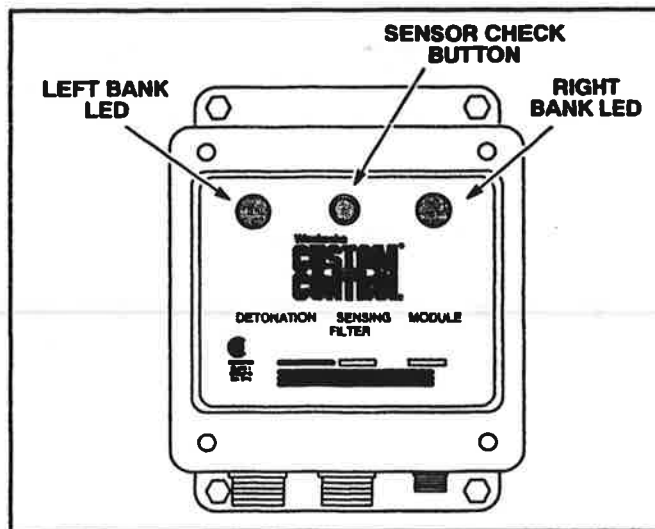


Figure 4.10-1. DSM Filter For 16 Cylinder Engines

# CHECKING FOR PROPER SENSOR CONNECTION

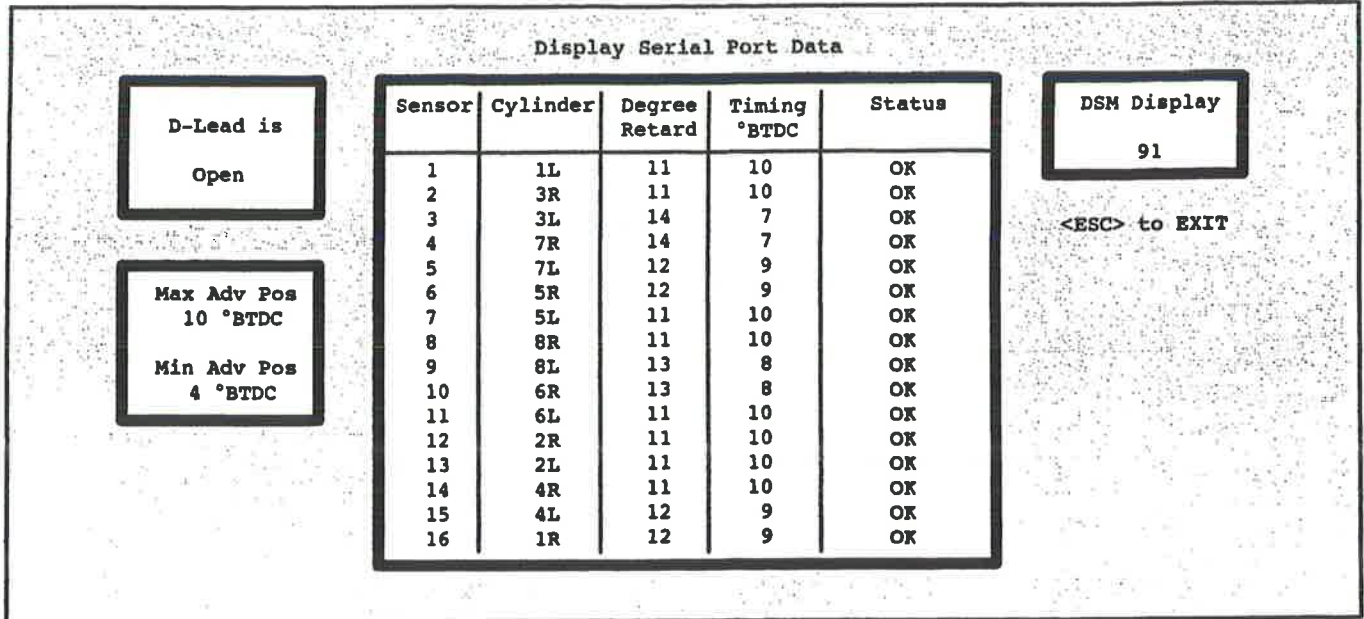


Figure 4.10-2. Display Serial Port Data Screen

3. If there are any bad or disconnected sensors on the right bank of the engine, the status shown on the Display Serial Port Data Screen will change from "OK" to "Sensor Low" for both cylinders in the pair within three minutes (see Figure 4.10-3).

4. After three minutes, press the SENSOR CHECK button again to perform the sensor test on the left bank of the engine.

5. If there are any bad or disconnected sensors on the left bank of the engine, the status shown on the Display Serial Port Data Screen will change from "OK" to

"Sensor Low" for both cylinders in the pair within three minutes.

6. After three minutes, press the SENSOR CHECK button again to exit the lost sensor check test. The LEDs will turn off.

**NOTE:** The DSM system will automatically exit the "sensor check" mode after 5 minutes and the LEDs will turn off, returning the DSM system to normal operation.

7. Perform a sensor check whenever the safety controls and alarms are tested on the engine.

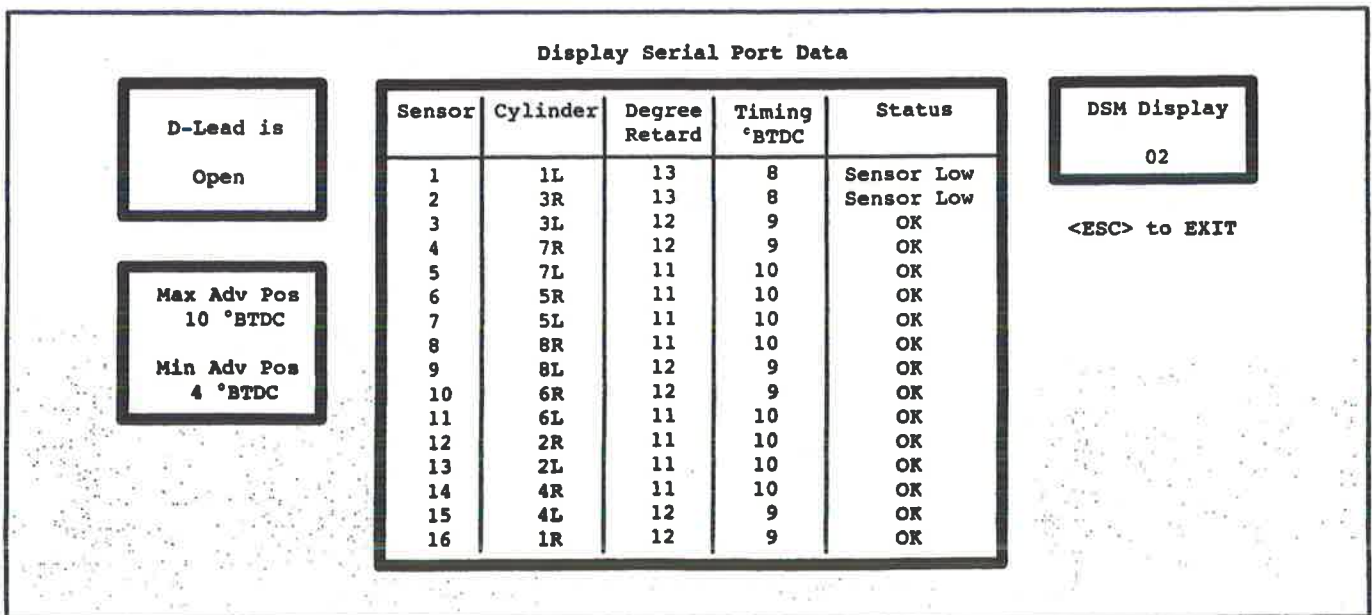


Figure 4.10-3. Display Serial Port Data Screen



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## SECTION 4.15

### EPROM CHIP REPLACEMENT

#### ABOUT EPROM CHIP REPLACEMENT

Engine parameters and data-sets for your engine are saved on an EPROM chip (ROM, permanent memory) inside the DSM module. Replacement of the EPROM chip is necessary because the EPROM chip is "full" of saved data-sets, the EPROM chip is damaged, or the EPROM chip is to be upgraded (for example: version 5.3c to version 6 series EPROM).

**NOTE:** For EPROM version 6.X (where X is the revision level), the DSM module allows 25 saves to the EPROM chip. For version 5.3c, the DSM module allows 20 saves to the EPROM chip. Once the EPROM chip has been fully configured, the chip must be replaced.

**NOTE:** Contact your Waukesha Engine Distributor for EPROM chip part number for replacement.

Damaged or corrupt EPROM chips are referred to several times in the troubleshooting suggestions from Section 4.00. A damaged or corrupt EPROM chip could be caused by any of the following:

- Serial cable became disconnected from DSM module while the program was being saved to the EPROM chip (permanent memory).
- The power to the DSM module was inadequate or excessively "dirty" during EPROM chip save.
- EPROM chip was installed improperly (for example, with indentation notch installed facing the wrong direction or pins not aligned in socket).

Inside the DSM module is a circuit board assembly comprised of two circuit boards. The EPROM chip is located on the bottom circuit board (between the two circuit boards). To replace the EPROM chip it is necessary to remove the circuit board assembly from the DSM module, disassemble the circuit board assembly, and remove the full or damaged EPROM chip. Follow the steps in this section when replacing an EPROM chip.

#### SAVING DATA-SET TO DISK

To simplify reprogramming of the DSM system after EPROM replacement, save the existing data-set to a file on disk **BEFORE** replacing the EPROM chip. The data-set is assigned a filename and saved on disk so the data-set can be retained for reprogramming when replacing the EPROM chip with the same version chip.

**NOTE:** If you are upgrading the EPROM chip and DSM Interface Program to the current version (version 6.X), make a printout (or hard copy) of the saved data-set seen on the View/Edit Control Data Values Screen to allow for easy reprogramming. A saved data-set from an earlier version of DSM software cannot be retrieved electronically with the newer DSM software/EPROM chip.

If the existing data-set is already saved to disk or you do not want to save the existing data-set to a disk for reprogramming, continue with the section "Replacing EPROM Chip."

1. With the DSM Interface Program's Main Menu showing on your screen, highlight "Edit/Create Setup" and press [Enter].

**NOTE:** For information on installing and/or accessing the DSM Interface Program, refer to the white card at the back of this manual which holds the 3-1/2" diskette for installation and accessing instructions.

2. Highlight "Retrieve from DSM" from the next menu and press [Enter]. Several screens will appear indicating that the data is being retrieved from the DSM module. Then the View/Edit Control Data Values Screen appears. This screen shows the engine's saved data-set parameters. The information shown on the screen is stored on the DSM EPROM chip (ROM or permanent memory).

3. Save the existing data-set to disk by pressing [F10] (see Figure 4.15-1).

4. Highlight "Save Data to Filename" from the menu and press [Enter].

# EPROM CHIP REPLACEMENT

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE          Engine Model : L7042 V-12          # of Cylinders: 12          Primary Fuel : NATURAL          Secondary Fuel: DIGESTED          Comments:</p> <p>Timing Disk Reference          &lt;F3&gt; To Calculate IDK</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">D-Lead Position - - -&gt;</td> <td style="width: 30%;">Grounded</td> <td style="width: 30%;">Open</td> </tr> <tr> <td>Most Advanced Timing</td> <td>10 °BTDC</td> <td>10 °BTDC</td> </tr> <tr> <td>Most Retarded Timing</td> <td>4 °BTDC</td> <td>4 °BTDC</td> </tr> <tr> <td>Default Timing</td> <td>8 °BTDC</td> <td>8 °BTDC</td> </tr> <tr> <td>End of Sample Window</td> <td>30 °ATDC</td> <td></td> </tr> </table> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Retard 1° Every</td> <td style="width: 30%;">1 Knock Sample(s)</td> <td style="width: 30%;"></td> </tr> <tr> <td>Advance 1° Every</td> <td>5 No-Knock Sample(s)</td> <td></td> </tr> </table> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Warm-Up Delay Time</td> <td style="width: 30%;">300 Seconds</td> <td style="width: 30%;"></td> </tr> <tr> <td>Shutdown Delay Time</td> <td>15 Seconds</td> <td></td> </tr> </table>	D-Lead Position - - ->	Grounded	Open	Most Advanced Timing	10 °BTDC	10 °BTDC	Most Retarded Timing	4 °BTDC	4 °BTDC	Default Timing	8 °BTDC	8 °BTDC	End of Sample Window	30 °ATDC		Retard 1° Every	1 Knock Sample(s)		Advance 1° Every	5 No-Knock Sample(s)		Warm-Up Delay Time	300 Seconds		Shutdown Delay Time	15 Seconds		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td>Sensor 1</td><td style="text-align: right;">656 mV</td></tr> <tr><td>Sensor 2</td><td style="text-align: right;">882 mV</td></tr> <tr><td>Sensor 3</td><td style="text-align: right;">705 mV</td></tr> <tr><td>Sensor 4</td><td style="text-align: right;">617 mV</td></tr> <tr><td>Sensor 5</td><td style="text-align: right;">705 mV</td></tr> <tr><td>Sensor 6</td><td style="text-align: right;">705 mV</td></tr> <tr><td>Sensor 7</td><td style="text-align: right;">833 mV</td></tr> <tr><td>Sensor 8</td><td style="text-align: right;">793 mV</td></tr> <tr><td>Sensor 9</td><td style="text-align: right;">656 mV</td></tr> <tr><td>Sensor 10</td><td style="text-align: right;">882 mV</td></tr> <tr><td>Sensor 11</td><td style="text-align: right;">617 mV</td></tr> <tr><td>Sensor 12</td><td style="text-align: right;">744 mV</td></tr> </tbody> </table> <p style="font-size: small;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select		Sensor 1	656 mV	Sensor 2	882 mV	Sensor 3	705 mV	Sensor 4	617 mV	Sensor 5	705 mV	Sensor 6	705 mV	Sensor 7	833 mV	Sensor 8	793 mV	Sensor 9	656 mV	Sensor 10	882 mV	Sensor 11	617 mV	Sensor 12	744 mV
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<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

**Figure 4.15-1. Saving Options Menu**

View/Edit Control Data Values

<p>Engine Family : VHP GAS ENGINE          Engine Model : L7042 V-12          # of Cylinders: 12          Primary Fuel : NATURAL          Secondary Fuel: DIGESTED          Comments:</p> <p>Timing Disk Reference          &lt;F3&gt;</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">D-Lead Position</td> <td style="width: 30%;">Grounded</td> <td style="width: 30%;">Open</td> </tr> <tr> <td>Most Advanced Timing</td> <td>10 °BTDC</td> <td>10 °BTDC</td> </tr> <tr> <td>Most Retarded Timing</td> <td>4 °BTDC</td> <td>4 °BTDC</td> </tr> <tr> <td>Default Timing</td> <td>8 °BTDC</td> <td>8 °BTDC</td> </tr> <tr> <td>End of Sample Window</td> <td>30 °ATDC</td> <td></td> </tr> </table> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Retard 1° Every</td> <td style="width: 30%;">1 Knock Sample(s)</td> <td style="width: 30%;"></td> </tr> <tr> <td>Advance 1° Every</td> <td>5 No-Knock Sample(s)</td> <td></td> </tr> </table> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Warm-Up Delay Time</td> <td style="width: 30%;">300 Seconds</td> <td style="width: 30%;"></td> </tr> <tr> <td>Shutdown Delay Time</td> <td>15 Seconds</td> <td></td> </tr> </table>	D-Lead Position	Grounded	Open	Most Advanced Timing	10 °BTDC	10 °BTDC	Most Retarded Timing	4 °BTDC	4 °BTDC	Default Timing	8 °BTDC	8 °BTDC	End of Sample Window	30 °ATDC		Retard 1° Every	1 Knock Sample(s)		Advance 1° Every	5 No-Knock Sample(s)		Warm-Up Delay Time	300 Seconds		Shutdown Delay Time	15 Seconds		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Detonation Level Select</th> </tr> </thead> <tbody> <tr><td>r 1</td><td style="text-align: right;">656 mV</td></tr> <tr><td>r 2</td><td style="text-align: right;">882 mV</td></tr> <tr><td>r 3</td><td style="text-align: right;">705 mV</td></tr> <tr><td>r 4</td><td style="text-align: right;">617 mV</td></tr> <tr><td>r 5</td><td style="text-align: right;">705 mV</td></tr> <tr><td>r 6</td><td style="text-align: right;">705 mV</td></tr> <tr><td>r 7</td><td style="text-align: right;">833 mV</td></tr> <tr><td>r 8</td><td style="text-align: right;">793 mV</td></tr> <tr><td>r 9</td><td style="text-align: right;">656 mV</td></tr> <tr><td>r 10</td><td style="text-align: right;">882 mV</td></tr> <tr><td>r 11</td><td style="text-align: right;">617 mV</td></tr> <tr><td>r 12</td><td style="text-align: right;">744 mV</td></tr> </tbody> </table> <p style="font-size: small;">NOTE: Entries above 2400mV result in a Disabled Sensor.</p>	Detonation Level Select		r 1	656 mV	r 2	882 mV	r 3	705 mV	r 4	617 mV	r 5	705 mV	r 6	705 mV	r 7	833 mV	r 8	793 mV	r 9	656 mV	r 10	882 mV	r 11	617 mV	r 12	744 mV
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<F10> to Save
<ESC> to Main Menu
<F5> to AUTOCAL

**Figure 4.15-2. Entering Filename Of Data-Set**

5. Enter a filename according to the following procedure (see Figure 4.15-2). Read all three steps prior to saving the file to the disk.

- A. Locate the engine's serial number on the nameplate.
- B. If the engine has a "C-" number, remove the "C-" and the "/" from the number. Example: C-10768/01 would give a root file name of "1076801". If the engine does not have a "C-" number use all six digits in the serial number for the filename.
- C. The first time the configuration is saved to the disk add an "A" to the end. This is to indicate that

this is the first save of this configuration. If changes are made to the configuration, save the next file with the same numerical information and change the suffix letter to "B". Continue in this manner for each revision to the file.

Once eight characters have been entered, the file will automatically be saved to the computer disk where the DSM program resides. If the filename is less than eight characters, press [Enter] to save.

**NOTE:** When saving to disk, the data-set will be saved to the drive and directory where the DSM Interface Program is located.

6. Press [ESC] to return to the Main Menu.

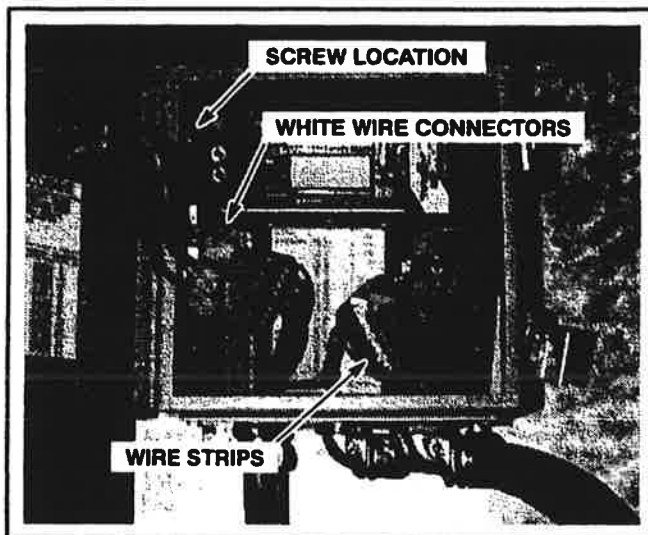
## REPLACING EPROM CHIP

1. Disconnect the DSM module from the Ignition Module by removing the "DSM to ignition" harness from the 14 pin connector on the side of the Ignition Module.

### **⚠ WARNING**

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

2. Remove power from DSM module
3. Label the white connectors on the left side "T" (top), "M" (middle), "B" (bottom) (see Figure 4.15-3). These wires need to be identified so that reconnections of the wires are made correctly.
4. Disconnect all the wire strips from inside the DSM module including the white wire connectors (see Figure 4.15-3).



**Figure 4.15-3. Disconnecting Wire Strips**

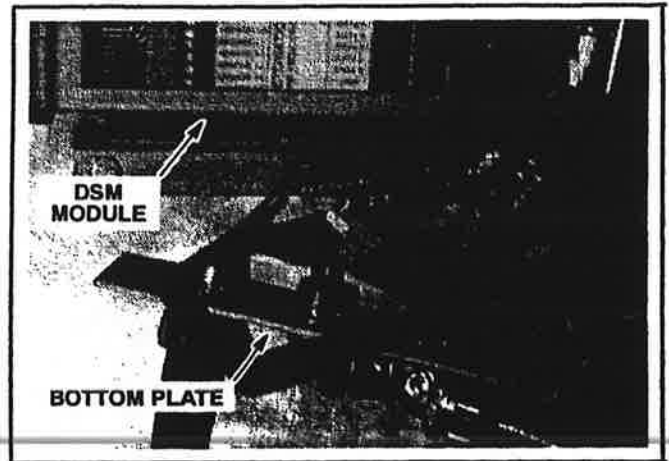
5. Remove the four corner screws securing the circuit board assembly to the DSM module.

**NOTE:** Screws are sealed with Loctite® to prevent loosening under vibration. Be sure to use Loctite® on screws when reinstalling.

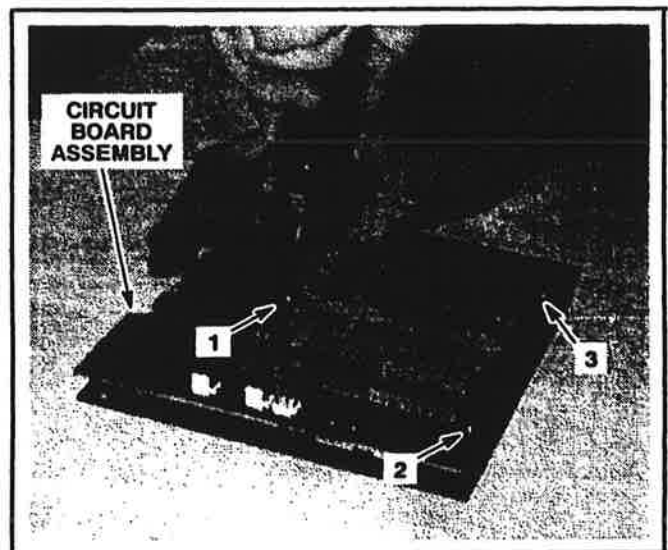
6. Carefully remove the circuit board assembly through the front of the DSM module.

**NOTE:** If you cannot remove the circuit board assembly because the wire connectors are blocking the opening, remove the bottom plate from the DSM module (see Figure 4.15-4). The wires can be pulled out of the module and the circuit board assembly will come out through the front of the DSM module.

7. Remove the three screws from the top circuit board in the order shown in Figure 4.15-5.

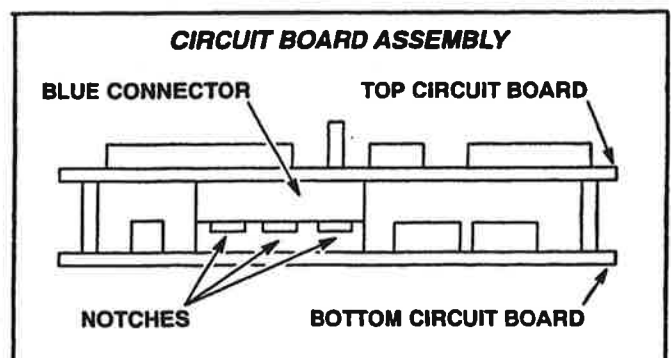


**Figure 4.15-4. Removing Bottom Plate Of DSM Module**



**Figure 4.15-5. Removing Screws From Circuit Board Assembly**

8. On the right side of the circuit board assembly is a blue connector which holds the two circuit boards together. Using a small flat screwdriver, pry apart the blue connector at the three notches (see Figure 4.15-6).



**Figure 4.15-6. Disassembling Circuit Board Assembly**

## EPROM CHIP REPLACEMENT

9. The EPROM chip is located on the upper left side of the bottom circuit board as shown Figure 4.15-7. At the same time, press down the two blue tabs located on both sides of the EPROM chip and the chip will pop off.

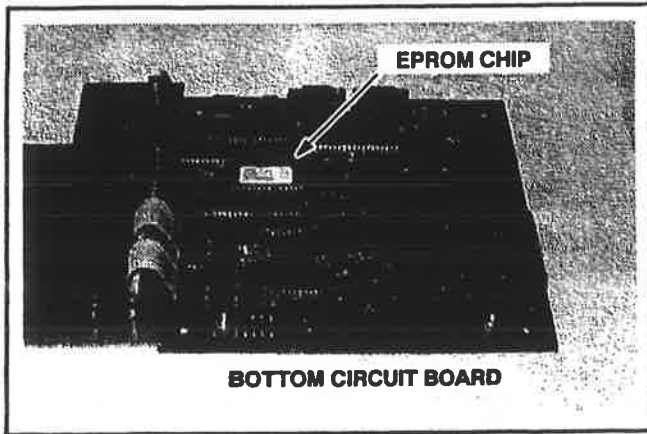


Figure 4.15-7. EPROM Chip Location On Bottom Circuit Board

10. Remove the full/damaged EPROM chip from the circuit board.

11. Carefully place a new EPROM chip in place on the circuit board. Make sure the notched side of the EPROM chip is installed to face toward the right side of the circuit board as shown in Figure 4.15-8 and Figure 4.15-9.

### **⚠ WARNING**

The EPROM chip must be installed so the indentation notch on the chip is installed to face toward the right side of the bottom circuit board. Failure to install the EPROM chip correctly will result in a non-functional DSM module and the EPROM chip will need to be replaced.

12. Press the EPROM chip into place making sure that all the pins of the EPROM chip are aligned with the socket. Failure to install the EPROM correctly will result in a non-functional DSM module.

**NOTE:** If the pins on the new EPROM chip do not align with the socket on the circuit board, press on the side of the pins very carefully until pin alignment allows for installation.

13. After the new EPROM chip is installed, carefully align the top circuit board with the bottom circuit board.

14. Press the circuit boards together so the blue connector on the right sides of the circuit boards snap together.

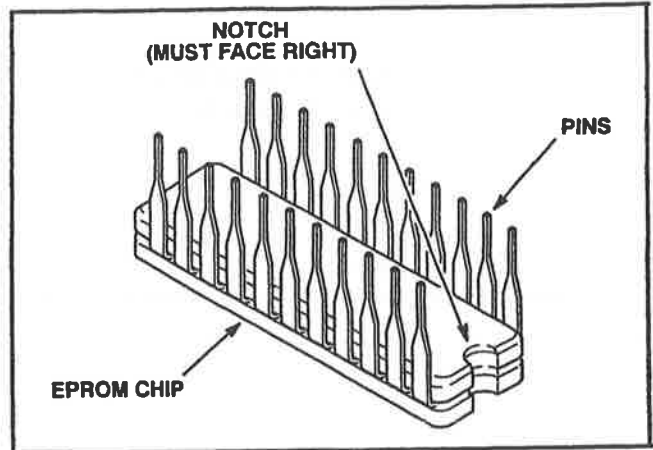


Figure 4.15-8. Correct EPROM Chip Direction

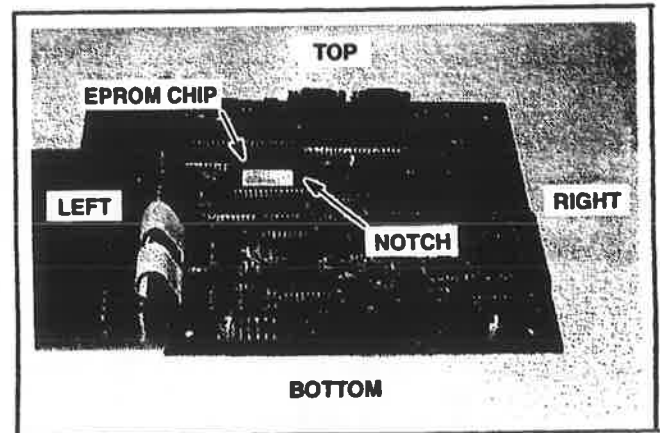


Figure 4.15-9. EPROM Chip Location On Bottom Circuit Board

15. Secure the two circuit boards with the three screws removed in Step 7.

16. Place the circuit board assembly into the DSM module.

17. Secure the circuit board assembly to the DSM module with the four screws removed in Step 5.

18. Reconnect all wire strips and white wire connectors inside the DSM module. Make sure the white connectors are reconnected in the order marked in Step 3.

**NOTE:** If you had to remove the bottom plate of the DSM module to remove the circuit board assembly, reinstall bottom plate.

19. Reapply power to the DSM module.

## REPROGRAMMING THE EPROM CHIP

The EPROM chip just installed will not have a saved data-set. You will need to reprogram the EPROM chip. After reapplying power to the DSM module, the internally mounted LCD display will read "99" (no data). The DSM module is sensing that a new EPROM chip is installed in the DSM module.

- If you want to reprogram the EPROM chip with a completely new data-set, complete the programming steps in Section 3.10, *Programming The DSM System For A New Application*.
- If you have a saved data-set on disk and want to use that information to re-program the EPROM chip, complete the steps in "Retrieving A Saved Data-Set" below.

**NOTE:** If you are upgrading the EPROM chip and DSM Interface Program from a previous software version (example Version 5.3c) to the current version (version 6.X), you may use the values from a previous data-set to reprogram the DSM system. However, **DO NOT** use AutoCal values from older versions of DSM software when reprogramming a newer version. When upgrading to the current DSM Interface Program software you must rerun the AutoCal program. Refer to Section 4.05 Running The DSM AutoCal Program to run the AutoCal program.

### Retrieving A Saved Data-Set

1. With the DSM Interface Program's Main Menu showing on your screen, highlight "Edit/Create Setup" and press [Enter] (see Figure 4.15-10).

**NOTE:** Verify that the DSM module is disconnected from the Ignition Module before reprogramming the EPROM chip. If the DSM module is not disconnected from the Ignition Module, disconnect the "DSM to ignition" harness from the 14 pin DSM connector on the side of the Ignition Module.

**NOTE:** For information on installing and/or accessing the DSM Interface Program, refer to the white card at the back of this manual which holds the 3-1/2" diskette for installation and accessing instructions.

2. On the next menu highlight "Retrieve from Filename" and press [Enter] (see Figure 4.15-11).

3. Highlight the file name (serial number) you want to open and press [Enter] (see Figure 4.15-12). The View/Edit Control Data Values Screen appears with the saved data-set information.

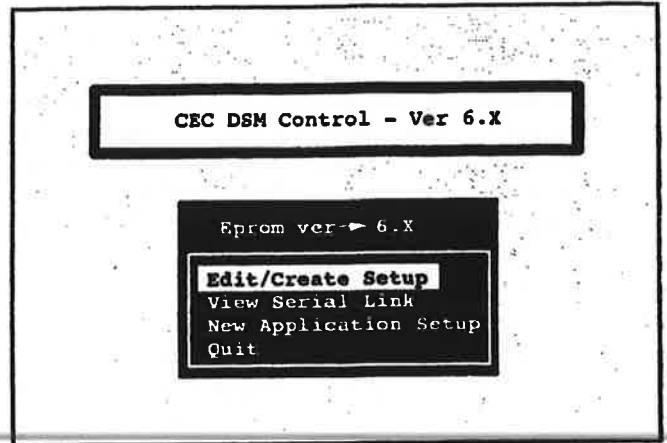


Figure 4.15-10. DSM Interface Program Main Menu

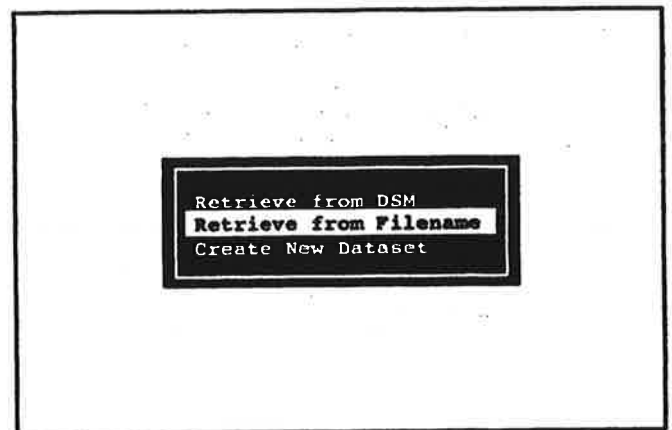


Figure 4.15-11. Edit/Create Setup Menu

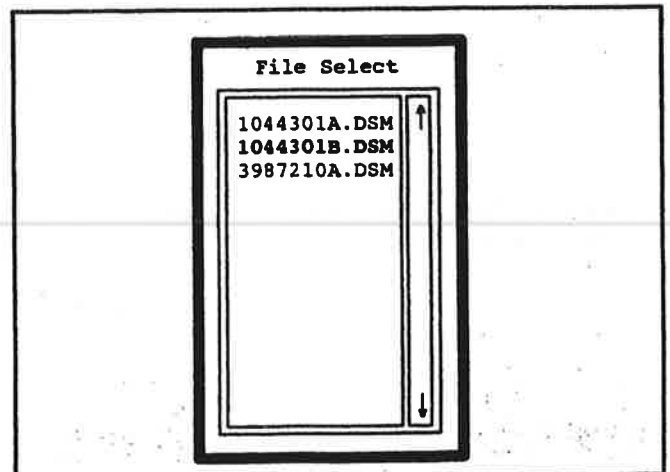


Figure 4.15-12. Selecting File Name Of Saved Data-Set

## EPROM CHIP REPLACEMENT

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4. The information that is shown on the View/Edit Control Data Values Screen has NOT been stored on the DSM module's EPROM chip (permanent memory). Press [F10] to save the loaded data-set to ROM (permanent memory). Highlight "Configure DSM Memory" on the next menu and press [Enter]. When the Verification Screen appears press [Y]. Several screens will appear indicating that the data-set is being saved to ROM, permanent memory on the EPROM chip inside the DSM module. Once the data-set has been saved to ROM, a message will state that the DSM memory has been configured to ROM. Press any key to continue.

5. Reconnect the DSM module to the Ignition Module by threading the "DSM to ignition" harness from the 14 pin connector on the side of the Ignition Module.

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**WAUKESHA ENGINE DIVISION, DRESSER INDUSTRIES, INC.**  
**EXPRESS LIMITED WARRANTY FOR CUSTOM ENGINE CONTROLS®**

**INTRODUCTION**

Custom Engine Controls® (CEC) are sold as standard, or as options on new Engines or as Genuine Service Parts, and include the Detonation Sensing Module (DSM), Air Fuel Module (AFM), Turbo Control Management System (TCMS), and Ignition Module (IM), or any other control device identified as a CEC product.

**I. TERMS OF EXPRESS LIMITED WARRANTY**

Waukesha Engine Division warrants that it will repair or replace, AT ITS ELECTION AND EXPENSE, any CEC installed on an engine, or Enginator®, or product (hereinafter referred to as "Products") manufactured by Waukesha, or purchased as a Genuine Service Part, which proves to have had a defect in material or workmanship.

**II. TERM LIMITATIONS OF EXPRESS LIMITED WARRANTY**

A. This coverage shall commence upon initial new Products start-up date or the purchase date, in the case of service parts sales, and shall expire upon the earlier of the following:

1. New Products
  - A. 12 months after the initial new Product start-up date; or
  - B. 24 months after the original shipment date of the covered Products by Waukesha Engine Division.
2. Genuine Service Parts
  - A. 12 months from the date the CEC is put into service; or
  - B. 18 months from the purchase date.

B. Notwithstanding the foregoing, Waukesha further warrants that it will repair or replace, AT ITS ELECTION AND EXPENSE, any component of the Waukesha Product damaged as the direct result of a warrantable defect in a CEC product.

**III. WAUKESHA'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY**

Waukesha shall be responsible for:

- A. The repair or replacement, at Waukesha's election, of covered defective parts and all reasonable labor required regarding a warranted failure during the express limited warranty term. All such labor shall be provided by Waukesha's authorized contractor or distributor.
- B. For the repair of CEC's installed on Products shipped from Waukesha, reasonable and necessary travel and expenses incurred by Waukesha's authorized contractor or distributor.
- C. Replacement of lubricating oil, coolant, filter elements, Waukesha supplied engine components, or other normal maintenance items that are contaminated and/or damaged as a direct result of a warranted failure.

**IV. OWNER'S RESPONSIBILITIES UNDER THE EXPRESS LIMITED WARRANTY**

Owner shall be responsible for:

- A. The operation and maintenance of the Products within the guidelines established by Waukesha.
- B. Making the Products available to Waukesha or Waukesha's authorized contractors or distributors for any warranty repair, during normal business hours.
- C. All additional costs incurred for premium or overtime labor, should owner request that repairs be made on a premium or overtime schedule.
- D. All costs incurred as the result of removal or reinstallation of the Products as may be required to effect any warranted repair.
- E. All administrative costs and expenses resulting from a warranted failure.
- F. Any costs of transportation, towing, repair facilities, or associated costs.
- G. All travel, mileage, and other related Distributor costs and expenses associated with repair under the terms of the Service Parts Warranty.
- H. All additional labor time in excess of Waukesha's Labor Guide for the warrantable repair.
- I. Loss of revenue and loss of/or damage to real and/or personal property.

**V. LIMITATION OF WAUKESHA'S OBLIGATIONS**

The obligations of Waukesha under this express limited warranty shall be waived and voided, and Waukesha shall not, thereafter, be responsible for:

- A. Any failure resulting from owner or operator abuse or neglect, including but not by way of limitation, any operation, installation, application, or maintenance practice not in accordance with guidelines or specifications established by Waukesha; or
- B. Any failure resulting from unauthorized modifications or repairs of the Products; or
- C. Any failure resulting from overload, overspeed, overheat, accident, improper storage; or
- D. Failure of owner to promptly provide notice of a claimed defect; or
- E. Failure of Products for which Waukesha did not receive properly completed start-up reports; or
- F. Repairs of a covered failure performed with non-genuine Waukesha parts; or
- G. Repairs of a covered failure performed by non-authorized contractors or distributors; or
- H. Failure to make Products available to Waukesha or its authorized representatives; or
- I. Failure to supply documents such as drawings and specifications relating to the specific application of the Products; or
- J. Improper diagnosis of a Product problem for which a CEC product is replaced.
- K. Failure of Service Parts for which Waukesha did not receive proper documentation concerning the Service Parts purchase date from an Authorized Waukesha Engine Distributor; or
- L. Any failure of a Service Part resulting from misapplication or improper repair procedures; or
- M. Any failure or damage resulting from the improper or extended storage of a Service Part; or
- N. Freight, Customs, Broker Fees, and Import Duties if appropriate documentation is not provided.

**VI. APPLICABILITY AND EXPIRATION**

The warranties set out above are extended to all owners in the original chain of distribution. The warranties and obligations of Waukesha shall expire and be of no further effect upon the dates of expiration of the applicable warranty periods.

**VII. WARRANTY ADMINISTRATION**

This warranty is administered exclusively by an Authorized Waukesha Distributor. The invoice for the failed Service Parts must be provided to the Distributor to determine whether the warranty is applicable.

Contact the nearest Authorized Waukesha Distributor for assistance with warranty matters or questions. The location of the nearest Authorized Distributor is available by contacting Waukesha Engine Division at (414) 547-3311.

THE FOREGOING SETS FORTH WAUKESHA'S ONLY OBLIGATIONS AND OWNERS' EXCLUSIVE REMEDY FOR BREACH OF WARRANTY, WHETHER SUCH CLAIMS ARE BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE AND STRICT LIABILITY), OR OTHER THEORIES, AND THE FOREGOING IS EXPRESSLY IN LIEU OF OTHER WARRANTIES WHATSOEVER EXPRESSED, IMPLIED, AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.

Notwithstanding the preceding, in no event shall Waukesha be liable for any direct, special, incidental, or consequential damages (whether denominated in contract, tort strict liability, negligence, or other theories) arising out of this Agreement or the use of any Products provided under this Agreement.

Any action arising hereunder or relating hereto, whether based on breach of contract, tort (including negligence and strict liability), or other theories must be commenced within two (2) years after the cause of action accrues or it shall be barred.

All disputes and claims between the parties which may arise out of or in connection with this Contract shall be settled by good faith negotiation between an executive level representative of each party. If the parties are nonetheless unable to reach agreement, such dispute shall be resolved by binding arbitration. The arbitration shall be administered by the American Arbitration Association according to its rules of Commercial Arbitration then in force. The arbitration shall take place in Milwaukee, Wisconsin, before one arbitrator. The language to be used in the arbitration shall be English. The law of Texas shall govern. Judgment upon the award of the arbitrators may be entered in any court of competent jurisdiction.

See Form M-462 for the most current warranty terms, Effective May 1, 1995

# AUTOCAL WORKSHEET (6, 8, & 12 CYLINDER ENGINES)

The AutoCal Worksheet is to be used to assist you when programming the DSM module during AutoCal programming. Detach or copy this worksheet when use of the worksheet is required for DSM module programming.

**NOTE:** This worksheet applies to 6, 8, and 12 cylinder engines. The yellow worksheet applies to 16 cylinder engines. Make sure you use the worksheet that applies to your engine application.

**NOTE:** Use this worksheet when running the DSM AutoCal Program as described in Section 3.10, Programming The DSM System For A New Application, and Section 4.05, Running The DSM AutoCal Program.

## About The AutoCal Program

The DSM AutoCal program is the automatic calibration of the detonation threshold levels by the DSM Interface Program. The DSM module monitors for detonation using the frequency output of each cylinder with engine mounted detonation knock sensors. These knock sensors must be calibrated or "AutoCaled." During AutoCal, the knock sensors are calibrated so that the DSM system can operate properly.

An AutoCal should be run the first time the DSM is programmed for an engine or whenever the DSM is programmed for a new application. Additionally, the DSM system must be re-AutoCaled using the DSM Interface Program and a PC after doing any removal, repair, or replacement of engine cylinder heads,

cylinder liners, cylinder gaskets, pistons, or knock sensors; or when upgrading to a new version of DSM software. This calibration **MUST BE** done using the AutoCal program.

**NOTE:** If the results recorded in the "Highest 'S' Value" column vary by more than 500 from one sensor to another, refer to Table 4.00-4, "DSM System Troubleshooting", in Section 4.00 of the Detonation Sensing Module Installation, Operation, And Maintenance Manual (Form 6278). If the values do vary by more than 500 from sensor to sensor it may indicate 1) engine detonation, 2) sensor mounting imperfections, 3) unattached or incorrectly routed wire harnesses and/or ground wiring, or 4) other engine related problems.

## AutoCal Worksheet For 6, 8, And 12 Cylinder Engines

SENSOR	SET-POINT "S" COLUMN RESULTS										HIGHEST "S" VALUE
	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

DATE: \_\_\_\_\_

PERFORMED BY: \_\_\_\_\_

ENGINE SITE/NUMBER: \_\_\_\_\_

# AUTO CAL WORKSHEET (16 CYLINDER ENGINES)

The AutoCal Worksheet is to be used to assist you when programming the DSM module during AutoCal programming. Detach or copy this worksheet when use of the worksheet is required for DSM module programming.

**NOTE:** This worksheet applies to 16 cylinder engines. The blue worksheet applies to 6, 8, and 12 cylinder engines. Make sure you use the worksheet that applies to your engine application.

**NOTE:** Use this worksheet when running the DSM AutoCal Program as described in Section 3.10, Programming The DSM System For A New Application, and Section 4.05, Running The DSM AutoCal Program.

## About The AutoCal Program

The DSM AutoCal program is the automatic calibration of the detonation threshold levels by the DSM Interface Program. The DSM module monitors for detonation using the frequency output of each cylinder with engine mounted detonation knock sensors. These knock sensors must be calibrated or "AutoCaled." During AutoCal, the knock sensors are calibrated so that the DSM system can operate properly.

An AutoCal should be run the first time the DSM is programmed for an engine or whenever the DSM is programmed for a new application. Additionally, the DSM system must be re-AutoCaled using the DSM Interface Program and a PC after doing any repair or

replacement of engine cylinder heads, cylinder liners, pistons, or knock sensors; or when upgrading to a new version of DSM software. This calibration **MUST BE** done using the AutoCal program.

**NOTE:** If the results recorded in the "Highest 'S' Value" column vary by more than 500 from one sensor to another, refer to Table 4.00-4, "DSM System Troubleshooting", in Section 4.00 of the Detonation Sensing Module Installation, Operation, And Maintenance Manual (Form 6278). If the values do vary by more than 500 from sensor to sensor it may indicate 1) engine detonation, 2) sensor mounting imperfections, 3) unattached or incorrectly routed wire harnesses and/or ground wiring, or 4) other engine related problems.

## AutoCal Worksheet For 16 Cylinder Engines

SENSOR PAIRS	SET-POINT "S" COLUMN RESULTS										HIGHEST "S" VALUE
	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	RUN #	
1 & 2											
3 & 4											
5 & 6											
7 & 8											
9 & 10											
11 & 12											
13 & 14											
15 & 16											

DATE: \_\_\_\_\_

PERFORMED BY: \_\_\_\_\_

ENGINE SITE/NUMBER: \_\_\_\_\_

# **CUSTOM ENGINE CONTROL<sup>®</sup>**

## **DETONATION SENSING MODULE INTERFACE PROGRAM SOFTWARE**

**SEE INSTALLATION INSTRUCTIONS ON OTHER SIDE**



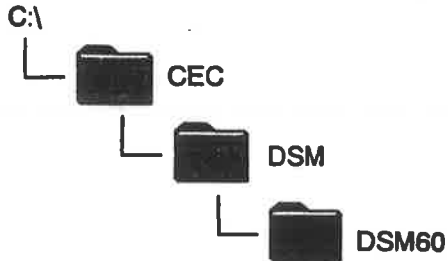
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**DRESSER**

# DSM INTERFACE PROGRAM INSTALLATION

## INSTALLATION OF DSM INTERFACE PROGRAM SOFTWARE

The DSM Interface Program software contains an installation program to automatically load the DSM Interface Program software. The installation disk also contains a copy of the DSM executable file for those users who want to run the DSM Interface Program from the disk in DOS. When installing the DSM Interface Program using the installation program, a "CEC" directory will automatically be created with "DSM" as a subdirectory.



Complete the steps that follow to install the DSM Interface Program using the installation program.

**NOTE:** If a CEC directory has already been created as a result of loading another CEC program, the DSM Interface Program will automatically be placed in that directory. An additional CEC directory will not be created.

**NOTE:** This manual assumes you are already familiar with basic MS-DOS commands for viewing directories, copying files, and other MS-DOS concepts. If you need more information on these subjects, refer to an MS-DOS instruction manual.

## DOS INSTALLATION

1. Begin at the DOS prompt.
2. Insert the DSM Interface Program disk into the 3-1/2" disk drive on your computer.
3. At the DOS prompt, type **a:\install** if you are using the A drive or **b:\install** if you are using the B drive. Then press [Enter] (there will be a 30-60 second delay before the installation screen appears).
4. Follow the instructions that appear on the screen.
5. When installation is complete, the CEC directory and subdirectory will be created on the hard drive (c:\). To change to the correct directory, type at the DOS prompt: **cd c:\cec\dsm\dsm60** and press [Enter]. To run the DSM Interface Program, change to the correct directory and type **dsm60a.exe** (the executable file - see note below) and press [Enter].

**NOTE:** To find the name of the executable file (.exe), view the directory of the drive on which your DSM program is saved by typing **DIR** at the drive prompt and then pressing [Enter]. Listed in the directory will be an executable file. The executable file is the letters "dsm" followed by the version number. Filename Example: **dsm60a.exe** ("60a" is the version number in this example)

## WINDOWS 3.1x OR WINDOWS NT 3.5x

1. Start Windows 3.1x or Windows NT 3.5x on your computer.
2. Close any other applications that may be open on your computer's desktop.
3. Insert the DSM Interface Program disk into the 3-1/2" disk drive on your computer.
4. Select **File/Run** from the Program Manager menu.
5. When the Run dialog box appears, type **a:\install** if you are using the A drive or **b:\install** if you are using the B drive. Then click **OK** (there will be a 30-60 second delay before the installation screen appears).
6. Follow the instructions that appear on the screen.
7. When installation is complete, a new "CEC" program group will be created in Windows with an icon for the DSM Interface Program. Double-click the DSM icon to start the DSM Interface program.

## WINDOWS 95 OR WINDOWS NT 4.0

1. Start Windows 95 or Windows NT 4.0 on your computer.
2. Close any other applications that may be open on your computer's desktop.
3. Insert the DSM Interface Program disk into the 3-1/2" disk drive on your computer.
4. Click the **Start** button and select **Run**.
5. Type **a:\install** if you are using the A drive or **b:\install** if you are using the B drive. Then click **OK** (there will be a 30-60 second delay before the installation screen appears).
6. Follow the instructions that appear on the screen.
7. When installation is complete, a DSM icon will appear on the desktop. Double-click the DSM icon to start the DSM Interface Program.

## RUNNING EXECUTABLE FILE ONLY

If you want to run the DSM Interface Program software from the installation disk in DOS, a copy of the DSM executable file is saved on the disk. The executable file for the DSM Interface Program is the letters "dsm" followed by the version number. Filename Example: **dsm60a.exe** ("60a" is the version number in this example)

To run the DSM Interface Program in DOS using the installation disk, change to the correct drive/directory. Type the name of the executable file, **dsm60a.exe** (the executable file - see note to left), at the DOS prompt and press [Enter].

**NOTE:** If you are running the DSM Interface Program from the installation disk using the executable file, you must be in DOS or a DOS window.



# Waukesha Engine Division Welcomes Your Comments

In order to continue bringing you the BEST in Waukesha product information, we ask that you take a moment to let us know about any errors or omissions in this publication. Comments and suggestions are also welcome. Please use one of the self-addressed, postage paid cards attached below.

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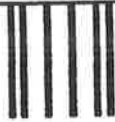
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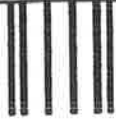


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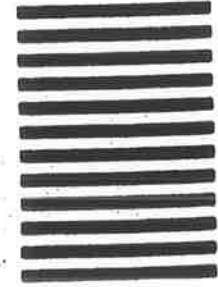
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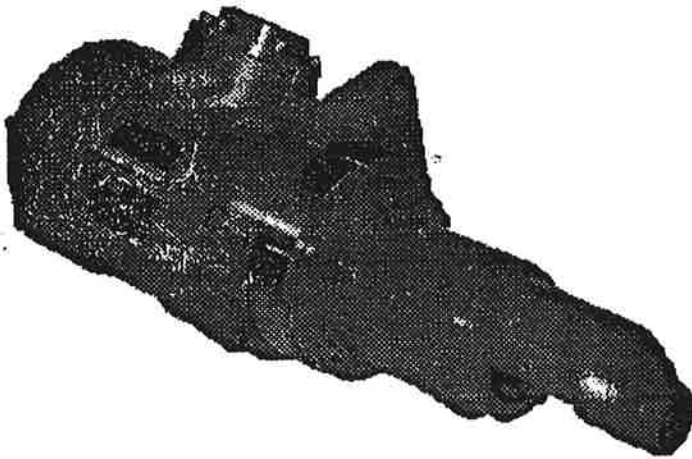
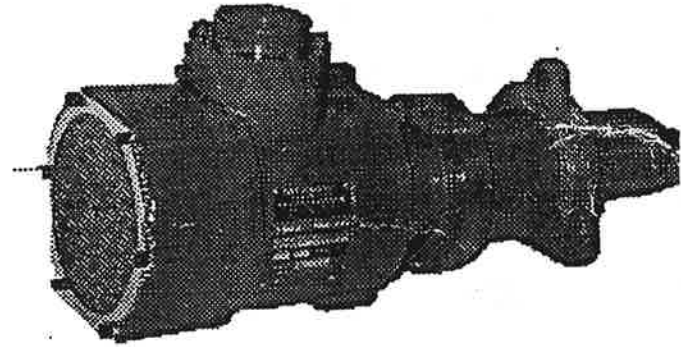
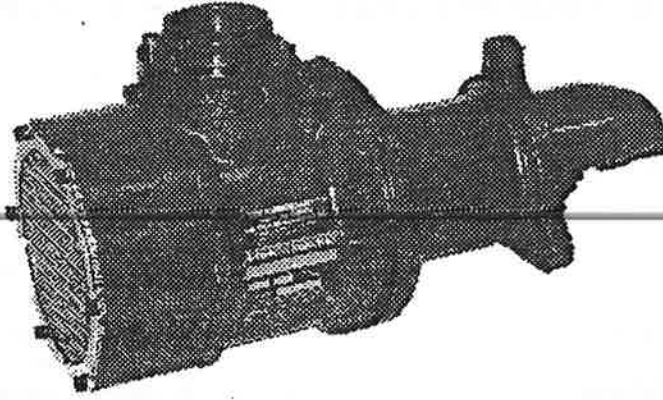


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P.O. BOX 330, FARMSUMERWEG 43, 9900 AH APPINGEDAM, THE NETHERLANDS

STR-227

# TDI *TURBOTWIN* Engine Air Starters



**INSTALLATION AND OPERATING INSTRUCTIONS**  
**MODELS T112B/T121 T106F/T112F, T112D/T121D**

**INSTALLATION & OPERATING MANUAL  
FOR  
MODELS T106F/T112F, T112B/T121B, T112D/T121D  
TURBINE STARTERS**

**USE WITH COMPRESSED AIR OR NATURAL GAS**

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# TDI *TURBOTWIN*

FROM TECH DEVELOPMENT INC

## 1.0 GENERAL INFORMATION

This manual provides instructions for the installation and operation of the TDI *TURBOTWIN* Starters. If there are questions not answered in this manual, please contact your TDI *TURBOTWIN* distributor or dealer for assistance. See Appendix A for the listing of distributors by state.

The *TURBOTWIN* models are turbine driven starters with an inertially engaged starter drive. Depending on the starter model and engine installation, the *TURBOTWIN* starters have applications ranging from 1000 CID (16 Liters) on diesel engines and up to 20000 CID (320 Liters) on gas engines. The *TURBOTWIN* models are suited to operate within a wide range of inlet pressures and ambient temperatures. Refer to Figure 1 for general specification information. The engine size and parasitic loading will determine the exact minimum pressure that will assure reliable starting.

The *TURBOTWIN* starters are designed for operation with compressed air or natural gas; materials used are compatible with "sour" natural gas and marine environments. Small amounts of foreign matter or liquid in the air stream will not adversely affect *TURBOTWIN* starters. As with all other TDI starters, no lubrication is required in the air supply.

You need to review the rest of this manual before installing your TDI *TURBOTWIN* starter.

### Note

Throughout this manual, the term "air" is used to denote the starter drive medium. Unless otherwise stated, "air" means either compressed air or natural gas.

## WARNINGS, CAUTIONS AND NOTES

Certain types of information are highlighted in this manual for your attention:

**WARNING** - used where injury to personnel or damage to the equipment is likely.

**CAUTION** - used where there is the possibility of damage to the equipment.

**NOTE** - used to point out special interest information.

## 1.1 DESCRIPTION

Figures 2, 3, 4 and 5 show the outline of the four basic *TURBOTWIN* models of starters. All models feature three basic subassemblies: a unique two stage turbine motor section, a planetary gearbox section and an inertia drive assembly.

Compressed air or natural gas is used to power the *TURBOTWIN* through the inlet port. The air or gas is expanded through the first nozzle or stators. The high velocity gas impinges on the first stage rotor to yield torque to the gearbox. The gas is further expanded through the second stage stators which impart additional torque to the second stage rotor.

The two stage motor section features greater stall torque than a single stage turbine plus aerodynamic speed control. This aerodynamic speed control helps protect the *TURBOTWIN* starter from damage caused by starter motor over speed. In addition, a steel motor housing module and low-mass rotors provide fail-safe operation.

All *TURBOTWIN*s employ the same basic 7.5:1 ratio planetary gearbox. Reliability and part commonality are designed into all *TURBOTWIN*s. This low gear ratio allows the turbine motor to spin at low speeds for long bearing life. At a typical 3000 rpm pinion speed, the turbine is cruising at a low 22500 rpm.

A simple and reliable inertia drive delivers the torque to the pinion. The pinion is thrown out to engage the engine's ring gear by the turbine motor's acceleration. Lighter weight rotating parts used in the *TURBOTWIN* provide low inertia and even "softer" engagement. In the event of over-pressure, the friction clutch used in every *TURBOTWIN* protects ring gear teeth from static torque overloads. In addition, an inertia engaged starter eliminates the need for complex pre-engagement control plumbing...and is easier to install and maintain than pre-engaged type starters.

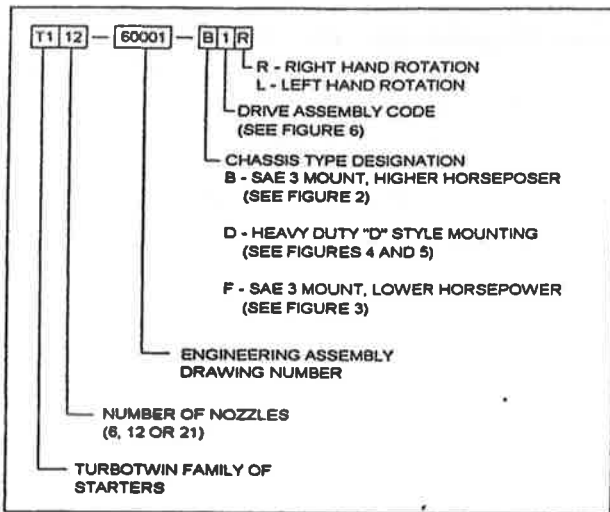
## 1.2 PRODUCT IDENTIFICATION

Figure 1 lists the available part numbers for the TDI *TURBOTWIN* Starters. The starter nameplate which is pinned to the turbine housing contains the following information: model number, serial number, part number, direction of rotation and the maximum rated operating pressure. An example nameplate is shown in Figure 7.

The model number is a shorthand description of the part number. The part number is described as follows:

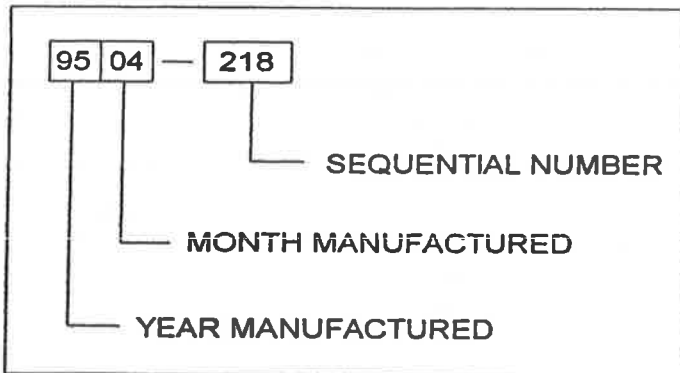
# TDI TURBOTWIN

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The direction of rotation is either right hand or left hand rotation as defined by Figure 8. Right Hand rotation is defined as counterclockwise rotation as viewed from the exhaust end of the starter.

The serial number is coded as follows:



The maximum operating pressure is also stamped on the nameplate. The example nameplate shows 150 psig. This pressure is measured at the check port on the starter inlet with the starter in operation.

### CAUTION

Exceeding the maximum operating pressure shown on the nameplate may result in drive failure, damage to the starter, damage to the engine or cause personal injury.

The proof pressure is 600 psig and is also shown on the nameplate. This means the turbine housing will not burst when subjected to a static pressure of 600 psig.

Figures 2, 3, 4 and 5 show the installation drawings for the four basic variations of the *TURBOTWIN* Starter.

**TDI TURBOSTART™**

Engine Air Starter  
 FROM TECH DEVELOPMENT, INC  
 A BARBER-COLMAN COMPANY  
 6800 POE AVE., DAYTON, OH 45414

MODEL NO. SERIAL NO.

T112B	9504-218
PART NUMBER	
<b>T112-60001-B1R</b>	
CW (RH) <input checked="" type="checkbox"/>	CCW (LH) <input type="checkbox"/>
AIR OR NAT. GAS USAGE	
MAX PRESS. <span style="border: 1px solid black; padding: 2px 10px;">150</span> PSIG	
MEASURED AT INLET WHILE OPERATING PROOF PRESSURE OF HOUSING IS 600 PSIG	
WARNING: DO NOT OPERATE UNLOADED OR WITHOUT TURBINE GUARD OR EXHAUST FITTING.	
U.S. PATENT 4509896	

Figure 7. Nameplate

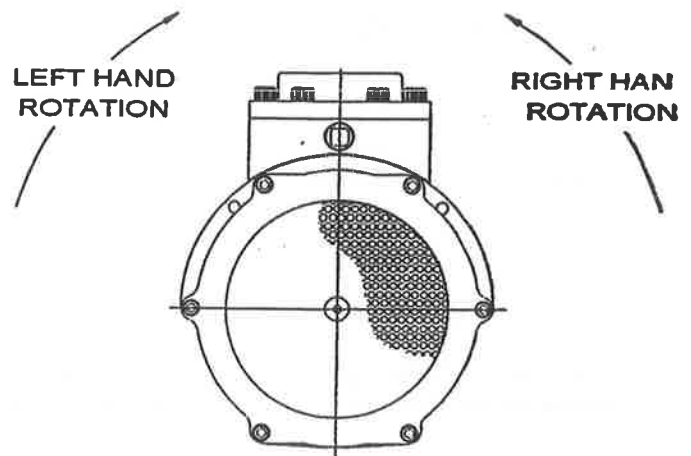


Figure 8. Direction of Rotation as viewed from exhaust end of Starter.

### 1.3 PHYSICAL CHARACTERISTICS

Figures 2, 3, 4 and 5 show the outlines and packag dimensions of the four sizes of *TURBOTWIN* starters.

# TDI TURBOTWIN

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MODEL NUMBER	PART NUMBER	PRESSURE RANGE (PSIG)	PRESSURE RANGE (BAR)	PINION ROTATION	MAX STALL TORQUE lb-ft	TDI DRIVE NUMBER
T121B	T121-60001-B1R	30 - 90	3.1 - 7.2	RIGHT HAND	300	1-18828
T121B	T121-60001-B2L	30 - 80	3.1 - 7.2	LEFT HAND	300	1-19083
T112B	T112-60001-B1R	60 - 150	5.2 - 11.4	RIGHT HAND	300	1-18828
T112B	T112-60001-B2L	60 - 150	5.2 - 11.4	LEFT HAND	300	1-19083
T106F	T106-60002-F3R	60 - 150	5.2 - 11.4	RIGHT HAND	160	2-22147
T106F	T106-60002-F4L	60 - 150	5.2 - 11.4	LEFT HAND	160	2-22148
T112F	T112-60002-F3R	30 - 90	3.1 - 7.2	RIGHT HAND	160	2-22147
T112F	T112-60002-F4L	30 - 90	3.1 - 7.2	LEFT HAND	160	2-22148
T121D	T121-60003-D1R	30 - 90	3.1 - 7.2	RIGHT HAND	300	1-18828
T121D	T121-60003-D2L	30 - 90	3.1 - 7.2	LEFT HAND	300	1-19083
T112D	T112-60003-D1R	60 - 150	5.2 - 11.4	RIGHT HAND	300	1-18828
T112D	T112-60003-D2L	60 - 150	5.2 - 11.4	LEFT HAND	300	1-19083
T112D	T112-60004-D5R	60 - 150	5.2 - 11.4	RIGHT HAND	300	2-22795
T112D	T112-60004-D6L	60 - 150	5.2 - 11.4	LEFT HAND	300	2-22796
T121D	T121-60004-D5R	30 - 90	3.1 - 7.2	RIGHT HAND	300	2-22795
T121D	T121-60004-D6L	30 - 90	3.1 - 7.2	LEFT HAND	300	2-22796

Figure 1. TURBOTWIN Starter Part Number Listing

Figure 2 shows the Models T112B/T121B which are 20.1" long overall and 8.2" in height. This model weighs 54 pounds. The turbine housing diameter is 6.8" which is common to all TURBOTWINs. The rotary inertia of all rotating components is \_\_\_\_\_ lb-in<sup>2</sup>.

Figure 3 shows the Models T106F/T112F which are 17.4" long overall and 8.2" in height. This model weighs 47 pounds. The turbine housing diameter is 6.8". The rotary inertia of all rotating components is \_\_\_\_\_ lb-in<sup>2</sup>.

Figure 4 shows the Models T112D/T121D which are 20.1" long overall and 8.4" in height. The mounting flange is 10.2" wide. This model weighs 70 pounds. The turbine housing diameter is 6.8". The rotary inertia of all rotating components is \_\_\_\_\_ lb-in<sup>2</sup>.

Figure 5 shows the Models T106F/T112F which are 20.4" long overall and 8.4" in height. The mounting flange is 10.2" wide. This model weighs 70 pounds. The turbine housing diameter is 6.8". The rotary inertia of all rotating components is \_\_\_\_\_ lb-in<sup>2</sup>.

## 1.4 PERFORMANCE

Graphs of the performance curves are shown in Figures 9 through 12. These graphs feature pinion torque versus pinion speed (rpm) at constant drive air pressures and shaft horsepower versus pinion speed at constant drive air

pressures. Pinion speed is shown on the horizontal axis. The pinion torque is shown along the left edge vertical axis. The shaft horsepower is shown along the right edge vertical axis. Air consumption rates are given for the various drive pressure lines. These performance curves feature air as the drive gas and have open exhaust (standard exhaust guard) which have basically no back pressure.

## 2.0 INSTALLING THE STARTER

### WARNING

Do not operate this starter unless it is properly attached to an engine.

Information on typical TURBOTWIN installations is shown in Figures 13 and 14. The components illustrated may vary in shape, but there must at least be an air source, a starter valve or switch and an air piloted relay valve in order to properly install the TURBOTWIN starter. Refer to Section 3 for information on TDI accessories.

## 2.1 GENERAL

Figure 13 shows a typical starter installation using compressed air. The starter is mounted to the SAE 3 engine mounting pad and is secured with three 5/8" bolts on TURBOTWIN models T1XXB and T1XXF. Model T!XXD

# TDI TURBOTWIN

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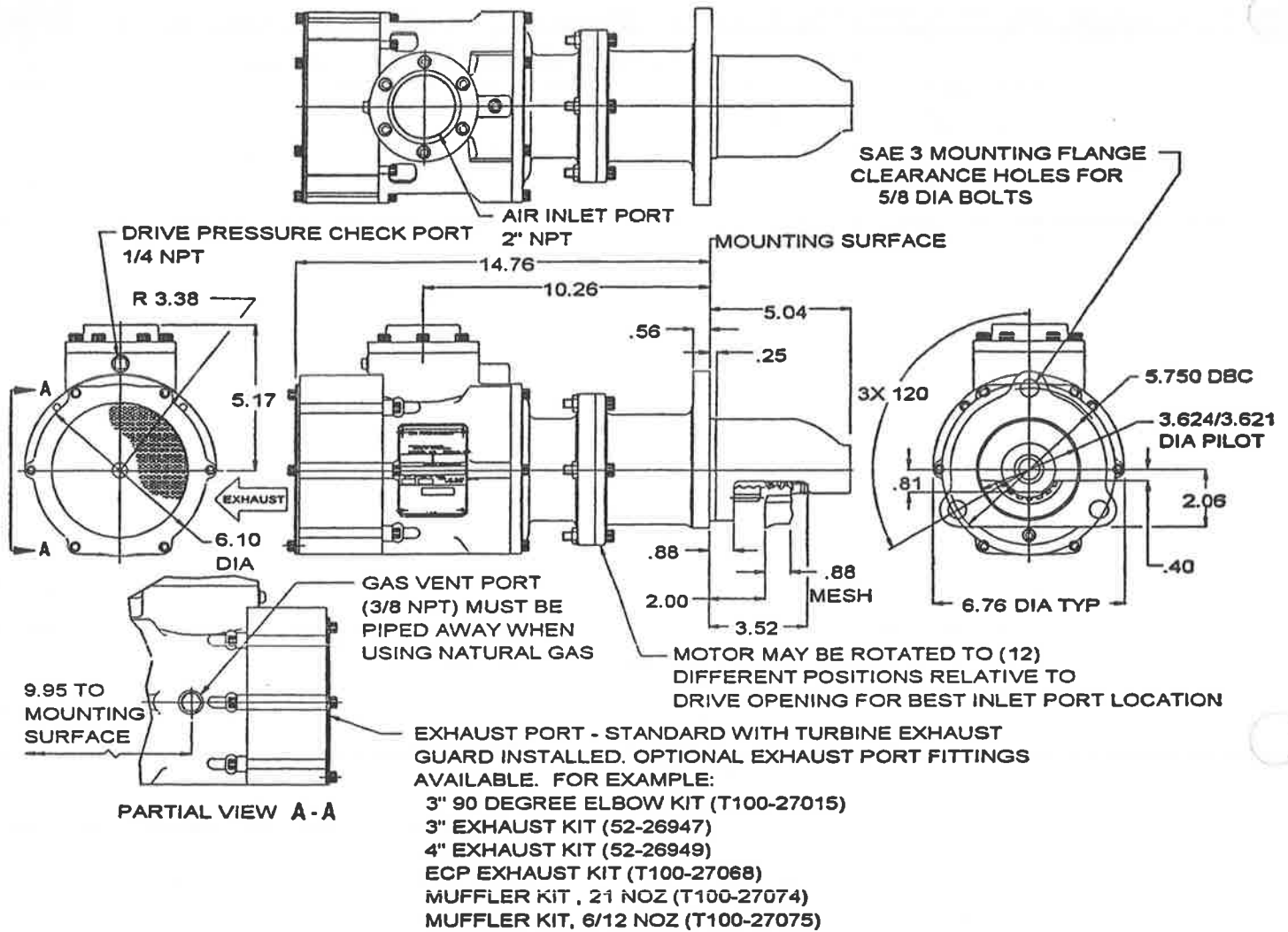


Figure 2. Model T112B/T121B TURBOTWIN

has the heavy-duty "D" style mounting flange which also uses three 5/8" bolts.

The air line to the starter contains a pressure regulator (when necessary) and a manual or remotely controlled valve. All TURBOTWIN starters features a 2" NPT pipe thread on the inlet port.

Most compressed air installations may use the standard exhaust guard. Figure 17 lists the optional exhaust hardware kits. Figure 18 shows illustrations of the various exhaust options.

## 2.2 ORIENTATION OF THE STARTER

If the factory orientation of the starter's pinion housing assembly, in relation to the inlet port, does not fit your engine installation, these components can easily be re-oriented. Refer to Figures 2, 3, 4 and 5.

All TURBOTWINS have the capability to rotate the inlet port relative to the drive opening for the optimum inlet port location. the number of different positions is 6 to 12 depending on model and application.

The starter should be installed with the inlet valve in a position between horizontal and straight down. Any condensation will be restricted to the air lines, and not in the starter.

### CAUTION

All screw threads are treated at the factory with a fastener retention compound. Every screw and tapped hole must be clean and have a drop of Loctite 290 applied to the threads before being reinstalled.



# TDI TURBOTWIN

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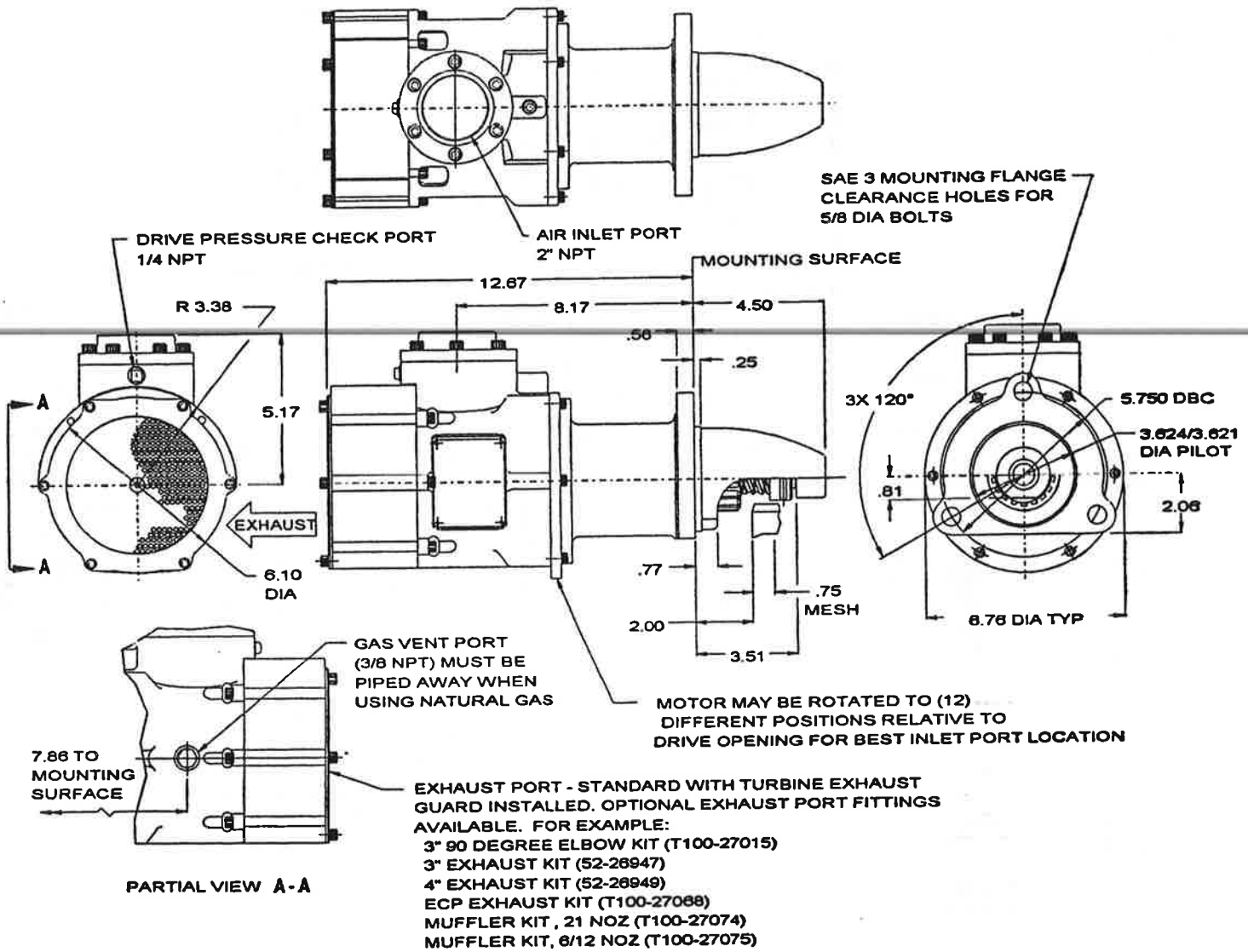


Figure 3, Model T106F/T112F TURBOTWIN

## 2.2.1 MODELS T112B/T121B

Refer to Figure 2. The drive housing may be rotated to 12 different positions relative to the inlet port. This task should be completed prior to installing the starter on the engine. The following procedure describes how to accomplish this. First, remove the (6) 5/16" X 1.5" long bolts by loosening the (6) nuts. Next, rotate the drive housing without removing it from the starter to the desired position. Clean the bolts and nuts with Loctite Safety Solvent or equivalent. Reinstall the (6) bolts and nuts using Loctite #290 Threadlocker adhesive or equivalent. Torque the bolts and nuts to 25 lb-ft maximum.

## 2.2.2 MODELS T106F/T112F

Refer to Figure 3. The drive housing may be rotated to 12 different positions relative to the inlet port. This task should be completed prior to installing the starter on the engine. The following procedure describes how to accomplish this. First, remove the (6) 1/4" X .75" long screws which attach the drive housing to the turbine housing. Next, rotate the drive housing without removing it from the starter to the desired position. Clean the screws with Loctite Safety Solvent or equivalent. Reinstall the (6) screws using Loctite #290 Threadlocker adhesive or equivalent. Torque the screws to 10 lb-ft maximum.

# TDI TURBOTWIN

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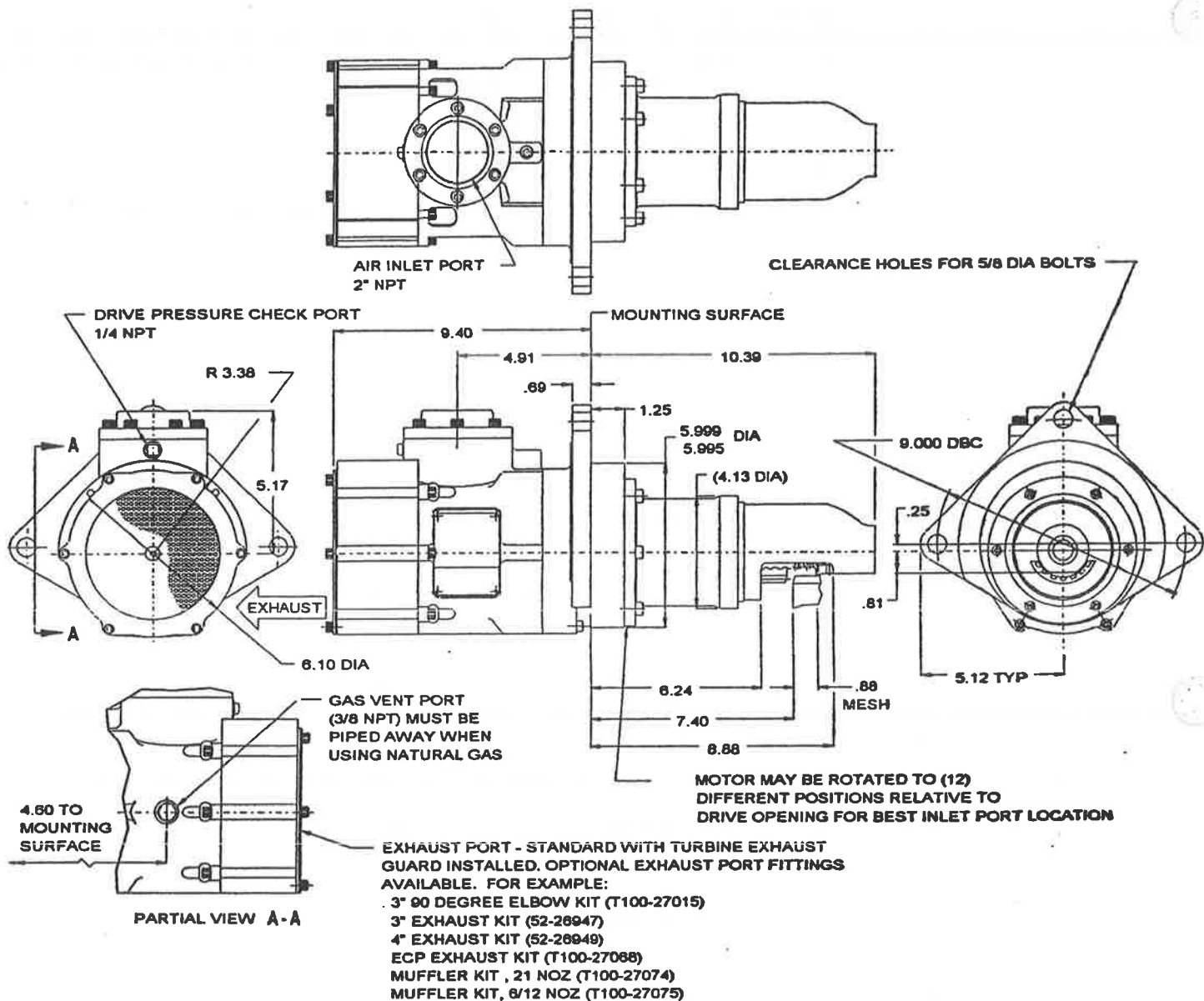


Figure 4. T112D/T121D (Standard Mesh) TURBOTWIN

## 2.2.3 MODELS T112D/T121D

Refer to Figure 4 or 5. The drive housing may be rotated to 12 different positions relative to the inlet port. This task should be completed prior to installing the starter on the engine. The following procedure describes how to accomplish this. First, remove the (6) 5/16" X 1.25" long screws which attach the drive housing to the turbine housing. Next, rotate the drive housing without removing it from the starter to the desired position. Clean the screws with Loctite Safety Solvent or equivalent. Reinstall the (6) screws using Loctite #290 Threadlocker adhesive or equivalent. Torque the screws to 25 lb-ft maximum.

## 2.3 INERTIA DRIVE ASSEMBLY

The inertia drive assembly consists of a friction clutch pack and the drive pinion which rides on a helical shaft. The pinion is thrown out to engage the engine's ring gear by the turbine motor's acceleration. Lighter weight rotating parts used in the TURBOTWIN provide low inertia and even "softer" engagement. In the event of over-pressure, the friction clutch used in every TURBOTWIN protects ring gear teeth from static torque overloads.

The torque carrying limit on the friction clutch pack is factory set by the manufacturer. Models T112B/T121B T112D/T121D are set to 275-300 lb-ft. Models

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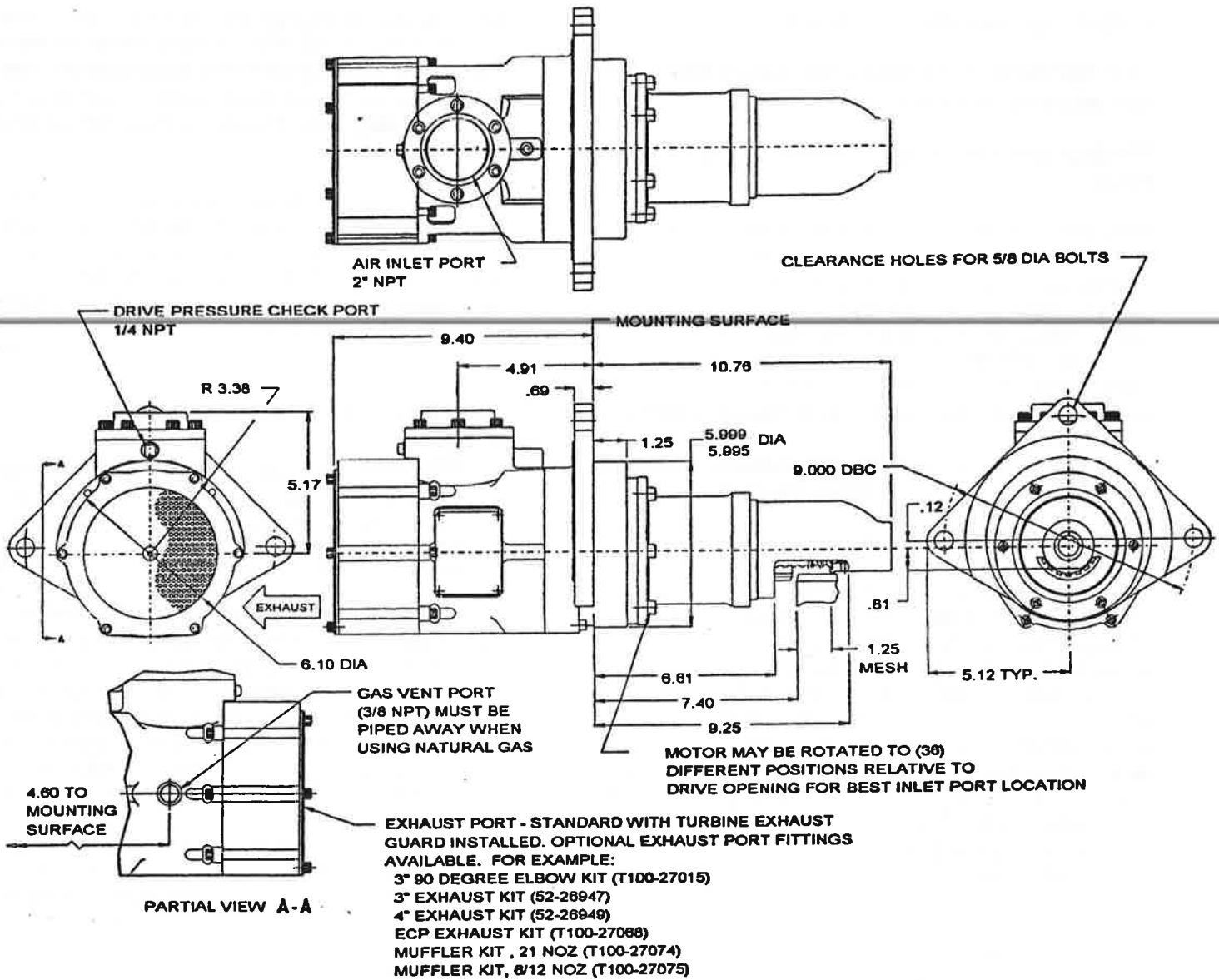


Figure 5. Model T112D/T121D (Long Mesh) TURBOTWIN

BENDIX CODE	TDI PART NUMBER	ROTATION	PITCH	#TEETH/BLANK	PINION PITCH DIA	PRESSURE ANGLE	CLUTCH SET.	LENGTH	TRAVEL	PIN O.D.
1	1-18828	R.H.	6/8	12/12	2.000	20	275-300	8.875	1.062	2.250
2	1-19083	L.H.	6/8	12/12	2.000	20	275-300	8.875	1.062	2.250
3	2-22147	R.H.	6/8	12/11	2.000	20	140-160	7.450	1.000	2.250
4	2-22148	L.H.	6/8	12/11	2.000	20	140-160	7.450	1.000	2.250
5	2-22795	R.H.	6/8	12/12	2.000	20	275-300	9.312	1.4375	2.250
6	2-20927-001	L.H.	6/8	12/12	2.000	20	275-300	9.312	1.4375	2.250

Figure 6. Inertia Drive Assembly Specifications

# TDI TURBOTWIN

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T106F/T112F are set to 140-160 lb-ft.

All *TURBOTWIN* starters listed in this manual have a pinion with 6/8 diametral pitch teeth.

The pinion gear data and clutch torque settings are listed in Figure 6.

Backlash is the "free play" between the mesh of two gears. Figure 15 shows the backlash between two gears. Maintaining the proper gear backlash setting allows the gears to mesh smoothly. Proper backlash and alignment allow smooth engagement/disengagement of the pinion gear and loads the tooth face surfaces evenly producing longer gear life. The correct backlash setting for 6/8 diametral pitch gearing used on larger engines is as follows:

Minimum backlash	.015 inch
Maximum backlash	.025 inch

To check the backlash, the pinion will need to be rolled out onto the end of the drive prior to starter installation. This can be accomplished by using a hex drive wrench to rotate the turbine end of the starter while holding the pinion from rotating. The pinion will simply walk to the end of the shaft. An access hole to reach the turbine screw is provided in the turbine standard exhaust guard. The starter must then be installed on the engine. Checking backlash can be accomplished using a dial indicator or a simple blade-type feeler gauge. Because ring gears are not usually perfectly round, it is necessary to check backlash at several (six or more) points around the circumference of the ring gear. Average the highs and lows to allow a setting that is in the range cited above.

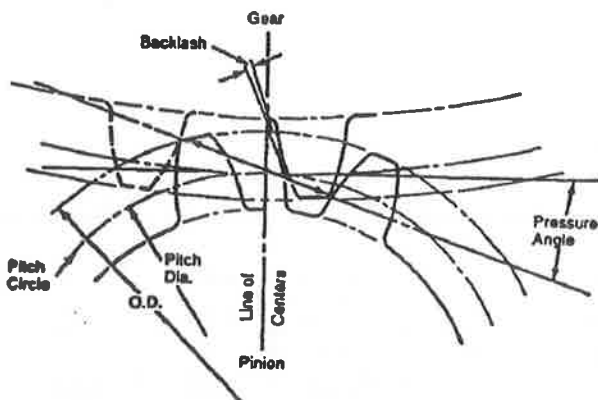


Figure 15. Inertia Drive Pinion Backlash

Setting the correct backlash may involve "shimming" and/or moving the starter bracket(s). An adjustable starter bracket design will simplify this procedure. Always re-check backlash after the installation of a ring gear replacement.

Liberal grease the starter's drive teeth with chassis lube and then mount the *TURBOTWIN* starter on the engine. Tighten all mounting hardware as appropriate. Make sure to use Loctite Threadlocker #290 or equivalent on the starter mounting bolts. Torque the three 5/8" screws to 100 lb-ft.

After mounting the starter to the engine, attach the supply air line to the starter, connect the control air lines and install the solenoid between the ignition switch and air piloted relay valve. See Sections 2.4, 2.5 and 2.6. The following sections describe the connection of the supply line, exhaust piping and optional control lines.

## 2.4 Supply Line Installation

### CAUTION

Be sure to either bleed the pressurized air reservoir and /or safety the air system such as closing all valves prior to installing any starter supply line.

All *TURBOTWIN* starters come standard with a 2" NPT female pipe thread for the inlet connection port. Figures 13 and 14 show typical starter installations. The supply line consists of the line from the air source, a pressure regulator (when necessary), a manual or relay valve, and then the connection to the starter inlet. Hard piping may be used, but a section of flexible tubing should be used right at starter for mobile applications to prevent leaks due to engine vibration.

A turbine driven starter does not require lubrication in the supply air. Therefore, if a vane-type starter motor is being replaced, TDI recommends that all lubrication devices and lines be removed to minimize flow restrictions.

### WARNING

If a fuel (pulse) lubricator has previously been installed in the system, disconnect and plug the line to eliminate spraying diesel fuel on the engine.

Care must be taken to ensure that all inlet supply line piping is no less than 1.5" (38 mm) and that all valves used are capable of passing the required air flow.

### NOTE

Valves with a  $C_v$  of 40, or higher, are recommended.

If the supply line must be longer than 20 feet (6.1M), the inlet supply line piping should be increased to 2" (50.8 mm) to assure proper performance by your *TURBOTWIN*.

# TDI TURBOTWIN

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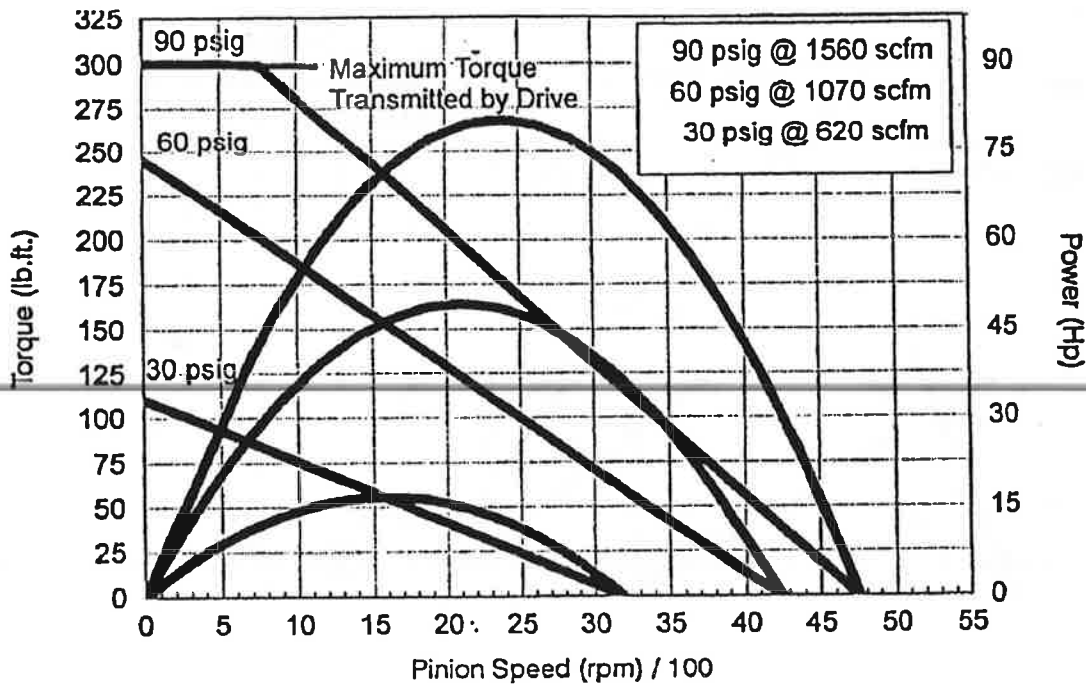


Figure 9. Performance Curves for Model T121B/T121D  
(21 Nozzles, Air, 7.5:1)

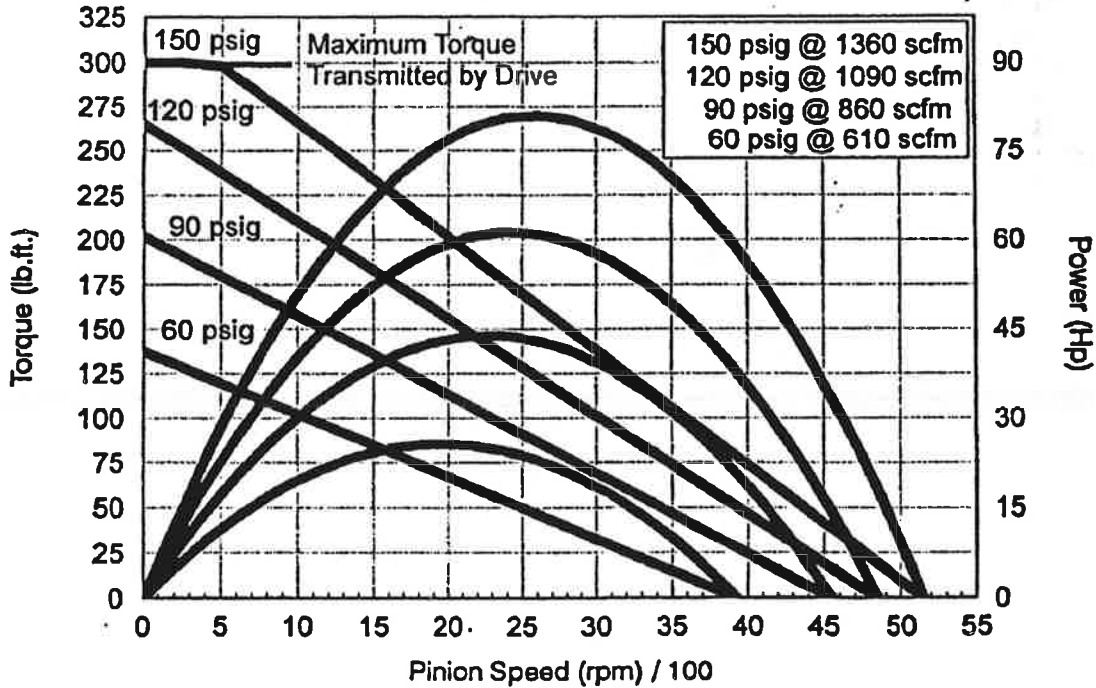


Figure 10. Performance Curves for Model T112B/T112D  
(12 Nozzles, Air, 7.5:1)

# TDI TURBOTWIN

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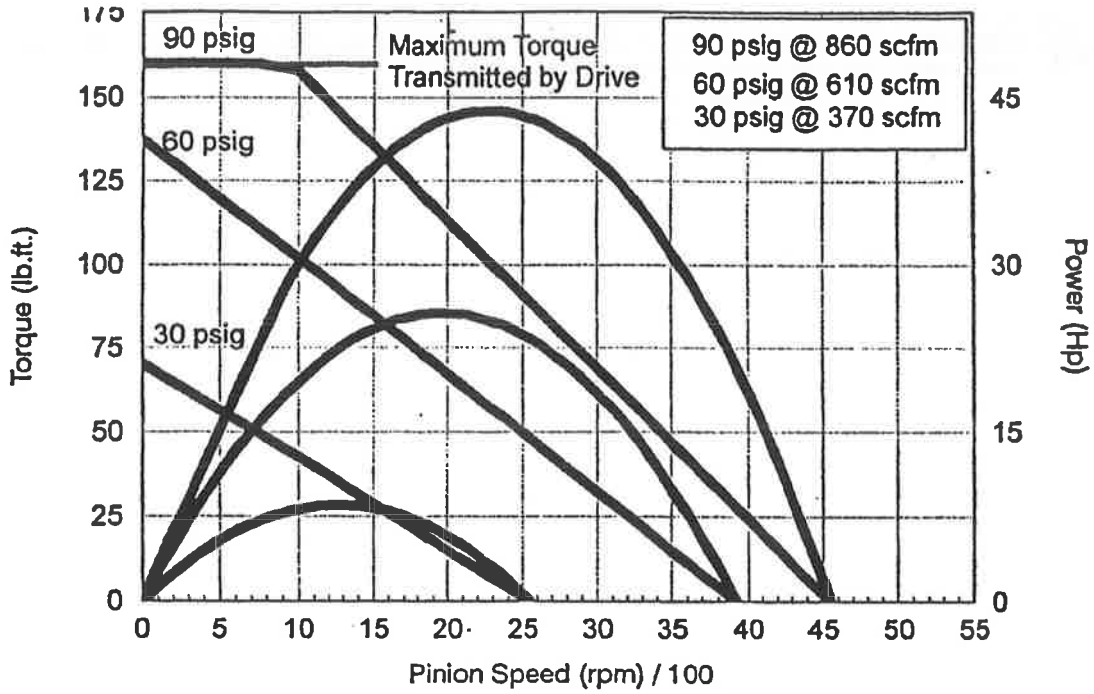


Figure 11. Performance Curves for Model T112F  
(12 Nozzles, Air, 7.5:1)

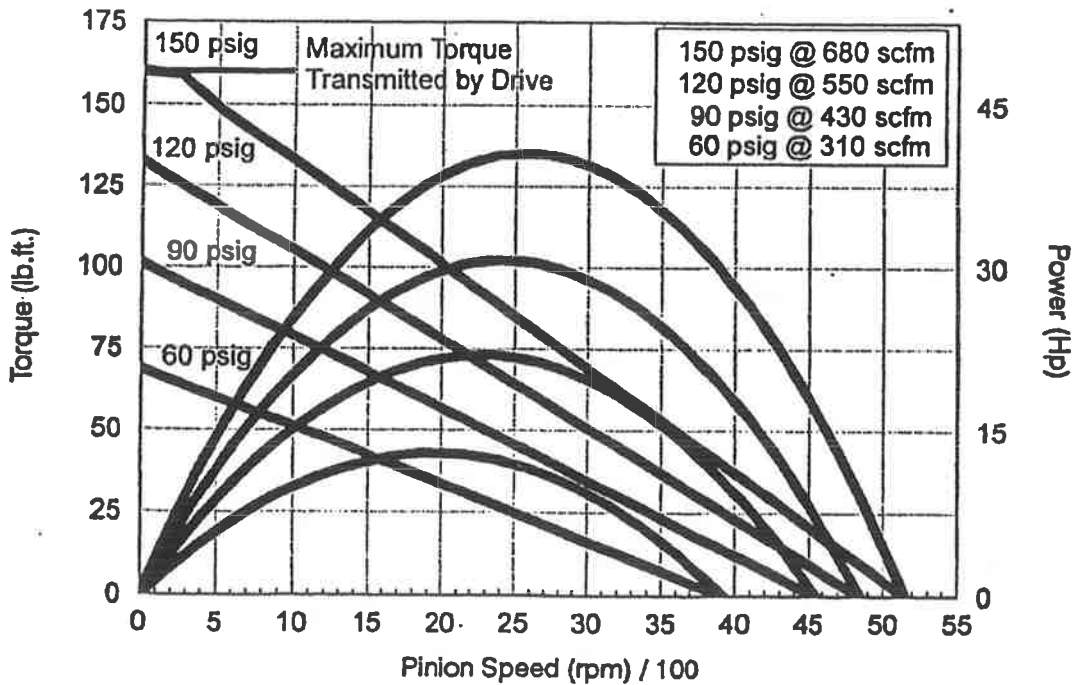
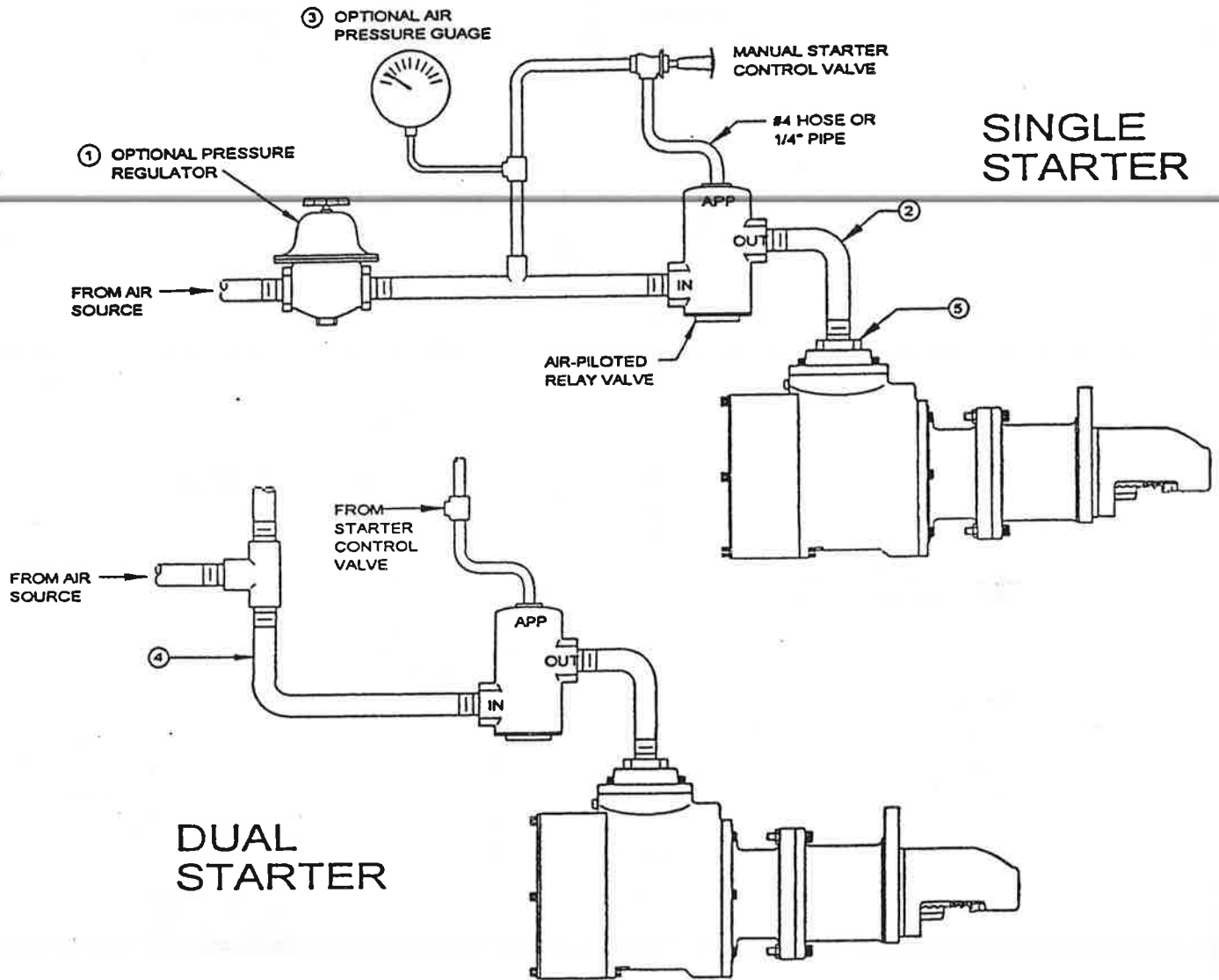


Figure 12. Performance Curves for Model T106F  
(6 Nozzles, Air, 7.5:1)

# TDI TURBOTWIN

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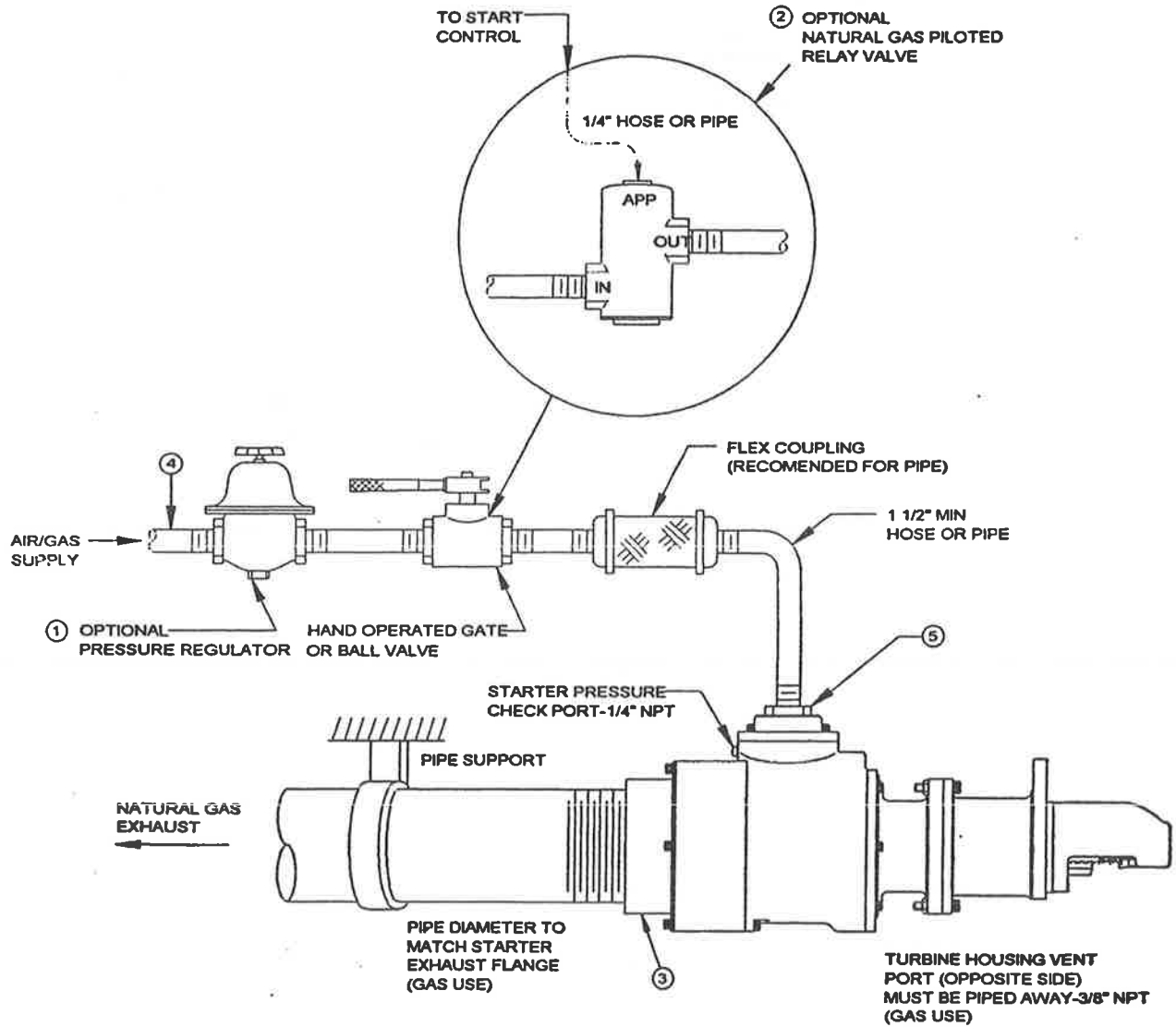
## STARTER INSTALLATION - AIR USAGE



- NOTES:**
- ① IF DUAL STARTERS ARE USED, A SINGLE PRESSURE REGULATOR DEVICE SHOULD BE USED IF PRESSURE REGULATION IS REQUIRED.
  - ② REFER TO SECTION 4.0 FOR HARDWARE AND ACCESSORIES AVAILABLE FROM TDI.
  - ③ 4" NPT EXHAUST FLANGE - ALL STARTERS, 15 NOZZLES AND HIGHER.  
3" NPT EXHAUST FLANGE - ALL STARTERS, 14 NOZZLES AND HIGHER.
  - ④ INLET PIPE SIZE: 1.5" - ALL STARTERS, 14 NOZZLES AND LOWER  
2.0" - ALL STARTERS, 15 NOZZLES AND LOWER
  - ⑤ 2" TO 1" NPT REDUCING BUSHING - ALL STARTERS, 14 NOZZLES AND LOWER.

Figure 13. Typical Starter Installation - Compressed Air

**STARTER INSTALLATION - NATURAL GAS USAGE**



**NOTES:**

- ① IF DUAL STARTERS ARE USED, A SINGLE PRESSURE REGULATOR DEVICE SHOULD BE USED IF PRESSURE REGULATION IS REQUIRED.
- ② REFER TO SECTION 4.0 FOR HARDWARE AND ACCESSORIES AVAILABLE FROM TDI.
- ③ 4" NPT EXHAUST FLANGE - ALL STARTERS, 15 NOZZLES AND HIGHER.  
3" NPT EXHAUST FLANGE - ALL STARTERS, 14 NOZZLES AND HIGHER.
- ④ INLET PIPE SIZE: 1.5" - ALL STARTERS, 14 NOZZLES AND LOWER  
2.0" - ALL STARTERS, 15 NOZZLES AND LOWER
- ⑤ 2" TO 1" NPT REDUCING BUSHING - ALL STARTERS, 14 NOZZLES AND LOWER.

**Figure 14. Typical Starter Installation - Natural Gas**



# TDI *TURBOTWIN*

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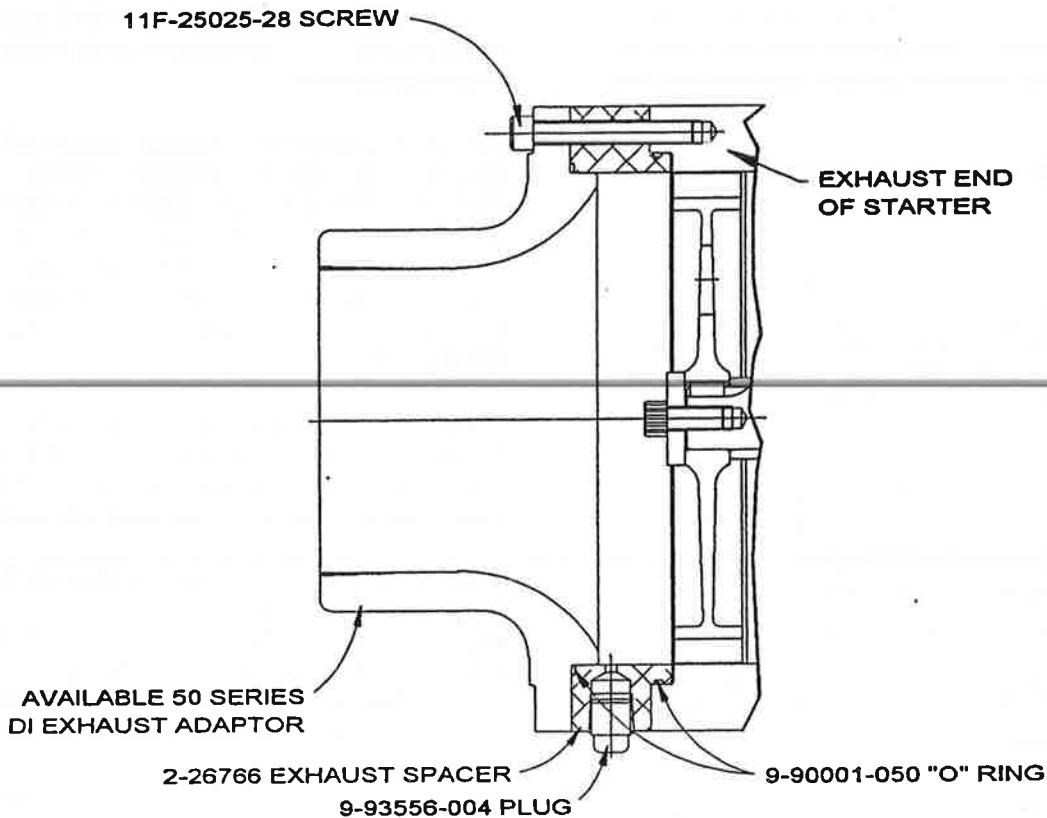


Figure 16. Part Number 52-26839 Exhaust Adaptor Kit

Because turbine starters such as the *TURBOTWIN* are sensitive to flow restrictions, care must be taken to use uniform hose or tubing and fittings for connection of the supply air line. Tees, elbows and line length must be kept to a minimum. TDI recommends that hose or flex couplings be installed to eliminate possible leakage caused by strain on the supply air line.

Normally, an air strainer is not required. In dirty environments, use of a #40 mesh Y-strainer is recommended. The *TURBOTWIN* is highly tolerant of dirt in the air line, however, the starter life can be increased with the use of the air strainer.

The pressure regulator is required when the air supply pressure is great enough to exceed the starter operating pressure (at the inlet port) and/or the maximum torque.

A manual ball valve may be used to admit air to the starter. The manual valve should be located in a safe position away from the engine.

A preferred valve is pilot-operated relay valve which can be pneumatically or electrically actuated. The valve can be

located very close or even on the starter inlet for better performance. Pneumatic or electrical control lines may be routed virtually anywhere for the customer's preferred operating station. This type of valve actuates from a fully closed to a fully open position very rapidly (usually  $\frac{1}{2}$  second or less). TDI offers a variety of relay valves such as P/N RLVA-25683-001-2-01 which is a 1-1/2" port, pneumatically actuated valve.

The supply line should be dry-fitted for proper alignment/location prior to final assembly. All pipe threaded joints should be sealed with Loctite Pipe Thread Sealant (TDI P/N 9-94085) or equivalent for leak tight joints prior to final assembly. Be sure to tighten all joints to proper torque after final assembly.

### CAUTION

In cold climate conditions, care should be taken while designing your installation to prevent condensation from developing in the starter system. In systems with a regulator valve or relay valve, there is the possibility of freeze-up.

A tee connection with a quick disconnect can be added to

# TDI *TURBOTWIN*

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the inlet. This will allow an external air source to be used to accomplish a "blow start" if the system freezes. Once the engine has been started, the other system components may be thawed.

This installation option may be especially useful in off-highway equipment.

### CAUTION

Especially on new installations, it is strongly recommended to blow out the supply line with air to remove possible dirt and weld slag prior to final connection to the *TURBOTWIN* starter. Be sure to secure the free end of the supply line prior to the blow-down.

KIT PART NUMBER	DESCRIPTION	USED ON MODELS
52-420	Exhaust Guard Screen Kit	All
T100-27068	Exhaust Closure Plate Kit	All
T100-27015	3 Inch NPT 90 Degree Elbow Kit	All
52-26947	3 Inch NPT Straight Fitting Kit	All
52-26949	4 Inch NPT Straight Fitting Kit	All
T100-27075	Short Muffler Kit	T106F/T112F T121B/T121D
T100-27074	Long Muffler Kit	T121B/T121D
52-26839	Exhaust Adaptor Kit	All

Figure 17. Exhaust Hardware Kits

### 2.5 Inlet Pressure Port

A 1/4" NPT port is located on the exhaust side of the air inlet. This port may be used to check the supply pressure at the starter when the starter is operating. Remove the 1/4" NPT pipe plug and save for later use. Install a 1/4" minimum size tubing to the port. Route the tubing away from the starter to a safe location away from the engine. Install a pressure gauge on the tubing. This pressure monitoring line/gauge may be permanently installed. Use Loctite Pipe Thread Sealant or equivalent. Alternately, a pressure transducer may be installed at the pressure check port and electrical lines would be routed to a digital display at the operator's station.

This pressure port is invaluable in diagnosing air starter performance problems.

### 2.6 Exhaust Piping

The turbine exhaust may be plumbed away from the starter area. 3" NPT and 4" NPT exhaust fittings are available from

TDI. Also see Section 3. All starters using natural gas must be piped away according to industry codes and local regulations.

The performance of a turbine starter will be decreased because of back pressure when smaller than recommended exhaust piping is installed. When the starter's exhaust is to be piped away, refer to Figure 8 for minimum piping size and TDI kit numbers. If back pressure hampers starter performance, compensation can be made by increasing the supply pressure. Consult your TDI distributor for advice.

The various exhaust fitting options are listed and shown in Figures 17 and 18, respectively. The standard exhaust treatment is the turbine exhaust guard P/N 52-420. This exhaust guard should not be used with natural gas.

In installations with a starter length restriction, the 3" right angle exhaust elbow may be required. The 3" NPT 90 degree elbow kit is P/N T100-27015 and features a welded steel pipe with a male 3" NPT pipe thread. An aluminum adapter ring is included with this kit to attach this elbow fitting to the *TURBOTWIN*.

The exhaust closure plate kit is P/N T100-27068. This kit features a movable plate which protects the inside of starter from dirt when the starter is not operating. The end plate opens during starter operation. This exhaust fitting should not be used with natural gas.

The 3" NPT straight exhaust fitting features a female 3" NPT pipe thread. This kit is P/N 52-26947. An adapter ring is included with this kit.

The 4" NPT straight exhaust fitting features a female 4" NPT pipe thread. This kit is P/N 52-26949. An adapter ring is included with this kit.

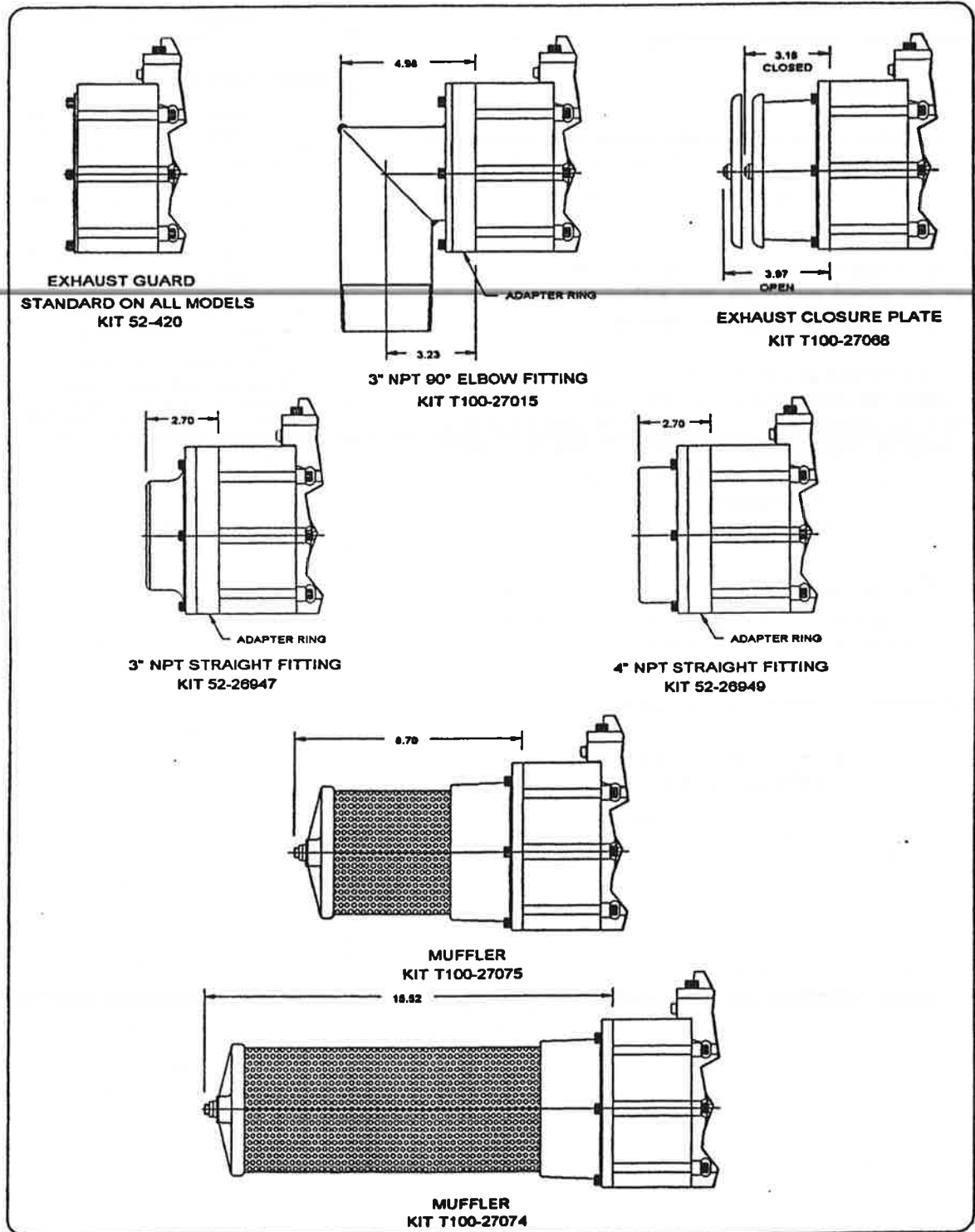
The muffler kit for the 6 or 12 nozzle *TURBOTWIN* starter is P/N T100-27075. This exhaust fitting should not be used with natural gas.

The muffler kit for the 21 nozzle *TURBOTWIN* starter is P/N T100-27074. This exhaust fitting should not be used with natural gas.

All older TDI Series 52 exhaust options may be used on the *TURBOTWIN* with the exhaust adapter kit P/N 52-26839. A typical installation using the adapter ring is shown in Figure 16. This adapter ring must be used with the older fittings, otherwise the starter will be damaged.

Exhaust piping should be routed downward to help prevent any accumulation of condensate in the starter motor.

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**Figure 18. Illustrated Exhaust Hardware Options**

# TDI TURBOTWIN

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If the overhung section of the starter is not otherwise supported, TDI recommends that the exhaust piping be supported with a suitable bracket(s).

## 2.7 Natural Gas Installation

The installation of the starter using natural gas is similar to the air installation except all fittings, piping, valves and regulators must be compatible with natural gas.

Proper control of natural gas is a major consideration when used in the starter system. All starters using natural gas must be piped away on the exhaust according to industry codes and local regulations.

There is a natural gas vent port in the turbine housing that is plugged for compressed air use. This vent is used to remove any natural gas which could leak past the primary turbine shaft seal. Remove this 3/8"NPT plug and install a line to carry gas away from the starter area and vent to atmosphere; refer to Figures 2,3,4 and 5. Do not connect this vent line to the starter exhaust line.

### CAUTION

Do not connect the turbine housing vent line to the turbine exhaust line; exhaust gas can pressurize the turbine housing.

## 3.0 HARDWARE and ACCESSORIES

Refer to Figures 16 through 19 for exhaust hardware and installation accessories available from Tech Development.

DESCRIPTION	PART NUMBER
Pressure Regulator, Air, 1.5"	52-20724-100
Pressure Regulator, Air, 2.0"	52-20724-200
Pressure Gauge, 0 - 200 PSIG	52-21982
Pressure Gauge, with U-Clamp, 0 - 200 PSIG	52-21982-100
Manual Control Valve, Air	52-93504
Natural Gas Piloted Relay Valve, 1.5"	52-93505
Natural Gas Piloted Relay Valve, 2.0"	52-93505-100
Air Piloted Relay Valve, Buna-N, 1.5"	RLVA-25683-001-1-01
Air Piloted Relay Valve, Viton, 1.5"	RLVA-25683-001-2-01
Air Piloted Relay Valve, High Pressure, 1.5"	RLVA-25683-001-3-01
Solenoid Control Air Valve, 12VDC, 1.5" Buna-N	RLVA-25683-012-1-01
Solenoid Control Air Valve, 12VDC, 1.5" Viton	RLVA-25683-012-2-01

Figure 19. Installation Accessories

DESCRIPTION	PART NUMBER
Solenoid Control Air Valve, 24VDC, 1.5" Buna-N	RLVA-25683-014-1-01
Solenoid Control Air Valve, 24VDC, 1.5", Viton	RLVA-25683-024-2-01
Solenoid Control Air Valve, 110VDC, 1.5"	RLVA-25683-110-2-01
Solenoid Control Air Valve, 120 VAC, 1.5"	RLVA-25683-120-2-01
Valve, Natural Gas, Manually Operated / Spring Loaded, 1.5"	52-93508
Valve, Natural Gas, Manually Operated / Spring Loaded, 2.0"	52-93508-400
Pressure Regulator, Natural Gas, 2", 300 PSIG Max Upstream Pressure	52-93552
Pressure Regulator, Natural Gas, 2", 125 PSIG Max Upstream Pressure	52-93553
Y-Strainer, 1.5 NPT, Natural Gas, 600 PSIG	52-93549-100
Y-Strainer, 2.0" NPT, Natural Gas, 600 PSIG	52-93549-200
Y-Strainer, 1.5" NPT, Air, 250 PSIG	52-93550-100
Y-Strainer, 2.0" NPT, Air, 250 PSIG	52-93550-200
Grease, 1 Lb Can	9-94121
Grease, 16 Oz Tube	9-94121-002
Anti-Seize Compound, 1 Oz Tube	42-94081
Anti-Seize Compound, 1 Lb Can	9-94081
Sealant, Pipe Thread, Loctite 59231, 1.69 Oz Tube	9-94085

Figure 19. (Continued) Installation Accessories

## 4.0 STARTER OPERATION

Prior to operation, check that all connections are tight and free from leaks. Check the 1/4" NPT pipe plug (from Section 2.5) or a pressure gauge/transducer and air line is connected to the pressure port on the starter inlet.

### WARNING

Do not operate the TDI *TURBOTWIN* starter with air pressure greater than the pressure rating on the nameplate. This pressure is to be measured at the starter inlet while the starter is running.

The maximum operating pressure limit is the inlet pressure when measured at the starter inlet pressure check port and reflects all supply air pipe and valving losses. In order to check the starter, a 1/4"NPT pipe tap connection is provided in the inlet housing to attach a pressure gauge/transducer; refer to Figures 4 and 5.) **IN NO CASE SHOULD INLET OPERATING PRESSURE EXCEED 200 PSIG (14.8 BAR) WITH AN OPEN EXHAUST!** This will exceed the maximum torque limit of the inertia drive assembly. The maximum

# TDI *TURBOTWIN*

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operating pressure limit of all models of *TURBOTWIN* starters is shown in Figure 1. These maximum pressures assumes air as the working gas and an open exhaust (the standard turbine exhaust guard). The standard exhaust guard basically causes no back pressure.

The static supply pressure will always be higher than the operating pressure. As a guideline, the maximum pressure limit (proof pressure) that the *TURBOTWIN* starter housings may be subjected to is 600 PSIG (42 BAR). System pressure that exceeds the maximum operating limit must use a pressure reducer device to ensure that the operating pressure limit to the *TURBOTWIN* starter is maintained.

System pressure that exceeds the 600 PSIG (42 BAR) limit must, in addition to pressure reducer devices, incorporate a pressure relief valve, set below 600 PSIG (42 BAR), in the supply air line.

All appropriate local pressure codes and pressure limitations on other system components must be adhered to and would supersede the guidelines given in this manual.

Consult your TDI distributor if you have exhaust plumbing which creates back pressure and reduces starter performance. You may be able to increase the supply pressure to restore the lost power.

Follow the engine manufacturer's instructions for starting the engine.

### 4.1 Basic Operation

The basic operation of the starter follows:

Pressurized air or natural gas is admitted to the starter by the opening of the manual or relay valve. The air expands through the turbine which produces shaft rotation and torque. The acceleration of the drive assembly causes the pinion to advance and engage the ring gear of the engine. The starter motor torque causes the engine to accelerate. The fuel and ignition systems now fire the engine. The starter is stopped by closing the manual or relay valve.

The *TURBOTWIN* features a unique two stage turbine which limits the maximum starter speed from its aerodynamic design. The operator may prematurely decrease starter life by the continual operation of the starter after the engine has started. Upon a successful engine start, shut the air off to the starter immediately. Minimizing the time the starter is operating unloaded (i.e. the engine is running) will maximize the starter life. If a start is aborted, a restart may be attempted after the engine and the starter have come to rest.

### WARNING

Do not engage the starter while the engine is running.

The drive air pressure is the primary starter control parameter. It is important, especially on new installations, to measure this pressure during several engine starts. The secondary parameter is the starter pinion speed. This speed is usually measured by knowledge of the engine starting speed and the starter cranking ratio. The cranking ratio is the number of ring gear teeth divided by the number of pinion teeth. The starter pinion speed is then found by multiplying the engine speed by the cranking ratio. The pinion speed is usually 2000-3500 rpm for a typical engine starting speed.

If the engine fails to function properly when first operated, or its performance deteriorates with use, refer to the Operator's Trouble Shooting Guide, Section 7.0. If you cannot solve the problem, or repair is necessary, contact your local TDI *TURBOTWIN* distributor or dealer.

### 4.2 Manual Valve Operation

The operator opens a valve manually to admit pressurized air to the starter. As the engine approaches starting engine speed, the operator must monitor the various engine parameters or listen for the engine firing. Upon engine firing, the operator must stop the air flow to the starter by closing the manual valve.

Leaving the air on to the starter more than one second after the engine is running, may result in damage to the starter.

### 4.3 Automated Start Panel

As mentioned previously, the starter drive pressure will need to be set. This pressure is measured at the starter inlet.

The speed control parameter will then need to be set. Engine starting speed along with the cranking ratio number can be used to determine starter pinion speed. The pinion speed is usually 2000-3500 rpm for a typical engine starting speed. Once the start sequence has begun, the air is admitted to the starter. The starter begins to accelerate the engine. Once the firing speed of the engine is reached, the automated start panel may start fuel to the engine (diesel). The engine will begin to accelerate under its own power. The starter should be dropped out of the sequence at an rpm slightly higher than the firing speed, but certainly less than the engine idle speed.

The automated start panel should be set to monitor engine

# TDI *TURBOTWIN*

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speed and/or starter speed to determine air on and air off. Do not use simply time as a control parameter. Avoiding excessive over speed of the starter after the engine is firing will maximize the starter life.

## 5.0 PREVENTIVE MAINTENANCE

The TDI *TURBOTWIN* starters provide distinct advantages of size and efficiency as compared to electric motor, vane-type or other turbine-type starters. It is important to properly install the starter to receive full benefit of these advantages. Repair technicians or service organizations without turbine starter experience should not attempt to repair this machine until they receive factory approved training from TDI, or its representatives.

Proper operation and repair of your TDI *TURBOTWIN* starter will assure continued reliable and superior performance for many years.

### 5.1 Every Six (6) Months

Perform the following procedures at six(6) months intervals if the normal cranking cycle is 0 - 10 seconds.

5.1.1 Check the amount and condition of grease in the planetary gearbox. If gearbox requires re-greasing, only use TDI grease. Approximately one (1) pint of grease is needed to repack the gearbox.

5.1.2 Check the turbine bearing and carrier output bearings for freedom of rotation without excessive play between races. If bearings are damaged, replace them with genuine TDI parts. Refer to TDI Service Manual for part numbers.

5.1.3 Place a small amount of chassis lube on the starter's pinion teeth.

### 5.2 Every Three (3) Months

Follow the six (6) month procedures if there is severe starter loading or extended duration crank cycles. Also perform these procedures every three (3) months when starter is used for motoring the engine for maintenance or valve adjustments.

    Motoring Crank Cycle: 10 -60 seconds

    Extended Crank Cycle: 60 seconds or longer

## 6.0 STARTER DISASSEMBLY AND REPAIR

The TDI service manual P/N T1-701 provides a step by step procedure to assemble and disassemble the *TURBOTWIN* starter. All models are covered by this manual.

Section 2.2 discusses the partial disassembly in detail. Do not change the orientation of the air inlet relative to the starter mounting flange.

Repair technicians or service organizations without turbine starter experience should not attempt to repair this machine until they receive factory approved training from TDI or its representatives. If repair is required, consult your local TDI *TURBOTWIN* dealer or distributor.

For safe and reliable operation of your TDI *TURBOTWIN* starter, use only genuine TDI replacement parts. The component part numbers are found in the Illustrated Parts Breakdown which is P/N T1-703. All models are covered in this publication.

# TDI *TURBOTWIN*

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TROUBLE	PROBABLE CAUSE	SOLUTION	
1. Starter does not run; small air flow from exhaust.	A. Relay valve not fully open.	A. Repair or replace relay valve.	
	B. Nozzle blockage.	B. Remove blockage or obstruction from nozzles.	
2. Starter does not run; normal air flow from exhaust.	A. Broken turbine rotor.	A. Replace all damaged parts.	
	B. Broken gear train.	B. Repair or replace geartrain.	
	C. Damaged starter drive.	C. Repair or replace starter drive.	
3. Reduced Starter output power.	A. Inlet air pressure too low.	A. Increase air pressure in 10 PSIG (0.6 BAR) increments; DO NOT EXCEED OPERATING LIMIT.	
	B. Inlet supply piping too small.	B. Supply piping must be a minimum of 1.5" diameter.	
	C. Pressure regulator orifice too small.	C. Increase orifice size or replace pressure regulator	
	D. Inlet supply line valve (ball, gate, relay, plug) too small.	D. Install larger valve.	
	E. In line lubricator installed in supply line.	E. Remove lubricator.	
	F. Y-Strainer in supply line clogged.	F. Clean strainer.	
	G. Excessive back pressure; exhaust restricted.	G. Clean exhaust piping or increase size to at least the minimum diameter recommended.	
	H. Damaged turbine nozzle.	H. Replace turbine nozzle.	
	I. Broken started drive.	I. Repair or replace starter drive.	
	J. Wrong rotation starter.	J. Replace with starter or proper rotation.	
	K. Wrong size starter.	K. Check the Application Guide for the correct starter.	
	4. Engine cranks too quickly.	A. Inlet air pressure too high.	A. Decrease air pressure in 10 PSIG (0.6 BAR) increments. OR If there is a manual shut-off valve in the supply line, partially close it. OR Install a restriction orifice in the inlet supply line.
		B. Wrong size starter.	B. Check the Application Guide for the correct starter.

## 7.0 OPERATOR'S TROUBLE SHOOTING GUIDE

If repair is required, consult your local TDI *TURBOTWIN* dealer or distributor.

For your nearest TDI dealer contact:

Phone: (513)898-9600 Customer Service  
 Fax: (513)898-8431 Tech Development Inc  
 6800 Poe Avenue  
 Dayton, Ohio 45414

**TDI TURBOTWIN**  
FROM TECH DEVELOPMENT INC

**8.0 WARRANTY**

**TDI TURBOSTART ENGINE STARTER WARRANTY**

Tech Development Inc. Warrants to the original user of the TDI TURBOTWIN starters that the starters and related components manufactured by TDI will be free from defects in material and workmanship for a period of One (1) Year from the date of purchase by such user. The conditions of this warranty are: a) TDI is notified within this period by return of such product to TDI or its authorized distributor or dealer, transportation prepaid by user; b) such product has been installed according to TDI's specifications; c) such product has not been misused, abused, or improperly maintained by user; d) the defect is not the result of normal wear and tear; and e) such starter product has not been repaired with parts not manufactured or authorized by TDI and that TDI installation and repair procedures as outlined in the appropriate manual were properly followed.

Tech Development Inc. shall, at its option, either repair or replace, without charge, any such starter product found upon TDI's examination to be so defective, or by mutual agreement, refund the user's purchase price in exchange for such starter product. Repairs or replacements under this warranty are warranted for the remainder of the original warranty period.

Tech Development Inc. Makes no other warranty, and IMPLIED WARRANTIES INCLUDING ANY WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

This warranty constitutes the entire obligation of Tech Development Inc. Relating to the sale and use of such product, and TDI's maximum liability is limited to the purchase price of such product at the date of purchase. In no event shall TDI be liable for incidental, indirect, consequential or special damages of any nature from the sale of such engine starter product.



**TECH DEVELOPMENT INC.**  
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PHONE: (937) 898-9600 • FAX: (937) 898-8431

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Propak

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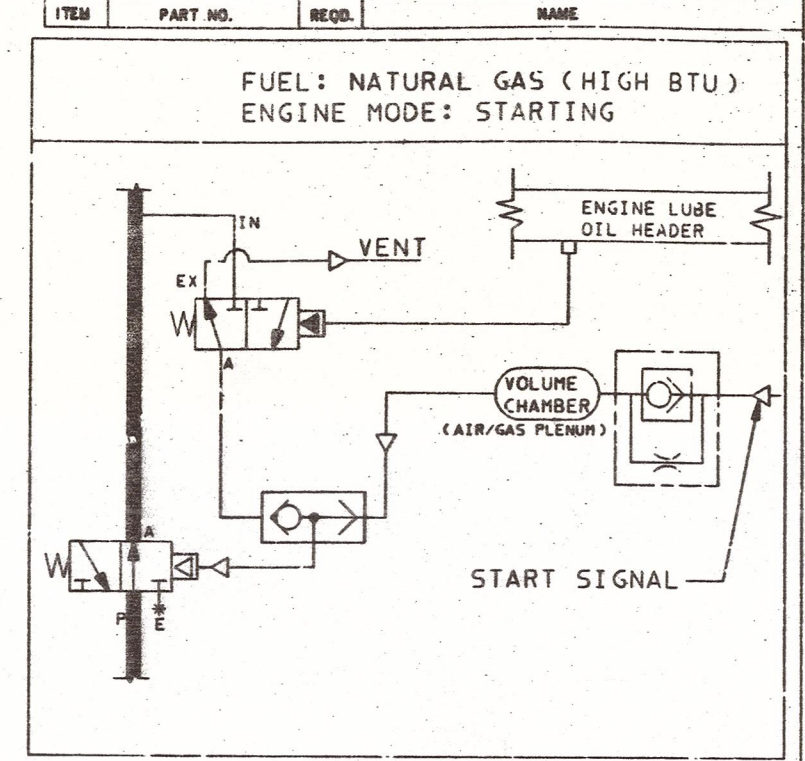
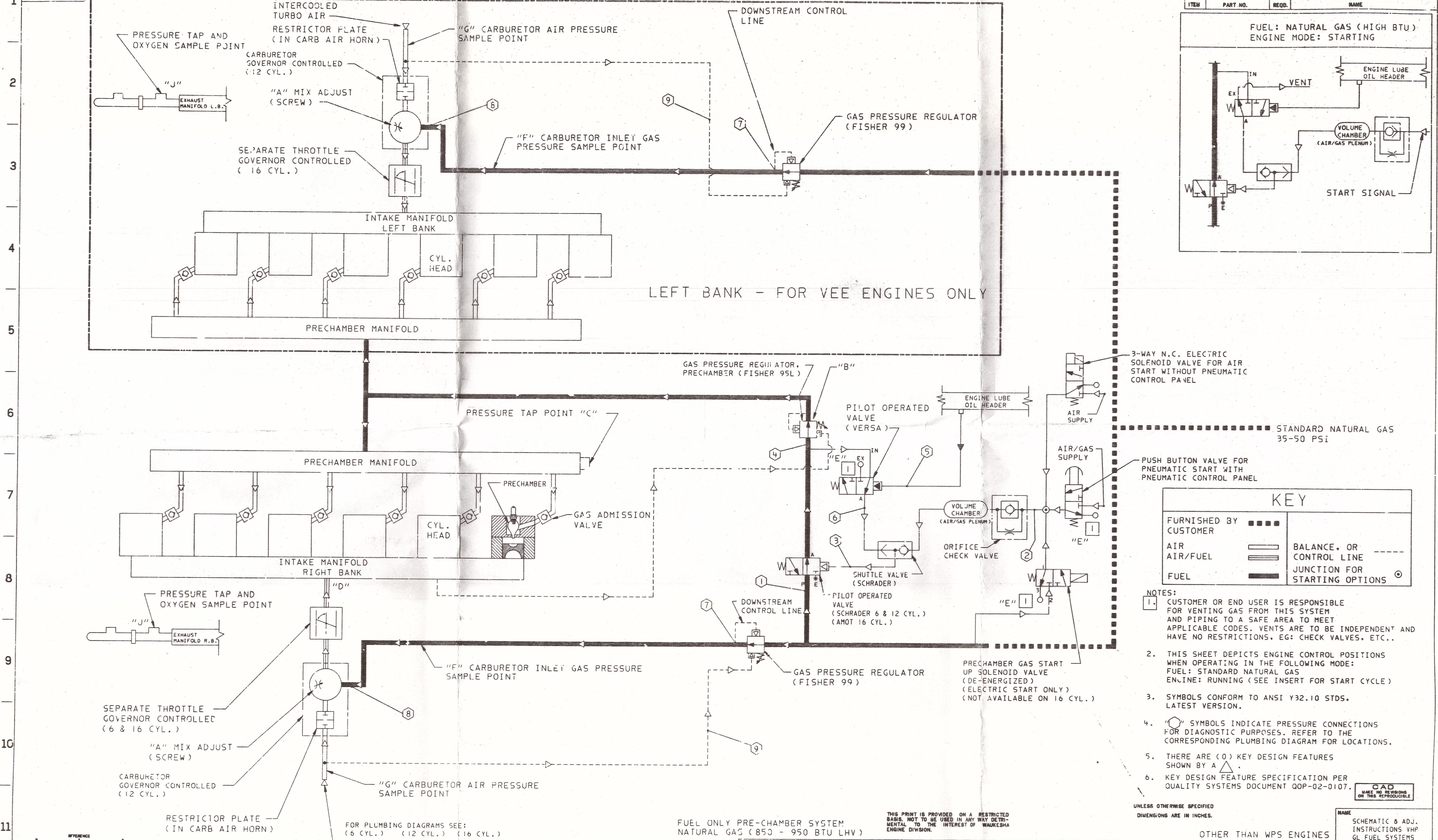
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MOD CFG., 7042GL

EFF. DATE: 012600 SHIPPED LOOSE 02/02

GROUP NO.	ITEM	PART	DESCRIPTION	QUANTITY	UOM	PCC	WC	OP
G-012-1740	1	*489344	MANUAL, IGN. MODULE (FORM 6272)	1	EA	B	0950	012
	2	*S-08311-1	POWER REQUIREMENTS CEC IGN.	1	EA	X	0950	012
G-012-1754	1	*489360	MANUAL, VHP ALL OPER & MAINT.	1	EA	B	0950	012
G-012-1775	1	*S-07232-201	DIAG. TEMP. & PRESS. TEST POINTS	1	EA	X	0950	012
G-017-1993	1	A211857	COOLER ASM., 38" LUBE OIL	1	EA	M	0950	017
	3	*S-05613-286	SCHEMATIC, LUBE OIL PIPING	1	EA	X	0950	017
	4	*S-05613-288	PLUMBING DIAG. REMOTE COOLER	1	EA	X	0950	017
G-018-399	1	167164F	SOCKET, SPARK PLUG (.88)	1	EA	B	0950	017
G-020-5055	51	*28641	PLUG, PIPE, 3/4 SOCKHD	1	EA	B	0950	018
G-021-1683	1	159991C	CPLG, 38 DRESS, 6 PIPE	4	EA	B	0950	020
G-022-5908	3	*S-05609-103	DIAGRAM, IGNITION WIRING CSA	1	EA	B	0950	021
	5	*S-07232-147	INSTR; CABLE ASM TO SPARK PLUG	1	EA	X	0950	022
G-031-5754	2	954350K	CONN AMPH 2 CONTACT	1	EA	X	0950	022
	3	154080	CABLE CLAMP	1	EA	B	0950	031
G-048-13	1	*600017	STD., EXHAUST OUTLET CONN.	1	EA	B	0950	031
	2	199515G	CONN., FLEX EXHAUST	1	EA	X	0950	048
	3	168334E	COUPLING, V-BAND	1	EA	B	0950	048
-055-2274	1	AE167600N	FILTER ASM., LUBE OIL	1	EA	B	0950	048
	2	*26750	PLUG, PIPE, HXHD 1/4	1	EA	B	0950	055
G-061-389	1	*061-0038902	SB5614-209 WAT SCHEM	2	EA	B	0950	055
G-097-25	3	*S-08382-2	ALARM & SHUTDOWN SETPOINTS	1	EA	X	0950	061
G-230-457	1	*S-05609-108	WIRING DIAG., DC JUNCTION BOX	1	EA	X	0950	097
	2	*S-05609-106	WIRING SCHEM., DC JUNCTION BOX	1	EA	X	0950	230
G-253-202	2	*S-06143-82	SCHEM, PNEUMATIC CONT	1	EA	X	0950	230
G-268-177	3	*S-05612-93	FUEL ADJUSTMENT SCHEMATIC	1	EA	X	0950	253
	5	*S-05612-125	SCHEM. AND ADJ. INSTR.	1	EA	X	0950	268

A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
186003 4-90	RELEASED, SUPERSEDES SD5612-92	115204 7-92	SEE EN FOR CHANGES	119475 9-95	SEE EN & SHEETS 2 & 3.											
186008 10-90	SUPERSEDES SD5888-8)	118006 9-94	SEE SHEET 2													
"	"	SUPERSEDES SD6566-22	118846 7-95	SEE EN												

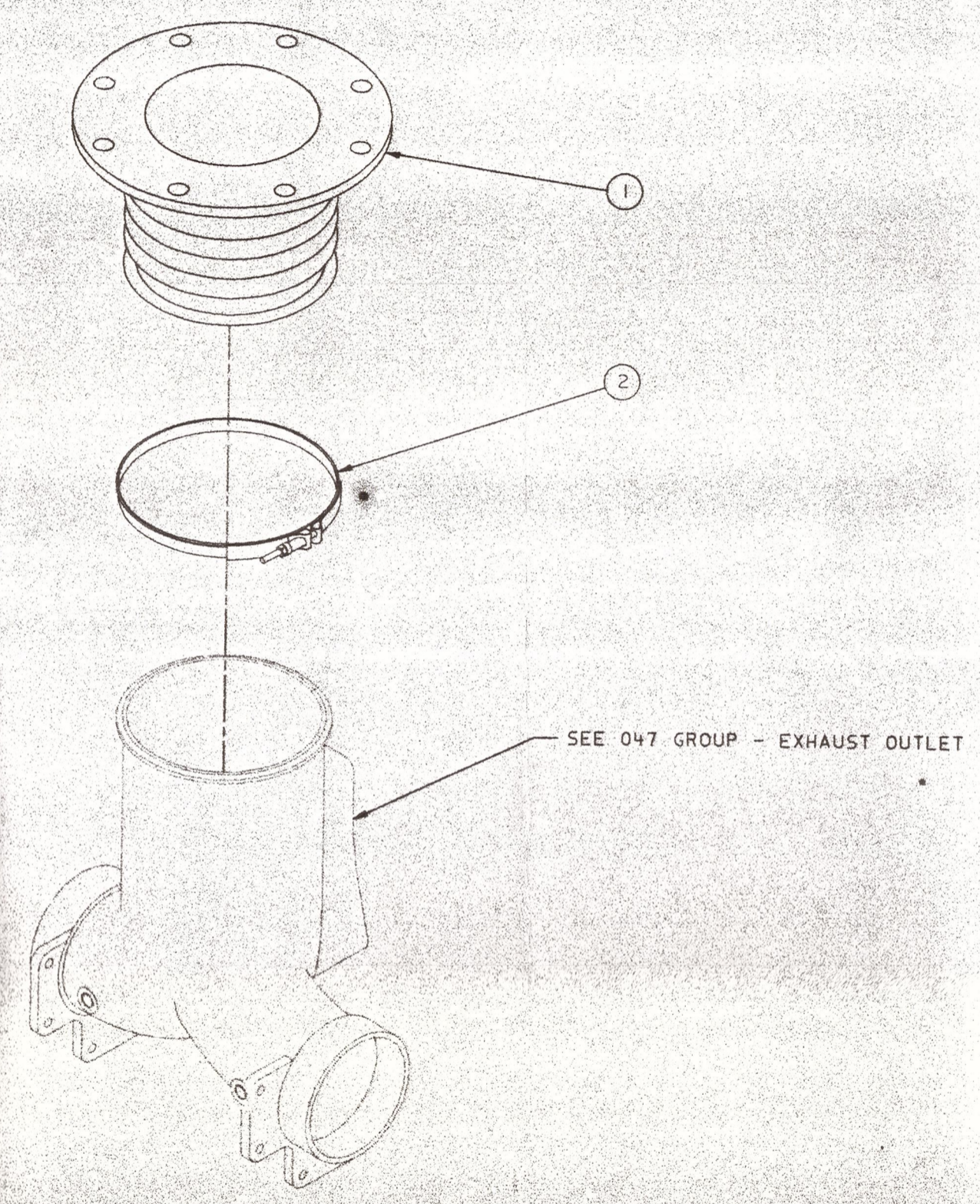


<p>FOR PLUMBING DIAGRAMS SEE: (6 CYL.) (12 CYL.) (16 CYL.)</p> <p>SD5888-111, SD5612-116, SD6566-36 PNEUMATIC START WITH PNEUMATIC CONTROL PANEL SD5888-114, SD5612-118, PNEUMATIC START WITHOUT PNEUMATIC CONTROL PANEL SD5388-112, SD5612-117, ELECTRIC START</p>	<p>OTHER THAN WPS ENGINES</p> <p>Waukesha</p>	<p>DR. TJG DATE 4-23-89 CK. PRR DATE 7-24-90 APP. JMD DATE 7-24-90</p>	<p>PART NO. S-05612-125 SHEET 1 OF 3 SCALE NONE</p>
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A B C D E F G H J K L M N P R S T

1 600017

ITEM	PART NO.	REQD.	NAME
1	199515G	1	CONNECTION, FLEX EXHAUST
2	168334E	1	COUPLING, V BAND



NOTE:  
 1. PARTS SHOWN ARE IN THE 048 GROUP - EXHAUST CONNECTION.  
 2. THERE ARE (0) KEY DESIGN FEATURES SHOWN BY  $\Delta$ . REFER TO QUALITY SYSTEMS DOCUMENT QOP-02-0107, KEY DESIGN FEATURE IDENTIFICATION.



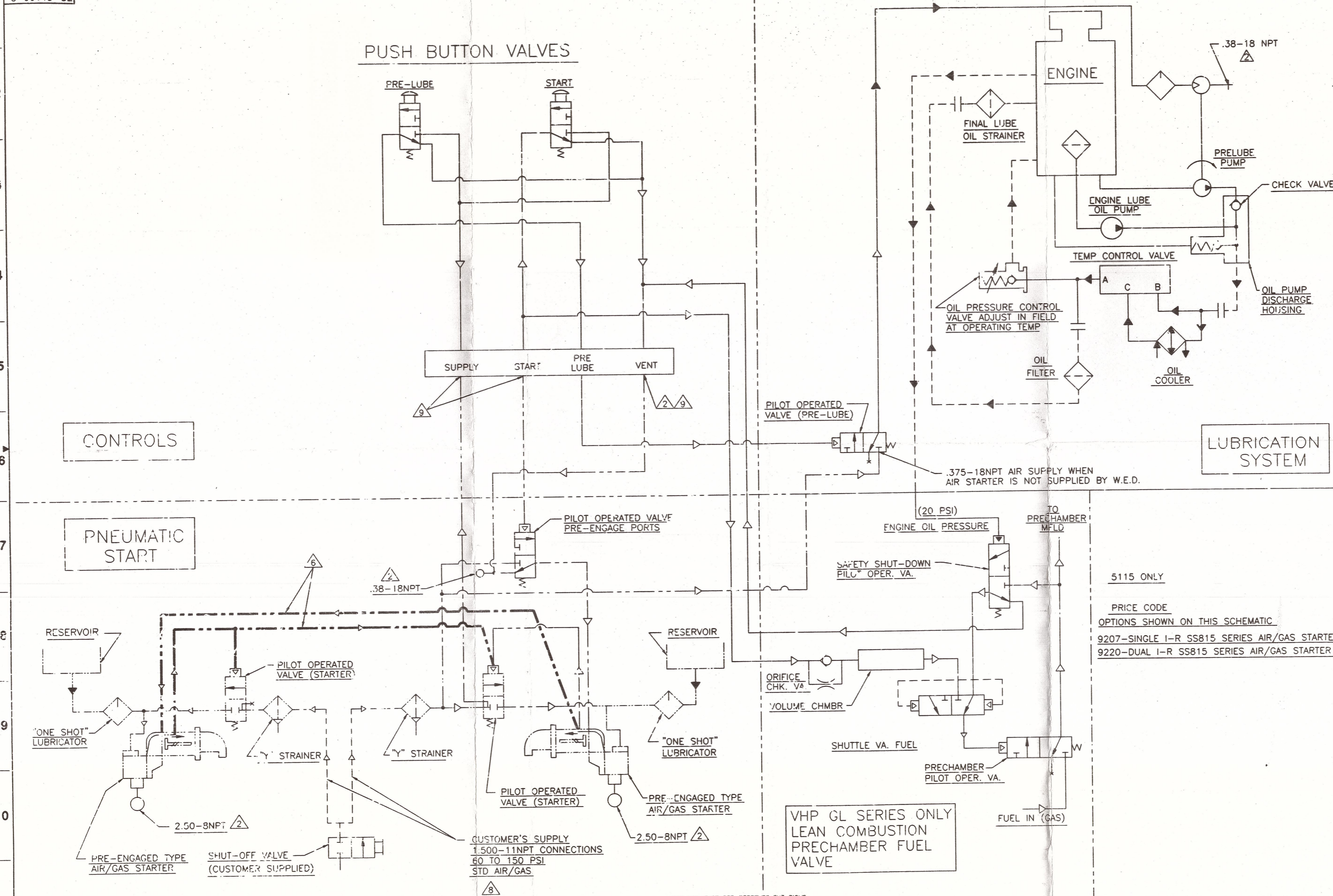
THIS PRINT IS PROVIDED ON A RESTRICTED BASIS. NOT TO BE USED IN ANY MANNER DETERMINED TO BE IN THE INTEREST OF WAUKESHA ENGINE DIVISION.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.

MODELS VHP LS115	REFERENCE DRAWING LR7943-8	MATERIAL SEE ABOVE	DR. DATE 6-16-95	CHK. DATE 6-16-95	APP. DATE 6-30-95	FILE	Waukesha WAUKESHA WI	NAME STD., EXHAUST OUTLET CONN	PART NO. 600017	SHEET 1 OF 1	SCALE NONE
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3-3  
 CAD DATA IS THREE DIMENSIONAL  
 CAD  
 MARKED DIMENSIONS ON THIS RESPONSIBLE

Wright Corp.



- NOTES:**
1. SYMBOLS CONFORM TO ANSI Y32.10 STANDARDS.
  2. CUSTOMER VENT CONNECTION MUST BE PIPED TO MEET APPLICABLE CODES.
  3. EQUIPMENT FURNISHED BY W.E.D. AS OPTIONAL PRICE CODE ITEMS ARE INDICATED BY PHANTOM LINES. ( - - - - - )
  4. ALL COMPONENTS FURNISHED BY W.E.D. ARE COMPATIBLE FOR USE WITH NON-CORROSIVE COMBUSTIBLE GAS, EXCEPT AS NOTED.
  5. ALL SYMBOLS ARE SHOWN IN A DE-ENERGIZED STATE.
  6. HEAVY PHANTOM LINES INDICATE PILOT LINES FOR DUAL START.
  7. ALL EQUIPMENT FURNISHED BY W.E.D. IS ENGINE MOUNTED UNLESS OTHERWISE SPECIFIED.
  8. TUBING AND PIPING FURNISHED BY CUSTOMER INDICATED BY HIDDEN LINE. ( - - - - - )
  9. CUSTOMER CONNECTIONS WHEN AIR STARTER IS NOT SUPPLIED BY W.E.D. 6 & 12 CYL-.25 DIA TUBE CONN.

5115 ONLY  
 PRICE CODE  
 OPTIONS SHOWN ON THIS SCHEMATIC  
 9207-SINGLE I-R SS815 SERIES AIR/GAS STARTER  
 9220-DUAL I-R SS815 SERIES AIR/GAS STARTER

VHP GL SERIES ONLY  
 LEAN COMBUSTION  
 PRECHAMBER FUEL  
 VALVE

<p>REFERENCE                  0 1 2 3 4 5 6 7 8 9 10 11 INCHES</p> <p>DIMENSIONS ARE IN INCHES [MILLIMETERS].</p>	<p>THIS PRINT IS PROVIDED ON A RESTRICTED BASIS. NOT TO BE USED IN ANY WAY DETRIMENTAL TO THE INTEREST OF Waukesha ENGINE DIVISION.</p>	<p>THE MANUFACTURER RESERVES THE RIGHT TO CHANGE OR MODIFY THE DESIGN OR EQUIPMENT SPECIFICATIONS AS HEREIN SET FORTH WITHOUT INCURRING ANY OBLIGATION EITHER WITH RESPECT TO ENGINES PREVIOUSLY SOLD OR IN THE PROCESS OF CONSTRUCTION.</p>	<p>MODELS                  5115</p>	<p>REFERENCE DRAWINGS                  LR-7923-442                  SC-6143-82                  LR-7921-324</p>	<p>MATERIAL                  HEAT TREATMENT</p>	<p>DR. DJS DATE 7-14-95                  CK. DDM DATE 7-14-95                  APP. DEM DATE 7/27/95</p>	<p>Waukesha                  Waukesha WI</p>	<p>NAME SCHEMATIC                  PNEUMATIC CONTROL SYSTEM FOR AIR/GAS START AND PRELUBE                  PART NO.                  S-06143-82                  SHEET 3 OF 3 SCALE NONE</p>
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04-15-99  
 04-15-99

112236	3/90	REVISED INSTRUCTION #1,3,4,7	124-31	3/99	REDRAWN ON AUTOCAD															
119076	7-30	REMOVED INST# 6; SEE EN																		
S-06143-82		SHEET 2 OF 3 WAS 2 OF 2																		

OPERATION OF PNEUMATIC PRELUBE AND START SYSTEMS:

1. THE MAIN AIR/GAS SUPPLY TO THE PILOT OPERATED STARTER VALVE HAS BRANCH LINES LEADING TO THE PILOT OPERATED PRELUBE VALVE, TO THE PILOT OPERATED PRE-ENGAGE VALVE, AND TO THE PRELUBE AND START PUSHBUTTON VALVES.
2. WHEN THE PRELUBE PUSHBUTTON IS DEPRESSED, AIR PRESSURE IS DIRECTED TO THE PRELUBE VALVE PILOT, CAUSING THE PRELUBE VALVE TO OPEN AND ADMIT AIR TO THE PRELUBE PUMP AIR MOTOR.
3. WHEN THE START PUSHBUTTON IS DEPRESSED, AIR PRESSURE IS DIRECTED TO THE PILOT OPERATED PRE-ENGAGE VALVE. PILOT PRESSURE SHIFTS THE PRE-ENGAGE VALVE, ADMITTING PRESSURE TO THE PRE-ENGAGE CONNECTION ON THE STARTER, CAUSING THE STARTER PINION TO SHIFT INTO ENGAGEMENT WITH THE FLYWHEEL RING GEAR.  
WHEN THE PINION MOVES TO THE ENGAGE POSITION, A PASSAGEWAY IS OPENED FOR AIR PRESSURE TO PASS THRU TO THE STARTER PILOT VALVE. PILOT PRESSURE OPENS THE STARTER VALVE(S), ADMITTING AIR TO THE STARTER MOTOR, CAUSING IT TO CRANK THE ENGINE.
4. ON LEAN COMBUSTION GAS ENGINES (VHP-GL MODELS), AIR PRESSURE FROM THE START VALVE ALSO OPENS A PILOT OPERATED VALVE TO ADMIT GAS TO THE PRECHAMBER FUEL SYSTEM. THE PILOT PRESSURE FROM THE START VALVE IS DIRECTED THRU A FLOW CONTROL(CHECK/CHOKE) VALVE, VOLUME TANK, AND A SHUTTLE VALVE BEFORE REACHING THE PILOT OPERATED PRECHAMBER GAS VALVE. THE VOLUME TANK AND FLOW CONTROL VALVE SERVE AS A PNEUMATIC TIMER TO RETARD THE BLOW DOWN OF PILOT PRESSURE WHEN THE START VALVE IS CLOSED.  
  
ANOTHER PILOT OPERATED VALVE, PILOTED BY ENGINE LUBE OIL PRESSURE, ADMITS DOWNSTREAM GAS PRESSURE TO THE OTHER SIDE OF THE SHUTTLE VALVE. WHEN THE PRESSURE IN THE VOLUME TANK BLEEDS DOWN TO LESS THAN GAS PRESSURE, THE SHUTTLE VALVE SHIFTS AND GAS PRESSURE THEN HOLDS THE PRECHAMBER GAS VALVE OPEN WHILE THE ENGINE IS RUNNING. THE TIME DELAY PROVIDED BY THE VOLUME TANK AND FLOW CONTROL VALVE KEEPS PILOT PRESSURE ON THE GAS VALVE LONG ENOUGH FOR OIL PRESSURE TO RISE AND SHIFT THE VALVE TO ADMIT PILOT PRESSURE FROM THE DOWNSTREAM GAS LINE.  
  
LOSS OF ENGINE LUBE OIL PRESSURE WILL SHUT OFF THE PRECHAMBER GAS SUPPLY. FAILURE TO START WITH AN AUTOMATIC START SYSTEM WILL PROVIDE SHUTOFF OF THE PRECHAMBER GAS SUPPLY AS SOON AS THE PILOT PRESSURE IN THE VOLUME TANK IS EXHAUSTED.
5. ON DUAL STARTER ARRANGEMENTS, THE PRE-ENGAGE CONNECTIONS ARE IN SERIES SO AS TO ENGAGE BOTH BEFORE PRESSURIZING THE PILOT-OPERATED VALVES TO ADMIT AIR TO THE STARTER MOTORS.
6. THE PUSHBUTTON VALVES ARE THREE-WAY VALVES. AIR PRESSURE IS CONNECTED TO THE NORMALLY CLOSED PORT OF EACH. THE NORMALLY OPEN PORT OF EACH VALVE VENTS THE DOWNSTREAM SIDE WHEN THE VALVE IS NOT BEING OPERATED.
7. PRESSURE WILL BEGIN TO REGISTER ON THE LUBE OIL PRESSURE GAUGE WHEN THE SYSTEM IS FULLY PRIMED. APPROXIMATELY 30 SECONDS PRELUBE IS RECOMMENDED BEFORE CRANKING THE ENGINE. MORE TIME MAY BE REQUIRED AFTER SERVICING THE FILTER OR IF THE OIL COOLER HAS BEEN DRAINED.



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DIMENSIONS ARE IN INCHES (MILLIMETERS).

MODELS	REFERENCE DRAWINGS	MATERIAL
VHP	LR-7921-324	
GAS	LR-7923-442	HEAT TREATMENT
	SD-6143-48	

DR. DAS	DATE 8-30-88
CK. ROCK	DATE 8-31-88
APP. DEM	DATE 7/27/95



AUTOCAD  
MAKE NO REVISIONS  
ON THIS REPRODUCIBLE

NAME  
SCHEMATIC, PNEUMATIC  
CONTROL SYSTEM FOR  
AIR START & PRELUBE

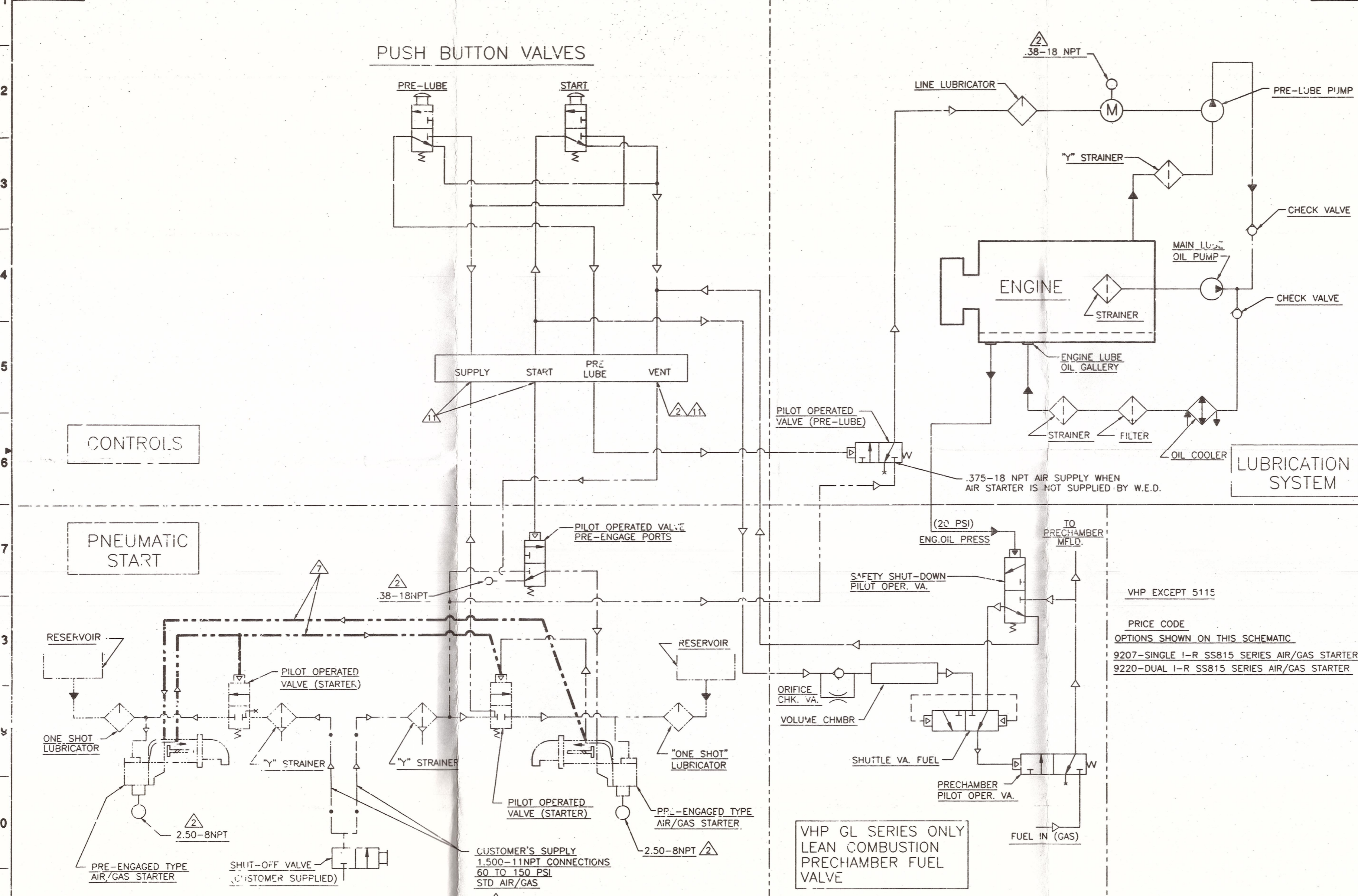
PART NO  
S-06143-82

SHEET 2 OF 3 SCALE NONE

04-15-99

04-15-99

111345	8-88	RELEASED	112236	3/90	NOTE 11: PRICE CODE 9207 WAS 18205 SS815 WAS SS800	124031	3-99	REDRAWN ON AUTOCAD											
		SUPERSEDES SD-6143-49	119076	7-95	SHEET 1 OF 3 WAS 1 OF 2.														
112236	3/90	REMOVED OPTIMUM SOLENOID VALVE - NOTE 12 REVISED			SUPERSEDES SD5616-173.														
S-06143-82																			

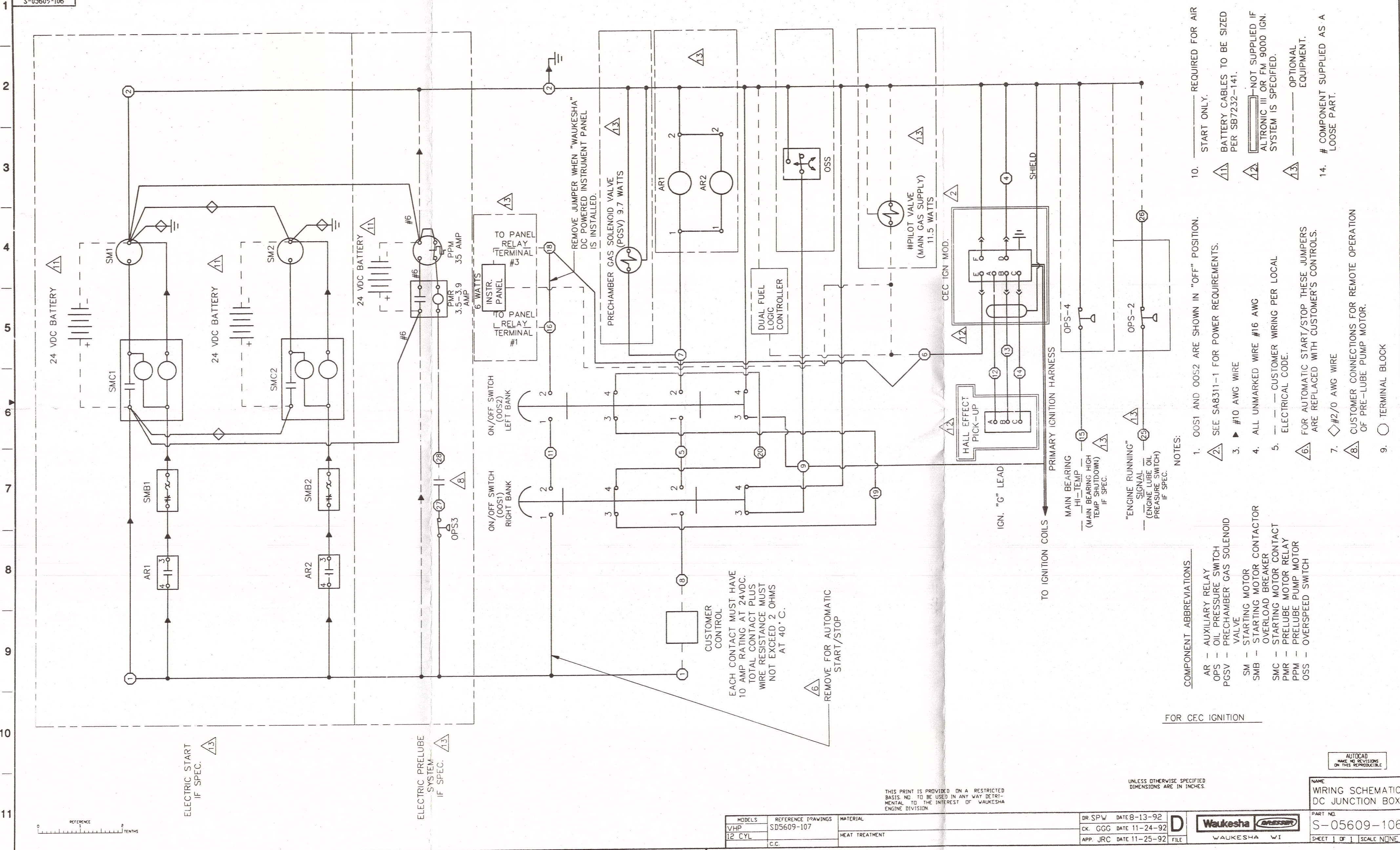


- NOTES:
1. SYMBOLS CONFORM TO ANSI Y32.10 STANDARDS.
  2. CUSTOMER VENT CONNECTION MUST BE PIPED TO MEET APPLICABLE CODES.
  3. EQUIPMENT FURNISHED BY W.E.D. AS OPTIONAL PRICE CODE ITEMS ARE INDICATED BY PHANTOM LINES. (-----)
  4. ALL COMPONENTS FURNISHED BY W.E.D. ARE COMPATIBLE FOR USE WITH NON-CORROSIVE COMBUSTIBLE GAS EXCEPT AS NOTED.
  5. ALL SYMBOLS ARE SHOWN IN A DE-ENERGIZED STATE.
  6. HEAVY PHANTOM LINES INDICATE PILOT LINES FOR DUAL START.
  7. ALL EQUIPMENT FURNISHED BY W.E.D. IS ENGINE MOUNTED UNLESS OTHERWISE SPECIFIED.
  8. TUBING AND PIPING FURNISHED BY CUSTOMER INDICATED BY (-----)
  9. CUSTOMER CONNECTIONS WHEN AIR STARTER IS NOT SUPPLIED BY W.E.D. 6 & 12 CYL-.25 DIA TUBE CONN. P9390G, GSI-.125-27 NPSF P9390GL-.250-18 NPSF

<p>THE MANUFACTURER RESERVES THE RIGHT TO CHANGE OR MODIFY THE DESIGN OR EQUIPMENT SPECIFICATIONS AS HEREIN SET FORTH WITHOUT INCURRING ANY OBLIGATION EITHER WITH RESPECT TO ENGINES PREVIOUSLY SOLD OR IN THE PROCESS OF CONSTRUCTION.</p>		<p>MODEL: VHP GAS</p>	<p>REFERENCE DRAWINGS: LR-7923-442 SC-6143-82 LR-7921-324</p>	<p>MATERIAL: HEAT TREATMENT</p>	<p>DR. DAS DATE 8-30-88 CK. ROCK DATE 8-31-88 APP. DEM. DATE 7/27/95</p>	<p>NAME SCHEMATIC: PNEUMATIC CONTROL SYSTEM FOR AIR/GAS START AND PRELUDE PART NO. S-06143-82 SHEET 1 OF 3 SCALE NONE</p>
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04-15-99  
04-15-99

112567	11-92	RELEASED	116201	5-93	ALL WIRE 16 GA WAS 14 GA (S-8) MOVED PGSV FROM BLOCK 6 TO 7 (J-8)	116980	11-93	ADDED OPTIONAL EQUIPMENT BOX AROUND ART AR2 (K-2)	122568	1-98	ADDED GRD WIRE (H-2)	123160	6-98	DFLC POWER FROM 6 WAS FROM 7 (K-5)
115884	2-93	SEE EN	116744	9-93	SEE EN	119290	8-95	ADDED OVERSPEED SWITCH (S-3, S-9) DRAWING NUMBER WAS SD5609-106	122918	4-98	ADDED DUAL FUEL CHANGE OVER LOGIC (K-5)	124558	11-99	REDRAWN ON AUTOCAD
115967	2-93	SEE EN	116980	11-93	REMOVED WIRE CONNECTING TERMINAL #18 TO TERMINAL #2 (G-3, J-3)	121758	6-97	REMOVED FUSE 2 (T-2) REMOVED FUSE 3 (Q-1)	123160	6-98	REMOVED FUSE 2 (T-2) REMOVED FUSE 3 (Q-1)			



- NOTES:
- 00S1 AND 00S2 ARE SHOWN IN "OFF" POSITION.
  - SEE SA8311-1 FOR POWER REQUIREMENTS.
  - #10 AWG WIRE
  - ALL UNMARKED WIRE #16 AWG
  - CUSTOMER WIRING PER LOCAL ELECTRICAL CODE.
  - FOR AUTOMATIC START/STOP THESE JUMPERS ARE REPLACED WITH CUSTOMER'S CONTROLS.
  - #2/0 AWG WIRE
  - CUSTOMER CONNECTIONS FOR REMOTE OPERATION OF PRE-LUBE PUMP MOTOR.
  - TERMINAL BLOCK
  - START ONLY.
  - BATTERY CABLES TO BE SIZED PER SB7232-141.
  - NOT SUPPLIED IF ALTRONIC III OR FM 9000 IGN. SYSTEM IS SPECIFIED.
  - OPTIONAL EQUIPMENT.
  - # COMPONENT SUPPLIED AS A LOOSE PART.

- COMPONENT ABBREVIATIONS
- AR - AUXILIARY RELAY
  - OPS - OIL PRESSURE SWITCH
  - PGSV - PRECHAMBER GAS SOLENOID VALVE
  - SM - STARTING MOTOR
  - SMB - STARTING MOTOR CONTACTOR OVERLOAD BREAKER
  - SMC - STARTING MOTOR RELAY
  - PMR - PRELUDE MOTOR RELAY
  - PPM - PRELUDE PUMP MOTOR
  - OSS - OVERSPEED SWITCH

- FOR CEC IGNITION
- IGN. "C" LEAD
  - PRIMARY IGNITION HARNESS
  - MAIN BEARING HI-TEMP (MAIN BEARING HIGH TEMP SHUTDOWN)
  - "ENGINE RUNNING" SIGNAL (ENGINE LUBE OIL PRESSURE SWITCH) IF SPEC.



ELECTRIC START IF SPEC.

ELECTRIC PRELUDE SYSTEM IF SPEC.

CUSTOMER CONTROL  
EACH CONTACT MUST HAVE 10 AMP RATING AT 24VDC. TOTAL CONTACT PLUS WIRE RESISTANCE MUST NOT EXCEED 2 OHMS AT 40°C.

REMOVE FOR AUTOMATIC START/STOP

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MODELS V/HP 12 CYL C.C.	REFERENCE DRAWINGS SD5609-107	MATERIAL HEAT TREATMENT	DR. SPW DATE 8-13-92 CK. GGG DATE 11-24-92 APP. JRC DATE 11-25-92	Waukesha WAUKESHA WI	PART NO. S-05609-106 SHEET 1 OF 1 SCALE NONE
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12-02-99  
12-02-99



MODEL	REFERENCE DRAWINGS MATERIAL	DC SPV DATE 8-18-92	Waukesha	DATE 11-25-99	TLC
VHP	S05609-108, 107	DC GGC DATE 11-24-99			
12 CYL	HEAT TREATMENT	APP. JRC DATE 11-25-99			
S-05609-108					

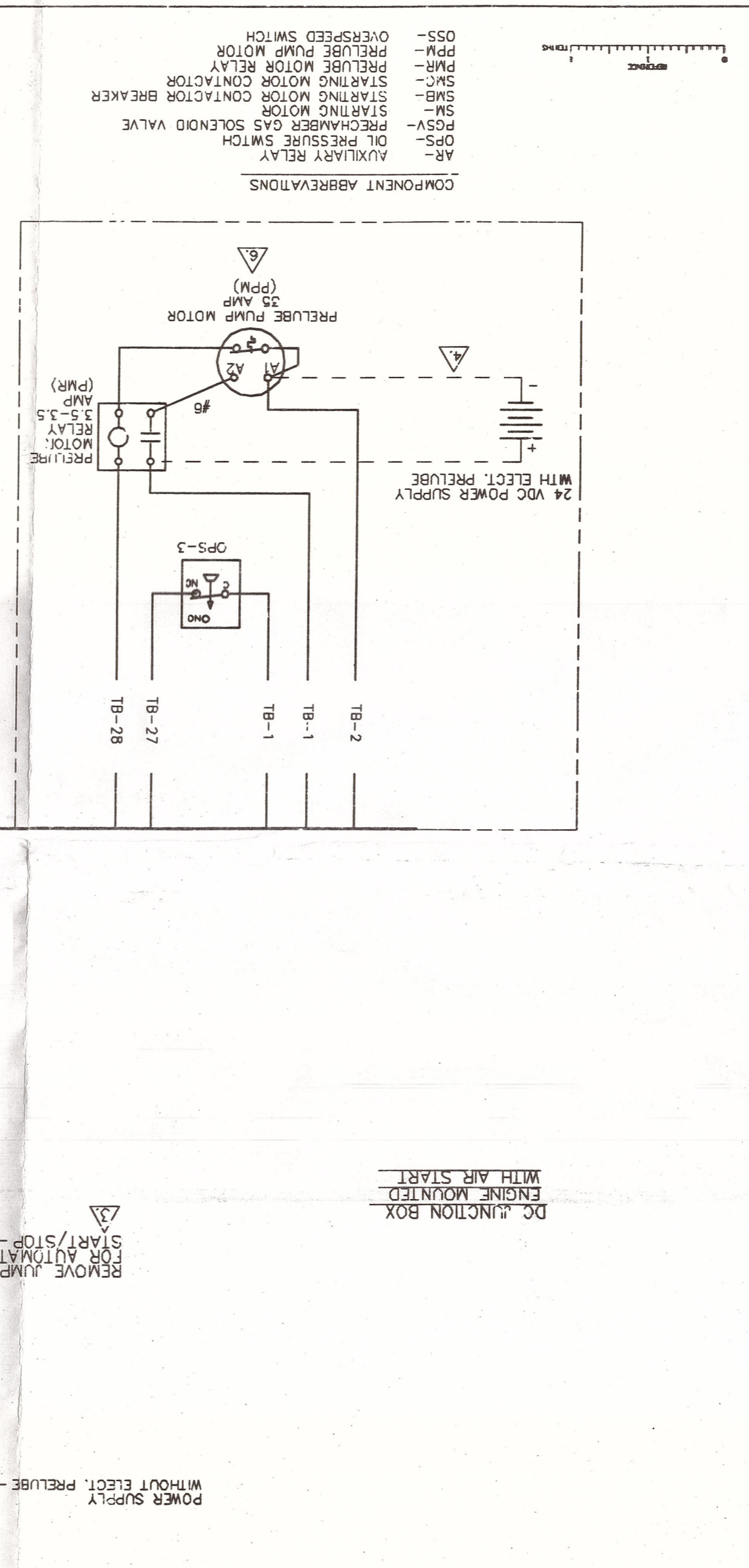
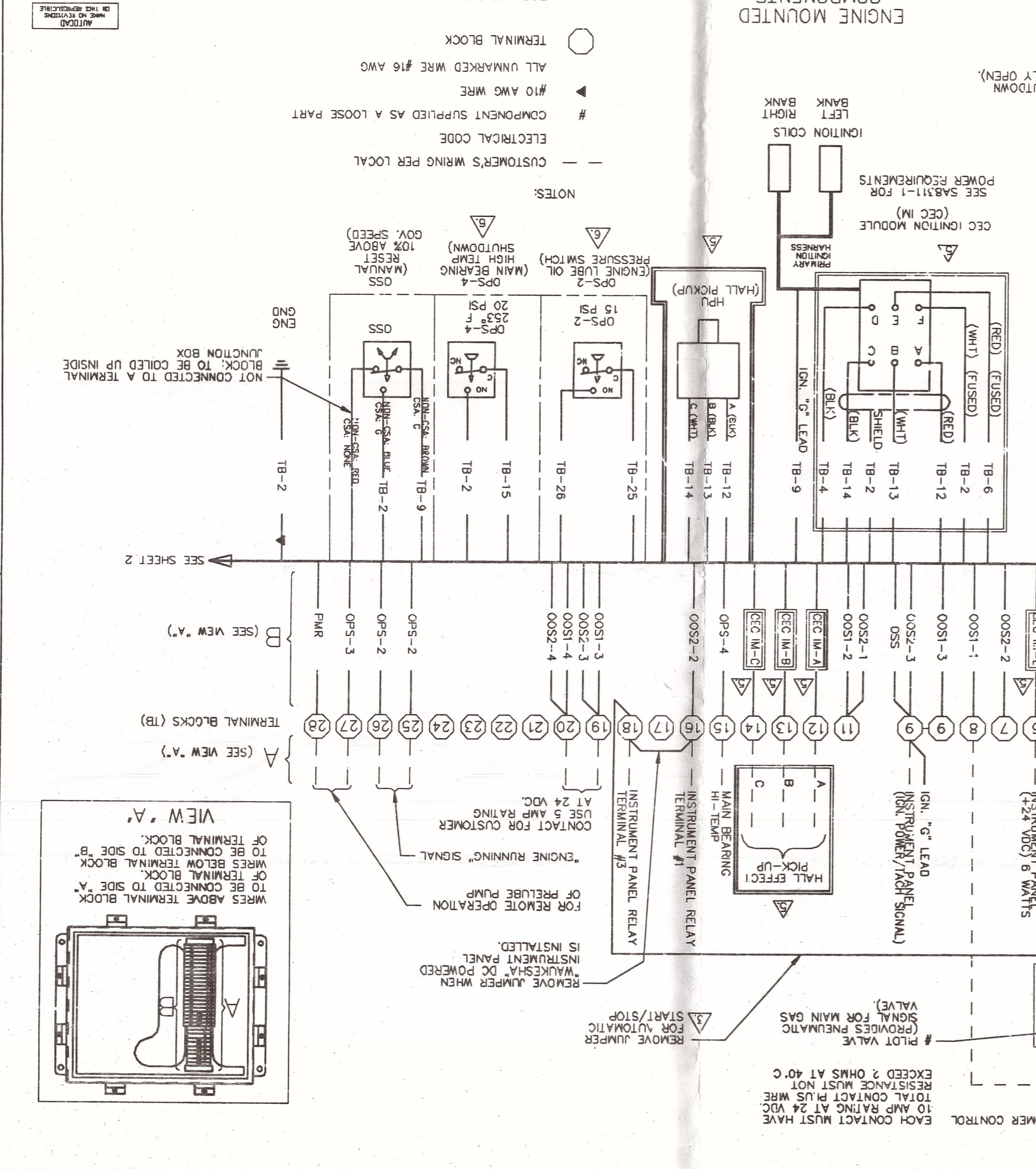
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NAME: DC JUNCTION BOX WIRING DIAGRAM

WIRING DIAGRAM

PART NO. S-05609-108

SHEET 1 OF 2 SCALE NONE



ITEM	PART NO.	RECD	DATE	BY
112567	1-93	RELEASED		
115884	2-93	SEE EN		
119201	5-93	ALL WIRE 18 GA. WAS 14 GA. (P-10)		
116744	9-93	SEE EN		
121758	4-97	REMOVED 10A FUSES (H4)		
119920	8-95	WAS 10A FUSES (H4)		
123160	6-98	WAS 10A FUSES (H4)		
124558	11-99	REDRAWN ON AUTOCAD		
122918	4-98	ADDED SHEET 2		
118104	10-94	REMOVED 10A FUSES (H4)		
119201	5-93	ALL WIRE 18 GA. WAS 14 GA. (P-10)		
116744	9-93	SEE EN		
121758	4-97	REMOVED 10A FUSES (H4)		
119920	8-95	WAS 10A FUSES (H4)		
123160	6-98	WAS 10A FUSES (H4)		
124558	11-99	REDRAWN ON AUTOCAD		

WIRING CONNECTIONS: Terminal A: 24 VDC POWER SUPPLY WITH ELECT. PRELUBE; Terminal B: PRELUBE MOTOR RELAY (3.5-5.5 AMP (PMR)); Terminal C: PRELUBE PUMP MOTOR (25 AMP (PPM)).

REMOVE JUMPER FOR AUTOMATIC START/STOP

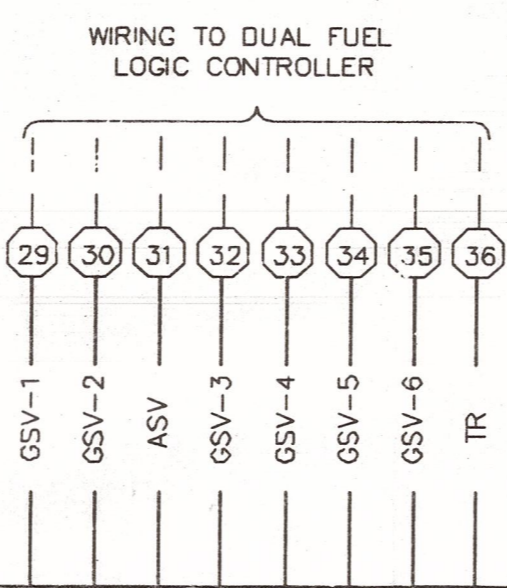
POWER SUPPLY WITHOUT ELECT. PRELUBE

WIRING CONNECTIONS: Terminal A: Wires above terminal block to be connected to side "A" of terminal block; Terminal B: Wires below terminal block to be connected to side "B" of terminal block; Terminal T: Wires above terminal block to be connected to side "A" of terminal block.

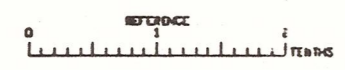
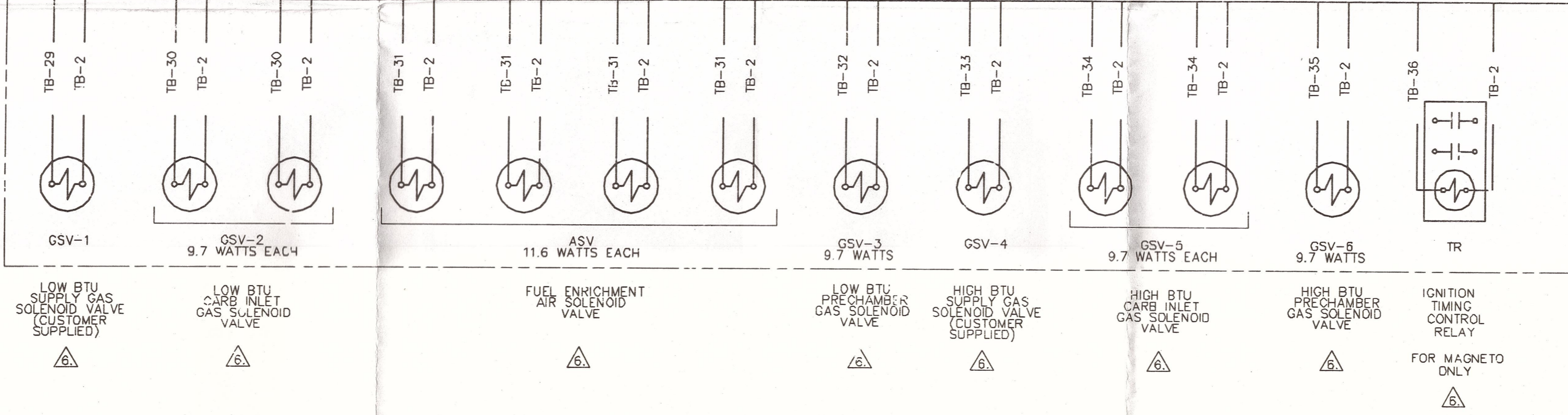
WIRING CONNECTIONS: Terminal A: ENG GRD (OPS-3); Terminal B: ENG GRD (OPS-4); Terminal C: SHIELD (U052-4); Terminal D: IGN. "C" LEAD (U052-1); Terminal E: IGN. "C" LEAD (U052-1); Terminal F: IGN. "C" LEAD (U052-1); Terminal G: IGN. "C" LEAD (U052-1); Terminal H: IGN. "C" LEAD (U052-1); Terminal I: IGN. "C" LEAD (U052-1); Terminal J: IGN. "C" LEAD (U052-1); Terminal K: IGN. "C" LEAD (U052-1); Terminal L: IGN. "C" LEAD (U052-1); Terminal M: IGN. "C" LEAD (U052-1); Terminal N: IGN. "C" LEAD (U052-1); Terminal O: IGN. "C" LEAD (U052-1); Terminal P: IGN. "C" LEAD (U052-1); Terminal Q: IGN. "C" LEAD (U052-1); Terminal R: IGN. "C" LEAD (U052-1); Terminal S: IGN. "C" LEAD (U052-1); Terminal T: IGN. "C" LEAD (U052-1).

122918	4-98	ADDED SHEET 2																		
123160	6-98	LOGIC WAS CHANGEOVER (G-4)																		
124558	11-99	REDRAWN ON AUTOCAD																		
S-05609-108																				

ITEM	PART NO	QTY	NAME
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SEE SHEET 1



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MODELS VHP 12 CYL	REFERENCE DRAWINGS SC5609-84 C.C.	MATERIAL HEAT TREATMENT	DR. DJS DATE 4-22-98 CK. DJS DATE 4-28-98 APP. DJS DATE 4-28-98		NAME <b>WIRING DIAGRAM DC JUNCTION BOX</b> PART NO. <b>S-05609-108</b> SHEET 2 OF 2 SCALE NONE
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12-02-99

12-02-99

SD5612-93

ITEM	PART NO.	REQ.	NAME
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**FUEL SYSTEM ADJUSTMENT INSTRUCTIONS**  
**VHP 6 & 12 CYL. GL ENGINES USING IMPCO 6000 CARBURETORS**  
**WITH LOW BTU METERING VALVE #211291 (IMPCO V2-73, 20°00')**  
**LOW BTU FUEL**

**I. PHYSICAL REQUIREMENTS**

- 35-50 PSI line pressure to Fisher regulator(s).
- 2" pipe size Fisher 99 regulator(s) (2 on Vee engines)
  - 1.125" orifice
  - Red spring
  - .38" I.D. Minimum balance line to carburetor air horn(s).
- Regulator(s) are to be mounted as close to carburetor as possible. (Normally furnished with engine)
- Check/adjust governor to throttle control linkage to assure that the fly is closed when the governor is in the minimum stroke position. On Vee engines both throttle plates must be synchronized so they open and close together.

**II. FUEL SYSTEM ADJUSTMENT PRIOR TO ENGINE START-UP**

- Set the primary or line regulator to provide 35-50 PSI at the inlet to the engine mounted Fisher 99 regulator(s).
- Turn prechamber fuel only regulator "B" fully in (CW) (locking nut positioned against the square), and then five turns out (CCW).
- Turn carburetor mixture screw(s) "A" full open (Fully CCW). Both banks on Vee engines.
- Make sure that the prechamber gas controls (connection "E") are properly vented to a safe location.
- Install a mercury manometer to measure the differential pressure between the prechamber manifold "C" and the intake manifold "D". Right bank only on Vee engines.
- From the fitting in the connection between the exhaust manifold and the turbocharger, "J" install a sample line with an ON/OFF valve to measure exhaust manifold oxygen concentration. Both banks on Vee engines.
- Install a water manometer to measure the gas over air pressure differential between the carburetor gas inlet(s) and the carburetor air horn(s). Both banks on Vee engine.

**III. PRELIMINARY SETTINGS AFTER ENGINE START-UP**

- At idle speed and no load adjust the engine mounted Fisher 99 regulator(s) to the gas over air pressure listed below. The banks are to be within 0.5" water column on Vee engines.

**GAS OVER AIR PRESSURE DIFFERENTIAL - INCHES WATER COLUMN**

- 400 BTU = 30"
- 500 BTU = 12"
- 600 BTU = 0.5"

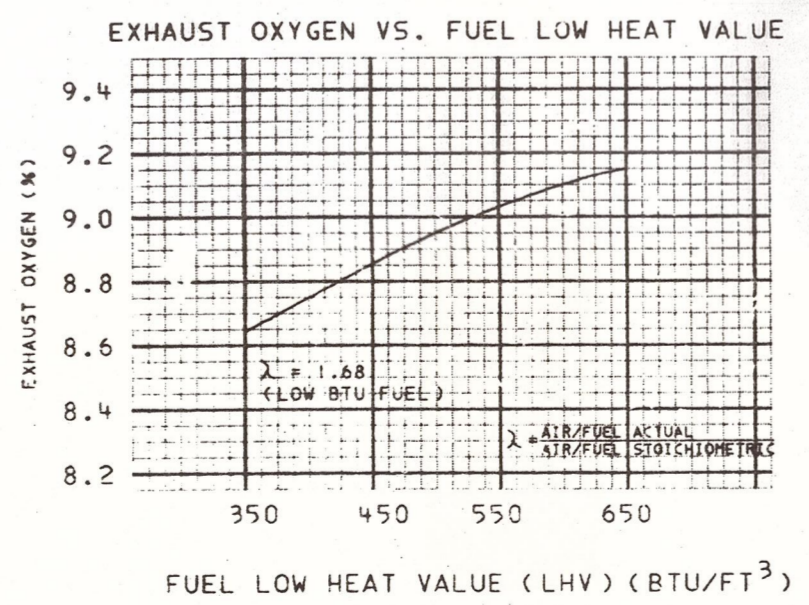


FIGURE 1

- Adjust prechamber fuel only regulator "B" to 13" ± 1" HG differential pressure (Prechamber manifold over intake manifold pressure).
- Follow break-in procedure up to 50 BMEP.
- Set engine at rated speed and add load to produce 50 BMEP, or approximately 0" HG gauge intake manifold pressure (or 30" HGA, HGA = Barometer plus intake manifold pressure in inches of mercury).
- Adjust Fisher 99 regulator(s) to obtain the percent exhaust oxygen level (± 0.3%) shown in Figure 1 for the specific fuel being run (see note 3). Adjust both banks on Vee engines. To increase the exhaust oxygen level, lower the gas over air pressure. To decrease the exhaust oxygen level, raise the gas over air pressure.
- At rated speed and 100 BMEP, or approximately 40" HGA intake manifold pressure, adjust Fisher 99 regulator(s) to obtain the percent exhaust oxygen level (± 0.3%) shown in Figure 1 for the specific fuel being run. Adjust both banks on Vee engines.
- Follow break-in procedure up to rated load.

**IV. FINAL FUEL SYSTEM ADJUSTMENTS**

- Set engine at rated load and speed (in the field, maximum load available if less than rated load). Adjust the Fisher 99 regulator(s) to obtain the percent exhaust oxygen level (± 0.1%) shown in Figure 1 for the specific fuel being run (see note 3). Adjust both banks on Vee engines.
- On Vee engines, check the intake manifold pressures on both banks. If the difference is greater than 1" HG, recheck Step I.4 for throttle plate synchronization. Do not attempt to equalize bank to bank pressures by adjusting throttle plates out of synchronization.
- If improved carburetor tracking is required, the carburetor mixture screw(s) "A" may be used.
- Tighten locking nuts on regulators.

**NOTES:**

- These instructions apply to sales and/or field gas with a Low Heat Value (LHV) of 400-600 BTU/FT<sup>3</sup>.
- Gas over air pressure at the carburetor(s) may be less at full load than at the initial idle setting. This drop should not be more than 1" water column. Any more pressure drop would indicate insufficient supply pressure to the regulator, under size piping, incorrect regulator orifice size, inadequate regulator capacity or a malfunctioning regulator.
- Always verify that all cylinders are firing before adjusting the carburetor. Individual exhaust thermocouples have been provided for this purpose.

LANDFILL OR DIGESTER GAS (LOW BTU) FUEL SYSTEM  
 WITH LOW BTU METERING VALVE #211291 (V2-73, 20°00')

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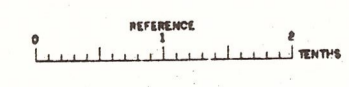
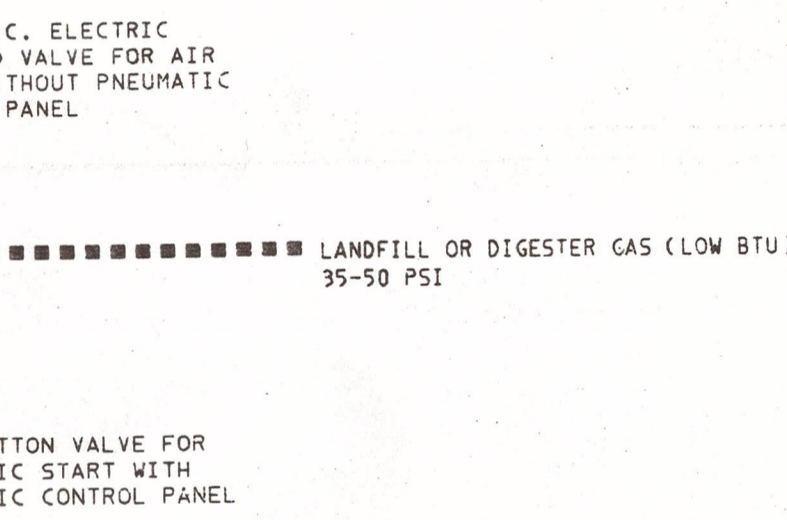
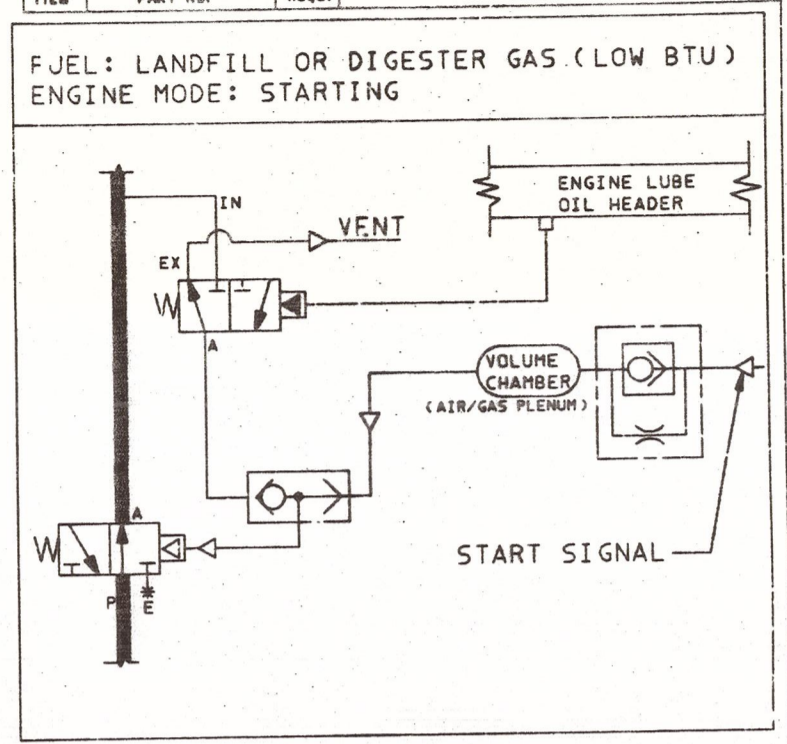
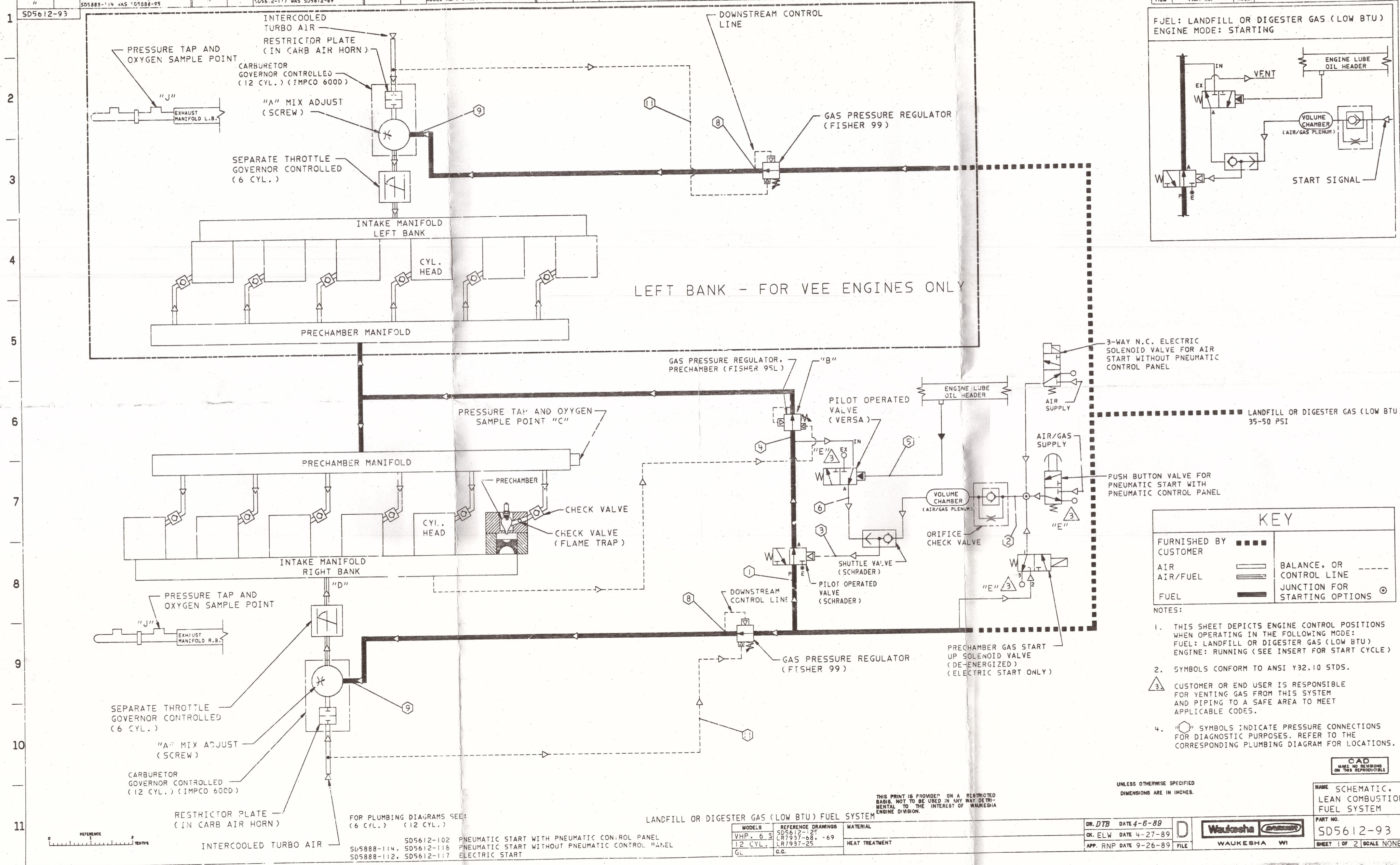


MODEL# VHP, 6 & 12 CYL. GL	REFERENCE DRAWINGS C.D.	MATERIAL HEAT TREATMENT	DR. DTB DATE 4-20-89 OK. ELW DATE 4-27-89 APP. RNP DATE 9-26-89	FILE	Waukesha WAUKESHA WI	PART NO. SD5612-93 SHEET 2 OF 2 SCALE NONE
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CAD  
 MAKE NO REVISIONS  
 ON THIS REPRODUCTION

NAME INSTRUCTIONS, LEAN COMBUSTION FUEL SYSTEM ADJUSTMENTS

1096639-89	RELEASED, SUPERSEDES SD5612-93	1860038-90	SD5888-112 WAS SD5122-88	1860038-90	CHANGED REF. DRAWING	1860038-90	DELETED REF. DWG. LR7937-22
1860038-90	CHANGED PLUMBING DIAGRAMS	"	SD5612-118 WAS SD5612-88	"	SD5612-125 WAS SD5612-92	"	"
"	SD5888-114 WAS SD5888-95	"	SD5612-117 WAS SD5612-89	"	ADDED REF. DWGS. LR7937-68, -69	"	"



FOR PLUMBING DIAGRAMS SEE:  
 SD5888-114, SD5612-102 PNEUMATIC START WITH PNEUMATIC CONTROL PANEL  
 SD5612-118, SD5612-118 PNEUMATIC START WITHOUT PNEUMATIC CONTROL PANEL  
 SD5888-112, SD5612-117 ELECTRIC START

**LANDFILL OR DIGESTER GAS (LOW BTU) FUEL SYSTEM**

MODELS	REFERENCE DRAWINGS	MATERIAL
VHP. 6 2	SD5612-125	
12 CYL.	LR7937-68, -69	HEAT TREATMENT
G.C.	G.C.	

DR. DTB DATE 4-6-89  
 CK. ELW DATE 4-27-89  
 APP. RNP DATE 9-26-89



NAME SCHEMATIC, LEAN COMBUSTION FUEL SYSTEM  
 PART NO. SD5612-93  
 SHEET 1 OF 2 SCALE NONE

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CAD MAKE NO REVISIONS ON THIS REPRODUCTION

**FUEL SYSTEM ADJUSTMENT INSTRUCTIONS  
VHP GL ENGINES USING IMPCO 600VF3D-20E CARBURETORS  
AND ENGINE MOUNTED FISHER 99 REGULATORS  
(WITH FUEL-OILY PRECHAMBER SYSTEM)**

**I. FUEL SYSTEM ADJUSTMENT PRIOR TO ENGINE START-UP**

1. MAKE SURE THAT THE PRECHAMBER GAS CONTROLS "E" ARE PROPERLY VENTED TO A SAFE LOCATION.
2. CHECK GOVERNOR LINKAGE TO INSURE THAT IT IS PROPERLY ADJUSTED. THE THROTTLE PLATES MUST BE CLOSED WHEN THE GOVERNOR IS IN THE MINIMUM STROKE POSITION. BOTH THROTTLE PLATES MUST BE SYNCHRONIZED SO THEY OPEN AND CLOSE TOGETHER.
3. PIPING TO ENGINE MUST BE PROPERLY SIZED SO THAT A MINIMUM OF 35 PSI FUEL PRESSURE WILL BE PROVIDED AT INLET TO FISHER 99 REGULATOR ACROSS THE ENTIRE LOAD RANGE. MAXIMUM PRESSURE IS 50 PSI.
4. TURN PRECHAMBER FUEL REGULATOR "B" FULLY IN (CW) (LOCKING NUT POSITIONED AGAINST THE SQUARE), AND THEN SIX TURNS OUT (CCW).
5. TURN CARBURETOR MIXTURE SCREW "A" TWO TURNS (CCW) FROM FULL CLOSED (CW) POSITION. ADJUST BOTH BANKS.
6. INSTALL PRESSURE MEASURING EQUIPMENT TO MEASURE THE PRESSURE DIFFERENTIAL, IN INCHES OF MERCURY, BETWEEN THE PRECHAMBER MANIFOLD "C" AND THE INTAKE MANIFOLD "D". INSTALL ON RIGHT BANK ONLY.
7. FROM THE FITTING "J" IN THE CONNECTION BETWEEN THE EXHAUST MANIFOLD AND THE TURBOCHARGER, INSTALL A SAMPLE LINE WITH AN ON/OFF VALVE TO MEASURE EXHAUST MANIFOLD OXYGEN CONCENTRATION. INSTALL ON BOTH BANKS.
8. INSTALL PRESSURE MEASURING EQUIPMENT TO MEASURE THE GAS OVER AIR PRESSURE DIFFERENTIAL, IN INCHES OF WATER, BETWEEN THE CARBURETOR GAS INLET "F" AND THE CARBURETOR AIR HORN "G". INSTALL ON BOTH BANKS.
9. START ENGINE PER INSTRUCTIONS IN THE ENGINE OPERATION AND MAINTENANCE MANUAL.

3. FOLLOW BREAK-IN PROCEDURE UP TO RATED SPEED AND 100 BMEP AS SPECIFIED IN S-08470-2.

NOTE: IF UNABLE TO ATTAIN 100 BMEP, ADJUST CARBURETOR MIXTURE SCREW "A" TO OBTAIN OXYGEN LEVEL OF 9.9% ± .5% MEASURED BEFORE THE TURBOCHARGER. (TO INSURE AIR/FUEL RATIO OF 28:1) ADJUST BOTH BANKS. TURN THE SCREW "A" IN (CW) TO INCREASE OXYGEN LEVEL, OR OUT (CCW) TO DECREASE OXYGEN LEVEL. ALWAYS VERIFY THAT ALL CYLINDERS ARE FIRING BEFORE ADJUSTING THE CARBURETORS. INDIVIDUAL EXHAUST THERMOCOUPLES HAVE BEEN PROVIDED FOR THIS PURPOSE.

4. INSURE THAT THE OXYGEN LEVEL AT RATED SPEED AND 100 BMEP (14-16 IN-HG) IS 9.9% ± .5% BEFORE GOING ON TO STEP 5. VERIFY BOTH BANKS.
5. FOLLOW BREAK-IN PROCEDURE UP TO RATED SPEED AND LOAD.

	RATED LOAD	INTAKE MANIFOLD PRESSURE (IN-HG)
5115GL 130°F ICW: 150 BMEP		33-35
5115GL 85°F ICW: 157 BMEP		32-34

6. READJUST THE G/A PRESSURE DIFFERENTIAL BETWEEN THE CARBURETOR GAS INLET AND THE CARBURETOR AIR HORN TO 6.5" ± 1" (IN. W.C.) AT RATED SPEED AND LOAD. READJUST BOTH BANKS.
7. CHECK THE PRECHAMBER MANIFOLD OVER INTAKE MANIFOLD PRESSURE DIFFERENTIAL AT RATED SPEED AND LOAD. IF NECESSARY, READJUST TO 6" ± 1" HG.
8. READJUST CARBURETOR MIXTURE SCREW "A", IF NECESSARY, TO OBTAIN OXYGEN LEVEL OF 9.9% ± .1% MEASURED BEFORE THE TURBOCHARGER AT RATED SPEED AND LOAD. READJUST BOTH BANKS.
9. CHECK INTAKE MANIFOLD PRESSURE ON BOTH BANKS. IF THIS DIFFERENCE IS GREATER THAN 1" HG, RECHECK THROTTLE PLATE SYNCHRONIZATION. IF PLATES ARE SYNCHRONIZED, CONTACT WAUKESHA ENGINE DIVISION SERVICE DEPARTMENT FOR ASSISTANCE. DO NOT ATTEMPT TO EQUALIZE BANK TO BANK PRESSURES BY ADJUSTING THROTTLE PLATES OUT OF SYNCHRONIZATION.

**II. FUEL SYSTEM ADJUSTMENT SETTINGS AFTER ENGINE START-UP**

1. AT IDLE SPEED AND NO LOAD, ADJUST THE ENGINE MOUNTED FISHER 99 REGULATORS SO THAT THE GAS OVER AIR (G/A) PRESSURE DIFFERENTIAL BETWEEN THE CARBURETOR GAS INLET AND THE CARBURETOR AIR HORN IS 6.5" ± 1" (IN. W.C.). ADJUST AND MEASURE BOTH BANKS. THE BANKS ARE TO BE WITHIN 0.5" (IN. W.C.).
2. AT IDLE SPEED AND NO LOAD, ADJUST PRECHAMBER FUEL REGULATOR "B" TO 6" ± 1" HG PRESSURE DIFFERENTIAL (PRECHAMBER MANIFOLD OVER INTAKE MANIFOLD PRESSURE). TIGHTEN LOCKING NUTS ON REGULATOR.

10. SPECIAL FUEL SYSTEM SETTINGS MUST BE APPROVED BY WAUKESHA ENGINE APPLICATION ENGINEERING DEPARTMENT.

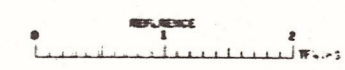
OTHER THAN WPS ENGINES  
FUEL-ONLY PRECHAMBER SYSTEM

NATURAL GAS FUEL SYSTEM (850-950 BTU LHV)  
WITH STANDARD RELAY ORIFICE Ø.047

THIS PRINT IS PROVIDED ON A RESTRICTED BASIS, NOT TO BE USED IN ANY WAY DETRIMENTAL TO THE INTEREST OF WAUKESHA ENGINE DIVISION.

UNLESS OTHERWISE SPECIFIED  
DIMENSIONS ARE IN INCHES.

CAD  
MAKE NO REVISIONS  
ON THIS REPRODUCIBLE



MODELS	REFERENCE DRAWINGS	MATERIAL	DR. JMZ DATE 8-18-95	D	Waukesha	PART NO.
5115GL			DR. GGG DATE 8-18-95			5-05612-125
	C.C.	HEAT TREATMENT	APP.PRR DATE 8-18-95			FILE

	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
1	115204	7-92	SEE EN FOR CHANGES	119475	9-95	REVISED INSTRUCTIONS SEE EN											
	118006	9-94	ADDED 5115GL SPEC. (E-911L-5)														
	118846	7-95	SEE EN														
	5-05612-125																

**FUEL SYSTEM ADJUSTMENT INSTRUCTIONS  
VHP GL ENGINES USING IMPCO 6000 CARBURETORS  
AND ENGINE MOUNTED FISHER 99 REGULATORS  
(WITH FUEL-ONLY PRECHAMBER SYSTEM)**

**I. FUEL SYSTEM ADJUSTMENT PRIOR TO ENGINE START-UP**

1. MAKE SURE THAT THE PRECHAMBER GAS CONTROLS "E" ARE PROPERLY VENTED TO A SAFE LOCATION.
2. CHECK GOVERNOR LINKAGE TO INSURE THAT IT IS PROPERLY ADJUSTED. THE THROTTLE PLATE(S) MUST BE CLOSED WHEN THE GOVERNOR IS IN THE MINIMUM STROKE POSITION. ON VEE ENGINES, BOTH THROTTLE PLATES MUST BE SYNCHRONIZED SO THEY OPEN AND CLOSE TOGETHER.
3. PIPING TO ENGINE MUST BE PROPERLY SIZED SO THAT A MINIMUM OF 35 PSI FUEL PRESSURE WILL BE PROVIDED AT INLET TO FISHER 99 REGULATOR ACROSS THE ENTIRE LOAD RANGE. MAXIMUM PRESSURE IS 50 PSI.
4. TURN PRECHAMBER FUEL REGULATOR "B" FULLY IN (CW) (LOCKING NUT POSITIONED AGAINST THE SQUARE), AND THEN SIX TURNS OUT (CCW).
5. TURN CARBURETOR MIXTURE SCREW "A" TWO TURNS (CCW) FROM FULL CLOSED (CW) POSITION. ADJUST BOTH BANKS ON VEE ENGINES.
6. INSTALL PRESSURE MEASURING EQUIPMENT TO MEASURE THE PRESSURE DIFFERENTIAL, IN INCHES OF MERCURY, BETWEEN THE PRECHAMBER MANIFOLD "C" AND THE INTAKE MANIFOLD "D". INSTALL ON RIGHT BANK ONLY ON VEE ENGINES.
7. FROM THE FITTING "J" IN THE CONNECTION BETWEEN THE EXHAUST MANIFOLD AND THE TURBOCHARGER, INSTALL A SAMPLE LINE WITH AN ON/OFF VALVE TO MEASURE EXHAUST MANIFOLD OXYGEN CONCENTRATION. INSTALL ON BOTH BANKS ON VEE ENGINES.
8. INSTALL PRESSURE MEASURING EQUIPMENT TO MEASURE THE GAS OVER AIR PRESSURE DIFFERENTIAL, IN INCHES OF WATER, BETWEEN THE CARBURETOR GAS INLET "F" AND THE CARBURETOR AIR HORN "G". INSTALL ON BOTH BANKS ON VEE ENGINES.
9. START ENGINE PER INSTRUCTIONS IN THE ENGINE OPERATION AND MAINTENANCE MANUAL.

2. AT IDLE SPEED AND NO LOAD, ADJUST PRECHAMBER FUEL REGULATOR "B" TO  $6" \pm 1"$  HG PRESSURE DIFFERENTIAL (PRECHAMBER MANIFOLD OVER INTAKE MANIFOLD PRESSURE.) TIGHTEN LOCKING NUTS ON REGULATOR.
3. FOLLOW BREAK-IN PROCEDURE UP TO RATED SPEED AND 100 BMEP, AS SPECIFIED IN S-08470-2.

NOTE: IF UNABLE TO ATTAIN 100 BMEP, ADJUST CARBURETOR MIXTURE SCREW(S) "A" TO OBTAIN OXYGEN LEVEL OF  $9.8\% \pm .5\%$  MEASURED BEFORE THE TURBOCHARGER (TO INSURE AIR/FUEL RATIO OF 28:1). ADJUST BOTH BANKS ON VEE ENGINES. TURN THE SCREW "A" IN (CW) TO INCREASE OXYGEN LEVEL, OR OUT (CCW) TO DECREASE OXYGEN LEVEL. ALWAYS VERIFY THAT ALL CYLINDERS ARE FIRING BEFORE ADJUSTING THE CARBURETORS. INDIVIDUAL EXHAUST THERMOCOUPLES HAVE BEEN PROVIDED FOR THIS PURPOSE.

4. INSURE THAT THE OXYGEN LEVEL AT RATED SPEED AND 100 BMEP IS  $9.8\% \pm .5\%$  BEFORE GOING ON TO STEP 5. VERIFY ON BOTH BANKS ON VEE ENGINES.

5. FOLLOW BREAK-IN PROCEDURE UP TO RATED SPEED AND LOAD.

	<u>RATED LOAD</u>
85°F ICW:	145 BMEP
130°F ICW:	138 BMEP

REFER TO S-08223-1 FOR RATED LOAD IN BRAKE HORSEPOWER AS A FUNCTION OF INTAKE MANIFOLD CHARGE DENSITY.

6. CHECK THE PRECHAMBER MANIFOLD OVER INTAKE MANIFOLD PRESSURE DIFFERENTIAL AT RATED SPEED AND LOAD. IF NECESSARY, READJUST TO  $6" \pm 1"$  HG.
7. WITH ENGINE AT RATED SPEED AND LOAD, VERIFY THAT GAS OVER AIR IS WITHIN TOLERANCE SPECIFIED UNDER SECTION II. I. IF GAS OVER AIR IS NOT WITHIN SPECIFIED LIMITS AT RATED SPEED AND LOAD, IT WILL BE NECESSARY TO BRING ENGINE BACK TO IDLE CONDITIONS AND READJUST THE REGULATOR(S). WHEN THE GAS OVER AIR IS WITHIN TOLERANCE AT RATED SPEED AND LOAD, READJUST CARBURETOR MIXTURE SCREW "A" IF NECESSARY TO OBTAIN OXYGEN LEVEL OF  $9.8\% \pm .1\%$  MEASURED BEFORE THE TURBOCHARGER. ADJUST BOTH BANKS ON VEE ENGINES.
8. ON VEE ENGINES, CHECK INTAKE MANIFOLD PRESSURE ON BOTH BANKS. IF THIS DIFFERENCE IS GREATER THAN 1" HG, RECHECK THROTTLE PLATE SYNCHRONIZATION. IF PLATES ARE SYNCHRONIZED, CONTACT WAUKESHA ENGINE DIVISION SERVICE DEPARTMENT FOR ASSISTANCE. DO NOT ATTEMPT TO EQUALIZE BANK TO BANK PRESSURES BY ADJUSTING THROTTLE PLATES OUT OF SYNCHRONIZATION.
9. SPECIAL FUEL SYSTEM SETTINGS MUST BE APPROVED BY WAUKESHA ENGINE APPLICATION ENGINEERING DEPARTMENT.

**II. FUEL SYSTEM ADJUSTMENT SETTINGS AFTER ENGINE START-UP**

1. AT IDLE SPEED AND NO LOAD ADJUST THE ENGINE MOUNTED FISHER 99 REGULATOR(S) SO THAT THE GAS OVER AIR (G/A) PRESSURE DIFFERENTIAL BETWEEN THE CARBURETOR GAS INLET AND THE CARBURETOR AIR HORN IS WITHIN THE RANGE LISTED BELOW. ADJUST BOTH BANKS ON VEE ENGINES. THE BANKS ARE TO BE WITHIN 0.5" WATER COLUMN ON VEE ENGINES.

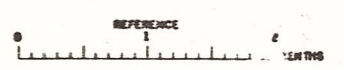
<u>MODEL</u>	<u>G/A (IN. W.C.) AT IDLE</u>	<u>G/A AT RATED LOAD</u>
L5108 GL	8" ± .5"	7" ± 1"
F2895GL, L5790 GL, P9390GL,	7" ± .5"	6" ± 1"
F3521GL, L7042 GL	5" ± .5"	4" ± 1"

**OTHER THAN WPS ENGINES**  
FUEL-ONLY PRECHAMBER SYSTEM

NATURAL GAS FUEL SYSTEM (850-950 BTU LHV)  
WITH STANDARD RELAY ORIFICE  $\phi .047$

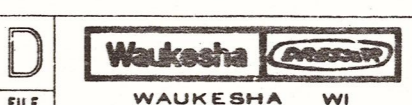
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UNLESS OTHERWISE SPECIFIED  
DIMENSIONS ARE IN INCHES.



MODELS	REFERENCE DRAWINGS	MATERIAL
VHP.		
GL		HEAT TREATMENT
	C.C.	

DR. TJG	DATE 4-20-90
CK. PRR	DATE 7-24-90
APP. JMD	DATE 7-24-90



<small>CAD MADE NO REVISIONS ON THIS REPRODUCIBLE</small>
<small>NAME</small> SCHEMATIC AND ADJ. INSTRUCTIONS VHP GL FUEL SYSTEM
<small>PART NO.</small> 5-05612-125
<small>SHEET 2 OF 3</small>   <small>SCALE NONE</small>

## RECOMMENDED ALARM AND SHUTDOWN SETPOINTS

The following is a list of recommended "alarm" and "shutdown" setpoints by engine series for various engine operating parameters. These values can be used as a guide when designing protection or monitoring systems.

The "alarm" values shown are suggested values – they can be changed to suit a specific application or measurement device. By utilizing controls that simultaneously shut off the fuel supply and ignition system upon reaching a "shutdown" value, the potential for engine damage is reduced.

**CAUTION:** Alarm and shutdown values indicate deviation from designed operation and are not meant for continuous engine service. Engine and control systems must be designed to and operated at normal values. Disregard may result in engine damage.

Alarm and shutdown values are based on using dry natural gas of 900 BTU/cu.ft. (35.38 MJ/m<sup>3</sup> [25,V(0;101.325)]) Saturated Lower Heating Value (SLHV) as fuel. Refer to the "Gaseous Fuel Specification for Waukesha Engines" standard sheet, S-7884-6 or latest version, and the "Lubricating Oil Recommendations for Waukesha Engines" standard sheet, S-1015-29 or latest version, for typical changes to operating temperatures for jacket water and lube oil when running on landfill or digester gas fuels.

Refer to the most recent version of the *Gas Engine Price Book* to determine which shutdown devices are included as standard equipment with any specific engine model.

EN 124417 8/99 Revised  
 EN 124390 8/99 Revised  
 EN 124244 6/99 New Release

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Title - **RECOMMENDED ALARM AND SHUTDOWN SETPOINTS**

DR. KWS 6/99
CH. RWS 6/99
APP. JMD 6/99

**S-**  
08382-2

## AT25GL / AT27GL

### JACKET WATER OUTLET TEMPERATURE:

#### Standard Cooling System:

Normal: 180° F (82° C) for continuous rating.  
200° F (93° C) for intermittent rating.  
Alarm: 10° F (5.5° C) above normal / design temperature.  
Shutdown: 20° F (11° C) above normal / design temperature.

#### Elevated Temperature, Solid Water Cooling System:

Normal: 210° – 250° F (99° – 121° C) for solid water.  
Alarm: 5° F (3° C) above normal / design operating temperature<sup>1</sup>.  
Shutdown: 10° F (5.5° C) above normal / design operating temperature<sup>1</sup>.

### LUBE OIL HEADER TEMPERATURE:

Normal: 172° F (78° C)  
Alarm: 187° F (86° C)  
Shutdown: 197° F (92° C)

### LUBE OIL HEADER PRESSURE:

Normal: 60 – 65 psi (415 – 450 kPa)  
Alarm: 50 psi (345 kPa)  
Shutdown: 45 psi (310 kPa)

### INTAKE MANIFOLD TEMPERATURE:

#### AT25GL Models

Normal: Up to 10° F (5.5° C) above design intercooler water inlet temperature.  
Alarm: 20° F (11° C) above design intercooler water inlet temperature.  
Shutdown: 30° F (17° C) above design intercooler water inlet temperature.

#### AT27GL Models

Normal: Up to 10° F (5.5° C) above design intercooler water inlet temperature.  
Alarm: 15° F (11° C) above design intercooler water inlet temperature.  
Shutdown: 20° F (17° C) above design intercooler water inlet temperature.

### INTAKE MANIFOLD PRESSURE:

Contact Waukesha Sales Engineering.

### MAIN BEARING TEMPERATURE:

Shutdown: 250° F (121° C)

### OVERSPEED:

Shutdown: Not to exceed 10% over governed speed.

- (1) Waukesha Power Systems Code 1105, 1105A, or equivalent pressure / temperature shutdown system is recommended when jacket water temperature exceeds 210° F (99° C).
- (2) Do not revise any values on this page without revising the same values on the "AT General Operating Limits" and "Diagram Temperature/Pressure Test Points and Pump Settings" s-sheets for the 8L, 12V, and/or 16VATGL engines.

EN 124417 8/99 Revised  
EN 124390 8/99 Revised  
EN 124244 6/99 New Release

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Title - **RECOMMENDED ALARM AND SHUTDOWN SETPOINTS**

DR. RWS 6/99  
CH. RWS 6/99  
APP. JMD 6/99

**S-**  
08382-2



# VHP

## JACKET WATER OUTLET TEMPERATURE:

### Standard Cooling System:

Normal: 180° F (82° C) for continuous rating.  
200° F (93° C) for intermittent rating.  
Alarm: 10° F (5.5° C) above normal / design temperature.  
Shutdown: 20° F (11° C) above normal / design temperature.

### Elevated Temperature Solid Water Cooling System:

Normal: 210° – 235° F (99° – 113° C) for solid water.  
Alarm: 5° F (3° C) above normal / design operating temperature<sup>1</sup>.  
Shutdown: 10° F (5.5° C) above normal / design operating temperature<sup>1</sup>.

### Ebullent Cooling System:

Normal: 212° – 250° F (100° – 121° C)  
Alarm: See Note 2 below.  
Shutdown: See Note 2 below.

## LUBE OIL HEADER TEMPERATURE:

Normal: 180° F (82° C)  
Alarm: 195° F (91° C)  
Shutdown: 205° F (96° C)

## LUBE OIL HEADER PRESSURE:

### Six and Twelve Cylinder Models:

Normal: 50 – 60 psi (345 – 415 kPa)  
Alarm: 30 psi (207 kPa)  
Shutdown (except 5115GL model): 20 psi (138 kPa)  
Shutdown (5115GL model): 25 psi (172 kPa)

### Sixteen Cylinder Models:

Normal: 50 – 60 psi (345 – 415 kPa)  
Alarm: 25 psi (172 kPa)  
Shutdown: 15 psi (103 kPa)

- (1) Waukesha Power Systems Code 1105, 1105A, or equivalent shutdown system is recommended when jacket water temperature exceeds 210° F (99° C).
- (2) Waukesha Power Systems Code 1106, 1106A, or equivalent shutdown system is recommended for ebulliently cooled engines.

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EN 124390 8/99 Revised  
EN 124244 6/99 New Release

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Title - RECOMMENDED ALARM AND SHUTDOWN SETPOINTS

DR. RWS 6/99  
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08382-2

## VHP (cont.)

### **INTAKE MANIFOLD TEMPERATURE (GSI & GL Engines):**

Normal: Up to 10° F (5.5° C) above design intercooler water inlet temperature.  
Alarm: 15° F (8.5° C) above design intercooler water inlet temperature.  
Shutdown: 20° F (11° C) above design intercooler water inlet temperature.

### **INTAKE MANIFOLD PRESSURE:**

Contact Waukesha Sales Engineering.

### **MAIN BEARING TEMPERATURE:**

Shutdown: 250° F (121° C)

### **OVERSPEED:**

Shutdown: Not to exceed 10% over governed speed.

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EN 124390 8/99 Revised  
EN 124244 6/99 New Release

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Title - **RECOMMENDED ALARM AND  
SHUTDOWN SETPOINTS**

DR. RWS 6/99  
CH. RWS 6/99  
APP. JMD 6/99

**S-**  
08382-2

# **VGF**

## **JACKET WATER OUTLET TEMPERATURE:**

### **Standard Cooling System (<= 176 BMEP Engines):**

Normal: 180° F (82° C) for continuous rating.  
200° F (93° C) for intermittent rating.  
Alarm: 10° F (5.5° C) above normal / design temperature.  
Shutdown: 20° F (11° C) above normal / design temperature.

### **Elevated Temperature, Solid Water Cooling System (<= 176 BMEP Engines):**

Normal: 210° – 265° F (99° – 130° C) for solid water.  
Alarm: 5° F (3° C) above normal / design temperature<sup>1</sup>.  
Shutdown: 10° F (5.5° C) above normal / design temperature<sup>1</sup>.

### **Elevated Temperature, Solid Water Cooling System (200 BMEP Engines):**

Normal: 210° F (99° C) for solid water.  
Alarm: 10° F (5.5° C) above normal / design temperature<sup>1</sup>.  
Shutdown: 15° F (8.5° C) above normal / design temperature<sup>1</sup>.

## **LUBE OIL HEADER TEMPERATURE:**

### **<= 176 BMEP Engines**

**Jacket Water Outlet Temperature of 180° F (82° C) and Intercooler Temperatures of 85° – 130° F (29° – 54° C).**

#### **All Models**

Normal: 170° – 195° F (76.5° – 90.5° C)  
Alarm: 200° F (93° C)  
Shutdown: 205° F (96° C)

**Jacket Water Outlet Temperature of 265° F (129° C) and Intercooler Temperatures of 85° – 130° F (29° – 54° C).**

#### **All Models**

Normal: 170° – 195° F (76.5° – 90.5° C)  
Alarm: 200° F (93° C)  
Shutdown: 205° F (96° C)

### **200 BMEP Engines**

**Jacket Water Outlet Temperature of 210° F (99° C) and Intercooler Temperatures of 158° – 176° F (70° – 80° C).**

#### **GLD Model Only**

Normal: 190° F (88° C)  
Alarm: 200° F (93° C)  
Shutdown: 205° F (96° C)

(1) Waukesha Power Systems Code 1105, 1105A, or equivalent pressure / temperature shutdown system is recommended when jacket water temperature exceeds 210° F (99° C)

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EN 124244 6/99 New Release



## VGF (con't)

### LUBE OIL HEADER PRESSURE:

#### F18/H24 Models

Normal: 67 – 83 psi (462 – 572 kPa)  
Alarm: 40 psi (276 kPa)  
Shutdown: 35 psi (241 kPa)

#### L36/P48 Models

Normal: 47 -- 63 psi (324 – 434 kPa)  
Alarm: 40 psi (276 kPa)  
Shutdown: 35 psi (241 kPa)

### INTAKE MANIFOLD TEMPERATURE):

#### </= 176 BMEP Engines (GL/GLD/GSID Models)

##### With Standard Intercooler Water Temperatures of 85° – 130° F (29° – 54° C)

Normal: Up to 10° F (5.5° C) above design intercooler water temperature.  
Alarm: 15° F (8.5° C) above design intercooler water temperature.  
Shutdown: 20° F (11° C) above design intercooler water temperature.

##### With Elevated Intercooler Water Temperatures of 131° – 176° F (55° – 80° C)

Normal: Up to 10° F (5.5° C) above design intercooler water temperature.  
Alarm: 10° F (5.5° C) above design intercooler water temperature.  
Shutdown: 15° F (8.5° C) above design intercooler water temperature.

#### 200 BMEP Engines (GLD Model Only)

##### With Elevated Intercooler Water Temperatures of 158° – 176° F (70° – 80° C)

Normal: Up to 10° F (5.5° C) above design intercooler water temperature.  
Alarm: 10° F (5.5° C) above design intercooler water temperature.  
Shutdown: 15° F (8.5° C) above design intercooler water temperature.

### INTAKE MANIFOLD PRESSURE:

Contact Waukesha Sales Engineering.

### MAIN BEARING TEMPERATURE:

Contact Waukesha Sales Engineering.

### OVERSPEED:

Shutdown: Not to exceed 15% over governed speed.

EN 124417 8/99 Revised  
EN 124390 8/99 Revised  
EN 124244 6/99 New Release

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Title - RECOMMENDED ALARM AND  
SHUTDOWN SETPOINTS

DR. RWS 6/99  
CH. RWS 6/99  
APP. JMD 6/99

**S-**  
08382-2

# VSG

## JACKET WATER OUTLET TEMPERATURE:

Normal: 180° F (82° C)  
Alarm: 200° F (93° C)  
Shutdown: 210° F (99° C)

## LUBE OIL HEADER TEMPERATURE:

With a Jacket Water Temperature of 180° F (82° C).

### F11G Model

Normal: 205° F (96° C)  
Alarm: 215° F (102° C)  
Shutdown: 225° F (107° C)

### F11GSI Model

Normal: 190° F (89° C)  
Alarm: 200° F (93° C)  
Shutdown: 210° F (99° C)

## LUBE OIL HEADER PRESSURE:

Normal: 65 – 87 psi (450 – 600 kPa)  
Alarm: 40 psi (276 kPa)  
Shutdown: 30 psi (207 kPa)

## INTAKE MANIFOLD TEMPERATURE (GSI Engines):

Normal: Up to 15° F (8.5° C) above design intercooler water inlet temperature.  
Alarm: 20° F (11° C) above design intercooler water inlet temperature.  
Shutdown: 25° F (14° C) above design intercooler water inlet temperature.

## INTAKE MANIFOLD PRESSURE (GSI Engines):

Contact Waukesha Sales Engineering.

## MAIN BEARING TEMPERATURE:

Contact Waukesha Sales Engineering.

## OVERSPEED:

Shutdown: Not to exceed 15% over governed speed.

EN 124417 8/99 Revised  
EN 124390 8/99 Revised  
EN 124244 6/99 New Release

# **F1197**

## **JACKET WATER OUTLET TEMPERATURE:**

Normal: 180° F (82° C)

Alarm: 200° F (93° C)

Shutdown: 210° F (99° C)

## **LUBE OIL HEADER TEMPERATURE:**

Normal: 160° – 210° F (71° – 99° C)

Alarm: 225° F (107° C)

Shutdown: 235° F (113° C)

## **LUBE OIL HEADER PRESSURE:**

Normal: 40 – 50 psi (276 – 345 kPa)

Alarm: 15 psi (103 kPa)

Shutdown: 10 psi (69 kPa)

## **INTAKE MANIFOLD TEMPERATURE:**

Not Applicable.

## **INTAKE MANIFOLD PRESSURE:**

Contact Waukesha Sales Engineering.

## **MAIN BEARING TEMPERATURE:**

Contact Waukesha Sales Engineering.

## **OVERSPEED:**

Shutdown: Not to exceed 15% over governed speed.

EN 124417 8/99 Revised  
EN 124390 8/99 Revised  
EN 124244 6/99 New Release

Page 8 of 10



Title - **RECOMMENDED ALARM AND SHUTDOWN SETPOINTS**

DR. RWS 6/99

CH. RWS 6/99

APP. JMD 6/99

**S-**

08382-2

# F817

## JACKET WATER OUTLET TEMPERATURE:

Normal: 180° F (82° C)  
Alarm: 195° F (91° C)  
Shutdown: 205° F (96° C)

## LUBE OIL HEADER TEMPERATURE:

Normal: 160° – 230° F (71° – 110° C)  
Alarm: 240° F (116° C)  
Shutdown: 250° F (121° C)

## LUBE OIL HEADER PRESSURE:

Normal: 35 – 45 psi (241 – 310 kPa)  
Alarm: 15 psi (103 kPa)  
Shutdown: 10 psi (69 kPa)

## INTAKE MANIFOLD TEMPERATURE:

Not Applicable.

## INTAKE MANIFOLD PRESSURE:

Contact Waukesha Sales Engineering.

## OVERSPEED:

Shutdown: Not to exceed 15% over governed speed.

EN 124417 8/99 Revised  
EN 124390 8/99 Revised  
EN 124244 6/99 New Release



## VR

### JACKET WATER OUTLET TEMPERATURE:

Normal: 180° F (82° C)  
Alarm: 205° F (96° C)  
Shutdown: 210° F (99° C)

### LUBE OIL HEADER TEMPERATURE:

Normal: 210° F (99° C)  
Alarm: 225° F (107° C)  
Shutdown: 230° F (110° C)

### LUBE OIL HEADER PRESSURE:

#### VR 155

Normal: 25 – 35 psi (172 – 241 kPa)  
Alarm: 15 psi (103 kPa)  
Shutdown: 10 psi (69 kPa)

#### VR220 and VR330

Normal: 25 – 50 psi (172 – 345 kPa)  
Alarm: 15 psi (103 kPa)  
Shutdown: 10 psi (69 kPa)

### INTAKE MANIFOLD TEMPERATURE:

Not Applicable.

### INTAKE MANIFOLD PRESSURE:

Contact Waukesha Sales Engineering.

### OVERSPEED:

Shutdown: Not to exceed 15% over governed speed.

EN 124417 8/99 Revised  
EN 124390 8/99 Revised  
EN 124244 6/99 New Release

Page 10 of 10



Title - RECOMMENDED ALARM AND  
SHUTDOWN SETPOINTS

DR. RWS 6/99  
CH. RWS 6/99  
APP. JMD 6/99

**S-**  
08382-2



5  
4  
3  
2  
1

MODELS	VHP
REFERENCE DRAWINGS	LR 7923-440
	SB 5614-180
	GC. _____

MATERIAL \_\_\_\_\_  
HEAT TREATMENT \_\_\_\_\_

DR. D.J.S.	DATE 4/12/87
CK. HWB	DATE 4-16-87
APP. <i>AM</i>	DATE 4-20-87

Waukesha  
DRESSER  
WAUKESHA, WIS.

PART NO. SB 5614-209  
SHEET 1 OF 1  
SCALE NONE

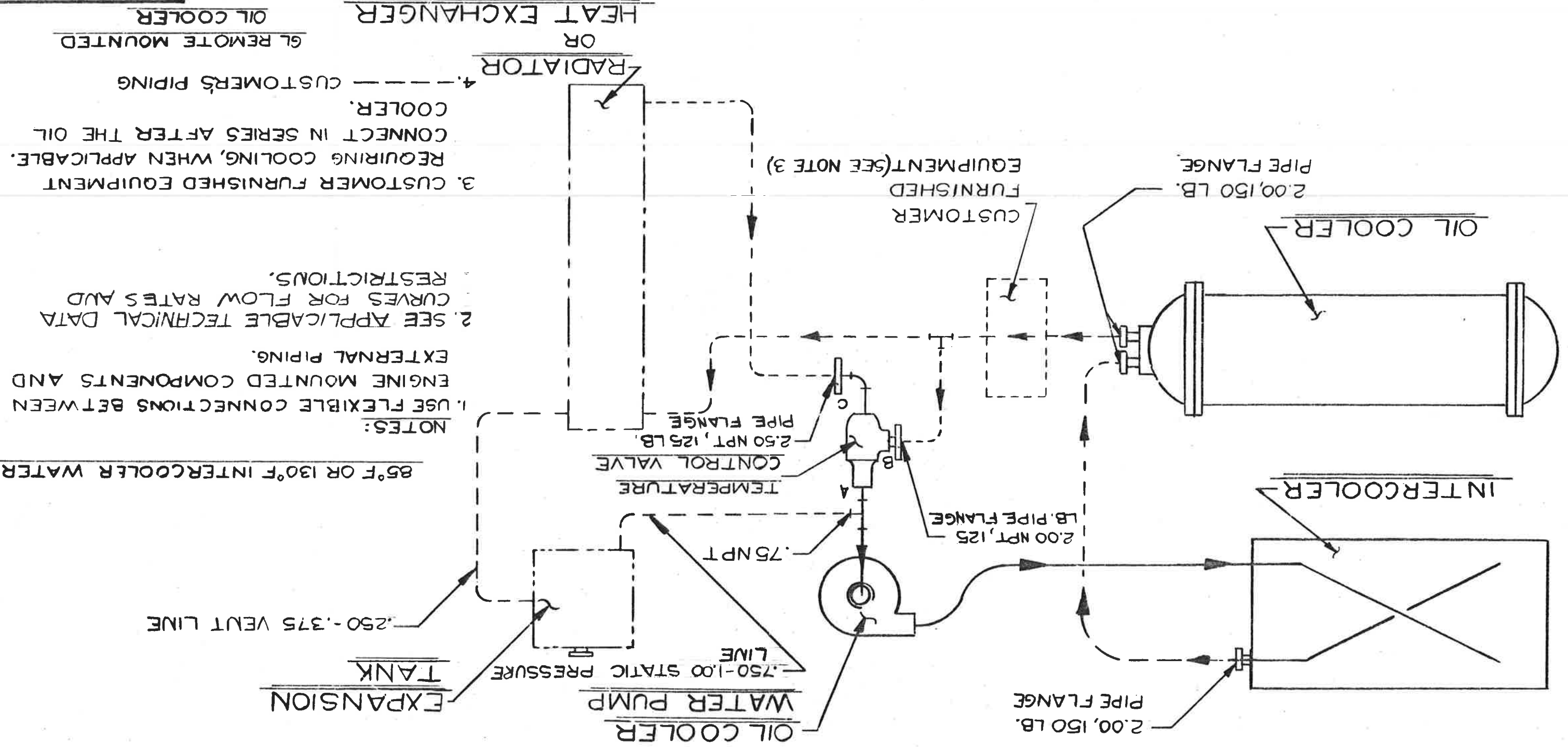
NAME  
SCHEMATIC  
WATER PIPING



THIS PRINT IS PROVIDED ON A RESTRICTED BASIS, NOT TO BE USED IN ANY WAY DETRIMENTAL TO THE INTEREST OF WAUKESHA ENGINE DIVISION.

DIMENSIONS ARE IN INCHES

UNLESS OTHERWISE SPECIFIED



- NOTES:
1. USE FLEXIBLE CONNECTIONS BETWEEN ENGINE MOUNTED COMPONENTS AND EXTERNAL PIPING.
  2. SEE APPLICABLE TECHNICAL DATA CURVES FOR FLOW RATES AND RESTRICTIONS.
  3. CUSTOMER FURNISHED EQUIPMENT REQUIRING COOLING, WHEN APPLICABLE, CONNECT IN SERIES AFTER THE OIL COOLER.
  4. CUSTOMER'S PIPING

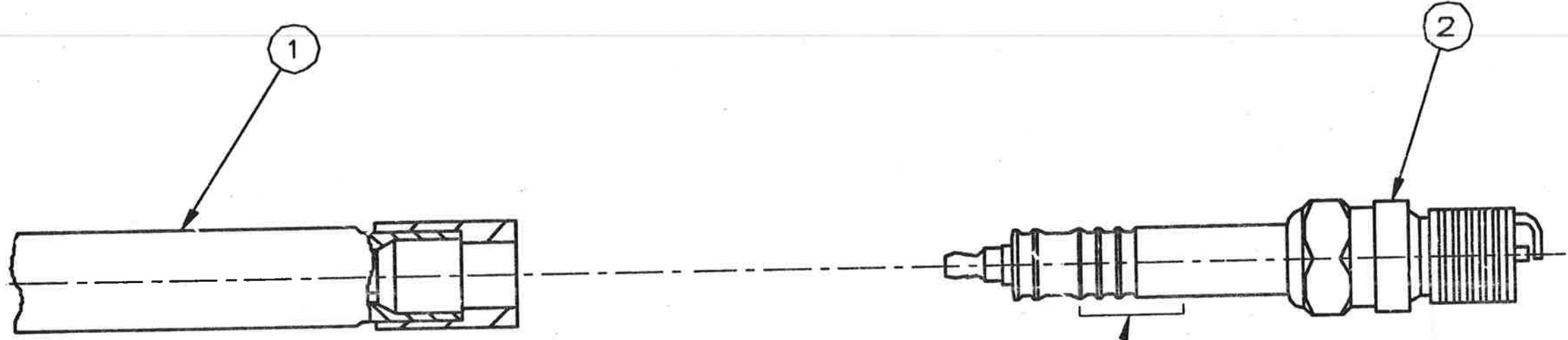
85°F OR 130°F INTERCOOLER WATER

ITEM	PART NO.	REQD.	NAME
109343 4-87	RELEASED		
109344 4-87	2.00 NPT, 125 LB PIPE FLANGE WAS 2.00 NPT (G-2), 2.50 NPT, 125 LB PIPE		
109344 4-87	FLANGE WAS 2.50 NPT. (D-3)		
8-88	11182		ADDED NOTES: 150-1.00 STATIC PRESSURE LINE (E-1), 250-.375 VENT LINE (G-2) NOTE 2 WAS: PRESSURE DROP THROUGH COOLING SYSTEM AND PIPING FROM OIL COOLER OUTLET TO WATER PUMP INLET, MUST NOT EXCEED 10 PSI. FOR 100 GPM FLOW RATE. (F-3)
8-88	11182		
8-88	11182		

7802	8-94	RELEASED	1211/2	11-96	DU PONT KRYTOX GPL-206 WAS DOW CORNING 4 (E4)
8011	9-94	ITEM 1 AS SPEC WAS 211357H (F1) ITEM 2 AS SPEC WAS 80999T (F1)	124558	10-99	REDRAWN ON AUTOCAD
8987	6-95	SILICON COATING ON THE SPARK PLUG WAS ON THE BOOT.			

S-07232-147

ITEM	PART NO.	RECD.	NAME
1	AS SPEC		CABLE ASM., SPARK PLUG
2	AS SPEC		SPARK PLUG

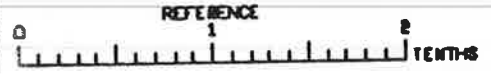


LIGHTLY COAT SPARK PLUG CERAMIC  
WHERE INDICATED WITH A HIGH  
TEMPERATURE DIELECTRIC GREASE  
SUCH AS DU PONT KRYTOX GPL-206  
OR EQUIVALENT.

AUTOCAD  
MAKE NO REVISIONS  
ON THIS REPRODUCIBLE

UNLESS OTHERWISE SPECIFIED  
DIMENSIONS ARE IN INCHES.

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BASIS NOT TO BE USED IN ANY WAY DETRI-  
MENTAL TO THE INTEREST OF VAUKESHA  
ENGINE DIVISION.

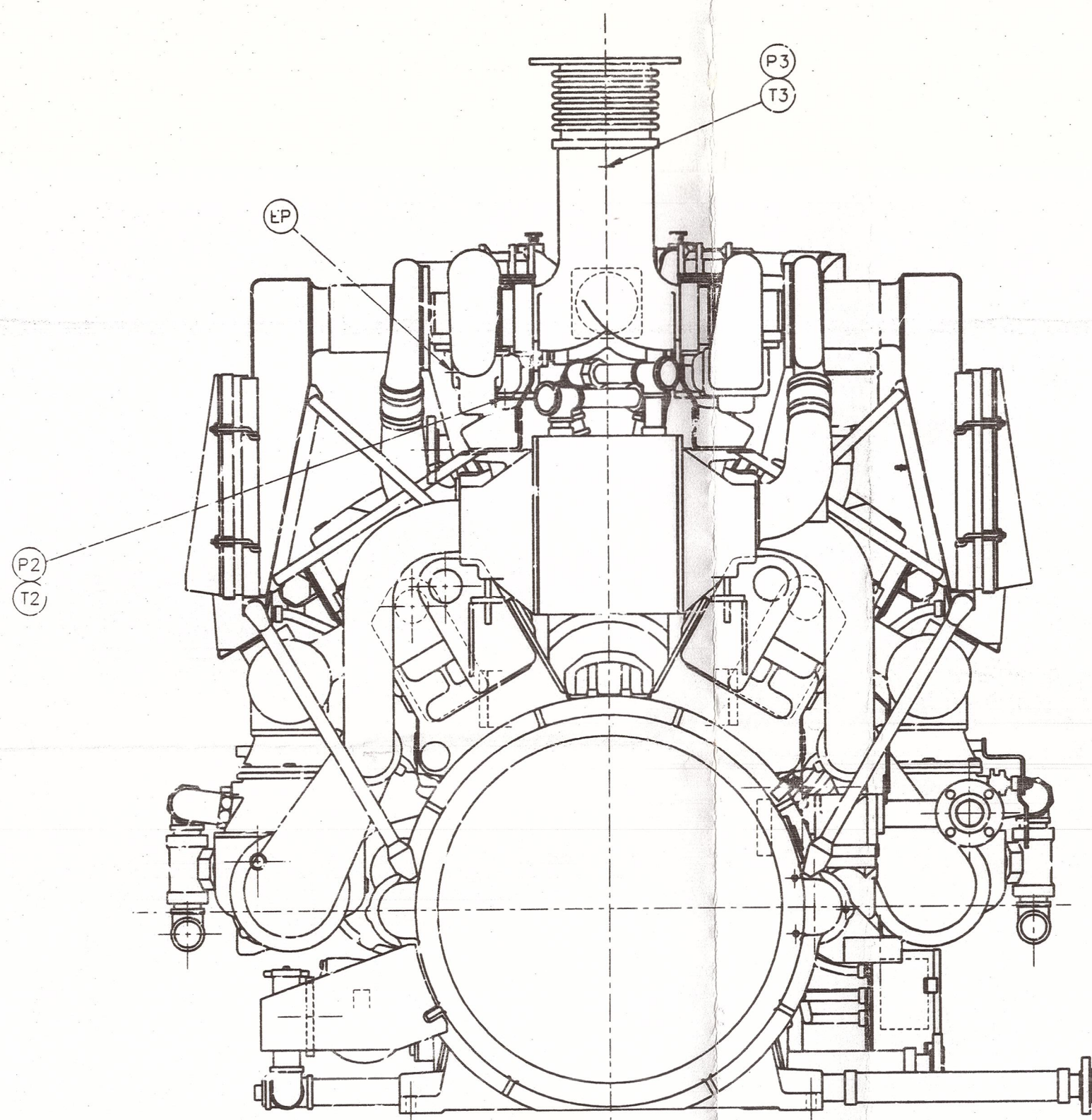


MODELS	REFERENCE DRAWINGS	MATERIAL SEE ABOVE	DR. CBW DATE 8-3-94	B			NAME
VHP	211357H	HEAT TREATMENT	CK GGG DATE 8-8-94				ASM. INSTRUCTIONS, CABLE ASM. TO SPARK PLUG
5115	C.C.		APP. RMP DATE 8-8-94				PART NO.
			FILE	WAUKESHA WI		S-07232-147	
						SHEET 1 OF 1 SCALE NONE	

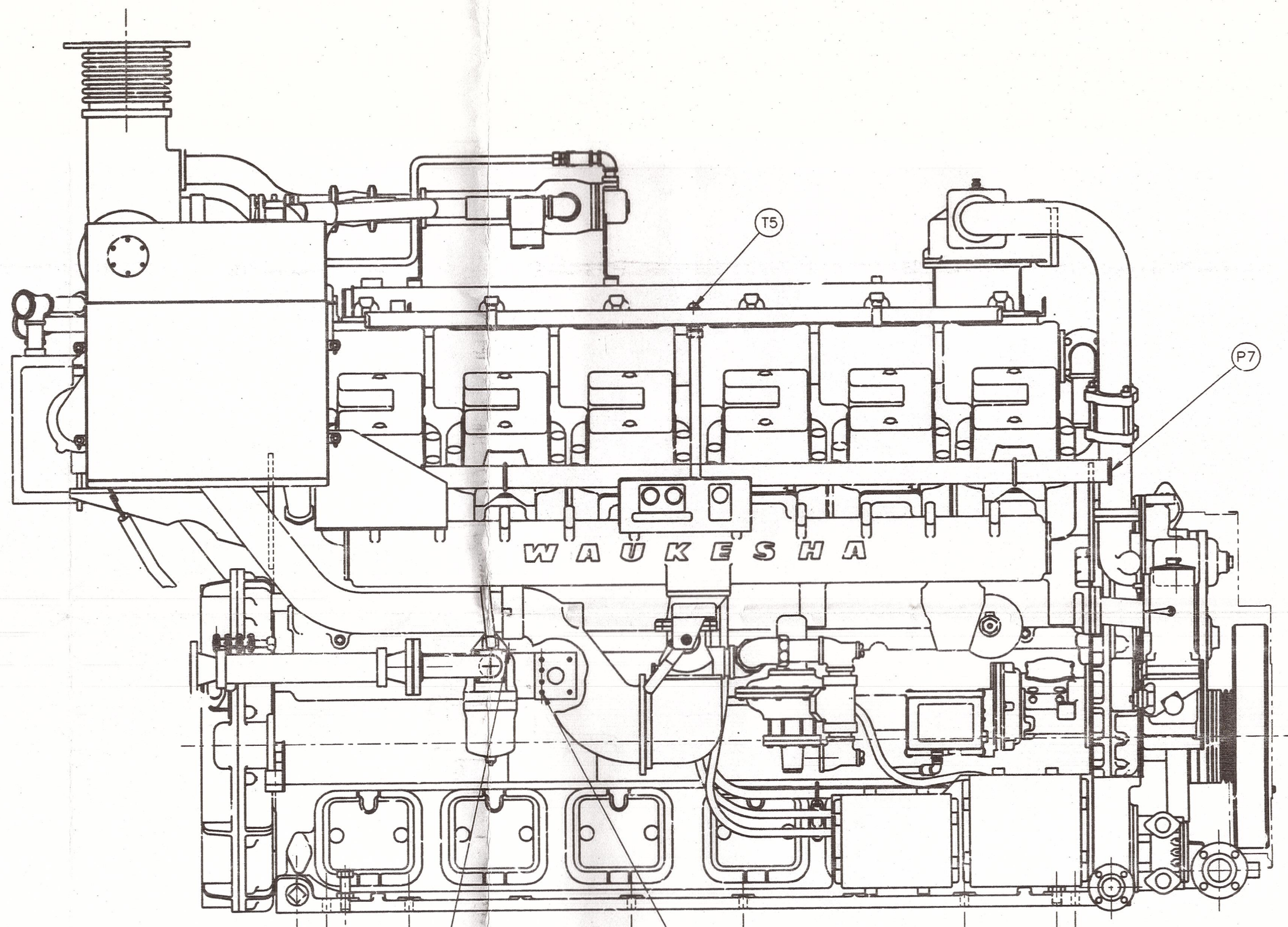
A B C D E F G H J K L M N P R S T

S-07232-201

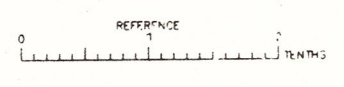
ITEM PART NO. RECD. NAME



REAR VIEW



RIGHT SIDE VIEW



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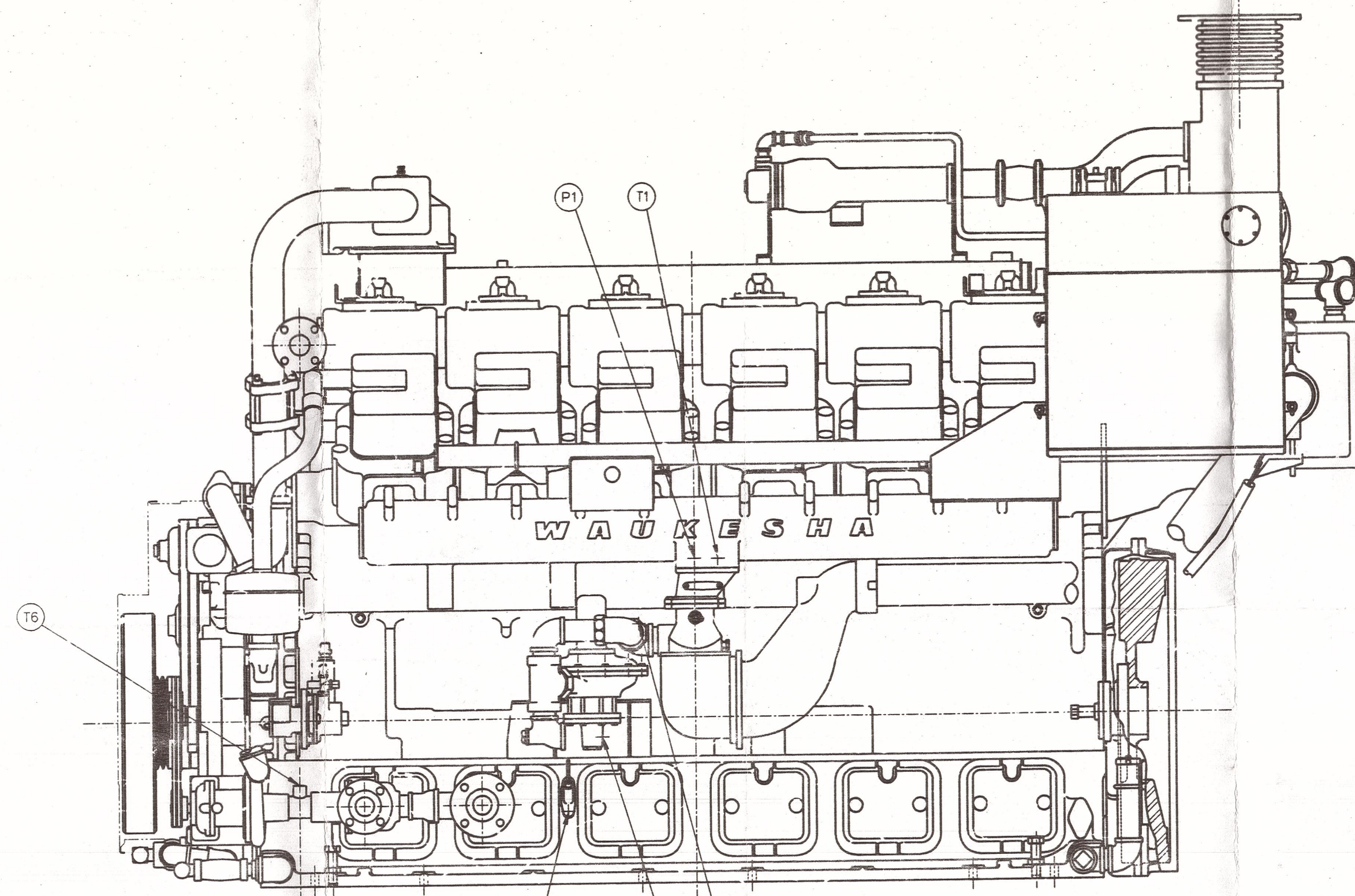
AUTOCAD MAKE NO REVISIONS ON THIS REPRODUCTION

NAME DIAGRAM, TEMPERATURE AND PRESSURE TEST POINTS

MODELS L5108CL L5/90CL L7042CL	REFERENCE DRAWINGS C.C.	MATERIAL HEAT TREATMENT	DR. <i>WJC</i> DATE 3-5-99 CK. <i>DOY</i> DATE 3-5-99 APP. <i>LC</i> DATE 3-8-99	FILE	 WALUKESHA WI	PART NO. S-07232-201 SHEET 2 OF 2 SCALE 1:8
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03-09-99

03-09-99



LEFT SIDE VIEW

**OFFICIAL PARAMETER NAMES**

**PRESSURES**

- P1 INTAKE MANIFOLD
- P2 EXHAUST MANIFOLD
- P3 EXHAUST BACK PRESSURE
- P4 OIL
- P5 CARBURATOR AIR
- P6 CARBURATOR FUEL
- P7 PRECHAMBER FUEL
- P8 CRANKCASE VACUUM
- P9 JACKET WATER

- TAP ON THE INLET TO THE MANIFOLD (INSIDE OR OUTSIDE IS OK)
- TAP IN THE BOTTOM OF THE TURBINE INLET ELBOW
- TAP IN THE TOP OF THE Y PIPE
- BOTTOM TAP OF PRESSURE PANEL ON RB
- FISHER 99 BALANCE LINE TEE
- TAP ON TOP OF THE ELBOW GOING TO THE CARB
- TAP ON FRONT END OF PRECHAMBER MANIFOLD (RIGHT BANK)
- TAP JUST BELOW THE DIPSTICK
- N/A

**TEMPERATURES**

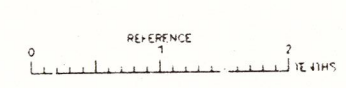
- T1 INTAKE MANIFOLD
- T2 EXHAUST MANIFOLD
- T3 EXHAUST STACK
- T4 OIL
- T5 JACKET WATER OUT
- T6 AUXILIARY WATER IN

- TAP ON THE INLET TO THE MANIFOLD (INSIDE OR OUTSIDE IS OK)
- TAP IN THE BOTTOM OF THE TURBINE INLET ELBOW
- TAP IN THE TOP OF THE Y PIPE OR UP TO 24" ABOVE Y PIPE
- TAP ON THE SHORT PIPE FROM STRAINER TO CRANKCASE
- TAP IN RIGHT SIDE OF HEADER
- TAP RIGHT BEFORE THE PUMP INLET

**OTHER**

- EP EXHAUST PROBE

- TAP IN SIDE OF TURBINE INLET ELBOW



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AUTOCAD MAKE NO REVISIONS ON THIS REPRODUCTION

NAME DIAGRAM, TEMPERATURE AND PRESSURE TEST POINTS

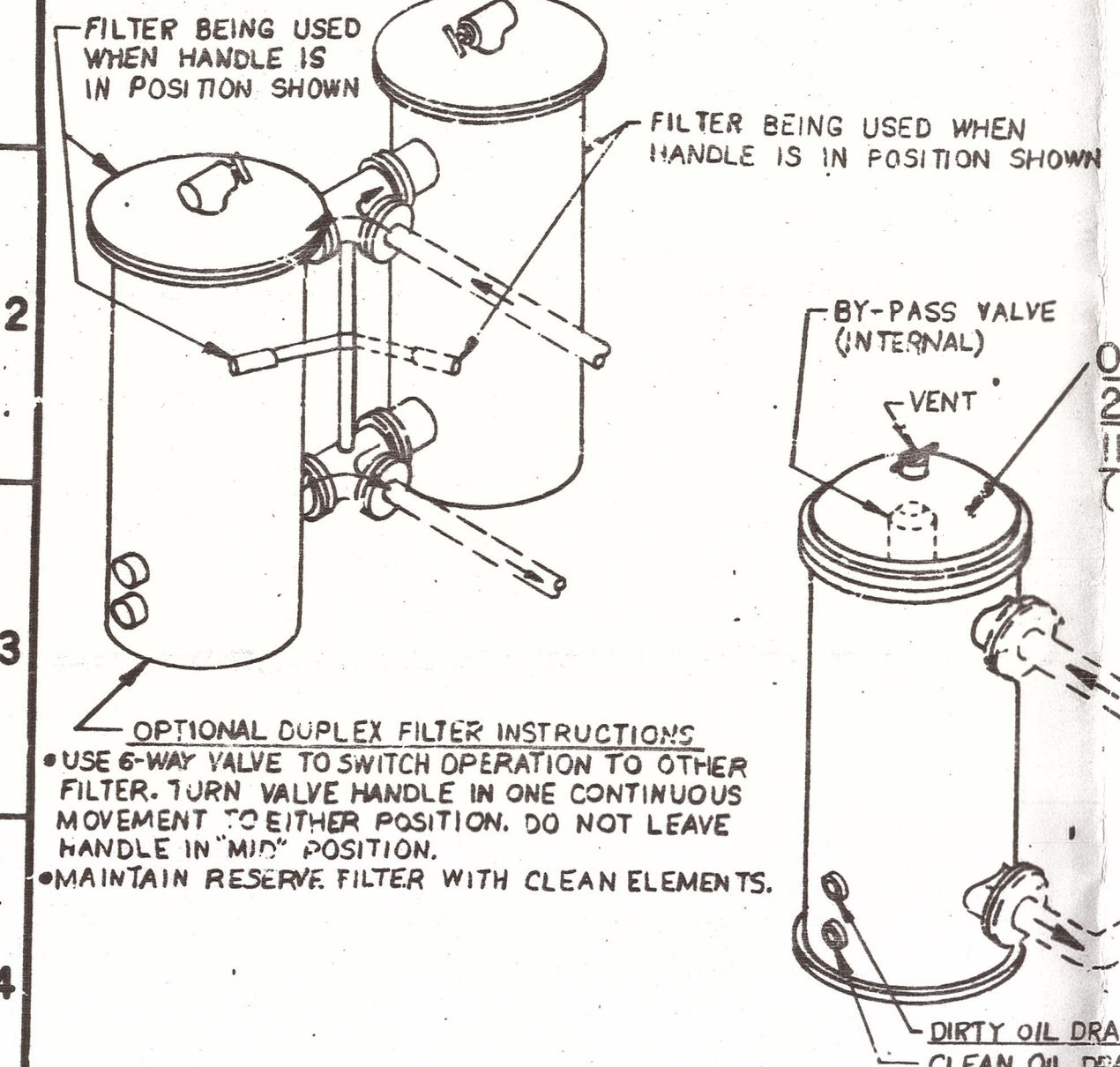
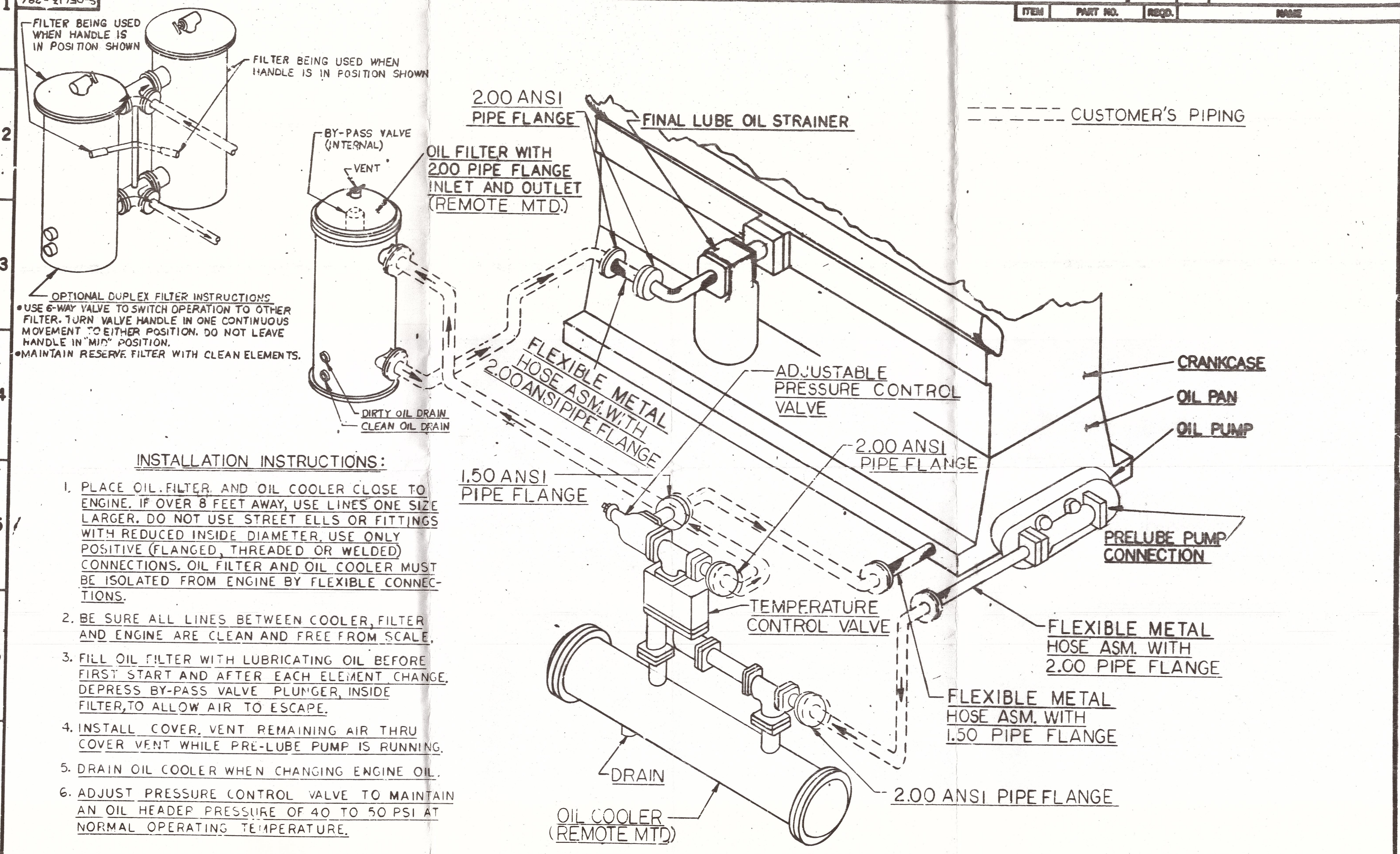
MODELS L5108CL L5790CL L7042CL	REFERENCE DRAWINGS C.C.	MATERIAL HEAT TREATMENT	DR. <i>DD</i> DATE 3-5-99 CK. <i>DD</i> DATE 3-5-99 APP. <i>DD</i> DATE 3-2-99	FILE		PART NO. S-07232-201 SHEET 1 OF 2 SCALE 1:8
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03-09-99

03-09-99

113369	2-91	RELEASED														
117924	9-94	ADDED DUPLEX FILTERS (B-2) FLEXIBLE WAS CORRECTED (E-4, H-6)	121425	1-97	A211857 WAS GA208 924 C 3 A211859 WAS MA208 629 A											
121425	1-97	S-05613-286 WAS SCSW 5-286 DELETED (RTHCS-506)														
982-81950-5																

ITEM	PART NO.	REQD.	NAME
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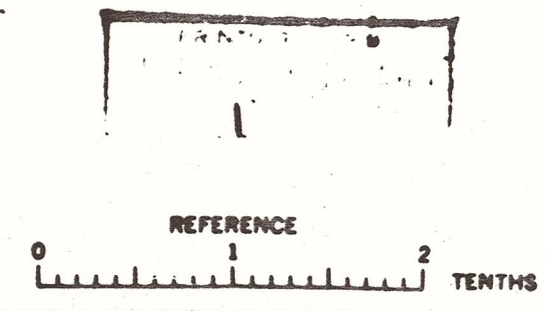
**OPTIONAL DUPLEX FILTER INSTRUCTIONS**

- USE 6-WAY VALVE TO SWITCH OPERATION TO OTHER FILTER. TURN VALVE HANDLE IN ONE CONTINUOUS MOVEMENT TO EITHER POSITION. DO NOT LEAVE HANDLE IN "MID" POSITION.
- MAINTAIN RESERVE FILTER WITH CLEAN ELEMENTS.

**INSTALLATION INSTRUCTIONS:**

1. PLACE OIL FILTER AND OIL COOLER CLOSE TO ENGINE. IF OVER 8 FEET AWAY, USE LINES ONE SIZE LARGER. DO NOT USE STREET ELLS OR FITTINGS WITH REDUCED INSIDE DIAMETER. USE ONLY POSITIVE (FLANGED, THREADED OR WELDED) CONNECTIONS. OIL FILTER AND OIL COOLER MUST BE ISOLATED FROM ENGINE BY FLEXIBLE CONNECTIONS.
2. BE SURE ALL LINES BETWEEN COOLER, FILTER AND ENGINE ARE CLEAN AND FREE FROM SCALE.
3. FILL OIL FILTER WITH LUBRICATING OIL BEFORE FIRST START AND AFTER EACH ELEMENT CHANGE. DEPRESS BY-PASS VALVE PLUNGER, INSIDE FILTER, TO ALLOW AIR TO ESCAPE.
4. INSTALL COVER. VENT REMAINING AIR THRU COVER VENT WHILE PRE-LUBE PUMP IS RUNNING.
5. DRAIN OIL COOLER WHEN CHANGING ENGINE OIL.
6. ADJUST PRESSURE CONTROL VALVE TO MAINTAIN AN OIL HEADER PRESSURE OF 40 TO 50 PSI AT NORMAL OPERATING TEMPERATURE.

**REMOTE MOUNTED OIL COOLER**



MODELS	REFERENCE DRAWINGS	MATERIAL
VHP	A211857	
12 CYL.	A211859	HEAT TREATMENT
C.C.		

THIS PRINT IS PROVIDED ON A RESTRICTED BASIS, NOT TO BE USED IN ANY WAY DETRIMENTAL TO THE INTEREST OF WAUKESHA ENGINE DIVISION.

DESIGNING ARE IN CHARGE. TWO-PHASE ENGINE DIVISION. IN THREE-PHASE ENGINE OPERATING 2-500 RPM. APPROX. 2-1/2" BY 2-1/2" DIA. SHAFT. APPROX. 2-1/2" DIA. SHAFT. APPROX. 2-1/2" DIA. SHAFT. APPROX. 2-1/2" DIA. SHAFT.

OR L.K.G. DATE 1-31-91  
OR G.G.G. DATE 5-8-91  
APR 980 DATE 11/3/91

**Waukesha** **BRASSER**

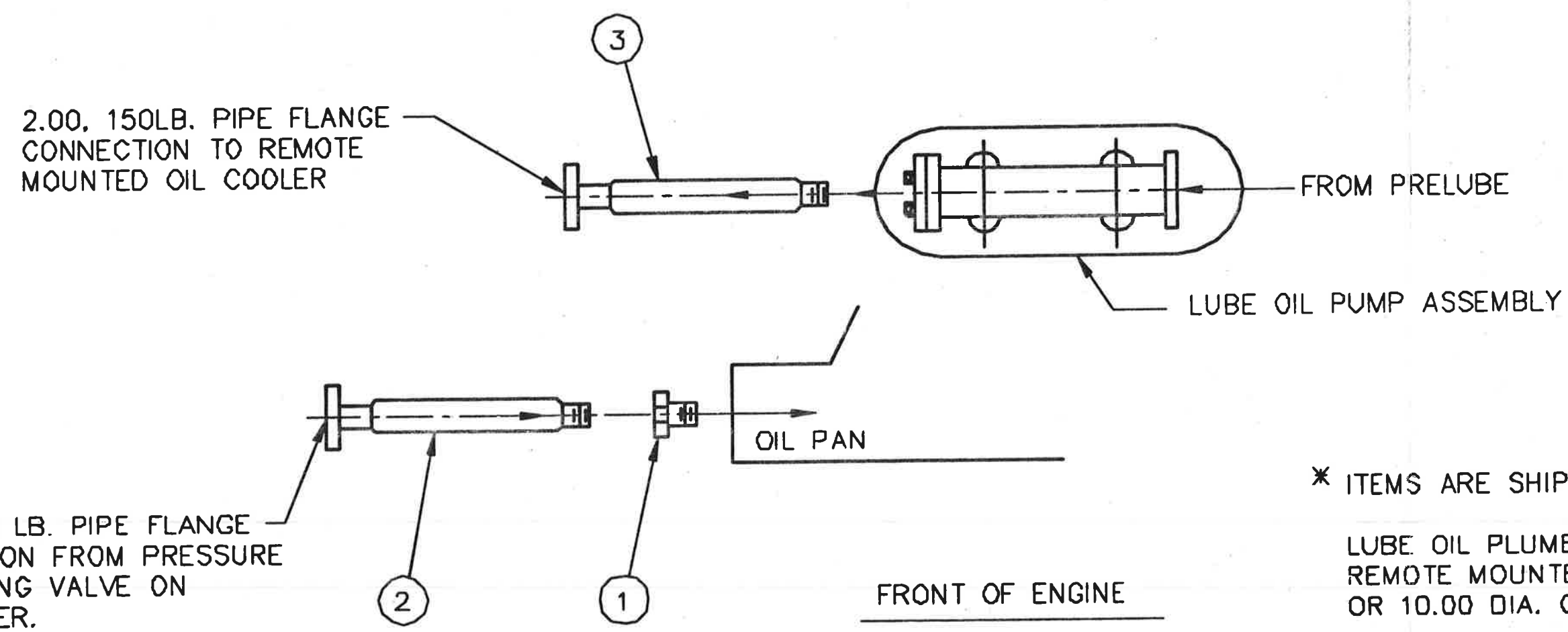
WAUKESHA, WIS.

NAME	SCHMATIC, LUBE OIL PIPING
PART NO.	S-05613-286
SHEET	1 OF 1

186002 4-91 RELEASED,SUPERSEDES SB5613-232  
 124558 10-99 REDRAWN ON AUTOCAD

S-05613-288

ITEM	PART NO.	REQD.	NAME
1	78212W	1	BUSHING, RED. 2.00-1.50
* 2	207534	1	HOSE ASM., FLEX. 1.50 NPT
* 3	207534A	1	HOSE ASM., FLEX. 2.00 NPT



2.00, 150LB. PIPE FLANGE CONNECTION TO REMOTE MOUNTED OIL COOLER

FROM PRELUBE

LUBE OIL PUMP ASSEMBLY

OIL PAN

1.50, 150 LB. PIPE FLANGE CONNECTION FROM PRESSURE REGULATING VALVE ON OIL COOLER.

\* ITEMS ARE SHIPPED LOOSE

LUBE OIL PLUMBING FOR REMOTE MOUNTED 8.00 OR 10.00 DIA. OIL COOLER

FRONT OF ENGINE

AUTOCAD  
 MAKE NO REVISIONS  
 ON THIS REPRODUCIBLE

UNLESS OTHERWISE SPECIFIED  
 DIMENSIONS ARE IN INCHES.

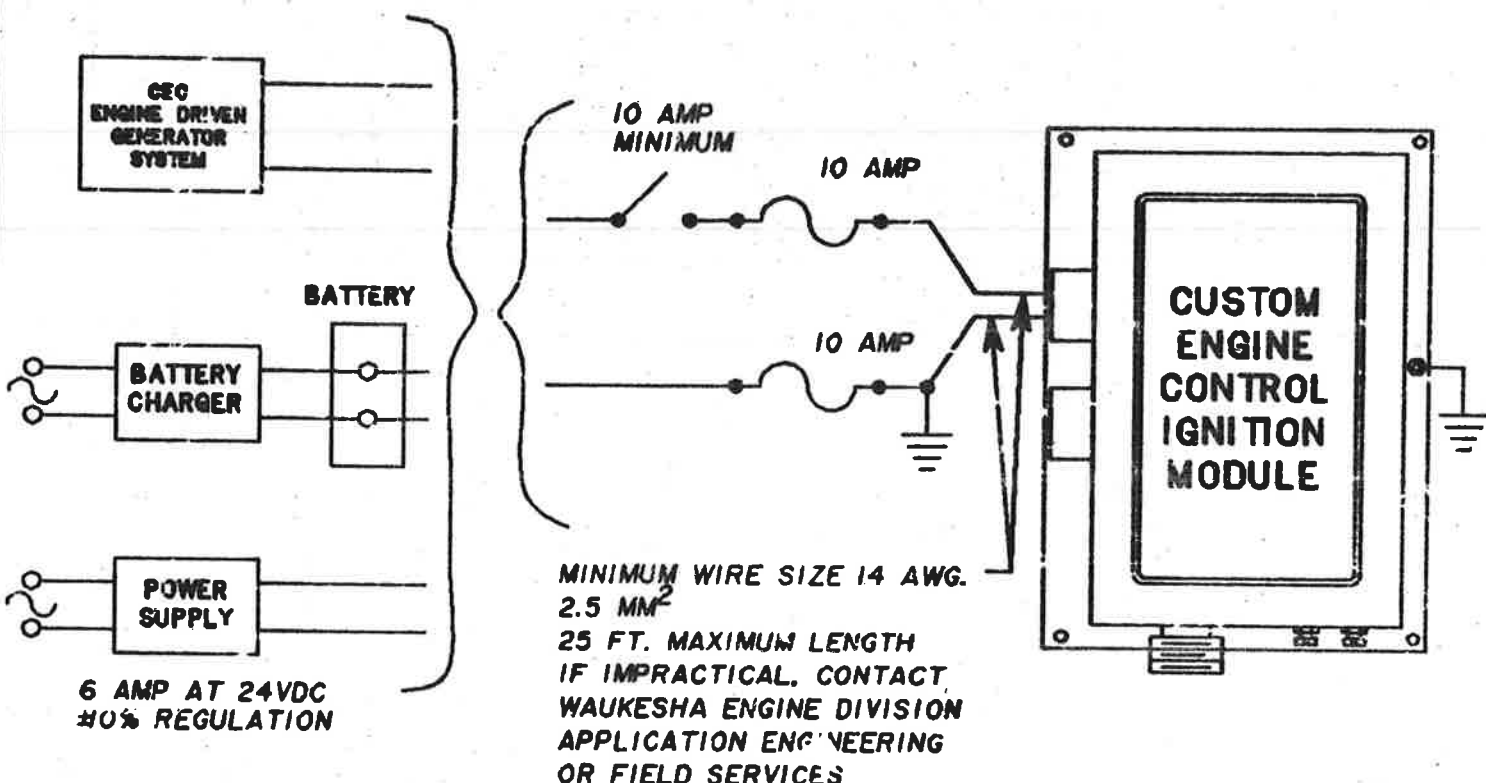
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NAME  
 DIAGRAM, OIL PLUMBING

MODELS VHP 12 CYL GAS	REFERENCE DRAWINGS SC5613-286	MATERIAL _____	DR. SFT DATE 4-24-91	<b>B</b>	Waukesha	PART NO. S-05613-288	
C.C. _____	HEAT TREATMENT _____	CK SFT DATE 4-24-91	FILE			WAUKESHA WI	SHEET 1 OF 1
		APP. SFT DATE 4-24-91					SCALE NONE

SA8311-1



**NOTES:**

An AC to DC power supply is not preferred unless care is taken to eliminate the possibility of a momentary loss of AC power which will result in an engine shutdown. An AC voltage filter (battery) is recommended to eliminate voltage fluctuations.

The GEC Ignition System will function properly with a power source as defined above. However, if the supply is capable of providing a pulse current (higher current level for a shorter period of time such that the average current is the same), the ignition will utilize that pulse capability. In this case, the voltage fluctuations on the supply wiring, including the ground return to the power source, may cause erratic operation of other electrical devices. For this reason, it is recommended that the ignition power source wiring, specifically the ground return, be sized for at least 30 amps even though the average current will be less than 6 amps.

**CAD**  
MAKE NO REVISIONS  
ON THIS REPRODUCIBLE



TITLE  
**POWER REQUIREMENTS  
GEC IGNITION MODULE**

DR.	HLL 8-3-93	<b>SA</b> 8311-1
CH.	HJS 8-12-93	
APP.	JAD 8-12-93	





PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				DISPLACEMENT PUMP		SHEET OF	
CUSTOMER : APACHE CANADA LIMITED				REV	BY	DATE	REVISION DESCRIPTION
				0	GWW	00.09.20	FOR PURCHASE
PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE							
SERVICE : ENGINE & COMPRESSOR LUBE OIL TRANSFER PUMP							
JOB NO. : 99404 TAG NO: P-260							
MFR. : WILDEN MODEL NO: T2/AAAB/BN/BN/ABN T2							
1 SERVICES : ENGINE LUBE OIL TRANSFER PUMP							
2							
3 NO OF PUMP REQD		1		NO OF DRIVER REQD		N/A	
4 PUMP - MFR		WILDEN		TYPE		DIAPHRAGM	
5 DESIGN CONDITIONS				PERFORMANCE			
6 LIQUID		SAE 30W LUBE OIL		RATIO		1:1	
7 FLOW : MIN		CFD N/A		SUCTION : MIN		psig	
8 NOR		CFD N/A		NOR		psig	
9 MAX		CFD N/A		MAX		psig	
10 TEMP : MIN		° F 50		DISCHARGE : MIN		psig	
11 NOR		° F 70		NOR		psig	
12 MAX		° F 200		MAX		psig	
13 VISCOSITY: MIN		cP 2279		DIFF PRESS : MIN		psig	
14 NOR		cP 767		NOR		psig	
15 MAX		cP 22		MAX		psig	
16 DENSITY : MIN		lb / cu. ft 55.8		VAPOR PRESS TEMP		° F	
17 NOR		lb / cu. ft 55.4		VAPOR PRESS		psig	
18 MAX		lb / cu. ft 52.7		NPSHA		in ATM	
19 CORROSION CAUSED BY				SOLIDS		NONE	
20							
21 CONSTRUCTION & MATERIALS							
22 CASING		ALUMINUM		WETTED PARTS		ALUMINUM	
23 GEAR / ROTOR				AIR CHAMBERS		ALUMINUM	
24 STATOR				CENTER SECTION		ALUMINUM	
25 WEAR PLATE				AIR VALVE		BRASS	
26 CONNECTION: GAS INLET		1/4" FNPT		DIAPHRAGMS		BUNA-N (RED DOT)	
27 CONNECTION: GAS OUTLET		1/2" FNPT		VALVE BALL		BUNA-N (RED DOT)	
28 CONNECTION: SUCTION		1" FNPT		VALVE SEAT		ALUMINUM	
29 DISCHARGE		3/4" FNPT		VALVE SEAT O-RING		BUNA-N (RED DOT)	
30							
31 DRIVER DETAILS (NOT APPLICABLE)							
32 DIRECT COUPLED				PUMP RPM		ELECTRIC MOTOR	
33 BELT DRIVE				ENCLOSURE		VOLTS/ PHASE/ CYCLES	
34 GEAR / GEAR MOTOR				MFR		FRAME	
35 VARIABLE SPEED				BEARING / LUBE		TYPE	
36 DRIVER RPM				INSULATION		FULL LOAD AMPS	
37 -POWER AT MAX RPM		Hp				LOCKED ROTOT AMP	
38 -POWER AT MIN RPM		Hp				TEMP RISE ° F	
39 BASE				DRIP RIM		COUPLING - MFR	
40 WEIGHT-PUMP & BASE		lb				- MODEL	
41 - DRIVE		lb					
42							
43							
44							
45							
46 MISC. INFORMATION							
47 SURFACE PREP		MFR. STD.		PAINT SPEC/ COLOR		MFR. SRD.	
48							
49							
50							
51							
52							
53							
54 REMARKS:							
55							

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				DISPLACEMENT PUMP			SHEET OF							
CUSTOMER : APACHE CANADA LIMITED PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE SERVICE : ENGINE & COMPRESSOR LUBE OIL TRANSFER PUMP JOB NO. : 99404 TAG NO: P-270 MFR. : WILDEN MODEL NO: T2/AAAB/BN/BN/ABN T2				REV	BY	DATE	REVISION DESCRIPTION							
				0	GWW	00.09.20	FOR PURCHASE							
1 SERVICES : COMPRESSOR LUBE OIL TRANSFER PUMP														
2														
3 NO OF PUMP REQD				1	NO OF DRIVER REQD			N/A	SUPPLIED BY	WAJAX PROCESS TECH.				
4 PUMP MFR				WILDEN	TYPE			DIAPHRAGM	MOUNTED BY	PROPAK				
5 DESIGN CONDITIONS						PERFORMANCE								
6 LIQUID				SAE 30W LUBE OIL			RATIO		1:1					
7 FLOW : MIN				CFD	N/A	SUCTION : MIN		psig	MAXIMUM FLOW	gpm	35			
8				NOR	CFD	N/A	NOR		psig	AIR INLET	1/4" FNPT			
9				MAX	CFD	N/A	MAX		psig	FLUID INLET	1" FNPT			
10 TEMP : MIN				° F	50	DISCHARGE : MIN		psig	FLUID OUTLET		3/4" FNPT			
11				NOR	° F	70	NOR		psig	MAX OPERATING PRESSURE		125 psig		
12				MAX	° F	200	MAX		psig	SOLIDS MAX DIAMETER		1/8"		
13 VISCOSITY: MIN				cP	2279	DIFF PRESS : MIN		psig						
14				NOR	cP	767	NOR		psig	WEIGHT	lb	26		
15				MAX	cP	22	MAX		psig	DISCH. PRESS. HEAD		psig	40	
16 DENSITY : MIN				lb / cu. ft	55.8	VAPOR PRESS TEMP		° F	INLET GAS PRESSUR			psig	100	
17				NOR	lb / cu. ft	55.4	VAPOR PRESS		psig	LIQUID FLOW		gpm	35	
18				MAX	lb / cu. ft	52.7	NPSHA		in	ATM	GAS CONSUMPTION		SCFM	13
19 CORROSION CAUSED BY							SOLIDS		NONE					
20														
21 CONSTRUCTION & MATERIALS														
22 CASING				ALUMINUM			WETTED PARTS		ALUMINUM					
23 GEAR / ROTOR							AIR CHAMBERS		ALUMINUM					
24 STATOR							CENTER SECTION		ALUMINUM					
25 WEAR PLATE							AIR VALVE		BRASS					
26 CONNECTION: GAS INLET				1/4" FNPT			DIAPHRAGMS		BUNA-N (RED DOT)					
27 CONNECTION: GAS OUTLET				1/2" FNPT			VALVE BALL		BUNA-N (RED DOT)					
28 CONNECTION: SUCTION				1" FNPT			VALVE SEAT		ALUMINUM					
29 DISCHARGE				3/4" FNPT			VALVE SEAT O-RING		BUNA-N (RED DOT)					
30														
31 DRIVER DETAILS (NOT APPLICABLE)														
32 DIRECT COUPLED							PUMP RPM		ELECTRIC MOTOR					
33 BELT DRIVE							ENCLOSURE		VOLTS/ PHASE/ CYCLES					
34 GEAR / GEAR MOTOR							MFR		FRAME					
35 VARIABLE SPEED							BEARING / LUBE		TYPE					
36 DRIVER RPM							INSULATION		FULL LOAD AMPS					
37 -POWER AT MAX RPM				Hp				LOCKED ROTOT AMP		° F				
38 -POWER AT MIN RPM				Hp				TEMP RISE		° F				
39 BASE							DRIP RIM		COUPLING - MFR					
40 WEIGHT-PUMP & BASE				lb				- MODEL						
41 - DRIVE				lb										
42														
43														
44														
45														
46 MISC. INFORMATION														
47 SURFACE PREP				MFR. STD.		PAINT SPEC/ COLOR		MFR. SRD.						
48														
49														
50														
51														
52														
53														
54 REMARKS:														
55														



# Safety Supplement



# WILDEN®

AIR OPERATED DOUBLE DIAPHRAGM PUMPS

A DOVER RESOURCES COMPANY



## SUPLEMENTO DE SEGURIDAD INDUSTRIAL

### WILDEN PUMP & ENGINEERING CO. MANUAL DE SEGURIDAD INDUSTRIAL

Complementa el Manual de Ingeniería, Operación y Mantenimiento

**LEA SIEMPRE PRIMERO ESTE MANUAL ANTES DE LA INSTALACIÓN, LA PUESTA EN MARCHA, O EL MANTENIMIENTO.**

**Este manual de seguridad industrial se aplica a todas las bombas Wilden y comprende instrucciones para la instalación, utilización y mantenimiento seguro de su bomba.**

**Además de este manual, en el Manual de Ingeniería, Operación y Mantenimiento se dan instrucciones más detalladas sobre la instalación, sugerencias de operación e instrucciones de mantenimiento y solución de problemas de la bomba en cuestión.**

En este manual usted puede ser advertido en cuanto a riesgos remanentes. Este tipo de información esta precedida de la siguiente etiqueta.

**⚠ PRECAUCIÓN** = Riesgos o prácticas inseguras que pueden resultar en lesiones personales severas, muerte o daños sustanciales a los productos o a la propiedad.

#### **⚠ PRECAUCIÓN**

- Verifique el modelo de la bomba recibida contra la orden de compra o contra la hoja de especificaciones.
- Verifique la torsión de todos los tornillos contra las especificaciones de la tabla de torques.
- Retire los tapones de embarque.
- Las bombas que se deban sumergir deben tener partes recubiertas y no recubiertas compatibles con el material que está siendo bombeado.
- Las bombas sumergidas deben tener una manguera conectada a la descarga de aire de la bomba y el aire descargado debe liberarse por encima del nivel de líquido.
- Las bombas deben lavarse meticulosamente con agua antes de su instalación.
- Las bombas FDA, USDA, y 3A se deben desinfectar antes de su uso.

#### **⚠ PRECAUCIÓN**

- Deje correr aire por la línea de 10 a 20 segundos antes de conectarla a la bomba para asegurar que todas las líneas estén libres de escombros.
- Siempre use gafas de seguridad cuando opere la bomba. Si ocurre una ruptura de diafragma, el material que está siendo bombeado puede ser forzado a salir por la descarga de aire.

**⚠ PRECAUCIÓN:** Todas las mangueras/tuberías de succión y descarga deben ser seleccionadas para que resistan la presión y la temperatura de la aplicación específica.

**⚠ PRECAUCIÓN:** No exceda de 0.7 bar (10 psig) la presión de la entrada del líquido al portal de la bomba; esto crearía la posibilidad de un desgaste prematuro y la falla de las partes.

**⚠ PRECAUCIÓN:** No exceda de 8.5 bares (125 psig) de presión el suministro de aire. Los modelos UL listados no deben excederse de un suministro de aire de 50 psi.

**1.0** Debido a la acción pulsante de la bomba, puede haber inestabilidades laterales durante la operación normal, de modo que las bombas con patas deben ser sujetadas a concreto estructuras metálicas.

**1.1** La mayoría de las bombas Wilden pueden usarse en aplicaciones sumergidas sólo cuando las partes recubiertas y no recubiertas son compatibles con el material que esta siendo bombeado. Si la bomba se va a usar en una aplicación sumergida, se debe conectar una manguera a la descarga de aire de la bomba y el aire descargado debe liberarse por encima del nivel de líquido.

**1.2** Cada bomba Wilden tiene una capacidad máxima de sólidos particular. Siempre que exista la posibilidad de que objetos sólidos más grandes sean succionados dentro de la bomba, se debe usar una rejilla para prevenir el daño de la bomba y el consiguiente riesgo para el operador.

#### **1.3 Instrucciones de Montaje**

Instrucciones detalladas sobre el montaje se encuentran en la sección 7 Del Manual de Ingeniería, Operación y Mantenimiento.

**⚠ PRECAUCIÓN:** **1.4** Asegúrese de que exista una ventilación apropiada de los tanques o recipientes que contienen el líquido a suministrar. Debido a la capacidad de bombeo de alto vacío de las bombas, una ventilación inapropiada de los tanques de suministro puede ocasionar la implosión de los tanques cuando se haga evacuado completamente el fluido.

# SUPLEMENTO DE SEGURIDAD INDUSTRIAL

## PRECAUCIÓN: 1.5 RIESGOS ELÉCTRICOS

Prevenga las chispas de electricidad estática. Fuego o explosiones puede resultar, especialmente cuando se trasiegan líquidos inflamables. La bomba, tubería, válvulas, tanques u otros equipos deben de estar debidamente puestos a tierra.

## PRECAUCIÓN: 1.6 RIESGOS DE TEMPERATURA

El material que esta siendo bombeado debe ser compatible con los materiales de construcción de la bomba y los límites establecidos de temperatura según se indica en la Guía de Resistencia Química de Wilden (E4).




## PRECAUCIÓN: 1.7 RIESGOS GENERADOS POR RUIDO

El Ruido de la bomba puede exceder 75 DBA bajo ciertas condiciones, por ejemplo: Presión alta de suministro de aire y poca contrapresión en la descarga. Los periodos extensos de operación bajo dichas condiciones pueden crear un riesgo a los operadores que estén trabajando en la cercanía de las bombas. Utilice dispositivos de protección auditiva apropiados.


## PRECAUCIÓN: 1.8 MATERIALES PELIGROSOS

- a. Las instrucciones de mantenimiento en la sección ocho de su manual de Ingeniería, Operación y Mantenimiento deben de acatarse para evitar fallas en los diafragmas.
- b. Cuando sea posible, las bombas Wilden acondicionadas con Teflón® deben dotarse del Sistema de Monitoreo de Diafragmas Wil-Gard™ II, el cual detecta la rotura del diafragma antes de que el material peligroso salga de la bomba.
- c. **AVISO:** Todos los sujetadores deben revisarse para que cumplan las especificaciones de torque dados en las especificaciones de la bomba, listados en la Sección 8 del Manual de Ingeniería, Operación Y Mantenimiento.
- d. El operario debe obtener la Hoja de Información de Seguridad Industrial del Material por parte del proveedor de todos los materiales que estén siendo bombeados con el fin de cumplir las instrucciones de manejo apropiadas.

## 1.9 COMPATIBILIDAD QUÍMICA

-  **PRECAUCIÓN: a.** Cuando se especifique una bomba para una aplicación en particular, los materiales de construcción de recubrimiento de la bomba y los materiales elastoméricos deben ser compatibles con el fluido del proceso. Por favor consulte la Guía de Resistencia Química de Wilden (E4) o su distribuidor Wilden local autorizado para mayor información.
-  **PRECAUCIÓN: b.** Reacción explosiva: Algunos materiales como los solventes de tipo hidrocarburo halogenado no se deben bombear con una bomba construida en aluminio debido a la posibilidad de que se genere una reacción explosiva.
-  **PRECAUCIÓN: c.** La compatibilidad química de ciertos materiales con una bomba de construcción particular (y en especial las partes recubiertas con plástico) puede cambiar a medida que la concentración del material y la temperatura varíen. Por favor consulte a su distribuidor Wilden local autorizado para mayor información.

## 2.0 OPERACIÓN

-  **PRECAUCIÓN: 2.1** Asegúrese de que todos los operadores estén debidamente capacitados y que utilicen procedimientos de operación y mantenimiento seguros como son descritos en este manual de seguridad, la Guía para Usuarios de bombas y en el manual de Ingeniería, Operación y mantenimiento de su bomba.

### Límites de Temperatura

Polipropileno	32°F to 175°F	0°C to 79°C
PVDF	10°F to 225°F	-12°C to 107°C
Acetal con relleno de carbón	-20°F to 150°F	-28.9°C to 65.6°C
Teflon® PFA	-20°F to 300°F	-28.9°C to 148.9°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N®	10°F to 180°F	-12.2°C to 82.2°C
Nordel®	-60°F to 280°F	-51.1°C to 137.8°C
Viton®	-40°F to 350°F	-40°C to 176.7°C
Wil-Flex™	-40°F to 225°F	-40°C to 107.2°C
Poliuretano	10°F to 150°F	12.2°C to 65.6°C
Saniflex™	-20°F to 220°F	-28.9°C to 104.4°C
Teflon® PTFE	40°F to 300°F	4.4°C to 148.9°C



# SUPPLÉMENT À LA NOTICE DE SERVICE



**FRENCH**

## WILDEN PUMP & ENGINEERING CO.


**Consignes de sécurité** - Supplément à la notice de service

### LIRE ATTENTIVEMENT CETTE NOTICE AVANT D'INSTALLER, D'UTILISER, OU DE REPARER LA POMPE.

Cette notice de sécurité s'applique à toutes les pompes WILDEN et comprend les instructions de sécurité pour mise en service, utilisation, installation et maintenance.

En complément à cette notice, de plus amples détails concernant l'installation, les opérations de maintenance et la recherche des pannes vous seront fournis dans la notice de service de la pompe concernée.

Dans cette notice, vous serez informés des dangers par les signes suivants:

 **ATTENTION** = Dangers ou pratiques dangereuses pouvant provoquer des lésions corporelles ou des dommages matériels.

 **ATTENTION**

- A réception du matériel, vérifier l'état de l'emballage et faire éventuellement des réserves auprès du transporteur en cas de détérioration.
- Déballer la pompe et constater son état. Vérifier sa conformité par rapport à la commande.
- Enlever les obturateurs de protection avant de raccorder la tuyauterie.
- Vérifier le serrage des vis et écrous. Resserrer aux couples préconisés si besoin.

• Certaines pompes Wilden peuvent être utilisées en immersion quand les colliers, la boulonnerie, le bloc central et le distributeur sont compatibles chimiquement.

L'échappement de la pompe doit être remonté à l'air libre au moyen d'un tube compatible avec le produit pompé et d'une section suffisante pour ne pas freiner la pompe.

- Les pompes alimentaires doivent être stérilisées avant usage.

 **ATTENTION**

- Avant d'intervenir sur la pompe, couper l'air comprimé et l'alimentation électrique si elle est présente. Vidanger les tuyauteries avant de démonter les connexions aspiration et refoulement et, si nécessaire, rincer la pompe.
- Porter des lunettes de sécurité lorsque la pompe fonctionne et lors d'interventions. Si une membrane se perce, le fluide pompé peut être expulsé par l'échappement de la pompe.

 **ATTENTION**

- La tuyauterie d'aspiration et de refoulement doit être prévue pour supporter la pression et la température de service et être compatible chimiquement avec le fluide pompé.

Le diamètre de la tuyauterie d'aspiration doit être au minimum égal à celui de la taille de la pompe, voire plus dans le cas de pompage de fluides visqueux. Le tuyau doit supporter la dépression importante de la pompe sans s'écraser. Prévoir un tuyau renforcé. La tuyauterie de refoulement doit être également au minimum du diamètre de sortie de la pompe. Une tuyauterie d'un diamètre plus important peut être indispensable dans le cas de longueurs importantes avec un fluide visqueux. Il ne doit pas y avoir de prises d'air et les raccordements doivent être réalisés dans les règles de l'art. La pompe ne doit en aucun cas supporter la tuyauterie. Le raccordement sera effectué sans contraintes mécaniques.

 **ATTENTION**

- Ne pas dépasser 0.7 bar à l'aspiration de la pompe (0.5 bar pour les membranes PTFE). En dépassant cette limite, la durée de vie des membranes peut être fortement réduite et provoquer une fuite de produit à l'échappement de la pompe.

 **ATTENTION:** Ne dépasser en aucun cas 8.5 bars en alimentation d'air. La pompe M1 est limitée à 7.5 bars, et la pompe M8 haute pression à 5.5 bars.

**1.0** Le mouvement alternatif de la pompe peut induire une certaine instabilité durant le fonctionnement. Les pieds doivent être correctement fixés sur un sol plat et de niveau.


**1.1** Certaines pompes Wilden peuvent être utilisées en immersion quand les colliers, la boulonnerie, le bloc central et le distributeur sont compatibles chimiquement.

L'échappement de la pompe doit être remonté à l'air libre au moyen d'un tube compatible avec le produit pompé et d'une section suffisante pour ne pas freiner la pompe.

**1.2** Ne pas dépasser la taille maximum de particule admissible pour chaque type de pompe. Consulter votre distributeur Wilden pour plus d'informations et utiliser une filtration adéquate.

### **1.3 Installation détaillée.**

Les recommandations d'utilisations sont indiquées dans le chapitre 7 de votre notice de service.

 **ATTENTION: 1.4** S'assurer que les réservoirs sont équipés d'une mise à l'air avant de démarrer la pompe. Celle-ci peut engendrer une dépression importante qui risque de conduire à leur déformation.

# SUPPLÉMENT À LA NOTICE DE SERVICE

## ATTENTION: 1.5

Attention à l'électricité statique. Un incendie ou une explosion sont possibles surtout lorsque des liquides inflammables sont pompés. La pompe, la tuyauterie, les vannes, les réservoirs et tous les autres équipements doivent impérativement être raccordés à la masse.

## ATTENTION: 1.6 TEMPÉRATURE DE SERVICE

Les matériaux de construction de la pompe ainsi que la tuyauterie d'aspiration et de refoulement doivent être prévus pour supporter la pression et la température de service et être compatible chimiquement avec le fluide pompé (à vérifier dans le guide Wilden E4).

## ATTENTION: 1.7 BRUIT DE FONCTIONNEMENT

Les bruits d'échappement et de fonctionnement de la pompe peuvent dépasser 75 dba dans certaines conditions notamment lorsque la pression d'alimentation en air est importante et que la pression au refoulement est nulle. Réduire la pression d'air d'alimentation de la pompe. Canaliser l'échappement en dehors de la zone de travail.


## ATTENTION: 1.8 FLUIDES POMPÉS DANGEREUX

- Les opérations de maintenance concernant la prévention des ruptures de membranes sont détaillées dans le chapitre 8 de la notice de service.
- Quand cela est possible, utiliser le système de détection de rupture Wil-Gard™ II (non ADF) qui détecte la présence du fluide entre la membrane PTFE et sa contre-membrane.
- Vérifier le serrage des colliers, vis et écrous. Resserrer aux couples préconisés dans la notice de service si besoin.
- L'utilisateur doit impérativement demander la fiche de sécurité du fluide pompé à son fabricant afin de vérifier les signes de sécurité.

## 1.9 COMPATIBILITÉ CHIMIQUE

 ATTENTION: a. Les matériaux de construction de la pompe doivent toujours être compatibles avec le fluide pompé. A vérifier dans le guide de résistance chimique Wilden (E4) ou demander un complément d'information à votre distributeur Wilden.

 ATTENTION: b. Explosion : certains fluides comme les solvants halogénés ou chlorés (trichloréthylène par ex.) ne doivent jamais être pompés avec une pompe en construction aluminium.

 ATTENTION: c. Vérifier les compatibilités chimiques dans le cas de variations de températures et/ou de concentrations. Dans le cas d'une rupture de membrane, l'air et l'huile du circuit de commande entrant en contact avec le fluide peuvent provoquer une explosion. Vérifier la compatibilité de l'air et de l'huile de lubrification ou utiliser une pompe à fonctionnement en air sec.

## 2.0 MODE OPÉRATOIRE:

 ATTENTION: 2.1 S'assurer que le personnel utilisateur est suffisamment compétent et a bien subi une formation sur le matériel. Lire attentivement la notice de service et les consignes de sécurité avant la mise en service.

### Limites de températures

Polypropylene	32°F to 175°F	0°C to 79°C
PVDF	10°F to 225°F	-12°C to 107°C
Acétal chargé carbone	-20°F to 150°F	-28.9°C to 65.6°C
Teflon® PFA	-20°F to 300°F	-28.9°C to 148.9°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N®	10°F to 180°F	-12.2°C to 82.2°C
Nordel®	-60°F to 280°F	-51.1°C to 137.8°C
Viton®	-40°F to 350°F	-40°C to 176.7°C
Wil-Flex™	-40°F to 225°F	-40°C to 107.2°C
Polyurethane	10°F to 150°F	12.2°C to 65.6°C
Saniflex™	-20°F to 220°F	-28.9°C to 104.4°C
Teflon® PTFE	40°F to 300°F	4.4°C to 148.9°C





## WILDEN PUMP & ENGINEERING CO.

### SICHERHEITS-BESTIMMUNGEN

Anhang zur Konstruktions-, Betriebs- und Wartungsanleitung

#### **VOR INSTALLATION, INBETRIEISNAHME ODER WARTUNG IMMER ZUERST DIESES HANDBUCH LESEN!**

**Diese für alle Wilden-Pumpen geltenden Sicherheits-Bestimmungen enthält Anweisungen zum sicheren Einbauen, Betreiben und Warten Ihrer Pumpe.**

**Zusätzlich zu diesem Handbuch finden Sie ausführlichere Anweisungen zu Installation, Betrieb und Wartung sowie zur Fehlersuche in der zur jeweiligen Pumpe gehörenden Konstruktions-, Betriebs- und Wartungsanleitung.**

In diesem Handbuch finden Sie Warnhinweise, die auf Gefahren aufmerksam machen. Diesen Warnhinweisen ist jeweils das folgende Symbol vorangestellt:

**⚠ VORSICHT!** = Gefahren oder unsichere Vorgehensweisen, die schwere, wenn nicht tödliche Verletzungen oder beträchtliche Sach-/Vermögensschäden zur Folge haben können.

#### **⚠ VORSICHT!**

- Das erhaltene Pumpenmodell auf Übereinstimmung mit dem Auftrag bzw. Datenblatt prüfen.
- Alle Schrauben gemäß den Angaben in der Drehmomenttabelle nachziehen. Versandverschlüsse entfernen.
- Bei Pumpen, die getaucht werden sollen, müssen sowohl die benetzten als auch die nicht benetzten Teile mit dem zu pumpenden Produkt verträglich sein.
- Bei getauchten Pumpen muß ein Schlauch an den Entlüftungsanschluß der Pumpe angeschlossen werden, der oberhalb des Flüssigkeitsspiegels endet. Pumpen sind vor dem Einbau gründlich mit Wasser durchzuspülen.
- FDA-, USDA- und 3A-Pumpen sind vor Benutzung zu desinfizieren.

#### **⚠ VORSICHT!**

- Druckluftleitung vor dem Anschließen an die Pumpe 10 bis 20 Sekunden lang durchblasen, um sicherzugehen, daß sich keine Fremdkörper mehr in der Rohrleitung befinden.
- Immer Schutzbrille tragen, da bei einem Bruch der Membran die Prozeßflüssigkeit aus dem Entlüftungsanschluß herauspritzen kann.

**⚠ VORSICHT!** Alle Saug- und Druckleitungen bzw. -rohre müssen so ausgelegt sein, daß sie dem Druck und der Temperatur der spezifischen Anwendung widerstehen können.

**⚠ VORSICHT!** Am Saugstutzen der Pumpe sollte ein Druck von 0,7 bar (10 psig) nicht überschritten werden; andernfalls droht vorzeitiger Verschleiß und Ausfall von Teilen.

**⚠ VORSICHT!** Der Druck der Druckluftzufuhr darf 8,5 bar (125 psi) nicht übersteigen (bei UL-geführten Modellen 50 psi).

**1.0** Aufgrund der Hin- und Herbewegung der Pumpe können bei normalem Betrieb seitliche Schwankungen auftreten. Aus diesem Grund sollten Pumpen mit Füßen mit Hilfe von Bolzen auf Baustahl- bzw. Betonelementen befestigt werden.

**1.1** Die meisten Wilden-Pumpen eignen sich für Tauchanwendungen nur dann, wenn sowohl ihre benetzten als auch ihre nicht benetzten Teile mit dem zu pumpenden Produkt verträglich sind. Bei für Tauchanwendungen vorgesehenen Pumpen muß ein Schlauch an den Entlüftungsanschluß der Pumpe angeschlossen werden, der oberhalb des Flüssigkeitsspiegels endet.

**1.2** Jede Wilden-Pumpe läßt feste Partikel bis zu einem bestimmten maximalen Durchmesser passieren. Wenn die Möglichkeit besteht, daß feste Partikel mit größerem Durchmesser in die Pumpe gesaugt werden können, muß ein Sieb in die Saugleitung eingebaut werden, um eine Beschädigung der Pumpe und damit verbundene Gefahren für den Bediener zu vermeiden.

#### **1.3 Installierungs-Anweisungen**

Detaillierte Installierungs-Anweisungen finden Sie im Abschnitt 7 oder im Handbuch "Konstruktion, Betrieb und Wartung" für Ihre Pumpe.

**⚠ VORSICHT! 1.4** Die richtige Belüftung von Tanks und Kesseln, aus denen Flüssigkeit abgesaugt wird, muß sicherstellt sein. Wegen der Fähigkeit der Pumpe, starken Unterdruck zu erzeugen, kann eine schlechte Belüftung dieser Versorgungstanks zu deren Implosion führen, wenn die Flüssigkeit ganz abgesaugt wird.



# SICHERHEITS-BESTIMMUNGEN

## **VORSICHT! 1.5 ELEKTRISCHE GEFAHREN**

Durch elektrostatische Aufladung kann Funkenbildung entstehen. Bei Förderung entzündliches Flüssigkeiten kann dies zu Entzündungen bzw. Explosionen führen. Pumpen, Ventile, Behälter, u anderes Zubehör muß geerdet werden.

## **VORSICHT! 1.6 TEMPERATURGEFAHREN**

Die gepumpte Flüssigkeit muß laut der Wilden-Korrosionstabelle (E4) mit den Konstruktionswerkstoffen und Temperaturgrenzen der Pumpe verträglich sein.




## **VORSICHT! 1.7 DURCH LÄRM VERURSACHTE GEFAHREN**

Der Geräuschpegel der Pumpe kann unter gewissen Betriebsbedingungen 75 Dexibel überschreiten, z B. bei hoher Druckzuführung oder wenn das Abflußrohr sehr eng oder gar nicht vorhanden ist. Werden Pumpen über längere Zeit unter solchen Bedingungen betrieben, sind in der Nähe dieser Pumpen arbeitende Bediener gefährdet. Geeigneten Gehörschutz verwenden.

## **VORSICHT! 1.8 GEFAHRSTOFFE**

- a. Instandhaltung entsprechend Punkt 8 Ihrer Betriebsanleitung verhindert Membranbruch.
- b. Mit Teflon® ausgerüstete Wilden-Pumpen sollten, wo möglich, mit dem Wil-Gard™ II Membranüberwachungssystem ausgestattet werden, das Membrandefekte erkennt, bevor gefahrenträchtige Prozeßflüssigkeit entweichen kann.
- c. **HINWEIS:** Sämtliche Befestigungsschrauben sind darauf zu prüfen, ob sie den in Abschnitt 8 der Konstruktions-, Betriebs- und Wartungsanleitung angegebenen Anzugsdrehmomenten entsprechend angezogen sind.
- d. Vom Chemikalien-Lieferanten ist für alle zu pumpenden Produkte ein Gefahrstoff-Datenblatt mit den entsprechenden Hinweisen für den Umgang mit diesen anzufordern.

## **1.9 CHEMISCHE VERTRÄGLICHKEIT**

-  **VORSICHT!** a. Beim Spezifizieren einer Pumpe für eine bestimmte Anwendung ist darauf zu achten, daß benetzte Pumpenwerkstoffe und Elastomere mit der Prozeßflüssigkeit verträglich sind. Weitere Informationen entnehmen Sie bitte der Wilden-Korrosionstabelle (E4), oder Sie erhalten sie von Ihrem autorisierten Wilden-Händler.
-  **VORSICHT!** b. Explosive Reaktion: Bestimmte Stoffe wie halogenierte Kohlenwasserstoffe dürfen wegen möglicher explosiver Reaktionen nicht mit aus Aluminium bestehenden Pumpen gefördert werden.
-  **VORSICHT!** c. Die chemische Verträglichkeit bestimmter Werkstoffe einer Pumpenkonstruktion, insbesondere benetzte Kunststoffteile, kann bei veränderlicher Produktkonzentration und -temperatur schwanken. Weitere Informationen erhalten Sie von Ihrem autorisierten Wilden-Händler.

## **2.0 BEDIENUNG**

-  **VORSICHT! 2.1** Bedienung der Pumpe nur durch geschultes u. eingewiesenes Personal unter Beachtung d. Sicherheitsbestimmungen, des Pumpenhandbuches u. der Betriebsanleitung.

### **Temperatur Grenzen**

Polypropylene	32°F to 175°F	0°C to 79°C
PVDF	10°F to 225°F	-12°C to 107°C
Carbon-Filled		
Acetal	-20°F to 150°F	-28.9°C to 65.6°C
Teflon® PFA	-20°F to 300°F	-28.9°C to 148.9°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N®	10°F to 180°F	-12.2°C to 82.2°C
Nordel®	-60°F to 280°F	-51.1°C to 137.8°C
Viton®	-40°F to 350°F	-40°C to 176.7°C
Wil-Flex™	-40°F to 225°F	-40°C to 107.2°C
Polyurethane	10°F to 150°F	12.2°C to 65.6°C
Saniflex™	-20°F to 220°F	-28.9°C to 104.4°C
Teflon® PTFE	40°F to 300°F	4.4°C to 148.9°C





**WILDEN PUMP & ENGINEERING CO.**

## **MANUALE DI SICUREZZA**


Supplemento del Engineering Operation and Maintenance Manual  
(Manuale d'Uso e Manutenzione)

### **LEGGERE SEMPRE QUESTO MANUALE PRIMA DI INSTALLARE, AVVIARE O EFFETTUARE LA MANUTENZIONE.**

**Questo manuale di sicurezza si applica a tutte le pompe Wilden e comprende istruzioni per l'avviamento, l'uso, l'installazione e la manutenzione.**

**Oltre a questo manuale, istruzioni più dettagliate su installazione, esercizio, manutenzione e riparazione sono date nel manuale Engineering, Operation and Maintenance (Norme d'uso e Manutenzione) allegato ad ogni pompa.**

In questo manuale sono descritti i probabili rischi da evitare. Questo tipo di informazione è preceduto dal seguente logo.

 **ATTENZIONE** = Rischi o manovre pericolose che potrebbero causare lesioni personali gravi, morte o considerevoli danni al prodotto o alle cose.

#### **ATTENZIONE**

- Controllare il modello della pompa ricevuta a fronte di un ordine o di una specifica.
- Serrare nuovamente i bulloni secondo le specifiche fornite dalla tabelle delle coppie.
- Rimuovere i tappi di plastica.
- Le pompe usate in applicazioni sommerse devono avere sia le parti a contatto del fluido che quelle a contatto con l'aria compatibili con il materiale pompato.
- Le pompe usate in applicazioni sommerse devono avere un flessibile collegato allo scarico dell'aria e l'aria di scarico con vogliata sopra la superficie del liquido.
- Le pompe devono essere lavate con acqua prima di essere installate.
- Le pompe FDA, USDA e 3A devono essere sanitizzate prima dell'installazione.

#### **ATTENZIONE**

- Soffiare la tubazione dell'aria per 10-20 secondi prima di collegarla alla pompa per essere sicuri che siano eliminati eventuali detriti.
- Indossare sempre gli occhiali protettivi. In caso di rottura delle membrane possono verificarsi espulsioni del materiale pompato dallo scarico dell'aria.

 **ATTENZIONE:** Tutte le tubazioni ed i flessibili di aspirazione e di mandata dovranno essere calcolati per resistere alla pressione e alla temperatura richieste dall'applicazione in questione.

 **ATTENZIONE:** Non superare 0,7 barg di pressione del liquido all'aspirazione della pompa; questo potrebbe provocare la rottura prematura delle parti di usura.

 **ATTENZIONE:** Non superare 8,5 barg di pressione aria di alimentazione. I modelli approvati U.L. non devono superare 3,5 barg.


**1.0** A causa dell'azione alternativa della pompa, fenomeni di spinta laterale possono verificarsi durante il normale funzionamento, pertanto le pompe dotate di piedini devono essere fissate a un piano di supporto in metallo.

**1.1** La maggior parte delle pompe Wilden può essere usata in applicazioni sommerse solo quando tutte le parti che la compongono (a contatto e non a contatto del fluido) siano compatibili con il prodotto pompato.

**1.2** Ogni pompa Wilden è caratterizzata da una dimensione massima di solidi pompabili. Quando esiste la possibilità che solidi più grandi possano essere aspirati dalla pompa, un filtro deve essere montato sulla tubazione di aspirazione per prevenire danni alla pompa e conseguenti rischi per l'operatore.

### **1.3 Istruzione Dettagliata**

Consultare la sezione 7 del manuale d'uso e manutenzione della pompa.

 **ATTENZIONE: 1.4** Assicurarsi che i serbatoi contenenti il liquido da pompare siano adeguatamente areati. A causa dell'elevato grado di vuoto generato dalla pompa una areazione non adeguata di questi serbatoi può causare l'implosione quando venissero completamente svuotati.

## **⚠ ATTENZIONE: 1.5 RISCHI DA ELETTRICI**

Prevenire la formazione di cariche elettrostatiche. Fiamme o esplosioni possono essere generate, specialmente in presenza di liquidi infiammabili. La pompa, e tubazioni, le valvole, i serbatoi e tutti gli altri componenti devono essere provvisti di una adeguata messa a terra.

## **⚠ ATTENZIONE: 1.6 RISCHI DI TEMPERATURA**

I fluidi pompati devono essere compatibili con i materiali di costruzione della pompa ed i limiti di temperatura ammessi come riportato nella Tabella di compatibilità chimica della Wilden.

## **⚠ ATTENZIONE: 1.7 RISCHI DA ELEVATA RUMOROSITA'**

La rumorosità della pompa può superare i 75 dba in alcune condizioni operative, come, per esempio quando el alimentazione dell' aria é a pressione elevata e assenza o bassl valori di prevaenza in mandata. Lunghi periodi di funzionamento in tali condizioni possono creare pericolo per gli operatori vicini alla pompa. Usare adeguate protezioni dell'udito.

## **⚠ ATTENZIONE: 1.8 MATERIALI PERICOLOSI**

- Le istruzioni indicate nella sezione 8 del manuale d'uso e manutenzione della pompa devono essere seguite per la rottura della membrana.
- Dove possibile, le pompe Wilden dovrebbero essere equipaggiate con il sistema di monitoraggio Wilden Wil-Gard II™, che rileva la rottura della membrana prima che il fluido pericoloso esca dalla pompa.
- AVVISO:** Tutti gli elementi di serraggio devono essere controllati per assicurarsi che siano stati serrati con le coppie di serraggio specificate nella Sezione 8 del Engineering Operation and Maintenance Manual (Manuale d'Uso e Manutenzioni).
- L'utilizzatore dovrebbe ottenere dal fornitore le Norme di Sicurezza per tutti i materiali pompati con adeguate istruzione sui modi di maneggiarli.

### **1.9 COMPATIBILITA' CHIMICA**

- ATTENZIONE:** Quando si seleziona una pompa per una certa applicazione i materiali costruttivi a contatto con il fluido pompato e gli elastomeri devono essere chimicamente compatibili con esso. Consultare la Tabella di compatibilità chimica della Wilden o la Generalcontrol per maggiori dettagli.
- ATTENZIONE:** Reazione esplosiva: Alcuni materiali come i solventi alogenati non dovrebbero essere pompati con una pompa in alluminio perchè potrebbe verificarsi una reazione esplosiva.
- ATTENZIONE:** Per alcuni tipi di pompa, in particolare per quelle con le parti a contatto del fluido in plastica, la compatibilità chimica verso alcuni fluidi può variare cambiando la temperatura e la concentrazione del prodotto. Consultare la Generalcontrol, distributore autorizzato, per maggiori informazioni.

### **2.0 FUNZIONAMENTO**

- ATTENZIONE:** Assicurarsi che tutti gli operatori siano adeguatamente istruiti e che si attengano scrupolosamente alle istruzioni di esercizio e manutenzione indicate in questo manuale di sicurezza, nella guida per l'utilizzatore e nel Manuale d'Uso e Manutenzione della pompa.

#### **Limiti Di Temperatura**

Polypropylene	32°F to 175°F	0°C to 79°C
PVDF	10°F to 225°F	-12°C to 107°C
Carbon-Filled		
Acetal	-20°F to 150°F	-28.9°C to 65.6°C
Teflon® PFA	-20°F to 300°F	-28.9°C to 148.9°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N®	10°F to 180°F	-12.2°C to 82.2°C
Nordel®	-60°F to 280°F	-51.1°C to 137.8°C
Viton®	-40°F to 350°F	-40°C to 176.7°C
Wil-Flex™	-40°F to 225°F	-40°C to 107.2°C
Polyurethane	10°F to 150°F	12.2°C to 65.6°C
Saniflex™	-20°F to 220°F	-28.9°C to 104.4°C
Teflon® PTFE	40°F to 300°F	4.4°C to 148.9°C





## SUPLEMENTO DE SEGURANÇA WILDEN PUMP & ENGINEERING CO. MANUAL DE SEGURANÇA

Suplemento do manual de engenharia, operação e manutenção das bombas Wilden

**POR FAVOR LEIA AS INSTRUÇÕES DESSE MANUAL ANTES DE INSTALAR, OPERAR E PARA REALIZAR MANUTENÇÃO NA SUA BOMBA WILDEN.**

**Esse manual de segurança abrange todas as bombas Wilden e a informação nele contido refere-se a segura instalação, uso e manutenção de sua bomba.**

**Adicional a este manual, informações e instruções mais detalhadas referente a instalação, operação e manutenção são encontradas na manual de Engenharia, Operação e Manutenção da bomba em questão.**

O manual de segurança contém importante informação referente a possíveis problemas na área de segurança. Esse tipo de informação é precedido pelo seguinte sinal.

**⚠ CAUTELA!!!!** Uso indevido desse produto pode resultar em ferimentos graves ou morte, ou falha do produto, ou danos materiais e a propriedade.

**⚠ CAUTELA!!**

- Verifique o modelo da bomba e a sua nota fiscal ou tabela de especificações.
- Aperte todos as porcas para as especificações na tabela.
- Retire todos os plug.
- Bombas submersas necessitam ter todas as partes (em contato com a solução e estéril) testadas para compatibilidade com solução em questão.
- Bombas submersas necessitam ter uma mangueira conectada na saída do escapamento para atmosfera.
- E aconselhável lavar as bombas antes de instala-las.
- Bombas com denominação FDA, USDA e 3A necessitam passar por um processo sanitário antes do uso.

**⚠ CAUTELA!!**

- Antes de conectar linha de ar, tenha certeza que linha esta desobstruída.
- Sempre use óculos de proteção quando operando as bombas. Caso ocorra fratura ou falha do diafragma, solução poderá escapar pela saída do escapamento.

**⚠ CAUTELA!!**

Certifique-se que as linhas de tubulação de entrada e saída, além das conexões sejam designadas a suportar as temperaturas e pressões em questão.

**⚠ CAUTELA!!**

Pressão na entrada do líquido não deve exceder 0.7 bar (10 psig).

**⚠ CAUTELA!!** Pressão na entrada do ar não deve exceder 8.5 bar (125 psig). Nas Bombas listadas UL, Pressão não deve exceder 50 psig.

**1.0** Devido á acção recíproca da bomba, pode ter instabilidades laterais durante a operação normal. Por isso as bombas com patas devem ser sujeitas a estruturas metálicas ou concreto.

**1.1** Quase todas as bombas Wilden podem ser submersas, contanto que todos os materiais presentes na bomba sejam compatíveis quimicamente com a solução a ser bombeada. Bombas submersas precisam ter uma mangueira conectada na saída do escapamento para atmosfera.

**1.2** Cada modelo das bombas Wilden tem a capacidade de bombear partículas sólidas. O uso de um crivo é recomendado quando houver a possibilidade de que partículas sólidas maiores que a capacidade da bomba para prevenir falha ou rompimento do diafragma e risco de acidentes com o operador.

### 1.3 Instruções De Instalação

Instruções detalhadas sobre a instalação são fornecidas na secção 7 do manual de engenharia, operação e manutenção.

**⚠ CAUTELA!! 1.4** Certifique-se para que haja ventilação apropriada nos tanques que armazenam líquidos bombeados. Devido a alta capacidade de sucção da bomba, tanques que não são devidamente ventilados podem implodir quando bombeado.

## ⚠ CAUTELA!! 1.5

Prevenir a formação de eletricidade estática. Fogo ou explosão podem ocorrer especialmente na presença de líquidos inflamáveis. A bomba, as válvulas, e outros equipamentos devem ser aterrados.

## ⚠ CAUTELA!! 1.6 EFEITOS DA TEMPERATURA

Material bombeado deve ser compatível com material de construção da bomba e limites de temperatura – favor consultar Guia de resistência química da Wilden (E4).

## ⚠ CAUTELA!! 1.7 RISCOS NOCIVOS COM RELAÇÃO A POLUIÇÃO SONORA

O ruído da bomba pode ultrapassar 75 DBA Devido a certas condições de operação. Por exemplo: Alta pressão de entrada de ar e pouca contrapressão na descarga. Exposição durante elevados períodos pode ocasionar efeitos nocivos ao operador e/ou pessoas nas proximidades. Use devida proteção sonora.

## ⚠ CAUTELA!! 1.8 RISCOS COM RELAÇÃO A MATERIAIS

- Instruções na seção 8 do Manual de Uso, Manutenção e Operação devem ser seguidas para evitar falha prematura do diafragma.
- Quando possível, bombas que usam elastômeros Teflon® devem disponer do sistema Wil-Gard™ Monitoramento de Diafragma, que ira detectar falha do diafragma antes do que o material escape pela saída de ar.
- AVISO:** Todos os parafusos e porcas devem ser checados para assegurar que os mesmos estão em conformidade com as especificações dadas na seção 8 do manual de Engenharia, Operacao e Manutenção.
- Usuário deve obter Planilha de Dados de Material e Segurança do fabricante de todos os materiais bombeados e como reagir em caso de emergência.

## 1.9 COMPATIBILIDADE QUÍMICA

- CAUTELA!!** Material de construção das bombas Wilden devem ser compatíveis com a solução a ser bombeada. Favor consultar o guia química (E4) ou o seu distribuidor local das bombas Wilden para maiores informações.
- CAUTELA!!** Reação Explosiva: Materiais como solventes não devem ser bombeadas usando bombas de alumínio devido ao alto risco de explosão.
- CAUTELA!!** Certos materiais podem sofrer ataque químico quando exposto a temperaturas e/ou mudança de concentração do liquido bombeado. Favor consultar o seu distribuidor local das bombas Wilden para maiores informações.

## 2.0 OPERAÇÃO

- CAUTELA!!** 2.1 Certifique-se que operadores são treinados quanto á operação e utilização das bombas Wilden. Favor observar cautela e práticas definidas nesse Manual de Segurança, no Manual do Usuário, e no Manual de uso, Manutenção e Operação.

### Limites de Temperatura

Polipropileno	32°F to 175°F	0°C to 79°C
PVDF	10°F to 225°F	-12°C to 107°C
Acetal com recheio de carvão	-20°F to 150°F	-28.9°C to 65.6°C
Teflon® PFA	-20°F to 300°F	-28.9°C to 148.9°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N®	10°F to 180°F	-12.2°C to 82.2°C
Nordel®	-60°F to 280°F	-51.1°C to 137.8°C
Viton®	-40°F to 350°F	-40°C to 176.7°C
Wil-Flex™	-40°F to 225°F	-40°C to 107.2°C
Poliuretano	10°F to 150°F	12.2°C to 65.6°C
Saniflex™	-20°F to 220°F	-28.9°C to 104.4°C
Teflon® PTFE	40°F to 300°F	4.4°C to 148.9°C





## VEILIGHEIDS SUPPLEMENT:

### LEES DIT MANUAL VOORDAT U DE POMP INSTALLEERT, IN GEBRUIK NEEMT OF REPAREERT

Dit veiligheidsblad geldt voor alle WILDEN pompen en bevat instructies voor een veilige installatie, gebruik en onderhoud voor Uw WILDEN membraanpomp.

Behalve dit veiligheidsblad, vind U meer detail informatie in het Engineering, Operation and Maintenance (EOM) manual dat is meegeleverd met de pomp. Raadpleeg de installatie, gebruiksaanwijzingen en onderhoudsinstructie in het EOM manual.

In het EOM manual wordt u gewaarschuwd voor mogelijke gevaren. Hierbij treft u altijd het volgende symbool aan:

 **WAARSCHUWING** = Gevaarlijke of onveilige situatie die kan leiden tot ernstig letsel, de dood of ernstige materiaal schade.

#### **WAARSCHUWING**

- Controleer of u de juiste pomp heeft ontvangen.
- Trek alle bouten en moeren na, zoals aangegeven In het EOM manual onder 8E.
- Verwijder alle afdek pluggen.
- Pompen die u als onderwaterpomp gebruikt, moeten zowel aan de vloeistofzijde als aan de luchtzijde chemisch bestand zijn tegen het te verpompen medium.
- Pompen die u geheel onderdompelt moeten aan de luchtuitlaat worden voorzien van een lucht-afvoerslang om de uitlaat boven het peil te brengen van de vloeistof die moet worden verpompt.
- Spoel de pomp grondig met water voor ingebruikname
- FDA, USDA en 3A pompen moeten worden gereinigd voor ingebruikname.

#### **WAARSCHUWING**

- Laat de luchtleiding 10 tot 20 seconden door blazen, voordat u deze bevestigd aan de pomp. Dit om te zorgen dat alle vuil uit de luchtleiding is verdwenen.
- Draag altijd een veiligheidsbril als U de pomp bedient, als er een membraanbreuk optreedt, kan de vloeistof die U verpompt uit de lucht-uitlaat komen..

 **WAARSCHUWING:** Alle zuigleidingen en persleidingen moeten geschikt zijn om de druk die ontstaat in Uw toepassingen te kunnen weerstaan.

 **WAARSCHUWING:** Zorg dat de vloeistof voordruk op de inlaat van de pomp nooit méér bedraagt dan 0,7 BAR. U voorkomt hiermee voortijdige slijtage van de elastomeren. hetgeen weer kan leiden het lekken van vloeistof door de lucht-uitlaat van de pomp.

 **WAARSCHUWING:** Maximale luchtdruk mag niet meer bedragen dan 8,5 BAR. (3,5 BAR bij UL-modellen en 5,5 BAR bij type HP250).

**1.0** Door het bewegen van de membranen in de pomp is het mogelijk dat de pomp zich beweegt. Voor permanente installatie moet de pomp op een bevestigingsplaat worden gemonteerd. De bodem moet bij voorkeur vlak zijn.

**1.1** De meeste WILDEN pompen kunt u gebruiken als onderwaterpomp, pompen die u geheel onderdompelt, moeten zowel aan de vloeistofzijde als aan de luchtzijde resistent zijn tegen het te verpompen product. Pompen die u geheel onderdompelt moeten aan de luchtuitlaat worden voorzien van een lucht-afvoerslang om de lucht uitlaat boven het peil te brengen van de vloeistof die moet worden verpompt.

**1.2** Elke type WILDEN pomp heeft een specifieke vrije doorlaat. Om te voorkomen dat te grote vaste delen de werking van de pomp verstoren en persoonlijk letsel veroorzaken, is het wenselijk een filter in de zuigleiding te monteren.

### **1.3 Installatie Instructies**

Gedetailleerde installatie instructies kunt U vinden in Section 7 van het bij de pomp behorende Engineering, Operation, and Maintenance manual.

 **WAARSCHUWING: 1.4** Het vacuum in de pomp kan leiden tot implosie van vaten en tanks bij het legen van deze vaten en tanks. Zorg altijd voor een goede ventilatie van vaten en tanks.

## **WAARSCHUWING: 1.5 ELECTRISCHE RISICO'S**

Neem maatregelen om statische electriciteit te voorkomen. Voorkom explosies en brandgevaar. speciaal bij het verpompen van licht ontvlambare vloeistoffen. De pomp, het leidingnet, kleppen, containers en andere toegepaste materialen moeten op de juiste wijze worden geaard.

## **WAARSCHUWING: 1.6 TEMPERAATUUR LIMIETEN**

Het materiaal en de temperatuurlimieten van de pomp moeten geschikt zijn voor de vloeistoffen die worden verpompt. Raadpleeg hiervoor de Wilden Chemical Resistance Guide (E4) of neem contact op met Holland Air Pumps voor meer informatie.

## **WAARSCHUWING: 1.7 GELUIDSNIVEAU**

Onder bepaalde omstandigheden kan het geluidsniveau van de pomp hoger zijn dan 75 dba. Dit komt voor bij een hoge inlaatluchtdruk en weinig of geen tegendruk. Langdurig werken in deze condities kunnen een gevaar opleveren voor Uw gehoor. Gebruik geschikte gehoorbescherming.

## **WAARSCHUWING: 1.8 GEVAARLIJKE VLOEISTOFFEN**

- a. Onderhouds instructies in section twee van uw pomp Engineering, Operations and Maintenance Manual moeten worden opgevolgd om membraanbreuk te voorkomen.
- b. Het gebruik van een WIL-GARD™ II lekdetectie-systeem (bij TEFLON® membranen) geeft u een waarschuwings signaal bij membraanbreuk. Hierdoor kunt U voorkomen dat de gevaarlijke vloeistoffen ongemerkt via de luchtuitlaat uit de pomp lekken en dat U in contact komt met deze vloeistof.
- c. **LET OP:** Trek alle bouten en moeren na, zoals aangegeven in de tabel in het EOM manual section 8.
- d. Als U de pomp gebruikt voor het verpompen van gevaarlijke vloeistoffen dient U in het bezit te zijn van een materiaal veiligheids data sheet van de betreffende vloeistof.

## **1.9 CHEMISCHE RESISTENTIE**

 **WAARSCHUWING: a.** Bij de selectie van een pomp voor een bepaalde toepassing, moet U er zeker van zijn dat de pompmaterialen die in contact komen met de vloeistof ook chemisch geschikt zijn voor deze vloeistoffen. Raadpleeg de Wilden Chemical Resistance Guide (E4) of neem contact op met Holland Air Pumps.

 **WAARSCHUWING: b.** Sommige vloeistoffen, zoals b.v. gehalogeneerde solvents kunnen, onder bepaalde omstandigheden, alu minium of gegalvaniseerde delen aantasten.

 **WAARSCHUWING: c.** De chemische resistentie van de materialen van uw WILDEN pomp, speciaal de kunststof uitvoeringen, kan zich veranderen indien de temperatuur en concentratie van de vloeistof die U verpompt zich wijzigt. Neem contact op met Holland Air Pumps voor meer informatie.

## **2.0 BEDIENING**

 **WAARSCHUWING: 2.1** Zorg dat iedereen die de WILDEN pomp gebruikt op de hoogte is van de veiligheidsvoorschriften en gebruiksaanwijzingen zoals beschreven in deze handleiding en in dit veiligheidsblad, de pomp gebruikers gid en in uw pomp Engineering, Operation and Maintenance Manual. Gebruik oog- en oorbescherming als U de pomp bedient.

### **Temperatuur Limieten**

Polypropylene	32°F to 175°F	0°C to 79°C
PVDF	10°F to 225°F	-12°C to 107°C
Carbon-Filled		
Acetal	-20°F to 150°F	-28.9°C to 65.6°C
Teflon® PFA	-20°F to 300°F	-28.9°C to 148.9°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N®	10°F to 180°F	-12.2°C to 82.2°C
Nordel®	-60°F to 280°F	-51.1°C to 137.8°C
Viton®	-40°F to 350°F	-40°C to 176.7°C
Wil-Flex™	-40°F to 225°F	-40°C to 107.2°C
Polyurethane	10°F to 150°F	12.2°C to 65.6°C
Saniflex™	-20°F to 220°F	-28.9°C to 104.4°C
Teflon® PTFE	40°F to 300°F	4.4°C to 148.9°C





## SÄKERHETSBILAGA

WILDEN PUMP & ENGINEERING CO.

### SÄKERHETSHANDBOK


Tillägg till Teknik-, drifts- och underhållshandbok

#### Läs alltid denna handbok före montering, start eller underhåll.

Denna säkerhetshandbok gäller för samtliga pumpar från Wilden och innehåller anvisningar för säkert handhavande vid installation, användande och underhåll av din pump.

Dessutom finns ytterligare installationsanvisningar, förslag till drifts- och underhållsanvisningar samt felsökningsrutiner i Teknik-, drifts- och underhållsmanual för respektive pump.

I denna handbok förekommer varningar för övriga risker. Denna typ av anvisning föregås av nedanstående symbol.

 **VARNING** = Risker eller osäkra rutiner som kan leda till svår personskada, dödsfall eller till avsevärd skada på produkt eller egendom.

 **VARNING**

- Kontrollera att mottagen pumpmodell överensstämmer med specifikation.
- Dra åt samtliga skruvar enligt specifikation i tabell för åtdragningsmoment.
- Ta bort alla transportsäkringar och pluggar.
- Materialet i såväl vätskeberörda delar som torra delar på dränkbara pumpar ska vara kompatibelt med den pumpade vätskan.
- Dränkbara pumpar ska vara försedda med luftslang vid pumpens luftutsläpp som ska leda utloppsluften över vätskenivån.
- Spola noggrant igenom pumpen med vatten före montering.
- FDA-, USDA- och 3A-godkända pumpar bör genomgå sanitär rengöring innan användande.

 **VARNING**

- Blås igenom luftledning i 10-20 sekunder innan den monteras på pump för att kontrollera att ledningarna är fria från allt skräp.
- Bär alltid skyddsglasögon vid arbete med pump. Om ett membran brister kan den- pumpade vätskan tvingas ut genom luftutsläppet.

 **VARNING:** Alla inlopps- och utloppsrör/slangar ska vara konstruerade så att de kan tåla den aktuella tillämpningens tryck och temperatur.

 **VARNING:** Vätskans inloppstryck får inte överskrida 0,7 bar. Detta kan medföra förtida slitage och haveri.

 **VARNING:** Drivtrycket får inte överskrida 8,5 bar. För UL-klassade modeller bör drivtrycket inte överskrida 3,4 bar.

**1.0** På grund av pumpens växelverkande arbetssätt kan sidostabilitet uppstå vid normal drift. Pumpar med fot skall därför bultas fast med gummifötter i stål- eller betongkonstruktion.

**1.1** De flesta pumpar från Wilden kan nedsänkas i vätska om materialet i såväl vätskeberörda- som torra delar är kemiskt resistent mot den pumpade vätskan. Om pumpen ska nedsänkas i vätska bör en slang monteras på pumpens luftutsläpp och utloppsluften ledas över vätskenivån. Varje pump från Wilden klarar en viss partikelstorlek. Om det finns en risk för att större fasta partiklar kan sugas in i pumpen bör en sil eller ett grovfilter användas i sugledningen för att förhindra att skada uppstår på pumpen med medföljande risk för operatören.

#### 1.3 Installationsanvisningar

Detaljerade anvisningar för installation återfinnes i avsnitt 7 i Teknik-, drifts- och underhållsmanualen (EOM) för respektive pump.

 **VARNING 1.4** Kontrollera att de tankar eller behållare som rymmer vätskelagret från vilken pumpen suger är väl ventilerade. På grund av pumpens starka förmåga att skapa vakuum kan otillräcklig ventilation av lagringstankar leda till implosion när en tank har tömts helt på vätska.



## ⚠️ VARNING: 1.5 ELEKTRISKA FAROR

Åtgärder för att förhindra uppkomst av gnistor från statisk uppladdning måste vidtagas. Vid pumpning kan brand eller explosion uppstå. Pumpen, rörledningar, ventiler, förvaringskärl eller annan utrustning måste jordanslutas.

## ⚠️ VARNING 1.6 RISKER VID HÖG TEMPERATUR

Vätskan som ska pumpas bör vara kompatibel med materialet som pumpen är tillverkad av samt angivna maxvärden för temperatur, se Wilden Chemical Resistance Guide (E4).

## ⚠️ VARNING: 1.7 FAROR ORSAKADE AV BULLER

Pumpens ljudnivå kan överskrida 75 dba under vissa driftsbetingelser så som vid högt drivtryck och litet eller inget mottryck av vätska på pumpens trycksida. Långa driftsperioder vid sådana förhållanden kan skapa risker för operatör som arbetar nära pumparna. Använd hörselskydd.

## ⚠️ VARNING: 1.8 FARLIGA MATERIAL

- Underhållsinstruktionerna i avsnitt åtta (8) i din Teknik- drifts- och underhållsmanual måste följas för att undvika mem branhaveri.
- Där det är möjligt bör Teflon® bestyckade pumpar från Wilden förses med Wil-Gard™ II membranövervakningssystem. Detta system upptäcker eventuellt membranbiveri innan vätskan tränger ut ur pumpen.
- OBS:** Alla bultar och skruvar bör kontrolleras så att de är dragna med angivet åtdragningsmoment innan start, se avsnitt 8 i Teknik-, drift- och underhållshandboken.
- Handhavaren bör införskaffa varuinformation från leverantören av vätskan som ska pumpas. Dessa innehåller erforderliga hanteringsanvisningar för respektive vätska.

## 1.9 KEMISK KOMPATIBILITET/RESISTENS

- VARNING:** Vid val av pump för en speciell applikation, måste pumpens vätskeberörda delar och gummimaterial vara av sådant material att de är kompatibla med processvätskorna. Se Wilden Chemical Resistance Guide (E4), eller rådgör med din auktoriserade leverantör av Wildenprodukter.
- VARNING:** Explosiv reaktion: Vissa vätskor, som t ex lösningsmedel med halogenkolväte bör inte pumpas med en pump som har vätskeberörda delar i aluminium på grund av risken för möjlig explosiv reaktion.
- VARNING:** Vissa materials/vätskors kemiska kompatibilitet med en speciell pumpkonstruktion, speciellt med vätskeberörda delar i plast, kan förändras med variationer i vätskornas koncentration och temperatur. Rådgör med auktoriserad leverantör av Wildenprodukter.

## 2.0 DRIFT

- VARNING: 2.1** Se till att samtliga operatörer har fått relevant utbildning och att de utövar ett säkert drift- och underhållshandhavande samt följer säkerhets- och underhållsrutinerna angivna i denna säkerhetsbilaga, användarhandboken och Teknik- drifts- och underhållsmanualen.

### Temperaturbegränsningar

Polypropylene	32°F to 175°F	0°C to 79°C
PVDF	10°F to 225°F	-12°C to 107°C
Carbon-Filled		
Acetal	-20°F to 150°F	-28.9°C to 65.6°C
Teflon® PFA	-20°F to 300°F	-28.9°C to 148.9°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N®	10°F to 180°F	-12.2°C to 82.2°C
Nordel®	-60°F to 280°F	-51.1°C to 137.8°C
Viton®	-40°F to 350°F	-40°C to 176.7°C
Wil-Flex™	-40°F to 225°F	-40°C to 107.2°C
Polyurethane	10°F to 150°F	12.2°C to 65.6°C
Saniflex™	-20°F to 220°F	-28.9°C to 104.4°C
Teflon® PTFE	40°F to 300°F	4.4°C to 148.9°C





## SIKKERHEDSSUPPLEMENT

### WILDEN PUMP & ENGINEERING CO. SIKKERHEDSMANUAL

Supplement til Brugsanvisning

#### LÆS ALTID DENNE MANUAL FØR INSTALLATION, OPSTART ELLER VEDLIGEHOLDELSE.

Denne sikkerhedsmanual gælder for alle Wilden pumper og indeholder instruktioner i sikker installation, brug og vedligeholdelse af Deres pumpe.

For mere detaljerede instruktioner i installation, anbefalet drift, vedligeholdelse samt fejlfinding, se Brugsanvisningen for den pumpetype det drejer sig om.

I denne manual kan der være advarsler mod risici.

Foran denne type information vil følgende mærkat blive vist.


 **ADVARSEL** = Risici eller farlig fremgangsmåde som kan resultere i alvorlig personskade, død eller alvorlig beskadigelse af produkt eller ejendom.

#### **ADVARSEL**


- Check at modtaget pumpemodell svarer til ordren og specifikationen.
- Spænd alle bolte til specifikationerne i moment tabellen.
- Fjern forsendelsens blindpropper.
- På pumper som skal anvendes nedsænket i væske skal både væskeberørte og ikke-væskeberørte dele være kompatible med materialet der skal pumpes.
- Nedsænkede pumper skal have en slange tilsluttet til pumpens luftafgang og slangen føres op over væskenniveauet.
- Pumper bør skylles grundigt igennem med vand før installation.
- FDA, USDA OG 3A pumper bør steriliseres før brug.

#### **ADVARSEL**

- Blæs slanger igennem i 10-20 sekunder før de sættes på pumper for at sikre at alt løst materiale er fjernet.
- Brug altid sikkerhedsbriller. Ved membranbrud kan materialet der pumpes blive presset ud gennem luftafgangen.

 **ADVARSEL:** Alle indsugnings- og afgangsslanger skal være designet til at modstå tryk og temperatur for den specifikke applikation.

 **ADVARSEL:** Overstig ikke 0,7 bar (10 psig) væske indsugningstryk, da dette skaber slid og fejl.

 **ADVARSEL:** Overstig ikke 8,5 bar (125 psig) luftryk. UL-godkendte modeller bør ikke overstige 3,4 bar (50 psi) luftryk.


**1.0** Grundet pumpens frem og tilbagegående bevægelse kan rystelser opstå under normal brug, derfor skal pumperne fast spændes. Pumper med fod bør derfor så vidt muligt boltes fast til overfladen.

**1.1** De fleste Wilden pumper kan kun anvendes i neddykkede applikationer, når både væskeberørte og ikke-væskeberørte dele er kompatible med materialet der pumpes. Hvis pumpen skal anvendes neddykket, bør en slange tilsluttes pumpens luftafgang så afgangsluften føres over væskenniveauet.

**1.2** Hver Wilden pumpe tillader en bestemt max. partikel størrelse. Ved enhver risiko for at større partikler kan blive suget ind i pumpen, bør et filter installeres på sugesiden for at undgå beskadigelse af pumpen og deraf følgende risiko for brugeren.

#### **1.3 Instruktion til installation**

Detalieret de Instruktioner til installation er i kapitel 7 i manualen.

 **ADVARSEL: 1.4** Sørg for ordentlig ventilation af tanke/beholdere som indeholder væsken. På grund af en pumpe høje suge evne kan dårlig ventilation af disse forsyningstanke føre til implosion (sammenklapning) af tanke når væsken er fuldstændig evakueret.

## ADVARSEL: 1.5 ELEKTRISKE RISICI

Sørg for at forebygge statisk elektricitet. Brand eller eksplosion kan være resultatet, specielt ved håndtering af brændbare væsker. Pumpen, slangeføring, ventiler, beholdere eller andet apparatur skal jordes.

## ADVARSEL: 1.6 TEMPERATUR RISICI

Materialet der pumpes skal være kompatibelt med pumpens konstruktionsmaterialer og angivne temperatur grænser som anført i Wilden Chemical Resistance Guide (E4).

## ADVARSEL: 1.7 STØJGENERENDE RISICI

Pumpestøj kan overstige 75 dba under specielle forhold som f.eks. højt lufttryk og lavt modtryk. Længere tids drift under disse betingelser kan skabe en risiko for brugere, som arbejder i nærheden af pumperne. Brug af høreværn.

## ADVARSEL: 1.8 FARLIGE MATERIALER

- Vedligeholdelsesanvisningerne i afsnit 8 i pumpens brugsanvisning skal følges for at forebygge membranbrud.
- Når det er muligt bør Wilden pumper med Teflon® forsynes med Will-Gard™ II lækage alarm, som opdager membranbrud før farligt materiale kommer ud af pumpen.
- BEMÆRK:** Alle spændebånd bør checkes for tilspænding ifølge moment specifikationerne anført i sektion 8 i Brugsanvisningen.
- Der bør anskaffes et materiale sikkerhedsdatablad for alle materialer der pumpes for korrekte håndteringsinstruktioner.

## 1.9 KEMISK KOMPATIBILITET

-  **ADVARSEL:** a. Når en pumpe specificeres til en bestemt applikation skal pumpens væskeberørte materialer og membran materialer være kompatible med procesvæsken. Se Wilden Chemical Resistance Guide (E4) eller kontakt Deres forhandler.
-  **ADVARSEL:** b. Eksplosiv reaktion: Visse materialer såsom halogeneret kulbrinte opløsningsmidler bør ikke pumpes med en aluminium pumpe på grund af en mulig eksplosiv reaktion.
-  **ADVARSEL:** c. Visse materialers kemiske kompatibilitet med en speciel pumpe konstruktion, specielt plastik væske berørte dele, kan ændre sig når materialekoncentration og temperatur varierer. Kontakt Deres lokale forhandler.

## 2.0 DRIFT

-  **ADVARSEL: 2.1** Sørg for at alle brugere er korrekt trænet i og anvender sikkerheds- og vedligeholdelsesanvisningerne anført i denne sikkerhedsmanual, Pump Users's Guide og pumpens brugsanvisning. Derudover bør sikkerhedsbriller og høreværn anvendes når det er nødvendigt.

### Temperaturgrænser

Polypropylene	32°F to 175°F	0°C to 79°C
PVDF	10°F to 225°F	-12°C to 107°C
Carbon-Filled		
Acetal	-20°F to 150°F	-28.9°C to 65.6°C
Teflon® PFA	-20°F to 300°F	-28.9°C to 148.9°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N®	10°F to 180°F	-12.2°C to 82.2°C
Nordel®	-60°F to 280°F	-51.1°C to 137.8°C
Viton®	-40°F to 350°F	-40°C to 176.7°C
Wil-Flex™	-40°F to 225°F	-40°C to 107.2°C
Polyurethane	10°F to 150°F	12.2°C to 65.6°C
Saniflex™	-20°F to 220°F	-28.9°C to 104.4°C
Teflon® PTFE	40°F to 300°F	4.4°C to 148.9°C





### WILDEN PUMP & ENGINEERING CO.

#### KÄYTTÖTURVALLISUUSTIEDOTE

Lue tämä turvallisuustiedote aina ennen pumpun asennusta, käyttöönottoa ja huoltoa. Tämä turvallisuustiedote koskee kaikkia WILDEN pumppumalleja ja sisältää ohjeet pumppunne turvallista asennusta, käyttöä ja huoltoa varten.

Yksityiskohtaisemmat ohjeet on annettu pumppumallikohtaisesti Käyttö ja Huolto käsikirjassa.

Käsikirjassa varoitetaan mahdollisista vaaratekijöistä. Vaaratekijöiden kohdalla tekstissä käytetään alla olevaa varoitusmerkkiä.

 **•VAROITUS** = turvatoimien laiminlyönti voi aiheuttaa henkilövahinkoja, invalideettia, hengenmenon tai huomattavia tuote- tai omaisuusvahinkoja.

 **•VAROITUS**

- Tarkista, että vastaanotettu pumppumalli vastaa tilattua tai spesifioitua pumppumallia.
- Kiristä kaikki pumpun pultit kiristysmomenttitaulukon mukaisesti.
- Poista pumpusta kuljetustulpat.
- Uppopumpun materiaalit, sekä neste että ilmaosat, on oltava materiaailtaan yhteen sopivat pumpattavan nesteen kanssa.
- Uppopumpun poistoilma on johdettava letkulla nestepinnan yläpuolelle.
- Pumput on huolella huuhdeltava vedellä ennen käyttöönottoa.
- FDA, USDA ja 3A luokitellut pumput on desinfioitava ennen käyttöönottoa.

 **•VAROITUS**

- Puhalla paineilmalinjaa 10-20 sekuntia ennen pumpun liittämistä, näin varmistat ettei paineilmalinjassa ole epäpuhtauksia.
- Käytä aina suojalaseja pumppua käsitellessäsi.

Rikkoutunut kalvo voi aiheuttaa vuodon ja pumpattava neste voi roiskua poistoilman mukana ympäristöön.

 **•VAROITUS:** Kaikki imu- ja poistoputket/letkut ja liittimet on mitoitettava riittävän kestäviksi käytetyn paineen ja lämpötilan suhteen.

 **•VAROITUS:** Älä ylitä 0,7 bar nestepainetta pumpun imupuolella. Ylipaine voi aiheuttaa ennenaikaista kulumista ja osien vioittumista.

 **•VAROITUS:** Älä ylitä 8,5 bar syöttöilmanpainetta. UL-luetteloitujen mallien syöttöilmanpaine ei saa ylittää 3,5 baria.


**1.0** Pumpussa voi esiintyä normaalkäytössä sen edestakaisesta liikkeestä johtuvaa poikittaissuuntaista epuavakaisuutta. Jalustalliset pumput on siksi kiinnitettävä pulteilla kiinteään teräs- tai betonirakenteeseen.

**1.1** WILDEN pumppuja voidaan käyttää uppopumppuina ainoastaan jos sekä pumpun nesteosat että ilmaosat ovat yhteensopivat pumpattavan nesteen kanssa. Mikäli pumppua käytetään uppopumppuna on poistoilma johdettava letkulla nestepinnan yläpuolelle.

**1.2** Jokaiselle WILDEN pumpulle on ilmoitettu suurin sallittu kiintoainekoko. Mikäli on mahdollista, että kiintoainekoko ylittää suurimman sallitun koon, on ennen pumppua asennettava imusuodin estämään pumpun rikkoutuminen ja käyttäjän vahingoittuminen.

#### 1.3 Asennusohjeet

Pumppumallien yksityiskohtaiset asennusohjeet löytyvät valmistajan Engineering, Operation, and Maintenance Manual osasta 7.

 **•VAROITUS: 1.4** Varmista että säiliössä, mistä neste pumpataan, on riittävän suuri korvausilma-aukko. Pumpun suuri imuteho voi aiheuttaa säiliön litistymisen, jollei korvausilman saanti ole riittävä.

## ⚠️ •VAROITUS: 1.5 SÄHKÖTEKNISET VAARATEKIJÄT

Sähköstaattinen kipinä on estettävä. Muutoin seurauksena voi olla tulipalo tai räjähdys etenkin herkästi syttyviä nesteitä käsiteltäessä. Pumppu, putket, venttiilit, säiliöt ja muut varusteet on maadoitettava.

## ⚠️ •VAROITUS: 1.6 LÄMPÖTILASTA JOHTUVAT VAARATEKIJÄT

Tarkista, että pumpattava neste on pumpun nesteosien materiaaleilta ja annetuilta lämpötilarajoiltaan yhteensopiva. Soveltuvuuden voi tarkistaa materiaalitaulukosta WILDEN CHEMICAL RESISTANCE GUIDE (E4).

## ⚠️ •VAROITUS: 1.7 MELUSTA JOHTUVIA VAAROJA

Pumpun aiheuttama melu voi ylittää 75 dba joissakin käyttöolosuhteissa, esimerkiksi pumpun syöttöpaineen ollessa korkea tai antopaineen ollessa alhainen tai sen kokonaan puuttuessa.

## ⚠️ •VAROITUS: 1.8 VAARALLISET NESTEET

- Pumpun rakenne-, käyttö- ja huolto-oppaan kahdeksannessa luvussa annettuja huolto-ohjeita on noudatettava, jotta vältetään kalvon vioittuminen.
- Mikäli mahdollista on Teflon®-kalvoja käyttävät pumput varustettava Wil-Gard™ kalvonvalvontajärjestelmällä. Tällöin kalvonrikkoutuminen havaitaan ennen kuin vaarallinen neste vuotaa pumpusta ulos.
- HUOM:** Tarkista, että kaikkien pulttien kiristysmomentit vastaavat käyttöohjetaulukon kiristysmomenttiarvoja.
- Oikeat nesteiden käsittelytiedot saadakse on pumppukäyttäjän hankittava jokaisen pumpattavan nesteen käyttöturvallisuustiedote nesteen toimittajalta.

## 1.9 KEMIALLINEN YHTEENSOPIVUUS

- VAROITUS:** a. Määriteltäessä pumppua määrättyyn käyttötarkoitukseen on pumpun nesteosien materiaalien sekä kalvo- ja venttiilipallomateriaalien oltava yhteensopiva pumpattavan nesteen kanssa. Yhteensopivuus tarkistetaan materiaalitaulukosta WILDEN CHEMICAL RESISTANCE GUIDE (E4) tai valtuutetulta WILDEN edustajalta.
- VAROITUS:** b. Räjähdys reaktio: Eräät materiaalit, kuten halogenoidut hiilivedyt, eivät sovellu pumpattaviksi alumiinirunkoisella pumpulla, koska ne voivat aiheuttaa räjähtävän kemiallisen reaktion.
- VAROITUS:** c. Määrättyjen nesteiden kemiallinen yhteensopivuus pumpun nesteosien kanssa voi vaihdella nesteen väkevyyden ja lämpötilan mukaan. Tämä koskee erityisesti nestettä koskettavia pumpun muoviosia.

## 2.0 KÄYTTÖ

- VAROITUS: 2.1** On myös varmistauduttava siitä, että pumpun kaikki käyttäjät ovat saaneet asianmukaisen koulutuksen pumpun käyttöön ja että he noudattavat tässä turvaohjeessa, pumpun käyttöohjeessa sekä pumpun rakenne-, käyttö- ja huolto-oppaassa selostettua käyttö- ja huoltomenettelyä.

### Lämpötilarajat

Polypropylene	32°F to 175°F	0°C to 79°C
PVDF	10°F to 225°F	-12°C to 107°C
Carbon-Filled		
Acetal	-20°F to 150°F	-28.9°C to 65.6°C
Teflon® PFA	-20°F to 300°F	-28.9°C to 148.9°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N®	10°F to 180°F	-12.2°C to 82.2°C
Nordei®	-60°F to 280°F	-51.1°C to 137.8°C
Viton®	-40°F to 350°F	-40°C to 176.7°C
Wil-Flex™	-40°F to 225°F	-40°C to 107.2°C
Polyurethane	10°F to 150°F	12.2°C to 65.6°C
Saniflex™	-20°F to 220°F	-28.9°C to 104.4°C
Teflon® PTFE	40°F to 300°F	4.4°C to 148.9°C





## ΣΥΜΠΛΗΡΩΜΑ ΑΣΦΑΛΕΙΑΣ

WILDEN PUMP & ENGINEERING CO.  
ΕΓΧΕΙΡΙΔΙΟ ΑΣΦΑΛΕΙΑΣ

Συμπλήρωμα στο εγχειρίδιο λειτουργίας, συντήρησης και τεχνικών οδηγιών

**ΠΑΝΤΑ ΝΑ ΔΙΑΒΑΖΕΤΑΙ ΠΡΩΤΑ ΑΥΤΟ ΤΟ ΕΓΧΕΙΡΙΔΙΟ ΠΡΙΝ ΤΗΝ ΕΓΚΑΤΑΣΤΑΣΗ, ΤΗΝ ΕΚΚΙΝΗΣΗ Ή ΤΗΝ ΣΥΝΤΗΡΗΣΗ**

Αυτό το εγχειρίδιο ασφαλείας έχει εφαρμογή σε όλες τις αντλίες WILDEN και περιλαμβάνει οδηγίες για την ασφαλή λειτουργία, χρήση και συντήρηση της αντλίας σας.

Επιπρόσθετα από αυτό το εγχειρίδιο, λεπτομερέστερες πληροφορίες, προτεινόμενες οδηγίες λειτουργίας και συντήρησης και οδηγός αντιμετώπισης προβλημάτων, δίδονται στο αντίστοιχο εγχειρίδιο τεχνικών οδηγιών, λειτουργίας και συντήρησης της αντλίας.

Σε αυτό το εγχειρίδιο μπορεί να προειδοποιηθείτε για διαφόρους κινδύνους. Αυτού του τύπου η προειδοποίηση σημαίνεται με το ακόλουθο σήμα.

**⚠ ΠΡΟΣΟΧΗ** = Κίνδυνοι ή μη ασφαλείς πρακτικές που μπορεί να προκαλέσουν σοβαρό τραυματισμό, θάνατο ή σημαντικές υλικές ζημιές.

**⚠ ΠΡΟΣΟΧΗ**

- Ελέγξτε τον τύπο της αντλίας που παραλάβατε σε σύγκριση με την παραγγελία σας.
- Σφίξτε ξανά όλες τις βίδες σύμφωνα με τις προδιαγραφές του πίνακα ροπών.
- Αφαιρέστε όλες τις τάπες της μεταφοράς.
- Οι αντλίες που θα λειτουργήσουν σαν υποβρύχιες πρέπει να έχουν και τα βρεχόμενα και τα μη βρεχόμενα μέρη συμβατά με το αντλούμενο υγρό.
- Οι αντλίες που λειτουργούν σαν υποβρύχιες πρέπει να έχουν στην εξαγωγή του αέρα προσαρμοσμένο σωλήνα ο οποίος να καταλήγει πάνω από την επιφάνεια του υγρού.
- Οι αντλίες πρέπει να ξεπλένονται καλά με νερό, πριν την εγκατάσταση.
- Οι αντλίες FDA, USDA και 3A, πρέπει να απολυμαίνονται πριν την χρήση τους.

**⚠ ΠΡΟΣΟΧΗ**

- Ξεφουσίξτε την γραμμή του αέρα για 10-20 δευτερόλεπτα πριν να συνδέσετε την αντλία και βεβαιωθείτε ότι όλη η σωληνογραμμή είναι καθαρή από σκουπίδια.
- Πάντα να φοράτε γυαλιά ασφαλείας, όταν λειτουργεί η αντλία. Αν σπάσει κάποιο διάφραγμα, το αντλούμενο υγρό μπορεί να εκτιναχθεί από την εξαγωγή του αέρα.

**⚠ ΠΡΟΣΟΧΗ:** Όλες οι σωληνογραμμές και τα εξαρτήματά τους πρέπει να σχεδιάζονται για να αντέχουν την πίεση και την θερμοκρασία των προδιαγραφών.

**⚠ ΠΡΟΣΟΧΗ:** Να μην υπερβαίνετε τα 0.7 bar (10 psig) πίεση υγρού στην είσοδο της αντλίας. Διαφορετικά δημιουργείται κίνδυνος πρόωρης φθοράς της αντλίας.

**⚠ ΠΡΟΣΟΧΗ:** Η πίεση του αέρα τροφοδοσίας να μην υπερβαίνει τα 8 bar (125 psig). Για τις αντλίες με προδιαγραφές UL η πίεση του αέρα να μην υπερβαίνει τα 50 psig.

- 1.0 Λόγω της παλινδρομικής λειτουργίας της αντλίας, μπορεί να συμβούν διάφορες αστάθειες κατά την κανονική λειτουργία της αντλίας. Πρέπει λοιπόν οι αντλίες που έχουν πόδια να βιδώνονται σε μεταλλική / τσιμενένια βάση.
- 1.1 Οι περισσότερες αντλίες WILDEN μπορούν να λειτουργήσουν σαν υποβρύχιες μόνο αν όλα τα μέρη τους είναι συμβατά με το αντλούμενο υγρό. Εάν η αντλία πρόκειται να εργασθεί σαν υποβρύχια, πρέπει να έχουν στην εξαγωγή του αέρα προσαρμοσμένο σωλήνα ο οποίος να καταλήγει πάνω από την επιφάνεια του υγρού.
- 1.2 Κάθε αντλία WILDEN, έχει ένα μέγιστο όριο διέλευσης στερεών. Όταν υπάρχει πιθανότητα να αναρροφηθούν στερεά μεγαλύτερας διαμέτρου, θα πρέπει να τοποθετείται ένα φίλτρο στη γραμμή αναρρόφησης ώστε να εμποδίζεται η πρόκληση βλάβης στην αντλία και τυχόν κίνδυνοι στον χειριστή της.
- 1.3 Οδηγίες εγκατάστασης

α. Λεπτομερείς οδηγίες εγκατάστασης δίνονται στο Τμήμα 7 του εγχειρίδιου γιουργίας και συντήρησης της αντλίας.

**⚠ ΠΡΟΣΟΧΗ:** 1.4 Εξασφαλίστε καλό εξαερισμό τυχόν δοχείων από τα οποία γίνεται η άντληση του υγρού. Λόγω της μεγάλης αναρροφητικής ικανότητας της αντλίας, μπορεί τα δοχεία να ετραγού εάν δεν διαθέτουν επαρκή εξαερισμό.

## ⚠️ ΠΡΟΣΟΧΗ: 1.5 ΗΛΕΚΤΡΙΚΟΙ ΚΙΝΔΥΝΟΙ

Πάρτε μέτρα αποτροπής στατικού ηλεκτρισμού. Μπορεί να προξηνηθεί σπινθήρας, ειδικά όταν διακινούνται εύφλεκτα υγρα. Η αντλία, οι σωλήνες, οι βάνες, οι σεξαμενές ή τυχόν άλλα υλικά πρέπει να είναι γειωμένα.

## ⚠️ ΠΡΟΣΟΧΗ: 1.6 ΚΙΝΔΥΝΟΙ ΘΕΡΜΟΚΡΑΣΙΑΣ

Τα αντλούμενα υλικά πρέπει να είναι συμβατά με τα υλικά κατασκευής της αντλίας και τα συγκεκριμένα όρια θερμοκρασίας αυτών, όπως αυτά εκθέτονται στον Οδηγό Χημικής Ανθεκτικότητας της WILDEN (E4).

## ⚠️ ΠΡΟΣΟΧΗ: 1.7 ΚΙΝΔΥΝΟΙ ΠΑΡΑΓΟΜΕΝΟΙ ΑΠΟ ΘΟΡΥΒΟ

α. Ο θόρυβος της αντλίας μπορεί να ξεπεράσει τα 75 dba σε ορισμένες λειτουργίες, όπως πχ. σε περίπτωση τροφοδοσίας με αέρα υψηλής πίεσης ή σε λειτουργία σε μικρό ή σε μηδενικό μανομετρικό.

Παρατεταμένη περίοδος λειτουργίας κάτω από τέτοιες καταστάσεις μπορεί να δημιουργήσει κινδύνους στο χειριστή κοντά στην αντλία. Χρησιμοποιήστε κατάλληλες συσκευές προστασίας της ακοής.

## ⚠️ ΠΡΟΣΟΧΗ: 1.8 ΕΠΙΚΙΝΔΥΝΑ ΥΛΙΚΑ

- Οι οδηγίες συντήρησης στο τμήμα 8 του μηχανολογικού εγχειριδίου λειτουργίας και συντήρησης πρέπει να ακολουθούνται για την αποφυγή καταστροφής των διαφραγμάτων.
- Όπου είναι δυνατόν οι αντλίες WILDEN με Teflon<sup>®</sup> θα πρέπει να εφοδιάζονται με το WIL-GARD<sup>™</sup> II Σύστημα Ελέγχου Διαρροών Διαφραγμάτων το οποίο ανιχνεύει διαρροή του διαφράγματος πριν επικίνδυνα υλικά εξαχθούν από την αντλία.
- ΠΑΡΑΤΗΡΗΣΗ: Όλοι οι σφικτήρες και οι βίδες πρέπει να ελεγχθούν ώστε να ταιριάζουν με τις προδιαγραφές ροπών σύσφιξης που αναφέρονται στο κεφάλαιο 8 του εγχειριδίου τεχνικών οδηγιών, λειτουργίας και συντήρησης της αντλίας.
- Ο χειριστής θα πρέπει να αποκτήσει το Έντυπο Στοιχείων Ασφαλείας Υλικών από τον προμηθευτή για όλα τα αντλούμενα υλικά με οδηγίες σωστής χρήσης.

## 1.9 ΧΗΜΙΚΗ ΣΥΜΒΑΤΟΤΗΤΑ

⚠️ ΠΡΟΣΟΧΗ: α. Όταν προδιαγράφετε αντλία για συγκεκριμένη εφαρμογή, τα βρεχόμενα υλικά κατασκευής της αντλίας και τα ελαστομερή υλικά πρέπει να είναι συμβατά με το υγρό.

Παρακαλούμε συμβουλευτείτε τον οδηγό Χημικής Ανθεκτικότητας της WILDEN (E4) ή τον τοπικό εξουσιοδοτημένο αντιπρόσωπο της WILDEN για περισσότερες πληροφορίες.

⚠️ ΠΡΟΣΟΧΗ: β. Εκρηκτική αντίδραση : Μερικά υλικά όπως διαλύτες αλογονωμένων υδρογονανθράκων δεν πρέπει να αντλούνται με αντλία κατασκευασμένη από αλουμίνιο εξαιτίας πιθανής εκρηκτικής αντίδρασης.

⚠️ ΠΡΟΣΟΧΗ: γ. Η χημική συμβατικότητα ορισμένων υλικών με συγκεκριμένης κατασκευής αντλία, ειδικότερα με πλαστικά βρεχόμενα μέρη, πιθανότατα να αλλάζουν καθώς η συγκέντρωση υλικού και η θερμοκρασία ποικίλουν. Παρακαλούμε συμβουλευτείτε τον τοπικό εξουσιοδοτημένο αντιπρόσωπο της WILDEN για περισσότερες πληροφορίες.

## 2.0 ΛΕΙΤΟΥΡΓΙΑ

⚠️ ΠΡΟΣΟΧΗ : 2.1 Βεβαιωθείτε ότι όλοι οι χειριστές είναι επαρκώς εκπαιδευμένοι και χρησιμοποιούν τις ασφαλείς πρακτικές λειτουργίας και συντήρησης που περιγράφονται στο εγχειρίδιο ασφαλείας, στον οδηγό χρήστη και στο μηχανολογικό εγχειρίδιο λειτουργίας και συντήρησης.

Όρια θερμοκρασίας

Polypropylene	32°F to 175°F	0°C to 79°C
PVDF	10°F to 225°F	-12°C to 107°C
Carbon-Filled		
Acetal	-20°F to 150°F	-28.9°C to 65.6°C
Teflon <sup>®</sup> PFA	-20°F to 300°F	-28.9°C to 148.9°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N <sup>®</sup>	10°F to 180°F	-12.2°C to 82.2°C
Nordel <sup>®</sup>	-60°F to 280°F	-51.1°C to 137.8°C
Viton <sup>®</sup>	-40°F to 350°F	-40°C to 176.7°C
Wil-Flex <sup>™</sup>	-40°F to 225°F	-40°C to 107.2°C
Polyurethane	10°F to 150°F	12.2°C to 65.6°C
Saniflex <sup>™</sup>	-20°F to 220°F	-28.9°C to 104.4°C
Teflon <sup>®</sup> PTFE	40°F to 300°F	4.4°C to 148.9°C



# EC Declaration of Conformity

**Manufacturer Name:** Wilden Pump and Engineering Company  
**Manufacturer Address:** 22069 Van Buren Street  
Grand Terrace, California 92313-5607 U.S.A.  
Tel. (909) 422-1730 Fax (909) 783-3440  
www.wildenpump.com

**Declare that the machinery described below complies with the relevant essential health and safety requirements of Part 1 of Annex I of the Machinery Directive 98/37/EC.**

**Description:** Wilden Air Operated Double Diaphragm Pump  
**Model Number:** .....  
**Size:** .....  
**Serial Number:** .....

**The following standards have either been referred to or been complied with in part or in full as relevant:**

EN 60529	Machinery Safety -	Ingress Protection
EN 1299	Machinery Safety -	Mechanical vibration and shock – Vibration isolation of machines – Information for the application of source isolation.
EN 60947	Low Voltage Safety -	Specification for low voltage switchgear and control gear.
EN 954-1	Safety of Machinery -	Safety Related Parts of Control Systems – Part 1: General Principles for Design.
EN 418	Safety of Machinery -	Emergency stop equipment – principles for design.
EN 60204-1	Safety of Machinery-	Electrical equipment of machines.

**Full Name of responsible person:**

John D. Allen **Position** President / COO  
**Signature**  **Date** November 16, 1999

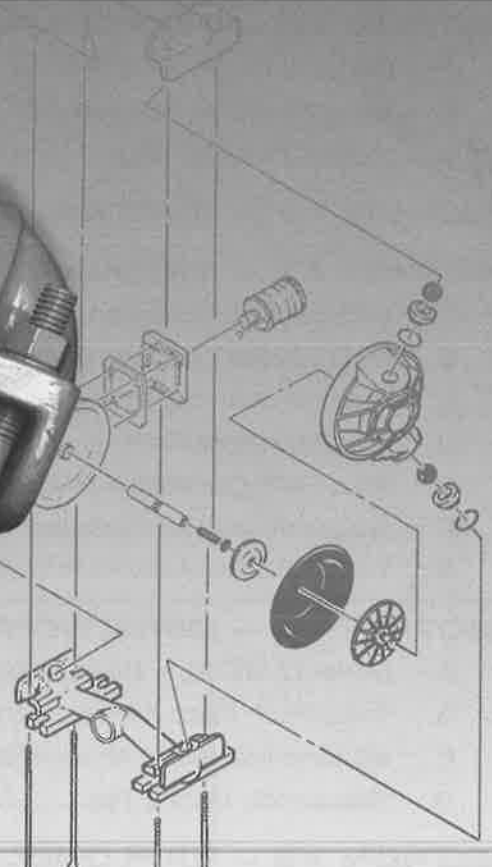
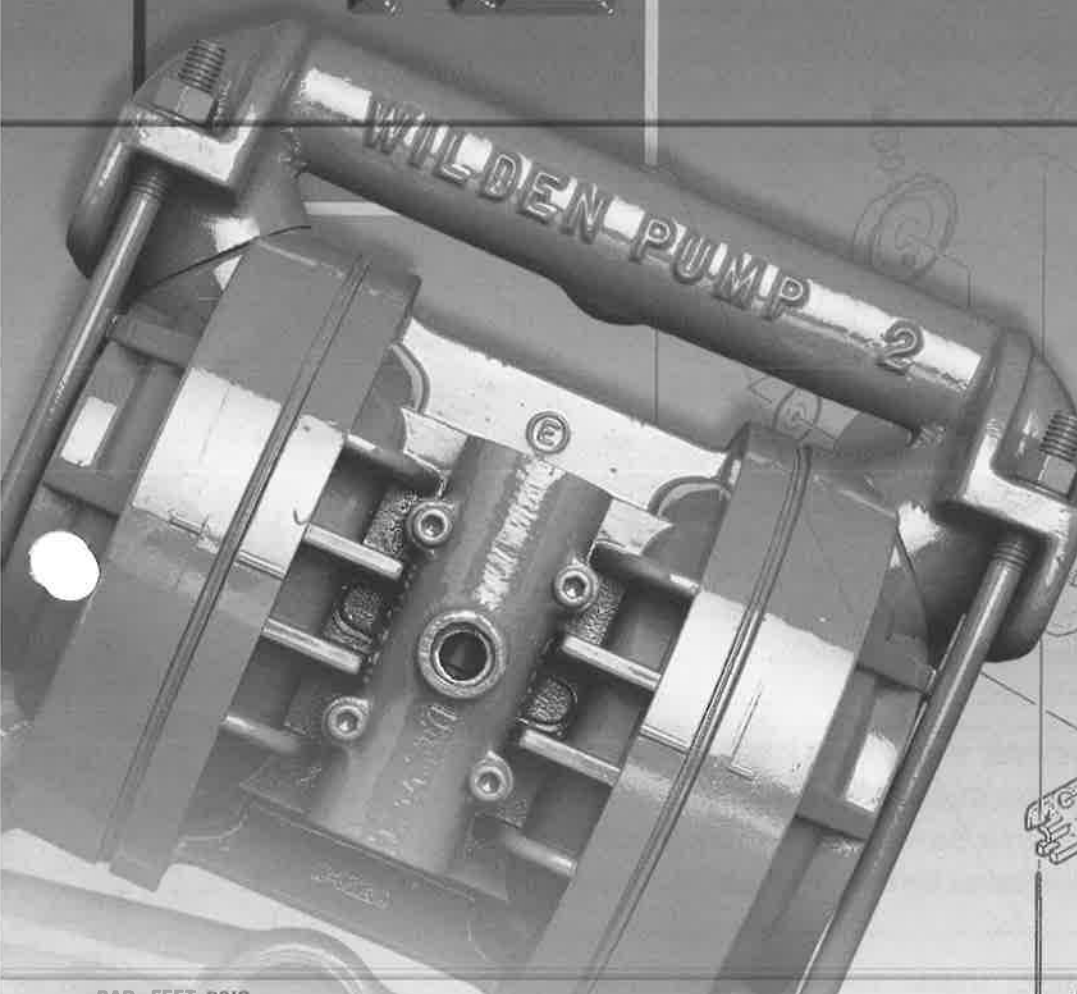
**Full Name of Authorized European Representative:**

..... (Typed) **Position** ..... (Typed)  
**Signature** ..... **Date** .....  
**Address** ..... **Phone** .....



T2  
A2

# Engineering Operation & Maintenance



BAR FEET PSIG



# WILDEN®

AIR OPERATED DOUBLE DIAPHRAGM PUMPS

A DOVER RESOURCES COMPANY

40 5 10 15 20 25 30 35  
116.9 [37.9] [56.8] [75.7] [94.6] [113.6] [132.6]

**TURBOFLO™**  
PROGRESSIVE PUMP TECHNOLOGY

**ACCUFLO™**  
SOLENOID PUMP TECHNOLOGY

## Metal Pumps

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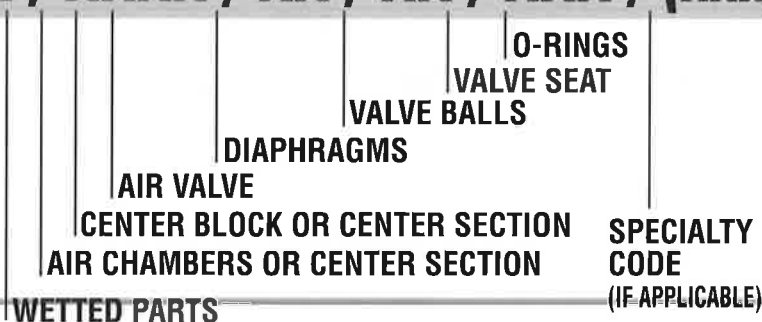


## SECTION 1

# WILDEN PUMP DESIGNATION SYSTEM

**T or A2 / XXXX / XX / XX / XXX / (xxx)**

MODEL



In the case where a center section is used instead of a center block and air chambers, the designation will be as follows: Aluminum = AA, Teflon®-Coated = CC, Nickel-Plated = NN, Polypropylene = PP

## MODEL T2 OR A2 METAL MATERIAL CODES

### WETTED PARTS

A = ALUMINUM  
H = HASTELLOY  
S = STAINLESS STEEL

### AIR CHAMBERS

A = ALUMINUM  
C = TEFLON®-COATED  
N = NICKEL-PLATED  
P = POLYPROPYLENE

### CENTER SECTION

A = ALUMINUM  
C = TEFLON®-COATED  
N = NICKEL-PLATED  
P = POLYPROPYLENE

### AIR VALVE

A = ALUMINUM  
(ACCU-FLO™ PUMPS ONLY)  
B = BRASS  
C = TEFLON®-COATED  
N = NICKEL-PLATED  
Z = ISOPLAST (LUBE FREE)

### DIAPHRAGMS

BN = BUNA-N® (Red Dot)  
FG = SANIFLEX™  
ND = NORDEL®  
NE = NEOPRENE  
PU = POLYURETHANE  
TF = TEFLON® PTFE  
VT = VITON®  
WF = WIL-FLEX™ (Orange)

### VALVE BALL

BN = BUNA-N® (Red Dot)  
FG = SANIFLEX™  
FV = FOOD GRADE VITON®  
ND = NORDEL  
NE = NEOPRENE  
PU = POLYURETHANE  
SS = STAINLESS STEEL  
TF = TEFLON® PTFE (White)  
VT = VITON® (Silver or White Dot)  
WF = WIL-FLEX™ (Orange)

### VALVE SEAT

A = ALUMINUM  
H = HASTELLOY  
K = KYNAR/PVDF  
P = POLYPROPYLENE  
S = STAINLESS STEEL

### VALVE SEAT O-RING

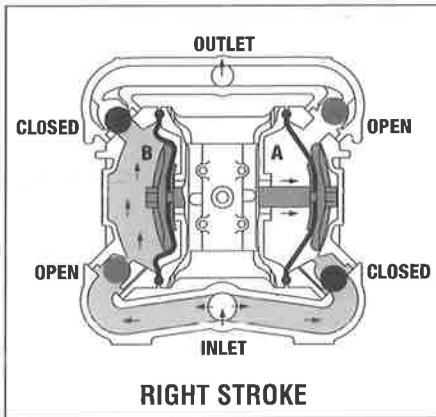
BN = BUNA-N® (Red Dot)  
FG = SANIFLEX™  
ND = NORDEL  
PU = POLYURETHANE  
TF = TEFLON® PTFE  
WF = WIL-FLEX™

**NOTE:** ELASTOMERIC MATERIALS USE COLORED DOTS FOR IDENTIFICATION.

## SECTION 2

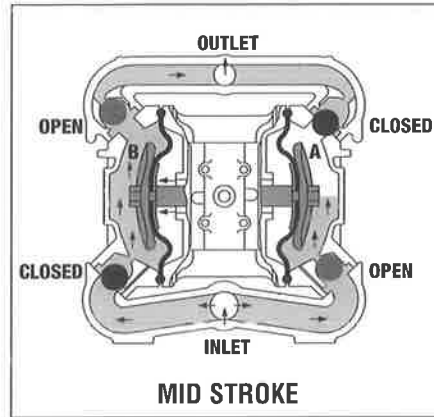
# THE WILDEN PUMP — HOW IT WORKS

The Wilden diaphragm pump is an air-operated, positive displacement, self-priming pump. These drawings show the flow pattern through the pump upon its initial stroke. It is assumed the pump has no fluid in it prior to its initial stroke.



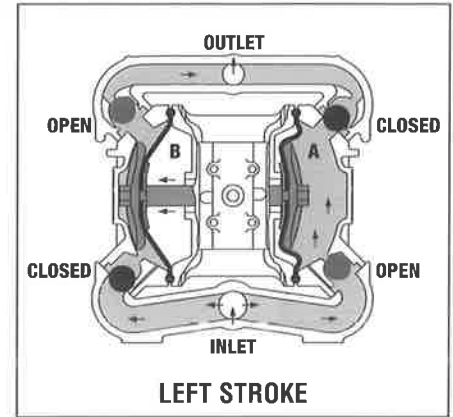
**RIGHT STROKE**

FIGURE 1 The air valve directs pressurized air to the back side of diaphragm A. The compressed air is applied directly to the liquid column separated by elastomeric diaphragms. The diaphragm acts as a separation membrane between the compressed air and liquid, balancing the load and removing mechanical stress from the diaphragm. The compressed air moves the diaphragm away from the center block of the pump. The opposite diaphragm is pulled in by the shaft connected to the pressurized diaphragm. Diaphragm B is on its suction stroke; air behind the diaphragm has been forced out to the atmosphere through the exhaust port of the pump. The movement of diaphragm B toward the center block of the pump creates a vacuum within chamber B. Atmospheric pressure forces fluid into the inlet manifold forcing the inlet valve ball off its seat. Liquid is free to move past the inlet valve ball and fill the liquid chamber (see shaded area).



**MID STROKE**

FIGURE 2 When the pressurized diaphragm, diaphragm A, reaches the limit of its discharge stroke, the air valve redirects pressurized air to the back side of diaphragm B. The pressurized air forces diaphragm B away from the center block while pulling diaphragm A to the center block. Diaphragm B is now on its discharge stroke. Diaphragm B forces the inlet valve ball onto its seat due to the hydraulic forces developed in the liquid chamber and manifold of the pump. These same hydraulic forces lift the discharge valve ball off its seat, while the opposite discharge valve ball is forced onto its seat, forcing fluid to flow through the pump discharge. The movement of diaphragm A toward the center block of the pump creates a vacuum within liquid chamber A. Atmospheric pressure forces fluid into the inlet manifold of the pump. The inlet valve ball is forced off its seat allowing the fluid being pumped to fill the liquid chamber.



**LEFT STROKE**

FIGURE 3 At completion of the stroke, the air valve again redirects air to the back side of diaphragm A, which starts diaphragm B on its exhaust stroke. As the pump reaches its original starting point, each diaphragm has gone through one exhaust and one discharge stroke. This constitutes one complete pumping cycle. The pump may take several cycles to completely prime depending on the conditions of the application.

## SECTION 3

# WILDEN MODEL T2 METAL CAUTIONS – READ FIRST!



### TEMPERATURE LIMITS:

Polypropylene	+32°F to 175°F	0°C to 79°C
Neoprene	0°F to 200°F	-17.8°C to 93.3°C
Buna-N®	+10°F to +180°F	-12.2°C to 82.2°C
Nordel®	-60°F to 280°F	-51.1°C to 137.8°C
Viton®	-40°F to +350°F	-40°C to 176.7°C
Wil-Flex™	-40°F to +225°F	-40°C to 107.2°C
Polyurethane	10°F to 150°F	12.2°C to 65.6°C
Saniflex™	-20°F to 220°F	-28.9°C to 104.4°C
Teflon® PTFE	+40°F to +300°F	+4.4°C to 148.9°C



**CAUTION:** When choosing pump materials, be sure to check the temperature limits for all wetted components. Example: Viton® has a maximum limit of 350°F (176.7°C) but polypropylene has a maximum limit of only 175°F (79°C).



**CAUTION:** Maximum temperature limits are based upon mechanical stress only. Certain chemicals will significantly reduce maximum safe operating temperatures. Consult engineering guide for chemical compatibility and temperature limits.



**CAUTION:** Always wear safety glasses when operating pump. If diaphragm rupture occurs, material being pumped may be forced out air exhaust.



**WARNING:** Prevention of static sparking — If static sparking occurs, fire or explosion could result. Pump, valves, and containers must be properly grounded when handling flammable fluids and whenever discharge of static electricity is a hazard.



**CAUTION:** Do not exceed 125 psig (8.6 Bar) air supply pressure. (50 psig [3.4 Bar] for UL models.)



**CAUTION:** Before any maintenance or repair is attempted, the compressed air line to the pump should be disconnected and all air pressure allowed to bleed from pump. Disconnect all intake, discharge and air lines. Drain the pump by turning it upside down and allowing any fluid to flow into a suitable container.



**CAUTION:** Blow out air line for 10 to 20 seconds before attaching to pump to make sure all pipe line debris is clear. Use an in-line air filter. A 5µ (micron) air filter is recommended.



**NOTE:** Tighten clamp bands and retainers prior to installation. Fittings may loosen during transportation.



**NOTE:** When installing Teflon® diaphragms, it is important to tighten outer pistons simultaneously (turning in opposite directions) to ensure tight fit.



**NOTE:** Before starting disassembly, mark a line from each liquid chamber to its corresponding air chamber. This line will assist in proper alignment during reassembly.



**CAUTION:** Verify the chemical compatibility of the process and cleaning fluid to the pump's component materials in the Chemical Resistance Guide (see RBG E4).



**CAUTION:** When removing the end cap using compressed air, the air valve end cap may come out with considerable force. Hand protection such as a padded glove or rag should be used to capture the end cap.



**CAUTION:** Only explosion proof (NEMA 7) solenoid valves should be used in areas where explosion proof equipment is required.



**NOTE:** All non lube-free air-operated pumps must be lubricated. Wilden suggests an arctic 5 weight oil (ISO grade 15). Do not over-lubricate pump. Over-lubrication will reduce pump performance.



**NOTE:** UL-listed pumps must not exceed 50 psig (3.4 Bar) air supply pressure.



**CAUTION:** Do not lubricate lube-free pumps.

## SECTION 4A

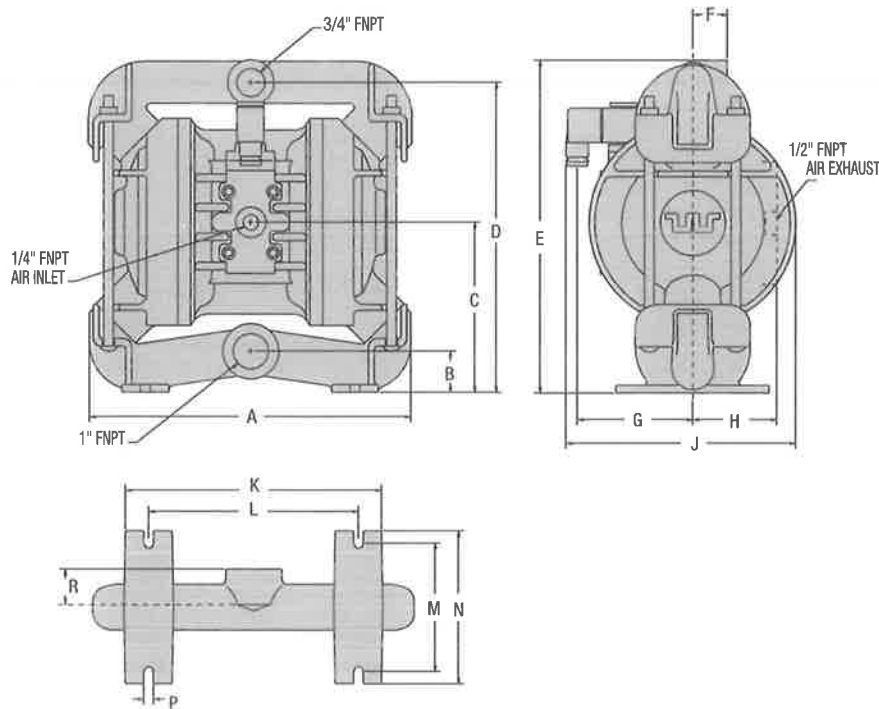
# DIMENSIONAL DRAWING WILDEN MODEL T2 METAL

DIMENSIONS - T2 (METAL)		
ITEM	STANDARD (inch)	METRIC (mm)
A	10 17/32	267.5
B	1 7/16	36.5
C	5 7/16	138.0
D	10	254.0
E	11	279.4
F	1 1/8	28.6
G	3 3/4	95.3
H	3 1/32	77.0
J	7 1/4	184.2
K	8 1/4	209.6
L	6 3/4	171.5
M	4 3/16	106.4
N	5	127.0
P	5/16	7.9
R	1 1/4	31.8

BSP threads available.

## SECTION 4B

# DIMENSIONAL DRAWING WILDEN MODEL A2 METAL ACCU-FLO™



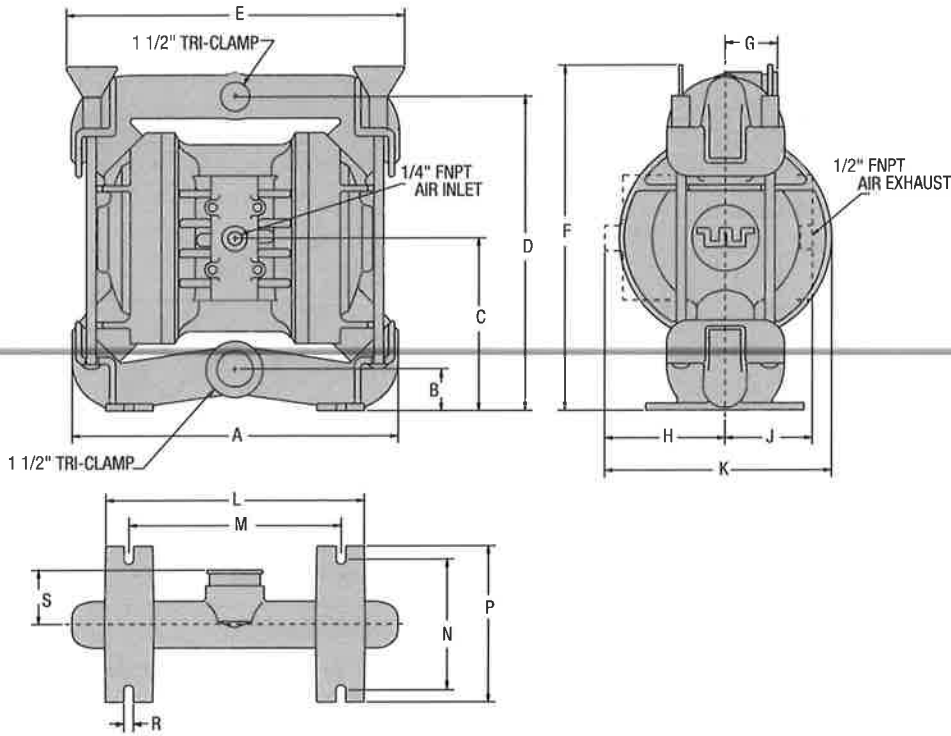
DIMENSIONS - A2 (METAL) SOLENOID-OPERATED		
ITEM	STANDARD (inch)	METRIC (mm)
A	10 17/32	267.5
B	1 7/16	36.5
C	5 7/16	138.0
D	10	254.0
E	11	279.4
F	1 1/8	28.6
G	3 25/32	96.0
H	3 1/32	77.0
J	7 1/2	190.5
K	8 1/4	209.6
L	6 3/4	171.5
M	4 3/16	106.4
N	5	127.0
P	5/16	7.94
R	1 1/4	31.8

BSP threads available.

## SECTION 4C

# DIMENSIONAL DRAWING

## WILDEN MODEL T2 METAL SANIFLO<sup>FDA</sup>

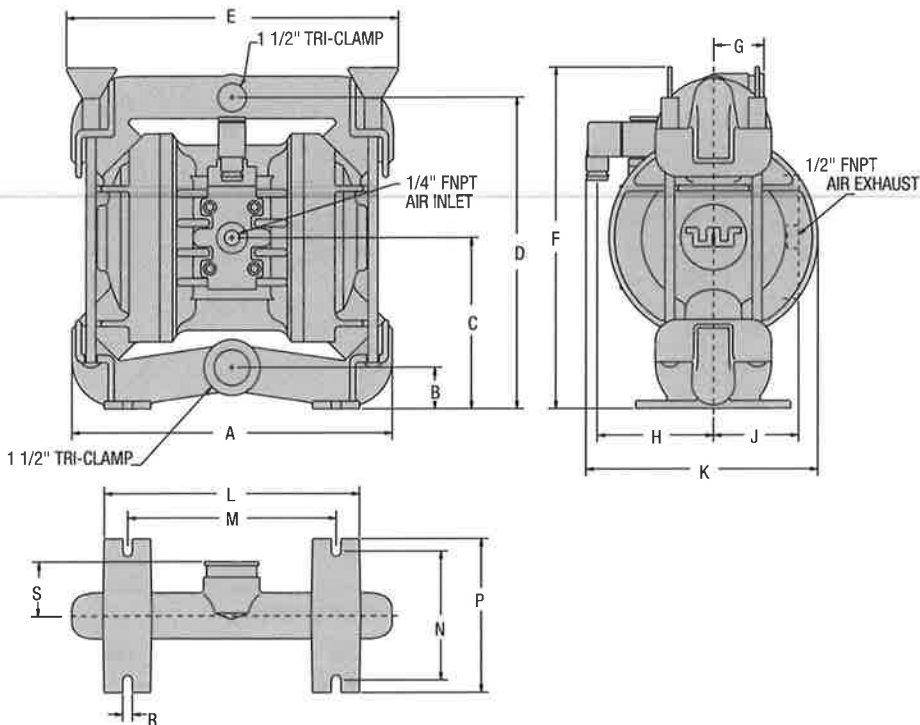


DIMENSIONS - T2 (FOOD PROCESSING)		
ITEM	STANDARD (inch)	METRIC (mm)
A	10 3/8	263.5
B	1 3/8	34.9
C	5 7/16	138.1
D	10 1/16	255.6
E	10 1/2	266.7
F	11 5/8	295.3
G	1 5/8	41.3
H	3 27/32	97.6
J	2 31/32	75.4
K	7 7/32	183.4
L	8 1/4	209.6
M	6 3/4	171.5
N	4 3/16	106.4
P	5	127.0
R	5/16	7.9
S	1 23/32	43.6

## SECTION 4D

# DIMENSIONAL DRAWING

## WILDEN MODEL A2 METAL SANIFLO<sup>FDA</sup> ACCU-FLO<sup>TM</sup>



DIMENSIONS - A2 (FOOD PROCESSING) SOLENOID-OPERATED		
ITEM	STANDARD (inch)	METRIC (mm)
A	10 3/8	263.5
B	1 3/8	34.9
C	5 7/16	138.1
D	10 1/16	255.6
E	10 1/2	266.7
F	11 5/8	295.3
G	1 5/8	41.3
H	3 25/32	96.0
J	2 31/32	75.4
K	7 1/2	190.5
L	8 1/4	209.6
M	6 3/4	171.5
N	4 3/16	106.4
P	5	127.0
R	5/16	7.9
S	1 23/32	43.6

## SECTION 5A

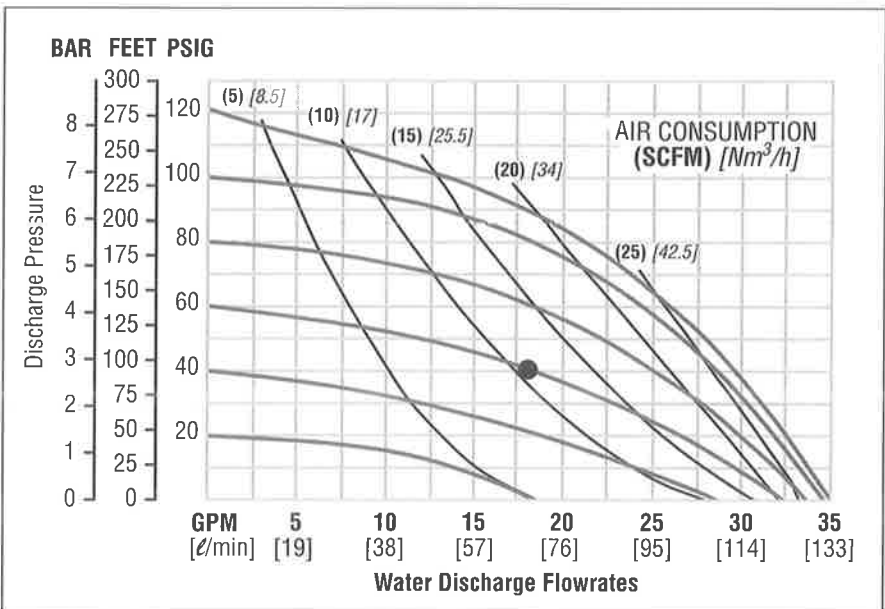
# PERFORMANCE CURVES MODEL T2 METAL RUBBER-FITTED

Height .....11" (27.94 cm)  
 Width.....10<sup>17</sup>/<sub>32</sub>" (26.75 cm)  
 Depth.....7<sup>1</sup>/<sub>4</sub>" (18.42 cm)  
 Ship Weight .....Aluminum 26 lbs. (12 kg)  
                           Stainless Steel 36 lbs. (16.6 kg)  
                           Hastelloy 40 lbs. (16 kg)  
 Air Inlet .....1/4" (6.35 mm)  
 Inlet.....1" (2.54 cm)  
 Outlet.....3/4" (1.91 cm)  
 Suction Lift .....17' Dry (5.18 m)  
                           31' Wet (9.45 m)

Displacement per  
 Stroke ..... 0.105 gal. (.41 l)  
 Max. Flow Rate.....35 gpm (132.49 lpm)  
 Max. Size Solids.....1/8" (3.18 mm)  
 \*Displacement per stroke was calculated at 70 psig (4.8 Bar) air inlet pressure against a 30 psig (2 Bar) head pressure.

**Example:** To pump 18 gpm (68.1 lpm) against a discharge pressure head of 40 psig (2.7 Bar) requires 60 psig (4.1 Bar) and 11 scfm (18.7 Nm<sup>3</sup>/h) air consumption. (See dot on chart.)

**Caution: Do not exceed 125 psig (8.6 Bar) air supply pressure.**



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

## SECTION 5B

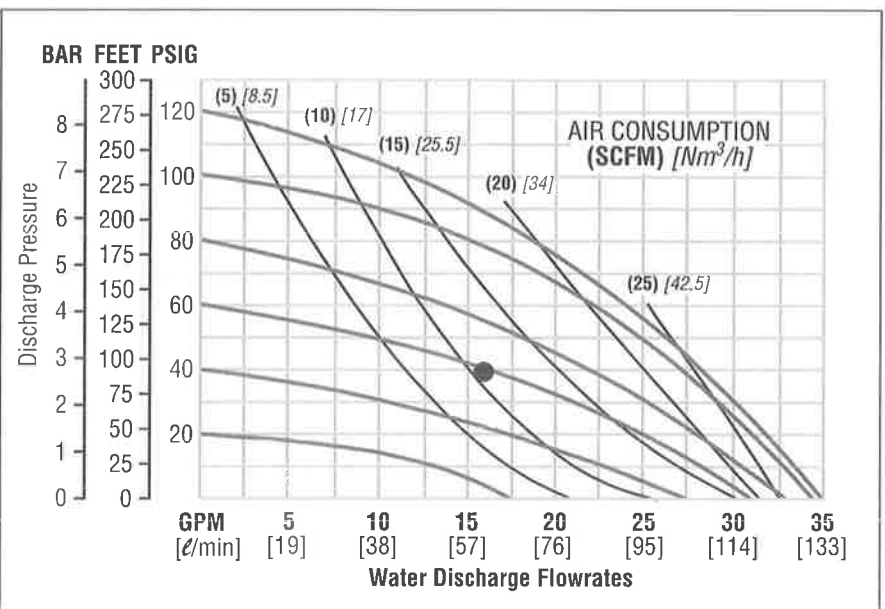
# PERFORMANCE CURVES MODEL T2 METAL TPE-FITTED

Height .....11" (27.94 cm)  
 Width.....10<sup>17</sup>/<sub>32</sub>" (26.75 cm)  
 Depth.....7<sup>1</sup>/<sub>4</sub>" (18.42 cm)  
 Ship Weight .....Aluminum 26 lbs. (12 kg)  
                           Stainless Steel 36 lbs. (16.6 kg)  
                           Hastelloy 40 lbs. (16 kg)  
 Air Inlet .....1/4" (6.35 mm)  
 Inlet.....1" (1.27 cm)  
 Outlet.....3/4" (1.91 cm)  
 Suction Lift .....5' Dry (1.52 m)  
                           31' Wet (9.45 m)

Displacement per  
 Stroke ..... 0.105 gal. (.41 l)  
 Max. Flow Rate.....35 gpm (132.49 lpm)  
 Max. Size Solids.....1/8" (3.18 mm)  
 \*Displacement per stroke was calculated at 70 psig (4.8 Bar) air inlet pressure against a 30 psig (2 Bar) head pressure.

**Example:** To pump 16 gpm (60.6 lpm) against a discharge pressure head of 40 psig (2.7 Bar) requires 60 psig (4 Bar) and 10 scfm (17 Nm<sup>3</sup>/h) air consumption. (See dot on chart.)

**Caution: Do not exceed 125 psig (8.6 Bar) air supply pressure.**



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.



## SECTION 5C

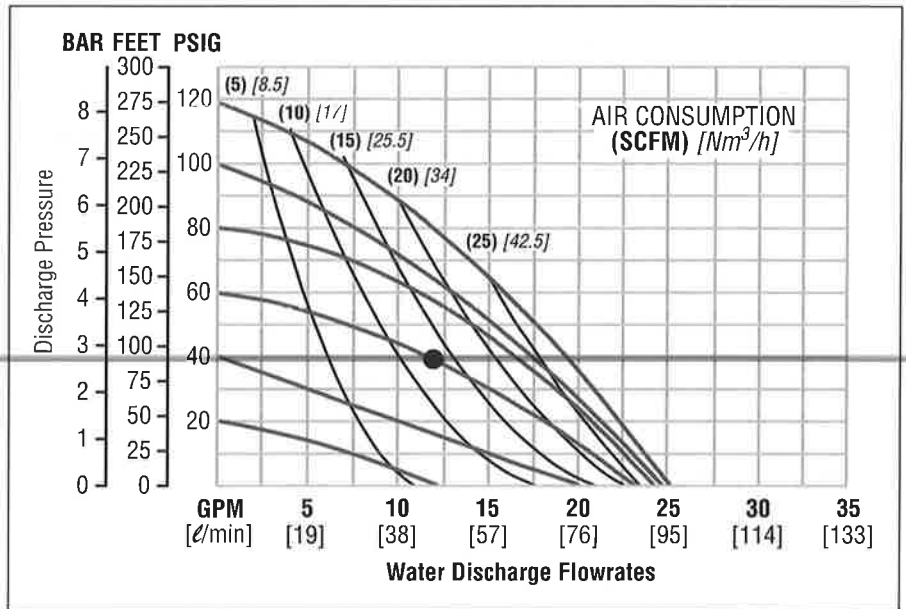
# PERFORMANCE CURVES MODEL T2 METAL TEFLON®-FITTED

Height .....11" (27.94 cm)  
 Width .....10<sup>1</sup>/<sub>2</sub>" (26.75 cm)  
 Depth .....7<sup>1</sup>/<sub>4</sub>" (18.42 cm)  
 Ship Weight .....Aluminum 26 lbs. (12 kg)  
                                   Stainless Steel 36 lbs. (16.6 kg)  
                                   Hastelloy 40 lbs. (16 kg)  
 Air Inlet .....1/4" (6.35 mm)  
 Inlet .....1" (2.54 cm)  
 Outlet .....3/4" (1.91 cm)  
 Suction Lift .....6' Dry (1.83 m)  
                                   31' Wet (9.45 m)

Displacement per  
 Stroke ..... 0.05 gal. (.19 l)  
 Max. Flow Rate .....25 gpm (94.64 lpm)  
 Max. Size Solids .....1/8" (3.18 mm)  
 \*Displacement per stroke was calculated at 70 psig (4.8 Bar) air inlet pressure against a 30 psig (2 Bar) head pressure.

**Example:** To pump 12 gpm (45.4 lpm) against a discharge pressure head of 40 psig (2.7 Bar) requires 60 psig (4.1 Bar) and 13 scfm (22.1 Nm<sup>3</sup>/h) air consumption. (See dot on chart.)

**Caution:** Do not exceed 125 psig (8.6 Bar) air supply pressure.

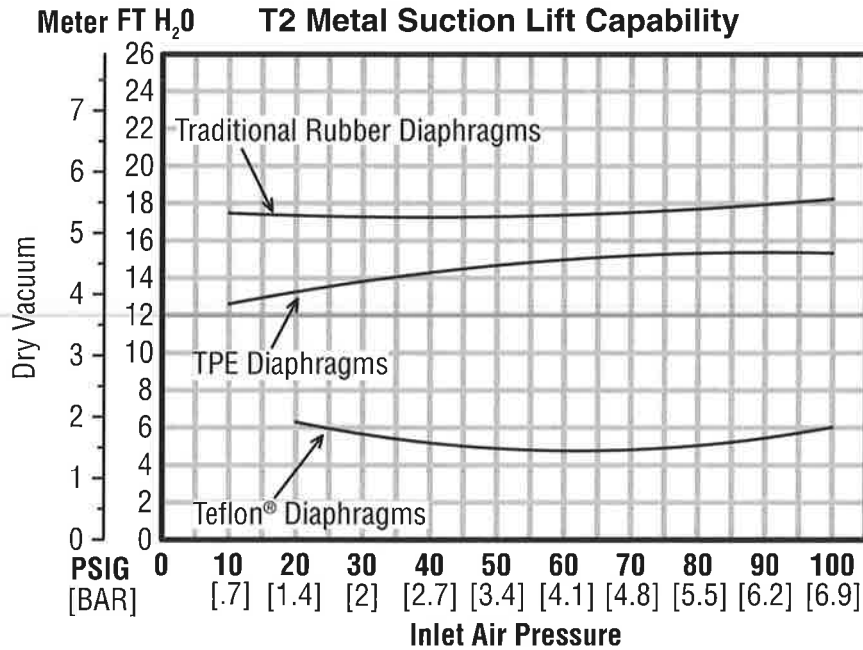


Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

## SECTION 6

# SUCTION LIFT CURVES & DATA



Suction lift curves are calibrated for pumps operating at 1,000' (305 m) above sea level. This chart is meant to be a guide only. There are many variables which can affect your pump's operating characteristics. The number of intake and discharge elbows,

viscosity of pumping fluid, elevation (atmospheric pressure) and pipe friction loss all affect the amount of suction lift your pump will attain.

## SECTION 7A

# INSTALLATION – T2 METAL AIR-OPERATED PUMPS

The Model T2 Metal pump has a 1" (2.54 cm) inlet and ¾" (1.91 cm) outlet and is designed for flows to 35 gpm (132.49 lpm). The T2 Metal pump is manufactured with wetted parts of aluminum or stainless steel. The center section of the T2 Metal pump is of aluminum or polypropylene construction. Two types of air distribution systems are available: *LUBED AND LUBE-FREE*. The LUBED air distribution system consists of a brass air valve body, aluminum air valve piston, Glyd™ rings and a bronze center section bushing. The LUBE-FREE air distribution system is constructed solely of high-tech, engineered thermoplastics which function together without lubrication. The encircled letters "LF" stamped on the top of the pump's center section denotes that the pump is LUBE-FREE. The lube-free air valve body is off-white in color and also has "LF" molded into the valve body. A variety of diaphragms, valve balls, valve seats, and O-rings are available to satisfy temperature, chemical compatibility, abrasion and flex concerns.

The suction pipe size should be at least 1" (2.54 cm) diameter or larger if highly viscous material is being pumped. The suction hose must be non-collapsible, reinforced type as the T2 is capable of pulling a high vacuum. Discharge piping should be at least ¾" (1.91 cm); larger diameter can be used to reduce friction losses. It is critical that all fittings and connections are airtight or a reduction or loss of pump suction capability will result.

**INSTALLATION:** Months of careful planning, study, and selection efforts can result in unsatisfactory pump performance if installation details are left to chance.

Premature failure and long term dissatisfaction can be avoided if reasonable care is exercised throughout the installation process.

**LOCATION:** Noise, safety, and other logistical factors usually dictate that "utility" equipment be situated away from the production floor. Multiple installations with conflicting requirements can result in congestion of utility areas, leaving few choices for siting of additional pumps.

Within the framework of these and other existing conditions, every pump should be located in such a way that four key factors are balanced against each other to maximum advantage.

1. **ACCESS:** First of all, the location should be accessible. If it's easy to reach the pump, maintenance personnel will have an easier time carrying out routine inspections and adjustments. Should major repairs become necessary, ease of access can play a key role in speeding the repair process and reducing total downtime.

2. **AIR SUPPLY:** Every pump location should have an air line large enough to supply the volume of air necessary to achieve the desired pumping rate (see pump performance chart). Use air pressure up to a maximum of 125 psi (8.6 Bar) depending upon pumping requirements. The use of an air filter before the pump will ensure that the majority of any pipeline contaminants will be eliminated. For best results, the pumps should use an air filter, regulator, and lubricator system.

3. **ELEVATION:** Selecting a site that is well within the pump's suction lift capability will assure that loss-of-prime troubles will

be eliminated. In addition, pump efficiency can be adversely affected if proper attention is not given to elevation (see pump performance chart).

4. **PIPING:** Final determination of the pump site should not be made until the piping problems of each possible location have been evaluated. The impact of current and future installations should be considered ahead of time to make sure that inadvertent restrictions are not created for any remaining sites.

The best choice possible will be a site involving the shortest and the straightest hook-up of suction and discharge piping. Unnecessary elbows, bends, and fittings should be avoided. Pipe sizes should be selected so as to keep friction losses within practical limits. All piping should be supported independently of the pump. In addition, it should line up without placing stress on the pump fittings.

Expansion joints can be installed to aid in absorbing the forces created by the natural reciprocating action of the pump. If the pump is to be bolted down to a solid foundation, a mounting pad placed between the pump and foundation will assist in minimizing pump vibration. Flexible connections between the pump and rigid piping will also assist in minimizing pump vibration. If quick-closing valves are installed at any point in the discharge system, or if pulsation within a system becomes a problem, a surge suppressor should be installed to protect the pump, piping and gauges from surges and water hammer.

When pumps are installed in applications involving flooded suction or suction head pressures, a gate valve should be installed in the suction line to permit closing of the line for pump service.

The T2 can be used in submersible applications only when both wetted and non-wetted portions are compatible with the material being pumped. If the pump is to be used in a submersible application, a hose should be attached to the pump's air exhaust and the exhaust air piped above the liquid level.

If the pump is to be used in a self-priming application, be sure that all connections are airtight and that the suction lift is within the pump's ability. Note: Materials of construction and elastomer material have an effect on suction lift parameters. Please refer to pump performance data.

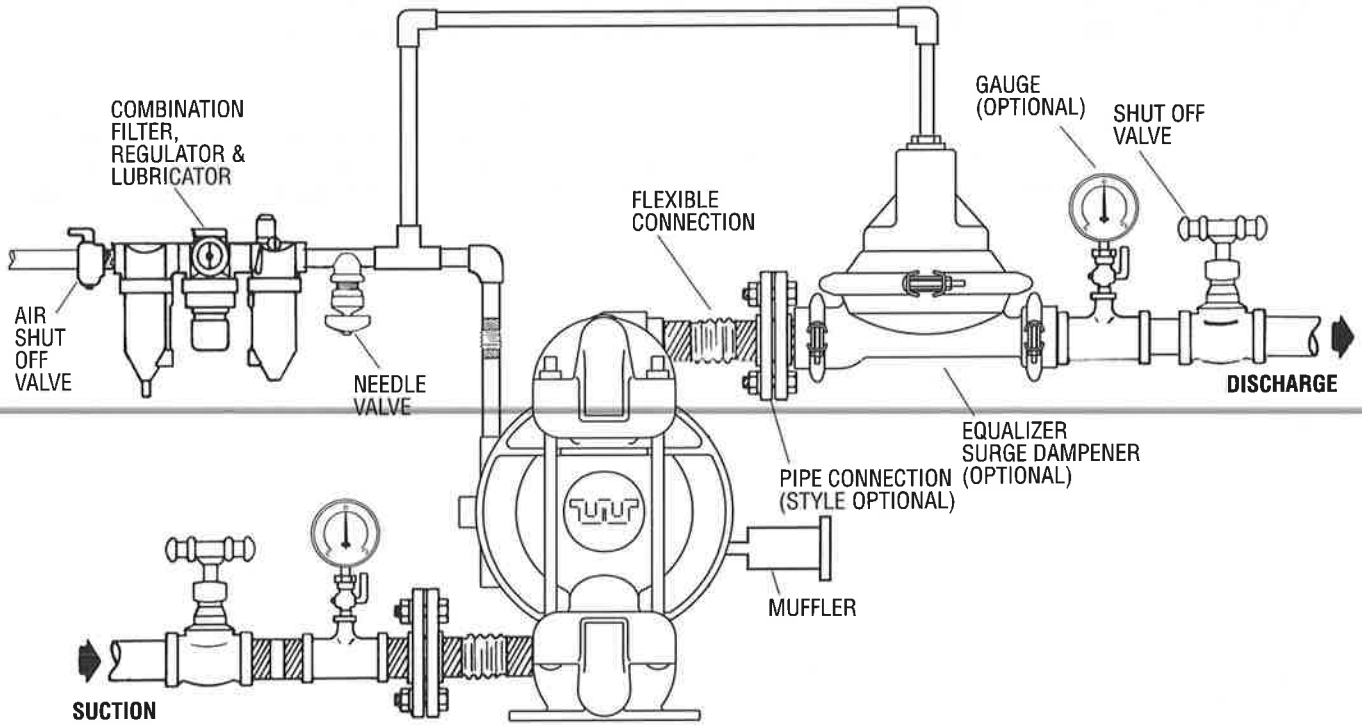
Pumps in service with a positive suction head are most efficient when inlet pressure is limited to 7–10 psig (.5–.7 Bar). Premature diaphragm failure may occur if positive suction is 11 psig (.8 Bar) and higher.

**THE MODEL T2 WILL PASS ⅛" (3.18 mm) SOLIDS. WHENEVER THE POSSIBILITY EXISTS THAT LARGER SOLID OBJECTS MAY BE SUCKED INTO THE PUMP, A STRAINER SHOULD BE USED ON THE SUCTION LINE.**

**CAUTION: DO NOT EXCEED 125 PSIG (8.6 BAR) AIR SUPPLY PRESSURE. (50 PSIG [3.4 BAR] FOR UL MODELS.)**

**BLOW OUT AIR LINE FOR 10 TO 20 SECONDS BEFORE ATTACHING TO PUMP TO MAKE SURE ALL PIPE LINE DEBRIS IS CLEAR. ALWAYS USE AN IN-LINE AIR FILTER.**

# SUGGESTED INSTALLATION



## SECTION 7B – AIR-CONTROLLED SUGGESTED OPERATION AND MAINTENANCE INSTRUCTIONS

**OPERATION:** Pump discharge rate can be controlled by limiting the volume and/or pressure of the air supply to the pump (preferred method). An air regulator is used to regulate air pressure. A needle valve is used to regulate volume. Pump discharge rate can also be controlled by throttling the pump discharge by partially closing a valve in the discharge line of the pump. This action increases friction loss which reduces flow rate. This is useful when the need exists to control the pump from a remote location. When the pump discharge pressure equals or exceeds the air supply pressure, the pump will stop; no bypass or pressure relief valve is needed, and pump damage will not occur. The pump has reached a "deadhead" situation and can be restarted by reducing the fluid discharge pressure or increasing the air inlet pressure. The Wilden T2 pump runs solely on compressed air and does not generate heat, therefore your process fluid temperature will not be affected.

**RECORDS:** When service is required, a record should be made of all necessary repairs and replacements. Over a period of time, such records can become a valuable tool for predicting and preventing future maintenance problems and unscheduled downtime. In addition, accurate records make it possible to identify pumps that are poorly suited to their applications.

**MAINTENANCE AND INSPECTIONS:** Since each application is unique, maintenance schedules may be different for every pump. Frequency of use, line pressure, viscosity and abrasiveness of process fluid all affect the parts life of a Wilden pump. Periodic inspections have been found to offer the best means for preventing unscheduled pump downtime. Personnel familiar with the pump's construction and service should be informed of any abnormalities that are detected during operation.

## **SECTION 7C**

# **OPERATING PRINCIPLES BEHIND SOLENOID-OPERATED PUMPS**

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In the solenoid-operated pump models, the standard air valve is replaced with a two position, four-way solenoid valve that has a single operator and spring return. The valve is internally air piloted for longer coil and operator life.

When the solenoid is unpowered, one air chamber is pressurized with air, while the opposite chamber is exhausted. When electric power is applied, the solenoid shifts, and the pressurized air chamber is exhausted while the opposite chamber is pressurized. By alternately applying and removing power, the solenoid-operated pump runs like a standard Wilden pump.

The speed of the pump is controlled electrically. Since each stroke is controlled by an electrical signal, the pump is ideal for batching and other electrically controlled dispensing applications.

Although the speed of the pump is controlled electrically, the air pressure is important. Air pressure displaces the fluid, and if the pressure is insufficient to complete the physical stroke before an electronic impulse signals the pump to shift, the stroke will not be completed, and the displacement per stroke will be reduced. This does not harm the unit in any way, but it may cause inaccuracy when attempting to batch specific quantities with high precision if this effect is not taken into account.

There are three coil voltage options available. One coil allows for 24V DC operation. The second coil option allows for operation with either 12V DC or 24V AC at 60 Hz and the third coil option allows for 110V AC operation.

## **SECTION 7D**

# **INSTALLATION – A2 METAL ACCU-FLO™ PUMPS**

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Before installing your A2 Accu-Flo™ pump, review Section 7A for general installation suggestions including Location, Access, Air Supply, Elevation, and Piping.

The Accu-Flo™ Model A2 has a 1" (2.54 cm) inlet and ¾" (1.91 cm) outlet and is designed for flows to 24.5 gpm (94.94 lpm). This maximum flow rate was calculated at 550 strokes per minute with 100 psig air inlet against 0 psig discharge head. The A2 Metal pump is manufactured with wetted parts of aluminum or 316 stainless steel. The center section of the A2 Metal pump is of aluminum or polypropylene construction. A variety of diaphragms, valve balls, and O-rings are available to satisfy temperature, chemical compatibility, abrasion and flex concerns.

All wiring used to operate the pump should be placed and connected according to the proper electrical codes. It is important that the wiring is of adequate gauge to carry the current required to operate the pump. In addition, it is necessary that the electrical power supply is large enough to supply the current required to operate the pump. Wiring should be above ground level if possible (in case of fluid spill or leakage), and all wiring and connections which could become wet or damp should be made watertight.

If the pump is to be used in a self-priming application, be sure that all connections are airtight and that the suction lift is within the pump's ability. Note: Materials of construction and elastomer material have an effect on suction lift parameters. Please refer to pump performance data.

Pumps in service with a positive suction head are most efficient when inlet pressure is limited to 7–10 psig (.5–.7 Bar). Premature diaphragm failure may occur if positive suction head is 11 psig (.8 Bar) and higher.

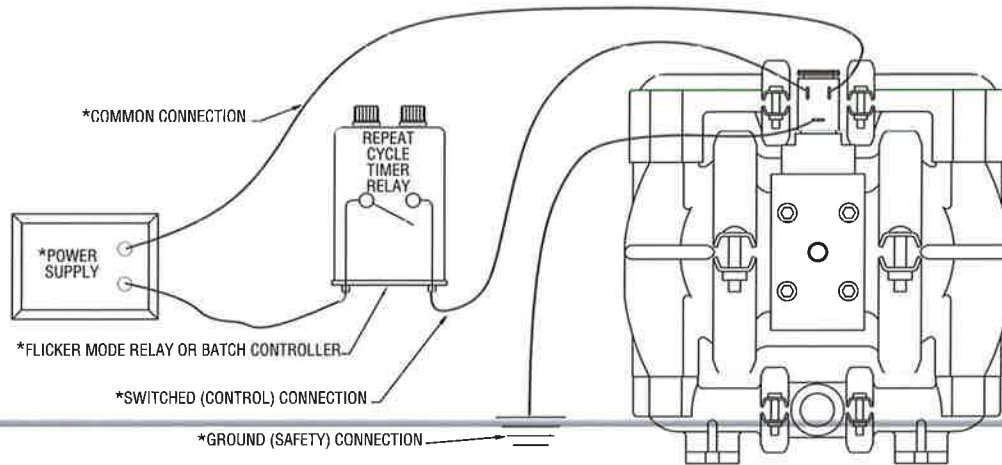
The solenoid valve is rated for continuous duty; however, stopping on an even number stroke count insures that the electrical power is off when pump is stopped. This practice is safer and also eliminates unwanted strokes when the system is shut down and electrical power is off.

THE MODEL A2 WILL PASS ¼" (3.18 mm) SOLIDS. WHENEVER THE POSSIBILITY EXISTS THAT LARGER SOLID OBJECTS MAY BE SUCKED INTO THE PUMP, A STRAINER SHOULD BE USED ON THE SUCTION LINE.

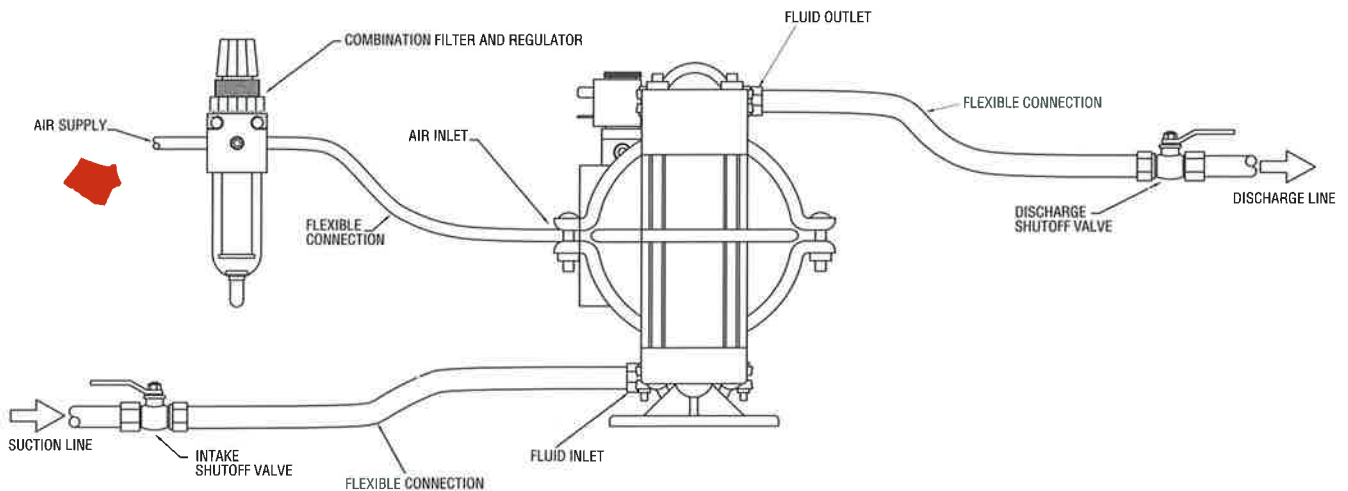
**WARNING: The solenoid valve should not be used in an area where explosion proof equipment is required unless NEMA 7 valve is specified.**

There are three coil options available in both NEMA 4 and NEMA 7 ratings. One coil allows for 110V AC operation, one allows for 24V DC operation, and the third allows for either 24V AC or 12V DC operation.

# ELECTRICAL CONNECTIONS



# PLUMBING CONNECTIONS



## SECTION 7E – SOLENOID OPERATION

# SUGGESTED OPERATION AND MAINTENANCE INSTRUCTIONS

**OPERATION:** The speed of the pump is controlled electrically. Since each stroke is controlled by an electrical signal, the pump is ideal for batching and other electrically controlled dispensing applications.

Although the speed of the pump is controlled electrically, the air pressure is important. Air pressure displaces the fluid, and if the pressure is insufficient to complete the physical stroke before an electronic impulse signals the pump to shift, the stroke will not be completed, and the displacement per stroke will be reduced. This does not harm the unit in any way, but it may cause inaccuracy when attempting to batch specific quantities with high precision.

The solenoid operated pump is permanently lubricated during assembly, and requires no additional lubrication under normal operation. If the unit runs under extreme conditions (continuous operation at high speeds), it may be necessary to relubricate the center block with a **Buna-N® compatible NLGI Grade 2 grease** every 50 million cycles. Continuous lubrication with a compatible oil is not harmful, and will provide longer seal life, but it may flush all grease out of the unit.

A red button on the side of the air valve is a manual override; when

actuated it will shift the valve as if an electric current had actuated the solenoid.

**RECORDS:** When service is required, a record should be made of all necessary repairs and replacements. Over a period of time, such records can become a valuable tool for predicting and preventing future maintenance problems and unscheduled downtime. In addition, accurate records make it possible to identify pumps that are poorly suited to their applications.

**MAINTENANCE AND INSPECTIONS:** Since each application is unique, maintenance schedules may be different for every pump. Frequency of use, line pressure, viscosity and abrasiveness of process fluid all affect the parts life of a Wilden pump. Periodic inspections have been found to offer the best means for preventing unscheduled pump downtime. Personnel familiar with the pump's construction and service should be informed of any abnormalities that are detected during operation. Internal maintenance is not recommended for Accu-Flo™ solenoid air valves. When worn or damaged, a new air valve body, coil or terminal connector must be purchased. Please consult section 9C for part numbers.

## **SECTION 7F – AIR OPERATION**

# **TROUBLESHOOTING**

### ***Pump will not run or runs slowly.***

1. Check air inlet screen and air filter for debris.
2. Check for sticking air valve, flush air valve in solvent.
3. Check for worn out air valve. If piston face in air valve is shiny instead of dull, air valve is probably worn beyond working tolerances and must be replaced.
4. Check center block Glyd™ rings. If worn excessively, they will not seal and air will simply flow through pump and out air exhaust. Use only Wilden Glyd™ rings as they are of special construction.
5. Check for rotating piston in air valve.
6. Check type of lubricant being used. A higher viscosity oil than suggested may cause the piston to stick or run erratically. Wilden suggests the use of an oil with arctic characteristics (ISO 15-5 wt.).

### ***Pump runs but little or no product flows.***

1. Check for pump cavitation; slow pump speed down to match thickness of material being pumped.

2. Check for sticking ball check valves. If material being pumped is not compatible with pump elastomers, swelling may occur. Replace ball check valves and O-rings with the proper elastomers.
3. Check to make sure all suction connections are air tight, especially clamp bands around intake balls.

### ***Pump air valve freezes.***

Check for excessive moisture in compressed air. Either install dryer or hot air generator for compressed air.

### ***Air bubbles in pump discharge.***

1. Check for ruptured diaphragm.
2. Check tightness of clamp bands, especially at intake manifold.

### ***Product comes out air exhaust.***

1. Check for diaphragm rupture.
2. Check tightness of piston plates to shaft.

## **SECTION 7G – SOLENOID OPERATION**

# **TROUBLESHOOTING**

### ***Pump will not run.***

1. Check for pressurized air at the inlet. (Min. 45 psig.)
2. Check air inlet and filter for debris.
3. Connect a test lamp to the two wires which run to pump and ensure that the lamp cycles on and off.
4. Make sure that the air valve manual override (small red knob on front of valve) is switched to the "0" position.
5. Check pilot pressure vent at the top of the operator/coil assembly to ensure that it is not clogged.
6. Check for a worn out air valve. If air continually blows out the exhaust in very large quantities, the air valve seals may be worn beyond their ability to function. In this case, the valve must be replaced.

NOTE: Before the valve is scrapped, it is possible that it may be saved by completely disassembling the valve, cleaning all components and relubricating the valve.

### ***Pump runs but little or no fluid comes out.***

1. Check that the discharge isolation valve is not closed.
2. Check that the electronic signal is slow enough that the pump is able to complete each physical stroke before it is signaled to change direction. The time required to complete the stroke is determined by a variety of factors which include fluid viscosity and head pressure. The shaft can be viewed if the muffler is removed to verify that the pump is stroking.
3. Check for pump cavitation; slow pump speed down to match the thickness of the material being pumped.
4. Check for sticking ball check valves. If the material being pumped is not compatible with the pump elastomers, swelling may occur. Replace ball check valves and O-ring with the proper elastomers.
5. Check to make sure that all suction connections are air tight, and that the clamp bands are properly tightened.

### ***Pump air passages blocked with ice.***

Check for excessive moisture in compressed air line. As the air expands out the exhaust during the operation of the pump,

water vapor entrapped in the compressed air can freeze and block the air passageways in the pump. If this occurs, it may be necessary to install a coalescing filter, an air dryer, or a hot air generator for the compressed air.

### ***Air bubbles in pump discharge.***

1. Check for ruptured diaphragm.
2. Check tightness of clamp bands, and the integrity of the O-rings, especially at intake manifold.

### ***Product comes out air exhaust.***

1. Check for diaphragm rupture.
2. Check tightness of piston plates to shaft.

### ***Pump rattles.***

1. See RBG E9 Troubleshooting Guide.
2. Create false discharge head or suction lift.

### ***Solenoid buzzes or solenoid burnout.***

1. Incorrect voltage, faulty or dirty solenoid.

### ***Solenoid valve fails to shift electrically but shifts with manual override.***

1. Incorrect voltage, defective coil or wiring.

### ***Solenoid valve fails to shift electrically or with manual override.***

1. Inadequate air supply, contamination, inadequate or improper lubrication, mechanical binding in the valve.

### ***Valve shifts but fails to return.***

1. Broken spring, mechanical binding.

### ***Excessive leaking from air valve vent.***

1. Worn seals in air valve.

## SECTION 8A

# MODEL T2 METAL DIRECTIONS FOR DISASSEMBLY/REASSEMBLY

**CAUTION:** Before any maintenance or repair is attempted, the compressed air line to the pump should be disconnected and all air pressure allowed to bleed from the pump. Disconnect all intake, discharge, and air lines. Drain the pump by turning it upside down and allowing any fluid to flow into a suitable container. Be aware of any hazardous effects of contact with your process fluid.

The Wilden model T2 has a 1" (2.54 cm) inlet and 3/4" (1.91 cm) outlet and is designed for flows up to 35 gpm (132.49 lpm). The single-piece center section, consisting of center block and air chambers, is molded of polypropylene or aluminum. The air valve is manufactured of brass or high-tech, engineered thermoplastics. All O-rings used in the pump are of a special material and shore hardness that should only be replaced with factory-supplied parts.

### TOOLS REQUIRED:

Adjustable Wrench

5/16" Box Wrench

3/4" Box Wrench

Vise equipped with soft jaws (such as plywood, plastic or other suitable material)

**NOTE:** The model used for these instructions incorporates rubber diaphragms, balls, and seats. Models with Teflon® diaphragms, balls and seats are the same except where noted. The procedures for A2 Accu-Flo™ pumps are the same except for the air distribution system.

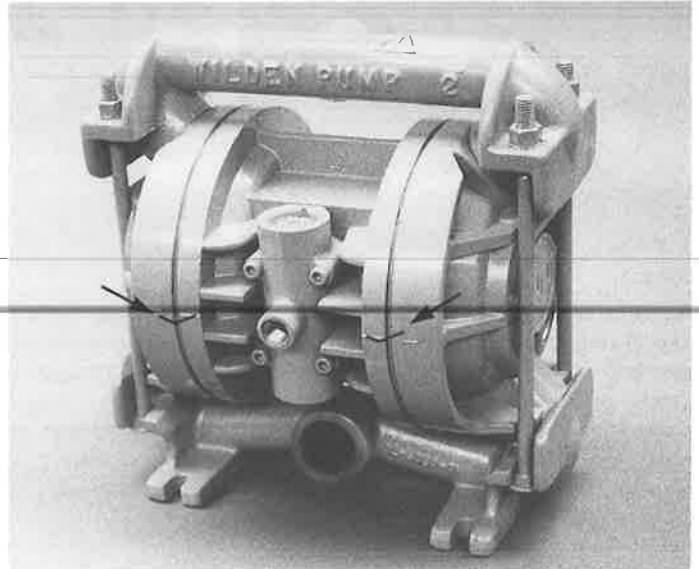
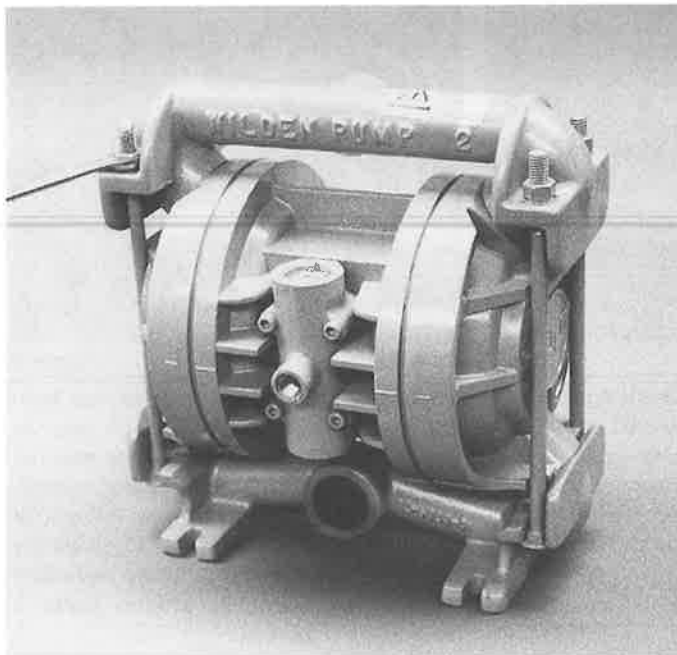


Figure 1

### DISASSEMBLY:

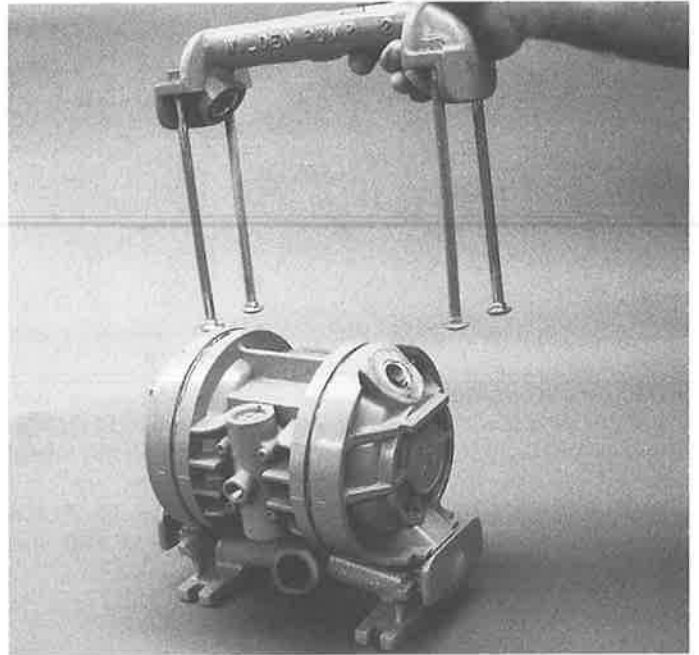
#### Step 1.

Before starting disassembly, mark a line from each liquid chamber to its corresponding air chamber. This line will assist in proper alignment during reassembly. (Figure 1)



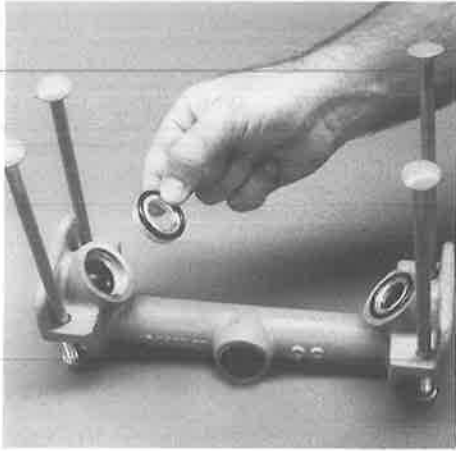
Step 2. Figure 2

Utilizing the 5/16" box wrench, start by removing the four long carriage bolts that secure the top and bottom manifolds to the center section. (Figure 2)



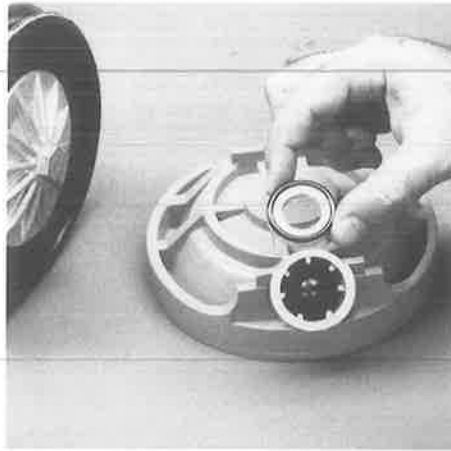
Step 3. Figure 3

Remove the top manifold and lift the center section off the inlet manifold. (Figure 3)



**Step 4.** *Figure 4*

Remove the discharge valve balls, seats and O-rings from the discharge manifold and inspect for nicks, gouges, chemical attack or abrasive wear. Replace worn parts with genuine Wilden parts for reliable performance. Teflon® O-rings should be replaced when reassembled. (*Figure 4*)



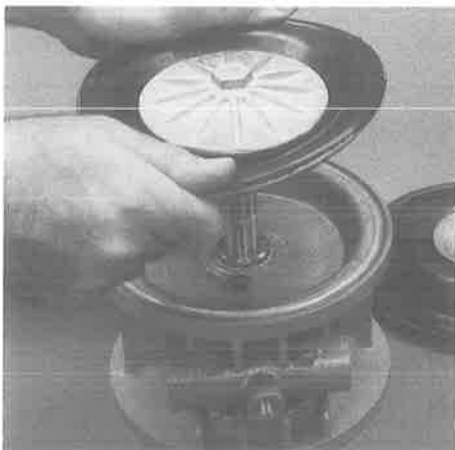
**Step 5.** *Figure 5*

Inspect the valve seat, valve seat O-ring, and valve ball from intake manifold. Check for nicks, gouges, chemical attack or abrasive wear. Replace worn parts with genuine Wilden parts for reliable performance. Teflon® O-rings should be replaced when reassembled. (*Figure 5*)



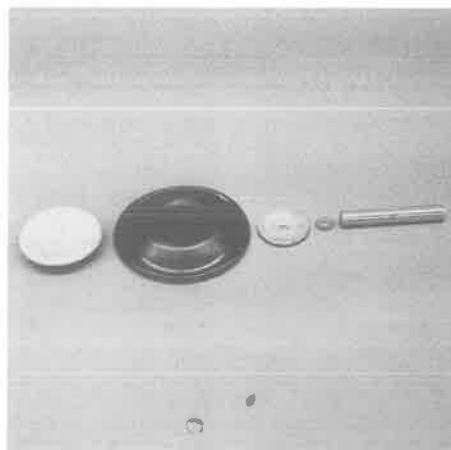
**Step 6.** *Figure 6*

With the 3/4" box wrench or by rotating the diaphragm by hand, remove the diaphragm assembly. (*Figure 6*)



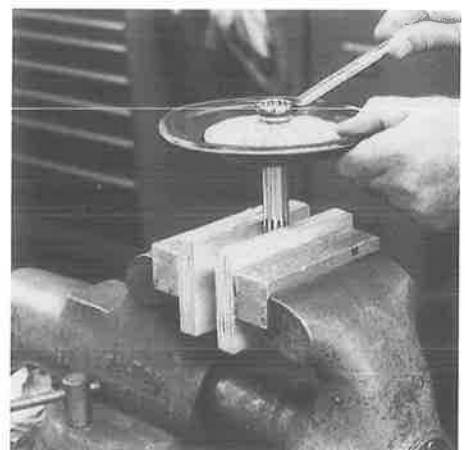
**Step 7.** *Figure 7*

**NOTE:** Due to varying torque values, one of the following two situations may occur:  
1) The outer piston, diaphragm and inner piston remain attached to the shaft and the entire assembly can be removed from the center section (*Figure 7*).



**Step 8.** *Figure 8*

2) The outer piston, diaphragm, inner piston, and disc spring separate from the shaft which remains connected to the opposite side diaphragm assembly (*Figure 8*). Teflon®-fitted pumps come standard with back-up diaphragms (not shown).



**Step 9.** *Figure 9*

To remove the diaphragm assembly from the shaft, secure shaft with soft jaws (a vise fitted with plywood or other suitable material) to ensure shaft is not nicked, scratched, or gouged. Using an adjustable wrench, remove diaphragm assembly from shaft. Inspect all parts for wear and replace with genuine Wilden parts if necessary. (*Figure 9*)



## SECTION 8B – TURBO-FLO™ PUMPS

# AIR VALVE / CENTER SECTION REPAIR / MAINTENANCE

The air valve assembly consists of the air valve body and piston. The unique design of the air valve relies only on differential pressure to cause the air valve to shift. It is reliable and simple to maintain. The bushing in the center block, along with the diaphragm shaft, provides the "trigger" to tell the air valve to shift. The following procedure will ensure that the air valve on your Wilden pump will provide long trouble-free service.

### AIR VALVE BODY AND PISTON ASSEMBLY AND DISASSEMBLY

The air valve body and piston can be disconnected from the pump by removing the four socket-head cap screws which attach it to the center section. The piston in the air valve is aluminum with a dark anodized coating (see *Figure A*). The piston should move freely and the ports in the piston should line up with the ports on the face of the air valve body. The piston should also appear to be dull black in color. If the piston appears to be a shiny aluminum color, the air valve is probably worn beyond working tolerances and should be replaced.

If the piston does not move freely in the air valve, the entire air valve should be immersed in a cleaning solution. (NOTE: Do not

force the piston by inserting a metal object.) This soaking should remove any accumulation of sludge and grit which is preventing the air valve piston from moving freely. If the air valve piston does not move freely after the above cleaning, the air valve should be disassembled as follows: Remove the snap ring from the top end of the air valve and apply an air jet alternately to the two holes located in the face of the air valve until the end cap is blown out. (See *Figure B*, next page) [CAUTION: The air valve end cap may come out with considerable force. Hand protection such as a padded glove or a rag should be used to capture the end cap.] Inspect the piston and cylinder bore for nicks and scoring.

Small nicks can usually be dressed out and the piston returned to service. Inspect the cylinder end caps. Make sure that the guide pin is straight and smooth or the piston will not move freely in the cylinder. Clean out anti-centering pin holes located on each side of the piston. Pin holes are located on each side of the annular groove on the top of the piston and travel to each end. New O-rings should be installed on the end caps. Lubricate the O-rings and install the end caps, assuring that proper alignment of the piston and cylinder ports is maintained. Use an oil with arctic characteristics (ISO 15-5wt).

### GLYD™ RING REPLACEMENT/ CENTER SECTION

The pump's center section consists of a molded housing with a bronze bushing. (Bushing is not removable.) This bushing has grooves cut into the inside diameter. Glyd™ rings are installed in these grooves. When the Glyd™ rings become worn, they will no longer seal and must be replaced.

There are two versions of center sections: PRE-ENHANCED (pumps manufactured before March 1, 1992) and ENHANCED (pumps manufactured since March 1, 1992). An encircled letter "E" stamped on the top of the center section denotes the ENHANCED type center section (*Figure C*).

Please contact your local authorized distributor for enhanced air distribution retrofit packages.

If the encircled "E" is present, an enhanced (02-3800-09-07) shaft should be utilized to maximize performance. The center section Glyd™ rings (02-3210-55-225) must be installed in the appropriate grooves as shown (1, 3, 6, 8).

If the encircled "E" is not present, a pre-enhanced shaft (02-3800-09 or 02-3820-09) must be utilized. An enhanced (non-dented) shaft will not function correctly. The center section O-rings (02-3200-52) must be installed in the appropriate grooves as shown (1, 3, 4, 6).

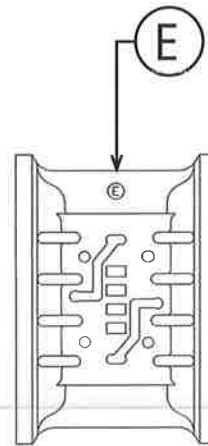
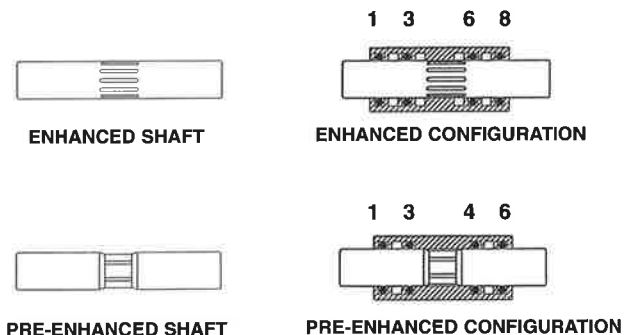


Figure C



## SECTION 8C – M2 LUBE-FREE PUMPS

# AIR VALVE / CENTER SECTION DISASSEMBLY, CLEANING, INSPECTION

### AIR VALVE/CENTER SECTION REPAIR/MAINTENANCE

The center section assembly consists of both the air valve body and piston, and the center section. The lube-free design utilizes high-tech, engineered thermoplastics in place of the brass air valve, aluminum piston, and bronze bushing. This new system also includes slipper seals to reduce the coefficient of friction between the shaft and center section. This lube-free design includes the straight shaft and altered exhaust port configuration utilized in the enhanced M2 air distribution system. Low start-up pressure, on/off reliability, and increased sealing in a dead-head condition are a few of the advantages of the lube-free air distribution system. The selected thermoplastics have the ability to function together without lubrication making the M2 Wilden pump truly lube-free. **The M2 lube-free pumps are not pre-lubed with oil or grease.**

### AIR VALVE BODY AND PISTON ASSEMBLY AND DISASSEMBLY

The air valve body and piston (P/N 02-2000-65-200) is externally serviceable by removing the four socket-head cap screws which attach it to the center section. The lube-free air valve body is off-white in color and has an encircled "LF" molded into the exterior. The thermoplastic air valve piston is gray in color like the aluminum lubed style, but is differentiated by a "D-shaped hole" in the top of the piston, and two small holes in the annular groove. (See *Figure B*.)

The piston should move freely and the ports in the piston must line-up with the ports on the face of the air valve body (see *Figure B*). If the piston does not move freely in the valve body, the entire air valve assembly should be immersed in a mild soap solution to remove any accumulation of sludge and/or grit. If the air valve does not move freely after the above cleaning, the air valve should be disassembled as follows: Remove the snap ring from the top of the air valve cylinder and apply an air jet to the 1/8" hole on the opposite end of the air valve face. Caution: The end cap may come out with considerable force. Verify that the guide pin molded into one of the end caps (P/N 02-2340-23-200) is straight and smooth to allow the piston to shift properly. Inspect the piston and cylinder bore for nicks and scoring. Small nicks can be dressed with fine sandpaper and the piston returned to service. Clean and reassemble. **Install air valve to center section and tighten to the required torque specifications\*.**

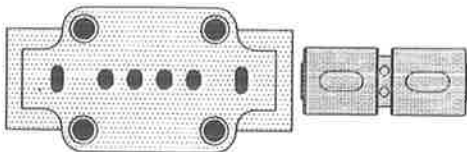


Figure B

### O-RING REPLACEMENT/CENTER SECTION

The M2 lube-free Champ series pumps are constructed with a polypropylene center section with a thermoplastic bushing. The M2 lube-free Metal pumps are constructed with a polypropylene center section with a thermoplastic bushing. (Lube-free aluminum center sections are not available.) These center sections are easily distinguished by the encircled letter "LF" stamped on the top of the center section. These bushings are not removable. The bushing has grooves cut into the inside diameter where back-up O-rings and slipper seals are installed. It is important that the correct O-ring is utilized. The back-up O-ring for the lube-free model has a bigger diameter and smaller cross-section in comparison to the "Lubed" model. The straight shaft (P/N 02-3800-09-07) must be utilized in the lube-free pump.

The back-up O-ring is installed first. This is most easily accomplished by using a tool called an O-ring pick, available through most industrial supply companies. The O-rings must be installed in the appropriate grooves as shown in *Figure C* (1, 3, 6, 8). Upon completion of the O-ring installation, the slipper seals (P/N 02-3210-55-200) must be installed in the same grooves (1, 3, 6, 8). This task is accomplished by utilizing long nose pliers and a flat head screw driver covered with tape to ensure seal integrity. Please see *Figures D, E, and F*.

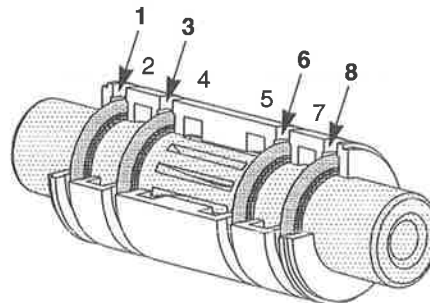


Figure C

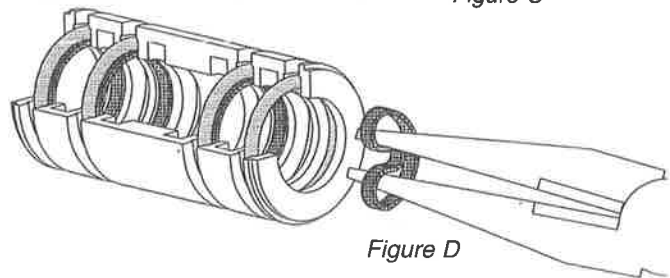


Figure D

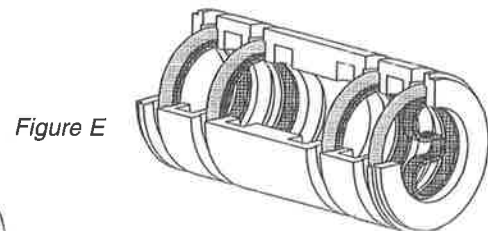


Figure E

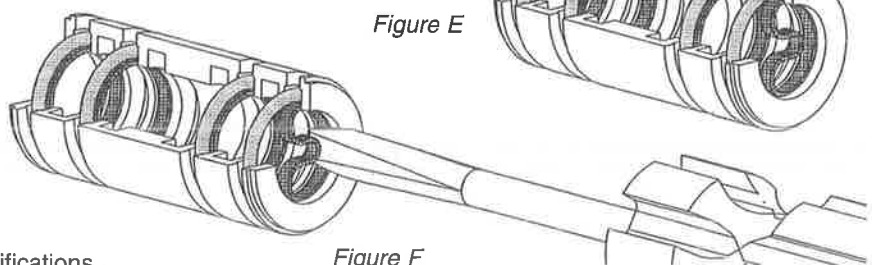


Figure F

\*Refer to Section 8D for the required torque specifications.

## SECTION 8D

# REASSEMBLY HINTS & TIPS

### ASSEMBLY:

Upon performing applicable maintenance to the air distribution system, the pump can now be reassembled. Please refer to the disassembly instructions for photos and parts placement. To reassemble the pump, follow the disassembly instructions in reverse order. The air distribution system needs to be assembled first, then the diaphragms and finally the wetted path. Please find the applicable torque specifications on this page. The following tips will assist in the assembly process.

- Clean the inside of the center section shaft bushing to ensure no damage is done to new seals.
- Stainless bolts should be lubed to reduce the possibility of seizing during tightening.
- Level the water chamber side of the intake/discharge manifold to ensure a proper sealing surface. This is most easily accomplished by placing them on a flat surface prior to tightening their clamp bands to the desired torque (see this page for torque specs).

### MAXIMUM TORQUE SPECIFICATIONS

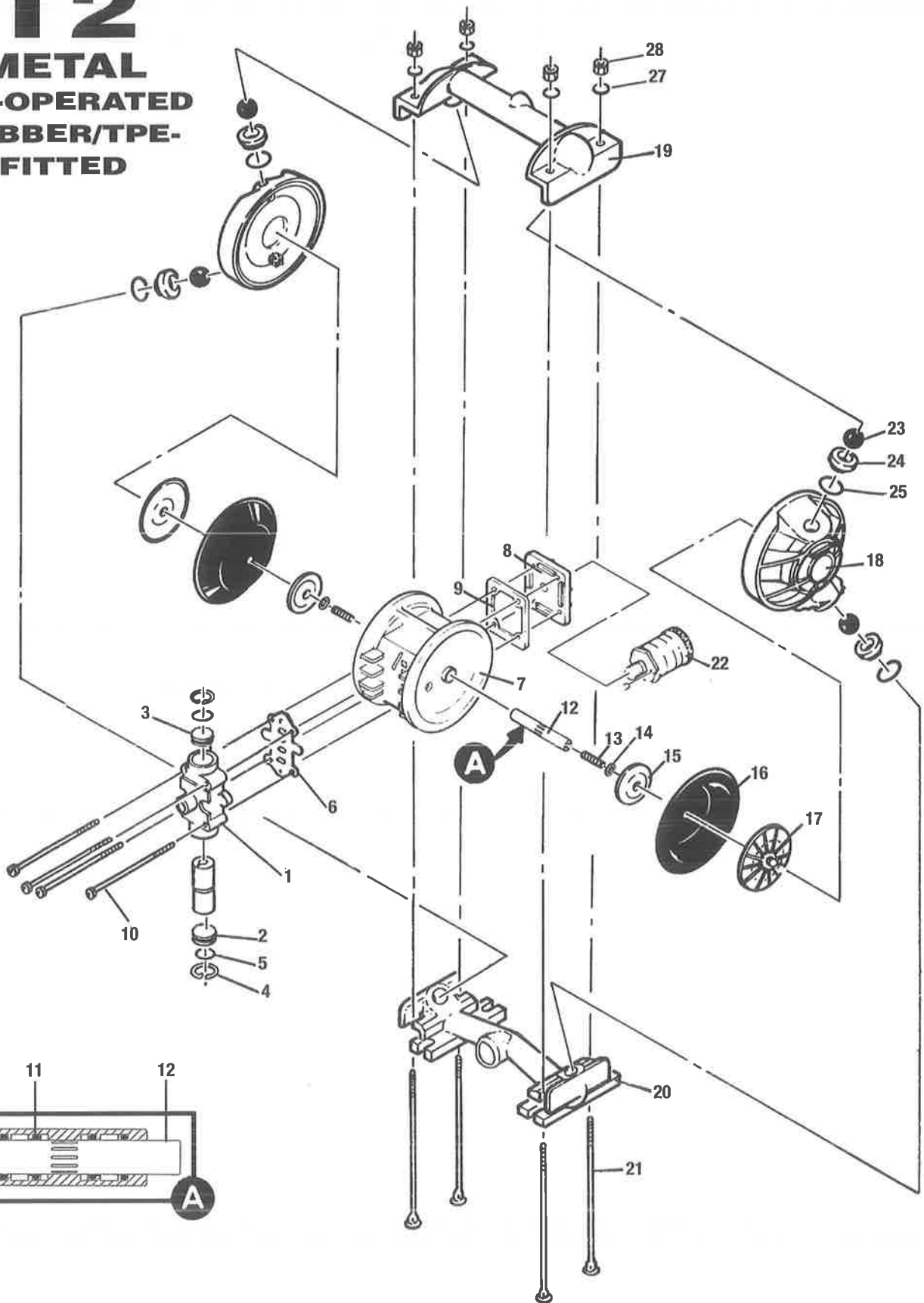
Description of Part	Metal Pumps
Air Valve, Lubed	30 in.-lbs. [3.4 m-N]
Air Valve, Lube-Free	20 in.-lbs. [2.3 m-N]
Outer Piston, Rubber and Teflon®-Fitted	28 ft.-lbs. [38 m-N]
Vertical Bolts	115 in.-lbs. [13.0 m-N]

- Be sure to tighten outer pistons simultaneously on Teflon®-fitted pumps to ensure proper torque values.
- Place one liquid chamber on its side and align center section with chamber using alignment marks made during disassembly. Push down on diaphragm assembly until diaphragm is inverted. Place opposite liquid chamber on center section and align.
- Position valve balls, seats, and O-rings in discharge manifold. Place vertical through discharge manifold with threads pointing up. Install washer and start threads of bolt (about 1½ turns).
- Place center section and liquid chambers on intake manifold.
- Position discharge manifold and bolt assembly on liquid chambers. Ensure proper alignment of mating surfaces between liquid chambers and manifolds before tightening bolts.
- Apply a small amount of Loctite 242 to the steel bore of the shaft from the diaphragm assembly.

**SECTION 9A**

**EXPLODED VIEW/PARTS LISTING**

**T2**  
**METAL**  
**AIR-OPERATED**  
**RUBBER/TPE-**  
**FITTED**

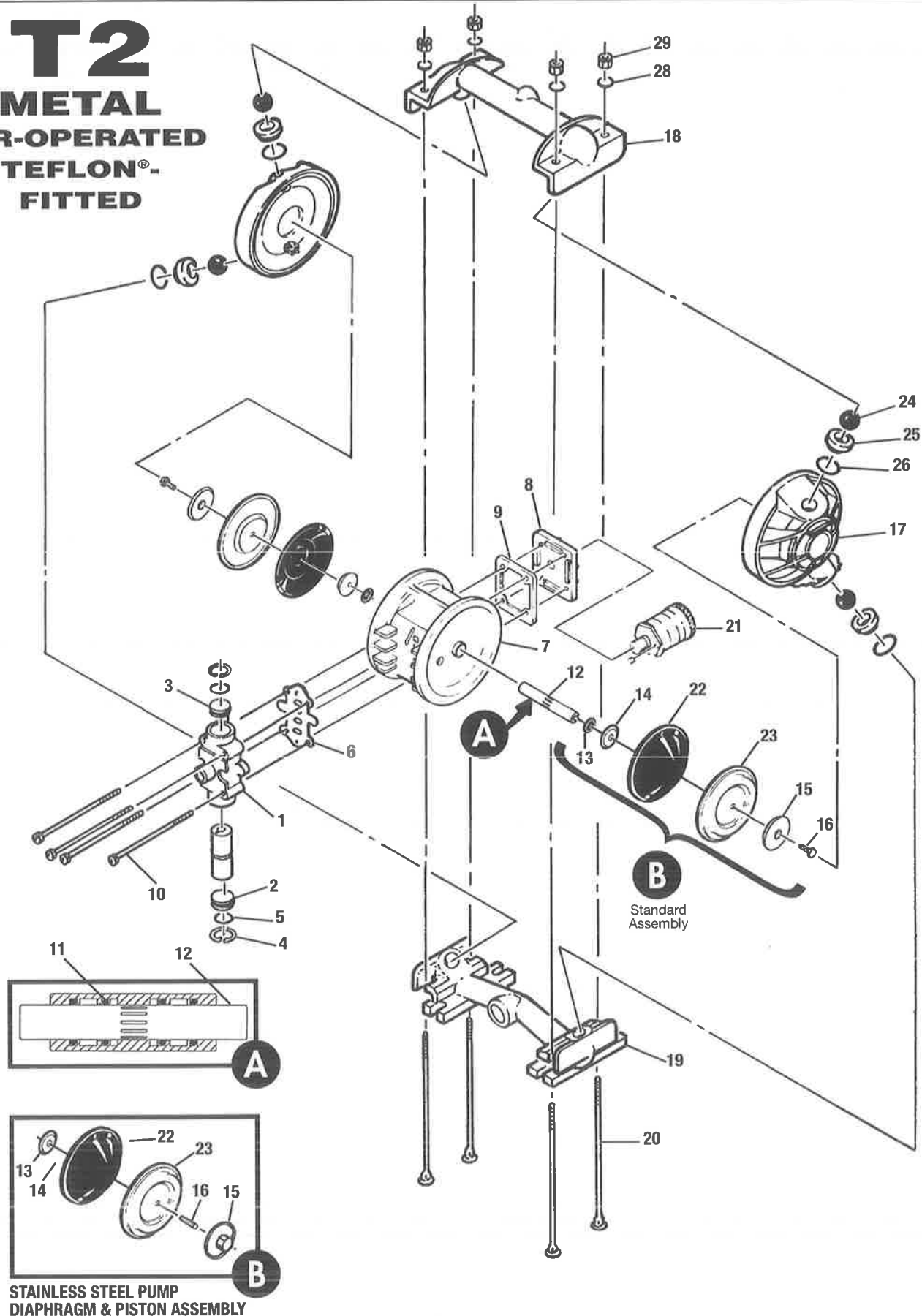




# SECTION 9B

# EXPLODED VIEW/PARTS LISTING

**T2  
METAL  
AIR-OPERATED  
TEFLON®-  
FITTED**

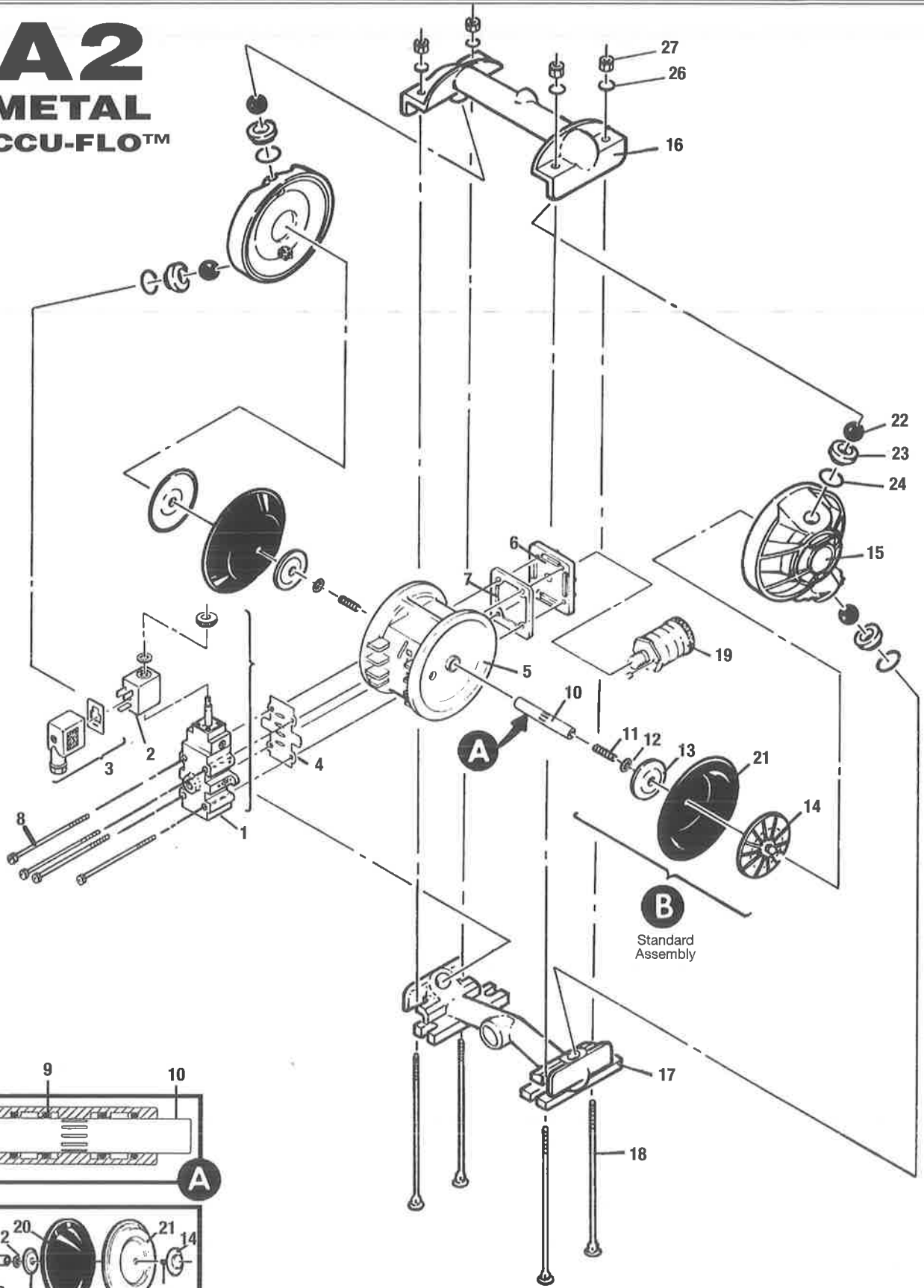




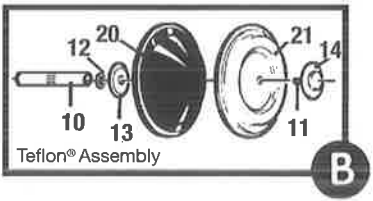
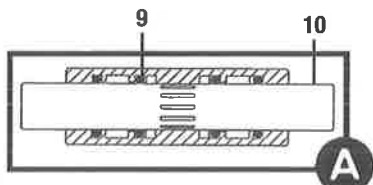
# SECTION 9C

# EXPLODED VIEW/PARTS LISTING

**A2**  
**METAL**  
**ACCU-FLO™**



**B**  
 Standard  
 Assembly



NOTE: Teflon® Diaphragm Models Assembled With Teflon® Gasket Kit At Factory (Not Shown)





# SECTION 10A

## ELASTOMER OPTIONS

### Elastomer Options for Model T2 Metal Pumps

Material	Diaphragm P/N	Valve Ball P/N	Valve Seat P/N	Valve Seat O-Ring* P/N
Polyurethane	02-1010-50	02-1080-50	N/A	02-1200-50
Buna-N®	02-1010-52	02-1080-52	N/A	02-1200-52
Neoprene	02-1010-51	02-1080-51	N/A	N/A
Nordel (EPDM)	02-1010-54	02-1080-54	N/A	02-1200-54
Viton®	02-1010-53	02-1080-53	N/A	N/A
Wil-Flex™	02-1010-58	02-1080-58	N/A	02-1200-58
Saniflex™	02-1010-56	02-1080-56	N/A	02-1200-56
Teflon® PTFE	02-1010-55	02-1080-55	N/A	02-1200-55
Stainless Steel	N/A	N/A	02-1120-03	N/A
Aluminum	N/A	N/A	02-1120-01	N/A
Hastelloy	N/A	N/A	02-1120-04	N/A

\*NOTE: Rubber valve seats do not require an O-ring.

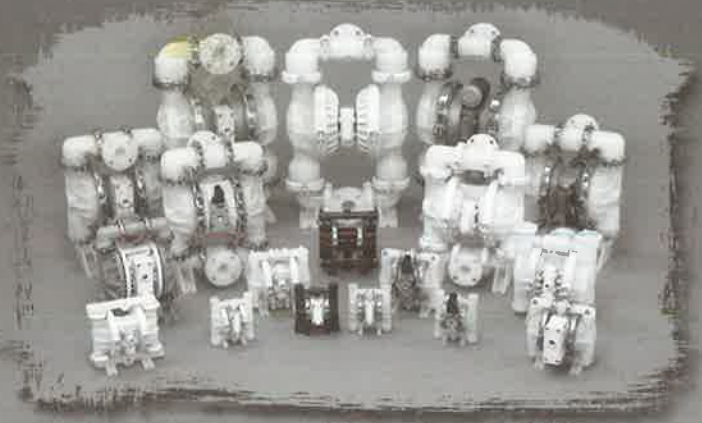
# MAINTENANCE RECORD

---

DATE	SERVICE RENDERED	SERVICED BY

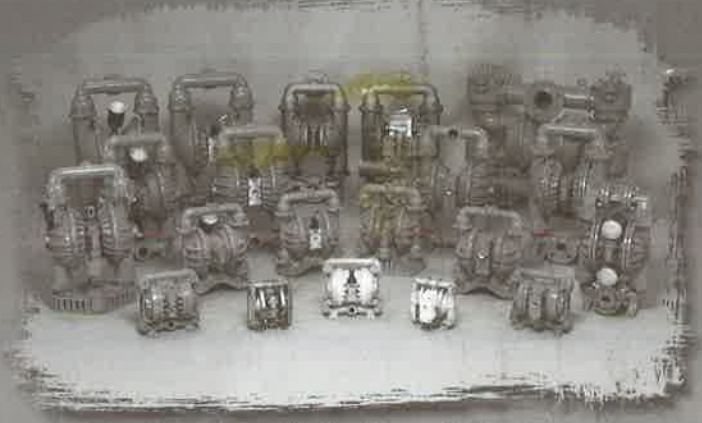
# ENGINEERED REVOLUTION

"Revolutionizing the way you solve your toughest pumping problems"



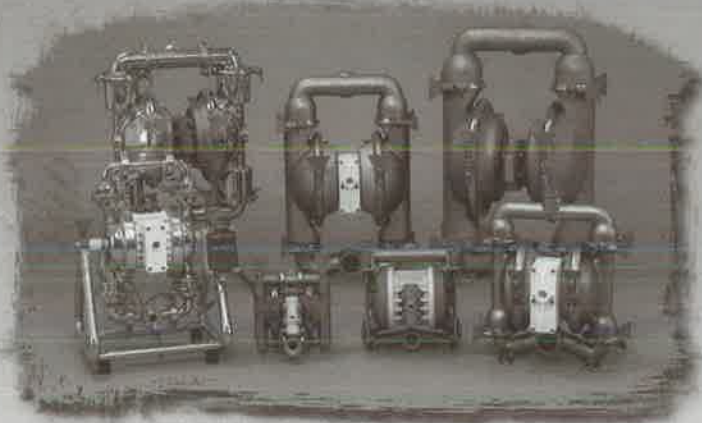
## Plastic

- Polypropylene
- Carbon-Filled Acetal
- PVDF
- Teflon® PTFE
- Teflon® PFA



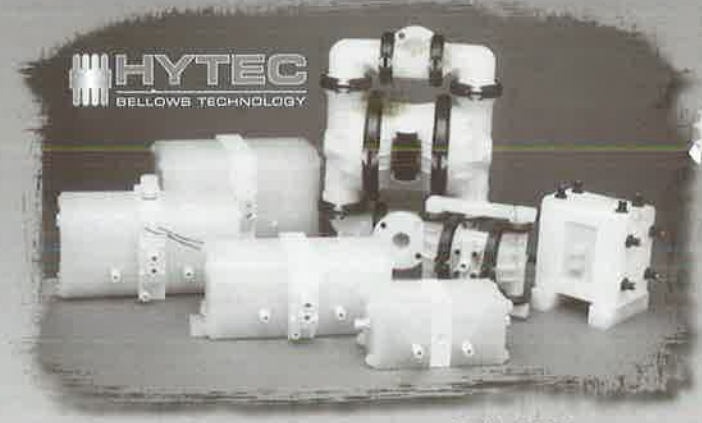
## Metal

- Aluminum
- 316 S.S.
- Cast Iron
- Hastelloy



## SANIFLO™

FDA USDA 3A  
SANITARY PUMP TECHNOLOGY



## HYTEC

BELLOWS TECHNOLOGY

## ULTRAPURE

TEFLON PROCESS PUMPS

- Teflon® PFA
- Teflon® PTFE



## Accessories

- SPCI
- Wil-Gard
- FCSI
- Equalizers
- Drum Pump Kits
- APV



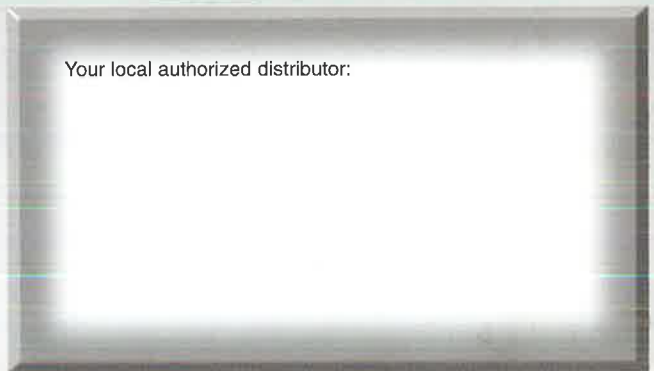
## WILDEN®

AIR OPERATED DOUBLE DIAPHRAGM PUMPS

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Telephone (909) 422-1730 • Fax (909) 783-3440  
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A **DOVER** RESOURCES COMPANY

Your local authorized distributor:



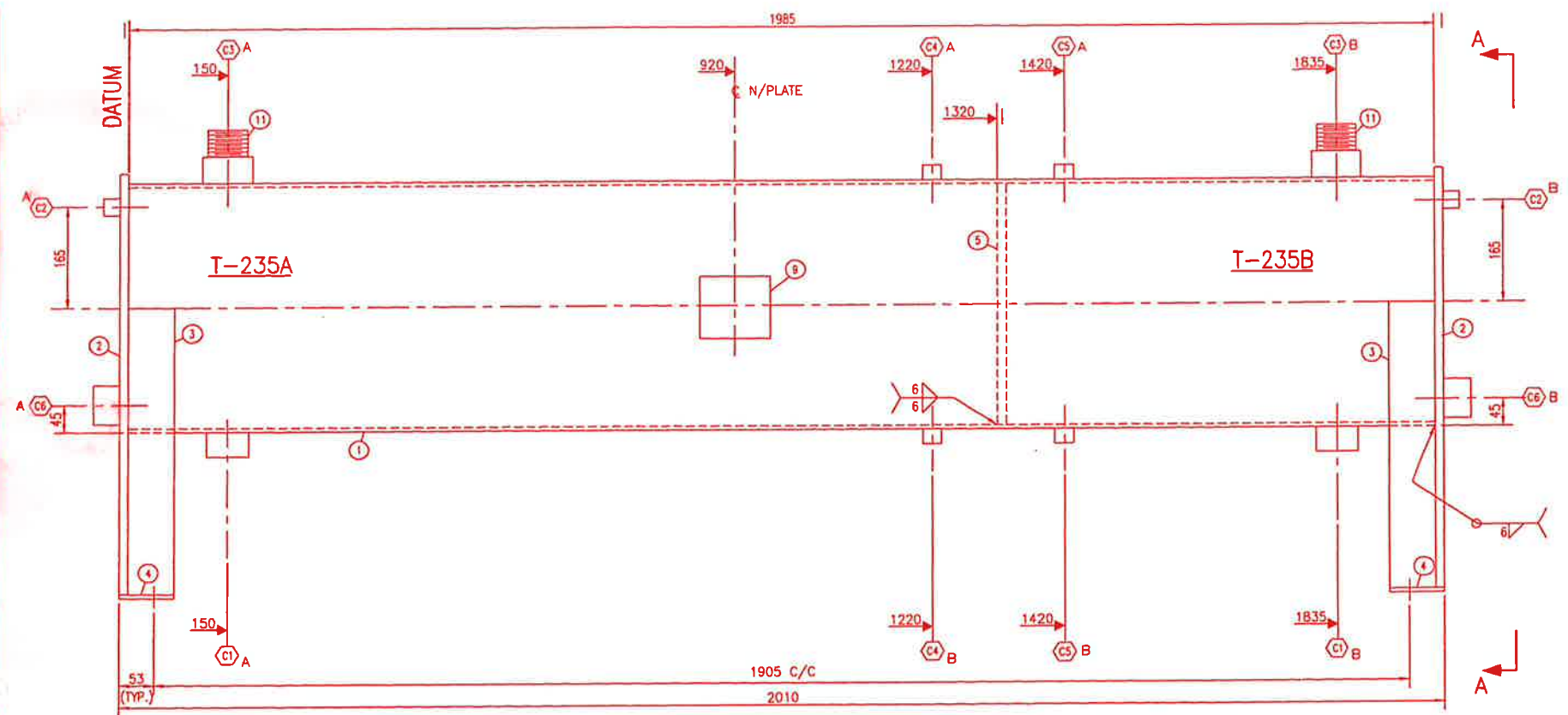


PROPAK SYSTEMS LTD POSTAL BAG #2, AIRDRIE, ALBERTA, CANADA T4B 2C3				TANK				SHEET 1	OF
				REV	BY	DATE	REVISION DESCRIPTION		
CUSTOMER : APACHE CANADA LIMITED				1	PC	99/12/21	FOR DRAFTING DESIGN		
PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE									
SERVICE : JACKET / AUXILLARY WATER SURGE TANKS									
JOB NO. : 99404* TAG NO. : T-235A/D									
MFR. : PSL MODEL NO.:									
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL	6.35 mm	SA-53- B SMLS	N1					
3	HEADS	6.35 mm	SA-36	N2					
4	FLOOR		---	N3					
5	SUPPORT / STAND		SA-36	N4					
6	PIPE		SA-106 B	N5					
7	PIPE FITTINGS		SA-234 WPB SMLS	N6					
8	FLANGES		---	N7					
9	COUPLINGS		SA-105	N8					
10	BOLTS		SA-193-B7	N9					
11	NUTS		SA-194-2H	N10					
12	GASKETS		---	N11					
13	COIL		---	N12					
14	RISER		---						
15	BAFFLES		SA-36	C1A/B	SHUNT LINE/LG LIQUID SIDE	27	3000#	TOL	
16	INTERNAL LADDER		---	C2A/B	VENT	33	3000#	TOL	
17	SUMP		---	C3A/B	PRV VENT / FILL	60	3000#	TOL	
18	SYPHON DRAIN		---	C4A/B	VENT / LG VENT SIDE	27	3000#	TOL	
19	VORTEX BREAKER		---	C5A/B	LSL	48	3000#	TOL	
20	DISTRIB SPIDER		---	C6					
21	LADDER		---	C7					
22	PLATFORMS		---	C8					
23	LADDER CLIPS		---	C9					
24	PLATFORM CLIPS		---	C10					
25	PIPE CLIPS		---	C11					
26	FIREPROOF CLIPS		---	C12					
27	INSULATION RINGS		---						
28	LIFTING LUGS		---	M1					
29	LEVEL INDICATOR		---	M2					
30	THIEF HATCH		---						
31	PRESS / VAC RELIEF		---						
32	EXTENDED MANWAY		---						
33									
34									
35									
36									
37	DESIGN DATA								
38	SIZE: ID (mm)		OD: (mm)	406	NOTES:				
39	S/S (mm)	1321 / 508							
40	DES. PRESS. (kPa)	ATM.	OPER. PRESS. (kPa)	ATM.					
41	DES. TEMP. °C	100	OPER. TEMP. °C	93 / 57					
42	HYDROTEST (kPag)	130	CORR. ALLOW. (mm)	0.0					
43	MDMT	-28	CYCLIC LOAD	NO					
44	X-RAY	PER CODE	STRESS RELIEVE	NO					
45	WIND LOAD (km / h)	---	EARTHQUAKE ZONE	NO					
46	SOUR SERVICE	NO	INSUL. THK. (mm)	NONE					
47	FIREPROOF	NONE	REFRACTORY THK. (mm)	NONE					
48	INT. SURFACE PREP.	NONE	EXT. SURFACE PREP.	PNT-1					
49	INT. COATING	NONE	PRIMER COAT	PNT-1					
50	ASME SEC. VIII DIV.	NO	FINISH COAT	PNT-1					
51	'U' STAMP REQ'D	NO	FINISH COLOR	C705 (CARBOLINE GRAY)					
52									
53	WEIGHT EMPTY (kg)	110	HYDRO WEIGHT (kg)	225					
54	LSD	TBA							
55									
56									
57									
58									
59									

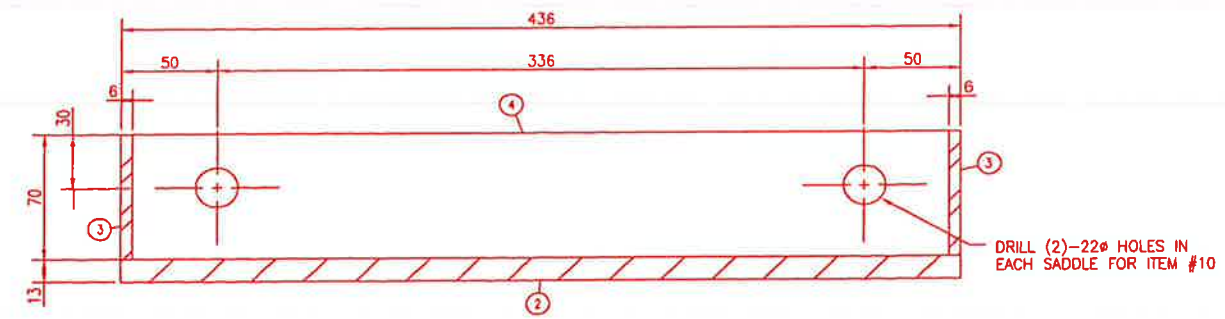


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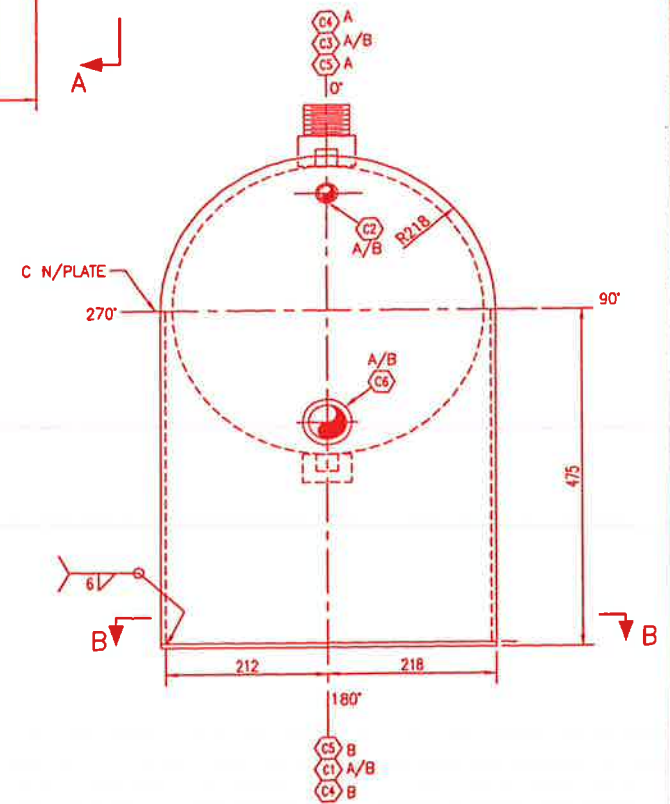
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**ELEVATION**  
SCALE: 1:5



**VIEW 'B-B'**  
SCALE: 1:2



**VIEW 'A-A'**  
SCALE: 1:5

NOZZLE SCHEDULE										
MK	SIZE	RATING	FACING	SCH	SERVICE	INT.	PROJ	EXT.	PROJ	WELD
A/B	C1	48	3000#	HALF CPLG	-	SHUNT LINE	-	-	-	5
A/B	C2	21	3000#	HALF CPLG	-	VENT	-	-	-	5
A/B	C3	60	3000#	HALF CPLG	-	PRV VENT/FILL	-	-	-	5
A/B	C4	21	3000#	HALF CPLG	-	LG	-	-	-	5
A/B	C5	21	3000#	HALF CPLG	-	LG	-	-	-	5
A/B	C6	48	3000#	HALF CPLG	-	LSI-235 A/B	-	-	-	5

BILL OF MATERIAL		
ITEM	QUA	DESCRIPTION
1	1	PIPE: 406 O/D x 6.35 W.T. x 1985 LG. SA-53-B (MIN)
2	2	PLATE: 12.70 THK x 436 WD. x 693 LG. (CTS) SA-36
3	4	PLATE: 6 THK x 70 WD. x 469 LG. SA-36
4	2	FLAT BAR: 6 THK x 83 WD. x 436 LG. SA-36
5	1	PLATE: 12.70 THK x 390 O/D SA-36
6	2	HALF CPLG: 60 - 3000# NPT SA-105
7	4	HALF CPLG: 48 - 3000# NPT SA-105
8	6	HALF CPLG: 21 - 3000# NPT SA-105
9	1	NAMEPLATE c/w MOUNTING BRACKET SS/SA-36
10	4	ZINC PLATED BOLTS: 19# x 50 LG. c/w (1) HEXNUT & WASHER EACH SA-325
11	2	NIPPLE: 60 O/D SCH. STD. x 76 LG. (T.B.E.) SMLS SA-106-B

CAPACITY: T-235A: 0.161 m<sup>3</sup>  
T-235B: 0.079 m<sup>3</sup>

WEIGHT EMPTY: 237 kg  
WEIGHT FULL OF WATER: 477 kg  
SURFACE PREPARATION: PNT-11  
PRIMER: PNT-11  
FINISH PAINT: PNT-11  
INSULATION: NONE

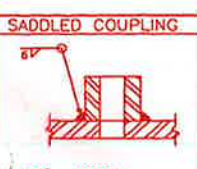
SERIAL NO: 99404-118 CRN: N/A  
TAG NO: T-235 A/B YEAR BUILT: 2000  
LSD #: -  
CODE: **NON CODE**

DESIGN PRESS: 101 kPag  
DESIGN TEMP: 100 °C  
HYDROTEST: 150 kPag

MATERIAL: HEAD: SA-36  
SHELL: SA-53-B (MIN)

RADIOGRAPHY:  
LONG: N/A  
CIRC: N/A  
P.W.H.T.: YES/NO  
CORR. ALLOW: NIL

SERVICE: GLYCOL  
LONG & CIRC. WELDS TYPE 1  
QWP: 590.2  
QCP: AQP-1050(S) AQP-1227(S)  
TACK WELDS: WPS# 101  
PRESS. TO STRUCT. WELD WPS# 101,105,109



WPS# 101,107,109

GENERAL NOTES		GENERAL NOTES		REVISION		APPROVED		DRAWN		PROPAG SYSTEMS LTD.		REV.	
DATE: 2000.05.03 11:36am FILE NAME: j:\jobs99\DWG\99404\Comp\VSL\TNK-99404-118-01.dwg		2 NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION		D SMITH 00/05/03 M.I. S.W.		MECH./STRUCT. BY D. SMITH		DATE 00/04/28		PROPAG SYSTEMS LTD.		440 East Lake Road,	
		1 ISSUED FOR CONSTRUCTION		R.J. 00/01/28 M.I. T.K.		ELECTRICAL CHECKED		DATE 00/05/03		1478 STOCK COMPRESSOR		Postal Bag #2	
						DATE 00/05/03		SCALE AS NOTED		JACKET WATER EXPANSION TANK		Airdrie, Alberta	
										406 O/D x 1985 LG.		Canada T4B 2C3	
										DWG. No.: D-TNK-99404-118		REV. 2	





PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 2	
CUSTOMER : APACHE CANADA LIMITED PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE SERVICE : STAGE-1 INLET SCRUBBER - SOUR GAS JOB NO. : 99404 TAG NO: V-100 MFR. : PROPAK MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION		
				0	TK	12/29/99	ISSUED TO DRAFTING		
				1	DP	03/24/00	GENERAL REVISION		
				2	SW	05/08/00	AS DRAWN		
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-516 GR. 70N	N1	INLET	273	300#	RFWN	SPEC $\Delta$
3	HEADS		SA-516 GR. 70N	N2	OUTLET	219	300#	RFWN	200 $\Delta$
4	SKIRTS		SA-516 GR. 70N $\Delta$	N3					
5	SADDLES		-	N4					
6	PIPE		SA-106 GR. B	N5					
7	PIPE FITTINGS		SA-234-WPB	N6					
8	FLANGES		SA-105N	N7					
9	COUPLINGS		SA-105N	N8					
10	BOLTS		SA-193-B7M	N9					
11	NUTS		SA-194-2HM	N10					
12	GASKETS		316L SS	N11					
13	COIL		-	N12					
14	RISER		SA-106 GR. B $\Delta$						
15	PACKING SUPPORT		-	C1	LEVEL CONTROL VALVE	33	6000#	TOL $\Delta$	
16	TRAY SUPPORTS		-	C2	DRAIN	33	6000#	CPLG	
17	BAFFLES		-	C3A/B	LEVEL GAUGE	27	6000#	TOL $\Delta$	
18	INLET BAFFLE		SA-516 GR. 70N $\Delta$	C4					
19	VORTEX BREAKER		-	C5	LEVEL SWITCH	48	6000#	CPLG 1/2 $\Delta$	
20	SYPHON DRAIN		-	C6 A/B	INSPECTION CW PLUG $\Delta$	60	6000#	TOL $\Delta$	
21	DEMISTER	152mm	316LSS 144kg/m3	C7	LEVEL CONTROL	60	6000#	CPLG 1/2 $\Delta$	
22	DEMISTER SUPPORTS		SA-36 $\Delta$	C8					
23	PACKING		-	C9					
24	TRAYS		-	C10					
25	PLATFORM		-	C11					
26	LADDER		-	C12					
27	DAVIT		-						
28	INSULATION RINGS		-	M1					
29	LIFTING LUGS	YES	SA-516-70N	M2					
30	PIPE CLIPS			SA	SKIRT ACCESS $\Delta$	150 $\Delta$			
31	PIPE SUPPORTS		SA-516-70N	SV	SKIRT VENT $\Delta$	2 @ 50 $\Delta$			
32	REINFORCEMENT PADS	AS PER CODE	SA-516-70N						
33									
34									
35	DESIGN DATA								
36	SIZE: ID (mm)	774.9 $\Delta$	OD: (mm)	813	NOTES:				
37	S/S (mm)	1930							
38	DES PRESS (kPa)	4516	OPER. PRESS (kPag)						
39	DES TEMP ° C	149	OPER. TEMP ° C						
40	HYDROTEST (mm)	5871 $\Delta$	CORR. ALLOW. (mm)	3.2					
41	MDMT ° C	-28	CYCLIC LOAD	NO					
42	X-RAY	FULL $\Delta$	STRESS RELIEVE	YES					
43	WIND LOAD (km / h)	NO	EARTHQUAKE ZONE	NO					
44	SOUR SERVICE	YES	INSUL THK (mm)	NO					
45	FIREPROOF	NO	REFRACTORY THK (mm)	NO					
46	INT. SURFACE PREP.	SHOP FLUSH	EXT. SURFACE PREP.	PNT-11					
47	INT. COATING	OIL	PRIMER COAT	PNT-11					
48	ASME SEC. VIII DIV. 1	YES $\Delta$	FINISH COAT	PNT-11					
49	STAMP REQ'D	YES	FINISH COLOR	C705 GREY					
50									
51	WEIGHT EMPTY ((kg)	1842 $\Delta$	HYDRO WEIGHT (kg)	2922 $\Delta$					
52	LSD								
53									
54									
55									
56									
57									

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 2	
CUSTOMER : APACHE CANADA LIMITED				REV	BY	DATE	REVISION DESCRIPTION		
PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE				0	TK	12/29/99	ISSUED TO DRAFTING		
SERVICE : STAGE-2 INLET SCRUBBER - SOUR GAS				1	DP	03/24/00	GENERAL REVISION		
JOB NO. : 99404 TAG NO: V-110				2	SW	05/08/00	AS DRAWN		
MFR. : PROPAK MODEL NO:									
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-516 GR 70N	N1	INLET	168	300#	RFWN	SPEC $\Delta$
3	HEADS		SA-516 GR. 70N	N2	OUTLET	168	300#	RFWN	200 $\Delta$
4	SKIRTS		SA-516 GR. 70N $\Delta$	N3					
5	SADDLES		-	N4					
6	PIPE		SA-106 GR. B	N5					
7	PIPE FITTINGS		SA-234-WPB	N6					
8	FLANGES		SA-105N	N7					
9	COUPLINGS		SA-105N	N8					
10	BOLTS		SA-193-B7M	N9					
11	NUTS		SA-194-2HM	N10					
12	GASKETS		316L SS	N11					
13	COIL		-	N12					
14	RISER		SA-106 GR. B $\Delta$						
15	PACKING SUPPORT		-	C1	LEVEL CONTROL VALVE	33	6000#	TOL $\Delta$	
16	TRAY SUPPORTS		-	C2	DRAIN	33	6000#	CPLG	
17	BAFFLES		-	C3A/B	LEVEL GAUGE	27	6000#	TOL $\Delta$	
18	INLET BAFFLE		SA-36 $\Delta$	C4	LEVEL CONTROL $\Delta$	60 $\Delta$	6000# $\Delta$	CPLG 1/2 $\Delta$	
19	VORTEX BREAKER		-	C5	LEVEL SWITCH	48	6000#	CPLG 1/2 $\Delta$	
20	SYPHON DRAIN		-	C6A/B	INSPECTION CW PLUG $\Delta$	60	6000#	TOL $\Delta$	
21	DEMISTER	152mm	316LSS 144kg/m3	C7					
22	DEMISTER SUPPORTS		SA-36 $\Delta$	C8					
23	PACKING		-	C9					
24	TRAYS		-	C10					
25	PLATFORM		-	C11					
26	LADDER		-	C12					
27	DAVIT		-						
28	INSULATION RINGS		-	M1					
29	LIFTING LUGS	YES	SA-36 $\Delta$	M2					
30	PIPE CLIPS			SA	SKIRT ACCESS $\Delta$	150 $\Delta$			
31	PIPE SUPPORTS		SA-516-70N	SV	SKIRT VENT $\Delta$	2 @ 50 $\Delta$			
32	REINFORCEMENT PADS	AS PER CODE	SA-516-70N						
33									
34									
35	DESIGN DATA								
36	SIZE: ID (mm)	628.2 $\Delta$	OD: (mm)	660	NOTES:				
37	S/S (mm)	1626							
38	DES PRESS (kPa)	4516	OPER. PRESS (kPag)						
39	DES TEMP ° C	149	OPER. TEMP ° C						
40	HYDROTEST	5871 $\Delta$	CORR. ALLOW. (mm)	3.2					
41	MDMT ° C	-28	CYCLIC LOAD	NO					
42	X-RAY	FULL $\Delta$	STRESS RELIEVE	YES					
43	WIND LOAD (km / h)	NO	EARTHQUAKE ZONE	NO					
44	SOUR SERVICE	YES	INSUL THK (mm)	NO					
45	FIREPROOF	NO	REFRACTORY THK (mm)	NO					
46	INT. SURFACE PREP.	SHOP FLUSH	EXT. SURFACE PREP.	PNT-11					
47	INT. COATING	OIL	PRIMER COAT	PNT-11					
48	ASME SEC. VIII DIV. 1	YES $\Delta$	FINISH COAT	PNT-11					
49	STAMP REQ'D	YES	FINISH COLOR	C705 GREY					
50									
51	WEIGHT EMPTY ((kg)	1080 $\Delta$	HYDRO WEIGHT (kg)	1681 $\Delta$					
52	LSD	ALBERTA (TBA)							
53									
54									
55									
56									
57									

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 2	
CUSTOMER : APACHE CANADA LIMITED				REV	BY	DATE	REVISION DESCRIPTION		
PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE				0	TK	12/29/99	ISSUED TO DRAFTING		
SERVICE : STAGE-3 INLET SCRUBBER - SOUR GAS				1	DP	03/24/00	GENERAL REVISION		
JOB NO. : 99404 TAG NO: V-120				2	DP	04/03/00	CORRECTED TO MFS		
MFR. : PROPAK MODEL NO:				3	SW	05/08/00	AS DRAWN		
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-516 GR 70N	N1	INLET	114	600#	RFWN	460 $\Delta$
3	HEADS		SA-516 GR. 70N	N2	OUTLET	114	600#	RFWN	SPEC. $\Delta$
4	SKIRTS		SA-516 GR. 70N $\Delta$	N3					
5	SADDLES		-	N4					
6	PIPE		SA-106 GR. B	N5					
7	PIPE FITTINGS		SA-234-WPB	N6					
8	FLANGES		SA-105N	N7					
9	COUPLINGS		SA-105N	N8					
10	BOLTS		SA-193-B7M	N9					
11	NUTS		SA-194-2HM	N10					
12	GASKETS		316L SS	N11					
13	COIL		-	N12					
14	RISER		SA-106 GR. B $\Delta$						
15	PACKING SUPPORT		-	C1	LEVEL CONTROL VALVE	33	6000#	TOL	$\Delta$
16	TRAY SUPPORTS		-	C2	DRAIN	33	6000#	CPLG	
17	BAFFLES		-	C3A/B	LEVEL GAUGE	27	6000#	TOL	$\Delta$
18	INLET BAFFLE		SA-36 $\Delta$	C4	INSPECTION C/W PLUG $\Delta$	60 $\Delta$	6000# $\Delta$	TOL	$\Delta$
19	VORTEX BREAKER		-	C5	LEVEL SWITCH	48	6000#	CPLG 1/2	$\Delta$
20	SYPHON DRAIN		-	C6	INSPECTION C/W PLUG $\Delta$	60	6000#	TOL	$\Delta$
21	DEMISTER	152mm	316LSS 144kg/m3	C7	LEVEL CONTROL	60	6000#	CPLG 1/2	$\Delta$
22	DEMISTER SUPPORTS		SA-36 $\Delta$	C8					
23	PACKING		-	C9					
24	TRAYS		-	C10					
25	PLATFORM		-	C11					
26	LADDER		-	C12					
27	DAVIT		-						
28	INSULATION RINGS		-	M1					
29	LIFTING LUGS	YES	SA-36 $\Delta$	M2					
30	PIPE CLIPS			SA	SKIRT ACCSS $\Delta$	150 $\Delta$			
31	PIPE SUPPORTS		SA-516-70N	SV	SKIRT VENT $\Delta$	2 @ 50 $\Delta$			
32	REINFORCEMENT PADS	AS PER CODE	SA-516-70N						
33									
34									
35	DESIGN DATA								
36	SIZE: ID (mm)	463.5 $\Delta$	OD: (mm)	508	NOTES:				
37	S/S (mm)	1473 $\Delta$							
38	DES PRESS (kPa)	9067	OPER. PRESS (kPag)						
39	DES TEMP ° C	149	OPER. TEMP ° C						
40	HYDROTEST	11787 $\Delta$	CORR. ALLOW. (mm)	3.2					
41	MDMT ° C	-28	CYCLIC LOAD	NO					
42	X-RAY	FULL $\Delta$	STRESS RELIEVE	YES					
43	WIND LOAD (km / h)	NO	EARTHQUAKE ZONE	NO					
44	SOUR SERVICE	YES	INSUL THK (mm)	NO					
45	FIREPROOF	NO	REFRACTORY THK (mm)	NO					
46	INT. SURFACE PREP.	SHOP FLUSH	EXT. SURFACE PREP.	PNT-11					
47	INT. COATING	OIL	PRIMER COAT	PNT-11					
48	ASME SEC. VIII DIV. 1 $\Delta$	YES $\Delta$	FINISH COAT	PNT-11					
49	STAMP REQ'D	YES	FINISH COLOR	C705 GREY					
50									
51	WEIGHT EMPTY ((kg)	816 $\Delta$	HYDRO WEIGHT (kg)	1109 $\Delta$					
52	LSD	ALBERTA (TBA)							
53									
54									
55									
56									
57									

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				SUCTION BOTTLE			SHEET 1 OF 2		
CUSTOMER : APACHE CANADA LIMITED PLANT : 14781 IP HAMBURG COMPRESSOR PACKAGE SERVICE : STAGE-1 SUCTION BOTTLE - SOUR SERVICE JOB NO. : 99404 TAG NO: V-121 MFR. : PROPAK MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION		
				0	TK	12/29/99	ISSUED TO DRAFTING		
				1	DP	03/24/00	GENERAL REVISION		
				2	DP	04/12/00	ADDED CHOKE TUBE		
3	SW	00/05/09	AS DRAWN						
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SI7F	RATING	FLANGE	PROJECT
2	SHELL		SA-516 GR. 70N	N1	INLET PROCESS GAS	219	300#	RFWN	SPEC $\Delta$ 3
3	HEADS		SA 516 GR. 70N	N2A/B	OUTLET NOZZLE - CYL 1	219	300#	RFWN	200 $\Delta$ 3
4	SKIRTS		-	N3					
5	SADDLES		-	N4					
6	PIPE		SA-106 GR. B	N5					
7	PIPE FITTINGS		SA-234 WPB	N6					
8	FLANGES		SA-105N	N7					
9	COUPLINGS		SA-105N	N8					
10	BOLTS		SA-193-B7M	N9					
11	NUTS		SA-194-2HM	N10					
12	GASKETS		316SS FLEX $\Delta$ 3	N11					
13	COIL		-	N12					
14	RISER		-						
15	PACKING SUPPORT		-	C1A/B	INSPECTION C/W PLUG $\Delta$ 3	60 $\Delta$ 3	6000# $\Delta$ 3	TOL $\Delta$ 3	
16	TRAY SUPPORTS		-	C2					
17	BAFFLES		-	C3					
18	INLET BAFFLE		-	C4					
19	VORTEX BREAKER		-	C5					
20	SYPHON DRAIN		-	C6					
21	DEMISTER		-	C7					
22	DISTRIB. SPIDER		-	C8					
23	PACKING		-	C9					
24	TRAYS		-	C10					
25	PLATFORM		-	C11					
26	LADDER		-	C12					
27	DAVIT		-						
28	INSULATION RINGS		-		CHOKE TUBE				LENGTH
29	LIFTING LUGS		-		6" SCH 40				1168 mm
30	PIPE CLIPS		-						
31	PIPE SUPPORTS		-						
32	RE-PADS/GUSSETS	YES	SA-516 GR. 70N						
33	CHOKE TUBE		SA-106 GR. B $\Delta$ 3						
34	BELL MOUTH	N/A	SA-234 WPB $\Delta$ 3						
35	DESIGN DATA								
36	SIZE: ID (mm)	578.2 $\Delta$ 3	OD: (mm)	610	NOTES:  [ 1 ] SEE PAGE 2 FOR SKETCH [ 2 ] INTERNAL CHEMICAL CLEANING & OILING				
37	S/S (mm)	1778							
38	DES. PRESS (kPag)	4516	OPER. PRESS (kPag)						
39	DES. TEMP (°C)	149	OPER. TEMP (°C)						
40	HYDROTEST (kPag)	5871 $\Delta$ 3	CORR. ALLOW. (mm)	3.2					
41	MDMT (°C)	-28	CYCLIC LOAD	NO					
42	X-RAY	FULL $\Delta$ 3	STRESS RELIEVE	YES					
43	WIND LOAD	NO	EARTHQUAKE ZONE	NO					
44	SOUR SERVICE	YES	INSUL. THK. (mm)	NO					
45	FIREPROOF	NO	REFRACTORY THK (mm)	NO					
46	INT. SURFACE PREP.	NOTE 2	EXT. SURFACE PREP.	PNT-11 $\Delta$ 3					
47	INT. COATING	NOTE 2	PRIMER COAT	PNT-11 $\Delta$ 3					
48	ASME SEC. VIII DIV. 1	YES $\Delta$ 3	FINISH COAT	PNT-11 $\Delta$ 3					
49	STAMP REQ'D	YES	FINISH COLOR	C705 GREY					
50									
51	WEIGHT EMPTY (kg)	797 $\Delta$ 3	HYDRO WEIGHT (kg)	1337 $\Delta$ 3					
52	LSD								
53									
54									
55									
56									
57									

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				DISCHARGE BOTTLE				SHEET 1 OF 2	
CUSTOMER : APACHE CANADA LIMITED PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE SERVICE : STAGE-1 DISCHARGE BOTTLE - SOUR SERVICE JOB NO. : 99404 TAG NO: V-122 MFR. : PROPAK MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION		
				4	DP	04/12/00	OD, CHOKE TUBE TO SUIT LAYOUT		
				5	SW	05/09/00	AS DRAWN		
				2	TK	01/20/00	REVISED BOTTLE DIAMETER & CHOKE TUBE SIZE		
				3	DP	03/24/00	GENERAL REVISION		
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-516 GR. 70N	N1	INLET NOZZLE - CYL 1	219	300#	RFWN	220 $\triangle 5$
3	HEADS		SA-516 GR. 70N	N2	INLET NOZZLE - CYL 2	219	300#	RFWN	220 $\triangle 5$
4	SKIRTS		-	N3	PROCESS GAS OUTLET	168	300#	RFWN	SPEC $\triangle 5$
5	SADDLES		-	N4					
6	PIPE		SA-106 GR. B	N5					
7	PIPE FITTINGS		SA-234 WPB	N6					
8	FLANGES		SA-105N	N7					
9	COUPLINGS		SA-105N	N8					
10	BOLTS		SA-193-B7M	N9					
11	NUTS		SA-194-2HM	N10					
12	GASKETS		316 SS FLEX $\triangle 5$	N11					
13	COIL		-	N12					
14	RISER		-						
15	PACKING SUPPORT		-	C1	THERMOWELL	27	6000#	TOL	$\triangle 5$
16	TRAY SUPPORTS		-	C2	THERMOWELL	27	6000#	TOL	$\triangle 5$
17	BAFFLES		-	C3	DRAIN	27	6000#	CPLG	
18	INLET BAFFLE		-	C4/A/B	INSPECTION C/W PLUG $\triangle 5$	48	$\triangle 5$ 6000# $\triangle 5$	TOL	$\triangle 5$
19	VORTEX BREAKER		-	C5					
20	SYPHON DRAIN		SA-106 GR. B $\triangle 5$	C6					
21	DEMISTER		-	C7					
22	DISTRIB. SPIDER		-	C8					
23	PACKING		-	C9					
24	TRAYS		-	C10					
25	PLATFORM		-	C11					
26	LADDER		-	C12					
27	DAVIT		-						LENGTH
28	INSULATION RINGS		-		CHOKE TUBE	114 SCH 40			1321 mm
29	LIFTING LUGS		-						
30	PIPE CLIPS		-						
31	PIPE SUPPORTS		-						
32	RE-PADS/GUSSETS	YES	SA-516 GR. 70N						
33	CHOKE TUBE	YES	SA-106 GR. B						
34	BELL MOUTH	YES	SA-234 WPB						
35	DESIGN DATA								
36	SIZE: ID	431.6 $\triangle 5$	OD:	(mm)	457	NOTES:  [ 1 ] SEE PAGE 2 FOR SKETCH.			
37	S/S (mm)	2235							
38	DES. PRESS (kPag)	4447	OPER. PRESS (kPag)						
39	DES. TEMP ° C	176	OPER. TEMP ° C						
40	HYDROTEST (kPag)	5781	CORR. ALLOW. (mm)	3.2					
41	MDMT ° C	-28	CYCLIC LOAD	NO					
42	X-RAY	FULL $\triangle 5$	STRESS RELIEVE	YES					
43	WIND LOAD	NO	EARTHQUAKE ZONE	NO					
44	SOUR SERVICE	YES	INSUL. THK. (mm)	NO					
45	FIREPROOF	NO	REFRACTORY THK (mm)	NO					
46	INT. SURFACE PREP.	SHOP FLUSH	EXT. SURFACE PREP.	PNT-12					
47	INT. COATING	OIL	PRIMER COAT	PNT-12					
48	ASME SEC. VIII DIV. 1	YES $\triangle 5$	FINISH COAT	PNT-12					
49	STAMP REQ'D	YES	FINISH COLOR	ALUMINUM $\triangle 5$					
50									
51	WEIGHT EMPTY (kg)	586 $\triangle 5$	HYDRO WEIGHT (kg)	950 $\triangle 5$					
52	LSD	ALBERTA (TBA)							
53									
54									
55									
56									
57									

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				SUCTION BOTTLE			SHEET 1 OF 2		
CUSTOMER : APACHE CANADA LIMITED PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE SERVICE : STAGE-2 SUCTION BOTTLE - SOUR SERVICE JOB NO. : 99404 TAG NO: V-123 MFR. : PROPAK MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION		
				0	TK	12/20/09	ISSUED TO DRAFTING		
				1	DP	03/24/00	GENERAL REVISION		
				2	SW	05/09/00	AS DRAWN		
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-516 GR. 70N	N1	INLET PROCESS GAS	168	300#	RFWN	SPEC [2]
3	HEADS		SA-510 GR. 70N	N2	OUTLET PROCESS GAS [2]	168	600#	RFWN	200 [2]
4	SKIRTS		-	N3					
5	SADDLES		-	N4					
6	PIPE		SA-106 GR. B	N5					
7	PIPE FITTINGS		SA-234 WPB	N6					
8	FLANGES		SA-105N	N7					
9	COUPLINGS		SA-105N	N8					
10	BOLTS		SA-193-B7M	N9					
11	NUTS		SA-194-2HM	N10					
12	GASKETS		316SS FLEX [2]	N11					
13	COIL		-	N12					
14	RISER		-						
15	PACKING SUPPORT		-	C1A/B	INSPECTION C/W PLUG [2]	48 [2]	6000# [2]	TOL [2]	
16	TRAY SUPPORTS		-	C2					
17	BAFFLES		-	C3					
18	INLET BAFFLE		-	C4					
19	VORTEX BREAKER		-	C5					
20	SYPHON DRAIN		-	C6					
21	DEMISTER		-	C7					
22	DISTRIB. SPIDER		-	C8					
23	PACKING		-	C9					
24	TRAYS		-	C10					
25	PLATFORM		-	C11					
26	LADDER		-	C12					
27	DAVIT		-						LENGTH
28	INSULATION RINGS		-		CHOKE TUBE				N/A
29	LIFTING LUGS		-						
30	PIPE CLIPS		-						
31	PIPE SUPPORTS		-						
32	RE-PADS/GUSSETS	YES	SA-516 GR. 70N						
33	CHOKE TUBE	N/A							
34	BELL MOUTH	N/A							
35	DESIGN DATA								
36	SIZE: ID (mm)	431.6 [2]	OD: (mm)	457	NOTES:  [ 1 ] SEE PAGE 2 FOR SKETCH [ 2 ] INTERNAL CHEMICAL CLEANING & OILING				
37	S/S (mm)	914							
38	DES. PRESS (kPag)	4516	OPER. PRESS (kPag)						
39	DES. TEMP (°C)	149	OPER. TEMP (°C)						
40	HYDROTEST (kPag)	5871 [2]	CORR. ALLOW. (mm)	3.2					
41	MDMT (°C)	-28	CYCLIC LOAD	NO					
42	X-RAY	FULL [2]	STRESS RELIEVE	YES					
43	WIND LOAD	NO	EARTHQUAKE ZONE	NO					
44	SOUR SERVICE	YES	INSUL. THK. (mm)	NO					
45	FIREPROOF	NO	REFRACTORY THK (mm)	NO					
46	INT. SURFACE PREP.	NOTE 2	EXT. SURFACE PREP.	PNT-11					
47	INT. COATING	NOTE 2	PRIMER COAT	PNT-11					
48	ASME SEC. VIII DIV. 1	YES [2]	FINISH COAT	PNT-11					
49	STAMP REQ'D	YES	FINISH COLOR	C705 GREY					
50									
51	WEIGHT EMPTY (kg)	301 [2]	HYDRO WEIGHT (kg)	471 [2]					
52	LSD								
53									
54									
55									
56									
57									

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				DISCHARGE BOTTLE			SHEET 1 OF 2		
CUSTOMER : APACHE CANADA LIMITED				REV	BY	DATE	REVISION DESCRIPTION		
PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE				4	SW	05/09/00	AS DRAWN		
SERVICE : STAGE-2 DISCHARGE BOTTLE - SOUR SERVICE				1	PC	1/11/2000	REVISED DESIGN TEMPERATURE (WAS 177°C)		
JOB NO. : 99404 TAG NO: V-124				2	TK	01/20/00	REVISED DIAMETER AND CHOKE TUBE		
MFR. : PROPAK MODEL NO:				3	DP	03/24/00	GENERAL REVISION		
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FI ANGE	PROJECT
2	SHELL		SA-106 GR. B	N1	PROCESS INLET	168	600#	RFWN	250
3	HEADS		SA-510 GR. 70N	N2	PROCESS OUTLET	114	600#	RFWN	200
4	SKIRTS		-	N3					
5	SADDLES		-	N4					
6	PIPE		SA-106 GR. B	N5					
7	PIPE FITTINGS		SA-234 WPB	N6					
8	FLANGES		SA-105N	N7					
9	COUPLINGS		SA-105N	N8					
10	BOLTS		SA-193-B7M	N9					
11	NUTS		SA-194-2HM	N10					
12	GASKETS		316 SS FLEX	N11					
13	COIL		-	N12					
14	RISER		-						
15	PACKING SUPPORT		-	C1	THERMOWELL	27	6000#	TOL	
16	TRAY SUPPORTS		-	C2	DRAIN C/W PLUG	27	6000#	TOL	
17	BAFFLES		-	C3A/B	INSPECTION C/W PLUG	48	6000#	TOL	
18	INLET BAFFLE		-	C4					
19	VORTEX BREAKER		-	C5					
20	SYPHON DRAIN		-	C6					
21	DEMISTER		-	C7					
22	DISTRIB. SPIDER		-	C8					
23	PACKING		-	C9					
24	TRAYS		-	C10					
25	PLATFORM		-	C11					
26	LADDER		-	C12					
27	DAVIT		-						
28	INSULATION RINGS		-						
29	LIFTING LUGS		-						
30	PIPE CLIPS		-						
31	PIPE SUPPORTS		-						
32	RE-PADS/GUSSETS	YES	SA-516 GR. 70N						
33	CHOKE TUBE	N/A							
34	BELL MOUTH	N/A							
35	DESIGN DATA								
36	SIZE: ID	363.1	OD: (mm)	406	NOTES:  [ 1 ] SEE PAGE 2 FOR SKETCH.  				
37	S/S (mm)	1016							
38	DES. PRESS (kPag)	8908	OPER. PRESS (kPag)						
39	DES. TEMP ° C	176	OPER. TEMP ° C						
40	HYDROTEST (kPag)	11580	CORR. ALLOW. (mm)	3.2					
41	MDMT ° C	-28	CYCLIC LOAD	NO					
42	X-RAY	FULL	STRESS RELIEVE	YES					
43	WIND LOAD	NO	EARTHQUAKE ZONE	NO					
44	SOUR SERVICE	YES	INSUL. THK. (mm)	NO					
45	FIREPROOF	NO	REFRACTORY THK (mm)	NO					
46	INT. SURFACE PREP.	SHOP FLUSH	EXT. SURFACE PREP.	PNT-12					
47	INT. COATING	OIL	PRIMER COAT	PNT-12					
48	ASME SEC. VIII DIV. 1	YES	FINISH COAT	PNT-12					
49	STAMP REQ'D	YES	FINISH COLOR	ALUMINUM					
50									
51	WEIGHT EMPTY (kg)	460	HYDRO WEIGHT (kg)	590					
52	LSD								
53									
54									
55									
56									
57									

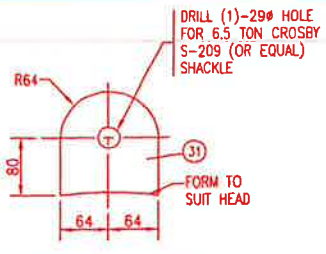


PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				SUCTION BOTTLE				SHEET 1 OF 2	
CUSTOMER : APACHE CANADA LIMITED PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE SERVICE : STAGE-3 SUCTION BOTTLE - SOUR SERVICE JOB NO. : 99404 TAG NO: V-125 MFR. : PROPAK MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION		
				0	TK	12/29/99	ISSUED TO DRAFTING		
				1	DP	03/24/00	GENERAL REVISION		
				2	SW	05/09/00	AS DRAWN		
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-106 GR. B	N1	PROCESS INLET	114	600#	RFWN	SPEC
3	HEADS		SA-510 GR. 70N	N2	PROCESS OUTLET	114	900#	RFWN	200
4	SKIRTS		-	N3					
5	SADDLES		-	N4					
6	PIPE		SA-106 GR. B	N5					
7	PIPE FITTINGS		SA-234 WPB	N6					
8	FLANGES		SA-105N	N7					
9	COUPLINGS		SA-105N	N8					
10	BOLTS		SA-193-B7M	N9					
11	NUTS		SA-194-2HM	N10					
12	GASKETS		316SS FLEX	N11					
13	COIL		-	N12					
14	RISER		-						
15	PACKING SUPPORT		-	C1	INSPECTION C/W PLUG	48	6000#	TOL	
16	TRAY SUPPORTS		-	C2	INSPECTION C/W PLUG	48	6000#	TOL	
17	BAFFLES		-	C3					
18	INLET BAFFLE		-	C4					
19	VORTEX BREAKER		-	C5					
20	SYPHON DRAIN		-	C6					
21	DEMISTER		-	C7					
22	DISTRIB. SPIDER		-	C8					
23	PACKING		-	C9					
24	TRAYS		-	C10					
25	PLATFORM		-	C11					
26	LADDER		-	C12					
27	DAVIT		-						LENGTH
28	INSULATION RINGS		-		CHOKE TUBE	73 SCH 160			737mm
29	LIFTING LUGS		-						
30	PIPE CLIPS		-						
31	PIPE SUPPORTS		-						
32	RE-PADS/GUSSETS	YES	SA-516 GR. 70N						
33	CHOKE TUBE	YES	SA-106 GR. B						
34	BELL MOUTH		SA-234-WPB						
35	DESIGN DATA								
36	SIZE: ID (mm)	363.1	OD (mm)	406	NOTES:  [ 1 ] SEE PAGE 2 FOR SKETCH [ 2 ] INTERNAL CHEMICAL CLEANING & OILING [ 3 ] UT ALL CAT D WELDS				
37	S/S (mm)	914							
38	DES. PRESS (kPag)	9067	OPER. PRESS (kPag)						
39	DES. TEMP (° C)	149	OPER. TEMP (° C)						
40	HYDROTEST (kPag)	11787	CORR. ALLOW. (mm)	3.2					
41	MDMT (° C)	-28	CYCLIC LOAD	NO					
42	X-RAY	FULL	STRESS RELIEVE	YES					
43	WIND LOAD	NO	EARTHQUAKE ZONE	NO					
44	SOUR SERVICE	YES	INSUL. THK. (mm)	NO					
45	FIREPROOF	NO	REFRACTORY THK (mm)	NO					
46	INT. SURFACE PREP.	NOTE 2	EXT. SURFACE PREP.	PNT-11					
47	INT. COATING	NOTE 2	PRIMER COAT	PNT-11					
48	ASME SEC. VIII DIV. 1	YES	FINISH COAT	PNT-11					
49	STAMP REQ'D	YES	FINISH COLOR	C705 GREY					
50									
51	WEIGHT EMPTY (kg)	402	HYDRO WEIGHT (kg)	522					
52	ISD								
53									
54									
55									
56									
57									

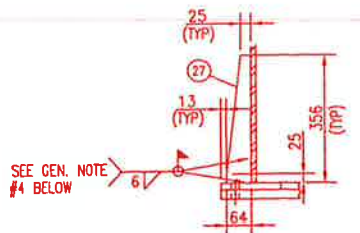
PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				DISCHARGE BOTTLE			SHEET 1 OF 2		
CUSTOMER : APACHE CANADA LIMITED PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE SERVICE : STAGE-3 DISCHARGE BOTTLE - SOUR SERVICE JOB NO. : 99404 TAG NO: V-126 MFR. : PROPAK MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION		
				4	SW	05/09/00	AS DRAWN		
				1	PC	1/11/2000	REVISED DESIGN TEMPERATURE (WAS 177°C)		
				2	TK	01/20/00	REVISED DIAMETER AND CHOKE TUBE		
			3	DP	03/24/00	GENERAL REVISION			
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-106 GR. B	N1	INLET	114	900#	RFWN	260 <sup>△</sup>
3	HEADS		SA-518 GR. 70N	N2	PROCESS GAS OUTLET	89	000#	RFWN	SPEC <sup>△</sup>
4	SKIRTS		-	N3					
5	SADDLES		-	N4					
6	PIPE		SA-106 GR. B	N5					
7	PIPE FITTINGS		SA-234 WPB	N6					
8	FLANGES		SA-105N	N7					
9	COUPLINGS		SA-105N	N8					
10	BOLTS		SA-193-B7M	N9					
11	NUTS		SA-194-2HM	N10					
12	GASKETS		316 SS FLEX <sup>△</sup>	N11					
13	COIL		-	N12					
14	RISER		-						
15	PACKING SUPPORT		-	C1	THERMOWELL	27	6000#	TOL	<sup>△</sup>
16	TRAY SUPPORTS		-	C2	DRAIN	27	6000#	TOL	<sup>△</sup>
17	BAFFLES		-	C3A/B	INSPECTION C/W PLUG	48	6000#	TOL	<sup>△</sup>
18	INLET BAFFLE		-	C4					
19	VORTEX BREAKER		-	C5					
20	SYPHON DRAIN		-	C6					
21	DEMISTER		-	C7					
22	DISTRIB. SPIDER		-	C8					
23	PACKING		-	C9					
24	TRAYS		-	C10					
25	PLATFORM		-	C11					
26	LADDER		-	C12					
27	DAVIT		-						LENGTH
28	INSULATION RINGS		-		CHOKE TUBE	60 SCH 160			940 mm
29	LIFTING LUGS		-						
30	PIPE CLIPS		-						
31	PIPE SUPPORTS	<sup>△</sup>							
32	RE-PADS/GUSSETS	YES	SA-516 GR. 70N						
33	CHOKE TUBE	YES	SA-106 GR. B						
34	BELL MOUTH	YES	SA-234 WPB						
35	DESIGN DATA								
36	SIZE: ID	308.3 <sup>△</sup>	OD:	(mm)	356	NOTES:  [ 1 ] SEE PAGE 2 FOR SKETCH. <sup>△</sup>			
37	S/S (mm)	1016							
38	DES. PRESS (kPag)	11377	OPER. PRESS (kPag)						
39	DES. TEMP ° C	176	OPER. TEMP ° C						
40	HYDROTEST (kPag)	14790 <sup>△</sup>	CORR. ALLOW. (mm)	3.2					
41	MDMT ° C	-28	CYCLIC LOAD	NO					
42	X-RAY	FULL <sup>△</sup>	STRESS RELIEVE	YES					
43	WIND LOAD	NO	EARTHQUAKE ZONE	NO					
44	SOUR SERVICE	YES	INSUL. THK. (mm)	NO					
45	FIREPROOF	NO	REFRACTORY THK (mm)	NO					
46	INT. SURFACE PREP.	SHOP FLUSH	EXT. SURFACE PREP.	PNT-12					
47	INT. COATING	OIL	PRIMER COAT	PNT-12					
48	ASME SEC. VIII DIV. 1	YES <sup>△</sup>	FINISH COAT	PNT-12					
49	STAMP REQ'D	YES	FINISH COLOR	ALUMINUM <sup>△</sup>					
50									
51	WEIGHT EMPTY (kg)	393 <sup>△</sup>	HYDRO WEIGHT (kg)	484 <sup>△</sup>					
52	LSD								
53									
54									
55									
56									
57									

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				PRESSURE VESSEL				SHEET 1 OF 1	
CUSTOMER : APACHE CANADA LIMITED PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE SERVICE : PACKING VENT AND DRAIN SEAL POT JOB NO. : 99404 TAG NO: V-130 MFR. : PROPAK MODEL NO:				REV	BY	DATE	REVISION DESCRIPTION		
				0	TK	12/29/99	ISSUED TO DRAFTING		
1	PART	REQ'D(THICKNESS)	MATERIAL (SPEC)	MK	SERVICE	SIZE	RATING	FLANGE	PROJECT
2	SHELL		SA-106-D	N1					
3	HEADS	PIPE CAP	SA-234-WPB	N2					
4	SKIRTS		N/A	N3					
5	SADDLES		C.S.	N4					
6	PIPE		SA-106-B	N5					
7	PIPE FITTINGS		SA-105-N	N6					
8	FLANGES		N/A	N7					
9	COUPLINGS		N/A	N8					
10	BOLTS		N/A	N9					
11	NUTS		N/A	N10					
12	GASKETS		N/A	N11					
13	COIL		N/A	N12					
14	RISER		N/A						
15	PACKING SUPPORT		N/A	C1	Cylinder packing vent & drain	33 NPT	3000#		
16	TRAY SUPPORTS		N/A	C2	Cyl. distance piece drain	33 NPT	3000#		
17	BAFFLES		N/A	C3	Seal pot vapour to flare header	33 NPT	3000#		
18	INLET BAFFLE		N/A	C4	Liquids to drain tank	33 NPT	3000#		
19	VORTEX BREAKER		N/A	C5A/B	Level gauge	21 NPT	3000#		
20	SYPHON DRAIN		N/A	C6	Seal Pot pressure relief	48 NPT	3000#		
21	DEMISTER		N/A	C7					
22	DISTRIB. SPIDER		N/A	C8					
23	PACKING		N/A	C9					
24	TRAYS		N/A	C10					
25	PLATFORM		N/A	C11					
26	LADDER		N/A	C12					
27	DAVIT		N/A						
28	INSULATION RINGS		N/A	M1					
29	LIFTING LUGS		N/A	M2					
30	PIPE CLIPS		N/A						
31	PIPE SUPPORTS		N/A						
32									
33									
34									
35	DESIGN DATA								
36	SIZE: ID (mm)		OD (mm)	273	NOTES: (1) Use 45° ELL threaded fittings for connections C1, C2, C6				
37	S/S (mm)	813							
38	DES PRESS (kPa)	ATMOSPHERIC	OPER. PRESS (kPa)	ATMOSPHERIC					
39	DES TEMP ° C	149	OPER. TEMP ° C	25					
40	HYDROTEST (kPag)	345	CORR. ALLOW. (mm)	N/A					
41	MDMT	-28	CYCLIC LOAD	N/A					
42	X-RAY	N/A	STRESS RELIEVE	NO					
43	WIND LOAD (km / h)	N/A	EARTHQUAKE ZONE	N/A					
44	SOUR SERVICE	YES	INSUL THK (mm)	NONE					
45	FIREPROOF	NO	REFRACTORY THK (mm)	NONE					
46	INT. SURFACE PREP.	NO	EXT. SURFACE PREP.	SSPC-6					
47	INT. COATING	NO	PRIMER COAT	PNT-1					
48	ASME SEC. VIII DIV.	NO	FINISH COAT	PNT-1					
49	STAMP REQ'D	NO	FINISH COLOR	C705 GREY					
50									
51	WEIGHT EMPTY ((kg)		HYDRO WEIGHT (kg)						
52	LSD								
53									
54									
55									
56									
57									

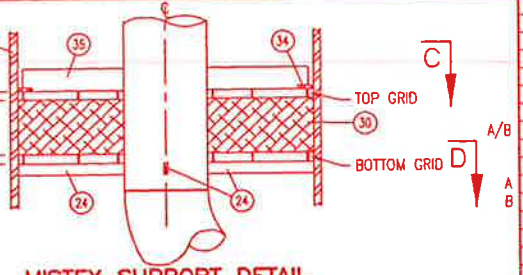
IF THESE OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE, WITHOUT THE WRITTEN CONSENT OF PROPAC SYSTEMS LTD., AND SHALL NOT BE DISCLOSED



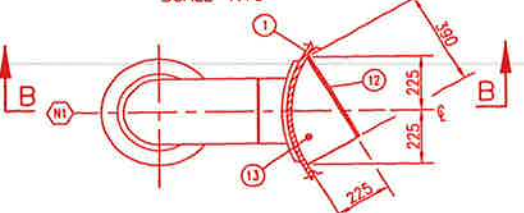
**LIFT LUG DETAIL**  
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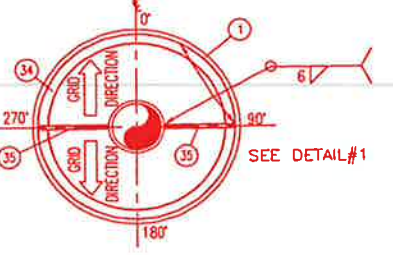
**GUSSET DETAIL**  
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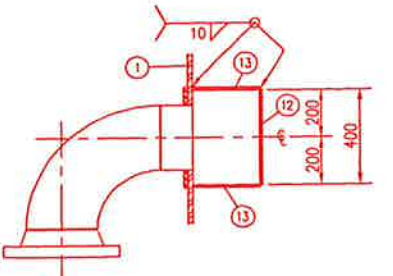
**MISTEX SUPPORT DETAIL**  
SCALE 1:10



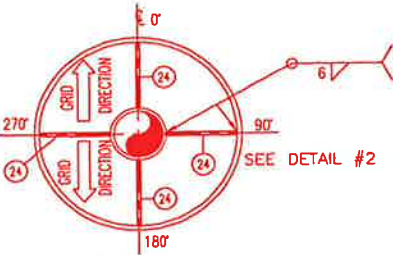
**INLET DIVERTER**  
SCALE 1:15



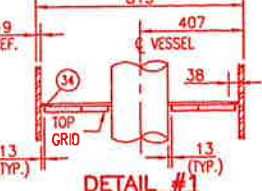
**VIEW C-C**  
SCALE 1:15



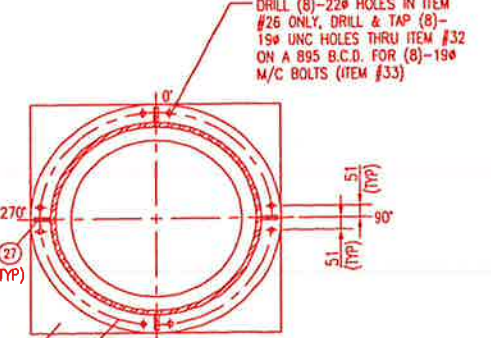
**SECTION B-B**  
SCALE 1:15



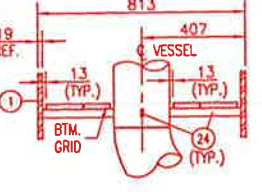
**VIEW D-D**  
SCALE 1:15



**DETAIL #1**  
SCALE 1:15



**VIEW A-A**  
SCALE 1:15



**DETAIL #2**  
SCALE 1:15

NOZZLE SCHEDULE										
MK	SIZE	RATING	FACING	SCH	SERVICE	INT.	PROJ.	EXT.	PROJ.	WELD
N1	273	300#	RFWN	80	INLET	MIN	SPEC	200	200	12/14
N2	219	300#	RFWN	80	OUTLET	SPEC				7/14
C1	33	6000#	TOL	-	LCV-100	-				6
C2	33	6000#	CPLG	XXH	DRAIN	0	SPEC			11
C3	27	6000#	TOL	-	LG-100	-				6
C4										
C5	48	6000#	1/2 CPLG	NPT	LS-100	MIN				5
C6	60	6000#	TOL	-	INSPECTION w/PLUG	-				6
C6	60	6000#	TOL	-	INSPECTION/VENT w/PLUG	-				6
C7	60	6000#	1/2 CPLG	NPT	LC-100	MIN				5
SA	150	-	-	-	SKIRT ACCESS	-				-

BILL OF MATERIAL		
ITEM	QUA	DESCRIPTION
1	1	SHELL: PLATE 19.05 THK x 1930 LG (ROLL TO 813 O/D)
2	2	HEAD: PLATE 813 O/D x 19.05 NOM (17.48 MIN) 2:1 S.E. c/w 51 S.F.
3	1	FLANGE: 219-300# RFWN SCH 80 BORE
4	1	PIPE: 219 O/D x 12.7 WT x 186 LG (SMLS)
5	1	REPAD: 15.88 THK x 330 O/D x 222 I/D (ROLL TO 813 I/D)
6	1	ELBOW: 219 O/D 90° L.R. SCH 80 BW (SMLS)
7	1	FLANGE: 273-300# RFWN SCH 80 BORE
8	1	ELBOW: 273 O/D 90° L.R. SCH 80 BW (SMLS)
9	1	PIPE: 273 O/D x 15.09 WT x 176 LG (SMLS) (CTS)
10	1	REPAD: PLATE 15.88 THK x 425 O/D x 278 I/D (ROLL TO 813 I/D)
11	1	PIPE: 168 O/D x 7.11 WT x 200 LG (SMLS)
12	1	PLATE: 10 THK x 390 WD x 400 LG
13	2	PLATE: 10 THK x 225 WD x 390 LG (CTS)
14	1	TOL: 60-6000# NPT ON A 813 O/D RUN
15	1	TOL: 60-6000# NPT ON FLAT
16	1	1/2 CPLG: 60-6000# NPT
17	2	TOL: 27-6000# NPT ON A 813 O/D RUN
18	1	1/2 CPLG: 48-6000# NPT
19	1	CPLG: 33-6000# SW x NPT
20	1	TOL: 33-6000# NPT ON A 813 O/D RUN
21	1	PIPE: 33 O/D x 9.09 WT x 505 LG (CTS) (SMLS)
22	1	PIPE: 33 O/D x 9.09 WT x 103 LG (CTS) (SMLS)
23	1	ELBOW: 33-6000# 90° SW SCH XXH BORE
24	4	FLAT BAR: 13 THK x 32 x 275 LG
25	1	PLATE: 12.7 THK x 430 LG (ROLL TO 813 O/D)
26	1	BASEPLATE: 19 THK x 965 O/D x 660 I/D
27	4	PLATE: 13 THK x 64 WD x 356 LG (CTS)
28	1	NAMEPLATE c/w MOUNTING BRACKET
29	1	PIPE: 219 O/D x 12.70 WT x 518 LG
30	1	MISTEX: 152 THK x 775 O/D x 219 I/D x 144 Kg/CM c/w 3 x 25 x 749 O/D x 245 I/D 316LSS
31	2	PLATE: 25 THK x 128 WD x 144 LG (CTS)
32	1	SKID PLATE: 25 THK x 965 SQ.
33	8	ZINC PLATED M/C BOLTS: 19# x 44 LG. c/w (1) FLAT WASHER EA.
34	1	RING PLATE: 10 THK x 772 O/D x 696 I/D
35	2	F/BAR: 10 THK x 51 x 275 LG

CAPACITY: 1.08 m<sup>3</sup>  
 WEIGHT EMPTY: 1842 kg  
 WEIGHT FULL OF WATER: 2922 kg  
 SURFACE PREPARATION: PNT-11  
 PRIMER:  
 FINISH PAINT:  
 INSULATION: NONE  
 MECHANICAL LOADINGS GOVERN AS PER UG22:  YES  NO  
 IMPACT TEST:  YES  NO

SERIAL NO: 99404-101 CRN:  
 TAG NO: V-100 YEAR BUILT: 2000  
 LSD #: -  
 CODE:  
 ASME SECT. VIII DIV I, '98, ADDENDA '99

MAX. DESIGN PRESS: 4516 kPag @ TEMP: 149°C  
 HYDROTEST: 5871 kPag  
 MIN DESIGN METAL TEMP: -28°C @ MAWP 4516 kPag  
 MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N

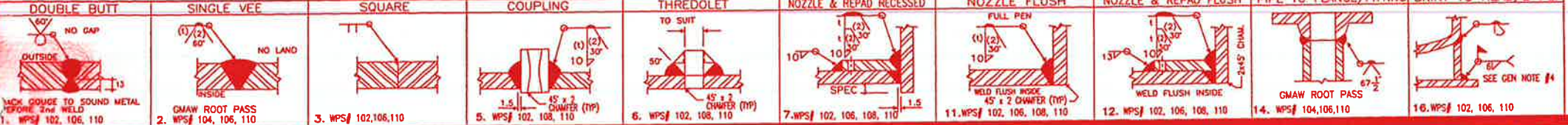
RADIOGRAPHY:  
 LONG & CIRC. WELDS TYPE 1  
 COR. ALLOW: 3.20 mm

PRODUCTION IMPACT TEST REQ'D:  YES  NO

SHIP LOOSE:  YES  NO  
 SERVICE: HYDROCARBONS  
 LONG & CIRC. WELDS TYPE 1  
 QWP: 590.2  
 TACK WELDS WPS# 101  
 PRESS. TO STRUCT. WELD WPS# 102, 106, 110

P.W.H.T.:  
 YES  NO MIN. TEMP: 593°C, TIME: (1) hr (MIN)  
 CORR. ALLOW: 3.20 mm

**"SOUR SERVICE"**



**GENERAL NOTES**

- DO NOT PROFILE INTERNAL PROJECTION UNLESS SPECIFIED.
- SANDBLAST INTERVALS TO ENSURE THAT THE INSIDE SURFACE OF THE VESSEL IS FREE OF LOOSE MILL SCALE AND WELD SPLATTER. PRIOR TO WELDER INSTALLATION & CLOSING OF VESSEL.
- VESSEL TO BE FLUSHED OUT AT HYDROTEST, AIR DRIED AND OILED INTERNALLY.
- VESSEL SHOP TO TACK WELD BASEPLATES & GUSSETS TO SKIRT ASSEMBLY SHOP TO COMPLETE WELDING ON ASSEMBLY.
- VESSEL OPENINGS TO BE SEALED PRIOR TO ANY SHIPPING TO OTHER SHOPS.
- HALF CPLGS. ITEMS #16 & 18 MUST HAVE A FULL BORE.
- TAPER BORE TO CLEAR FLOAT, CLEAN THREADS AFTER WELDING.

**GENERAL NOTES**

- N2 DIM WAS 996
- NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION
- ISSUED FOR CONSTRUCTION

DATE: 2000.05.08 2:39pm FILE NAME: J:\jobs99\DWG\99404\Comp\VSL\SCR-99404-101-01.dwg

APPROVED		DRAWN	
MECH./STRUCT.	BY D. SMITH	DATE 00/04/05	CHECKED
ELECTRICAL	BY M. IWANILUK	DATE 00/04/28	SCALE AS SHOWN
PROJECT	S. WARD	DATE 00/04/28	
DATE	00/04/28		

**PROPAC SYSTEMS LTD.**  
 1478 HP COMPRESSOR  
 STAGE-1 INLET SCRUBBER-SOUR GAS  
 813mm O/D x 1930mm S/S

440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

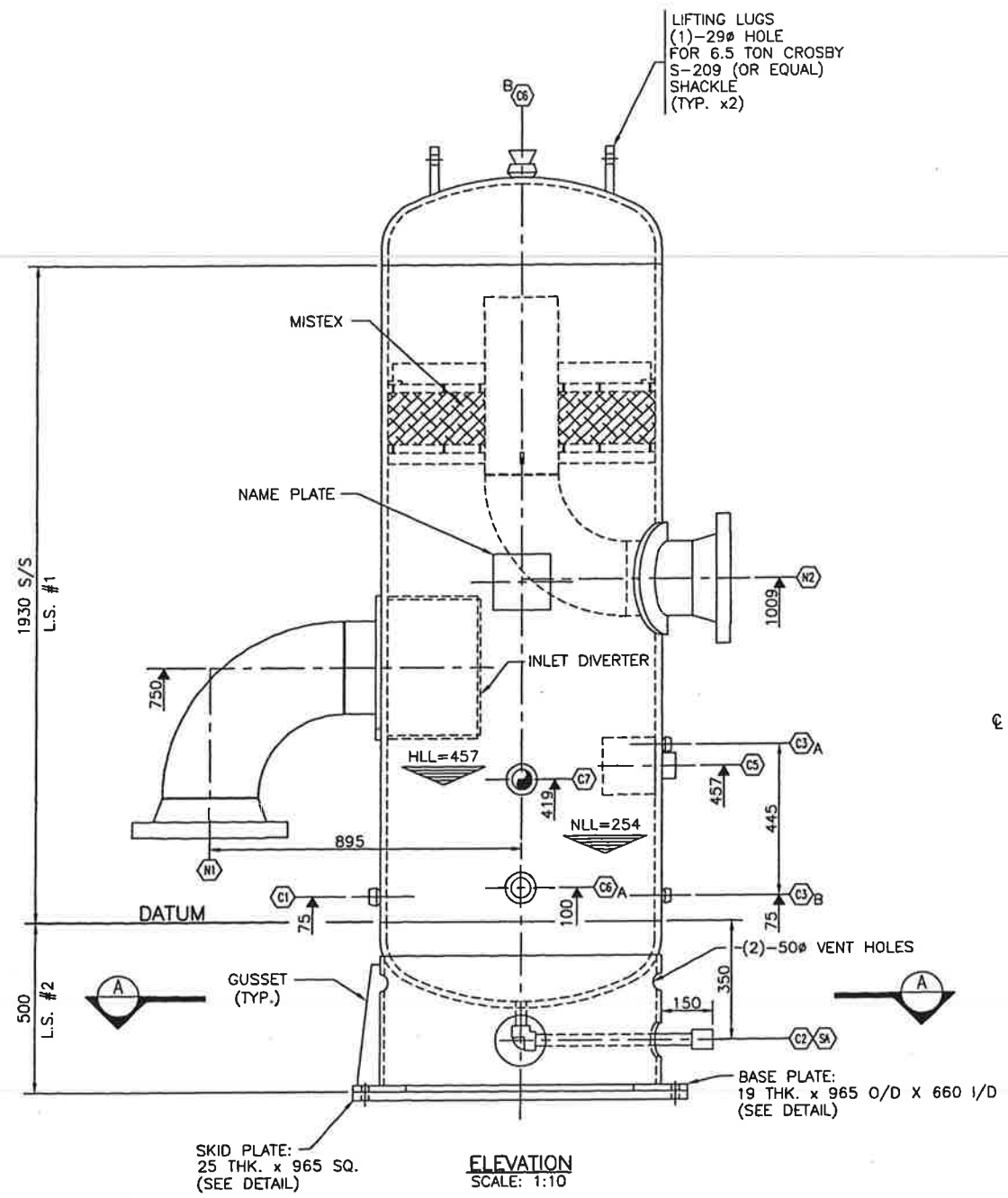
DWG. No.: D-SCR-99404-101  
 REV. 3

OF PROPAC

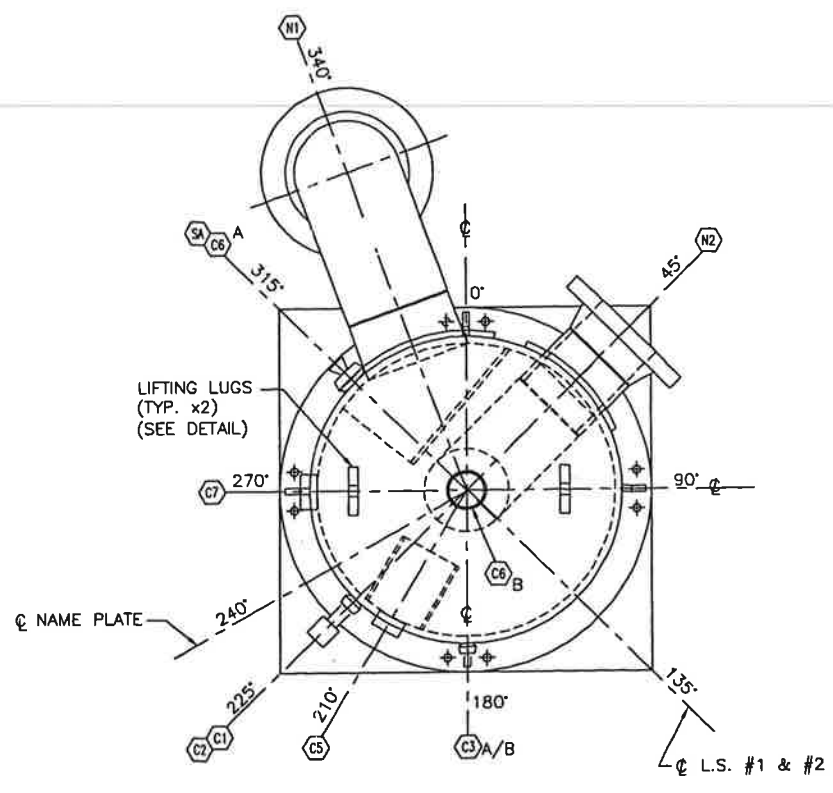
TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT

THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAC SYSTEMS LTD., AND SHALL NOT BE DISCLOSED

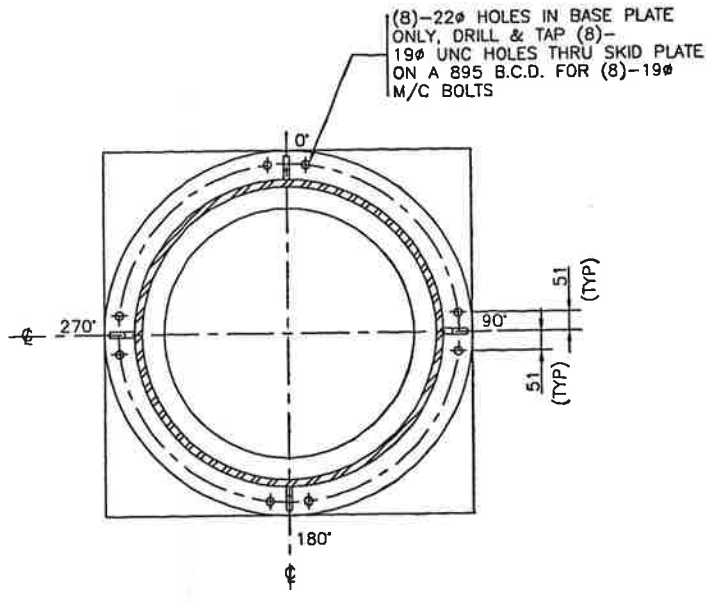
THIS DRAWING AND



**ELEVATION**  
SCALE: 1:10



**ORIENTATION**  
SCALE: 1:10



**VIEW 'A-A' (SKID/BASE PLATE DETAILS)**  
TRUE ORIENT. OF GUSSETS & HOLES  
SCALE: 1:10

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ	EXT. PROJ	WELD	
N1	273	300	RFWN	80	INLET	MIN	SPEC	200	-
N2	219	300	RFWN	80	OUTLET	SPEC			-
C1	33	6000	TOL	-	LCV-100	-	-	-	-
C2	33	6000	CPLG	XXH	DRAIN	0	SPEC		-
C3	27	6000	TOL	-	LC-100	-	-	-	-
C4									
C5	48	6000	1/2 CPLG	NPT	LS-100	MIN	-	-	-
C6	60	6000	TOL	-	INSPECTION w/PLUG	-	-	-	-
C7	60	6000	1/2 CPLG	NPT	LC-100	MIN	-	-	-
SA	150	-	-	-	SKIRT ACCESS	-	-	-	-

CAPACITY: 1.08 m<sup>3</sup>  
 WEIGHT EMPTY: 1842 kg  
 WEIGHT FULL OF WATER: 2922 kg  
 SURFACE PREPARATION:  
 PRIMER: PNT-11  
 FINISH PAINT:  
 INSULATION: NONE  
 MECHANICAL LOADINGS GOVERN AS PER UG22:  YES  NO  
 IMPACT TEST:  YES PER UG84 AS FOLLOWS:  
 NO PER UG20(f):  
~~UGC 66(a) AND FIG. UGS 66~~  
~~UGC 66(b) AND FIG. UGS 66.1~~  
~~UGC 66(c) UGS 66.2~~  
 PRODUCTION IMPACT TEST REQ'D:  YES  NO  
 SHIP LOOSE:  YES  NO  
 SERVICE: HYDROCARBONS

SERIAL NO: 99404-101 CRN:  
 TAG NO: V-100 YEAR BUILT: 2000  
 LSD #: -  
 CODE:  
 ASME SECT. VIII DIV I, '98, ADDENDA '99  
 MAX. DESIGN PRESS: 4516 kPag @ TEMP: 149°C  
 HYDROTEST: 5871 kPag  
 MIN<sup>M</sup> DESIGN METAL TEMP: -28°C @ MAWP 4516 kPag  
 MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N  
 RADIOGRAPHY:  
 LONGL: ~~FULL UW11(a)~~ SPOT UW11(b) NPL UW11(c)  
 (INCLUDING ALL BUTT WELDS)  
 CIRC: ~~FULL UW11(a)~~ SPOT UW11(b) UW11(c), 5(b), 12(d) NPL UW11(e)  
 (INCLUDING ALL BUTT WELDS)  
 P.W.H.T.:  
 YES  NO MIN. TEMP: 593°C, TIME: (1) hr (MIN)  
 CORR. ALLOW: 3.20mm

"SOUR SERVICE"

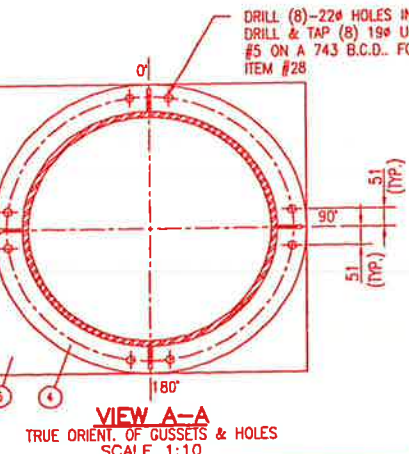
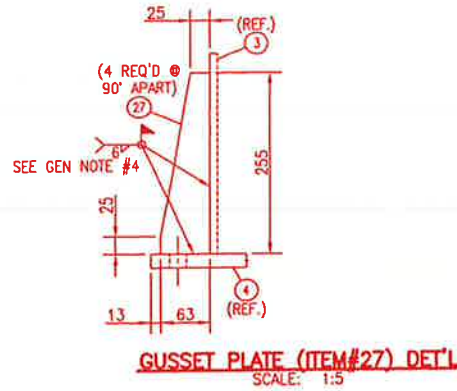
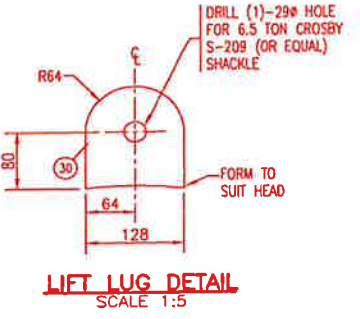
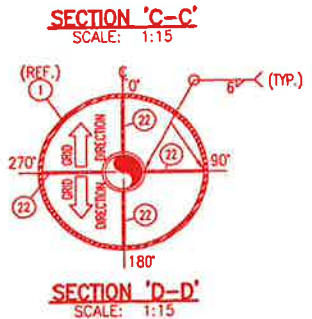
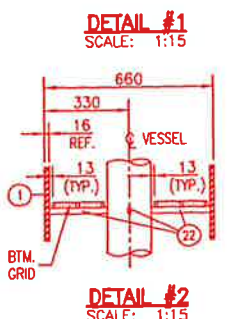
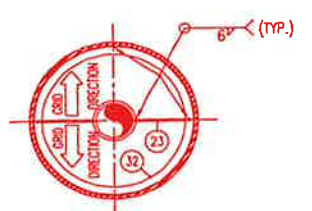
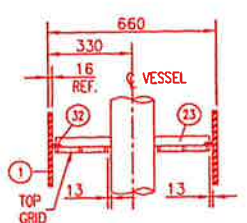
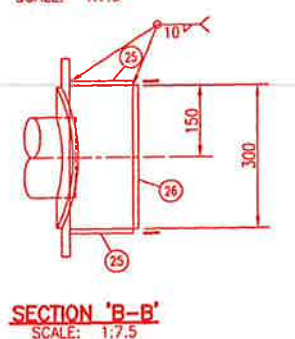
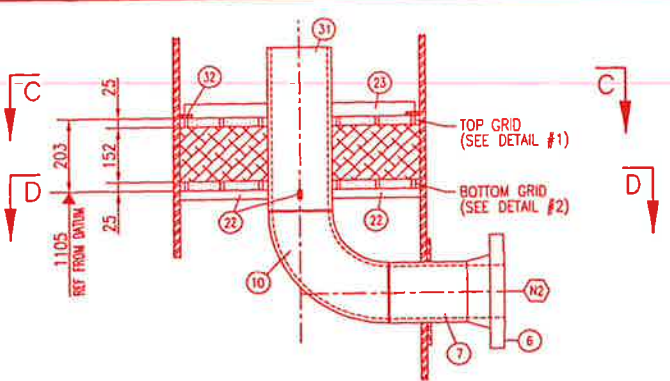
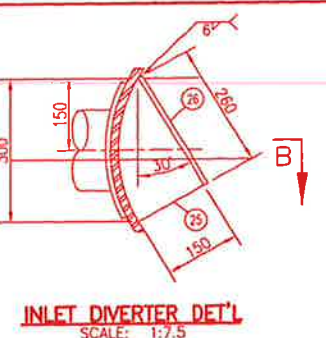
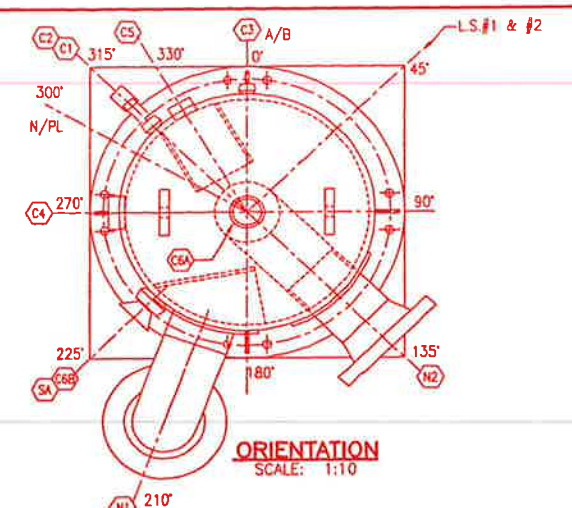
GENERAL NOTES		GENERAL NOTES		SKT	ISSUED FOR DOCUMENTATION	D. DOR	00/09/15	VK	SW
DATE	BY	DATE	BY	No.	REVISION	BY	DATE	CKD	ENG
2000.09.25	4:05pm								

APPROVED		DRAWN	
MECH/STRUCT.	BY	D. DORAN	
DATE	DATE		
ELECTRICAL	BY	CHECKED	
DATE	DATE		
PROJECT	DATE		
DATE	SCALE	AS NOTED	

**APACHE CANADA LIMITED**  
 1478 HP HAMBURG COMPRESSOR PACKAGE  
 STAGE-1 INLET SCRUBBER-SOUR GAS (V-100)  
 813 O/D x 1930 S/S  
 DWG. No.: D-SCR-99404-101-SKT SHT. 1 OF 1 REV. SKT

**PROPAC**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

THIS DRAWING AND THE PROPERTY OF PROPAC SYSTEMS LTD. AND SHALL NOT BE REPRODUCED OR USED FOR ANY PURPOSE WITHOUT WRITTEN CONSENT.



MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	WELD
						MIN	SPEC.	
N1	168	300#	RFRW	XH	INLET	-	-	8/14
N2	168	300#	RFRW	XH	OUTLET	-	200	7/14
C1	33	6000#	TOL	-	CONTROL VALVE CONN.	-	-	6
C2	33	6000#	CPLG	XXH	DRAIN	-	0	SPEC. 12/SW
C3	27	6000#	TOL	-	LG-110	-	-	6
C4	60	6000#	CPLG	HALF	LC-110	-	-	4
C5	48	6000#	CPLG	HALF	LSH-110	-	-	4
C6	60	6000#	TOL	-	INSPECTION/VENT C/W PLUG	-	-	6
C8	60	6000#	TOL	-	INSPECTION C/W PLUG	-	-	6
SA	150	-	-	-	SKIRT ACCESS OPENING	-	-	-

ITEM	QUA	DESCRIPTION	SA-516-70N
1	1	SHELL PL: 15.88 THK X 1626 LG (ROLL TO 660 O/D)	SA-516-70N
2	2	HEAD PL: 660 O/D X 15.88 THK NOM. (13.72 MIN.) 2:1 S.E. C/W 51 S.F.	SA-516-70N
3	1	SKIRT PL: 9.53 THK X 440 LG (ROLL TO 660 O/D)	SA-516-70N
4	1	BASE PL: 19.05 THK X 813 O/D X 533 I/D	SA-36
5	1	SOLE PL: 25.4 THK X 813 SQ.	SA-36
6	2	REPAD PL: 9.53 THK X 295 O/D X 172 I/D (ROLL TO 660 I/D)	SA-105N
7	2	FLG: 168-300# RFRW XH BORE	SA-105N
8	1	PIPE: 168 O/D X 10.97 WT X 197 LG SMLS	SA-106-B
9	1	PIPE: 168 O/D X 10.97 WT X 113 LG SMLS (CTS)	SA-106-B
10	2	ELBOW: 168 O/D X 90° L.R. XH SMLS BW	SA-234-WPB
11	1	PIPE: 33 O/D X 9.09 WT X 150 LG SMLS (CTS)	SA-106-B
12	1	PIPE: 33 O/D X 9.09 WT X 411 LG SMLS	SA-106-B
13	1	ELBOW: 33-6000# X 90° SW XXH BORE	SA-105N
14	1	CPLG: 33-6000# NPT X SW XXH BORE	SA-105N
15	2	TOL: 27-6000# (ON A 660 O/D RUN)	SA-105N
16	1	TOL: 33-6000# (ON A 660 O/D RUN)	SA-105N
17	1	TOL: 60-6000# (ON A 660 O/D RUN) C/W PLUG	SA-105N
18	1	TOL: 60-6000# (ON FLAT) C/W PLUG	SA-105N
19	1	HALF CPLG: 48-6000# NPT	SA-105N
20	1	HALF CPLG: 60-6000# NPT	SA-105N
21	1	NAME PLATE C/W MOUNTING BRACKET	SS/SA-36
22	4	F/BAR: 13 THK X 25 X 227 LG	G40.21M-300W
23	2	F/BAR: 10 THK X 38 X 217 LG	G40.21M-300W
24	1	MISTEX: 152 THK X 628 O/D X 168 I/D C/W 25 X 3 X 602 O/D X 194 I/D	318LSS
		GRIDS (TOP & BTM) IN 1 SECTION (144 kg/cu.m)	
25	2	PLATE: 10 THK X 150 WD X 260 LG (CTS)	SA-36
26	1	PLATE: 10 THK X 260 WD X 300 LG	SA-36
27	4	PLATE: 16 THK X 63 WD X 255 LG (CTS)	SA-36
28	8	ZINC PLATED M/C BOLT: 19.05# X 44 LG c/w 1 FLAT WASHER EA.	SA-325
29	1	PIPE: 168 O/D X 7.11 WT X 200 LG SMLS (CTS)	SA-106-B
30	2	PLATE: 25.4 THK X 128 WD X 146 LG (CTS)	SA-36
31	1	PIPE: 168 O/D X 10.97 WT X 452 LG (SMLS)	SA-106-B
32	1	RING PLATE: 10 THK X 625 O/D X 561 I/D	SA-36

NOTE: THE FOLLOWING SUBSTITUTIONS ARE PERMITTED (THE OPPOSITE NOT ALLOWED)  
SA-350-LF2 for SA-105, SA-333-Gr6 for SA-106-B, SA-420-WPL6 for SA-234-WPB

CAPACITY: 0.601 m<sup>3</sup>  
SURFACE AREA OF TUBES: N/A m<sup>2</sup>  
WEIGHT EMPTY: 1080 kg  
WEIGHT FULL OF WATER: 1681 kg  
SURFACE PREPARATION:  
PRIMER: PNT-11  
FINISH PAINT:  
INSULATION: NONE  
MECHANICAL LOADINGS GOVERNS AS PER UG 22:  
IMPACT TEST:  PER UG20(e)

SERIAL NO: 99404-102 CRN:  
TAG NO: V-110 YEAR BUILT: 2000  
LSD #: -  
CODE:  
ASME SECT. VIII DIV I, '98, ADDENDA '99  
TEMA CLASS N/A, ADDENDA N/A  
MAX. DESIGN PRESS: 4516 kPaG @ TEMP: 149 °C  
MIN. DESIGN PRESS: N/A kPaG  
HYDROTEST:  
VESSEL 5871 kPaG  
COIL N/A kPa  
MIN. DESIGN METAL TEMP: -28 °C @ MAWP 4516 kPaG  
MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N  
RADIOGRAPHY:  
LONG<sup>L</sup> FULL UWH(e)  
CIRC: FULL UWH(e) (INCL. ALL BUTT WELDS)  
P.W.H.T.: YES MIN. TEMP: 593 °C, TIME: 1hr MIN  
CORR. ALLOW: 3.2 mm  
SOUR SERVICE

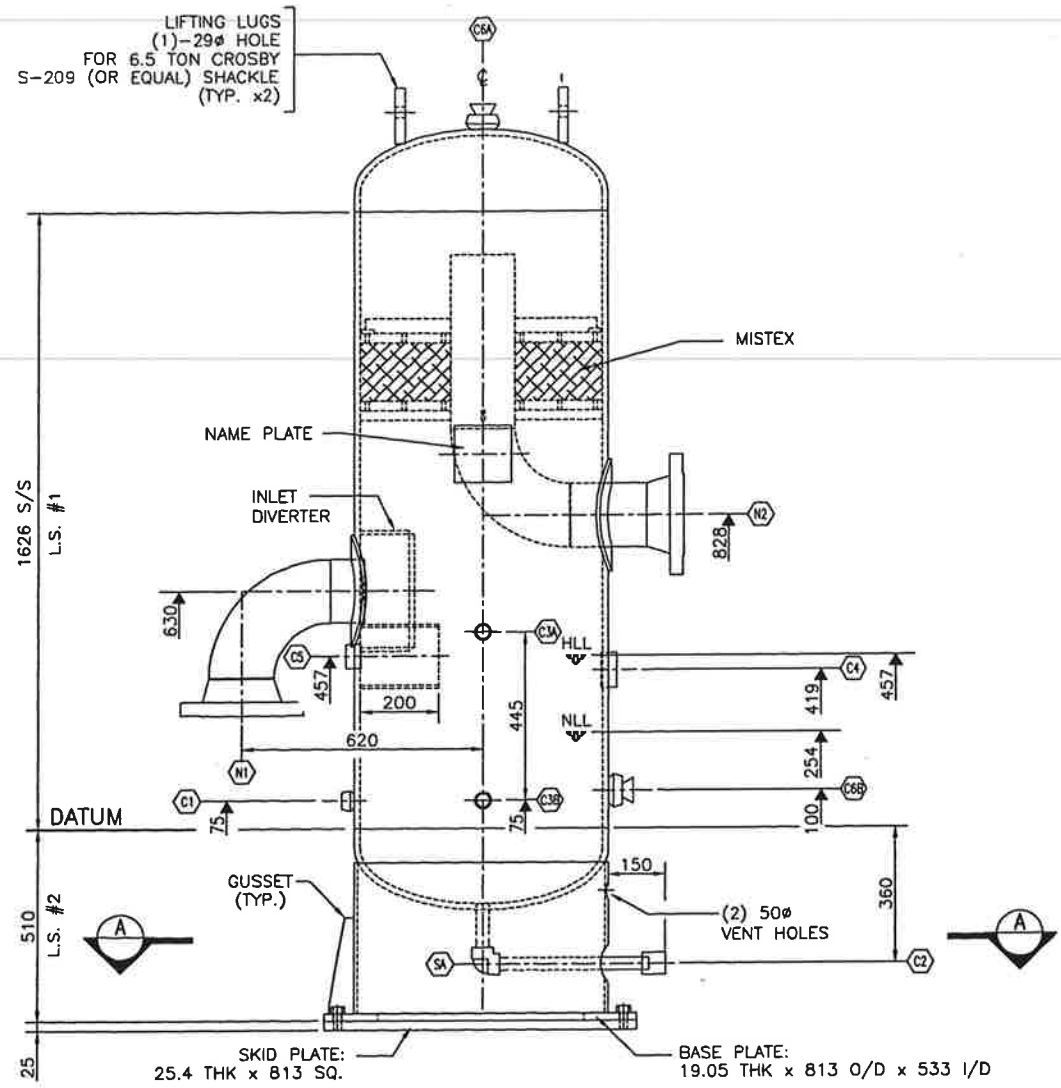
DOUBLE BUTT	SINGLE VEE	COUPLING	THRODLET	NOZZLE & REPAD RECESSED	NOZZLE & REPAD FLUSH	NOZZLE FLUSH	PIPE TO FLANGE/FITTING SKIRT TO HEAD/B PL.	DOUBLE BUTT - SQUARE
Welding diagram showing double butt joint with dimensions.	Welding diagram showing single vee joint with dimensions.	Welding diagram showing coupling joint with dimensions.	Welding diagram showing throddlet joint with dimensions.	Welding diagram showing nozzle & repad recessed joint with dimensions.	Welding diagram showing nozzle & repad flush joint with dimensions.	Welding diagram showing nozzle flush joint with dimensions.	Welding diagram showing pipe to flange/fitting skirt to head/b pl. joint with dimensions.	Welding diagram showing double butt square joint with dimensions.
BACK DRONE TO SOUND METAL 02,106,110	2. WPS# 104,106,110	4. WPS# 102,106,110	6. WPS# 102,106,110	7. WPS# 102,106,108,110	8. WPS# 102,106,108,110	12. WPS# 102,106,108,110	14. WPS# 104,106,110	20. WPS# 102,106,110

GENERAL NOTES		GENERAL NOTES	
1. PROFILE INTERNAL PROJECTION UNLESS SPECIFIED.	4. VESSEL SHOP TO TACK WELD BASEPLATES & GUSSETS TO SKIRT. ASSEMBLY SHOP TO COMPLETE WELDING ON ASSEMBLY.	6. MIN. HEAD THICKNESS WAS 13.97	
2. SANDLAST INTERNALS TO ENSURE THAT THE INSIDE SURFACE OF THE VESSEL IS FREE OF LOOSE MILL SCALE AND WELD SPLATTER.	5. VESSEL OPENINGS TO BE SEALED PRIOR TO ANY SHIPPING TO OTHER SHOPS	7. N2 DIM WAS 815	
3. PRIOR TO MISTEX INSTALLATION & CLOSING OF VESSEL, ALL VESSEL TO BE RUSTED OUT AT HYDROTEST, AIR DRIED AND OILED INTERNALLY.	6. HALF CPLGS. ITEMS #19 & 20 MUST HAVE A FULL BORE TAPER BORE TO CLEAR FLOAT. CLEAN THREADS AFTER WELDING.	8. NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION	
	7. MIN. HEAD THK. WAS 14.29	9. D.T.S. 00/02/04 Q.N. T.K.	
	8. CHANGED ORIENTATION OF N1 (WAS 285°)	10. S.FARWELL 00/01/27 M.A. P.C.	
	9. ISSUED FOR CONSTRUCTION	11. Q. NGUYEN 00/01/26 L.W. P.C.	
		12. BY DATE CKD ENG	

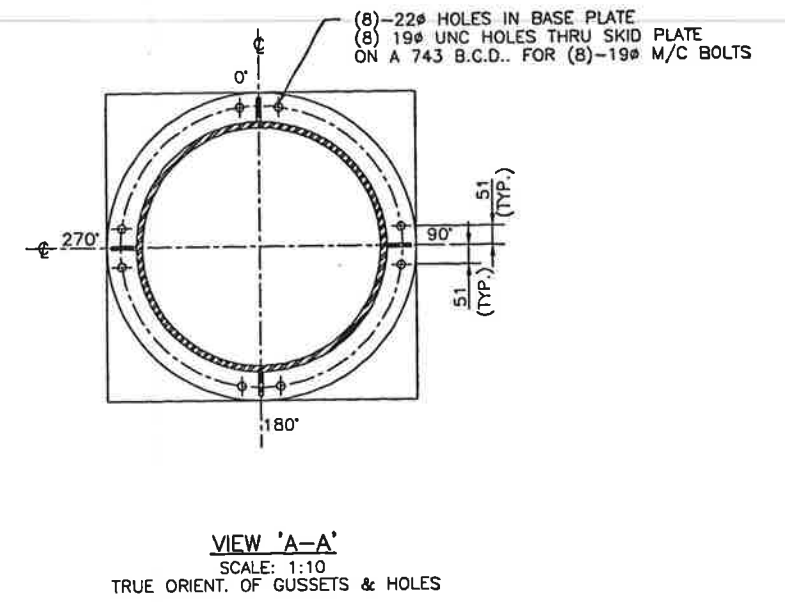
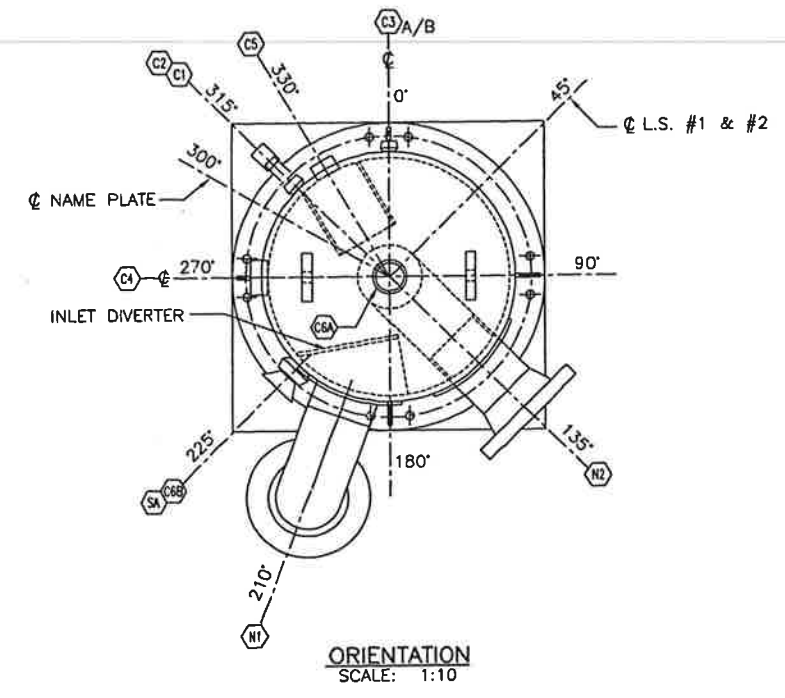
APPROVED				DRAWN			
MECH./STRUCT.	BY	D. SMITH		DATE	00/04/20		
ELECTRICAL	CHECKED			DATE			
PROJECT	BY	M. IWANIUK		DATE	00/04/28		
DATE				SCALE	AS SHOWN		
DWG. No.: D-SCR-99404-102				REV. 6			

**PROPAC SYSTEMS LTD.**  
 STOCK 1478 HP COMPRESSOR  
 2ND STAGE INLET SCRUBBER  
 660 O/D X 1626 S/S  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAK SYSTEMS LTD., AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT OF PROPAK.



**ELEVATION**  
SCALE: 1:10



NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	WELD	
N1	168	300#	RFWN	XH	INLET	MIN	SPEC.	200	-
N2	168	300#	RFWN	XH	OUTLET	SPEC.			
C1	33	6000#	TOL	-	CONTROL VALVE CONN.	-	-	-	-
C2	33	6000#	CPLG	XXH	DRAIN	0	SPEC.		
C3	27	6000#	TOL	-	LG-110	-	-	-	-
C4	60	6000#	CPLG	HALF	LSH-110	MIN.	-	-	-
C5	48	6000#	CPLG	HALF	LSH-110	MIN.	-	-	-
C6	60	6000#	TOL	-	INSPECTION/VENT C/W PLUG	-	-	-	-
C6	60	6000#	TOL	-	INSPECTION C/W PLUG	-	-	-	-
SA	150	-	-	-	SKIRT ACCESS OPENING	-	-	-	-

CAPACITY: 0.601 m<sup>3</sup>  
 SURFACE AREA OF TUBES: N/A m<sup>2</sup>  
 WEIGHT EMPTY: 1080 kg  
 WEIGHT FULL OF WATER: 1681 kg  
 SURFACE PREPARATION:  
 PRIMER: PNT-11  
 FINISH PAINT: PNT-11  
 INSULATION: NONE  
 MECHANICAL LOADINGS GOVERNS AS PER UG 22:  NO  
 IMPACT TEST:  NO - PER UG20(f)  
 PRODUCTION IMPACT TEST REQ'D:  NO  
 SHIP LOOSE:  NO  
 SERVICE: SOUR GAS

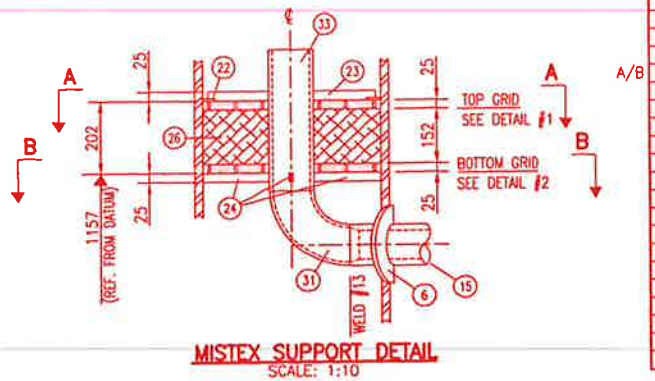
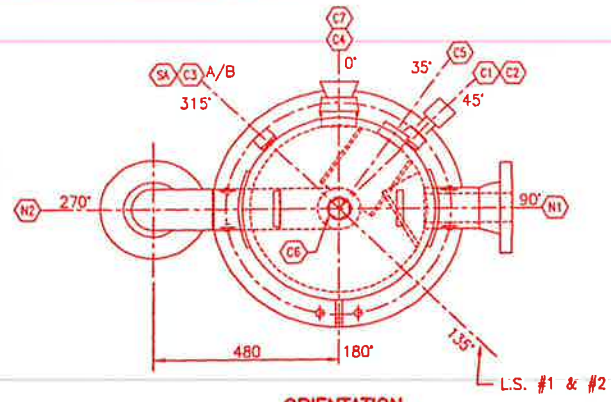
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 TAG NO: V-110 YEAR BUILT: 2000  
 LSD #: -  
 CODE:  
 ASME SECT. VIII DIV I, '98, ADDENDA '99  
 TEMA CLASS N/A, ADDENDA N/A  
 MAX: DESIGN PRESS: 4516 kPaG @ TEMP: 149 °C  
 MIN: DESIGN PRESS: N/A kPaG  
 HYDROTEST:  
 VESSEL 5871 kPaG  
 COIL N/A kPa  
 MIN<sup>M</sup> DESIGN METAL TEMP: -28 °C @ MAWP 4516 kPaG  
 MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N  
 RADIOGRAPHY:  
 LONG L: FULL UWII(a)  
 CIRC: FULL UWII(a) (INCL. ALL BUTT WELDS)  
 P.W.H.T.:  
 YES MIN. TEMP: 593 °C, TIME: 1hr MIN.  
 CORR. ALLOW: 3.2 mm

"SOUR SERVICE"

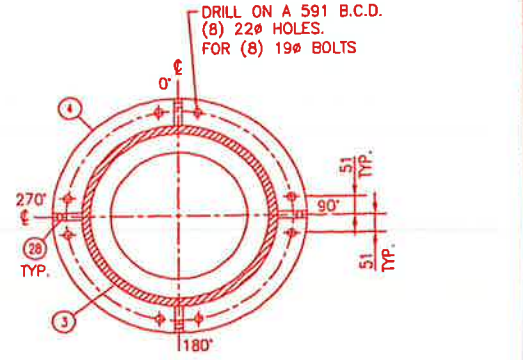
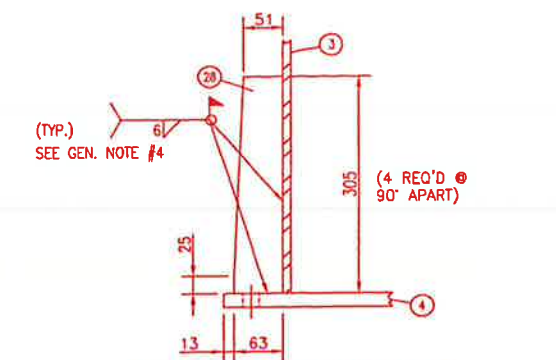
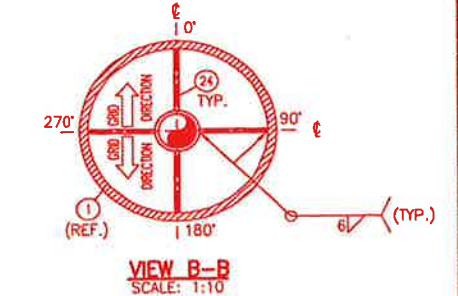
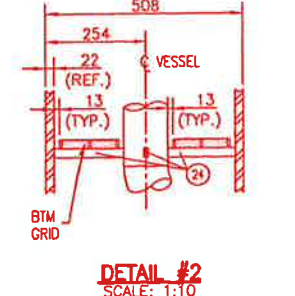
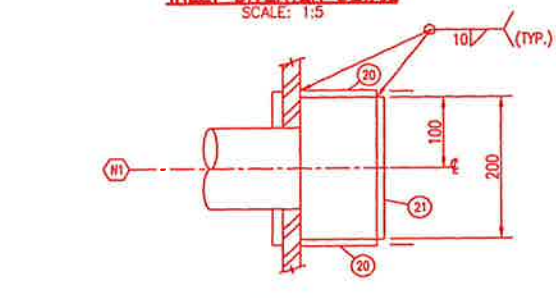
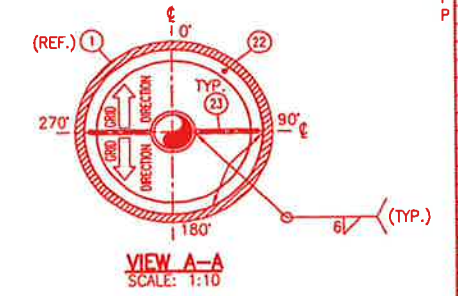
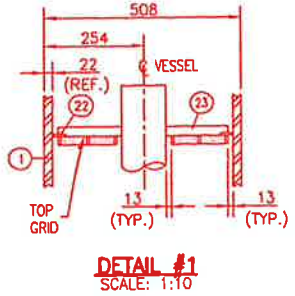
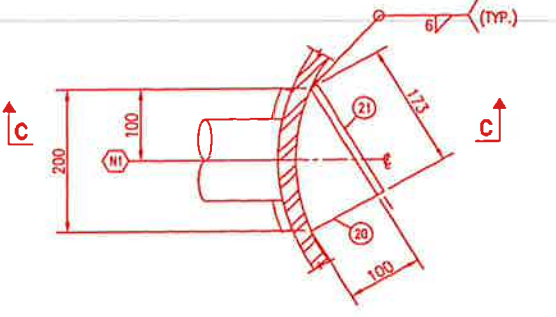
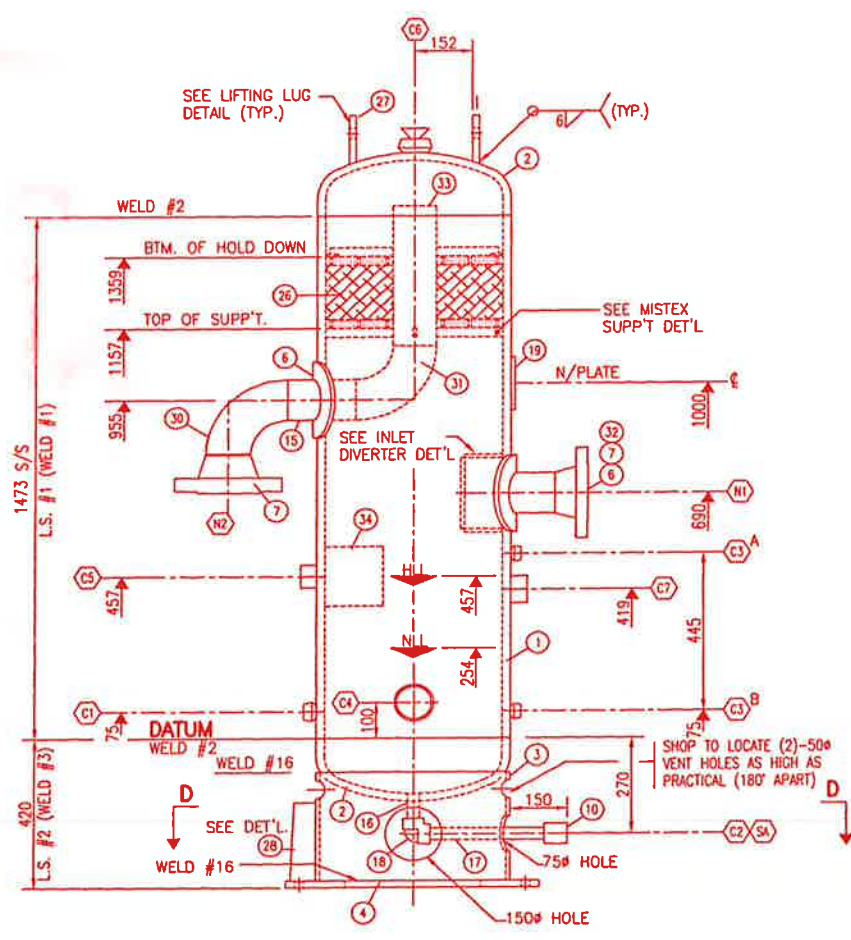
GENERAL NOTES		GENERAL NOTES		APPROVED		DRAWN		APACHE CANADA LIMITED	
DATE: 2000.09.25 4:06pm	FILE NAME: J:\jobs99\DWG\99404\Comp\Misc\SCR-99404-102-SKT-01.dwg	SKT	ISSUED FOR DOCUMENTATION	J. JUA	00/09/15	VK	SW	1478 HP HAMBURG COMPRESSOR PACKAGE	
		No.	REVISION	BY	DATE	CKD	ENG	2ND STAGE INLET SCRUBBER (V-110)	
								660 O/D X 1626 S/S	
								DWG. No.:	D-SCR-99404-102-SKT SHT. 1 OF 1
								REV. SKT	

**PROPAK**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

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NOZZLE SCHEDULE						
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ. EXT. PROJ. WELD
N1	114	600#	RFWN	XXH	INLET	MIN. 200 8/14
N2	114	600#	RFWN	XXH	OUTLET	SPEC. SPEC 7/14
C1	33	6000#	TOL	-	CONTROL VALVE CONN.	- - 6
C2	33	6000#	CPLG	XXH	DRAIN	- 0 SPEC. 11/SW
C3	27	6000#	TOL	-	LEVEL GAUGE (LG-120)	- - 6
C4	60	6000#	TOL	-	INSPECTION c/w PLUG	- - 6
C5	48	6000#	1/2 CPLG	-	LEVEL SWITCH HIGH (LSDH-120)	MIN. - 4
C6	60	6000#	TOL	-	INSPECTION/VENT c/w PLUG	- - 6
C7	60	6000#	1/2 CPLG	-	LEVEL CONTROL (LC-120)	MIN. - 4
SA	150	-	-	-	SKIRT ACCESS OPENING	- - -



BILL OF MATERIAL			
ITEM	QUA	DESCRIPTION	SA
1	1	SHELL PLATE: 22.23 THK. x 1473 LG. (ROLL TO 508 O/D)	SA-516-70N
2	2	HEAD PLATE: 22.23 THK. NOM. (20.64 MIN.) x 508 O/D 2:1 c/w 51 S.F.	SA-516-70N
3	1	SKIRT PLATE: 10 THK. x 350 LG. (ROLL TO 508 O/D)	SA-516-70N
4	1	BASE PLATE: 19 THK. x 660 O/D x 356 I/D	SA-36
5	-	-	-
6	2	REPAD PLATE: 9.53 THK. x 216 O/D x 117 I/D (ROLL TO 508 I/D)	SA-516-70N
7	2	FLANGE: 114-600# SCH XXH BORE	SA-105N
8	1	HALF CPLG: 60-6000# NPT	SA-105N
9	1	HALF CPLG: 48-6000# NPT	SA-105N
10	1	CPLG: 33-6000# SW x NPT	SA-105N
11	2	TOL: 27-6000# (ON A 508 O/D RUN)	SA-105N
12	1	TOL: 33-6000# (ON A 508 O/D RUN)	SA-105N
13	1	TOL: 60-6000# (ON A 508 O/D RUN) c/w PLUG	SA-105N
14	1	TOL: 60-6000# (ON FLAT) c/w PLUG	SA-105N
15	1	PIPE: 114 O/D x 17.12 W.T. x 170 LG.	SA-106-B
16	1	PIPE: 33 O/D x 9.09 W.T. x 101 LG. (CTS)	SMLS SA-106-B
17	1	PIPE: 33 O/D x 9.09 W.T. x 333 LG.	SMLS SA-106-B
18	1	ELBOW: 33-6000# SCH XXH BORE x 90° SW	SA-105N
19	1	NAMEPLATE c/w MOUNTING BRACKET	SS/SA-36
20	2	PLATE: 10 THK. x 100 WD. x 173 LG. (CTS)	SA-36
21	1	PLATE: 10 THK. x 173 WD. x 200 LG. (CTS)	SA-36
22	1	RING PLATE: 10 THK. x 461 O/D x 397 I/D	SA-36
23	2	F/BAR: 10 THK. x 25 x 160 LG.	G40.21M-300W
24	4	F/BAR: 10 THK. x 25 x 172 LG.	G40.21M-300W
25	-	-	-
26	1	MISTEX: 152 THK x 464 O/D x 114 I/D c/w 25 x 3 x 438 O/D x 140 I/D	SS-316L
27	2	GRID (TOP & BOTTOM) IN (1) SECTION (144 kg/cu. M)	SA-36
28	4	PLATE: 19 THK. x 100 WD. x 130 LG.	SA-36
29	-	-	-
30	1	ELBOW: 114 O/D 90° LR SCH. XXH B.W.	SMLS SA-234-WPB
31	1	ELBOW: 114 O/D 90° LR SCH. XXH B.W.	SMLS SA-234-WPB
32	1	PIPE: 114 O/D x 17.12 W.T. x 146 LG.	SMLS SA-106-B
33	1	PIPE: 114 O/D x 8.56 W.T. x 399 LG.	SMLS SA-106-B
34	1	PIPE: 168 O/D x 7.11 W.T. x 200 LG. (CTS)	SMLS SA-106-B

NOTE: THE FOLLOWING SUBSTITUTIONS ARE PERMITTED (THE OPPOSITE NOT ALLOWED)  
SA-350-LF2 for SA-105, SA-333-Gr6 for SA-106-B, SA-420-WPL6 for SA-234-WPB

CAPACITY: 0.293 m<sup>3</sup>  
SURFACE AREA OF TUBES: N/A m<sup>2</sup>  
WEIGHT EMPTY: 816 kg  
WEIGHT FULL OF WATER: 1109 kg

SERIAL NO: 99404 '103' CRN:  
TAG NO: V-120 YEAR BUILT: 2000  
LSD #: -  
CODE:  
ASME SECT. VIII DIV I, '98, ADDENDA '99  
TEMA CLASS, N/A, ADDENDA N/A  
MAX. DESIGN PRESS: 9067 kPag @ TEMP: 149 °C  
HYDROTEST:  
VESSEL 11787 kPag  
COIL N/A kPag  
MIN<sup>m</sup> DESIGN METAL TEMP: -28 °C @ MAWP 9067 kPag  
MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N  
RADIOGRAPHY:  
LONG L FULL UMI (a)  
CIRC. FULL UMI (a) (INCL. ALL BUTT WELD)

IMPACT TEST: (NO) PER UG20(e)

PRODUCTION IMPACT TEST REQ'D: (NO)  
SHIP LOOSE: (NO)  
SERVICE: HYDROCARBONS  
LONG & CIRC. WELDS TYPE 1  
QWP: 590.2  
AQP-1050(S) AQP-1227(S)  
TACK WELDS: WPS#101  
PRESS. TO STRUCT. WELD WPS#: 102, 106 & 110

P.W.H.T.:  
(YES) MIN. TEMP: 593 °C, TIME: 1 h (MIN.)  
CORR. ALLOW: 3.2 mm

**'SOUR SERVICE'**

DOUBLE BUTT	SINGLE VEE	SQUARE	COUPLING	THREDOLET	NOZZLE & REPAD RECESSED	NOZZLE & REPAD FLUSH	NOZZLE FLUSH	TRANSITION WELD	PIPE TO FLANGE/FITTING	SKIRT TO HEAD/B.PL.
1. WPS# 102.106.110	2. WPS# 104.106.110	3. WPS# 102.106.110	4. WPS# 102.106.110	6. WPS# 102.106.110	7. WPS# 102.106.108.110	8. WPS# 102.106.108.110	11. WPS# 102.106.108.110	13. WPS# 104.106.110	14. WPS# 104.106.110	16. WPS# 102.106.110

1) DO NOT PROFILE INTERNAL PROJECTION UNLESS SPECIFIED.  
2) SANDBLAST INTERNALS TO ENSURE THAT THE INSIDE SURFACE OF THE VESSEL IS FREE OF LOOSE MILL SCALE AND WELD SPLATTER. PRIOR TO MISTEX INSTALLATION & CLOSING OF VESSEL.  
3) VESSEL TO BE FLUSHED OUT AT HYDROTEST, AIR DRIED AND OILED INTERNALLY TAPER BORE TO CLEAR FLOAT. CLEAN THREADS AFTER WELDING.

4) VESSEL SHOP TO TACK WELD BASEPLATES & GUSSETS TO SKIRT. ASSEMBLY SHOP TO COMPLETE WELDING ON ASSEMBLY.  
5) VESSEL OPENINGS TO BE SEALED PRIOR TO ANY SHIPPING TO OTHER SHOPS.  
6) HALF CPLGS. ITEMS #8 & 9 MUST HAVE A FULL BORE.

GENERAL NOTES

GENERAL NOTES		REVISION	
2	NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION	D SMITH	00/05/08
1	ISSUED FOR CONSTRUCTION	P.T.	00/02/03
No.		BY	DATE
		CKD	ENG

APPROVED		DRAWN	
MECH./STRUCT.	BY D. SMITH	DATE	00/04/05
ELECTRICAL	CHECKED		
DATE	BY M. IWANIUK	DATE	00/05/08
PROJECT	S.WARD	DATE	00/05/08
DATE		SCALE	AS NOTED

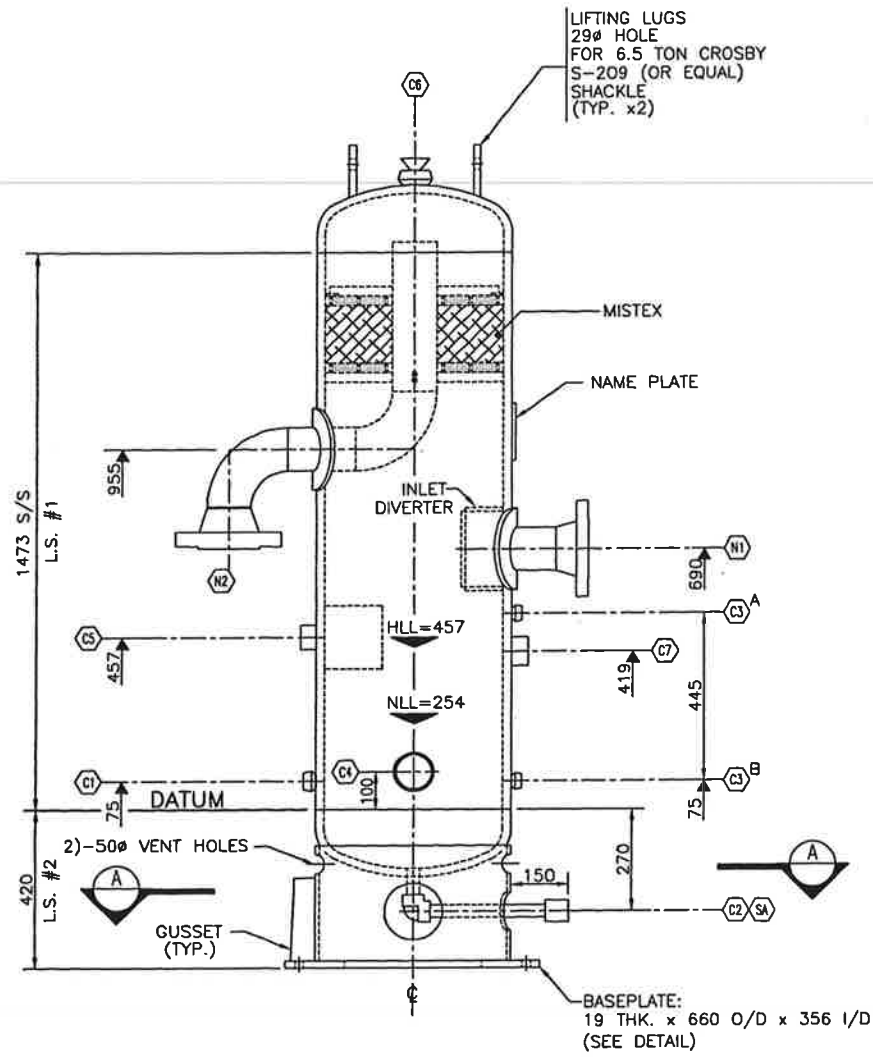
**PROPAK SYSTEMS LTD.**  
STOCK 1478 HP COMPRESSOR  
STAGE-3 INLET SCRUBBER - SOUR GAS  
508 O/D x 1473 S/S

DWG. No.: D-SCR-99404-103

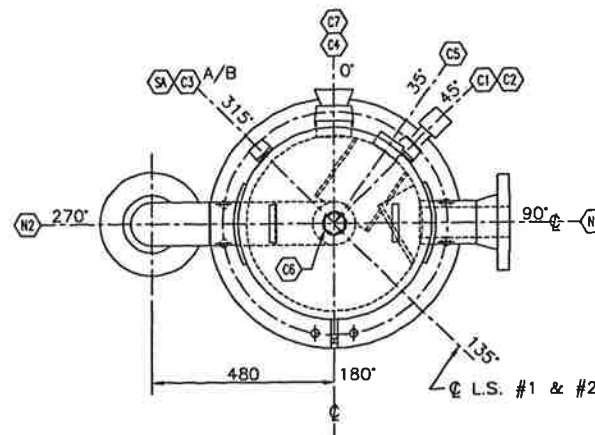
**PROPAK**  
440 East Lake Road,  
Postal Bag #2  
Airdrie, Alberta  
Canada T4B 2C3



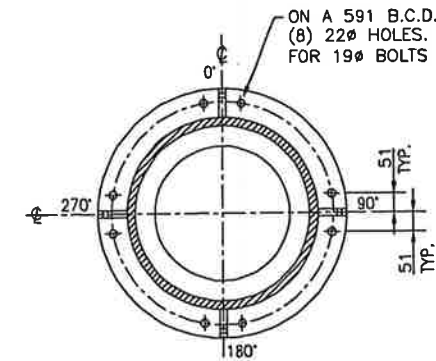
NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	PROJ. WELD	
N1	114	600#	RFWN	XXH	INLET	MIN. SPEC.	200		
N2	114	600#	RFWN	XXH	OUTLET				
C1	33	6000#	TOL	-	CONTROL VALVE CONN.				
C2	33	6000#	CPLG	XXH	DRAIN	0	SPEC.		
C3	27	6000#	TOL	-	LEVEL GAUGE (LG-120)				
C4	60	6000#	TOL	-	INSPECTION c/w PLUG				
C5	48	6000#	1/2 CPLG	-	LEVEL SWITCH HIGH (LSDH-120)	MIN.			
C6	60	6000#	TOL	-	INSPECTION/VENT c/w PLUG				
C7	60	6000#	1/2 CPLG	-	LEVEL CONTROL (LC-120)	MIN.			
SA	150	-	-	-	SKIRT ACCESS OPENING				



ELEVATION  
SCALE: 1:10



ORIENTATION  
SCALE: 1:10



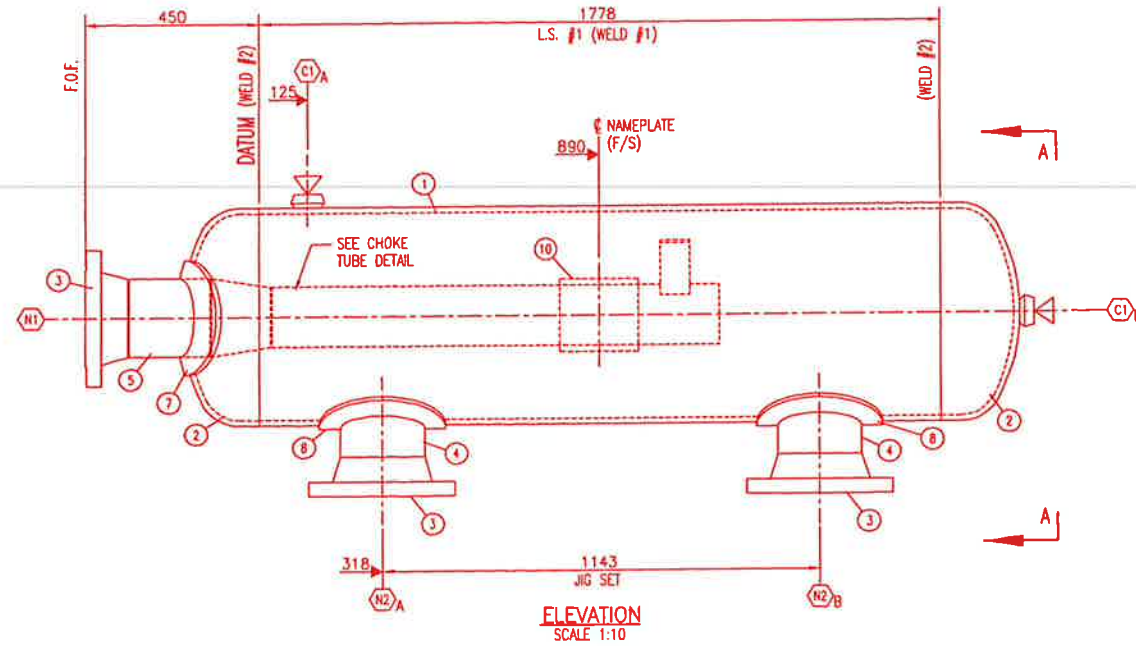
VIEW 'A-A' (BASE PLATE DETAILS)  
TRUE ORIENT. OF GUSSETS & HOLES  
SCALE: 1:10

CAPACITY: 0.293 m <sup>3</sup>	SERIAL NO: 99404 '103' CRN:
SURFACE AREA OF TUBES: N/A m <sup>2</sup>	TAG NO: V-120 YEAR BUILT: 2000
WEIGHT EMPTY: 816 kg	LSD #: -
WEIGHT FULL OF WATER: 1109 kg	CODE:
SURFACE PREPARATION:	ASME SECT. VIII DIV 1, '98, ADDENDA '99
PRIMER: PNT-11	TEMA CLASS, N/A, ADDENDA N/A
FINISH PAINT: PNT-11	MAX. DESIGN PRESS: 9067 kPag @ TEMP: 149 °C
INSULATION: NONE	HYDROTEST:
MECHANICAL LOADINGS GOVERNS AS PER UG 22: <input checked="" type="checkbox"/> (NO)	VESSEL 11787 kPag
	COIL N/A kPag
	MIN <sup>M</sup> DESIGN METAL TEMP: -28°C @ MAWP 9067 kPag
	MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N
IMPACT TEST: (NO) -PER UG20(f)	RADIOGRAPHY:
	LONG L: FULL UWII(a)
	CIRC: FULL UWII(a) (INCL. ALL BUTT WELD)
PRODUCTION IMPACT TEST REQ'D: <input checked="" type="checkbox"/> (NO)	P.W.H.T.:
SHIP LOOSE: <input checked="" type="checkbox"/> (NO)	<input checked="" type="checkbox"/> MIN. TEMP: 593°C, TIME: 1 h (MIN.)
SERVICE: HYDROCARBONS	CORR. ALLOW: 3.2 mm

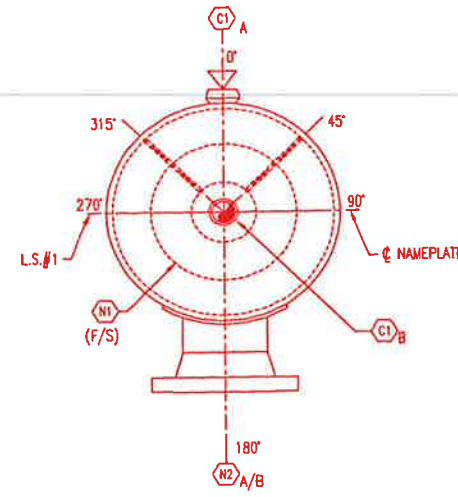
'SOUR SERVICE'

APPROVED		DRAWN		APACHE CANADA LIMITED	
MECH./STRUCT.	BY	BY	BY	1478 HP HAMBURG COMPRESSOR PACKAGE	
DATE	DATE	DATE	DATE	STAGE-3 INLET SCRUBBER - SOUR GAS (V-120)	
ELECTRICAL	BY	CHECKED		508 O/D x 1473 S/S	
DATE	DATE			DWG. No.: D-SCR-99404-103-SKT SHT. 1 OF 1 REV. SKT	
PROJECT	DATE			440 East Lake Road,	
DATE	SCALE AS NOTED			Postal Bag #2	
				Airdrie, Alberta	
				Canada T4B 2C3	

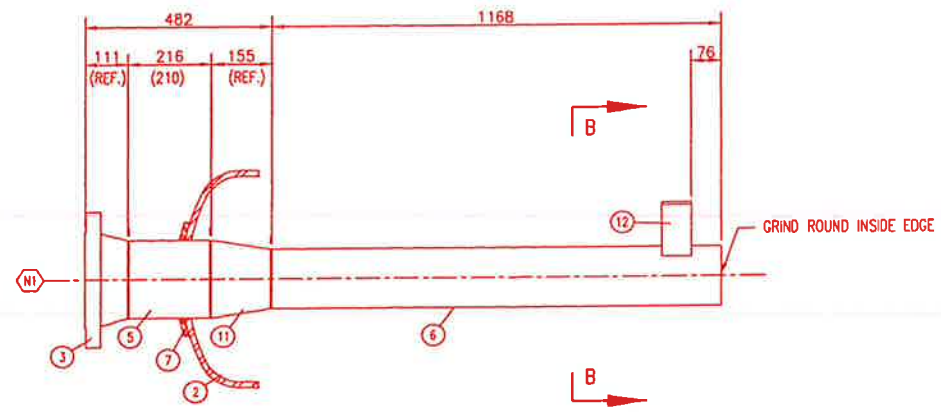
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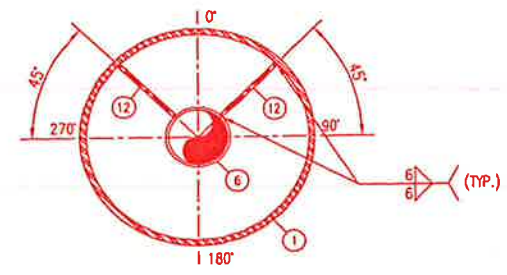
ELEVATION  
SCALE 1:10



ORIENTATION  
VIEW 'A-A'  
SCALE 1:10



CHOKE TUBE DETAIL  
SCALE 1:10



SECTION B-B  
SCALE 1:10

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	PROJ.	WELD
N1	219	300#	RFWN	XH	INLET PROCESS GAS	SPEC	SPEC	7/14	
N2	219	300#	RFWN	XH	OUTLET PROCESS GAS	0	200	8/14	
A	C1	60	6000#	TOL	INSPECTION/VENT c/w PLUG	-	-	-	6
B	C1	60	6000#	TOL	INSPECTION c/w PLUG	-	-	-	6

BILL OF MATERIAL		
ITEM	QUA	DESCRIPTION
1	1	SHELL PLATE: 15.88 THK. x 1778 LG. (ROLLED TO 610 O/D)
2	2	HEAD PLATE: 15.88 NOM. (13.72 MIN.) THK. x 610 O/D, 2:1 S.E. c/w 51 SF.
3	3	FLANGE: 219-300# RFWN SCH XH BORE
4	2	PIPE: 219 O/D x 12.7 WT. x 152 LG (CTS)
5	1	PIPE: 219 O/D x 12.7 WT. x 210 LG
6	1	PIPE: 168 O/D x 7.11 WT. x 1168 LG
7	1	REPAD PLATE: 12.7 THK. x 321 O/D x 222 I/D (DISHED TO SUIT 610 O/D, 2:1 S.E. HEAD)
8	2	REPAD PLATE: 9.53 THK. x 330 O/D x 222 I/D (ROLLED TO 610 I/D)
9	2	TOL: 60-6000# NPT c/w PLUG (1)-ON A 610 O/D RUN, (1)-FLAT
10	1	NAMEPLATE c/w MOUNTING BRACKET
11	1	CONCENTRIC REDUCER: 219 XH x 168 SCH 40 BW (SMLS)
12	2	F/BAR: 10 THK x 76 x 202 LG

CAPACITY: 0.54 m<sup>3</sup>  
 WEIGHT EMPTY: 797 kg  
 WEIGHT FULL OF WATER: 1337 kg  
 SURFACE PREPARATION: PNT-11  
 PRIMER: PNT-11  
 FINISH PAINT: PNT-11  
 INSULATION: NONE  
 MECHANICAL LOADINGS GOVERN AS PER UG22: YES/NO  
 IMPACT TEST: YES/NO PER UG22 FOLLOWING

SERIAL NO: 99404-105 CRN:  
 TAG NO: V-121 YEAR BUILT: 2000  
 LSD #: -  
 CODE: ASME SECT. VIII DIV I, '98, ADDENDA '99  
 MAX. DESIGN PRESS: 4516 kPag @ TEMP: 149°C  
 HYDROTEST: 5871 kPag  
 MIN\* DESIGN METAL TEMP: -28°C @ MAWP 4516 kPag  
 MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N

PRODUCTION IMPACT TEST REQ'D: YES/NO  
 SHIP LOOSE: YES/NO  
 SERVICE: SOUR GAS  
 LONG & CIRC. WELDS TYPE 1  
 QWP: 590.2  
 QCP: AQP-1050 (S) AQP-1227 (S)  
 TACK WELDS WPS# 101  
 PRESS. TO STRUCT. WELD WPS# 102, 106, 110

RADIOGRAPHY:  
 LONG: (FULL UNITS) (INCLUDING ALL BUTT WELDS)  
 CIRC: (FULL UNITS) (INCLUDING ALL BUTT WELDS)  
 P.W.H.T.: YES/NO MIN. TEMP: 593°C, TIME: (1) hr (MIN)  
 CORR. ALLOW: 3.20 mm

"SOUR SERVICE"

DOUBLE BUTT	SINGLE VEE	THREDOLET	NOZZLE & REPAD RECESSED	NOZZLE & REPAD FLUSH	PIPE TO FLANGE/FITTING
WPS# 102, 106, 110	2. WPS# 104, 106, 110	6. WPS# 102, 106, 110	7. WPS# 102, 106, 108, 110	8. WPS# 102, 106, 108, 110	14. WPS# 104, 106, 110

GENERAL NOTES  
 1) DO NOT PROFILE INTERNAL PROJECTION UNLESS SPECIFIED.  
 2) SANDBLAST INTERNALS TO ENSURE THAT THE INSIDE SURFACE OF THE VESSEL IS FREE OF LOOSE MILL SCALE AND WELD SPLATTER.  
 3) VESSEL TO BE FLUSHED OUT AT HYDROTEST, AIR DRIED AND OILED INTERNALLY.  
 4) VESSEL OPENINGS TO BE SEALED PRIOR TO ANY SHIPPING TO OTHER SHOPS.

GENERAL NOTES  
 2 NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION  
 1 ISSUED FOR CONSTRUCTION

No.	REVISION	BY	DATE	CHK	ENG
2	NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION	D SMITH	00/05/01	N.I.	S.W.
1	ISSUED FOR CONSTRUCTION	L. B.	00/01/26	M.J.	P.C.

APPROVED		DRAWN	
MECH./STRUCT.	BY	D. SMITH	DATE
ELECTRICAL	BY	M. IWANIUK	DATE
DATE	00/05/01	DATE	00/05/01
PROJECT	S. WARD	DATE	00/05/01
DATE	00/05/01	SCALE	AS NOTED

PROPAC SYSTEMS LTD.  
 STOCK 1478HP COMPRESSOR  
 STAGE-1 SUCTION BOTTLE  
 610mm O/D x 1778 mm S/S  
 DWG. No.: D-BTL-99404-105  
 REV. 2

PROPAC  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

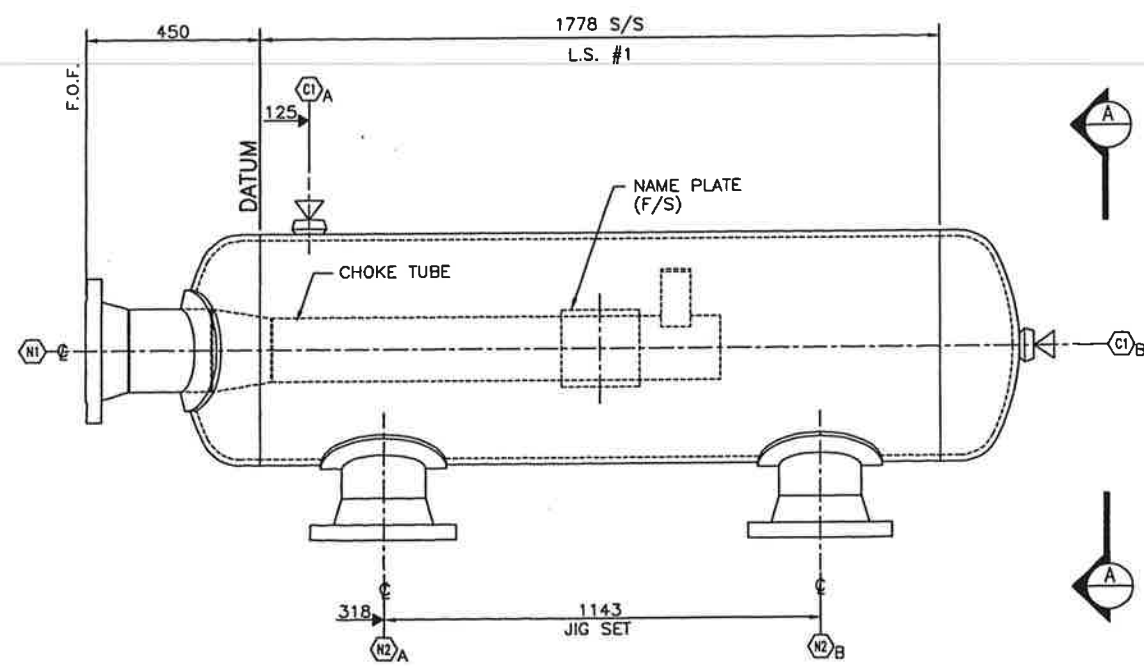
OF PROPAC

TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT

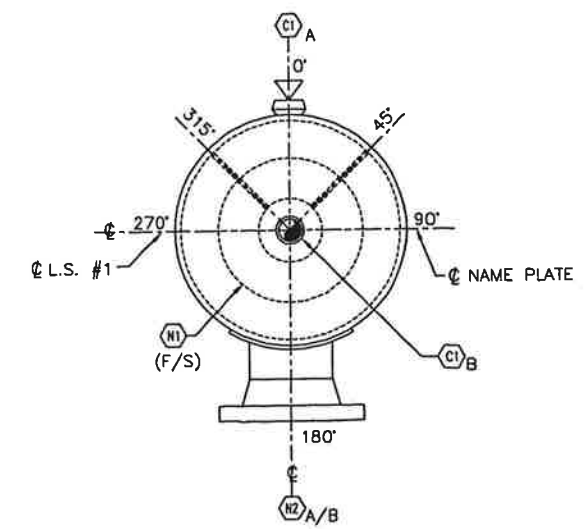
THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAC SYSTEMS LTD., AND SHALL NOT BE DISCLOSED

THIS DRAWING AND

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	WELD	
N1	219	300	RFWN	XH	INLET PROCESS GAS	SPEC.	SPEC.	-	
N2	219	300	RFWN	XH	OUTLET PROCESS GAS	0	200	-	
A	C1	60	6000	TOL	INSPECTION/VENT c/w PLUG	-	-	-	
B	C1	60	6000	TOL	INSPECTION c/w PLUG	-	-	-	



**ELEVATION**  
SCALE: 1:10

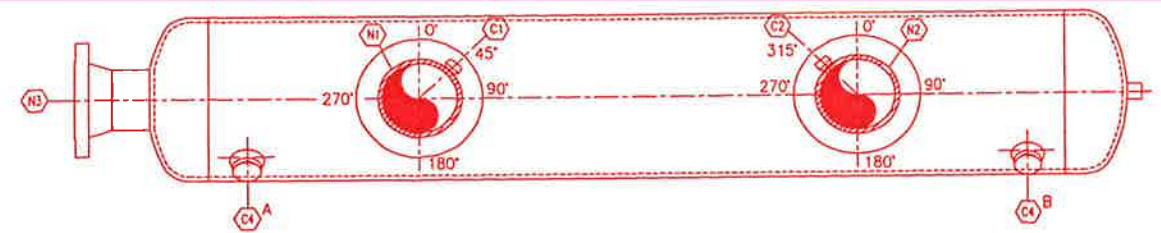


**ORIENTATION**  
**(VIEW 'A-A')**  
SCALE: 1:10

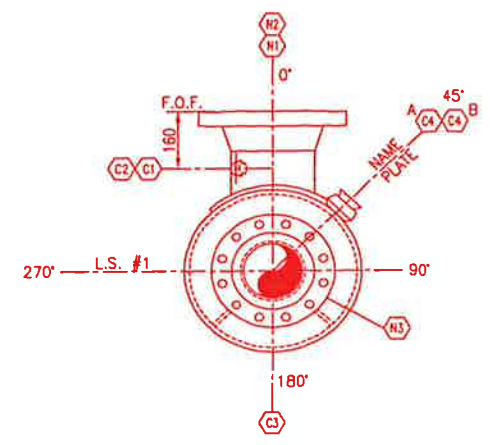
<p>CAPACITY: 0.54 m<sup>3</sup></p> <p>WEIGHT EMPTY: 797 kg</p> <p>WEIGHT FULL OF WATER: 1337 kg</p> <p>SURFACE PREPARATION: ] PNT-11</p> <p>PRIMER: ]</p> <p>FINISH PAINT: ]</p> <p>INSULATION: NONE</p> <p>MECHANICAL LOADINGS GOVERN AS PER UG22: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>IMPACT TEST: <input checked="" type="checkbox"/> YES PER UG81 AS FOLLOWS:</p> <p><input type="checkbox"/> NO PER UG20(f);</p> <p><del>UGS 66(a) AND FIG. UGS 66</del></p> <p><del>UGS 66(a) AND FIG. UGS 66</del></p> <p><del>UGS 66(a) AND FIG. UGS 66</del></p> <p>PRODUCTION IMPACT TEST REQ'D: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>SHIP LOOSE: <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>SERVICE: SOUR GAS</p>	<p>SERIAL NO: 99404-105 CRN:</p> <p>TAG NO: V-121 YEAR BUILT: 2000</p> <p>LSD #: -</p> <p>CODE: ASME SECT. VIII DIV I, '98, ADDENDA '99</p> <p>MAX. DESIGN PRESS: 4516 kPag @ TEMP: 149°C</p> <p>HYDROTEST: 5871 kPag</p> <p>MIN<sup>M</sup> DESIGN METAL TEMP: -28 °C @ MAWP 4516 kPag</p> <p>MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N</p> <p>RADIOGRAPHY:</p> <p>LONGL: <input checked="" type="checkbox"/> FULL UW11(a); <input checked="" type="checkbox"/> SPOT UW11(b); <input checked="" type="checkbox"/> NIL UW11(c)</p> <p>(INCLUDING ALL BUTT WELDS)</p> <p>CIRC: <input checked="" type="checkbox"/> FULL UW11(a); <input checked="" type="checkbox"/> SPOT UW11(b); <input checked="" type="checkbox"/> UW11(c); <input checked="" type="checkbox"/> E(b); <input checked="" type="checkbox"/> J2(d); <input checked="" type="checkbox"/> NIL UW11(e)</p> <p>(INCLUDING ALL BUTT WELDS)</p> <p>P.W.H.T.:</p> <p><input checked="" type="checkbox"/> YES <input type="checkbox"/> NO MIN. TEMP: 593 °C, TIME: (1) hr (MIN)</p> <p>CORR. ALLOW: 3.20 mm</p> <p style="text-align: center;"><b>"SOUR SERVICE"</b></p>
--	---

<p><b>GENERAL NOTES</b></p> <p>DATE: 2000.09.25 4:28pm FILE NAME: J:\jobs99\DWG\99404\Comp\Misc\BTL-99404-105-SKT-01.dwg</p>		<p><b>GENERAL NOTES</b></p> <p>SKT ISSUED FOR DOCUMENTATION</p>		<p><b>REVISION</b></p> <p>No. BY DATE CKD ENG</p>		<p><b>APPROVED</b></p> <p>MECH/STRUCT. BY DATE</p> <p>ELECTRICAL BY DATE</p> <p>PROJECT BY DATE</p> <p>DATE SCALE AS NOTED</p>		<p><b>DRAWN</b></p> <p>CHECKED</p>		<p><b>APACHE CANADA LIMITED</b></p> <p>1478 HP HAMBURG COMPRESSOR PACKAGE</p> <p>STAGE-1 SUCTION BOTTLE (V-121)</p> <p>610 O/D x 1778 S/S</p> <p>DWG. No.: D-BTL-99404-105-SKT SHT. 1 OF 1 REV. SKT</p>		<p><b>PROPAK</b></p> <p>440 East Lake Road,</p> <p>Postal Bag #2</p> <p>Airdrie, Alberta</p> <p>Canada T4B 2C3</p>	
--	--	---	--	---	--	--	--	------------------------------------	--	---	--	--	--

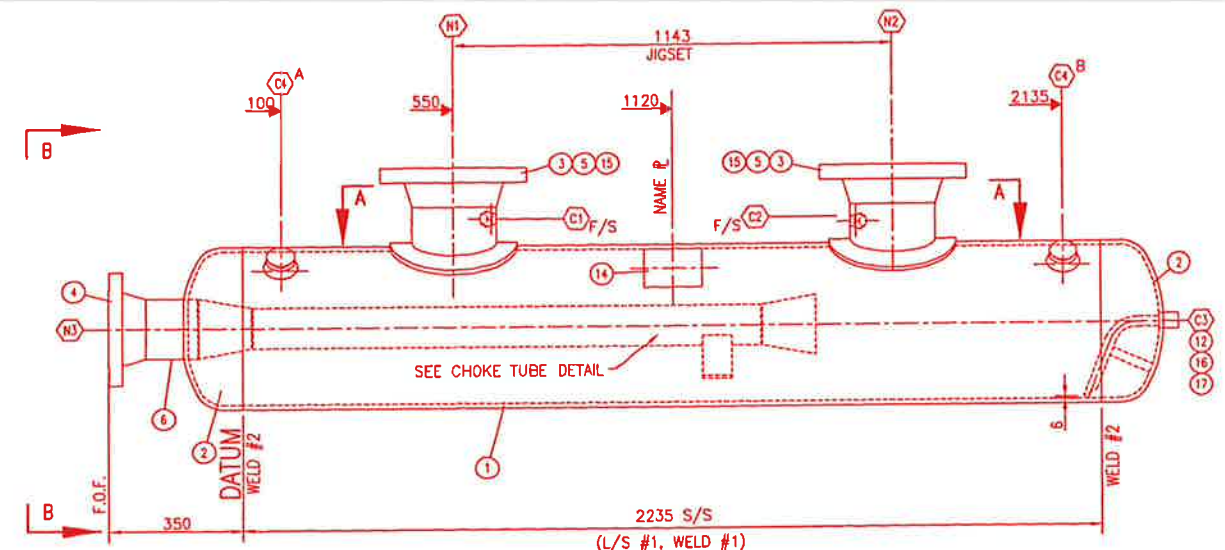
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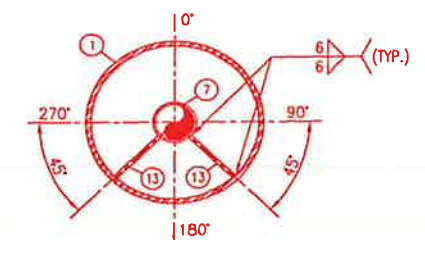
**PLAN VIEW A-A**  
SCALE 1:10



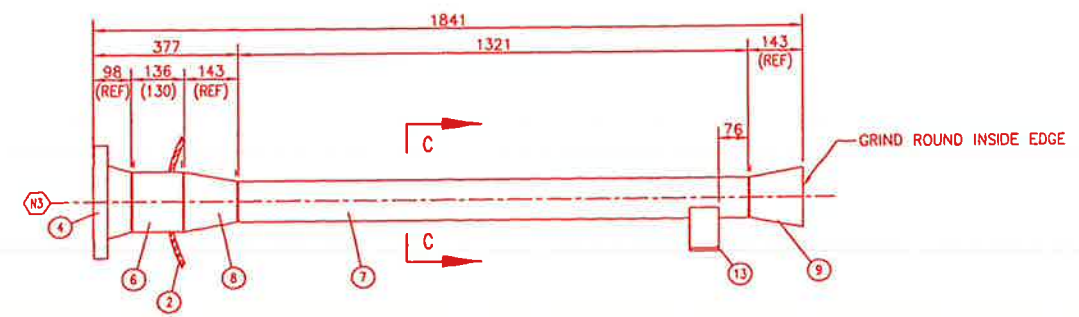
**ORIENTATION B-B**  
SCALE 1:10



**ELEVATION VIEW**  
SCALE 1:10



**VIEW C-C**  
SCALE 1:10



**CHOKE TUBE DETAIL**  
SCALE 1:10

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	WELD	
N1	219	300#	RFWN	XH	INLET CYL #1	MIN	220	8, 14	
N2	219	300#	RFWN	XH	INLET CYL #2	MIN	220	8, 14	
N3	168	300#	RFWN	XXH	PROCESS GAS OUTLET	SPEC.	SPEC.	10, 14	
C1	27	6000#	TOL	-	THERMOWELL	-	-	6	
C2	27	6000#	TOL	-	THERMOWELL	-	-	6	
C3	27	6000#	CPLG	XXH	SYPHON DRAIN	-	-	4	
C4	48	6000#	TOL	-	INSPECTION (PLUGGED)	-	-	6	

BILL OF MATERIAL			
ITEM	QUA	DESCRIPTION	SA
1	1	SHELL PLATE: 12.7 THK. x 2235 LG. (ROLL TO 457 O/D)	SA-516-70N
2	2	HEAD PLATE: 457 O/D x 12.70 NOM. (10.62 MIN.) 2:1 S.E. c/w 51 S.F.	SA-516-70N
3	2	FLANGE: 219-300# RFWN XH BORE	SA-105N
4	1	FLANGE: 168-300# RFWN XXH BORE	SA-105N
5	2	PIPE: 219 O/D x 12.70 WT x 177 LG. (SMLS)	SA-106-B
6	1	PIPE: 168 O/D x 21.92 WT x 130 LG. (SMLS)	SA-106-B
7	1	PIPE: 114 O/D x 6.02 WT x 1321 LG. (SMLS)	SA-106-B
8	1	CONC. RED: 168 O/D XXH x 114 O/D SCH 40 BW (SMLS)	SA-234-WPB
9	1	CONC. RED: 168 O/D x 114 O/D SCH 40 SMLS	SA-234-WPB
10	2	TOL: 48-6000# c/w PLUG (ON 457 O/D RUN)	SA-105N
11	2	TOL: 27-6000# (ON 219 O/D RUN)	SA-105N
12	1	CPLG: 27 - 6000# SW x NPT	SA-105N
13	2	FLAT BAR: 10 THK. x 76 x 156 LG.	G40.21M-300W
14	1	NAMEPLATE c/w MOUNTING BRACKET	SS/SA-36
15	2	REPAD: 9.53 THK x 330 O/D x 222 I/D (ROLLED TO 457 I/D)	SA-516-70N
16	1	PIPE: 27 O/D x 7.82 WT x 400 LG. (SMLS) (C.T.S. & B.I.S.)	SA-106-B
17	1	F/BAR: 10 THK x 25 x 111 LG	G40.21M-300W

NOTE: THE FOLLOWING SUBSTITUTIONS ARE PERMITTED (THE OPPOSITE NOT ALLOWED)  
SA-350-LF2 for SA-105, SA-333-Gr6 for SA-106-B, SA-420-WPL6 for SA-234-WPB

CAPACITY: 0.364 m<sup>3</sup>

WEIGHT EMPTY: 586 kg  
WEIGHT FULL OF WATER: 950 kg

SURFACE PREPARATION: PNT-12

PRIMER: ASME SECT. VIII DIV I, '98, ADDENDA '99

FINISH PAINT: TEMA CLASS N/A, ADDENDA N/A

INSULATION: NONE

MECHANICAL LOADINGS GOVERNS AS PER UG 22:  PNT

HYDROTEST: VESSEL 5871 kPag  
COIL N/A kPag  
MIN<sup>m</sup> DESIGN METAL TEMP: -28 °C @ MAWP 4447 kPag

MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N

RADIOGRAPHY: LONG L FULL UMI(a)  
CIRC: FULL UMI(a) (INCL. ALL BUTT WELDS)

PRODUCTION IMPACT TEST REQ'D:

SHIP LOOSE:

SERVICE: SOUR GAS

LONG & CIRC. WELDS TYPE 1

QWP: 590.2

QCP: AQP-1050(S) AQP-1227(S)

TACK WELDS: WPS# 101

PRESS: TO STRUCT: WPS# 102 106 110

IMPACT TEST:  PER UG20(f)

SERIAL NO: 99404 '106' CRN:  
TAG NO: V-122 YEAR BUILT: 2000  
LSD #: -  
CODE: N/A kPag

P.W.H.T.:  MIN. TEMP: 593 °C, TIME: 1.0 h (MIN.)  
CORR. ALLOW: 3.2 mm

**SOUR SERVICE**

DOUBLE BUTT	SINGLE VEE	COUPLING	THREDOLET	NOZZLE & REPAD FLUSH	NOZZLE RECESSED	PIPE TO FLANGE/FITTING
WPS# 102,106,110	2. WPS# 104, 106, 110	4. WPS# 102,106,110	6. WPS# 102,108,110	8. WPS# 102,106,108,110	10. WPS# 102,106,108,110	14. WPS# 104,106,110

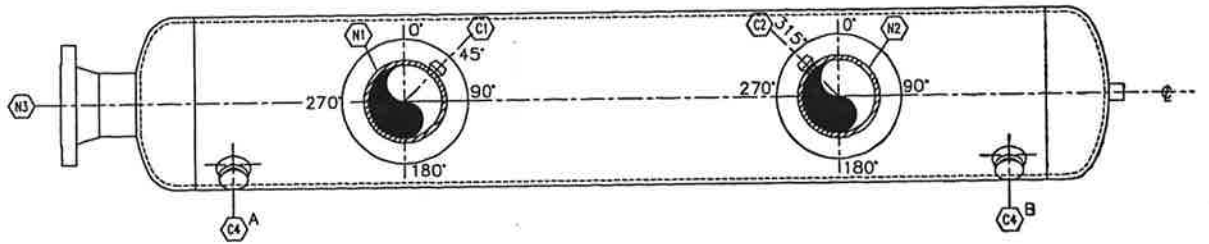
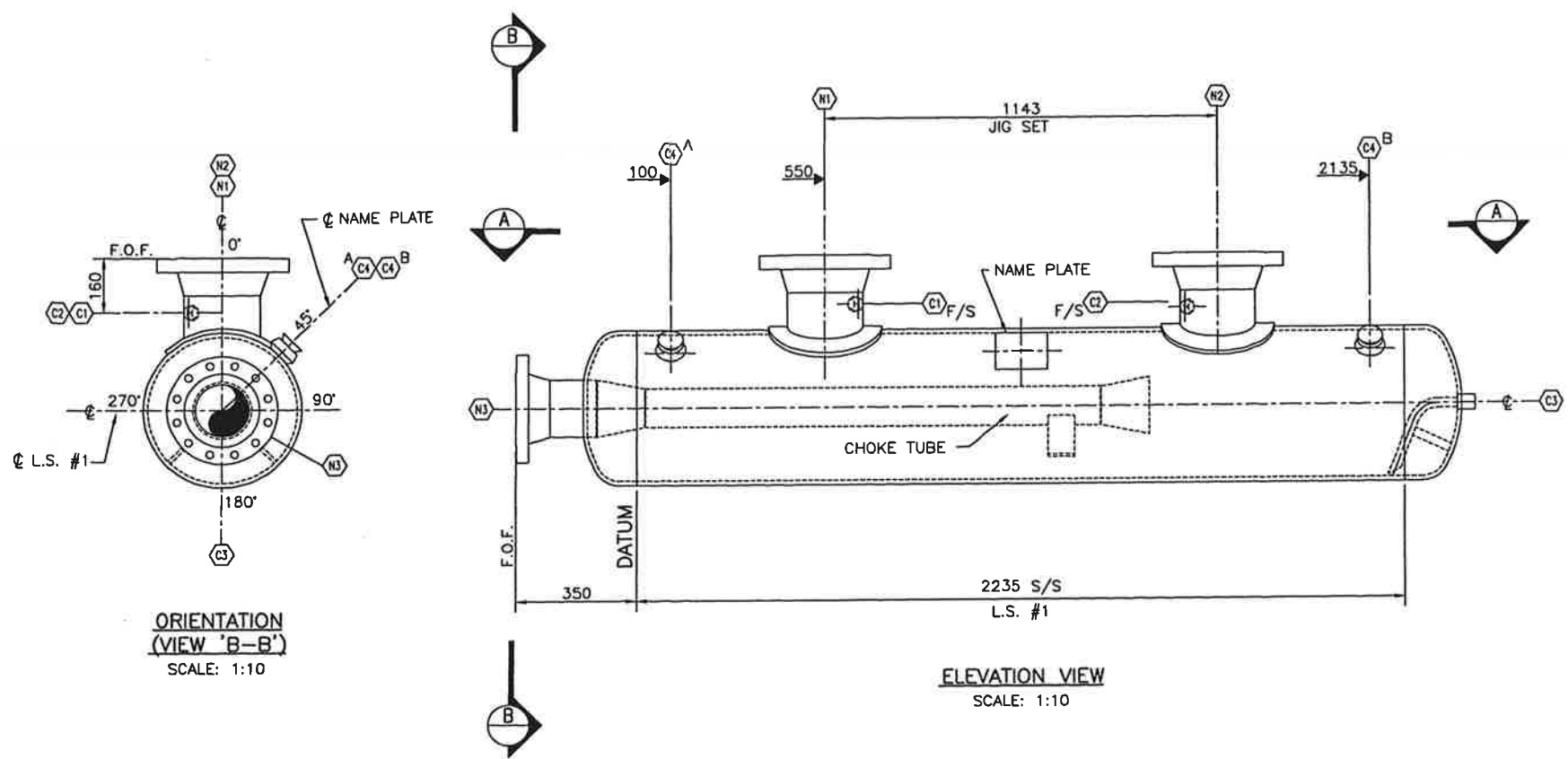
GENERAL NOTES		GENERAL NOTES	
1) DO NOT PROFILE INTERNAL PROJECTION UNLESS SPECIFIED.		2) SANDBLAST INTERNALS TO ENSURE THAT THE INSIDE SURFACE OF THE VESSEL IS FREE OF LOOSE MILL SCALE AND WELD SPLATTER.	
3) VESSEL TO BE FLUSHED OUT AT HYDROTEST, AIR DRIED AND OILED INTERNALLY.		4) VESSEL OPENINGS TO BE SEALED PRIOR TO ANY SHIPPING TO OTHER SHOPS.	
DATE: 2000.04.28 11:27am	FILE NAME: J:\Jobs99\DWG\99404\Comp\VSL\BTL-99404-106-01.dwg	No.	REVISION

APPROVED		DRAWN	
MECH./STRUCT.	BY D. SMITH	DATE	00/04/07
ELECTRICAL	CHECKED	DATE	
PROJECT	BY M. IWANIUK	DATE	00/04/28
DATE	00/04/28	SCALE	AS NOTED

PROPAC SYSTEMS LTD.	
STOCK 1478 HP COMPRESSOR	440 East Lake Road, Postal Bag #2
1st STAGE DISCHARGE BOTTLE	Airdrie, Alberta
457 O/D x 2235 S/S	Canada T4B 2C3
DWG. No.: D-BTL-99404-106	REV. 2

THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAK SYSTEMS LTD., AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT OF PROPAK.

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	WELD	
N1	219	300#	RFWN	XH	INLET CYL. #1	MIN	220	-	
N2	219	300#	RFWN	XH	INLET CYL. #2	MIN	220	-	
N3	168	300#	RFWN	XXH	PROCESS GAS OUTLET	SPEC.	SPEC.	-	
C1	27	6000#	TOL	-	THERMOWELL	-	-	-	
C2	27	6000#	TOL	-	THERMOWELL	-	-	-	
C3	27	6000#	CPLG	XXH	SYPHON DRAIN	-	-	-	
A/B C4	48	6000#	TOL	-	INSPECTION (PLUGGED)	-	-	-	



**ORIENTATION**  
(VIEW 'B-B')  
SCALE: 1:10

**ELEVATION VIEW**  
SCALE: 1:10

**PLAN**  
(VIEW 'A-A')  
SCALE: 1:10

CAPACITY: 0.364 m <sup>3</sup>	SERIAL NO: 99404 '106' CRN:
WEIGHT EMPTY: 586 kg	TAG NO: V-122 YEAR BUILT: 2000
WEIGHT FULL OF WATER: 950 kg	LSO #: -
SURFACE PREPARATION:	CODE:
PRIMER:	ASME SECT. VIII DIV I, '98, ADDENDA '99
FINISH PAINT: PNT-12	TEMA CLASS: N/A, ADDENDA N/A
INSULATION: NONE	MAX: DESIGN PRESS: 4447 kPag @ TEMP: 176 °C
MECHANICAL LOADINGS GOVERNS AS PER UG 22: <input checked="" type="checkbox"/> NO	MIN: DESIGN PRESS: N/A kPag
IMPACT TEST: <input checked="" type="checkbox"/> NO - PER UG20(f)	HYDROTEST:
PRODUCTION IMPACT TEST REQ'D: <input checked="" type="checkbox"/> NO	VESSEL 5781 kPag
SHIP LOOSE: <input checked="" type="checkbox"/> NO	COIL: N/A kPag
SERVICE: SOUR GAS	MIN <sup>M</sup> DESIGN METAL TEMP: -28 °C @ MAWP 4447 kPag
	MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N
	RADIOGRAPHY:
	LONG: FULL UWII(a)
	CIRC: FULL UWII(a) (INCL. ALL BUTT WELDS)
	P.W.H.T.:
	<input checked="" type="checkbox"/> MIN. TEMP: 593 °C, TIME: 1.0 h (MIN.)
	CORR. ALLOW: 3.2 mm

"SOUR SERVICE"

**PROPAK**  
440 East Lake Road,  
Postal Bag #2  
Airdrie, Alberta  
Canada T4B 2C3

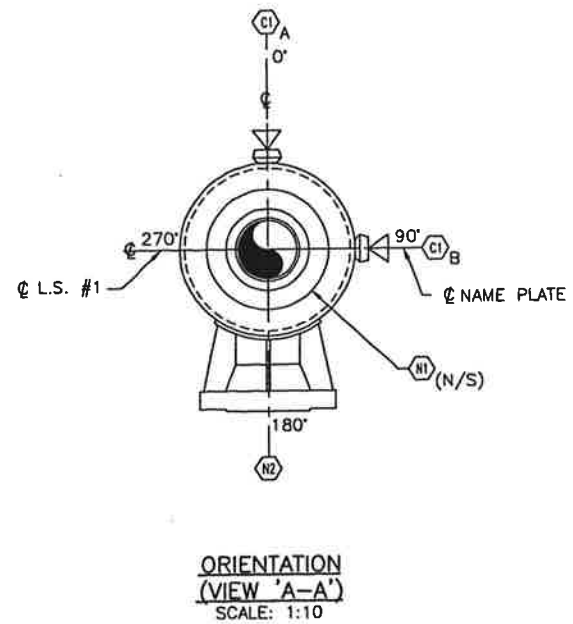
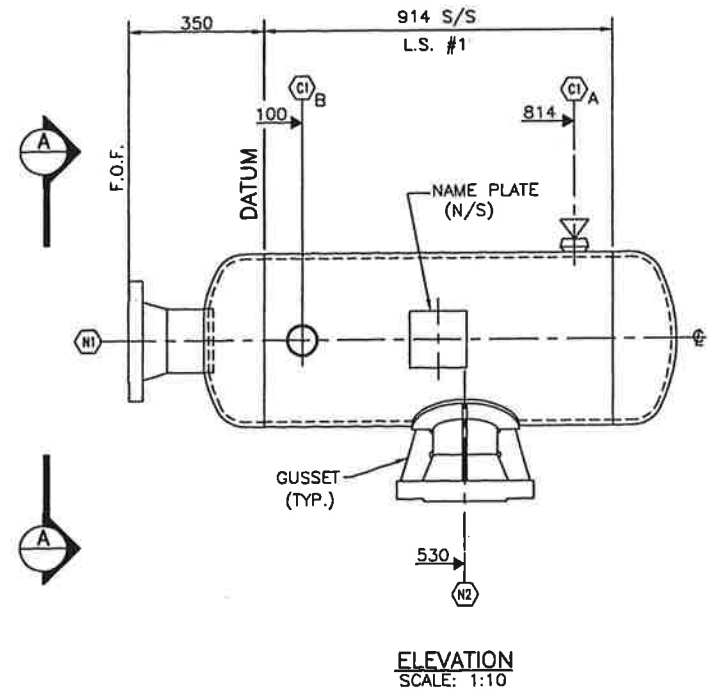
APPROVED		DRAWN		APACHE CANADA LIMITED	
MECH/STRUCT.	BY	BY	BY	1478 HP HAMBURG COMPRESSOR PACKAGE	
				1st STAGE DISCHARGE BOTTLE (V-122)	
				457 O/D x 2235 S/S	
				DWG. No.: D-BTL-99404-106-SKT	SHT. 1 OF 1
					REV. SKT

DATE	BY	DATE	CKD	ENG
00/09/15 <td>VK <td> </td> <td> </td> <td> </td> </td>	VK <td> </td> <td> </td> <td> </td>			

GENERAL NOTES: SKT ISSUED FOR DOCUMENTATION  
 DATE: 2000.09.25 4:10pm FILE NAME: J:\jobs99\DWG\99404\Comp\Misc\BTL-99404-106-SKT-01.dwg

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NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	WELD	
N1	168	300	RFWN	XXH	INLET PROCESS GAS	13	SPEC.	-	
N2	168	600	RFWN	XH	OUTLET PROCESS GAS	0	200	-	
A	C1	48	6000	TOL	-	INSPECTION/VENT c/w PLUG	-	-	-
B	C1	48	6000	TOL	-	INSPECTION c/w PLUG	-	-	-



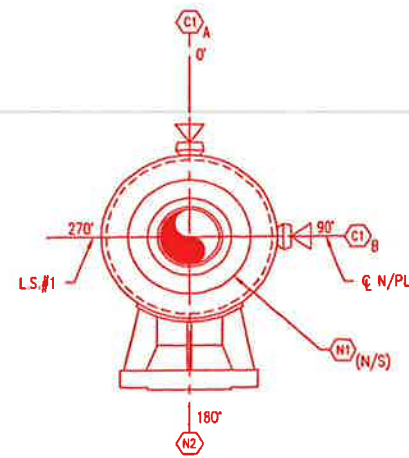
CAPACITY: 0.17 m<sup>3</sup>  
 WEIGHT EMPTY: 301 kg  
 WEIGHT FULL OF WATER: 471 kg  
 SURFACE PREPARATION: }  
 PRIMER: } PNT-11  
 FINISH PAINT: }  
 INSULATION: NONE  
 MECHANICAL LOADINGS GOVERN AS PER UG22:  YES  NO  
 IMPACT TEST: ~~YES PER UG81 AS FOLLOWS~~  
 NO - PER UG20(f);  
~~UG 58(a) AND PG. UG 58;~~  
~~UG 58(b), UG 58(c)~~  
 PRODUCTION IMPACT TEST REQ'D:  YES  NO  
 SHIP LOOSE:  YES  NO  
 SERVICE: SOUR GAS

SERIAL NO: 99404-107 CRN:  
 TAG NO: V-123 YEAR BUILT: 2000  
 LSD #: -  
 CODE:  
 ASME SECT. VIII DIV I, '98, ADDENDA '99  
 MAX. DESIGN PRESS: 4516 kPag @ TEMP: 149°C  
 HYDROTEST: 5871 kPag  
 MIN<sup>M</sup> DESIGN METAL TEMP: -28°C @ MAWP 4516 kPag  
 MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N  
 RADIOGRAPHY:  
 LONG L. ~~FULL UW11(0); SPOT UW11(b); NIL UW11(c)~~  
 (INCLUDING ALL BUTT WELDS)  
 CIRC: ~~FULL UW11(0); SPOT UW11(b); UW11(c), 5(b), 12(d); NIL UW11(e)~~  
 (INCLUDING ALL BUTT WELDS)  
 P.W.H.T.:  
 YES  NO MIN. TEMP: 593°C, TIME: (1) hr (MIN)  
 CORR. ALLOW: 3.20mm  
**"SOUR SERVICE"**

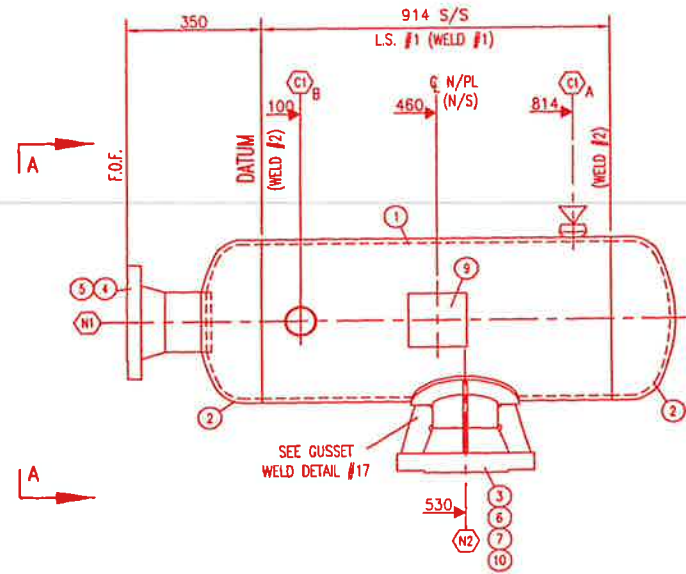
GENERAL NOTES		GENERAL NOTES		APPROVED		DRAWN		APACHE CANADA LIMITED	
DATE: 2000.09.25 4:11pm	FILE NAME: J:\jobs99\DWG\99404\Comp\Misc\BTL-99404-107-SKT-01.dwg	SKT	ISSUED FOR DOCUMENTATION	D. DOR	00/09/15	VK	SW	1478 HP HAMBURG COMPRESSOR PACKAGE	
		No.	REVISION	BY	DATE	CKD	ENG	STAGE-2 SUCTION BOTTLE (V-123)	
								457 0/D x 914 S/S	
								DWG. No.: D-BTL-99404-107-SKT SHT. 1 OF 1 REV. SKT	

**PROPAK**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

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**ORIENTATION**  
**VIEW 'A-A'**  
SCALE 1:10



**ELEVATION**  
SCALE 1:10

NOZZLE SCHEDULE								
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ	EXT. PROJ	WELD
N1	168	300#	RFWN	XXH	INLET PROCESS GAS	13	SPEC.	16/14
N2	168	600#	RFWN	XH	OUTLET PROCESS GAS	0	200	8/14
C1	48	6000#	TOL	-	INSPECTION/VENT c/w PLUG	-	-	6
C1	48	6000#	TOL	-	INSPECTION c/w PLUG	-	-	6

BILL OF MATERIAL			
ITEM	QUA	DESCRIPTION	
1	1	SHELL PLATE: 12.70 THK. x 914 LG. (ROLLED TO 457 O/D)	SA-516-70N
2	2	HEAD PLATE: 457 O/D x 12.70 NOM. (10.62 MIN.) THK. 2:1 S.E. c/w 51 S.F.	SA-516-70N
3	1	FLANGE: 168-600# RFWN XXH BORE	SA-105N
4	1	FLANGE: 168-300# RFWN XXH BORE	SA-105N
5	1	PIPE: 168 O/D x 21.95 WT. x 125 LG	SA-106-B
6	1	PIPE: 168 O/D x 10.97 WT. x 131 LG (CTS)	SA-106-B
7	1	REPAD PLATE: 9.53 THK. x 279 O/D x 171 I/D (ROLLED TO 457 I/D)	SA-516-70N
8	2	TOL: 48-6000# NPT c/w PLUG (ON 457 O/D RUN)	SA-105N
9	1	NAMEPLATE c/w MOUNTING BRACKET	SS/SA-36
10	4	PLATE: 10 THK. x 84 WD x 200 LG. (CTS)	SA-516-70N

CAPACITY: 0.17 m<sup>3</sup>  
 WEIGHT EMPTY: 301 kg  
 WEIGHT FULL OF WATER: 471 kg  
 SURFACE PREPARATION: PNT-11  
 FINISH PAINT: PNT-11  
 INSULATION: NONE  
 MECHANICAL LOADINGS GOVERN AS PER UG22:  YES  NO  
 IMPACT TEST:  YES  NO PER UG20(b) FOLLOWING

SERIAL NO: 99404-107 CRN:  
 TAG NO: V-123 YEAR BUILT: 2000  
 LSD #: -  
 CODE: ASME SECT. VIII DIV I, '98, ADDENDA '99  
 MAX. DESIGN PRESS: 4516 kPag @ TEMP: 149°C  
 HYDROTEST: 5871 kPag  
 MIN DESIGN METAL TEMP: -28°C @ MAMP 4516 kPag  
 MATERIAL: HEAD: SA-516-70N SHELL: SA-516-70N

RADIOGRAPHY:  
 LONG: [FULL UNITS] (INCLUDING ALL BUTT WELDS)  
 CIRC: [FULL UNITS] (INCLUDING ALL BUTT WELDS)

PRODUCTION IMPACT TEST REQ'D:  YES  NO  
 SHIP LOOSE:  YES  NO  
 SERVICE: SOUR GAS  
 LONG & CIRC. WELDS TYPE 1  
 QWP: 590.2  
 QCP: AQP-1050 (S) AQP-1227 (S)  
 TACK WELDS WPS# 101  
 PRESS. TO STRUCT. WELD WPS# 102, 106, 110

**"SOUR SERVICE"**

DOUBLE BUTT	SINGLE VEE	THREDOLET	NOZZLE & REPAD FLUSH	NOZZLE RECESSED	PIPE TO FLANGE/FITTING	GUSSETS
1. WPS# 102, 106, 110	2. WPS# 104, 106, 110	6. WPS# 102, 106, 110	8. WPS# 102, 106, 108, 110	10. WPS# 102, 106, 108, 110	14. WPS# 104, 106, 110	17. WPS# 102, 106, 110

GENERAL NOTES		GENERAL NOTES	
1. 2000 RPT 102-1 INTERNAL PROJECTION UNLESS SPECIFIED.		3. NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION	D. SMITH 00/04/28 M.L. S.W.
2. BY SHIPLOAST INFORMATION TO ENSURE THAT THE INSIDE SURFACE OF THE VESSEL IS FREE OF LOOSE MILL SCALE AND WELD SPATTER.		2. MOVED LOCATION OF N1 (WAS 726 FROM DATUM)	S. FAWCETT 00/01/27 M.A. P.C.
3. VESSEL TO BE CLEANED OUT AT HYDROTEST, AIR DRIED AND OILED INTERNALLY.		1. ISSUED FOR CONSTRUCTION	L. ES. 00/01/26 M.L. P.C.
4. ALL OPENINGS TO BE SEALED PRIOR TO ANY SHIPPING TO OTHER SHOPS.			

NO.	REVISION	BY	DATE	CKD	ENG
3	NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION	D. SMITH	00/04/28	M.L.	S.W.
2	MOVED LOCATION OF N1 (WAS 726 FROM DATUM)	S. FAWCETT	00/01/27	M.A.	P.C.
1	ISSUED FOR CONSTRUCTION	L. ES.	00/01/26	M.L.	P.C.

APPROVED		DRAWN	
MECH./STRUCT.	BY D. SMITH	DATE	00/04/11
DATE	CHECKED	BY M. IWANIUK	DATE 00/04/28
ELECTRICAL	BY S. WARD	DATE	00/04/28
DATE	SCALE AS NOTED		

**PROPAC SYSTEMS LTD.**  
 STOCK 1478HP COMPRESSOR  
 STAGE-2 SUCTION BOTTLE  
 457mm O/D x 914 mm S/S

DWG. No.: D-BTL-99404-107  
 REV. 3

**PROPAC**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

OF PROPAC

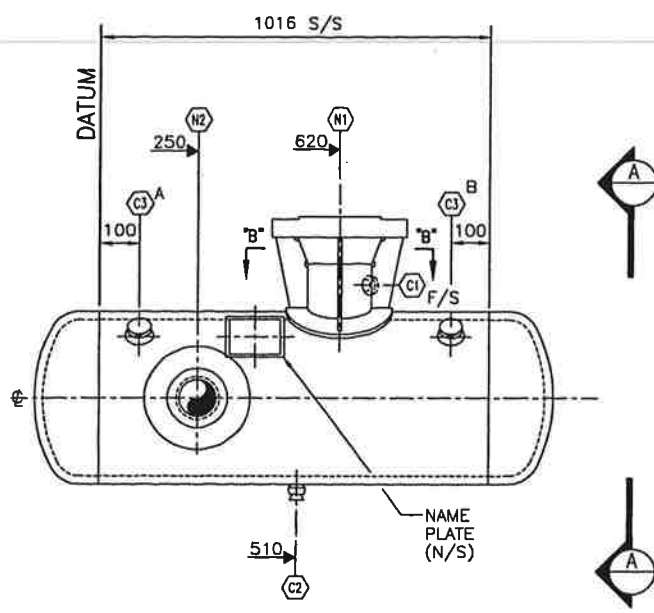
TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT

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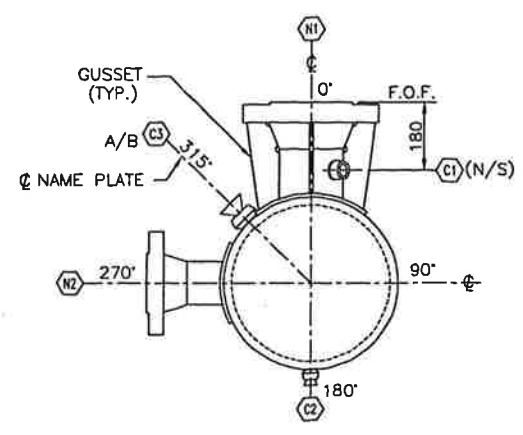
THIS DRAWING AND

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ	EXT. PROJ	WELD	
N1	168	600#	RFWN	XXH	PROCESS INLET	MIN.	250	-	
N2	114	600#	RFWN	XXH	PROCESS OUTLET	0	200	-	
C1	27	6000#	TOL	-	THERMOWELL	-	-	-	
C2	27	6000#	TOL	-	DRAIN c/w PLUG	-	-	-	
C3	48	6000#	TOL	-	INSPECTION c/w PLUG	-	-	-	

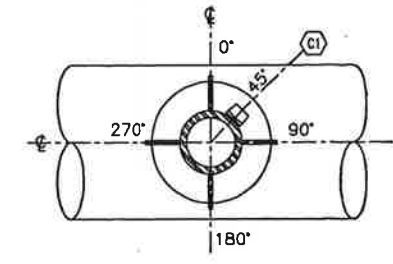
A/B



ELEVATION  
SCALE: 1:10



ORIENTATION  
(VIEW 'A-A')  
SCALE: 1:10



VIEW 'B-B'  
SCALE: 1:10

CAPACITY: 0.13 m<sup>3</sup>  
 SURFACE AREA OF TUBES: N/A m<sup>2</sup>  
 WEIGHT EMPTY: 460 kg  
 WEIGHT FULL OF WATER: 590 kg  
 SURFACE PREPARATION: PNT-12  
 PRIMER: PNT-12  
 FINISH PAINT: PNT-12  
 INSULATION: NONE  
 MECHANICAL LOADINGS GOVERNS AS PER UG 22: (NO)  
 IMPACT TEST: NO - PER UG20(f)  
 PRODUCTION IMPACT TEST REQ'D: (NO)  
 SHIP LOOSE: (NO)  
 SERVICE: SOUR GAS

SERIAL NO: 99404 '108' CRN:  
 TAG NO: V-124 YEAR BUILT: 2000  
 LSD #: -  
 CODE:  
 ASME SECT. VIII DIV I, '98, ADDENDA '99  
 TEMA CLASS, N/A, ADDENDA N/A  
 DESIGN PRESS: 8908 kPag @ TEMP: 176°C  
 HYDROTEST:  
 VESSEL 11580 kPag  
 COIL N/A kPa  
 MIN<sup>M</sup> DESIGN METAL TEMP: -28°C @ MAWP 8908 kPag  
 MATERIAL: HEAD: SA-516-70N SHELL: SA-106B  
 RADIOGRAPHY:  
 [LONG L FULL UWII(a)]  
 [CIRC: FULL UWII(a) (INCL. ALL BUTT WELDS)]  
 P.W.H.T.:  
 YES/ MIN. TEMP: 593°C, TIME: 1 hr min.  
 CORR. ALLOW: 3.2mm  
 'SOUR SERVICE'

APPROVED		DRAWN		APACHE CANADA LIMITED	
MECH./STRUCT.	DATE	BY	DATE	1478 HP HAMBURG COMPRESSOR PACKAGE	
				2ND STAGE DISCHARGE BOTTLE (V-124)	
				406 O/D x 1016 S/S	
				DWG. No.:	D-BTL-99404-108-SKT
				SHT.	1 OF 1
				REV.	SKT

**PROPAC**  
 440 East Lake Road,  
 Postal Bag #2  
 Airdrie, Alberta  
 Canada T4B 2C3

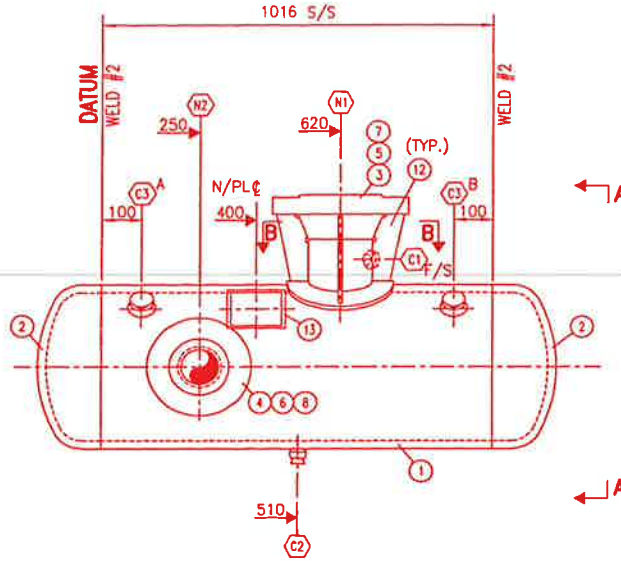
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GENERAL NOTES  
 SKT ISSUED FOR DOCUMENTATION  
 D. DOR 00/09/19 WK SW  
 BY DATE CKD ENG

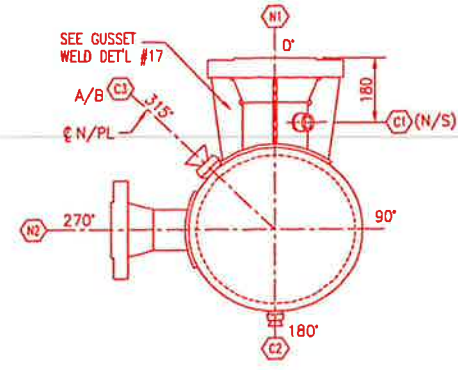
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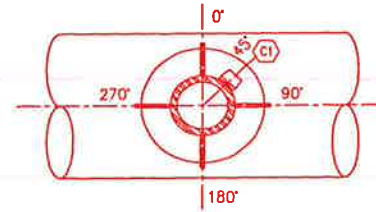
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**ELEVATION**  
SCALE: 1:10



**ORIENTATION**  
**VIEW A-A**  
SCALE: 1:10



**VIEW B-B**  
SCALE: 1:10

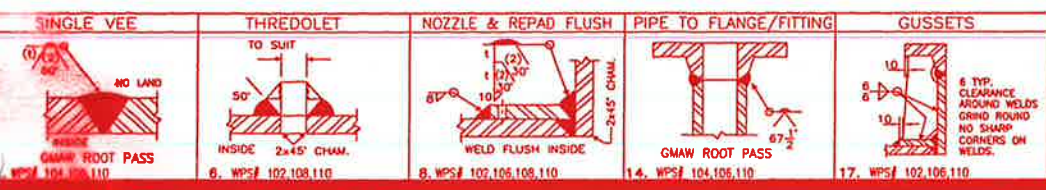
NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ	EXT. PROJ	WELD	
N1	168	600#	RFWN	XXH	PROCESS INLET	MIN.	250	8/14	
N2	114	600#	RFWN	XXH	PROCESS OUTLET	0	200	8/14	
C1	27	6000#	TOL	-	THERMOWELL	-	-	6	
C2	27	6000#	TOL	-	DRAIN c/w PLUG	-	-	6	
C3	48	6000#	TOL	-	INSPECTION c/w PLUG	-	-	6	

BILL OF MATERIAL		
ITEM	QUA	DESCRIPTION
1	1	SHELL PIPE: 406 O/D x 21.44 WT x 1016 LG. SA-106-B
2	2	HEAD PLATE: 406 O/D x 22.23 THK. NOM. (20.07 MIN.) 2:1 S.E. c/w 51 S.F. SA-516-70N
3	1	FLANGE: 168-600# RFWN XXH BORE SA-105N
4	1	FLANGE: 114-600# RFWN XXH BORE SA-105N
5	1	REPAD: 9.53 x 280 O/D x 171 I/D (ROLL TO 406 I/D) SA-516-70N
6	1	REPAD: 9.53 x 216 O/D x 117 I/D (ROLL TO 406 I/D) SA-516-70N
7	1	PIPE: 168 O/D x 21.95 W.T. x 190 LG. SMLS SA-106-B
8	1	PIPE: 114 O/D x 17.12 W.T. x 147 LG. SMLS SA-106-B
9	1	TOL: 27-6000# (ON A 168 O/D RUN) SA-105N
10	1	TOL: 27-6000# (ON A 406 O/D RUN) c/w PLUG SA-105N
11	2	TOL: 48-6000# (ON A 406 O/D RUN) c/w PLUG SA-105N
12	4	PLATE: 10 THK. x 84 WD. x 250 LG. (CTS) SA-36
13	1	NAMEPLATE c/w MOUNTING BRACKET SS/SA-36
14		

NOTE: THE FOLLOWING SUBSTITUTIONS ARE PERMITTED (THE OPPOSITE NOT ALLOWED)  
SA-350-LF2 for SA-105, SA-333-Gr6 for SA-106-B, SA-420-WPL6 for SA-234-WPB

CAPACITY: 0.13 m<sup>3</sup>  
SURFACE AREA OF TUBES: N/A m<sup>2</sup>  
WEIGHT EMPTY: 460 kg  
WEIGHT FULL OF WATER: 590 kg  
SURFACE PREPARATION: PNT-12  
PRIMER: PNT-12  
FINISH PAINT: PNT-12  
INSULATION: NONE  
MECHANICAL LOADINGS GOVERNS AS PER UG 22:  NO

SERIAL NO: 99404 '108' CRN:  
TAG NO: V-124 YEAR BUILT: 2000  
LSD #: -  
CODE:  
ASME SECT. VIII DIV I, '98, ADDENDA '99  
TEMA CLASS N/A, ADDENDA N/A  
DESIGN PRESS: 8908 kPag @ TEMP: 176 °C  
HYDROTEST:  
VESSEL 11580 kPag  
COIL N/A kPag  
MIN<sup>m</sup> DESIGN METAL TEMP: -28 °C @ MAWP 8908 kPag  
MATERIAL: HEAD: SA-516-70N SHELL: SA-106B  
RADIOGRAPHY:  
LONG L- FULL UW(c)  
CIRC: FULL UW(c) (INCL. ALL BUTT WELDS)  
PRODUCTION IMPACT TEST REQ'D:  NO  
SHIP LOOSE:  NO  
SERVICE: SOUR GAS  
LONG & CIRC. WELDS TYPE 1  
QWP: 590.2  
QCP: AQP-1050 (S) AQP-1227 (S)  
TACK WELDS: WPS #101  
PRESS. TO STRUCT WELD: WPS #102,106,110  
P.W.H.T.:  
YES MIN. TEMP: 593 °C, TIME: 1 hr min.  
CORR. ALLOW: 3.2 mm  
**'SOUR SERVICE'**



GENERAL NOTES		GENERAL NOTES	
1	DO NOT PROFILE INTERNAL PROJECTION UNLESS SPECIFIED.	3	NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION
2	SANDBLAST INTERNALS TO ENSURE THAT THE INSIDE SURFACE OF THE VESSEL IS FREE OF LOOSE MILL SCALE AND WELD SPATTER.	2	REVISED N2
3	VESSEL TO BE FLUSHED OUT AT HYDROTEST, AIR DRIED AND OILED INTERNALLY.	1	ISSUED FOR CONSTRUCTION
4	VESSEL OPENINGS TO BE SEALED PRIOR TO ANY SHIPPING TO OTHER SHOPS.		

No.	REVISION	BY	DATE	CHKD	ENG
3	NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION	D. SMITH	00/04/28	M.J.	S.W.
2	REVISED N2	S. FARWELL	00/02/03	M.A.	
1	ISSUED FOR CONSTRUCTION	P. TRAN	00/01/26	M.J.	P.C.

APPROVED		DRAWN	
MECH./STRUCT.	BY D. SMITH	DATE	00/04/11
ELECTRICAL	CHECKED	DATE	00/04/28
PROJECT	S. WARD	DATE	00/04/28
DATE	00/04/28	SCALE	AS NOTED

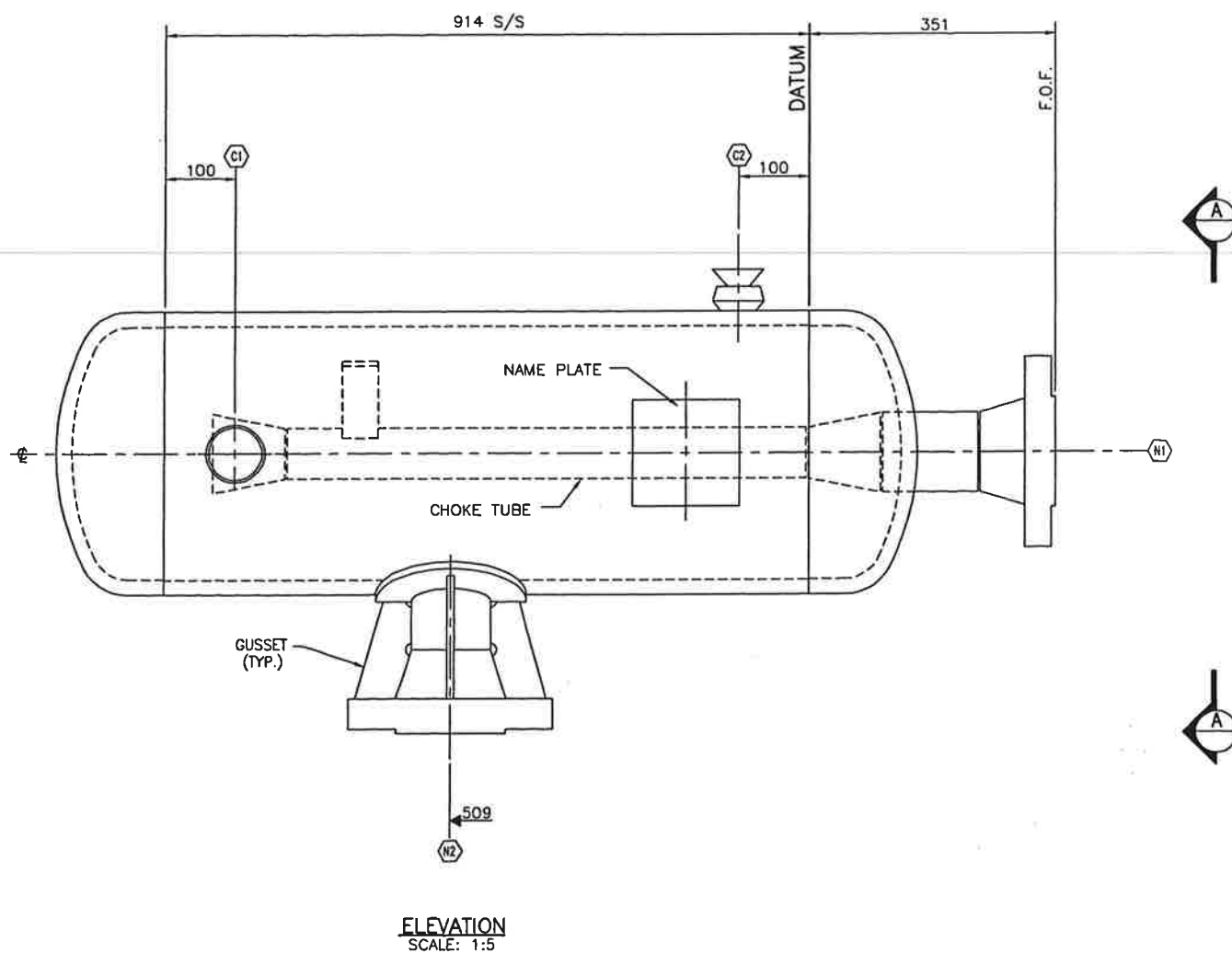
**PROPAC SYSTEMS LTD.**  
1478 HP STOCK COMPRESSOR  
2ND STAGE DISCHARGE BOTTLE  
406mm O/D x 1016mm S/S

440 East Lake Road,  
Postal Bag #2  
Airdrie, Alberta  
Canada T4B 2C3

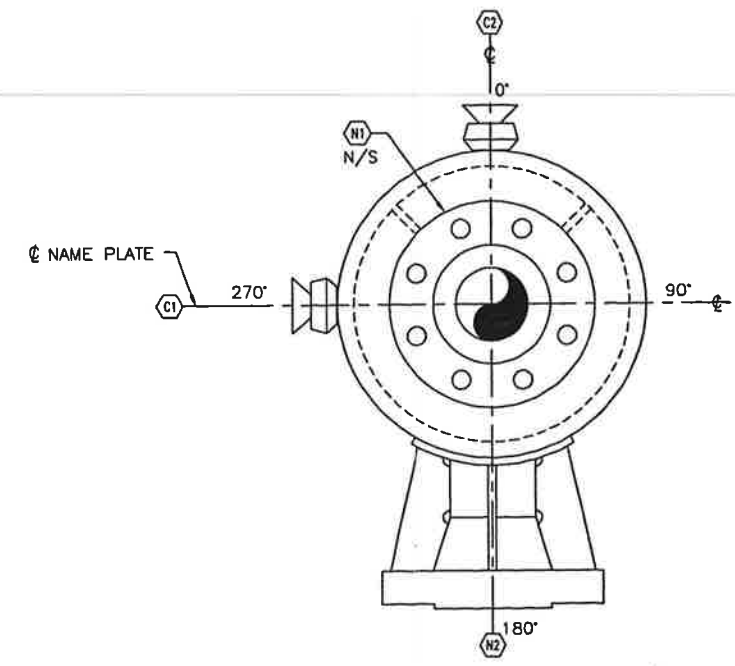
DWG. No.: D-BTL-99404-108 REV. 3

THE DESIGN IT COVERS ARE CONFIDENTIAL AND THE PROPERTY OF PROPAK SYSTEMS LTD. AND SHALL NOT BE DISCLOSED TO OTHERS OR REPRODUCED IN ANY MANNER OR USED FOR ANY PURPOSE WHATSOEVER EXCEPT BY WRITTEN CONSENT OF PROPAK.

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	WELD	
N1	114	600#	RFWN	XXH	PROCESS INLET	SPEC	SPEC.		
N2	114	900#	RFWN	XXH	PROCESS OUTLET	0	200		
C1	48	6000#	TOL	-	INSPECTION c/w PLUG	-	-		
C2	48	6000#	TOL	-	INSPECTION/VENT c/w PLUG	-	-		



**ELEVATION**  
SCALE: 1:5



**ORIENTATION**  
**VIEW 'A-A'**  
SCALE: 1:5

CAPACITY: 0.12 m<sup>3</sup>  
 SURFACE AREA OF TUBES: N/A m<sup>2</sup>  
 WEIGHT EMPTY: 402 kg  
 WEIGHT FULL OF WATER: 522 kg  
 SURFACE PREPARATION:  
 PRIMER: PNT-11  
 FINISH PAINT: PNT-11  
 INSULATION: NONE  
 MECHANICAL LOADINGS GOVERNS AS PER UG 22:  NO  
 IMPACT TEST: NO - PER UG20(f)  
 PRODUCTION IMPACT TEST REQ'D:  NO  
 SHIP LOOSE:  NO  
 SERVICE: SOUR GAS

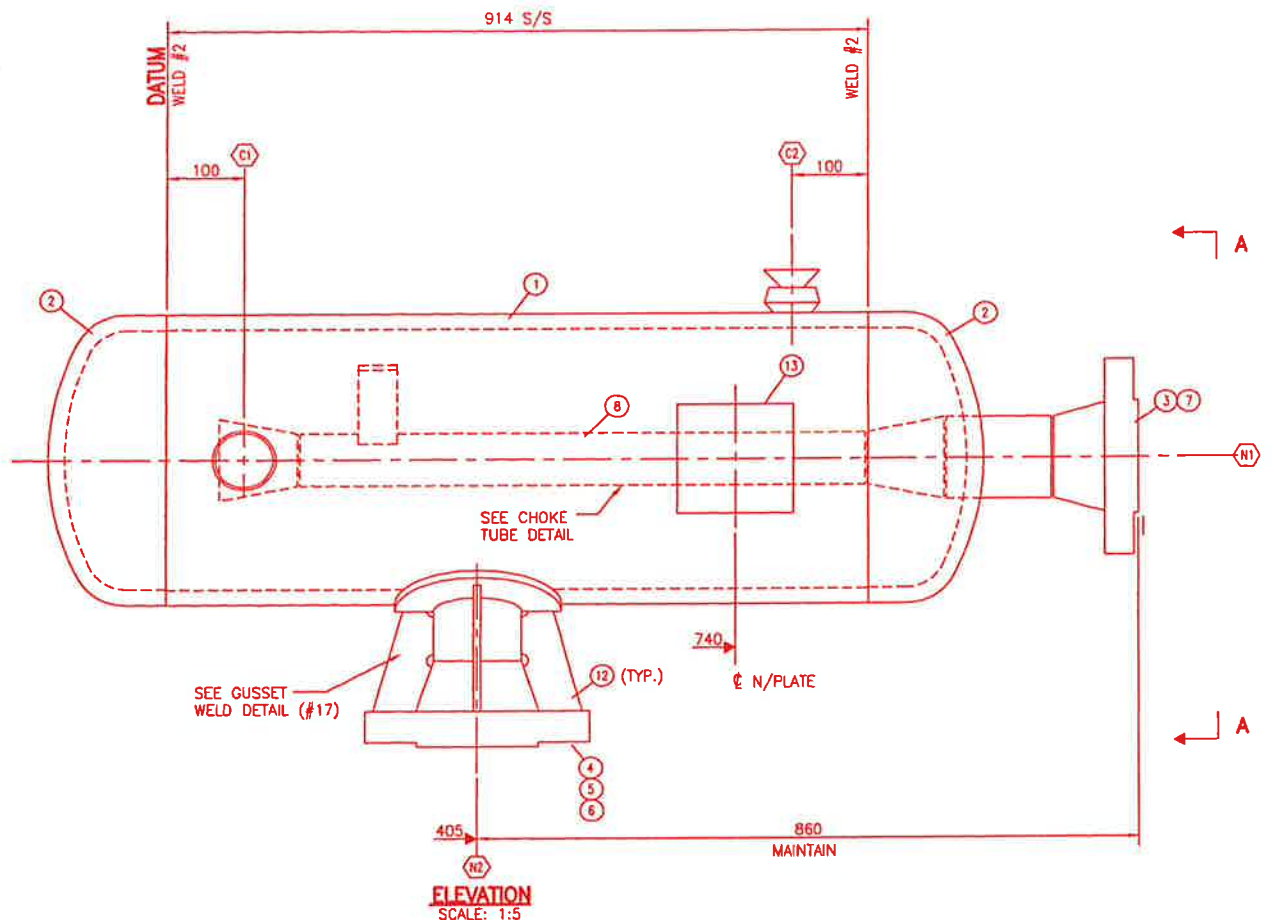
SERIAL NO: 99404 '109' CRN:  
 TAG NO: V-125 YEAR BUILT: 2000  
 LSD #: -  
 CODE:  
 ASME SECT. VIII DIV I, '98, ADDENDA '99  
 TEMA CLASS N/A, ADDENDA N/A  
 DESIGN PRESS: 9067kPag @ TEMP: 149 °C  
 HYDROTEST:  
 VESSEL 11787 kPag  
 COIL N/A kPag  
 MIN<sup>M</sup> DESIGN METAL TEMP: -28°C @ MAWP 9067 kPag  
 MATERIAL: HEAD: SA-516-70N SHELL: SA-106-B  
 RADIOGRAPHY:  
 LONG L. FULL UWII(a)  
 CIRC: FULL UWII(a) (INCL. ALL BUTT WELDS)  
 P.W.H.T.:  
 YES MIN. TEMP: 593°C, TIME: 1 h (MIN.)  
 CORR. ALLOW: 3.2 mm

'SOUR SERVICE'

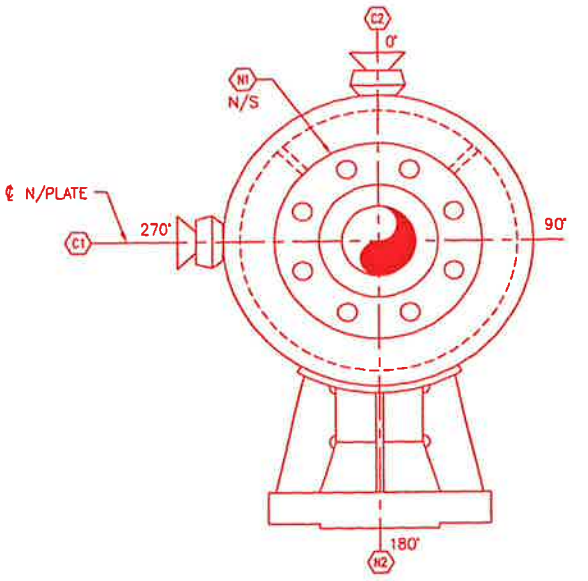
APPROVED		DRAWN		APACHE CANADA LIMITED		440 East Lake Road, Postal Bag #2 Aldrie, Alberta Canada T4B 2C3	
MECH./STRUCT.	BY	BY	CHECKED	1478 HP HAMBURG COMPRESSOR PACKAGE			
DATE	DATE	DATE	DATE	3RD STAGE SUCTION BOTTLE (V-125)			
ELECTRICAL	BY	BY	DATE	406 O/D x 914 S/S			
DATE	DATE	DATE	DATE	DWG. No.:	D-BTL-99404-109-SKT SHT. 1 OF 1		
PROJECT	DATE	DATE	DATE	REV. SKT			
DATE	SCALE	SCALE	SCALE	AS NOTED			

GENERAL NOTES		GENERAL NOTES		SKT ISSUED FOR DOCUMENTATION		J. JUA 00/09/15 VK SW	
DATE: 2000.09.25 4:13pm FILE NAME: J:\jobs99\DWG\99404\Comp\Misc\BTL-99404-109-SKT-01.dwg		No.		REVISION		BY DATE CKD ENG	

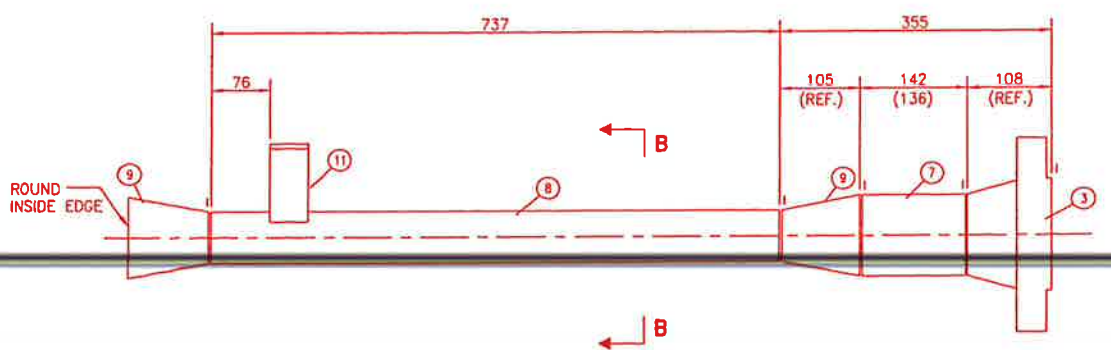
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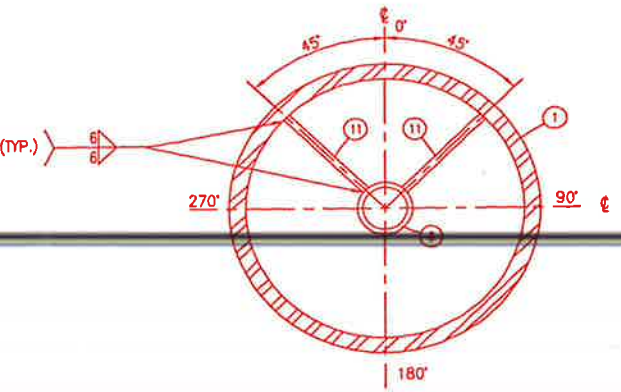
**ELEVATION**  
SCALE: 1:5



**ORIENTATION**  
**VIEW A-A**  
SCALE: 1:5



**CHOKE TUBE DETAIL**  
SCALE: 1:5



**SECTION B-B**  
SCALE: 1:5

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	PROJ.	WELD
N1	114	600#	RFWN	XXH	PROCESS INLET	SPEC	SPEC.	10/14	
N2	114	900#	RFWN	XXH	PROCESS OUTLET	0	200	8/14	
C1	48	6000#	TOL	-	INSPECTION c/w PLUG	-	-	-	6
C2	48	6000#	TOL	-	INSPECTION/VENT c/w PLUG	-	-	-	6

BILL OF MATERIAL		
ITEM	QUA	DESCRIPTION
1	1	SHELL PIPE: 406 O/D x 21.44 WT x 914 LG. SA-106-B
2	2	HEAD PLATE: 406 O/D x 22.23 THK. NOM. (20.06 MIN.) 2:1 S.E. c/w S.F. SA-516-70N
3	1	FLANGE: 114-600# RFWN XXH BORE SA-105H
4	1	FLANGE: 114-900# RFWN XXH BORE SA-105H
5	1	REPAD PLATE: 9.53 THK. x 216 O/D x 117 I/D (ROLL TO 406 I/D) SA-516-70N
6	1	PIPE: 114 O/D x 17.11 W.T. x 1.35 LG. (CIS) SMLS SA-106-B
7	1	PIPE: 114 O/D x 17.11 W.T. x 1.36 LG. (CIS) SMLS SA-106-B
8	1	PIPE: 73 O/D x 9.53 W.T. x 737 LG. SMLS SA-106-B
9	2	CONC. RED: 114 O/D x 73 O/D SCH XXH LE x SCH 160 SE BW SMLS SA-234-WPB
10	2	TOL: 48-6000# (ON A 406 O/D RUN) c/w PLUG SA-105N
11	2	F/BAR: 10 THK. x 50 x 143 LG. G40.21M-300W
12	4	PLATE: 10 THK. x 79 WD. x 200 LG. (CIS) SA-36
13	1	NAMEPLATE c/w MOUNTING BRACKET SS/SA-36
14		

NOTE: THE FOLLOWING SUBSTITUTIONS ARE PERMITTED (THE OPPOSITE NOT ALLOWED)  
SA-350-LF2 for SA-105, SA-333-Gr6 for SA-106-B, SA-420-WPL6 for SA-234-WPB

CAPACITY: 0.12 m<sup>3</sup>  
SURFACE AREA OF TUBES: N/A m<sup>2</sup>  
WEIGHT EMPTY: 402 kg  
WEIGHT FULL OF WATER: 322 kg  
SURFACE PREPARATION: PNT-11  
PRIMER: PNT-11  
FINISH PAINT: PNT-11  
INSULATION: NONE  
MECHANICAL LOADINGS GOVERNS AS PER UG 22:  NO

SERIAL NO: 99404 '109' CRN  
TAG NO: V-125 YEAR BUILT: 2000  
LSD #: -  
CODE:  
ASME SECT. VIII DIV I, '98, ADDENDA '99  
TEMA CLASS N/A, ADDENDA N/A  
DESIGN PRESS: 9067 kPag @ TEMP: 149 °C  
HYDROTEST:  
VESSEL 11787 kPag  
COIL N/A kPag  
MIN<sup>m</sup> DESIGN METAL TEMP: -28 °C @ MAWP 9067 kPag  
MATERIAL: HEAD: SA-516-70N SHELL: SA-106-B  
RADIOGRAPHY:  
LONG- FULL UWR(c)  
CIRC: FULL UWR(c) (INCL. ALL BUT WELDS)

PRODUCTION IMPACT TEST REQ'D:  NO  
SHIP LOOSE:  NO  
SERVICE: SOUR GAS  
LONG & CIRC. WELDS TYPE 1  
QWP: 590.2  
AQP-1050(S) AQP-1227(S)  
TACK WELDS: WPS #101  
PRESS. TO STRUCT. WELD: WPS #102,106,110

IMPACT TEST: NO - PER UG20(e)  
P.W.H.T.:  YES MIN. TEMP: 593 °C, TIME: 1 h (MIN.)  
CORR. ALLOW: 3.2 mm

**'SOUR SERVICE'**

SINGLE VEE	THREDOLET	NOZZLE & REPAD FLUSH	NOZZLE RECESSED	PIPE TO FLANGE/FITTING	GUSSETS
2. WPS# 104,106,110	6. WPS# 102,106,110	8. WPS# 102,106,108,110	10. WPS# 102,106,108,110	14. WPS# 104,106,110	17. WPS# 102,106,110

1) DO NOT PROFILE INTERNAL PROJECTION UNLESS SPECIFIED.  
2) SANDBLAST INTERNALS TO ENSURE THAT THE INSIDE SURFACE OF THE VESSEL IS FREE OF LOOSE MILL SCALE AND WELD SPLATTER.  
3) VESSEL TO BE FLUSHED OUT AT HYDROTEST, AIR DRIED AND OILED INTERNALLY.  
4) VESSEL OPENINGS TO BE SEALED PRIOR TO ANY SHIPPING TO OTHER SHOPS.

GENERAL NOTES

No.	REVISION	BY	DATE	CHKD	ENG
2	NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION	D. SMITH	00/04/28	M.L.	S.W.
1	ISSUED FOR CONSTRUCTION	P.T.	00/01/26	M.L.	P.C.

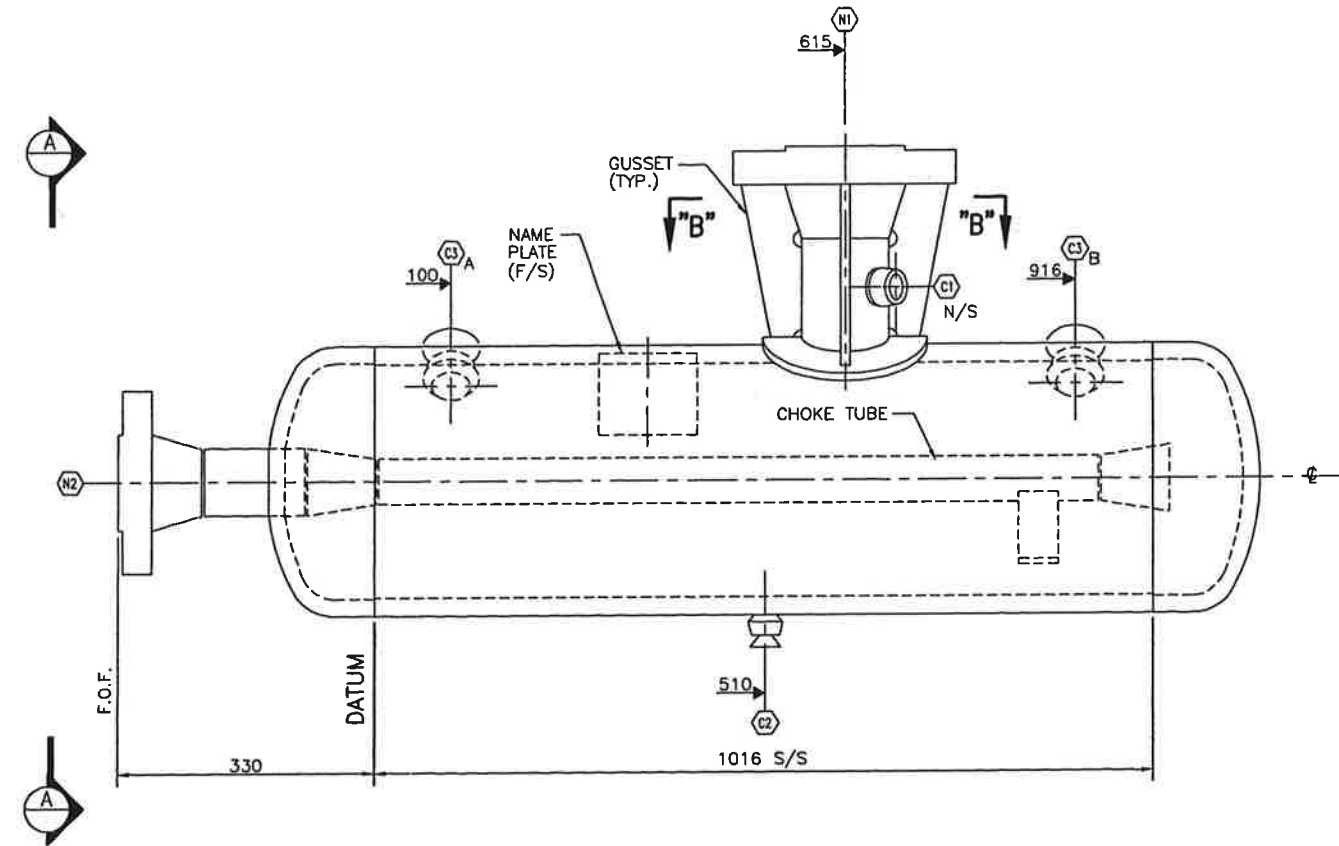
APPROVED		DRAWN	
MECH./STRUCT.	BY D. SMITH	DATE	00/04/12
ELECTRICAL	CHECKED	DATE	00/04/28
DATE	BY M. IWANIUK	DATE	00/04/28
PROJECT	S. WARD	DATE	00/04/28
DATE	00/04/28	SCALE	AS NOTED

**PROPAG SYSTEMS LTD.**  
1478 HP STOCK COMPRESSOR  
3RD STAGE SUCTION BOTTLE  
406mm O/D x 914mm S/S

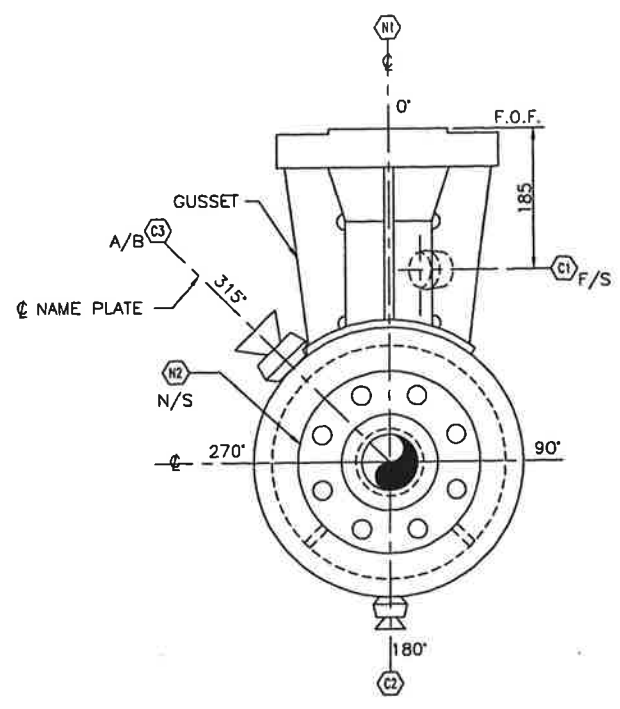
**PROPAG**  
440 East Lake Road,  
Postal Bag #2  
Airdrie, Alberta  
Canada T4B 2C3

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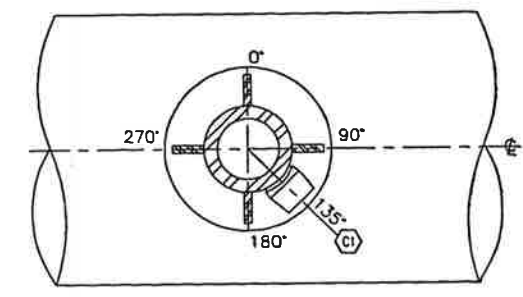
NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ.	EXT. PROJ.	WELD	
N1	114	900#	RFWN	XXH	INLET	MIN.	260	-	
N2	89	900#	RFWN	XXH	PROCESS GAS OUTLET	SPEC	SPEC.	-	
C1	27	6000#	TOL	-	THERMOWELL (TE-126)	-	-	-	
C2	27	6000#	TOL	-	DRAIN c/w PLUG	-	-	-	
C3	48	6000#	TOL	-	INSPECTION c/w PLUG	-	-	-	



**ELEVATION**  
SCALE: 1:5



**ORIENTATION**  
**(VIEW 'A-A')**  
SCALE: 1:5

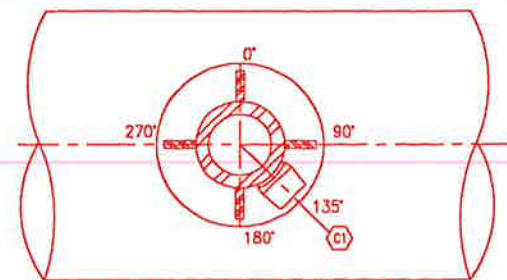


**SECTION 'B-B'**  
SCALE: 1:5

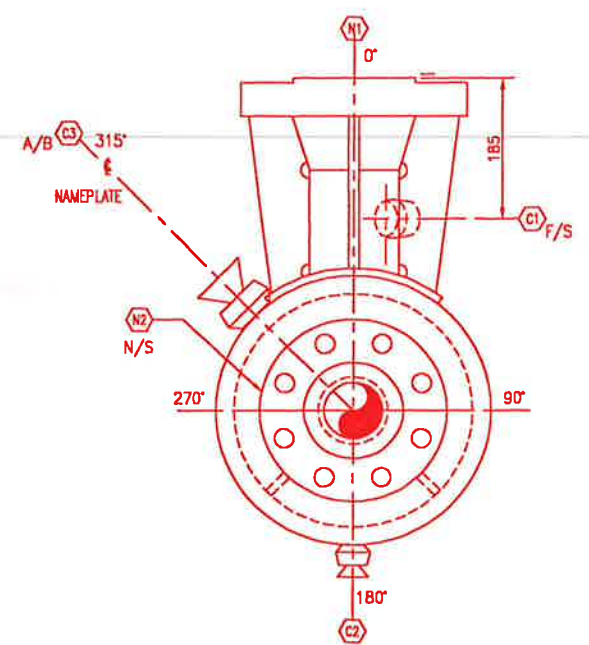
<p>CAPACITY: 0.091 m<sup>3</sup>          SURFACE AREA OF TUBES: N/A m<sup>2</sup>          WEIGHT EMPTY: 393 kg          WEIGHT FULL OF WATER: 484 kg          SURFACE PREPARATION: PNT-12          PRIMER: PNT-12          FINISH PAINT: PNT-12          INSULATION: NONE          MECHANICAL LOADINGS GOVERNS AS PER UG 22: <input checked="" type="checkbox"/> YES <input checked="" type="checkbox"/> NO          IMPACT TEST: NO - PER UG20(f)          PRODUCTION IMPACT TEST REQ'D: <input checked="" type="checkbox"/> YES <input checked="" type="checkbox"/> NO          SHIP LOOSE: <input checked="" type="checkbox"/> YES <input checked="" type="checkbox"/> NO          SERVICE: SOUR GAS</p>	<p>SERIAL NO: 99404 '110' CRN:          TAG NO: V-126 YEAR BUILT: 2000          LSD #: -          CODE:          ASME SECT. VIII DIV I, '98, ADDENDA '99          TEMA CLASS, N/A, ADDENDA N/A          DESIGN PRESS: 11377 kPag @ TEMP: 176 °C          HYDROTEST:          VESSEL 14790 kPag          COIL N/A kPag          MIN<sup>M</sup> DESIGN METAL TEMP: -28 °C @ MAWP 11377 kPag          MATERIAL: HEAD: SA-516-70N SHELL: SA-106-B          RADIOGRAPHY:          LONG L FULL UWII(a)          CIRC: FULL UWII(a) (INCL. ALL BUTT WELDS)          P.W.H.T.:          YES MIN. TEMP: 593 °C, TIME: 1h(MIN.)          CORR. ALLOW: 3.2 mm  <b>'SOUR SERVICE'</b></p>
---	--

<p>APPROVED</p> <p>MECH/STRUCT. BY</p> <p>DATE DATE</p> <p>ELECTRICAL CHECKED</p> <p>DATE BY</p> <p>PROJECT DATE</p> <p>DATE DATE</p> <p>SCALE AS NOTED</p>		<p>DRAWN</p> <p>BY</p> <p>DATE</p> <p>CHECKED</p> <p>BY</p> <p>DATE</p> <p>SCALE AS NOTED</p>		<p>APACHE CANADA LIMITED</p> <p>1478 HP HAMBURG COMPRESSOR PACKAGE</p> <p>3RD STAGE DISCHARGE BOTTLE (V-126)</p> <p>356 O/D x 1016 S/S</p>		<p>DWG. No.: D-BTL-99404-110-SKT SHT. 1 OF 1 REV. SKT</p>	
<p>GENERAL NOTES</p> <p>DATE: 2000.09.25 4:14pm FILE NAME: J:\jobs99\DWG\99404\Comp\Misc\BTL-99404-110-SKT-01.dwg</p>		<p>GENERAL NOTES</p> <p>SKT ISSUED FOR DOCUMENTATION</p> <p>No. REVISION</p>		<p>D. DOR 00/09/15 VK SW</p> <p>BY DATE CKD ENG</p>		<p>PROPAC</p> <p>440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3</p>	

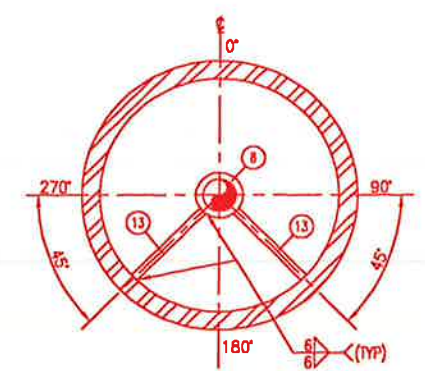
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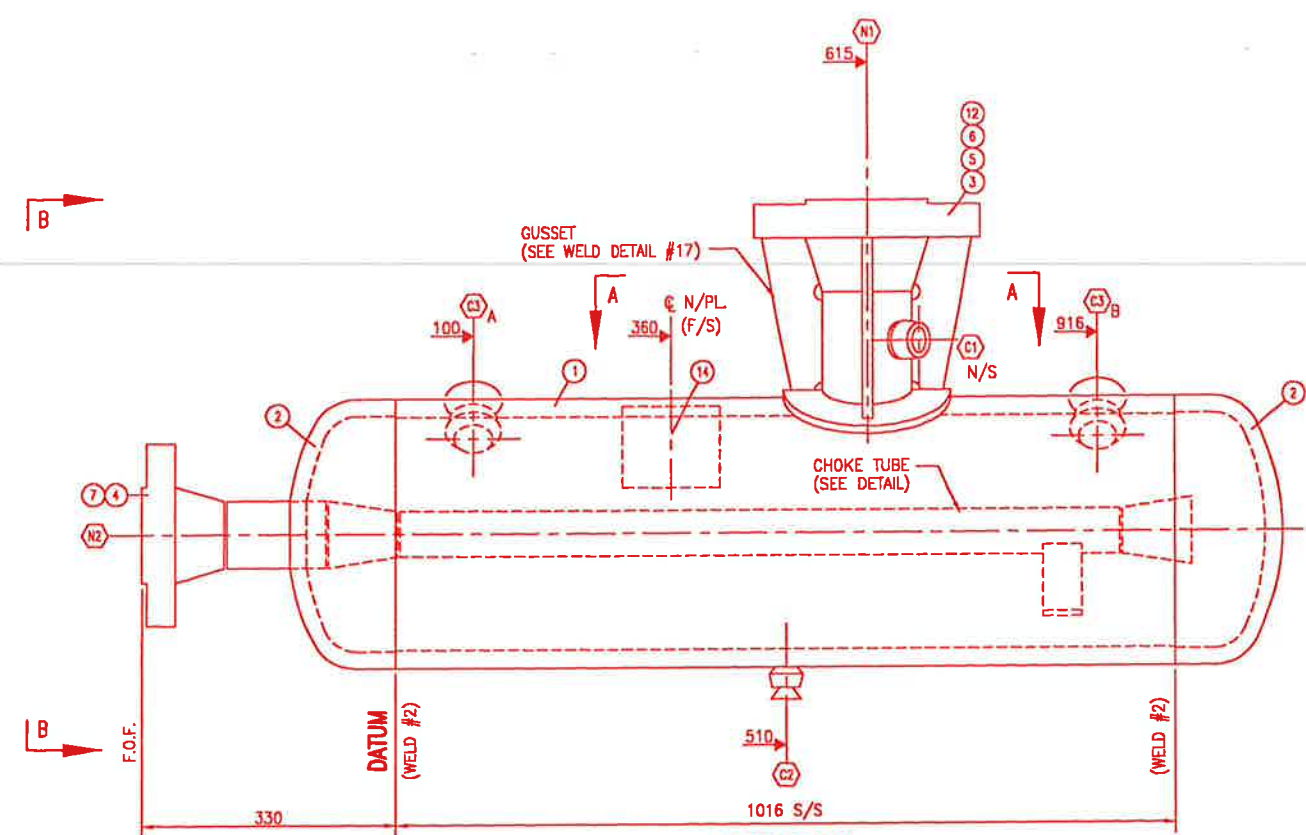
**SECTION 'A-A'**  
SCALE 1:5



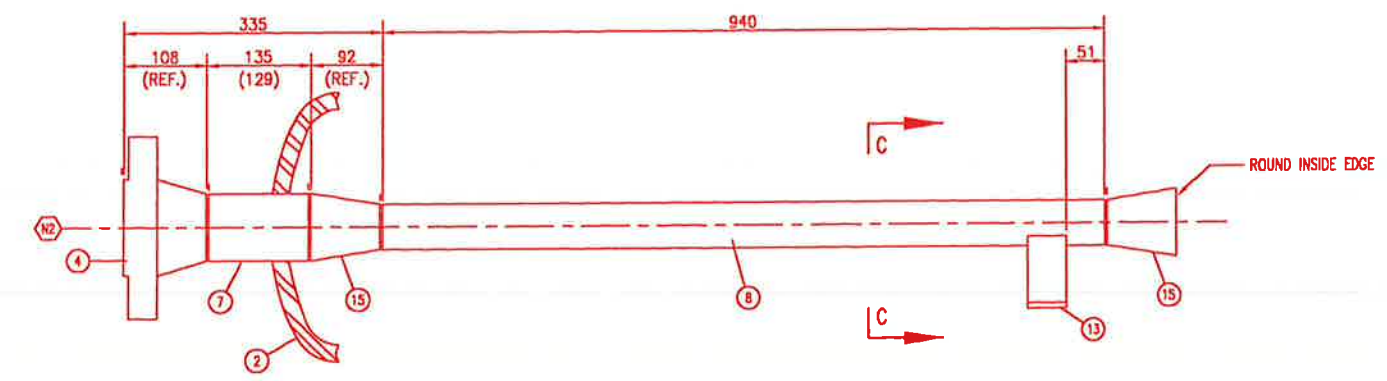
**ORIENTATION 'B-B'**  
SCALE 1:5



**SECTION 'C-C'**  
SCALE 1:5



**ELEVATION**  
SCALE 1:5



**CHOKE TUBE DETAIL**  
SCALE 1:5

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ	EXT. PROJ	WELD	
N1	114	900#	RFWN	XXH	INLET	MIN.	260	8/14	
N2	89	900#	RFWN	XXH	PROCESS GAS OUTLET	SPEC	SPEC.	10/14	
C1	27	6000#	TOL	-	THERMOWELL (TE-126)	-	-	6	
C2	27	6000#	TOL	-	DRAIN c/w PLUG	-	-	6	
C3	48	6000#	TOL	-	INSPECTION c/w PLUG	-	-	6	

BILL OF MATERIAL			
ITEM	QUA	DESCRIPTION	
1	1	SHELL PIPE: 356 O/D x 23.83 THK. x 1016 LG.	SA-106-B
2	2	HEAD PLATE: 356 O/D x 22.23 THK. NOM. (19.81 MIN.) 2:1 S.E. c/w 51 S.F.	SA-516-70N
3	1	FLANGE: 114-900# RFWN XXH BORE	SA-105N
4	1	FLANGE: 89-900# RFWN XXH BORE	SA-105N
5	1	REPAD: 9.53 x 216 O/D x 117 I/D (ROLL TO 356 I/D)	SA-516-70N
6	1	PIPE: 114 O/D x 17.12 WT. x 199 LG.	(SMLS) SA-106-B
7	1	PIPE: 89 O/D x 15.24 WT. x 129 LG.	(SMLS) SA-106-B
8	1	PIPE: 60 O/D x 8.74 WT x 940 LG	(SMLS) SA-106-B
9	1	TOL: 27-6000# (ON A 114 O/D RUN) c/w PLUG	SA-105N
10	1	TOL: 27-6000# (ON A 356 O/D RUN) c/w PLUG	SA-105N
11	2	TOL: 48-6000# (ON A 356 O/D RUN) c/w PLUG	SA-105N
12	4	PLATE: 10 THK. x 79 WD. x 260 LG. (CTS)	SA-516-70N
13	2	PLATE: 10 THK. x 51 WD. x 122 LG. (CTS)	SA-516-70N
14	1	NAMEPLATE c/w MOUNTING BRACKET	SS/SA-36
15	2	CONC. REDUCER: 89 XXH x 60 SCH 160 BW	(SMLS) SA-234-WPB
16			

NOTE: THE FOLLOWING SUBSTITUTIONS ARE PERMITTED (THE OPPOSITE NOT ALLOWED)  
SA-350-LF2 for SA-105, SA-333-Gr6 for SA-106-B, SA-420-WPL6 for SA-234-WPB

CAPACITY: 0.091 m<sup>3</sup>  
SURFACE AREA OF TUBES: N/A m<sup>2</sup>  
WEIGHT EMPTY: 393 kg  
WEIGHT FULL OF WATER: 484 kg  
SURFACE PREPARATION: PNT-12  
PRIMER:  
FINISH PAINT:  
INSULATION: NONE  
MECHANICAL LOADINGS GOVERNS AS PER UG 22: YES/NO

SERIAL NO: 99404 '110' CRN: P-0249.2  
TAG NO: V-126 YEAR BUILT: 2000  
LSD #: -  
CODE:  
ASME SECT. VIII DIV I, '98, ADDENDA '99  
TEMA CLASS, N/A, ADDENDA N/A  
DESIGN PRESS: 11377 kPag @ TEMP: 176 °C

IMPACT TEST: NO - PER UG20(f)

HYDROTEST:  
VESSEL 14790 kPag  
COIL N/A kPag  
MIN<sup>m</sup> DESIGN METAL TEMP: -28 °C @ MWP 11377 kPag  
MATERIAL: HEAD: SA-516-70N SHELL: SA-106-B  
RADIOGRAPHY:  
LONG - FULL UWI(c)  
CIRC. FULL UWI(c) (INCL. ALL BUTT WELDS)

PRODUCTION IMPACT TEST REQ'D: NO  
SHIP LOOSE: NO  
SERVICE: SOUR GAS  
LONG & CIRC. WELDS TYPE 1  
QWP: 590.2  
QCP: AQP:1050(S) AQP-1227(S)  
TACK WELDS: WPS #101  
PRESS. TO STRUCT WELD: WPS #102,106,110

P.W.H.T.:  
YES MIN. TEMP: 593 °C, TIME: 1h(MIN.)  
CORR. ALLOW: 3.2 mm

**'SOUR SERVICE'**

SINGLE VEE	THREDOLET	NOZZLE & REPAD FLUSH	NOZZLE RECESSED	PIPE TO FLANGE/FITTING	GUSSETS
2. WPS# 104,106,110	6. WPS# 102,106,110	8. WPS# 102,106,106,110	10. WPS# 102,106,106,110	14. WPS# 104,106,110	17. WPS# 102,106,110

1) DO NOT PROFILE INTERNAL PROJECTION UNLESS SPECIFIED.  
2) SANDBLAST INTERNALS TO ENSURE THAT THE INSIDE SURFACE OF THE VESSEL IS FREE OF LOOSE MILL SCALE AND WELD SPATTER.  
3) VESSEL TO BE FLUSHED OUT AT HYDROTEST, AIR DRIED AND OILED INTERNALLY.  
4) VESSEL OPENINGS TO BE SEALED PRIOR TO ANY SHIPPING TO OTHER SHOPS.

3 NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION  
2 INCREASED EXT. PROJ. OF N1 (WAS 250)  
1 ISSUED FOR CONSTRUCTION

No.	REVISION	BY	DATE	CKD	ENG
3	NEW DESIGN: VESSEL RE-ISSUED FOR CONSTRUCTION	D. SMITH	00/05/01	M.L.	S.W.
2	INCREASED EXT. PROJ. OF N1 (WAS 250)	S. FARWELL	00/02/09	M.L.	N.E.
1	ISSUED FOR CONSTRUCTION	RAEMELA J	00/01/26	M.L.	P.C.

APPROVED		DRAWN	
MECH./STRUCT.	BY D. SMITH	DATE	00/04/12
ELECTRICAL	CHECKED	BY	M. IWANIUK
DATE	00/05/01	DATE	00/05/01
PROJECT	S. WARD	DATE	00/05/01
DATE	00/05/01	SCALE	AS NOTED

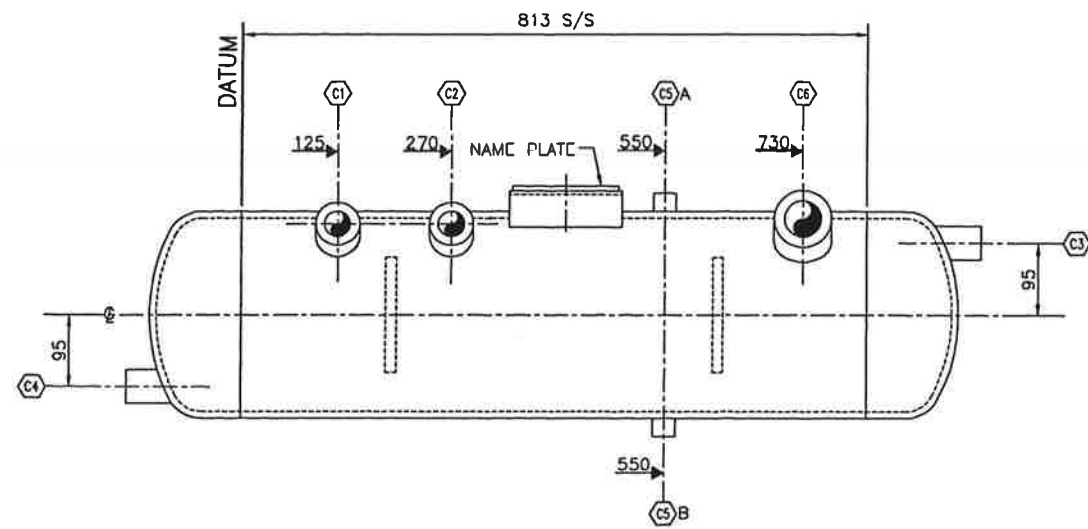
**PROPAG SYSTEMS LTD.**  
440 East Lake Road,  
Postal Bag #2  
Airdrie, Alberta  
Canada T4B 2C3

STOCK 1478 HP COMPRESSOR  
3RD STAGE DISCHARGE BOTTLE  
356mm O/D x 1016mm S/S

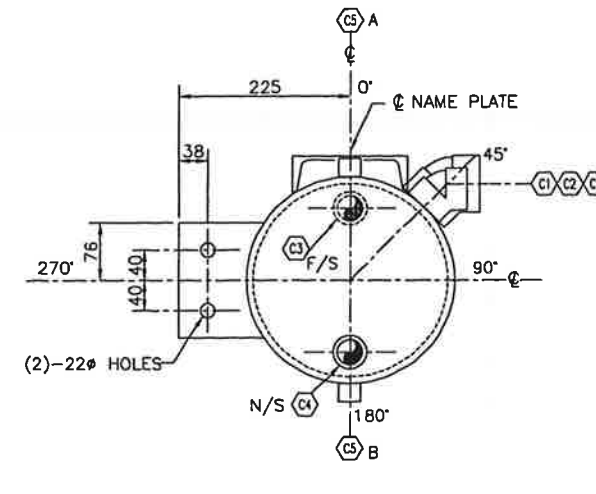
DWG. No.: D-BTL-99404-110  
REV. 3

NOZZLE SCHEDULE									
MK	SIZE	RATING	FACING	SCH	SERVICE	INT. PROJ	EXT. PROJ	WELD	
C1	3.3	3000#	45° ELBOW	-	CYLINDER PACKING VENT & DRAIN	-	-	-	
C2	3.3	3000#	45° ELBOW	-	CYLINDER DISTANCE PIECE DRAIN	-	-	-	
C3	3.3	3000#	1/2 CPLG	-	SEAL POT VAPOUR TO FLARE HEADER	-	-	-	
C4	3.3	3000#	1/2 CPLG	-	LIQUIDS TO DRAIN TANK	-	-	-	
C5	21	3000#	1/2 CPLG	-	LEVEL GAUGE	-	-	-	
C6	48	3000#	45° ELBOW	-	SEAL POT PRESSURE RELIEF	-	-	-	

A/B



**ELEVATION**  
SCALE: 1:5



**ORIENTATION**  
SCALE: 1:5

CAPACITY: 0.05 m <sup>3</sup> WEIGHT EMPTY: 90 kg WEIGHT FULL OF WATER: 140 kg SURFACE PREPARATION: PRIMER: PNT-11 FINISH PAINT: INSULATION: NONE IMPACT TEST: NO YES - PER UG84 AS FOLLOWS: PRODUCTION IMPACT TEST REQ'D: <input checked="" type="checkbox"/> NO SHIP LOOSE: <input checked="" type="checkbox"/> NO SERVICE: HYDROCARBONS	SERIAL NO: 99404 '117' TAG NO: V-130 LSD #: CODE: NON-CODE CRN: N/A YEAR BUILT: 2000 MAX: DESIGN PRESS: 01 kPag @ TEMP. 149°C HYDROTEST: VESSEL 345 kPag MIN <sup>M</sup> DESIGN METAL TEMP: -28 °C MATERIAL: HEAD: SA-234-WPB SHELL: SMLS SA-106-B RADIOGRAPHY: LONG L: N/A CIRC: N/A P.W.H.T.: <input checked="" type="checkbox"/> NO CORR. ALLOW: NONE "SOUR SERVICE"
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GENERAL NOTES		GENERAL NOTES		APPROVED		DRAWN		APACHE CANADA LIMITED		PROPAC	
DATE: 2000.09.25 4:16pm	FILE NAME: J:\jobs99\DWG\99404\Comp\Misc\POT-99404-117-SKT-01.dwg	SKT	ISSUED FOR DOCUMENTATION	J. JUA	00/09/15	YK	SW	1478 HP HAMBURG COMPRESSOR PACKAGE PACKING VENT & DRAIN SEAL POT (V-130) 273 O/D x 813 S/S		440 East Lake Road, Postal Bag #2 Airdrie, Alberta Canada T4B 2C3	
		No.	REVISION	BY	DATE	CKD	ENG	DWG. No.:	D-POT-99404-117-SKT	SHT. 1 OF 1	REV. SKT









**APACHE CANADA LIMITED**  
**INSTRUMENT LIST - PROPAK SO# 99404**  
**HAMBURG 2 - 6 COMPRESSOR STATION**  
**LSD: 02-06-097-11 W6M**

DATA SHEET	REV #	TAG #	MFS #	RANGE	ENG UNIT	SET POINT	INSTRUMENT TYPE	MANUFACTURER	MODEL #	COMMENTS	AREA #	BOM ITEM#		
							<b>PROCESS</b>							
YES	2	ESDV	101	100-04			Emergency Shutdown Valve	Fisher	357-40	33mm NPT connect	19.1mm Port, WCC body, NACE MR-0175 certified	152	72	
YES	2	I/P	100	100-04	4-20 / 6-30		Transducer	Fisher	546		C/W PCV-100	152	74	
YES	2	LC	100	100-04		241	Level Controller	Fisher	2680-268T	1st Stage Scrubber Displacer, vert. Mount	NACE MR-01-75, 60mm NPT, 48 x 305mm	152	68	
YES	2	LC	110	100-04		241	Level Controller	Fisher	2680-268T	2nd Stage Scrubber Displacer, vert. Mount	NACE MR-01-75, 60mm NPT, 48 x 305mm	152	68	
YES	2	LC	120	100-04		241	Level Controller	Fisher	2680-268T	3rd Stage Scrubber Displacer, vert. Mount	NACE MR-01-75, 60mm NPT, 48 x 305mm	152	68	
YES	2	LCV	100	100-04	0-241		Level Control Valve	Fisher	128-PQC	1st Stage Dump Valve, 9.5mm Port, fail closed	NACE MR-10-75, 33mm NPT connect,	152	69	
YES	2	LCV	110	100-04	0-241		Level Control Valve	Fisher	128-PQC	2nd Stage Dump Valve, 9.5mm Port, fail closed	NACE MR-10-75, 33mm NPT connect,	152	69	
YES	2	LCV	120	100-04	0-241		Level Control Valve	Fisher	128-PQC	3rd Stage Dump Valve, 9.5mm Port, fail closed	NACE MR-10-75, 33mm NPT connect,	152	69	
YES	2	LG	100	100-04	321		Level Gauge	Penberthy	1RL9	NACE MR-01-75, c/w 330J cocks, 100/110: 4516 KPAG @ 149°C; 120: 9067 KPAG @ 149°C		152	71	
YES	2	LG	110	100-04	321		Level Gauge	Penberthy	1RL9	NACE MR-01-75, c/w 330J cocks, 100/110: 4516 KPAG @ 149°C; 120: 9067 KPAG @ 149°C		152	71	
YES	2	LG	120	100-04	321		Level Gauge	Penberthy	1RL9	NACE MR-01-75, c/w 330J cocks, 100/110: 4516 KPAG @ 149°C; 120: 9067 KPAG @ 149°C		152	71	
YES	2	LS	100	100-04	138-4516		Level Switch - High	Murphy	1100-SS	1st Stage Scrubber, specific gravity, sour water	NACE MR-01-75, 48mm NPT connect, 1.0	152	70	
YES	2	LS	110	100-04	961-4516		Level Switch - High	Murphy	1100-SS	2nd Stage Scrubber, specific gravity, sour water	NACE MR-01-75, 48mm NPT connect, 1.0	152	70	
YES	2	LS	120	100-04	2976-9067		Level Switch - High	Murphy	1100-SS	3rd Stage Scrubber, specific gravity, sour water	NACE MR-01-75, 48mm NPT connect, 1.0	152	70	
YES	2	PCV	100	100-04	41-207		Pressure Control Valve	Fisher	357-40	33mm NPT connect	9.5mm Port, WCC body, c/w 546 Transducer	152	74	
	2	PRV	120	100-04	241 - 414	276	Pressure Regulator	Fisher	67 CFR	4-20MA input, 6-30 PSIG output, nace MR-0175		152		
YES	2	PSV	200	100-04		3412	Pressure Safety Valve	Crosby	2 H 3 JOS 35 J	60mm 300# RF inlet x 89mm 150# RF outlet, 506.45mm Orifice, Nace MR-1075		152	75	
YES	2	PSV	202	100-04		8727	Pressure Safety Valve	Crosby	1-1/2 F 2 JOS 45 J	48mm 600# RF inlet x 60mm 150# RF outlet, 198.064mm Orifice, Nace MR-1075		152	76	
YES	2	PSV	203	100-04		11377	Pressure Safety Valve	Crosby	1-1/2 F 2-1/2 JOS 55 J	48mm 900# RTJ inlet x 73mm 300# RF outlet, 198.064mm Orifice, Nace MR-1075		152	77	
YES	2	PT	100	100-04	0-2068		Pressure Transmitter	Wika	892.23.520	4-20 MA output, 24 VDC power, class 1 div. 2 group D, Nace c/w 21mm NPT bushing				
YES	2	PT	210	100-04	0-6895		Pressure Transmitter	Wika	892.23.520	4-20 MA output, 24 VDC power, class 1 div. 2 group D, Nace c/w 21mm NPT bushing		152	80	
YES	2	PT	211	100-04	0-13790		Pressure Transmitter	Wika	892.23.520	4-20 MA output, 24 VDC power, class 1 div. 2 group D, Nace c/w 21mm NPT bushing		152	101	
YES	2	PT	212	100-04	0-13790		Pressure Transmitter	Wika	892.23.520	4-20 MA output, 24 VDC power, class 1 div. 2 group D, Nace c/w 21mm NPT bushing		152	81	
	2	RO	121	100-04			Orifice	Daniel	Orifice Plate	219mm 300#, c/w 7.981" bore		152	109	
	2	RO	123	100-04			Orifice	Daniel	Orifice Plate	168mm 600#, c/w 6.265" bore		152	110	
	2	RO	124	100-04			Orifice	Daniel	Orifice Plate	114mm 600#, c/w 3.826" bore		152	111	
YES	2	SOV	101	100-04			Solenoid Valve	ASCO	EF8320G202	3-Way, 24 VDC, XP	CSA approved, instrument gas service	152	73	

**APACHE CANADA LIMITED**  
**INSTRUMENT LIST - PROPAK SO# 99404**  
**HAMBURG 2 - 6 COMPRESSOR STATION**  
**LSD: 02-06-097-11 W6M**

REV	1	2	
DATE	99/12/28	00/05/28	

DATA SHEET	REV #	TAG #	MFS #	RANGE	ENG UNIT	SET POINT	INSTRUMENT TYPE	MANUFACTURER	MODEL #	COMMENTS	AREA #	BOM ITEM#	
	2	TC	210	100-04	-34 - 204	°C	49	Temperature Controller	Kimray	HT 12T	c/w 316SS thermowell, separable socket model 3/4" SS-12-SS and 3PG valve	152	108
	2	TC	211	100-04	-34 - 204	°C	49	Temperature Controller	Kimray	HT 12T	c/w 316SS thermowell, separable socket model 3/4" SS-12-SS and 3PG valve	152	108
	2	TC	212	100-04	-34 - 204	°C	49	Temperature Controller	Kimray	HT 12T	c/w 316SS thermowell, separable socket model 3/4" SS-12-SS and 3PG valve	152	108
YES	2	TE	100	100-04	0 - 1260	°C	35	Temperature Element	Thermo-Kenetics	K Type	Single Thermocouple, spring loaded c/w 27mm NPT, 304 SS, 52mm Insertion Thermowell	152	84
YES	2	TE	110	100-04	0 - 1260	°C	80	Temperature Element	Thermo-Kenetics	K Type	Single Thermocouple, spring loaded c/w 27mm NPT, 304 SS, 102mm Insertion Thermowell	152	83
YES	2	TE	120	100-04	0 - 1260	°C	80	Temperature Element	Thermo-Kenetics	K Type	Single Thermocouple, spring loaded c/w 27mm NPT, 304 SS, 63.5mm Insertion Thermowell	152	82
YES	2	TE	124	100-04	0 - 1260	°C	176	Temperature Element	Thermo-Kenetics	K Type	Single Thermocouple, spring loaded c/w 27mm NPT, 304 SS, 102mm Insertion Thermowell	152	83
YES	2	TE	126	100-04	0 - 1260	°C	176	Temperature Element	Thermo-Kenetics	K Type	Single Thermocouple, spring loaded c/w 27mm NPT, 304 SS, 63.5mm Insertion Thermowell	152	82
YES	2	TE	122A	100-04	0 - 1260	°C	176	Temperature Element	Thermo-Kenetics	K Type	Single Thermocouple, spring loaded c/w 27mm NPT, 304 SS, 102mm Insertion Thermowell	152	83
YES	2	TE	122B	100-04	0 - 1260	°C	176	Temperature Element	Thermo-Kenetics	K Type	Single Thermocouple, spring loaded c/w 27mm NPT, 304 SS, 102mm Insertion Thermowell	152	83
YES	2	TI	210	100-04	50-500/10-260	°F/°C		Temperature Indicator	Trend	33040-A-0-06-G-4	Dual Scale, 3" dial, 1/2" stem, 1/2" NPT c/w 304 SS Thermowell, 3/4" NPTM X 1/2" NPTF	152	85
YES	2	TI	211	100-04	50-500/10-260	°F/°C		Temperature Indicator	Trend	33040-A-0-06-G-4	Dual Scale, 3" dial, 1/2" stem, 1/2" NPT c/w 304 SS Thermowell, 3/4" NPTM X 1/2" NPTF	152	85
YES	2	TI	212	100-04	50-500/10-260	°F/°C		Temperature Indicator	Trend	33025-A-0-06-G-4	Dual Scale, 3" dial, 2.5" stem, 1/2" NPT c/w 304 SS Thermowell, 3/4" NPTM x 1/2" NPTF	152	86
<b>ENGINE FUEL / START GAS SYSTEM</b>													
YES	2	FCV	223	100-05		kPag	21	Flow Control Valve	Murphy	M5180-P	Fuel Gas Valve, semi-automatic, 552 KPA MAWP, 2" NPT	152	8
N/A	2	FCV	227	100-05				Flow Control Valve	Ingersol Rand	SRV-150	1-1/2" NPT	152	98
N/A	2	IP	219	100-05	34 - 241	kPa		Transducer	Fisher	546	4-20 mA Input , 3-15 psig output, XP c/w 67 AFR 5-35 PSIG, c/w 1/4" NPT tapped bonnet	152	10
YES	2	PI	222	100-05	0-1103	kPag	207	Pressure Gauge	Wika	233.53	Engine fuel gas, 2-1/2" dial, 1/4" NPT bottom connect	152	11
YES	2	PI	227	100-05	0-1103	kPag	689	Pressure Gauge	Wika	233.53	Starter gas, 2-1/2" dial, 1/4" npt bottom connect	152	11
YES	2	PRV	221	100-05	103-276	kPag	172	Pressure Regulator	Fisher	627	33 mm NPT, 9.5 mm Port, sweet natural gas	152	2
YES	2	PRV	225	100-05	69-414	kPag	241	Pressure Regulator	Fisher	1805-1	33 mm NPT, Cast Iron c/w NPT tapped closing cap, sweet natural gas	152	3
N/A	2	SOV	223	100-05				Solenoid Valve	ASCO	EF8320G202-24	3-way, 24 VDC, CSA Approved Class 1, Division 1, Groups C & D	152	6
N/A	2	SOV	227	100-05				Solenoid Valve	ASCO	EF8320G202-24	3-way, 24 VDC, CSA Approved Class 1, Division 1, Groups C & D	152	6
N/A	2	SS	229	100-05		RPM		Speed Switch	Dynalco	M204	3-way, 24 VDC, CSA Approved Class 1, Division 1, Groups C & D	152	117
	2	STR	227			RPM		Starter	TDI	T1112-60001-B1R	c/w cable assembly for M204, 30 feet long p/n C101-30	152	65
	2	VSH	230	100-05		RPM		Starter	TDI	T1112-60001-B1R	c/w 3" FNPT, 90° Elbow (52-26947), starter relay valve (RLVA 25683-001-2-01)	152	9
<b>GLYCOL COOLING SYSTEM</b>													
YES	2	LG	235A	100-06		mm		Level Gauge	Penberthy	Tubular	Jacket Water Surge Tank, c/w (1) set N7A gauge cocks and glass guards	152	21
YES	2	LG	235B	100-06		mm		Level Gauge	Penberthy	Tubular	Aux Water Surge Tank, c/w (1) set N7A gauge cocks and glass guards	152	21

**APACHE CANADA LIMITED**  
**INSTRUMENT LIST - PROPAK SO# 99404**  
**HAMBURG 2 - 6 COMPRESSOR STATION**  
**LSD: 02-06-097-11 W6M**

DATA SHEET	REV	1	2									COMMENTS	AREA #	BOM ITEM#
	DATE	99/12/28	00/05/28	MFS #	RANGE	ENG UNIT	SET POINT	INSTRUMENT TYPE	MANUFACTURER	MODEL #				
YES	2	LSL	235A	100-06				Level Switch-Low	Murphy	L1111		Jacket Water Tank, 1-1/2" (48mm) NPT, 1.0 SG Float, Class 1, Div. 1, Horizontal fit 1/2 CPLG	152	20
YES	2	LSL	235B	100-06				Level Switch-Low	Murphy	L1111		Aux Water Tank, 1-1/2" (48mm) NPT, 1.0 SG Float, Class 1, Div. 1, Horizontal fit 1/2 CPLG	152	20
N/A	2	RC	235A	100-06	103	kPag		Radiator Cap	Kenco	1794		2" NPT F, 7 psig	152	99
N/A	2	RC	235B	100-06	103	kPag		Radiator Cap	Kenco	1794		2" NPT F, 7 psig	152	99
	2	TI	230	100-06	0-250/-20-120	°F/°C		Temperature Indicator	Trend	33025-A-0-06-G-4		Dual scale 3" dial, 1/2" NPT c/w 3/4" NPTM, x 1/2" NPTF, 304 SST, 2.5" insert Thermowell	152	121
YES	2	TI	231	100-06	0-250/-20-120	°F/°C		Temperature Indicator	Trend	33025-A-0-06-G-4		Dual scale 3" dial, 1/2" NPT c/w 3/4" NPTM, x 1/2" NPTF, 304 SST, 2.5" insert Thermowell	152	22
	2	TI	235	100-06	0-250/-20-120	°F/°C		Temperature Indicator	Trend	33025-A-0-06-G-4		Dual scale 3" dial, 1/2" NPT c/w 3/4" NPTM, x 1/2" NPTF, 304 SST, 2.5" insert Thermowell	152	121
	2	TI	236	100-06	0-250/-20-120	°F/°C		Temperature Indicator	Trend	33028-A-0-06-G-4		Dual scale, 3" dial, 1/2" NPT c/w 3/4" MNPT x 1/2" FNPT, 304SS, 2.5" insert Thermowell	152	22
<b>ENGINE LUBE OIL SYSTEM</b>														
YES	2	DPI	253	100-07	0-103	kPag		Differential Pressure Indicator	Midwest	120-AA-10-50-30		c/w 3-way manifold valve and mounting bracket, liquid filled	152	34
YES	2	LG	260	100-07		mm		Level Gauge	Penberthy	Tubular		Lube Oil Supply Tank, c/w (1) Set N7A gauge valves	152	31
								Level Indicator /Controller /Switch - Low	KENCO	LCE-27		SPDT, XP, CSA approved, Class 1, Div. 1, Group C & D, 1/2" NPT Inlet, 1/4" thick Pyrex Sight Glass c/w shutdown switch		
YES	2	LI/LC/LSL	262	100-07									152	100
YES	2	PI	259	100-07	0-1103	kPag	690	Pressure Indicator	Wika	233.53		Lube Oil, 2-1/2" dial, 1/4" NPT bottom connect	152	35
	2	PRV	200	100-07		kPag		Pressure Regulator	Waukesha			c/w KD-200 model 17042GL		
YES	2	PT	257	100-07	0-690	kPag		Pressure Transmitter	Wika	892.13.500		1/2" MNPT, 4-20mA signal output c/w 21mm NPT bushing, sweet lub oil service	152	33
	2	SV	258	100-07				3 Way Ball Valve	Whitey	42XS4		6.4mm Swagelok connections, SS construction	152	129
	2	TCV	200	100-07		°c		Temperature Control Valve	Amot			c/w KD-200 model 17042GL		
	2	TE	205	100-07	0 - 1260	kPa	70	Temperature Element	Thermo-Kenetics	K-Type		Single thermocouple, c/w 27mm NPT, 63.5mm insert 304SS thermowell	152	134
YES	2	TI	256	100-07	0-250/-20-120	°F/°C	75°C	Temperature Indicator	Trend	33025-A-0-06-G-4		Dual scale, 3" dial, 2.5" stem 1/2" NPT c/w 304SS thermowell, 3/4" NPTM x 1/2" NPTF	152	36
	2	TI	258	100-07	0-250/-20-120	°F/°C		Temperature Indicator	Trend	33025-A-0-06-G-4		Dual Scale, 3" dial, 2.5" stem, 1/2" NPT c/w 304 SS Thermowell, 3/4" NPTM x 1/2" NPTF	152	135
N/A	2	VT	205	100-07	-40 - 100	°C		Vibration Transmitter	Metrix	5484C-123		non-indicating, 1/4" NPT w/ 1/2" bushing, 4-20 mA output, 5-1500 HZ, 24 VDC, 50 OHM load resist, Class 1, Div 1, Groups C&D, hazardous loc.	152	64
<b>COMPRESSOR LUBE OIL SYSTEM</b>														
YES	2	LG	270	100-08		mm		Level Gauge	Penberthy	Tubular		Lube Oil Supply Tank, c/w (1) Set N7A gauge valves	152	31
YES	2	LG	284	100-08		mm		Level Gauge	Penberthy	Tubular		Waste Oil Tank, c/w (1) Set N7A gauge valves	152	31
								Level Indicator /Controller /Switch - Low	KENCO	LCE-9		SPDT, XP, CSA approved, Class 1, Div. 1, Group C & D, 1/2" NPT Inlet x 3/4" NPT Outlet c/w shutdown switch		
YES	2	LI/LC/LSL	270	100-08								1/2" MNPT, 4-20 mA signal output c/w 21mm NPT bushing, sweet lubricating oil service	152	30
YES	2	PT	281	100-08	0 - 690	kPa		Pressure Transmitter	Wika	892.13.500			152	63
N/A	2	SOV	276	100-08				Solenoid Valve	ASCO	EF8320G202		3-Way, CSA approved, XP, 24 VDC	152	130
	2	SV	276	100-08	34 - 103	kPa		3 Way Valve	Amot	4057CT		BUNA-N Seals, spring return	152	131
YES	2	TE	282	100-08	0 - 1260	°C	82	Temperature Element	Thermo-Kenetics	K-Type		Single thermocouple, c/w 27mm NPT, 63.5mm insert 304SS thermowell	152	37

**APACHE CANADA LIMITED**  
**INSTRUMENT LIST - PROPAK SO# 99404**  
**HAMBURG 2 - 6 COMPRESSOR STATION**  
**LSD: 02-06-097-11 W6M**

DATA SHEET	REV	1	2									COMMENTS	AREA #	BOM ITEM#
	DATE	99/12/28	00/05/28											
	REV #	TAG #		MFS #	RANGE	ENG UNIT	SET POINT	INSTRUMENT TYPE	MANUFACTURER	MODEL #				
YES	2	TI	275	100-08	0-250/-20-120	°F/°C		Temperature Indicator	Trend	33025-A-0-06-G-4		Dual scale, 3" dial, 2.5" stem 1/2" NPT c/w 304SS thermowell, 3/4" NPTM x 1/2" NPT	152	37
YES	2	TI	280	100-08	0-250/-20-120	°F/°C		Temperature Indicator	Trend	33025-A-0-06-G-4		Dual scale, 3" dial, 2.5" stem 1/2" NPT c/w 304SS thermowell, 3/4" NPTM x 1/2" NPT	152	37
N/A	2	VT	288	100-08	-40 - 100	°C		Vibration Transmitter	Metrix	5484C-123		non-indicating, 1/4" NPT w/ 1/2" bushing, 4-20 mA output, 5-1500 HZ, 24 VDC, 50 OHM load resist, Class 1, Div 1, Groups C&D, hazardous loc.	152	64
<b>COMPRESSOR PACKING VENT &amp; DRAINS</b>														
	2	DPS	288	100-09	14 - 490	kPag	70	Differential Pressure Switch	CCS	646DZE2		Falling, class 1 div 2 Groups C & D. NACE	152	136
NO	2	FI	286	100-09	0-60	SCFH		Flow Indicator	Zimco	7510-3-3-2A-11		1/4" NPT, ss inlet and outlet, sweet natural gas C.65 SG, Vertical mount	152	56
NO	2	FI	287	100-09	0-60	SCFH		Flow Indicator	Zimco	7510-3-3-2A-11		1/4" NPT, ss inlet and outlet, sweet natural gas C.65 SG, Vertical mount	152	56
	2	FSL	289	100-09										
YES	2	LG	130	100-09				Level Gauge	Penberthy	Tubular		c/w (1) set N7A gauge valves	152	51
YES	2	PI	286	100-09	0-103	kPag	41	Pressure Indicator	Wika	233.53		Packing Vent, 2-1/2" dial, 1/4" NPT bottom connect	152	57
YES	2	PI	287	100-09	0-414	kPag	172	Pressure Indicator	Wika	233.53		Packing Vent, 2-1/2" dial, 1/4" NPT bottom connect	152	58
YES	2	PRV	130	100-09	34-241	kPag	100	Pressure Regulator	Fisher	98H		48mm NPT, WCB steel body, for sour service	152	53
YES	2	PRV	286	100-09	34-241	kPag	41	Pressure Regulator	Fisher	67-AFR		13mm FNPT, 2000#, Nace, ventable bonnet	152	54
YES	2	PRV	287	100-09	34-241	kPag	172	Pressure Regulator	Fisher	67-AFR		13mm FNPT, 2000#, Nace, ventable bonnets	152	55
YES	2	PSH	130	100-09	21-83	kPag	69	Pressure Switch	CCS	6900GZE12		3/4" NPTM, 1/4" FNPT, CSA-Class 1 Div 1 group C&D, sour service	152	52
<b>DRIVE TRAIN EQUIPMENT</b>														
N/A	2	VSH	299	100-10				Vibration Switch - High	Murphy	VS-2 EX		CSA Approved, XF Contacts Open on HI	238	1
<b>BUILDING UTILITIES</b>														
	2	PRV	240A	100-11					CATADYNE			VENDOR SUPPLIED		
	2	PRV	240B	100-11					CATADYNE			VENDOR SUPPLIED		
	2	PRV	240C	100-11					CATADYNE			VENDOR SUPPLIED		



# M2582, M5081, and M5180 Series Electromechanical and Pneumatic, Fuel Gas Shut- off Valves Installation and Operation Instructions



Please read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended before mounting. It is your responsibility to have a qualified person install the unit and make sure installation conforms with NEC and local codes.

## GENERAL INFORMATION

### WARNING

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

- ✓ Disconnect all electrical power to the machine.
- ✓ Make sure the machine cannot operate during installation.
- ✓ Follow all safety warnings of the machine manufacturer.
- ✓ Read and follow all installation instructions.

### M2582 and M5081 Series

#### Tripping Power From Engine Ignition System or Battery (Models available for magneto, CD ignition or 12/24 V battery)

These fuel shut-off valves are semi-automatic devices for shutdown of natural gas fueled engines. The standard valve opens by manual operation of the reset handle. A latch in the upper body of the valve will set and hold the valve open. At this point no electric power is used. The electromagnetic coil is de-energized, the snap-switch(es) is SET.

If a SWICHGAGE® contact closes, a circuit is completed from power through the snap-switch and coil. Now energized, the electromagnet trips the latch, (latch can be tripped manually), the valve closes, and the snap-switch resets. Power switches from the coil circuit to your choice of an open line, an electrical ground, or an alarm. After tripping, the vent seal opens, and on the M50 models, the open/close indicator (green button) retracts to indicate that the valve is closed.

Valve body is sandcast aluminum. Optional cast steel for M5081 models.

### M2582-P, M5180-P and M5180-V

#### MURPHY-NUMATIC™ Pneumatic Version for Pressure or Vacuum

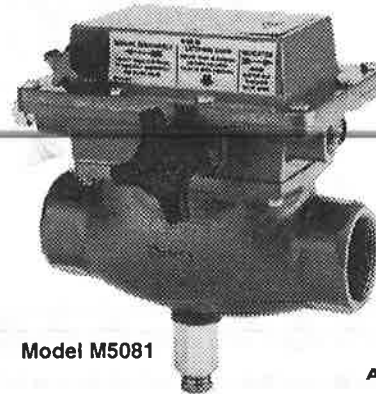
Pneumatically controlled valves are designed to open and close automatically or semi-automatically (the supply can be air, oil or gas). M5180 models can operate from vacuum or pressure (pressure fittings can be swapped for vacuum control). The M2582-P is not available for vacuum.

**NOTE:** If using oil as a pressure source, use a lightweight oil.

These valves will open on rising control pressure and close on decreasing control pressure. M2582-P and M5180-P automatically open at 2 psi (14 kPa) [0.14 bar] and fully open at 3 psi (21 kPa) [0.21 bar].

All models include a built-in lever to aid in opening the valve manually. The M2582-P can be manually opened against inlet pressure of 80 psi (552 kPa) [5.52 bar]. The M5180-P valve can be opened against inlet pressure of 100 psi (689 kPa) [6.89 bar].

Standard models include an escape vent for gas trapped forward in the line after shut-off.



Model M5081



Approved\*

### M5081FS

#### Normally Energized Circuit

The M5081FS is manually opened, electrically latched open and tripped by interrupting the coil power circuit.

#### Magnetic Switch Adapter

As ignition systems wear from usage, their power output becomes less and less. Ignition may not have the capacity to reliably trip the Fuel Valve. Therefore, the use of a Magnetic Switch Adapter for CD ignition systems is recommended. The Magnetic Switch Adapter is a device that stores energy from the CD ignition to trip the Fuel Valve. Three models are available:

**65020126:** For Negative Ground CD Ignitions up to 240 VDC

**65020127:** For Positive Ground CD Ignitions up to 450 VDC

**65020155:** For Negative Ground CD Ignitions up to 450 VDC

#### 100 ohm, 2 watt Resistor

For Capacitor Discharge Ignitions that are specified to be grounded when the valve closes, and a Magnetic Switch Adapter is in use. The resistor must be connected in the system to prevent damage to the snap-switches in the fuel shut-off valve (see typical wiring diagrams).

A 100 ohm, 2 watt resistor is supplied on page 11, for your convenience.

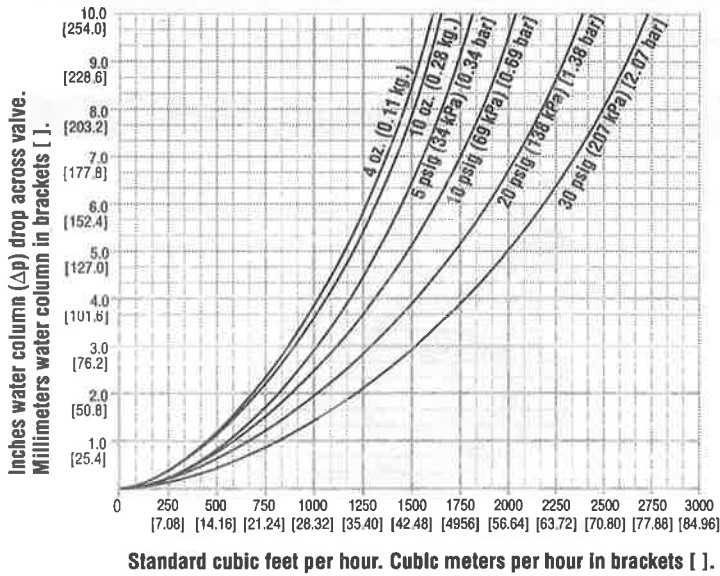
#### Diode Package

The Murphy diode package (65010065) is designed to allow the fuel shut-off valve to be used with dual Magneto Ignition systems.

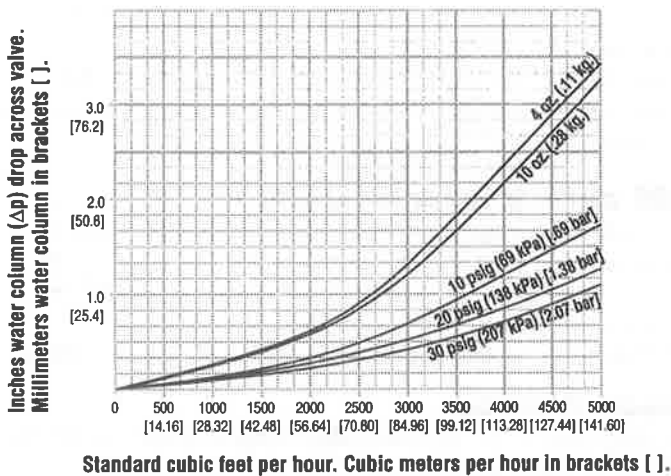
\* M5081 model is CSA approved for Class I, Division 1, Groups C and D. See Specifications on page 12.

## FLOW CHARACTERISTICS

### M2582 Series



### M5081 Series



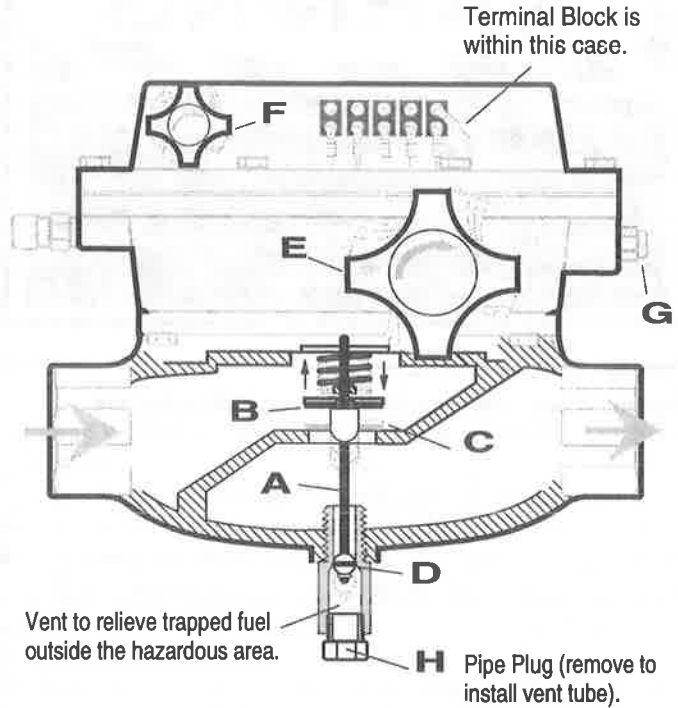
## VALVE CUT-OUT

### Understanding the Basic Operation of the Fuel Shut-off Valve

The valve below is shown in the run (open) position. Pressure is equalized, seat (B) is open, allowing the fuel to flow. When valve is in the tripped position (closed), seat closes (C).

The vent (D) opens to relieve trapped downstream fuel to vent to a non-hazardous area.

TYPICAL MODEL (M5081) SHOWN



- A. Main Stem
- B. Pressure Disc/seal (in run/open)
- C. Pressure Disc/seal (in trip/closed)
- D. Vent Seal Gland
- E. Reset Knob (latches valve open)
- F. Manual Trip Knob (not available for M5081FS)
- G. Indicator Button (out with valve open)
- H. Pipe Plug

**NOTE:** If the vent-after-tripping feature is not used, remove O-ring (D), to avoid condensation accumulation that can hamper trip action.

**Be sure** to replace Pipe Plug (H) and to clean vent periodically.

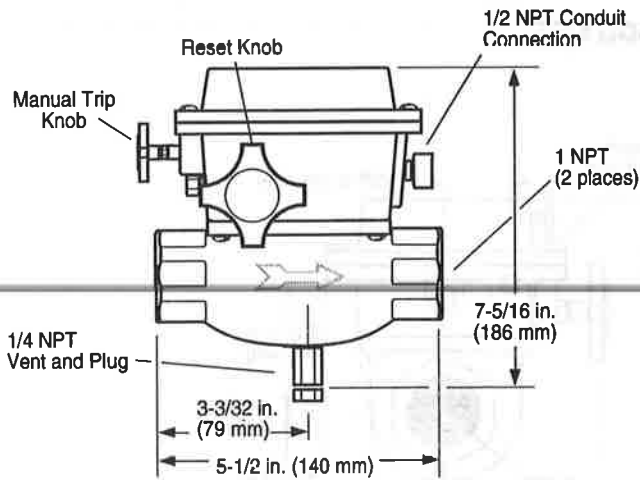


## DIMENSIONS

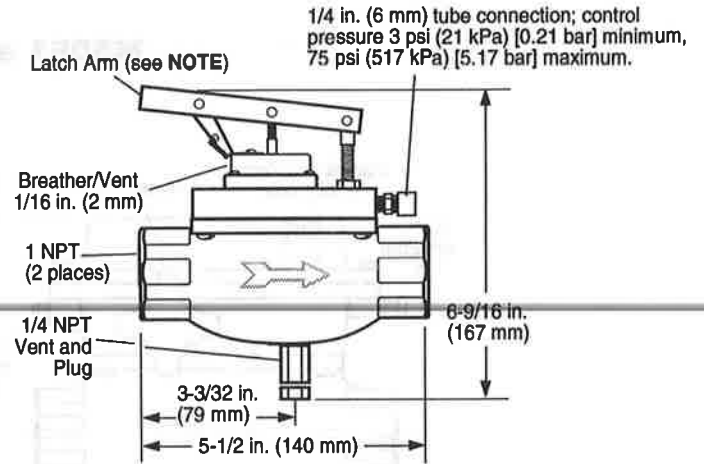


**CAUTION:** THE ARROW ON THE SIDE OF THE FUEL VALVE **MUST** POINT TO THE CORRECT DIRECTION OF THE FLOW, FROM FUEL SOURCE TO THE ENGINE. APPLY PIPE DOPE **ONLY** TO FUEL PIPE, **NOT** TO THE FUEL VALVE.

### M2582

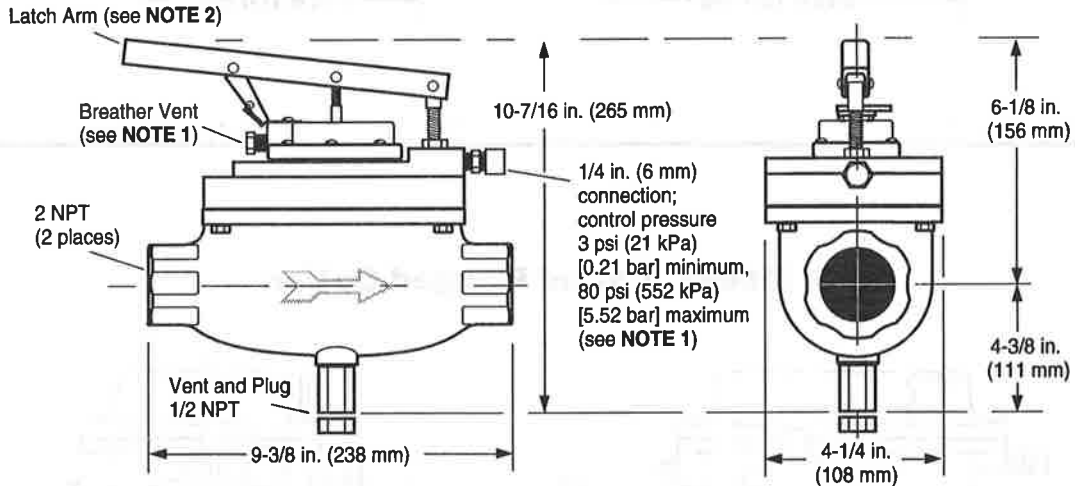


### M2582-P



**NOTE:** Thumb operated opening latch (2.5 psi [17 kPa] [0.17 bar] required to release cocking latch)

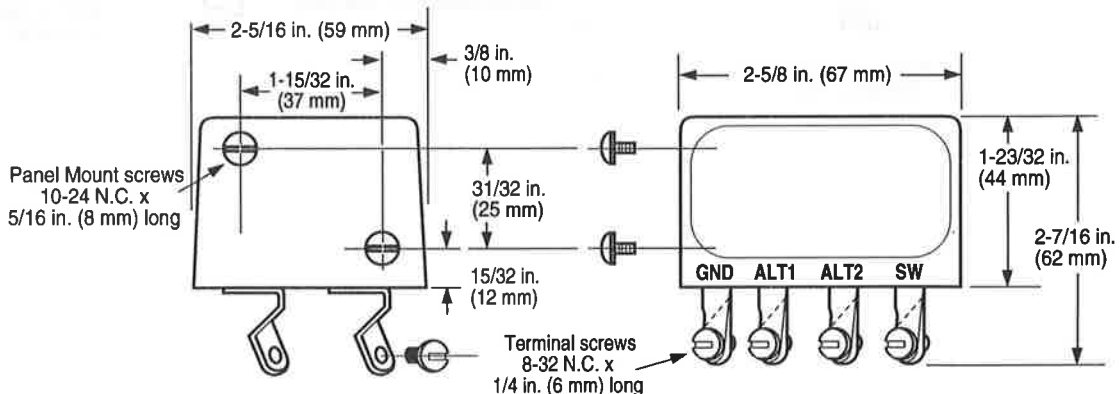
### M5180-P and M5180-V



**NOTE 1:** Control pressure connection fitting and breather vent fitting can be swapped to convert to vacuum control.

**NOTE 2:** Thumb operated opening latch (2.5 psi [17 kPa] [0.17 bar] required to release cocking latch).

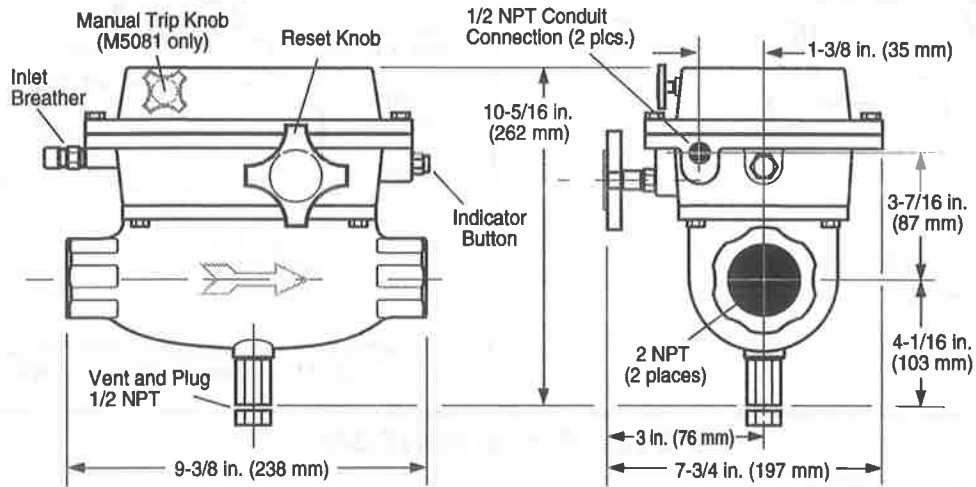
### Magnetic Switch Adapters 65020126, 65020127 and 65020155



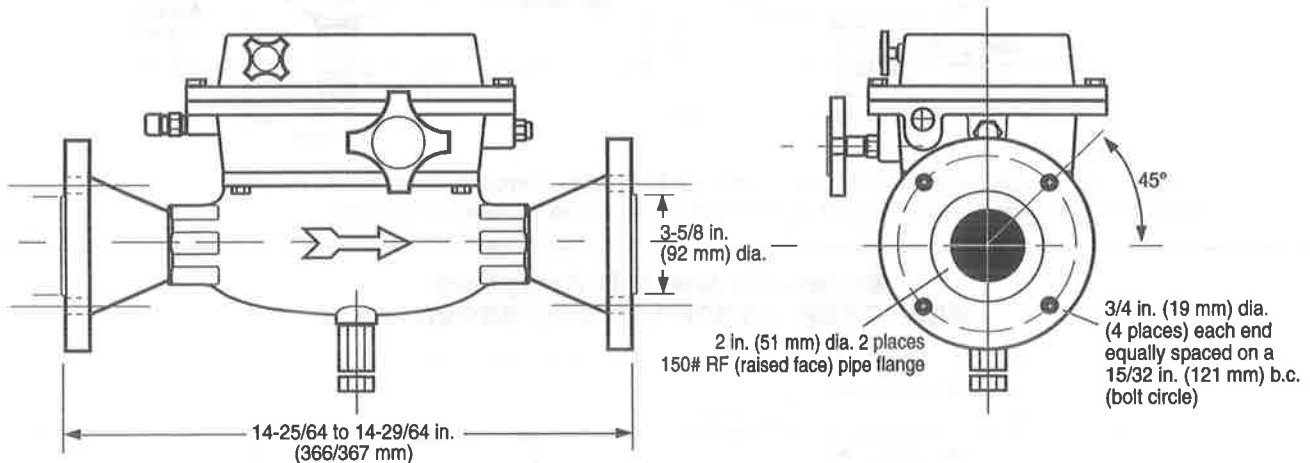


**CAUTION:** THE ARROW ON THE SIDE OF THE FUEL VALVE **MUST** POINT TO THE CORRECT DIRECTION OF THE FLOW, FROM FUEL SOURCE TO THE ENGINE. APPLY PIPE DOPE **ONLY** TO FUEL PIPE, **NOT** TO THE FUEL VALVE.

**M5081 and M5081FS**



**M5081-3 Steel Flanged Option**



## INSTALLATION



**WARNING:** STOP THE ENGINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION. BEGIN THE INSTALLATION BY SECURING AREA OF ANY HAZARDOUS CONDITIONS. SHUTOFF THE FUEL GAS SUPPLY. FOR HAZARDOUS APPLICATIONS REFER TO NATIONAL ELECTRICAL CODE SPECIFICATIONS.

### Connecting the Fuel Shut-off Valve

1. Before connecting the unit, apply pipe dope to plumbing male threads that will be inserted into the valve. Do **not** apply pipe dope to the valve.
2. Make sure that the arrow on the side of the valve indicates the correct direction of the flow.
3. Fuel shut-off valves can be installed in all three planes. However, mounting the valve horizontally (with vent pointing down) is recommended. Do **not** install valve with top down. (Refer to *Figure 1*.)
4. Hold valve in position, (use a tool on valve wrench flats) and tighten plumbing into inlet and outlet ends. (Refer to *dimensions on pages 3-4*.)



**CAUTION:** DO NOT TWIST THE VALVE BODY HOUSING.

5. To mount flanged models, follow the appropriate installation codes and ordinances for the application. (For *dimensions* see *page 4*.)
6. A vent line (to allow gas trapped forward between fuel valve and the carburetor to escape) should be attached to the vent connection at the bottom of the valve housing. Remove the plug and install the line. (Refer to *Figure 1*.)

### Connecting Pneumatic Models M2582-P, M5180-P and M5180-V

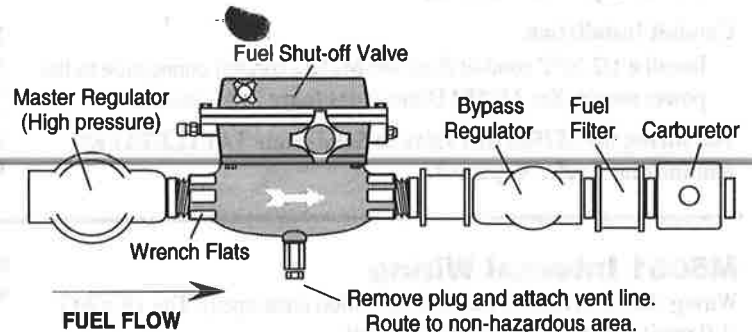
1. Repeat the steps above (1 thru 5), and observe the necessary cautions.
2. A lever/arm (handle) and a cocking latch are provided to allow manual opening of the valve. The thumb-operated latch can be locked in place to hold the lever/arm latched. The cocking latch will be released when pilot pressure reaches 2.5 psi (17 kPa) [0.17 bar]. M2582-P and M5180-P automatically open at 2 psi (14 kPa) [0.14 bar], and fully open at 3 psi (21 kPa) [0.21 bar]. See Specifications, page 12 for maximum control pressure.



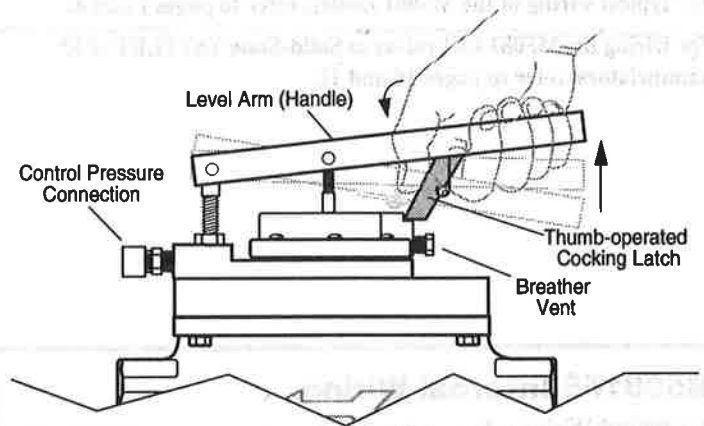
**CAUTION:** BE SURE PNEUMATIC SOURCE RELEASES THE MECHANICAL LATCH WHEN RUNNING.

3. If vacuum control is desired, swap the Control Pressure connection fitting and the Breather Vent fitting on your M5180-P model (see *Fig. 2*).

**Figure 1**  
**Physical Location and Plumbing (typical)**



**Figure 2**  
**Pull the lever up, and press the latch down into ridge with thumb.**



## WIRING INFORMATION



**WARNING:** PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.

### M2582 Internal Wiring

Wiring shown in normal mode of operation (seat open). The 18 AWG (1.0 mm<sup>2</sup>) wire is color coded to the coil:

*For CD ignitions:* White and Orange

*For Magneto ignitions:* White and Green

*For Battery:* White and Blue

#### Conduit Installation

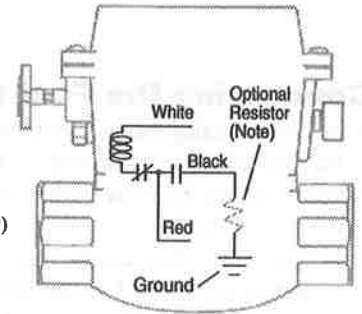
Install a 1/2 NPT conduit from the M2582 conduit connection to the power source. See M2582 Dimensions (page 3) for location.

For wiring the M2582 fuel valve to Solid-State TATTLETALE<sup>®</sup> annunciators, refer to page 9.

### Internal Wiring for M2582

#### NOTE:

For grounding the ignition (CD models only) through the fuel valve snap-switch, use a Magnetic Switch Adapter (see Magnetic Switch Adapter, below) and install a 100 ohm; 2 watt resistor (included on page 11).



### M5081 Internal Wiring

Wiring shown in normal mode of operation (seat open). The 18 AWG (1.0 mm<sup>2</sup>) wire is color coded to the coil:

*For CD Ignitions:* White and Orange

*For Magneto Ignitions:* White and Green

*For Battery:* White and Blue

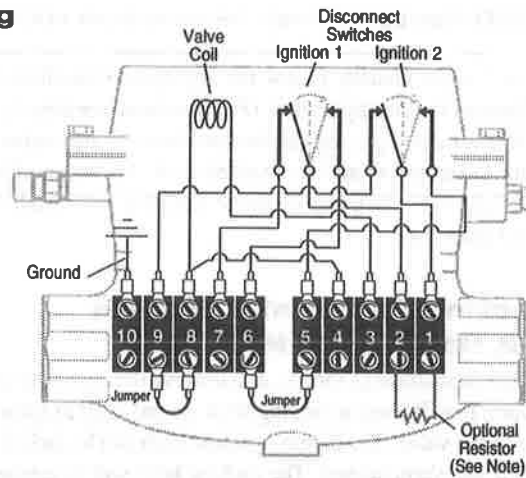
#### Conduit Installation

Install a 1/2 NPT conduit from the M5081 conduit connection to the power source. Refer to Dimensions (on page 4) for location.

For typical wiring of the M5081 models refer to pages 7 and 8.

For wiring the M5081 fuel valves to Solid-State TATTLETALE<sup>®</sup> annunciators, refer to pages 10 and 11.

### M5081 Internal Wiring

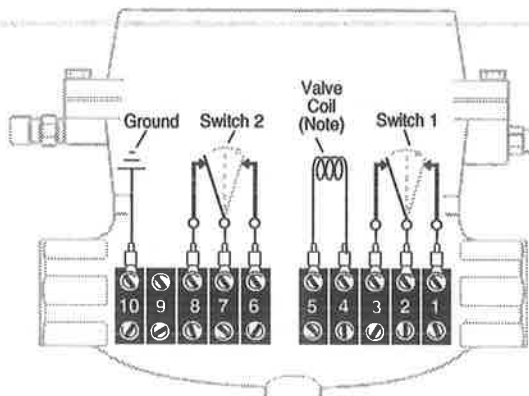


**NOTE:** For grounding the ignition (CD models only) through the fuel valve snap-switches, use a Magnetic Switch Adapter (see Magnetic Switch Adapter, below) and install a 100 ohm; 2 watt resistor (included in page 11).

### M5081FS Internal Wiring

For typical Wiring refer to page 8.

For wiring the M5081FS to MARK IV 12/24 refer to page 11.



**NOTE:** Wiring shown in normal mode of operation (seat open). The 18 AWG (1.0 mm<sup>2</sup>) wire is red color for both options: 12 VDC and 24 VDC.

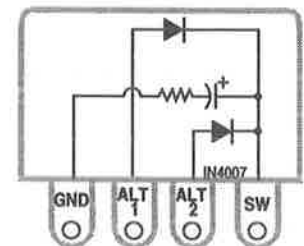
### Magnetic Switch Adapters for Use with Capacitor Discharge Ignitions

Connect the Magnetic Switch Adapter between the fuel Valve terminal 1 and the CD Ignition. See wiring diagrams on pages 7, 9, 10.

65020155: For use with negative ground ignitions up to 450 VDC.

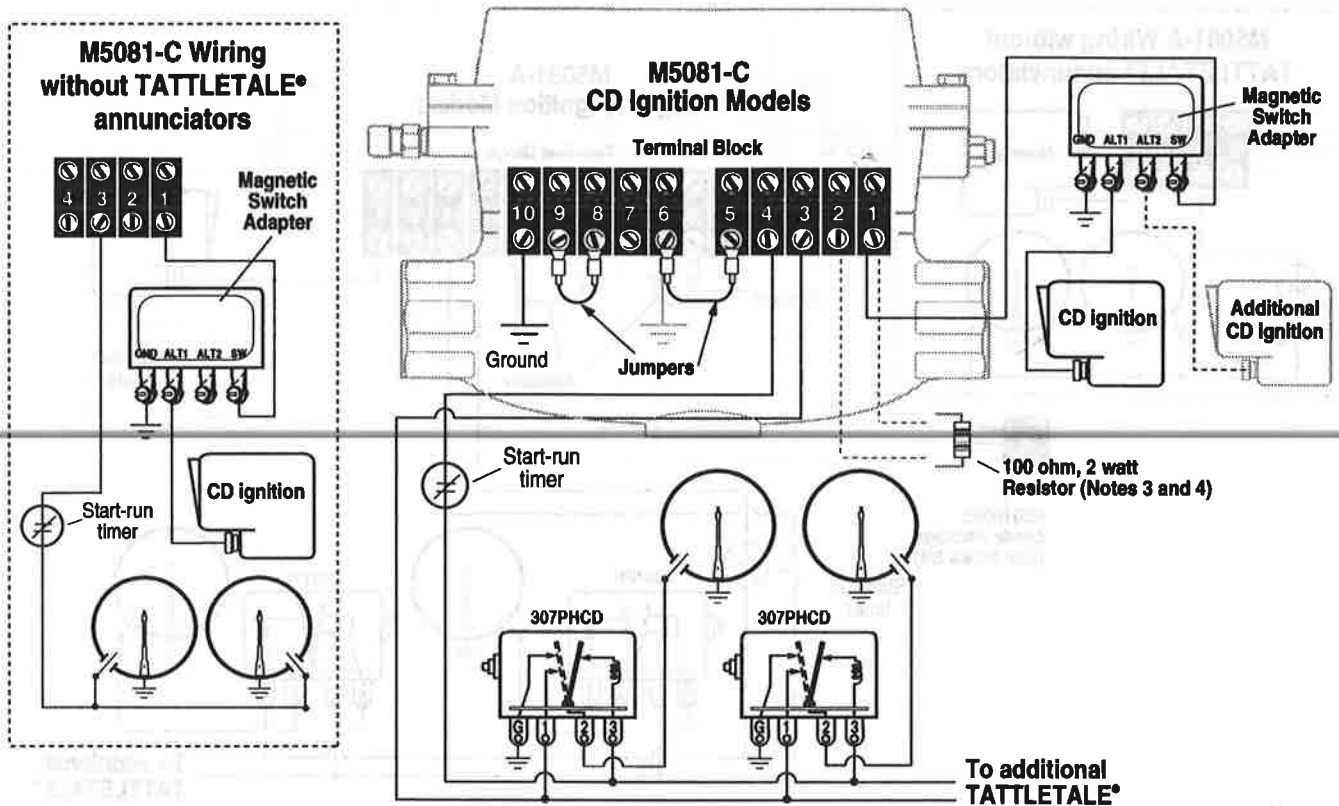
65020127: For use with positive ground ignitions up to 450 VDC.

65020126: For use with negative ground ignitions up to 240 VDC.



Negative ground  
Magnetic Switch Adapter shown

## TYPICAL WIRING for M5081-C (CD IGNITION MODELS)



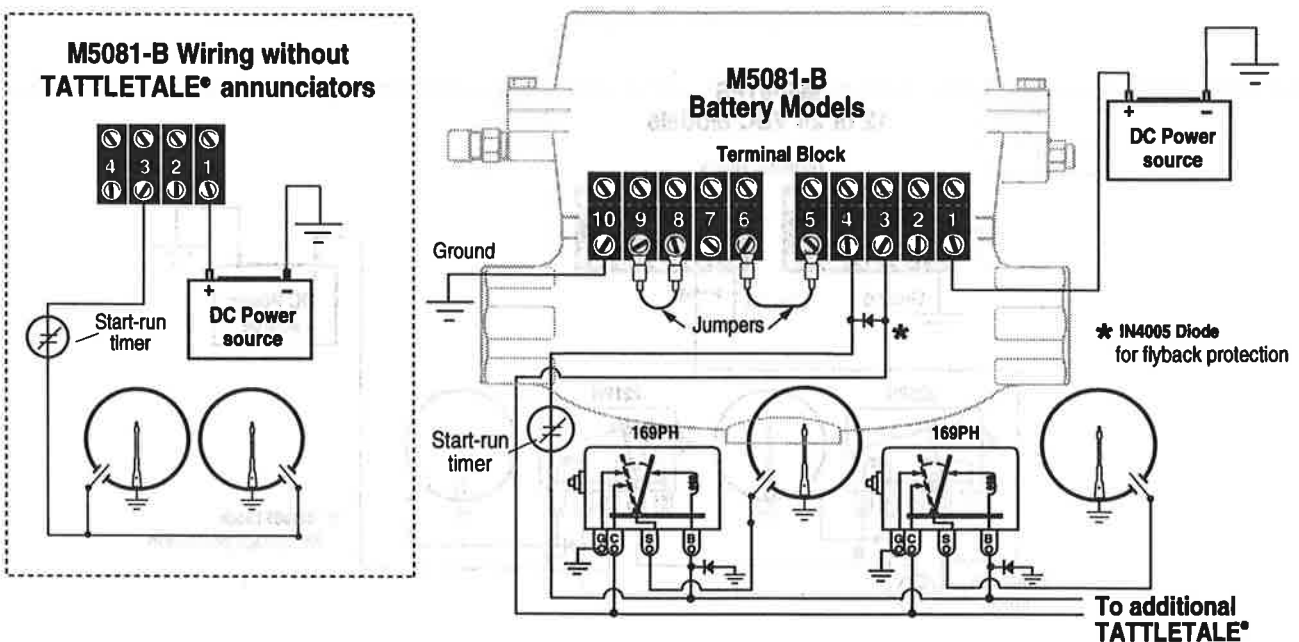
**NOTE 1:** To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITION (Single CD Ignition Systems) Remove the factory-installed jumper on terminals 6-5. Do NOT ground terminal 6.

**NOTE 2:** To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITIONS (Dual CD Ignition Systems) Remove the jumper on terminals 6-5. Connect second ignition to Magnetic Switch Adapter terminal ALT2.

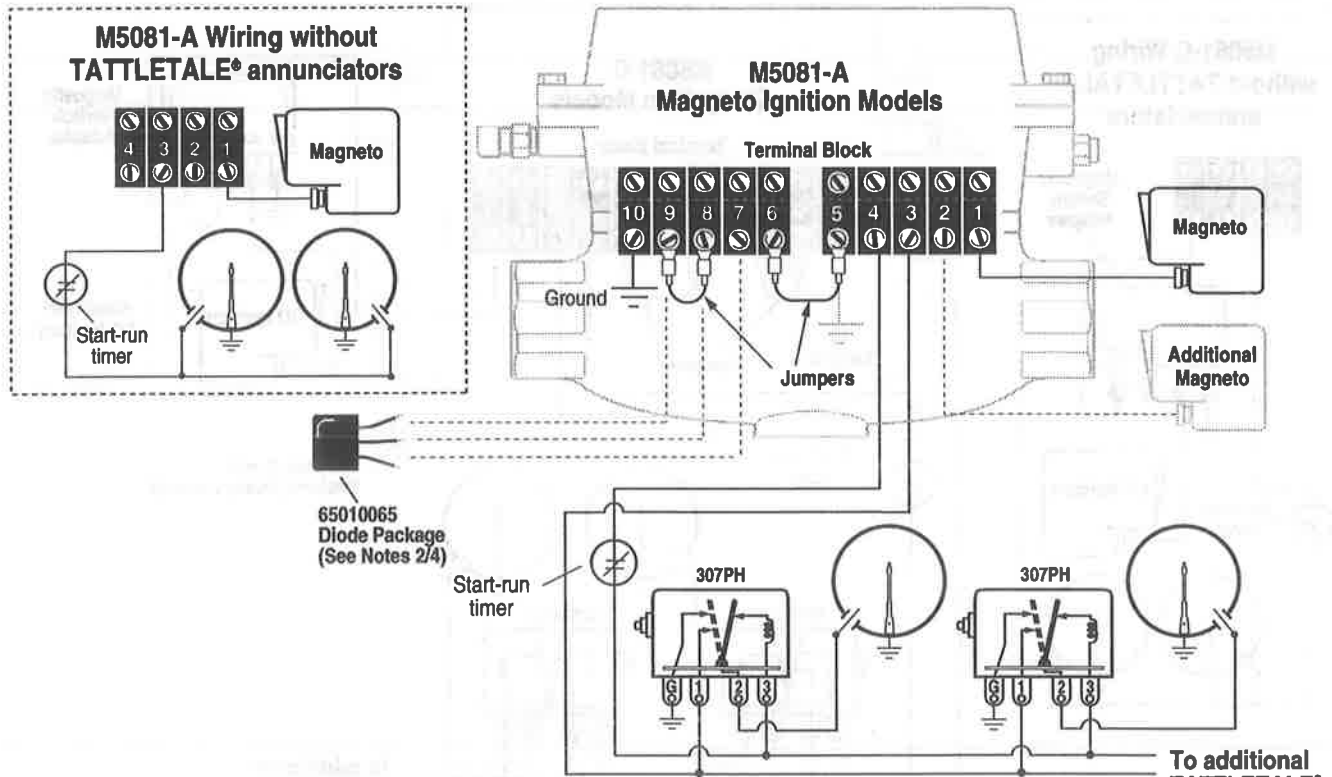
**NOTE 3:** To CLOSE FUEL VALVE and GROUND THE IGNITION (Single CD Ignition Systems) Remove the jumper on terminals 6-5. Connect a 100 ohm, 2 watt resistor between valve terminals 1-2. Ground terminal 6.

**NOTE 4:** To CLOSE FUEL VALVE and GROUND THE IGNITION (Dual CD Ignition Systems) Remove the jumper on terminals 6-5. Connect a 100 ohm, 2 watt resistor between valve terminals 1-2. Ground terminal 6. Connect second ignition to Magnetic Switch Adapter terminal ALT2.

## TYPICAL WIRING for M5081-B (BATTERY IGNITION MODELS)

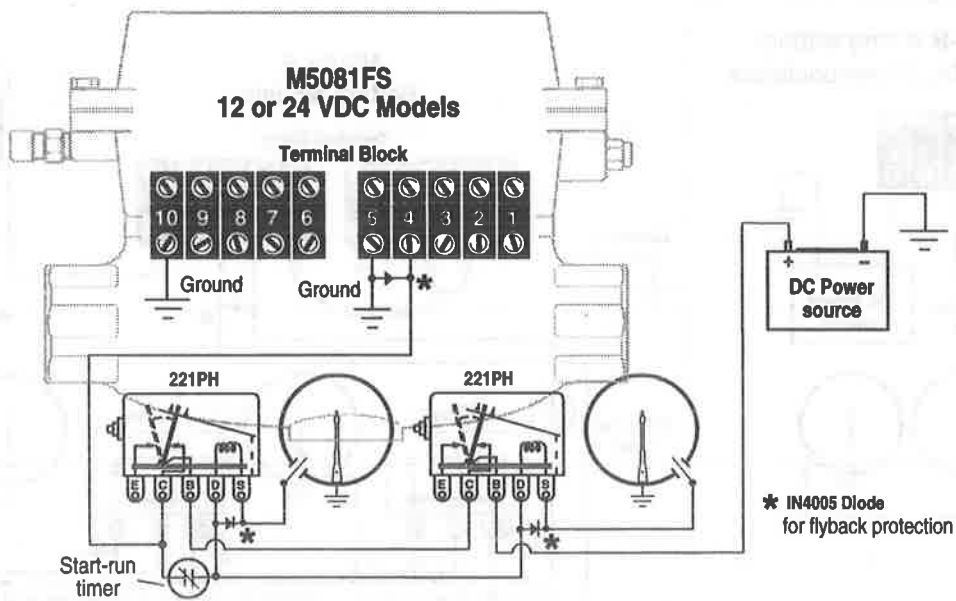


## TYPICAL WIRING for M5081-A (MAGNETO IGNITION MODELS)



- NOTE 1:** To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITION (Single Magneto Systems) Remove the factory-installed jumper on terminals 6-5. Do NOT ground terminal 5.
- NOTE 2:** To CLOSE FUEL VALVE—NOT GROUNDING THE IGNITIONS (Dual Magneto Systems) Remove the factory-installed jumpers on terminals 6-5 and 9-8. Add 65010065 diode package as shown. Do NOT ground terminals.
- NOTE 3:** To CLOSE FUEL VALVE and GROUND THE IGNITION (Single Magneto Systems) The factory-installed jumpers (6-5 and 9-8) must be in place. Add ground wire to terminal 5.
- NOTE 4:** To CLOSE FUEL VALVE and GROUND THE IGNITION (Dual Magneto Systems) Remove the jumper on terminals 9-8. Add 65010065 diode package as shown. Add ground wire to terminal 5.

## TYPICAL WIRING for M5081FS (NORMALLY ENERGIZED MODELS)

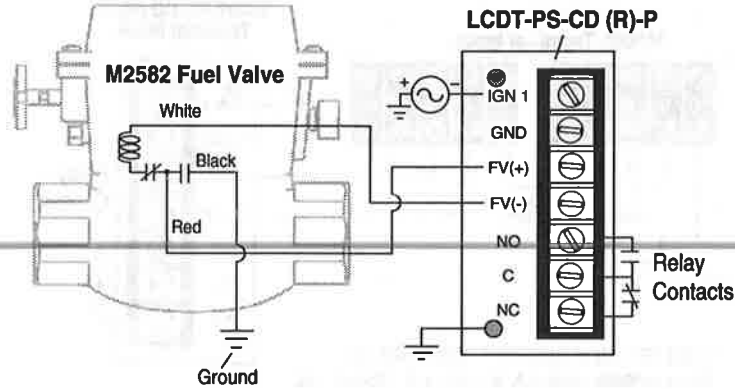


# TYPICAL WIRING for M2582 to SOLID-STATE TATTLETALE®



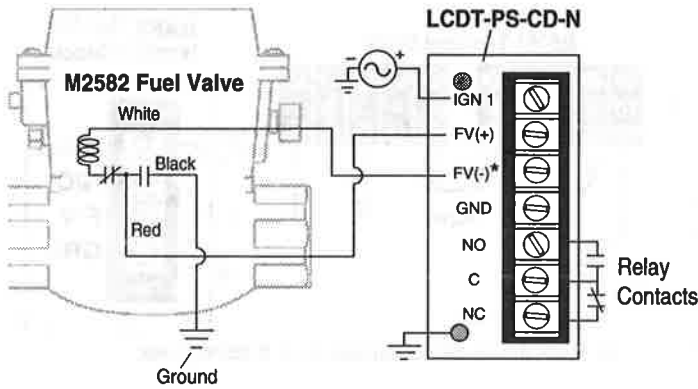
**WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.**

## M2582 to LCDT-PS-CD (R)-P (positive ground)



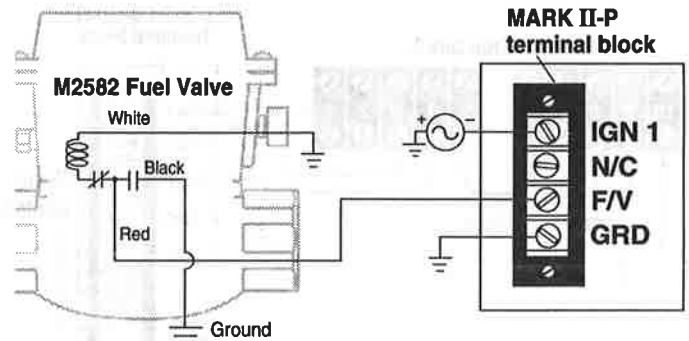
Relay contacts rated: 3 A, 30 VDC, 4 A, 125/250 VAC

## M2582 to LCDT-PS-CD-N (negative ground)



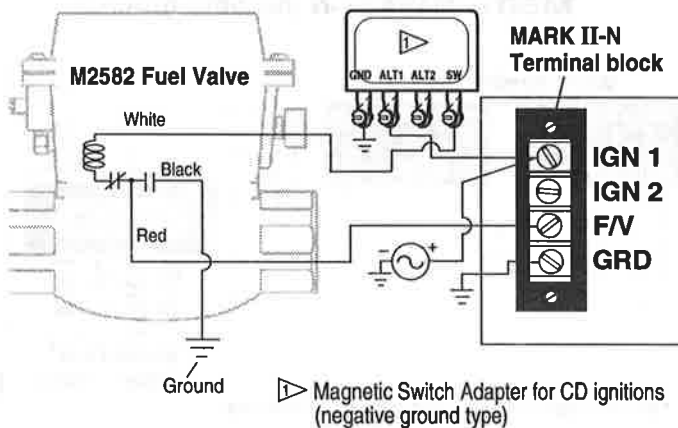
\* Relay contacts rated: 3 A, 30 VDC, 4 A, 125/250 VAC

## M2582 to MARK II-P (positive ground)



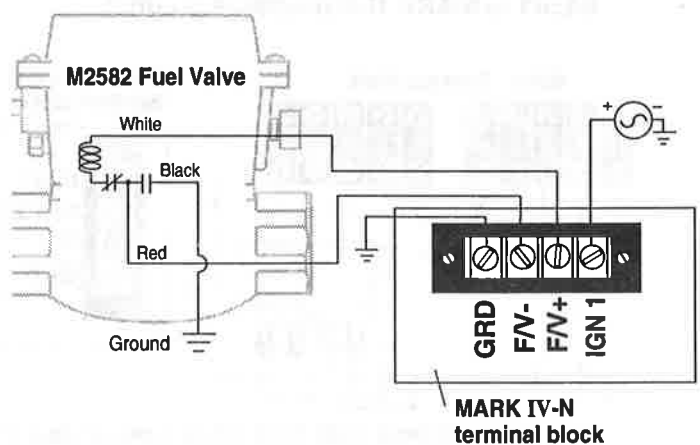
FET output rated: 0.5 A @ 250 VDC max.

## M2582 to MARK II-N (negative ground)



▶ Magnetic Switch Adapter for CD ignitions (negative ground type)

## M2582 to MARK IV-N (negative ground)

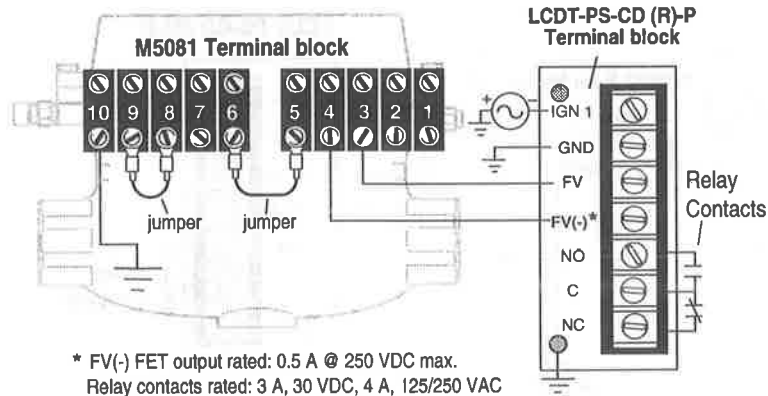


# TYPICAL WIRING for M50 to SOLID-STATE TATTLETALE®

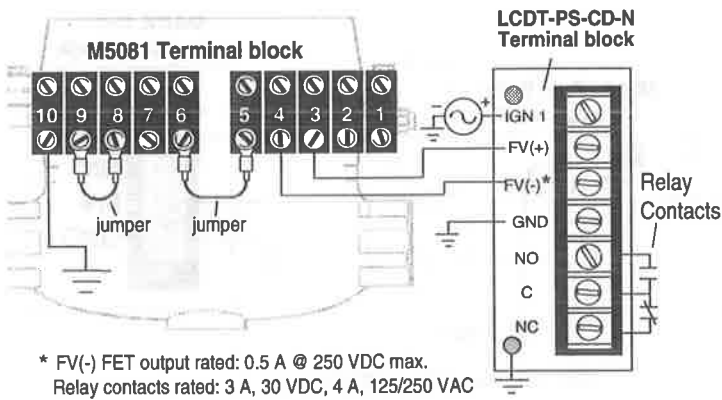


**WARNING:** PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.

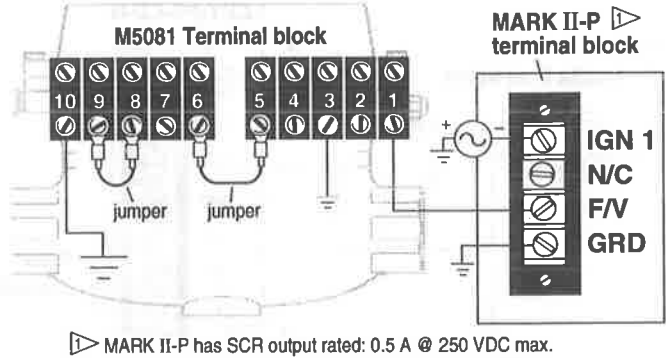
## M50 to LCDT-PS-CD (R)-P (positive ground)



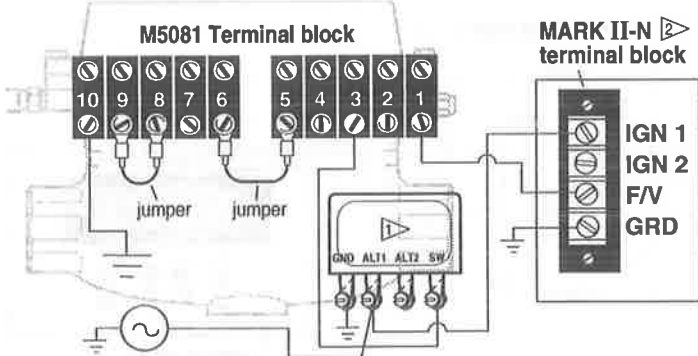
## M50 to LCDT-PS-CD-N (negative ground)



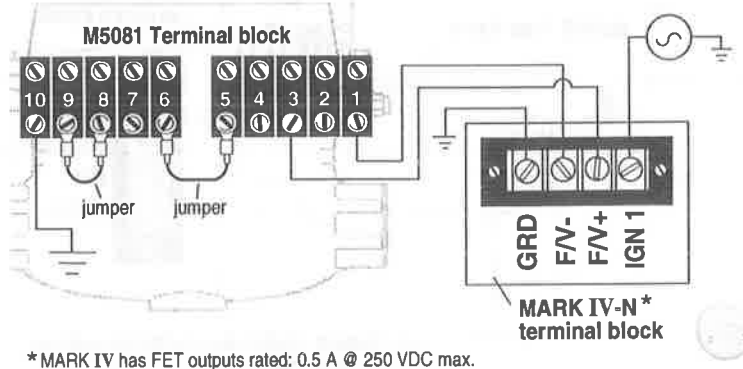
## M50 to MARK II-P (positive ground)



## M50 to MARK II-N (negative ground)



## M50 to MARK IV-N (negative ground)



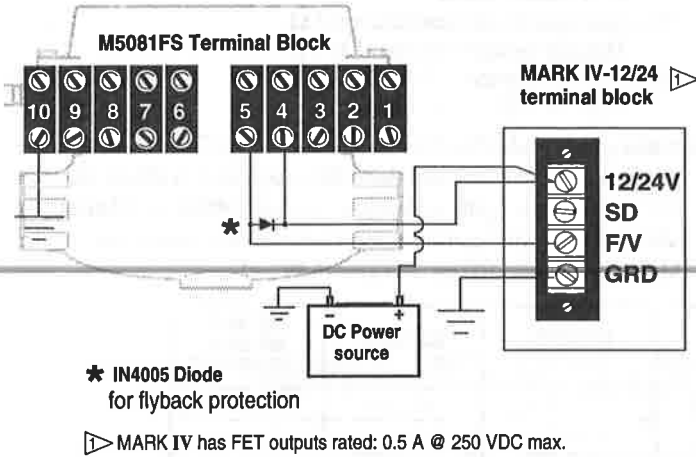


## TYPICAL WIRING for M50 to SOLID-STATE TATTLETALE® *continued*

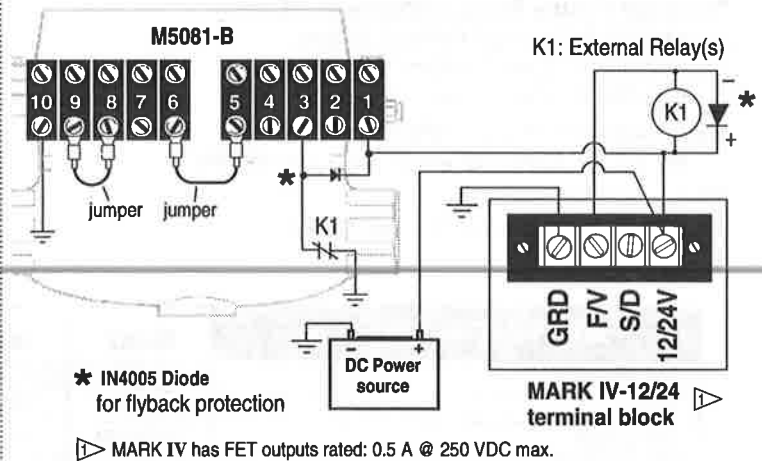


**WARNING: PERFORM THE WIRING OPERATION WITH THE POWER SOURCE "OFF" AND THE AREA MADE NON-HAZARDOUS. MAKE SURE THE VOLTAGE AND CURRENT REQUIREMENTS ARE WITHIN THE FUEL SHUT-OFF VALVE RATINGS. HARD CONDUIT WITH APPROVED SEALS IS REQUIRED BY THE NEC FOR HAZARDOUS AREA INSTALLATIONS.**

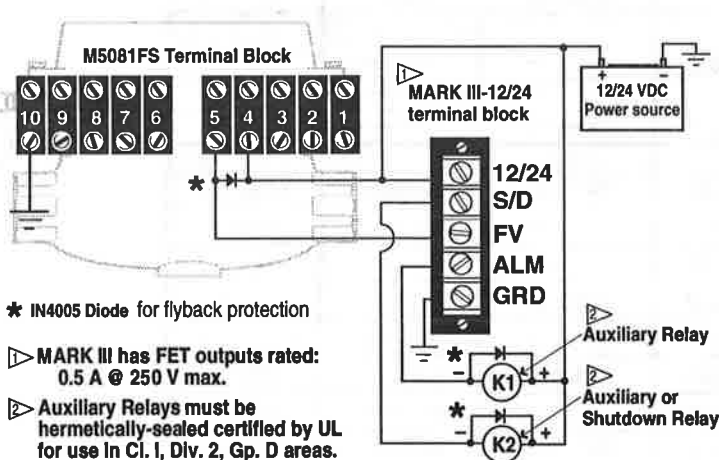
### M5081 FS to MARK IV-12/24



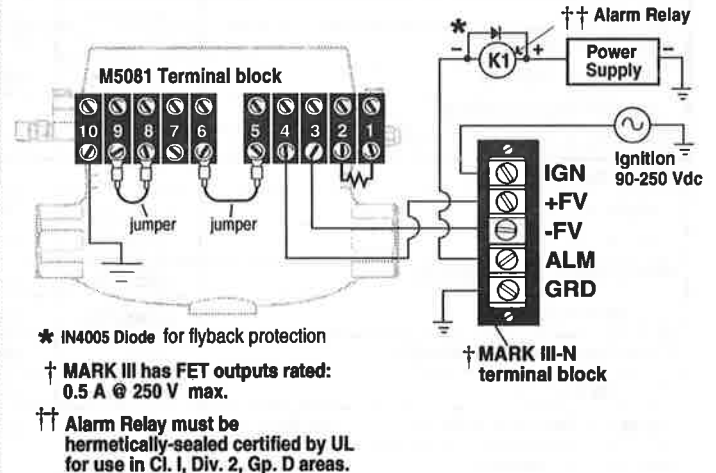
### M5081-B to MARK IV-12/24



### M5081 FS to MARK III-12/24



### M5081 to MARK III-N



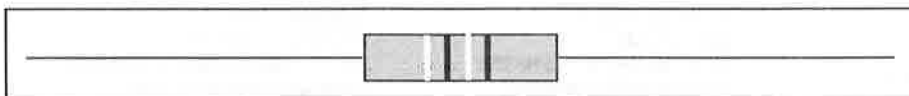
## TO CLOSE FUEL VALVE AND GROUND THE IGNITION

When *Capacitor Discharge Ignition Systems* are specified to be *grounded* when the *fuel gas valve closes*, and a *Magnetic Switch Adapter* is in use, a resistor must be used in the system to prevent damage to the valve snap-switches.

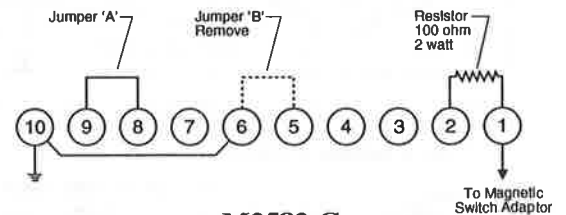
**M5081-C:** Place the 100 ohm, 2 watt resistor between valve terminals 1 and 2 as shown. Remove jumper "B" from terminals 5 and 6. Place a ground wire to terminal 6 only. Do not ground terminal 5 or damage will occur.

**M2582-C:** Place the 100 ohm, 2 watt resistor in the black wire and ground as shown. All other input and output wiring shown in bulletins, or other specific wiring diagrams, remain the same.

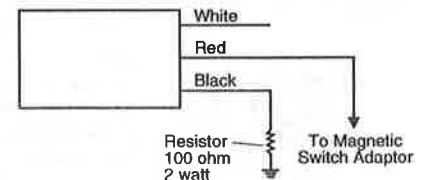
**A 100 ohm, 2 watt resistor for your convenience.**



### M5081-C



### M2582-C



## SPECIFICATIONS

**Valve Body:** Sandcast aluminum, painted red (corrosion resistance);  
Optional cast steel available for M5081 and M5081FS models only.

**Valve Seat:** Buna-N

**Maximum Valve Inlet Pressure:**

- M2582/M2582-P: 80 psi (552 kPa) [5.52 bar]
- M5081/M5081FS/ M5180-P: 100 psi (689 kPa) [6.89]

**Maximum Control Pressure (Pneumatic Models):**

- M2582-P: 75 psi (517 kPa) [5.17 bar]
- M5180-P: 80 psi (552 kPa) [5.52 bar]
- M5180-V: 30 in. Hg vac. (-100 kPa) [-1.00 bar]

**Snap-switch:** M2582: One SPDT, 5 A @ 480 VAC  
M5081, and M5081FS: Two SPDT, 5 A @ 480 VAC

**Wiring:** M2582: Wire leads  
M5081, and M5081FS: Terminal blocks

**Coil Rating:** Intermittent duty; coil type must match power source;

- CD ignition coil resistance: 72 Ω  
CD ignition primary voltage: 1.38 to 3.8 A
- M5081FS model: Energized to Run (continuous-duty coil)  
coil resistance:  
12 V model: 33 Ω;  
24 V model: 136 Ω
- Magneto ignition coil resistance: 0.5 Ω  
Magneto primary voltage: 1 to 5 A
- Battery coil resistance : 7 Ω  
12 or 24 VDC: 1.2 to 2.4 A

**Laboratory Approval:** CSA listed for Class I, Groups C and D Hazardous Locations. 5 amps maximum; intermittent duty; models M5081 and M5081-CD engine ignition powered, and model M5081-B, 12 or 24 VAC or VDC; switch contacts rated 5 A @ 480 VAC maximum. Maximum pressure 100 psi (689 kPa) [6.89 bar]

SERVICE PARTS	M2582	M5081	M5081FS	M2582-P	M5180-P M5180-V
<b>Coil Assembly</b>					
Battery	55000128	55000126	-----	-----	-----
CD Ignition	55000129	55000127	-----	-----	-----
Magneto Ignition	55000094	55000080	-----	-----	-----
<b>M5081FS Coil Assembly</b>					
12 VDC	-----	-----	55000158	-----	-----
24 VDC	-----	-----	55000159	-----	-----
<b>Latch Block Assembly</b>					
Latch block assembly	55000095	55000074	-----	-----	-----
Latch block switch and coil assembly	-----	-----	-----	-----	-----
Latch block switch and mounting bracket assembly	-----	55000118	55000196	-----	-----
<b>Handle and Latch Kit</b>					
Handle and latch kit	-----	55000102	55000102	5500148	55000154
Handle kit	55000096	-----	-----	-----	-----
<b>Manual Disconnect Assembly</b>	55000097	55000137	-----	-----	-----
<b>Snap Switch Assembly</b>	55000098	55000072	55000160	-----	-----
<b>Close/Open Indicator Assembly</b>	-----	55000138	55000138	-----	-----
<b>Stem and Seat Kit</b>	55000093	55000075	55000135	55000147	55000135
<b>Top Works Complete Valve Less Body and Vent</b>	55000146	55000131	55000161	55000150	55000155
<b>Vent Bushing Assembly</b>	55000143	55000132	55000132	55000143	55000132
<b>Diaphragm Assembly</b>	-----	-----	-----	55000184	55000153
<b>Pilot Diaphragm</b>	-----	-----	-----	00007908	55050420
<b>Diode Package for Dual Magneto Ignitions</b>	-----	65010065	-----	-----	-----
<b>Magnetic Switch Adapter for CD Ignitions</b>					
Single/Dual ign. – negative ground up to 240 VDC	65020126	65020126	-----	-----	-----
Single/Dual ign. – positive ground up to 450 VDC	65020127	65020127	-----	-----	-----
Single/Dual ign. – negative ground up to 450 VDC	65020155	65020155	-----	-----	-----

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USA-ISO 9001 FM 28221  
UK-ISO 9002 FM 29422

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# INSTALLATION AND MAINTENANCE MANUAL

## for

### NO. SRV100, SRV125, SRV150 OR SRV150SS

### STARTER RELAY VALVE



#### ▲ WARNING

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

**FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.  
IT IS THE RESPONSIBILITY OF THE EMPLOYER TO PLACE THE INFORMATION  
IN THIS MANUAL INTO THE HANDS OF THE OPERATOR.**

- Always bleed off the air pressure before attempting to unscrew the Starter Relay Valve from the Receiver or before attempting to perform any maintenance on the Starter Relay Valve.
  - Never attempt to remove the Retaining Ring (12) from the bottom side of the Starter Relay Valve until after the air pressure has been bled off. If the Retaining Ring is removed while there is pressure in the Receiver, internal parts of the Starter Relay Valve will be blown out with considerable force.
2. Apply No. SMB-441 Ingersoll-Rand Sealant to the male thread on the nipple, and install the nipple in the Receiver. Tighten the connection so that it is airtight.
  3. Note that one of the tapped inlets on the Relay Valve is marked "IN". Thread this inlet onto the nipple and tighten the connection so that it is airtight.
  4. Apply Ingersoll-Rand Sealant to the male threads on the air line that goes to the Starter, and thread this line into the tapped outlet on the Relay Valve that is marked "OUT". Make certain the connection is airtight.
  5. Attach the air hose from the outlet side of a 3-way normally vented Control Valve to the small tapped hole in the top of the Relay Valve. Use Ingersoll-Rand Sealant on the male thread.

#### NOTICE

This Starter Relay Valve is specially designed and manufactured by Ingersoll-Rand for use on Starter installations. Install it in accordance with the following instructions.

#### Installation of the Starter Relay Valve

1. Use a short pipe nipple between the Receiver and the Relay Valve. Use a 1" nipple with the SRV100, 1-1/4" nipple with the SRV125, and a 1-1/2" nipple with the SRV150 or SRV150SS.

#### NOTICE

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

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

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

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

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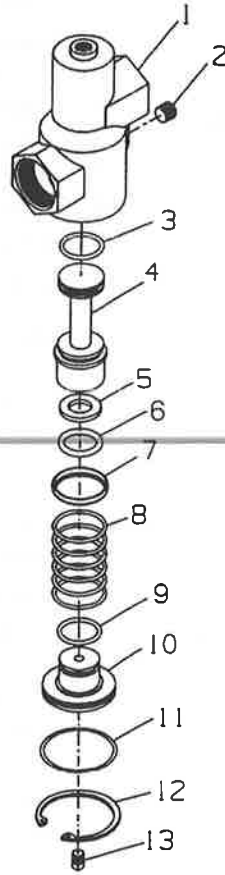
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**INGERSOLL-RAND®**  
**ENGINE STARTING SYSTEMS**

# WARNING LABEL IDENTIFICATION

	 <b>WARNING</b>
	<b>Always wear eye protection when installing, removing or performing maintenance on this Starter Relay Valve.</b>

# MAINTENANCE SECTION



(Dwg. TPD1731)

PART NUMBER FOR ORDERING

PART NUMBER FOR ORDERING

1	Valve Housing for SRV100 ..... for SRV125 ..... for SRV150 ..... for SRV150SS .....	SRV100-40 SRV125-40 SRV150-40 SRV150SS-40	10	End Plug for SRV100, SRV125 and SRV150 ..... for SRV150SS .....	SRV150-338 SRV150SS-338
2	Pipe Plug .....	HSPPS-2	◆ 11	End Plug Seal O-ring .....	Y327-143
◆ 3	Upper Piston O-ring .....	SRV150-210	◆ 12	Retaining Ring .....	SRV150-340
4	Piston .....	SRV150-246	13	Pipe Plug (for SRV150SS only) .	SRV150-368
◆ 5	Bumper .....	SRV150-339	*	Tune-up Kit (includes illustrated parts 3, 5, 6, 7, 9, 11, 12 and non-illustrated Part No. SRV-GR55 Grease) .....	SRV150-TK3
◆ 6	Piston O-ring .....	SRV150-211			
◆ 7	O-ring Retainer .....	SRV150-33			
8	Spring .....	SRV150-250			
◆ 9	End Plug O-ring .....	SRV150-67			

◆ Indicates Tune-up Kit part.

## MAINTENANCE SECTION

### WARNING

Always wear eye protection when lubricating or performing maintenance on the Starter Relay Valve. Always bleed off the air pressure before lubricating or performing any maintenance on the Starter Relay Valve.

### LUBRICATION

Periodically lubricate the Starter Relay Valve as follows:

1. Bleed off the air pressure.
2. Disconnect the No. 4 Hose from the tank at the control air supply port near the bottom of the valve opposite the air inlet. In some installations, this 1/4" N. P. T. will be plugged.
3. Remove the plug. Squirt about 1 ounce (30 cc) of 10W oil into the valve through the hose or plug opening.
4. Reconnect the hose or reinstall the plug.

### NOTICE

No. SRV150-TK3 Tune-up Kit is available for maintaining the Starter Relay Valve. This Tune-up Kit includes all O-rings, Bumper and End Plug Retaining Ring.

### INSTALLATION OF THE TUNE-UP KIT

#### Disassembly of the Starter Relay Valve

1. Bleed off the air pressure.
2. Clamp the Relay Valve in a vise with the Retaining Ring (12) up.

3. Carefully remove the Retaining Ring. The End Plug (10) should spring out. If it does not, tap the Valve Housing (1) lightly with a soft hammer until the End Plug springs out.
4. Remove the End Plug, Spring (8), and Piston Assembly (4).
5. Remove and discard all used O-rings and Bumper (5).
6. Clean all other parts in a clean, suitable cleaning solution in a well ventilated area.

#### Assembly of the Starter Relay Valve

1. Using o-ring lubricant, lubricate and install the new Piston O-ring (6) and the new Upper Piston O-ring (3) on the Piston.

### NOTICE

The Upper Piston O-ring is slightly larger in diameter than the End Plug O-ring (9).

2. Turn the Piston over and insert the new Bumper (5).
3. Using o-ring lubricant, lubricate and install the new End Plug Seal O-ring (11) and the new End Plug O-ring (9) on the End Plug (10).
4. Lubricate the lower small bore of the Valve Housing (1) with o-ring lubricant.
5. Insert the Piston Assembly into the Valve Housing. Push on the Piston until the Piston O-ring (6) seats against the beveled face.
6. Install the O-ring Retainer (7) with the large opening over the Piston O-ring.
7. Place the Piston Spring (8) on the Piston.
8. Place the End Plug Assembly on the Piston Spring.
9. Using a press to hold down the End Plug Assembly, install the End Plug Retaining Ring (12).

PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				LEVEL CONTROL VALVES				SHEET 1 OF 1					
CUSTOMER : APACHE CANADA LIMITED PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE SERVICE : LEVEL CONTROL VALVES				NO		BY		DATE		REVISION			
				1		PC		99/12/21		FOR PURCHASE		JOB # 99404	
												DATE	
												REQ.	
				BY		CHK'D		APPR					
				DCP									
G	1	TAG NO.		LCV-100		LCV-110		LCV-120					
E	2	SERVICE		1ST STAGE DUMP VALVE		2ND STAGE DUMP VALVE		3RD STAGE DUMP VALVE					
N	3	LINE NO. / VESSEL NO.		V-100		V-110		V-120					
E	4	LINE SIZE / SCHED. NO.		33 mm / sch. 160		33 mm / sch. 160		33 mm / sch. 160					
	5	TYPE OF BODY		Combination (Globe / Angle)		Combination (Globe / Angle)		Combination (Globe / Angle)					
	6	BODY SIZE	PORT SIZE	33 mm	9.5 mm	33 mm	9.5 mm	33 mm	9.5 mm	mm	mm		
	7	GUIDING	NO. OF PORTS	TOP	ONE	TOP	ONE	TOP	ONE				
B	8	END CONN. & RATING		33 mm FNPT, 6000#		33 mm FNPT, 6000#		33 mm FNPT, 6000#					
O	9	BODY MATERIAL		WCB STEEL		WCB STEEL		WCB STEEL					
D	10	PACKING MATERIAL		NITRILE AND COTTON		NITRILE AND COTTON		NITRILE AND COTTON					
Y	11	LUBRICATOR	ISOLAT. VALVE										
	12	BONNET TYPE		MFR. STANDARD		MFR. STANDARD		MFR. STANDARD					
	13	TRIM FORM		MFR. STANDARD		MFR. STANDARD		MFR. STANDARD					
	14	TRIM MATERIAL SEAT / PLUG		SST/TUNGSTEN CARBIDE		SST/TUNGSTEN CARBIDE		SST/TUNGSTEN CARBIDE					
		SHAFT / MAT'L		SST		SST		SST					
	15	REQUIRED SEAT TIGHTNESS		ANSI Class IV		ANSI Class IV		ANSI Class IV					
	16	MAX. ALLOW SOUND LEV. dBA		85		85		85					
A	17	MODEL NO. & SIZE		MFR. STANDARD (128)		MFR. STANDARD (128)		MFR. STANDARD (128)					
C	18	TYPE OF ACTUATOR		SPRING AND DIAPHRAGM		SPRING AND DIAPHRAGM		SPRING AND DIAPHRAGM					
T	19	CLOSE AT	OPEN AT	0 kPa	241 kPa	0 kPa	241 kPa	0 kPa	241 kPa	kPa	kPa		
U	20	FLOW ACTION TO		CLOSE		CLOSE		CLOSE					
A	21	FAIL POSITION		CLOSE		CLOSE		CLOSE					
T	22	HANDWHEEL & LOCATION											
P	23	MFR. & MODEL NO.											
O	24	FILT REG   GAGES   BYPASS											
S	25	INPUT SIGNAL											
I	26	OUTPUT SIGNAL											
T	27	AIR SUPPLY PRESS		kPa		kPa		kPa		kPa			
T	28	MFR. & MODEL NO.											
R	29	INPUT SIGNAL											
N	30	OUTPUT SIGNAL											
O	31	SPRING COLOUR (NUMBER)		CADMIUM (14A8831 X012)		CADMIUM (14A8831 X012)		CADMIUM (14A8831 X012)					
P	32												
T	33												
	34	FLOW UNITS		SCFH		SCFH		SCFH					
	35	FLUID		SOUR HC'S AND WATER		SOUR HC'S AND WATER		SOUR HC'S AND WATER					
	36	QUANT. MAX.	MAX. Cv	SMALL		SMALL		SMALL					
S	37	QUANT. OPER.	OPER Cv										
E	38	VALVE Cv	VALVE FL	106		106		106					
R	39	NORM IN PRES	NORM DELTA P	138 kPa(g)	133 kPa	961 kPa(g)	956 kPa	2976 kPa(g)	2971 kPa	kPa(g)	kPa		
V	40	MAX. INLET PRESS.		4516 kPa		4516 kPa		9067 kPa		9067 kPa			
I	41	MAX SHUT OFF	MAX DELTA P	4516 kPa(g)	4516 kPa	4516 kPa(g)	4516 kPa	9067 kPa(g)	9067 kPa	kPa(g)	kPa		
C	42	TEMP. MAX.	OPER. TEMP	149 ° C	16 ° C	149 ° C	49 ° C	149 ° C	49 ° C	° C	° C		
E	43	OPER. SP. GR.	MOL. WT.	1.00		1.00		1.00					
	44	OPER. VISC.	% FLASH										
	45	% SUPERHEAT	% SOLIDS										
	46	VAPOR PRESS	CRIT PRESS	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)		
	47	PREDICTED SOUND LEVEL dBA											
	48	MANUFACTURER		FISHER		FISHER		FISHER					
	49	MODEL NO.		128-PQC		128-PQC		128-PQC					
	50	P. O. NUMBER											

NOTES:

1. NACE COMPLIANCE REQUIRED

AREA UNIT #: 152

# Type 128-PQC Control Valves

## Contents

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## Introduction

### Scope of Manual

This manual provides installation, maintenance, and parts information for the Type 128-PQC control valve. Instructions and parts lists for Fisher Controls pneumatic instrumentation and other equipment used with this control valve are found in separate manuals.

Only personnel qualified through training or experience should install, operate, or maintain the Type 128-PQC control valve. If you have any questions concerning the instructions in this manual, please contact your Fisher Controls sales office or sales representative before proceeding.

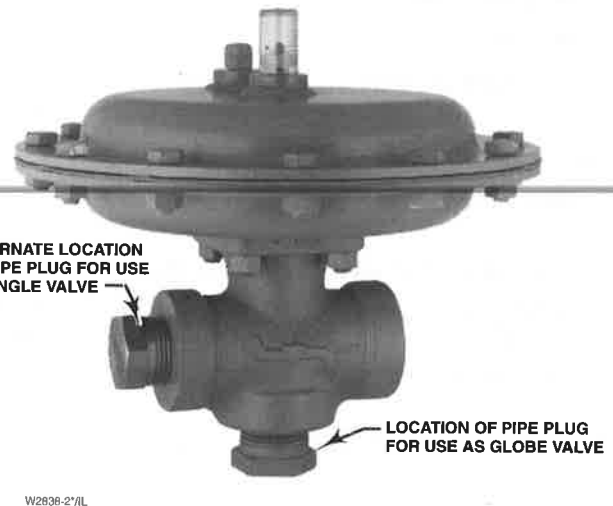


Figure 1. Type 128-PQC Control Valve

## Description

The Type 128-PQC control valve provides on-off dump valve service for such oil production applications as separators, scrubbers, and treaters, even under sour gas conditions. It also may be used in general on-off high-pressure control of a wide variety of liquids and gases, including those which are sticky or gritty and erosive. The Type 128-PQC valve is a 1-inch combination control valve with a pipe plug in the bottom connection for straight-through globe valve flow as shown in figure 1. However, the pipe plug may be field-changed to the left-hand end connection as shown in figure 3 for angle flow.

## Specifications

Table 1 lists specifications for the Type 128-PQC control valve. Some of the specifications for a given control valve as it originally comes from the factory are stamped on a nameplate, shown in figure 2, located on the upper diaphragm casing flange.





Table 1. Specifications

### Available Configurations

**Type 128 Actuator:** Yokeless, on-off spring-and-diaphragm actuator with action field-reversible between

- spring-open and
- spring-close

**Design PQC Valve:** See table 2

### Valve Sizes and End Connection Styles

See table 2

### Maximum Inlet Pressures and Temperatures<sup>(1)</sup>

3600 psig from -20 to 100°F, 3550 psig at 150°F, and 3520 psig at 180°F (248 bar from -29 to 38°C, 245 bar at 66°C, and 243 bar at 82°C)

### Maximum Pressure Drops<sup>(1)</sup>

See table 3

### Actuator Input Signal

- 0 or 20 psig (0 or 1.4 bar) or
- 0 or 35 psig (0 or 2.4 bar)

### Maximum Actuator Casing Pressure

100 psig (6.9 bar)

### Shutoff Classifications

- Metal Seats:** ANSI Class IV ANSI/FCI 70-2
- Soft Seats:** ANSI Class VI ANSI/FCI 70-2

### Material Temperature Capabilities<sup>(1)</sup>

**Metal Seat:** -20 to 180°F (-29 to 82°C)

**Soft Seat:** -20 to 150°F (-29 to 66°C)

**LCC Valve Body:** -50 to 180°F (-46 to 82°C)

### Flow Characteristic

Quick-opening with 45-degree taper valve plug

### Flow Direction

Either way

### Port Diameters

See table 2

### Maximum Travel

3/8-inch (10 mm)

### Actuator Diaphragm Effective Area

33 inches<sup>2</sup> (213 cm<sup>2</sup>)

### Actuator Pressure Connections

1/4 inch NPT female

### Valve Travel Indication

Scale divisions for each 25% of travel are provided on plastic travel indicator cover

### Approximate Weight

17 lb (7.7 kg)

1. The pressure and temperature limitations in this manual, and any applicable code limitation, should not be exceeded.

Table 2. End Connections and Port Diameters

DESIGN		PQC	
VALVE STYLE		Combination globe and angle valve body; common end and bottom connections and pipe plug allow conversion between globe and angle styles	
END CONNECTIONS		1 inch NPT female	
SEATING		Metal	Soft
PORT DIAMETERS	Inch	1/4, 3/8, 1/2	1/4, 3/8, 1/2, 3/4 <sup>(1)</sup>
	mm	6.4, 9.5, 12.7	6.4, 9.5, 12.7, 19.1 <sup>(1)</sup>
C <sub>v</sub> AT MAX TRAVEL FOR LARGEST PORT WITH FLOW TENDING TO CLOSE VALVE		8.32 (angle-style valve body)	
1. Cageless construction with seat cut into valve body for soft seat only.			

Table 3. Maximum Allowable Shutoff Pressure Drops

SEATING	ACTUATOR ACTION	FLOWING PRESSURE DROP TENDS TO:	PORT DIAMETER		CADMIUM COLORED MAIN SPRING 14A8831X012				RED MAIN SPRING 14A9077X012			
			Inches	mm	0 to 20 Psig (0 or 1.4 Bar) Actuator Input Signal (2 Springs Required)		0 to 35 Psig (0 or 2.4 Bar) Actuator Input Signal (4 Springs Required)		0 to 20 Psig (0 or 1.4 Bar) Actuator Input Signal (2 Springs Required)		0 to 35 Psig (0 or 2.4 Bar) Actuator Input Signal (4 Springs Required)	
					Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar
Metal	Spring closes valve	Open valve	1/4	6.4	1510	104	3370	232	3380	233	3600	248
			3/8	9.5	520	36	1340	92	1340	92	3120	215
			1/2	12.7	220	15	690	47	700	48	1720	118
			3/4	19.1	30	2.1	240	16	240	16	710	49
	Close valve	1/4	6.4	940	65	1860	128	1370	94	2920	201	
		3/8	9.5	1130	78	2450	169	1540	106	3300	227	
		1/2	12.7	1330	92	2920	201	1710	118	3600	248	
		3/4	19.1	2030	140	3600	248	2320	160	3600	248	
Spring opens valve	Close valve	1/4	6.4	170	12	350	24	Valve will not shut off with this combination of spring and application				
		3/8	9.5	530	36	610	42					
		1/2	12.7	540	37	1150	79					
		3/4	19.1	1400	96	2910	200					
Soft	Spring closes valve	Open valve	1/4	6.4	1000	69	1000	69	1000	69	1000	69
			3/8	9.5	710	49	1000	69	1000	69	1000	69
			1/2	12.7	400	28	830	57	830	57	1000	69
			3/4	19.1	160	11	350	24	360	25	790	54
	Close valve	1/4	6.4	940	65	1000	69	1000	69	1000	69	
		3/8	9.5	1000	69	1000	69	1000	69	1000	69	
		1/2	12.7	1000	69	1000	69	1000	69	1000	69	
		3/4	19.1	1000	69	1000	69	1000	69	1000	69	
	Spring opens valve	Close valve	1/4	6.4	560	39	660	45	Valve will not shut off with this combination of spring and application			
			3/8	9.5	480	33	960	66				
			1/2	12.7	540	37	1000	69				
			3/4	19.1	1000	69	1000	69				

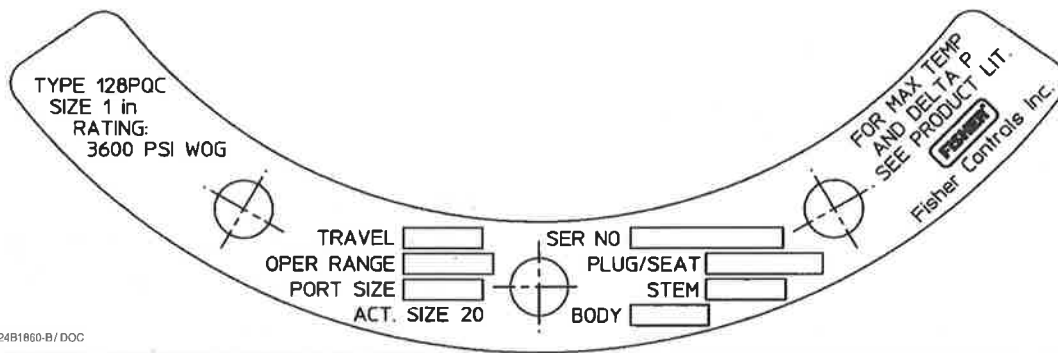


Figure 2. Typical Nameplate

## Installation

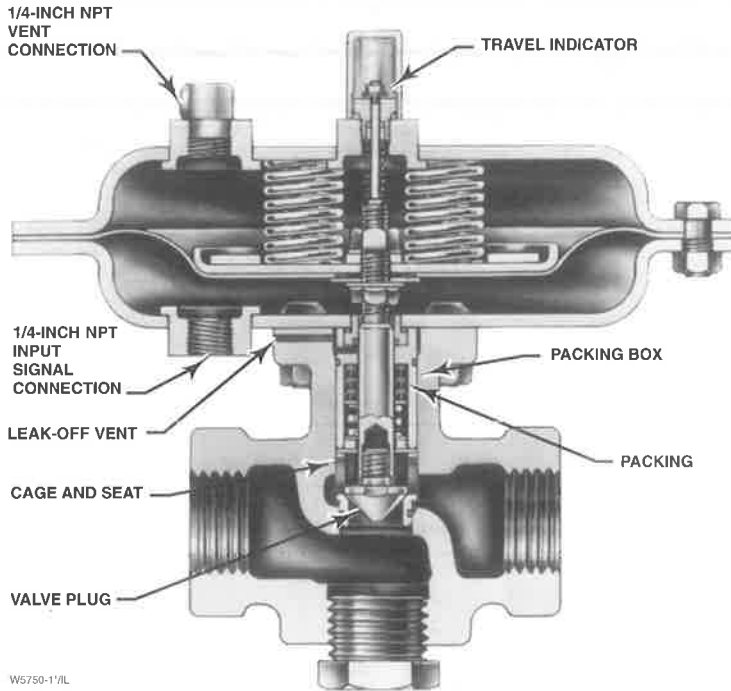
### WARNING

To avoid personal injury or property damage resulting from the sudden release of pressure, do not install the valve assembly where service conditions could exceed the limits given in this manual or on the appropriate nameplates. The leakoff and spring case vents must be kept open. Avoid danger

of fire or explosion from venting of flammable or otherwise hazardous fluid into a closed or poorly vented location by providing adequate ventilation.

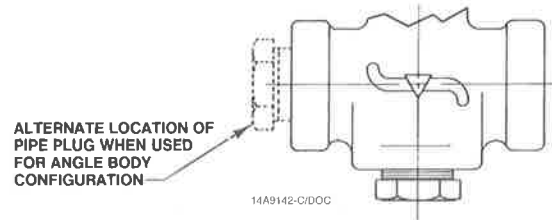
1. Before installing the valve, inspect the valve body and associated equipment for any damage and for any foreign material.
2. The control valve may be installed in any orientation. However, the normal method is with the actuator above the valve, especially for an angle configuration.

# 128-PQC



W5750-1/IL

**INTERNAL CONSTRUCTION**



**DETAIL OF BODY WEB CAST ON TYPE 128-PQC EXTERIOR**

*Figure 3. Type 128-PQC Control Valve with Spring-Close Action*

3. Make sure that the valve is oriented so that flow is in the desired direction. If angle flow is desired, switch the pipe plug to the left-hand end connection as shown in figure 3.
4. Install the valve following local and national piping codes when they apply to the application. Use a good grade pipe compound on all male threads. If continuous operation is required during inspection and maintenance, install a three-valve bypass around the control valve.
5. Refer to figure 3. Connect the input signal line to the 1/4-inch NPT connection in the lower diaphragm casing of a spring-close control valve or in the upper diaphragm casing of a spring-open control valve.

## Principle of Operation

The Type 128-PQC control valve has push-down-to-close valve plug action, as shown in figure 3. With a metal seat, the valve uses a caged construction and the valve plug shuts off against the integral seat ring in the cage. In the cageless soft-seat construction, the valve plug shuts off against the seat cut into the web of the valve body.

A nylon insert in the valve plug thread is used to help keep the valve plug from rotating.

A leakoff vent passes through the packing box and out the valve body. This permits any process leakage through the packing to escape before passing along the stem into the actuator. It also permits loading pressure leakage from the lower diaphragm case to escape before passing along the stem into the valve body.

## Maintenance

### **WARNING**

**Avoid personal injury from sudden release of process pressure. Before performing any maintenance operations:**

- **Disconnect any operating lines providing air pressure or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**

- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.**

- **Vent the actuator loading pressure and relieve any actuator spring precompression.**

- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing and trim maintenance, changing the main spring range, reversing the action, and replacing actuator parts.

Because of the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Fisher Controls.

All maintenance operations can be performed with the valve in the line.

## Replacing Packing and Trim

Perform these procedures either when using a complete replacement packing and trim assembly or when replacing individual packing and trim parts. Replacement packing and trim assembly part numbers are listed in the *Parts List*. Packing and trim assembly key numbers are referenced in figure 5. Control valve assembly key numbers are shown in figure 7 for the valve body and in figure 8 for the actuator except where indicated. Most packing and trim assembly key numbers are duplicated in both figure 5 and figure 7.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut-off all pressure lines to the actuator and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

If the valve is equipped with an optional handjack, be sure the handjack assembly is not restricting the valve from closing. Rotate the handles or handjack body (key 48 or 47 in figure 9), if necessary, to allow the main springs (key 19) to close the valve.

2. Remove the four nuts (key 14) from the integral screws of the lower diaphragm casing. Disconnect the input signal line, and lift the actuator and attached trim parts out of the valve body. Cleaning or other necessary maintenance may be performed on any accessible areas. The actuator and attached trim parts may be turned over and the valve body used to hold them as an aid in further maintenance.

3. To disassemble trim and gain access to packing parts or seal O-rings, unscrew the valve plug (key 3A) and remove the packing box washer (key 4).

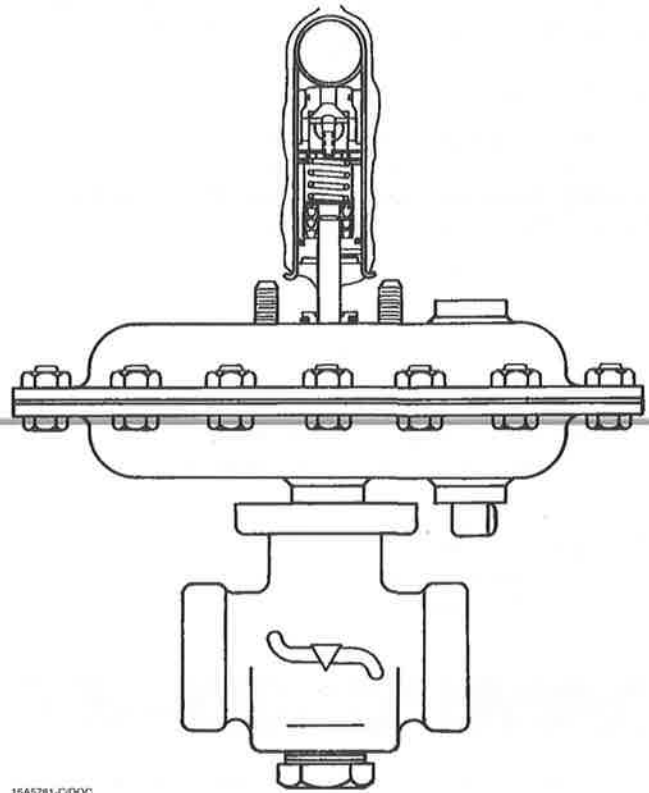


Figure 4. Installing Replacement Packing and Trim Assembly on Valve Stem

4. Pull the packing box (key 9), O-ring retainer (key 39), O-ring (key 11), and diaphragm casing O-ring (key 35) off the stem.
5. Install the packing and trim assembly or individual parts over the stem as shown in figure 4. With a packing and trim assembly, remove the assembly from the tube (key 42), but do not remove the web sleeve (key 43) from the assembly. The sleeve helps to keep the assembly parts in place during installation; roll back the sleeve as necessary during installation of the assembly.

If installing nitrile/cotton packing, lubricate the packing rings (key 8) with Dow-Corning No. 3 silicon-base lubricant or equivalent.

6. If installing a packing and trim assembly, continue pushing the assembly onto the stem until the stem pushes the valve plug and cage (key 2) away from the packing box washer (key 4). Roll the sleeve back just past the packing box (key 9).
7. Push the packing box all the way onto the stem until the packing box, the O-ring (key 11), the O-ring retainer (key 39), and the diaphragm casing O-ring (key 35) are sealed against the diaphragm casing. Make sure the O-rings are positioned properly so that they will not be cut when the other parts are com-

pressed against them. Then, push the packing spring washer (key 6), packing spring (key 7), other packing spring washer, wiper ring, and packing box washer (key 4) down on the stem.

8. If installing a packing and trim assembly, remove the sleeve, cage puller (key 44, if included in the assembly), cage, and spring clip (key 38, if included in the assembly) from the valve plug.

9. Install the valve plug into the stem.

### Note

**Rotate the valve plug until the shoulder on the plug contacts the stem snugly. Further tightening is not needed.**

To replace the cage (if used) or to gain access to the O-ring (key 12), use the cage puller (key 44) or a wire hook to remove the cage from the valve body (key 1). Then, install replacement parts as necessary.



### CAUTION

**Use care performing the installation in the next step to avoid damaging the O-ring.**

10. Install the actuator and attached trim parts back into the valve body (key 1), and secure with the four nuts (key 14) attached to the lower diaphragm casing assembly screws. Tighten the nuts to 15 lbf•ft. (20 N•m).

11. Connect the input signal line to the 1/4-inch NPT connection of the appropriate diaphragm casing.

## Changing Main Spring Range

Key numbers used in this procedure are shown in figure 8 unless otherwise indicated.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut-off all pressure lines to the actuator and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

If the valve is equipped with an optional handjack, be sure the handjack assembly is not restricting the valve from closing. Rotate the handles or handjack body (key 48 or 47 in figure 9), if necessary, to allow the main springs (key 19) to close the valve. Unscrew the handles or pipe plugs and remove the indicator cover (key 41 in figure 9). Drive out the groove pin (key 50 in

figure 9) and remove the stem nut and thrust washer (keys 49 and 51 in figure 9).

2. Disconnect the input signal line, if necessary, and remove the diaphragm casing nuts (key 14), cap screws (key 21), and upper diaphragm casing (key 20).

3. With spring-close action, remove the existing main springs (key 19) and install replacement springs of the correct quantity and description as listed in table 3. Make sure that the springs rest in the spring plate holes and will not ride on the upper diaphragm casing vent boss.

### Note

**Do not loosen the stem nut (key 14). Disturbing its position in the following step may keep the valve either from shutting off or from opening completely at the correct input signal pressure, thus requiring complete reassembly of the stem and diaphragm assembly.**

4. With spring-open action, remove the locknut (key 46), flat washer (key 15), diaphragm (key 16), diaphragm plate (key 17), spring plate (key 18), and main springs (key 19). Install replacement springs of the correct quantity and description as listed in table 3. Re-install the removed parts (keys 18, 17, 16, 15, and 46) so that the lower ends of the main springs rest over the weld stud heads of the lower diaphragm casing and the spring plate holes fit over the upper ends of the springs. Tighten the locknut (key 46) to 12 lbf•ft (20 N•m).

5. Install the upper diaphragm casing cap screws and casing nuts. To avoid crushing the diaphragm, tighten the cap screws and nuts evenly in a crisscross pattern to 15 lbf•ft (20 N•m).

6. Connect the input signal line to the 1/4-inch NPT connection of the upper diaphragm casing.

7. If an optional handjack is used, reinstall the handjack parts. Be sure to secure the stem nut (key 49 in figure 9) with the groove pin (key 50 in figure 9).

## Reversing Action or Replacing Actuator Parts

Key numbers used in this procedure are shown in figure 8 unless otherwise indicated.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut-off all pressure lines to the actuator and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

If the valve is equipped with an optional handjack, be sure the handjack assembly is not restricting the valve from closing. Rotate the handles or handjack body (key 48 or 47 in figure 9), if necessary, to allow the main springs (key 19) to close the valve. Unscrew the handles or pipe plugs and remove the indicator cover (key 41 in figure 9). Drive out the groove pin (key 50 in figure 9) and remove the stem nut and thrust washer (keys 49 and 51 in figure 9).

The optional handjack is used only with spring-close valves. If changing the action of a spring-close valve with a handjack to spring-open action, the only function the handjack performs is to restrict the valve from closing.

2. Disconnect the input signal line and remove the diaphragm casing nuts (key 14), cap screws (key 21), and upper diaphragm casing (key 20).

3. Remove the main springs (key 19), stem nut (key 14), locknut (key 46), lock washer (key 29), spring plate (key 18), diaphragm plate (key 17), diaphragm (key 16), and flat washer (key 15).

4. Remove the four nuts (key 14) from the integral screws of the lower diaphragm casing. Lift the casing and attached trim parts off of the valve body.

5. Unscrew the valve plug (key 3A) and remove the packing box washer (key 4).

6. Pull the packing box (key 9), O-ring retainer (key 39), O-ring (key 11), and diaphragm casing O-ring (key 35) off the stem.

7. Remove the stem (key 3B), and replace it, the bottom stem nut (key 14), or the locknut (key 46) as necessary.

8. When reinstalling the stem nut (key 14) or locknut (key 46), make sure the distance between the bottom shoulder of the nut and the plug end of the stem is equal to dimension A in figure 6.

9. Begin the following procedure as appropriate, depending on whether the desired control valve action is spring-close or spring-open.

**For spring-close action**, install the flat washer (key 15), diaphragm (key 16), diaphragm plate (key 17), spring plate (key 18), lock washer (key 29), and stem nut (key 14). Tighten the stem nut to 12 lbf•ft (16 N•m).

**For spring-open action**, install the lock washer (key 29), spring plate (key 18), diaphragm plate (key 17), diaphragm (key 16), flat washer (key 15), and locknut (key 46). Tighten the locknut to 12 lbf•ft (16 N•m).

10. For spring-open action only, install the main springs (key 19) into the lower diaphragm casing so

that the lower ends of the springs rest over the weld stud heads of the lower diaphragm casing.

11. Install the stem and diaphragm assembly into the lower diaphragm casing. For spring-open action, make sure that the assembly is oriented so that the spring plate holes fit over the upper ends of the springs.

12. Secure the stem by installing the packing and trim parts according to steps 5 through 9 of the *Replacing Packing and Trim* section.

13. If reversing action from what it was previously, remove the vent assembly (key 31), and install it in the 1/4-inch NPT connection of the lower diaphragm casing for spring-open action or the upper diaphragm casing for spring-close action.

14. For spring-close action only, install the main springs, making sure they rest in the spring plate holes and will not ride on the upper diaphragm casing vent boss.

15. Install the upper diaphragm casing, cap screws, and casing nuts. To avoid crushing the diaphragm, tighten the cap screws and nuts evenly in a crisscross pattern to 15 lbf•ft (20 N•m).

16. Install the actuator and attached trim parts back into the valve body (key 1), and secure with the four nuts (key 14) attached to the lower diaphragm casing assembly screws. Tighten the nuts to 15 lbf•ft (20 N•m).

17. Connect the input signal line to the 1/4-inch NPT connection of the appropriate diaphragm casing.

18. If an optional handjack is used, reinstall the handjack parts. Be sure to secure the stem nut (key 49 in figure 9) with the groove pin (key 50 in figure 9).

## Parts Ordering

The Type 128-PQC control valve is assigned a serial number which can be found on the nameplate. A typical nameplate is shown in figure 2. Refer to the serial number when contacting your Fisher Controls representative or sales office for assistance. When ordering replacement parts, refer to the serial number and to the 11-character part number from the following *Parts List*.

## Parts Kits

Key	Description	Part Number
	Type 128-PQC Repair Kits (soft parts only. Kit includes key 5, 8, 10, 11, 12, and 35)	
	w/PTFE V-ring packing	RPQCX000012
	w/Nitrile/cotton packing	RPQCX000022

For additional kit information, see the *Replacement Packing and Trim Assembly Part Number* table.

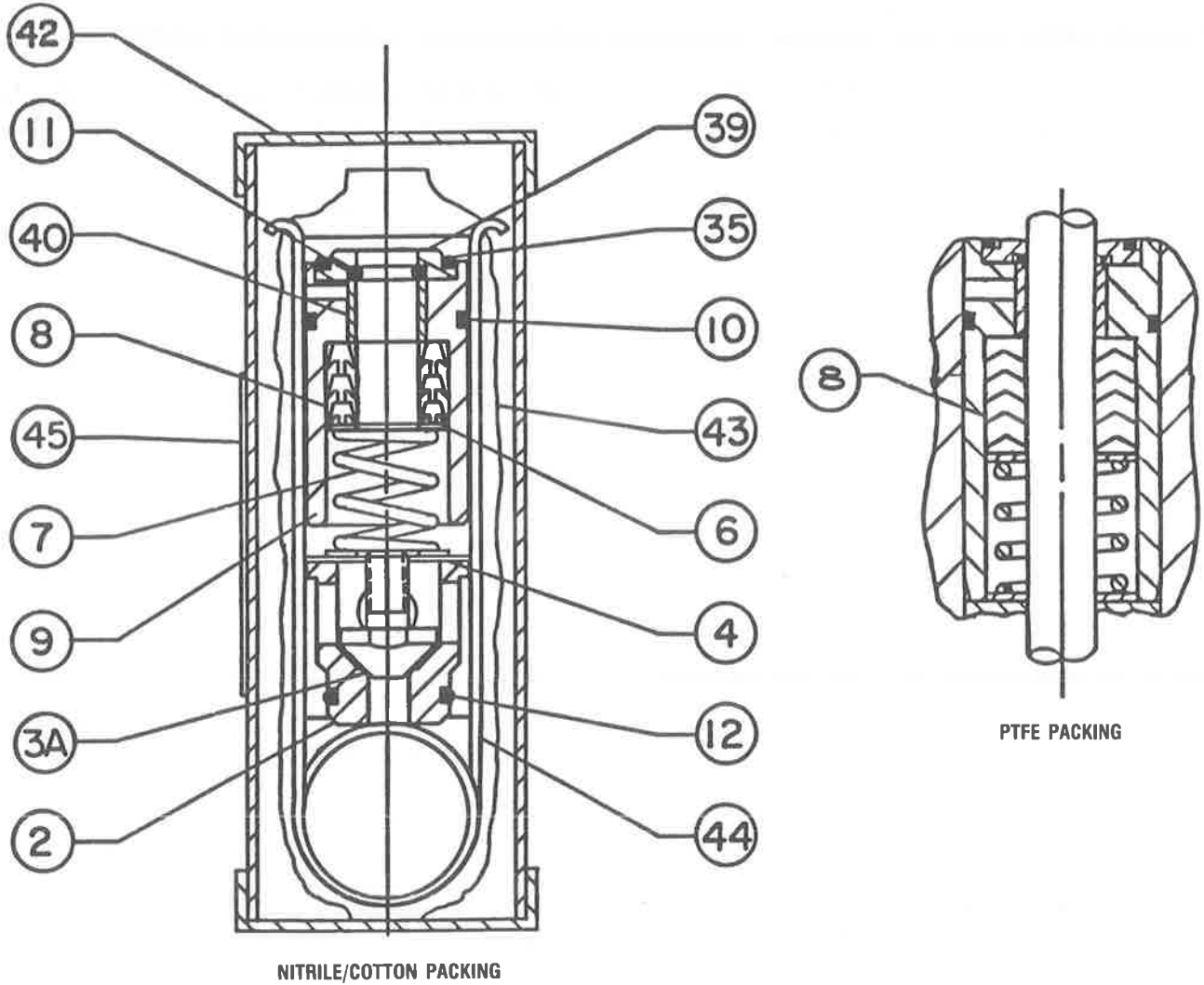


Figure 5. Replacement Packing and Trim Assemblies for Metal-Seated Construction

Key	Description	Part Number	Key	Description	Part Number
	<b>Parts List</b>				
	Travel Indicator Assembly	35A1588X0A2			
1	Valve Body, 1-inch NPT	24A8802X012	3A*	Valve Plug	
2*	Cage			Metal Seat,	
	440C stainless steel, heat-treated <sup>(1,2)</sup>			1/4 & 3/8 inch ports	
	1/4 inch port	14A8823X022		440C stainless steel, heat treated <sup>(1)</sup>	16A2087X012
	3/8 inch port	14A8805X022		Nitronic 50 stainless steel <sup>(1)</sup>	16A2087X022
	1/2 inch port	14A7157X022		Carbide seating surface <sup>(2)</sup>	15A6804X012
	Nitronic 50 <sup>(1)</sup> stainless steel			1/2 inch (12.7 mm) port	
	1/4 inch port	14A8823X032		440C stainless steel, heat-treated <sup>(1)</sup>	14A6618X012
	3/8 inch port	14A8805X032		Nitronic 50 stainless steel <sup>(1)</sup>	14A6618X022
	1/2 inch port	14A7157X032		Soft Seat	
	Carbide seating surface <sup>(1,2)</sup>			3/4 inch port	
	1/4 inch port	15A6800X012		Austenitic stainless steel/nitrile	15A3197X022
	3/8 inch port	15A6801X012		Austenitic stainless steel/polyethylene	15A3197X012
			3B*	Stern, 316 stainless steel <sup>(2)</sup>	
				w/o handjack	14A8806X012
				w/handjack	26A1765X012

1. May also be ordered from the Replacement Packing and Trim Assembly Part Numbers table.

2. May also be ordered as part of the cage/plug/stem assembly (key 52).

\*Recommended spare parts

Key	Description	Part Number
4	Packing Box Washer, stainless steel <sup>(1)</sup> 1/2 inch and smaller ports 3/4 inch port	14A6617X012 14A8807X012
6	Washer, stainless steel <sup>(1)</sup> (2 req'd)	14A8808X012
7	Packing Spring, 17-7PH stainless steel <sup>(1)</sup> Inconel X750	10B7429X012 10B7430X012
8*	Packing Set, PTFE V-Ring <sup>(1)</sup>	10B7279X012
8*	Packing Ring, nitrile/cotton (6 req'd)	14A9057X012
9	Packing Box, stainless steel <sup>(1)</sup>	10B7278X022
10*	O-Ring, fluoroelastomer <sup>(1)</sup>	1U841806382
11*	O-Ring, nitrile <sup>(1)</sup>	1P420706992
12*	O-Ring, fluoroelastomer <sup>(1)</sup>	11A8741X012
13	Lower Diaphragm Casing, steel	24A8810X012
14	Hex Nut, zn pl steel (1/ req'd)	1A346524122
15	Flat Washer, zn pl steel	14A9770X012
16*	Diaphragm, neoprene w/nitrile insert	14A8813X012
17	Diaphragm Plate, zn pl steel	14A8814X012
18	Spring Plate, zn pl steel	14A8819X012
19	Main Spring, pl steel	See table 3
20	Upper Diaphragm Casing, steel w/o handjack w/handjack	24A8816X012 26A1770X012
21	Cap Screw, pl steel (12 req'd)	1E760324052

**Note**

Key numbers 22 through 27 are not req'd with a handjack. These parts are also included in the stem travel assembly, part number 35A1588X0A2, but are omitted when a handjack is used.

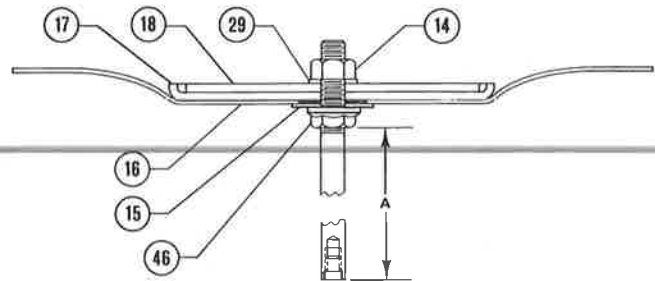
22	Travel Indicator Disk Nut, plastic	1F730506992
23	Indicator Fitting, stainless steel	15A0726X012
24	Indicator Bushing, 316 stainless steel	13A2323X012
25*	O-Ring, nitrile	1H292606992
26	Machine Screw, stainless steel	14A8818X012
27	Spring, stainless steel	16A0431X012
28	Pipe Plug, steel	1A794728992
29	Lock Washer, steel	1A742328992
31	Vent Assembly	
35*	Diaphragm Casing O-ring	13A1584X012
39*	O-Ring Retainer, polyethylene	14A9053X012
40*	Bushing, PTFE (used with metal seat only)	10B7431X012
41	Indicator Cover, plastic w/o handjack w/handjack	15A1580X012 26A1764X012
42	Paper Tube <sup>(1)</sup>	1M3227X0012
43	Web Sleeve <sup>(1)</sup>	1M3512X0012
44	Cage Puller, steel <sup>(1)</sup>	15A2525X012
45	Paper Label <sup>(1)</sup>	15A6827X012
46	Locknut, pl steel	15A7591X012

**Note**

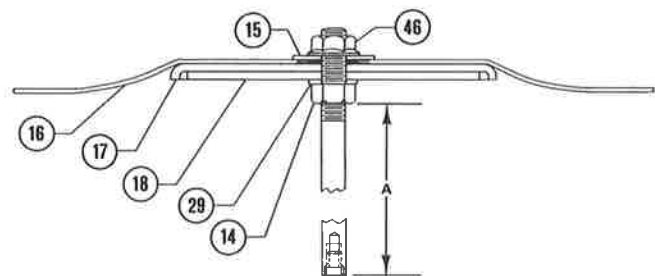
Key numbers 47 through 51 are handjack parts.

47	Handjack Body, steel	16A1769X012
48	Pipe Plug or Handle, steel (2 req'd) Pipe Plug Handle	1A500828992 16A1768X012

DIMENSION A			
Inches		mm	
Spring-Close Assembly	Spring-Open Assembly	Spring-Close Assembly	Spring-Open Assembly
2.46	2.72	62.5	69.1



**SPRING-CLOSE ASSEMBLY**



**SPRING-OPEN ASSEMBLY**

34A8839-G  
34A8839-G  
A2223-2/IL

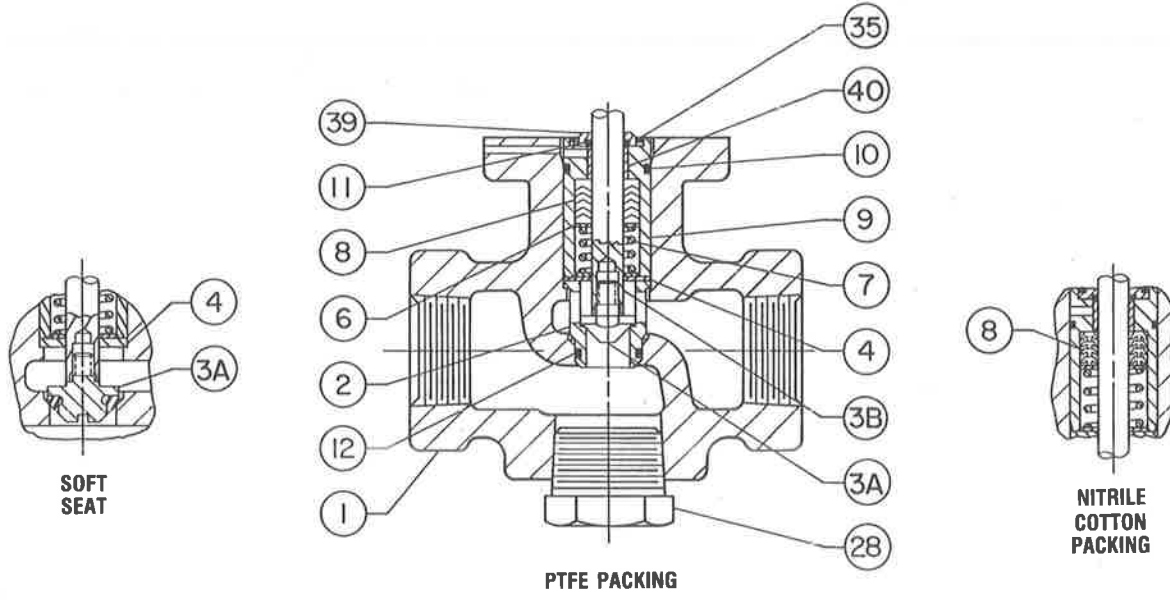
Figure 6. Stem and Diaphragm Assembly Dimensions

Key	Description	Part Number
49	Stem Nut, pl steel	16A1763X012
50	Groove Pin, 316 stainless steel	1B599135072
51	Thrust Washer, steel	16A1508X012
52*	Cage/Plug/Stem Assembly, austenitic stainless steel w/carbide seating surface (not shown) (includes keys 2, 3A, and 3B) w/o handjack 1/4 inch port 3/8 inch port w/handjack 1/4 inch port 3/8 inch port	16A4601X012 16A4601X032 16A4601X022 16A4601X042
54	Nameplate	22B6762X0A2

1. May also be ordered from the Replacement Packing and Trim Assembly Part Numbers table.

\*Recommended spare parts



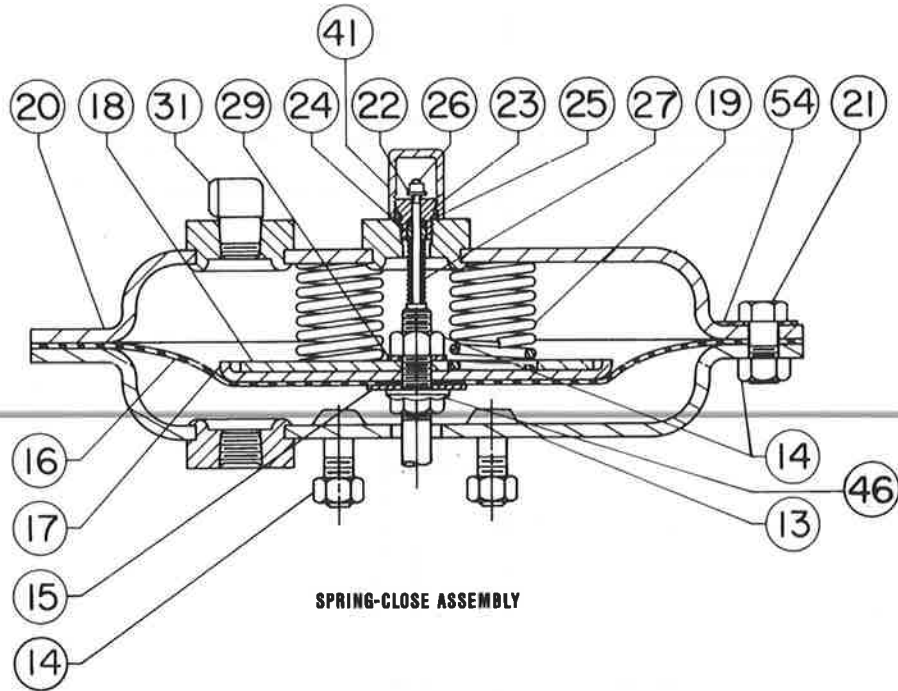


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Figure 7. Design PQC Valve Body Assembly

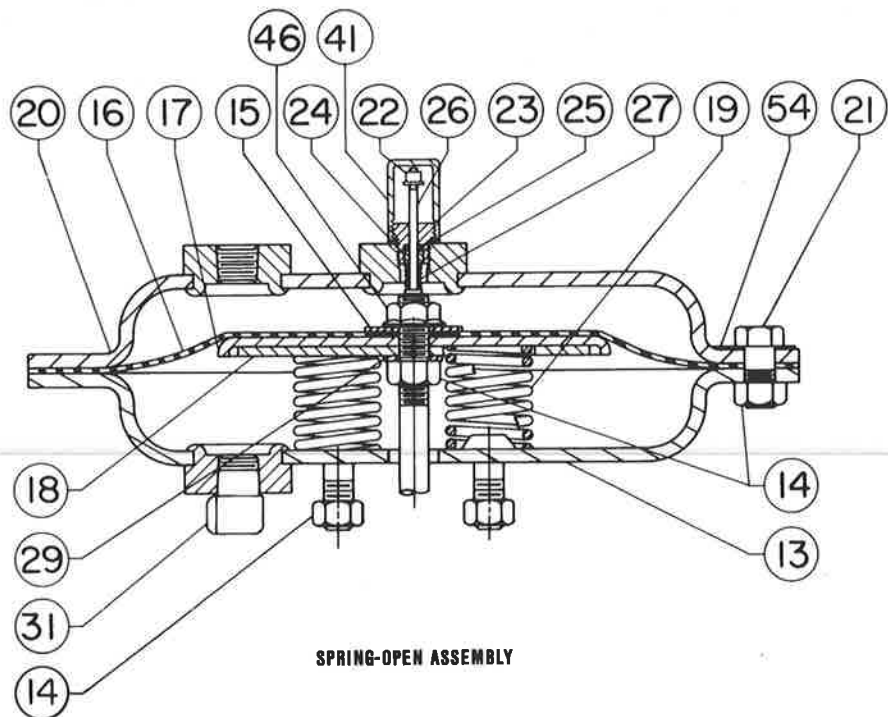
*Replacement Packing and Trim Assembly Part Numbers*

PORT DIAMETER		TFE V-RING PACKING, HEAT-TREATED 440C STAINLESS STEEL VALVE PLUG AND CAGE AND 17-7 PH STAINLESS STEEL PACKING SPRING	TFE V-RING PACKING, NITRONIC 50 STAINLESS STEEL VALVE PLUG AND CAGE AND INCONEL X750 PACKING SPRING
Inches	mm		
1/4	6.4	10B7899X012	10B7899X042
3/8	9.5	10B7899X022	10B7899X052
1/2	12.7	10B7899X032	10B7899X062
3/4	10.1		



**SPRING-CLOSE ASSEMBLY**

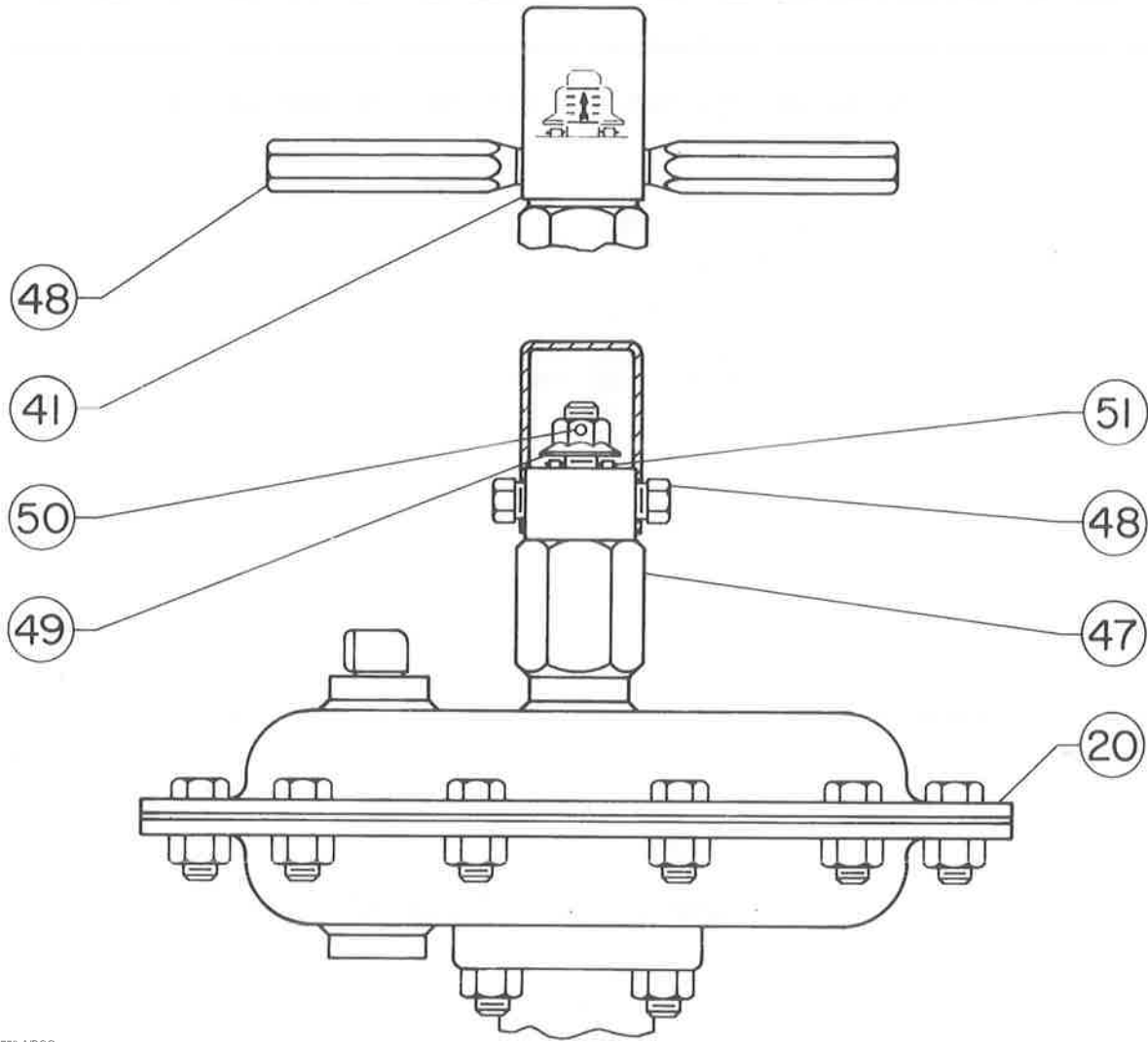
29A0341-A/DOC



**SPRING-OPEN ASSEMBLY**

29A0343-A/DOC

Figure 8. Type 128 Actuator



36A1772-A/DOC

Figure 9. Optional Handjack Assembly

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 Singapore 128461



PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3			LEVEL CONTROL VALVES				SHEET 1 OF 1	
CUSTOMER : APACHE CANADA LIMITED PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE SERVICE : PROCESS			NO	BY	DATE	REVISION	SPEC NO	FILE 14.11
			1	PC	99/12/21	FOR PURCHASE	JOB #	99404
							DATE	
							REQ.	
				BY	CHK'D	APPR.		
G 1	TAG NO.	PCV-100						
E 2	SERVICE	COMPRESSOR MIN. FLOW						
N 3	LINE NO. / VESSEL NO.							
E 4	LINE SIZE / SCHED. NO.	33 mm / sch. 160						
5	TYPE OF BODY	Combination (Globe / Angle)						
6	BODY SIZE	PORT SIZE	33 mm	19.1 mm	mm	mm	mm	mm
7	GUIDING	NO. OF PORTS	TOP	ONE				
B 8	END CONN. & RATING	33 mm FNPT, 6000#						
O 9	BODY MATERIAL	WCC STEEL (NACE)						
D 10	PACKING MATERIAL	NITRILE AND COTTON						
Y 11	LUBRICATOR	ISOLAT. VALVE						
12	BONNET TYPE	MFR. STANDARD						
13	TRIM FORM	MFR. STANDARD						
14	TRIM MATERIAL SEAT / PLUG	NITRILE / SST						
		SHAFT / MAT'L	17-4 PH SST					
15	REQUIRED SEAT TIGHTNESS	ANSI Class IV						
16	MAX. ALLOW SOUND LEV. dBA							
A 17	MODEL NO. & SIZE	SIZE 40						
C 18	TYPE OF ACTUATOR	SPRING AND DIAPHRAGM						
T 19	CLOSE AT	OPEN AT	41 kPa	207 kPa	kPa	kPa	kPa	kPa
U 20	FLOW ACTION TO	OPEN						
A 21	FAIL POSITION	OPEN						
T 22	HANDWHEEL & LOCATION							
P 23	MFR. & MODEL NO.							
O 24	FILT REG   GAGES   BYPASS							
S 25	INPUT SIGNAL							
I 26	OUTPUT SIGNAL							
T 27	AIR SUPPLY PRESS		kPa		kPa		kPa	kPa
T 28	MFR. & MODEL NO.	FISHER 546						
R 29	INPUT SIGNAL	4-20 MA						
N 30	OUTPUT SIGNAL	6-30 PSIG						
O 31	SPRING COLOUR (NUMBER)	15A9929X012						
P 32								
T 33								
34	FLOW UNITS	MMSCFD						
35	FLUID	Sour HC's and Water						
36	QUANT. MAX.	MAX. Cv	5.496	157,863				
S 37	QUANT. OPER.	OPER Cv						
E 38	VALVE Cv	VALVE C1	342	35.3				
R 39	NORM IN PRES	NORM DELTA P	8411 kPa(g)	8311 kPa	kPa(g)	kPa	kPa(g)	kPa
V 40	MAX. INLET PRESS.		11377	kPa		kPa		kPa
I 41	MAX SHUT OFF	MAX DELTA P	11377 kPa(g)	11377 kPa	kPa(g)	kPa	kPa(g)	kPa
C 42	TEMP. MAX.	OPER. TEMP	149 ° C	49 ° C	° C	° C	° C	° C
E 43	OPER. SP. GR.	MOL. WT.		18.827				
44	OPER. VISC.	% FLASH						
45	% SUPERHEAT	% SOLIDS						
46	VAPOR PRESS	CRIT PRESS	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)
47	PREDICTED SOUND LEVEL dBA							
48	MANUFACTURER	FISHER						
49	MODEL NO.	357-40						
50	P. O. NUMBER							

NOTES:

1. NACE COMPLIANCE REQUIRED
2. VALVE IS TO BE USED INTERMITTENTLY - HIGH NOISE.B55

AREA. UNIT #: 152

# 357 Series Control Valves

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## Introduction

### Scope of Manual

This instruction manual provides installation, maintenance, and parts information for 357 Series control valves. Refer to separate manuals for instruction covering accessories used with the control valve.

### Description

The 357 Series control valves (figure 1) are designed for high-pressure on-off and throttling applications and are used as dump valves on oil and gas separators, scrubbers, and other field process equipment. They are also used for well-head applications where rugged

steel construction and easy maintenance are necessary. (The bonnet/body connection is covered by patent.)

Only personnel qualified through training or experience should install, operate, and maintain this control valve. If you have any questions concerning these instructions, contact your Fisher Controls sales office or sales representative before proceeding.

### Specifications

Table 1 lists specifications for the 357 Series control valves. Some of the specifications for the control valve, as it originally comes from the factory, are stamped on nameplates.



W5810/L

Figure 1. 357 Series Control Valve



# 357 Series

Table 1. Specifications

<p><b>Available Configurations</b> See table 2</p> <p><b>Valve Body Sizes and End Connection Styles</b> See table 3</p> <p><b>Maximum Inlet Pressures and Temperatures<sup>(1)</sup></b> 276 bar from -29 to 93°C (4000 psig from -20 to 200°F), 276 bar at -45°C (4000 psig at -50°F), and 268 bar at 149°C (3880 psig at 300°F) unless limited by end connection rating</p> <p><b>Maximum Pressure Drops<sup>(1)</sup></b> <b>Metal Seats:</b> See tables 4 and 5</p> <p><b>Input Signal to Actuator</b> See tables 4 and 5</p> <p><b>Actuator Maximum Casing Pressure</b> Size 20: 3.4 bar (50 psig) Size 40: 3.4 bar (50 psig)</p> <p><b>Shutoff Classification</b> <b>Metal Seats:</b> ANSI Class IV per ANSI/FCI 70-2 <b>Soft Seats:</b> ANSI Class VI per ANSI/FCI 70-2</p> <p><b>Material Temperature Capabilities<sup>(1)(2)</sup></b> <b>With Nitrile O-Rings, Nylon Bushings, and WCC Valve Bodies:</b> -29 to 93°C (-20 to 200°F) <b>With Fluoroelastomer O-Rings, Ryton Bushings, and WCC Valve Bodies:</b> -23 to 149°C (-10 to 300°F)</p>	<p><b>With Nitrile<sup>(3)</sup> O-Rings, Nylon Bushings, and LCC Valve Bodies:</b> -45 to 82°C (-50 to 180°F)</p> <p><b>Flow Characteristic</b> <b>Metal or Ceramic Seats:</b> Equal percentage <b>Soft Seats:</b> Quick opening</p> <p><b>Flow Direction</b> May be in either direction as suits the application</p> <p><b>Port Diameters</b> ■ 6.4, ■ 9.5, ■ 12.7, ■ 19.1, ■ 25.4, or ■ 38.1 mm (1/4, 3/8, 1/2, 3/4, 1, or 1-1/2 inch) port diameters for both 1-inch and 2-inch valve bodies. See tables 4 and 5 for more information.</p> <p><b>Maximum Rated Valve Plug Travel</b> 19 mm (3/4 inch)</p> <p><b>Valve Plug Style</b> Micro-Form valve plug<sup>(4)</sup></p> <p><b>Actuator Diaphragm Effective Area</b> Size 20: 213 cm<sup>2</sup> (33 inches<sup>2</sup>) Size 40: 452 cm<sup>2</sup> (70 inches<sup>2</sup>)</p> <p><b>Actuator Spring Information</b> See table 6</p> <p><b>Actuator Pressure Connection Size</b> 1/4 inch NPT female</p> <p><b>Approximate Weight</b> See table 7</p>
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1. The pressure or temperature limits in the referenced tables and any applicable ANSI code limitations should not be exceeded.  
 2. Process temperature should not go below -29°C (-20°F).  
 3. Low temperature material.  
 4. Contact your Fisher Controls sales office or sales representative for other valve plug requirements.

Table 2. Available Configurations

VALVE TYPE NUMBER AND FAIL ACTION	357, FAIL DOWN (SPRING CLOSES—AIR OPENS)				357, FAIL UP (SPRING OPENS—AIR CLOSES)			
	20		40		20		40	
Actuator Sizes								
Valve Configurations	Globe	Angle	Globe	Angle	Globe	Angle	Globe	Angle
Valve Size, Inches	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2

Table 3. Valve Sizes and Connection Styles

VALVE SIZE, INCHES	SCREWED <sup>(1)</sup>	RAISED FACE (RF) FLANGED				RING TYPE JOINT (RTJ) FLANGED	
		Class 150	Class 300	Class 600	Class 1500	Class 600	Class 1500
1	X	X	X	X	---	X	---
2	X	X	X	X	X	X	X

X = Available construction.  
 1. The 1-inch screwed valve is a combination valve that uses a pipe plug in the unused connection to make either a globe or angle configuration (see figure 3).

Table 4. Maximum Allowable Shutoff Pressure Drops<sup>(1)</sup> for 357 Series Valves with Metal Seats (Fail Down, Spring Closes—Air Opens Configuration)

ACTUATOR SIZE	FLOW DIRECTION	PORT DIAMETER		INPUT SIGNAL TO ACTUATOR, SPRING PART NUMBER											
				0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
				16A9594X012		16A9595X012		16A9656X012		16A9594X012		16A9595X012		16A9656X012	
mm	Inches	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi		
20	Up to Open	6.4	1/4	117	1700	276	4000	257	3720	257	3720	276	4000	276	4000
		9.5	3/8	42	610	166	2400	104	1510	104	1510	276	4000	276	4000
		12.7	1/2	18	260	88	1270	53	770	53	770	157	2280	169	2450
		19.1	3/4	3	40	34	490	19	270	19	270	65	940	70	1010
		25.4	1	---	---	17	240	8	110	8	110	34	490	37	530
		38.1	1-1/2	---	---	5	70	1	10	1	10	12	180	14	200
	Down to Close	6.4	1/4	66	960	111	1620	111	1620	111	1620	186	2700	232	3360
		9.5	3/8	76	1100	178	2590	178	2590	178	2590	276	4000	276	4000
		12.7	1/2	87	1270	236	3420	247	3580	121	1760	276	4000	276	4000
		19.1	3/4	31	450	76	1100	103	1490	76	1100	141	2050	195	2830
		25.4	1	12	180	32	460	43	620	32	460	54	850	81	1180
		38.1	1-1/2	---	---	12	170	16	230	12	170	22	320	30	440
40	Up to Open	6.4	1/4	276	4000	276	4000	276	4000	276	4000	276	4000	276	4000
		9.5	3/8	201	2920	276	4000	276	4000	276	4000	276	4000	276	4000
		12.7	1/2	108	1560	157	2270	157	2270	181	2630	276	4000	276	4000
		19.1	3/4	43	620	65	940	65	940	76	1100	30	1890	174	2520
		25.4	1	21	310	34	490	34	490	39	570	70	1020	95	1380
		38.1	1-1/2	7	100	12	180	12	180	15	220	29	420	39	570
	Down to Close	6.4	1/4	159	2300	276	4000	257	3720	257	3720	276	4000	276	4000
		9.5	3/8	259	3750	276	4000	276	4000	276	4000	276	4000	276	4000
		12.7	1/2	276	4000	276	4000	276	4000	276	4000	276	4000	276	4000
		19.1	3/4	83	1210	182	2640	248	3860	182	2640	276	4000	276	4000
		25.4	1	34	500	76	1100	117	1690	76	1100	141	2050	190	2760
		38.1	1-1/2	13	190	28	410	44	630	28	410	52	760	71	1030

1. For valves with soft seats, the maximum allowable pressure drop is limited to 69 bar (1000 psig) or to the values in the table, whichever is less.

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Table 5. Maximum Allowable Shutoff Pressure Drops<sup>(1)</sup> for 357 Series Valves with Metal Seats (Fail Up, Spring Opens—Air Closes Configuration)

ACTUATOR SIZE	FLOW DIRECTION <sup>(3)</sup>	PORT DIAMETER		INPUT SIGNAL TO ACTUATOR <sup>(2)</sup> , SPRING PART NUMBER					
				0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)	
		mm	Inches	16A9594X012		16A9929X012		16A9595X012	
				Bar	Psi	Bar	Psi	Bar	Psi
20	Up to Open <sup>(2)</sup>	6.4	1/4	276	4000	276	4000	276	4000
		9.5	3/8	152	2210	276	4000	276	4000
		12.7	1/2	80	1160	173	2510	273	3960
		19.1	3/4	30	440	72	1040	117	1690
		25.4	1	14	210	37	540	63	910
		38.1	1-1/2	3	50	14	200	26	370
40	Up to Open <sup>(2)</sup>	6.4	1/4	0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)	
				1F176727032		1F714327092		1E795627082	
				Bar	Psi	Bar	Psi	Bar	Psi
				276	4000	276	4000	276	4000
				276	4000	276	4000	276	4000
				194	2810	276	4000	276	4000
12.7	1/2	86	1250	175	2540	119	1730		
19.1	3/4	48	700	96	1390	64	930		
25.4	1	21	300	40	580	26	380		
38.1	1-1/2								

- For valves with soft seats, the maximum allowable pressure drop is limited to 69 bar (1000 psig) or to the values in the table, whichever is less.
- Actual operating pressure includes an additional 0.2 bar (3 psig) input supply to the controller.
- Consult your Fisher Controls sales office or sales representative for maximum allowable shutoff pressure drops of flow down to close valve configuration.

Table 6. Spring Part Number, Color Code, Spring Rate and Free Length

ACTUATOR SIZE	SPRING PART NUMBER	COLOR CODE	SPRING RATE		FREE LENGTH	
			N/mm	Lb/in	mm	Inch
20	16A9594X012	Aluminum	36	205	140	5.5
	16A9595X012	Light Green	100	571		
	16A9656X012	Yellow	160	912		
	16A9929X012	Black	67	380		
40	1E792427082	Light Green	257	1470	165	6.5
	1E793327082	Yellow	367	2100		
	1E795627082	White	441	2520		
	1F176727032	Dark Green	64	368		
	1F176827092	Aluminum	86	490		
	1F714327092	Aluminum/Dark Blue	145	830		
	1J258127092	Aluminum/Brown	175	1000		

Table 7. 357 Series Approximate Weights, Kg (Pounds)

Actuator Size	20				40			
	1		2		1		2	
Valve Size, Inches	Globe	Angle	Globe	Angle	Globe	Angle	Globe	Angle
Screwed	21 (47) <sup>(1)</sup>	21 (47) <sup>(1)</sup>	28 (61)	23 (51)	29 (64) <sup>(1)</sup>	29 (64) <sup>(1)</sup>	35 (78)	31 (68)
Class 150	23 (50)	22 (48)	27 (60)	27 (60)	30 (67)	29 (65)	35 (77)	35 (77)
Class 300 & 600	26 (57)	26 (57)	37 (82)	35 (77)	34 (74)	34 (74)	45 (99)	43 (94)
Class 1500	---	---	55 (122)	57 (126)	---	---	63 (139)	65 (143)

- The 1-inch screwed valve is a combination valve that uses a pipe plug in the unused connection to make either a globe or angle configuration (see figure 3).



## Installation

Some types of ceramic trim, including the VTC (very tough ceramic) variety, can create a spark under certain circumstances. When the edge of a ceramic part is struck against a second ceramic part with enough force, a spark can be created.



### WARNING

**Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim.**

**Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).**



### WARNING

**To avoid personal injury or property damage caused by bursting of pressure-retaining parts or by uncontrolled process fluid, be certain the service conditions do not exceed the limits shown on the valve nameplate and in tables 1, 4, and 5.**

1. Before installing the control valve assembly, inspect it for any damage and for any foreign material that may have collected in the valve body.
2. Remove any pipe scale, welding slag, and other foreign material from the pipeline.
3. The control valve can be installed in any position, but normally the actuator is vertical above the valve. Install the valve so the flow direction arrow on the side of the valve indicates the direction of the process flow.
4. Install the valve following local and national piping codes when they apply to the application. For screwed connections, treat the male pipe threads with a good grade pipe compound. For flanged valves, use suitable gaskets between valve and pipeline flanges.
5. If continuous operation is required during maintenance and inspection, install a conventional three-valve bypass around the valve.
6. Connect loading pressure for the fail-up configuration to the 1/4-18 NPT connection in the spring case. The fail-down configuration loading pressure connection is in the lower casing assembly as shown in figure 3.

## CAUTION

**If a fail-up configuration is used, do not plug the 1/4-18 NPT connection in the lower casing. It acts as a vent for the lower casing, permitting air to move in and out of the lower casing cavity as the diaphragm moves up and down. If the vent is plugged, the actuator will not respond properly to loading pressure changes and may be incapable of completely opening or shutting off the valve.**

## Spring Adjustment

The spring supplied with the actuator has been selected to meet the requirements of the application as specified on the order. This pressure condition is stamped on the actuator nameplate.

The spring has a fixed pressure span over which loading pressure will stroke the valve. Adjustment of the spring compression shifts the span so that more or less loading pressure is required to start travel. Since the span does not change, there will be a corresponding increase or decrease in the pressure requirements at the end of the valve stroke.

If the actuator has been disassembled or pressure conditions have changed, the spring may need adjustment to make the valve travel coincide with the diaphragm pressure range. Make the adjustment in the following manner.

1. Loosen the adjusting screw nut (key 35, figure 3) on the fail-down configuration, or unscrew the spring case assembly (key 46, figure 2) on the fail-up configuration.
2. Turn the fail-down adjusting screw (key 34, figure 3) or the fail-up adjusting stem nut (key 35, figure 2) clockwise to compress the spring or counterclockwise to decrease spring compression.

Increased spring compression results in increased loading pressure necessary to start travel. Decreased spring compression results in less loading pressure required to start travel. With the fail-down configuration flow-to-open, increased spring compression will balance a higher line pressure or provide additional seating load. With the fail-up configuration flow-to-open, decreased spring compression may be necessary if the line pressure is increased or if more valve plug seating load is required from the input signal.

3. After adjustment, tighten the adjusting screw nut (fail-down configuration), or replace the spring case assembly (fail-up configuration).

The maximum pressure drop conditions are shown in tables 4 and 5. Note that the springs can be identified

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by the color code. Depending on how much conditions are changed, it may be necessary to change the actuator spring. If so, check the *Parts List* section to see if a different adjusting screw or adjusting stem assembly (key 34) is required.

## Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and maintenance depends on the severity of the service conditions.

Due to the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured by Fisher Controls.

### WARNING

**Avoid personal injury from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:**

- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**

Some types of ceramic trim, including the VTC (very tough ceramic) variety, can create a spark under certain circumstances. When the edge of a ceramic part is struck against a second ceramic part with enough force, a spark can be created.

### WARNING

**Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim.**

**Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).**

The following describes the procedure for complete disassembly and assembly of the actuator-valve combination. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job. Key numbers refer to figure 2 for the fail-up configuration and figure 3 for the fail-down configuration.

## Disassembly

1. Remove the loading pressure tubing and any accessories that may hamper disassembly.
2. Unscrew the hammer nut (key 3). If the bonnet is stuck on the valve, continue to unscrew the hammer nut. The hammer nut will contact the spring pins (key 58) and will force the bonnet out of the valve. Carefully lift the actuator, bonnet, and valve plug assembly from the valve body.

If the bonnet is stuck on the valve, insert a large screwdriver or steel rod into the pry hole in the bonnet. Push down on the screwdriver or rod to loosen the bonnet.

### Note

**The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.**

3. Remove the cage (key 5). For ceramic trim, remove the cage (key 60) and seat ring (key 61). Inspect the cage and bonnet O-rings (keys 6 and 11) for wear or damage.
4. To remove valve plug (key 7), drive out roll pin (key 9) and unscrew valve plug from stem (key 8).  
If valve plug cannot be easily unscrewed from stem, disassemble actuator in accordance with steps 7 through 9. Hold wrench on hex nut (key 29) to prevent stem and diaphragm from rotating.

**CAUTION**

**Be careful to avoid damaging the seating surface on the valve plug or the cage as damage in these areas will allow excessive leakage at shutoff. Avoid damaging the highly polished valve stem surface. A damaged valve stem could cut the packing and allow process fluid to leak to the atmosphere.**

5. If packing parts (keys 12, 13, 14, 15 for PTFE V-ring and nitrile/cotton; keys 12, 13, 14, and 16 for PTFE/composition) are to be replaced with new parts, remove washer (key 10) and pull out old parts using a formed wire hook.

**Note**

**Save three flat washers (key 13) when removing packing.**

6. No further disassembly is necessary if only the trim and/or packing is being serviced. To reassemble the unit, proceed to the *Assembly* section step 1 and steps 7 through 15.

**WARNING**

**To avoid personal injury caused by sudden release of spring force, relieve all spring compression before continuing disassembly. Use step 7 to relieve spring compression.**

7. To relieve all spring compression,

**For fail-down configuration,** loosen adjusting screw nut (key 35, figure 3) and turn adjusting screw (key 34, figure 3) counterclockwise to remove all spring compression.

**For fail-up configuration,** unscrew spring case assembly (key 46, figure 2) and turn adjusting stem nut (key 35, figure 2) counterclockwise to remove all spring compression. Remove adjusting stem nut, spring seat, and spring.

8. Unscrew the casing cap screws and hex nuts (keys 36 and 37), and remove the upper casing assembly (key 23) from the lower casing (key 22).

9. For fail-up configuration, remove cotter pin (key 50, figure 2) and unscrew adjusting stem (key 34, figure 2) from stem.

10. Lift out the diaphragm, diaphragm plate, and stem assembly.

11. To replace the diaphragm (key 26), separate the diaphragm assembly by using a wrench on the hex nuts (key 29) to unscrew the assembly.

12. Separate the parts—diaphragm washer, actuator O-ring (keys 27 and 28), diaphragm, and diaphragm plate, (keys 26 and 24).

13. Inspect the diaphragm and the actuator O-ring for damage or deterioration, and replace if necessary. If the diaphragm is replaced, a new O-ring should also be installed.

14. Inspect stem O-ring (key 19) and bonnet bushing (key 20); replace if necessary. To inspect casing O-ring (key 18), remove cap screws (key 21) and lift off lower casing (key 22). Replace O-ring if necessary.

**Note**

**The stem O-ring and bonnet bushing (keys 19 and 20), when used in fail-down, seal against loading pressure. The stem O-ring and bonnet bushing in fail-up have atmospheric pressure on the actuator side.**

15. If the hammer nut needs to be removed from the bonnet, the spring pins (key 58) can be removed with locking pliers.

16. The travel indicator assembly on the fail-up configuration has an O-ring (key 44, figure 2) that may become worn and leak loading pressure. If this happens, replace with a new assembly (key 43).

17. Fail-up configuration has adjusting stem bushing and actuator stem O-ring (keys 48 and 49, figure 2) that seals against loading pressure around the adjusting stem.

**Assembly**

1. Before starting assembly, make sure all parts are clean and in good condition. There should be no burrs or sharp edges on any threads or surfaces that might cut or damage an O-ring, bushing, the packing, or the diaphragm. When replacing O-rings and bushings, be sure the O-ring or bushing groove is clean and undamaged. Using a general purpose lubricant, lubricate all O-rings and bushings and the threads of parts that have to pass through the O-rings and bushings.

**CAUTION**

**The threads on factory-produced valve stems have been specially machined to avoid O-ring, bushing, or packing damage during trim maintenance. Use of other than a factory-produced valve stem may result in early stem O-ring, bushing, and packing failure.**

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2. If the actuator being reassembled is a fail-up configuration, replace the O-ring and bushing (keys 49 and 48, figure 2).

3. Assemble the diaphragm and diaphragm plate assembly. Place the patterned side of the diaphragm (key 26) (size 40 only) against the diaphragm plate (key 24). Be sure to turn the diaphragm washer (key 27) so that the side that is beveled on the inside diameter is against the O-ring (key 28). Also, make sure that it is assembled for installation with the diaphragm on the loading pressure side and the lockwasher (key 30) and lower spring seat (key 31), if used, are on the spring side.

4. Place the hammer nut and spring pins on the bonnet, if removed. Install the casing O-ring (key 18), the stem O-ring (key 19), and the bonnet bushing (key 20); then bolt the lower casing to the bonnet.

## Note

**Spring pins must always be in place during valve operation, acting as a safeguard against injury when the unit is being disassembled.**

5. Fasten diaphragm and diaphragm plate assembly on the stem with hex nuts (key 29). Place the diaphragm and diaphragm plate, and stem assembly into the lower casing and bonnet.

6. For fail-up configuration, screw the adjusting stem (key 34) onto the stem (key 8) and secure with cotter pin (key 50). Make sure bushing (key 48) and O-ring (key 49) are in place in the upper casing.

7. Install packing parts (keys 12, 13, 14, 15, or 16). Install washer (key 10). Screw valve plug onto stem. Drive in roll pin.

8. Make sure the cage O-ring (key 6) is in the cage. Install the cage into the valve.

For ceramic trim, ensure the O-ring (key 6) is in the seat ring. Install the seat ring and cage into the valve.

9. Make sure bonnet O-ring (key 11) is on the bonnet.

10. Lubricate the threads on the valve body and hammer nut and on the contact surfaces of bonnet and hammer nut flange. Install bonnet with attached diaphragm and valve plug onto the valve body. Tighten hammer nut using a hammer until the nut stops turning. A few extra hammer blows will be required to ensure that the assembly is tight. To avoid overloading of the cage, do not use excessive force, which can be seen by deformation of the nut.

## CAUTION

**Over-tightening the diaphragm casing cap screws and nuts (keys 36 and 37) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.**

11. If valve is a fail-up, position upper casing (key 23) on lower casing (key 22). Insert cap screws (key 36) and tighten hex nuts (key 37). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern. Replace the spring, spring seat, (keys 32 and 33) and adjusting stem nut (key 35) over the adjusting stem (key 34). Replace the spring case assembly (key 46).

12. If the valve is fail-down, replace the spring (key 32) on the diaphragm plate (key 24). Replace upper spring seat (key 33). Position upper casing (key 23) on lower casing (key 22). Insert cap screws (key 36) and tighten hex nuts (key 37). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern.

13. Install the travel indicator assembly.

14. Refer to the *Spring Adjustment* section.

15. Adjust the travel indicator nut (key 42).

## Parts Ordering

Each 357 Series control valve is assigned a serial number, which can be found on the nameplate. Refer to the number when contacting the Fisher Controls representative for assistance or when ordering replacement parts. When ordering replacement parts, also be sure to include the complete 11-character part number from the following parts list.

## Parts Kits

### Repair kits for the valve portion only.

PTFE V-Ring Packing Repair Kit (includes keys 6, 11, 12, and 15)	
Nitrile seal	R357XPTFE12
Fluoroelastomer seal	R357XPTFE22
Nitrile/Cotton Packing Repair Kit (includes 6, 11, 12, and 15)	
Nitrile seal	R357X00NC12
Fluoroelastomer seal	R357X00NC22
Ceramic Trim Package (includes keys 7, 9, 60, and 61)	
6.4 mm (1/4-inch) port diameter	R357XVTC012
9.5 mm (3/8-inch) port diameter	R357XVTC022
12.7 mm (1/2-inch) port diameter	R357XVTC032
19.1 mm (3/4-inch) port diameter	R357XVTC042
25.4 mm (1-inch) port diameter	R357XVTC052
38.1 mm (1-1/2 inch) port diameter	R357XVTC062

### Repair kits for the valve and actuator assembly.

Diaphragm is not included and must be ordered separately by appropriate part number.

PTFE V-Ring Packing Repair Kit (includes keys 6, 11, 12, 15, 18, 19, 20, 28, 44, 48, and 49)	
Nitrile seal	R357X000012
Fluoroelastomer seal	R357X000032
Nitrile/Cotton Packing Repair Kit (includes 6, 11, 12, 15, 18, 19, 20, 28, 44, 48, and 49)	
Nitrile seal	R357X000022
Fluoroelastomer seal	R357X000042

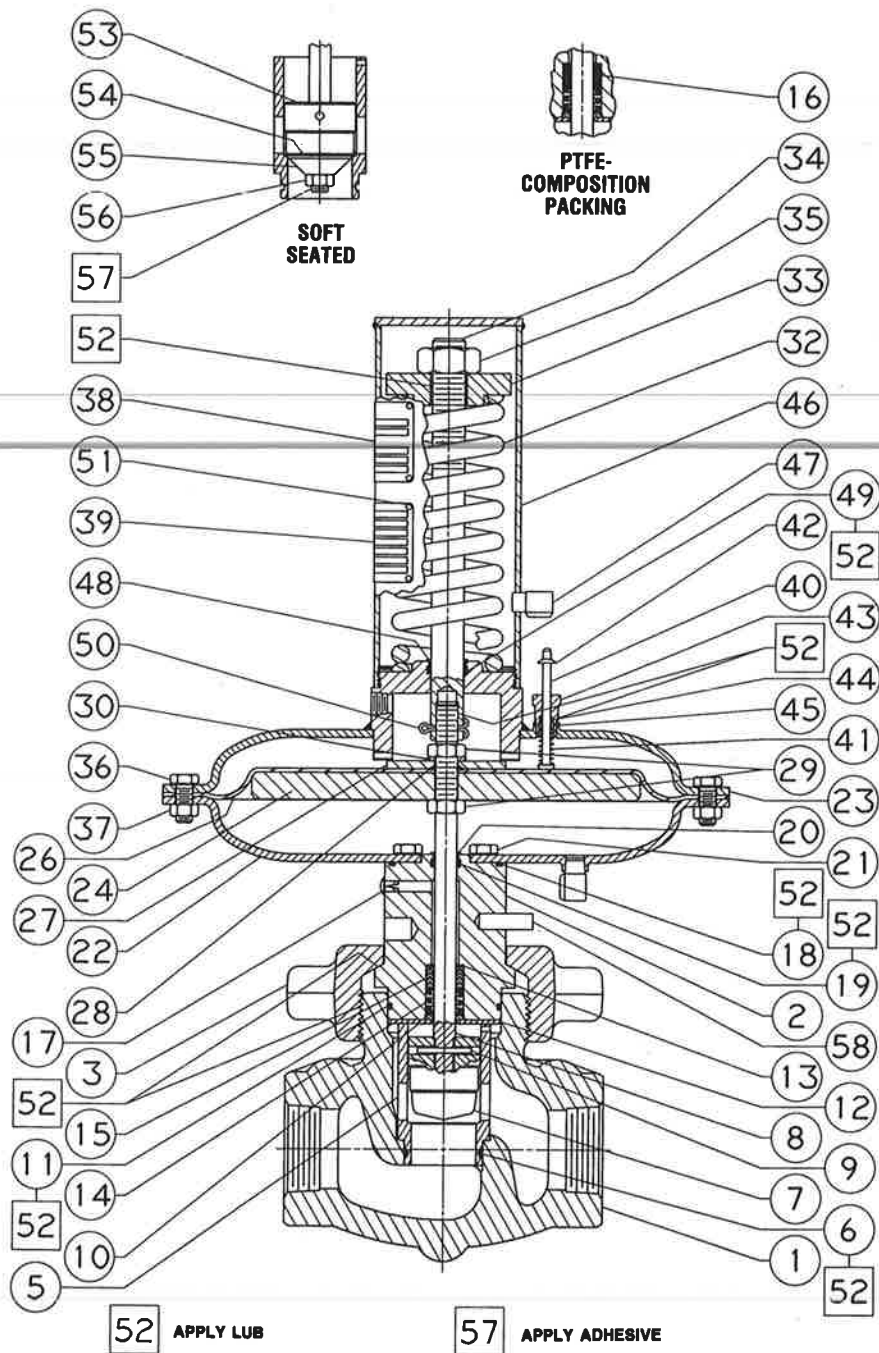
## Parts List

Key	Description	Part Number
2	Bonnet	
	For WCC (steel) valve & NACE, SA-105 steel	32B3485X012
	For LCC (steel) valve & NACE, SA-350 steel	32B3485X022
3	Hammer Nut	
	Size 1 & 2, Class 150 through 600 flanged and screwed	
	For WCC valve & NACE, SA-105 steel	22B3483X012
	For LCC valve & NACE, SA-350 steel	22B3483X022
	Size 2, Class 1500	
	For WCC (steel) valve & NACE, SA-105 steel	22B3549X012
	For LCC (steel) valve & NACE, SA-350 steel	22B3549X022
4	Pipe Plug (1-inch screwed valve only)	
	For WCC valve & NACE, SA-105 steel	1A794728992
	For LCC valve & NACE, S31600 (316 SST)	1A7947X00A2

Key	Description	Part Number
5*	Cage w/Integral Seat Ring	
	Metal Seat	
	17-4PH stainless steel H1075	
	6.4 mm (1/4-inch) port diameter	32B3486X012
	9.5 mm (3/8-inch) port diameter	32B3487X012
	12.7 mm (1/2-inch) port diameter	32B3488X012
	19.1 mm (3/4-inch) port diameter	32B3489X012
	25.4 mm (1-inch) port diameter	32B3490X012
	38.1 mm (1-1/2 inch) port diameter	32B3491X012
	17-4PH stainless steel DH1150 (NACE)	
	6.4 mm (1/4-inch) port diameter	32B3486X022
	9.5 mm (3/8-inch) port diameter	32B3487X022
	12.7 mm (1/2-inch) port diameter	32B3488X022
	19.1 mm (3/4-inch) port diameter	32B3489X022
	25.4 mm (1-inch) port diameter	32B3490X022
	38.1 mm (1-1/2 inch) port diameter	32B3491X022
	Soft Seat	
	17-4PH stainless steel H1075	
	12.7 mm (1/2-inch) port diameter	32B3488X012
	19.1 mm (3/4-inch) port diameter	32B3489X012
	25.4 mm (1-inch) port diameter	32B3490X012
	38.1 mm (1-1/2 inch) port diameter	32B3491X012
	17-4PH stainless steel DH1150 (NACE)	
	12.7 mm (1/2-inch) port diameter	32B3488X022
	19.1 mm (3/4-inch) port diameter	32B3489X022
	25.4 mm (1-inch) port diameter	32B3490X022
	38.1 mm (1-1/2 inch) port diameter	32B3491X022
6*	Cage O-Ring	See following table
7*	Valve Plug	
	Taper Plug (all port diameters)	
	416 stainless steel	22B3498X012
	17-4PH stainless steel DH1150 (NACE)	22B3498X022
	Micro-Form Plug	
	416 stainless steel	
	6.4 mm (1/4-inch) port diameter	22B3492X012
	9.5 mm (3/8-inch) port diameter	22B3493X012
	12.7 mm (1/2-inch) port diameter	22B3494X012
	19.1 mm (3/4-inch) port diameter	22B3495X012
	25.4 mm (1-inch) port diameter	22B3496X012
	38.1 mm (1-1/2 inch) port diameter	22B3497X012
	17-4PH stainless steel DH1150 (NACE)	
	6.4 mm (1/4-inch) port diameter	22B3492X022
	9.5 mm (3/8-inch) port diameter	22B3493X022
	12.7 mm (1/2-inch) port diameter	22B3494X022
	19.1 mm (3/4-inch) port diameter	22B3495X022
	25.4 mm (1-inch) port diameter	22B3496X022
	38.1 mm (1-1/2 inch) port diameter	22B3497X022
	VTC (ceramic) (standard or NACE)	
	6.4 mm (1/4-inch) port diameter	22B8922X012
	9.5 mm (3/8-inch) port diameter	22B8923X012
	12.7 mm (1/2-inch) port diameter	22B8924X012
	19.1 mm (3/4-inch) port diameter	22B8925X012
	25.4 mm (1-inch) port diameter	22B8926X012
	38.1 mm (1-1/2 inch) port diameter	22B8927X012
8*	Valve Stem	
	S31600 (316 stainless steel)	22B3516X012
	S20910 (Nitronic 50) (NACE)	22B3516X032
9*	Roll Pin, 18-8 stainless steel	1U5972X0012
9*	Pin, 17-4PH SST (DH1150) (NACE)	12B3507X022
10	Cage/Packing Washer, 304 stainless steel	12B3519X012
11*	Bonnet O-Ring	See following table
12*	Packing Wiper, PTFE	15A9637X012
13	Packing Washer, SST (3 req'd)	1H981836042
14	Packing Spring, N07750 (Inconel)	15A3183X012

# 357 Series

Key	Description	Part Number	Key	Description	Part Number
15*	Packing Set		36	Cap Screw, pl steel	
	PTFE V-ring	12A9016X012		Size 20 (12 req'd)	1E760324052
	Nitrile/cotton	19A5772X012		Size 40 (16 req'd)	1E760324052
16*	Packing Ring, PTFE comp (3 req'd)	1P390501042	37	Hex Nut, pl steel	
17	Leak-off Plug	15A0983X012		Size 20 (12 req'd)	1A346524122
18*	Casing O-Ring	See following table		Size 40 (16 req'd)	1A346524122
19*	Stem O-Ring	See following table	38	Actuator Nameplate	14B2028X0A2
20*	Bonnet Bearing	See following table	40	Indicator Rod (included in key 43 assembly)	
21	Cap Screw, pl steel (4 req'd)	1D529824052	41	Indicator Spring (included in key 43 assembly)	
22	Lower Casing, pl (plated) steel		42	Indicator Nut (included in key 43 assembly)	
	Fail up or fail down		43	Indicator Assembly	
	Size 20	32B3499X012		Fail up (includes keys 40, 41, 42, 43, 44, and 45)	
	Size 40	42B3500X012		-29 to 149°C (-20 to 300°F)	22B3524X022
23	Upper Casing Assy, pl steel			-45 to 82°C (-50 to 180°F)	22B3524X032
	Size 20			Fail down (includes keys 40, 41, 42, and 43)	22B3523X022
	Fail up	22B3503X012	44	Indicator O-Ring (included in key 43 assembly)	
	Fail down	32B3501X012		(fail up only)	
	Size 40		45	Indicator Bushing (included in key 43 assembly)	
	Fail up	22B3510X012	46	Spring Case Assembly, steel (for fail up)	23A2349X012
	Fail down	32B3508X012	47	Vent Assy, SST (2 req'd) (for fail up)	27A5516X012
24	Diaphragm Plate, steel		48*	Adjusting Stem Bushing, nylon (for fail up)	17A4059X012
	Size 20	22B3514X012	49*	Actuator Stem O-Ring (for fail up)	See following table
	Size 40	24B1785X012	50*	Cotter Pin, S30200 (302 stainless steel)	
26*	Diaphragm (O-Ring, key 28 should be ordered with diaphragm)			(for fail up)	1C608035022
	Size 20		51	Drive Screw, SST (8 req'd)	1A368228982
	Nitrile/nylon	32B3520X012	52	Lubricant, Lubriplate Mag-1	---
	Fluoroelastomer	32B3520X022		Not included with control valve	
	Size 40		53*	Plug, Disk Holder, S17400 D1150	
	Neoprene/nylon	22B3521X012		12.7 mm (1/2-inch) port diameter	22B3533X012
	Fluoroelastomer	22B3521X032		19.1 mm (3/4-inch) port diameter	22B3532X012
27	Diaphragm Washer, pl steel	12B3517X012		25.4 mm (1-inch) port diameter	22B3531X012
28*	Actuator O-Ring	See following table		38.1 mm (1-1/2 inch) port diameter	22B3530X012
29	Hex Nut, pl steel (2 req'd)	1A353724122	54*	Disk, Plug Seat, UHMWPE <sup>(1)</sup>	
30	Lockwasher, pl steel	1A353828982		12.7 mm (1/2-inch) port diameter	15A3584X012
31	Lower Spring Seat, pl steel (for fail down only)	12B3518X012		19.1 mm (3/4-inch) port diameter	13A7446X012
32	Actuator Spring See tables 4, 5, and 6			25.4 mm (1-inch) port diameter	13A7450X012
33	Upper Spring Seat, pl steel			38.1 mm (1-1/2 inch) port diameter	13A7463X012
	Fail up (size 20 or 40 actuator)	13A2343X012	55*	Disk Retainer, S31600	
	Fail down			12.7 mm (1/2-inch) port diameter	15A3583X022
	Size 20 actuator	16A9460X012		19.1 mm (3/4-inch) port diameter	13A7447X012
	Size 40 actuator	17A3513X012		25.4 mm (1-inch) port diameter	13A7451X012
34	Adjusting Screw, pl steel			38.1 mm (1-1/2 inch) port diameter	12B3529X012
	Fail down		56	Hex Nut, S31600	
	Size 20 flow-up-to-open			19.1 mm (3/4-inch) port diameter	1A391535072
	0.2 to 1.0 bar (3 to 15 psig) signal range	1D336628982		25.4 mm (1-inch) port diameter	1A3753X0282
	All other ranges	1A6441X0012		38.1 mm (1-1/2 inch) port diameter	1A3753X0282
	Size 40 flow-up-to-open		57	Adhesive, Loctite No. 262	T13060T0012
	0.2 to 1.0 bar (3 to 15 psig) signal range	17A3515X012	58	Spring Pin, Pl carbon steel, (2 req'd)	12B9011X012
	All other ranges	1V360928982	60*	Cage for Ceramic Trim	
34	Adjusting Stem, S31600 (316 stainless steel)			S17400 D1150 (std or NACE) all port dia	22B8912X012
	For fail up	22B3512X012	61*	Seat Ring for Ceramic Trim	
35	Adjusting screw nut, pl steel (fail down)	1A352424122		S17400 D1150 (std or NACE)	
35	Adjusting stem nut, pl steel (fail up)	1A599324122		6.4 mm (1/4 inch) port diameter	17B1949X012
				9.5 mm (3/8 inch) port diameter	17B1950X012
				12.7 mm (1/2 inch) port diameter	17B1951X012
				19.1 mm (3/4 inch) port diameter	17B9680X012
				25.4 mm (1-inch) port diameter	17B9681X012
				Ceramic (std or NACE)	
				38.1 mm (1-1/2 inch) port diameter	32B8918X012



42B6430-D/DOC

Figure 2. 2-Inch 357 Series Valve—Fail-Up

# 357 Series

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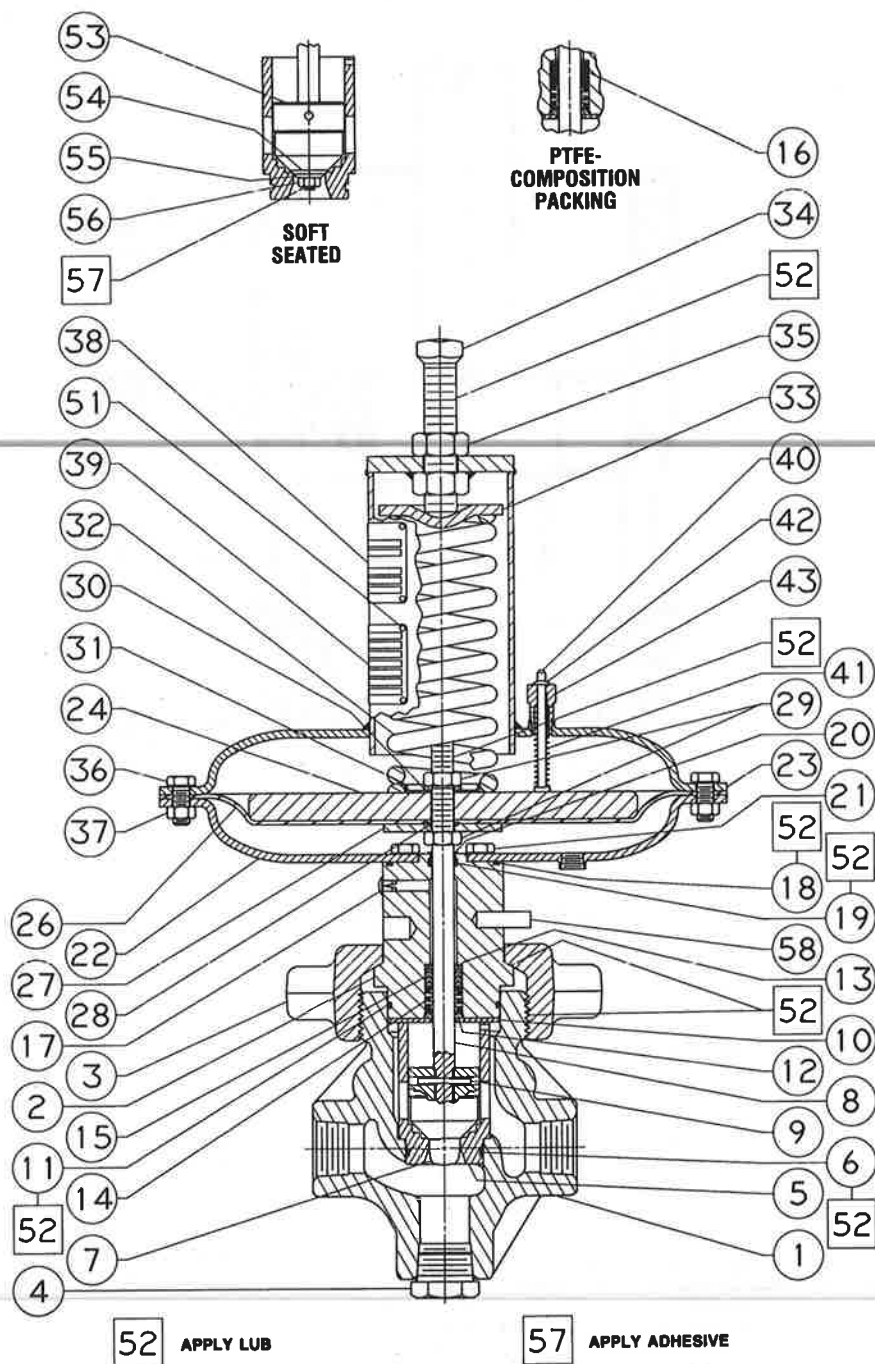
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Sao Paulo 05424 Brazil  
Singapore 128461



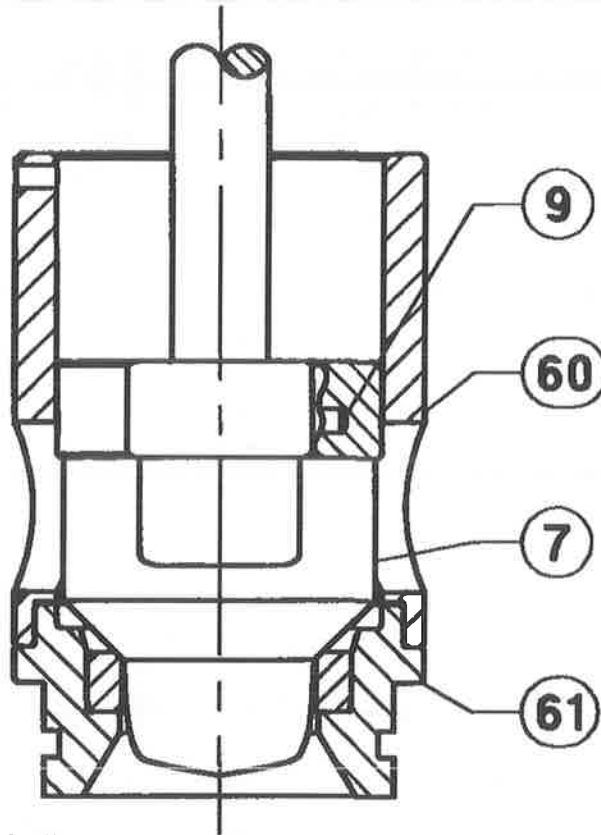


# 357 Series



42B6428-D/DOC

Figure 3. 1-Inch 357 Series Valve—Fail-Down



17B9686-A/DOC

Figure 4. Ceramic Trim Assembly

Keys 6\*, 11\*, 18\*, 19\*, 28\*, and 49\* O-Rings and Key 20\* Bushing

KEY NUMBER	PART NAME	WCC VALVE BODY MATERIAL		LCC VALVE BODY MATERIAL
		Temperature Capabilities		
		-29 to 93°C (-20 to 200°F)	-23 to 149°C (-10 to 300°F)	-45 to 82°C (-50 to 180°F)
		O-Ring Materials		
		Nitrile	Fluoroelastomer	Nitrile <sup>(1)</sup>
6*	Cage O-Ring	12B3522X012	12B3522X022	12B3522X042
11*	Bonnet O-Ring	1F9141X0042	1F9141X0012	1F9141X0052
18*	Casing O-Ring	1F9141X0042	1F9141X0012	1F9141X0052
19*	Stem O-Ring	1K7561X0012	1K756106382	1K7561X0022
28*	Actuator O-Ring	1K7561X0012	1K756106382	1K7561X0022
49*(2)	Actuator Stem O-Ring	1C7812X0012	1C7821X0012	1C782106992
		Bushing Materials		
		Nylon	Ryton	Nylon
20*	Bonnet Bushing	17A7112X012	17A7112X032	17A7112X012

1. Low-temperature material.  
2. For fail-up configuration.

\* Recommended spare part.  
1. Ultra High Molecular Weight Polyethylene





PROPAK SYSTEMS LTD  
 POSTAL BAG #2 AIRDRIE, ALBERTA, CANADA T4B 2C3

CUSTOMER : APACHE CANADA LIMITED  
 PLANT : 1478HP HAMBURG COMPRESSOR PACKAGE  
 SERVICE : DIFFERENTIAL PRESSURE SWITCH

PRESSURE SWITCHES				SHEET 1 OF 1
NO	BY	DATE	REVISION	FILE 14.11.P
1	SW	06/09/00	ISSUED FOR PURCHASE	JOB # 99404
				DATE 06/09/00
				REQ.
				BY _____
				CHK'D _____
				APPR. _____
				SW _____

**GENERAL**

1. TYPE: PRESS  VACUUM \_\_\_\_\_  
 COMP. \_\_\_\_\_ DIFF. PRESS. \_\_\_\_\_

2. SETTING: SET IN FIELD \_\_\_\_\_ FACTORY SET   
 INTERNAL \_\_\_\_\_ EXTERNAL  DAILY \_\_\_\_\_

3. DEAD BAND: FIXED \_\_\_\_\_ ADJ. \_\_\_\_\_ MIN. \_\_\_\_\_

**ELEMENT**

4. TYPE : DIAPHRAGM  BOURDON \_\_\_\_\_ BELLOWS \_\_\_\_\_  
 OTHER \_\_\_\_\_

5. MATERIAL: BRONZE \_\_\_\_\_ SS  ALLOY ST. \_\_\_\_\_  
 OTHER \_\_\_\_\_

6. CONNECTION: MFR STD \_\_\_\_\_ OTHER SIZE \_\_\_\_\_  
 BOTTOM 1/4"FNPT \_\_\_\_\_ BACK \_\_\_\_\_

7. MOUNTING : LOCAL  SURFACE \_\_\_\_\_ FLUSH \_\_\_\_\_

**SWITCH**

8. TYPE : MERCURY \_\_\_\_\_ SNAP  \_\_\_\_\_  
 OTHER \_\_\_\_\_

9. QUANTITY: SINGLE  DUAL \_\_\_\_\_

10. FORM: SPST \_\_\_\_\_ SPDT  DPDT \_\_\_\_\_  
 OTHER \_\_\_\_\_

11. RATING: 0.4 AMPS 125 VDC \_\_\_\_\_  
 DC OTHER 15A @ 250VAC 60 Hz \_\_\_\_\_

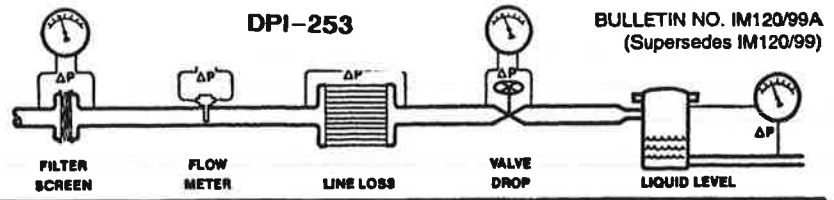
12. LOAD: INDUCTIVE \_\_\_\_\_ NON-INDUCTIVE \_\_\_\_\_

13. ENCLOSURE: C.S.A APPROVED - CLASS 1 DIV.1 GRP C&D  
 NON-EXP \_\_\_\_\_ EXPLOSION PROOF  \_\_\_\_\_

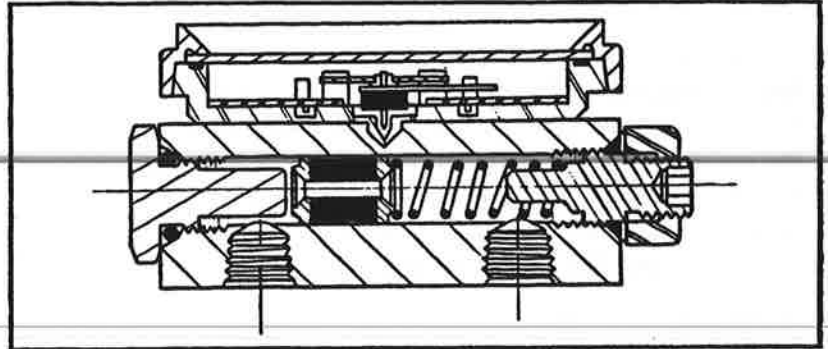
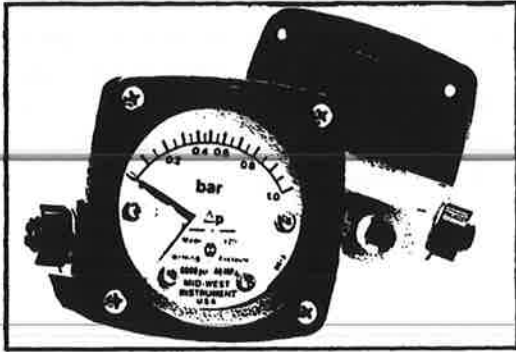
14. CONDUIT CONNECTION: MFR STD  1/2" NPTM \_\_\_\_\_  
 OTHER \_\_\_\_\_

TAG NO.	REV	CONTACTS OPEN ON PROC. COND.	COMPOUND ADJ. RANGE kPag	SET POINT		OPERATION		SERVICE	NOTES	ASSEMBLY & UNIT #
				PROCESS kPa	SIGNAL kPag	TEMP C	PRESS kPag			
DPS-288	1	FALLING	14 - 490	70		70	100	PURGE PACKING LEAK	NACE, SOUR VAPOUR	152

MFR: CCS  
 MODEL NUMBER: 646DZE2  
 P.O. NUMBER:  
 NOTES: 1) NACE COMPLIANT



## Model 120 Series "Filter Minder"<sup>®</sup> Installation and Operating Instructions



### INSPECTION

Before installation check the nameplate on each instrument against the receiving paperwork and the intended application for correct part number, materials of construction, working pressure, dial range, etc. If equipped with switches, check electrical rating, type of enclosure, etc. Inspect for shipping damage and, if damaged, report it immediately.

**NOTE - Before attempting repairs contact your local Mid-West Representative or our factory. Failure to do so will void any warranty.**

### PRODUCT DESCRIPTION

The Model 120 Series "Filter Minder"<sup>®</sup> is a rugged, medium-range differential pressure instrument available as a switch, a gauge, or both. See "Part Numbering System". (Fig. 4) for available options.

Differential pressure is sensed by the movement of a floating piston magnet against a calibrated spring. The magnetically coupled gauge pointer outside the pressure housing follows the movement of the piston magnet and indicates differential pressure on the dial scale.

When equipped with switches, a contact is made or broken by the magnetic field of the piston magnet. See Bulletin ELECIM120/latest for gauges with switches.

The unit provides full over-range protection to the rated working pressure of the housing in either direction.

The precise piston/bore fit allows minimal leakage from high to low sides. This leakage is only 5 to 15 SCFH air at ambient conditions and a pressure differential of 100 PSID.

### INSTALLATION

Model 120 Series "Filter Minder"<sup>®</sup> is calibrated and tested prior to shipment and is ready for immediate installation. Use of the following installation procedures should eliminate potential damage and provide optimum trouble-free operation.

#### **1. CONNECTIONS**

1/4" FNPT are provided as standard but check paperwork for connections ordered. There are two connections on the housing identified as "hi" and "lo" for high pressure and low pressure (Fig. 2). Be sure these get plumbed to the proper connections on your system. Improper connection will not damage the instrument, but it will not function properly. Flexible tubing is recommended to minimize the effect of any vibration that may exist.

#### **2. INSTRUMENT LOCATION**

On liquid service the instrument should be mounted **below** the process connections to facilitate self-bleeding. On gas service it should be located **above** the process connections to promote self-draining. If the process contains particulates, a "pigtail" loop or drop leg (manometer "U-tube" configuration) in the tubing will minimize the possibility of it migrating into the instrument.

### 3. PANEL MOUNTING

Gauges with 2-1/2" dials can only be mounted through the rear of the panel. Make the proper panel cutout as indicated in (Fig.1). Remove the (4) bezel screws. Insert the gauge front through the rear of the panel and reinstall the bezel screws through the front of the panel and into the gauge bezel. Tighten the screws securely, alternating in a diagonal pattern.

Gauges with 3-1/2" dial should be mounted from the front of the panel. Contact factory for mounting information and dimensional data.

Gauges with 4-1/2" dial should be mounted from the front of the panel. Make the cutout as indicated in (Fig. 1). Insert the (4) panel mounting studs, finger tight, into the metal inserts located in the rear of the bezel. Insert the gauge through the panel, aligning the panel mounting studs with the holes in the panel. Install the (4) #8-32 nuts onto the studs and tighten securely.

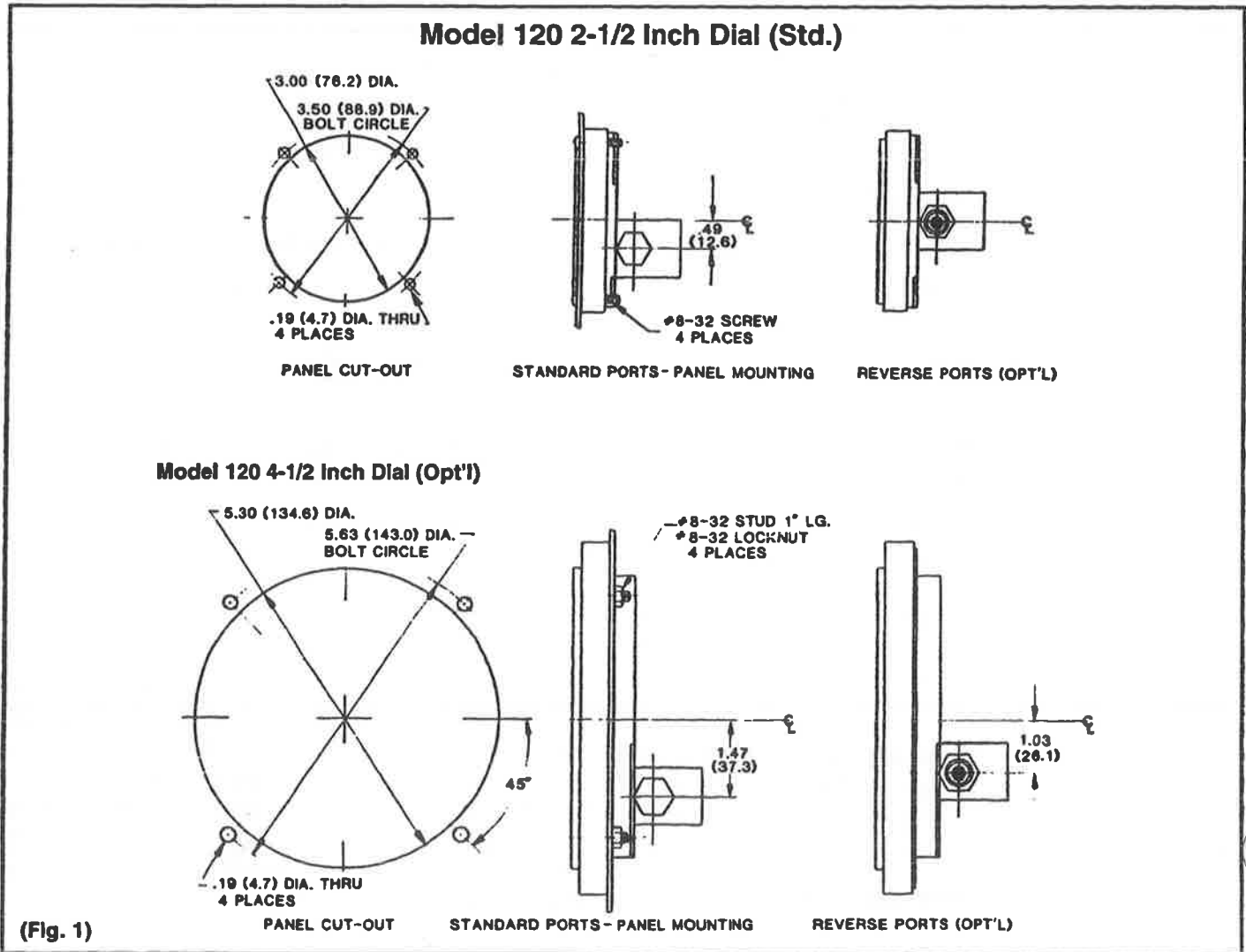
### 4. PIPE MOUNTING

An optional pipe mounting kit is available for mounting the gauge to a 2" vertical or horizontal pipe (Fig. 3).

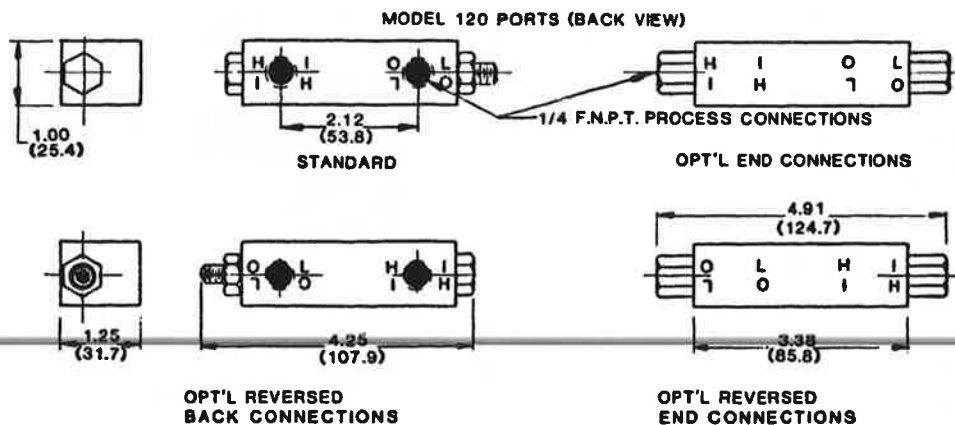
### TROUBLE SHOOTING

#### 1. Gauge does not indicate differential.

- Check for proper hook up, high to "hi" and low to "lo".
- Make certain block valves are open and, if using a 3-valve manifold, that the equalizer (balance) valve is closed.
- If A & B check out correctly, loosen or disconnect the high pressure line to determine if there is pressure to the instrument.
- If there is pressure to the instrument, check to determine that there is differential across the unit being monitored. If so, contact the factory for assistance and/or an "RGA" (return goods authorization) number to return the instrument for repair or replacement.



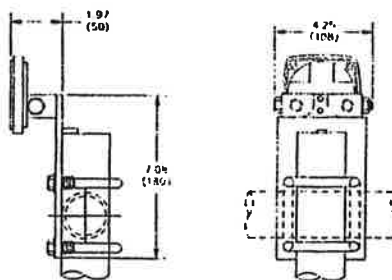
## Supplementary 120 Dimensional/Mounting Data



**(Fig. 2)**

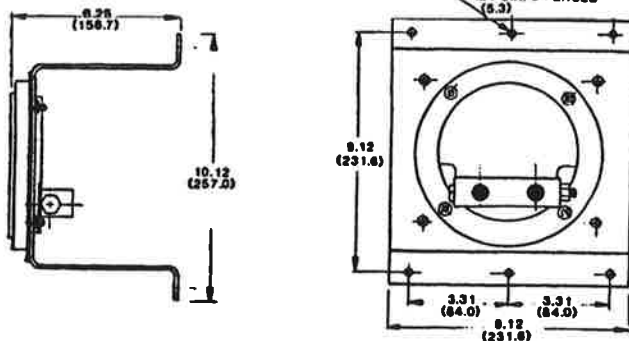
**TYPICAL 2" PIPE MOUNTING (BACK CONNECTIONS ONLY)**

3.75 (95) FOR 2-1/2 INCH DIAL  
4.18 (106.1) FOR 4-1/2 INCH DIAL

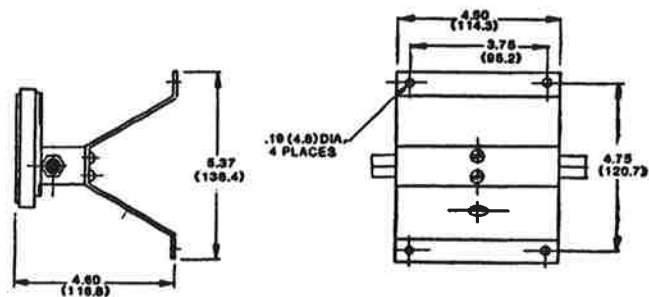


**TYPICAL WALL MOUNTING 4-1/2 INCH DIAL (BACK OR END CONNECTIONS)**

.21 DIA. 8 PLACES



**TYPICAL WALL MOUNTING 2-1/2 INCH DIAL (END CONNECTION OPTION ONLY)**



**(Fig. 3)**

- NOTES:**
1. Drawings show standard gauge nominal dimensions. (not to scale)
  2. Dimensions shown in parentheses are in millimeters.
  3. Manufacturer reserves the right to change specifications without prior notice.

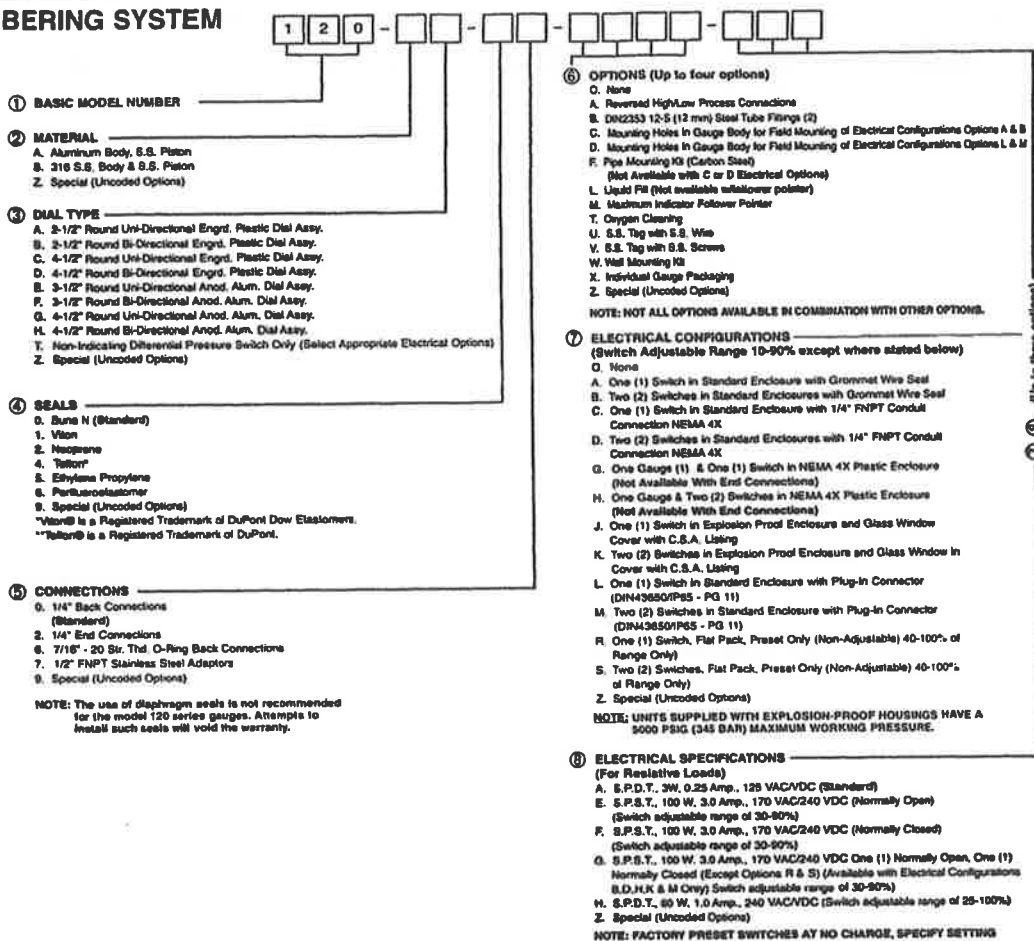


# STANDARD MODEL SPECIFICATIONS

120-AA-00-00

6000 P.S.I.G. Working Pressure Aluminum Body, Stainless Steel Piston, Ceramic Magnets, Buna N Seals, 2-1/2" Engineering Plastic Case with Shatter-Resistant Lens. 1/4" FNPT Back Connections. Accuracy  $\pm 3-2-3\%$  Full Scale (Ascending).

## PART NUMBERING SYSTEM



(Fig. 4)

Manufacturer reserves the right to change specifications without prior notice.

**PROOF PRESSURE: 12,000 PSI.**

**TEMPERATURE LIMITS: -40°F (-40°C) to +200°F (+93°C)** - These limits are based on the entire instrument being saturated to these temperatures. System (process) temperatures may exceed these limitations with proper installation. Contact our customer service representative for details.

**STANDARDS:** All Model 120 Series differential pressure gauges either conform to and/or are designed to the requirements of the following standards:

- |                            |                             |
|----------------------------|-----------------------------|
| ASME B1.20.1               | NACE MR0175                 |
| ASME B40.1                 | NEMA Std. No. 250           |
| CSA-C22.2 No. 14.25 and 30 | SAE J514i                   |
| EN-61010-1                 | UL Std. No. 50,508 and 1203 |

REPRESENTED BY:

# Mid-West® Instrument

6500 Dobry Dr. □ Sterling Heights, MI 48314  
 (810) 254-6500 □ FAX (810) 254-6509  
 E-mail: sales@midwestinstrument.com  
 Website: www.midwestinstrument.com

Printed in U.S.A.

# EXTERNAL ADJUSTMENT

# LOW/MID RANGE DIAPHRAGM SS PORT

# DIFFERENTIAL

DPS-288

Diff. .4 to 75 psid

## SERIES: 646DZE

### Standard Features:

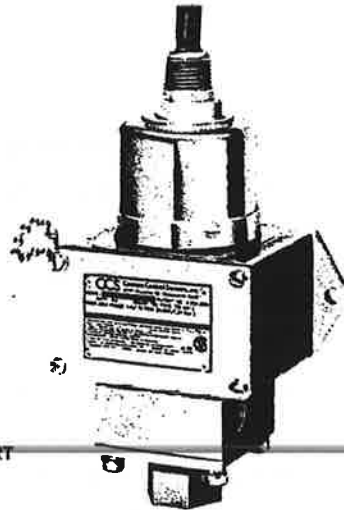
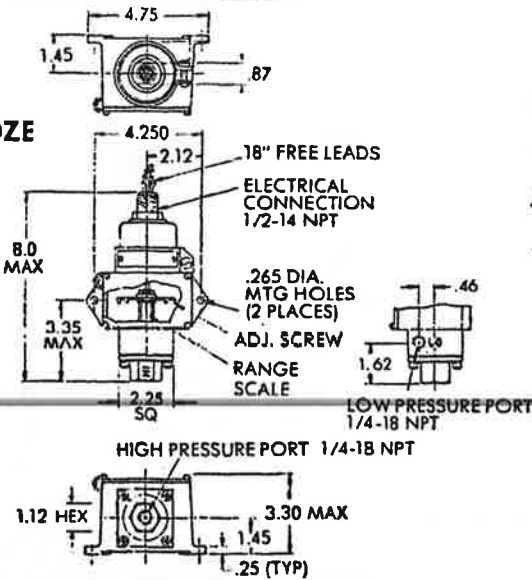
- U.L./CSA — See Note
- Explosion Proof: Div. 1, 2
- NEMA: 4, 7, 9, 13
- Fire Resistant
- Steel Body

### AMBIENT TEMP. RANGE

- 30° to 160° F
- 34° to 71° C

## INSTALLATION DRAWING

646DZE



SHIPPING WT.  
APPROX. 60 OZ.  
(1700 GRAMS)

## OPERATING AND ORDERING DATA:

**DIFFERENTIAL SWITCHES** 1/4" STAINLESS STEEL  
**MODEL 646DZE** • PRESSURE PORTS AND  
POLYIMIDE DIAPHRAGM

Maximum System Pressure psi		Proof (Test) Pressure psi		Adjustable Set-Point Range		Approx. Dead band psi	Model Number and Wetted Parts			
High Press. Port	Low Press. Port	Both Ports Simultaneous	High Over Low	Low Over High	On Increasing Pressure psid		On Decreasing Pressure psid	MODEL SPDT-Std.	MODEL DPDT "M"	Wetted Parts
400		750	750	400	1.2 to 18 6 to 75	.4 to 17.2 2 to 71	.8 4	646DZE1 646DZE2	646DZEM1 646DZEM2	300 SS Polyimide Viton

## ELECTRICAL CHARACTERISTICS:

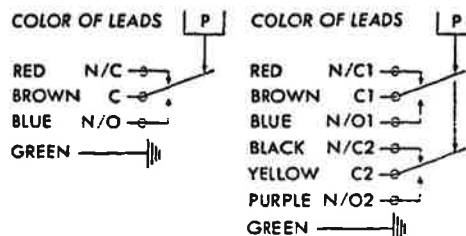
### Rating of Switch Element

VOLTS	AMPERES	
	SPDT Res.	DPDT "M" Res.
125 AC-50 60 Hz	15	5
250 AC-50 60 Hz	15	5
480 AC-50 60 Hz	15	—
125 DC	.4	.5

## SCHEMATIC AND WIRING CODE

SPDT-Standard

DPDT "M"



### NOTE:

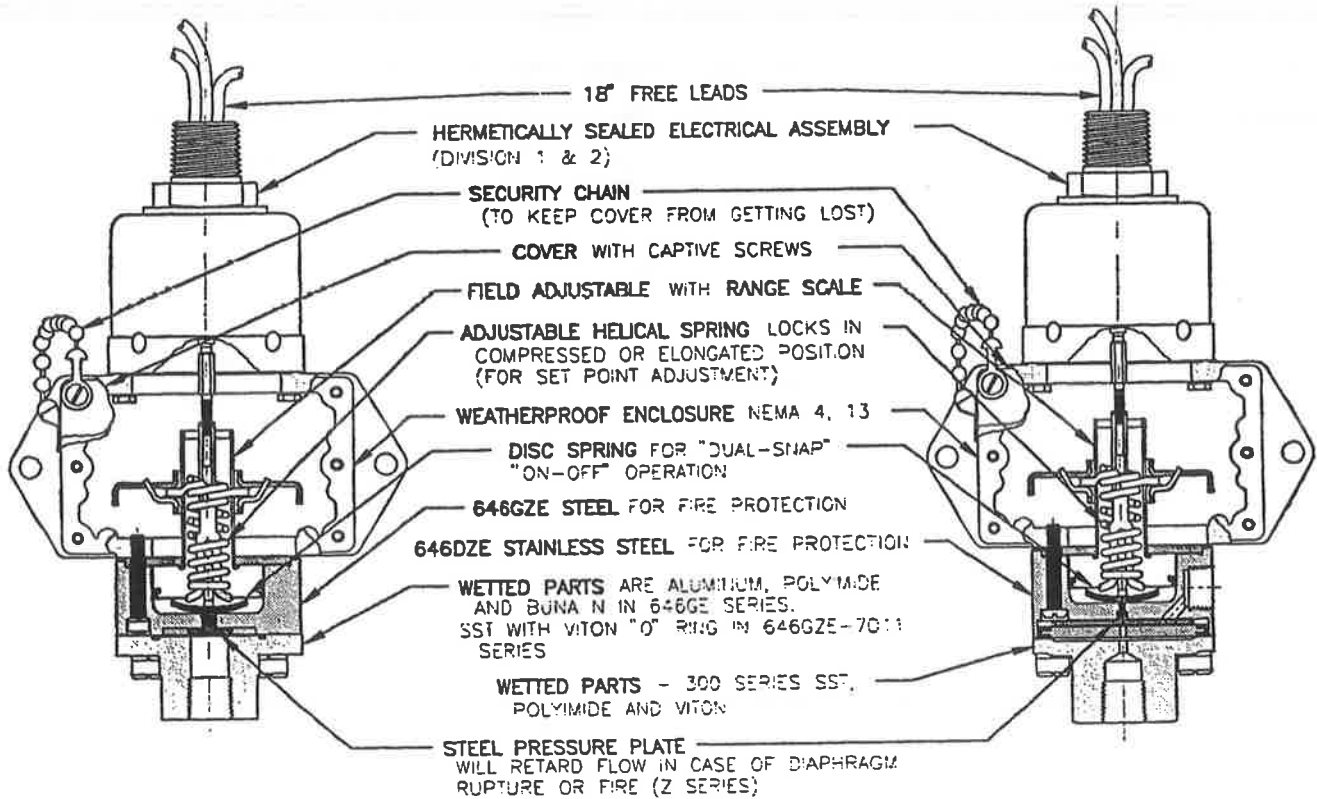
Div. 1 explosion-proof and hermetically sealed electrical assembly Part No. 17-51 (17-73 for "M" model option) listed by both Underwriters' Laboratories, Inc. (File No. E32961) and CSA Testing Laboratories (File No. 22921) for hazardous locations, Class 1, Groups A, B, C, and D; Class 2, Groups E, F, and G.

## HOW TO ORDER:

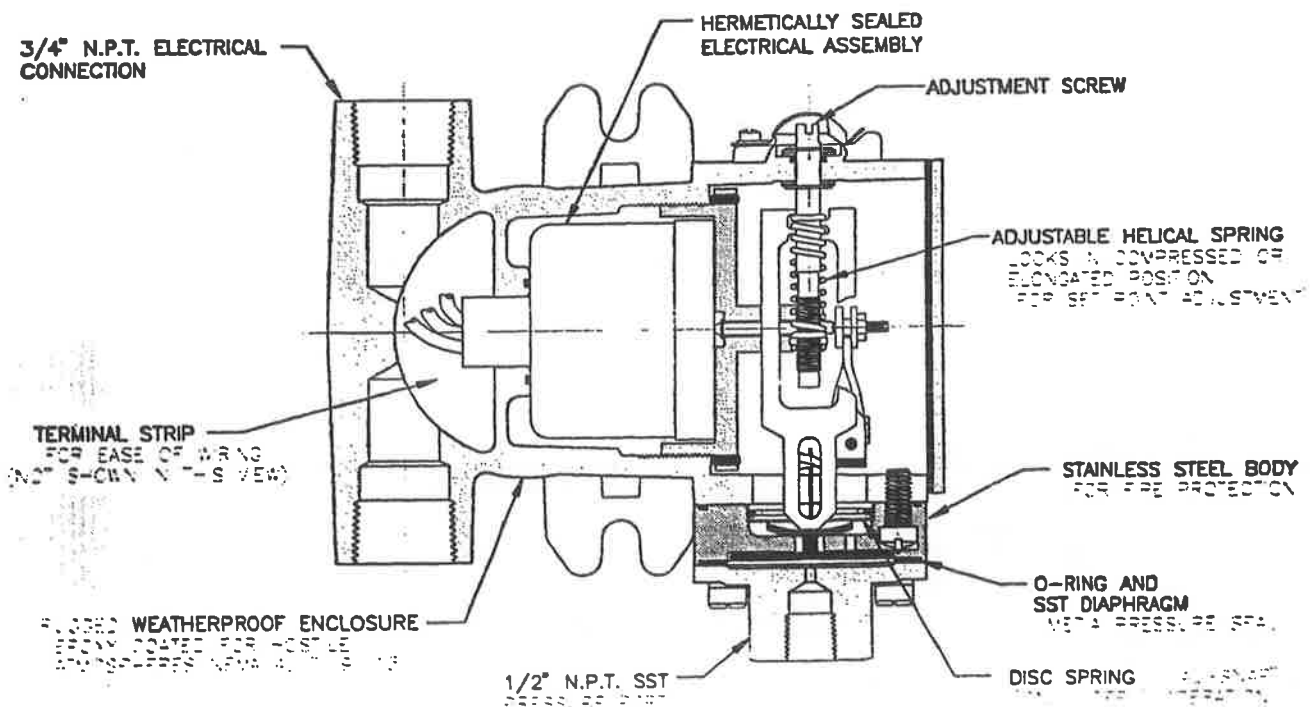
1. Specify model number.

## SERIES 646GE

## SERIES 646DZE



## SERIES 6401GZE





PROPAK SYSTEMS LTD POSTAL BAG # 2, AIRDRIE, ALBERTA, CANADA T4B 2C3				LEVEL CONTROL VALVES				SHEET 1 OF 1					
CUSTOMER : APACHE CANADA LIMITED PLANT : 1478HP HAMBIURG COMPRESSOR PACKAGE SERVICE : EMERGENCY SHUTDOWN VALVE				NO		BY		DATE		REVISION			
				1		PC		99/12/21		FOR PURCHASE		DATE	
				2		CG		00/01/06		MODEL WAS 128PQC		REQ.	
								JOB # 99404		FILE 14.11			
								BY		CHK'D APPR.			
G	1	TAG NO.		ESDV-101									
E	2	SERVICE		BLOWDOWN									
N	3	LINE NO. / VESSEL NO.											
E	4	LINE SIZE / SCHED. NO.		33 mm SCH.160									
	5	TYPE OF BODY		GLOBE									
	6	BODY SIZE	PORT SIZE	33	mm	19.1	mm	mm	mm	mm	mm		
	7	GUIDING	NO. OF PORTS	TOP	ONE								
B	8	END CONN. & RATING		33 mm FNPT 6000#									
O	9	BODY MATERIAL		WCC									
D	10	PACKING MATERIAL		TFE									
Y	11	LUBRICATOR	ISOLAT. VALVE										
	12	BONNET TYPE		HAMMER NUT									
	13	TRIM FORM		MICRO-FORM									
	14	TRIM MATERIAL SEAT / PLUG		17-4 PH									
		SHAFT / MAT'L		NIT 50									
	15	REQUIRED SEAT TIGHTNESS		CLASS IV									
	16	MAX ALLOW SOUND LEV. dBA											
A	17	MODEL NO. & SIZE		357-40									
C	18	TYPE OF ACTUATOR		DIAPHRAGM									
T	19	CLOSE AT	OPEN AT	207	kPa	41	kPa	kPa	kPa	kPa	kPa		
U	20	FLOW ACTION TO		OPEN									
A	21	FAIL POSITION		OPEN									
T	22	HANDWHEEL & LOCATION											
P	23	MFR. & MODEL NO.											
O	24	FILT REG   GAGES   BYPASS											
S	25	INPUT SIGNAL											
I	26	OUTPUT SIGNAL											
T	27	AIR SUPPLY PRESS				kPa		kPa		kPa			
T	28	MFR. & MODEL NO.		NO									
R	29	INPUT SIGNAL											
N	30	OUTPUT SIGNAL											
O	31	SPRING COLOUR (NUMBER)											
P	32												
T	33	SOLENIOD VALVE (BY PSL)		ASCO EF8320G202-24									
	34	FLOW UNITS											
	35	FLUID		SOUR HC GAS									
	36	QUANT. MAX.	MAX. Cv										
S	37	QUANT. OPER.	OPER Cv										
E	38	VALVE Cv	VALVE C1	342									
R	39	NORM IN PRES	NORM DELTA P	8411	kPa(g)	8273	kPa	kPa(g)	kPa	kPa(g)	kPa		
V	40	MAX INLET PRESS.		11377		kPa		kPa		kPa			
I	41	MAX SHUT OFF	MAX DELTA P	11377	kPa(g)	11377	kPa	kPa(g)	kPa	kPa(g)	kPa		
C	42	TEMP. MAX.	OPER. TEMP	149	* C	48	* C	* C	* C	* C	* C		
E	43	OPER. SP. GR.	MOL. WT.	0.68									
	44	OPER. VISC.	% FLASH										
	45	% SUPERHEAT	% SOLIDS										
	46	VAPOR PRESS	CRIT PRESS		kPa(g)		kPa(g)	kPa(g)	kPa(g)	kPa(g)	kPa(g)		
	47	PREDICTED SOUND LEVEL dBA											
	48	MANUFACTURER		FISHER									
	49	MODEL NO.		357-40									
	50	P. O. NUMBER											

NOTES:

1. NACE COMPLIANCE REQUIRED
2. VALVE TO BE USED INTERMITTANTLY - HIGH NOISE

AREA UNIT #: 152

## 357 Series Control Valves

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W5810/L

Figure 1. 357 Series Control Valve

### Introduction

#### Scope of Manual

This instruction manual provides installation, maintenance, and parts information for 357 Series control valves. Refer to separate manuals for instruction covering accessories used with the control valve.

#### Description

The 357 Series control valves (figure 1) are designed for high-pressure on-off and throttling applications and are used as dump valves on oil and gas separators, scrubbers, and other field process equipment. They are also used for well-head applications where rugged

steel construction and easy maintenance are necessary. (The bonnet/body connection is covered by patent.)

Only personnel qualified through training or experience should install, operate, and maintain this control valve. If you have any questions concerning these instructions, contact your Fisher Controls sales office or sales representative before proceeding.

#### Specifications

Table 1 lists specifications for the 357 Series control valves. Some of the specifications for the control valve, as it originally comes from the factory, are stamped on nameplates.



# 357 Series

Table 1. Specifications

<p><b>Available Configurations</b> See table 2</p> <p><b>Valve Body Sizes and End Connection Styles</b> See table 3</p> <p><b>Maximum Inlet Pressures and Temperatures<sup>(1)</sup></b> 276 bar from -29 to 93°C (4000 psig from -20 to 200°F), 276 bar at -45°C (4000 psig at -50°F), and 268 bar at 149°C (3880 psig at 300°F) unless limited by end connection rating</p> <p><b>Maximum Pressure Drops<sup>(1)</sup></b> <b>Metal Seats:</b> See tables 4 and 5</p> <p><b>Input Signal to Actuator</b> See tables 4 and 5</p> <p><b>Actuator Maximum Casing Pressure</b> Size 20: 3.4 bar (50 psig) Size 40: 3.4 bar (50 psig)</p> <p><b>Shutoff Classification</b> <b>Metal Seats:</b> ANSI Class IV per ANSI/FCI 70-2 <b>Soft Seats:</b> ANSI Class VI per ANSI/FCI 70-2</p> <p><b>Material Temperature Capabilities<sup>(1)(2)</sup></b> <b>With Nitrile O-Rings, Nylon Bushings, and WCC Valve Bodies:</b> -29 to 93°C (-20 to 200°F) <b>With Fluoroelastomer O-Rings, Ryton Bushings, and WCC Valve Bodies:</b> -23 to 149°C (-10 to 300°F)</p>	<p><b>With Nitrile<sup>(3)</sup> O-Rings, Nylon Bushings, and LCC Valve Bodies:</b> -45 to 82°C (-50 to 180°F)</p> <p><b>Flow Characteristic</b> <b>Metal or Ceramic Seats:</b> Equal percentage <b>Soft Seats:</b> Quick opening</p> <p><b>Flow Direction</b> May be in either direction as suits the application</p> <p><b>Port Diameters</b> ■ 6.4, ■ 9.5, ■ 12.7, ■ 19.1, ■ 25.4, or ■ 38.1 mm (1/4, 3/8, 1/2, 3/4, 1, or 1-1/2 inch) port diameters for both 1-inch and 2-inch valve bodies. See tables 4 and 5 for more information.</p> <p><b>Maximum Rated Valve Plug Travel</b> 19 mm (3/4 inch)</p> <p><b>Valve Plug Style</b> Micro-Form valve plug<sup>(4)</sup></p> <p><b>Actuator Diaphragm Effective Area</b> Size 20: 213 cm<sup>2</sup> (33 inches<sup>2</sup>) Size 40: 452 cm<sup>2</sup> (70 inches<sup>2</sup>)</p> <p><b>Actuator Spring Information</b> See table 6</p> <p><b>Actuator Pressure Connection Size</b> 1/4 inch NPT female</p> <p><b>Approximate Weight</b> See table 7</p>
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1. The pressure or temperature limits in the referenced tables and any applicable ANSI code limitations should not be exceeded.  
2. Process temperature should not go below -29°C (-20°F).  
3. Low temperature material.  
4. Contact your Fisher Controls sales office or sales representative for other valve plug requirements.

Table 2. Available Configurations

VALVE TYPE NUMBER AND FAIL ACTION	357, FAIL DOWN (SPRING CLOSES—AIR OPENS)				357, FAIL UP (SPRING OPENS—AIR CLOSES)			
	20		40		20		40	
Actuator Sizes	20		40		20		40	
Valve Configurations	Globe	Angle	Globe	Angle	Globe	Angle	Globe	Angle
Valve Size, Inches	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2	1 and 2

# 357 Series

Table 3. Valve Sizes and Connection Styles

VALVE SIZE, INCHES	SCREWED <sup>(1)</sup>	RAISED FACE (RF) FLANGED				RING TYPE JOINT (RTJ) FLANGED	
		Class 150	Class 300	Class 600	Class 1500	Class 600	Class 1500
1	X	X	X	X	---	X	---
2	X	X	X	X	X	X	X

X = Available construction.  
 1. The 1-inch screwed valve is a combination valve that uses a pipe plug in the unused connection to make either a globe or angle configuration (see figure 3).

Table 4. Maximum Allowable Shutoff Pressure Drops<sup>(1)</sup> for 357 Series Valves with Metal Seats (Fail Down, Spring Closes—Air Opens Configuration)

ACTUATOR SIZE	FLOW DIRECTION	PORT DIAMETER		INPUT SIGNAL TO ACTUATOR, SPRING PART NUMBER											
				0.2 to 1.0 Bar (3 to 15 Psig)		0.4 to 2.0 Bar (6 to 30 Psig)		0.7 to 3.4 Bar (10 to 50 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
				16A9594X012		16A9595X012		16A9656X012		16A9594X012		16A9595X012		16A9656X012	
		mm	Inches	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
20	Up to Open	6.4	1/4	117	1700	276	4000	257	3720	257	3720	276	4000	276	4000
		9.5	3/8	42	610	166	2400	104	1510	104	1510	276	4000	276	4000
		12.7	1/2	18	260	88	1270	53	770	53	770	157	2280	169	2450
		19.1	3/4	3	40	34	490	19	270	19	270	65	940	70	1010
		25.4	1	---	---	17	240	8	110	8	110	34	490	37	530
		38.1	1-1/2	---	---	5	70	1	10	1	10	12	180	14	200
	Down to Close			16A9929X012		16A9656X012		16A9656X012		16A9929X012		16A9656X012		16A9656X012	
				Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
		6.4	1/4	66	960	111	1620	111	1620	111	1620	186	2700	232	3360
		9.5	3/8	76	1100	178	2590	178	2590	178	2590	276	4000	276	4000
		12.7	1/2	87	1270	236	3420	247	3580	121	1760	276	4000	276	4000
		19.1	3/4	31	450	76	1100	103	1490	76	1100	141	2050	195	2830
40	Up to Open	6.4	1/4	276	4000	276	4000	276	4000	276	4000	276	4000	276	4000
		9.5	3/8	201	2920	276	4000	276	4000	276	4000	276	4000	276	4000
		12.7	1/2	108	1560	157	2270	157	2270	181	2630	276	4000	276	4000
		19.1	3/4	43	620	65	940	65	940	76	1100	30	1890	174	2520
		25.4	1	21	310	34	490	34	490	39	570	70	1020	95	1380
		38.1	1-1/2	7	100	12	180	12	180	15	220	29	420	39	570
	Down to Close			1J258127092		1E793327082		1E795627082		1J258127092		1E793327082		1E795627082	
				Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
		6.4	1/4	159	2300	276	4000	257	3720	257	3720	276	4000	276	4000
		9.5	3/8	259	3750	276	4000	276	4000	276	4000	276	4000	276	4000
		12.7	1/2	276	4000	276	4000	276	4000	276	4000	276	4000	276	4000
		19.1	3/4	83	1210	182	2640	248	3860	182	2640	276	4000	276	4000
25.4	1	34	500	76	1100	117	1690	76	1100	141	2050	190	2760		
38.1	1-1/2	13	190	28	410	44	630	28	410	52	760	71	1030		

1. For valves with soft seats, the maximum allowable pressure drop is limited to 69 bar (1000 psig) or to the values in the table, whichever is less.



# 357 Series

by the color code. Depending on how much conditions are changed, it may be necessary to change the actuator spring. If so, check the *Parts List* section to see if a different adjusting screw or adjusting stem assembly (key 34) is required.

## Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and maintenance depends on the severity of the service conditions.

Due to the care Fisher Controls takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured by Fisher Controls.

### WARNING

**Avoid personal injury from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:**

- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**

Some types of ceramic trim, including the VTC (very tough ceramic) variety, can create a spark under certain circumstances. When the edge of a ceramic part is struck against a second ceramic part with enough force, a spark can be created.

### WARNING

**Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim.**

**Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).**

The following describes the procedure for complete disassembly and assembly of the actuator-valve combination. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job. Key numbers refer to figure 2 for the fail-up configuration and figure 3 for the fail-down configuration.

## Disassembly

1. Remove the loading pressure tubing and any accessories that may hamper disassembly.
2. Unscrew the hammer nut (key 3). If the bonnet is stuck on the valve, continue to unscrew the hammer nut. The hammer nut will contact the spring pins (key 58) and will force the bonnet out of the valve. Carefully lift the actuator, bonnet, and valve plug assembly from the valve body.

If the bonnet is stuck on the valve, insert a large screwdriver or steel rod into the pry hole in the bonnet. Push down on the screwdriver or rod to loosen the bonnet.

### Note

**The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.**

3. Remove the cage (key 5). For ceramic trim, remove the cage (key 60) and seat ring (key 61). Inspect the cage and bonnet O-rings (keys 6 and 11) for wear or damage.
4. To remove valve plug (key 7), drive out roll pin (key 9) and unscrew valve plug from stem (key 8).

If valve plug cannot be easily unscrewed from stem, disassemble actuator in accordance with steps 7 through 9. Hold wrench on hex nut (key 29) to prevent stem and diaphragm from rotating.

**CAUTION**

**Be careful to avoid damaging the seating surface on the valve plug or the cage as damage in these areas will allow excessive leakage at shutoff. Avoid damaging the highly polished valve stem surface. A damaged valve stem could cut the packing and allow process fluid to leak to the atmosphere.**

5. If packing parts (keys 12, 13, 14, 15 for PTFE V-ring and nitrile/cotton; keys 12, 13, 14, and 16 for PTFE/composition) are to be replaced with new parts, remove washer (key 10) and pull out old parts using a formed wire hook.

**Note**

**Save three flat washers (key 13) when removing packing.**

6. No further disassembly is necessary if only the trim and/or packing is being serviced. To reassemble the unit, proceed to the *Assembly* section step 1 and steps 7 through 15.

**WARNING**

**To avoid personal injury caused by sudden release of spring force, relieve all spring compression before continuing disassembly. Use step 7 to relieve spring compression.**

7. To relieve all spring compression,

**For fail-down configuration**, loosen adjusting screw nut (key 35, figure 3) and turn adjusting screw (key 34, figure 3) counterclockwise to remove all spring compression.

**For fail-up configuration**, unscrew spring case assembly (key 46, figure 2) and turn adjusting stem nut (key 35, figure 2) counterclockwise to remove all spring compression. Remove adjusting stem nut, spring seat, and spring.

8. Unscrew the casing cap screws and hex nuts (keys 36 and 37), and remove the upper casing assembly (key 23) from the lower casing (key 22).

9. For fail-up configuration, remove cotter pin (key 50, figure 2) and unscrew adjusting stem (key 34, figure 2) from stem.

10. Lift out the diaphragm, diaphragm plate, and stem assembly.

11. To replace the diaphragm (key 26), separate the diaphragm assembly by using a wrench on the hex nuts (key 29) to unscrew the assembly.

12. Separate the parts—diaphragm washer, actuator O-ring (keys 27 and 28), diaphragm, and diaphragm plate, (keys 26 and 24).

13. Inspect the diaphragm and the actuator O-ring for damage or deterioration, and replace if necessary. If the diaphragm is replaced, a new O-ring should also be installed.

14. Inspect stem O-ring (key 19) and bonnet bushing (key 20); replace if necessary. To inspect casing O-ring (key 18), remove cap screws (key 21) and lift off lower casing (key 22). Replace O-ring if necessary.

**Note**

**The stem O-ring and bonnet bushing (keys 19 and 20), when used in fail-down, seal against loading pressure. The stem O-ring and bonnet bushing in fail-up have atmospheric pressure on the actuator side.**

15. If the hammer nut needs to be removed from the bonnet, the spring pins (key 58) can be removed with locking pliers.

16. The travel indicator assembly on the fail-up configuration has an O-ring (key 44, figure 2) that may become worn and leak loading pressure. If this happens, replace with a new assembly (key 43).

17. Fail-up configuration has adjusting stem bushing and actuator stem O-ring (keys 48 and 49, figure 2) that seals against loading pressure around the adjusting stem.

**Assembly**

1. Before starting assembly, make sure all parts are clean and in good condition. There should be no burrs or sharp edges on any threads or surfaces that might cut or damage an O-ring, bushing, the packing, or the diaphragm. When replacing O-rings and bushings, be sure the O-ring or bushing groove is clean and undamaged. Using a general purpose lubricant, lubricate all O-rings and bushings and the threads of parts that have to pass through the O-rings and bushings.

**CAUTION**

**The threads on factory-produced valve stems have been specially machined to avoid O-ring, bushing, or packing damage during trim maintenance. Use of other than a factory-produced valve stem may result in early stem O-ring, bushing, and packing failure.**

# 357 Series

2. If the actuator being reassembled is a fail-up configuration, replace the O-ring and bushing (keys 49 and 48, figure 2).

3. Assemble the diaphragm and diaphragm plate assembly. Place the patterned side of the diaphragm (key 26) (size 40 only) against the diaphragm plate (key 24). Be sure to turn the diaphragm washer (key 27) so that the side that is beveled on the inside diameter is against the O-ring (key 28). Also, make sure that it is assembled for installation with the diaphragm on the loading pressure side and the lockwasher (key 30) and lower spring seat (key 31), if used, are on the spring side.

4. Place the hammer nut and spring pins on the bonnet, if removed. Install the casing O-ring (key 18), the stem O-ring (key 19), and the bonnet bushing (key 20); then bolt the lower casing to the bonnet.

## Note

**Spring pins must always be in place during valve operation, acting as a safeguard against injury when the unit is being disassembled.**

5. Fasten diaphragm and diaphragm plate assembly on the stem with hex nuts (key 29). Place the diaphragm and diaphragm plate, and stem assembly into the lower casing and bonnet.

6. For fail-up configuration, screw the adjusting stem (key 34) onto the stem (key 8) and secure with cotter pin (key 50). Make sure bushing (key 48) and O-ring (key 49) are in place in the upper casing.

7. Install packing parts (keys 12, 13, 14, 15, or 16). Install washer (key 10). Screw valve plug onto stem. Drive in roll pin.

8. Make sure the cage O-ring (key 6) is in the cage. Install the cage into the valve.

For ceramic trim, ensure the O-ring (key 6) is in the seat ring. Install the seat ring and cage into the valve.

9. Make sure bonnet O-ring (key 11) is on the bonnet.

10. Lubricate the threads on the valve body and hammer nut and on the contact surfaces of bonnet and hammer nut flange. Install bonnet with attached diaphragm and valve plug onto the valve body. Tighten hammer nut using a hammer until the nut stops turning. A few extra hammer blows will be required to ensure that the assembly is tight. To avoid overloading of the cage, do not use excessive force, which can be seen by deformation of the nut.

## CAUTION

**Over-tightening the diaphragm casing cap screws and nuts (keys 36 and 37) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.**

11. If valve is a fail-up, position upper casing (key 23) on lower casing (key 22). Insert cap screws (key 36) and tighten hex nuts (key 37). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern. Replace the spring, spring seat, (keys 32 and 33) and adjusting stem nut (key 35) over the adjusting stem (key 34). Replace the spring case assembly (key 46).

12. If the valve is fail-down, replace the spring (key 32) on the diaphragm plate (key 24). Replace upper spring seat (key 33). Position upper casing (key 23) on lower casing (key 22). Insert cap screws (key 36) and tighten hex nuts (key 37). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern.

13. Install the travel indicator assembly.

14. Refer to the *Spring Adjustment* section.

15. Adjust the travel indicator nut (key 42).

## Parts Ordering

Each 357 Series control valve is assigned a serial number, which can be found on the nameplate. Refer to the number when contacting the Fisher Controls representative for assistance or when ordering replacement parts. When ordering replacement parts, also be sure to include the complete 11-character part number from the following parts list.

## Parts Kits

### Repair kits for the valve portion only.

<b>PTFE V-Ring Packing Repair Kit</b>	
(includes keys 6, 11, 12, and 15)	
Nitrile seal	R357XPTFE12
Fluoroelastomer seal	R357XPTFE22
<b>Nitrile/Cotton Packing Repair Kit</b>	
(includes 6, 11, 12, and 15)	
Nitrile seal	R357X00NC12
Fluoroelastomer seal	R357X00NC22
<b>Ceramic Trim Package (includes keys 7, 9, 60, and 61)</b>	
6.4 mm (1/4-inch) port diameter	R357XVTC012
9.5 mm (3/8-inch) port diameter	R357XVTC022
12.7 mm (1/2-inch) port diameter	R357XVTC032
19.1 mm (3/4-inch) port diameter	R357XVTC042
25.4 mm (1-inch) port diameter	R357XVTC052
38.1 mm (1-1/2 inch) port diameter	R357XVTC062

### Repair kits for the valve and actuator assembly.

Diaphragm is not included and must be ordered separately by appropriate part number.

<b>PTFE V-Ring Packing Repair Kit</b>	
(includes keys 6, 11, 12, 15, 18, 19, 20, 28, 44, 48, and 49)	
Nitrile seal	R357X000012
Fluoroelastomer seal	R357X000032
<b>Nitrile/Cotton Packing Repair Kit</b>	
(includes 6, 11, 12, 15, 18, 19, 20, 28, 44, 48, and 49)	
Nitrile seal	R357X000022
Fluoroelastomer seal	R357X000042

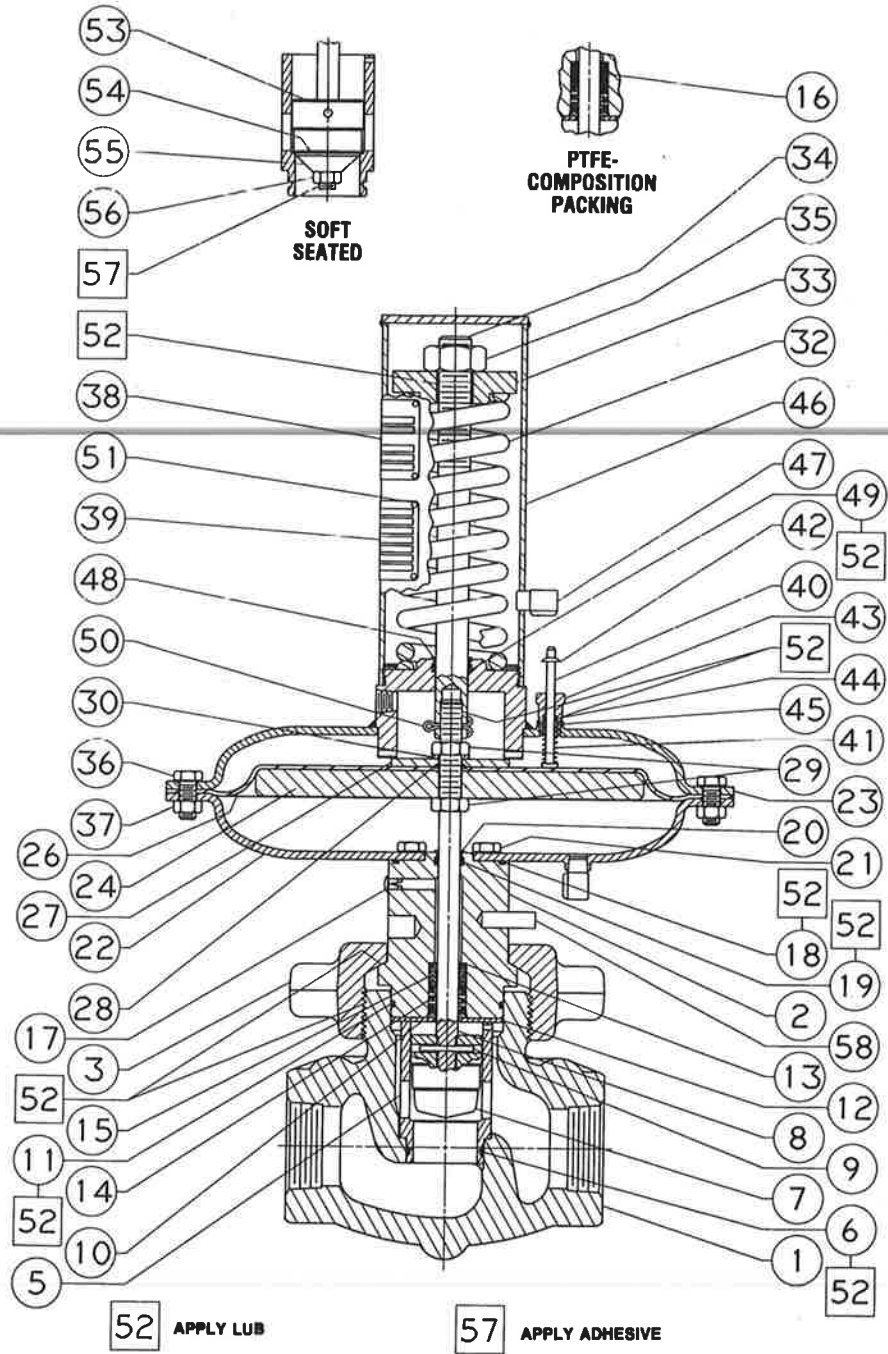
## Parts List

Key	Description	Part Number
2	Bonnet	
	For WCC (steel) valve & NACE, SA-105 steel	32B3485X012
	For LCC (steel) valve & NACE, SA-350 steel	32B3485X022
3	Hammer Nut	
	Size 1 & 2, Class 150 through 600 flanged and screwed	
	For WCC valve & NACE, SA-105 steel	22B3483X012
	For LCC valve & NACE, SA-350 steel	22B3483X022
	Size 2, Class 1500	
	For WCC (steel) valve & NACE, SA-105 steel	22B3549X012
	For LCC (steel) valve & NACE, SA-350 steel	22B3549X022
4	Pipe Plug (1-inch screwed valve only)	
	For WCC valve & NACE, SA-105 steel	1A794728992
	For LCC valve & NACE, S31600 (316 SST)	1A7947X00A2

Key	Description	Part Number
5*	Cage w/Integral Seat Ring	
	Metal Seat	
	17-4PH stainless steel H1075	
	6.4 mm (1/4-inch) port diameter	32B3486X012
	9.5 mm (3/8-inch) port diameter	32B3487X012
	12.7 mm (1/2-inch) port diameter	32B3488X012
	19.1 mm (3/4-inch) port diameter	32B3489X012
	25.4 mm (1-inch) port diameter	32B3490X012
	38.1 mm (1-1/2 inch) port diameter	32B3491X012
	17-4PH stainless steel DH1150 (NACE)	
	6.4 mm (1/4-inch) port diameter	32B3486X022
	9.5 mm (3/8-inch) port diameter	32B3487X022
	12.7 mm (1/2-inch) port diameter	32B3488X022
	19.1 mm (3/4-inch) port diameter	32B3489X022
	25.4 mm (1-inch) port diameter	32B3490X022
	38.1 mm (1-1/2 inch) port diameter	32B3491X022
	Soft Seat	
	17-4PH stainless steel H1075	
	12.7 mm (1/2-inch) port diameter	32B3488X012
	19.1 mm (3/4-inch) port diameter	32B3489X012
	25.4 mm (1-inch) port diameter	32B3490X012
	38.1 mm (1-1/2 inch) port diameter	32B3491X012
	17-4PH stainless steel DH1150 (NACE)	
	12.7 mm (1/2-inch) port diameter	32B3488X022
	19.1 mm (3/4-inch) port diameter	32B3489X022
	25.4 mm (1-inch) port diameter	32B3490X022
	38.1 mm (1-1/2 inch) port diameter	32B3491X022
6*	Cage O-Ring	See following table
7*	Valve Plug	
	Taper Plug (all port diameters)	
	416 stainless steel	22B3498X012
	17-4PH stainless steel DH1150 (NACE)	22B3498X022
	Micro-Form Plug	
	416 stainless steel	
	6.4 mm (1/4-inch) port diameter	22B3492X012
	9.5 mm (3/8-inch) port diameter	22B3493X012
	12.7 mm (1/2-inch) port diameter	22B3494X012
	19.1 mm (3/4-inch) port diameter	22B3495X012
	25.4 mm (1-inch) port diameter	22B3496X012
	38.1 mm (1-1/2 inch) port diameter	22B3497X012
	17-4PH stainless steel DH1150 (NACE)	
	6.4 mm (1/4-inch) port diameter	22B3492X022
	9.5 mm (3/8-inch) port diameter	22B3493X022
	12.7 mm (1/2-inch) port diameter	22B3494X022
	19.1 mm (3/4-inch) port diameter	22B3495X022
	25.4 mm (1-inch) port diameter	22B3496X022
	38.1 mm (1-1/2 inch) port diameter	22B3497X022
	VTC (ceramic) (standard or NACE)	
	6.4 mm (1/4-inch) port diameter	22B8922X012
	9.5 mm (3/8-inch) port diameter	22B8923X012
	12.7 mm (1/2-inch) port diameter	22B8924X012
	19.1 mm (3/4-inch) port diameter	22B8925X012
	25.4 mm (1-inch) port diameter	22B8926X012
	38.1 mm (1-1/2 inch) port diameter	22B8927X012
8*	Valve Stem	
	S31600 (316 stainless steel)	22B3516X012
	S20910 (Nitronic 50) (NACE)	22B3516X032
9*	Roll Pin, 18-8 stainless steel	1U5972X0012
9*	Pin, 17-4PH SST (DH1150) (NACE)	12B3507X022
10	Cage/Packing Washer, 304 stainless steel	12B3519X012
11*	Bonnet O-Ring	See following table
12*	Packing Wiper, PTFE	15A9637X012
13	Packing Washer, SST (3 req'd)	1H981836042
14	Packing Spring, N07750 (Inconel)	15A3183X012

# 357 Series

Key	Description	Part Number	Key	Description	Part Number
15*	Packing Set		36	Cap Screw, pl steel	
	PTFE V-ring	12A9016X012		Size 20 (12 req'd)	1E760324052
	Nitrile/cotton	19A5772X012		Size 40 (16 req'd)	1E760324052
16*	Packing Ring, PTFE comp (3 req'd)	1P390501042	37	Hex Nut, pl steel	
17	Leak-off Plug	15A0983X012		Size 20 (12 req'd)	1A346524122
18*	Casing O-Ring	See following table		Size 40 (16 req'd)	1A346524122
19*	Stem O-Ring	See following table	38	Actuator Nameplate	14B2028X0A2
20*	Bonnet Bearing	See following table	40	Indicator Rod (included in key 43 assembly)	
21	Cap Screw, pl steel (4 req'd)	1D529824052	41	Indicator Spring (included in key 43 assembly)	
			42	Indicator Nut (included in key 43 assembly)	
22	Lower Casing, pl (plated) steel		43	Indicator Assembly	
	Fail up or fail down			Fail up (includes keys 40, 41, 42, 43, 44, and 45)	
	Size 20	32B3499X012		-29 to 149°C (-20 to 300°F)	22B3524X022
	Size 40	42B3500X012		-45 to 82°C (-50 to 180°F)	22B3524X032
23	Upper Casing Assy, pl steel			Fail down (includes keys 40, 41, 42, and 43)	22B3523X022
	Size 20		44	Indicator O-Ring (included in key 43 assembly)	
	Fail up	22B3503X012		(fail up only)	
	Fail down	32B3501X012	45	Indicator Bushing (included in key 43 assembly)	
	Size 40		46	Spring Case Assembly, steel (for fail up)	23A2349X012
	Fail up	22B3510X012	47	Vent Assy, SST (2 req'd) (for fail up)	27A5516X012
	Fail down	32B3508X012	48*	Adjusting Stem Bushing, nylon (for fail up)	17A4059X012
24	Diaphragm Plate, steel		49*	Actuator Stem O-Ring (for fail up)	See following table
	Size 20	22B3514X012	50*	Cotter Pin, S30200 (302 stainless steel)	
	Size 40	24B1785X012		(for fail up)	1C608035022
26*	Diaphragm (O-Ring, key 28 should be ordered with diaphragm)		51	Drive Screw, SST (8 req'd)	1A368228982
	Size 20		52	Lubricant, Lubriplate Mag-1	- - -
	Nitrile/nylon	32B3520X012		Not included with control valve	
	Fluoroelastomer	32B3520X022	53*	Plug, Disk Holder, S17400 D1150	
	Size 40			12.7 mm (1/2-inch) port diameter	22B3533X012
	Neoprene/nylon	22B3521X012		19.1 mm (3/4-inch) port diameter	22B3532X012
	Fluoroelastomer	22B3521X032		25.4 mm (1-inch) port diameter	22B3531X012
27	Diaphragm Washer, pl steel	12B3517X012		38.1 mm (1-1/2 inch) port diameter	22B3530X012
28*	Actuator O-Ring	See following table	54*	Disk, Plug Seat, UHMWPE <sup>(1)</sup>	
29	Hex Nut, pl steel (2 req'd)	1A353724122		12.7 mm (1/2-inch) port diameter	15A3584X012
30	Lockwasher, pl steel	1A353828982		19.1 mm (3/4-inch) port diameter	13A7446X012
31	Lower Spring Seat, pl steel (for fail down only)	12B3518X012		25.4 mm (1-inch) port diameter	13A7450X012
32	Actuator Spring See tables 4, 5, and 6			38.1 mm (1-1/2 inch) port diameter	13A7463X012
33	Upper Spring Seat, pl steel		55*	Disk Retainer, S31600	
	Fail up (size 20 or 40 actuator)	13A2343X012		12.7 mm (1/2-inch) port diameter	15A3583X022
	Fail down			19.1 mm (3/4-inch) port diameter	13A7447X012
	Size 20 actuator	16A9460X012		25.4 mm (1-inch) port diameter	13A7451X012
	Size 40 actuator	17A3513X012		38.1 mm (1-1/2 inch) port diameter	12B3529X012
34	Adjusting Screw, pl steel		56	Hex Nut, S31600	
	Fail down			19.1 mm (3/4-inch) port diameter	1A391535072
	Size 20 flow-up-to-open			25.4 mm (1-inch) port diameter	1A3753X0282
	0.2 to 1.0 bar (3 to 15 psig) signal range	1D336628982		38.1 mm (1-1/2 inch) port diameter	1A3753X0282
	All other ranges	1A6441X0012	57	Adhesive, Loctite No. 262	T1306070012
	Size 40 flow-up-to-open		58	Spring Pin, Pl carbon steel, (2 req'd)	12B9011X012
	0.2 to 1.0 bar (3 to 15 psig) signal range	17A3515X012	60*	Cage for Ceramic Trim	
	All other ranges	1V360928982		S17400 D1150 (std or NACE) all port dia	22B8912X012
34	Adjusting Stem, S31600 (316 stainless steel)		61*	Seat Ring for Ceramic Trim	
	For fail up	22B3512X012		S17400 D1150 (std or NACE)	
35	Adjusting screw nut, pl steel (fail down)	1A352424122		6.4 mm (1/4 inch) port diameter	17B1949X012
35	Adjusting stem nut, pl steel (fail up)	1A599324122		9.5 mm (3/8 inch) port diameter	17B1950X012
				12.7 mm (1/2 inch) port diameter	17B1951X012
				19.1 mm (3/4 inch) port diameter	17B9680X012
				25.4 mm (1-inch) port diameter	17B9681X012
				Ceramic (std or NACE)	
				38.1 mm (1-1/2 inch) port diameter	32B8918X012



42B6430-D/DOC

Figure 2. 2-Inch 357 Series Valve—Fail-Up

# 357 Series

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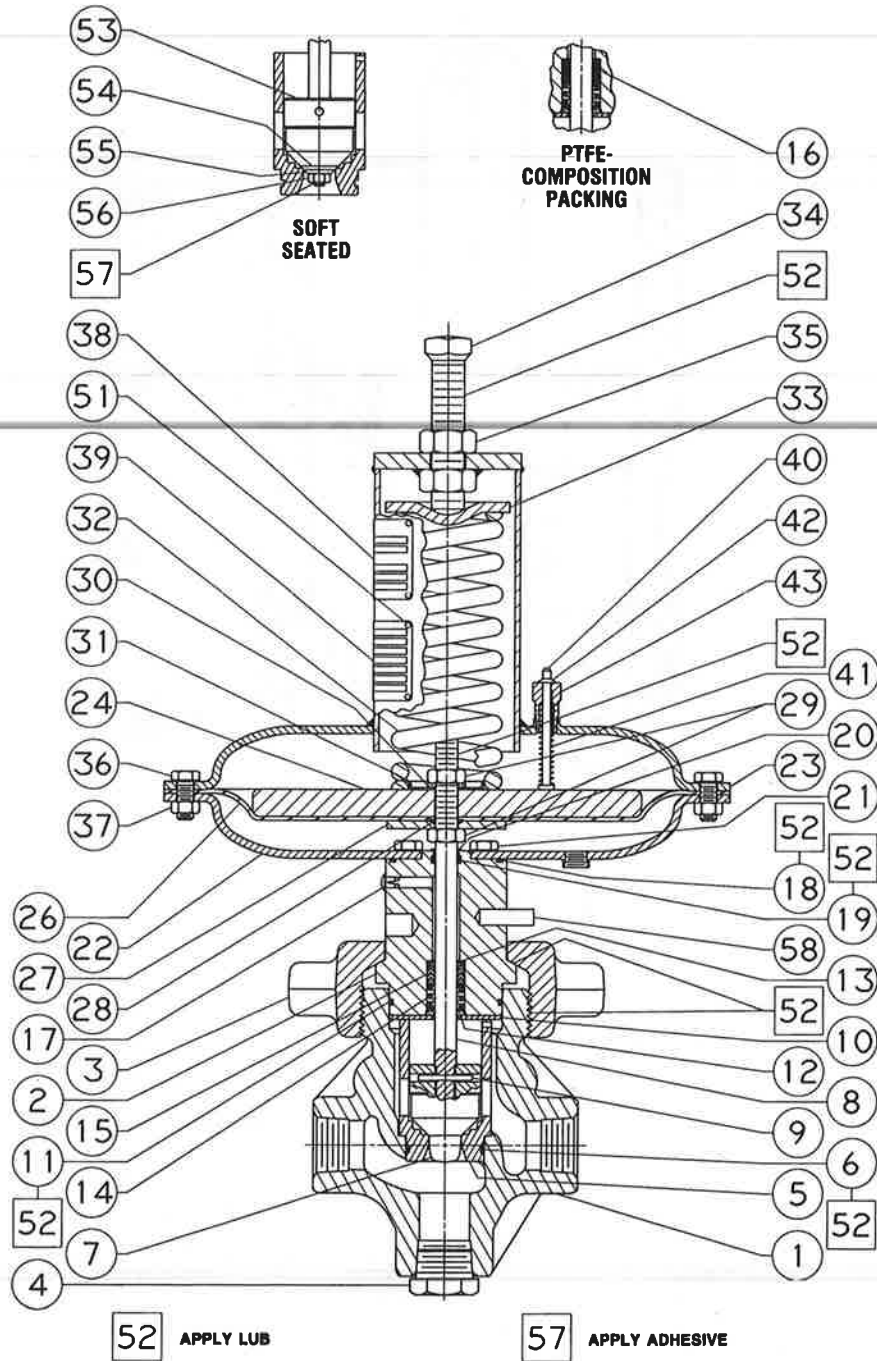
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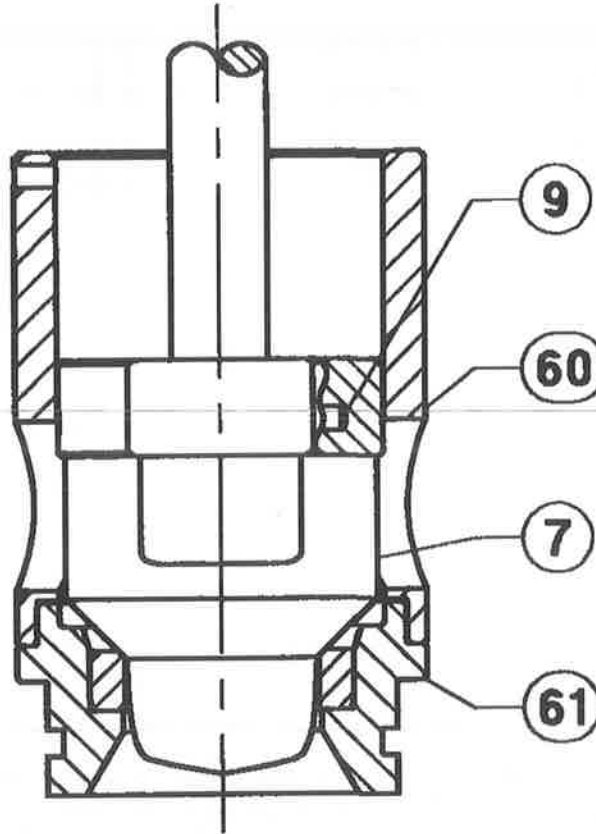
# 357 Series



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Figure 3. 1-Inch 357 Series Valve—Fail-Down





17B9686-A/DOC

Figure 4. Ceramic Trim Assembly

Keys 6\*, 11\*, 18\*, 19\*, 28\*, and 49\* O-Rings and Key 20\* Bushing

KEY NUMBER	PART NAME	WCC VALVE BODY MATERIAL		LCC VALVE BODY MATERIAL
		Temperature Capabilities		
		-29 to 93°C (-20 to 200°F)	-23 to 149°C (-10 to 300°F)	-45 to 82°C (-50 to 180°F)
		O-Ring Materials		
	Nitrile	Fluoroelastomer	Nitrile <sup>(1)</sup>	
6*	Cage O-Ring	12B3522X012	12B3522X022	12B3522X042
11*	Bonnet O-Ring	1F9141X0042	1F9141X0012	1F9141X0052
18*	Casing O-Ring	1F9141X0042	1F9141X0012	1F9141X0052
19*	Stem O-Ring	1K7561X0012	1K756106382	1K7561X0022
28*	Actuator O-Ring	1K7561X0012	1K756106382	1K7561X0022
49*(2)	Actuator Stem O-Ring	1C7812X0012	1C7821X0012	1C782106992
		Bushing Materials		
		Nylon	Ryton	Nylon
20*	Bonnet Bushing	17A7112X012	17A7112X032	17A7112X012

1. Low-temperature material.  
2. For fail-up configuration.

\* Recommended spare part.  
1. Ultra High Molecular Weight Polyethylene



**7500**  
**SERIES**

**MACHINED CAST ACRYLIC, BLOCK TYPE**

**7500 SERIES**

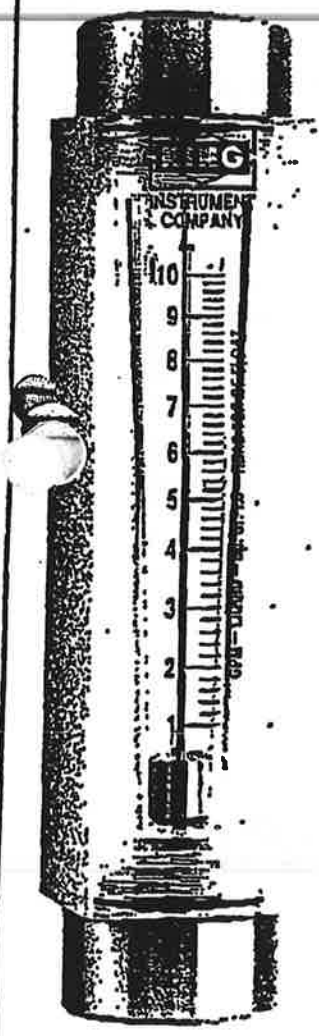
- All meter blocks are precision CNC machined from solid cast acrylic stock. (Cast material is the most durable of all Acrylic resins.)
- Direct reading scales for Water or Air are standard. (Special scales are available.)
- A uniform white back on all 7500 Series meters enhances scale readability.
- Factory certified calibration is available.

**7510 MODELS**

- Connections are in line (vertical) type.
- Scale lengths are 50mm (2"), 100mm (4"), 127mm (5") and 250mm (10").
- Fitting material is either PVC or Brass depending on model. (316 Stainless Steel is optional.)
- Threaded inserts for panel mounting are included.

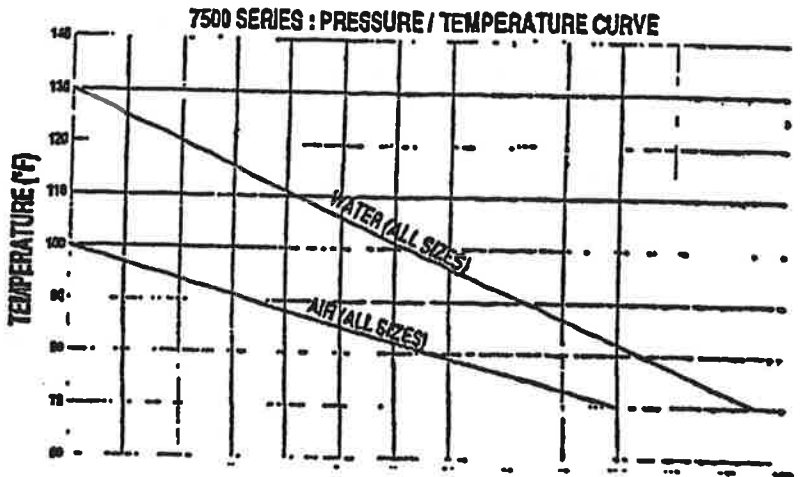
**7511 MODELS**

- Large diameter taper and floats provide reduced pressure loss and add superior float stability.
- Same in line connections and panel mount capability as 7510 models.
- Choose from either 50mm (2") or 127mm (5") scale lengths.
- Seven flow ranges are available from 1 to 5 GPM—Water and 8 to 20 SCFM—Air.
- Connections are 1/2" FNPT.
- PVC fittings are standard. (Brass and 316 Stainless Steel are optional.)
- Panel mounting threaded inserts are included.



**METER CAPACITIES**  
7 GPH to 20 GPM—Water  
2 SCFH to 62 SCFM—Air

SCALE LENGTH	FULL SCALE ACCURACY (±)
50 mm (2")	6%
75 mm (3")	4%
100 mm (4")	4%
127 mm (5")	3%
250 mm (10")	2%



# 7500 SERIES

## 7510 AND 7511 MODELS, IN LINE TYPE

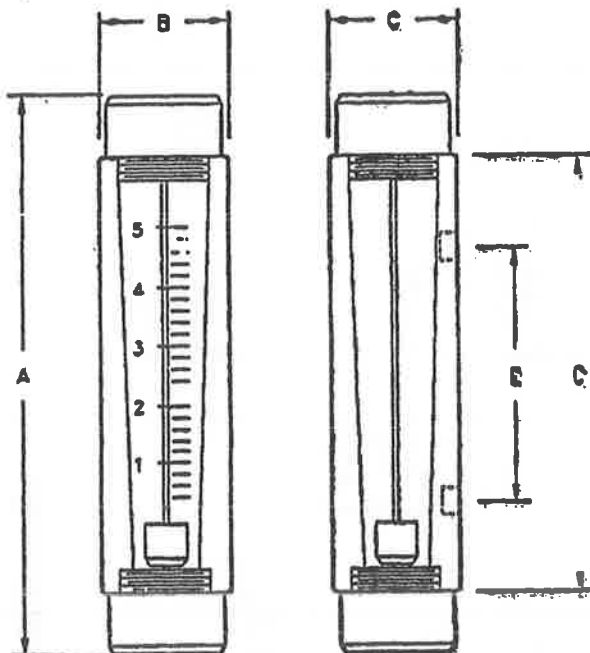
### FLOAT INFORMATION AND CAPACITY TABLES

ORDER NUMBER	FLOW WATER	ORDER NUMBER	FLOW AIR	ORDER NUMBER	FLOW WATER	ORDER NUMBER	FLOW AIR
<b>Block #2A, 50mm (2 Inch) Scale</b>				<b>BLOCK #5B, 127mm (5 Inch) Scale</b>			
2A-02	7 GPH	2A-01	2.6 SCFH	5B-02	1 GPM	5B-01	4.2 SCFM
2A-04	12 GPH	2A-03	5 SCFH	5B-04	2 GPM	5B-03	8.2 SCFM
2A-06	22 GPH	2A-05	10 SCFH	5B-06	3.5 GPM	5B-05	15 SCFM
2A-08	44 GPH	2A-07	20 SCFH	5B-08	5 GPM	5B-07	21 SCFM
2A-10	60 GPH	2A-09	30 SCFH	<b>BLOCK #6A, 100mm (4 Inch) Scale</b>			
2A-12	75 GPH	2A-11	60 SCFH	6A-02	10 GPM	6A-01	40 SCFM
		2A-13	100 SCFH	6A-04	15 GPM	6A-03	60 SCFM
		2A-15	180 SCFH	6A-06	20 GPM	—	—
		2A-17	4 SCFM	<b>BLOCK #7A, 250mm (10 Inch) Scale</b>			
<b>BLOCK #2B, 50mm (2 Inch) Scale</b>				7A-02	2 GPM	7A-01	8 SCFM
2B-02	1 GPM	2B-01	4 SCFM	7A-04	3.5 GPM	7A-03	14.8 SCFM
2B-04	2 GPM	2B-03	8 SCFM	7A-06	5 GPM	7A-05	20 SCFM
2B-06	3.6 GPM	2B-05	15 SCFM	7A-08	10 GPM	7A-07	40 SCFM
2B-08	5 GPM	2B-07	20 SCFM				

### DIMENSIONS

BLOCK NUMBER	DETAIL LETTER					CONNECTION SIZE
	A	B	C	D	E	
2A	4 3/4	1	1 1/8	3 1/2	1 1/2	1/4" FNPT*
2B	6 1/2	1 3/8	1 3/8	5	2 1/2	1/2" FNPT
5B	9 1/4	1 3/4	1 3/8	7 3/4	5 1/4	1/2" FNPT
6A	8 3/8	1 3/4	1 13/16	6 5/8	4	1" FNPT
7A	13 3/8	1 3/4	1 13/16	11 7/8	8	3/4" FNPT

\* Block 2A has 1/4" FNPT with Brass or Stainless Steel Fittings, 1/4" MNPT with PVC fittings.





# INSTRUCTION MANUAL

## **MODEL S106A**

Three Relay  
Smart Sensor for  
Combustible Gas Applications



**GENERAL MONITORS**

*Protection for life.*



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# **MODEL S106A**

**Three Relay  
Smart Sensor for  
Combustible Gas Applications**



The information and technical data disclosed in this document may be used and disseminated only for the purposes and to the extent specifically authorized in writing by General Monitors.

## **INSTRUCTION MANUAL 05/99**

General Monitors reserves the right to change published specifications and designs without prior notice.

Part No.  
Revision

MANS106A  
D/05-99



# GENERAL MONITORS

## Model S106A

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### Warranty

General Monitors warrants the *Model S106A* to be free from defects in workmanship or material under normal use and service within two (2) years from the date of shipment. General Monitors will repair or replace without charge any equipment found to be defective during the warranty period. Full determination of the nature of, and responsibility for, defective or damaged equipment will be made by General Monitors' personnel. Defective or damaged equipment must be shipped prepaid to General Monitors' plant or the representative from which shipment was made. In all cases this warranty is limited to the cost of the equipment supplied by General Monitors. The customer will assume all liability for the misuse of this equipment by its employees or other personnel.

All warranties are contingent upon proper use in the application for which the product was intended and do not cover products which have been modified or repaired without General Monitors' approval or which have been subjected to neglect, accident, improper installation or application, or on which the original identification marks have been removed or altered. Except for the express warranty stated above, General Monitors disclaims all warranties with regard to the products sold, including all implied warranties of merchantability and fitness and the express warranties stated herein are in lieu of all obligations or liabilities on the part of General Monitors for damages including, but not limited to, consequential damages arising out of/or in connection with the use or performance of the product.

### Warning

The Model S106A Combustible Gas Enhanced Smart Sensor Assembly contains components which can be damaged by static electricity. Special care must be taken when wiring the system to ensure that only the connection points are touched.





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# GENERAL MONITORS

## Model S106A

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# GENERAL MONITORS

## Model S106A

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# GENERAL MONITORS

26776 Simpatica Circle  
Lake Forest, California 92630-8128  
Telephone: (714) 581-4464  
Fax: (714) 581-1151

## EC Declaration of Conformity in accordance with EC Directives

We, at General Monitors, Inc., 26776 Simpatica Circle, Lake Forest, California 92630, U.S.A., hereby declare that the equipment described below, both in its basic design and construction, and in the version or versions marketed by us, conforms to the relevant safety and health related requirements of the appropriate EC Directives, only as follows:

- a) Conforms with the protection requirements of Council Directive 89/336/EEC, +Amd 92/31/EEC, +Amd 93/68/EEC relating to Electro-magnetic Compatibility, by the application of;

A Technical Construction File No. GMI96008-1 and Competent Body Report No. 4473/1H5.

and

- b) Conforms with protection requirements of IEC 1010-1:1990 + Amd 1:1992 relating to the safety by the application of;

A Technical Construction File No. GMI96008-1 and Competent Body Report Nos. 96-0215 and 96-0383, issued by;

ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey, KT22 7SA, England. Tel: +44-1372-367000

This declaration shall cease to be valid if modifications are made to the equipment without our approval.

PRODUCT: HC and H2S Smart Sensors

MODEL /S: S106A, S216A, S104, S214

It is ensured through internal measures and our ISO 9001:1994 certification, that series production units conform at all times to the requirements of these current EC Directives and relevant standards.

Responsible Person:

Robert J. Wek  
Chief Operating Officer

Date: 14 OCT 96

The signatory acts on behalf of company management, and with full power of attorney.





# GENERAL MONITORS

## Model S106A

---

## 1.0 Introduction

### 1.1 General Description

The Model S106A is an enhanced Smart Sensor assembly that can be used for detecting combustible gases. The microprocessor based electronics process information at the sensor site within an explosion proof housing.

A digital display provides indications and display codes that can be viewed through a window in the cover. Relay contacts and an analog signal (4-20mA) provide remote and/or discrete indications of the sensor's operation.

The Model S106A enhanced Smart Sensor assembly is rated explosion proof for use in Class I, Division 1, Group B, C, and D hazardous areas.

### 1.2 Features and Benefits

**Microprocessor Based Electronics:** monitors nine individual fault conditions, processing input signals from the sensor and providing outputs in the form of display codes, relay contact activation, and an analog signal.

**One Person Calibration:** initiate the calibration sequence with a magnet, apply the gas, and wait for the display to indicate that the unit has completed the calibration. No tools or adjustments are required.

**2 Digit Display:** indicates gas concentrations, fault codes, calibration cues, and is used for selecting relay options.

**4 to 20 mA Output:** transmits fault, over range, calibration, and gas concentrations to a remote display, computer or other device.

**Relay Contacts (SPDT):** provides discrete relay contacts for Alarm, Warn and Fault indications to activate hazard prevention or safety control devices (such as fans, vacuum pumps, ventilation equipment, etc.).

### 1.3 Applications

This is a partial listing of applications:

- Drilling and Production Platforms
- Fuel Loading Facilities
- Compressor Stations
- Oil Well Logging
- LNG/LPG Processing and Storage
- Waste Water Treatment
- Gas Turbines
- Solvent Vapors
- Hydrogen Storage



# GENERAL MONITORS

## Model S106A

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## 2.0 Sensor Assembly

### 2.1 Sensor Signal Processing

Combustible material is found in many gases and vapors. General Monitors uses a low temperature catalytic bead to detect the presence of combustible gases and vapors. The catalytic bead converts the combustible materials to heat. A change in heat is then converted to a change in resistance, which can be measured.

By taking a matched pair of catalytic beads and coating one so that it does not respond to the presence of combustible gases, we can compare the change in resistance between the two beads. The bead that is coated is called the reference bead and the other is called the active bead (figure 1). Environmental factors can also influence the temperature of the catalytic beads. Because the beads are a matched pair, they will respond to changes in ambient temperature, humidity, and pressure equally.

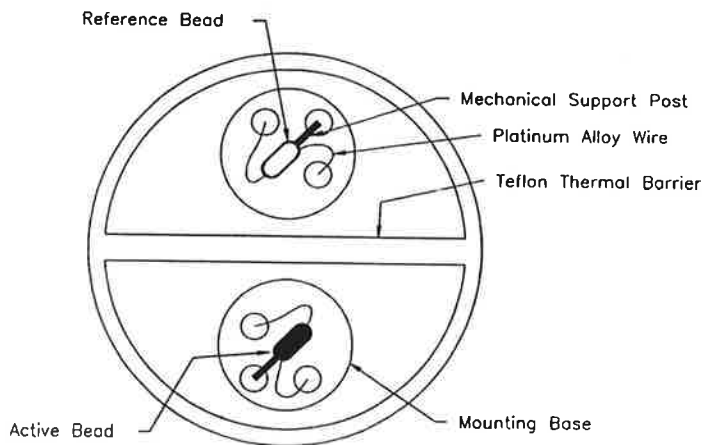


figure 1

By connecting one end of each catalytic bead together, a series circuit is formed. This circuit is supplied with a constant voltage. The voltage drop across each of the beads will be identical in the absence of combustible gases. As combustible material is converted to heat, the resistance of the active bead increases causing the voltage drop across each bead to be different. This difference is proportional to the amount of combustible gas that is present.

The voltage from the sensor is amplified and fed to an Analog to Digital (A/D) converter and then made available to the microprocessor (figure 2).

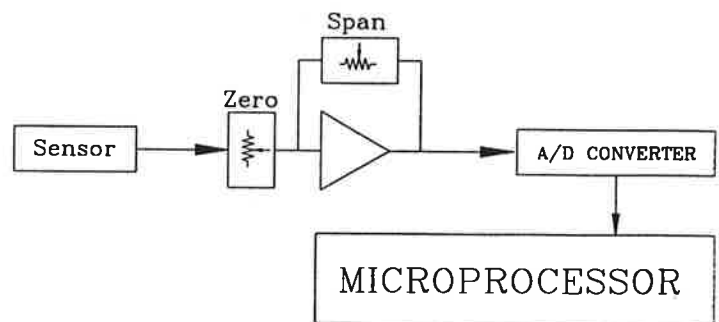


figure 2

The baseline and the gain for the amplifier are determined by digital potentiometers. They are adjusted by the microprocessor during calibration.



# GENERAL MONITORS

## Model S106A

## Sensor Assembly

### 2.2 Power Supply

The Model S106A operates from a +24 VDC (nominal) input. This unregulated source is fed to a converter board that produces voltages (see figure 3). These signals are the source for operating all of the circuitry on the control and the display boards, and supplying the sensor with power. Terminal connections inside of the housing have been provided for accepting the input power.

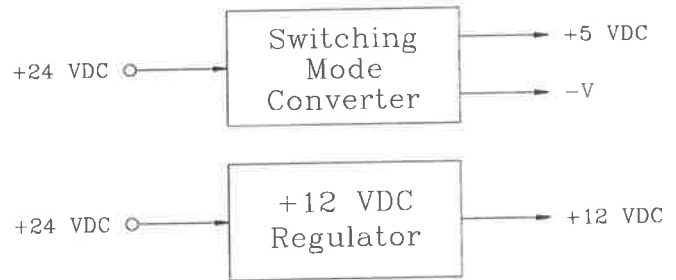


figure 3

### 2.3 Control Electronics

The control electronics are centered around an eight bit microprocessor (figure 4). The sensor signal, the CAL switch, the non-volatile memory (NOVRAM), and certain fault conditions are monitored as inputs. By processing these inputs, the following outputs are generated; 4-20mA output signal, relay contact states, digital display indications, and calibration values (NOVRAM).

As the microprocessor (MPU) receives and processes the inputs, it determines what value is output to the display, the 4-20mA current generator, and the state of the relay contacts.

When the CAL Switch is activated, the MPU allows the user to choose between the Calibration, the Calibration Check, or the Alarm Set Point and Relay Option Selection modes. While the unit is in the Calibration Check mode, the MPU will fix the 4-20mA output signal to 1.5mA. The 0mA option applies to the calibration mode, the alarm set point and relay option selection modes.

**Calibration Mode:** When the unit is placed in this mode, the MPU accepts a ZERO value and waits for the signal from the sensor to increase and then stabilize. It accepts this final value as a SPAN value. These values are stored in NOVRAM and are used in adjusting with the digital potentiometers associated with the Input Amplifier.

**Calibration Check Mode:** In this mode, the MPU will output the gas concentration to the display while inhibiting the Warn & Alarm outputs. When the gas concentration drops below 10% LEL, the unit will return to normal operation. The purpose of this mode is to check the response of the unit to a known level of gas and determine if calibration is necessary.

**Warn & Alarm Set Points and Relay Options Selection Mode:** The Alarm Set Point can be set in increments of 5% LEL, from 5 to 60 on the display for each set point (Warn & Alarm). The two Relay Options that are available are Energized/De-Energized and Latching/Non-Latching for the Warn & Alarm relays.



# GENERAL MONITORS

## Model S106A

### Sensor Assembly

Control Electronics (*continued*)

**NOTE: Once the Warn & Alarm Set Points and Relay Options have been selected, the unit will revert to the calibration sequence, and must be calibrated.**

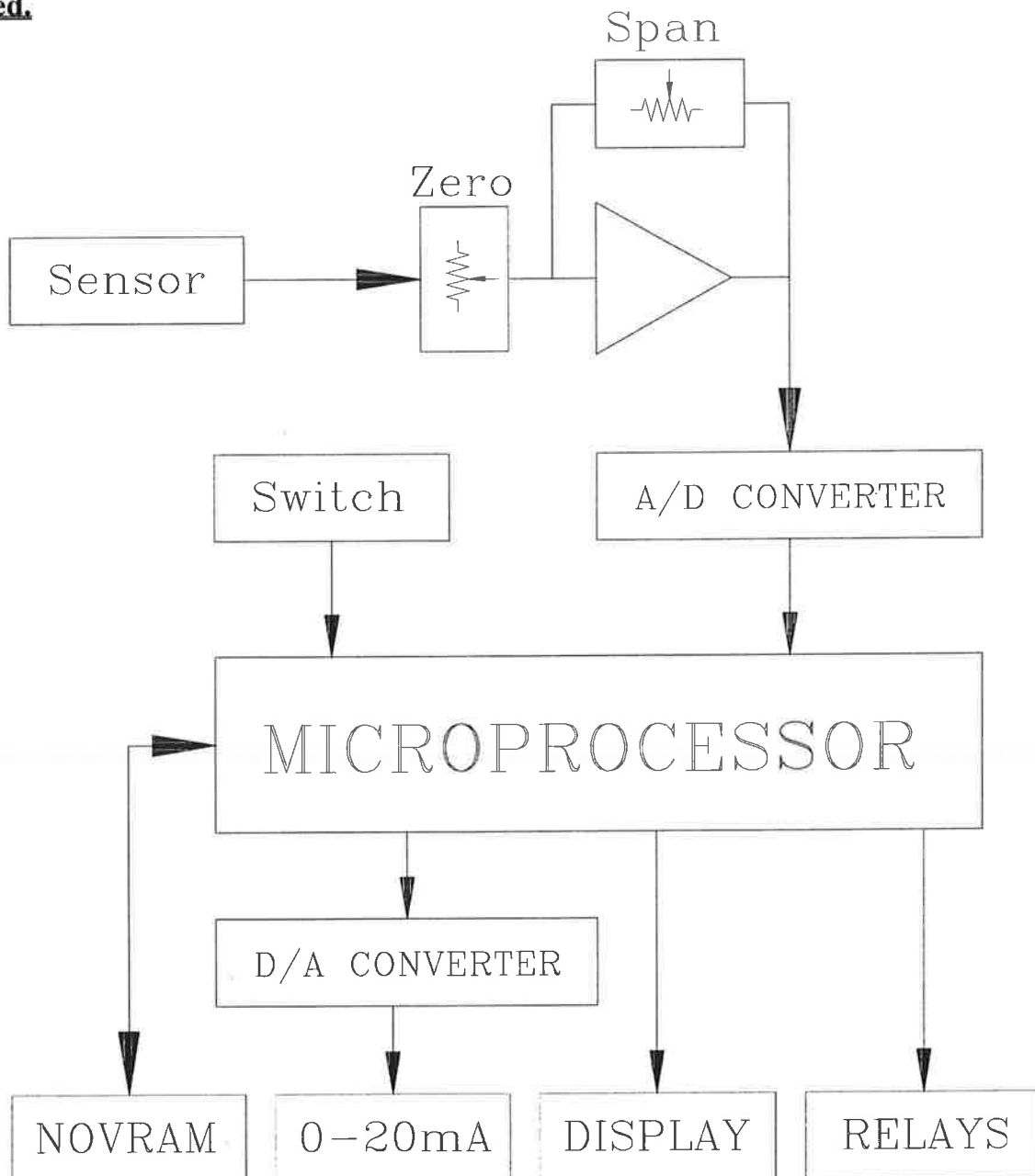


figure 4



# GENERAL MONITORS

## Model S106A

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# GENERAL MONITORS

## Model S106A

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### 3.0 Installation

#### 3.1 Receipt of Equipment

All equipment shipped by General Monitors is prepackaged in shock absorbing containers which provide considerable protection against physical damage. The contents should be carefully removed and checked against the packing slip. If any damage has occurred or if there is any discrepancy in the order, notify General Monitors as soon as possible. All subsequent correspondence with General Monitors must specify the equipment part and serial numbers.

Each Model S106A is completely checked by the factory. However, a complete check-out is necessary upon initial installation and start up to ensure system integrity.

#### 3.2 Sensor Location Considerations

There are no standard rules for sensor placement since the optimum sensor location is different for each application. The customer must evaluate conditions at the facility to make this determination. Generally, the Model S106A Enhanced Smart Sensor should be easily accessible for calibration checks.

- The sensor assembly should be mounted pointing down to prevent water build-up on the sensor head.
- The sensor assembly should not be placed where it may be coated by contaminating substances.
- Although the Model S106A is RFI resistant, it should not be mounted in close proximity to radio transmitters or similar equipment.

- Locate the Model S106A where prevailing air currents contain the maximum concentration of gas.
- Locate the Model S106A near possible sources of gas leaks.
- Observe the Model S106A's temperature specification and locate the unit away from concentrated sources of heat.
- Sensor Assemblies should be mounted in an area that is as free from wind, dust, water, shock, and vibration as possible. See Appendix, section 5.1.4 for the environmental specifications of the unit.

Sensors may be adversely affected by prolonged exposure to certain materials. Loss of sensitivity or corrosion may be gradual if such materials are present in low concentrations, or it may be rapid at high concentrations. The more important materials adversely affecting sensors are:

- Prolonged presence of Hydrogen Sulfide ( $H_2S$ ) gas
- Silicones (often contained in greases and aerosols)
- Halides . . . compounds containing Fluorine, Chlorine, Bromine and Iodine
- Heavy metals, e.g. Tetraethyl Lead

The presence of poisons and contaminants in an area does not necessarily preclude the use of a Model S106A Enhanced Smart Sensor. The feasibility of using a sensor in such areas must be determined by an analysis of the specific factors in each application and General Monitors should be consulted before attempting any such installation.



# GENERAL MONITORS

## Model S106A

### Installation

#### Sensor Location Considerations *(continued)*

Sensors used in these areas usually require more frequent calibration checks than normal, and typically have a shorter life. In many such applications the normal two year warranty would not apply.

**CAUTION: General Monitors discourages the painting of sensor assemblies. If the sensor head is painted over, the gas will not be able to diffuse into the sensor. If the assembly cover is painted over, the digital display cannot be read.**

#### Remoting the Sensor from the Electronics:

If it is necessary to remotely mount the sensor from the electronics and the housing, the maximum distance can be no greater than 100 feet, using 14 AWG wire. Sensors that are remotely mounted must be placed in a sensor housing (GMI P/N 10252) and the cable run must be contained in a conduit running from the sensor housing to the electronics. See Appendix, section 5.4 for FMRC approval requirements.

### 3.3 Installation Instructions

The overall and mounting dimensions for the Model S106A (figures 5 & 27) should be used when making installation determinations. A complete list of the mechanical specifications can be found in the Appendix (section 5.1.3).

To prevent possible corrosion due to moisture or condensation, it is recommended that the conduit connected to the Model S106A housing, be sealed or contain a drain loop (figure 6).

Each conduit run from a hazardous location to a non-hazardous location should be sealed so that gases, vapors, and/or flames can not pass beyond the seal. The purpose of seals in a Class I hazardous location is to prevent the passage of gases, vapors, or flames from one electrical installation to another through the conduit system.

It is not necessary to seal the Model S106A housing to maintain its explosion proof integrity, however, conduit runs containing wires attached to the Model S106A's relay contacts must be sealed (see section 5.4).

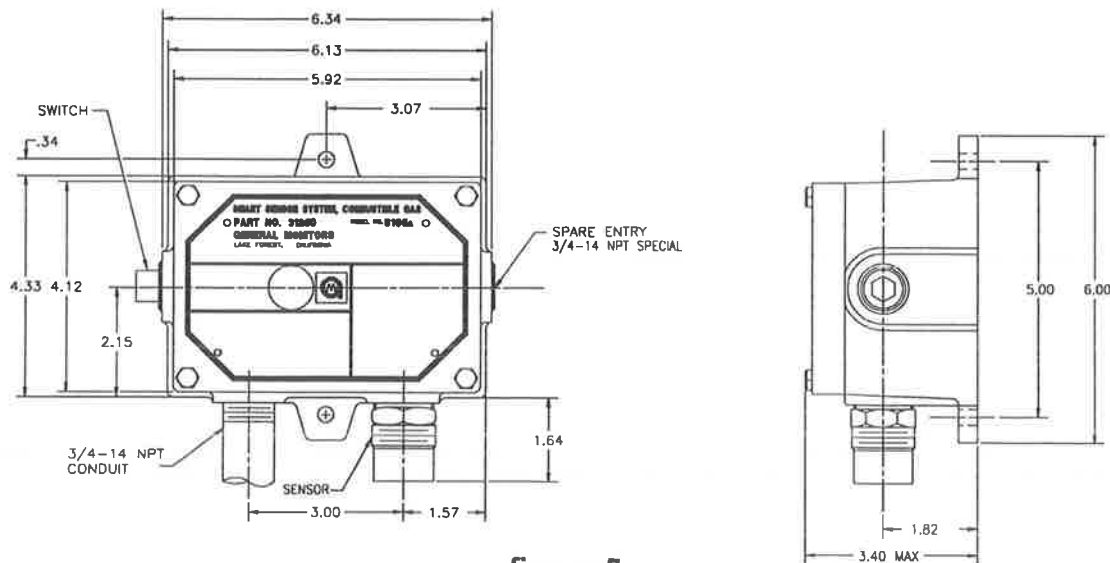


figure 5



# GENERAL MONITORS

## Model S106A

### Installation

#### Installation Instructions (continued)

Information on Class I location seals can be found in the NEC handbook, Article 501-5.

**NOTE: Acetic acid will cause damage to metal components, metal hardware, ceramic IC's, etc. If damage results from the use of a sealant that outgases acetic acid (RTV silicone), the warranty will be void.**

Once correctly installed, the Model S106A requires little or no maintenance other than periodic calibration checks to ensure system integrity. General Monitors recommends that a schedule be established and followed.

**NOTE: The system's full two year warranty will be voided if customer personnel or third parties damage the system during repair attempts.**

Sensor heads exposed to the elements may require the accessory mounting threads to be lubricated. Grease **must not** be used. As an alternate, PTFE (teflon) tape may be used on sensor accessory threads.

**NOTE: Do not use any material or substance on threads that contact the sensor housing.**

The removal of particulate matter from sensor accessories may be done through the use of an appropriate halogen-free solvent. Water or ethanol are examples of suitable solvents. The accessories should be thoroughly dried, with compressed air if necessary, before refitting to the sensor body.

General Monitors recommends that the complete system, including all alarm circuitry, be tested at least annually. Some typical items to check during maintenance examinations are:

- The sensor mounting, to see it is secure.
- The sensor screen, to see it is clear of water, oil, dust or paint.
- The cable connections for tightness and possible damage.
- All sensor placements, to see that they are up to date with the layout of the plant (e.g. modifications to the plant).
- The complete system, to see it has a back up supply for the full prescribed time.

### 3.4 Terminal Connections

The terminal blocks (TB) are located inside of the housing and can be accessed by removing the cover (figure 7, CE Marked units see figure 28). TB3 contains the three sensor connections, White (W), Black (B), and Red (R).

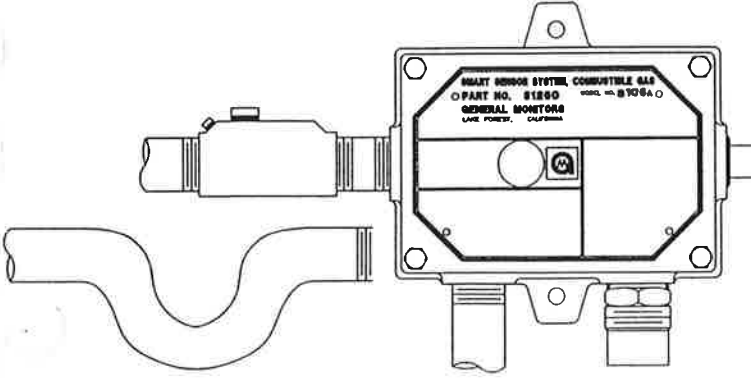


figure 6

SENSOR CONNECTIONS 1 ONLY.		TB3		TB2	
DO NOT APPLY +24VDC		W	B	R	
		SENSOR			
NOTE: RELAY CONTACT		TB1			
NORMALLY ENERGIZED		4-20mA OUT	1	WHT	WC
TB2 POS 1 - NO,	POS 4 - NO	COM	2		W2
TB2 POS 2 - C,	POS 5 - C	RELAY RESET	3		F NO
TB2 POS 3 - NC,	POS 6 - NC	COM	4	BLK	F C
NORMALLY DE-ENERGIZED		+24VDC	5	RED	F NC
TB2 POS 1 - NC,	POS 4 - NC				
TB2 POS 2 - C,	POS 5 - C				
TB2 POS 3 - NO,	POS 6 - NO				

figure 7



# GENERAL MONITORS

## Model S106A

### Installation

#### Terminal Connections *(continued)*

TB1 contains the connections for Power, Relay Reset, and Output Signal (CE Marked units, see figure 28).

<b>TB1 position</b>	<b>Function</b>
1	0-20mA Output
2	Reset Common
3	Relay Reset
4	Common (Ground)
5	+24VDC Power

TB2 contains the connections for the Relay Contacts. The function for the Warn and Alarm Relay connections vary according to the normal state of the relay. Use the following as a guide for determining the Normally Open (NO) and the Normally Closed (NC) contact:

Alarm Relay - Normally Energized

<b>TB2 position</b>	<b>Relay Contact</b>
1	Normally Open
2	Common
3	Normally Closed

Alarm Relay - Normally De-Energized

<b>TB2 position</b>	<b>Relay Contact</b>
1	Normally Closed
2	Common
3	Normally Open

Warn Relay - Normally Energized

<b>TB2 position</b>	<b>Relay Contact</b>
4	Normally Open
5	Common
6	Normally Closed

Warn Relay - Normally De-Energized

<b>TB2 position</b>	<b>Relay Contact</b>
4	Normally Closed
5	Common
6	Normally Open

The Fault Relay contacts are always Normally Energized.

<b>TB2 position</b>	<b>Relay Contact</b>
7	Normally Open
8	Common
9	Normally Closed

Inductive loads (bells, buzzers, relays, etc.) on dry relay contacts must be clamped down (figures 8 and 9). Unclamped inductive loads can generate voltage spikes in excess of 1000 volts. Spikes of this magnitude may cause false alarms and contact damage.

**NOTE:** Contact with PCB components should be avoided to prevent damage by static electricity. All wire connections are made to the Terminal Blocks.

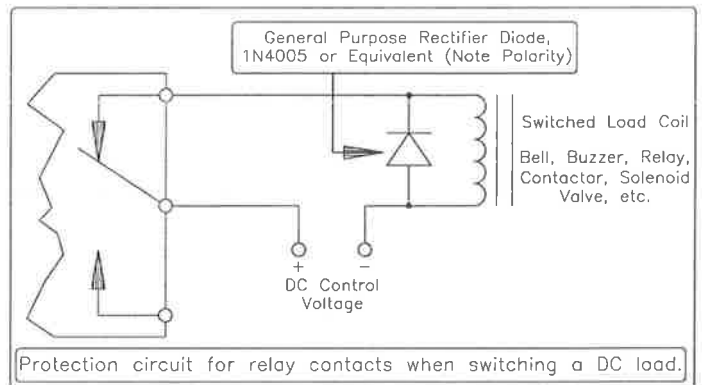


figure 8

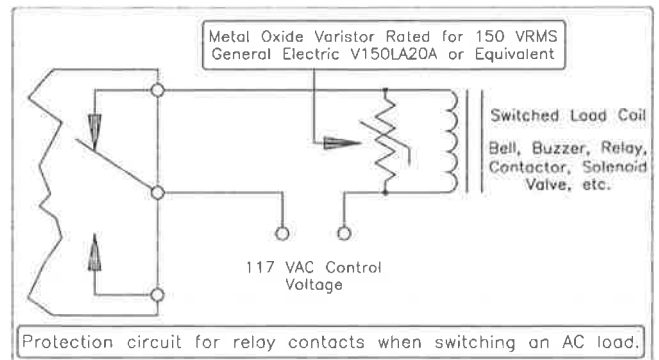


figure 9





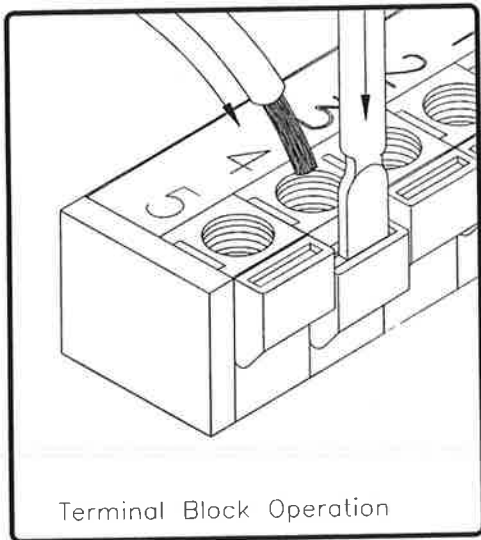
# GENERAL MONITORS

## Model S106A

### Installation

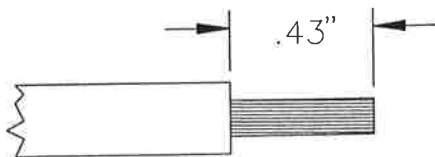
#### Terminal Connections *(continued)*

It is recommended that a three wire (red, black, white) shielded cable be used for making power and output signal connections on the Model S106A. The terminal block accepts 16 AWG to 22 AWG stranded or solid wire. Each wire should be stripped before wiring the Model S106A Combustible Gas Enhanced Smart Sensor. To connect wiring to the terminal block, insert a screw driver into the orange tab and press down (figure 10), opening the terminal. Insert the wire into the terminal and release the orange tab, clamping the wire in the terminal. Check the hold of the wire by GENTLY tugging it to ensure it is locked in.



**figure 10**

**NOTE: up to 14 AWG wire can be used if it is carefully stripped (figure 11).**



Strip Length

**figure 11**

A 4 to 20mA output signal is provided by the Model S106A Combustible Gas Enhanced Smart Sensor and can be sent up to 9000 feet (2740 meters) to a General Monitors readout/relay display module, industrial analog to digital converter, computer based monitor, PLC, DCS, etc. The 4 to 20mA signal provides for control room or other locations remote to the Model S106A to display indications of operation and alarm conditions. To connect the 4 to 20mA output signal with another unit, connect the white wire into TB1, position 1, labeled 4-20 mA OUT (CE Marked units TB 4, position 1). For making output signal connections to display devices, refer to the specific manual for that device (figure 12).

FROM	TO				
MODEL S106A	MODEL DC100	MODEL DC110	MODEL DC120	MODEL DC130	MODEL TA102A
TB1 PIN 1 4-20 mA OUT	REAR PIN 3 ANALOG IN	REAR CH 1-8 4-20mA	REAR TB 1 PIN 8 or 9	REAR PIN 2 or 5 ANALOG IN	REAR PIN 26d,z

4 to 20mA Output Connections

**figure 12**

If a device other than a General Monitors readout/relay display module is being used, the commons, COM, of both systems must be connected together See Appendix, section 5.4. The Model S106A Combustible Gas Enhanced Smart Sensor operates on a nominal power of +24 VDC.



# GENERAL MONITORS

## Model S106A

### Installation

#### Terminal Connections (continued)

Primary DC power must be provided by the customer unless one of the following General Monitors Modules is being used with the Model S106A:

- DC100 Readout/Relay Display Module
- DC110 Readout/Relay Display Module with Power Supply & Relay Module
- DC130 Readout/Relay Display Module
- TA102A Trip Amplifier Module with a PS002

The following General Monitors Modules provide power connections for the Model S106A, but need a customer supplied DC source:

- DC110 Readout/Relay Display Module without a Power Supply & Relay Module
- DC120 Dual Channel Display Module
- TA102A Trip Amplifier Module without a PS002

Since the Model S106A is designed to operate continuously, a power switch is not included, in order to prevent accidental system shut-down.

**NOTE: Power must remain disconnected until all other wiring connections have been made.**

The maximum distance between the Model S106A and the power supply is 4500 feet or 1372 meters (each cable run should be as short as possible). See the Appendix (section 5.1.2) for cable length specifications. To connect +24VDC to the Model S106A, connect the red wire to TB1, position 5, labeled +24VDC (CE Marked units TB 4, position 3). Connect the black wire to TB1, position 4, labeled COM (CE Marked units TB 4, position 2). For making power connections to display devices see figure 13 (CE Marked units see figure 28).

### 3.5 Applying Power

Before applying power to the system for the first time, all wiring connections should be checked for correctness and the housing cover replaced. Upon first power-up the sensor may take up to fifteen minutes to stabilize.

At the initial application of power, or after a fault condition, the unit will enter a fifty second Start-Up mode. During this period the display will indicate an SU.

FROM		TO				
COMMON	MODEL S106A	MODEL DC100	MODEL DC110	MODEL DC130	MODEL TA102A	
	TB1 PIN 4 "COM"	REAR TERMINAL BLOCK PIN 5 "ANALOG COM"	REAR COMMON (8X)	REAR PIN 3 or 6 "COM"	REAR PIN 30d,z	
FROM		TO				
+24 VDC	MODEL S106A	MODEL DC100	MODEL DC110	MODEL DC130	MODEL TA102A	
	TB1 PIN 5 "+24VDC"	REAR TERMINAL BLOCK PIN 4 "DC OUT"	REAR CH1-8 24V	REAR PIN 4 or 7 "DC OUT"	REAR PIN 28d,z	

Power Connections

figure 13



# GENERAL MONITORS

## Model S106A

### Installation

#### 3.6 Maintaining the X/P Integrity

The Model S106A is rated explosion proof for Class I, Division 1, Group B, C & D hazardous locations. Some of the factors that influence the explosion proof integrity of the Model S106A housing are:

- Strength of the enclosure material
- Thickness of the enclosure walls
- Flame path between the housing and cover
- Flame path of threaded joints

The acceptable limits for explosion proof housings that are used in Class I hazardous locations are defined in CSA Standard C22.2 No.30-M1986.

Anytime the cover of the smart sensor housing is removed or the cover bolts are loosened, the flame path between the lid and the housing is effected. If power is to be left on while removing the cover or loosening the cover bolts on the Model S106A, it will be necessary to de-classify the area.

When replacing the cover, the gap between the lid and the housing should be less than .0015 inch (.038 mm). Make sure that the flame path is clear of dirt and debris before replacing the cover. This can be verified by tightening the cover bolts to a torque setting of 50 inch-pounds or by using a feeler gauge to ensure the gap between the cover and the housing is less than .0015 inch (.038 mm).

There are four entry holes, one on the left and right sides and two on the bottom of the Model S106A housing. These holes are dedicated for the sensor, the reset switch and conduit. Each hole is tapped for 3/4 NPT threads. If a particular entry hole is not used, it must be plugged during operation in the field. The factory installs plugs in the unused entry holes, except one. A red plastic cap is placed into the remaining hole and must be removed before conduit can be attached to the housing.

The Model S106A will have the following items placed in the three remaining entry holes, at the factory:

- A sensor, if present (otherwise a red plastic cap)
- A reset switch, if present (otherwise an aluminum housing plug)
- An aluminum housing plug

The sensor, reset switch and aluminum housing plug have seven threads. Each of these components is screwed into the housing using five to seven turns. If it becomes necessary to replace the sensor, reset switch and/or the aluminum housing plug, the user must use five to seven turns to ensure the explosion proof integrity of the housing is maintained.



# GENERAL MONITORS

## Model S106A

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# GENERAL MONITORS

## Model S106A

### 4.0 Operation

#### 4.1 Relay Options

The Model S106A has user selectable relay options. The three types of relay options that are available for the Warn and Alarm Relays are Energized or De-Energized, Latching or Non-Latching and the Set Point. Each of these relays has one Normally Open and one Normally Closed contact.

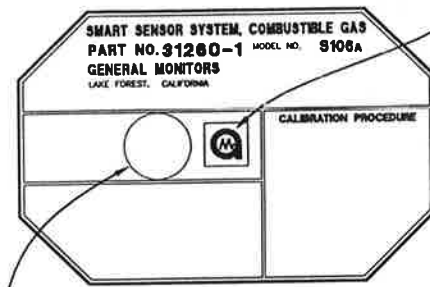
The Energized/De-Energized option specifies if the relay is to have power applied normally (energized) or if the relay is normally at mechanical rest (de-energized). The Latching/Non-Latching option specifies whether the Warn/Alarm relay contacts need to be manually reset or if they reset automatically. If the non-latching option is selected, the user should read section 5.4 in the Appendix. The set point option specifies the level of gas concentration at which the Warn/Alarm relay will activate. When the gas concentration exceeds a particular set point (Warn or Alarm, that relay will activate).

The Fault relay has no options that are user selectable options. The standard configuration for the Fault relay is Energized and Non-Latching. When a Fault condition is present the Fault circuit is activated and the Fault code appears in the display window. The Fault codes and their remedies are presented in section 4.4 of this Instruction Manual.

#### Procedure for setting the Warn & Alarm relay options:

- Place the magnet over the General Monitors' (GMI) Logo on the cover and observe the Digital Display (figure 14).

General Monitors Logo



Display Window  
figure 14

- The display will indicate a steady pair of bars “- -” (figure 15). This lets the user know that the magnet has been properly placed over the GMI Logo.

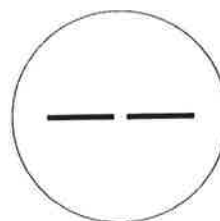


figure 15

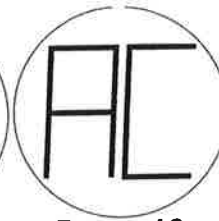


figure 16

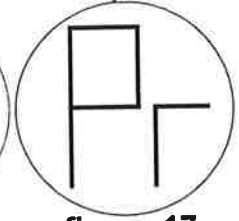


figure 17

- Keep the magnet placed over the Logo. Next, a flashing pair of bars “- -” will appear on the display, then the letters “AC” (figure 16) followed by “Pr” (figure 17). Then the letters “AL” will appear.
- When the letters “AL” (figure 18) appear on the display, remove the magnet. This is the Warn / Alarm Relay Options Mode. The Warn relay options will be selected first, then the Alarm options. The Warn & Alarm relay option sequences are identical.



figure 18



# GENERAL MONITORS

## Model S106A

### Operation

#### Relay Options (*continued*)

- The display will alternate between “En” and “dE” (figure 19), until the magnet is re-applied. Apply and remove the magnet when the desired option appears on the display. “En” stands for Energized and “dE” stands for De-Energized. When this selection has been made, the next option will appear.

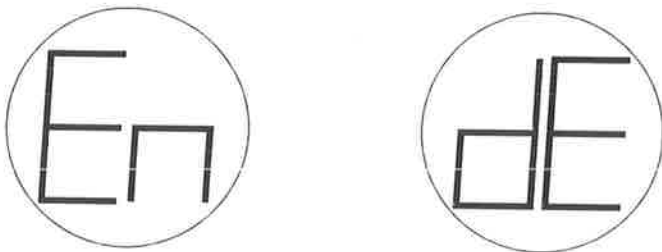


figure 19

- The display will alternate between “LA” and “nL” (figure 20), until the magnet is re-applied. Apply and remove the magnet when the desired option appears on the display. “LA” stands for Latching and “nL” stands for Non-Latching. When this selection has been made, the next option will appear.

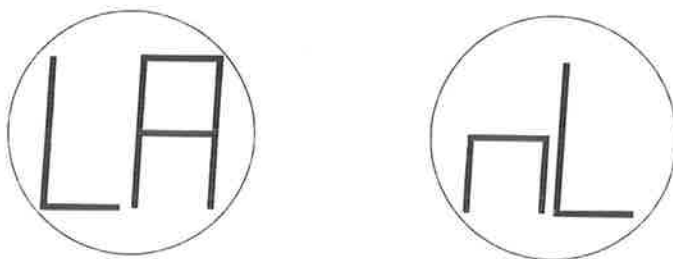


figure 20

- The display will sequence through the Warn Set Point Levels beginning with “5” and increasing in increments of 5 up to “60” and then back to “5” (figure 21),

where the the display will increase again in increments of 5. Apply and remove the magnet when the desired Warn Set Point appears on the display.

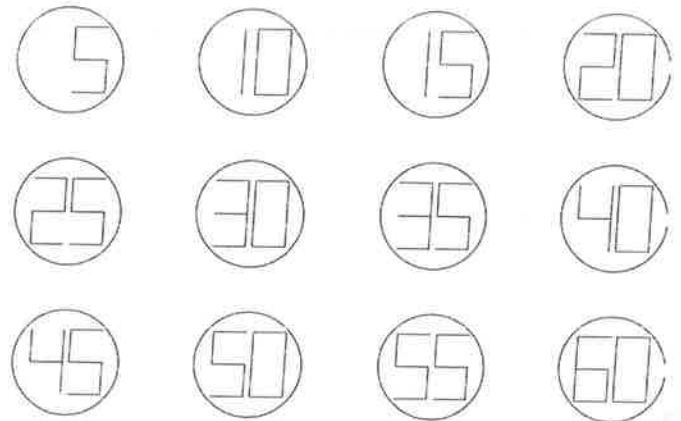


figure 21

- When this selection has been made, the Alarm sequence will begin and the same options will need to be set for the Alarm relay.
- The Energized/De-Energized option for the Alarm relay will be displayed as in figure 19.
- The Latching/Non-Latching option for the Alarm relay will be displayed as in figure 20.
- Finally, the Alarm Set Point option will be displayed as in figure 21 (cannot be lower than the Warn set point).

**NOTE:** After the Warn and Alarm relay options are selected the Model S106A will revert to the calibration mode and must be calibrated.



# GENERAL MONITORS

## Model S106A

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## Operation

### 4.2 Program Review Mode

The Program Review (Pr) Mode allows the operator to view the relay options that have been selected for the Warn & Alarm relays. To enter the Program Review Mode place the magnet over the GMI logo on the cover and wait until "Pr" appears in the display window. Then remove the magnet.

The display will indicate the Warn options and then the Alarm options in the sequence listed below:

- Warn Relay Options

Energized (En) or De-Energized (dE)  
Latching (LA) or Non-Latching (nL)  
Warn Set Point (#)

- Alarm Relay Options

Energized (En) or De-Energized (dE)  
Latching (LA) or Non-Latching (nL)  
Alarm Set Point (#)

Each selection will be displayed for approximately 5 seconds before sequencing to the next option. When the last option has been displayed the unit will return to normal operation.

**NOTE : The Program Review Mode does not allow the operator to make changes to the relay options.**

### 4.3 Calibration

Activating the Calibration Switch will automatically disable the alarm circuits by sending a 1.5mA (0mA optional) output signal. This will prevent activation of the relay contacts when using a General Monitors Readout/Relay Display Module with the Model S106A.

General Monitors recommends that the Model S106A Combustible Gas Enhanced Smart Sensor be calibrated one hour after start-up, and that calibration be checked at least every ninety (90) days to ensure system integrity. General Monitors is not implying that the customer should expect problems with sensor life or stability but "frequent" calibration checks merely ensure the integrity of the life protecting equipment.

The above statement is not intended to discourage the customer from checking calibration more frequently. Frequent calibration checks are recommended for environments that have problems such as mud collecting on the sensor head, sensors accidentally being painted over, etc.

**NOTE: A calibration check consists of applying a known concentration of gas to the sensor and observing the reading on the Model S106A, the Readout/Relay Module, or other computer data collecting systems.**

General Monitors recommends that a calibration schedule be established and followed. A log book should also be kept showing calibration dates and dates of sensor replacement.

#### Calibration Procedure:

- If it is suspected that combustible gas is present, it will be necessary to purge the sensor environment with *Zero Air*. If *Zero Air* is not available, cover the sensor for about thirty seconds before applying the calibration gas. *Zero Air* is air that is hydrocarbon free.



# GENERAL MONITORS

## Model S106A

### Operation

#### Calibration (continued)

- Place the magnet over the GMI Logo on the cover (figure 14) of the unit and hold it there until "AC" (figure 16) appears on the display (about ten seconds). Allow about five seconds for the unit to acquire the zero reading before applying the calibration gas. If the GMI Portable Purge Calibrator (P/N 1400150) is **not** used when calibrating the Model S106A with Methane (CH<sub>4</sub>), the SPAN gas flow rate needs to be 440cc/min to 460cc/min. See Appendix, section 5.4.

- Apply a 50% LEL gas concentration to the sensor. The display will change from "AC" (Automatic Calibration) to "CP" (Calibration in Progress) indicating that the sensor is responding to the calibration gas (figure 22).

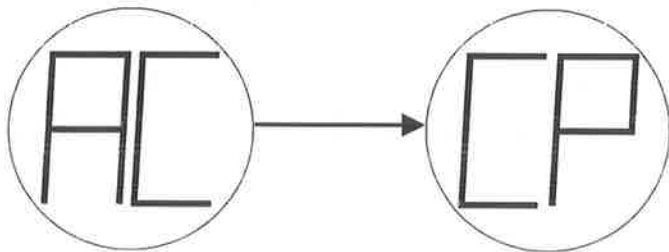


figure 22

- After one or two minutes the display will change from "CP" to "CC" (figure 23) indicating that the calibration is complete.

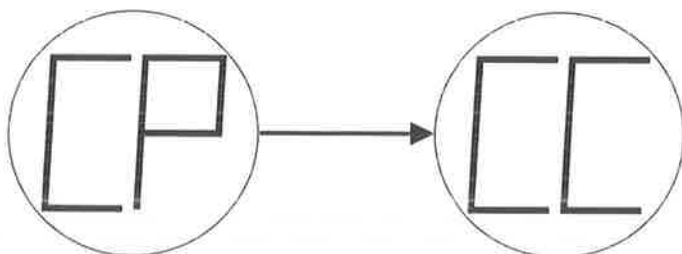


figure 23

- Remove the gas and wait for the unit to return to normal operation. The display will indicate a few percent LEL and then drop to "0" (figure 24).

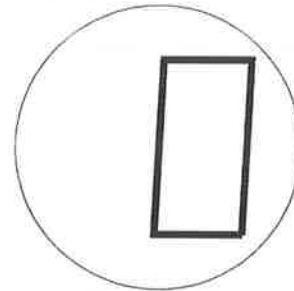


figure 24

- The unit is now calibrated and the new ZERO and SPAN values have been stored in the non-volatile memory (EEPROM).

The Model S106A can be returned to normal operation, if the magnet is re-applied ninety seconds after initiating the calibration sequence (with the old calibration values valid).

If the Model S106A is placed in the Calibration Mode and no gas is applied for six minutes, the unit will revert to a Fault condition. Re-applying the magnet over the GMI Logo will return the unit to the Calibration mode (with the old calibration values valid).

#### Calibration Check Mode:

If it is desired to check the sensor for its response without sending a gas concentration signal to a remote display device, this can be accomplished by placing the Model S106A into the "Calibration Check" mode. Placing the S106A in this mode inhibits the Warn & Alarm relays.





# GENERAL MONITORS

## Model S106A

## Operation

### Calibration (*continued*)

Procedure for checking the calibration:

- Place the magnet over the GMI Logo on the cover of the Model S106A. Remove the magnet when a **flashing** pair of bars, “- -”, appears on the display (about three seconds).

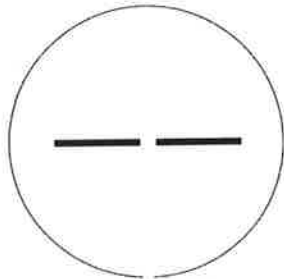


figure 25

- Apply the test gas to the sensor and the value of the gas concentration will be indicated by the flashing display in one to two minutes.
- When the reading has stabilized and the test is complete, remove the gas and the unit will return to normal operation when the concentration drops below 5% LEL.

The test gas concentration must be at least 10% LEL before the unit will complete the Calibration Check sequence. If the Model S106A is placed in the Calibration Check mode and no gas is applied for six minutes, the unit will revert to a Fault condition. Re-applying the magnet over the GMI Logo will return the unit to normal operation.

### Calibration Equipment:

The **Portable Purge Calibrator** is a compact, accurate and safe system containing no explosive gas concentration. The lecture bottle is filled with a standard 50% LEL mixture of gas/air. Using a known gas/air

mixture reduces the likelihood of error in field calibration. The included hose and cup adapter allow for quick calibrations.

Pre-mixed calibration gases at approximately 50% LEL are available, in lecture bottles, at 1200 psia, 8.3 MPa maximum pressure.

- Butadiene  $C_4H_6$
- Butane  $C_4H_{10}$
- Ethane  $C_2H_6$
- Hydrogen  $H_2$
- Methane  $CH_4$
- Propane  $C_3H_8$

Please specify the gas upon ordering. Spare bottles containing these gases may be ordered. Methane and Hydrogen lecture bottles may be returned to General Monitors for refilling.

The **Portable Calibration Chamber** is a 3 liter (3000 cc) sample chamber with a spring driven mixing fan. A porthole allows the chamber to be placed on the sensor for calibration. A syringe is included for accurate measurement of volatile test liquids. Sensors should be calibrated to a specific vapor for greatest accuracy. A hydrocarbon sensor calibrated for 50% LEL Acetone, for example, will detect all hydrocarbons and most combustible solvent vapors, however, it will accurately read ONLY the % LEL of Acetone.

The indicated measures of volatile liquids found on the next page produces 50% LEL vapor mixtures at 75° Fahrenheit (25° Celsius) temperature and standard pressure when used with the Portable Calibration Chamber (see Appendix, section 5.4).



# GENERAL MONITORS

## Model S106A

### Operation

#### Calibration (continued)

*Volatile liquids are not supplied by General Monitors. Below is a list of volatile liquids and the volume required (in microliters) to produce 50% LEL in the 3 liter chamber.*

Acetaldehyde	136
Acetic Acid	140
Acetone	112
Acetonitrile	96
Acrylonitrile	120
Amyl Acetate	100
Amylamine	156
Benzene	65
Butyl Acetate	137
Butyl Acrylate	132
Butyl Alcohol	78
sec-Butyl Alcohol	95
tert-Butyl Alcohol	138
Butyl Cellosolve	88
Butyraldehyde	102
Cyclohexane	86
Decane	95
Diethyl Ketone	103
Diisobutyl Ketone	82
Dimethylformamide	104
p-Dioxane	104
Dodecane	83
Ethanol (Ethyl Alcohol)	118
Ethyl Acetate	119
Ethyl Amine	140
Ethyl Benzene	60
Ethyl Ether	120
Ethylene Oxide	89
Gasoline 100 Octane	107
Heptane, Normal	94
Hexane, Normal	86
Isopentane	99
Isoprene	89
Isopropyl Alcohol	93
Isopropyl Ether	120
JP-4 Jet Fuel	183
Methanol	148
Methyl Ethyl Ketone (MEK)	76
Methyl Methacrylate	111
Naptha (Petroleum Ether)	96
Octane	99
Pentane, Normal	106
Propanal	114
Propyl Acetate	106
Propylamine	103
Propylbenzene	68
Propylene Oxide	98
Styrene	63
Tetradecane	79
Tetrahydrofuran	99
Tetrahydrofurfuryl Alcohol	89
Toluene	78
1,1,1-Trichlorethane	456
Trichloroethylene	438
Triethylamine	102
Vinyl Acetate	152
Vinyl Ethyl Ether	99
o-Xylene	67
p-Xylene	83
Xylenes	83

REFERENCE NFPA-1994

#### 4.4 Digital Display Codes

The following codes will appear on the display when then unit is placed in a mode other than the normal operating mode.

SU	Start-Up Mode
-- (steady)	Magnetic Switch Activated
-- (flashing)	Test Gas Mode
AC	Automatic Calibration
CP	Calibration in Progress
CC	Calibration is Complete
AL	Alarm Options Mode
Pr	Program Review
En	Energized Relay Option
dE	De-Energized Relay Option
LA	Latching Relay Option
nL	Non-Latching Relay Option
5,10,...,60	Alarm Set Point Option
F1	Failed to Zero during calibration
F2	Failed to complete the calibration
F3	Failed to Span during calibration
F4	Sensor Reference Bead Error
F5	Sensor Active Bead Error
F6	Low Supply Voltage
F7	EEPROM Verification Failure
F8	Negative Zero Drift
F9	Calibration check period exceeded

SU This is displayed for about fifty seconds during start-up and after a Fault condition has been corrected.

-- Appears on the display when the magnet has been properly positioned over the GMI Logo and when the Test Gas Mode can be or has been entered.



# GENERAL MONITORS

## Model S106A

### Operation

#### Digital Display Codes (continued)

**AC**            These codes appear on the display during the calibration process. For more information about these codes, refer to Section 4.3.

**AL, Pr**        These codes are used for selecting and viewing the Warn & Alarm Relay options. For more information about these codes, refer to section 4.1.

**F1,F2,F3**      These codes will appear on the display if a Fault condition occurs. For more information about these codes, refer to Section 4.5.

When the unit is in the normal operating mode, the display will indicate the presence of combustible gas in percent of the Lower Explosive Level (% LEL). The range of detection is from 0 to 99% LEL.

**99 (flashing)** Over-Range, a gas concentration exceeding 99% LEL is present.

#### 4.5 Fault Codes & Their Remedies

The Model S106A has self-diagnostics incorporated into the microprocessor's program. If a Fault is detected, the output signal will drop to 0mA, the Fault relay will de-energize and a Fault code will be displayed. The output signal will inform a remote display module that the Model S106A is in the Fault Mode. The display will indicate a Fault code that can be viewed at the sensor site. There are nine Fault conditions that are monitored by the microprocessor.

When a Calibration Fault (F1, F2, F3) has occurred and has been corrected, the unit will automatically revert to the calibration process and the unit must be re-calibrated. If a Fault other than a Calibration Fault occurs, after it is corrected the unit will return to the Start-Up Mode (SU).

#### Fault Codes and their Remedies:

**F1 = Failed to Zero during Calibration**

**Faulty Sensor** - If both Catalytic Beads are not closely matched. This may happen as a sensor approaches the end of its useful life or if the Beads have become corroded. **ACTION** - Replace the sensor.

**Gas Present** - If the magnet was applied with a high level of gas present, the Model S106A will not be able to obtain a valid ZERO. **ACTION** - Ensure the sensor is in clean air.

**F2 = Failed to complete the Calibration**

This Fault will occur if the unit is placed in the calibration mode and no gas has been applied within six minutes. **ACTION** - Make sure there is calibration gas present, re-apply magnet and attempt to calibrate.

**F3 = Failed to Span during Calibration**

**Low Gas** - If the gas concentration applied to the unit does not give sufficient response for a valid SPAN parameter. **ACTION** - Use the correct gas concentration, i.e. 50% LEL.

**Bad Sensor** - If the sensor response has gone below an acceptable level. **ACTION** - Replace the sensor.



# GENERAL MONITORS

## Model S106A

### Operation

#### Fault Codes & Their Remedies (*continued*)

**NOTE:** If the unit fails to calibrate and an F1 or an F3 code is displayed, the calibration gas must be removed, and the sensor must see clean air for at least five minutes before a second calibration is initiated.

#### F4 = Sensor Reference Bead Error

This fault may occur as a result of one of the following:

- excessive negative drift
- an open sensor reference bead
- the sensor BLACK wire is disconnected

**ACTION** - Attempt to recalibrate the unit. If this is unsuccessful make sure that the BLACK sensor wire is connected to the terminal block. If these actions do not cure the fault condition, then replace the sensor.

#### F5 = Sensor Active Bead Error

This fault occurs if the sensor active bead becomes open circuited or, if the sensor WHITE or the sensor RED lead becomes disconnected. **ACTION** - Check the WHITE and RED wires then replace the sensor.

#### F6 = Low Supply Voltage

This fault occurs if the supply voltage drops below +17.5VDC approximately. **ACTION** - Ensure that the supply voltage is at least +20VDC at the Model S106A.

Correcting Fault conditions F4 through F9 will initiate the Start-Up Mode.

**NOTE:** With long supply leads, a considerable voltage drop may occur due to the electrical resistance of the leads.

The maximum cable resistance which the Model S106A can tolerate is dependent on the supply voltage.

A maximum of 20 ohms per conductor (40 ohms loop) at +24VDC minimum, or a maximum of 10 ohms per conductor (20 ohms loop) at +20VDC minimum.

#### F7 = EEPROM Verification Failure

This fault occurs during calibration when an attempt to verify the calibration parameters just written to the non-volatile memory fails. **ACTION** - Place the magnet over the GMI Logo and the unit will attempt another EEPROM write and verify.

#### F8 = Negative Zero Drift

If the zero baseline of the sensor drifts 10% of full scale below zero for more than 20 seconds this fault will occur. **ACTION** - A routine re-calibration will be required.

#### F9 = Calibration Check Period Exceeded

If the Model S106A is left in the Test Gas Mode for more than six minutes without a Test Gas being applied, this fault will occur. **ACTION** - Place the magnet over the General Monitors Logo to return the unit to normal operation.

**NOTE:** Anytime a sensor is replaced, the unit should be disconnected from all alarms, as the unit may go upscale upon power-up.



# GENERAL MONITORS

## Model S106A

### 5.0 Appendix

#### 5.1 Specifications

##### 5.1.1 System Specifications

Sensor Type:  
Diffusion, low temp. catalytic bead

Standard industrial types: Combustible Gas; Solvent Special; Standard and High Temperature Versions (See section 5.3)

Typical Life: 3 years in normal service

Accuracy:  
 $\pm 3\%$  LEL up to 50% LEL,  $\pm 5\%$  LEL above 50% LEL and less than 100% LEL

Zero Drift:  
Less than 5% per year

Response Time:  
With 100% LEL Methane Applied,  
 $T_{50} < 10$  sec. &  $T_{90} < 30$  sec.

Readout/Relay Modules (See section 5.4):

DC100	Single Channel Display
DC110	Eight Channel Display
DC120	X/P, Dual Channel Display
DC130	Dual Channel Display
TA102A	Single Channel, 02 Series

Fault Conditions Monitored:  
Low DC Supply, Sensor Bead Open,  
Calib. Out of Range, EEPROM Failure

Warranty:  
Two Years

Approvals:  
CSA certified to C22.2 No.152

Cenelec certified (with SST flame arrestor sensors only)

FMRC Approved.

CE Mark approval against EMC Directive and Product Safety

##### 5.1.2 Electrical Specifications

Input Power:  
24 VDC @ 250 mA nom., 1A during SU  
20 to 30 VDC range

Output Current: (0-22mA @ 300 Ohms max. load)  
Fault: 0.0mA  
Calibration: 1.5mA (0mA optional)  
Test Gas: 1.5mA (always)  
Relay Options: 1.5mA (always)  
0-100%LEL: 4 to 20mA  
Over-range: 20 to 22mA

Electrical Classification:  
Class I, Division 1, Groups B, C & D  
NEMA 4x rated

Alarm, Warn & Fault Relay Contact Rating:  
SPDT - 5A 250VAC, 5A 30VDC,  
resistive max.

Recommend Three Wire Shielded Cable:

Maximum distance between the Model S106A and the power source.

<u>AWG</u>	<u>Feet</u>	<u>Meters</u>
22	750	228
20	1100	335
18	1600	488
16	2250	685
14	4500	1372



# GENERAL MONITORS

## Model S106A

### Appendix

#### Specifications (*continued*)

##### Electrical Specifications (*continued.*)

For interfacing with 250 ohm input impedance devices, the following maximum cable lengths apply, with respect to the Analog Signal, with the total loop resistance less than 300 ohms.

<u>AWG</u>	<u>Feet</u>	<u>Meters</u>
22	1600	488
20	2400	730
18	3800	1160
16	5200	1585
14	9000	2740

**NOTE:** Good design practices dictate cable lengths conservatively shorter than the maximum given values.

##### 5.1.3 Mechanical Specifications

Weight (approx)	5.5 LB	2.5 kg
Length	6.34 in.	161 mm
Height (w/bolts)	3.40 in.	86 mm
Width at the base	4.10 in.	104 mm
Between mounting hole centers	4.99 in.	127 mm
Between outside edges of mounting flanges	6.00 in.	152 mm

##### 5.1.4 Environmental Specifications

Operating Temperature Range:  
Sensor (See section 5.4)  
-65°F to 200°F  
-55°C to 93°C

High Temperature Sensor (See section 5.4)  
-65°F to 400°F  
-55°C to 200°C

Electronics (pc board assemblies)  
-40°F to 140°F  
-40°C to 60°C

Storage Temperature Range:  
(Smart Sensor Assembly)  
-58°F to 158°F  
-50°C to 70°C

Humidity Range:  
10 to 95% Relative Humidity  
(non-condensing)



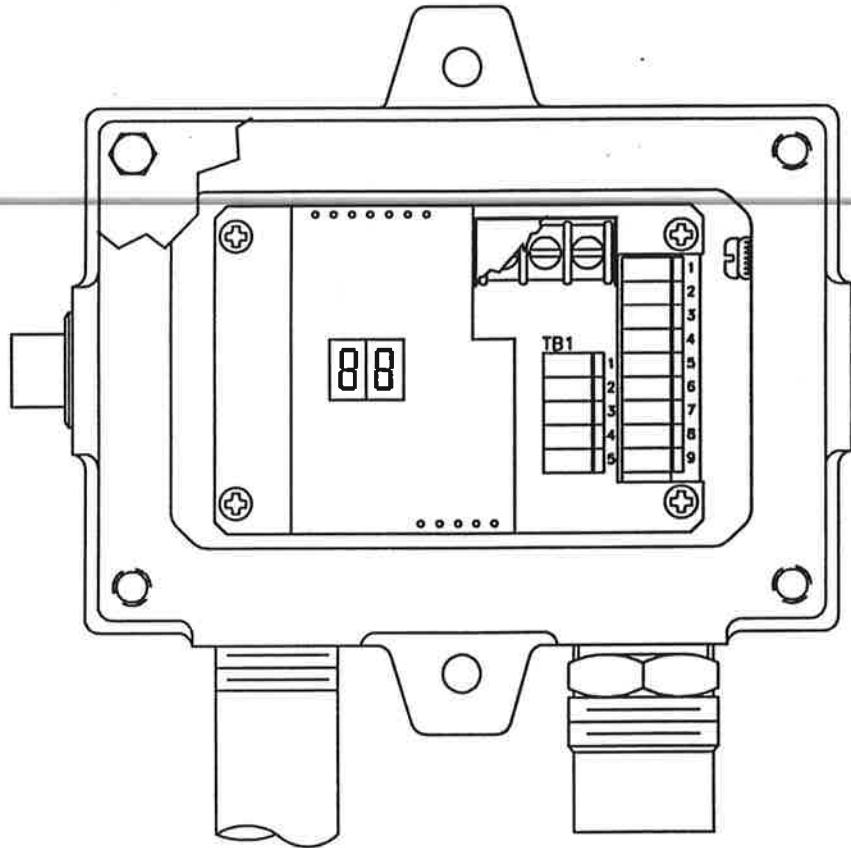
# GENERAL MONITORS

## Model S106A

### Appendix

#### 5.2 Engineering Documentation

##### 5.2.1 Termination & Outline Drawings



<b>SENSOR CONNECTIONS 1 ONLY.</b>		TB3			
<b>DO NOT APPLY +24VDC</b>		W	B	R	
		SENSOR			
<b>NOTE: RELAY CONTACT NORMALLY ENERGIZED</b>					
TB2 POS 1 - NO,	POS 4 - NO	4-20mA OUT	1	WHT	TB2 A1 1
TB2 POS 2 - C,	POS 5 - C	COM	2		AC 2
TB2 POS 3 - NC,	POS 6 - NC	RELAY RESET	3		A2 3
<b>NORMALLY DE-ENERGIZED</b>					W1 4
TB2 POS 1 - NC,	POS 4 - NC	COM	4	BLK	WC 5
TB2 POS 2 - C,	POS 5 - C	+24VDC	5	RED	W2 6
TB2 POS 3 - NO,	POS 6 - NO				F NO 7
					F C 8
					F NC 9

figure 26



# GENERAL MONITORS

## Model S106A

### Appendix

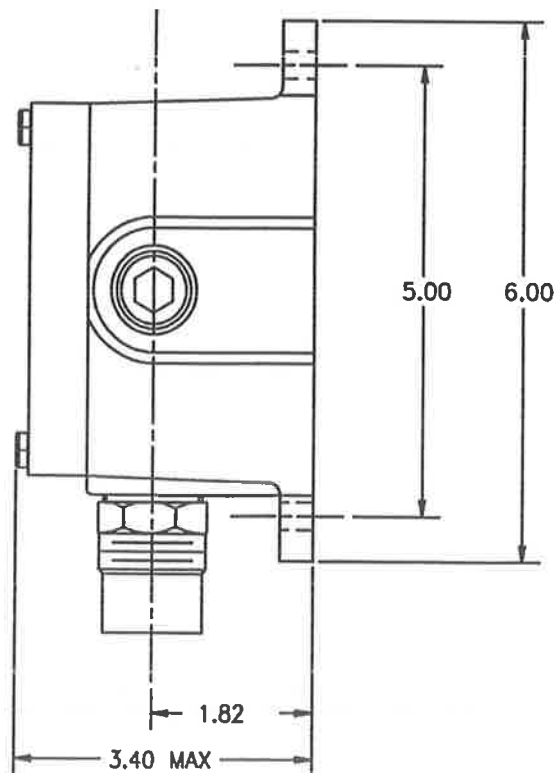
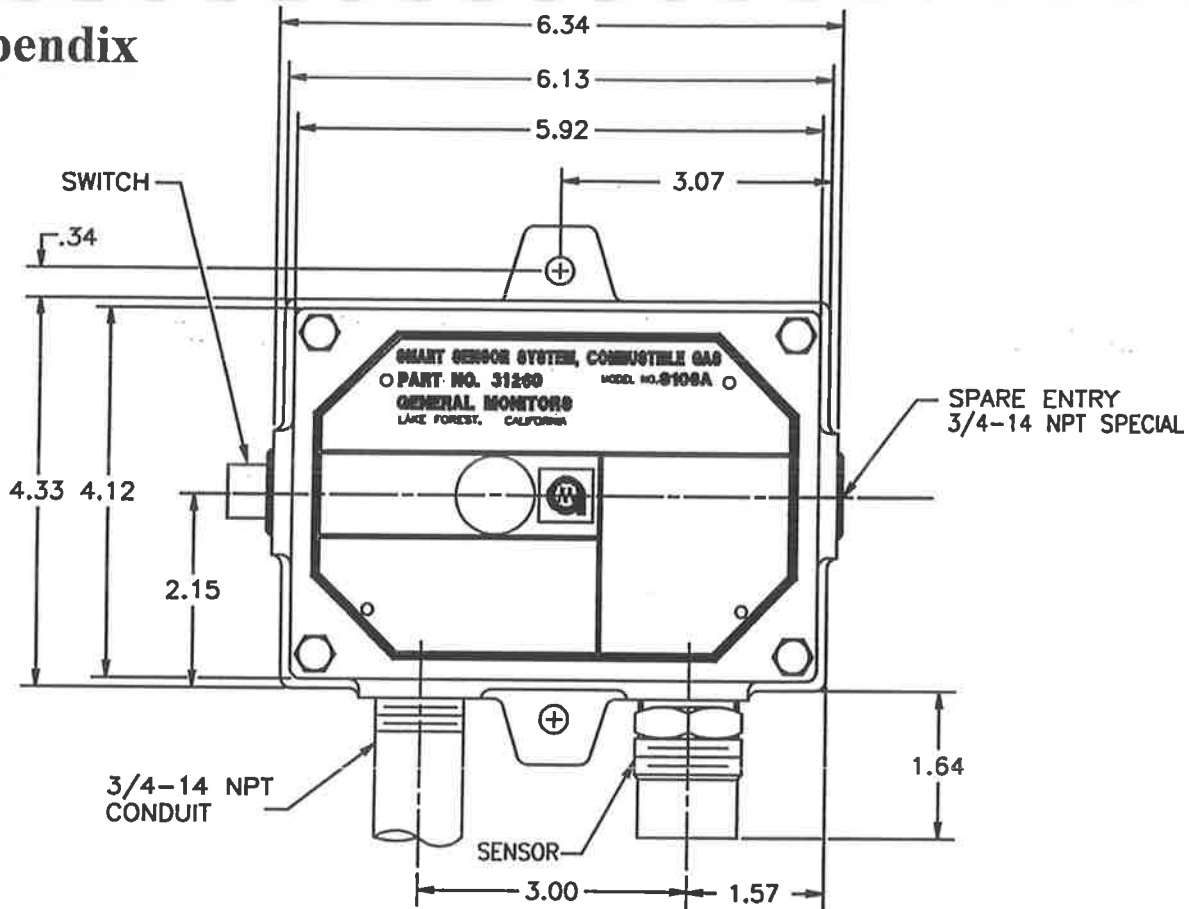


figure 27





# GENERAL MONITORS

## Model S106A

### Appendix

#### 5.2.2 Termination Drawing

#### CE Marked Units

HOUSING WITH COVER REMOVED FOR CLARITY

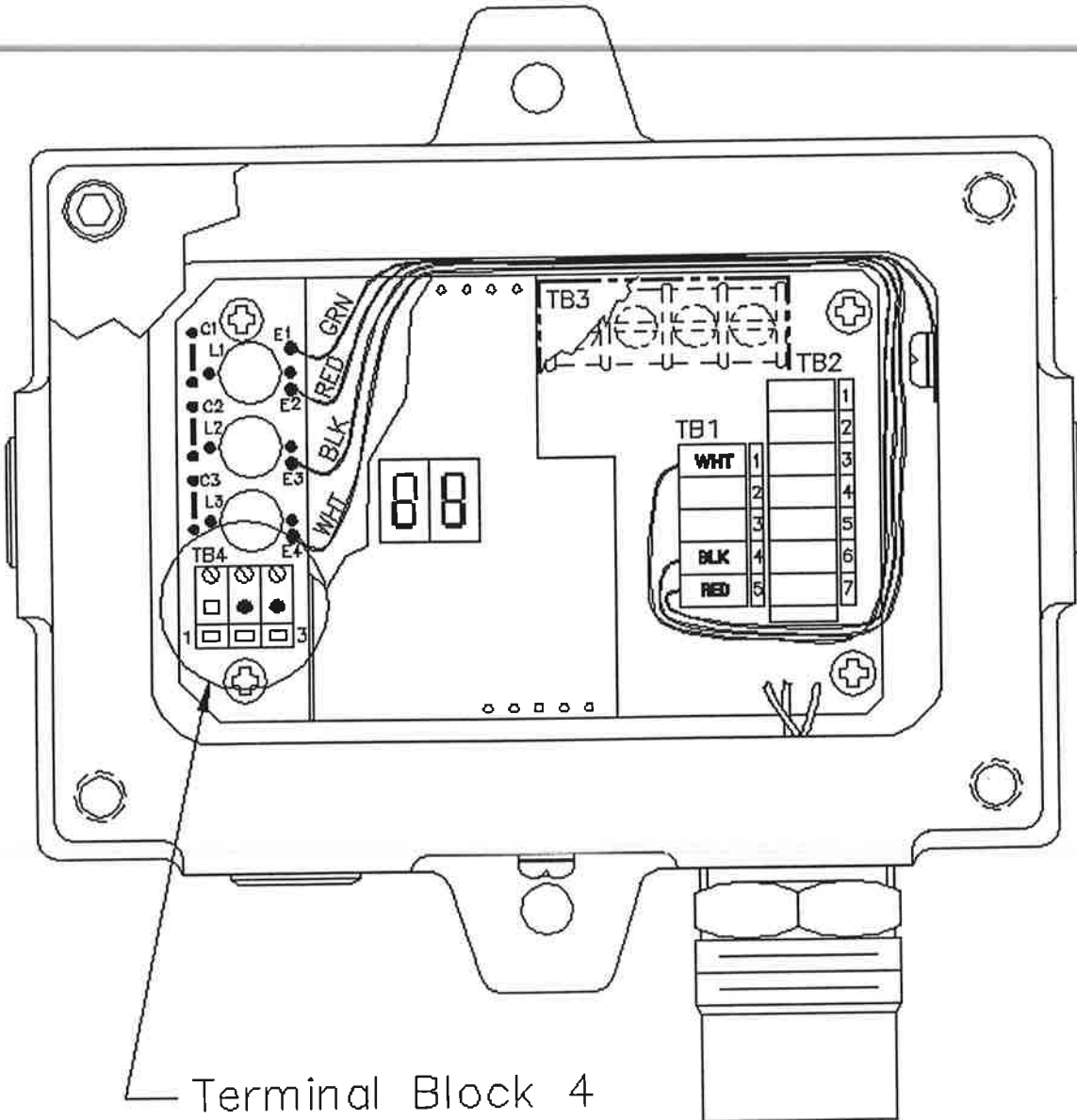


figure 28

- Position 1 – Analog (4–20 mA) White
- Position 2 – Common (–24 Vdc) Black
- Position 3 – Power (+24 Vdc) Red



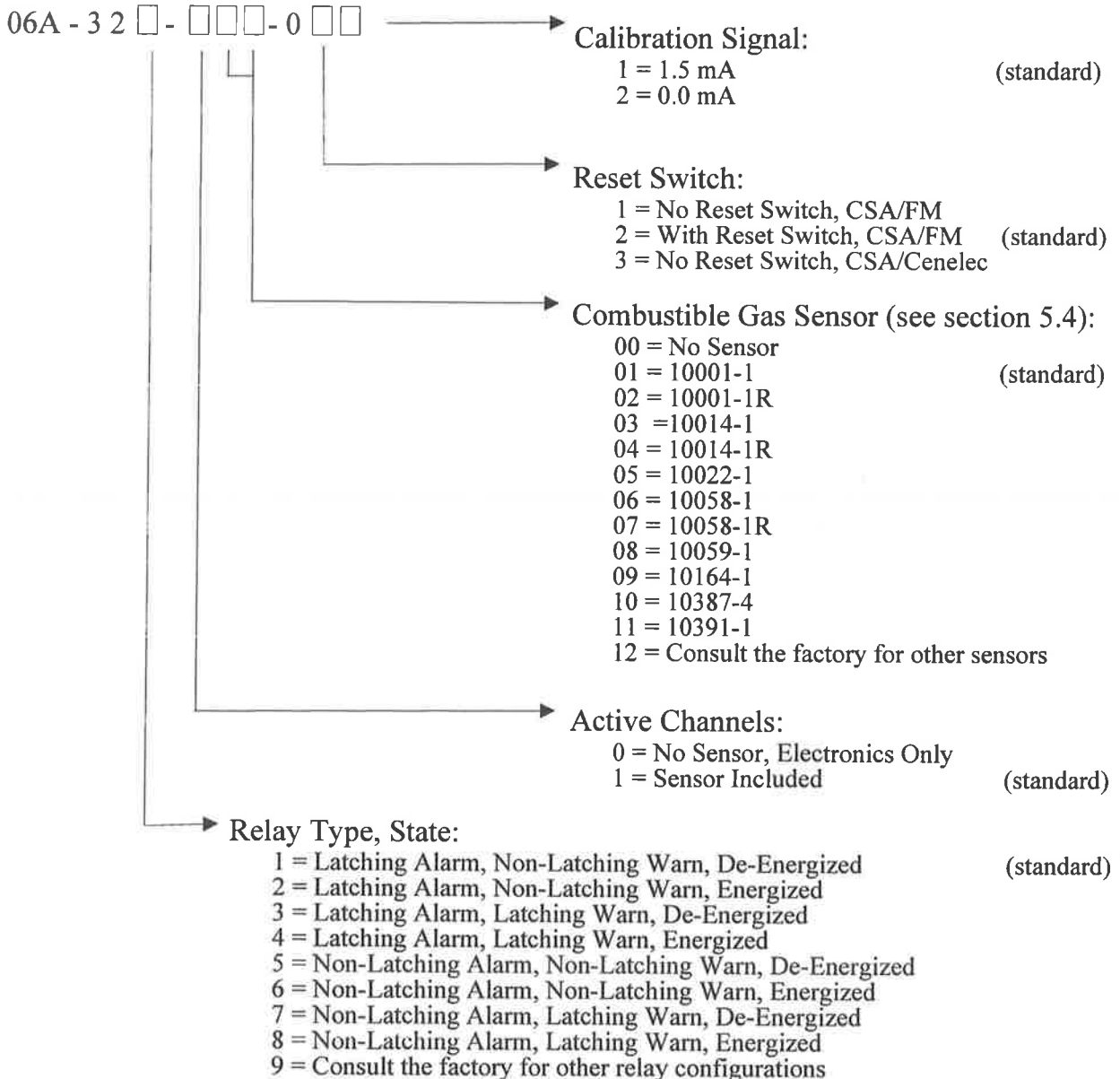
# GENERAL MONITORS

## Model S106A

### Appendix

#### 5.3 Ordering Information

##### 5.3.1 Configuration Codes



The Standard Configuration for the Model S106A is: **S106A-321-101-021**



# GENERAL MONITORS

## Model S106A

### Appendix

#### 5.3.2 Spare Parts & Accessories

To order spare parts and/or accessories, please contact your nearest General Monitors Representative or General Monitors directly and give the following information:

- Part Number of Spare Part or Accessory

- Description of Spare Part or Accessory

- Quantity of Spare Part or Accessory

#### Sensors:

10001-1	General Purpose, Alum.,
10001-1R	General Purpose, Alum., Poison Resistant
10014-1	General Purpose, Alum., High Temperature
10014-1R	General Purpose, Alum., Hi-Temp, Poison Resistant
10022-1	General Purpose, Alum., Industrial PTB
10058-1	General Purpose, SST
10058-1R	General Purpose, SST, Poison Resistant
10059-1	General Purpose, SST, Industrial PTB
10164-1 Alum.	Hydrogen Specific,
10387-4	General Purpose, Alum., Super Poison Resistant
10391-1	General Purpose, SST, Hi-Temperature
10102-1	Dummy Sensor

#### Sensor Housing:

10252	Universal Housing
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#### Sensor Accessories:

10460-2	Test Gas Applicator
10041	Duct Mounting Plate
10044-1	Dust Guard Kit - 1 Guard 12 Replaceable Screens
10042-1	Replaceable Screens, Box of 12
10395-1	Splash Guard Assembly
50060-1	H <sub>2</sub> S Guard Filter
50061-1	Purafil Insert Assembly
10110-1	Dust Guard Assembly
1800822 SST	Dust Guard, Sintered

#### Calibration Equipment:

10221-1	Model RC-3, Remote Calibrator Assembly
10378-1	RC-3 Interconnection Assembly
10345-1	RC-3 Position Indicator
10375-1	RC-3 Battery Assembly
10233-1	RC-3 Wind Shield
1400200	3 Liter CAL Chamber with syringe
1400204	Fan Motor for the 3 liter Chamber
1400207	Fan Blade for the 3 liter Chamber



# GENERAL MONITORS

## Model S106A

### Appendix

#### Calibration Equipment (*continued*):

928-700 Chamber	Dish for the 3 liter	Cylinder refills are available for Methane and Hydrogen only. Replacement cylinders must be ordered for the other gases.
928-715	250 microliter syringe	
1400150-M Calibrator,	Portable Purge Methane @ 50% LEL	922-009 Gauge
1400150-H Calibrator,	Portable Purge Hydrogen @ 50% LEL	1400152-1
1400150-BD Calibrator,	Portable Purge Butadiene @ 50% LEL	1400154
1400150-B Calibrator,	Portable Purge Butane @ 50% LEL	Smart Sensor (S106A) Replacement Parts:
1400150-E Calibrator,	Portable Purge Ethane @ 50% LEL	31265-1
1400150-PR Calibrator,	Portable Purge Propane @ 50% LEL	31270-1
1400155-M	Replacement Cylinder, Methane @ 50% LEL	30080-1
1400155-H	Replacement Cylinder, Hydrogen @ 50% LEL	10884-8
1400155-BD	Replacement Cylinder, Butadiene @ 50% LEL	30051-1
1400155-B	Replacement Cylinder, Butane @ 50% LEL	30060-1
1400155-E	Replacement Cylinder, Ethane @ 50% LEL	925-5007
1400155-PR	Replacement Cylinder, Propane @ 50% LEL	
		Control Board
		Converter Board
		Display Board
		Cover Assembly
		Explosion-Proof SPST Switch
		Calibration Magnet
		Cover Assy O-Ring
		Recommended Spare Parts for One (1) Year:
		1 Extra Calibration Magnet (30060-1)



## Appendix

### 5.4 FMRC Approval

Factory Mutual Research Corporation  
1151 Boston-Providence Turnpike  
Norwood, Massachusetts 02062

Approval of the transmitter does not include or imply approval of apparatus to which the transmitter may be connected and which process the electronic signal for the eventual end use. In order to maintain FMRC approved system, the control instrument, to which the subject instrument is connected, must be FMRC approved.

The following sensors have been FMRC approved for use with the Model S106A:

- 10001-1 Aluminum Body General Purpose Combustible Gas Sensor
- 10058-1 Stainless Steel Body General Purpose Combustible Gas Sensor

The following apparatus have been FMRC approved (although they have not been verified as part of a Model S106A system):

- Model DC100 Single Channel Readout Relay Display Module
- Model DC110 Eight Channel Readout Relay Display Module
- Model DC120 Explosion Proof Dual Channel Readout Relay Display Module
- Model DC130 Dual Channel Readout Relay Display Module

Factory Mutual Research Corporation has tested the Model S106A according to the criteria listed under the FMRC Approval Standards for Combustible Gas Detector, Class Numbers 6310 & 6320.

FMRC has tested the Model S106A using the specifications listed in section 5.1 (of this instruction manual), permitting an operating temperature of  $-40^{\circ}\text{F}$  to  $+140^{\circ}\text{F}$  ( $-40^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$ ), a general purpose sensor (10001-1 or 10058-1) attached to the housing (i.e. not removed), calibration performed with a General Monitors' Portable Purge Calibrator using 50% LEL gas (Methane, Hydrogen, Butadiene, Butane, Ethane or Propane) and the procedure listed in section 4.3 of this (instruction manual). The conduit containing wires connected to the relay contacts must be sealed. If the non-latching relay option has been selected, from the relay options, the user must provide alternate means of latching the relay output.



# GENERAL MONITORS

## Model S106A

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## GENERAL MONITORS

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