INGERSOLL-RAND®

OPERATING, MAINTENANCE, PARTS MANUAL

COMPRESSOR MODEL

XHP1070WCAT

Code:

This manual contains important safety information.
Do not destroy this manual.
This manual must be available to the personnel who operate and maintain this machine.

Doosan purchased Bobcat Company from Ingersoll-Rand Company in 2007. Any reference to Ingersoll-Rand Company or use of trademarks, service marks, logos, or other proprietary identifying marks belonging to Ingersoll-Rand Company in this manual is historical or nominative in nature, and is not meant to suggest a current affiliation between Ingersoll-Rand Company and Doosan Company or the products of either.

Portable Air Compressor Division
P.O. Box 868 - 501 Sanford Ave
Mocksville, N.C. 27028

Book 35391903 (05/03) **Revised (09-12)**

QUALITY POLICY

We will supply products and services that consistently meet the requirements of our customers and each other.

CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Foreword

Machine models represented in this manual may be used in various locations worldwide. Machines sold and shipped into European common market countries requires that the machine display the EC Mark and conform to various directives. In such cases, the design specification of this machine has been certified as complying with EC directives. Any modification to any part is absolutely prohibited and would result in the CE certification and marking being rendered invalid. A declaration of that conformity follows:

Declaration of Conformity

WITH EC DIRECTIVE

98/37/EC

Ingersoll-Rand Company
P.O. Box 868
501 Sanford Avenue
Mocksville, North Carolina 27028

We

Represented In EC By:

Ingersoll-Rand Company Limited
Swan Lane, Hindley Green
Wigan WN2 4EZ
United Kingdom

Declare that, under our sole responsibility for manufacture and supply, the product(s)

HP1300WCU	VHP825WCU	XHP900WCAT	VHP750WCAT	XHP1070CAT
XP1400WCU	HP935WCU	XHP650WCAT	VHP850WCAT	NXP1300WCU
P1600WCU	XP1050WCU	XHP750WCAT	HP900WCAT	
XP900WCU	HP825WCU	XHP825WCAT	XP1000WCAT	

To which this declaration relates, is (are) in conformity with the provisions of the above directives using the following principal standards

EN1012-1, EN29001, EN202, EN60204-1
PN8NTC2, EN 50081, EN50082

Issued at Mocksville on 1-1-95

Ric Lunsford
Manager of Quality Control

Issued at Hindley Green on 1-1-95

H. Seddon, Q.A. Manager

Nothing contained in this document is intended to extend any promise, warranty or representation, expressed or implied, regarding the Ingersoll-Rand products described herein. Any such warranties or other terms and conditions of sale of products shall be in accordance with the standard terms and conditions of sale for such products, which are available upon request.
This manual contains instructions and technical data to cover all routine operation and scheduled maintenance tasks by operation and maintenance staff. Major overhauls are outside the scope of this manual and should be referred to an authorized Ingersoll-Rand service department.

All components, accessories, pipes and connectors added to the compressed air system should be:

- of good quality, procured from a reputable manufacturer and, wherever possible, be of a type approved by Ingersoll-Rand.
- clearly rated for a pressure at least equal to the machine maximum allowable working pressure.
- compatible with the compressor lubricant/coolant.
- accompanied with instructions for safe installation, operation and maintenance.

Details of approved equipment are available from Ingersoll-Rand Service departments.
The use of repair parts other than those included within the Ingersoll-Rand approved parts list may create hazardous conditions over which Ingersoll-Rand has no control. Therefore, Ingersoll-Rand cannot be held responsible for equipment in which non-approved repair parts are installed.

Ingersoll-Rand reserves the right to make changes and improvements to products without notice and without incurring any obligation to make such changes or add such improvements to products sold previously.

The intended uses of this machine are outlined below and examples of unapproved usage are also given. However, Ingersoll-Rand cannot anticipate every application or work situation that may arise. **If in doubt, consult supervision.**

This machine has been designed and supplied for above ground operation to be used for compression of normal ambient air containing no additional gases, vapors or particles within the ambient temperature range specified in the general data section of this manual.

This machine should not be used:

A. For direct or indirect human consumption of the compressed air.

B. Outside the ambient temperature range specified in the general data section of this manual.

C. When an actual or foreseeable risk of hazardous levels of flammable gases or vapors exists.

D. With other than Ingersoll-Rand approved components.

E. With guards, or controls or switches missing or disabled.

F. For storage or transportation of materials inside or on the enclosure.

This company accepts no responsibility for errors in translation of this manual from the original English version.

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SECTION 1- SAFETY

SAFETY PRECAUTIONS

General Information

Ensure that the operator reads and understands the decals and consults the manuals before maintenance or operation.

Ensure that the Operation and Maintenance manual, and the manual holder if equipped, are not removed permanently from the machine.

Ensure that maintenance personnel are adequately trained, competent and have read the manuals.

Make sure that all protective covers are in place and that the canopy/doors are closed during operation.

The specification of this machine is such that the machine is not suitable for use in flammable gas risk areas. If such an application is required then all local regulations, codes of practice and site rules must be observed. To ensure that the machine can operate in a safe and reliable manner, additional equipment such as gas detection, exhaust spark arrestors, and intake (shut-off) valves may be required, dependent on local regulations or the degree of risk involved.

Air discharged from this machine may contain carbon monoxide or other contaminants which will cause serious injury or death. Do not breathe this air.

Compressed air can be dangerous if incorrectly handled. Before doing any work on the unit, ensure that all pressure is vented from the system and that the machine cannot be started accidentally.

Ensure that the machine is operating at the rated pressure and that the rated pressure is known to all relevant personnel.

All air pressure equipment installed in or connected to the machine must have safe working pressure ratings of at least the machine safety valve rating.

If more than one compressor is connected to one common downstream plant, effective check valves and isolation valves must be fitted and controlled by work procedures, so that one machine cannot accidentally be pressurized or over pressurized by another.

Compressed air must not be used for a feed to any form of breathing apparatus or mask.

The discharged air contains a very small percentage of compressor lubricating oil and care should be taken to ensure that downstream equipment is compatible.

If the discharged air is to be ultimately released into a confined space, adequate ventilation must be provided.

When using compressed air, always use appropriate personal protective equipment.

All pressure containing parts, especially flexible hoses and their couplings, must be regularly inspected, be free from defects and be replaced according to the Manual instructions.

Avoid bodily contact with compressed air.

The safety valve located in the separator tank must be checked periodically for correct operation.

Never operate unit without first observing all safety warnings and carefully reading the operation and maintenance manual shipped from the factory with this machine.

Never operate the engine of this machine inside a building without adequate ventilation. Avoid breathing exhaust fumes when working on or near the machine. Do not alter or modify this machine.

A battery contains sulfuric acid and can give off gases which are corrosive and potentially explosive. Avoid contact with skin, eyes and clothing. In case of contact, flush area immediately with water.

Exercise extreme caution when using booster battery. To jump battery, connect ends of one booster cable to the positive (+) terminal of each battery. Connect one end of other cable to the negative (-) terminal of the booster battery and other end to a ground connection away from dead battery (to avoid a spark occurring near any explosive gases that may be present). After starting unit, always disconnect cables in reverse order.

Never operate unit without first observing all safety warnings and carefully reading the operation and maintenance manual shipped from the factory with this machine.

This machine may include such materials as oil, diesel fuel, antifreeze, brake fluid, oil/air filters and batteries which may require proper disposal when performing maintenance and service tasks. Contact local authorities for proper disposal of these materials.

A battery contains sulfuric acid and can give off gases which are corrosive and potentially explosive. Avoid contact with skin, eyes and clothing. In case of contact, flush area immediately with water.

High Pressure Air can cause serious injury or death. Relieve pressure before removing filler plugs/caps, fittings or covers.

Air pressure can remain trapped in air supply line which can result in serious injury or death. Always carefully vent air supply line at tool or vent valve before performing any service.

This machine produces loud noise with the doors open or service valve vented. Extended exposure to loud noise can cause hearing loss. Always wear hearing protection when doors are open or service valve is vented.

Never inspect or service unit without first disconnecting battery cable(s) to prevent accidental starting.

Do not remove the pressure cap from a HOT radiator. Allow radiator to cool down before removing pressure cap.

Do not use petroleum products (solvents or fuels) under high pressure as this can penetrate the skin and result in serious illness. wear eye protection while cleaning unit with compressed air to prevent debris from injuring eye(s).

Disconnected air hoses whip and can cause serious injury or death. Always attach a safety flow restrictor to each hose at the source of supply or branch line in accordance with OSHA Regulation 29CFR Section 1926.302(b).

Hot pressurized fluid can cause serious burns. Do not open radiator while hot.

Rotating fan blade can cause serious injury. Do not operate without guard in place.

Use care to avoid contacting hot surfaces (engine exhaust manifold and piping, air receiver and air discharge piping, etc.).

Ether is an extremely volatile, highly flammable gas. USE SPARINGLY! Do NOT use ETHER if unit has GLOW Plug starting aid. Engine damage will result.

Never allow the unit to sit stopped with pressure in the receiver-separator system. As a precaution, open the manual blowdown valve.

Never operate unit with guards, covers or screens removed. Keep hands, hair, clothing, tools, blow gun tips, etc. well away from moving parts.

Make sure wheels, tires and tow bar connectors are in safe operating condition and tow bar is properly connected before towing.

Whenever the machine is stopped, air will flow back into the compressor system from devices or systems downstream of the machine unless the service valve is closed. Install a check valve at the machine service valve to prevent reverse flow in the event of an unexpected shutdown when the service valve is open.

Hazardous Substance Precaution

The following substances are used in the manufacture of this machine and may be hazardous to health if used incorrectly.

Precaution: Avoid ingestion, skin contact and breathing fumes for the following substances: Antifreeze, Compressor Oil, Engine Lubricating Oil, Preservative Grease, Rust Preventative, Diesel Fuel and Battery Electrolyte.

The following substances may be produced during the operation of this machine and may be hazardous to health:

Avoid build-up of Engine Exhaust Fumes in confined spaces.

Avoid breathing Exhaust Fumes.

Avoid breathing Brake Lining Dust during maintenance.

SAFETY LABELS

Look for these signs on machines shipped to international markets outside North America, which point out potential hazards to the safety of you and others. Read and understand thoroughly. Heed warnings and follow instructions. If you do not understand, inform you supervisor.

Corrosion risk

Hot Surface

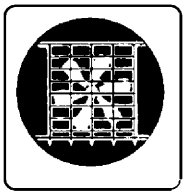
Lifting point

WARNING: Electrical shock risk.

Parking Brake

No open flame

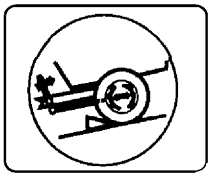
Diesel Fuel.
No open flame.



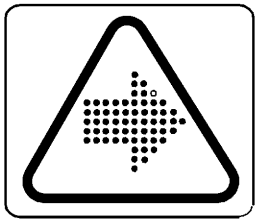
Do not operate the machine without guard being fitted.

Lifting point

WARNING - Flammable liquid.



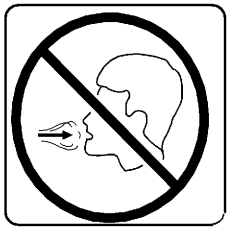
When parking use prop stand, handbrake and wheel chocks.



Air/gas flow or Air discharge.

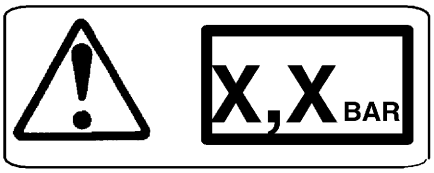
WARNING - Hot and harmful exhaust gas.

Tie down point

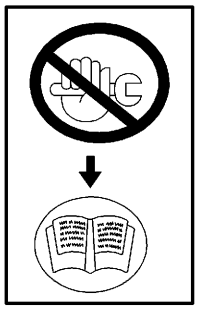


Do not breathe the compressed air from this machine.

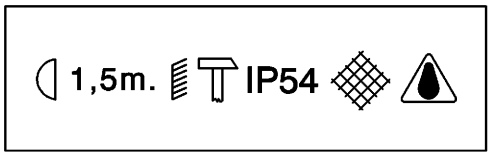
Read the Operation and Maintenance manual before operation or maintenance of this machine is undertaken.



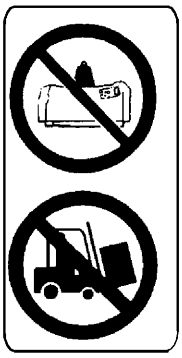
WARNING - Maintain correct tire pressure. (Refer to the *GENERAL INFORMATION* section of this manual).



WARNING: Consult the operation and maintenance manual before performing any maintenance.

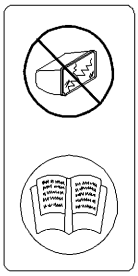


Rough Service Designation
Wet Location Operation

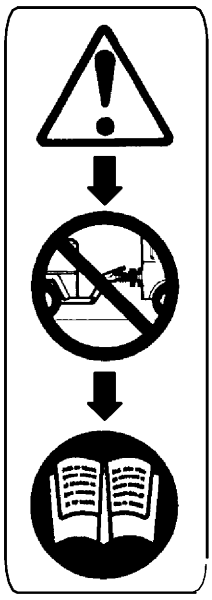


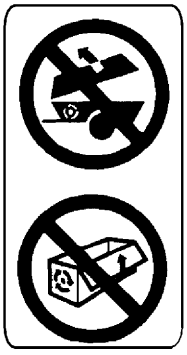
Do not stack

Do not use fork lift truck from this side

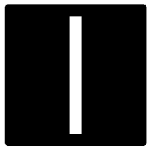


Replace any cracked protective shield.



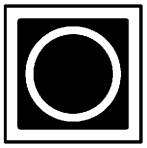


Do not operate with the doors or enclosure open.



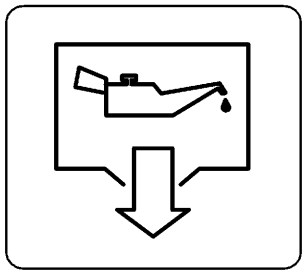
On (power).

Off (power).

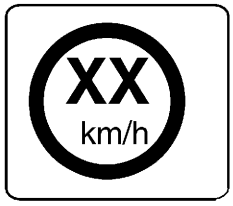


Emergency stop.

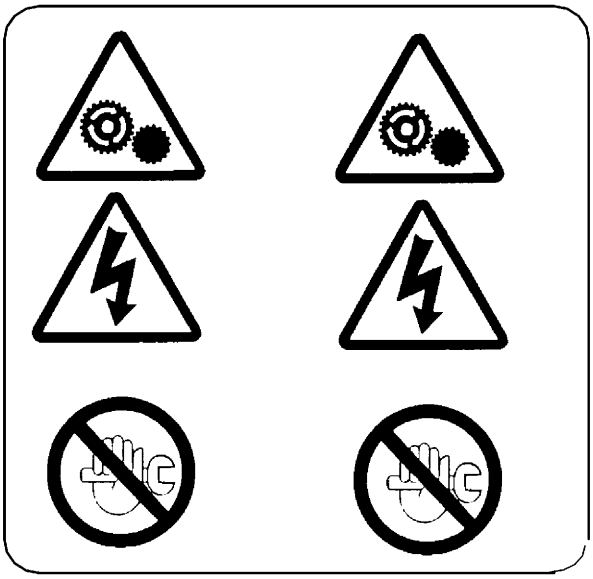
WARNING - Before connecting the tow bar or when preparing to tow, consult the operation and maintenance manual.



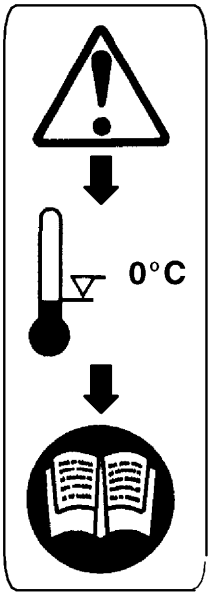
Oil Drain



Do not exceed the speed limit.



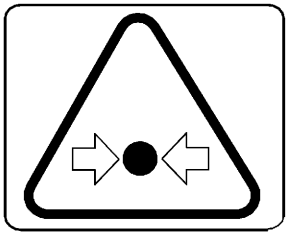
WARNING - Do not undertake any maintenance on this machine until the electrical supply is disconnected and the air pressure is totally relieved.



WARNING - For operating temperature below 0°C, consult the operation and maintenance manual.

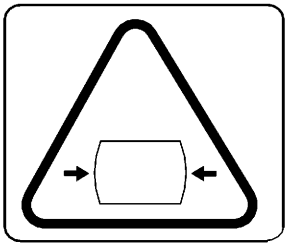
Read the Operation and Maintenance manual before operation or maintenance of this machine is undertaken

Do not remove the Operating and Maintenance manual and manual holder from this machine.



Pressurized vessel.

Use fork lift truck from this side only.



Pressurized component or system.

Look for these signs on machines shipped to markets in North America, which point out potential hazards to the safety of you and others. Read and understand thoroughly. Heed warnings and follow instructions. If you do not understand, inform you supervisor.

DANGER

(Red Background)

Indicates the presence of a hazard which WILL cause serious injury, death or property damage, if ignored.

WARNING

(Orange Background)

Indicates the presence of a hazard which CAN cause serious injury, death or property damage, if ignored.

CAUTION

(Yellow Background)

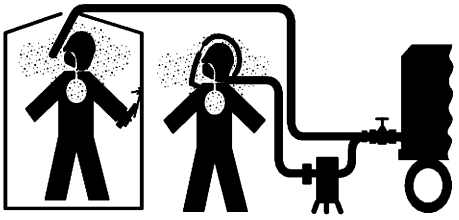
Indicates the presence of a hazard which WILL or can cause injury or property damage, if ignored.

NOTICE

(Blue Background)

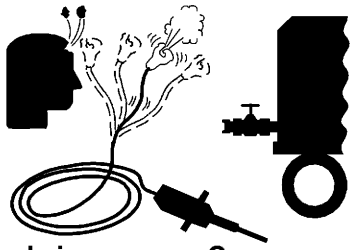
Indicates important set-up, operating or maintenance information.

DANGER



Air discharged from this machine can contain carbon monoxide or other contaminants which will cause serious injury or death. Do not breathe this air.

WARNING



Trapped air pressure. Can cause serious injury or death.

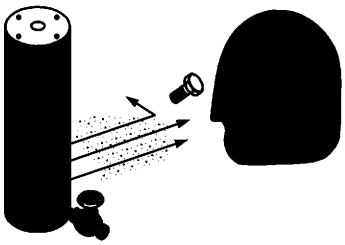
Close service valve and operate tool to vent trapped air before performing any service.

WARNING

Hot pressurized fluid.
Can cause serious burns.

Do not open radiator while hot.

WARNING



High pressure air. Can cause serious injury or death.

Relieve pressure before removing filler plugs/ caps, fittings or covers.

WARNING

Improper operation of this equipment. CAN cause serious injury or death.

Read Operator's Manual supplied with this machine before operation or servicing.

WARNING

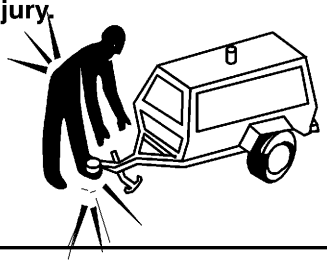
Modification or alteration of this machine. CAN cause serious injury or death.

Do NOT alter or modify this machine without the express written consent of the manufacturer.

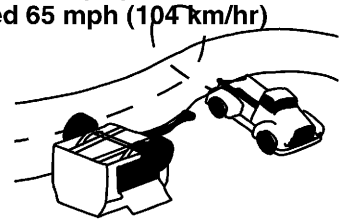
WARNING

Collapsing jack stand. Will cause serious injury.

Insert locking pin completely.

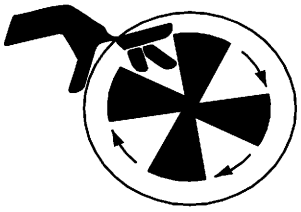


Excessive towing speed. Can cause serious injury or death. Do NOT exceed 65 mph (104 km/hr)



For Highway Towable Units

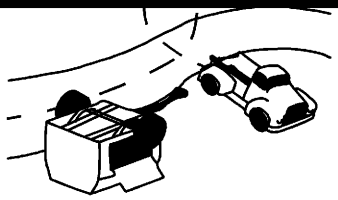
WARNING



Rotating Fan Blade. CAN cause serious injury.

Do NOT operate with guard removed.

WARNING

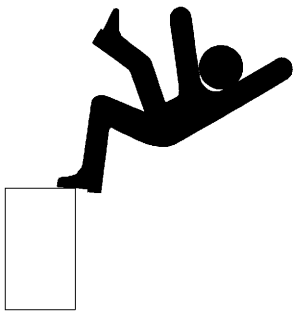


Excessive Towing Speed. CAN cause serious injury or death.

Do NOT Tow on Highway.
Do NOT exceed 20 mph (32 km/h)

For Non-Highway Towable Machines

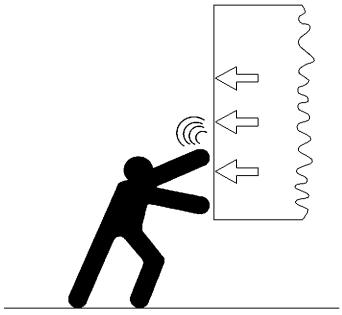
WARNING



Falling off machine. CAN cause serious injury or death.

Access Lifting Bail from inside machine.

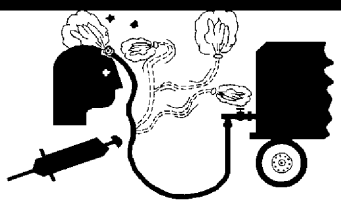
WARNING



Door under pressure CAN cause serious injury.

Use both hands to open door when machine is running.

WARNING



Disconnected Air Hoses Whip. CAN cause serious injury or death.

When using air tools attach safety device (OSHA Valve) at source of air supply for each tool.

WARNING

Combustible Gas. CAN cause serious burns, blindness or death.

Keep sparks and open flames away from batteries.

FREE SAFETY DECALS!

To promote communication of Safety Warnings on products manufactured by the Portable Compressor Division in Mocksville, N.C., Safety Decals are available **free** of charge. Safety decals are identified by the decal heading: **DANGER, WARNING or CAUTION.**

Decal part numbers are on the bottom of each decal and are also listed in the compressor's parts manual. Submit orders for Safety Decals to the Mocksville Parts Service Department. The no charge order should contain only Safety Decals. Help promote product safety! Assure that decals are present on the machines. Replace decals that are not readable.

SECTION 2 - Warranty

Ingersoll-Rand, through its distributor, warrants that each item of equipment manufactured by it and delivered hereunder to the initial user will be free of defects in material and workmanship for a period of three (3) months from initial operation or six (6) months from the date of shipment to the initial user, whichever occurs first.

With respect to the following types of equipment, the warranty period enumerated below will apply in lieu of the foregoing warranty period.

A. **Aftercoolers -** The earlier of nine (9) months from date of shipment to or six (6) months from start up by initial user.

B. **Portable Compressors, Portable Generator Sets (GENSET), Portable Light Towers and Air Dyers -** The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of service by the initial user.

C. **Portable Compressor Air Ends -** The earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of service by the initial user. For Air Ends, the warranty against defects will include replacement of the complete Air End, provided the original Air End is returned assembled and unopened.

C.1 **Portable Compressor Airend Limited Optional Warranty -** The earlier of sixty (60) months from shipment to or the accumulation of 10,000 hours of service. The optional warranty is limited to defects in rotors, housings, bearings and gears and provided all the following conditions are met:

The original airend is returned assembled and unopened.

Continued use of genuine Ingersoll-Rand parts, fluids, oils and filters.

Maintenance is performed at prescribed intervals.

D. **Genset Generators -** The earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of service by the initial user.

E. **Portable Light Tower Generators -** The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of service by the initial user. Light Source model only, the earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of service.

F. **Ingersoll-Rand Engines -** The earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of service.

G. **Ingersoll-Rand Platinum Drive Train Warranty (Optional)** - Platinum drive train pertains to the Ingersoll-Rand Engine and Airend combination. The earlier of sixty (60) months from shipment to, or the accumulation of 10,000 hours of service. The starter, alternator, fuel injection system and all electrical components are excluded from the extended warranty. The airend seal and drive coupling are included in the warranty (airend drive belts are not included). The optional warranty is automatically available when meeting the following conditions:

The original airend is returned assembled and unopened.

Continued use of genuine Ingersoll-Rand parts, fluids, oil and filters.

Maintenance is performed at prescribed intervals.

It is the obligation of the user to provide verification that these conditions have been satisfied when submitting warranty claims.

H. **Spare Parts** – Six (6) months from date of shipment.

Ingersoll-Rand will provide a new part or repaired part, at its election, in place of any part which is found upon its inspection to be defective in material and workmanship during the period prescribed above. Such part will be repaired or replaced without charge to the initial user during normal working hours at the place of business of an Ingersoll-Rand distributor authorized to sell the type of equipment involved or other establishment authorized by Ingersoll-Rand. User must present proof of purchase at the time of exercising warranty.

The above warrantees do not apply to failures occurring as a result of abuse; misuse, negligent repairs, corrosion, erosion and normal wear and tear, alterations or modifications made to the product without express written consent of Ingersoll-Rand; or failure to follow the recommended operating practices and maintenance procedures as provided in the product's operating and maintenance publications.

Accessories or equipment furnished by Ingersoll-Rand, but manufactured by others, including, but not limited to, engines, tires, batteries, engine electrical equipment, hydraulic transmissions, carriers, shall carry whatever warranty the manufacturers have conveyed to Ingersoll-Rand and which can be passed on to the initial user.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, (EXCEPT THAT OF TITLE),AND THERE ARE NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

GENERAL WARRANTY INFORMATION

GENERAL WARRANTY			Extended Coverage
Portable Compressor	Package	1 year/2000 hours	
	Airend	2 years/4000 hours	5 years/10,000 hours Limited warranty, major components (refer to operator's manual).

Portable Genset	Package	1 year/2000 hours	
	Generator	2 years/4000 hours	

Light Tower	Package	1 year/2000 hours	
	Generator	1 year/2000 hours	2 years/4000 hours, for Lightsource introduced 8/16/99.

ENGINES			
Caterpillar	**Months**	**Hours**	**Extended Coverage**
	12	No Limit	Available at dealer
Cummins	24	2000	Major components 3 yrs/10,000 hours - available at dealer
John Deere	24	2000	Available at dealer
Deutz	24	2000	Available at dealer
Kubota	24	2000	Major components 36 months/3000 hours - parts only
Ingersoll-Rand	24	4000	5 years/10,000 hours when using genuine Ingersoll-Rand fluids and parts. Refer to operator's manual.

PARTS			
	Months	**Hours**	**Coverage**
Ingersoll-Rand	6	No Limit	Parts Only

AIREND EXCHANGE			
	Months	**Hours**	**Extended Coverage**
Airend	12	2000 hours	2 years/4000 hours - available from IR.

Note: Actual warranty times may change. Consult the manufacturer's warranty policy as shipped with each new product.

Extended Limited Airend Warranty

Ingersoll-Rand Portable Compressor Division is pleased to announce the availability of extended limited airend warranty. Announcement of the extended warranty coincides with the introduction of PRO•TEC™ Compressor Fluid. PRO•TEC™ Compressor Fluid is an amber colored fluid specially formulated for Portable Compressors and is being provided as the factory filled fluid for all machines except [1] XHP650/900/1070 models.

All machines have the standard airend warranty - *The earlier of 24 months from shipment to, or the accumulation of 4000 hours of service.*

The warranty against defects will include replacement of the complete airend, provided the original airend is returned assembled and unopened.

The optional limited warranty is the earlier of 60 months from shipment to, or the accumulation of 10,000 hours of service. The optional warranty is limited to defects in major components (rotors, housings, gears, bearings), and is automatically available when the following three conditions are met:

1. The original airend is returned assembled and unopened.
2. Submissions of proof that Ingersoll-Rand fluid, filters and separators have been used. Refer to the Operation and Parts manual for the correct fluids, filters and separator elements required.
3. Submission of proof that maintenance intervals have been followed.

WARRANTY	TIME	*BARE AIREND	* * AIREND COMPONENTS
STANDARD	**2 yrs/4000 hrs**	**100% parts and labor**	**100% parts and labor**
OPTIONAL	**5 yrs/10,000 hrs**	**100% parts and labor**	**0%**

* Bare Airend - pertains to major airend parts (rotors, housings, gears and bearings).

** Airend Components - pertains to auxiliary attachments to the bare airend (drive coupling, seals, pumps, valves, tubes, hoses, fittings and filter housing).

PRO•TEC™ and XHP505 Compressor Fluids are available from the Mocksville Product Support department by calling 1-800-633-5206.

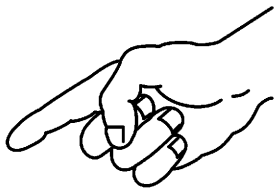
[1] XHP650/900/1070 will continue to use XHP505 and will have the extended warranty when above conditions are met.

WARRANTY REGISTRATION

Complete Machine Registration

Machines shipped to locations within the United States do not require a warranty registration unless the machine status changes (i.e. change of ownership).

Machines shipped outside the United States require notification be made to initiate the machine warranty.



Fill out the Warranty Registration Form in this section, keep a copy for your records and mail form to:

Ingersoll-Rand Company
Portable Compressor Division
P.O. Box 868
Mocksville, North Carolina 27028

Attn: Warranty Department

Note: Completion of this form validates the warranty.

Engine Registration:

John Deere requires a separate engine registration be completed and mailed direct to John Deere.
Separate engine registration material is included with this literature package for John Deere powered machines.
All other engine manufacturers do not require a separate engine registration.
You MUST present proof of in-service date at time of requesting engine warranty service.

Selling Distributor	Servicing Distributor	WARRANTY REGISTRATION
Name _____	Name _____	Owner/User Name _____
Address _____	Address _____	Address _____
City _____	City _____	City _____
County _____	County _____	County _____
State _____	State _____	State _____
Zip Code _____	Zip Code _____	Zip Code _____
Telephone _____	Telephone _____	Telephone _____

Complete the Applicable Blocks

Owner/User Type of Business (check one only)

☐ Construction–Heavy (highway, excavation, etc.)	☐ Asphalt Contractor	☐ Coal Mining	☐ Other Mining
☐ Construction–Light (carpentry, plumbing, pools, mason, etc.)	☐ Government (municipal, state, county, etc.)	☐ Quarry	☐ Shallow Oil & Gas
☐ Rental (rental center, rental fleet, etc.)	☐ Building Contractor	☐ Waterwell	☐ Utility Company (gas, electric, water, etc.)
☐ Industrial (plant use)	☐ Other specify _____	☐ Exploration	☐ Utility Contractor

Model	Unit S/N	Engine S/N	Date Delivered

Unit–Hours	Airend S/N	Truck S/N	Truck Engine S/N

SERVICING DISTRIBUTOR/USER ACKNOWLEDGEMENT

1. The Purchaser has been instructed and/or has read the manual and understands proper preventative maintenance, general operation and safety precautions.
2. The warranty and limitation of liability has been reviewed and understood by the owner/user.
3. In the event that this unit is to be used within a nuclear facility, the owner/user shall notify Ingersoll–Rand of such use so that Ingersoll–Rand may arrange for appropriate nuclear liability protection from the owner–licensee of the facility.
4. Ingersoll–Rand reserves the right to make design changes or modifications of Ingersoll–Rand products at anytime without incurring any obligation to make similar changes or modifications on previously sold units.

Attention: Warranty Department

Mocksville, North Carolina 27028
P.O. Box 868
Portable Compressor Division
Ingersoll-Rand Company

- *fold* -

SECTION 3 - NOISE EMISSION

This section pertains only to machines distributed within the United States.

WARNING

TAMPERING WITH NOISE CONTROL SYSTEM PROHIBITED

Federal law prohibits the following acts or the causing thereof:

(1) The removal or rendering inoperative by any persons, other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into any new compressor for the purpose of noise control prior to its sale or delivery to the ultimate purchaser or while it is in use; or (2) the use of the compressor after such device or element of design has been removed or rendered inoperative by any person.

Among those acts included in the prohibition against tampering are these:

4. Removal or rendering inoperative any of the following:
   a. the engine exhaust system or parts thereof
   b. the air intake system or parts thereof
   c. enclosure or parts thereof

5. Removal of any of the following:
   a. fan shroud
   b. vibration mounts
   c. sound absorption material

6. Operation of the compressor with any of the enclosure doors open.

Compressor Noise Emission Control Information

A. The removal or rendering inoperative, other than for the purpose of maintenance, repair, or replacement of any noise control device or element of design incorporated into this compressor in compliance with the noise control act;

B. The use of this compressor after such device or element of design has been removed or rendered inoperative.

Note: the above information applies only to units that are built in compliance with the U.S. Environmental Protection Agency.

Ingersoll-Rand Company reserves the right to make changes or add improvements without notice and without incurring any obligation to make such changes or add such improvements to products sold previously.

The Purchaser is urged to include the above provisions in any agreement for any resale of this compressor.

NOISE EMISSION CONTROL MAINTENANCE LOG

COMPRESSOR MODEL _____
SERIAL NO. _____
USER UNIT NO. _____

UNIT IDENTIFICATION	**DEALER OR DISTRIBUTOR FROM WHOM PURCHASED:**
Engine Make & Model: _____	
Serial No.: _____	_____
Purchaser or Owner: _____	_____
Address: _____	Date Purchased: _____

The Noise Control Act of 1972 (86 Stat. 1234) prohibits tampering with the noise control system of any compressor manufactured and sold under the above regulations, specifically the following acts or the causing thereof:

(1) the removal or rendering inoperative by any persons, other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into new compressor for the purpose of noise control prior to its sale or delivery to the ultimate purchaser or while it is in use; or (2) the use of the compressor after such device or element of design has been removed or rendered inoperative by any person.

NOISE EMISSION WARRANTY

The manufacturer warrants to the ultimate purchaser and each subsequent purchaser that this air compressor was designed, built and equipped to conform at the time of sale to the first retail purchaser, with all applicable U.S. EPA Noise Control Regulations.

This warranty is not limited to any particular part, component, or system of the air compressor. Defects in the design, assembly or in any part, component, or system of the compressor which, at the time of sale to the first retail purchaser, caused noise emissions to exceed Federal Standards are covered by this warranty for the life of the air compressor.

INTRODUCTION

The unit for which this Maintenance Log is provided conforms to U.S. E.P.A. Regulations for Noise Emissions, applicable to Portable Air Compressors.

The purpose of this book is to provide (1) the Maintenance Performance Schedule for all required noise emission controls and (2) space so that the purchaser or owner can record what maintenance was done, by whom, where and when. The Maintenance Schedule and detailed instructions on the maintenance items are given on following page.

MAINTENANCE SCHEDULE

ITEM	AREA	PERIOD
A.	Compressed Air Leaks	As Detected
B.	Safety and Control Systems	As Detected
C.	Acoustic Materials	Daily
D.	Fasteners	100 hours
E.	Enclosure Panels	100 hours
F.	Air Intake & Engine Exhaust	100 hours
G.	Cooling Systems	250 hours
H.	Isolation Mounts	250 hours
I.	Engine Operation	See Operator's Manual
J.	Fuels & Lubricants	See Operator's Manual

A. Compressed Air Leaks

Correct all compressed air leaks during the first shutdown period after discovery. If severe enough to cause serious noise problems and efficiency loss, shut down immediately and correct the leak(s).

B. Safety and Control Systems

Repair or replace all safety and control systems or circuits as malfunction occurs. No compressor should be operated with either system bypassed, disabled, or nonfunctional.

C. Acoustic Materials

In daily inspections, observe these materials. Maintain all acoustic material as nearly as possible in its original condition. Repair or replace all sections that have: 1) sustained damage, 2) have partially separated from panels to which they were attached, 3) are missing, or have otherwise deteriorated due to severe operating or storage conditions.

D. Fasteners

All fasteners such as hinges, nuts, bolts, clamps, screws, rivets, and latches should be inspected for looseness after each 100 hours of operation. They should be retightened, repaired, or if missing, replaced immediately to prevent subsequent damage and noise emission increase.

E. Enclosure Panels

Enclosure panels should also be inspected at 100 hour operational intervals. All panels that are warped, punctured, torn, or otherwise deformed, such that their noise containment function is reduced, should be repaired or replaced before the next operation interval. Doors, access panels, and hatch closures especially, should be checked and adjusted at this time to insure continuous seating between gasket or acoustic material and the mating frame.

F. Air Intake and Engine Exhaust

Engine and compressor air intake and engine exhaust systems should be inspected after each 100 hours of operation for loose, damaged, or deteriorated components. Repairs or replacements should be made before the next period of use.

G. Cooling Systems

All components of the cooling system for engine water and compressor oil should be inspected every 250 hours of use. Any discrepancies found should be corrected before placing the unit back in operation. Unrestricted airflow over the radiator and oil cooler must be maintained at all times during operation.

H. Isolation Mounts

Engine/airend isolation mounts should be inspected after each 250 hours of operation. Those mounts with cracks or splits in the molded rubber, or with bent or broken bolts due to operation or storage in severe environments, all should be replaced with equivalent parts.

I. Engine Operation

Inspect and maintain engine condition and operation as recommended in the manuals supplied by the engine manufacturer.

J. Fuels and Lubricants

Use only the types and grades of fuels and lubricants recommended in the Ingersoll-Rand Company and Engine Manufacturer's Operator and Maintenance Manuals.

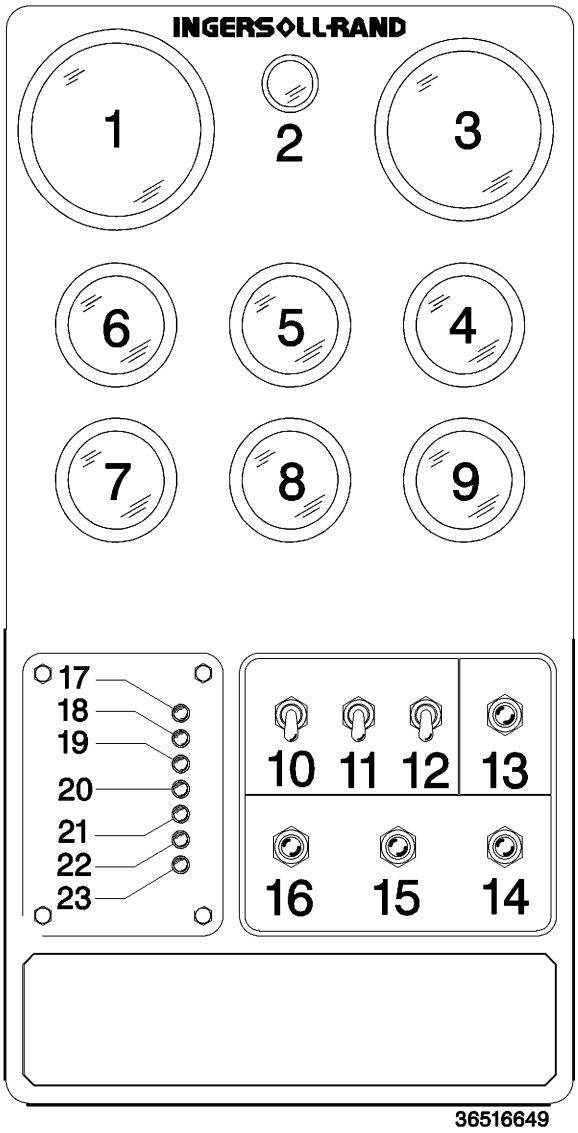
MAINTENANCE RECORD FOR NOISE EMISSION CONTROL AND EXTENDED WARRANTY					
ITEM NO.	DESCRIPTION OF WORK	HOURMETER READING	MAINT/ INSPECT DATE	LOCATION CITY/ STATE	WORK DONE BY (NAME)

SECTION 4 - GENERAL DATA

Model		1070
Rated Delivery: cfm (litres/sec)		1070 (505)
Rated Pressure: psi (kPa)		350 (2400)
Engine (Diesel) - Caterpillar		**3406**
Full Load Speed - rpm		1800
No Load Speed - rpm		1200
Electrical System - VDC		24
Fluid Capacities - U.S. Gallons (litres)		
Compressor Lubricant: Initial (dry) fill		55 (208)
Service refill		44 (167)
Engine Crankcase Lubricant		9.0 (34.1)
Engine Coolant (Radiator)		16.5 (62.5)
Fuel Tank (Clean DIESEL fuel)		180 (680)
Notice: Above 15°F (-9°C) use No.2 Diesel Fuel with sulfur content not greater than 0.5% and minimum cetane number of 42.		
Ambient Temperature Operating Range		-10° to117°F (-23°C to 47°C)
UNITS MEASUREMENTS/WEIGHTS	**Low Speed**	**High Speed**
Overall Length (drawbar up) feet (meters)	17.0 (5.18)	22.83 (6.96)
Overall Height feet (meters)	8.46 (2.58)	8.53 (2.60)
Overall Width feet (meters)	7.38 (2.25)	7.38 (2.25)
GrossnWeight (all fluids) pounds (kg)	15,200 (6,900)	16,600 (7,523)
RUNNING GEAR	**Low Speed**	**High Speed**
Tire Size/Load Range	8.25 x 15TR	215-75R 17.5
Load Range	"F"	"H"
Inflation Pressure (Cold) - psi (kPa)	105 (720)	125 (857)
Towing Speed (Maximum) mph (km/hr)	20 (32)	50 (80)

CAUTION: Any departure from the specifications may make this equipment unsafe.

SECTION 5 - OPERATING INSTRUCTIONS



1. Compressor Disch. Pressure Gauge - Indicates pressure in receiver tank, normally from 0 psi (kPa) to the rated pressure of the machine.

2. Lamp - Controlled by Switch 11.

3. Engine Tachometer - Indicates engine speed in RPM from 0 when stopped to full speed.

4. Discharge Air Temperature Gauge - Indicates in °F and °C. Normal operating range:185°F/85°C to 230 °F/110 °C.

5. Fuel Level Gauge - Indicates amount of fuel in tanks.

6. Engine Oil Pressure Gauge - Normal range is 45 to 70psi (310-480kPa) at 1800rpm with SAE 30 oil.

7. Hourmeter - Records running time for maintenance purposes.

8. Voltmeter - Indicates battery condition.

9. Engine Water Temperature Gauge - Indicates coolant temperature, with normal operating range from 180°F(82°C) to 210°F(99°C).

CONTROLS

10. Power Switch - Flip "On" to operate, "Off" to stop.

11. Lights Switch - Operates Lamp 2 and those within gauges.

12. Heaters Switch - Activates control system heaters for operation below 32°F(0°C).

13. Service Air Button - After warm up, provides full air pressure at the service outlet.

14. Bypass Button - Bypasses automatic shutdown circuit.

15. Start Button - Activates the engine starter.

16. Ether Inject Button - Injects a measured shot. USE SPARINGLY.

DIAGNOSTICS / AUTOMATIC SHUTDOWN

17. High Compressor Temperature - 248°F(120°C) or more.

18. Low Engine Oil Pressure - 12 psi (80kPa) or less.

19. High Engine Temperature - Coolant above 220°F (104°C).

19.

20. Low Fuel Level - Comes on first as a warning and eventually triggers a shutdown.

21. Alternator Not Charging - Needs attention.

22. Low Coolant Level - Dangerously low; needs attention.

23. Air Filters Restricted - Need servicing.

WARNING

Do not climb on top of unit. The lifting eye can be reached through the roof door ONLY from INSIDE of the unit.

BEFORE TOWING

- When lifting or lowering drawbar, always grasp drawbar firmly and stand to one side.

- Ensure that the tires, wheels and running gear are in good condition and secure.

Units equipped with electric brakes:

Start by making sure the trailer brakes are properly adjusted (see adjustment procedure). Vehicles towing units with electric brakes should be equipped with the Ingersoll-Rand Electric Brake Kit P/N 36088799. If tow vehicle is already equipped with an electric brake controller, check operation of the brakes before towing. Attach brake breakaway cable to hitch on towing vehicle.

TOWING

- Do not tow this unit in excess of 20mph (32km/hr).

- Use a tow vehicle whose towing capacity is greater than the gross weight of this unit.

SETTING - UP (ALL UNITS)

- Place the unit in an open, well-ventilated area. Position as level as possible. The design of these units permits a 15 degree sidewise limit on out-of-level operation.

- When the unit is to be operated out-of-level it is important: (1) to keep the engine crankcase oil level near the high level mark (with the unit level), and (2) to have the compressor oil level gauge show no more than mid-scale (with the unit running at full load). Do not overfill either the engine crankcase or the compressor lubricating oil system. Chock wheels or otherwise refrain from moving.

Do not connect the air discharge on this unit onto a common header with any other unit of any description, or any other source of compressed air, without first making sure a check-valve is used between the header and the unit. If this unit is connected in parallel with another unit of higher discharge pressure and capacity, a safety hazard could occur in a back-flow condition.

WARNING

Unrestricted air flow from a hose will result in a whipping motion of the hose which can cause serious injury or death. A safety device must be attached to the hose at the source of supply to reduce pressure in case of hose failure or other sudden pressure release. Reference: OSHA regulation 29 CFR Section 1926.302 (b).

BEFORE STARTING -

- Open service valve(s) to ensure pressure is relieved in receiver-separator system. Close valve (s) in order to build up full air pressure and ensure proper oil circulation.

- Check battery for proper connections and condition.

WARNING

COMBUSTIBLE GAS CAN CAUSE SEVERE BURNS, BLINDNESS OR DEATH. KEEP SPARKS AND OPEN FLAME AWAY FROM BATTERY.

- Check the compressor lubricating oil level. The proper oil level is mid-way on the sight gauge. Add oil if the level falls to the bottom of the sight gauge when the unit is running at full load. Do not overfill. If necessary, see Lubrication section for recommended lubricant.

- To jump-start, connect the positive booster/charger cable to the 24VDC positive (+) terminal of the battery. Then connect the negative booster/charger cable to the engine block...Not to the negative (-) terminal of the weak battery. After starting, disconnect the negative (-) cable from engine block; then from the booster battery/charger. Disconnect positive (+) cable from both batteries.

WARNING

Do not remove the cap from a HOT engine radiator. The sudden release of pressure from a heated cooling system can result in a loss of coolant and possible severe personal injury.

WARNING

Hot pressurized fluid can cause serious burns. Do not open radiator while hot.

• Check engine coolant level by removing the radiator top cap and looking for coolant in the filler neck of the radiator. Add coolant as required. Insure that radiator cap is installed properly and tightened. Note: this machine will not allow engine starting if engine coolant is low.

NOTICE: If the appropriate mixture of antifreeze is not used during freezing temperatures, failure to drain the engine may cause costly engine damage. Never use water only as corrosion inhibitors are required in engine coolant fluid.

CAUTION

No smoking, sparks, or open flame near fuel.

• Check the fuel level. Add only CLEAN DIESEL fuel for maximum service from the engine. Refer to the Engine Operator's Manual for fuel specifications.

NOTICE

To minimize condensation (water) in the fuel tank, it is recommended to fill the tank at the end of each day.

WARNING

This machine produces loud noise with doors open. Extended exposure to loud noise can cause hearing loss. Wear hearing protection when doors or valve(s) are open.

• Close the side doors to maintain a cooling air path and to avoid recirculation of hot air. This will maximize the life of the engine and compressor and protect the hearing of surrounding personnel.

• Make sure no one is IN or ON the compressor unit.

STARTING -

• Flip the POWER switch to "ON". All diagnostics lamps will light (glow) for two (2) seconds. Then all lamps should go off except for ALTERNATOR NOT CHARGING and LOW ENGINE OIL PRESSURE.

• In freezing weather (below 32°F / 0°C), flip HEATERS switch "On" and wait sixty (60) seconds. This applies heat to the control system components for easier starting. Leave this switch "On" while operating at these temperatures.

• Press and hold the BYPASS button for ten (10) to fifteen (15) seconds. This operates the 24 volt compressor which pressurizes the inlet valve air cylinder and holds the inlet valve closed for easier starting.

• Press both the START and the BYPASS buttons to crank the engine. DO NOT OPERATE THE STARTER MOTOR FOR MORE THAN TEN (10) SECONDS WITHOUT ALLOWING AT LEAST ONE MINUTE COOLING TIME BETWEEN START ATTEMPTS.

CAUTION

Ether is an extremely volatile, high flammable gas. Use Sparingly! If too much is injected, the uncontrolled explosion may result in costly damage to the engine.

• In cold weather, as required, press the ETHER INJECT button once or twice only while the engine is cranking. This injects a measured amount of ETHER to the engine.

• Release the START button when the engine starts and sustains running. If the engine does not start after a couple of attempts, refer to section 7 - Trouble Shooting.

• Release BYPASS button when the engine speed reaches 1000 rpm. The engine oil pressure should be above 20 psi.

• If the engine oil pressure does not rise within five (5) seconds, stop the unit and refer to Engine Operator's Manual.

WARNING

All DIAGNOSTIC lamps should be off. If not, stop the machine and investigate.

- Observe the gauges while the unit warms up for five (5) to ten (10) minutes or until the coolant temperature reaches 140° F (60° C).

- Push the SERVICE AIR button. The engine should go to full speed and the discharge pressure rise to slightly over rated pressure. If there is no air being consumed, the compressor will unload (intake should be throttled or closed) and the engine speed drop to the no load speed.

- Compressor is now ready to furnish air when the service valve is opened.

STOPPING

- Close air service valve(s).

- Allow the unit to run at "no load" for 3 to 5 minutes to reduce the engine temperatures

- Flip <u>all</u> toggle switches to "Off".

NOTICE

Once the engine stops, the automatic blowdown valve will begin to relieve all pressure from the receiver-separator system.

CAUTION

Never allow the unit to sit stopped with pressure in the receiver-separator system. As a precaution, open the service valve.

WARNING

Even after pressure is relieved from the receiver-separator system, any air supply line from the compressor to a tool or machine could remain under pressure and cause very serious personal injury or death. After the compressor stops, carefully open a valve at any tool or machine to exhaust the pressure in any line prior to removal or servicing.

NOTICE

Do NOT wire around or bypass a shutdown sensor or switch.

All units in this family of machines are protected by five (5) sensors or switches at the following locations:

(1) High engine COOLANT temperature in the engine.

(2) Low engine oil pressure, in the engine.

(3) Low Fuel Level. The light on the control panel will come on as a warning.

High Discharge AIR Temperature

(4) At the airend outlet.

(5) In the safety valve Tee.

UNITS RATED BELOW 200 PSI (1400 kPa)

These units include an additional low oil pressure switch in the supply line to the airend bearings.

AUTOMATIC SHUTDOWN/DIAGNOSTICS

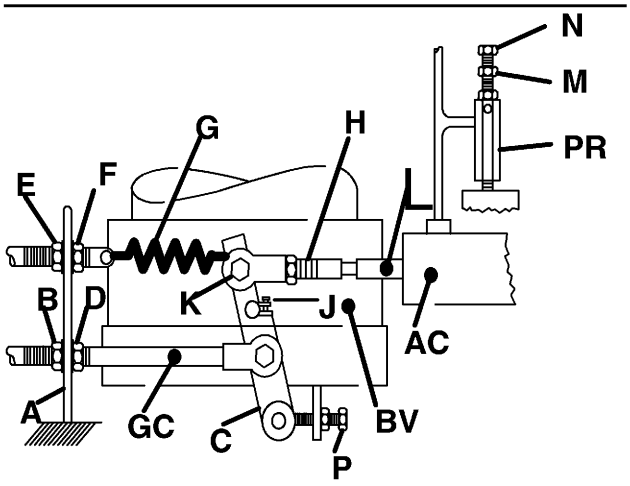
Should any of these problem situations occur, the unit will automatically shutdown and stop. BEFORE restarting the unit or flipping the POWER switch to "Off", check the DIAGNOSTICS area on the instrument panel.

The upper four (4) lamps are electronically "latched" to only respond to the first or primary signal for a shutdown. In other words, if the automatic shutdown is the result of one of these four problems, only that particular problem lamp will be lit. And the lamp will remain lit as long as the batteries provide power.

Refer to OPERATING CONTROLS AND INSTRUMENTS for the various problem signal criteria (°F, psi, etc.). The indicated problem area should be inspected for a physical cause (low fluid, broken fan belt, evidence of excessive heat, etc.) and corrections made.

Sensors (1) through (3), Switches (4) and (5) and additional low oil pressure switch (mentioned above) will automatically reset when the problem condition is corrected.

SPEED AND PRESSURE REGULATION



ADJUSTMENT INSTRUCTIONS

The operating pressure of this unit was set at the factory to the maximum rating (at full speed). See General Data. However, this pressure may be reset down to 150 psi (1050 kPa).

Normally, regulation requires no adjusting; but if proper adjustment is lost, proceed as follows:

Before Starting Unit –

1. **WITH UNIT STOPPED**, disconnect rod end bearing on governor cable (GC) at engine governor lever.
2. At bracket (A) near butterfly valve (BV) run nut (B) back on governor cable housing. Push governor cable housing toward lever (C). Tighten nut (D).
3. Loosen screw (J) on lever (C).
4. Loosen nut (E) to relax spring (G)
5. Loosen nut (H). Turn rod (L) in Air Cylinder (AC) until approximately 3/4 inch (20 mm) between nut (H) and flats on rod (L).
6. With locking pliers, clamp onto butterfly valve shaft and rotate and hold it so butterfly valve is fully shut. Place a wrench on lever screw (K) and rotate butterfly valve lever (C) so air cylinder rod (L) fully bottoms out in air cylinder. While holding the butterfly valve closed AND holding air cylinder shaft fully in, tighten lever screw (J). Then release hold on butterfly valve shaft and lever.
7. Turn rod (L) One and one-half rounds out of rod end bearing. Tighten nut (H). Rotate butterfly shaft/lever (C), open and close, several times to assure that linkage is not binding.
8. With engine governor lever in full speed position, reconnect rod end bearing.
9. Take slack out of spring (G) by moving nuts (E) and (F). Tighten nuts.

Adjust spring so it is full stretched, and nut (F) is at far end of rod, closest to spring (G). Tighten nuts.

10. Start unit and allow to warm up for 3 to 5 minutes.
11. Push "Service Air" button on control panel.
12. With service air valve closed, adjust pressure regulator (PR) to rated pressure (*) plus 30 psi (70 kPa) as follows:

13. Loosen locknut (M) counterclockwise;. Turn adjustment cap (N) clockwise to increase pressure, counterclockwise to decrease pressure.

14. Set idle speed (*) by adjusting position of rod end bearing on governor cable at engine. Tighten lock nut.

15. If pressure at unload is unsteady, loosen locknut (H) and rotate rod (L) out of rod end bearing one quarter turn at a time until steady. tighten locknut (H).

16. Open service air valve and observe full load engine speed (*). Adjust regulator to give rated operating pressure (*). Tighten locknut (M).

17. Close and slowly open service air valve. If engine speed surges, increase tension on spring (G) by moving nuts (E) and (F). ***XHP900 Units ONLY:*** *Should not be adjusted by moving nuts (E) and (F). See Step 7.* If set speeds are not correct, repeat steps 14 and15 as required.

18. To regulate to any pressure between 150 psi (1050 kPa) and maximum rating (*), make adjustments at the pressure regulator.

SECTION 6 - MAINTENANCE

GENERAL

In addition to periodic inspections, many of the components in these units require periodic servicing to provide maximum output and performance. Servicing may consist of pre-operation and post-operation procedures to be performed by the operating or maintenance personnel. The primary function of preventive maintenance is to prevent failure, and consequently, the need for repair. Preventive maintenance is the easiest and the least expensive type of maintenance. Maintaining your unit and keeping it clean at all times will facilitate servicing.

Correct engine speed is critical to the operation of this machine. Check the idle and full load rpm every three months and adjust in accordance with the speed and pressure adjustment instructions in this manual and included on a decal on the machine. Correct speeds are on the general data decal.

SCHEDULED MAINTENANCE

The maintenance schedule is based on normal operation of the unit. This page can be reproduced and used as a checklist by the service personnel. In the event unusual environmental operating conditions exist, the schedule should be adjusted accordingly.

COMPRESSOR OIL LEVEL

The oil level is most consistent when the unit is RUNNING AT FULL LOAD and should be checked at this time. The optimum operating level is midway of the sight tube on the side of the receiver tank. See the decal beside the sight tube. If the oil level is not in the "OK" range, make appropriate corrections (Add or Drain). A totally filled sight tube in which the level is not visible indicates an over-full condition and requires that oil be drained.

COMPRESSOR OIL

This machine was factory filled with Ingersoll-Rand ProTec® Compressor Fluid (Ingersoll-Rand XHP505 for XHP900 models).

By continued use of Ingersoll-Rand compressor fluids and filters, optional warranty will be extended for the base airend (rotors, housings, gears and bearings) when substantiated with proof of conformance to recommended maintenance intervals and purchase of OEM Ingersoll-Rand filters and fluids.

Optional Warranty - The earlier of 60 months from shipment to, or the accumulation of 10,000 hours of service by the initial user. The optional warranty is limited to defects in major components (rotors, housings and bearings), and is automatically available to the original user when he meets the following three conditions:

1.

2. Submissions of proof that Ingersoll-Rand fluid, filters and separators have been used. Refer to the Operation and Parts manual for the correct fluids, filters and separator elements required.

3. Submission of proof that maintenance intervals have been followed.

WARRANTY	TIME	*BARE AIREND	**AIREND COMPONENTS
STANDARD	2 yrs/4000 hrs	100% parts and labor	100% parts and labor
OPTIONAL	5 yrs/10,000 hrs	100% parts and labor	0%

* Bare Airend - Pertains to major airend parts (rotors, housings, and bearings).

** Airend Components - Pertains to auxiliary attachments to the bare airend (drive coupling, seals, pumps, valves, tubes, hoses, fittings and filter housing).

The compressor oil must be replaced every 500 hours of operation or six (6) months, whichever comes first for models HP600 - P1600.

Refer to the fluids and lubricants chart for ambient temperature ranges and specifications, in the lubrication section of this manual.

The compressor oil must be replaced every 500 hours of operation or six (6) months, whichever comes first for models P100-P600. The compressor oil must be replaced every 1000 hours of operation or six (6) months, whichever comes first for models HP600-P1600.

Refer to the fluids and lubricants chart for ambient temperature ranges and specifications in the lubrication section of this manual.

AIR CLEANER

This unit is equipped with an AIR FILTERS RESTRICTED lamp on the instrument panel, covering both the engine and the compressor.

This should be checked daily during operation. If the lamp glows (red) with the unit operating at full speed, servicing of the cleaner element is necessary.

Also weekly squeeze the rubber valve (precleaner dirt dump) on each air cleaner housing to ensure that they are not clogged. NOTICE: Holes or cracks downstream of the air cleaner housing will cause the restriction indicators to be ineffective.

The air filters restricted sensor will automatically reset after the main power switch is flipped to "OFF."

To service the air cleaners on all units proceed as follows:

1. Loosen outer wing nut and remove with outer element. Inspect red window on special inner wing nut to find small dot. If dot is not visible, remove cotter pin and special wing nut and inner (safety) element.
2. Inspect air cleaner housing for any condition that might cause a leak and correct as necessary.
3. Wipe inside of air cleaner housing with a clean, damp cloth to remove any dirt accumulation, especially in the area where the element seals against the housing.
4. Inspect the primary element by placing a bright light inside and rotating slowly. If any holes or tears are found in the paper, discard this element. If no ruptures are found, the element can be cleaned by one of the following procedures.
5. If a new air filter element is to be used check it closely for shipping damage. To reset the signal indicator in the special wing nut, apply suction to the red window.
6. Install cleaned or new elements in the reverse order to the above. Tighten wing nuts firmly and replace cotter pin.
7. Inspect to ensure that the end cap seals tightly 360 degrees around the air cleaner body.

In the event the element is contaminated with dry dirt, oil or greasy dirt deposits,and a new element is not available, cleaning can be accomplished by washing, using the air cleaner element manufacturer's recommendations.

NOTICE

To prevent damage to the element, never exceed a maximum air pressure of 100 psi (700 kPa).

NOTICE

It is highly recommended that new replacement elements be installed in the unit immediately in order that the unit be returned to service in the shortest possible time. In this manner, the elements just removed for cleaning can be washed and stored as future replacement elements.

In addition, the air cleaner system (housing and piping) should be inspected every month for any leakage paths or inlet obstructions. Make sure the air cleaner mounting bolts and clamps are tight. Check the air cleaner housing for dents or damage which could lead to a leak. Inspect the air transfer tubing from the air cleaner to the compressor and the engine for holes. Make sure that all clamps and flange joints are tight.

GAUGES

The instruments or gauges are essential for safety, maximum productivity and long service life of the machine. Inspect the gauges and test any diagnostic lamps prior to start-up. During operation observe the gauges and any lamps for proper functioning. Refer to Operating Controls for the normal readings.

FUEL TANK

This unit is equipped with dual tanks that can be filled from either side. Using clean fuel in the fuel tanks is vitally important and every precaution should be taken to ensure that only clean fuel is either poured or pumped into the tank. When filling the fuel tank on this unit, by methods other than a pump and hose, use a CLEAN non-metallic funnel.

Every six months the drain plugs should be removed from the tanks so that any sediment or accumulated condensate may be drained. When replacing the drain plugs, make sure they are tightened securely.

BATTERY

Heavy-duty, diesel cranking type batteries were installed at the factory and these should be inspected weekly. Keep the battery posts-to-cable connections clean, tight and lightly coated with a grease. Also the electrolyte level in each cell should cover the top of the plates. If necessary, top-up with clean distilled water.

TIRES

A weekly inspection is recommended. The proper inflation pressure for the tires is listed on General Data. Tires that have cuts or cracks or little tread should be repaired or replaced. Monthly check the wheel lug nuts for tightness.

AUTOMATIC SHUTDOWN SYSTEM

The discharge air temperature switches will require approximately 248°F (120°C) to actuate. The engine coolant temperature switch will require approximately 220° F (104°C) to actuate. Replace any defective switch before continuing to operate the unit.

A low oil pressure switch may be tested by removing it and connecting it to a source of controlled pressure while monitoring an ohmmeter connected to the switch terminals. As pressure is applied slowly from the controlled source, the switch should close at 12 psi (0.84 kgf per cm^2) and show continuity through the contacts. As the pressure is slowly decreased to 8 psi (0.56 kgf per cm^2) the contacts should open and the ohmmeter should show lack of continuity (infinite ohms) through the contacts. Replace a defective switch before continuing to operate the unit.

COMPRESSOR OIL COOLER

The compressor lubricating and cooling oil is cooled by means of the fin and tube-type oil cooler, located beside the radiator. The lubricating and cooling oil, flowing internally through the core section, is cooled by the air stream from the cooling fan flowing past the core section. When grease, oil and dirt accumulate on the exterior surfaces of the oil cooler, its efficiency is impaired.

Each month it is recommended that the oil cooler be cleaned by directing compressed air which contains a nonflammable safety solvent through the core of the oil cooler. This should remove the accumulation of grease, oil and dirt from the exterior surfaces of the oil cooler core so that the entire cooling area can transmit the heat of the lubricating and cooling oil to the air stream.

In the event foreign deposits, such as sludge and lacquer, accumulate in the oil cooler to the extent that its cooling efficiency is impaired, a resulting high discharge air temperature is likely to occur, causing shut down of the unit.

To correct this situation it will be necessary to clean it using a cleaning compound in accordance with the manufacturer's recommendations. Use only a dependable cleaning compound. This is of prime importance because different cleaners vary in concentration and chemical composition. After completing the cleaning procedure, the oil cooler must be flushed before returning to service.

RADIATOR

WARNING

Do not remove the cap from a HOT engine radiator. The sudden release of pressure from a heated cooling system can result in serious personal injury.

The engine cooling system is filled at the factory with a 50/50 mixture of water and ethylene glycol. This permanent type antifreeze contains rust inhibitors and provides protection to -35° F (-37°C).

The use of such a mixture is recommended for both summer and winter operation. When using water alone, be sure to add a reputable brand of rust inhibitor to prevent internal corrosion.

It is recommended to test the freezing protection of the coolant every six months or prior to freezing temperatures. Replenish with a fresh mixture every twelve months. A drain for the system is located in the bottom radiator tank. An alternate method would be to disconnect a bottom radiator hose.

Each month, inspect the radiator exterior for obstructions (dirt, bugs, etc.). If present, blow water or compressed air containing a nonflammable solvent between the fins in a direction opposite the normal air flow. Should the radiator be clogged internally, standard automotive practices should be followed.

HOSES

Each month it is recommended that all of the intake lines to and from the air cleaners, the engine cooling system hoses and all of the flexible hoses used for air, oil, and fuel be inspected.

To ensure freedom from air leaks, all rubber hose joints and the screw-type hose clamps must be absolutely tight. Regular inspection of these connections for wear or deterioration is a definite "must" if regulator servicing of the air cleaners is not to prove futile.

Premature wear of both the engine and compressor is ASSURED whenever dust-laden air is permitted to enter the engine's combustion chamber or the compressor intake practically unfiltered.

The flexible hoses used in the fuel, oil and air lines on these units are primarily used for their ability to accommodate relative movement between components. It is extremely important they be periodically inspected for wear and deterioration. Clamps are used to prevent hose cover abrasion through vibration. This abrasion may occur when two hose lines cross, or when a hose line rubs against a fixed point; therefore, it is necessary that all clamps be replaced if missing. It is also important the operator does not use the hoses as convenient hand hold or steps. Such use can cause early cover wear and hose failure.

NOTICE

Piping systems operating at less than 150 psi (1050 kPa) may use a special nylon tubing. The associated fittings are also of a special "push-in" design. If so, features are as follows:

Pulling on the tubing will cause the inner sleeve to withdraw and compress, thus tightening the connection. The tubing can be withdrawn only while holding the sleeve against the fitting. The tubing can be removed and replaced numerous times without losing its sealing ability.

To install the nylon tubing, make a mark (with tape or grease pencil) approximately 7/8 inch from the end of the tubing. Insert the tubing into the sleeve and "push-in" past the first resistance to the bottom. The mark should be approximately 1/16 inch from the sleeve, for the 3/8 inch O.D. tubing; 1/8 inch for the 0.25 inch O.D. tubing. This will ensure that the tubing is fully engaged in the sealing mechanism.

COMPRESSOR OIL FILTERS

The compressor lubrication and cooling oil system includes dual spin-on, throw away type oil filters, each with an internal bypass valve. With a clean, new filter element, all of the oil flows through the full element area, from the outside/inside. As each element becomes contaminated with dirt, a pressure differential is created in the filter housing between the oil inlet and outlet ports. As this differential approaches 25 psi (175 kPa), the bypass valve starts to open, thus permitting a small quantity of oil to bypass the filter. As the contaminants continue to build up, more and more of the oil bypasses the filter media itself.

This bypass does not provide any filtration but does allow a maximum flow of compressor lubricating and cooling oil to preclude any possible damage from loss of oil. Also the design of the filter prevents any washing-off of any dirt during oil bypassing.

NOTICE

The oil filter must be replaced every 500 hours of operation. On new or overhauled units, replace the element after the first 50 and 150 hours of operation; thereafter, service the oil filter every 500 hours.

To service the oil filters it will first be necessary to shut the unit down. Wipe off any external dirt and oil from the exterior of the filter to minimize any contamination from entering the lubrication system. Proceed as follows:

WARNING

High pressure air can cause severe injury or death from hot oil and flying parts. Always relieve pressure before removing caps, plugs, covers or other parts from pressurized air system.

1. Open the service air valve(s) to ensure that system is relieved of all pressure. Close the valve(s).

2. Turn the spin-on filter element counterclockwise to remove it from the filter housing. Inspect the filter element and then discard.

Note: If there is any indication of formation of varnishes, shellacs or lacquers on the oil filter element, it is a warning the compressor lubricating oil has improper characteristics and should be immediately changed.

3. Inspect the oil filter head to be sure the gasket was removed with the oil filter element. Clean the gasket seal area on the oil filter head.

Installing a new oil filter element when the old gasket remains on the oil filter head will cause an oil leak and can cause property damage.

4. Lubricate the new filter gasket with the same oil being used in the machine.

5. Install new filter by turning element clockwise until gasket makes initial contact. Tighten an additional 1/2 to 3/4 turn.

6. Start unit and allow to build up to rated pressure. Check for leaks before placing unit back into service.

FASTENERS

Visually check entire unit in regard to bolts, nuts and screws being properly secured. Spot check several capscrews and nuts for proper torque. If any are found loose, a more thorough inspection must be made. Take corrective action.

COMPRESSOR OIL

The lubricating and cooling oil must be replaced every 1000 hours of operation or six (6) months, whichever comes first.

RUNNING GEAR

Every month or 500 miles, tighten the wheel lug nuts to 85 - 95 lbs.-ft. Every six months the wheel bearings, grease seals and axle spindles should be inspected for damage (corrosion, etc.) or excessive wear. Replace any damaged or worn parts. Repack wheel bearings. Use a wheel bearing grease conforming to specification MIL-G-10924 and suitable for all ambient temperatures.

Grease can be replaced in a wheel bearing using a special fixture or by hand as follows.

Place a spoonful of grease in the palm of one hand and take the bearing in the other hand. Push a segment of the wider end of the bearing down into the outer edge of the grease pile closest to the thumb. Keep lifting and pushing the bearing down into the edge of the grease pile until grease oozes out both from the top and from between the rollers. Then rotate the bearing to repeat this operation on the next segment. Keep doing this until you have the entire bearing completely filled with grease.

Before installing bearing, place a light coat of grease on the bearing cups which are pressed in the hub.

NOTICE

Excessive grease in the hub or grease cap serves no purpose due to the fact that there is no way to force the grease into the bearing. The manufacturer's standard procedure is to thoroughly pack the inner and outer bearing with grease and then to apply only a very small amount of grease into the grease cap.

If bearing adjustment is required or the hub has been removed for any reason, the following procedure must be followed to ensure a correct bearing adjustment of 0.001 to 0.012 free play.

1. While rotating hub slowly to seat the bearings, tighten spindle nut to approximately 15 lbs.-ft. Grasp the tire at the top and bottom and rock, in and out. There should be no evidence of looseness (free play) at the bearing.

2. Loosen nut to remove preload torque. Do not rotate hub.

3. Finger tighten nut until just snug. Loosen nut until the first nut castellation lines up with cotter pin hole in spindle. Insert cotter pin.

4. Ensure a definite but minimal amount of free play by rocking the tire.

5. Bend over cotter pin legs to secure nut and clear grease cap.

6. Nut should be free to move with only restraint being the cotter pin.

RECEIVER-SEPARATOR SYSTEMS

WARNING

High pressure air can cause serious injury or death from hot oil and flying parts. Always relieve pressure before removing caps, plugs, covers or other parts from pressurized air system.

*** Open service valve at end of machine.**

*** Ensure pressure is relieved, with BOTH:**
- Discharge air pressure gauge reads zero (0).
- No air discharging from service valve.

* When draining oil, remove and replace (make tight) plug at bottom of separator tank.

* When adding oil, remove and replace (make tight) plug on side of separator tank.

In the compressor lubricating and cooling system, separation of the oil from the compressed air takes place in the receiver-separator tank. As the compressed air enters the tank, the change in velocity and direction drop out most of the oil from the air.

Additional separation takes place in the oil separator element which is located in the top of the tank.

Any oil accumulation in this separator element is continuously drained off by means of a scavenge tube which returns the accumulated oil to the system.

SCAVENGE LINE

WARNING

High pressure air can cause serious injury or death from hot oil and flying parts. Always relieve pressure before removing caps, plugs, covers or other parts from pressurized air system.

The scavenge line originates at the receiver-separator tank cover and terminates at the compressor airend through an orifice. Once a year or every 2000 hours of operation, whichever comes first, remove this line and any orifice, thoroughly clean, then reassemble.

NOTICE

Excessive oil carry-over may be caused by an oil-logged separator element. Do not replace element without first performing the following maintenance procedure:

1. Check oil level. Maintain as indicated earlier in this section.
2. Thoroughly clean scavenge line, any orifice and check valve.
3. Assure minimum pressure valve (if so equipped) has proper setting.
4. Run unit at rated operating pressure for 30 to 40 minutes to permit element to clear itself.

COOLING FAN DRIVE

The heat exchanger or cooling fan is driven by a multiple V-belt arrangement from the engine. Inspect the cooling fan belts weekly or at 50 hour intervals. These V-belts should be maintained at the proper tension. Fan belts that are too tight impose an undue load on the fan shaft bearings and shorten the life of the belts. Fan belts that are too loose allow slippage and lower the fan speed, cause excessive belt wear, and can lead to overheating of the cooling systems.

BRAKE SYSTEMS

This compressor may be equipped with mechanical parking brakes or electric brakes. The maintenance of these brake systems is required to ensure safe operation of this compressor.

Parking Brakes:

Every six months visually check the brake shoes for proper operation and deterioration. The common automotive standards and procedures would apply in replacing the brake shoes.

When replacing brake cables it is necessary to adjust the brake shoes before adjusting the parking brake system. To adjust the shoes, remove the rubber hole plug in the brake backing plate and rotate the star adjusting nut until you cannot rotate the wheel by hand. Then back off the adjustment ten to twelve (10-12) notches. Note: always rotate wheel in direction of forward travel only. Replace hole plug and proceed to next wheel and repeat procedure.

Adjust parking brakes after all brake shoes have been adjusted by:

1. Turning knob on brake lever until lever is perpendicular to bracket when in "OFF" position. Wheels should turn freely.

2. With lever in "OFF" position, adjust brake cables until each has approximately the same tension. Wheels should turn freely.

3. Move lever to "ON" position. Check each wheel to see that it will not rotate. If all wheels will rotate, adjust knob on lever until brakes are fully applied. If one or two wheels will still rotate, adjust the cables for those wheels and recheck.

4. After brakes are adjusted, move lever to "ON" position and apply grease to cable strands from conduit six inches toward lever. This is to prevent dirt from getting into the conduit.

NOTE: New cables will stretch and therefore should be readjusted after the first week of use.

Every six months, apply a multi-purpose grease to the fittings on the brake actuator.

Electric Brake Adjustment:

Brakes should be adjusted (1) after the first 200 miles of operation when the brake shoes and drums have "seated", (2) at 3000 mile intervals, (3) or as use and performance requires. The brakes should be adjusted in the following manner:

1. Jack up trailer and secure on adequate capacity jack stands. Check that the wheel and drum rotate freely.

2. Remove the adjusting hole cover from the adjusting slot on the bottom of the brake backing plate.

3. With a screwdriver or standard adjusting tool, rotate the starwheel of the adjuster assembly to expand the brake shoes. Adjust the brake shoes out until the pressure of the linings against the drum makes the wheel very difficult to turn.

4. Then rotate the starwheel in the opposite direction until the wheel turns freely with a slight lining drag.

5. Replace the adjusting hole cover and lower the wheel to the ground.

6. Repeat above procedures on all brakes.

OIL SEPARATOR ELEMENT

The life of the oil separator element is dependent upon the operating environment (soot, dust, etc.) and should be replaced every twelve months or 2000 hours. To replace the element proceed as follows:

* Ensure the tank pressure is zero.

* Disconnect the hose from the scavenge tube.

* Remove scavenge tube from tank cover.

* Disconnect service line from cover.

* Remove (16) cover mounting screws.

* Remove cover, element and inner shell.

* Remove any gasket material left on cover or tank.

* Install new gasket, inner shell and new element.

* Place a straightedge across top of element and measure from bottom of straightedge to bottom of element (See Fig. 4.1).

* Replace scavenge tube in cover (cover is still off of tank).

* Measure from bottom of cover to end of scavenge tube (See Fig. 4.2). Measurement should be from 1/8" to 1/4" less than the element measurement. If not, cut to size.

* Remove scavenge tube.

* Reposition cover (use care not to damage gaskets).

* Replace cover mounting screws: tighten in a crisscross pattern to 100 lbs.-ft.

* Reconnect service line. Replace scavenge tube. Reconnect hose.

* Close service valve. Start unit and look for leaks.

When replacing the element, the scavenge lines, orifice, filter, and check valve should be thoroughly cleaned and the oil changed.

Note: Do not remove staples from the element/gasket connection.

Figure No. 4.1 Element Measurement

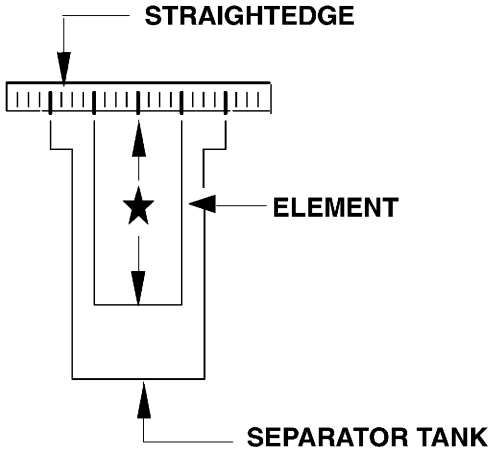
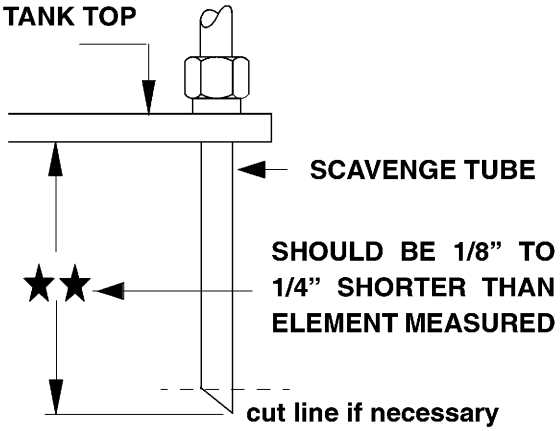


Figure No. 4.2 Tube Measurement



EXTERIOR FINISH CARE

This unit was painted and heat cured at the factory with a high quality, thermoset polyester powder coating. The following care will ensure the longest possible life from this finish.

1. **If necessary to remove dust, pollen, etc. from housing, wash with water and soap or dish washing liquid detergent. Do not scrub with a rough cloth, pad, etc.**
2. **If grease removal is needed, a fast evaporating alcohol or chlorinated solvent can be used. Note: This may cause some dulling of the paint finish.**
3. **If the paint has faded or chalked, the use of a commercial grade, non-abrasive car wax may partially restore the color and gloss.**

Field Repair of Texture Paint

1. **The sheet metal should be washed and clean of foreign material and then thoroughly dried.**
2. **Clean and remove all grease and wax from the area to be painted using Duponts 3900S Cleaner prior to sanding.**
3. **Use 320 grit sanding paper to repair any scratches or defects necessary.**
4. **Scuff sand the entire area to be painted with a red scotch brite pad.**
5. **Wipe the area clean using Duponts 3900S.**
6. **Blow and tack the area to be painted.**
7. **Apply a smooth coat of Duponts 1854S Tuffcoat Primer to all bare metal areas and allow to dry.**
8. **Apply 2 medium - wet coats of Duponts 222S Adhesion Promoter over the entire area to be painted, with a 5 minute flash in between coats.**
9. **To apply the texture coat, use Duponts 1854S Tuffcoat Primer. The proper technique to do this is to spray the Tuffcoat Primer using a pressure pot and use about 2-5 pounds of air pressure. This will allow the primer to splatter causing the textured look. Note: you must be careful not to put too much primer on at one time, this will effect the amount of texture that you are trying to achieve. Allow the texture coat to flash for 20 minutes or until dry to touch.**
10. **Apply any of Duponts Topcoat Finishes such as Imron™ or Centari™ according to the label instructions.**

Note: To re-topcoat the textured surfaces when sheet metal repairs are not necessary, follow steps 1, 2, 4, 5, 6, 8 and 10.

CAUTION

- Any unauthorized modification or failure to maintain this equipment may make it unsafe and out of factory warranty.

- If performing more than visual inspections, disconnect battery cables and open manual blowdown valve.

- Use extreme care to avoid contacting hot surfaces (engine exhaust manifold and piping, air receiver and air discharge piping, etc.).

- Never operate this machine with any guards removed.

- Inch and metric hardware was used in the design and assembly of this unit. Consult the parts manual for clarification of usage.

Notice: Disregard any maintenance pertaining to components not provided on your machine.

MAINTENANCE SCHEDULE

These time periods should be reduced if operating in extreme conditions (very hot, cold, dusty or wet).

	Daily	Weekly	Monthly	3 MOS .	6 MOS.	12 MOS.
LARGE UNITS				500 hours	1000 hours	2000 hours
**Hydraulic Oil Level		C			R	
Compressor Oil Level	C					
Engine Oil Level	C					
**Radiator Coolant Level	C					
Gauges/Lamps	C					
Air Cleaner Service Indicators	C					
Fuel Tank (fill at end of day)	C				DRAIN	
**Fuel/Water Separator DRAIN	C					
Air Cleaner Precleaner Dumps		C				
Fan/Alternator Belts		C				
Battery Connections/Electrolyte		C				
**Tire Pressure and Surface		C				
**Wheel Lug Nuts			C			
Hoses (oil, air, intake, etc.)			C			
Automatic Shutdown System Test			C			
Air Cleaner System Visual			C			
Compressor Oil Cooler Exterior			C	CLEAN		
**Engine Radiator Exterior			C	CLEAN		
Fasteners, Guards				C		
Air Cleaner Elements				WI		
** Fuel/Water Separator Element					R	
*Compressor Oil Filter Element					R	
*Compressor Oil					R	
**Wheels (bearings, seals, etc)					C	C
Engine Coolant Test					C	R
Shutdown Switch Settings Test						C
Scavenge Orifice & related parts						CLEAN
Oil Separator Element						R
**Lights (running, brake, & turn)	CBT					
**Pintle Eye Bolts	CBT					
Engine (oil changes, oil & fuel filters, etc)				R		

**Disregard if not appropriate for this particular machine.

R=replace, **C**=check (adjust if necessary), **WI**=OR when indicated, **CBT** = check before towing.

Refer to specific sections of the operator's manual for more information.

SECTION 7 - LUBRICATION

GENERAL INFORMATION

Lubrication is an essential part of preventive maintenance, affecting to a great extent the useful life of the unit. Different lubricants are needed and some components in the unit require more frequent lubrication than others. Therefore, it is important that the instructions regarding types of lubricants and the frequency of their application be explicitly followed. Periodic lubrication of the moving parts reduces to a minimum the possibility of mechanical failures.

The Preventive Maintenance Schedule shows those items requiring regular service and the interval in which they should be performed. A regular service program should be developed to include all items and fluids. These intervals are based on average operating conditions. In the event of extremely severe (hot, cold, dusty or wet) operating conditions, more frequent lubrication than specified may be necessary. Details concerning lubrication of the running gear are in Maintenance Section.

All filters and filter elements for air and compressor lubricant must be obtained through Ingersoll-Rand to assure the proper size and filtration for the compressor.

COMPRESSOR OIL CHANGE

These units are normally furnished with an initial supply of oil sufficient to allow operation of the unit for approximately 6 months or 1000 hours, whichever comes first. If a unit has been completely drained of all oil, it must be refilled with new oil before it is placed in operation. Refer to specifications in Lubrication Table.

NOTICE

Some oil types are incompatible when mixed and result in the formation of varnishes, shellacs, or lacquers which may be insoluble. Such deposits can cause serious troubles including clogging of the filters. Where possible, do NOT mix oils of different types and avoid mixing different brands. A type or brand change is best made at the time of a complete oil drain and refill.

If the unit has been operated for the time/ hours mentioned above, it should be completely drained of oil. If the unit has been operated under adverse conditions, or after long periods in storage, an earlier change period may be necessary as oil deteriorates with time as well as by operating conditions.

WARNING

High pressure air can cause severe injury or death from hot oil and flying parts. Always relieve pressure before removing caps, plugs, covers or other parts from pressurized air system. Ensure the following conditions are met:

- Discharge air pressure gauge reads zero (0).
- No air discharging from an "open" manual blowdown valve.

An oil change is good insurance against the accumulation of dirt, sludge, or oxidized oil products.

Completely drain the receiver- separator, piping, and oil cooler. If the oil is drained immediately after the unit has been run for some time, most of the sediment will be in suspension and, therefore, will drain more readily. However, the fluid will be hot and care must be taken to avoid contact with the skin or eyes.

After the unit has been completely drained of all old oil, close the drain valve. Add oil in the specified quantity at the filler plug. Tighten the filler plug and run the machine to circulate the oil. Check the oil level WHEN RUNNING AT FULL LOAD. If not near the middle of the sight tube, stop the unit and make corrections. DO NOT OVERFILL.

NOTICE

Ingersoll-Rand provides compressor oil specifically formulated for Portable Compressors and requires the use of these fluids in order to obtain extended limited airend warranty.

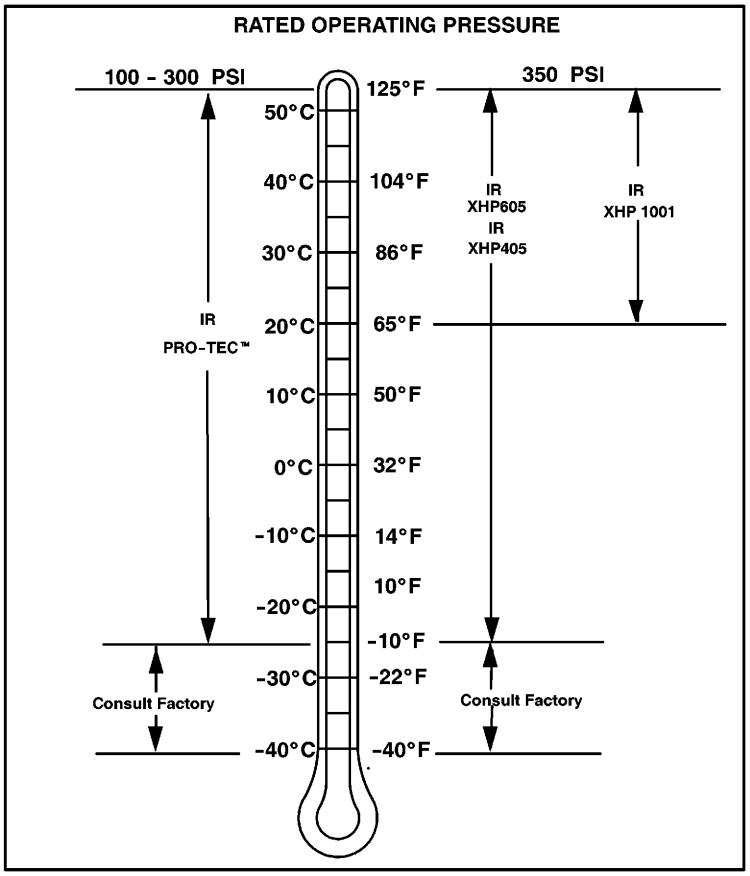
Portable Compressor Fluid Chart

Refer to these charts for correct compressor fluid required. Note that the selection of fluid is dependent on the design operating pressure of the machine and the ambient temperature expected to be encountered before the next oil change.

Note: Fluids listed as "preferred" are required for extended warranty.

Compressor oil carryover (oil consumption) may be greater with the use of alternative fluids.

Design Operating Pressure	Ambient Temperature	Specification
100 psi to 300 psi	-10°F to 125°F (-23°C to 52°C)	Preferred: **IR Pro-Tec™** Alternate: ISO Viscosity Grade 46 with rust and oxidation inhibitors, designed for air compressor service.
350 psi	(-23°C to 52°C) -10°F to 125°F	Preferred: **IR XHP 605** Alternate: IR XHP405 ISO Viscosity Grade 68 Group 3 or 5 with rust and oxidation inhibitors designed for air compressor service.
	65°F to 125°F (-18°C to 52°C)	Preferred: **XHP605** **IR XHP1001**



Preferred Ingersoll-Rand Fluids - Use of these fluids with original I-R filters can extend airend warranty. Refer to operator's manual warranty section for details or contact your I-R representative.

Ingersoll-Rand Preferred Fluids	1 gal. (3.8 Litre)	5 gal. (19.0 Litre)	55 gal. (208.2Litre)	220 gal. (836 litre)
Preferred:				
IR Pro-Tec™	36899698	36899706	36899714	36899722
IR XHP605	-	22252076	22252050	22252068
IR XHP1001	-	35612738	35300516	-
XHP405	-	22252126	22252100	22252118

SECTION 8 - Trouble Shooting

INTRODUCTION

Trouble shooting for a portable air compressor is an organized study of a particular problem or series of problems and a planned method of procedure for investigation and correction. The trouble shooting chart that follows includes some of the problems that an operator may encounter during the operation of a portable compressor.

The chart does not attempt to list all of the troubles that may occur, nor does it attempt to give all of the answers for correction of the problems. The chart does give those problems that are most apt to occur. To use the trouble shooting chart:

A. Find the "complaint" depicted as a bold heading.

B. Follow down that column to find the potential cause or causes. The causes are listed in order (1,2,3 etc.) to suggest an order to follow in trouble shooting.

ACTION PLAN

A. Think Before Acting

Study the problem thoroughly and ask yourself these questions:

(1) What were the warning signals that preceded the trouble?
(2) Has a similar trouble occurred before?
(3) What previous maintenance work has been done?
(4) If the compressor will still operate, is it safe to continue operating it to make further checks?

B. Do The Simplest Things First

Most troubles are simple and easily corrected. For example, most complaints are "low capacity" which may be caused by too low an engine speed or "compressor over- heats" which may be caused by low oil level.

Always check the easiest and most obvious things first; following this simple rule will save time and trouble.

Note: For trouble shooting electrical problems, refer to the Wiring Diagram Schematic found in Parts List Section.

C. Double Check Before Disassembly

The source of most compressor troubles can be traced not to one component alone, but to the relationship of one component with another. Too often, a compressor can be partially disassembled in search of the cause of a certain trouble and all evidence is destroyed during disassembly. Check again to be sure an easy solution to the problem has not been overlooked.

D. Find And Correct Basic Cause

After a mechanical failure has been corrected, be sure to locate and correct the cause of the trouble so the same failure will not be repeated. A complaint of "premature breakdown" may be corrected by repairing any improper wiring connections, but something caused the defective wiring. The cause may be excessive vibration.

TROUBLE SHOOTING CHART

Bold Headings depict the COMPLAINT - Subheadings suggest the CAUSE

Note: Subheadings suggest sequence to follow troubleshooting.

1. Unit Shutdown:

	Corrective Action
Out of Fuel	Add CLEAN diesel Fuel
Compressor Oil Temp. Too High	See Complaint 10
Engine Water Temp. Too High	Check coolant level. If necessary, Add.
Engine Oil Pressure Too Low	See Complaint 3 and Complaint 4.
Broken Engine Fan Belt	Replace fan belt.
Loose Wire Connection	Wiggle wires at switches & connector blocks. Make repairs.
Low Fuel Level Shutdown Switch	Replace switch.
Defective Discharge Air Temp. Switch	Replace switch.
Defective Engine Oil Pressure Switch	Replace switch.
Defective Shutdown Solenoid	Replace solenoid.
Malfunctioning Relay	Replace relay.
* < 16 Volts at Shutdown Solenoid	Check battery and alternator. Make repairs.
Blown Fuse	Replace fuse.
Engine Malfunctioning	See Trouble Shooting in Engine Manual.
Airend Malfunctioning	See Complaint 10.

2. Won't Start/Run:

Low Battery Voltage	Check electrolyte level. Check connections.
* <16 Volts at Shutdown Solenoid	Charge battery and alternator. Make repairs.
Blown Fuse	Replace fuse.
Malfunctioning Start Switch	Replace switch.
Defective Safety Bypass Switch	Replace switch.
Clogged Fuel Filters	Service filters. See Engine Operator's Manual.
Out of Fuel	Add CLEAN fuel.
Compressor Oil Temp. Too High	See Complaint 10.
Engine Water Temp. Too High	Check fluid level. If necessary, Add.
Engine Oil Pressure Too Low	See Complaint 3 and Complaint 4.
Loose Wire Connection	Repair or replace connection.
Defective Discharge Air Temp. Switch	Replace switch.
Defective Engine Oil Pressure Switch	Replace switch.
Defective Shutdown Solenoid	Replace solenoid.
Malfunctioning Relay	Replace relay.
Engine Malfunctioning	See Trouble Shooting in Engine Manual.
Airend Malfunctioning	See Complaint 10.

3. Engine Temperature Lamps Stays On:

Broken Engine Fan Belt	Replace fan belt set.
Malfunctioning Circuit Board	Replace circuit board.
* Ambient Temp. >125°F (52°C)	Above spec limit.
Dirty Operating Conditions	Move unit to cleaner environment.
Dirty Cooler	Clean exterior of cooler.
* Out of Level >15 degrees	Relocate or reposition unit.
Operating Pressure Too High	Reduce pressure to spec.
Recirculation of Cooling Air	Close side doors.
Loose Wire Connection	Repair or replace.
Malfunctioning circuit board.	Replace circuit board.

* : > = greater than, < = less than

4. Engine Oil Pressure Lamp Stays On:

	Corrective Action
Low Oil Level	Add oil.
Out of Level >15 degrees	Relocate or reposition.
Wrong Lube Oil	See Engine Oil Spec. Change oil.
Clogged Oil Filter Element(s)	Replace element(s).
Engine Malfunctioning	See Trouble Shooting in Engine Manual.
Loose Wire Connection.	Repair or replace.
Malfunctioning circuit board	Replace circuit.

5. Engine Temperature Lamps Stays Off:

Bulb Burned Out	Replace circuit board.
Malfunctioning circuit board	Replace circuit board.

6. Engine Oil Pressure Lamp Stays Off:

Bulb Burned Out	Replace circuit board.
Malfunctioning circuit board	Replace circuit board.

7. Alternator Lamp Stays On:

Loose or Broken Belts	Tighten or replace belt set.
Loose Wire Connection	Repair or replace connection.
Low Battery Voltage	Check electrolyte level. Add if necessary. Check connectors. Clean & tighten. Recharge battery.
Malfunctioning Alternator	Repair or replace alternator.
Malfunctioning circuit board	Replace circuit board.

8. Alternator Lamp Stays Off:

Bulb Burned Out	Replace circuit board.
Loose Wire Connection	Repair or replace connector.
Malfunctioning circuit board	Replace circuit board.

9. Unit Fails To Shutdown:

Defective Low Fuel Shutdown Switch	Pull wire off shutdown solenoid. Replace switch.
Defective Discharge Air Temperature Switch	Pull wire off. Replace switch.
Defective Engine Oil Pressure Switch	Pull wire off. Replace switch.
Defective Shutdown Solenoid	Carefully block air inlet to stop engine. Replace solenoid.
Malfunctioning Relay	Pull wire off shutdown solenoid. Replace relay.
Defective Safety Bypass Switch	Pull wire off shutdown solenoid. Replace defective item.

10. Excessive Compressor Oil Temperature:

	Corrective Action
Ambient Temp. > 125°F (52°C)	Above spec limit.
Out of Level > 15 degrees	Relocate or reposition unit.
Low Oil Level	Add oil. Look for any leaks.
Wrong Lube Oil	Check spec in this manual.
Dirty Cooler	Clean exterior surfaces.
Dirty Operating Conditions	Move unit to cleaner environment.
Clogged Oil Filter Elements	Replace elements. Change oil.
Loose or Broken Belts	Tighten or replace belt set.
Operating Pressure Too High	Reduce pressure to spec.
Recirculation Of Cooling Air	Close side doors. Replace belly pan.
Malfunctioning Thermostat	Replace thermostat in bypass valve.
Malfunctioning Fan	Check fan belt tension. Tighten or replace belt set.
Defective Oil Cooler Relief Valve	Replace valve.
Defective Minimum Pressure Valve	Repair or replace valve.
Blocked or Restricted Oil Lines	Clean by flushing or replace.
Airend Malfunctioning	See Complaint 11, 12, 13, 15, 16 or 18.

11. Engine RPM Down:

Clogged Fuel Filter	Clean primary filter. Replace final filter. Drain tanks. Add CLEAN fuel.
Operating Pressure Too High	Reduce pressure to spec limit.
Incorrect Pressure Regulator Adjustment	See Section 6 in this manual.
Malfunctioning Pressure Regulator	Replace regulator.
Incorrect Linkage Adjustment	See Section 6 in this manual.
Dirty Air Filter	Clean or replace elements.
Malfunctioning Air Cylinder	Replace air cylinder and adjust per Section 6.
Wrong Air Filter Element	Install correct element.
Defective Separator Element	Install new element per page 21.
Engine Malfunctioning	See Trouble Shooting in Engine Manual.
Airend Malfunctioning	Refer to Airend Rebuild Manual.

12. Excessive Vibration:

Rubber Mounts, Loose or Damaged	Tighten or replace.
Defective Fan	Replace fan.
Drive Coupling Defective	Replace coupling.
Engine Malfunctioning	See Trouble Shooting in Engine Manual.
Airend Malfunctioning	See Complaint 15 and 17.
Anti-rumble valve not working.	Repair or Replace.
Engine idle speed too low.	Raise “No Load” speed per Section 6.

13. Low CFM:

Dirty Air Filter	Clean or replace elements.
Incorrect Linkage Adjustment	See Section 6 in this manual.
Incorrect Pressure Regulator Adjustment	See Section 6 in this manual.
Malfunctioning Pressure Regulator	Replace regulator.
Malfunctioning Inlet Unloader/Butterfly Valve	Inspect valve. Make adjustment per Section 6.
Malfunctioning Air Cylinder	Replace air cylinder.
Defective Minimum Pressure Valve	Repair or replace valve.
Defective Separator Element	Install new element per Page 21.
Wrong Air Filter Element	Install correct element.

14. Short Air Cleaner Life:

	Corrective Action
Dirty Operating Conditions	Move unit to cleaner environment.
Inadequate Element Cleaning	Install new element.
Incorrect Stopping Procedure	Read procedure in this manual.
Wrong Air Filter Element	Install proper element.
Oil Pump Drive Coupling	Inspect coupling. If necessary, replace coupling.

15. Excessive Oil In Air:

High Oil Level	Read procedure in this manual.
Out of Level > 15 degrees	Relocate or reposition unit.
Clogged Scavenge Orifice	Remove scavenge orifice. Clean and Replace.
Scavenge Tube Blocked	Remove scavenge tube. Clean and Replace.
Defective Scavenge Check Valve	Remove check valve. Replace with new valve.
Sep. Tank Blow Down Too Quickly	Allow unit to blow down automatically.
Defective Minimum Pressure Valve	Remove valve. Repair valve and replace.

16. Oil Seal Leak:

Contaminated Lube Oil	Drain and flush system. Add new CLEAN oil.
Blocked or Restricted Oil Line(s)	Remove, clean and replace line(s).
Malfunctioning Seal	Refer to Airend Rebuild Manual.
Scored Shaft	See instructions in new seal kit.

17. Will Not Unload:

Leak in Regulator Piping	Find and repair leak(s).
Incorrect Pressure Regulator Adjustment	Refer to Section 6 in this manual.
Malfunctioning Pressure Regulator	Replace regulator.
Malfunctioning Inlet Butterfly Valve	Inspect valve fit. Readjust per Section 6.
Ice in Regulation Lines/Orifice	Apply heat to line(s) and or orifice.

18. Oil In Air Cleaner:

Incorrect Stopping Procedure	Read Procedure in this manual.
Oil Pump Drive Coupling	Inspect coupling. Replace if necessary.
Discharge Check Valve Faulty	Replace.

19. Safety Valve Relieves:

Operating Pressure Too High	Reduce pressure to spec limit.
Leak In Regulator Piping	Repair leak(s).
Incorrect Pressure Regulator Adjustment	Refer to Section 6 in this manual.
Malfunctioning Pressure Regulator	Replace regulator.
Malfunctioning Inlet Unloader/Butterfly Valve	Inspect valve fit. Readjust per Section 6.
Defective Safety Valve	Replace safety valve.
Defective Separator Element	Remove element. Install new.
Ice in Regulation Lines/Orifice	Apply heat to lines and/or orifice.

SECTION 9 - PARTS ORDERING

GENERAL

This publication, which contains an illustrated parts breakdown, has been prepared as an aid in locating those parts which may be required in the maintenance of the unit. All of the compressor parts, listed in the parts breakdown, are manufactured with the same precision as the original equipment. For the greatest protection always insist on genuine Ingersoll-Rand Company parts for your compressor.

NOTICE

Ingersoll-Rand Company can bear no responsibility for injury or damages resulting directly from the use of non-approved repair parts.

Ingersoll-Rand Company service facilities and parts are available worldwide. There are Ingersoll- Rand Company Construction Equipment Group Sales Offices and authorized distributors located in the principal cities of the United States. In Canada our customers are serviced by the Canadian Ingersoll-Rand Company, Limited. There are also Ingersoll-Rand International autonomous companies and authorized distributors located in the principal cities throughout the free world.

Special order parts may not be included in this manual. Contact the Mocksville Parts Department with the unit serial number for assistance with these special parts.

DESCRIPTION

The illustrated parts breakdown illustrates and lists the various assemblies, subassemblies and detailed parts which make up this particular machine. This covers the standard models and the more popular options that are available.

A series of illustrations show each part distinctly and in location relative to the other parts in the assembly. The part number, the description of the part and the quantity of parts required are shown on each illustration or on adjacent page. The quantities specified are the number of parts used per one assembly and are not necessarily the total number of parts used in the machine. Where no quantity is specified the quantity is assumed to be one.

Each description of a part is based upon the "noun first" method, i.e., the identifying noun or item name is always the first part of the description. The noun name is generally followed by a single descriptive modifier. The descriptive modifier may be followed by words or abbreviations such as upper, lower, inner, outer, front, rear, RH, LH, etc. when they are essential.

In referring to the rear, the front or to either side of the unit, always consider the **drawbar end** of the unit as the **front.** Standing at the rear of the unit facing the drawbar (front) will determine the right and left sides.

FASTENERS

Both SAE/inch and ISO/metric hardware have been used in the design and assembly of these units. In the disassembly and reassembly of parts, extreme care must be taken to avoid damaging threads by the use of wrong fasteners. In order to clarify the proper usage and for exact replacement parts, all standard fasteners have been identified by part number, size and description. This will enable a customer to obtain fasteners locally rather than ordering from the factory. These parts are identified in tables that will be found at the rear of the parts illustrations. Any fastener that has not been identified by both part number and size is a specially engineered part that must be ordered by part number to obtain the exact replacement part.

MARKINGS AND DECALS

NOTICE

Do not paint over safety warnings or instructional decals. If safety warning decals become illegible, immediately order replacements from the factory.

Part numbers for original individual decals and their mounting locations are shown within Parts List Section. These are available as long as a particular model is in production.

Afterwards, service sets of exterior decals and current production safety warning decals are available. Contact the Product Support Group at Mocksville for your particular needs and availability.

HOW TO USE PARTS LIST

a. Turn to Parts List.

b. Locate the area or system of the compressor in which the desired part is used and find illustration page number.

c. Locate the desired part on the illustration by visual identification and make note of part number and description.

HOW TO ORDER

The satisfactory ordering of parts by a purchaser is greatly dependent upon the proper use of all available information. By supplying your nearest sales office, autonomous company or authorized distributor, with complete information, you will enable them to fill your order correctly and to avoid any unnecessary delays.

In order that all avoidable errors may be eliminated, the following instructions are offered as a guide to the purchaser when ordering replacement parts:

a. Always specify the model number of the unit as shown on the general data decal attached to the unit.

b. Always specify the serial number of the unit. THIS IS IMPORTANT. The serial number of the unit will be found stamped on a plate attached to the unit. (The serial number on the unit is also permanently stamped in the metal of the frame side rail.)

c. Always specify the number of the parts list publication.

d. Always specify the quantity of parts required.

e. Always specify the part number, as well as the description of the part, or parts, exactly as it is given on the parts list illustration.

In the event parts are being returned to your nearest sales office, autonomous company or authorized distributor, for inspection or repair, it is important to include the serial number of the unit from which the parts were removed.

TERMS AND CONDITIONS ON PARTS ORDERS

Acceptance: Acceptance of an offer is expressly limited to the exact terms contained herein. If purchaser's order form is used for acceptance of an offer, it is expressly understood and agreed that the terms and conditions of such order form shall not apply unless expressly agreed to by Ingersoll-Rand Company ("Company") in writing. No additional or contrary terms will be binding upon the Company unless expressly agreed to in writing.

Taxes: Any tax or other governmental charge now or hereafter levied upon the production, sale, use or shipment of material and equipment ordered or sold is not included in the Company's price and will be charged to and paid for by the Purchaser.

Shipping dates shall be extended for delays due to acts of God, acts of Purchaser, acts of Government, fires, floods, strikes, riot, war, embargo, transportation shortages, delay or default on the part of the Company's vendors, or any other cause beyond the Company's reasonable control.

Should Purchaser request special shipping instruction, such as exclusive use of shipping facilities, including air freight when common carrier has been quoted and before change order to purchase order can be received by the Company, the additional charges will be honored by the Purchaser.

Warranty: The Company warrants that parts manufactured by it will be as specified and will be free from defects in materials and workmanship. The Company's liability under this warranty shall be limited to the repair or replacement of any part which was defective at the time of shipment provided Purchaser notifies the Company of any such defect promptly upon discovery, but in no event later than three (3) months from the date of shipment of such part by the Company. The only exception to the previous statement is the extended warranty as it applies to the special airend exchange program.

Repairs and replacements shall be made by the Company F.O.B. point of shipment. The Company shall not be responsible for costs of transportation, removal or installation.

Warranties applicable to material and equipment supplied by the Company but wholly manufactured by others shall be limited to the warranties extended to the Company by the manufacturer which are able to be conveyed to the Purchaser.

Delivery: Shipping dates are approximate. The Company will use best efforts to ship by the dates specified; however, the Company shall not be liable for any delay or failure in the estimated delivery or shipment of material and equipment or for any damages suffered by reason thereof.

The company makes no other warranty or representation of any kind whatsoever, expressed or implied, except that of title, and all implied warranties, including any warranty of merchantability and fitness for a particular purpose, are hereby disclaimed.

Limitation of Liability:

The remedies of the Purchaser set forth herein are exclusive, and the total liability of the Company with respect to this order whether based on contract, warranty, negligence, indemnity, strict liability or otherwise, shall not exceed the purchase price of the part upon which such liability is based. The Company shall in no event be liable to the Purchaser, any successors in interest or any beneficiary of this order for any consequential, incidental, indirect, special or punitive damages arising out of this order or any breach thereof, or any defect in, or failure of, or malfunction of the parts hereunder, whether based upon loss of use, lost profits or revenue, interest, lost goodwill, work stoppage, impairment of other goods, loss by reason of shutdown or non- operation, increased expenses of operation or claims of customers of Purchaser for service interruption whether or not such loss or damage is based on contract, warranty, negligence, indemnity, strict liability or otherwise.

AIREND EXCHANGE PROGRAM

Your Ingersoll-Rand Company Construction Equipment Group Sales Offices and authorized distributors as well as Ingersoll-Rand International autonomous companies and authorized distributors now have an airend exchange program to benefit portable compressor users.

On the airend exchange program the exchange price is determined by the age and condition of the airend and may be classified by one of the following categories.

Category "A": The airend must not be over two years old and must have reusable rotor housing(s) and rotor(s).

Category "B": The airend must be between two and five years old and returned with two or more reusable major castings.

Category "C": The airend must be over five years old.

Your nearest sales office, autonomous company or authorized distributor must first contact the Parts Service Department at the factory at which your portable air compressor was manufactured for an airend exchange number. The airend must be tagged with this preassigned number and returned to the factory prepaid. The airend must be intact, with no excluded parts, otherwise the exchange agreement may be cancelled. The warranty on an exchange or factory rebuilt airend is 365 days.

Airends being returned to the factory in connection with a WARRANTY CLAIM must be processed through the Customer Service Department. If returned without a Warranty MRR (Material Return Request) Number, no warranty claim will be considered.

SECTION 10 - PARTS LIST

Frame & Running Gear, Sht 1
Frame & Running Gear, Sht 2
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Decal Location, Sht 4
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Decal Location, Sht 2 (EEC Symbols)
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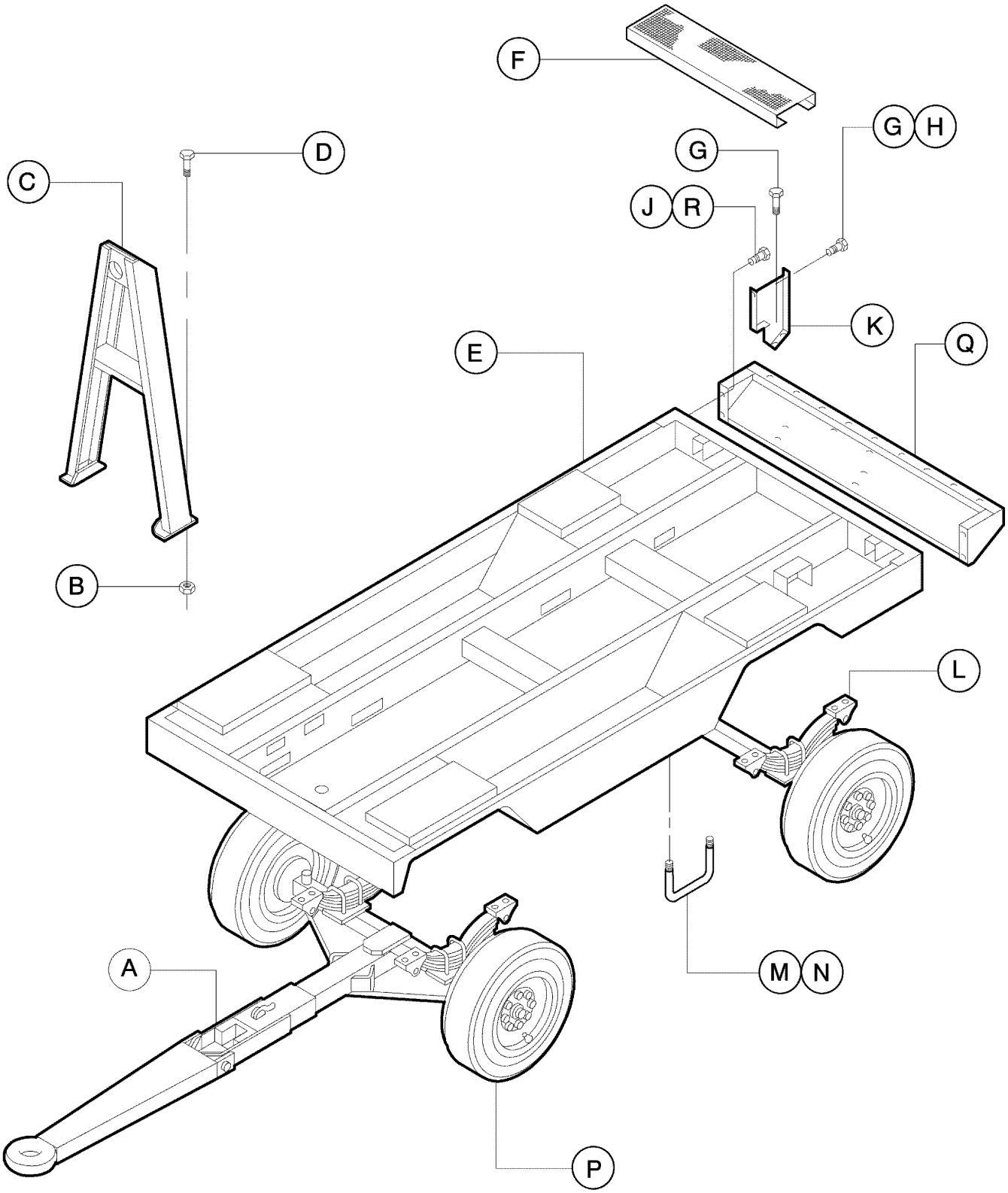
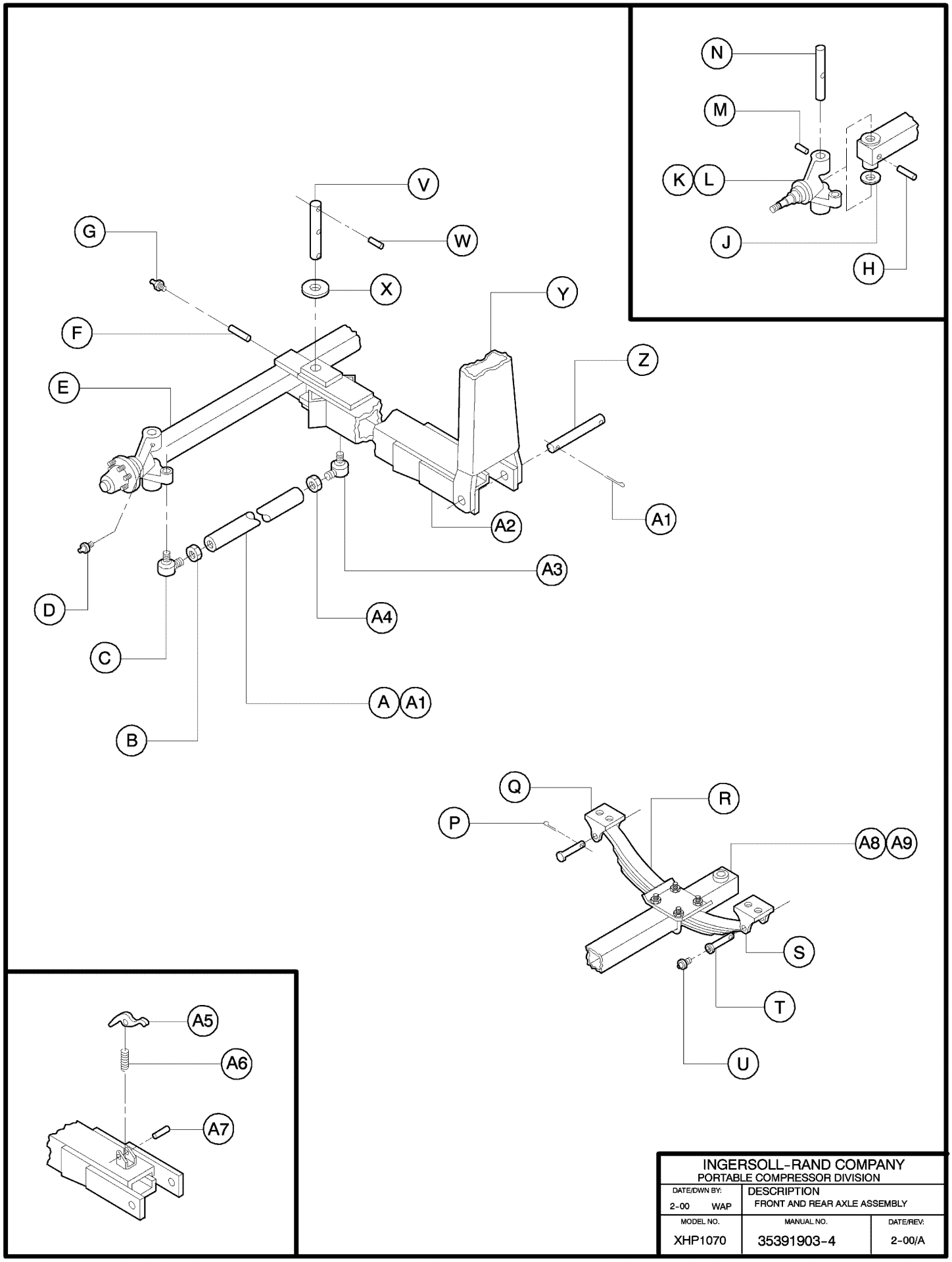
Decal Location, Sht 2 (EEC)
Decal Location, Sht 3 (EEC)
Decal Location, Sht 4 (EEC)



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FRAME & RUNNING GEAR	
MODEL NO. XHP1070	MANUAL NO. 35391903-2	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	36851376	1	FRONT AXLE ASSEMBLY
B	16A4C8Z1	6	NUT
C	36754620	1	BAIL , LIFTING
D	35A2D378Z1	6	SCREW
E	36884542	1	FRAME
F	36864809	1	STEP GRIP
G	35144344	4	SCREW
H	35145077	4	NUT
J	35A2D219Z1	4	SCREW
K	36786614	2	SUPPORT , STEP
L	36851392	1	REAR AXLE ASSEMBLY
M	35304666	3	STEP
N	16A4C7Z1	12	NUT
P	35091545	1	TIRE AND WHEEL ASSEMBLY
Q	36865491	1	FRAME EXTENSION
R	16A4C5Z1	4	NUT

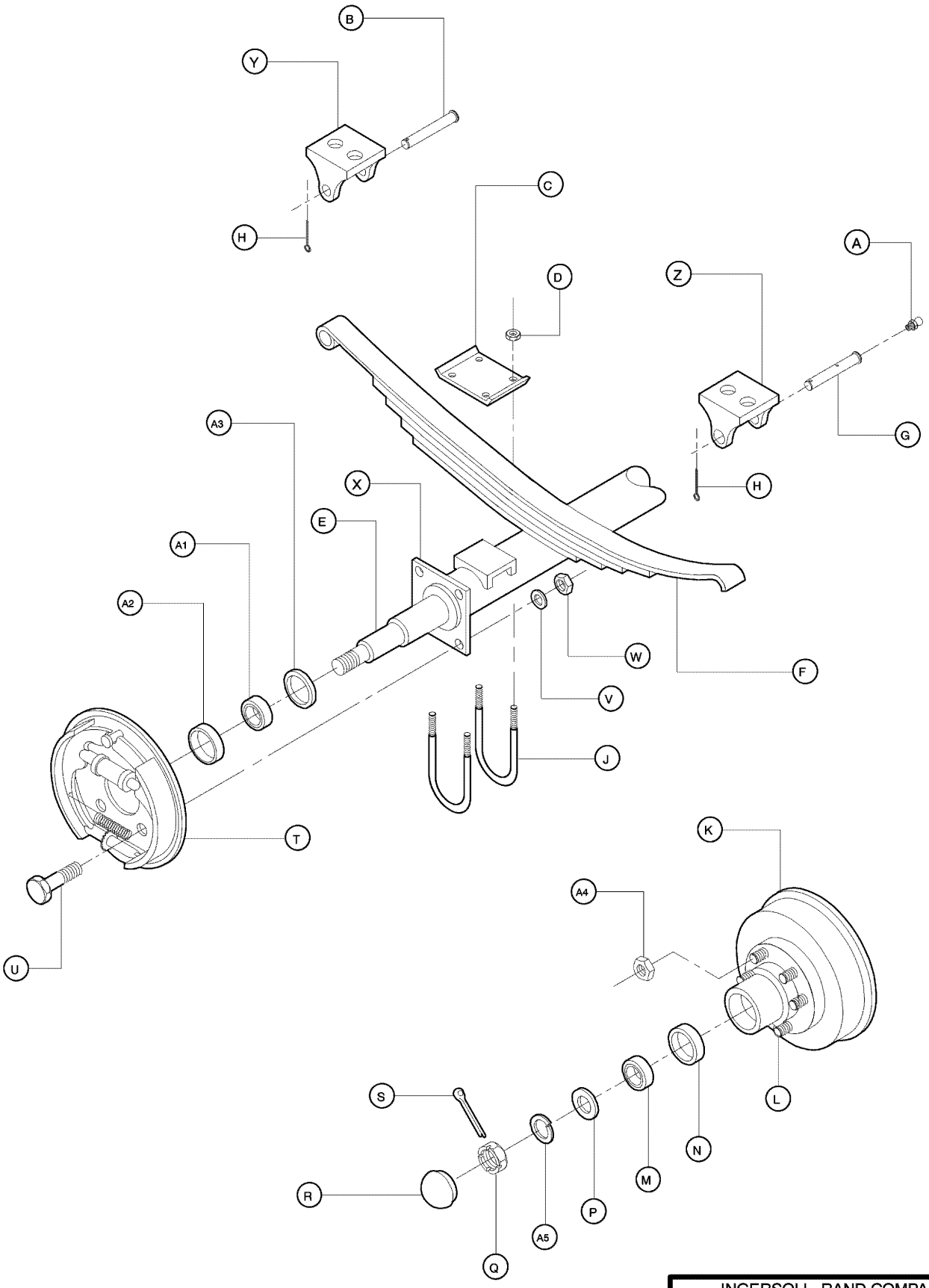
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FRAME & RUNNING GEAR	
MODEL NO. XHP1070	MANUAL NO. 35391903-3	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FRONT AND REAR AXLE ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-4	DATE/REV: 2-00/A

ITEM	C.P.N.	DESCRIPTION
A	36504389	ROD , TIE
B	36140730	NUT , JAM
C	35588961	BALL JOINT , OUTER
D	W86707	FITTING , LUBE
E	36753259	AXLE , FRONT
F	25A13C283	PIN , ROLL
G	W86707	FITTING , LUBE
H	25A13C301	PIN , ROLL
J	95239927	WASHER
K	36851566	L.H. KNUCKLE ASSEMBLY
L	36851574	R.H. KNUCKLE ASSEMBLY
M	25A13C281	PIN , ROLL
N	35319045	PIN , KING
P	11A13C66E	PIN , COTTER
Q	36719169	BRACKET
R	36719466	SPRING
S	36719177	BRACKET
T	35111590	BOLT , SHACKLE
U	250A10X1613C	FITTING , LUBE
V	35588755	PIN , CENTER
W	25A13C298	PIN , ROLL
X	12A5D13Z1	WASHER
Y	36719557	DRAWBAR
Z	35107168	PIN , HINGE
A1	11A13C83E	PIN , COTTER
A2	36753242	ARM , CENTER
A3	35588953	BALLJOINT , INNER
A4	35140722	NUT , JAM
A5	36719219	LATCH
A6	35141167	SPRING
A7	25A13C332	PIN , ROLL
A8	36851376	FRONT AXLE ASSEMBLY
A9	36851384	REAR AXLE ASSEMBLY
B1	36853042	TIE ROD ASSEMBLY (INCLUDES A,B,C,A3,A4)

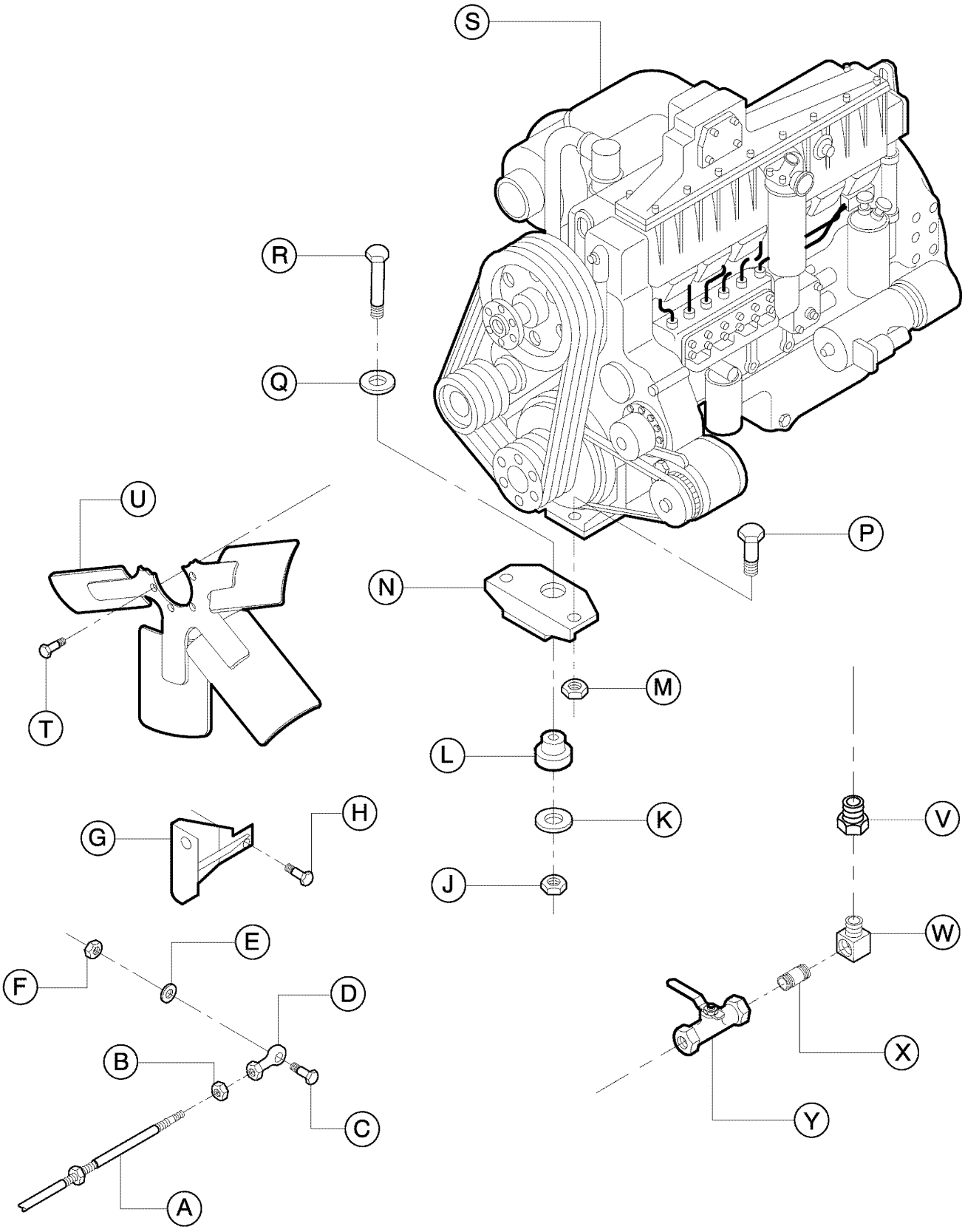
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FRONT AND REAR AXLE ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-5	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FRONT AND REAR AXLE ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-6	DATE/REV: 2-00/A

ITEM	C.P.N.	DESCRIPTION
A	250A10X1613C	FITTING , LUBE
B	35588839	RIVET
C	35589241	PLATE , CLAMP
D	35111566	NUT
E	36851640	AXLE , REAR
F	36719466	SPRING
G	35111590	BOLT , SHACKLE
H	11A13C66E	PIN , COTTER
J	35834621	U-BOLT
K	36851665	HUB ASSEMBLY (INCLUDES ITEMS N, L, A2)
L	36764983	STUD
M	36851590	OUTTER BEARING
N	36851616	OUTER RACE
P	36853109	WASHER , FLAT
Q	36853091	NUT
R	36776813	CAP , GREASE
S	11A13C41E	PIN , COTTER
T	36781920	PARKING BRAKE ASSEMBLY
U	36A2D326Z1	BOLT
V	14A5C120Z1	WASHER , FLAT
W	22A4C7G	NUT
X	36776839	FLANGE , BRAKE MTG
Y	36719177	BRACKET
Z	36719169	BRACKET
A1	36851608	INNER BEARING
A2	36851624	INNER RACE
A3	36851632	SEAL
A4	36776821	NUT , STUD
A5	36853117	WASHER , LOCK

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FRONT AND REAR AXLE ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-7	DATE/REV. 2-00/A

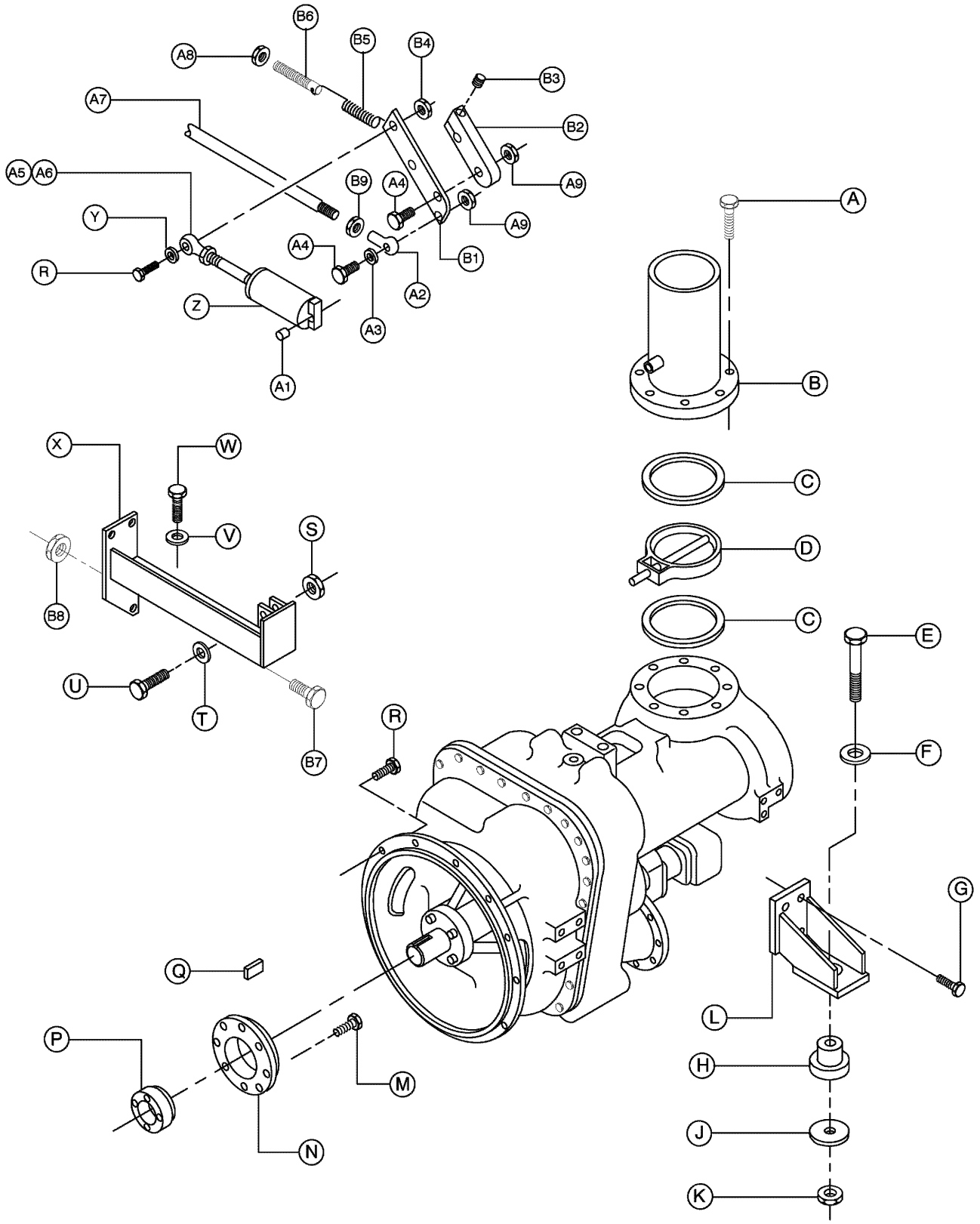


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ENGINE ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-8	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	35279579	1	CABLE , CONTROL
B	23A4C1Z1	1	NUT , JAM
C	35A2D5Z1	1	SCREW
D	W78185	1	BEARING
E	12A5G2	1	WASHER
F	67A4C1G	1	NUT
G	36763761	1	BRACKET
H	35A2D56G	2	SCREW
J	16A4C8G	1	NUT
K	35273937	1	WASHER
L	35306133	1	MOUNT , RUBBER
M	35145077	2	NUT
N	43209139	1	BRACKET
P	35144344	2	SCREW
Q	35306760	1	WASHER
R	35A2D386G	1	SCREW
S	36884062	1	ENGINE
T	35A2D221	6	SCREW
U	36884047	1	FAN
V	23A7S11	1	BUSHING
W	67A7M25	1	ELBOW
X	19A7J5Z1	1	NIPPLE
Y	36777399	1	VALVE , BALL

35362243 ——— **ENGINE FUEL FILTER**
35362235 ——— **ENGINE OIL FILTER**
35362268 ——— **ENGINE WATER SEPARATOR FILTER**
35362250 ——— **PRIMARY FUEL FILTER**

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ENGINE ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-9	DATE/REV: 11-01/B



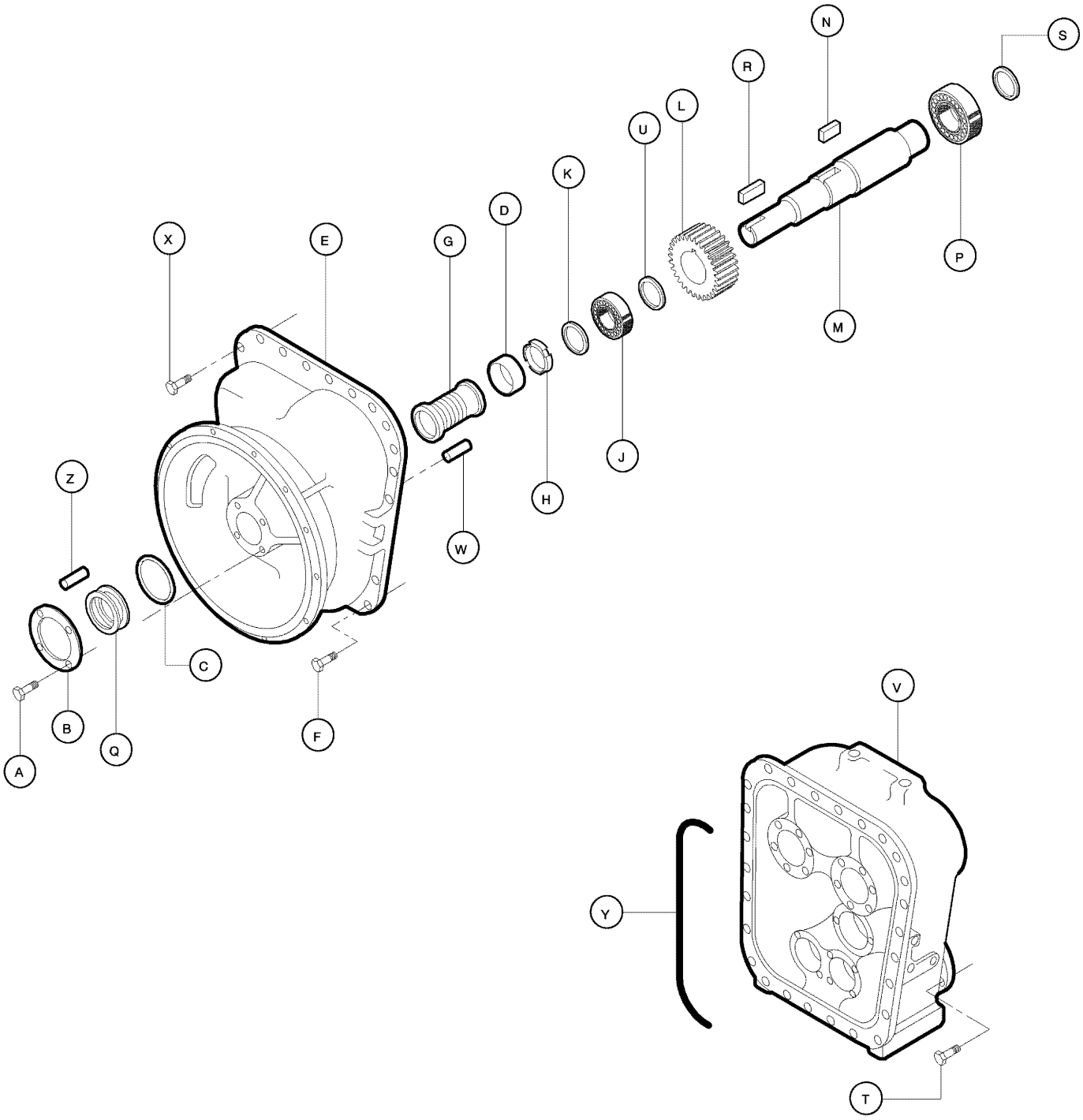
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR END COMPLETE	
MODEL NO. XHP1070	MANUAL NO. 35391903-10	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	35375963	8	SCREW
B	36884997	1	FLANGE , INTAKE
C	36754059	2	GASKET
D	36884112	1	VALVE , BUTTERFLY
E	35A2D386Z1	2	SCREW
F	35101468	2	WASHER , SNUBBER
G	35375856	8	SCREW
H	35306133	2	MOUNT , RUBBER
J	35273937	2	WASHER , SNUBBER
K	16A4C8Z1	2	NUT
L	36766988	2	BRACKET , CPRSR MTG
M	35A2D121G	8	SCREW
N	36783710	1	COUPLING
P	36897916	1	BUSHING
Q	35364975	1	KEY
R	35A2D168Z1	13	SCREW
S	67A4C2Z1	1	NUT
T	12A5D3Z1	1	WASHER , FLAT
U	35288893	1	PIVOT , LEVER REG
V	12A5D9Z1	2	WASHER , FLAT
W	35375856	2	SCREW
X	36898005	1	BRACKET , AIR CYLINDER
Y	11A5D4Z1	1	WASHER , FLAT
Z	35584689	1	CYLINDER , AIR
A1	35288885	1	BUSHING
A2	W78185	1	BEARING , ROD END
A3	12A5D2Z1	1	WASHER , FLAT
A4	35A2D10Z1	2	SCREW
A5	35300532	1	BEARING , ROD END
A6	23A4C4Z1	1	NUT
A7	35279579	1	CABLE , CONTROL
A8	35145077	2	NUT
A9	67A4C1Z1	1	NUT
B1	356079010	1	LEVER , REGULATION
B2	35264951	1	LEVER , CONTROL
B3	119A2A146Z1	1	SCREW , SET
B4	67A4C4Z1	1	NUT
B5	35579523	1	SPRING
B6	35605799	1	ROD , ADJUSTER
B7	35611680	1	BOLT
B8	16A4C3Z1	1	NUT , JAM
B9	23A4C1Z1	1	NUT , JAM

AIR END ASSEMBLY ——— 36017549

EXCHANGE AIREND OPTION: INGERSOLL-RAND OFFERS FACTORY REMANUFACTURED AIRENDS THAT ARE BUILT TO THE LATEST DESIGNS. MEANING IT WILL REFLECT ALL THE ENGINEERING UPGRADES AND PERFORMANCE ENHANCEMENTS MADE TO THAT SIZE UNIT. ALL EXCHANGE AIRENDS COME WITH A ONE YEAR WARRANTY. THESE BENEFITS MAKE A FACTORY REBUILT AIREND THE ONLY COST EFFECTIVE OPTION. CALL YOUR LOCAL IR DEALER FOR MORE DETAILS. PLEASE PROVIDE YOUR AIREND SERIAL NUMBER.

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR END COMPLETE	
MODEL NO. XHP1070	MANUAL NO. 35391903-11	DATE/REV: 2-00/A



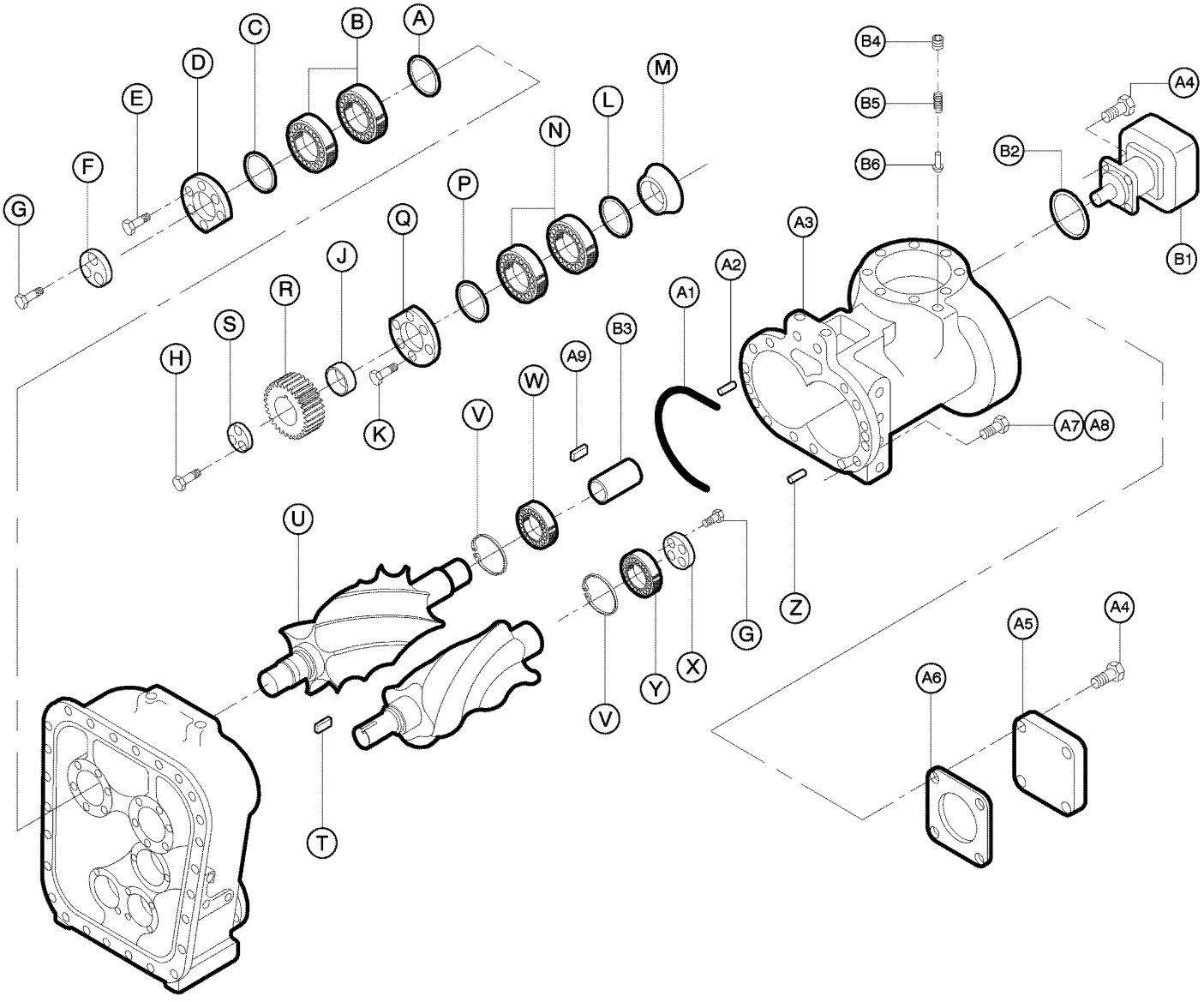
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR END ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-12	DATE/REV: 2-00/A

STARTING WITH SERIAL NO. 318481

A	34M2AB411	BOLT
B	39577648	COVER , OIL SEAL
C	35355536	O-RING
D	36795128	SPACER
E	36793750	CASE , GEAR
F	35318146	BOLT
G	39929351	SEAL , OIL
H	36795169	NUT , LOCK
J	36511640	BEARING
K	36795136	SPACER
L	SEE GEAR SET CHART	
M	36792836	SHAFT , DRIVE
N	36795110	KEY
P	35610203	BEARING
Q	36795151	SHIM SET
R	36795102	KEY
S	35372010	SPACER
T	35272533	SCREW
U	36795144	SPACER
V	36861367	HOUSING , MAIN
W	35336122	DOWEL
X	35272541	BOLT
Y	35355775	O-RING
Z	25A13C63	ROLL PIN

CFM	INPUT SPEED	GEAR SET PART NO.	HR2.5 A/E ASSY. NO.
1070	1800	36798973	36017549

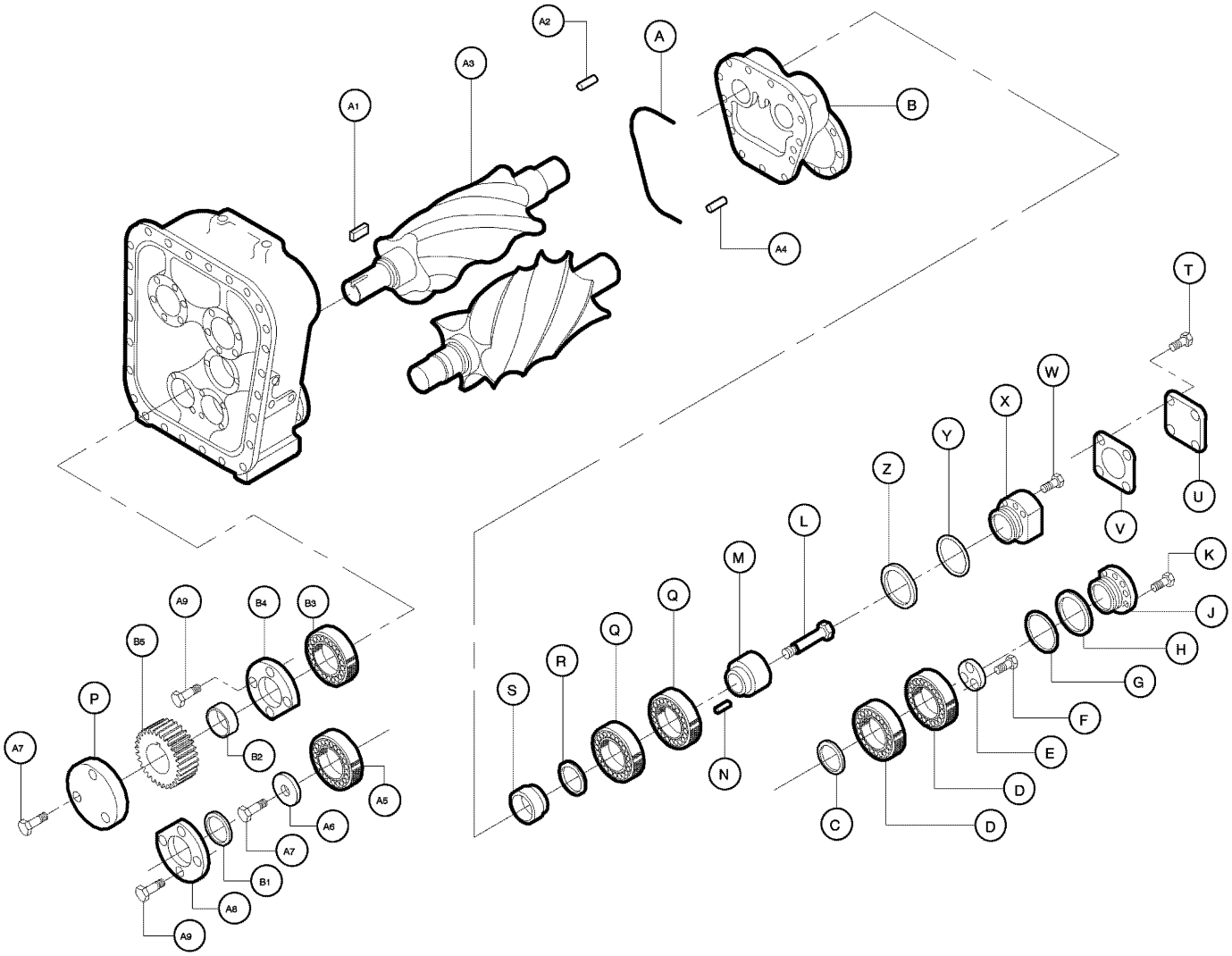
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR END ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-13	DATE/REV: 1-9/B



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR END ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-14	DATE/REV: 2-00/A

A	35355833	SHIM SET
B	35600105	BEARING
C	35355767	SHIM SET
D	35856418	PLATE , RETAINING
E	92304393	SCREW
F	36508414	PLATE , RETAINING
G	35311463	SCREW
H	96712187	SCREW
J	35355841	SPACER
K	96701487	SCREW
L	35355825	SHIM SET
M	35602457	PISTON , THRUST
N	35605203	BEARING
P	35355767	SHIM SET
Q	36501013	PLATE , RETAINER
R	SEE GEAR SET CHART / SHEET 2 OF 6	
S	35355858	PLATE , CLAMP
T	35355817	KEY
U	36017465	ROTOR SET , 1ST STAGE
V	95223178	SNAP RING
W	35600022	BEARING
X	35300193	PLATE , CLAMP
Y	35600030	BEARING , ROLLER
Z	35336122	DOWEL
A1	35355783	O-RING
A2	35336130	DOWEL
A3	36861193	HOUSING , ROTOR
A4	35271139	SCREW
A5	36509388	PLATE , COVER
A6	35275742	GASKET
A7	92398239	SCREW
A8	35295344	SCREW
A9	12A9C81	KEY
B1	36861144	PUMP , OIL
B2	95000410	O-RING
B3	36854701	COUPLING
B4	36861557	PLUG
B5	36861847	SPRING
B6	36861839	PISTON

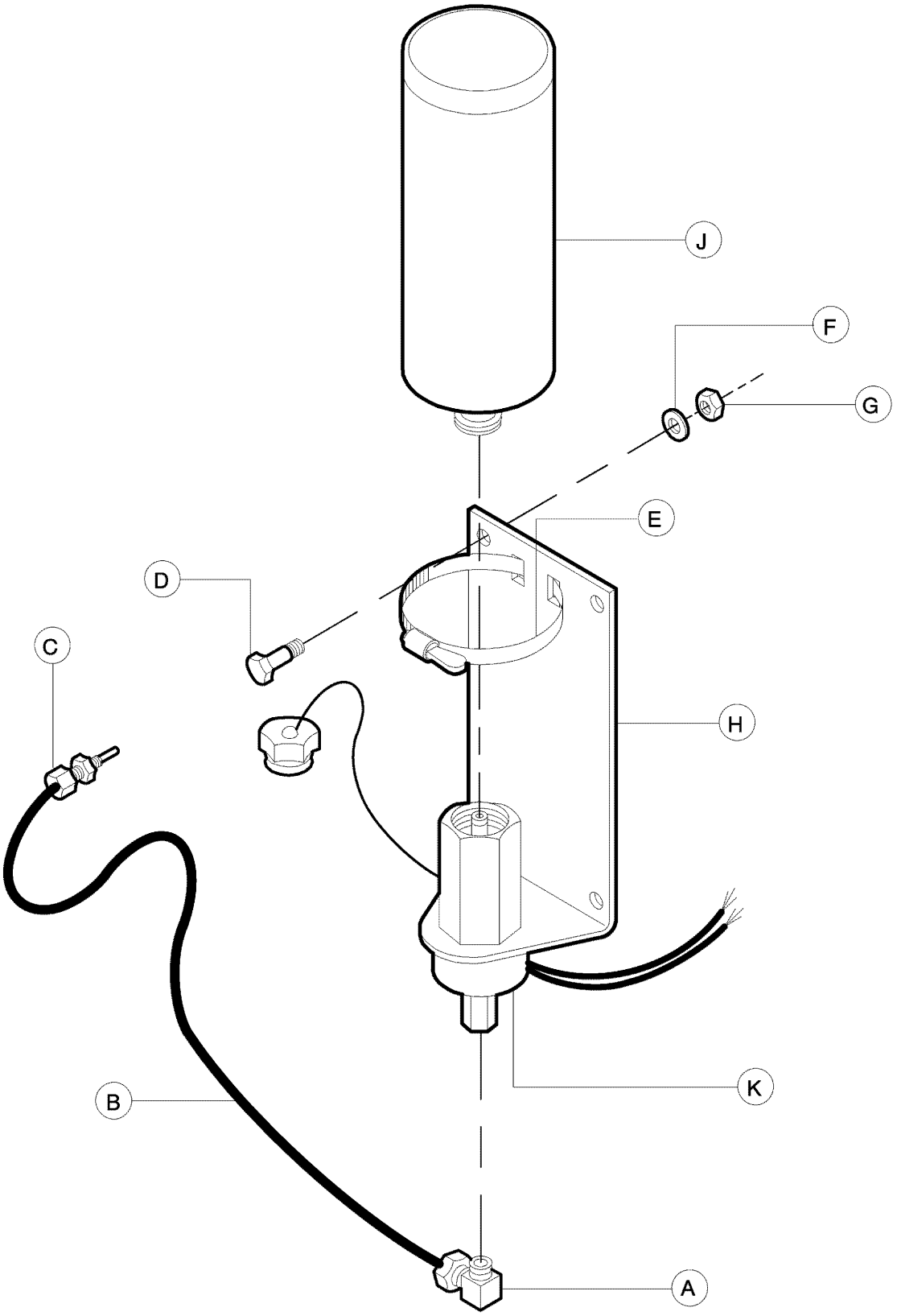
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR END ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-15	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR END ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-16	DATE/REV: 2-00/A

A	35355791	O-RING
B	36738128	HOUSING , REAR BEARING
C	35355874	SHIM SET
D	35600113	BEARING , TAPERED ROLLER
E	35355957	CLAMP , PLATE
F	35311463	BOLT
G	95026290	O-RING
H	35355924	SHIM SET
J	35856350	COVER , REAR BEARING
K	96702295	BOLT
L	36851277	BOLT
M	35864644	COUPLING
N	95069522	PIN , DOWEL
P	36847200	CLAMP , PLATE
Q	35600113	BEARING , TAPERED ROLLER
R	35355874	SHIM SET
S	35355940	PISTON , THRUST
T	35272533	BOLT
U	36509388	PLATE , COVER
V	35275742	GASKET
W	39125000	BOLT
X	36864676	COVER , BEARING
Y	95026290	O-RING
Z	35355916	SHIM SET
A1	35355817	KEY
A2	35336122	DOWEL
A3	36006732	ROTOR SET , 2ND STAGE
A4	35336130	DOWEL
A5	35600014	BEARING , ROLLER
A6	35300201	CLAMP , PLATE
A7	35311463	BOLT
A8	35355999	PLATE , RETAINING
A9	35273408	BOLT
B1	35355973	SPACER , BEARING
B2	35355866	SPACER
B3	35600022	BEARING , ROLLER
B4	35355965	PLATE , RETAINING
B5	SEE GEAR SET CHART / SHEET 2 OF 6	

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR END ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-17	DATE/REV: 2-00/A

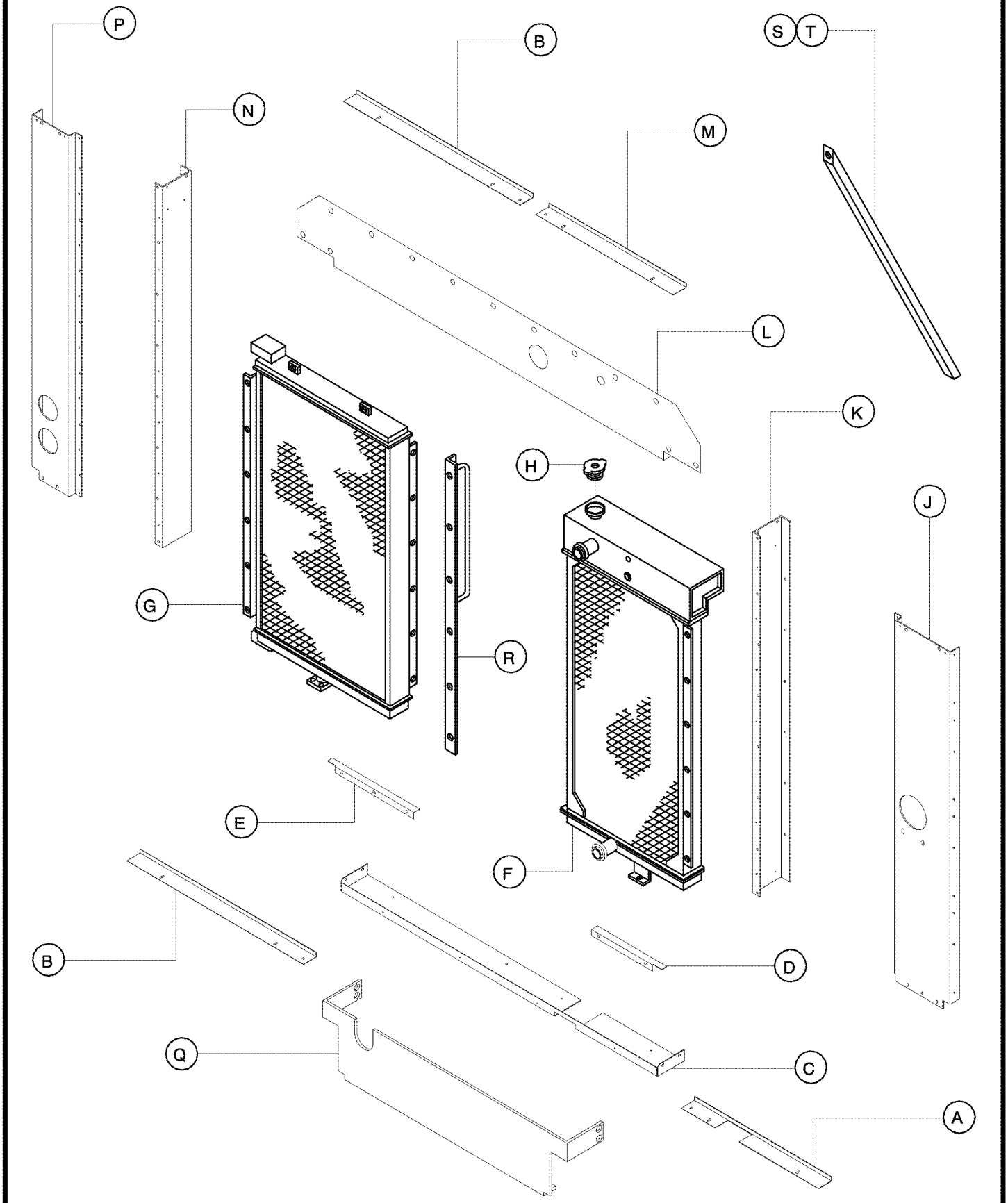


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION STARTING AID ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-18	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	35103498	1	ELBOW , 90°
B	35132174	84"	TUBING
C	35306166	1	ATOMIZER
D	92368687	4	SCREW
E	35103506	1	CLAMP
F	14A5C55	4	WASHER
G	92304500	4	NUT
H	35103506	1	VALVE & BRACKET ASSEMBLY
J	35112911	1	CYLINDER , ETHER
K	35306158	1	VALVE

35306182 STARTING AID KIT COMPLETE

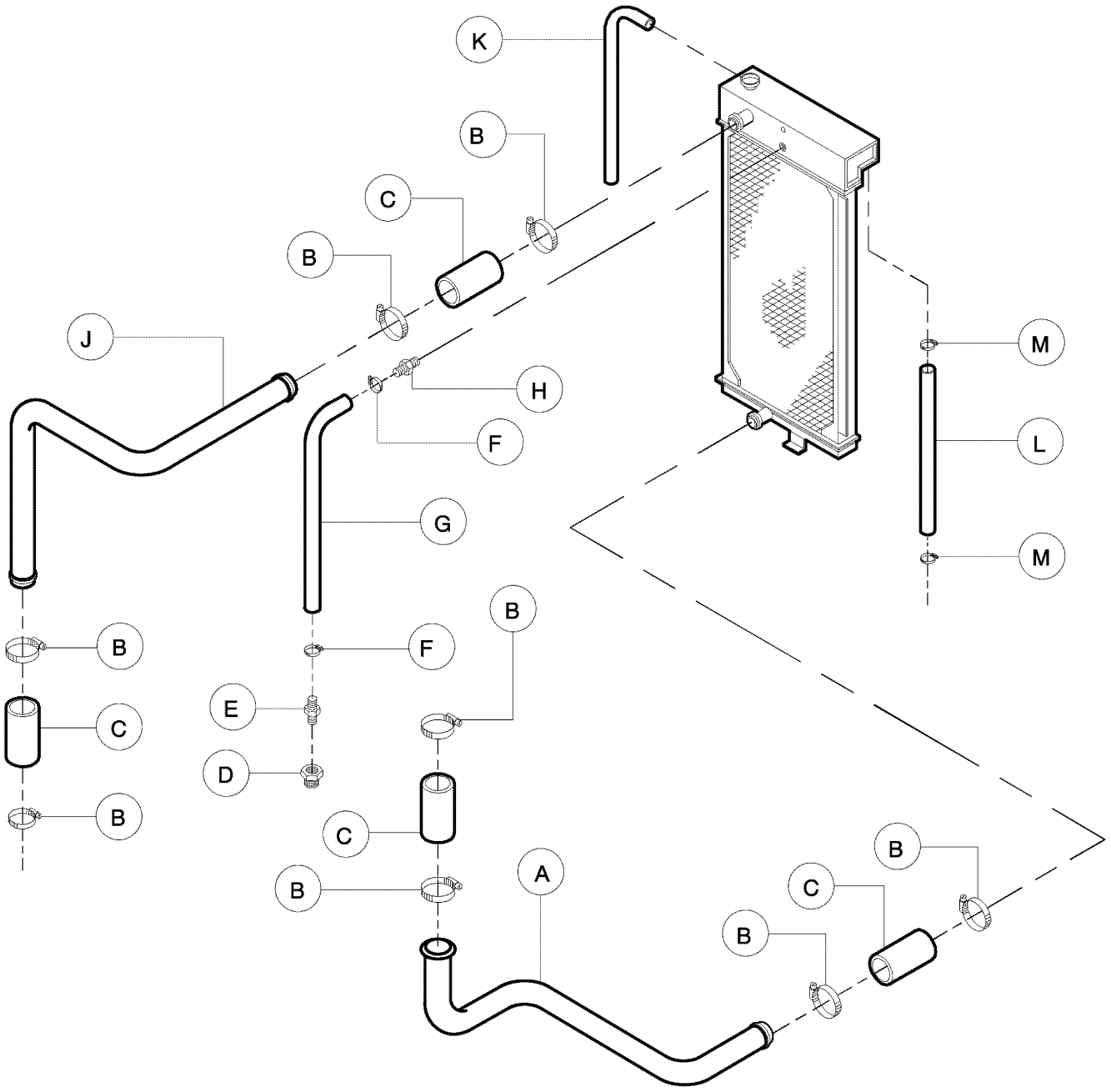
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION STARTING AID ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-19	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION RADIATOR AND OIL COOLER ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-20	DATE/REV: 2-00/A

A	36897767	ANGLE , BOTTOM RAD, ADJUSTING
B	36897742	ANGLE , COOLER ADJUSTING
C	36897734	BAFFLE , BOTTOM SHROUD
D	36897809	FILLER , L.H. RADIATOR
E	36897817	FILLER , R.H. COOLER
F	36884054	RADIATOR
G	36884013	OIL COOLER
H	36765634	CAP , RADIATOR
J	36897700	SUPPORT , L.H.
K	36897718	SHROUD , L.H.
L	36897726	SHROUD / BAFFLE , TOP
M	36897759	ANGLE , RADIATOR TOP ADJ.
N	36897692	SHROUD , R.H.
P	36897684	SUPPORT , R.H.
Q	36755650	BAFFLE , BOTTOM COOLER
R	36755114	SUPPORT , RADIATOR VERTICAL
S	36755106	SUPPORT , OIL COOLER VERTICAL

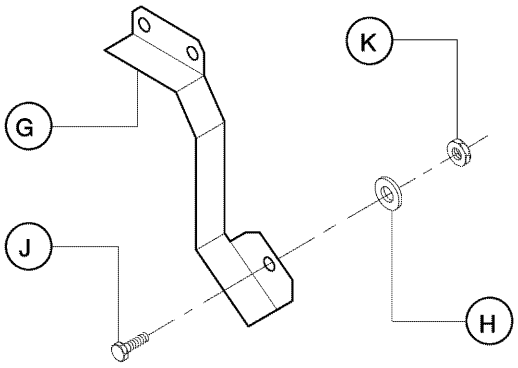
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION RADIATOR AND OIL COOLER ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-21	DATE/REV: 2-00/A

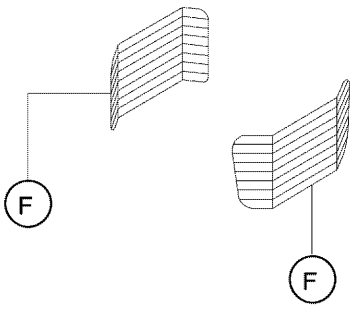


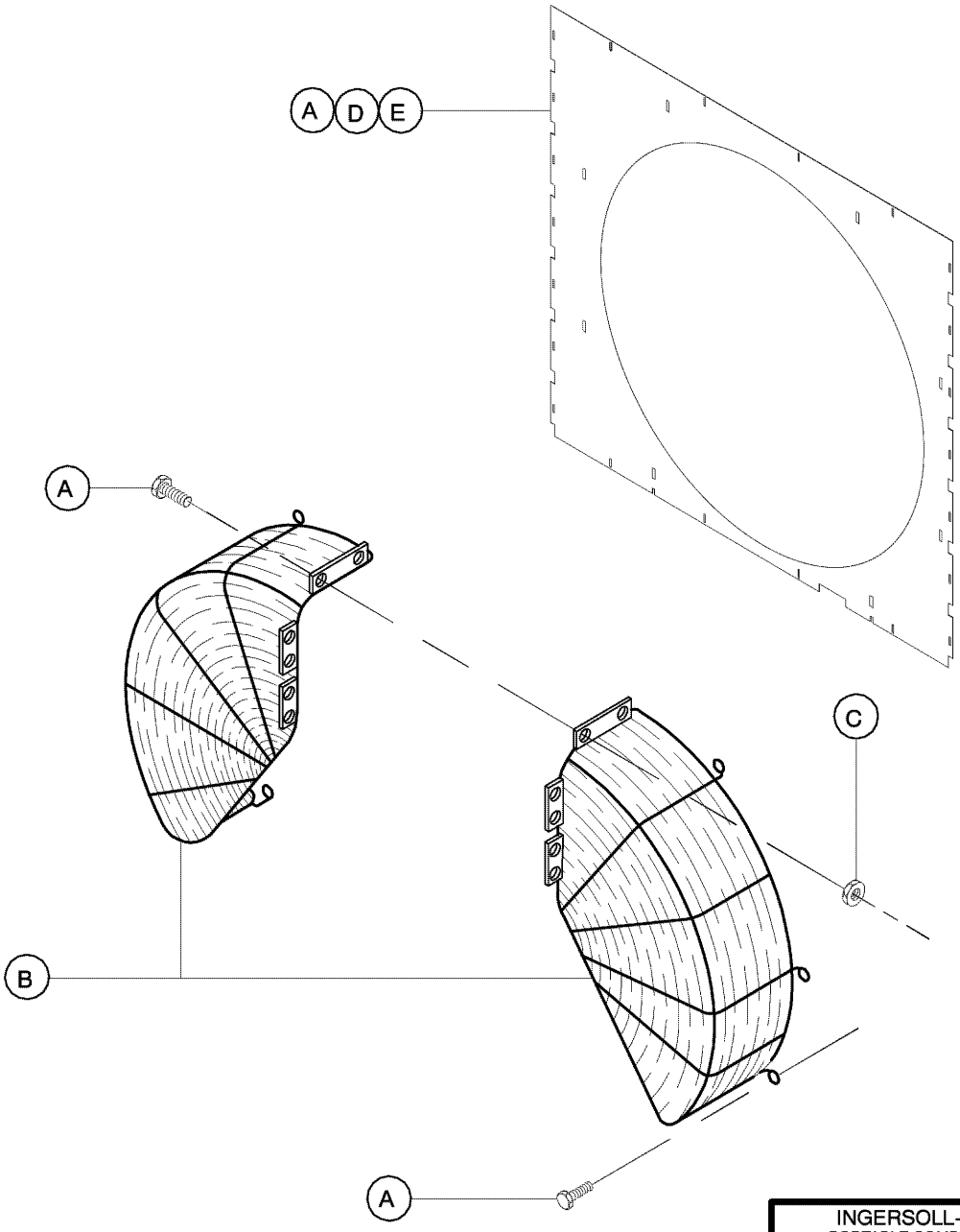
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION RADIATOR PIPING	
MODEL NO. XHP1070	MANUAL NO. 35391903-22	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	36762953	1	TUBE , LOWER
B	W86683	8	CLAMP , HOSE
C	35330570	3 at 5”	HOSE
D	23A7SZ5	1	BUSHING
E	35310598	1	ADAPTER
F	122A23S6	2	CLAMP , HOSE
G	35282086	68”	HOSE
H	35305234	1	ADAPTER
J	36762946	1	TUBE , UPPER
K	35360775	80”	TUBING
L	35135458	53”	HOSE
M	122A23S20	2	CLAMP , HOSE

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION RADIATOR PIPING	
MODEL NO. XHP1070	MANUAL NO. 35391903-23	DATE/REV: 2-00/A



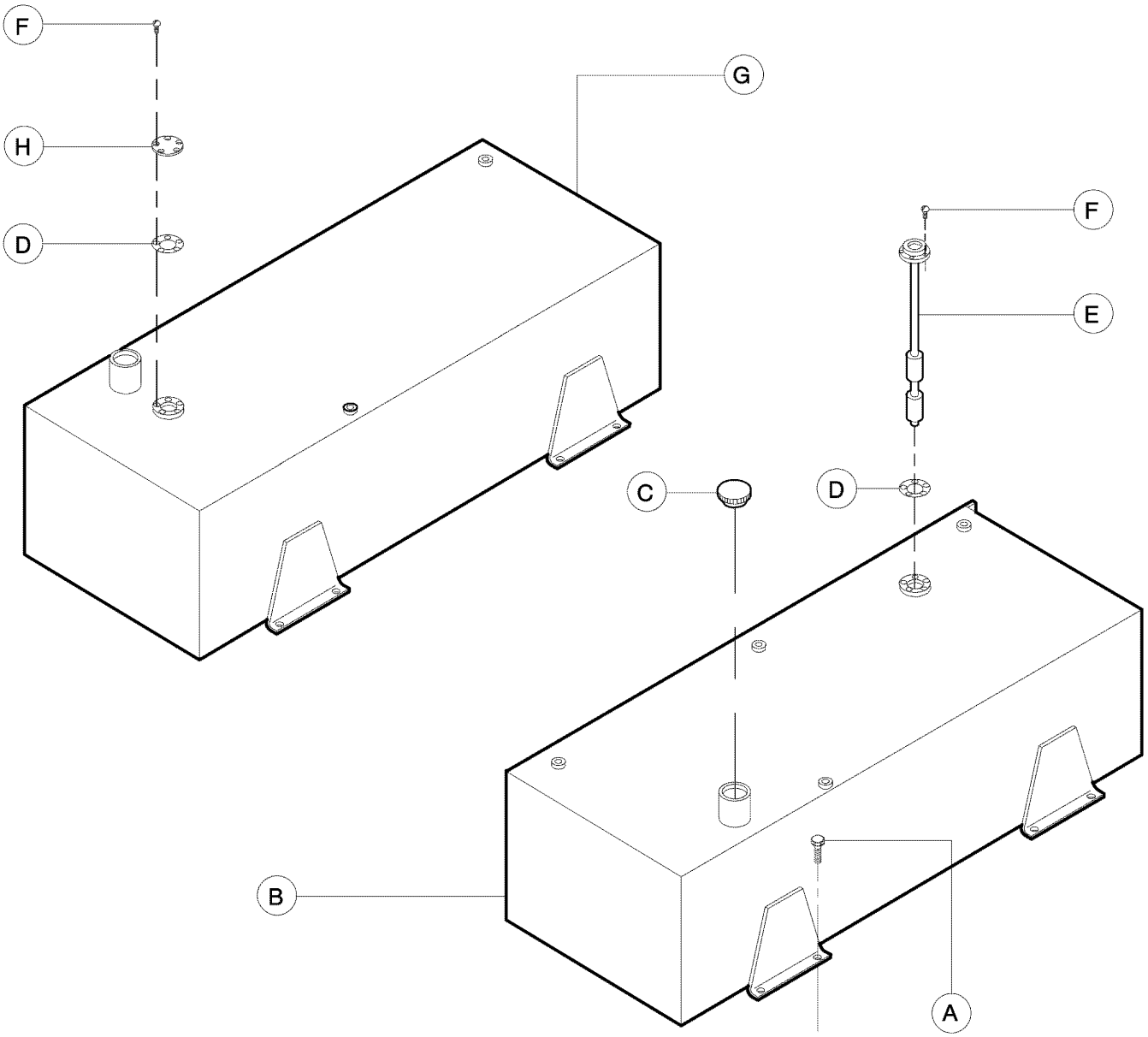




INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FAN GUARDS AND ORIFICE	
MODEL NO. XHP1070	MANUAL NO. 35391903-24	DATE/REV: 2-00/A

A	35144336	SCREW	(14 REQD)
B	36770667	GUARD	
C	35252600	NUT	(6 REQD)
D	36897676	ORIFICE	
E	35346741	NUT , RETAINER	(8 REQD)
F	36798205	GUARD , AIREND	
G	36898526	GUARD , FAN	
H	35603489	WASHER	(3 REQD)
J	35144344	BOLT	(3 REQD)
K	35145077	NUT	(3 REQD)

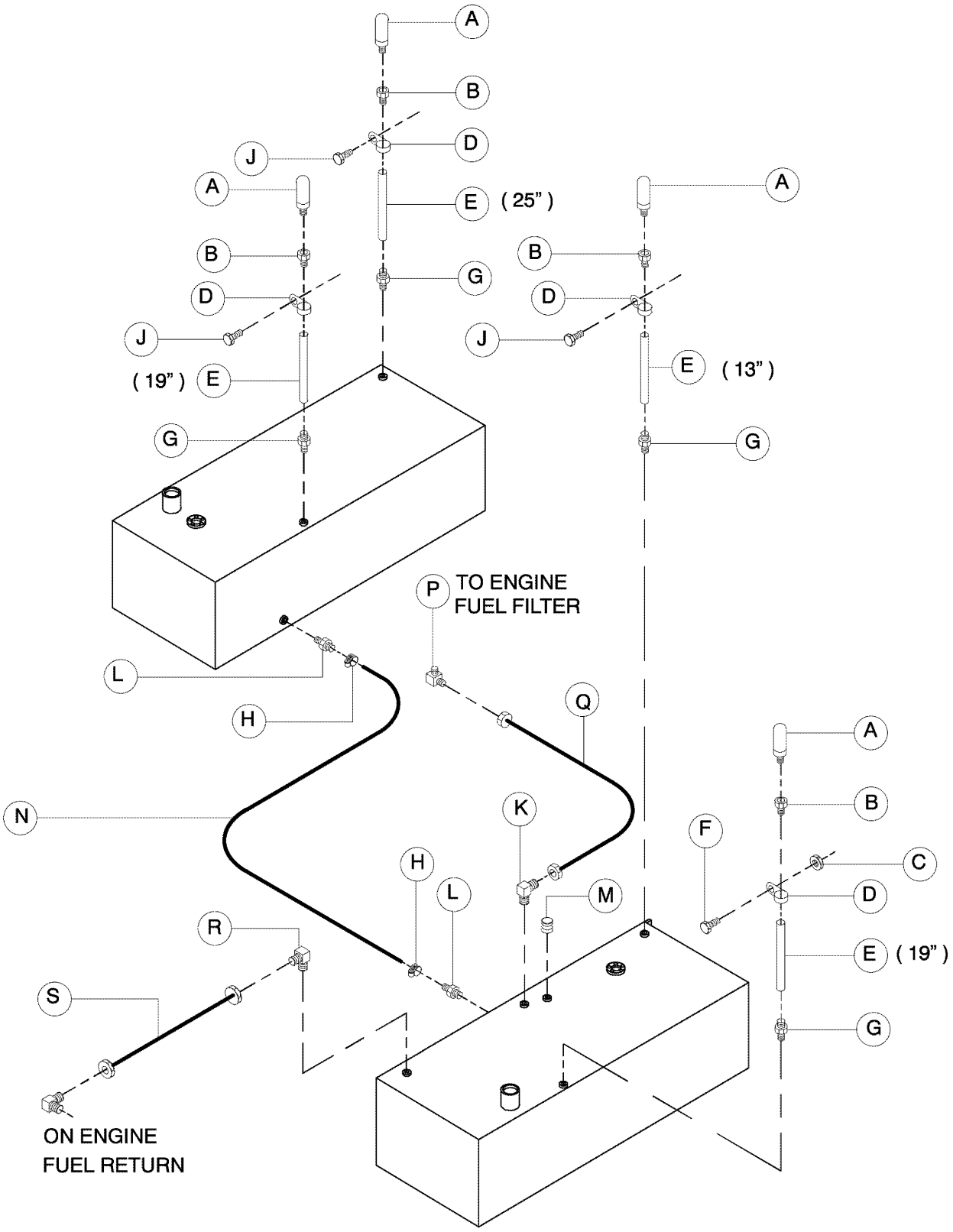
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FAN GUARDS AND ORIFICE	
MODEL NO. XHP1070	MANUAL NO. 35391903-25	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FUEL TANK ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-26	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	35130293	12	SCREW
B	36789428	1	TANK , RIGHT FUEL
	36870376	1	TANK , RIGHT FUEL (HIGH SPEED RUNNING GEAR)
C	35603679	2	FUEL CAP
D	35358159	2	GASKET
E	36840783	1	SENDER , FUEL LEVEL
F	35252279	10	SCREW
G	36755072	1	TANK , LEFT FUEL
	36870368	1	TANK , LEFT FUEL (HIGH SPEED RUNNING GEAR)
H	36792828	1	COVER

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FUEL TANK ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-27	DATE/REV: 2-00/A

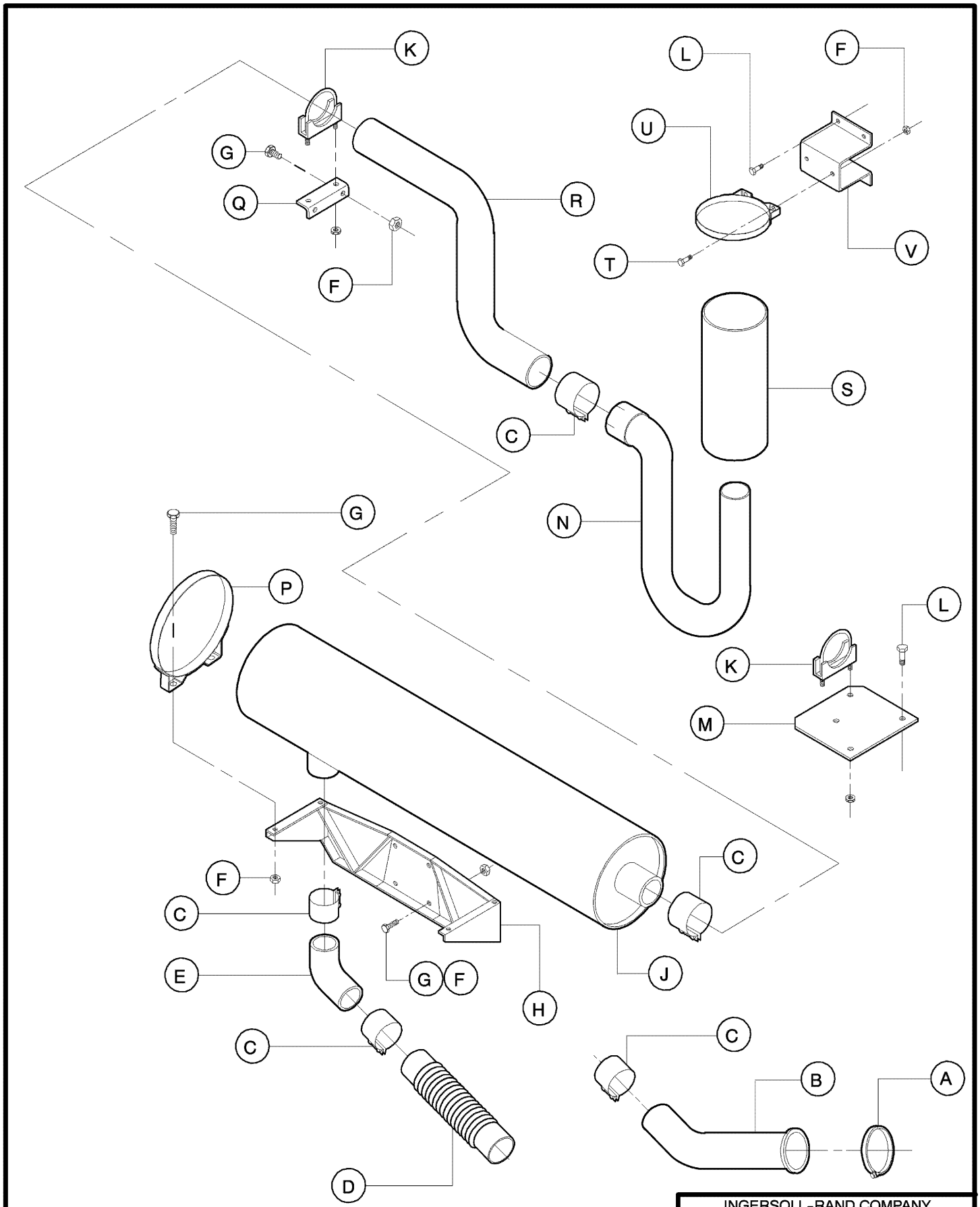


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FUEL PIPING	
MODEL NO. XHP1070	MANUAL NO. 35391903-28	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	35322395	4	SILENCER
B	35369339	4	CONNECTOR
C	35144492	1	NUT
D	W88678	4	CLAMP
E	35356484	★	TUBING
F	35144328	1	SCREW
G	35369347	4	CONNECTOR
H	35295773	2	CLAMP
J	92368687	3	SCREW
K	35309210	1	ELBOW , 90
L	36860039	2	CONNECTOR
M	35A7S7Z1	1	PLUG
N	35139500	1	HOSE
P	35283118	1	ELBOW , 90
Q	35310234	1	HOSE ASSY.
R	35279926	1	ELBOW , 90
S	35310994	1	HOSE ASSY.

★ SEE LENGTH REQD ON PAGE 1 of 2

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION FUEL PIPING	
MODEL NO. XHP1070	MANUAL NO. 35391903-29	DATE/REV: 2-00/A

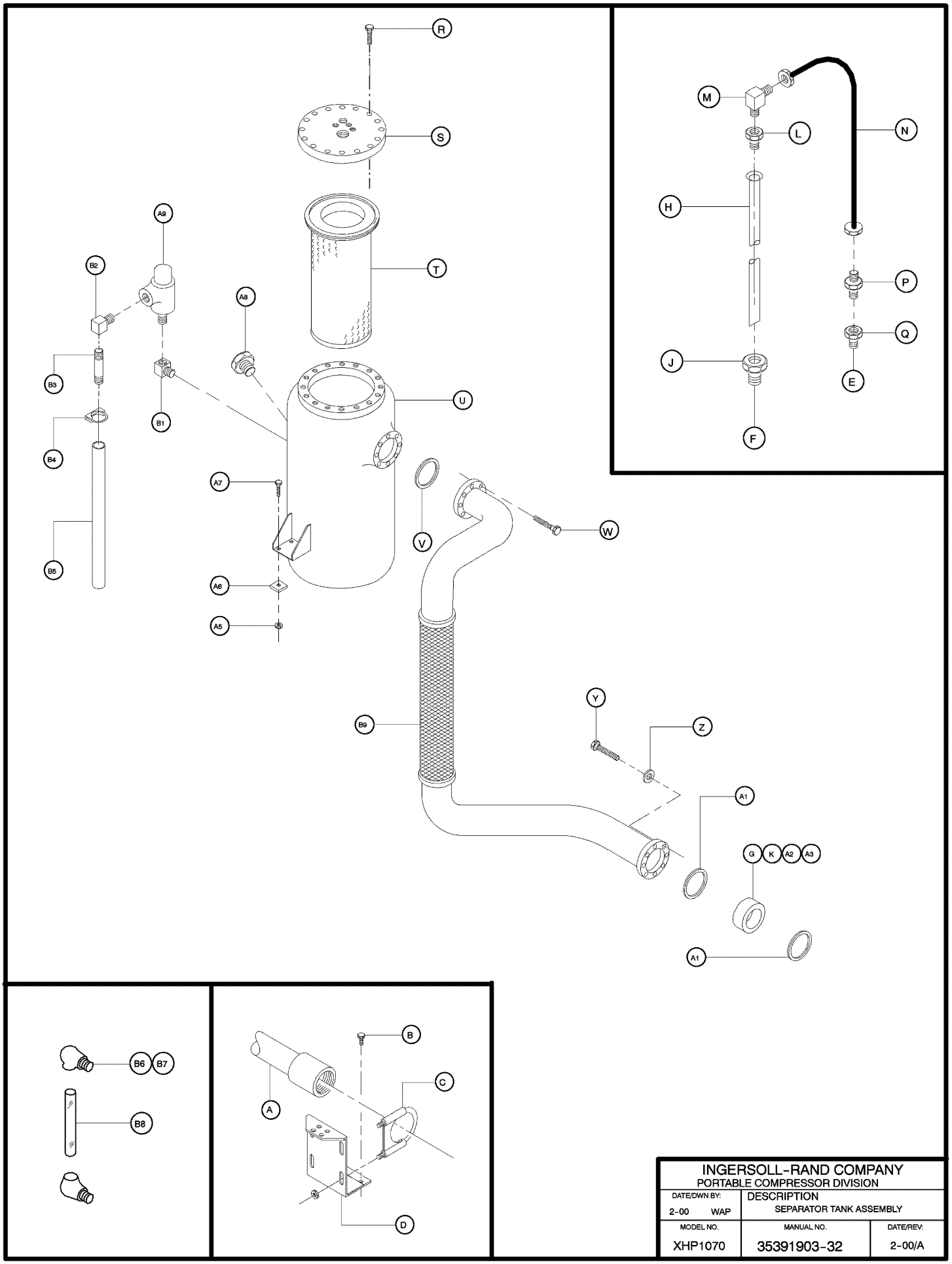


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION EXHAUST SYSTEM COMPLETE	
MODEL NO. XHP1070	MANUAL NO. 35391903-30	DATE/REV: 2-00/A

A	36758407	CLAMP , V-BAND
B	36506236	PIPE , TURBO
C	35307131	SEALCLAMP
D	36506095	PIPE , FLEX
E	36506228	PIPE , EHAUST
F	35145077	NUT
G	35144344	SCREW
H	36755569	BRACKET , MOUNTING
J	36755643	MUFFLER
K	35127653	CLAMP
L	36797652	SCREW
M	36849560	SUPPORT , CLAMP
N	36849610	PIPE , EXTENSION
P	36506079	BAND , MOUNTING
Q	35611235	BRACKET , PIPE
R	36765402	PIPE , TAIL
S	36787034	TUBE , EXHAUST
T	35252493	SCREW
U	36787026	BAND , MOUNTING
V	36845089	BRACKET , TUBE

INGERSOLL-RAND COMPANY
PORTABLE COMPRESSOR DIVISION

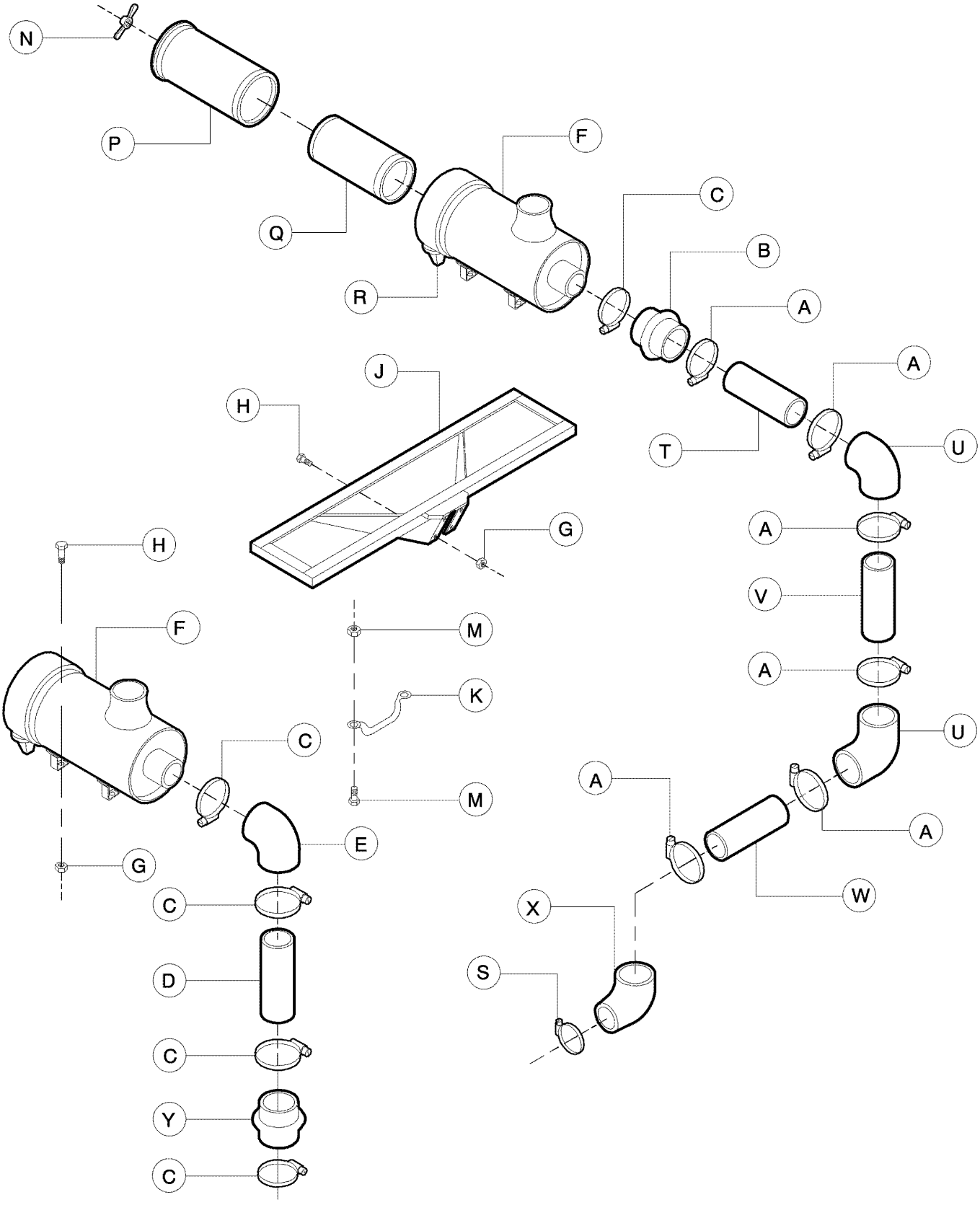
DATE/DWN BY:	DESCRIPTION	
2-00 WAP	EXHAUST SYSTEM COMPLETE	
MODEL NO.	MANUAL NO.	DATE/REV:
XHP1070	35391903-31	2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION SEPARATOR TANK ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-32	DATE/REV: 2-00/A

A	SEE AIR PIPING DRAWING		
B	35138171	SCREW	(2 REQD)
C	36799419 & 35586288	U-BOLTS	
D	36797702	BRACKET , SERV. PIPE	
E	TO AIR END		
F	TO SEPARATOR TANK COVER		
G	36843720	VALVE , DISCHARGE CHECK	
H	35593201	TUBE , SCAVENGE	
J	35329309	FITTING ,LENZ	
K	36768992	SEAL	
L	X1080T53A	ORIFICE	
M	35283464	ELBOW ,90	
N	35322494	HOSE	
P	35283076 & 35306109	CONN. & NUT	
Q	35306091	REDUCER	
R	35A2D382G	SCREW	(12 REQD)
S	36762318	COVER	(STANDARD)
	36856631	COVER	(CE MARK)
T	36762250	ELEMENT , SEP.	
U	36849180	TANK , SEPARATOR (STANDARD)	
	36848091	TANK , SEPARATOR (CE MARK)	
V	33A11C8	GASKET	
W	35A2D380G	SCREW	(8 REQD)
X	36897056	PIPE , DISCHARGE	
Y	35376094	SCREW	(8 REQD)
Z	11A5G8	WASHER	(8 REQD)
A1	33A11C8	GASKET	
A2	36843720	VALVE , CHECK	
A3	36769008	SPRING	
A4	PART ELIMINATED		
A5	35252618	NUT	(4 REQD)
A6	36762565	PAD	(4 REQD)
A7	35252568	SCREW	(4 REQD)
A8	35802933	PLUG , FILLER	
A9	35596733	VALVE , SAFETY	
B1	102A7MZ4	ELBOW , 90	
B2	67A7MZ7	ELBOW , 90	
B3	36762821	NIPPLE	
B4	35261155	CLAMP	
B5	36764868	PIPE	
B6	36860468	FITTING	
B7	35324649	GASKET	(2 REQD)
B8	36845444	TUBE , SIGHT	
B9	36897056	PIPE , DISCHARGE	

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION SEPARATOR TANK ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-33	DATE/REV: 2-00/A

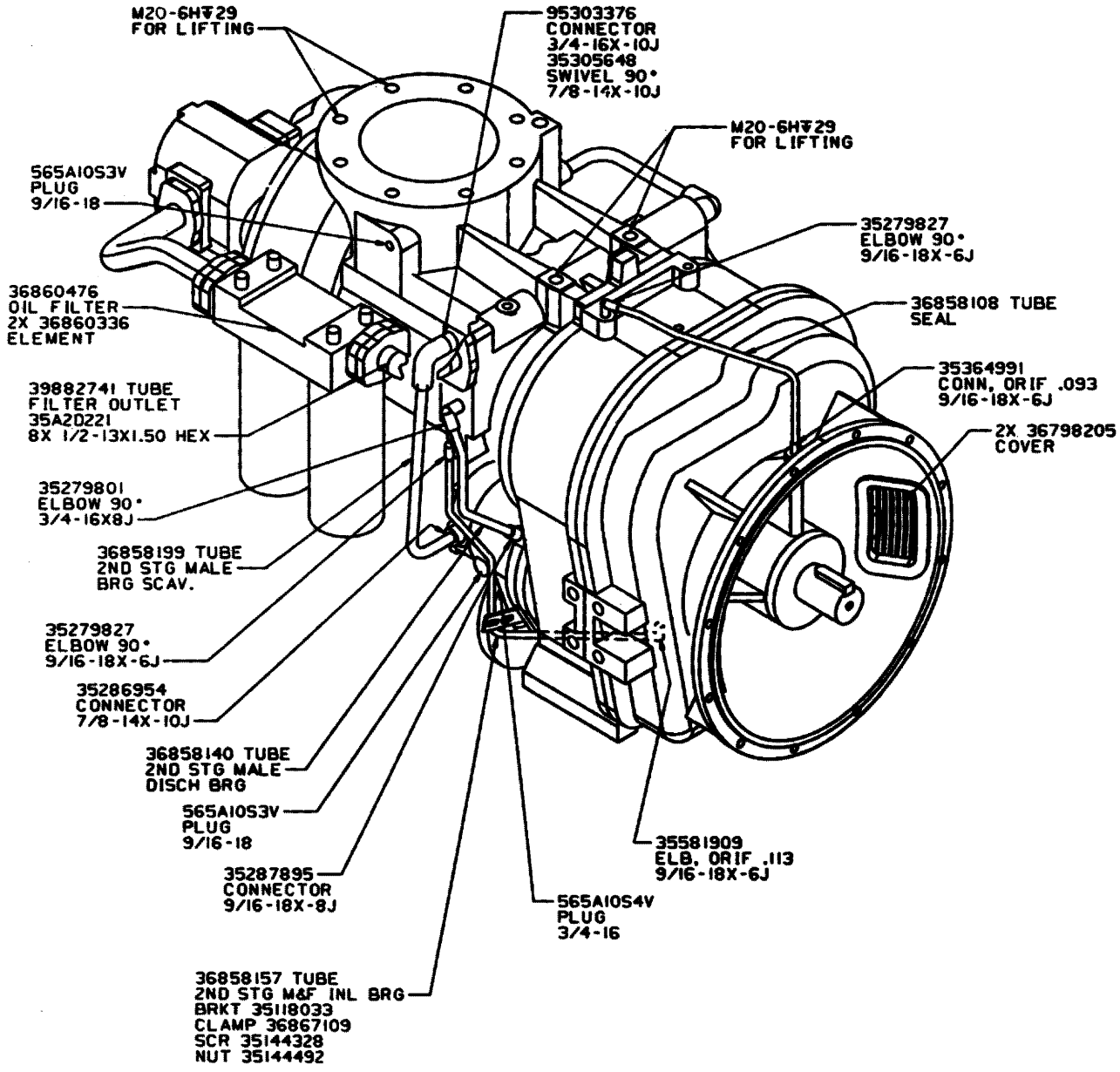


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR FILTERS AND MOUNTING	
MODEL NO. XHP1070	MANUAL NO. 35391903-34	DATE/REV: 2-00/A

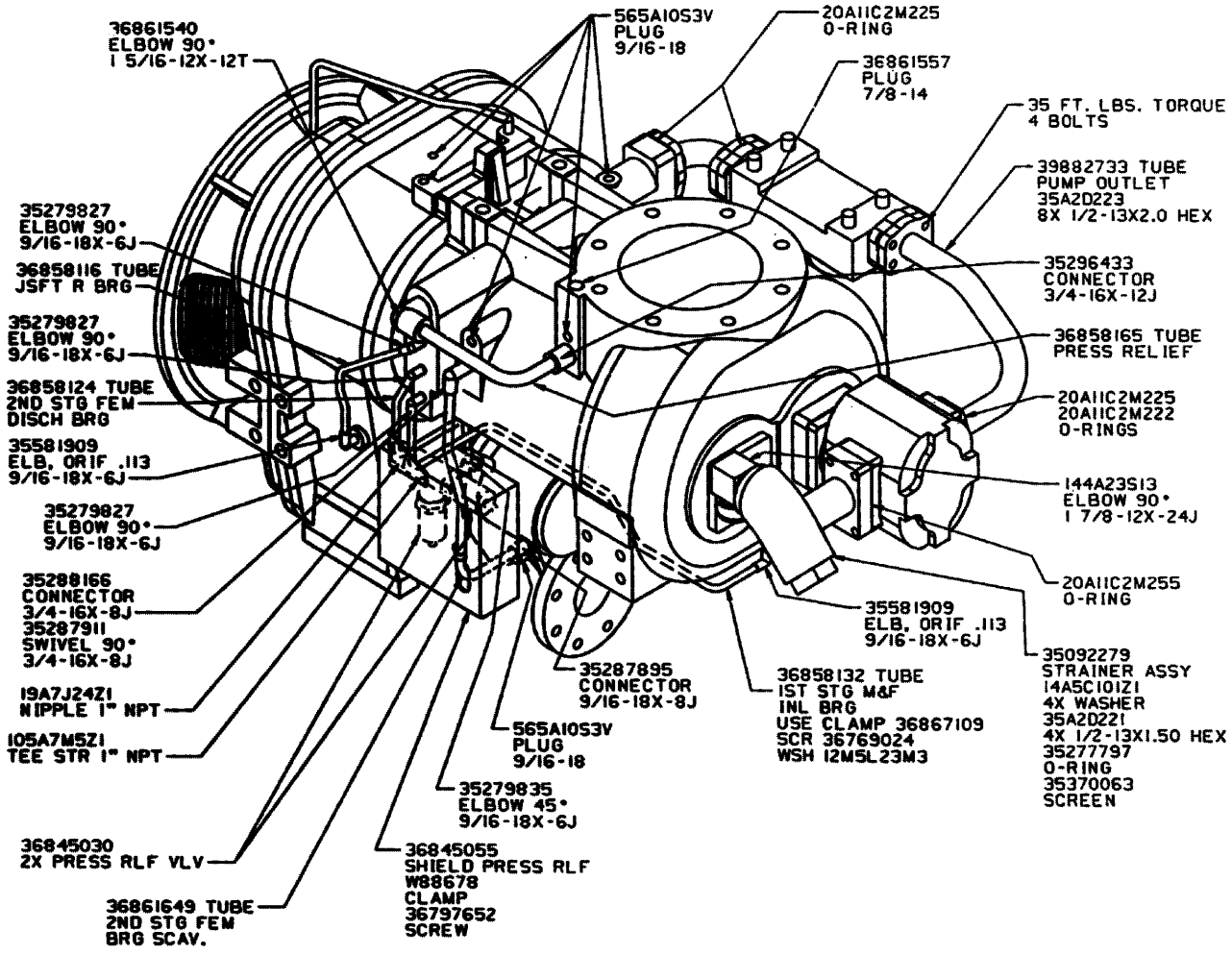
ITEM		C.P.N.	QTY	DESCRIPTION
A		35119858	6	CLAMP
B		35141290	1	HOSE , REDUCER HUMP
C		35129071	5	CLAMP
D		36864726	1	TUBE , CONNECTOR
E		35120211	1	ELBOW , RUBBER
F		36864346	2	AIR CLEANER ASSEMBLY
G		35145077	12	NUT
H		35144344	12	SCREW
J		36755163	1	BRACKET , AIR CLEANER
K		35130707	1	HOLD , HAND
L		35252600	2	NUT
M		35321108	2	SCREW
N	★	35388982	2	NUT , WING
P	★	36864361	1	ELEMENT , PRIMARY
Q	★	36864379	1	ELEMENT , SAFETY
R	★	35388990	1	EJECTOR , DUST
S		35123496	1	CLAMP
T		36794964	1	TUBE , CONNECTOR
U		35271683	2	ELBOW , RUBBER
V		35505866	1	TUBE , CONNECTOR
W		36505790	1	TUBE , CONNECTOR
X		35583236	1	ELBOW , RUBBER
Y		35120260	1	HOSE , HUMP

★ ITEMS INCLUDED IN AIR CLEANER ASSEMBLY 36864346

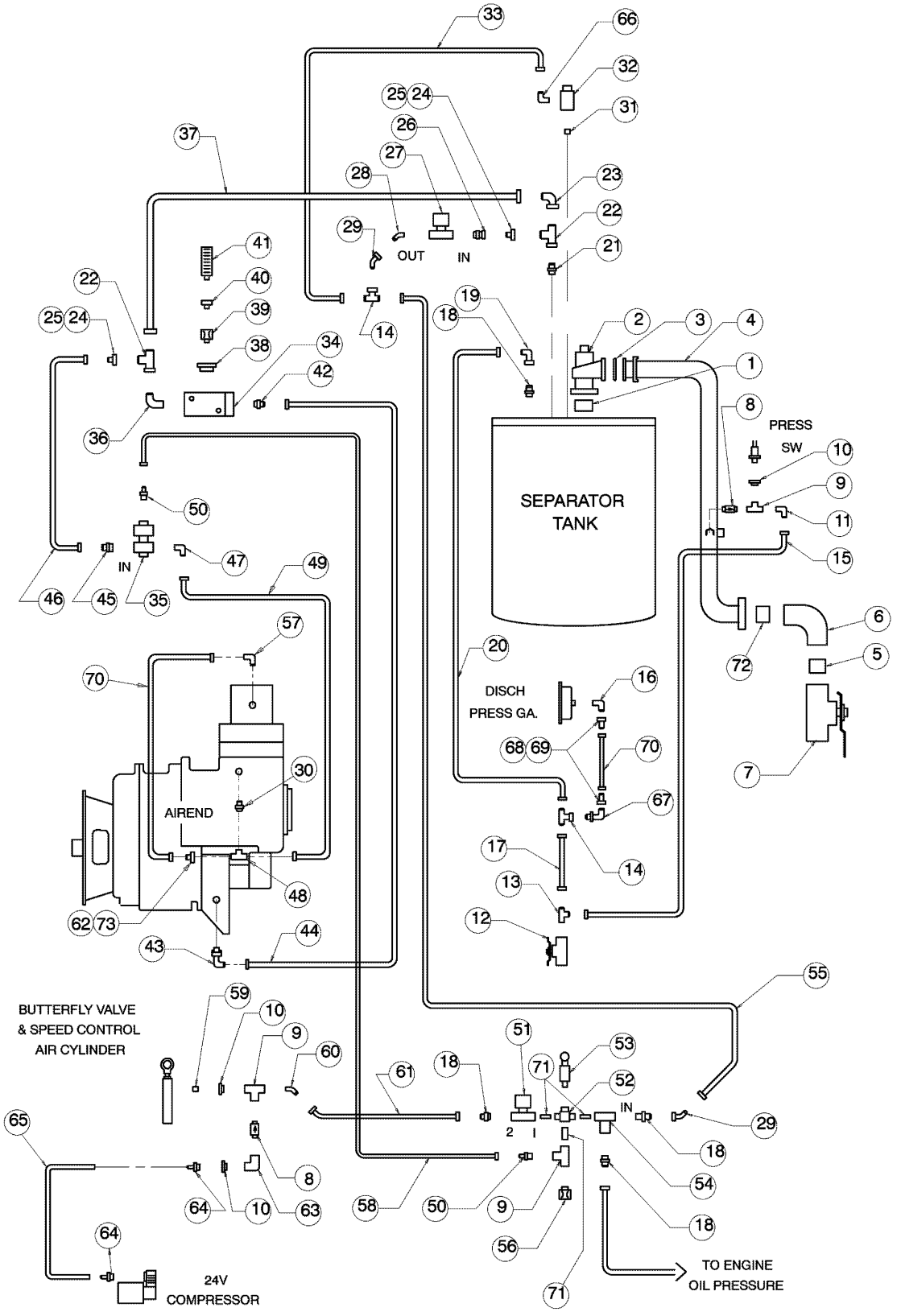
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR FILTERS AND MOUNTING	
MODEL NO. XHP1070	MANUAL NO. 35391903-35	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR END PIPING	
MODEL NO. XHP1070	MANUAL NO. 35391903-36	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR END PIPING	
MODEL NO. XHP1070	MANUAL NO. 35391903-37	DATE/REV: 2-00/A

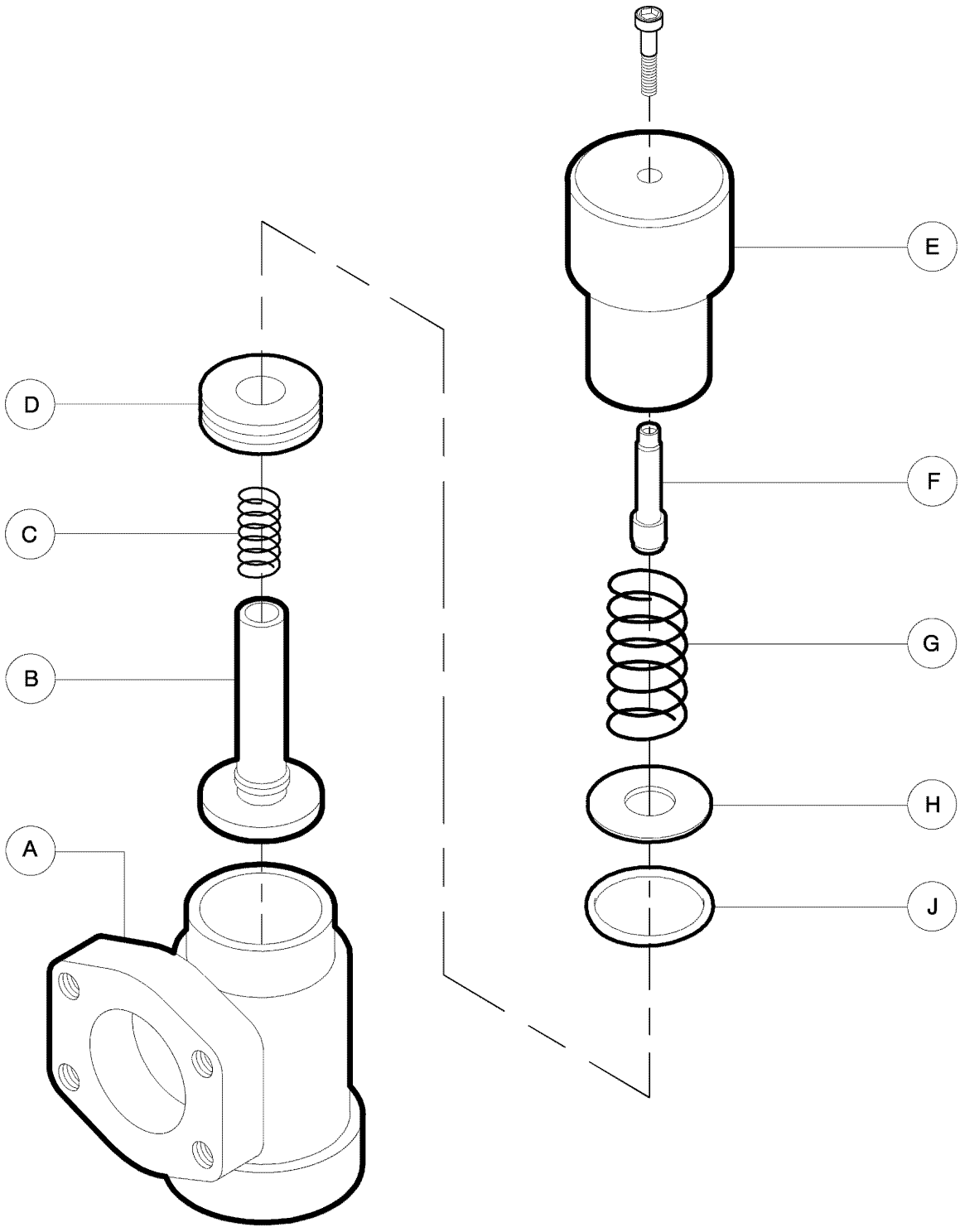


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR PIPING	
MODEL NO. XHP1070	MANUAL NO. 35391903-38	DATE/REV: 10-00/B

ITEM	C.P.N.	DESCRIPTION
1	95934287	NIP CLNPT300X262
2	36762268	V 3.0 IN. MIN PRESS
3	95358040	ORING
4	36797827	PIPE SERV
5	95940946	NIP SHTNPT300X300
6	95916581	ELL NPT300X90
7	36755718	V 3.0 BALL
8	35248145	VALVE 1/4 CHECK
9	35321272	TEE 1/4 NPT
10	95930301	BSHG RDCNPTO25X012
11	35279934	ELL,90,1/4NPT,-6JIC
12	35324839	VALVE BALL 1/4 NPT
13	35283050	TEE,RUN 1/4NPT -6JIC
14	35283092	TEE,BR,SWV NUT,-6JIC
15	35282961	HOSE,JIC -6 X 13
16	35280098	ELL,90,1/4NPT FEM,6JIC
17	35330513	HOSE, JIC -6 X 12
18	35284082	CONN,1/4 NPT X -6JIC
19	35283068	ELL,90,SWV NUT,-6JIC
20	35294701	HOSE, JIC -6 X 37
21	95219747	ADPTR 3/4PX3/4JIC
22	35287739	RUN TEE -12 JIC
23	35301506	ELB 90 SWIV NUT -12
24	35365774	REDUCER TUBE
25	35324987	NUT TUBE -12
26	35368927	3/8NPT X -6 FML SWL
27	36842300	V SOL 24V NC .375NPT
28	35294743	ELBOW 45
29	35283100	ELL,45,SWV NUT,-6JIC
30	35287895	CONN 9/16-18 ORING X -8 JIC
31	95944575	NIP CL NPT 025X088
32	35315795	VALVE, REGULATOR
33	35282946	HOSE, JIC -6 X 9.5
34	35849215	VALVE AUTO BLOWDOWN
35	35316405	VALVE ANTI-RUMBLE
36	35294735	ELB,3/4NPT X -12JIC
37	35323807	HOSE,-12 X 68.00
38	95944633	BSHG RDCNPT075X025
39	35322346	ORF CONN .156
40	95948501	ADPTR NPT 050X025
41	35132299	SILENCER,BLOWDN EPA
42	35290147	CONN 3/8 NPT -6 JIC
43	35279827	ELL,90,9/16-18X-6JIC
44	35282987	HOSE, JIC -6 X 34
45	35286426	CONN 1/2 NPT X-8 JIC
46	35252782	HOSE, JIC -8 X 13
47	35309210	ELBOW 90,1/2 NPTX-8 JIC
48	95642484	TEE,BR,SWV NUT,-8 JIC
49	35283308	HOSE,JIC -8 X 26
50	35283472	CONN, 1/4 NPT -4JIC
51	36842318	V SOL 24V NO .250NPT
52	35321264	CROSS 1/4 NPT
53	35325133	VALVE, SAFETY
54 *	35322379	BLOWDOWN VALVE
55	35284504	HOSE ASSY -6 X 26
56	37081528	ORIFIC .063
57	35283464	ELB 90,1/4 NPT -4 JIC
58	35283258	HOSE , JIC -4 X 34
59	95953493	NIP CLNPT012X075
60	35290253	ELB 45-1/4NPTX-6JIC
61	35282979	HOSE, JIC -6 X 21
62	35299734	RDCR -8 JIC X -4 JIC
63	95954095	ELB .25 NPT
64	95287629	ADPTR BARB012X012NPT
65	35282920	HOSE , JIC -4 X 30
66	35301126	ELL 90 1/8NPT X -6
67	36852499	ELB BULKHEAD -6
68	35306091	REDUCER TUBE -6 X -4
69	35306109	NUT TUBE -6
70	35282904	HOSE JIC -4 X 11.25
71	36793776	NIPPLE 0.25 NPT
72	54393210	ORIFICE,3 NPT X 3.0 LONG
73	35296219	NUT TUBE -8

* 35379064 KIT BLWDN V DIAPH

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION AIR PIPING	
MODEL NO. XHP1070	MANUAL NO. 35391903-39	DATE/REV: 10-00/B



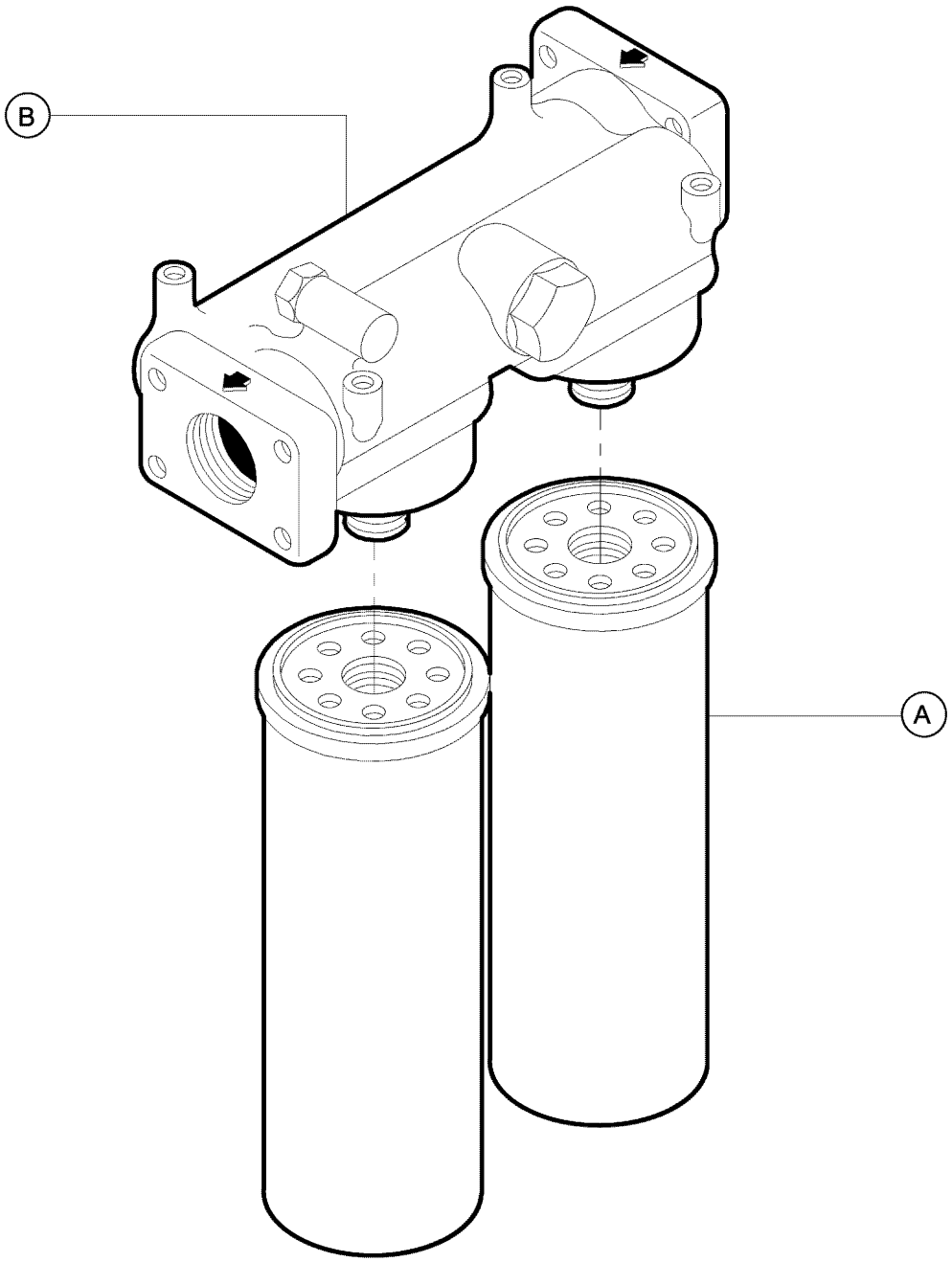
MINIMUM PRESSURE CHECK VALVE ASSEMBLY 36762268

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION MINIMUM PRESSURE CHECK VALVE	
MODEL NO. XHP1070	MANUAL NO. 35391903-40	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	36792323	1	BODY
B	36792307	1	VALVE , CHECK
C	36792356	1	SPRING , CHECK VALVE
D	36792315	1	PISTON
E	36792331	1	CAP
F	36792372	1	GUIDE
G	36792349	1	SPRING , MAIN
H	36792380	1	SPACER
J	36792364	1	O-RING

MINIMUM PRESSURE CHECK VALVE ASSEMBLY 36762268

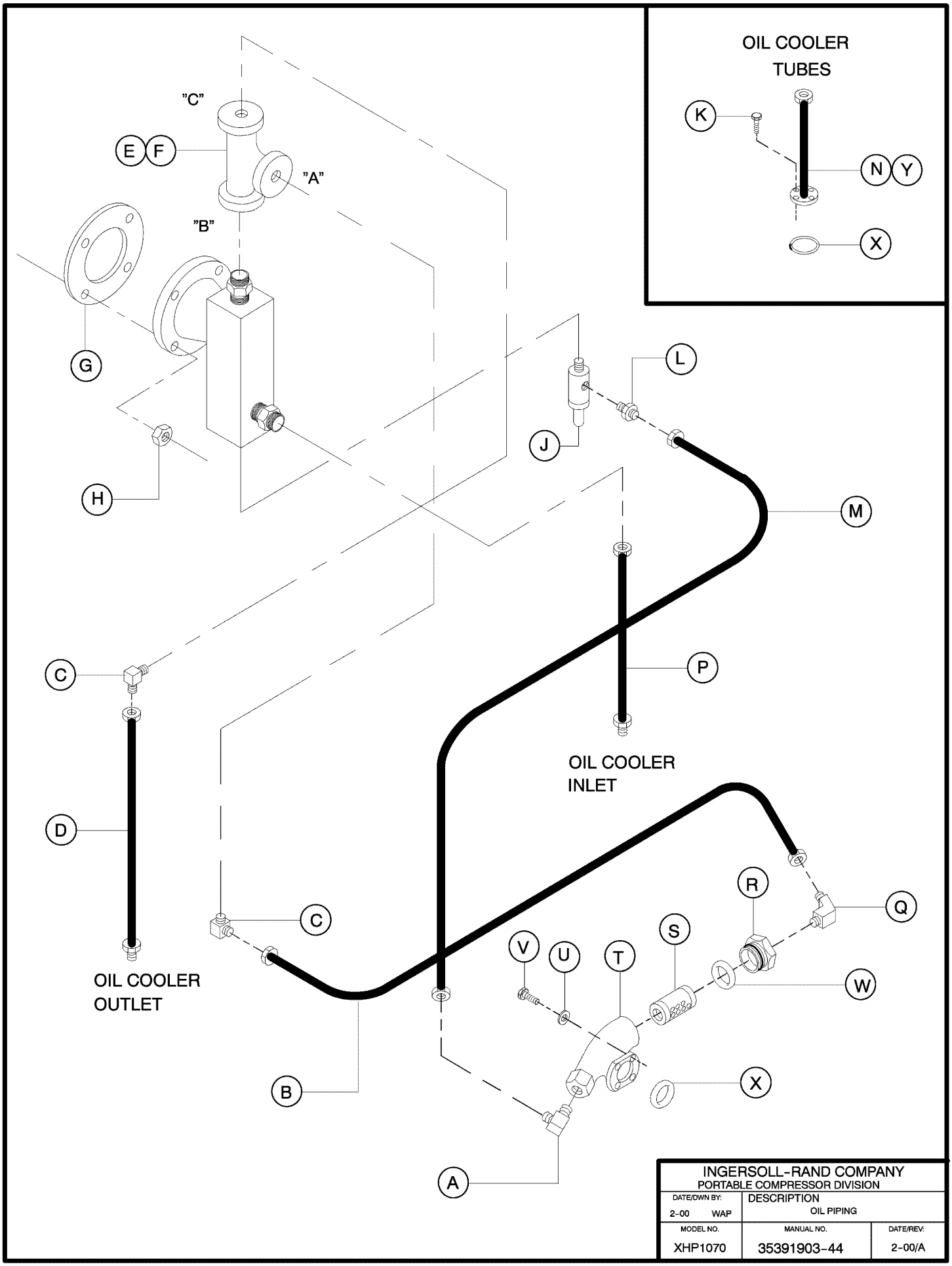
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION MINIMUM PRESSURE CHECK VALVE	
MODEL NO. XHP1070	MANUAL NO. 35391903-41	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION OIL FILTER ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-42	DATE/REV: 2-00/A

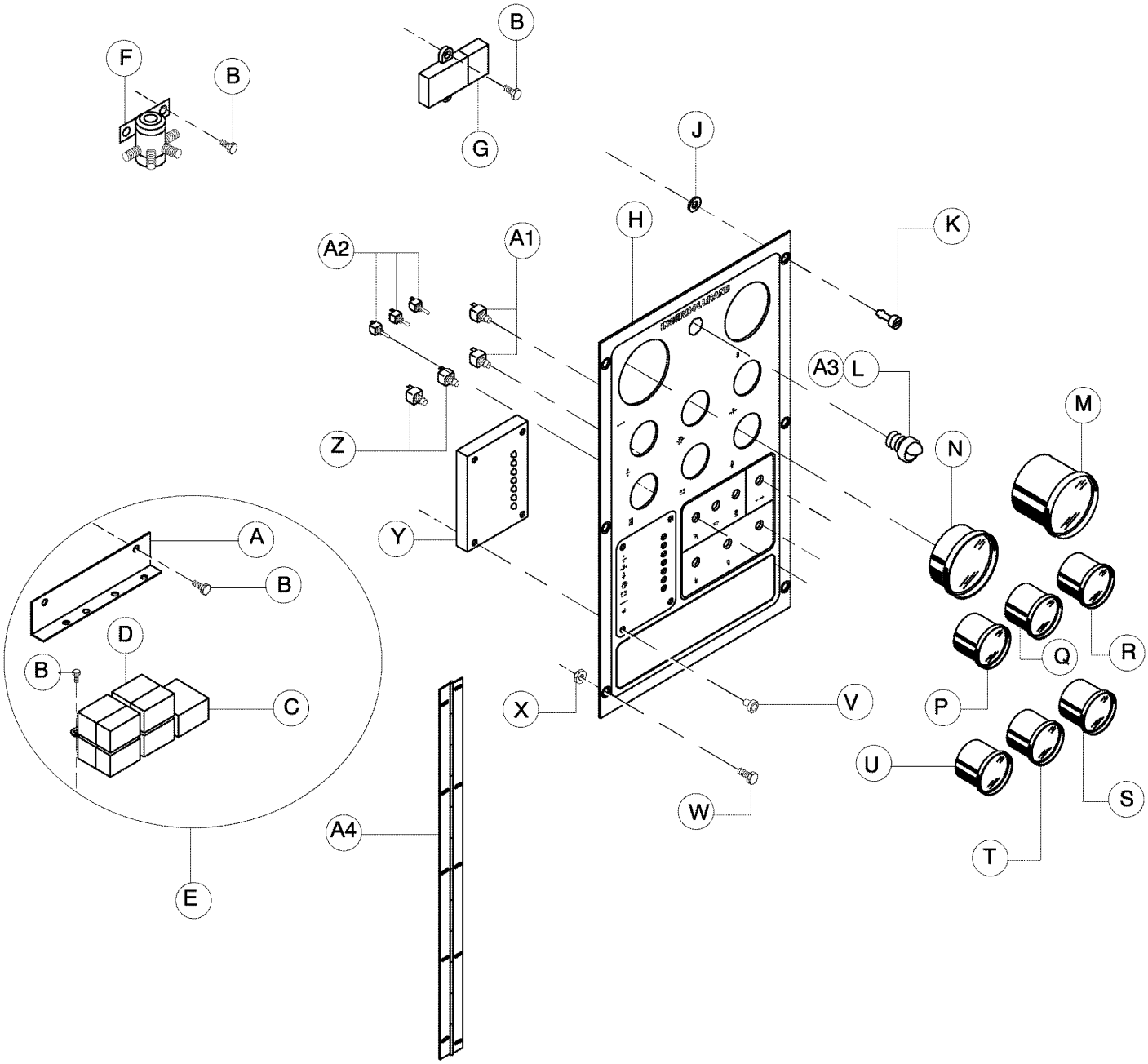
ITEM	C.P.N.	QTY	DESCRIPTION
A	36860336	2	ELEMENT , FILTER
B	36860476	1	FILTER HEAD ASSEMBLY

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION OIL FILTER ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-43	DATE/REV: 2-00/A


OIL COOLER
TUBES
K
N
Y
X
"C"
E
F
"A"
"B"
G
H
L
J
M
P
C
D
OIL COOLER
INLET
OIL COOLER
OUTLET
C
R
Q
V
U
T
S
W
B
X
A
INGERSOLL-RAND COMPANY
PORTABLE COMPRESSOR DIVISION
DATE/DWN BY:
2-00 WAP
DESCRIPTION
OIL PIPING
MODEL NO.
XHP1070
MANUAL NO.
35391903-44
DATE/REV:
2-00/A

A	35294750	ELBOW , 90 °
B	35130863	HOSE ASSEMBLY
C	95431292	ELBOW , 90 °
D	36897825	TUBE , OIL COOLER
E	39207402	THERMOSTAT
F	36897940	VALVE , OIL TEMP. BY-PASS
G	36786580	GASKET
H	95922928	NUT
J	36885887	VALVE , PRESS. RELIEF
K	95920708	SCREW
L	95279329	ADAPTER
M	35323864	HOSE ASSEMBLY
N	36767978	TUBE , OIL COOLER OUTLET
P	36897262	TUBE , OIL COOLER
Q	35296425	ELBOW , 45 °
R	35609098	PLUG
S	35370063	ELEMENT
T	36751295	BODY
U	95934733	WASHER
V	95104170	SCREW
W	35277797	O-RING
X	95357943	O-RING
Y	36767986	TUBE , OIL COOLER INLET

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION OIL PIPING	
MODEL NO. XHP1070	MANUAL NO. 35391903-45	DATE/REV: 2-00/A

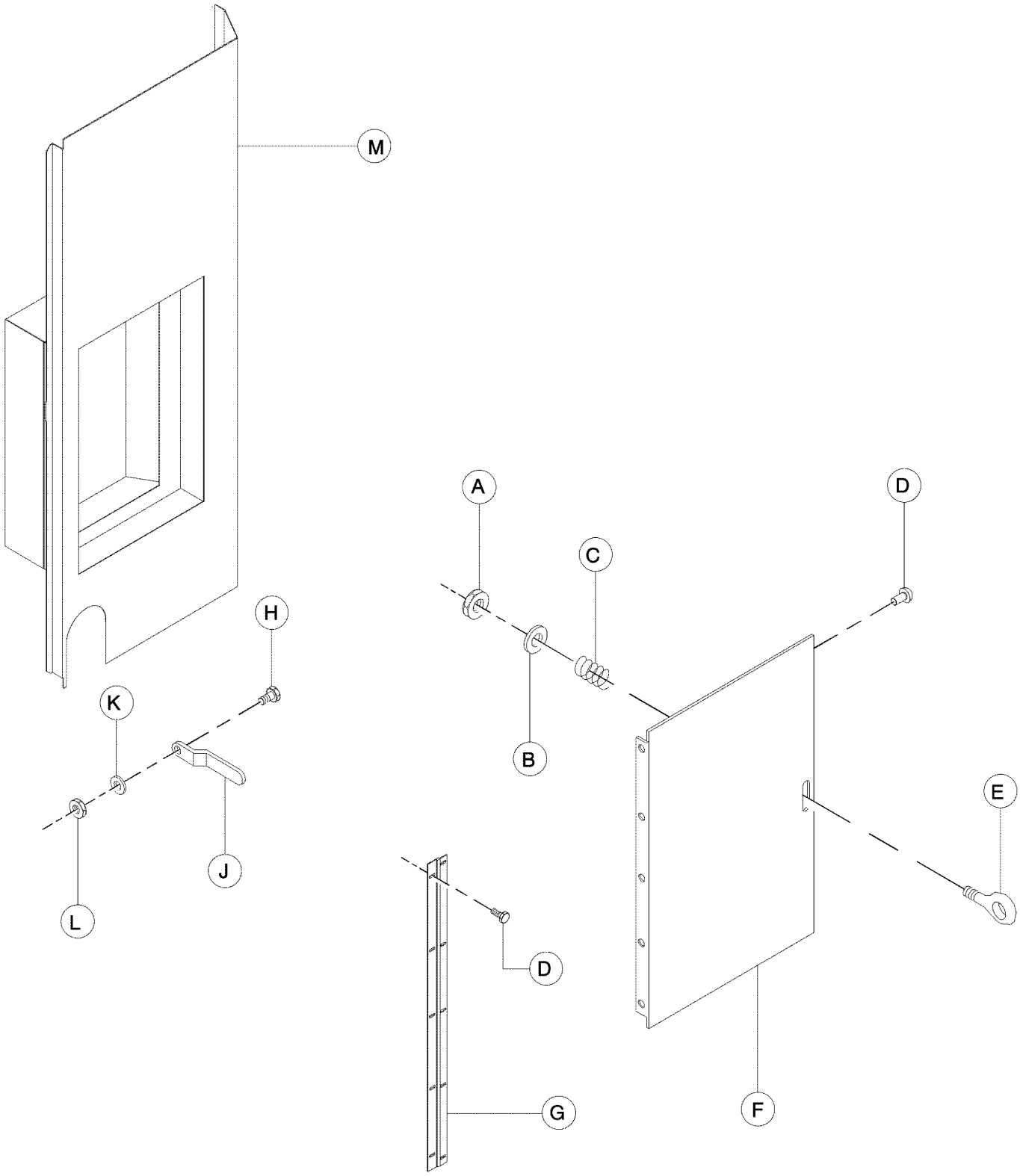


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION INSTRUMENT / CONTROL PANEL	
MODEL NO. XHP1070	MANUAL NO. 35391903-46	DATE/REV: 2-00/A

ITEM		C.P.N.	DESCRIPTION
A	★	36840924	BRACKET , RELAY
B		92368687	SCREW
C	★	35583442	RELAY , POWER SUPPLY
D	★	35586130	RELAY
E		36008522	RELAY ASSEMBLY
F		35577873	SWITCH , SOLENOID
G		35356781	MODULE , LOW WATER
H		36840239	PANEL , INSTR/CONTROL
J		35369180	RETAINER
K		36844124	STUD
L		36841252	LIGHT , INDICATOR
M		36861177	TACHOMETER
N		36841468	GAGE , DISCHARGE PRESS.
P		35604115	GAGE , AIR TEMP.
Q		35604099	GAGE , FUEL LEVEL
R		35373729	GAGE , ENG. OIL PRESS.
S		35604115	GAGE , WATER TEMP.
T		36841153	GAGE , VOLTMETER
U		36841245	GAGE , HOURMETER
V		36775484	RIVET
W		35365386	SCREW
X		35144492	NUT
Y		36771434	MODULE , DIAGNOSTIC
Z		35255553	SWITCH , ETHER/START
A1		35255561	SWITCH , BYPASS/AIR
A2		35337435	SWITCH , TOGGLE
A3		35290089	BULB , LIGHT
A4		36840908	HINGE

★ INCLUDED IN RELAY ASSEMBLY 36008522

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION INSTRUMENT / CONTROL PANEL	
MODEL NO. XHP1070	MANUAL NO. 35391903-47	DATE/REV: 2-00/A

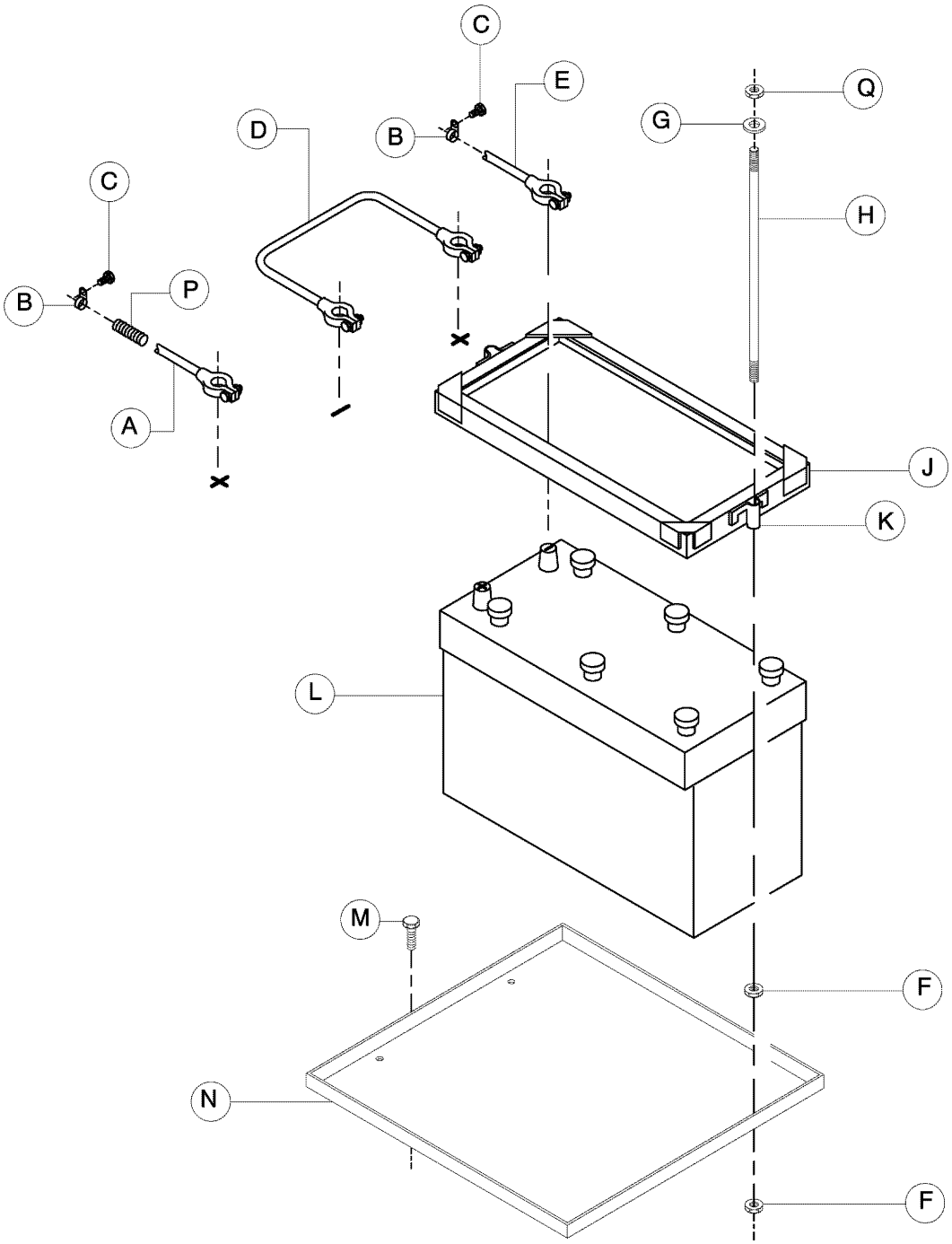


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION INSTRUMENT / CONTROL PANEL MOUNTING	
MODEL NO. XHP1070	MANUAL NO. 35391903-48	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	67A4C2Z1	1	NUT
B	11A5D3Z1	1	WASHER
C	35327311	1	SPRING
D	36797652	7	SCREW
E	35327303	1	EYEBOLT
F	36738565	1	DOOR , CONTROL PANEL
G	36740405	1	HINGE , CONTROL PANEL
H	35357995	1	STUD
J	35603349	1	HOLDER , DOOR
K	11A5D4Z1	1	WASHER
L	35273366	1	NUT
M	36863710	1	PANEL , L.F. VERTICAL CORNER

INGERSOLL-RAND COMPANY
PORTABLE COMPRESSOR DIVISION

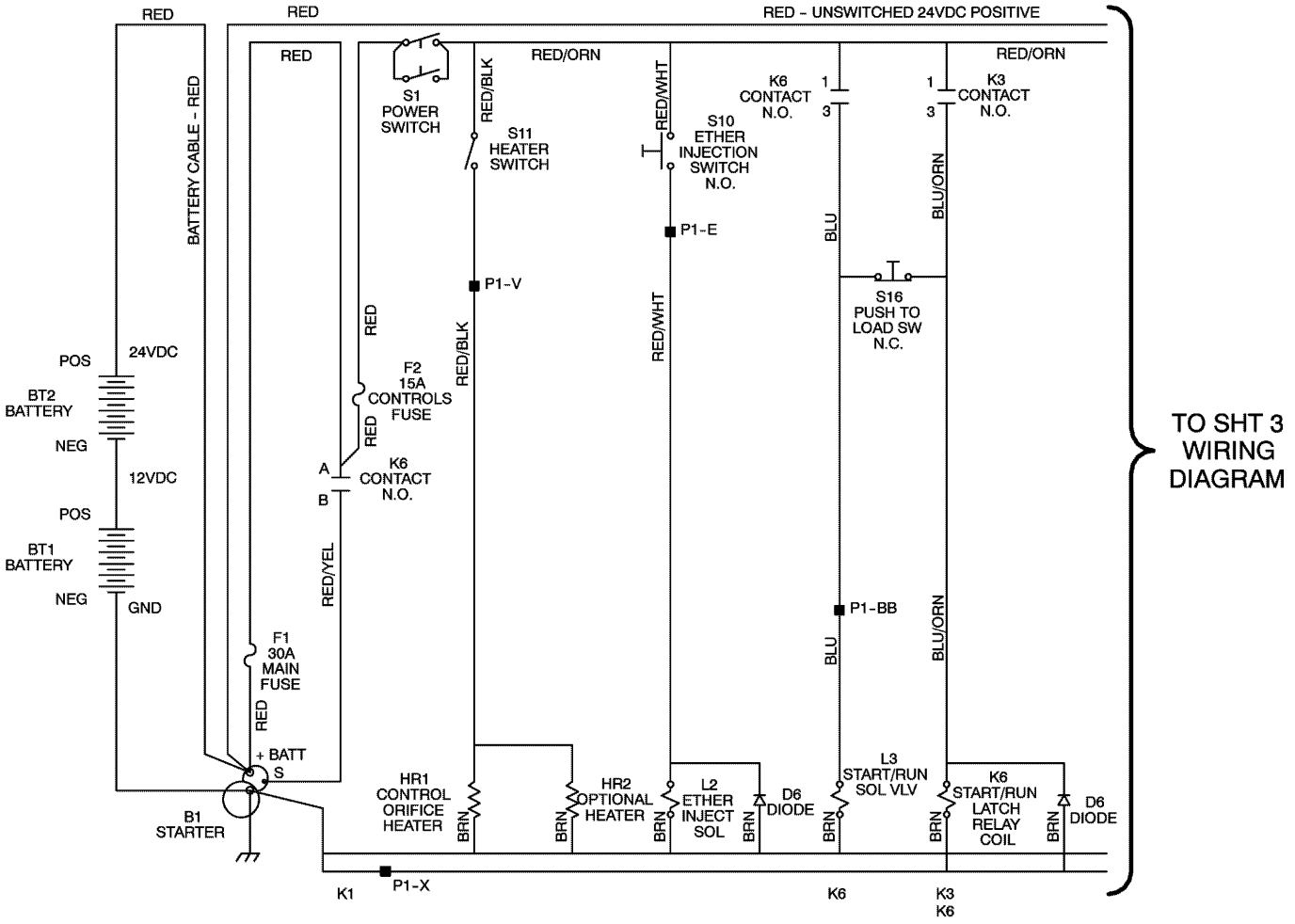
DATE/DWN BY:	DESCRIPTION	
2-00 WAP	INSTRUMENT / CONTROL PANEL MOUNTING	
MODEL NO.	MANUAL NO.	DATE/REV:
XHP1070	35391903-49	2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION BATTERY AND MOUNTING	
MODEL NO. XHP1070	MANUAL NO. 35391903-50	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	35579150	1	CABLE , POS.
B	W88421	4	CLAMP
C	35134550	2	SCREW
D	35128982	1	CABLE , JUMPER
E	35587088	1	CABLE , NEG.
F	35145077	8	NUT
G	11A5D4Z1	4	WASHER
H	35608116	4	STUD
J	R35343	2	FRAME
K	35108216	4	CLIP
L	W90195	2	BATTERY
M	92368687	3	SCREW
N	36786424	1	TRAY , BATTERY
P	35134519	32”	COIL , PLASTIC
Q	16A4C3Z1	4	NUT

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION BATTERY AND MOUNTING	
MODEL NO. XHP1070	MANUAL NO. 35391903-51	DATE/REV: 2-00/A

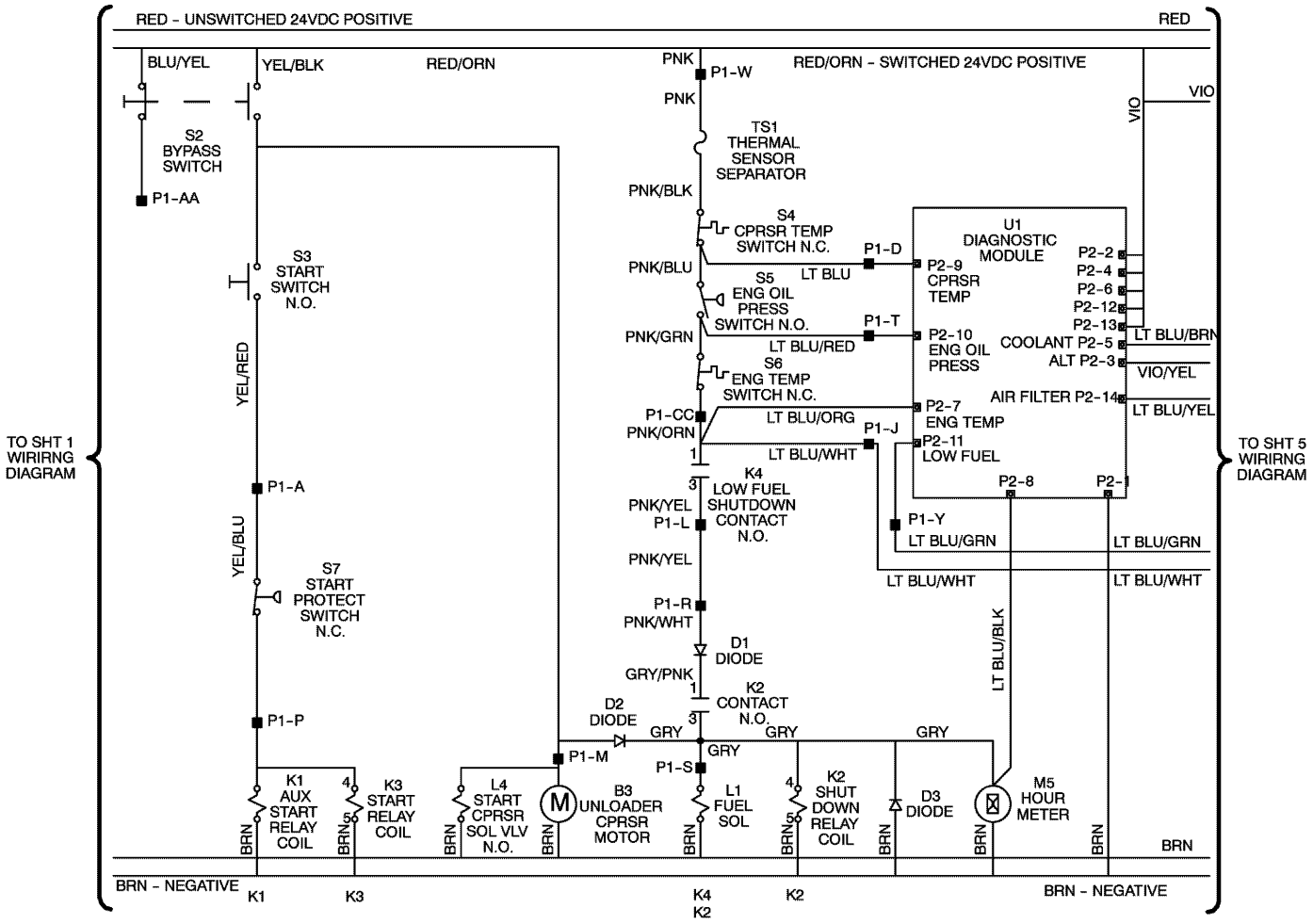


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION WIRING DIAGRAM	
MODEL NO. XHP1070	MANUAL NO. 35391903-52	DATE/REV: 2-00/A

ITEM	C.P.N.	DESCRIPTION
B1	★	STARTER
BT1	35254168	BATTERY
BT2	35254168	BATTERY
D5	35376169	DIODE
D6	35376169	DIODE
F1	36786259	30A FUSE
F2	36782464	15A FUSE
HR1	36841526	CONTROL HEATER
K3	35586130	RELAY
K6	35586130	RELAY
L2	35306158	ETHER SOLENOID
L3	36842300	START/RUN SOLENOID
S1	35337435	POWER SWITCH
S10	35255553	ETHER SWITCH
S11	35337435	HEATER SWITCH
S16	35255561	SERVICE AIR SWITCH

★ FURNISHED BY ENGINE MANUFACTURER

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION WIRING DIAGRAM	
MODEL NO. XHP1070	MANUAL NO. 35391903-53	DATE/REV: 2-00/A

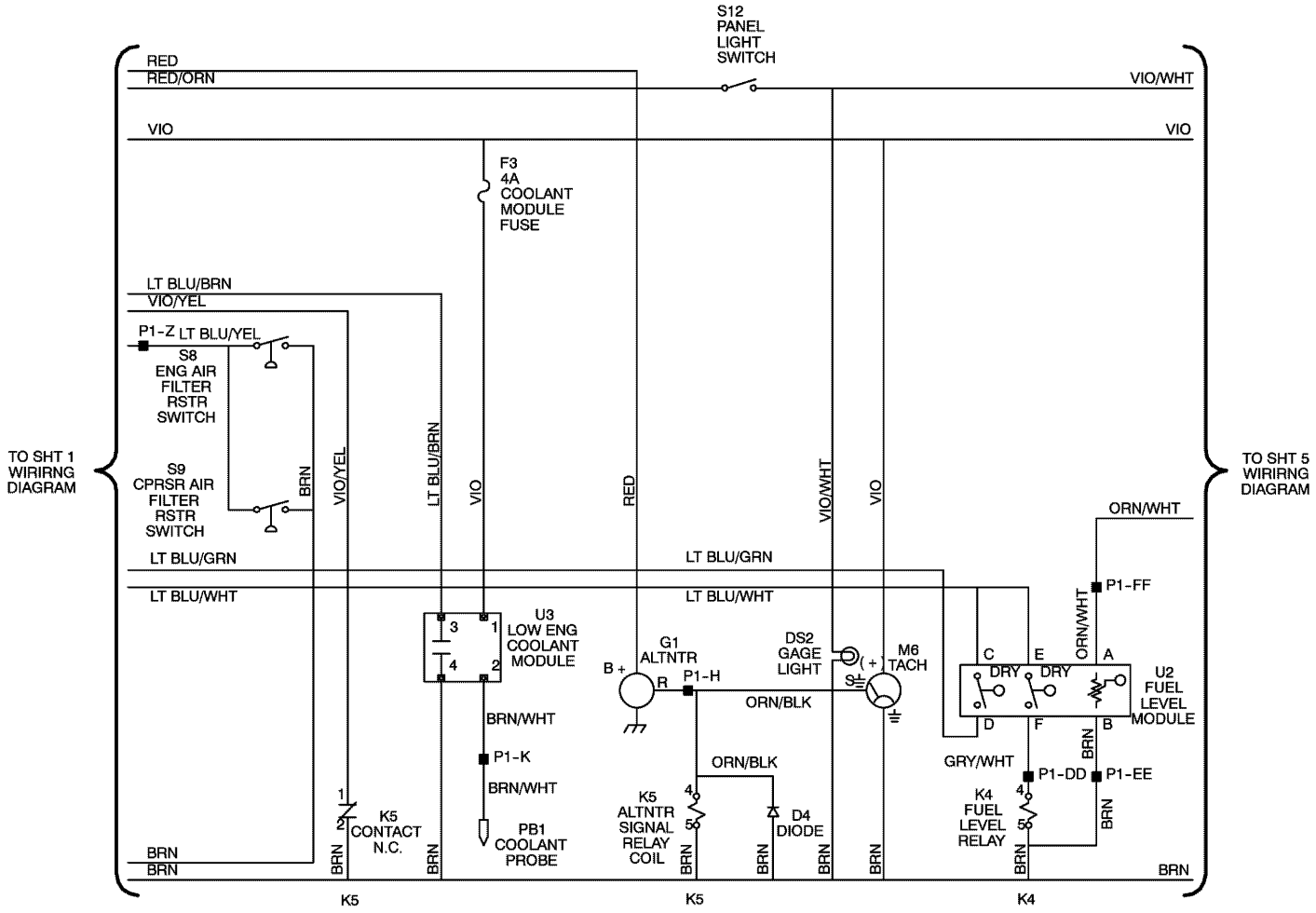


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION WIRING DIAGRAM	
MODEL NO. XHP1070	MANUAL NO. 35391903-54	DATE/REV: 2-00/A

ITEM	C.P.N.	DESCRIPTION
B3	36850691	COMPRESSOR MOTOR
D1	35376169	DIODE
D2	35376169	DIODE
D3	35376169	DIODE
K1	35577873	RELAY
K2	35586130	RELAY
K3	35586130	RELAY
K4	35586130	RELAY
L1	★	FUEL SOLENOID
L4	36842318	COMPRESSOR SOLENOID
M5	36841245	HOURMETER
S2	35255561	BY-PASS SWITCH
S3	35255553	START SWITCH
S4	35590983	CPRSR TEMP SWITCH
S5	36757581	ENGINE OIL PRESS SWITCH
S6	35327691	ENGINE WATER TEMP SWITCH
S7	36757573	START PROTECTION SWITCH
TS1	36764777	THERMAL SWITCH
U1	36771434	DIAGNOSTIC MODULE

★ FURNISHED BY ENGINE MANUFACTURER

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION WIRING DIAGRAM	
MODEL NO. XHP1070	MANUAL NO. 35391903-55	DATE/REV: 5-00/B

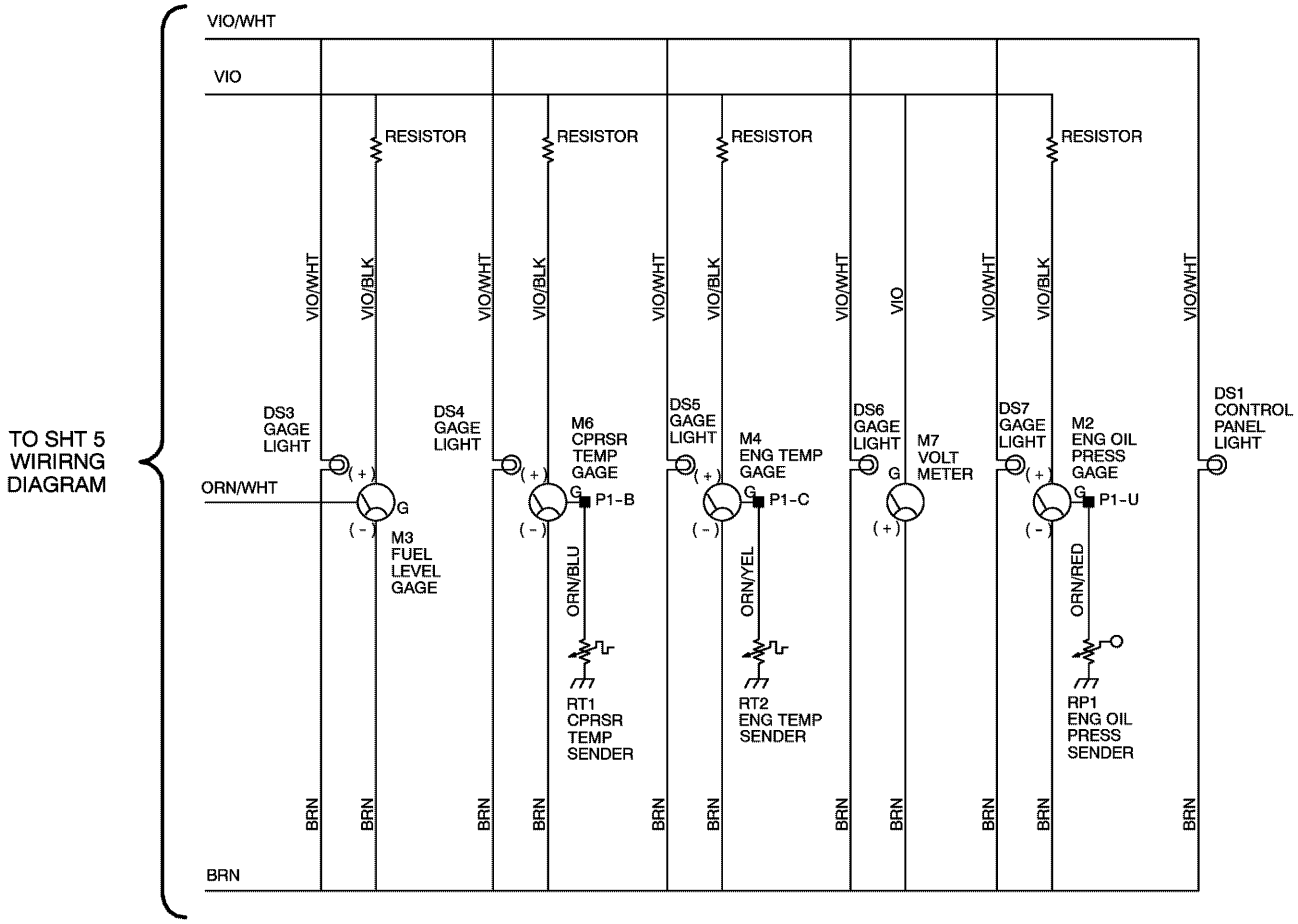


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION WIRING DIAGRAM	
MODEL NO. XHP1070	MANUAL NO. 35391903-56	DATE/REV: 2-00/A

ITEM	C.P.N.	DESCRIPTION
D4	35376169	DIODE
DS2	36842128	BULB
F3	35363472	4A FUSE
G1	★	ALTERNATOR
K4	35586130	RELAY
K5	35583442	RELAY
M6	36861177	TACHOMETER
PB1	35356799	LOW WATER PROBE
S8	35368992	RESTRICTION INDICATOR SWITCH
S9	35368992	RESTRICTION INDICATOR SWITCH
S12	35337435	PANEL LIGHT SWITCH
U2	36840783	FUEL LEVEL MODULE
U3	35356781	LOW WATER MODULE

★ FURNISHED BY ENGINE MANUFACTURER

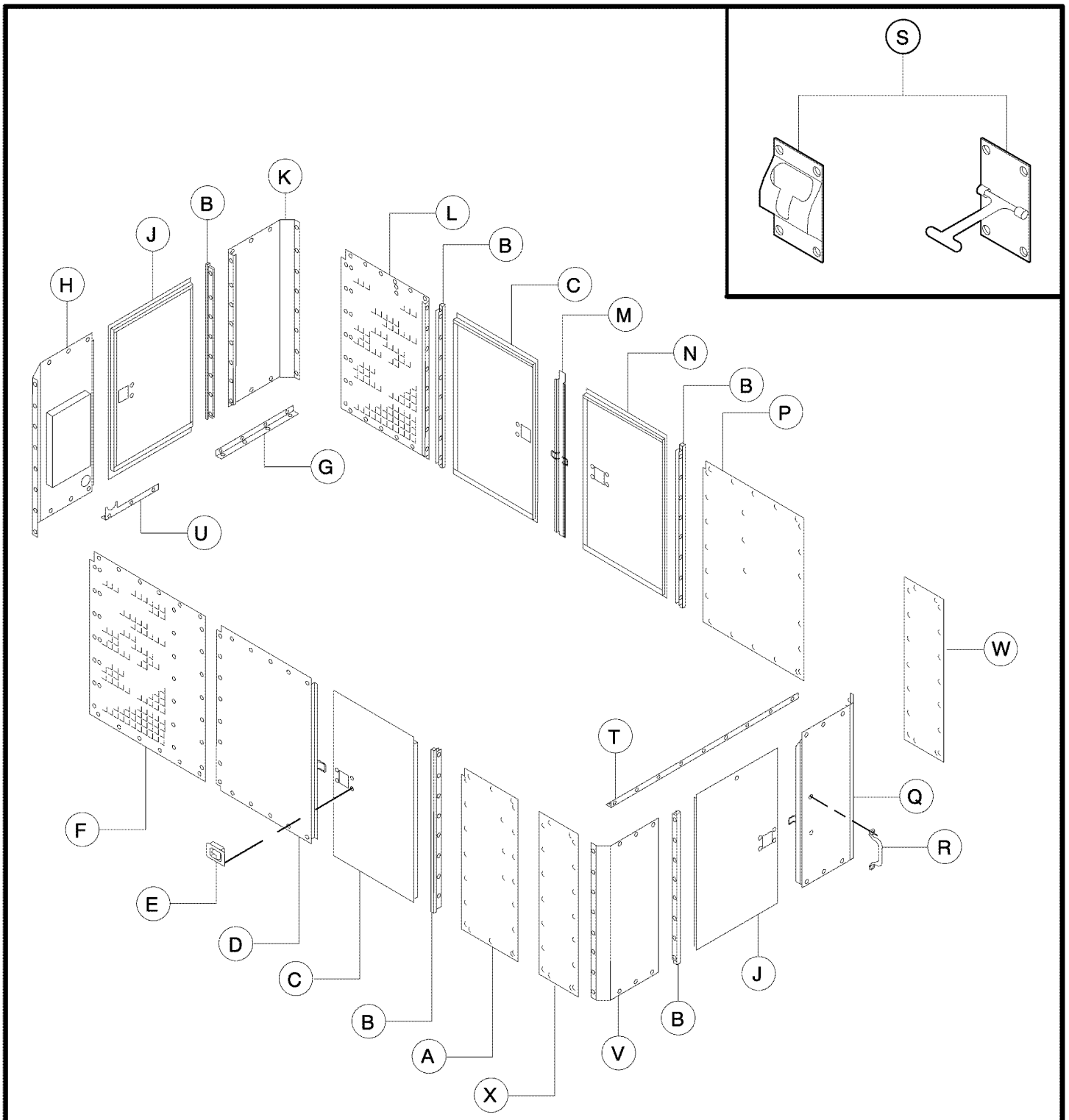
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION WIRING DIAGRAM	
MODEL NO. XHP1070	MANUAL NO. 35391903-57	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION WIRING DIAGRAM	
MODEL NO. XHP1070	MANUAL NO. 35391903-58	DATE/REV: 2-00/A

ITEM	C.P.N.	DESCRIPTION
DS1	36841252	PANEL LIGHT
	35290089	BULB
DS3	36842128	BULB
DS4	36842128	BULB
DS5	36842128	BULB
DS6	36842128	BULB
DS7	36842128	BULB
M2	35373729	ENGINE OIL PRESS GAGE
M3	35604099	FUEL LEVEL GAGE
M4	35604115	ENGINE WATER TEMP GAGE
M6	35604115	COMPRESSOR TEMP GAGE
M7	36841153	VOLTMETER
RP1	36870608	ENGINE OIL PRESS SENDER
RT1	35604180	COMPRESSOR TEMP SENDER
RT2	35604180	ENGINE TEMP SENDER

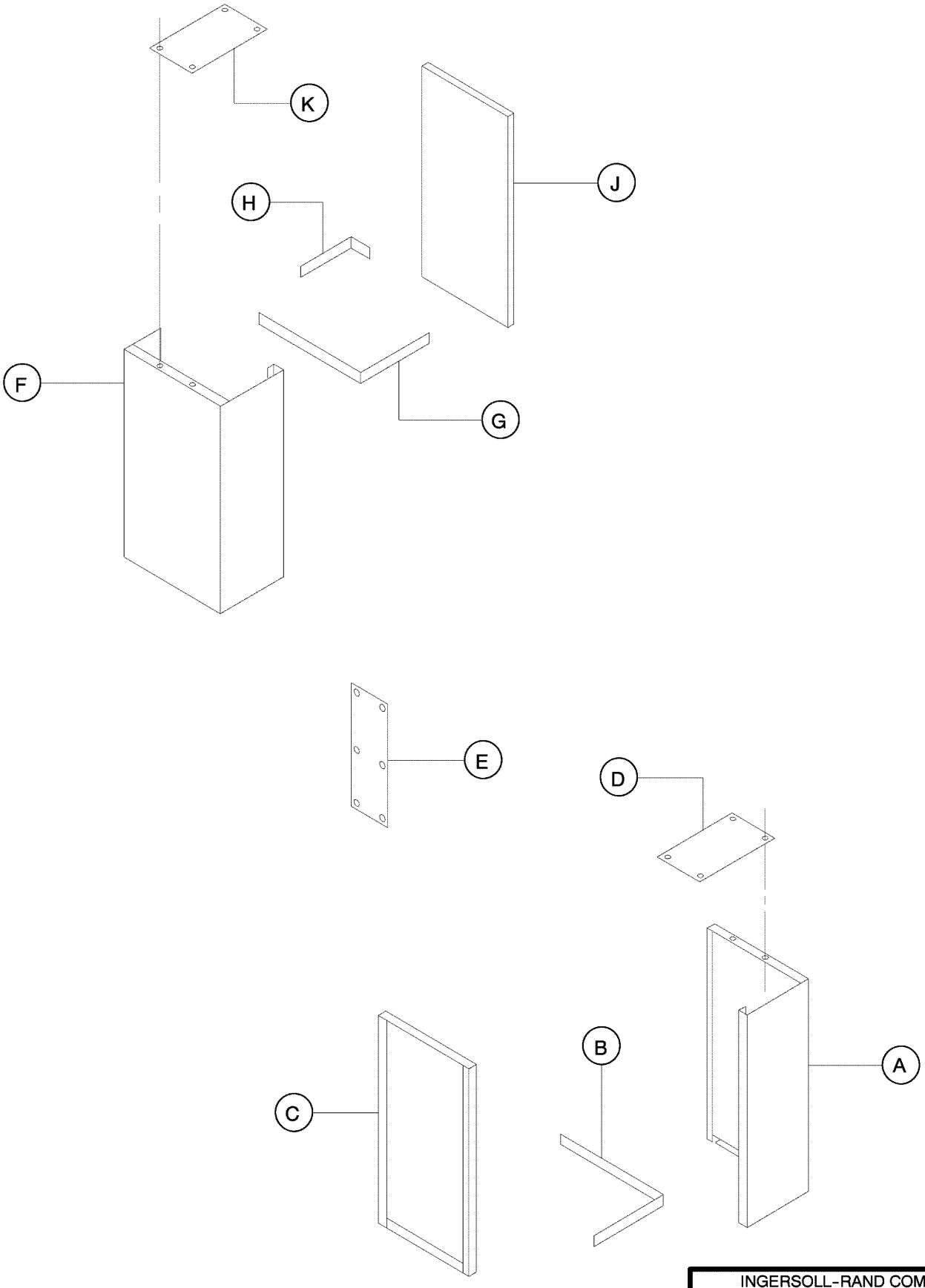
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION WIRING DIAGRAM	
MODEL NO. XHP1070	MANUAL NO. 35391903-59	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ENCLOSURE ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-60	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	36885986	1	PANEL , L.H. REAR SIDE
B	36863413	5	HINGE
C	36863652	2	DOOR , L.H. & R.H. FRONT SIDE
D	36863561	1	PANEL , L.H. MIDDLE SIDE
E	36793602	5	LATCH , DOOR SLAM
F	36863454	1	PANEL , L.H. FRONT SIDE
G	36863629	1	ANGLE , R.H. FRONT
H	36863710	1	PANEL , L.H. FRONT CORNER
J	36863363	2	DOOR , FRONT & REAR
K	36863330	1	PANEL , R.H. FRONT
L	36863447	1	PANEL , R.H. FRONT SIDE
M	36863587	1	PANEL , R.H. CENTER SIDE
N	36863660	1	DOOR , R.H. REAR
P	36885978	1	PANEL , R.H. REAR SIDE
Q	36863348	1	PANEL , R.H. REAR CORNER
R	35130707	1	HOLD , HAND
S	36849925	5	HOLDER , DOOR
T	36863322	1	ANGLE , REAR MOUNTING
U	36863645	1	ANGLE , L.H. FRONT
V	36866044	1	PANEL , L.H. REAR CORNER
W	36865517	1	PANEL , R.H. EXTENSION
X	36865509	1	PANEL , L.H. EXTENSION

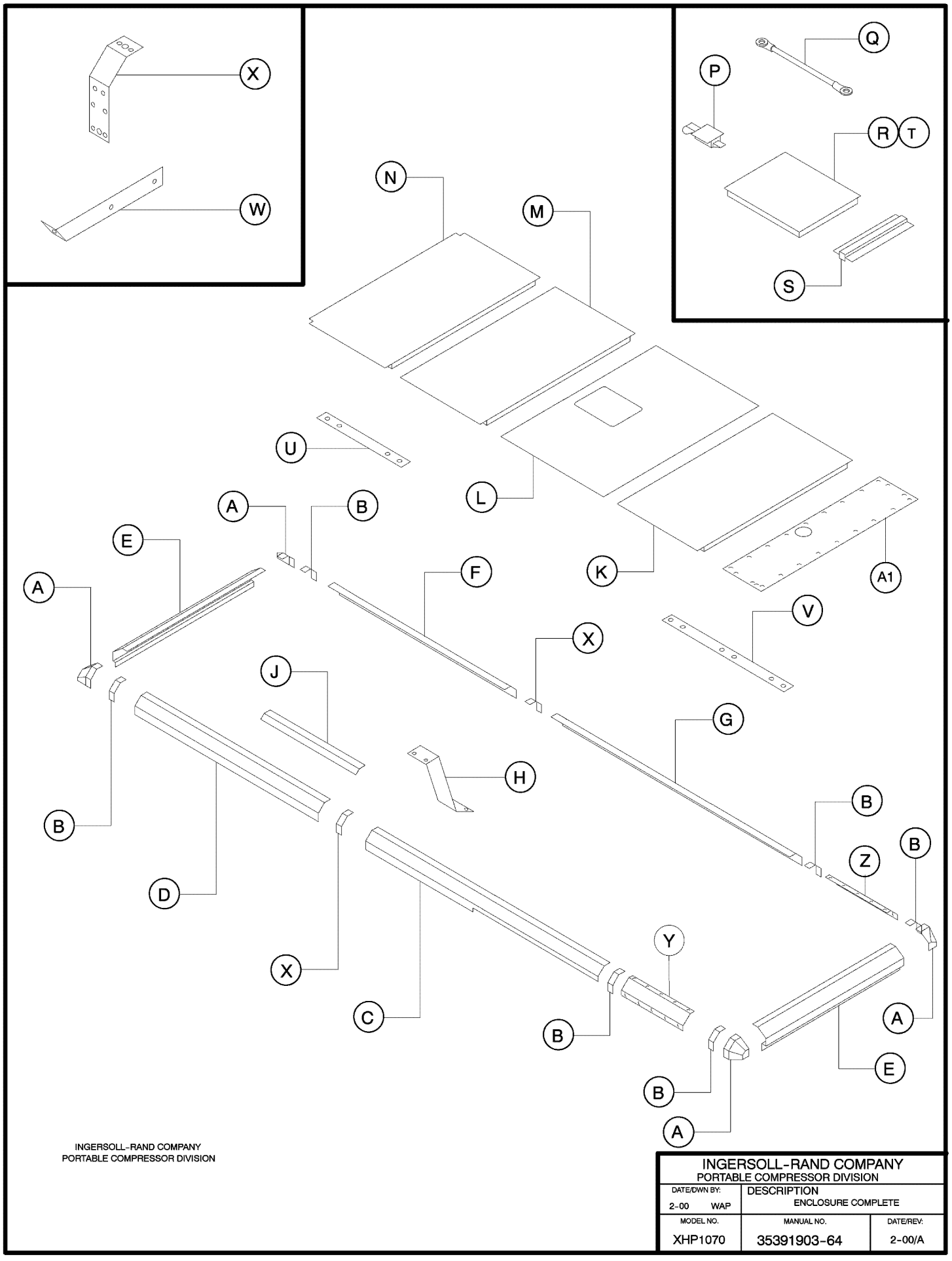
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ENCLOSURE ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-61	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ENCLOSURE ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-62	DATE/REV: 2-00/A

A	36756070	BAFFLE , L.H. AIR INTAKE
B	36756005	STRAP , L.H. (3 REQD)
C	36757714	BAFFLE , L.H. SPLITTER
D	36763878	BRACKET , L.H. BAFFLE SUPPORT
E	36763894	SUPPORT , BAFFLE
F	36756088	BAFFLE , R.H. AIR INTAKE
G	36756013	STRAP , R.H. (3 REQD)
H	36764736	BRACKET , SPLITTER BAFFLE
J	36757722	BAFFLE , R.H. SPLITTER
K	36762912	BRACKET , R.H. BAFFLE SUPPORT

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ENCLOSURE ASSEMBLY	
MODEL NO. XHP1070	MANUAL NO. 35391903-63	DATE/REV: 2-00/A

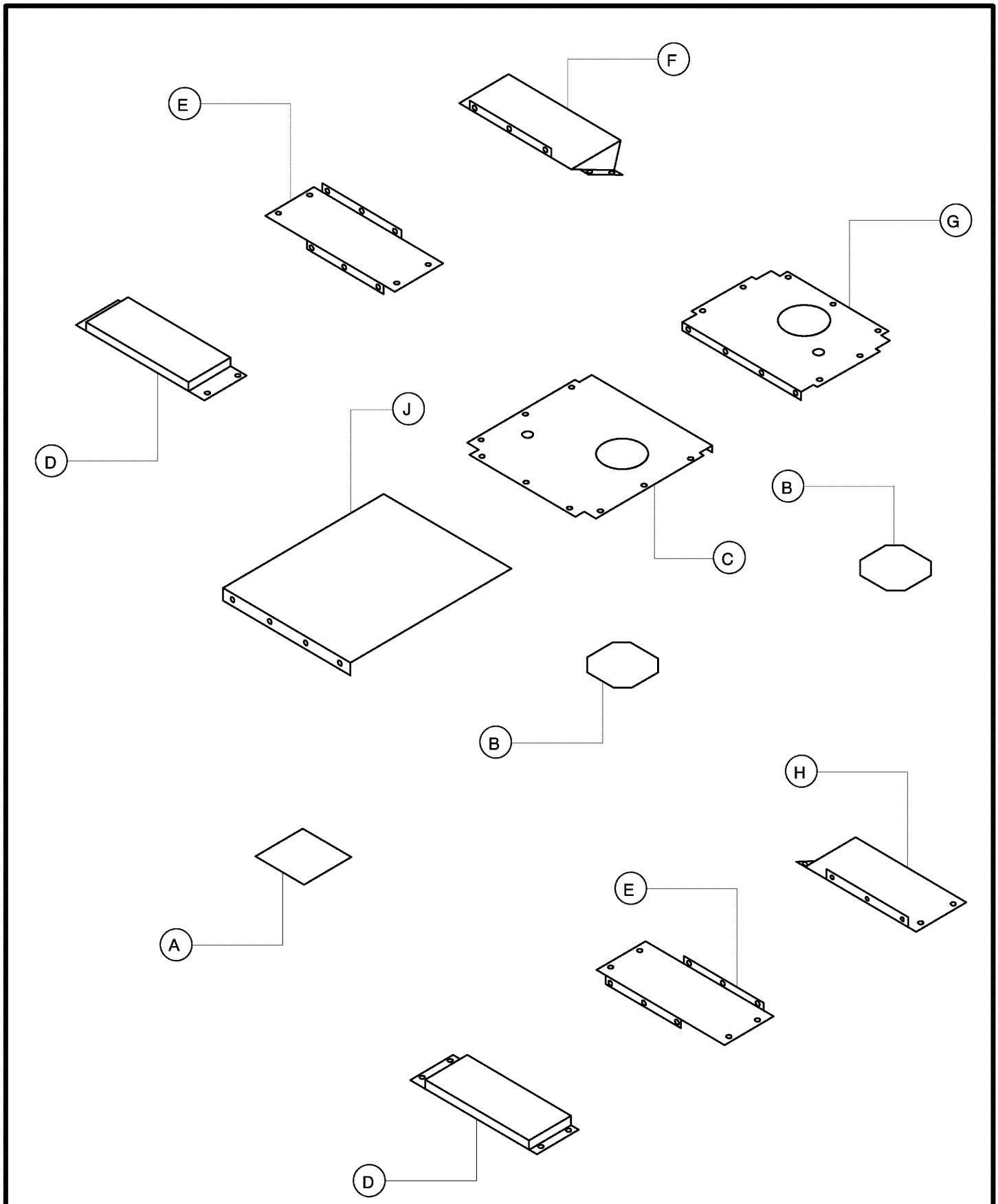


INGERSOLL-RAND COMPANY
PORTABLE COMPRESSOR DIVISION

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ENCLOSURE COMPLETE	
MODEL NO. XHP1070	MANUAL NO. 35391903-64	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	36755981		CORNER , END CAP
B	36755742		STRIP , CONNECTOR
C	36864023		CHANNEL , L.H. REAR
D	36863975		CHANNEL , L.H. FRONT
E	36863355		CHANNEL , FRONT & REAR
F	36864064		CHANNEL , R.H. FRONT
G	36864015		CHANNEL , R.H. REAR
H	36864312		BRACKET , ROOF SUPPORT (2 REQD)
J	36863371		SHIELD , DOOR RAIN (5 REQD)
K	36863991		PANEL , REAR ROOF
L	36864353		PANEL , CENTER ROOF
M	36864007		PANEL , FRONT MIDDLE
N	36863983		PANEL , FRONT ROOF
P	35131051		LATCH , DOOR
Q	36864304		CABLE , DOOR
R	36864403		DOOR , ROOF
S	36864288		HINGE , DOOR
T	36774495		STRIP , DOOR SEAL
U	36882843		STRAP , ACOUSTIC
V	36882850		STRAP , ACOUSTIC
W	36887933		BRACKET , REAR ROOF CHANNEL
X	36887925		STRIP , CONNECTOR (2 REQD)
Y	36865525		CHANNEL , L.H. EXTENSION
Z	36865533		CHANNEL , R.H. EXTENSION
A1	36897866		PANEL , ROOF EXTENSION

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ENCLOSURE COMPLETE	
MODEL NO. XHP1070	MANUAL NO. 35391903-65	DATE/REV: 2-00/A

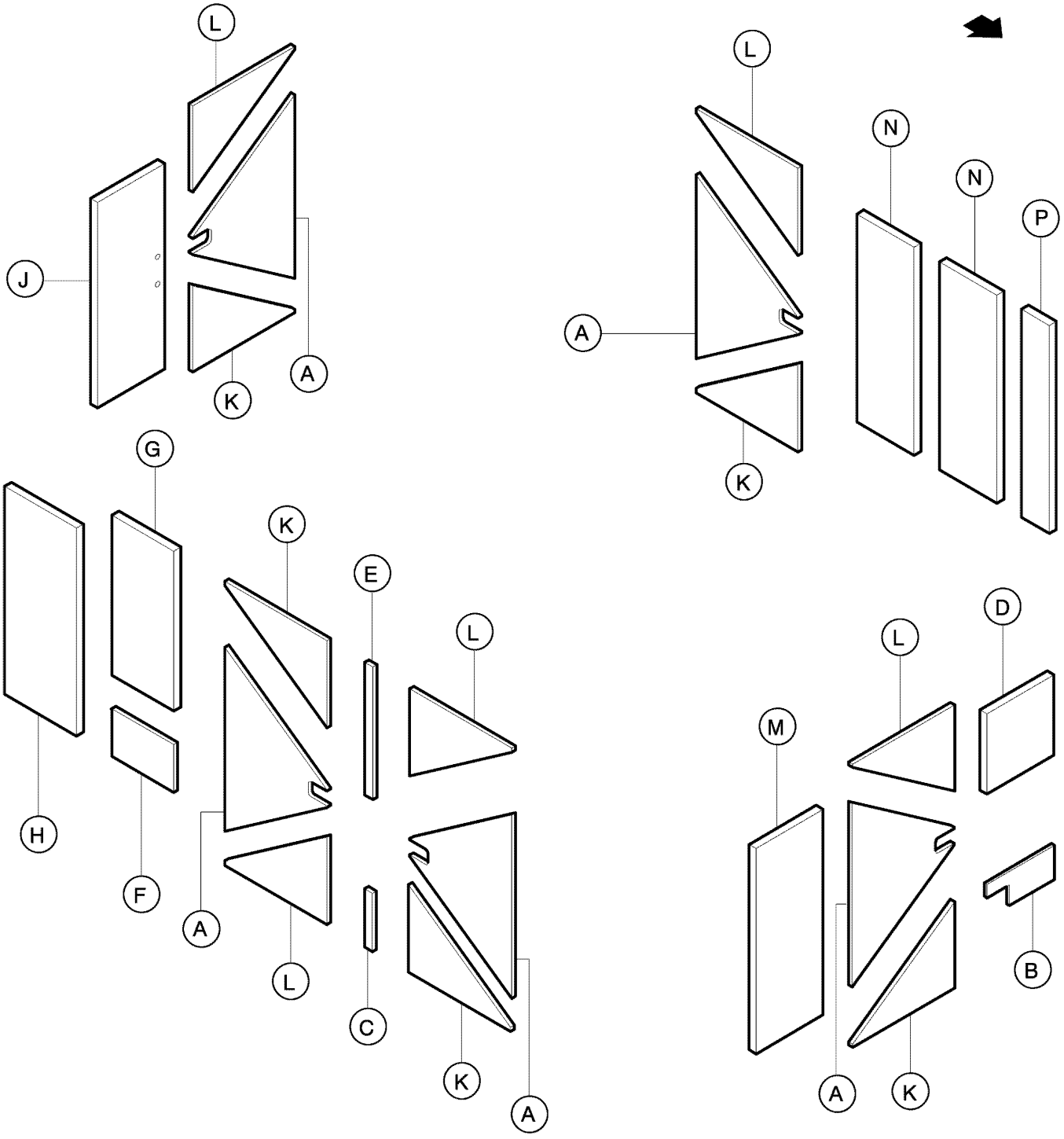


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION BELLY PANS	
MODEL NO. XHP1070	MANUAL NO. 35391903-66	DATE/REV: 2-00/A

A	36798445	COVER , RADIATOR HOSE
B	35279413	COVER , ACCESS
C	36758365	COVER , ENGINE REAR
D	36758548	COVER , FRONT FRAME
E	36781714	COVER , REAR FUEL
F	36759496	COVER , REAR FRAME
G	36758373	COVER , ENGINE FRONT
H	36759504	COVER , REAR FRAME
J	36762037	PAN , AIR END

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION BELLY PANS	
MODEL NO. XHP1070	MANUAL NO. 35391903-67	DATE/REV: 2-00/A

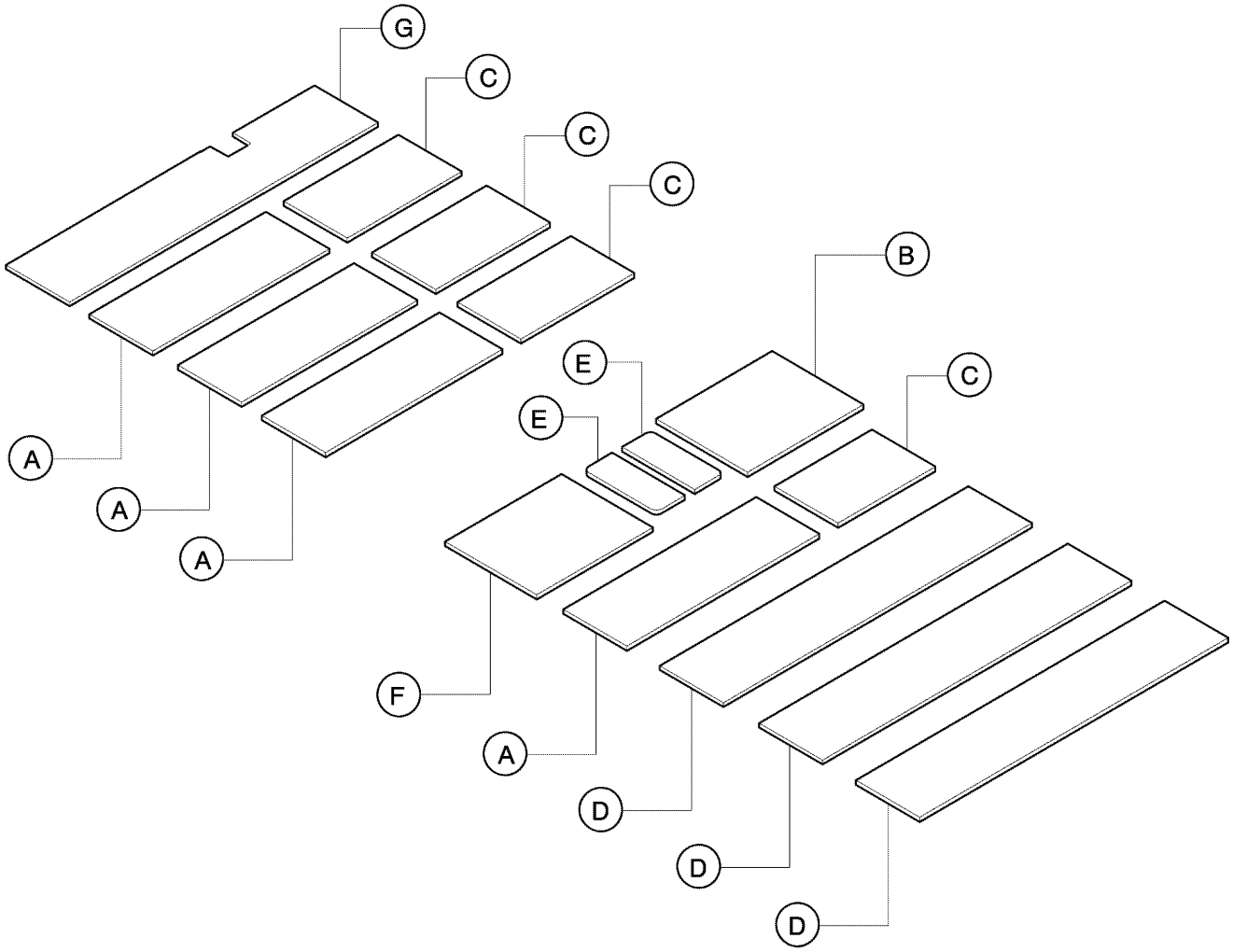
DRAWBAR END



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ACOUSTICAL PANELS	
MODEL NO. XHP1070	MANUAL NO. 35391903-68	DATE/REV: 2-00/A

ITEM	C.P.N.	DESCRIPTION
A	36864593	FOAM , CENTER DOOR
B	36864536	FOAM , L.H. FRONT BOTTOM
C	36864486	FOAM , CENTER POST BOTTOM
D	36864528	FOAM , L.H. FRONT TOP
E	36864494	FOAM , CENTER POST TOP
F	36864502	FOAM , R.H. BOTTOM
G	36864510	FOAM , R.H. TOP
H	36864445	FOAM , R.H. & L.H. REAR
J	36864460	FOAM , R.H. REAR CORNER
K	36864619	FOAM , FRONT & REAR DOOR
L	36864601	FOAM , FRONT & REAR DOOR
M	36864452	FOAM , FRONT & REAR CORNER
N	36864551	FOAM , L.H. FRONT SIDE
P	36864544	FOAM , L.H. FRONT SIDE

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ACOUSTICAL PANELS	
MODEL NO. XHP1070	MANUAL NO. 35391903-69	DATE/REV: 2-00/A

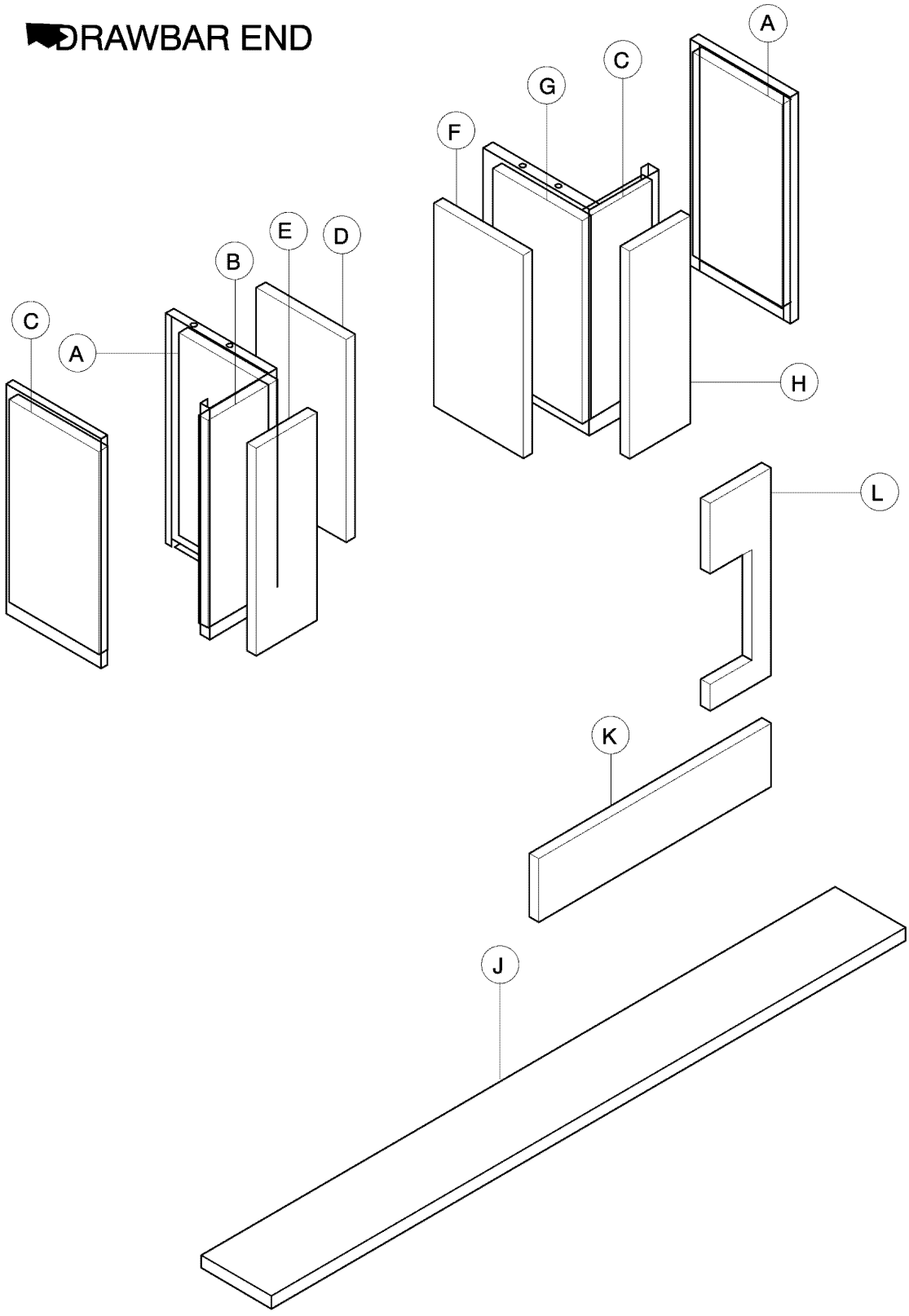


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ACOUSTICAL PANELS	
MODEL NO. XHP1070	MANUAL NO. 35391903-70	DATE/REV: 2-00/A

ITEM	C.P.N.	DESCRIPTION
A	36882827	FOAM , TOP
B	36882801	PANEL , TOP FIBERGLASS
C	36882835	PANEL , TOP FIBERGLASS
D	36864411	FOAM , TOP PANEL
E	36864437	FOAM , TOP DOOR
F	36864429	FOAM , TOP CENTER PANEL
G	36897874	FOAM , TOP EXHAUST PLENUM BAFFLE

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION ACOUSTICAL PANELS	
MODEL NO. XHP1070	MANUAL NO. 35391903-71	DATE/REV: 2-00/A

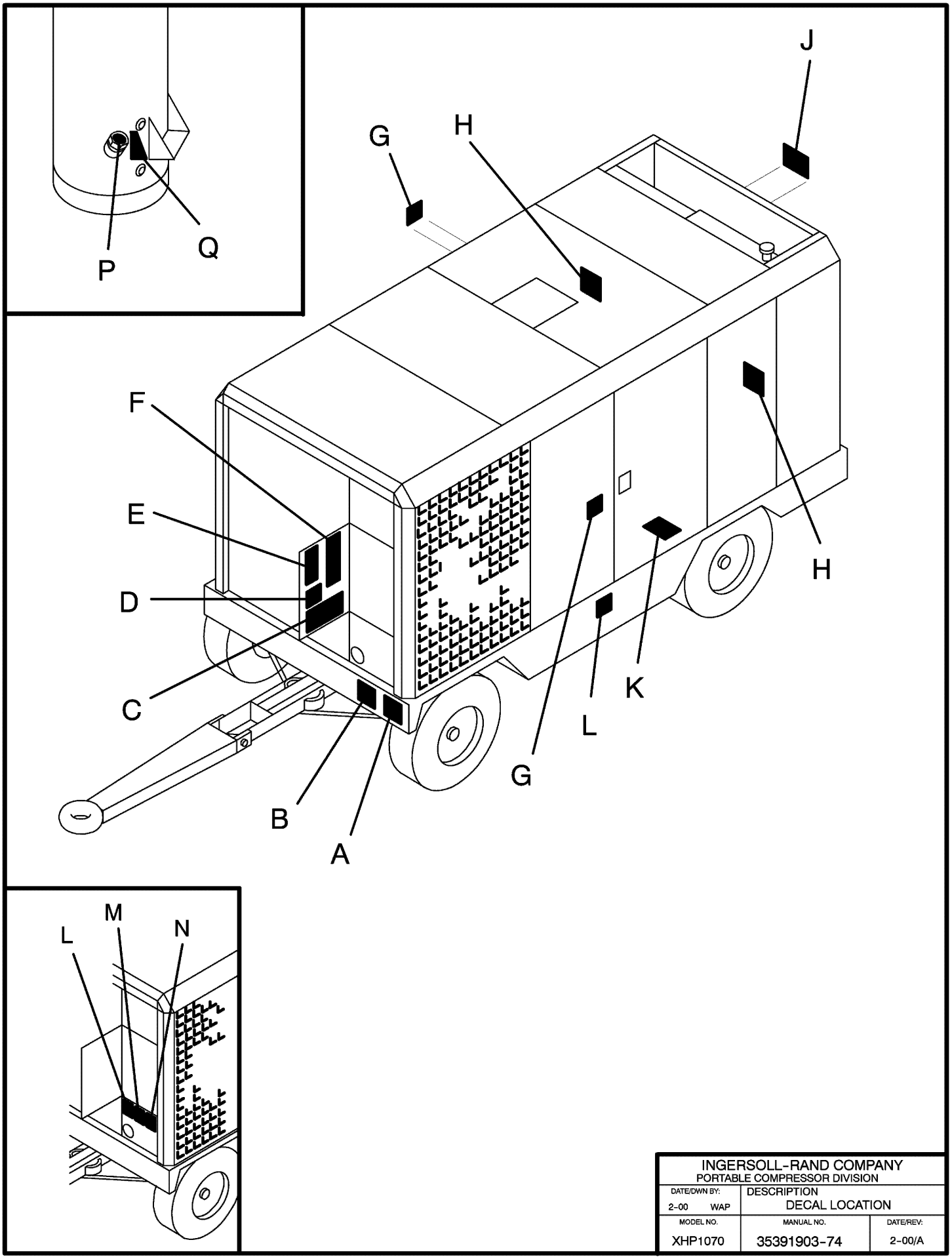
DRAWBAR END



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION BAFFLE WALL FOAM	
MODEL NO. XHP1070	MANUAL NO. 35391903-72	DATE/REV: 2-00/A

ITEM	C.P.N.	QTY	DESCRIPTION
A	36757938	2	ACOUSTIC PANEL , L.H. FRONT INLET BAFFLE / R.H. SPLITTER
B	36757920	1	ACOUSTIC PANEL , L.H. FRONT INLET BAFFLE
C	36757946	2	ACOUSTIC PANEL , R.H. FRONT INLET BAFFLE / L.H. SPLITTER
D	36797470	1	ACOUSTIC PANEL , L.H. FRONT INLET BAFFLE
E	36882777	1	ACOUSTIC PANEL , L.H. FRONT INLET BAFFLE
F	36797496	1	ACOUSTIC PANEL , R.H. FRONT INLET BAFFLE
G	36757953	1	ACOUSTIC PANEL , R.H. FRONT INLET BAFFLE
H	36797504	1	ACOUSTIC PANEL , R.H. FRONT INLET BAFFLE
J	36763464	1	ACOUSTIC PANEL , BOTTOM SHROUD
K	36788008	1	ACOUSTIC PANEL , CENTER FRAME
L	36797546	1	ACOUSTIC PANEL , R.H. REAR BAFFLE (COOLER SIDE)

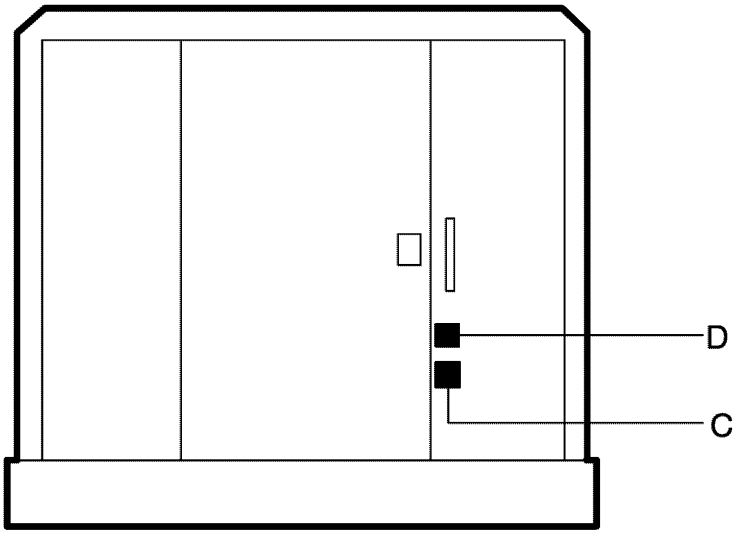
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION BAFFLE WALL FOAM	
MODEL NO. XHP1070	MANUAL NO. 35391903-73	DATE/REV: 2-00/A

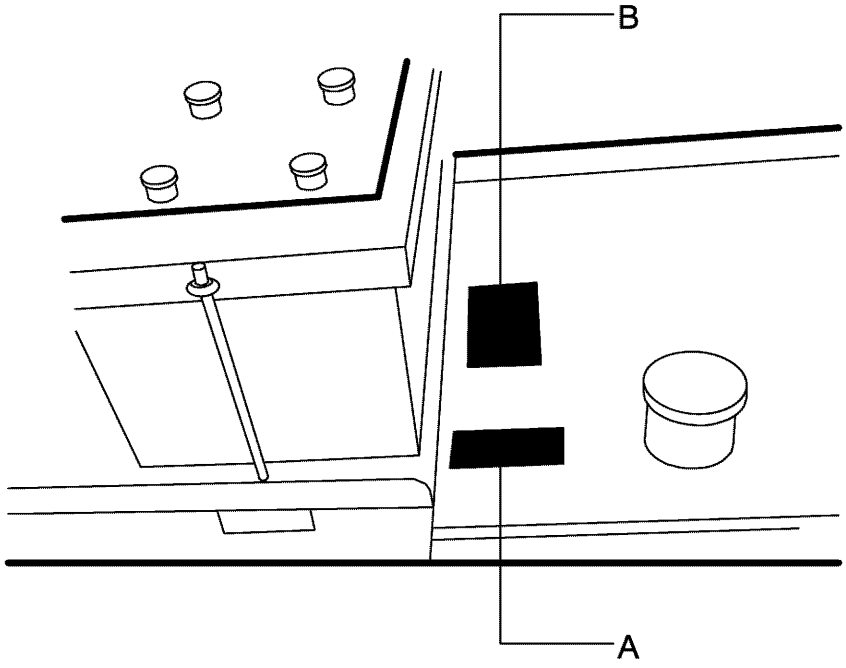


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION DECAL LOCATION	
MODEL NO. XHP1070	MANUAL NO. 35391903-74	DATE/REV: 2-00/A

A	36520690		UNRESTRICTED AIR FLOW DECAL
B	36508976		TRAPPED AIR DECAL
C	36522290		SAFETY CARD LAMINATE
D	36522035		IMPROPER OPERATION DECAL
E	36529428	(STANDARD)	GENERAL DATA DECAL
	36534147	(HIGH SPEED)	
F	36517134		PRESSURE ADJUSTING DECAL
G	36504942		HIGH PRESSURE AIR DECAL
H	36522050		ROTATING FAN DECAL
J	35859339		RADIATOR CAP DECAL
K	36516474		DIESEL FUEL DECAL
L	36508307		ROOF / LIFTING EYE DECAL
M	36522043		BREATHING AIR DECAL
N	36514602		EPA DECAL
P	35810357		OIL FILL DECAL
Q	36512739		OIL LEVEL DECAL

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION DECAL LOCATION	
MODEL NO. XHP1070	MANUAL NO. 35391903-75	DATE/REV: 2-00/A

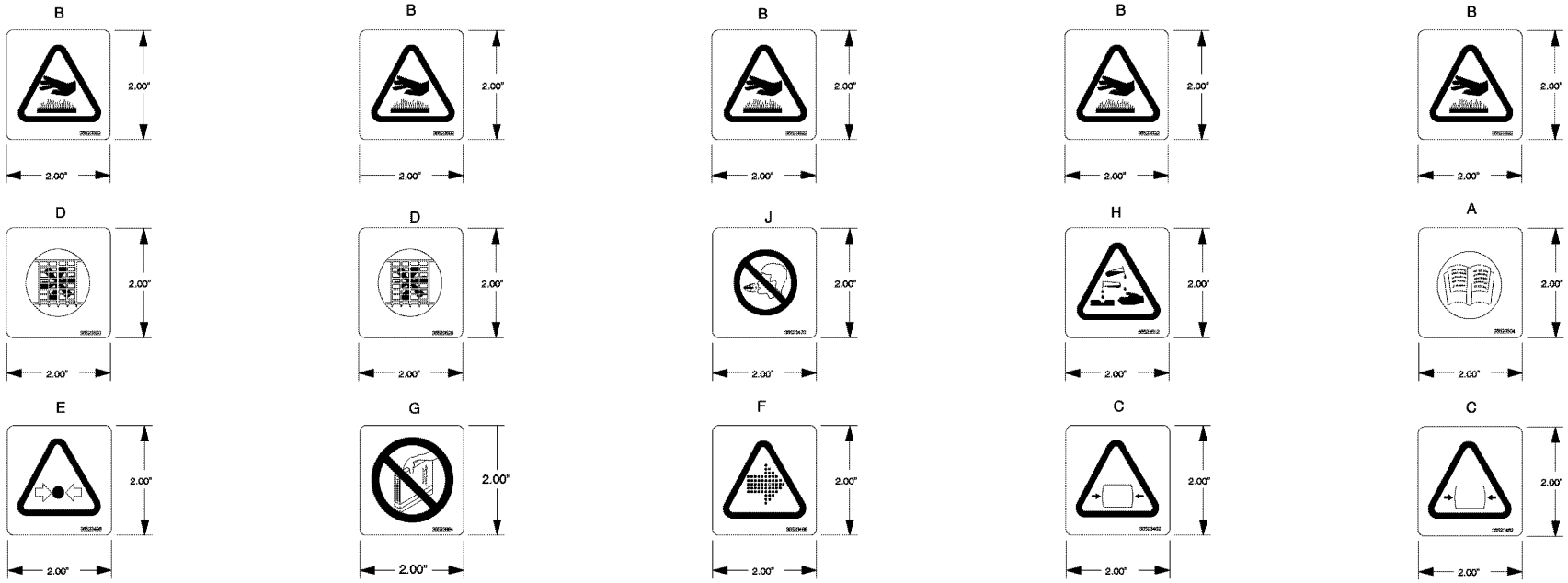


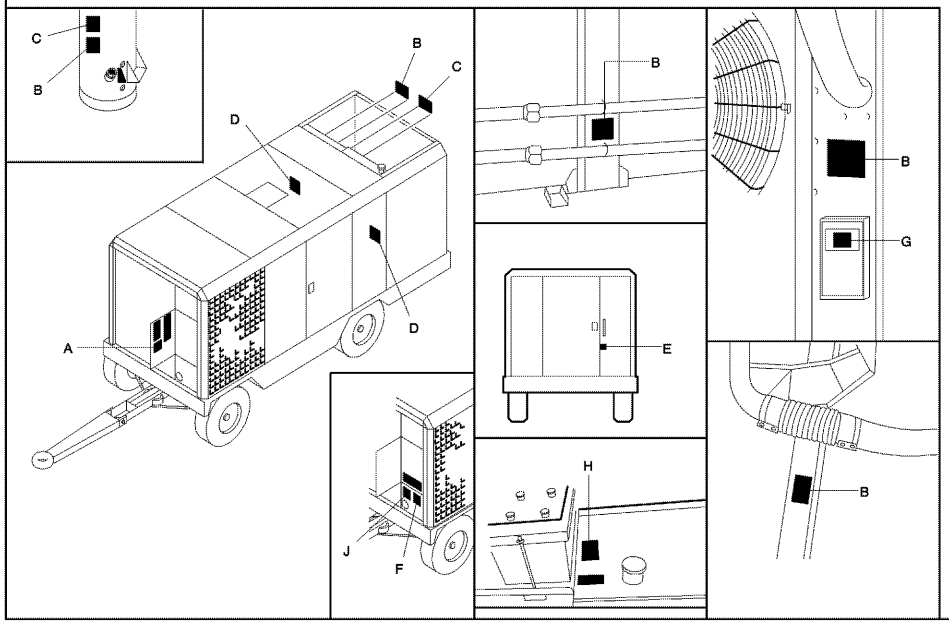


INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION DECAL LOCATION	
MODEL NO. XHP1070	MANUAL NO. 35391903-76	DATE/REV: 2-00/A

A	36516474	DIESEL FUEL DECAL
B	36519445	BATTERY GAS DECAL
C	36508323	DOOR UNDER PRESSURE DECAL
D	36508307	ROOF / LIFTING EYE

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION DECAL LOCATION	
MODEL NO. XHP1070	MANUAL NO. 35391903-77	DATE/REV: 2-00/A

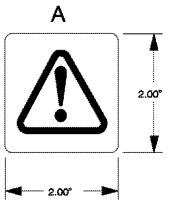


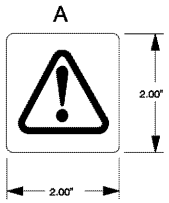


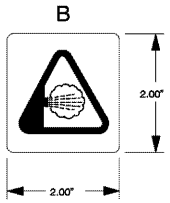
NOTES:

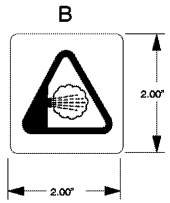
1. DO NOT USE THIS DRAWING FOR REPRODUCTION PURPOSES. REQUEST REPRODUCIBLE COPY OF ARTWORK WITH COLOR KEY FROM INGERSOLL-RAND, MOCKSVILLE PLANT, SERVICE LITERATURE DEPT.
2. NO PROOF OF DECAL REQUIRED
3. DIMENSION AS SHOWN ON DRAWING. OUTLINE SHOWS EDGE OF DECAL ONLY. DO NOT REPRODUCE.
4. USE 3M 7900 WHITE VINYL; MACTAC 8652 WHITE VINYL; FASCAL 960 TRANSPARENT VINYL OR EQUIVALENT MATERIAL FOR DESTRUCTIBLE CHARACTERISTICS.
5. PREFERRED APPLICATION OF COPY SHALL BE BY SCREEN PRINTING (USE ONLY INKS AND COATINGS RECOMMENDED BY MATERIAL MANUFACTURER.)
6. FINISHED DECAL SHALL BE CLEARCOATED WITH GLOSS CLEAR RECOMMENDED BY FILM MANUFACTURER.
7. ALL CORNERS SHALL BE DIE CUT ROUND.
8. FINISHED DECAL SHALL HAVE A (5) YEAR EXTERIOR DURABILITY (WHEN APPLIED PROPERLY TO A CLEAN, SMOOTH, NON-POROUS SURFACE).
9. LINER TO BE SCORED ON (3) THREE INCH INTERVALS AT 45 DEGREES FROM HORIZONTAL.

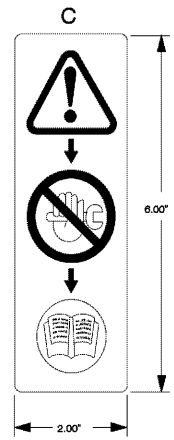
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION DECAL LOCATION (EEC SYMBOLS)	
MODEL NO. XHP1070	MANUAL NO. 35391903-78	DATE/REV. 2-00/A

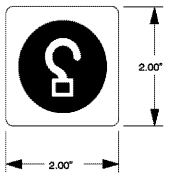


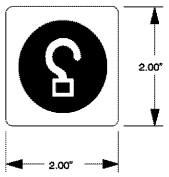


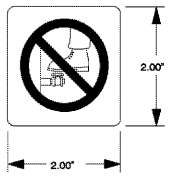


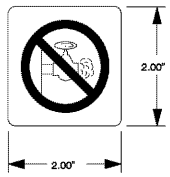


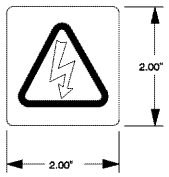


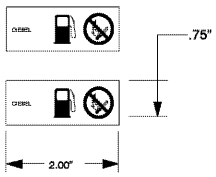


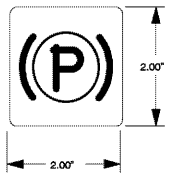


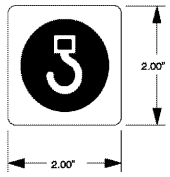


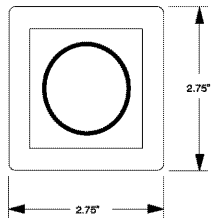


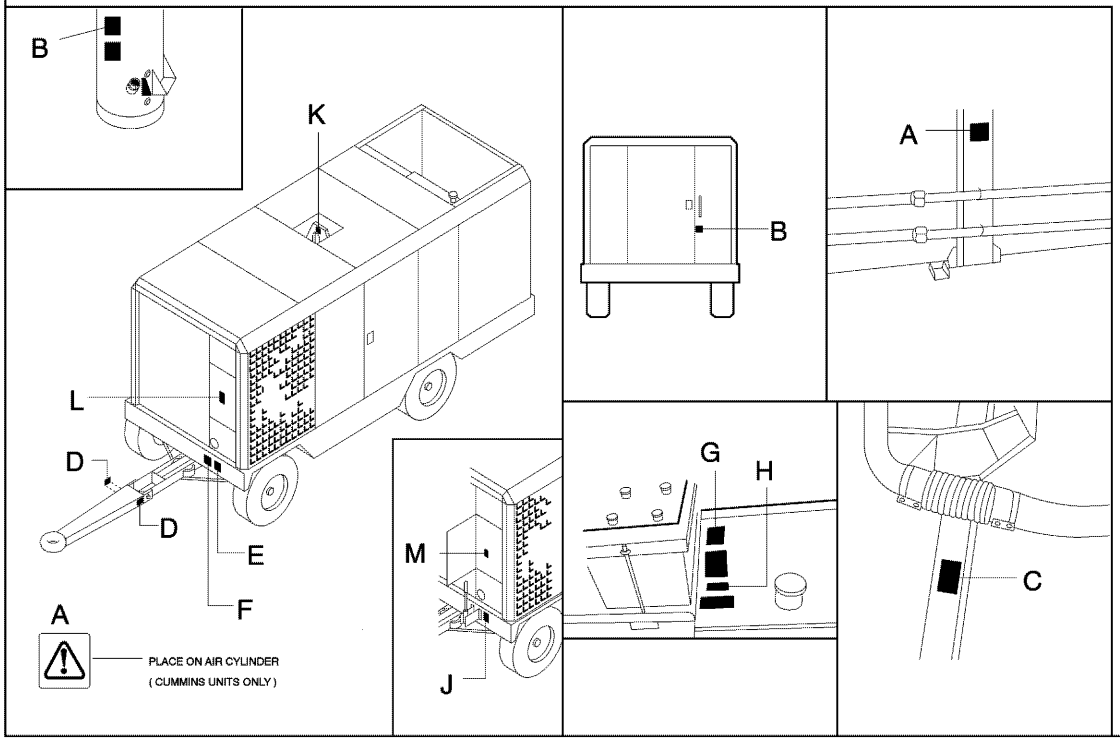


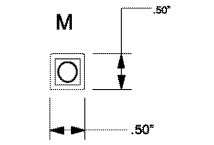








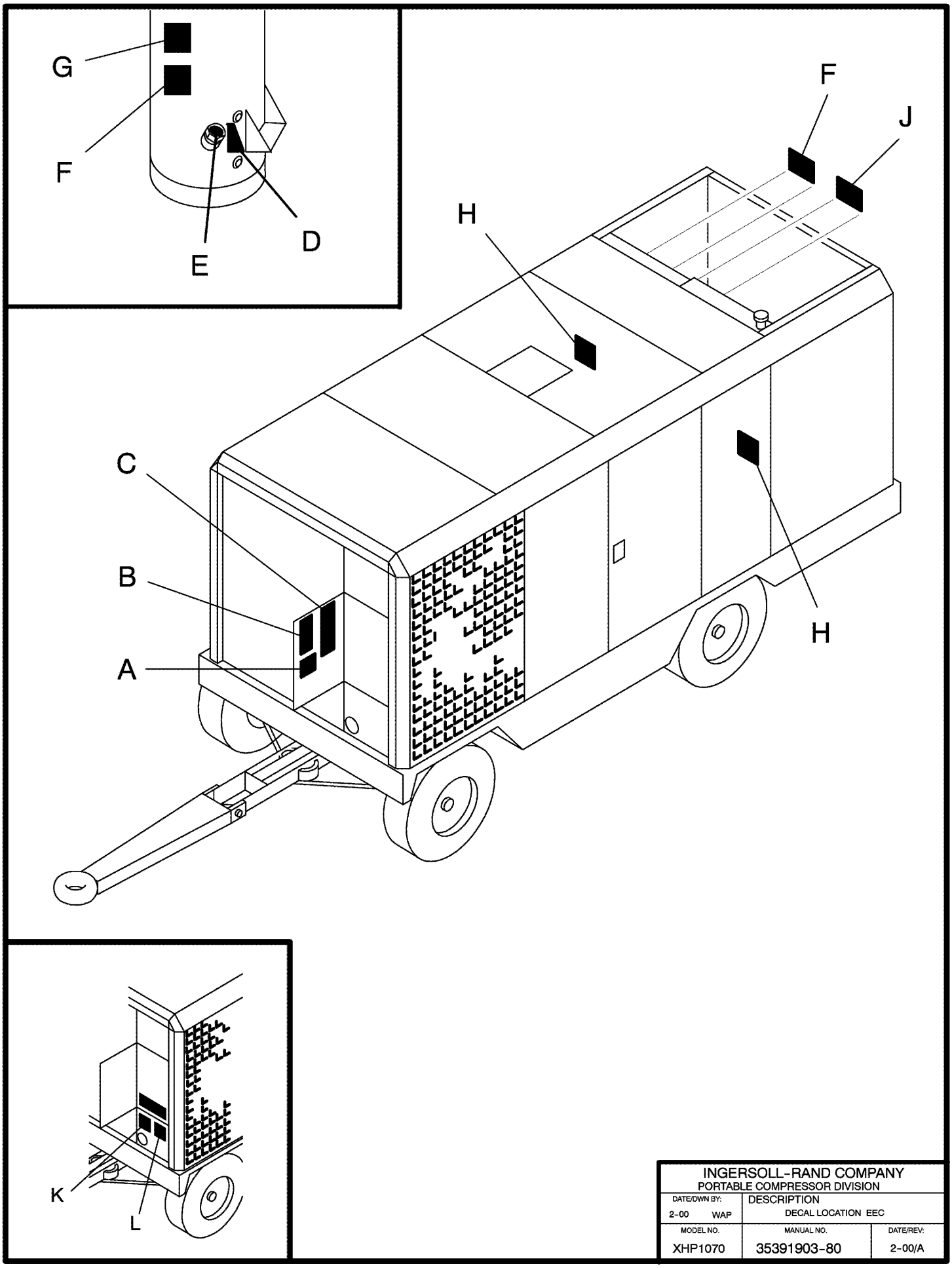




NOTES:

1. DO NOT USE THIS DRAWING FOR REPRODUCTION PURPOSES. REQUEST REPRODUCIBLE COPY OF ARTWORK WITH COLOR KEY FROM INGERSOLL-RAND, MOCKSVILLE PLANT, SERVICE LITERATURE DEPT.
2. NO PROOF OF DECAL REQUIRED
3. DIMENSION AS SHOWN ON DRAWING. OUTLINE SHOWS EDGE OF DECAL ONLY. DO NOT REPRODUCE.
4. USE 3M 7900 WHITE VINYL: MACTAC 8952 WHITE VINYL; FASCAL 960 TRANSPARENT VINYL OR EQUIVALENT MATERIAL FOR DESTRUCTIBLE CHARACTERISTICS.
5. PREFERRED APPLICATION OF COPY SHALL BE BY SCREEN PRINTING (USE ONLY INKS AND COATINGS RECOMMENDED BY MATERIAL MANUFACTURER.)
6. FINISHED DECAL SHALL BE CLEARCOATED WITH GLOSS CLEAR RECOMMENDED BY FILM MANUFACTURER.
7. ALL CORNERS SHALL BE DIE CUT ROUND.
8. FINISHED DECAL SHALL HAVE A (3) YEAR EXTERIOR DURABILITY (WHEN APPLIED PROPERLY TO A CLEAN, SMOOTH, NON-POROUS SURFACE).
9. LINER TO BE SCORED ON (3) THREE INCH INTERVALS AT 45 DEGREES FROM HORIZONTAL.

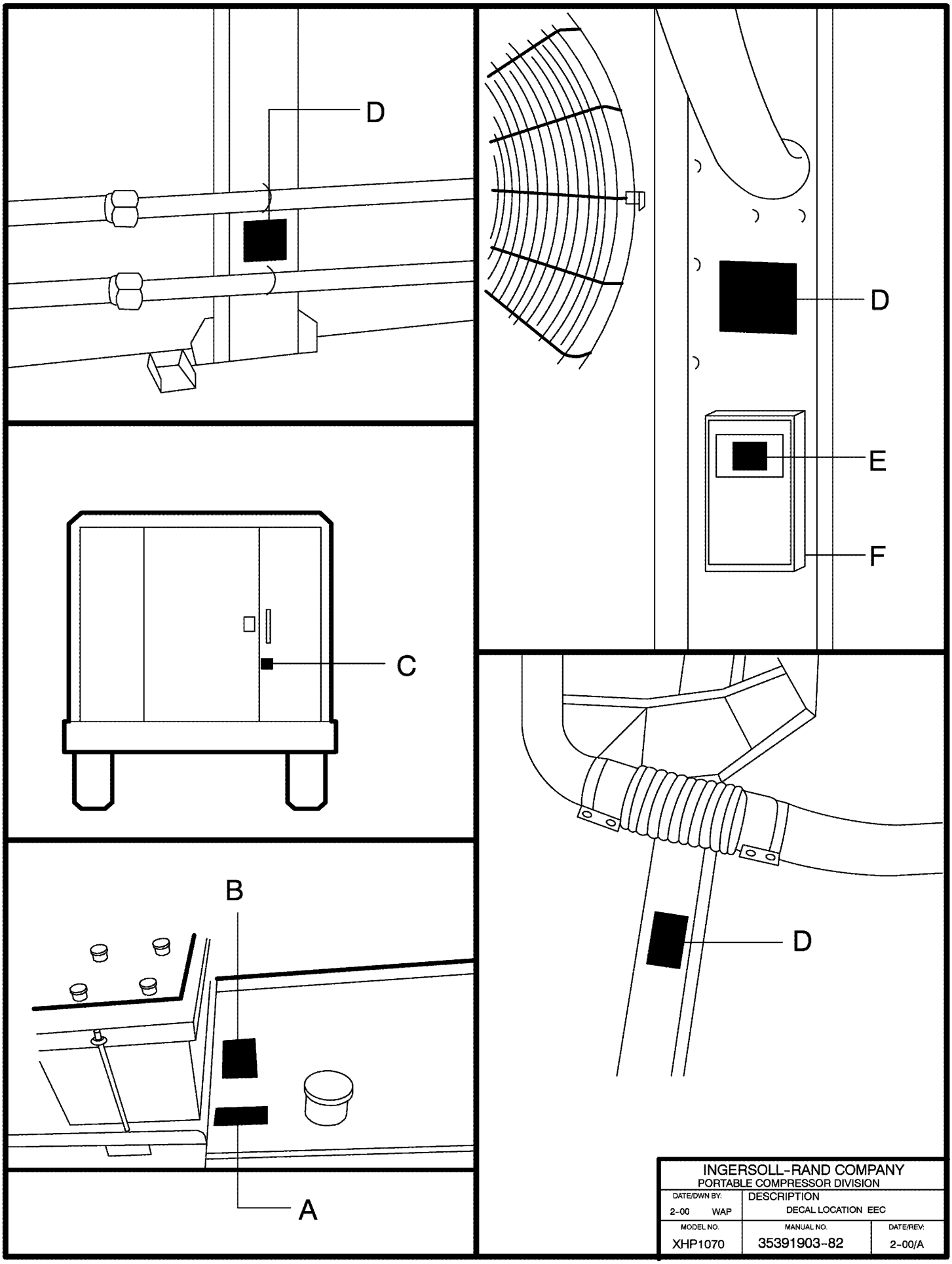
INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION: DECAL LOCATION (EEC SYMBOLS)	
MODEL NO.: XHP1070	MANUAL NO.: 35391903-79	DATE/REV: 2-00/A



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION DECAL LOCATION EEC	
MODEL NO. XHP1070	MANUAL NO. 35391903-80	DATE/REV: 2-00/A

A	36523504	DECAL , IMPROPER OPERATION
B	36529428	DECAL , GENERAL DATA
C	36517134	DECAL , REGULATION
D	36512739	DECAL , OIL LEVEL
E	35810357	DECAL , OIL FILLER PLUG
F	36523892	DECAL , HOT SURFACE
G	36523462	DECAL , HIGH PRESSURE
H	36523520	DECAL , ROTATING FAN
J	36523496	DECAL , RADIATOR CAP
K	36523470	DECAL , BREATHING AIR
L	36523488	DECAL , UNRESTRICTED AIR FLOW

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION DECAL LOCATION EEC	
MODEL NO. XHP1070	MANUAL NO. 35391903-81	DATE/REV: 2-00/A



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MODEL NO. XHP1070	MANUAL NO. 35391903-82	DATE/REV: 2-00/A

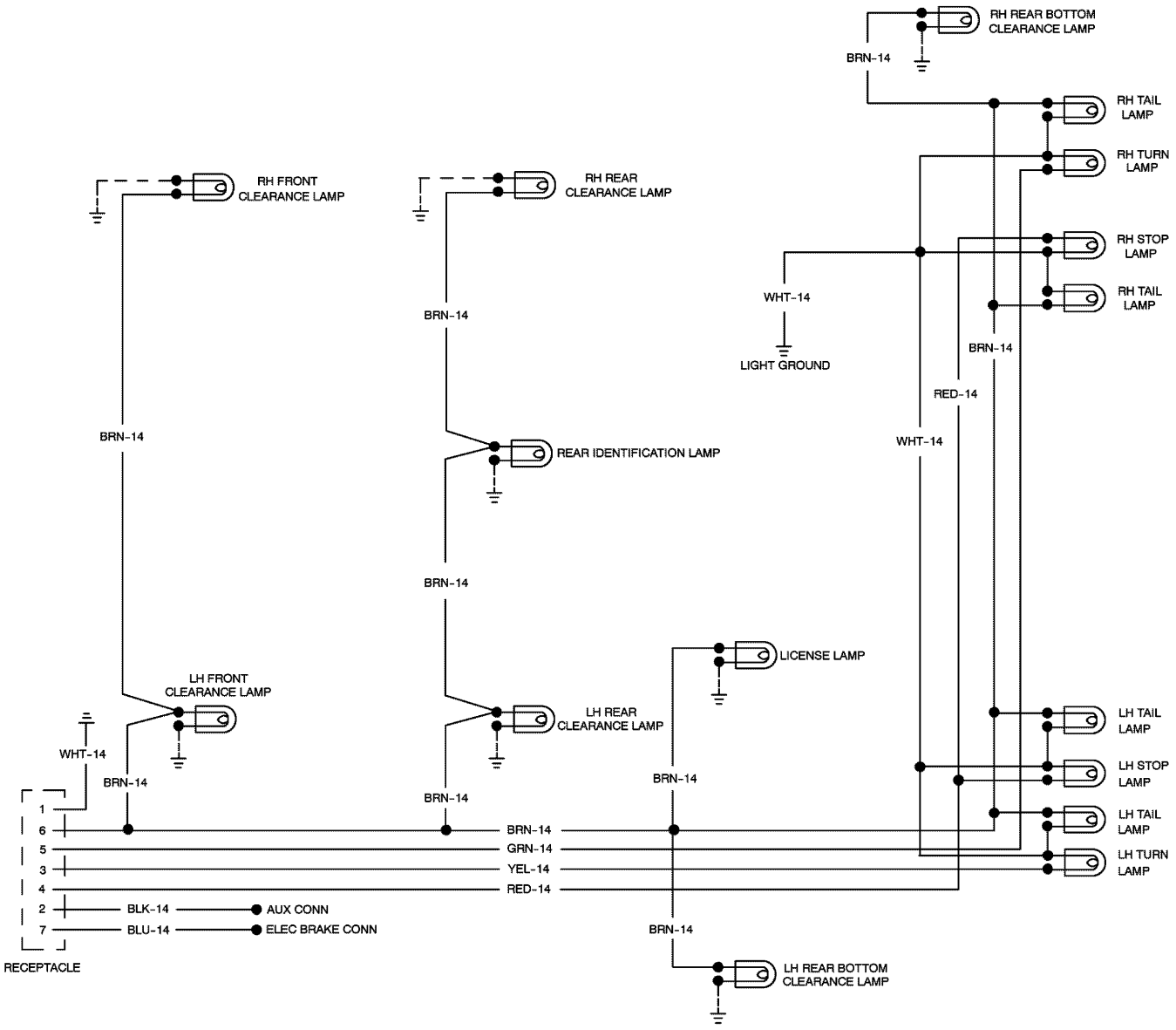
A	36516474	DECAL , DIESEL FUEL
B	36523512	DECAL , BATTERY
C	36523496	DECAL , DOOR UNDER PRESSURE
D	36523892	DECAL , HOT SURFACE
E	36523884	DECAL , DO NOT REMOVE MANUAL
F	36847580	POUCH , WATER RESISTANT MANUAL

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION DECAL LOCATION EEC	
MODEL NO. XHP1070	MANUAL NO. 35391903-83	DATE/REV: 2-00/A

SECTION 11 - OPTIONS

PARTS LIST INDEX

High Speed Running Gear Option, Sht 1
High Speed Running Gear Option, Sht 2
High Speed Running Gear Option, Sht 3
High Speed Running Gear Option, Sht 4
High Speed Running Gear Option, Sht 5
High Speed Running Gear Option, Sht 6



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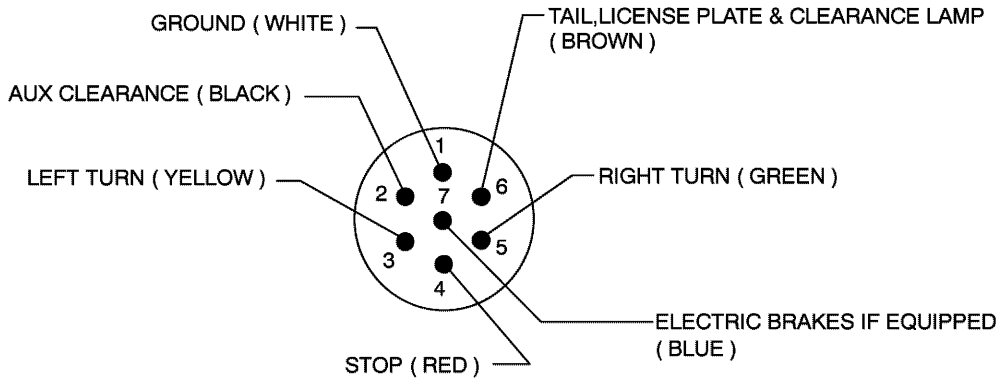
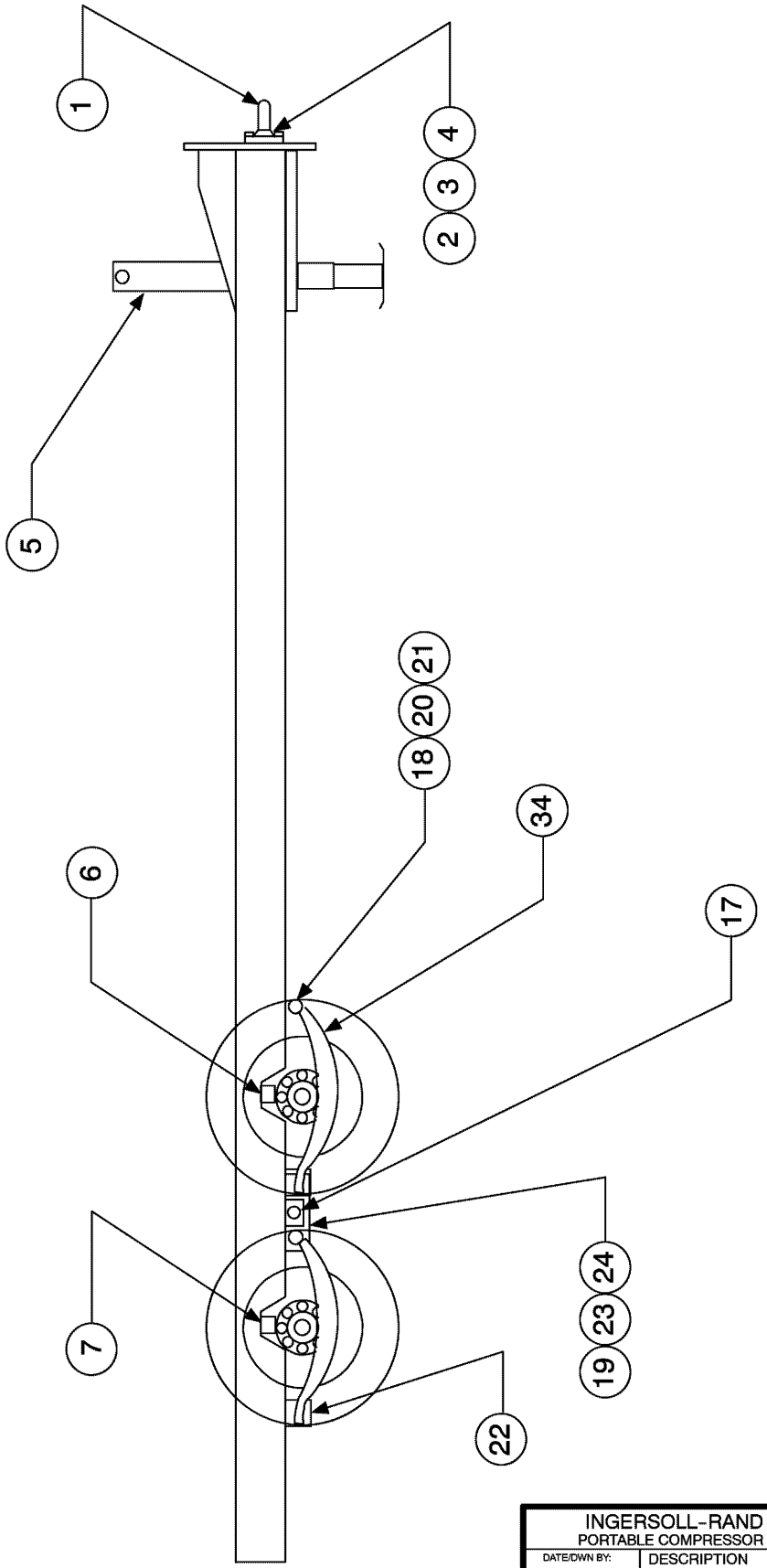
MODEL NO. XHP1070	MANUAL NO. 35391903-2	DATE/REV: 8-00/B



STOP,TAIL & TURN LIGHT OPTION
(AS VIEWED FROM REAR OF SOCKET)

LIST OF MATERIALS									
CKT	TERMINATION A	TYPE	SIZE	TERMINATION B	TYPE	SIZE	GAUGE	LENGTH	COLOR
1	RECEPTACLE 1	E		GROUND	A	1/4	14	46	WHT
2	RECEPTACLE 6	E		SPLICE 1	D		14	24	BRN
3	SPLICE 1			LH FRT CLEARANCE	B		14	95	BRN
4	LH FRT CLEAR W/CKT 3B			RH FRT CLEARANCE	B		14	89	BRN
5	SPLICE 1 W/CKT 3A			SPLICE 2	D		14	218	BRN
6	RECEPTACLE 3	E		RH TURN	G		14	342	YEL
7	RECEPTACLE 5	E		LH TURN	G		14	255	GRN
8									
9									
10	RH TURN/TAIL W/CKT 27B			RH REAR CLEAR BOT	B		14	22	BRN
11									
12	SPLICE 2			LH REAR CLEARANCE	B		14	19	BRN
13	LH REAR CLEAR W/CKT 12B			LH REAR TOP CLEAR	B		14	74	BRN
14	LH REAR TOP CLEAR W/CKT 13B			REAR ID W/CKT 15A	B		14	61	BRN
15	R ID W/CKT 14B			RH REAR TOP CLEAR	B		14	56	BRN
16	SPLICE 2 W/CKT 12A			LICENSE LAMP	B		14	31	BRN
17	SPLICE 2 W/CKT 12A			LH TURN/TAIL	G		14	13	BRN
18	RECEPTACLE 4	E		LH STOP LAMP	G		14	261	RED
19	LIGHT GRD W/CKT 24A			LIGHT GROUND			14	36	WHT
20	LEFT STOP LAMP W/CKT 18B			RIGHT STOP LAMP	G		14	99	RED
21	RECEPTACLE 7	E		ELECTRIC BRAKES			14	29	BLU
22	LEFT TURN GRD			LH ST/GRD W/CKT 23A	G		14	30	WHT
23	LEFT STOP GRD			RT ST/GRD W/CKT 24A	G		14	99	WHT
24	RIGHT STOP GRD			RH TURN GRD	G		14	30	WHT
25	LH TURN/TAIL W/CKT 17B			LEFT STOP/TAIL	G		14	30	BRN
26	LH STOP/TAIL W/CKT 25B			RIGHT STOP/TAIL	G		14	99	BRN
27	RH STOP/TAIL W/CKT 26B			RIGHT TURN/TAIL	G		14	30	BRN
28	RECEPTACLE 2	E		AUX	B		14	29	BLK

INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 2-00 WAP	DESCRIPTION HIGH SPEED RUNNING GEAR	
MODEL NO. XHP1070	MANUAL NO. 35391903-3	DATE/REV: 8-00/B



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
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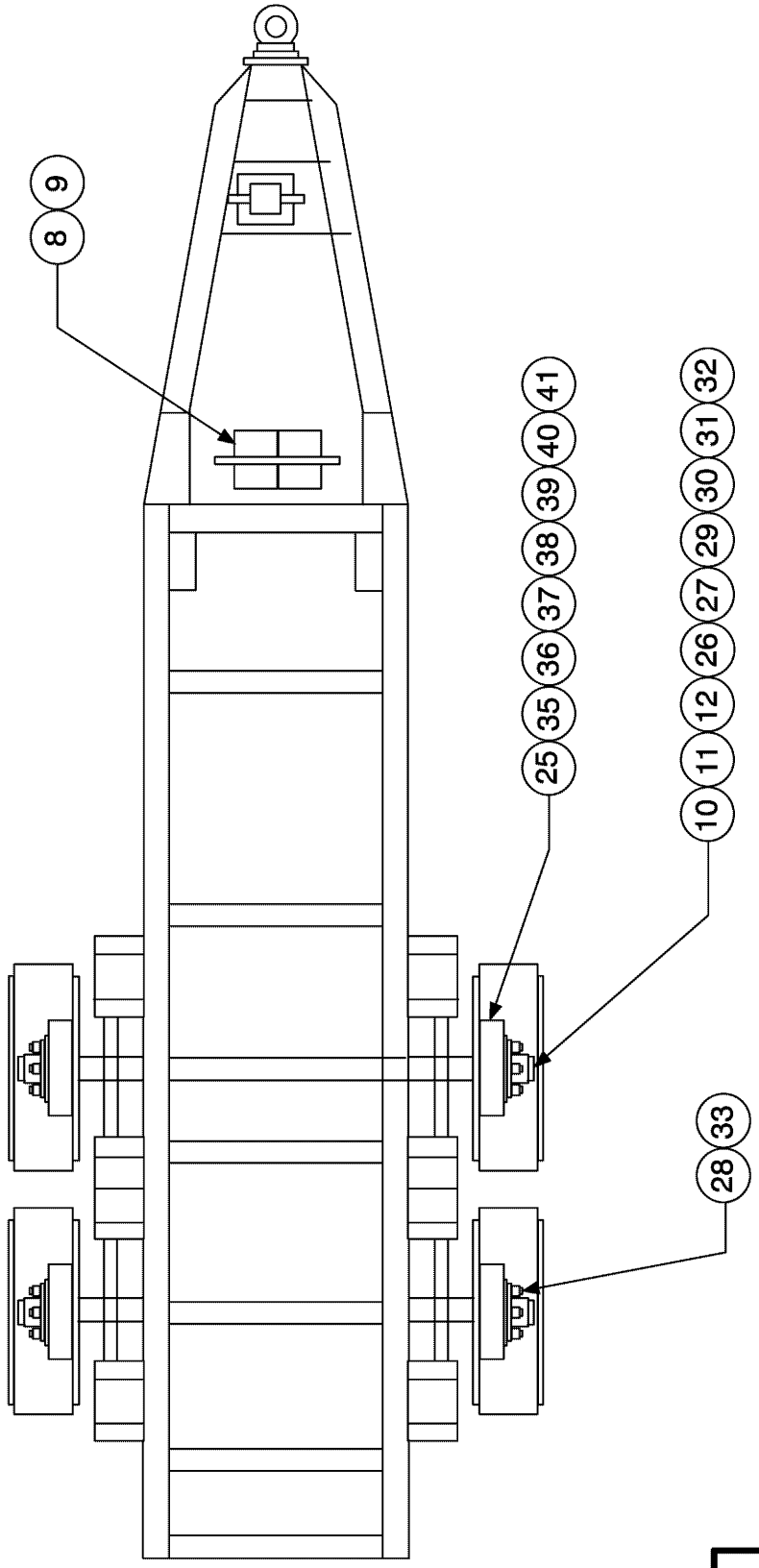
MODEL NO. XHP1070	MANUAL NO. 35391903-4	DATE/REV: 8-00/B



INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
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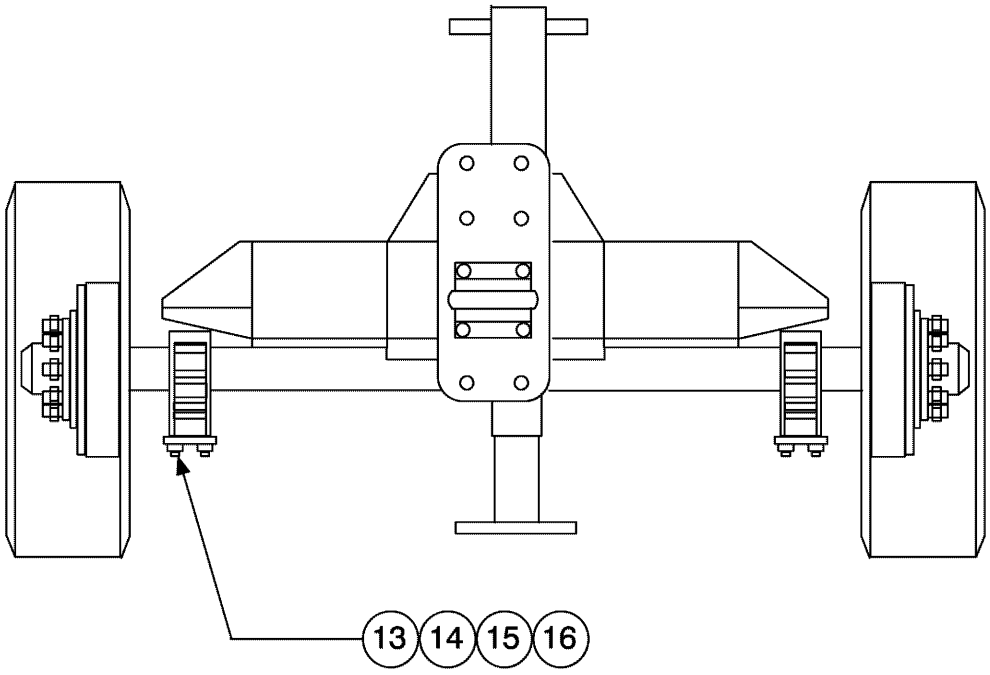
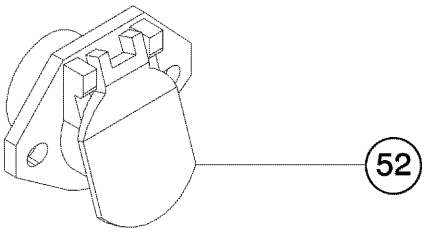
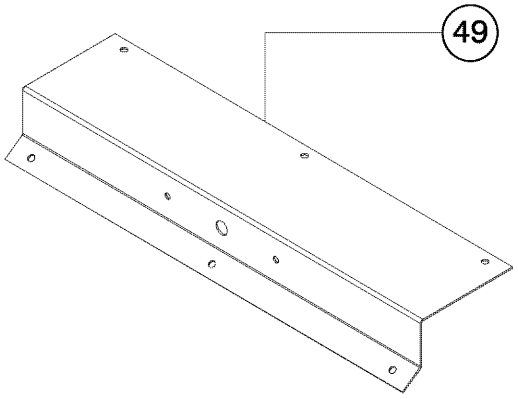
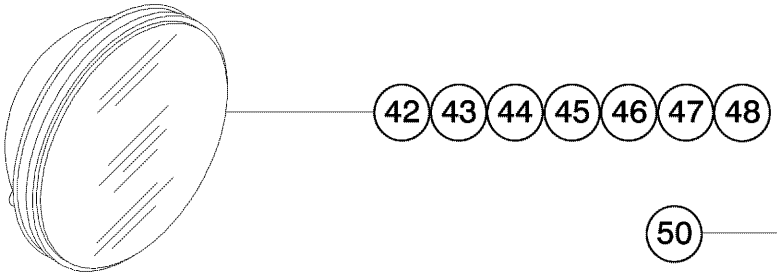
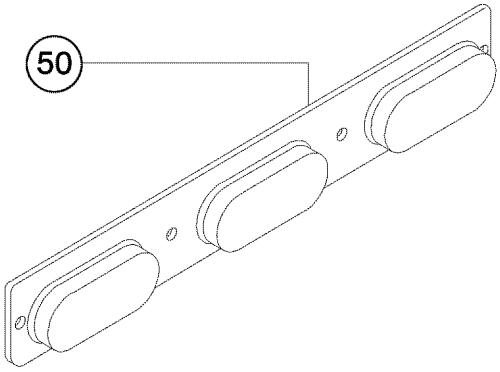
MODEL NO. XHP1070	MANUAL NO. 35391903-5	DATE/REV: 8-00/B

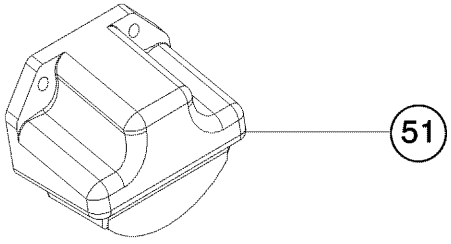












INGERSOLL-RAND COMPANY PORTABLE COMPRESSOR DIVISION		
DATE/DWN BY: 3-00 WAP	DESCRIPTION HIGH SPEED RUNNING GEAR	
MODEL NO. XHP1070	MANUAL NO. 35391903-6	DATE/REV: 8-00/B

ITEM	QTY.	PART NO.	DESCRIPTION
1	1	36880128	EYE , LUNETTE
2	4	36880136	BOLT
3	4	95935011	FLATWASHER
4	4	95077608	LOCKNUT
5	1	36880144	DROPLEG JACK
6	4	36880151	BUMPER , RUBBER
7	8	35144336	SCREW
8	2	35603190	CHOCK , WHEEL
9	2	35333830	STRAP , RUBBER
10	4	36853091	NUT
11	2	36853109	WASHER
12	2	36853117	WASHER , LOCK
13	2	36880169	PLATE , U-BOLT
14	4	36880177	U-BOLT
15	8	36880185	NUT
16	8	95934741	WASHER , LOCK
17	2	36880193	HANGER , CENTER
18	2	36880201	HANGER , FRONT
19	2	36880219	BAR , EQUALIZER
20	8	36880227	BOLT , SHACKLE
21	8	35336700	NUT , LOCK
22	2	36880235	HANGER , REAR
23	2	36880243	BOLT , EQUALIZER
24	2	36880250	LOCKNUT
25	4	36880268	HUB ASSEMBLY
26	1	36851624	INNER BEARING CUP
27	1	36851616	BEARING , OUTER CUP
28	8	35372150	STUD
29	1	36851608	BEARING , INNER
30	1	36851590	BEARING , OUTER
31	1	36851590	SEAL
32	1	36776813	CAP , DUST
33	8	36880276	NUT , CONE
34	4	36880284	SPRING , LEAF
35	2	36880292	L.H. ELECTRIC BRAKE ASSY.
36	2	36880300	R.H. ELECTRIC BRAKE ASSY.
37	4	36880318	BOTTOM DUST SHIELD
38	4	36880326	TOP DUST SHIELD
39	7	36880334	BOLT , HEX
40	7	95939955	WASHER , LOCK
41	7	36880342	LOCKNUT
42	2	36788081	STOP,TURN AND TAIL LIGHT
43	6	36787968	GROMMET (USE ON 42 & 44)
44	4	36859320	STOP,TURN AND TAIL LIGHT
45	4	35367051	YELLOW LIGHT
46	2	36893642	GROMMET (USE ON 45)
47	2	36893634	GROMMET (USE ON 45)
48	4	35367044	RED CLEARANCE LIGHT
49	1	36896306	ID BRACKET
50	1	36922144	3 LIGHT ASSEMBLY
51	1	36895860	LICENSE PLATE LIGHT
52	1	36894129	7-WAY CONNECTOR
	1	36893774	LIGHT HARNESS

INGERSOLL-RAND COMPANY
PORTABLE COMPRESSOR DIVISION

DATE/DWN BY:	DESCRIPTION	
3-00 WAP	HIGH SPEED RUNNING GEAR	
MODEL NO.	MANUAL NO.	DATE/REV:
XHP1070	35391903-7	8-00/B

CATERPILLAR®

SEBU6993-02
June 2000

Operation and Maintenance Manual

3406C Industrial Engines

3ER1-Up (Engine)

This Manual Must be Accessible at the Point of Operation

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “DANGER”, “WARNING” or “CAUTION”. The Safety Alert “WARNING” label is shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by “NOTICE” labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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Foreword

Literature Information

This manual contains safety, operation instructions, lubrication and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study and keep it with the literature and engine information.

English is the primary language for all Caterpillar publications. The English used facilitates translation and consistency in electronic media delivery.

Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual. Whenever a question arises regarding your engine, or this manual, please consult with your Caterpillar dealer for the latest available information.

Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance and repair on this product.

Operation

Operating techniques outlined in this manual are basic. They assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and its capabilities.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating and stopping the engine. This section also includes a discussion of electronic diagnostic information.

Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by fuel consumption, service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Use fuel consumption or service hours to determine intervals. Calendar intervals shown (daily, annually, etc.) may be used instead of service meter intervals if they provide more convenient schedules and approximate the indicated service meter reading.

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under extremely severe, dusty, wet or freezing cold operating conditions, more frequent lubrication and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

Maintenance Intervals

Perform maintenance on items at multiples of the original requirement. Each level and/or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation and application. We recommend that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. We also recommend that a maintenance record be maintained as part of the engine's permanent record.

See the section in the Operation and Maintenance Manual, "Maintenance Records" for information regarding documents that are generally accepted as proof of maintenance or repair. Your authorized Caterpillar dealer can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

Overhaul

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Caterpillar dealer. Your Caterpillar dealer offers a variety of options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available from your Caterpillar dealer. Consult with your dealer for information regarding these options.

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Battery posts, terminals and related accessories contain lead and lead compounds. **Wash hands after handling.**

Safety Section

i01368857

Safety Signs and Labels

SMCS Code: 1000; 7405

There may be several specific safety signs on an engine. The exact location of the hazards and the description of the hazards are reviewed in this section. Please become familiar with all safety signs.

Ensure that all of the safety signs are legible. Clean the safety signs or replace the safety signs if the words cannot be read or if the pictures are not visible. When the safety signs are cleaned, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the safety signs. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the safety signs. The safety signs that are loosened could drop off of the engine.

Replace any damaged safety signs or missing safety signs. If a safety sign is attached to a part of the engine that is replaced, install a new safety sign on the replacement part. Any Caterpillar dealer can provide new safety signs.

⚠ WARNING

Do not operate or work on this engine unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings could result in injury or death. Contact any Caterpillar dealer for replacement manuals. Proper care is your responsibility.

The safety signs that may be found on the engine are illustrated and described below.

Battery

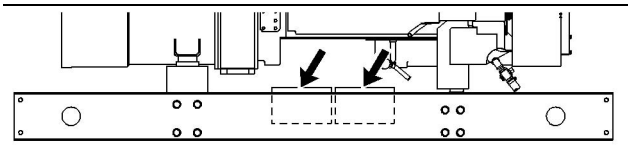


Illustration 1 g00524010

Typical location of the batteries in the battery compartment

The warning label for the battery is installed on the side of the engine or in a visible location near the battery. If batteries are located on both sides of the package, the warning label is located on both sides of the package.

g00455028

⚠ WARNING

Improper jumper cable connections can cause an explosion resulting in personal injury.

Batteries may be located in separate compartments. When you are using jump start cables, always connect the positive “+” cable to the positive “+” terminal of the battery that is connected to the starting motor solenoid. Connect the negative “-” cable from the external source to the negative “-” terminal of the starting motor. If the starting motor does not have a negative “-” terminal, connect the negative “-” cable from the external source to the engine block. Follow the procedure in this Operation and Maintenance Manual, “Engine Starting” topic (Operation Section).

Clutch

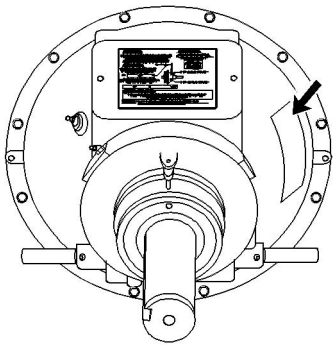
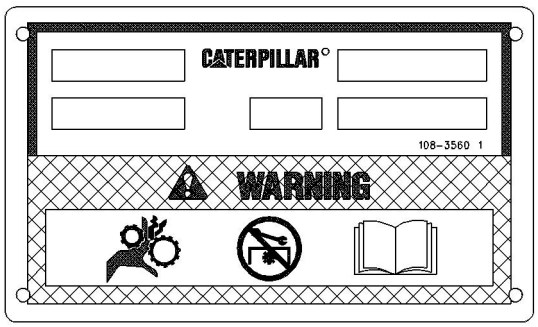


Illustration 2 g00107406

The warning label for the clutch is located on the clutch housing (if equipped).



g00107407

Rotating gears can cause finger entanglement or hand entanglement. Do not service this component without first reading the operator manual.

Engine Lifting

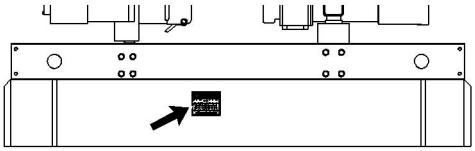
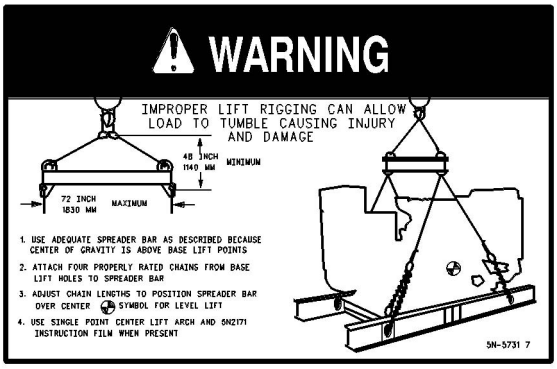


Illustration 3 g00367054

The warning label for lifting the engine with a fuel tank is located on the fuel tank (if equipped).



g00524148

WARNING

Lift eyes or tank can fail when lifting tank containing fluids resulting in possible personal injury. Drain tank of all fluids before lifting.

i01359759

General Hazard Information

SMCS Code: 1000; 7405

Illustration 4 g00104545

Attach a “Do Not Operate” warning tag or a similar warning tag to the start switch or to the controls before the engine is serviced or before the engine is repaired. These warning tags (Special Instruction, SEHS7332) are available from your Caterpillar dealer. Attach the warning tags to the engine and to each operator control station. When it is appropriate, disconnect the starting controls.

Do not allow unauthorized personnel on the engine, or around the engine when the engine is being serviced.

Engine exhaust contains products of combustion which may be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is in an enclosed area, vent the engine exhaust to the outside.

Cautiously remove the following parts. To help prevent spraying or splashing of pressurized fluids, hold a rag over the part that is being removed.

- Filler caps
- Grease fittings
- Pressure taps
- Breathers
- Drain plugs

Use caution when cover plates are removed. Gradually loosen, but do not remove the last two bolts or nuts that are located at opposite ends of the cover plate or the device. Before removing the last two bolts or nuts, pry the cover loose in order to relieve any spring pressure or other pressure.

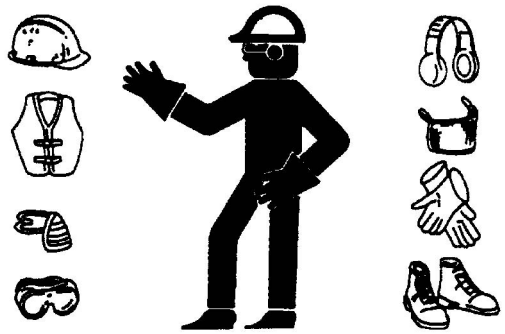


Illustration 5 g00702020

- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When work is performed around an engine that is operating, wear protective devices for ears in order to help prevent damage to hearing.
- Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.
- Ensure that all protective guards and all covers are secured in place on the engine.
- Never put maintenance fluids into glass containers. Glass containers can break.
- Use all cleaning solutions with care.
- Report all necessary repairs.

Unless other instructions are provided, perform the maintenance under the following conditions:

- The engine is stopped. Ensure that the engine cannot be started.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads in order to help prevent sparks.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.

California Proposition 65 Warning

Some engine exhaust constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Pressure Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This could result in personal injury.

When pressure air and/or pressure water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

Fluid Penetration

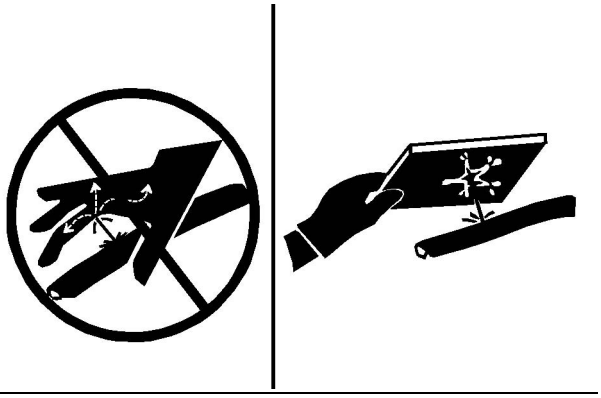


Illustration 6 g00687600

Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Containing Fluid Spillage

Care must be taken in order to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the engine. Prepare to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Tools and Shop Products Guide” for the following items:

- Tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids
- Tools that are suitable for containing fluids and equipment that is suitable for containing fluids

Obey all local regulations for the disposal of liquids.

Asbestos Information

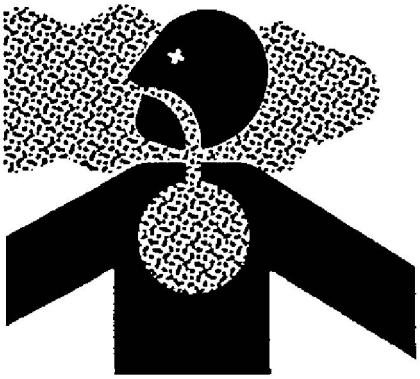


Illustration 7 g00702022

Caterpillar equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Caterpillar replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method in order to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.
- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.

- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in “29 CFR 1910.1001”.
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

Dispose of Waste Properly

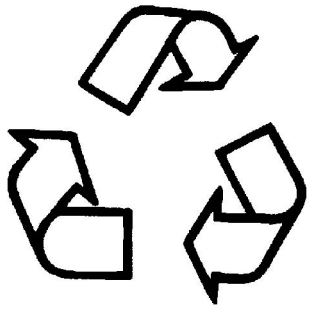


Illustration 8 g00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

i01329129

Burn Prevention

SMCS Code: 1000; 7405

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level only after the engine has been stopped.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly in order to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Hot oil and hot components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

Batteries

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes. Always wear protective glasses for servicing batteries. Wash hands after touching the batteries and connectors. Use of gloves is recommended.

i01359892

Fire Prevention and Explosion Prevention

SMCS Code: 1000; 7405

Illustration 9 g00704000

All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

A flash fire may result if the covers for the engine crankcase are removed within fifteen minutes after an emergency shutdown.

Determine whether the engine will be operated in an environment that allows combustible gases to be drawn into the air inlet system. These gases could cause the engine to overspeed. Personal injury , property damage, or engine damage could result.

If the application involves the presence of combustible gases, consult your Caterpillar dealer for additional information about suitable protection devices.

Remove all flammable materials such as fuel, oil, and debris from the engine. Do not allow any flammable materials to accumulate on the engine.

Store fuels and lubricants in properly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in case of a line, a tube, or a seal failure. Exhaust shields must be installed correctly.

Do not weld on lines or tanks that contain flammable fluids. Do not flame cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent prior to welding or flame cutting.

Wiring must be kept in good condition. All electrical wires must be properly routed and securely attached. Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Eliminate all wiring that is unattached or unnecessary. Do not use any wires or cables that are smaller than the recommended gauge. Do not bypass any fuses and/or circuit breakers.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

Inspect all lines and hoses for wear or for deterioration. The hoses must be properly routed. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Oil filters and fuel filters must be properly installed. The filter housings must be tightened to the proper torque.

Illustration 10 g00704059

Use caution when you are refueling an engine. Do not smoke while you are refueling an engine. Do not refuel an engine near open flames or sparks. Always stop the engine before refueling.

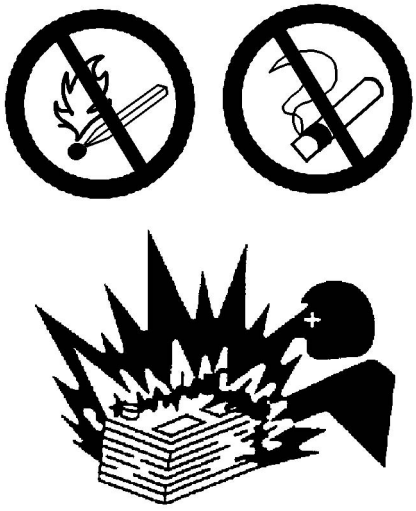


Illustration 11 g00704135

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions.

Do not charge a frozen battery. This may cause an explosion.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

Ether

Ether is flammable and poisonous.

Use ether in well ventilated areas. Do not smoke while you are replacing an ether cylinder or while you are using an ether spray.

Do not store ether cylinders in living areas or in the engine compartment. Do not store ether cylinders in direct sunlight or in temperatures above 49 °C (120 °F). Keep ether cylinders away from open flames or sparks.

Dispose of used ether cylinders properly. Do not puncture an ether cylinder. Keep ether cylinders away from unauthorized personnel.

Do not spray ether into an engine if the engine is equipped with a thermal starting aid for cold weather starting.

i01359666

Crushing Prevention and Cutting Prevention

SMCS Code: 1000; 7405

Support the component properly when work beneath the component is performed.

Unless other maintenance instructions are provided, never attempt adjustments while the engine is running.

Stay clear of all rotating parts and of all moving parts. Leave the guards in place until maintenance is performed. After the maintenance is performed, reinstall the guards.

Keep objects away from moving fan blades. The fan blades will throw objects or cut objects.

When objects are struck, wear protective glasses in order to avoid injury to the eyes.

Chips or other debris may fly off objects when objects are struck. Before objects are struck, ensure that no one will be injured by flying debris.

i01359622

Mounting and Dismounting

SMCS Code: 1000; 7405

Inspect the steps, the handholds, and the work area before mounting the engine. Keep these items clean and keep these items in good repair.

Mount the engine and dismount the engine only at locations that have steps and/or handholds. Do not climb on the engine, and do not jump off the engine.

Face the engine in order to mount the engine or dismount the engine. Maintain a three-point contact with the steps and handholds. Use two feet and one hand or use one foot and two hands. Do not use any controls as handholds.

Do not stand on components which cannot support your weight. Use an adequate ladder or use a work platform. Secure the climbing equipment so that the equipment will not move.

Do not carry tools or supplies when you mount the machine or when you dismount the machine. Use a hand line to raise and lower tools or supplies.

i01072501

Before Starting Engine

SMCS Code: 1000

Inspect the engine for potential hazards.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

Ensure that the engine is equipped with a lighting system that is suitable for the conditions. Ensure that all lights work properly.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

For the initial start-up of a new engine and for start-up of an engine that has been serviced, prepare to stop the engine if an overspeed occurs. This may be accomplished by shutting off the fuel and the air supply to the engine.

See the Service Manual for repairs and for adjustments.

i01103904

Engine Starting

SMCS Code: 1000

If a warning tag is attached to the engine start switch or to the controls, DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in this Operation and Maintenance Manual, "Engine Starting" topic (Operation Section). Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working properly, check the water temperature gauge and the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion that can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

Ether

Ether is poisonous and flammable.

Do not inhale ether, and do not allow ether to contact the skin. Personal injury could result.

Do not smoke while ether cylinders are changed.

Use ether in well ventilated areas.

Use ether with care in order to avoid fires.

Keep ether cylinders out of the reach of unauthorized persons.

Store ether cylinders in authorized storage areas only.

Do not store ether cylinders in direct sunlight or at temperatures above 49 °C (120 °F).

Discard the ether cylinders in a safe place. Do not puncture the ether cylinders. Do not burn the ether cylinders.

i00062369

Engine Stopping

SMCS Code: 1000

Stop the engine according to the procedure in the Operation and Maintenance Manual in order to avoid overheating of the engine and accelerated wear of the engine components.

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. Do not use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

On the initial start-up of a new engine or an engine that has been overhauled, be prepared to stop the engine if an overspeed condition occurs. This may be accomplished by shutting off the fuel supply to the engine and/or shutting off the air supply to the engine.

To stop an electronically controlled engine, cut the power to the engine.

Product Information Section

Model Views

i01369271

Model View Illustrations

SMCS Code: 1000

The following model views show typical 3406C Industrial Engine features. Due to individual applications, your engine may appear different from the illustrations.

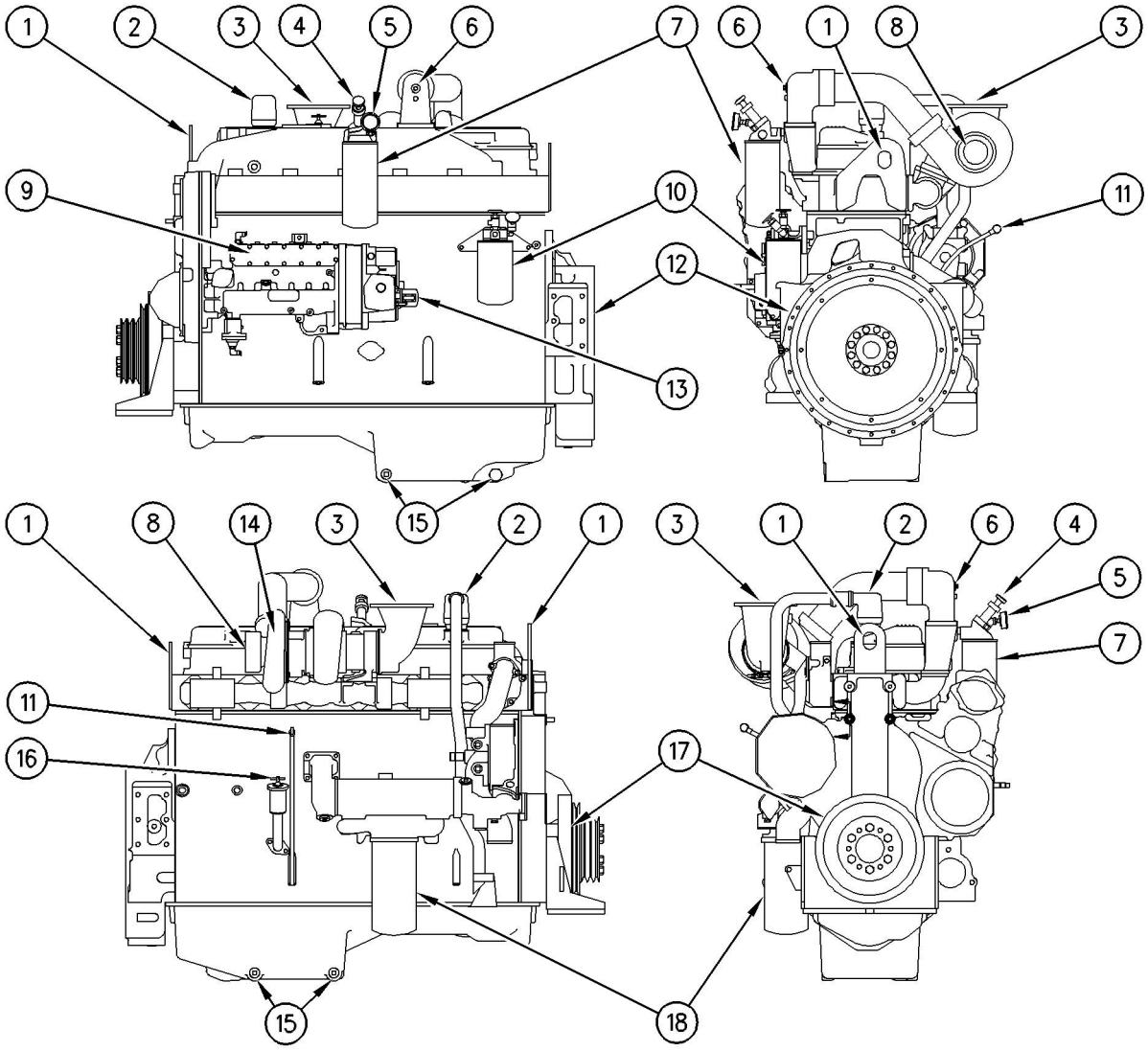


Illustration 12 g00722253

(1) Lifting eye
(2) Crankcase breather
(3) Exhaust
(4) Fuel priming pump
(5) Fuel pressure gauge
(6) Either starting aid (if equipped)
(7) Fuel filter
(8) Air inlet
(9) Fuel pump
(10) SCA element (if equipped)
(11) Oil level gauge
(12) Flywheel housing
(13) Service hour meter
(14) Turbocharger
(15) Oil drain plugs
(16) Oil filler cap
(17) Crankshaft vibration damper
(18) Oil filter

i01369284

Engine Description

SMCS Code: 1000

Engine Information

The 3406C Industrial Engine is designed primarily for agricultural, petroleum, and auxiliary applications.

A mechanical governor controls the fuel injection pump output. The output maintains the desired engine speed. An automatic timing advance provides the best fuel injection timing over the full range of engine speeds.

The fuel ratio control is located on the governor. The fuel ratio control restricts the fuel rack movement. Only the proper amount of fuel is allowed to be injected into the cylinders during acceleration. This minimizes exhaust smoke.

Inlet air is filtered by an air cleaner. The air is compressed by a turbocharger before the air enters the engine cylinders. The turbocharger is driven by engine exhaust. The engines can be turbocharged. The engines can also be turbocharged with jacket water aftercooling.

The engine is a four cycle engine. Each cylinder head has two inlet valves and two exhaust valves. The rocker arms and the valves are actuated by the camshaft. The action is performed by mechanical lifters and push rods.

Engine Cooling and Lubrication

The cooling system consists of the following components:

- Centrifugal pump that is driven by gears
- Thermostats which regulate the engine coolant temperature
- Oil cooler
- A radiator or expansion tank (incorporating a shunt system)

The engine lubricating oil, that is supplied by a gear type pump, is cooled. The engine lubricating oil is also filtered. Bypass valves provide unrestricted flow of lubrication oil to the engine components during the following conditions:

- High oil viscosity
- Plugged oil cooler or plugged oil filter elements (paper cartridge)

Engine efficiency, efficiency of emission controls, and engine performance depend on adherence to proper operation and maintenance recommendations. Engine performance and efficiency also depend on the following items:

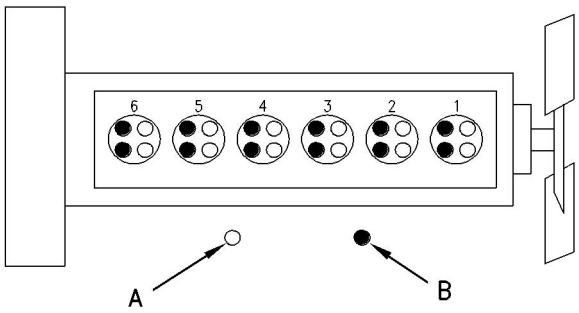
- Use of recommended coolant/antifreeze
- Use of recommended fuels
- Use of recommended lubrication oils

Refer to the recommended Maintenance Interval Schedule found within this publication in order to maintain the following emission related components:

- Air cleaner
- Engine oil
- Oil filter
- Fuel
- Fuel filter

Engine Specifications

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right sides of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.



g00284836

Illustration 13

Cylinder and valve locations

(A) Inlet valves
(B) Exhaust valves

Table 1

3406C Industrial Engine Specifications	
Cylinders and Arrangement	6 cylinder in-line block
Bore	137 mm (5.4 inch)
Stroke	165 mm (6.5 inch)
Compression Ratio	16:25:1
Aspiration	T or TA(1)
Displacement	14.6 L (893 in^3)
Firing Order	1-5-3-6-2-4
Rotation (flywheel end)	Counterclockwise
Valve Lash (inlet)	0.38 mm (.015 inch)
Valve Lash (exhaust)	0.76 mm (.030 inch)

(1) Turbocharged or Turbocharged and Aftercooled

Product Identification Information

i00826199

Engine Identification

SMCS Code: 1000

Caterpillar engines are identified with serial numbers, with performance specification numbers, and with arrangement numbers. In some of the cases, modification numbers are used. These numbers are shown on the serial number plate that is mounted on the engine.

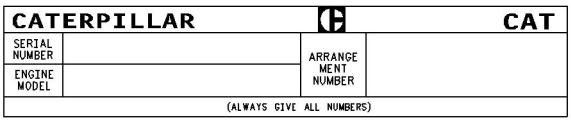
The numbers for fuel setting information for electronic engines are stored within the personality module. These numbers can be read by using Caterpillar electronic service tools.

Caterpillar dealers need these numbers in order to determine the components that were included with the engine. This permits accurate identification of replacement part numbers.

i01369380

Serial Number Plate

SMCS Code: 1000



g00722314

Illustration 14

Typical serial number plate

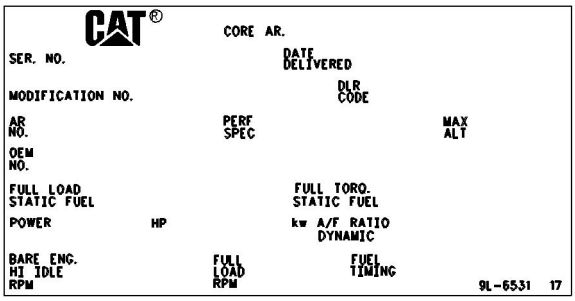
The Serial Number Plate is located on the left side of the cylinder block near the rear of the engine.

The following information is stamped on the Serial Number Plate: engine serial number, model, and arrangement number.

i00061495

Information Plate

SMCS Code: 1000



g00102789

Illustration 15

The Information Plate is on the valve cover. The following information is stamped on the Information Plate: engine's maximum altitude, horsepower, high idle, full load rpm, fuel settings, and other information.

i00610276

Reference Numbers

SMCS Code: 1000

Information for the following items may be needed to order parts. Locate the information for your engine. Record the information on the appropriate space. Make a copy of this list for a record. Retain the information for future reference.

Record for Reference

Engine Model _____

Engine Serial No. _____

Engine Arrangement No. _____

Modification No. _____

Engine Low Idle rpm _____

Engine Full Load rpm _____

Performance Specification No. _____

Primary Fuel Filter No. _____

Water Separator Element No. _____

Secondary Fuel Filter Element No. _____

Lubrication Oil Filter Element No. _____

Auxiliary Oil Filter Element No. _____

Supplemental Coolant Additive Maintenance Element No. (Optional) _____

Total Lubrication System Capacity _____

Total Cooling System Capacity _____

Air Cleaner Element No. _____

Fan Drive Belt No. _____

Alternator Belt No. _____

i01193826

Emissions Certification Film

SMCS Code: 1000

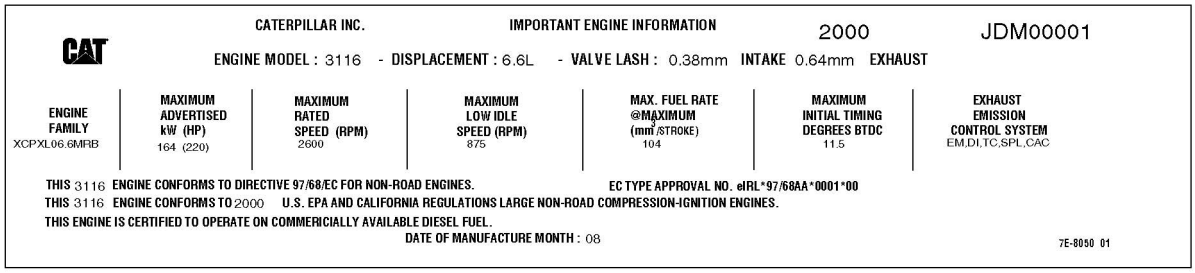


Illustration 16 g00638668

EPA/EU Emissions Certification Film (typical example)

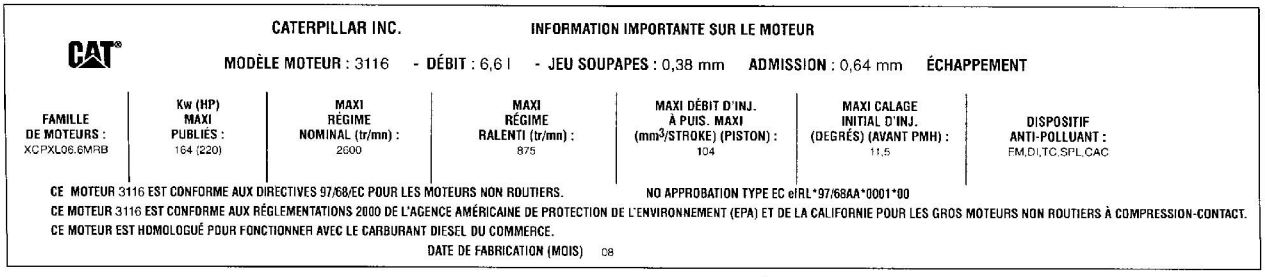


Illustration 17 g00638373

EPA/EU Emissions Certification Film (French-typical example)

The EPA/EU Emissions Certification Film (if applicable) is located either on the side, the top, or the front of the engine.

Operation Section

Engine Lifting and Storage

i01028339

Engine Lifting

SMCS Code: 1000; 1122

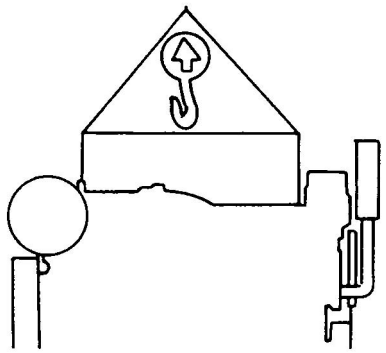


Illustration 18 g00103219

NOTICE

Never bend the eyebolts and the brackets. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

When it is necessary to remove a component at an angle, only use a link bracket that is properly rated for the weight.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

Some removals require lifting the fixtures in order to obtain proper balance and safety.

To remove the engine ONLY, use the lifting eyes that are on the engine.

Lifting eyes are designed and installed for the specific engine arrangement. Alterations to the lifting eyes and/or the engine make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided. Consult your Caterpillar dealer for information regarding fixtures for proper engine lifting.

Engine Lifting with a Fuel Tank

⚠ WARNING

Lift eyes or tank can fail when lifting tank containing fluids resulting in possible personal injury. Drain tank of all fluids before lifting.

Lifting the engine with a fuel tank that is mounted to the engine requires special equipment and procedures. Do not lift the unit with fuel in the fuel tank. Consult your Caterpillar dealer for information regarding fixtures for proper lifting of your complete package.

i00777190

Engine Storage

SMCS Code: 1000

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface. Rust on the cylinder liner surface will cause increased engine wear and a reduction in engine service life.

To help prevent excessive engine wear, use the following guidelines:

- Complete all of the lubrication recommendations that are listed in this Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section).
- If freezing temperatures are expected, check the cooling system for adequate protection against freezing. See this Operation and Maintenance Manual, “General Coolant Information” (Maintenance Section).

If an engine is out of operation and if use of the engine is not planned, special precautions should be made. If the engine will be stored for more than one month, a complete protection procedure is recommended.

For more detailed information on engine storage, see Special Instruction, SEHS9031, “Storage Procedure For Caterpillar Products”.

Your Caterpillar dealer can assist in preparing the engine for extended storage periods.

Gauges and Indicators

i01369505

Gauges and Indicators

SMCS Code: 1900; 7450

Your engine may not have the same gauges or all of the gauges that are described. For more information about the gauge package, see the OEM information.

Gauges provide indications of engine performance. Ensure that the gauges are in good working order. Determine the normal operating range by observing the gauges over a period of time.

Noticeable changes in gauge readings indicate a potential problem with a gauge or with the engine. Problems may also be indicated by gauge readings that change even if the readings are within specifications. Determine the cause of any significant change in the readings, and/or correct the cause of any significant change in the readings. Consult your Caterpillar dealer for assistance.

NOTICE
Be ready to activate the engine shutoff manually, if there is no oil pressure . Damage to the engine will result if the engine continues to run without the correct oil pressure.

Engine Oil Pressure – Typical oil pressure for an engine at rated speed with SAE 10W30 or with SAE 15W40 is 275 to 606 kPa (40 to 88 psi).

A lower oil pressure is normal at low idle. If the load is stable and the gauge reading changes, perform the following procedure:

1. Remove the load.

2. Reduce engine speed to low idle.

3. Check and maintain the oil level.

The minimum recommended oil pressure at 600 rpm is 103 kPa (15 psi). If low oil pressure or no oil pressure is indicated, stop the engine and determine the cause of the problem. Refer to Troubleshooting for further information or consult with your Caterpillar dealer.

Jacket Water Coolant Temperature – Typical temperature range is 87 to 98°C (189 to 208°F). The maximum allowable temperature with the pressurized cooling system is 104 °C (219 °F). Higher temperatures may occur under certain conditions. The water temperature reading may vary according to load. The reading should never exceed the boiling point for the pressurized system that is being used.

If the engine is operating above the normal range and steam becomes apparent, perform the following procedure:

1. Reduce the load and the engine speed (rpm).

2. Inspect the cooling system for leaks.

3. Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load.

Tachometer – This gauge indicates engine speed (rpm). When the throttle control lever is moved to the full throttle position without load, the engine is running at high idle. The engine is running at the full load rpm when the throttle control lever is at the full throttle position with maximum rated load.

NOTICE
Engine overspeed may cause serious damage.

Keep the tachometer indicator in the green operating range.

Note: The high idle speed (rpm) and the full load speed (rpm) are stamped on the Information Plate.

Ammeter – This gauge indicates the amount of charge or discharge in the battery charging circuit. Operation of the indicator should be to the right side of “0”(zero).

Service Hour Meter – This gauge indicates the total number of clock hours that the engine has operated.

Fuel Pressure – This gauge indicates fuel pressure to the injection pump. The indicator should indicate the “NORMAL” range. If the indicator moves to the “OUT” position or registers below 160 kPa (23 psi) when equipped with a numerical gauge, the engine will not operate properly. A decrease in fuel pressure usually indicates a plugged fuel filter.

Engine Features and Controls

i01369587

Engine Shutoffs and Engine Alarms

SMCS Code: 1900; 7400; 7418

Shutoffs

Shutoffs and alarms are electrically operated or mechanically operated. The operation of all electric shutoffs and alarms utilize components which actuate switches in a sensing unit.

Shutoffs are set at critical levels for the following items: operating temperature, operating pressure, operating coolant level, and operating speed (rpm). The particular shutoff may need to be reset before the engine will start.

NOTICE
Always determine the cause of the engine shutdown. Make necessary repairs before attempting to restart the engine.

Be familiar with the following items:

- Types and locations of shutoff
- Conditions which cause each shutoff to function
- The resetting procedure that is required to restart the engine

Air Shutoff Solenoid (If Equipped)

This optional solenoid is located on top of the engine. The air shutoff is part of the air inlet system. When the solenoid is activated, the solenoid mechanically shuts off the inlet air to the engine. The solenoid can be activated only by the overspeed switch or by the emergency stop push button (ESPB). The cause of the shutoff should be determined before the engine is restarted.

Fuel Shutoff Solenoid

The fuel shutoff solenoid is located on the governor or the fuel shutoff solenoid is located on the fuel injection pump. When the fuel shutoff solenoid is activated, the solenoid moves the fuel rack “OFF”. The fuel shutoff solenoid moves the fuel rack directly or the fuel shutoff solenoid moves the fuel rack through the governor.

Overspeed Shutoffs

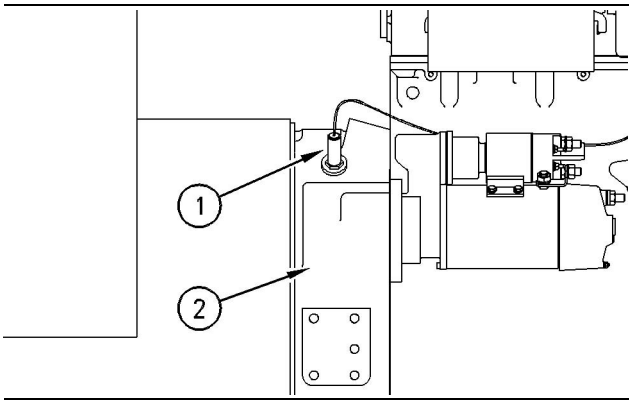


Illustration 19 g00293335

(1) Magnetic pickup
(2) Flywheel housing

The magnetic pickup senses the passage of the teeth that are on the flywheel ring gear. The Electronic Overspeed Switch is set at 118 percent of the rated engine speed. If the engine speed increases above the overspeed setting, the magnetic pickup will sense the overspeed. A signal is sent to the Electronic Overspeed Switch. The Electronic Overspeed Switch activates both the air shutoff solenoid (if equipped) and the fuel shutoff solenoid.

The shutoffs must be reset before the engine will restart. The air shutoff lever that is located at the top of the air inlet housing must be manually reset. The cause of the overspeed must be determined before the engine is restarted.

Alarms

Alarms consist of a switch and a contactor. The switches are wired to the contactors. The contactors activate alarm circuits in an annunciator panel. Your engine may be equipped with the following switches:

Engine oil pressure – The engine oil pressure switch indicates when oil pressure drops below rated system pressure.

Coolant level – The low coolant level switch indicates when the coolant level is low.

Coolant temperature – The coolant temperature switch indicates high jacket water coolant temperature.

Note: The sensing element of the coolant temperature switch must be submerged in coolant in order to operate.

Engines may be equipped with alarms in order to alert the operator when undesirable operating conditions occur.

NOTICE

When an alarm is activated, corrective measures must be taken before the situation becomes an emergency in order to avoid possible engine damage.

If corrective measures are not taken within a reasonable time, engine damage could result. The alarm will continue until the condition is corrected. The alarm may need to be reset.

A switch may be installed in the alarm while the engine is stopped for repairs. Before the engine is started, ensure that the switch is moved to the ON position and that the warning lights are flashing. The engine will not be protected if the switch is left in the OFF position.

Testing the Shutoff and Alarm System

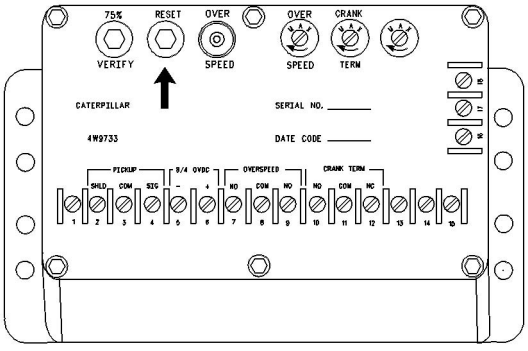
Most control panels are equipped with a lamp test switch. Turn the switch to the ON position in order to check the indicator lights for proper operation. Replace worn bulbs immediately.

NOTICE

During testing, abnormal operating conditions must be simulated. Perform the tests correctly in order to help prevent possible engine damage.

Refer to the Service Manual for more information on testing procedures or consult your Caterpillar dealer.

Testing of the Overspeed Switch



g00291056

Illustration 20

Electronic Overspeed Switch

The overspeed shutoff switch is located in the junction box. The overspeed shutoff switch must be reset before you can restart the engine. To reset the switch, push the “RESET” button. The button will remain in this position unless an overspeed condition occurs.

The Electronic Overspeed Switch with Cranking Termination has a 75 percent “VERIFY” button, a “RESET” button, and an “OVERSPEED” indicator lamp.

The Electronic Overspeed Shutoff Switch with Cranking Termination has a sensing circuit which prevents the starter pinion from remaining engaged in the flywheel at excessive rpm. Crank Termination has an adjustable engine speed setting. This signals the starter motor when the engine is firing. Cranking must be terminated. Once the speed setting is reached, a switch opens. This will start the engine hour meter.

Once the starting motor cranks the engine, the pinion gear can remain engaged with the flywheel as the engine speed increases. The magnetic pickup opens the circuit to the starting motor at 400 rpm. This will allow the pinion gear to disengage.

The circuit will remain open until the flywheel stops. This prevents energizing the starting motor circuit again while the flywheel is turning.

The engine may be equipped with either an Overspeed Shutoff Switch or an Electronic Overspeed Switch with Cranking Termination. Both switches can be checked for proper operation at 75 percent of overspeed condition. Use the following procedure:

1. Determine full load speed (rpm) from the Engine Information Plate.
2. Operate the engine at or slightly above the corresponding speed (rpm) shown for the engine. Refer to table 2.
3. Maintain the test speed (rpm). Push and hold the “VERIFY” button. The engine should stop. If the engine does not stop at the specified test speed (rpm), contact your Caterpillar dealer.

Table 2

INDUSTRIAL ENGINE OVERSPEED TEST RPM		
Full Load RPM	**Test RPM For Overspeed**(1)	**Actual RPM Of Overspeed**(2)
1500	1328	1770
1800	1593	2124
2000	1770	2360
2100	1859	2478

(1) The Test RPM for Overspeed is slower than the Full Load RPM. Multiply the Full Load RPM by 0.885. The product is the Test RPM.

(2) Multiply the Full Load RPM by 1.18. The product is the Actual RPM of Overspeed

Note: The “OVERSPEED” lamp will illuminate as the engine stops. Push the “RESET” button before you restart the engine.

Engine Starting

i01197471

Before Starting Engine

SMCS Code: 1000; 1400; 1450

Perform the required daily maintenance and other periodic maintenance before the engine is started. Inspect the engine compartment. This inspection can help prevent major repairs at a later date. Refer to the Operation and Maintenance Manual, “Maintenance Interval Schedule” for more information.

- For the maximum service life of the engine, make a thorough inspection before the engine is started. Look for the following items: oil leaks, coolant leaks, loose bolts, and trash buildup. Remove trash buildup and arrange for repairs, as needed.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage.
- Inspect the wiring for loose connections and for worn wires or frayed wires.
- Check the fuel supply. Drain water from the water separator (if equipped). Open the fuel supply valve.

NOTICE

All valves in the fuel return line must be open before and during engine operation to help prevent high fuel pressure. High fuel pressure may cause filter housing failure or other damage.

If the engine has not been started for several weeks, fuel may have drained from the fuel system. Air may have entered the filter housing. Also, when fuel filters have been changed, some air pockets will be trapped in the engine. In these instances, prime the fuel system. Refer to the Operation and Maintenance Manual, “Fuel System - Prime” for more information on priming the fuel system.

⚠ WARNING

Engine exhaust contains products of combustion which may be harmful to your health. Always start and operate the engine in a well ventilated area and, if in an enclosed area, vent the exhaust to the outside.

- Do not start the engine or move any of the controls if there is a “DO NOT OPERATE” warning tag or similar warning tag attached to the start switch or to the controls.
- Ensure that the areas around the rotating parts are clear.
- All of the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor (if equipped) is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset all of the shutoffs or alarm components.
- Check the engine lubrication oil level. Maintain the oil level between the “ADD” mark and the “FULL” mark on the oil level gauge.
- Check the coolant level. Observe the coolant level in the coolant recovery tank (if equipped). Maintain the coolant level to the “FULL” mark on the coolant recovery tank.
- If the engine is not equipped with a coolant recovery tank maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level in the sight glass.
- Observe the air cleaner service indicator (if equipped). Service the air cleaner when the yellow diaphragm enters the red zone, or when the red piston locks in the visible position.
- Ensure that any driven equipment has been disengaged. Remove any electrical loads.

i00970006

Starting the Engine

SMCS Code: 1000; 1450

Refer to the Service Manual for your type of controls. Use the following procedure to start the engine.

1. Place the manual stop control (if equipped) in the RUN position. Turn the ignition switch to the RUN position. Advance the throttle in order to supply fuel to the engine.

2. Turn the ignition switch to the START position in order to crank the engine.

   Allow the ignition switch to return to the RUN position as soon as the engine starts.

NOTICE

Oil pressure should rise within 15 seconds after the engine starts. Do not increase engine speed until the oil pressure gauge indicates normal. If oil pressure is not indicated on the gauge within 15 seconds, DO NOT operate the engine. STOP the engine, investigate and correct the cause.

3. Move the throttle to approximately one quarter of the engine rpm.

4. Allow the engine to idle for three to five minutes, or allow the engine to idle until the water temperature indicator begins to rise. The engine should run at low idle smoothly until speed is gradually increased to high idle. Allow the white smoke to disperse before proceeding with normal operation.

   To minimize white smoke for cold weather starting, start the engine and allow the engine to idle for 30 seconds. Increase the rpm until the engine speed reaches 1200 rpm. Return the engine to low idle rpm.

5. Operate the engine at low load until all systems reach operating temperature. Check the gauges during the warm-up period.

i00998863

Cold Weather Starting

SMCS Code: 1000; 1250; 1450; 1453; 1456; 1900

Refer to the Operation and Maintenance Manual that is for the control panels for detailed information on the control panels.

⚠ WARNING

When using starting fluid (ether), follow the manufacturer's instructions carefully. Use the starting fluid sparingly and spray only while cranking the engine. Failure to do so could result in an explosion and/or fire and personal injury.

NOTICE

The optional ether starting aid is the only starting fluid system that is recommended on the engine.

Startability will be improved at temperatures below –18 °C (0 °F) from the use of a jacket water heater or extra battery capacity.

When No. 2 diesel fuel is used, the following items provide a means of minimizing starting problems and fuel problems in cold weather: starting aids, engine oil pan heaters, jacket water heaters, fuel heaters, and fuel line insulation.

For temperatures below –23 °C (–10 °F), consult your Caterpillar dealer.

Use the procedure that follows for cold weather starting.

Note: If the engine has not been run for several weeks, fuel may have drained. Air may have moved into the filter housing. Also, when fuel filters have been changed, some air will be left in the filter housing. Refer to the Operation and Maintenance Manual for more information on priming the fuel system.

NOTICE

Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

1. Turn the ignition switch to the RUN position. Advance the throttle in order to supply fuel to the engine.

NOTICE

Excessive ether can cause piston and piston ring damage. Use ether for cold starting purposes only. Do not use excessive starting fluid while starting the engine. Do not use starting fluid after the engine is running.

2. If equipped, press the “Starting Aid” switch in order to improve cold weather starting. Release the “Starting Aid” switch when the engine starts. Use the starting fluid sparingly. Carefully follow the instructions of the OEM.

NOTICE

Oil pressure should rise within 15 seconds after the engine starts. Do not increase engine speed until the oil pressure gauge indicates normal. If oil pressure is not indicated on the gauge within 15 seconds, DO NOT operate the engine. STOP the engine, investigate and correct the cause.

3. Increase the engine rpm to approximately 1/4 of the full load rpm.

4. Allow the engine to idle for three to five minutes, or allow the engine to idle until the water temperature indicator begins to rise. The engine should run at low idle smoothly until speed is gradually increased to high idle. Allow the white smoke to disperse before proceeding with normal operation.

5. Operate the engine at low load until all systems reach operating temperature. Check the gauges during the warm-up period.

i01037941

Starting with Jump Start Cables

SMCS Code: 1000; 1401; 1402; 1900

⚠ WARNING

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

If the installation is not equipped with a backup battery system, it may be necessary to start the engine from an external electrical source.

First, determine the reason that it is necessary to start with power from an external source. Refer to Special Instruction, SEHS7768, “Use of the 6V-2150 Starting/Charging Analyzer”.

Many batteries which are considered unusable are still rechargeable. After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be charged to the proper voltage with a battery charger. For information on testing and charging, refer to the Special Instruction, SEHS7633, “Battery Test Procedure”.

NOTICE

Using a battery source with the same voltage as the electric starting motor. Use ONLY equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

When using an external electrical source to start the engine, turn the engine control switch to the “OFF” position. Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

1. Turn the start switch on the stalled engine to the OFF position. Turn off all accessories.

2. Connect one positive end of the jump start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump start cable to the positive cable terminal of the electrical source.

3. Connect one negative end of the jump start cable to the negative cable terminal of the electrical source. Connect the other negative end of the jump start cable to the engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting combustible gases that are produced by some batteries.

4. Charge the batteries. The engine will not continue to run after starting if the batteries have not been charged.

5. Start the engine.

6. Immediately after the stalled engine is started, disconnect the jump start cables in reverse order.

Refer to the Electrical Schematic for your engine. Consult your Caterpillar dealer for more information.

i01043333

After Starting Engine

SMCS Code: 1000

Note: In temperatures from 0 to 60°C (32 to 140°F), the warm-up time is approximately five minutes. In temperatures below 0°C (32°F), additional warm-up time may be required.

Note: Ensure that the self-test for the monitoring system (if equipped) is completed before operating the engine under load.

When the engine idles during warm-up, observe the following conditions:

- Check for any fluid or for any air leaks at idle rpm and at one-half full rpm (no load on the engine) before operating the engine under load.
- Operate the engine at low idle until all systems achieve operating temperatures. Check all gauges during the warm-up period.

Note: Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

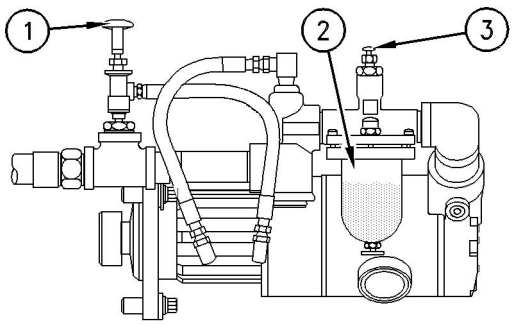
i00830307

Air Starting

SMCS Code: 1451

For good life of the air starting motor, the air supply must be free from dirt and water.

1. Open the drain valve and close the drain valve in order to drain condensation and oil carryover. This drain valve is located on the bottom of the air tank.
2. Check the air supply pressure. The air starting motor requires a minimum of 690 kPa (100 psi) air pressure to operate properly. The maximum air pressure must not exceed 1550 kPa (225 psi). The normal operating air pressure will be 758 to 965 kPa (110 to 140 psi).



g00381232

Illustration 21

(1) Air valve
(2) Lubricator bowl
(3) Adjustment knob

3. Check the oil level in lubricator bowl (2). Keep the bowl at least half full and add lubricant, if necessary.
4. Press air valve (1) or press the start button for the engine in order to crank the engine. After the engine starts, release the air valve or release the start button.

Engine Operation

i00718869

Engine Operation

SMCS Code: 1000

Proper operation and maintenance are key factors in obtaining the maximum life and economy of the engine. If the directions in the Operation and Maintenance Manual are followed, costs can be minimized and engine service life can be maximized.

The time that is needed for the engine to reach normal operating temperature can be less than the time needed for a walk-around inspection of the engine.

After the engine is started and after the engine reaches normal operating temperature, the engine can be operated at the rated rpm. The engine will reach normal operating temperature faster when the engine is at rated speed. The engine will reach normal operating temperature faster when the engine is at low power demand. This procedure is more effective than idling the engine at no load. The engine should reach operating temperature in a few minutes.

Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

i00808595

Engine Warm-up

SMCS Code: 1000

1. Run the engine at low idle for three to five minutes, or run the engine at low idle until the jacket water temperature starts to rise.

   More time may be necessary when the temperature is below –18° C (0° F).

2. Check all of the gauges during the warm-up period.

3. Perform another walk-around inspection. Check the engine for fluid leaks and air leaks.

4. Increase the rpm to the rated rpm. Check for fluid leaks and air leaks. The engine may be operated at full rated rpm and at full load when the engine oil temperature reaches 60° C (140° F).

i00162260

Engaging the Driven Equipment

SMCS Code: 1000

1. Operate the engine at one-half of the rated rpm.

2. Engage the driven equipment without a load on the equipment.

   Interrupted starts put excessive stress on the drive train. Interrupted starts also waste fuel. To get the driven equipment in motion, engage the clutch smoothly with no load on the equipment. This method should produce a start that is smooth and easy. The engine rpm should not increase and the clutch should not slip.

3. Ensure that the engine gauges register in the normal ranges when the engine is operating at one-half of the rated rpm. Ensure that any gauges for the equipment register in the normal ranges.

4. Increase the engine rpm to the rated rpm. Always increase the engine rpm to the rated rpm before the load is applied.

5. Apply the load. Begin operating the engine at low load. Check the gauges and equipment for proper operation. After normal oil pressure is reached and the temperature gauge begins to move, the engine may be operated at full load.

   Extended operation at low idle or at reduced load may cause increased oil consumption and carbon buildup in the cylinders. This carbon buildup results in a loss of power and/or poor performance. When the engine is operated at reduced load, the engine should be fully loaded in four hour increments. This procedure burns excess carbon from the cylinders. Check the gauges and equipment frequently when the engine is operated under load.

i00165110

Fuel Conservation Practices

SMCS Code: 1000; 1250

The efficiency of the engine can affect the fuel economy. Caterpillar's design and technology in manufacturing provides maximum fuel efficiency in all applications. Follow the recommended procedures in order to attain optimum performance for the life of the engine.

- Avoid spilling fuel.

  Fuel expands when the fuel is warmed up. The fuel may overflow from the fuel tank. Inspect fuel lines for leaks. Repair the fuel lines, as needed.

- Be aware of the properties of the different fuels. Use only the recommended fuels.

- Avoid unnecessary idling.

  Shut off the engine rather than idle for long periods of time.

- Observe the service indicator frequently. Keep the air cleaner elements clean.

- Ensure that the turbochargers are operating correctly so that the proper air/fuel ratio is maintained. Clean exhaust indicates proper functioning.

- Maintain a good electrical system.

  One defective battery cell will overwork the alternator. This will consume excess power and excess fuel.

- Ensure that the belts are properly adjusted. The belts should be in good condition.

- Ensure that all of the connections of the hoses are tight. The connections should not leak.

- Ensure that the driven equipment is in good working order.

- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.

- Settings for the fuel system and the limits for the operating altitude are stamped on the Engine Information Plate. If an engine is moved to a higher altitude, the settings must be changed by a Caterpillar dealer. Changing the settings will help prevent damage to the turbocharger. Changing the settings will help to provide the maximum efficiency for the engine. Engines can be operated safely at higher altitudes, but the engines will deliver less horsepower. The fuel settings should be changed by a Caterpillar dealer in order to obtain the rated horsepower.

Engine Stopping

i01057253

Emergency Stopping

SMCS Code: 1000; 7418

NOTICE
Emergency shutoff controls are for EMERGENCY use ONLY. DO NOT use emergency shutoff devices or controls for normal stopping procedure.

Ensure that any components for the external system that support the engine operation are secured after the engine is stopped.

Emergency Stop Button

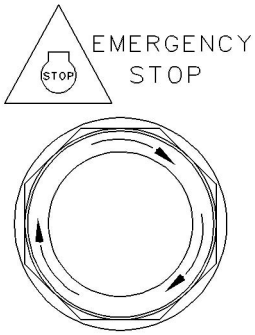


Illustration 22 g00104303
Typical emergency stop button

The emergency stop button is in the OUT position for normal engine operation. Push the emergency stop button. The engine will not start when the button is locked. Turn the button clockwise in order to reset.

i01370486

Manual Stop Procedure

SMCS Code: 1000

A manual shutoff shaft will override the governor control. The shaft will move the fuel control linkage to the FUEL OFF position. Refer to the MODEL VIEWS for the engine location of the shaft. The engine may be stopped by using the shaft and either the Woodward Actuator (if equipped) or the Mechanical Governor (if equipped).

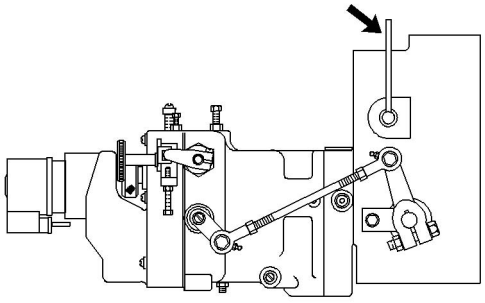


Illustration 23 g00723091
Typical Woodward actuator control lever

If the engine is equipped with a Woodward Actuator, move the control lever to the “FUEL OFF” position.

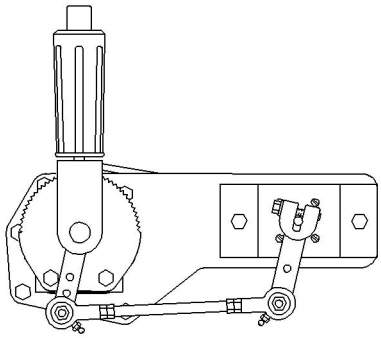


Illustration 24 g00723092
Typical mechanical governor control

If the engine is equipped with a Mechanical governor control, move the control lever to the FUEL OFF position.

Hold the lever at the FUEL OFF position until the engine stops.

Some engines are equipped with an air shutoff. The air shutoff is located between the aftercooler and the turbocharger. If the engine is equipped with an air shutoff lever, move the lever to the OFF position.

Note: Individual applications will have different control systems. Ensure that the shutoff procedures are understood. Use the following general guidelines in order to stop the engine.

1. Reduce the engine speed (rpm) to low idle. Remove the load.

2. Increase the engine speed (rpm) to no more than one-half of the rated speed (rpm). Perform this procedure for three to five minutes in order to cool the engine. Reduce the engine speed (rpm) to low idle.

3. After the cool down period, turn the start switch to the OFF position.

i01197515

After Stopping Engine

SMCS Code: 1000

- Check the crankcase oil level. Maintain the oil level between the “ADD” mark and the “FULL” mark on the oil level gauge.

- If necessary, perform minor adjustments. Repair any leaks and tighten any loose bolts.

- Note the service hour meter reading. Perform the maintenance that is in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.

- Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.

NOTICE

Only use antifreeze/coolant mixtures recommended in the Coolant Specifications that are in the Operation and Maintenance Manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level. Maintain the cooling system at 13 mm (0.5 inch) from the bottom of the pipe for filling.

- If freezing temperatures are expected, check the coolant for proper antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the proper coolant/water mixture, if necessary.

- Perform all required periodic maintenance on all driven equipment. This maintenance is outlined in the instructions from the OEM.

Cold Weather Operation

i00169595

Radiator Restrictions

SMCS Code: 1353; 1396

Caterpillar discourages the use of airflow restriction devices that are mounted in front of radiators. Airflow restriction can cause the following conditions:

- High exhaust temperatures
- Power loss
- Excessive fan usage
- Reduction in fuel economy

If an airflow restriction device must be used, the device should have a permanent opening directly in line with the fan hub. The device must have a minimum opening dimension of at least 770 cm^2 (120 in^2).

A centered opening that is directly in line with the fan hub is specified in order to prevent an interrupted airflow on the fan blades. Interrupted airflow on the fan blades could cause a fan failure.

Caterpillar recommends a warning device for the inlet manifold temperature and/or the installation of an inlet air temperature gauge. The warning device for the inlet manifold temperature should be set at 65°C (150°F). The inlet manifold air temperature should not exceed 65°C (150°F). Temperatures that exceed this limit can cause power loss and potential engine damage.

i01190421

Fuel and the Effect from Cold Weather

SMCS Code: 1000; 1250

The following fuels are the grades that are available for Caterpillar engines:

- No. 1
- No. 2
- Blend of No. 1 and No. 2

No. 2 diesel fuel is the most commonly used fuel. Either No. 1 diesel fuel or a blend of No. 1 and No. 2 is best suited for cold weather operation.

Quantities of No. 1 diesel fuel are limited. No. 1 diesel fuels are usually available during the months of the winter in the colder climates. During cold weather operation, if No. 1 diesel fuel is not available, use No. 2 diesel fuel, if necessary.

There are three major differences between No. 1 and No. 2 diesel fuel. No. 1 diesel fuel has the following properties:

- Lower cloud point
- Lower pour point
- Lower rating of kJ (BTU) per unit volume of fuel

When No. 1 diesel fuel is used, a decrease in power and in fuel efficiency may be noticed. Other operating effects should not be experienced.

The cloud point is the temperature when a cloud of wax crystals begins to form in the fuel. These crystals can cause the fuel filters to plug. The pour point is the temperature when diesel fuel will thicken. The diesel fuel becomes more resistant to flow through fuel pumps and through fuel lines.

Be aware of these values when diesel fuel is purchased. Anticipate the average ambient temperature within the area that the engine will be operated. Engines that are fueled in one climate may not operate well if the engines are moved to another climate. Problems can result due to changes in temperature.

Before troubleshooting for low power or for poor performance in the winter, check the type of fuel that is being used.

When No. 2 diesel fuel is used the following components provide a means of minimizing problems in cold weather:

- Starting aids
- Engine oil pan heaters
- Engine coolant heaters
- Fuel heaters
- Fuel line insulation

For more information on cold weather operation, see Operation and Maintenance Manual, SEBU5898, “Cold Weather Recommendations”.

i01250450

Fuel Related Components in Cold Weather

SMCS Code: 1000; 1250

Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after you operate the engine.

Fuel tanks should contain some provision for draining water and sediment from the bottom of the tanks. Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe.

Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Drain the water and sediment from any fuel storage tank at the following intervals: weekly, oil changes, and refueling of the fuel tank. This will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

Fuel Filters

It is possible that a primary fuel filter is installed between the fuel tank and the engine fuel inlet. After you change the fuel filter, always prime the fuel system in order to remove air bubbles from the fuel system. Refer to the Operation and Maintenance Manual in the Maintenance Section for more information on priming the fuel system.

The micron rating and the location of a primary fuel filter is important in cold weather operation. The primary fuel filter and the fuel supply line are the most common components that are affected by cold fuel.

NOTICE

In order to maximize fuel system life and prevent premature wear out from abrasive particles in the fuel, a two micron absolute high efficiency fuel filter is required for all Caterpillar Electronic Unit Injectors. Caterpillar High Efficiency Fuel Filters meet these requirements. Consult your Caterpillar dealer for the proper part numbers.

Fuel Heaters

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing. A fuel heater should be installed in the fuel system before the primary fuel filter.

The following fuel heaters are recommended for Caterpillar engines:

- 7C-3557 Fuel Heater Group
- 7C-3558 Heater Kit

For further information on fuel heaters, consult your Caterpillar dealer.

Disconnect the fuel heater in warm weather.

Note: Fuel heaters that are controlled by the water temperature regulator or self-regulating fuel heaters should be used with this engine. Fuel heaters that are not controlled by the water temperature regulator can heat the fuel in excess of 65°C (149°F). A loss of engine power can occur if the fuel supply temperature exceeds 37°C (100°F).

Note: Heat exchanger type fuel heaters should have a bypass provision in order to prevent overheating of the fuel in warm weather operation.

Maintenance Section

Torque Specifications

i01252954

General Torque Information

SMCS Code: 7553

⚠ WARNING

Mismatched or incorrect fasteners can result in damage or malfunction, or personal injury.

Take care to avoid mixing metric dimensioned fasteners and inch dimensioned fasteners.

Exceptions to these torques are given in the Service Manual, if necessary.

Prior to installation of any hardware, ensure that components are in near new condition. Bolts and threads must not be worn or damaged. Threads must not have burrs or nicks. Hardware must be free of rust and corrosion. Clean the hardware with a noncorrosive cleaner. Do not lubricate the fastener threads except for the rust preventive. The rust preventive should be applied by the supplier of that component for purposes of shipping and storage. Other applications for lubricating components may also be specified in the Service Manual.

i00621349

Standard Torque for Inch Fasteners

SMCS Code: 7553

Table 3

Inch Nuts and Bolts	
Thread Size Inch	**Standard Torque**
1/4	12 ± 3 N·m (9 ± 2 lb ft)
5/16	25 ± 6 N·m (18 ± 4 lb ft)
3/8	47 ± 9 N·m (35 ± 7 lb ft)
7/16	70 ± 15 N·m (50 ± 11 lb ft)
1/2	105 ± 20 N·m (75 ± 15 lb ft)
9/16	160 ± 30 N·m (120 ± 22 lb ft)
5/8	215 ± 40 N·m (160 ± 30 lb ft)
3/4	370 ± 50 N·m (275 ± 37 lb ft)
7/8	620 ± 80 N·m (460 ± 60 lb ft)
1	900 ± 100 N·m (660 ± 75 lb ft)
1 1/8	1300 ± 150 N·m (960 ± 110 lb ft)
1 1/4	1800 ± 200 N·m (1320 ± 150 lb ft)
1 3/8	2400 ± 300 N·m (1780 ± 220 lb ft)
1 1/2	3100 ± 350 N·m (2280 ± 260 lb ft)

Table 4

Inch Taperlock Studs	
Thread Size Inch	**Standard Torque**
1/4	8 ± 3 N·m (6 ± 2 lb ft)
5/16	17 ± 5 N·m (13 ± 4 lb ft)
3/8	35 ± 5 N·m (26 ± 4 lb ft)
7/16	45 ± 10 N·m (33 ± 7 lb ft)
1/2	65 ± 10 N·m (48 ± 7 lb ft)
5/8	110 ± 20 N·m (80 ± 15 lb ft)
3/4	170 ± 30 N·m (125 ± 22 lb ft)
7/8	260 ± 40 N·m (190 ± 30 lb ft)
1	400 ± 60 N·m (300 ± 44 lb ft)
1 1/8	525 ± 60 N·m (390 ± 44 lb ft)
1 1/4	750 ± 80 N·m (550 ± 60 lb ft)
1 3/8	950 ± 125 N·m (700 ± 90 lb ft)
1 1/2	1200 ± 150 N·m (880 ± 110 lb ft)

i00621350

Standard Torque for Metric Fasteners

SMCS Code: 7553

Table 5

Metric Nuts and Bolts	
Thread Size Metric	**Standard Torque**
M6	12 ± 3 N·m (9 ± 2 lb ft)
M8	28 ± 7 N·m (21 ± 5 lb ft)
M10	55 ± 10 N·m (41 ± 7 lb ft)
M12	100 ± 20 N·m (75 ± 15 lb ft)
M14	160 ± 30 N·m (120 ± 22 lb ft)
M16	240 ± 40 N·m (175 ± 30 lb ft)
M20	460 ± 60 N·m (340 ± 44 lb ft)
M24	800 ± 100 N·m (590 ± 75 lb ft)
M30	1600 ± 200 N·m (1180 ± 150 lb ft)
M36	2700 ± 300 N·m (2000 ± 220 lb ft)

Table 6

Metric Taperlock Studs	
Thread Size Metric	**Standard Torque**
M6	8 ± 3 N·m (6 ± 2 lb ft)
M8	17 ± 5 N·m (13 ± 4 lb ft)
M10	35 ± 5 N·m (26 ± 4 lb ft)
M12	65 ± 10 N·m (48 ± 7 lb ft)
M16	110 ± 20 N·m (80 ± 15 lb ft)
M20	170 ± 30 N·m (125 ± 22 lb ft)
M24	400 ± 60 N·m (300 ± 44 lb ft)
M30	750 ± 80 N·m (550 ± 60 lb ft)
M36	1200 ± 150 N·m (880 ± 110 lb ft)

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Standard Torque for Worm Drive Band Hose Clamps

SMCS Code: 7553; 7554

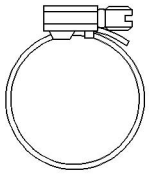

Illustration 25 g00280501

Table 7

Width of Clamp	Initial Installation Torque On New Hose
7.9 mm (0.31 inch)	0.9 ± 0.2 N·m (8 ± 2 lb in)
13.5 mm (0.53 inch)	4.5 ± 0.5 N·m (40 ± 4 lb in)
15.9 mm (0.63 inch)	7.5 ± 0.5 N·m (65 ± 4 lb in)
Width of Clamp	**Reassembly or Retightening Torque**
7.9 mm (0.31 inch)	0.7 ± 0.2 N·m (6 ± 2 lb in)
13.5 mm (0.53 inch)	3.0 ± 0.5 N·m (27 ± 4 lb in)
15.9 mm (0.63 inch)	4.5 ± 0.5 N·m (40 ± 4 lb in)

i01206414

Standard Torque for Constant Torque Hose Clamps

SMCS Code: 7553; 7554

Use a constant torque hose clamp in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard hose clamp. Due to extreme temperature changes, the hose will heat set. Heat setting can cause hose clamps to loosen. Loose hose clamps can result in leaks. There have been reports of component failures that have been caused by hose clamps that have loosened. The constant torque hose clamp will help prevent these failures.

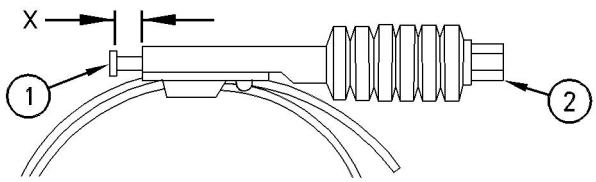

Illustration 26 g00279591

Use a torque wrench for proper installation of the constant torque hose clamps. The constant torque hose clamp is installed correctly under the following conditions:

- Screw tip (1) extends 6.35 mm (0.25 inch) (X) beyond the housing.
- The belleville washers are collapsed nearly flat after screw (2) is tightened to a torque of 11 ± 1 N·m (98 ± 9 lb in).

Lubricant Specifications

i01111306

Lubricant Information

SMCS Code: 1000; 1300; 7581

General Information

Because of government regulations regarding the certification of engine exhaust emissions, the lubricant recommendations must be followed.

Engine Manufacturers Association (EMA) Oils

The “Engine Manufacturers Association Recommended Guideline on Diesel Engine Oil” is recognized by Caterpillar. For detailed information about this guideline, see the latest edition of EMA publication, “EMA LRG-1”.

API Oils

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API) is recognized by Caterpillar. For detailed information about this system, see the latest edition of the “API publication No. 1509”. Engine oils that bear the API symbol are authorized by API.

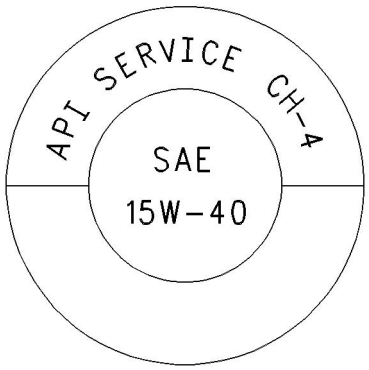

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Illustration 27

Typical API symbol

Diesel engine oils CC, CD, CD-2, and CE have not been API authorized classifications since 1 January 1996. Table 8 summarizes the status of the classifications.

Table 8

API Classifications	
Current	**Obsolete**
CF-4, CG-4, CH-4	CE
CF	CC, CD
CF-2(1)	CD-2(1)

(1) CD-2 and API CF-2 are classifications for two-cycle diesel engines. Caterpillar does not sell engines that utilize CD-2 and API CF-2 oils.

Note: API CF is not the same classification as API CF-4. API CF oils are only recommended for Caterpillar 3600 Series Diesel Engines and Caterpillar engines with precombustion chamber (PC) fuel systems.

Grease

The classifications of grease are based on the “ASTM D217” worked penetration characteristics. These characteristics for grease are given a defined consistency number.

Terminology

Certain abbreviations follow the nomenclature of “SAE J754”. Some classifications follow “SAE J183” abbreviations, and some classifications follow the “EMA Recommended Guideline on Diesel Engine Oil”. In addition to Caterpillar definitions, there are other definitions that will be of assistance in purchasing lubricants. Recommended oil viscosities can be found in this publication, “Engine Oil” topic (Maintenance Section).

i01261682

Engine Oil

SMCS Code: 1300; 1348; 7581

Caterpillar Diesel Engine Oil

Caterpillar Oils have been developed and tested in order to provide the full performance and service life that has been designed and built into Caterpillar Engines. Caterpillar Oils are currently used to fill diesel engines at the factory. These oils are offered by Caterpillar dealers for continued use when the engine oil is changed. Consult your Caterpillar dealer for more information on these oils.

Due to significant variations in the quality and in the performance of commercially available oils, Caterpillar makes the following recommendations:

- **Caterpillar Diesel Engine Oil (10W30)**

- **Caterpillar Diesel Engine Oil (15W40)**

Caterpillar multigrade Diesel Engine Oil is formulated with the correct amounts of detergents, dispersants, and alkalinity in order to provide superior performance in Caterpillar Diesel Engines.

Caterpillar multigrade Diesel Engine Oil is available in two viscosity grades (10W30 and 15W40). For direct injection engines, see Table 9 in order to choose the correct viscosity grade for the ambient temperature. Multigrade oils provide the correct viscosity for a broad range of operating temperatures.

Multigrade oils are effective in maintaining low oil consumption and low levels of piston deposits.

Caterpillar multigrade Diesel Engine Oil can be used in other diesel engines and in gasoline engines. See the engine manufacturer's guide for the recommended specifications. Compare the specifications to the specifications of Caterpillar multigrade Diesel Engine Oil. The current industry standards for Caterpillar Diesel Engine Oil are listed on the product label and on the data sheets for the product.

Consult your Caterpillar dealer for part numbers and for available sizes of containers.

Commercial Oils

The performance of commercial diesel engine oils is based on American Petroleum Institute (API) classifications. These API classifications are developed in order to provide commercial lubricants for a broad range of diesel engines that operate at various conditions.

If Caterpillar multigrade Diesel Engine Oil is not used, only use commercial oils that meet the following classifications:

- EMA LRG-1 multigrade oil (preferred oil)
- API CH-4 multigrade oil (preferred oil)
- API CG-4 multigrade oil (preferred oil)
- API CF-4 multigrade oil (acceptable oil)

In order to make the proper choice of a commercial oil, refer to the following explanations:

EMA LRG-1 – The Engine Manufacturers Association (EMA) has developed lubricant recommendations as an alternative to the API oil classification system. LRG-1 is a Recommended Guideline that defines a level of oil performance for these types of diesel engines: high speed, four stroke cycle, heavy-duty, and light duty. LRG-1 oils may be used in Caterpillar engines when the following oils are recommended: API CH-4, API CG-4, and API CF-4. LRG-1 oils are intended to provide superior performance in comparison to API CG-4 and API CF-4.

LRG-1 oils will meet the needs of high performance Caterpillar diesel engines that are operating in many applications. The tests and the test limits that are used to define LRG-1 are similar to the new API CH-4 classification. Therefore, these oils will also meet the requirements of the low emissions diesel engines. LRG-1 oils are designed to control the harmful effects of soot with improved wear resistance and improved resistance to oil filter plugging. These oils will also provide superior piston deposit control for engines with either two-piece steel pistons or aluminum pistons.

All LRG-1 oils must complete a full test program with the base stock and with the viscosity grade of the finished commercial oil. The use of "API Base Oil Interchange Guidelines" are not appropriate for LRG-1 oils. This feature reduces the variation in performance that can occur when base stocks are changed in commercial oil formulations.

LRG-1 oils are recommended for use in extended oil change interval programs that optimize oil life. These oil change interval programs are based on oil analysis. LRG-1 oils are recommended for conditions that demand a premium oil. Your Caterpillar dealer has the specific guidelines for optimizing oil change intervals.

API CH-4 – API CH-4 oils were developed in order to meet the requirements of the new high performance diesel engines. Also, the oil was designed to meet the requirements of the low emissions diesel engines. API CH-4 oils are also acceptable for use in older diesel engines and in diesel engines that use high sulfur diesel fuel. API CH-4 oils may be used in Caterpillar engines that use API CG-4 and API CF-4 oils. API CH-4 oils will generally exceed the performance of API CG-4 oils in the following criteria: deposits on pistons, control of oil consumption, wear of piston rings, valve train wear, viscosity control, and corrosion.

Three new engine tests were developed for the API CH-4 oil. The first test specifically evaluates deposits on pistons for engines with the two-piece steel piston. This test (piston deposit) also measures the control of oil consumption. A second test is conducted with moderate oil soot. The second test measures the following criteria: wear of piston rings, wear of cylinder liners, and resistance to corrosion. A third new test measures the following characteristics with high levels of soot in the oil: wear of the valve train, resistance of the oil in plugging the oil filter, and control of sludge.

In addition to the new tests, API CH-4 oils have tougher limits for viscosity control in applications that generate high soot. The oils also have improved oxidation resistance. API CH-4 oils must pass an additional test (piston deposit) for engines that use aluminum pistons (single piece). Oil performance is also established for engines that operate in areas with high sulfur diesel fuel.

All of these improvements allow the API CH-4 oil to achieve optimum oil change intervals. API CH-4 oils are recommended for use in extended oil change intervals. API CH-4 oils are recommended for conditions that demand a premium oil. Your Caterpillar dealer has specific guidelines for optimizing oil change intervals.

API CG-4 – API CG-4 oils were developed primarily for diesel engines that use a 0.05 percent level of fuel sulfur. However, API CG-4 oils can be used with higher sulfur fuels. The TBN of the new oil determines the maximum fuel sulfur level for API CG-4 and API CF-4 oils. See Illustration 28.

API CG-4 oils are the first oils that are required to pass industry standard tests for foam control and viscosity shear loss. API CG-4 oils must also pass tests that were developed for corrosion, wear and oxidation.

API CF-4 – These oils service a wide variety of modern diesel engines. API CF-4 oils provide more stable oil control and reduced piston deposits in comparison to API CF and the obsolete CE and CD classifications of oil. API CF-4 oils provide improved soot dispersancy in comparison to API CF and obsolete CD oils. The API CF-4 classification was developed with a 0.40 percent sulfur diesel fuel. This represents the type of diesel fuels that are commonly available worldwide.

Note: Do not use single grade API CF oils or multigrade API CF oils in Caterpillar Direct Injection (DI) Commercial Diesel Engines.

Some commercial oils that meet the API classifications may require reduced oil change intervals. To determine the oil change interval, closely monitor the condition of the oil and perform a wear metal analysis. Caterpillar's S·O·S oil analysis program is the preferred method.

NOTICE

Failure to follow these oil recommendations can cause shortened engine service life due to deposits and/or excessive wear.

Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines

The Total Base Number (TBN) for an oil depends on the fuel sulfur level. For direct injection engines that use distillate fuel, the minimum TBN of the new oil must be 10 times the fuel sulfur level. The TBN is defined by "ASTM D2896". The minimum TBN of the oil is 5 regardless of fuel sulfur level. Illustration 28 demonstrates the TBN.

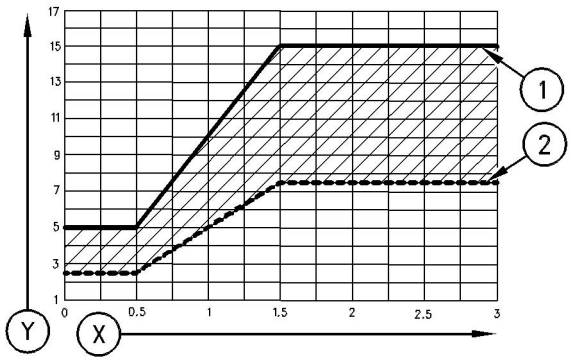

Illustration 28 g00104890

(Y) TBN by "ASTM D2896"
(X) Percentage of fuel sulfur by weight
(1) TBN of new oil
(2) Change the oil when the TBN deteriorates to 50 percent of the original TBN.

Use the following guidelines for fuel sulfur levels that exceed 1.5 percent:

- Choose an oil with the highest TBN that meets one of these classifications: EMA LRG-1, API CH-4, API CG-4, and API CF-4.
- Reduce the oil change interval. Base the oil change interval on the oil analysis. Ensure that the oil analysis includes the condition of the oil and a wear metal analysis.

Excessive piston deposits can be produced by an oil with a high TBN. These deposits can lead to a loss of control of the oil consumption and to the polishing of the cylinder bore.

NOTICE
Operating Direct Injection (DI) diesel engines with fuel sulfur levels over 1.0 percent may require shortened oil change intervals in order to help maintain adequate wear protection.

Lubricant Viscosity Recommendations for Direct Injection (DI) Diesel Engines

The proper SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation.

Refer to Table 9 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 9 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

Table 9

Engine Oil Viscosity		
Caterpillar DEO Multigrade EMA LRG-1 API CH-4 API CG-4 and API CF-4 Viscosity Grade	**Ambient Temperature**	
	Minimum	**Maximum**
SAE 0W20	–40 °C (–40 °F)	10 °C (50 °F)
SAE 0W30	–40 °C (–40 °F)	30 °C (86 °F)
SAE 0W40	–40 °C (–40 °F)	40 °C (104 °F)
SAE 5W30	–30 °C (–22 °F)	30 °C (86 °F)
SAE 5W40	–30 °C (–22 °F)	40 °C (104 °F)
SAE 10W30	–20 °C (–4 °F)	40 °C (104 °F)
SAE 15W40	–15 °C (5 °F)	50 °C (122 °F)

i01111406

Synthetic Base Stock Oils

SMCS Code: 1300; 1348; 7581

Synthetic base oils are acceptable for use in Caterpillar engines if these oils meet the performance requirements that are specified for the engine compartment.

Synthetic base oils generally perform better than conventional oils in the following two areas:

- Synthetic base oils have improved flow at low temperatures especially in arctic conditions.
- Synthetic base oils have improved oxidation stability especially at high operating temperatures.

Some synthetic base oils have performance characteristics that enhance the service life of the oil. However, Caterpillar does not recommend the automatic extension of oil change intervals for any type of oil. Oil change intervals for Caterpillar engines can only be adjusted after an oil analysis program that contains the following tests: oil condition and wear metal analysis (Caterpillar's S·O·S oil analysis), trend analysis, fuel consumption, and oil consumption.

i01111412

Re-refined Base Stock Oils

SMCS Code: 1300; 7581

Re-refined base stock oils are acceptable for use in Caterpillar engines if these oils meet the performance requirements that are specified by Caterpillar. Re-refined base stock oils can be used exclusively in finished oil or in a combination with new base stock oils. The US military specifications and the specifications of other heavy equipment manufacturers also allow the use of re-refined base stock oils that meet the same criteria.

The process that is used to make re-refined base stock oil should adequately remove all wear metals that are in the used oil and all additives that are in the used oil. The process that is used to make re-refined base stock oil generally involves the processes of vacuum distillation and hydrotreating the used oil. Filtering is inadequate for the production of high quality re-refined base stock oils from used oil.

i01113213

Cold Weather Lubricants

SMCS Code: 1300; 1348; 7581

When an engine is started and an engine is operated in ambient temperatures below –20 °C (–4 °F), use multigrade oils that are capable of flowing in low temperatures.

These oils have lubricant viscosity grades of SAE 0W or SAE 5W.

When an engine is started and operated in ambient temperatures below –30 °C (–22 °F), use a synthetic base stock multigrade oil with a 0W viscosity grade or with a 5W viscosity grade. Use an oil with a pour point that is lower than –50 °C (–58 °F).

The number of acceptable lubricants is limited in cold weather conditions. Caterpillar recommends the following lubricants for use in cold weather conditions:

First Choice – use an oil with an EMA LRG-1 Recommended Guideline or use a CH-4 oil that is API licensed with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade. A CG-4 oil that is API licensed with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade may also be used. A CF-4 oil that is API licensed with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade may also be used.

Second Choice – use an oil that contains the CH-4, CG-4, or CF-4 additive package although the oil has not been tested for the requirements of the API license. The oil must have an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade.

NOTICE
Shortened engine service life could result if second choice oils are used.

i01123104

Aftermarket Oil Additives

SMCS Code: 1300; 1348; 7581

Caterpillar does not recommend the use of aftermarket additives in oil. It is not necessary to use aftermarket additives in order to achieve the engine's maximum service life or rated performance. Fully formulated, finished oils consist of base oils and of commercial additive packages. These additive packages are blended into the base oils at precise percentages in order to help provide finished oils with performance characteristics that meet industry standards.

There are no industry standard tests that evaluate the performance or the compatibility of aftermarket additives in finished oil. Aftermarket additives may not be compatible with the finished oil's additive package, which could lower the performance of the finished oil. The aftermarket additive could fail to mix with the finished oil. This could produce sludge in the crankcase. Caterpillar discourages the use of aftermarket additives in finished oils.

To achieve the best performance from a Caterpillar engine, conform to the following guidelines:

- Select the proper Caterpillar oil or a commercial oil that meets the "EMA Recommended Guideline on Diesel Engine Oil" or the recommended API classification.
- See the appropriate "Lubricant Viscosities" table in order to find the correct oil viscosity grade for your engine.
- At the specified interval, service the engine compartment. Use new oil and install a new oil filter.
- Perform maintenance at the intervals that are specified in the Operation and Maintenance Manual, "Maintenance Interval Schedule".

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Lubricating Grease

SMCS Code: 7581

Caterpillar provides greases in order to cover a variety of applications and extreme temperature conditions. Consult your Caterpillar dealer for part numbers and for available sizes of containers.

Note: Some greases may not be used with other greases. When a commercial grease is used, ensure that the grease is compatible with the grease that is currently used in the system. If the commercial grease is not compatible, the system must be purged. If any questions arise concerning the compatibility of a grease, consult the supplier.

Multipurpose Greases

Multipurpose Lithium Complex Grease (MPGL)

Multipurpose Lithium Complex Grease (MPGL) is a general purpose lithium complex grease for medium-duty applications. This product has good characteristics at high temperatures such as a dropping point of 260 °C (500 °F). MPGL contains unleaded extreme pressure additives, antiwear inhibitors, and corrosion inhibitors that provide extra protection in the following applications:

- Construction
- Agricultural
- Automotive

MPGL meets the requirements for extended service intervals of automotive chassis points. MPGL also meets the requirements for extended service intervals of wheel bearings with disc brakes in automobiles, in vans and in light trucks. This product meets the NLGI certification of “GC-LB”. MPGL is also available in a NLGI No. 2 grade. Normal operating temperatures for this product are –28 to 149 °C (–18 to 300 °F). This product is also available as a white lithium complex grease.

Multipurpose Lithium Complex Grease with Molybdenum (MPGM)

Multipurpose Lithium Complex Grease with Molybdenum (MPGM) is a general purpose lithium complex grease that is used for light-duty applications and for medium-duty applications. The MPGM is available in the following grades: NLGI No. 2 and NLGI No. 0. The MPGM is strengthened with a molybdenum disulfide and a polymer for extra lubrication and protection. MPGM contains unleaded additives. MPGM also contains antiwear inhibitors, rust inhibitors, and corrosion inhibitors that are for protection and lubrication in many environments. The MPGM is formulated with a base fluid that has high viscosity.

The MPGM has the following features:

- Increased protection against water washout
- Increased retention
- Resistance to heavy loads

This product is recommended for heavily loaded pin joints and for journal bearings. This product meets the certification of “GC-LB”. Normal operating temperatures for this product are –28 to 149 °C (–18 to 300 °F) for the NLGI No. 0. Normal operating temperatures for this product are –18 to 149 °C (0 to 300 °F) for the NLGI No. 2.

Note: If MPGM is not available, use a multipurpose type grease which contains three to five percent molybdenum.

Special Purpose Grease (SPG)

Bearing Lubrication (SPG)

Bearing Lubricant (SPG) is available in a NLGI No. 2 grade with a polyurea thickener. This grease is recommended for high temperature antifriction bearings in the following applications: electric starting motors, alternators, fan drives, and generators. The Bearing Lubricant (SPG) has an effective operating range of –29 to 177 °C (–20 to 350 °F).

Water and Temperature Resistant Grease (WTR)

The Water and Temperature Resistant Grease is designed for use whenever the following conditions are a concern: water washout, severe corrosion, and high operating temperatures. The Water and Temperature Resistant Grease provides extreme pressure protection, antiwear protection, rust protection and corrosion protection. The Water and Temperature Resistant Grease is an environmentally friendly grease which does not contain the following materials: antimony, sulfur, barium, zinc, lead, and phosphorous materials. The Water and Temperature Resistant Grease has excellent shear stability. Water and Temperature Resistant Grease can also resist breakdown in the presence of water. The Water and Temperature Resistant Grease works well in the following applications:

- Construction
- Agricultural
- Automotive
- Industrial
- Marine

This product meets the NLGI certification of "GC-LB". Normal operating temperatures for this product are –40 to 204°C (–40 to 400°F).

Caterpillar Premium Grease (CPG)

Desert Gold (CPG)

Desert Gold is a heavy-duty, premium synthetic grease that is developed for the most extreme operating environments. This grease is formulated with the following characteristics: high viscosity synthetic base fluid, polymers, molybdenum disulfide, high viscosity index, and high dropping point.

Desert Gold will protect equipment against heavy shock loads. Desert Gold protects against corrosion in extreme heat, in moist conditions, or in dusty conditions. This product has excellent characteristics of adhesion and of stability. Desert Gold provides longer protection than other greases. Desert Gold is an environmentally friendly grease which does not contain the following materials: antimony, sulfur, barium, zinc, lead, and phosphorous materials. Normal operating temperatures are –6 to 230 °C (21 to 450 °F). Desert Gold can operate at higher temperatures for short time periods. Desert Gold has additional extreme pressure protection for highly loaded pin joints.

Arctic Platinum (CPG)

Arctic Platinum is a super-premium extreme pressure lubricating grease that is developed for lubrication in temperatures that are below zero to moderate operating temperatures. Arctic Platinum is available in grades 000, 00, 0, 1, and 2. These grades ensure pumpability in central lube systems in a variety of ambient temperatures from –60 to 18 °C (–76 to 65 °F). Arctic Platinum has a high dropping point. Arctic Platinum contains a five percent concentrate of molybdenum disulfide for protection against extra heavy loads. Arctic Platinum provides excellent corrosion protection and rust protection. Arctic Platinum is an environmentally friendly grease which does not contain the following materials: antimony, sulfur, barium, zinc, and phosphorous.

Arctic Platinum is designed for long life lubrication of the following components: horizontal pivot bearings, lower link bearings, steering cylinders, kingbolt bearings, upper hitch link bearings, and ejector carrier roller bearings. This grease is extra tacky for retention on excavator carbody bearings. Arctic Platinum has additional extreme pressure protection for highly loaded pin joints.

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S·O·S Oil Analysis

SMCS Code: 1348; 7542; 7581

Caterpillar recommends the use of the S·O·S oil analysis program in order to monitor the condition and the maintenance requirements of the equipment. The S·O·S oil analysis program will complement the preventive maintenance program.

The S·O·S oil analysis is a diagnostic tool that is used to determine oil performance and component wear rates. Contamination can be identified and measured through the use of the S·O·S oil analysis. The S·O·S oil analysis includes the following tests:

- The Wear Rate Analysis monitors the wear of the engine's metals. The amount of wear metal and type of wear metal that is in the oil is analyzed. The increase in the rate of engine wear metal in the oil is as important as the quantity of engine wear metal in the oil. For this reason, regular sampling at specified intervals is necessary in order to establish wear rates. Intermittent sampling does not allow wear rate trend lines to be established. Engine wear metals in the oil sample are compared to established Caterpillar norms in order to determine acceptability.
- Tests are conducted in order to detect contamination of the oil by water, glycol or fuel.
- The Oil Condition Analysis determines the loss of the oil's lubricating properties. An infrared analysis is used to compare the properties of new oil to the properties of the used oil sample. This analysis allows technicians to determine the amount of deterioration of the oil during use. This analysis also allows technicians to verify the performance of the oil according to the specification during the entire oil change interval.

The test results of the oil samples will then be used as a basis for determining the oil change interval for the engine. The results of the S·O·S oil analysis may allow the engine to operate longer between oil changes without the risk of engine damage.

Table 10

S·O·S Oil Analysis Interval	
Compartment	**Interval**
Engine crankcase	Every 250 Service Hours

For more information, see Special Publication, PEDP7036, "S·O·S Fluid Analysis". Consult your Caterpillar dealer for complete information and assistance about the program.

Fuel Specifications

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Fuel Recommendations

SMCS Code: 1250; 1280

Diesel engines have the ability to burn a wide variety of fuels. These fuels are divided into two general groups. The two groups are called the preferred fuels and the permissible fuels.

The preferred fuels provide maximum engine service life and performance. The preferred fuels are distillate fuels. These fuels are commonly called diesel fuel, furnace fuel, gas oil, or kerosene.

The permissible fuels are crude oils or blended fuels. Use of these fuels can result in higher maintenance costs and in reduced engine service life.

Diesel fuels that meet the specifications in Table 11 will help to provide maximum engine service life and performance. In North America, diesel fuel that is identified as No. 1-D or No. 2-D in "ASTM D975" generally meet the specifications. Table 11 is for diesel fuels that are distilled from crude oil. Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

Table 11

Caterpillar Specifications for Distillate Diesel Fuel		
Specifications	**Requirements**	**ASTM Test**
Aromatics	35% maximum	"D1319"
Ash	0.02% maximum (weight)	"D482"
Carbon Residue on 10% Bottoms	0.35% maximum (weight)	"D524"
Cetane Number	40 minimum (DI engines)	"D613"
	35 minimum (PC engines)	
Cloud Point	The cloud point must not exceed the lowest expected ambient temperature.	-
Copper Strip Corrosion	No. 3 maximum	"D130"

(continued)

(Table 11, contd)

Caterpillar Specifications for Distillate Diesel Fuel		
Specifications	**Requirements**	**ASTM Test**
Distillation	10% at 282 °C (540 °F) maximum	"D86"
	90% at 360 °C (680 °F) maximum	
Flash Point	legal limit	"D93"
API Gravity	30 minimum	"D287"
	45 maximum	
Pour Point	6 °C (10 °F) minimum below ambient temperature	"D97"
Sulfur (1)	3% maximum	"D3605" or "D1552"
Kinematic Viscosity (2)	1.4 cSt minimum and 20.0 cSt maximum at 40 °C (104 °F)	"D445"
Water and Sediment	0.1% maximum	"D1796"
Water	0.1% maximum	"D1744"
Sediment	0.05% maximum (weight)	"D473"
Gums and Resins (3)	10 mg per 100 mL maximum	"D381"
Lubricity (4)	3100 g minimum	"D6078"
	0.45 mm (0.018 inch) maximum at 60 °C (140 °F)	"D6079"
	0.38 mm (0.015 inch) maximum at 25 °C (77 °F)	

(1) Caterpillar fuel systems and engine components can operate on high sulfur fuels. Fuel sulfur levels affect exhaust emissions. High sulfur fuels also increase the potential for corrosion of internal components. Fuel sulfur levels above 1.0 percent may significantly shorten the oil change interval. For additional information, see this publication, "Engine Oil" topic (Maintenance Section).

(2) The values of the fuel viscosity are the values as the fuel is delivered to the fuel injection pumps. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain a 1.4 cSt viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters in order to bring down the viscosity to a 20 cSt viscosity. For additional information, see Special Publication, SEBD0717, "Diesel Fuel and Your Engine".

(3) Follow the test conditions and procedures for gasoline (motor).

(4) The lubricity of a fuel is a concern with low sulfur fuel. To determine the lubricity of the fuel, use either the "ASTM D6078 Scuffing Load Wear Test (SBOCLE)" or the "ASTM D6079 High Frequency Reciprocating Rig (HFRR)" test. If the lubricity of a fuel does not meet the minimum requirements, consult your fuel supplier. Do not treat the fuel without consulting the fuel supplier. Some additives are not compatible. These additives can cause problems in the fuel system.

NOTICE

Operating with fuels that do not meet Caterpillar's recommendations can cause the following effects: starting difficulty, poor combustion, deposits in the fuel injectors, reduced service life of the fuel system, deposits in the combustion chamber, and reduced service life of the engine.

In the USA, 0.05 percent diesel fuels have been used in all on-highway truck engines since 1 January 1994. This low sulfur diesel fuel was mandated as a means of directly reducing particulate emissions from diesel truck engines. This low sulfur fuel will also be used in Caterpillar commercial diesel engines when low emissions are required or when the fuel supply sources provide this type of fuel. Caterpillar has not seen any detrimental effects with 0.05 percent sulfur fuel in Caterpillar diesel engines.

NOTICE

Heavy Fuel Oil (HFO), Residual fuel, or Blended fuel must NOT be used in Caterpillar diesel engines (except in 3600 Series HFO engines). Severe component wear and component failures will result if HFO type fuels are used in engines that are configured to use distillate fuel.

In extreme cold ambient conditions, you may use the distillate fuels that are specified in Table 12. However, the fuel that is selected must meet the requirements that are specified in Table 11. These fuels are intended to be used in operating temperatures that are down to –54 °C (–65 °F).

Table 12

Distillate Fuels (1)	
Specification	**Grade**
"MIL-T-5624R"	JP-5
"ASTM D1655"	Jet-A-1
"MIL-T-83133D"	JP-8

(1) The fuels that are listed in this Table may not meet the requirements that are specified in the "Caterpillar Specifications for Distillate Diesel Fuel" Table. Consult the supplier for the recommended additives in order to maintain the proper fuel lubricity.

These fuels are lighter than the No. 2 grades of fuel. The cetane number of the fuels in Table 12 must be at least 40. If the viscosity is below 1.4 cSt at 38 °C (100 °F), use the fuel only in temperatures below 0 °C (32 °F). Do not use any fuels with a viscosity of less than 1.2 cSt at 38 °C (100 °F). Fuel cooling may be required in order to maintain the minimum viscosity of 1.4 cSt at the fuel injection pump.

There are many other diesel fuel specifications that are published by governments and by technological societies. Usually, those specifications do not review all the requirements that are addressed in this specification. To ensure optimum engine performance, a complete fuel analysis should be obtained before engine operation. The fuel analysis should include all of the properties that are listed in Table 11.

Cooling System Specifications

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General Coolant Information

SMCS Code: 1350; 1395

NOTICE
Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

NOTICE
If the engine is to be stored in, or shipped to an area with below freezing temperatures, the cooling system must be either protected to the lowest outside temperature or drained completely to prevent damage.

NOTICE
In cold weather, frequently check the specific gravity of the coolant solution to ensure adequate protection.

Clean the cooling system for the following reasons:

- Contamination of the cooling system
- Overheating of the engine
- Foaming of the coolant

Note: Air pockets can form in the cooling system if the cooling system is filled at a rate that is greater than 20 L (5 US gal) per minute.

After you drain the cooling system and after you refill the cooling system, operate the engine. Operate the engine without the filler cap until the coolant reaches normal operating temperature and the coolant level stabilizes. Ensure that the coolant is maintained to the proper level.

NOTICE
Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

Refer to Special Instruction, SEBD0518, “Know Your Cooling System” and Special Instruction, SEBD0970, “Coolant and Your Engine” for more detailed information.

Many engine failures are related to the cooling system. The following problems are related to cooling system failures: overheating, leakage of the water pump, plugged radiators or heat exchangers, and pitting of the cylinder liners.

These failures can be avoided with proper cooling system maintenance. Cooling system maintenance is as important as maintenance of the fuel system and the lubrication system. Quality of the coolant is as important as the quality of the fuel and the lubricating oil.

Coolant is normally composed of three elements: water, additives, and glycol.

Water

NOTICE
All Caterpillar diesel engines equipped with air-to-air aftercooling (ATAAC) require a minimum of 30 percent glycol to prevent water pump cavitation.

NOTICE
Never use water alone without Supplemental Coolant Additives (SCA) or without inhibited coolant. Water alone is corrosive at engine operating temperatures. Water alone does not provide adequate protection against boiling or freezing.

Water is used in the cooling system in order to transfer heat.

Distilled water or deionized water is recommended for use in engine cooling systems.

DO NOT use the following types of water in cooling systems: hard water, softened water that has been conditioned with salt, and sea water.

If distilled water or deionized water is not available, use water with the properties that are listed in Table 13.

Table 13

Caterpillar Minimum Acceptable Water Requirements		
Property	**Maximum Limit**	**ASTM Test**
Chloride (Cl)	40 mg/L (2.4 grains/US gal)	"D512", "D4327"
Sulfate (SO_4)	100 mg/L (5.9 grains/US gal)	"D516"
Total Hardness	170 mg/L (10 grains/US gal)	"D1126"
Total Solids	340 mg/L (20 grain/US gal)	"D1888"
Acidity	pH of 5.5 to 9.0	"D1293"

For a water analysis, consult one of the following sources:

- Caterpillar dealer
- Local water utility company
- Agricultural agent
- Independent laboratory

Additives

Additives help to protect the metal surfaces of the cooling system. A lack of coolant additives or insufficient amounts of additives enable the following conditions to occur:

- Corrosion
- Formation of mineral deposits
- Rust
- Scale
- Pitting and erosion from cavitation of the cylinder liner
- Foaming of the coolant

Many additives are depleted during engine operation. These additives must be replaced periodically. This can be done by adding Supplemental Coolant Additives (SCA) to Diesel Engine Antifreeze/Coolant (DEAC) or by adding ELC Extender to Extended Life Coolant (ELC).

Additives must be added at the proper concentration. Overconcentration of additives can cause the inhibitors to drop out-of-solution. The deposits can enable the following problems to occur:

- Formation of gel compounds
- Reduction of heat transfer
- Leakage of the water pump seal
- Plugging of radiators, coolers, and small passages

Glycol

Glycol in the coolant helps to provide protection against the following conditions:

- Boiling
- Freezing
- Cavitation of the water pump and the cylinder liner

For optimum performance, Caterpillar recommends a 1:1 mixture of a water/glycol solution.

NOTICE
All Caterpillar diesel engines equipped with air-to-air aftercooling (ATAAC) require a minimum of 30 percent glycol to prevent water pump cavitation.

Note: Use a mixture that will provide protection against the lowest ambient temperature.

Note: 100 percent pure glycol will freeze at a temperature of –23 °C (–9 °F).

Most conventional heavy-duty coolant/antifreezes use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with water, ethylene and propylene glycol provide similar protection against freezing and boiling. See Tables 14 and 15.

Table 14

Ethylene Glycol		
Concentration	**Freeze Protection**	**Boil Protection**
50 Percent	–36 °C (–33 °F)	106 °C (223 °F)
60 Percent	–51 °C (–60 °F)	111 °C (232 °F)

NOTICE
Do not use propylene glycol in concentrations that exceed 50 percent glycol because of propylene glycol's reduced heat transfer capability. Use ethylene glycol in conditions that require additional protection against boiling or freezing.

Table 15

Propylene Glycol		
Concentration	**Freeze Protection**	**Boil Protection**
50 Percent	−29 °C (−20 °F)	106 °C (223 °F)

To check the concentration of glycol, use the 1U-7298 Coolant/Battery Tester (Degree Celsius) or use the 1U-7297 Coolant/Battery Tester (Degree Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or propylene glycol.

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Coolant Recommendations

SMCS Code: 1350; 1395

The following two coolants are used in Caterpillar diesel engines:

Preferred – Caterpillar Extended Life Coolant (ELC) or a commercial extended life coolant that meets the Caterpillar EC-1 specification

Acceptable – A Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) or a commercial heavy-duty coolant/antifreeze that meets “ASTM D4985” or “ASTM D5345” specifications

NOTICE
Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 or D4656 specification. This type of coolant/antifreeze is made for light duty automotive applications.

Caterpillar recommends a 1:1 mixture of water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as a coolant/antifreeze.

Note: Caterpillar DEAC DOES NOT require a treatment with an SCA at the initial fill. Commercial heavy-duty coolant/antifreeze that meets “ASTM D4985” or “ASTM D5345” specifications MAY require a treatment with an SCA at the initial fill. Read the label or the instructions that are provided by the OEM of the product.

In stationary engine applications and marine engine applications that do not require anti-boil protection or freeze protection, a mixture of SCA and water is acceptable. Caterpillar recommends a six percent to eight percent concentration of SCA in those cooling systems. Distilled water or deionized water is preferred. Water which has the recommended properties may be used.

NOTICE
All Caterpillar diesel engines equipped with air-to-air aftercooling (ATAAC) require a minimum of 30 percent glycol to prevent water pump cavitation.

Table 16

Coolant Service Life	
Coolant Type	**Service Life**
Caterpillar ELC	6000 Service Hours or Six Years
Caterpillar DEAC	3000 Service Hours or Three Years
Commercial Heavy-Duty Coolant/Antifreeze that meets “ASTM D5345”	3000 Service Hours or Two Years
Commercial Heavy-Duty Coolant/Antifreeze that meets “ASTM D4985”	3000 Service Hours or One Year
Caterpillar SCA and Water	3000 Service Hours or Two Years
Commercial SCA and Water	3000 Service Hours or One Year

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S·O·S Coolant Analysis

SMCS Code: 1352; 1395; 7542

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and from corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and from freezing. The S·O·S Coolant Analysis can be done at your Caterpillar dealer. Caterpillar S·O·S Coolant Analysis is the best way to monitor the condition of your coolant and your cooling system. S·O·S Coolant Analysis is a program that is based on periodic samples.

NOTICE
Do not use the same vacuum sampling pump for extracting oil samples that is used for extracting coolant samples.

A small residue of either type sample may remain in the pump and may cause a false positive analysis for the sample being taken.

Always use a designated pump for oil sampling and a designated pump for coolant sampling.

Failure to do so may cause a false analysis which could lead to customer and dealer concerns.

New Systems, Refilled Systems, and Converted Systems

Perform a coolant analysis (Level 2) at 500 service hours for new systems, for refilled systems, or for converted systems that use ELC or use DEAC. This 500 hour check will also check for any residual cleaner that may have contaminated the system.

Recommended Interval for S·O·S Coolant Sample

Perform a coolant analysis (Level 1) at every 500 service hour interval. Perform a coolant analysis (Level 2) annually.

Note: Check the standard coolant's Supplemental Coolant Additive at every oil change.

S·O·S Coolant Analysis (Level 1)

A coolant analysis (Level 1) is a test of the properties of the coolant.

The following properties of the coolant are tested:

- Glycol Concentration for freeze protection
- Ability to protect from erosion and corrosion
- pH
- Conductivity
- Water hardness
- Visual analysis
- Odor analysis

The results are reported, and appropriate recommendations are made.

S·O·S Coolant Analysis (Level 2)

Level 2 coolant analysis is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the inside of the cooling system.

The S·O·S Coolant Analysis has the following five features:

- Full analysis of Level 1
- Identification of the source of metal corrosion and of contaminants
- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling
- Determination of possible electrolysis within the engines' cooling system

The results are reported, and appropriate recommendations are made.

For more information on S·O·S Coolant Analysis, consult your Caterpillar dealer.

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Extended Life Coolant (ELC)

SMCS Code: 1350; 1395

Caterpillar provides Extended Life Coolant (ELC) for use in the following applications:

- Heavy-duty spark ignited gas engines
- Heavy-duty diesel engines
- Automotive applications

The anti-corrosion package for Caterpillar ELC is different from the anti-corrosion package for other coolants. Caterpillar ELC is an ethylene glycol base coolant. However, Caterpillar ELC contains organic corrosion inhibitors and antifoam agents with low amounts of nitrite. Caterpillar ELC has been formulated with the correct amount of these additives in order to provide superior corrosion protection for all metals in engine cooling systems.

ELC extends the service life of the coolant to 6000 service hours or six years. ELC does not require a frequent addition of a Supplemental Coolant Additive (SCA). An Extender is the only additional maintenance that is needed at 3000 service hours or one half of the ELC service life.

ELC is available in a 1:1 premixed cooling solution with distilled water. The Premixed ELC provides freeze protection to –36 °C (–33 °F). The Premixed ELC is recommended for the initial fill of the cooling system. The Premixed ELC is also recommended for topping off the cooling system.

ELC Concentrate is also available. ELC Concentrate can be used to lower the freezing point to –51 °C (–60 °F) for arctic conditions.

Containers of several sizes are available. Consult your Caterpillar dealer for the part numbers.

Note: Caterpillar developed the EC-1 specification. The EC-1 specification is an industry standard. The EC-1 specification defines all of the performance requirements that are needed for an engine coolant to be sold as an extended life coolant for Caterpillar engines. ELC can be used in most OEM engines of the following types: diesel, gasoline, and natural gas. ELC meets the performance requirements of "ASTM D4985" and "ASTM D5345" for heavy-duty low silicate antifreeze/coolants. ELC also meets the performance requirements of "ASTM D3306" and "ASTM D4656" for automotive applications.

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Extended Life Coolant (ELC) Cooling System Maintenance

SMCS Code: 1350; 1352; 1395

Proper additions to the Extended Life Coolant

NOTICE

Use only Caterpillar products or commercial products that have passed Caterpillar's EC-1 specification for pre-mixed or concentrated coolants.

Use only Caterpillar Extender with Extended Life Coolant.

Mixing Extended Life Coolant with other products reduces the Extended Life Coolant service life. Failure to follow the recommendations can reduce cooling system components life unless appropriate corrective action is performed.

In order to maintain the correct balance between the antifreeze and the additives, you must maintain the recommended concentration of Extended Life Coolant (ELC). Lowering the proportion of antifreeze lowers the proportion of additive. This will lower the ability of the coolant to protect the system from pitting, from cavitation, from erosion, and from deposits.

NOTICE

Do not use a conventional coolant to top-off a cooling system that is filled with Extended Life Coolant (ELC).

Do not use standard supplemental coolant additive (SCA). Only use ELC Extender in cooling systems that are filled with ELC.

Caterpillar ELC Extender

Caterpillar ELC Extender is added to the cooling system halfway through the ELC service life. Treat the cooling system with ELC Extender at 3000 hours or one half of the coolant service life. Use Table 17 in order to determine the proper amount of ELC Extender that is required.

Containers of several sizes are available. Consult your Caterpillar dealer for the part numbers.

Table 17

Caterpillar ELC Extender Additions by Cooling System Capacity	
Cooling System Capacity	**Addition of ELC Extender**
22 to 30 L (6 to 8 US gal)	0.57 L (20 fl oz)
31 to 38 L (9 to 10 US gal)	0.71 L (24 fl oz)
39 to 49 L (11 to 13 US gal)	0.95 L (32 fl oz)
50 to 64 L (14 to 17 US gal)	1.18 L (40 fl oz)
65 to 83 L (18 to 22 US gal)	1.60 L (54 fl oz)
84 to 114 L (23 to 30 US gal)	2.15 L (72 fl oz)
115 to 163 L (31 to 43 US gal)	3.00 L (100 fl oz)
164 to 242 L (44 to 64 US gal)	4.40 L (148 fl oz)

For cooling system capacities that exceed the capacities that are specified in Table 17, use the equation that is in Table 18 in order to determine the proper amount of ELC Extender that is required.

Table 18

Equation For Adding ELC Extender To ELC
V × 0.02 = X
V is the total volume of the cooling system.
X is the amount of ELC Extender that is required.

Table 19 is an example for using the equation that is in Table 18.

Table 19

Example Of The Equation For Adding ELC Extender To ELC		
Total Volume of the Cooling System (V)	**Multiplication Factor**	**Amount of ELC Extender that is Required (X)**
946 L (250 US gal)	× 0.02	19 L (5 US gal)

NOTICE
When using Caterpillar ELC, do not use standard SCA's or SCA filters. To avoid SCA contamination of an ELC system, remove the SCA filter base and plug off or by-pass the coolant lines.

ELC Cooling System Cleaning

Note: If the cooling system is already using ELC, cleaning agents are not required to be used at the specified coolant change interval. Cleaning agents are only required if the system has been contaminated by the addition of some other type of coolant or by cooling system damage.

Clean water is the only cleaning agent that is required when ELC is drained from the cooling system.

ELC can be recycled. The drained coolant mixture can be distilled in order to remove the ethylene glycol and the water. The ethylene glycol and the water can be reused. Consult your Caterpillar dealer for more information.

After the cooling system is drained and after the cooling system is refilled, operate the engine while the cooling system filler cap is removed. Operate the engine until the coolant level reaches the normal operating temperature and until the coolant level stabilizes. As needed, add the coolant mixture in order to fill the system to the proper level.

Changing to Caterpillar ELC

To change from heavy-duty coolant/antifreeze to the Caterpillar ELC, perform the following steps:

NOTICE
Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant into a suitable container.

2. Dispose of the coolant according to local regulations.

NOTICE
Do not leave an empty SCA filter on an ELC system.

The filter housing may corrode and leak causing an engine failure.

Remove the SCA filter base and plug off or by-pass the coolant lines.

3. Remove the empty SCA filter and remove the filter base. Plug the coolant lines or bypass the coolant lines.

4. Flush the system with clean water in order to remove any debris.

5. Use Caterpillar cleaner to clean the system. Follow the instruction on the label.

6. Drain the cleaner into a suitable container. Flush the cooling system with clean water.

7. Fill the cooling system with clean water and operate the engine until the engine is warmed to 49° to 66°C (120° to 150°F).

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

8. Drain the cooling system into a suitable container and flush the cooling system with clean water.

Note: The cooling system cleaner must be thoroughly flushed from the cooling system. Cooling system cleaner that is left in the system will contaminate the coolant. The cleaner may also corrode the cooling system.

9. Repeat Steps 7 and 8 until the system is completely clean.

10. Fill the cooling system with the Caterpillar premixed ELC.

11. Attach the Special Publication, PEEP5027, "Label" to the cooling system filler for the engine in order to indicate the use of Caterpillar ELC.

ELC Cooling System Contamination

NOTICE

Mixing ELC with other products reduces the effectiveness of the ELC and shortens the ELC service life. Use only Caterpillar products or commercial products that have passed the Caterpillar EC-1 specification for premixed or concentrate coolants. Use only Caterpillar ELC Extender with Caterpillar ELC. Failure to follow these recommendations can result in shortened cooling system component life.

ELC cooling systems can withstand contamination to a maximum of ten percent of conventional heavy-duty coolant/antifreeze or SCA. If the contamination exceeds ten percent of the total system capacity, perform ONE of the following procedures:

- Drain the cooling system into a suitable container. Dispose of the coolant according to local regulations. Flush the system with clean water. Fill the system with the Caterpillar ELC.
- Drain a portion of the cooling system into a suitable container according to local regulations. Then, fill the cooling system with premixed ELC. This should lower the contamination to less than 10 percent.
- Maintain the system as a conventional Diesel Engine Antifreeze/Coolant (DEAC). Treat the system with an SCA. Change the coolant at the interval that is recommended for the conventional Diesel Engine Antifreeze/Coolant (DEAC).

Commercial ELC

If Caterpillar ELC is not used, then select a commercial ELC that meets the Caterpillar specification of EC-1 and either the “ASTM D5345” specification or the “ASTM D4985” specification. Do not use an extended life coolant that does not meet the EC-1 specification. Follow the maintenance guide for the coolant from the supplier of the commercial ELC. Follow the Caterpillar guidelines for the quality of water and the specified coolant change interval.

i01111753

Diesel Engine Antifreeze/ Coolant (DEAC)

SMCS Code: 1350; 1395

Caterpillar recommends using Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) for cooling systems that require a heavy-duty coolant/antifreeze. Caterpillar DEAC is an alkaline single-phase ethylene glycol type antifreeze that contains corrosion inhibitors and antifoam agents.

Caterpillar DEAC is formulated with the correct amount of Caterpillar Supplemental Coolant Additive (SCA). Do no use SCA at the initial fill when DEAC is used.

Containers of several sizes are available. Consult your Caterpillar dealer for the part numbers.

If concentrated DEAC is used, Caterpillar recommends mixing the concentrate with distilled water or with deionized water. If distilled water is not available or deionized water is not available, use water which has the required properties. For the water properties, see this publication, “General Coolant Information” topic (Maintenance Section).

i01069295

Supplemental Coolant Additive (SCA)

SMCS Code: 1350; 1352; 1395

The use of SCA helps to prevent the following conditions from occurring:

- Corrosion
- Formation of mineral deposits
- Cavitation erosion of the cylinder liners
- Foaming of the coolant

Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) is formulated with the correct level of Caterpillar SCA. When the cooling system is initially filled with DEAC, adding more SCA is not necessary until the concentration of SCA has been depleted. To ensure that the correct amount of SCA is in the cooling system, the concentration of SCA must be tested on a scheduled basis. Refer to the specific engine’s Operation and Maintenance Manual, “Maintenance Interval Schedule”.

Containers of SCA are available in several sizes. Consult your Caterpillar dealer for the part numbers.

i01164588

Commercial Heavy-Duty Coolant/Antifreeze and SCA

SMCS Code: 1350; 1395

If Caterpillar DEAC is not used, select a coolant/antifreeze with low silicate content for heavy-duty applications that meets “ASTM D5345” or “ASTM D4985” specifications.

Note: When you are not using Caterpillar DEAC the cooling system must be drained one time during every year. The cooling system must be flushed at this time as well.

When a heavy-duty coolant/antifreeze is used, treat the cooling system with three to six percent Caterpillar SCA by volume. For more information, see this publication, “Conventional Coolant/Antifreeze Cooling System Maintenance” topic (Maintenance Section).

If Caterpillar SCA is not used, select a commercial SCA. The commercial SCA must provide a minimum of 1200 mg/L or 1200 ppm (70 grains/US gal) of nitrites in the final coolant mixture.

Coolant/antifreeze that meets “ASTM D5345” or “ASTM D4985” specifications MAY require treatment with SCA at the initial fill. These coolants WILL require treatment with SCA on a maintenance basis.

When concentrated coolant/antifreeze is mixed, Caterpillar recommends mixing the concentrate with distilled water or with deionized water. If distilled water or deionized water is not available, water which has the required properties may be used. For the water properties, see this publication, “General Coolant Information” topic (Maintenance Section).

i01318169

Water/Supplemental Coolant Additive (SCA)

SMCS Code: 1350; 1352; 1395

NOTICE
All Caterpillar diesel engines equipped with air-to-air aftercooling (ATAAC) require a minimum of 30 percent glycol to prevent water pump cavitation.

NOTICE
Never use water alone without Supplemental Coolant Additives (SCA) or without inhibited coolant. Water alone is corrosive at engine operating temperatures. Water alone does not provide adequate protection against boiling or freezing.

Note: Premix the coolant solution in order to provide protection to the lowest ambient temperature that is expected.

Note: Pure undiluted antifreeze freezes at –23 °C (–9 °F).

In engine cooling systems that use water alone, Caterpillar recommends the use of SCA. SCA helps to prevent the following conditions from occurring:

- Corrosion
- Formation of mineral deposits
- Cavitation erosion of the cylinder liner
- Foaming of the coolant

If Caterpillar SCA is not used, select a commercial SCA. The commercial SCA must provide a minimum of 2400 mg/L or 2400 ppm (140 grains/US gal) of nitrites in the final coolant mixture.

The quality of the water is a very important factor in this type of cooling system. Distilled water or deionized water is recommended for use in cooling systems. If distilled water or deionized water is not available, use water that meets the minimum requirements that are listed in the table for recommended water properties in this publication, “General Coolant Information” topic (Maintenance Section).

A cooling system that uses a mixture of SCA and water only needs more SCA than a cooling system that uses a mixture of glycol and water. The SCA concentration in a cooling system that uses SCA and water should be six to eight percent by volume. Refer to Table 20 for the amount of SCA that is required for various capacities of the cooling system.

Table 20

Caterpillar SCA Requirements for SCA and Water Cooling Systems		
Cooling System Capacity	**Caterpillar SCA at Initial Fill**	**Caterpillar SCA at 250 Hours**
22 to 30 L (6 to 8 US gal)	1.75 L (64 fl oz)	0.44 L (15 fl oz)
31 to 38 L (9 to 10 US gal)	2.30 L (80 fl oz)	0.57 L (20 fl oz)
39 to 49 L (11 to 13 US gal)	3.00 L (100 fl oz)	0.75 L (25 fl oz)
50 to 64 L (14 to 17 US gal)	3.90 L (128 fl oz)	0.95 L (32 fl oz)
65 to 83 L (18 to 22 US gal)	5.00 L (168 fl oz)	1.25 L (42 fl oz)
84 to 110 L (23 to 29 US gal)	6.60 L (224 fl oz)	1.65 L (56 fl oz)
111 to 145 L (30 to 38 US gal)	8.75 L (296 fl oz)	2.19 L (74 fl oz)
146 to 190 L (39 to 50 US gal)	11.50 L (392 fl oz)	2.88 L (98 fl oz)
191 to 250 L (51 to 66 US gal)	15.00 L (512 fl oz)	3.75 L (128 fl oz)

Refer to Table 21 for part numbers and for quantities of SCA.

Table 21

Caterpillar Liquid SCA	
Part Number	**Quantity**
6V-3542	0.24 L (8 oz)
111-2372	0.36 L (12 oz)
8T-1589	0.47 L (16 oz)
3P-2044	0.94 L (32 oz)
8C-3680	19 L (5 US gal)
5P-2907	208 L (55 US gal)

Maintain the SCA in the same way as you would maintain a cooling system that uses heavy-duty coolant/antifreeze. Adjust the maintenance for the amount of SCA additions. See Table 20 for the amount of SCA that is required.

Cooling Systems with Larger Capacities

Adding the SCA to Water at the Initial Fill

Use the equation that is in Table 22 to determine the amount of Caterpillar SCA that is required at the initial fill. This equation is for a mixture of only SCA and water.

Table 22

Equation For Adding The SCA To Water At The Initial Fill
V × 0.07 = X
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 23 is an example for using the equation that is in Table 22.

Table 23

Example Of The Equation For Adding The SCA To Water At The Initial Fill		
Total Volume of the Cooling System (V)	**Multiplication Factor**	**Amount of SCA that is Required (X)**
946 L (250 US gal)	× 0.07	66 L (18 US gal)

Adding the SCA to Water for Maintenance

For the recommended service interval, refer to the Operation and Maintenance Manual, “Maintenance Interval Schedule” for your engine.

Use the 8T-5296 Coolant Conditioner Test Kit to test the concentration of SCA. Make the following modifications to Steps 3 and 5 of the 8T-5296 Coolant Conditioner Test Kit instructions:

STEP 3 – Add tap water to the vial up to the “20 ml” mark.

STEP 5 – When the defined procedure is used, a concentration of six to eight percent will yield between 20 drops and 27 drops. If the number of drops is below 20 drops, the concentration of SCA is low. If the number of drops is above 27 drops, the concentration of SCA is high. Make the appropriate adjustments to the concentration of SCA.

Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer. See this publication, “S·O·S Coolant Analysis” topic (Maintenance Section).

Additions of SCA are based on the results of the test or based on the results of the coolant analysis. The size of the cooling system determines the amount of SCA that is required.

Use the equation that is in Table 22 to determine the amount of Caterpillar SCA that is required for maintenance, if necessary:

Table 24

SCA To Water Addition Equation For Maintenance
V × 0.023 = X
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 25 is an example for using the equation that is in Table 22.

Table 25

SCA To Water Addition Equation Example For Maintenance		
Total Volume of the Cooling System (V)	**Multiplication Factor**	**Amount of SCA that is Required (X)**
946 L (250 US gal)	× 0.023	22 L (6 US gal)

Note: Specific engine applications may require maintenance practices to be periodically evaluated in order to properly maintain the engine's cooling system.

Table 21 lists part numbers and quantities of SCA that is available from your Caterpillar dealer.

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Conventional Coolant/ Antifreeze Cooling System Maintenance

SMCS Code: 1350; 1352; 1395

NOTICE
Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

Check the coolant/antifreeze (glycol concentration) in order to ensure adequate protection against boiling or freezing. Caterpillar recommends the use of a refractometer for checking the glycol concentration. Use the **1U-7298** Coolant/Battery Tester (Celsius) or use the **1U-7297** Coolant/Battery Tester (Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or with propylene glycol.

Caterpillar engine cooling systems should be tested at 250 hour intervals for the concentration of Supplemental Coolant Additive (SCA). SCA test kits are available from your Caterpillar dealer. Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer at 250 hour intervals. Refer to S·O·S Coolant Analysis for more information on this topic.

Additions of SCA are based on the results of the test or based on the results of the coolant analysis. An SCA that is liquid or a maintenance element for an SCA (if equipped) may be needed at 250 hour intervals.

Table 26 lists the amount of Caterpillar SCA that is needed at the initial fill in order to treat coolant/antifreeze. These amounts of SCA are for systems that use heavy-duty coolant/antifreeze.

Table 26 also lists additions of SCA for liquid and for maintenance elements at 250 hours. The additions are required for Caterpillar DEAC and for commercial coolant/antifreezes.

Table 26

Caterpillar SCA Requirements for Heavy-Duty Coolant/Antifreeze			
Cooling System Capacity	**Initial Fill(1)**	**250 Service Hour Maintenance(2)**	**Spin-on Element at 250 Service Hour Maintenance(3)**
22 to 30 L (6 to 8 US gal)	0.95 L (32 fl oz)	0.24 L (8 fl oz)	111-2370 (1)
31 to 38 L (9 to 10 US gal)	1.18 L (40 fl oz)	0.36 L (12 fl oz)	111-2369 (1)
39 to 49 L (11 to 13 US gal)	1.42 L (48 fl oz)	0.36 L (12 fl oz)	111-2369 (1)
50 to 64 L (14 to 17 US gal)	1.90 L (64 fl oz)	0.47 L (16 fl oz)	9N-3368 (1)
65 to 83 L (18 to 22 US gal)	2.37 L (80 fl oz)	0.60 L (20 fl oz)	111-2371 (1)
84 to 114 L (23 to 30 US gal)	3.32 L (112 fl oz)	0.95 L (32 fl oz)	9N-3718 (1)
115 to 163 L (31 to 43 US gal)	4.75 L (160 fl oz)	1.18 L (40 fl oz)	111-2371 (2)
164 to 242 L (44 to 64 US gal)	7.60 L (256 fl oz)	1.90 L (64 fl oz)	9N-3718 (2)

(1) When the coolant system is first filled, the SCA is not required to be used with Caterpillar DEAC.
(2) Do not exceed the six percent maximum concentration. Check the concentration of SCA with a SCA test kit.
(3) Do not use the maintenance element for the SCA and the liquid for the SCA at the same time.

Note: Specific engine applications may require maintenance practices to be periodically evaluated in order to properly maintain the engine's cooling system.

Refer to Table 27 for part numbers and for quantities of SCA.

Table 27

Caterpillar Liquid SCA	
Part Number	**Quantity**
6V-3542	0.24 L (8 oz)
111-2372	0.36 L (12 oz)
8T-1589	0.47 L (16 oz)
3P-2044	0.94 L (32 oz)
8C-3680	19 L (5 US gal)
5P-2907	208 L (55 US gal)

Cooling Systems with Larger Capacities

Adding the SCA to Conventional Coolant/Antifreeze at the Initial Fill

Note: Caterpillar DEAC DOES NOT require an addition of SCA when the cooling system is initially filled.

Commercial heavy duty coolant/antifreeze that meet "ASTM D4985" or "ASTM D5345" specifications MAY require an addition of SCA at the initial fill. Read the label or the instructions that are provided by the OEM of the product.

Use the equation that is in Table 28 to determine the amount of Caterpillar SCA that is required when the cooling system is initially filled with the following fluids:

- "ASTM D4985"
- "ASTM D5345"

Table 28

Equation For Adding The SCA To Conventional Coolant/Antifreeze At The Initial Fill
V × 0.045 = X
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 29 is an example for using the equation that is in Table 28.

Table 29

Example Of The Equation For Adding The SCA To Conventional Coolant/Antifreeze At The Initial Fill		
Total Volume of the Cooling System (V)	**Multiplication Factor**	**Amount of SCA that is Required (X)**
946 L (250 US gal)	× 0.045	43 L (11 US gal)

Adding the SCA to Conventional Coolant/Antifreeze For Maintenance

Heavy duty coolant/antifreeze of all types REQUIRE periodic additions of an SCA.

Test the coolant/antifreeze periodically for the concentration of SCA. For the interval, see the Operation and Maintenance Manual, “Maintenance Interval Schedule” (Maintenance Section). SCA test kits are available from your Caterpillar dealer. Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer. See this publication, “S·O·S Coolant Analysis” topic (Maintenance Section).

Additions of SCA are based on the results of the test or based on the results of the coolant analysis. The size of the cooling system determines the amount of SCA that is needed.

Use the equation that is in Table 30 to determine the amount of Caterpillar SCA that is required, if necessary:

Table 30

Equation For Adding The SCA To Conventional Coolant/Antifreeze For Maintenance
V × 0.014 = X
V is the total volume of the cooling system.
X is the amount of SCA that is required.

Table 31 is an example for using the equation that is in Table 30.

Table 31

Example Of The Equation For Adding The SCA To Conventional Coolant/Antifreeze For Maintenance		
Total Volume of the Cooling System (V)	**Multiplication Factor**	**Amount of SCA that is Required (X)**
946 L (250 US gal)	× 0.014	9 L (4 US gal)

Note: Specific engine applications may require maintenance practices to be periodically evaluated in order to properly maintain the engine’s cooling system.

Table 27 lists part numbers and quantities of SCA that is available from your Caterpillar dealer.

Cleaning the System of Heavy-Duty Coolant/Antifreeze

Caterpillar cooling system cleaners are designed to clean the cooling system of harmful scale and corrosion. Caterpillar cooling system cleaners dissolve mineral scale, corrosion products, light oil contamination and sludge.

- Clean the cooling system after used coolant is drained or before the cooling system is filled with new coolant.
- Clean the cooling system whenever the coolant is contaminated or whenever the coolant is foaming.
- For the recommended service interval, refer to the Operation and Maintenance Manual, “Maintenance Interval Schedule” for your engine.

Refill Capacities

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Refill Capacities

SMCS Code: 1348; 1395; 7560

Lubrication System

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. Refer to the Operation and Maintenance Manual, “Lubricant Specifications” (Maintenance Section) for more information.

Table 32

3406C Industrial Engine Approximate Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Crankcase Oil Sump (Standard)(1)	34.1	36.0

(1) These values are the approximate capacities for the crankcase oil sump which include the standard oil filters that are installed at the factory. Engines with auxiliary oil filters will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.

Cooling System

To maintain the cooling system, the total cooling system capacity must be known. The approximate capacity for the engine only cooling system is listed. External system capacities will vary among applications. Refer to the OEM specifications for the external system capacity. This capacity information will be needed in order to determine the amount of coolant/antifreeze that is required for the total cooling system.

Table 33

3406C Industrial Engine Approximate Refill Capacities		
Compartment or System	**Liters**	**Quarts**
Engine Only	22.7	24.0
External System (OEM)(1)		
Total Cooling System(2)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger, aftercooler, and piping. Refer to Caterpillar specifications or to the OEM specifications and enter the capacity for the External System in this row.

(2) The Total Cooling System includes the capacity for the Engine Only cooling system plus the capacity for the External System. Enter the total in this row.

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Maintenance Interval Schedule

SMCS Code: 1000; 7500

Before performing any operation or maintenance procedures, ensure that the Safety Information, warnings, and instructions are read and understood.

To determine the maintenance intervals, use fuel consumption, service hours, or calendar time, which ever occurs first.

Before each consecutive interval is performed, all of the maintenance requirements from the previous interval must be performed.

When Required

Battery - Replace 63
Battery or Battery Cable - Disconnect 64
Engine - Clean 72
Engine Air Cleaner Element (Single Element) - Inspect/Replace 72
Fuel System - Prime 79

Daily

Air Starting Motor Lubricator Oil Level - Check 61
Air Tank Moisture and Sediment - Drain 61
Cooling System Coolant Level - Check 68
Driven Equipment - Check 71
Engine Air Cleaner Service Indicator - Inspect 73
Engine Oil Level - Check 74
Power Take-Off Clutch - Check/Adjust/Lubricate .. 86
Walk-Around Inspection 88

Every Week

Battery Charger - Check 64

Every 1000 Service Hours

Engine Protective Devices - Check 77
Fuel Control Linkage - Check/Lubricate 78

Every 9500 L (2500 US gal) of Fuel or 250 Service Hours or Yearly

Aftercooler Core - Clean/Test 60
Alternator Belt - Inspect/Adjust/Replace 62
Battery Electrolyte Level - Check 63
Cooling System Supplemental Coolant Additive (SCA) - Test/Add 69
Engine Crankcase Breather - Clean 73
Engine Oil Sample - Obtain 74
Engine Oil and Filter - Change 75
Fan Drive Bearing - Lubricate 78
Fuel System Primary Filter - Clean/Replace 80
Fuel Tank Water and Sediment - Drain 81
Hoses and Clamps - Inspect/Replace 82
Radiator - Clean 86

Every 114 000 L (30 000 US gal) of Fuel or 3000 Service Hours or 2 Years

Cooling System Coolant (DEAC) - Change 65
Cooling System Coolant Extender (ELC) - Add 68
Cooling System Water Temperature Regulator - Replace 70
Crankshaft Vibration Damper - Inspect 71
Engine Mounts - Inspect 74
Engine Valve Lash - Inspect/Adjust 77
Engine Valve Rotators - Inspect 77
Fuel Ratio Control - Inspect/Adjust 79
Turbocharger - Inspect 87

Every 190 000 L (50 000 US gal) of Fuel or 5000 Service Hours

Air Compressor - Inspect 60
Alternator - Inspect 62
Fuel Injection Nozzles - Test/Exchange 78
Starting Motor - Inspect 87
Water Pump - Inspect 89

Every 228 000 L (60 000 US gal) of Fuel or 6000 Service Hours or 6 Years

Cooling System Coolant (ELC) - Change 67

Every 380 000 L (100 000 US gal) of Fuel or 10 000 Service Hours

Overhaul Considerations 83

i01371758

Aftercooler Core - Clean/Test (Air-To-Air Aftercooler)

SMCS Code: 1064-070; 1064-081

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the aftercooler for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the aftercooler, if necessary.

For air-to-air aftercoolers, use the same methods that are used for cleaning radiators.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a "comb".

Note: If parts of the aftercooler system are repaired or replaced, a leak test is highly recommended.

Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, see Special Publication, SEBD0518, "Know Your Cooling System".

i01183385

Air Compressor - Inspect

SMCS Code: 1803-040

⚠ WARNING

Do not disconnect the air line from the air compressor governor without purging the air brake and the auxiliary air systems. Failure to purge the air brake and the auxiliary air systems before removing the air compressor and/or the air lines could cause personal injury.

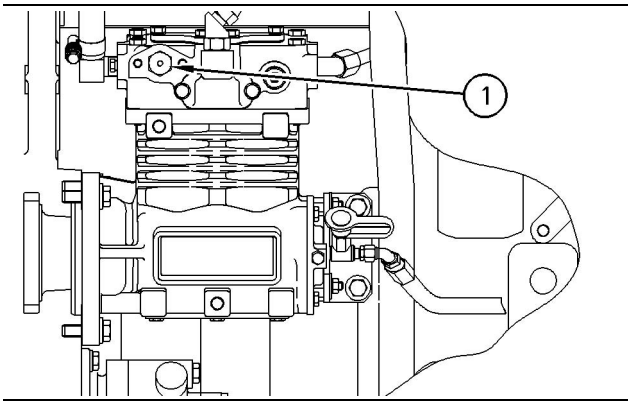


Illustration 29 g00633741

(1) Air compressor pressure relief valve

⚠ WARNING

If the air compressor pressure relief valve that is mounted in the air compressor cylinder head is bypassing compressed air, there is a malfunction in the air system, possibly ice blockage. Under these conditions, your engine may have insufficient air for normal brake operation.

Do not operate the engine until the reason for the air bypass is identified and corrected. Failure to heed this warning could lead to property damage, personal injury, or death to the operator or bystanders.

The function of the air compressor pressure relief valve is to bypass air when there is a malfunction in the air compressor system.

The air compressor pressure relief valve releases air at 1723 kPa (250 psi). It is very important that all personnel stand clear of the air compressor pressure relief valve when compressed air is released. All personnel should also stay clear of the air compressor when the engine is operating and the air compressor is exposed.

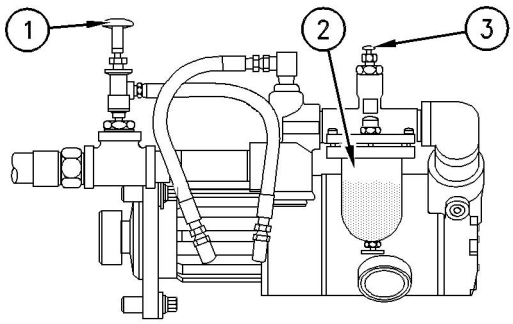
Refer to the Service Manual or refer to the OEM specifications in order to find information concerning the air compressor. Consult your Caterpillar dealer for assistance.

i00805129

Air Starting Motor Lubricator Oil Level - Check (If Equipped)

SMCS Code: 1451-535

NOTICE
Never allow the lubricator bowl to become empty. The air starting motor will be damaged by a lack of lubrication. Ensure that sufficient oil is in the lubricator bowl.



g00381232

Illustration 30

(1) Air valve
(2) Lubricator bowl
(3) Adjustment knob

1. The vanes of the air starting motor are lubricated with a fine mist of oil from the air starting motor lubricator. Check the level of oil in lubricator bowl (2). If the oil level is less than 1/2, add oil to the lubricator bowl.

2. Ensure that the air supply to the lubricator is OFF.

3. Remove the plug. Pour oil into lubricator bowl (2). Use “10W” oil for temperatures that are greater than 0° C (32° F). Use air tool oil for temperatures that are below 0° C (32° F).

4. Install the plug.

Oiler Feed Adjustment

If necessary, adjust the lubricator in order to release approximately two drops of fluid per 30 seconds into the starting motor air stream.

1. Ensure that the fuel supply to the engine is OFF.

2. Turn adjustment knob (3) clockwise until the adjustment knob locks.

3. Turn adjustment knob (3) counterclockwise for 1/4 turns.

NOTICE
Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

4. Crank the starting motor for ten seconds and observe the exhaust air from the mufflers of the starting motor. Look for oil mist. A slight oil mist should be barely visible.

If no mist is observed, or if the mist is excessive, rotate adjustment knob (3) in increments of 1/16 in order to increase or decrease the oil mist. Repeat the starting motor cranking and observe until the mist is satisfactory.

Note: Drip rates should only be made under an average steady flow condition. Once a steady flow condition is established, the lubricator will automatically adjust the drip rate in proportion to the variations in air flow.

i00847451

Air Tank Moisture and Sediment - Drain (If Equipped)

SMCS Code: 1466-543-M&S

Moisture and sediment in the air starting system can cause the following conditions:

- Freezing
- Corrosion of internal parts
- Malfunction of the air starting system

⚠ WARNING

When opening the drain valve, wear protective gloves, a protective face shield, protective clothing, and protective shoes. Pressurized air could cause debris to be blown and result in personal injury.

1. Open the drain valve that is on the bottom of the air tank. Allow the moisture and sediment to drain.
2. Close the drain valve.
3. Check the air supply pressure. The air starting motor requires a minimum of 620 kPa (90 psi) of air pressure to operate properly. The maximum air pressure must not exceed 1550 kPa (225 psi). The normal air pressure will be 758 to 965 kPa (110 to 140 psi).

i00072207

Alternator - Inspect

SMCS Code: 1405-040

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required. Refer to the Service Manual.

Check the alternator and the battery charger for proper operation. If the batteries are properly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power. If the battery is too cold, the battery will not crank the engine. The battery will not crank the engine, even if the engine is warm. When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

i00165437

Alternator Belt - Inspect/Adjust/Replace

SMCS Code: 1357-036; 1357-510

Inspection

To maximize the engine performance, inspect the belt for wear and for cracking. Check the belt tension. Adjust the belt tension in order to minimize belt slippage. Belt slippage will decrease the life of the belt.

To check the belt tension, apply 110 N (25 lb) of force midway between the pulleys. A correctly adjusted belt will deflect 13 to 19 mm (0.50 to 0.75 inch).

Adjustment

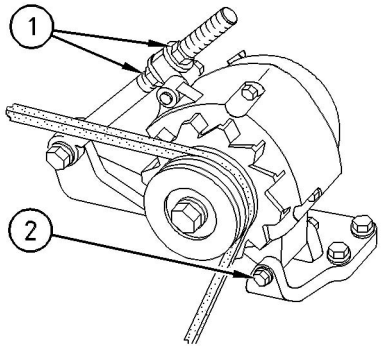


Illustration 31 g00122875

Typical Adjusting Nuts (1) and Mounting Bolt (2)

1. Remove the belt guard.
2. Loosen mounting bolt (2) and adjusting nuts (1).
3. Turn adjusting nuts (1) in order to increase or decrease the belt tension.
4. Tighten adjusting nuts (1). Tighten mounting bolt (2). Refer to the Operation and Maintenance Manual for the proper torques.
5. Reinstall the belt guard.

If new belts are installed, check the belt adjustment again after 30 minutes of engine operation at the rated rpm.

Replacement

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belts are stretched. The additional load on the new belt could cause the new belt to break.

Refer to the Service Manual for more information on the procedures for the following topics: belt removal and belt installation.

i01179608

Battery - Replace

SMCS Code: 1401-510

⚠ WARNING

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

1. Turn the key start switch to the OFF position. Remove the key and all electrical loads.
2. Turn OFF the battery charger. Disconnect the charger.
3. The NEGATIVE "-" cable connects the NEGATIVE "-" battery terminal to the ground plane. Disconnect the cable from the NEGATIVE "-" battery terminal.
4. The POSITIVE "+" cable connects the POSITIVE "+" battery terminal to the starting motor. Disconnect the cable from the POSITIVE "+" battery terminal.

Note: Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

5. Remove the used battery.
6. Install the new battery.

Note: Before the cables are connected, ensure that the key start switch is OFF.

7. Connect the cable from the starting motor to the POSITIVE "+" battery terminal.
8. Connect the cable from the ground plane to the NEGATIVE "-" battery terminal.

i01206348

Battery Electrolyte Level - Check

SMCS Code: 1401-535

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are properly charged, ammeter reading should be very near zero.

⚠ WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the "FULL" mark on the battery.

   If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

2. Check the condition of the electrolyte with the 1U-7298 Coolant/Battery Tester (°C) or the 1U-7297 Coolant/Battery Tester (°F).
3. Keep the batteries clean.

   Clean the battery case with one of the following cleaning solutions:

   - A mixture of 0.1 L (0.11 qt) of baking soda and 1 L (1 qt) of clean water
   - A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

   Thoroughly rinse the battery case with clean water.

Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM grease.

i00095575

Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.
2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.
3. Tape the leads in order to help prevent accidental starting.
4. Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

i01039758

Battery Charger - Check

SMCS Code: 1401-535

Checking Before Start-Up

Check the battery charger for proper operation. If the batteries are properly charged, the needle of the ammeter will register near “0” (zero).

The battery charger must not produce excessive current during start-up. Alternatively, the charger must be automatically disconnected for start-up. If the engine has an alternator, the charger must be automatically disconnected during start-up and during engine operation.

Charging the Battery

⚠ WARNING

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operated. A spark can cause an explosion from the flammable vapor mixture of hydrogen and oxygen that is released from the electrolyte through the battery outlets. Injury to personnel can be the result.

Perform the following procedure to charge the battery:

1. Ensure that the charger is turned OFF.
2. Adjust the voltage of the charger in order to match the voltage of the battery.
3. Connect the POSITIVE “+” lead of the charger to the POSITIVE “+” battery terminal. Connect the NEGATIVE “-” lead of the charger to the NEGATIVE “-” battery terminal.
4. Turn ON the battery charger.

Overcharging of Batteries

Overcharging reduces the service life of batteries. Use a battery charger that will not overcharge the battery. DO NOT charge the battery if the meter of the battery charger is in the RED zone.

Overcharging is indicated by the following symptoms:

- The battery is very warm to the touch.
- A strong odor of acid is present.
- The battery emits smoke or a dense vapor (gas).

Perform one of the following procedures if the battery shows symptoms of overcharging:

- Reduce the rate of charging by a significant amount. Complete the charging at the reduced rate.
- Turn OFF the charger.

Table 34 describes the effects of overcharging on different types of batteries.

Table 34

Effects of Overcharging Batteries	
Type of Battery	**Effect**
Caterpillar General Service Batteries Caterpillar Premium High Output Batteries	All of the battery cells have a low level of electrolyte.
	When the plates of the battery are inspected through the filler holes, the plates may appear to be warped. This is caused by an excessive temperature.
	The battery may not pass a load test.
Caterpillar Maintenance Free Batteries	The battery may not accept a charging current.
	The battery may not pass a load test.

Checking After Stopping

Ensure that the battery charger is connected properly. Observe the meter of the charger. Record the amperage.

i01206425

Cooling System Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

NOTICE
Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove one of the drain plugs.

   Allow the coolant to drain.

NOTICE
Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL

Flush

1. Flush the cooling system with clean water in order to remove any debris.
2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, “Torque Specifications” topic (Maintenance Section) for more information on the proper torques.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.

4. Start and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, “Torque Specifications” topic (Maintenance Section) for more information on the proper torques.

Cooling Systems with Heavy Deposits or Plugging

Note: For the following procedure to be effective, there must be some active flow through the cooling system components.

1. Flush the cooling system with clean water in order to remove any debris.

2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, “Torque Specifications” topic (Maintenance Section) for more information on the proper torques.

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap.

4. Start and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE
Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, “Torque Specifications” topic (Maintenance Section) for more information on the proper torques.

Fill

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

1. Fill the cooling system with coolant/antifreeze. Refer to the Operation and Maintenance Manual, “Cooling System Specifications” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.

3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i01206445

Cooling System Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

Note: When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

2. Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs.

   Allow the coolant to drain.

NOTICE

Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL
Inside Illinois: 1-800-541-TOOL
Canada: 1-800-523-TOOL

Flush

1. Flush the cooling system with clean water in order to remove any debris.

2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, “Torque Specifications” topic (Maintenance Section) for more information on the proper torques.

NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

3. Fill the cooling system with clean water. Install the cooling system filler cap.

4. Start and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, “Torque Specifications” topic (Maintenance Section) for more information on the proper torques.

Fill

NOTICE
Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

1. Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, “Cooling System Specifications” topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.

2. Start and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.

3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).

4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump in order to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.

5. Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i00259474

Cooling System Coolant Extender (ELC) - Add

SMCS Code: 1352-045; 1395-081

Caterpillar Extended Life Coolant (ELC) does not require the frequent Supplemental Coolant Additive (SCA) additions associated with the present conventional coolants. The Extender only needs to be added once.

Check the cooling system only when the engine is stopped and cool.

1. Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.

2. It may be necessary to drain enough coolant from the cooling system in order to add the Extender.

3. Add Extender according to the requirements for your engine’s cooling system capacity. Refer to the Operation and Maintenance Manual, “Refill Capacities” in the Maintenance Section for the capacity of the cooling system for your engine. Refer to the Operation and Maintenance Manual, “Cooling System Specifications” information for the Caterpillar ELC Extender additions.

4. Clean the cooling system filler cap. Inspect the cooling system filler cap gaskets. Replace the cooling system filler cap if the cooling system filler cap gaskets are damaged. Install the cooling system filler cap.

i01197583

Cooling System Coolant Level - Check

SMCS Code: 1395-082

Check the coolant level when the engine is stopped and cool.

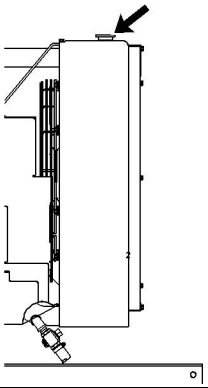


Illustration 32 g00285520

Cooling system filler cap

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Remove the cooling system filler cap slowly in order to relieve pressure.
2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the proper level in the sight glass.

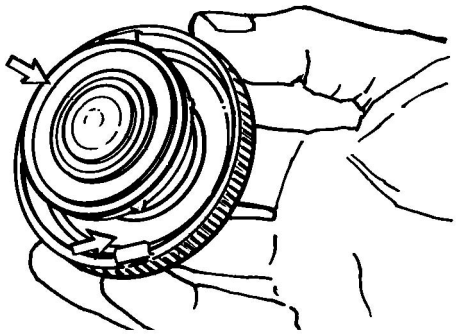


Illustration 33 g00103639

Typical filler cap gaskets

3. Clean the cooling system filler cap and check the condition of the filler cap gaskets. Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.
4. Inspect the cooling system for leaks.

i00992487

Cooling System Supplemental Coolant Additive (SCA) - Test/Add

SMCS Code: 1352-045; 1395-081

⚠ WARNING

Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and the eyes. Do not drink cooling system coolant additive.

Note: Test the concentration of the Supplemental Coolant Additive (SCA) or test the SCA concentration as part of an S·O·S Coolant Analysis.

Test for SCA Concentration

Coolant/Antifreeze and SCA

NOTICE
Do not exceed the recommended six percent supplemental coolant additive concentration.

Use the 8T-5296 Coolant Conditioner Test Kit or use the 4C-9301 Coolant Conditioner Test Kit in order to check the concentration of the SCA. Refer to the Operation and Maintenance Manual for more information on conventional coolant/antifreeze cooling system maintenance.

Water and SCA

NOTICE
Do not exceed the recommended eight percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T-5296 Coolant Conditioner Test Kit. Refer to the Operation and Maintenance Manual, “Water/Supplemental Coolant Additive (SCA)” topic (Maintenance Section). Refer to the Operation and Maintenance Manual, “Conventional Coolant/Antifreeze Cooling System Maintenance” topic (Maintenance Section).

S·O·S Coolant Analysis

S·O·S coolant samples can be analyzed at your Caterpillar dealer. S·O·S Coolant Analysis is a program that is based on periodic samples.

Level 1

Level 1 is a basic analysis of the coolant. The following items are tested:

- Glycol Concentration
- Concentration of SCA
- pH
- Conductivity

The results are reported, and recommendations are made according to the results. Consult your Caterpillar dealer for information on the benefits of managing your equipment with an S·O·S Coolant Analysis.

Add the SCA, If Necessary

NOTICE
Do not exceed the recommended amount of supplemental coolant additive concentration. Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components. Excessive supplemental coolant additive concentration could also result in radiator tube blockage, overheating, and/or accelerated water pump seal wear. Never use both liquid supplemental coolant additive and the spin-on element (if equipped) at the same time. The use of those additives together could result in supplemental coolant additive concentration exceeding the recommended maximum.

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Slowly loosen the cooling system filler cap in order to relieve the pressure. Remove the cooling system filler cap.

Note: Always discard drained fluids according to local regulations.

2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.
3. Add the proper amount of SCA. Refer to the Operation and Maintenance Manual for more information on SCA requirements.
4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets are damaged, replace the old cooling system filler cap with a new cooling system filler cap. Install the cooling system filler cap.

i00912898

Cooling System Water Temperature Regulator - Replace

SMCS Code: 1355-510

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

NOTICE
Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position. Ensure that the water temperature regulator vent hole is open.

Do not use liquid gasket material on the gasket or cylinder head surface.

Refer to the Service Manual for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

Note: If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i00894991

Crankshaft Vibration Damper - Inspect

SMCS Code: 1205-040

Damage to the crankshaft vibration damper or failure of the crankshaft vibration damper can increase torsional vibrations. This can result in damage to the crankshaft and to other engine components. A deteriorating damper can cause excessive gear train noise at variable points in the speed range.

The damper is mounted to the crankshaft which is located behind the belt guard on the front of the engine.

Rubber Damper

Your engine may be equipped with a rubber damper. The rubber damper uses a ring which is mounted in rubber in order to reduce vibrations in the crankshaft.

Inspect the damper and repair or replace the damper for any of the following reasons:

- There is deterioration and cracking of the rubber.
- There is slippage of the outer ring from the original position.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

Visconic Damper

Your engine may be equipped with a visconic damper. The visconic damper has a weight that is located inside a fluid filled case. The weight moves in the case in order to limit torsional vibration.

Inspect the damper for evidence of fluid leaks. If a fluid leak is found, determine the type of fluid. The fluid in the damper is silicone. Silicone has the following characteristics: transparent, viscous, smooth, and difficult to remove from surfaces.

If the fluid leak is oil, inspect the crankshaft seals for leaks. If a leak is observed, replace the crankshaft seals.

Inspect the damper and repair or replace the damper for any of the following reasons:

- The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by a lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

i00174798

Driven Equipment - Check

SMCS Code: 3279-535

Refer to the OEM specifications for more information on the following maintenance recommendations for the driven equipment:

- Inspection
- Adjustment
- Lubrication
- Other maintenance recommendations

Perform any maintenance for the driven equipment which is recommended by the OEM.

i01239442

Engine - Clean

SMCS Code: 1000-070

⚠ WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls "DO NOT OPERATE".

NOTICE
Water and/or condensation can cause damage to electrical components. Protect all electrical components from exposure to water.

NOTICE
Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

i01173387

Engine Air Cleaner Element (Single Element) - Inspect/Replace

SMCS Code: 1054-040; 1054-510

Perform the Operation and Maintenance Manual, "Engine Air Cleaner Service Indicator-Inspect" procedure and perform the Operation and Maintenance Manual, "Engine Air Precleaner Check/Clean" procedure (if equipped) before performing the following procedure.

NOTICE
Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent airborne debris from entering the air inlet.

NOTICE
Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

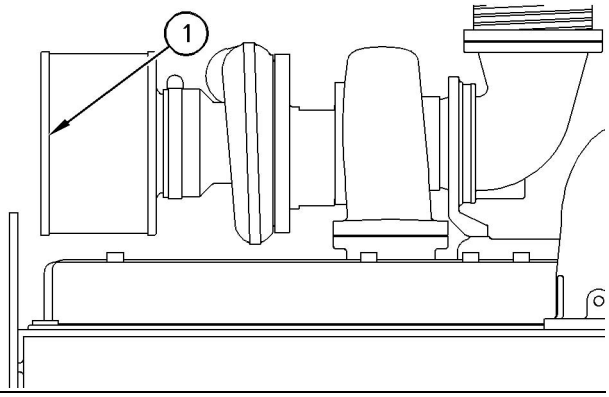


Illustration 34 g00310663

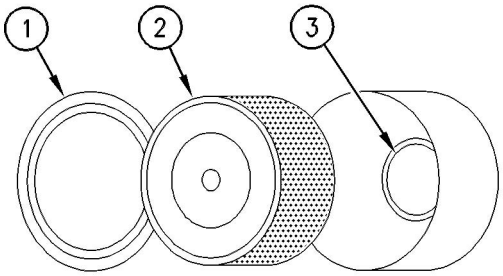


Illustration 35 g00310664

1. Remove the air cleaner cover (1) and remove the element (2).
2. Seal the air inlet (3) so that debris cannot enter the air inlet. Tape or a clean cloth can be used to cover the opening.
3. Clean the inside of the air cleaner cover. Clean the body that holds the air cleaner element.
4. Inspect the replacement element for the following items:damage, dirt, and debris.
5. Remove the seal from the opening of the air inlet.

6. Install a clean, undamaged element.

7. Install the air cleaner cover (1).

8. Reset the service indicator.

i01175055

Engine Air Cleaner Service Indicator - Inspect

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before the air cleaner element and the pressure that is measured after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the air cleaner element or in a remote location.

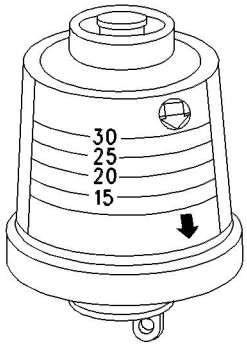


Illustration 36 g00103777

Typical service indicator

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated speed. The yellow core should latch approximately at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the hole for the service indicator may be plugged.

The service indicator may need to be replaced frequently in environments that are severely dusty, if necessary. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

Note: When a new service indicator is installed, excessive force may crack the top of the service indicator. Tighten the service indicator to a torque of 2 N·m (18 lb in).

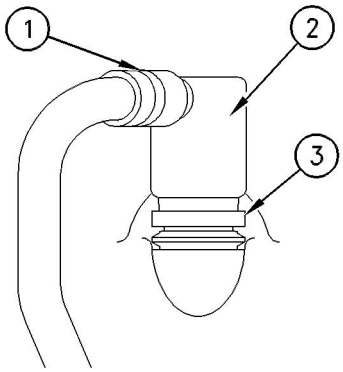
i00906289

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

NOTICE
Perform this maintenance with the engine stopped.

If the crankcase breather is not maintained on a regular basis, the crankcase breather will become plugged. A plugged crankcase breather will cause excessive crankcase pressure that may cause crankshaft seal leakage.



g00463048

Illustration 37

Typical example

(1) Hose clamp
(2) Breather assembly
(3) Retaining clamp

1. Loosen hose clamp (1) and remove the hose from breather assembly (2).

2. Loosen the retaining clamp (3). Remove breather assembly (2) and the seal.

3. Wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry before installation.

4. Install a breather element that is clean and dry. Install breather assembly and seal (2) and install clamp (3). Refer to the Operation and Maintenance Manual, “Torque Specifications” topic (Maintenance Section) for the proper torques.

5. Install the hose. Install hose clamp (1). Refer to the Operation and Maintenance Manual, “Torque Specifications” topic (Maintenance Section) for the proper torques.

i00687861

Engine Mounts - Inspect

SMCS Code: 1152-040

Inspect the engine mounts for deterioration and for proper bolt torque. Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- Deterioration of the engine mounts

Any engine mount that shows deterioration should be replaced. Refer to the Service Manual for the recommended torques. Refer to your Caterpillar dealer for more information.

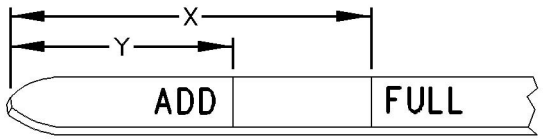
i00623423

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.



g00110310

Illustration 38

(Y) “ADD” mark. (X) “FULL” mark.

NOTICE
Perform this maintenance with the engine stopped.

1. Maintain the oil level between “ADD” mark (Y) and “FULL” mark (X) on oil level gauge (1). Do not fill the crankcase above “FULL” mark (X).

NOTICE
Operating your engine when the oil level is above the “FULL” mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil’s lubricating characteristics and could result in the loss of power.

2. Remove the oil filler cap and add oil, if necessary. Clean the oil filler cap. Install the oil filler cap.

i01070756

Engine Oil Sample - Obtain

SMCS Code: 1000-008; 1348-554-SM; 7542-554-OC, SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine.

Obtain the Sample and the Analysis

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. In order to help obtain the most accurate analysis, provide the following information:

- Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, well mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

Caterpillar recommends using the sampling valve in order to obtain oil samples. The quality and the consistency of the samples are better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 8T-9190 Fluid Sampling Bottle Group is recommended for use with the sampling valve. The bottle group includes the parts that are needed for obtaining oil samples. Instructions are also provided.

NOTICE

Do not use the same vacuum sampling pump for extracting oil samples that is used for extracting coolant samples.

A small residue of either type sample may remain in the pump and may cause a false positive analysis for the sample being taken.

Always use a designated pump for oil sampling and a designated pump for coolant sampling.

Failure to do so may cause a false analysis which could lead to customer and dealer concerns.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEHP6001, “How To Take A Good Oil Sample”. Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your engine.

i00652130

Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

⚠ WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Do not drain the oil when the engine is cold. As the oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with the draining cold oil. Drain the crankcase with the engine stopped. Drain the crankcase with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

Drain the Engine Oil

After the engine has been run at the normal operating temperature, stop the engine. Use one of the following methods to drain the engine crankcase oil:

- If the engine is equipped with a drain valve, turn the drain valve knob counterclockwise in order to drain the oil. After the oil has drained, turn the drain valve knob clockwise in order to close the drain valve.
- If the engine is not equipped with a drain valve, remove the oil drain plug in order to allow the oil to drain. If the engine is equipped with a shallow sump, remove the bottom oil drain plugs from both ends of the oil pan.

After the oil has drained, the oil drain plugs should be cleaned and installed.

Replace the Oil Filter

NOTICE
Caterpillar oil filters are built to Caterpillar specifications. Use of an oil filter not recommended by Caterpillar could result in severe engine damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

1. Remove the oil filter with a 1U-8760 Chain Wrench.

2. Cut the oil filter open with a 4C-5084 Oil Filter Cutter. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

   Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

   Nonferrous metals may indicate wear on the aluminum parts, brass parts or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

   Due to normal wear and friction, it is not uncommon to find small amounts of debris in the oil filter. Consult your Caterpillar dealer in order to arrange for a further analysis if an excessive amount of debris is found in the oil filter.

g00103713

Illustration 39

Typical filter mounting base and filter gasket

3. Clean the sealing surface of the filter mounting base. Ensure that all of the old oil filter gasket is removed.

4. Apply clean engine oil to the new oil filter gasket.

NOTICE
Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

5. Install the oil filter. Tighten the oil filter until the oil filter gasket contacts the base. Tighten the oil filter by hand according to the instructions that are shown on the oil filter. Do not overtighten the oil filter.

Fill the Engine Crankcase

1. Remove the oil filler cap. Refer to the Operation and Maintenance Manual for more information on lubricant specifications. Fill the crankcase with the proper amount of oil. Refer to the Operation and Maintenance Manual for more information on refill capacities.

NOTICE
If equipped with an auxiliary oil filter system or a remote oil filter system, follow the OEM or filter manufacturer's recommendations. Under filling or overfilling the crankcase with oil can cause engine damage.

NOTICE
To prevent crankshaft bearing damage, crank the engine with the fuel OFF. This will fill the oil filters before starting the engine. Do not crank the engine for more than 30 seconds.

2. Start the engine and run the engine at "LOW IDLE" for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.

3. Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.

4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the "ADD" and "FULL" marks on the oil level gauge.

i00626013

Engine Protective Devices - Check

SMCS Code: 7400-535

Alarms and shutoffs must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. It is impossible to determine if the engine protective devices are in good working order during normal operation. Malfunctions must be simulated in order to test the engine protective devices.

A calibration check of the engine protective devices will ensure that the alarms and shutoffs activate at the setpoints. Ensure that the engine protective devices are functioning properly.

NOTICE
During testing, abnormal operating conditions must be simulated.

The tests must be performed correctly in order to prevent possible damage to the engine.

To prevent damage to the engine, only authorized service personnel or your Caterpillar dealer should perform the tests.

Visual Inspection

Visually check the condition of all gauges, sensors and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

i00869628

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines is recommended at the first scheduled oil change. The adjustment is necessary due to the initial wear of the valve train components and to the seating of the valve train components.

This maintenance is recommended by Caterpillar as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

NOTICE
Only qualified service personnel should perform this maintenance. Refer to the Service Manual or your Caterpillar dealer for the complete valve lash adjustment procedure.

Operation of Caterpillar engines with improper valve adjustments can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

⚠ WARNING

Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.

Ensure that the engine is stopped before measuring the valve lash. To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

Refer to the Service Manual for more information.

i00937014

Engine Valve Rotators - Inspect

SMCS Code: 1109-040

⚠ WARNING

When inspecting the valve rotators, protective glasses or face shield and protective clothing must be worn, to help prevent being burned by hot oil or spray.

NOTICE
A valve rotator which does not operate properly will accelerate valve face wear and valve seat wear and shorten valve life. If a damaged rotator is not replaced, valve face guttering could result and cause pieces of the valve to fall into the cylinder. This can cause piston and cylinder head damage.

Valve rotators cause the valves to rotate when the engine runs. This helps to prevent deposits from building up on the valves and the valve seats.

Perform the following steps after the valve lash is set, but before the valve covers are installed:

1. Start the engine according to this Operation and Maintenance Manual, “Engine Starting” procedure (Operation Section).

   Operate the engine at low idle.

2. Observe the top surface of each valve rotator. The valve rotators should turn slightly when the valves close.

If a valve fails to rotate, consult your Caterpillar dealer.

i00175571

Fan Drive Bearing - Lubricate

SMCS Code: 1359-086-BD

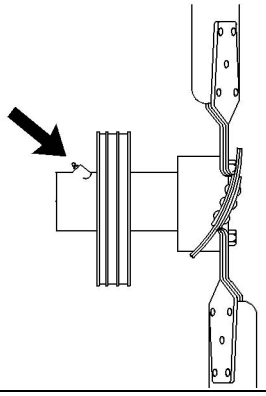


Illustration 40 g00123252

Typical Fan Drive Bearing Grease Fitting

Lubricate the fan drive bearing grease fitting with Bearing Lubricant Special Purpose Grease or the equivalent.

Inspect the fan drive pulley assembly. If the shaft is loose, an inspection of the internal components should be performed. Refer to the Service Manual.

i01370585

Fuel Control Linkage - Check/Lubricate

SMCS Code: 1257-086; 1257-535

Check the fuel control linkage for proper operation. If necessary, adjust the fuel control linkage . Refer to the Service Manual for the adjustment procedures.

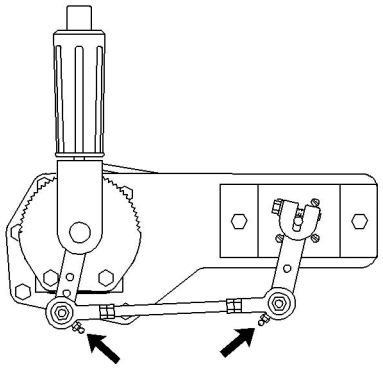


Illustration 41 g00723120

Typical grease fittings on the fuel control linkage

Some fuel control linkages require lubrication. Lubricate the grease fittings with 1P-0808 Multipurpose Grease or the equivalent.

i00626014

Fuel Injection Nozzles - Test/Exchange

SMCS Code: 1254-013; 1254-081

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over disconnected fuel system component.

Fuel injection nozzles are subject to tip wear. Tip wear is a result of fuel contamination. Tip wear can cause the following problems:

- Increased fuel consumption
- Black smoke
- Misfire
- Rough running

Fuel Injection nozzles should be cleaned, inspected, tested, and replaced, if necessary. Refer to Special Instruction, SEHS7292 for using the 8S-2245 Injection Cleaning Tool Group. Consult your Caterpillar dealer about cleaning the fuel injection nozzle and testing the fuel injection nozzle.

NOTICE
Never wire brush or scrape a fuel injection nozzle. Wire brushing or scraping a fuel injection nozzle will damage the finely machine orifice. Proper tools for cleaning and testing the fuel injection nozzles can be obtained from Caterpillar dealers.

The following items are symptoms of a malfunction of the fuel injection nozzle:

- Abnormal engine operation
- Smoke emission
- Engine knock

Each fuel injection nozzle must be isolated one at a time in order to determine the malfunctioning fuel injection nozzle.

1. Start the engine.
2. Loosen each fuel line nut one at a time at the fuel injection pump. A cloth or similar material must be used in order to prevent fuel from spraying on the hot exhaust components. Tighten each nut before loosening the next nut.
3. A defective fuel injection nozzle may be identified when a fuel line nut is loosened and the following conditions are present:
   - The exhaust smoke is partially eliminated or the exhaust smoke is completely eliminated.
   - Engine performance is not affected.

   A fuel injection nozzle that is suspected of being defective should be removed. A new fuel injection nozzle should be installed in the cylinder in order to determine if the removed fuel injection nozzle is defective.

Removal and Installation of the Fuel Injection Nozzles

For the removal and the installation of fuel injection nozzles, special tooling is required. Refer to the Service Manual for more information. Consult your Caterpillar dealer for assistance.

i00908934

Fuel Ratio Control - Inspect/Adjust

SMCS Code: 1278-025; 1278-040

Slow engine response and low power may indicate a need for adjustment or repair of the fuel ratio control. Refer to the Service Manual or your Caterpillar dealer for the complete adjustment procedure on the fuel ratio control.

i00891826

Fuel System - Prime

SMCS Code: 1258-548

⚠ WARNING

Personal injury or death can result from a fire.

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire.

Clean up all leaked or spilled fuel. Do not smoke while working on the fuel system.

Turn the disconnect switch OFF or disconnect the battery when changing fuel filters.

Prime the fuel system in order to fill dry fuel filters. You must also prime the fuel system after any one of the following conditions exist:

- The fuel system has run dry.
- The engine has been in prolonged storage.
- The fuel filter has been cleaned.
- The fuel filter has been replaced.

Note: If the engine does not have a fuel priming pump, refer to Step 4.

1. Unlock the priming pump, and operate the priming pump until a resistance is felt. This procedure will probably require a considerable amount of priming.
2. Push in the plunger, and hand tighten the plunger.

NOTICE
Do not crank the engine for more than 30 seconds. Allow the starter to cool for two minutes before cranking again. Turbocharger damage can result if the engine rpm is not kept low until the oil gauge display verifies that the oil pressure is sufficient.

3. Crank the engine.

If the engine starts and the engine runs rough, run the engine at low idle. Continue running the engine until the engine runs smoothly.

NOTICE
During periodic service, DO NOT remove the fuel filter plug that is in the fuel filter base in order to purge air from the fuel system. The periodic removal of the fuel filter plug will result in increased wear on the threads in the fuel filter base. This wear leads to fuel leakage.

4. Open the vent valve (if equipped) on the fuel injection pump's housing.

5. Operate the priming pump until the flow of fuel from the vent valve is continuous and the flow of fuel is free of air bubbles.

If the engine does not have a fuel priming pump, crank the engine. Crank the engine until the fuel flows freely and until the fuel is free of air bubbles.

6. Close the vent valve. Then, push in the plunger. Hand tighten the plunger.

7. Crank the engine. If the engine starts and if the engine runs rough, run the engine at low idle. Continue running the engine until the engine runs smoothly.

Note: If the engine will not start, more priming is necessary. If the engine continues to run rough, more priming is necessary as well.

NOTICE
Do not let the tops of fuel nozzles turn when the fuel line nuts are loosened or tightened.

The nozzles will be damaged if the top of the nozzle turns in the body.

The engine will be damaged if a defective fuel injection nozzle is used because the shape of fuel (spray pattern) that comes out of the nozzles will not be correct.

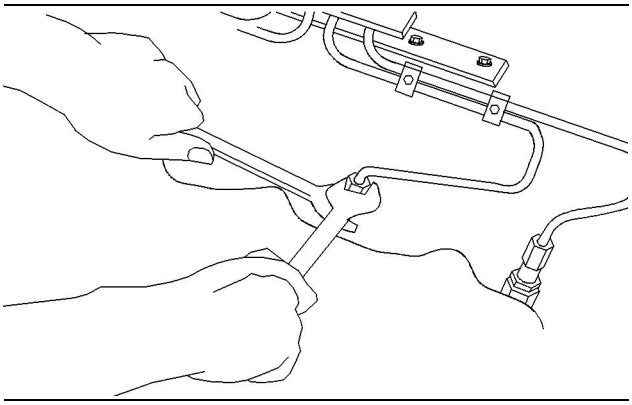


Illustration 42 g00290109

8. Loosen the fuel line nuts at the valve cover base. Loosen these line nuts one at a time.

9. Operate the priming pump until the flow of fuel from the fuel line is continuous and the flow of fuel is free of air bubbles.

10. Push in the plunger, and hand tighten the plunger. If the engine does not have a fuel priming pump, crank the engine.

11. Tighten each fuel line nut before you loosen the next fuel line nut. Tighten the fuel line nuts to a torque of 40 ± 7 N·m (30 ± 5 lb ft).

Continue this procedure until all of the fuel lines have been cleared of any air. Before you start the engine, make sure that the fuel line nuts are properly tightened. Also make sure that the priming is locked.

i00951418

Fuel System Primary Filter - Clean/Replace

SMCS Code: 1260-070; 1260-510

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

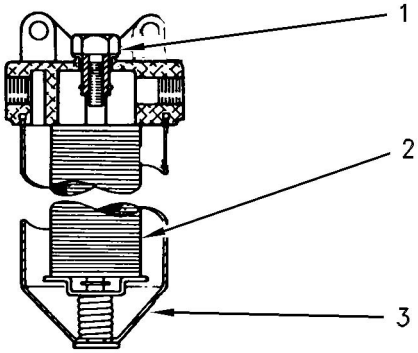
1. Stop the engine.

2. Turn the start switch to the "OFF" position. Disconnect the battery.

3. Shut off the fuel tank supply valve to the engine.

4. If the primary fuel filter is equipped with a drain valve, open the drain valve in order to drain any fuel from the filter case. Close the drain valve.

NOTICE
Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.



g00485293

Illustration 43

(1) Bolt
(2) Element
(3) Case

5. Loosen the bolt (1) that is on the filter housing. Remove the filter case (3).

6. Remove the element (2) and wash the element in clean, nonflammable solvent.

NOTICE
Do not fill the fuel filters with fuel before installing them. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

7. Install the element (2) and the filter case (3). Tighten the bolt (1) to a torque of 24 ± 4 N·m (18 ± 3 lb ft).

i00073301

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive fuel system wear. Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

Drain the Water and the Sediment

Fuel tanks should contain some provision for draining water and draining sediment from the bottom of the fuel tanks.

Open the drain valve on the bottom of the fuel tank in order to drain the water and the sediment. Close the drain valve.

Check the fuel daily. Drain the water and sediment from the fuel tank after operating the engine or drain the water and sediment from the fuel tank after the fuel tank has been filled. Allow five to ten minutes before performing this procedure.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe. Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank during the following conditions:

- Weekly
- Oil change
- Refill of the tank

This will help prevent water or sediment from being pumped from the storage tank into the engine fuel tank.

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i00907072

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

NOTICE

Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- Exposed wire that is used for reinforcement
- Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will heat set. Heat setting causes hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

1. Stop the engine. Allow the engine to cool.
2. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
4. Remove the hose clamps.
5. Disconnect the old hose.
6. Replace the old hose with a new hose.

Note: For torques on hose clamps, see this Operation and Maintenance Manual, “Torque Specifications” (Maintenance Section).

7. Install the hose clamps with a torque wrench.

Note: For the proper coolant to use, see this Operation and Maintenance Manual, “Coolant Recommendations” (Maintenance Section).

8. Refill the cooling system.

9. Clean the cooling system filler cap. Inspect the cooling system filler cap's gaskets. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

10. Start the engine. Inspect the cooling system for leaks.

i01037896

Overhaul Considerations

SMCS Code: 7595-043

Reduced hours of operation at full load will result in a lower average power demand. A decreased average power demand should increase both the engine service life and the overhaul interval.

The need for an overhaul is generally indicated by increased fuel consumption and by reduced power.

The following factors are important when a decision is being made on the proper time for an engine overhaul:

- The need for preventive maintenance
- The quality of the fuel that is being used
- The operating conditions
- The results of the S·O·S analysis

Oil Consumption as an Overhaul Indicator

Oil consumption, fuel consumption, and maintenance information can be used to estimate the total operating cost for your Caterpillar engine. Oil consumption can also be used to estimate the required capacity of a makeup oil tank that is suitable for the maintenance intervals.

Oil consumption is in proportion to the percentage of the rated engine load. As the percentage of the engine load is increased, the amount of oil that is consumed per hour also increases.

The oil consumption rate (brake specific oil consumption) is measured in grams per kW/h (lb per bhp). The brake specific oil consumption (BSOC) depends on the engine load. Consult your Caterpillar dealer for assistance in determining the typical oil consumption rate for your engine.

When an engine's oil consumption has risen to three times the original oil consumption rate due to normal wear, an engine overhaul should be scheduled. There may be a corresponding increase in blowby and a slight increase in fuel consumption.

Overhaul Options

Before Failure Overhaul

A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the standards for reusable parts.
- The engine's service life can be extended without the risk of a major catastrophe due to engine failure.
- The best cost/value relationship per hour of extended life can be attained.

After Failure Overhaul

If a major engine failure occurs and the engine must be removed, many options are available. An overhaul should be performed if the engine block or the crankshaft needs to be repaired.

If the engine block is repairable and/or the crankshaft is repairable, the overhaul cost should be between 40 percent and 50 percent of the cost of a new engine with a similar exchange core.

This lower cost can be attributed to three aspects:

- Specially designed Caterpillar engine features
- Caterpillar dealer exchange components
- Caterpillar Inc. remanufactured exchange components

Overhaul Recommendation

To minimize downtime, Caterpillar Inc. recommends a scheduled engine overhaul by your Caterpillar dealer before the engine fails. This will provide you with the best cost/value relationship.

Note: Overhaul programs vary according to the engine application and according to the dealer that performs the overhaul. Consult your Caterpillar dealer for specific information about the available overhaul programs and about overhaul services for extending the engine life.

If an overhaul is performed without overhaul service from your Caterpillar dealer, be aware of the following maintenance recommendations.

Rebuild or Exchange

Cylinder Head Assembly, Cylinder Packs, Oil Pump, and Fuel Transfer Pump

These components should be inspected according to the instructions that are found in various Caterpillar reusability publications. The Special Publication, SEBF8029 lists the reusability publications that are needed for inspecting the engine parts.

If the parts comply with the established inspection specifications that are expressed in the reusable parts guideline, the parts should be reused.

Parts that are not within the established inspection specifications should be dealt with in one of the following manners:

- Salvaging
- Repairing
- Replacing

Using out-of-spec parts can result in the following problems:

- Unscheduled downtime
- Costly repairs
- Damage to other engine parts
- Reduced engine efficiency
- Increased fuel consumption

Reduced engine efficiency and increased fuel consumption translates into higher operating costs. Therefore, Caterpillar Inc. recommends repairing out-of-spec parts or replacing out-of-spec parts.

Inspection and/or Replacement

Crankshaft Bearings, Valve Rotators, and Crankshaft Seals

The following components may not last until the second overhaul.

- Thrust bearings
- Main bearings
- Rod bearings
- Valve rotators
- Crankshaft seals

Caterpillar Inc. recommends the installation of new parts at each overhaul period.

Inspect these parts while the engine is disassembled for an overhaul.

Inspect the crankshaft for any of the following conditions:

- Deflection
- Damage to the journals
- Bearing material that has seized to the journals

Check the journal taper and the profile of the crankshaft journals. Check these components by interpreting the wear patterns on the following components:

- Rod bearing
- Main bearings

Inspect the camshaft for damage to the journals and to the lobes.

Note: If the camshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the camshaft.

Inspect the following components for signs of wear or for signs of scuffing:

- Camshaft bearings
- Camshaft followers

Caterpillar Inc. recommends replacing the crankshaft vibration damper.

Oil Cooler Core

During an overhaul, Caterpillar Inc. recommends the removal of the oil cooler core. Clean the oil cooler core. Then, pressure test the oil cooler core.

NOTICE

Do not use caustic cleaners to clean the core.

Caustic cleaners can attack the internal metals of the core and cause leakage.

Note: Use this cleaning procedure to clean the oil cooler core.

1. Remove the oil cooler core.

2. Remove any debris from the oil cooler core. To remove debris from the oil cooler core, turn the oil cooler core onto one end.

3. Flush the oil cooler core internally with cleaner in order to loosen foreign substances. This will also help to remove oil from the oil cooler core.

Note: Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 35 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 35

HydrosolvLiquid Cleaners		
Part Number	**Description**	**Size**
1U-8812	Hydrosolv4165	4 L (1 US gallon)
1U-5490		19 L (5 US gallon)
8T-7570		208 L (55 US gallon)
1U-8804	Hydrosolv100	4 L (1 US gallon)
1U-5492		19 L (5 US gallon)
8T-5571		208 L (55 US gallon)

4. Use steam to clean the oil cooler core. This removes any remaining residue from the cleaner. Flush the fins of the oil cooler core. Remove any other trapped debris.

5. Wash the oil cooler core with hot, soapy water. Rinse the oil cooler core thoroughly with clean water.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

6. Dry the oil cooler core with compressed air. Direct the air in the reverse direction of the normal flow.

7. Inspect the components in order to ensure cleanliness. The oil cooler core should be pressure tested. Repair the oil cooler core, if necessary. Install the oil cooler core.

For more information about cleaning the cores, consult your Caterpillar dealer.

Obtain Coolant Analysis

The concentration of supplemental coolant additive (SCA) should be checked regularly with test kits or with S·O·S Coolant Analysis (Level 1). Further coolant analysis is recommended when the engine is overhauled.

For example, considerable deposits are found in the water jacket areas on the external cooling system, but the concentrations of coolant additives were carefully maintained. The coolant water probably contained minerals that were deposited on the engine over time.

A coolant analysis can be conducted in order to verify the condition of the water that is being used in the cooling system. A full water analysis can be obtained by consulting your local water utility company or an agricultural agent. Private laboratories are also available for water analysis.

Caterpillar Inc. recommends an S·O·S Coolant Analysis (Level 2).

S·O·S Coolant Analysis (Level 2)

An S·O·S Coolant Analysis (Level 2) is a comprehensive coolant analysis which completely analyzes the coolant and the effects on the cooling system. An S·O·S Coolant Analysis (Level 2) provides the following information:

- Complete S·O·S Coolant Analysis (Level 1)
- Visual inspection of properties
- Identification of metal corrosion
- Identification of contaminants
- Identification of built up impurities (corrosion and scale)

S·O·S Coolant Analysis (Level 2) provides a report of the results of both the analysis and the maintenance recommendations.

For more information about coolant analysis, see your Caterpillar dealer.

i00339617

Power Take-Off Clutch - Check/Adjust/Lubricate

SMCS Code: 3055-036; 3055-086

NOTICE
New power take-offs should have the clutch adjustment checked before being placed into service. The clutch adjustment should be checked again after the first ten hours of operation. New clutch plates have a “wear in” period, and the clutch may require several adjustments until the new plates are “worn in”.

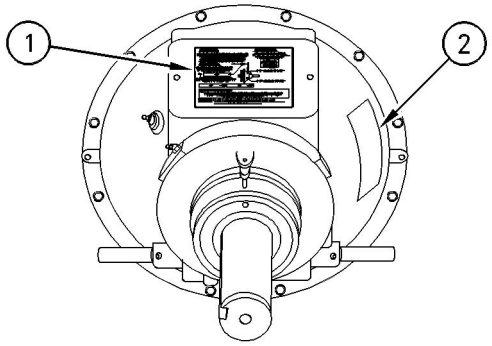


Illustration 44 g00108044

(1) Typical instruction plate for the clutch. (2) Typical serial number plate for the clutch.

The clutch adjustment should be checked regularly after “wear in”. Heavy-duty applications which have engagements that are frequent and relatively long periods of clutch slippage require more frequent adjustment than light-duty applications. The operating torque should be measured in order to determine if a clutch adjustment is required.

Refer to the OEM information and instruction plate (1) for instructions on the following items: lubrication, adjustment, and other service recommendations. Perform the maintenance that is specified on the instruction plate.

⚠ WARNING

Do not operate the engine with the Instruction Plate cover removed from the clutch. Personal injury may result.

If the clutch is damaged to the point of burst failure, expelled pieces can cause personal injury to anyone in the immediate area. Proper safeguards must be followed to help prevent accidents.

i01206548

Radiator - Clean

SMCS Code: 1353-070

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the radiator for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the radiator, if necessary.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan’s air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a “comb”. Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, see Special Publication, SEBD0518, “Know Your Cooling System”.

i00651416

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar Inc. recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for proper operation. Check the electrical connections and clean the electrical connections. Refer to the Service Manual for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i00912946

Turbocharger - Inspect

SMCS Code: 1052-040

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side). Any fumes from the crankcase are filtered through the air inlet system. Therefore, by-products from oil and from combustion can collect in the turbocharger compressor housing. Over time, this buildup can contribute to loss of engine power, increased black smoke and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head.

NOTICE

Turbocharger bearing failures can cause large quantities of oil to enter the air inlet and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of a turbocharger housing under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occurred.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is repaired or replaced.

An inspection of the turbocharger can minimize unscheduled downtime. An inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Note: Turbocharger components require precision clearances. The turbocharger cartridge must be balanced due to high rpm. Severe Service Applications can accelerate component wear. Severe Service Applications require more frequent inspections of the cartridge.

Removal and Installation

For options regarding the removal, installation, repair and replacement, consult your Caterpillar dealer. Refer to the Service Manual for this engine for the procedure and specifications.

Cleaning and Inspecting

1. Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil.

2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.

3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the wheel, there is a possibility of a failed turbocharger oil seal.

   The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the inlet air (plugged air filters), which causes the turbocharger to slobber.

4. Use a dial indicator to check the end clearance on the shaft. If the measured end play is greater than the Service Manual specifications, the turbocharger should be repaired or replaced. An end play measurement that is less than the minimum Service Manual specifications could indicate carbon buildup on the turbine wheel. The turbocharger should be disassembled for cleaning and for inspection if the measured end play is less than the minimum Service Manual specifications.

5. Inspect the bore of the turbine housing for corrosion.

6. Clean the turbocharger housing with standard shop solvents and a soft bristle brush.

7. Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

i00632301

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections and trash buildup. Make repairs, as needed:

- The guards must be in the proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order to reduce the chance of system contamination.

NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE

Accumulated grease and/or oil on an engine or deck is a fire hazard. Remove this debris with steam cleaning or high pressure water.

- Ensure that cooling lines are properly clamped and tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pump for coolant leaks.

Note: The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of water pump and the installation of water pump and/or seals, refer to the Service Manual for the engine or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

- Drain the water and the sediment from fuel tanks on a daily basis in order to ensure that only clean fuel enters the fuel system.

- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Inspect the engine-to-frame ground strap for a good connection and for good condition.
- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges which are cracked or can not be calibrated.

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Water Pump - Inspect

SMCS Code: 1361-040; 1361

A failed water pump might cause severe engine overheating problems that could result in the following conditions:

- Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine

Visually inspect the water pump for leaks. If any leaking is observed, replace the water pump seal or the water pump assembly. Refer to the Service Manual for the disassembly and assembly procedure.

Note: Refer to the Service Manual or consult your Caterpillar dealer if any repair is needed or any replacement is needed.

Reference Information Section

Customer Service

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Customer Assistance

SMCS Code: 1000

USA and Canada

When a problem arises concerning the operation of an engine or concerning the service of an engine, the problem will normally be managed by the dealer in your area.

Your satisfaction is a primary concern to Caterpillar and to Caterpillar dealers. If you have a problem that has not been handled to your complete satisfaction, follow these steps:

1. Discuss your problem with a manager from the dealership.

2. If your problem cannot be resolved at the dealer level without additional assistance, use the phone number that is listed below to talk with a Field Service Coordinator:

   1-800-447-4986

   The normal hours are from 8:00 to 4:30 Monday through Friday Central Standard Time.

3. If your needs have not been met still, submit the matter in writing to the following address:

   Caterpillar Inc.
   Manager, Customer Service, Engine Division
   Mossville Bldg A
   P.O. Box 600
   Peoria, Illinois 61552-0600

   Please keep in mind: probably, your problem will ultimately be solved at the dealership, using the dealership's facilities, equipment, and personnel. Therefore, follow the steps in sequence when a problem is experienced.

Outside of the USA and of Canada

If a problem arises outside the USA and outside Canada, and if the problem cannot be resolved at the dealer level, consult the appropriate Caterpillar office.

Central America and Caribbean
Caterpillar Americas Co.
15550 NW 59th Avenue
Miami Lakes, FL 33014
USA
Phone: 305-816-3306
Fax: 305-816-3307

Mexico
Grupo Financiero Caterpillar Mexico, S.A. de C.V.
Primer piso del Arco Oriente de Arco Bosques Corporativa,
Bosques del Alisos 45A
Bosques de Las Lomas
Mexico, D.F. 05120
Phone (from within Mexico): 915-258-1515
Fax (from within Mexico): 915-258-1530
Phone (from within USA): 011-525-258-1515
Fax (from within USA): 011-525-258-1530

Ecuador, Colombia, Venezuela, Guyana, and Suriname
Caterpillar Americas Co.
15550 NW 59th Avenue
Miami Lakes, FL 33014
USA
Phone: 305-816-3316
Fax: 305-816-3317

Peru, Chile, and Bolivia
Caterpillar Americas Co.
Edificio Centro Santa Maria
Av. Los Conquistadores 1700
Piso 14, Oficina A
Santiago, Chile
Phone: 011-562-366-5100
Fax: 011-562-366-5125

Brazil, Argentina, Paraguay, and Uruguay
Caterpillar Americas Co.
Birmann II
Rua Aleandre Dumas, 1.711-9.0
Chac., Sto. Antonio
04717-004-Sao Paulo, SP
Phone: 55-11-5180-2000
Fax: 55-11-5182-9694

Europe, Africa, and Middle East
Caterpillar Overseas S.A.
76 Route de Frontenex
P.O. Box 6000
1211 Geneva 6
Switzerland
Phone: 22-849-4444
Fax: 22-849-4544

Far East
Caterpillar Asia Pte. Ltd.
7 Tractor Road
Jurong, Singapore 627968
Republic of Singapore
Phone: 65-662-8333
Fax: 65-662-8302

China
Caterpillar China Ltd.
37/F, The Lee Gardens
33 Hysan Avenue
Causeway Bay, Hong Kong
China
Phone: 852-2848-0333
Fax: 852-2848-0440

Japan
Shin Caterpillar Mitsubishi Ltd.
Setagaya Business Square Tower
10-1, Yoga 4-chome
Setagaya, Tokyo
Japan
Phone: 81-3-5717-1121
Fax: 81-3-5717-1177

Japan
Caterpillar Power Systems, Inc.
Japan Branch Sanno Grand Bldg.
2-14-2 Nagatacho
Chiyoda-ku, Tokyo, 100
Japan
Phone: 81-335-93-3237
Fax: 81-335-93-3238

Australia and New Zealand
Caterpillar of Australia Ltd.
1 Caterpillar Drive
Private Mail Bag 4
Tullamarine, Victoria 3043
Australia
Phone: 03-9339-9333
Fax: 03-9335-3366

i01028392

Ordering Replacement Parts

SMCS Code: 7567

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

Quality Caterpillar replacement parts are available from Caterpillar dealers throughout the world. Caterpillar dealers' parts inventories are up-to-date. The parts stocks include all of the parts that are normally needed to protect your Caterpillar engine investment.

When you order parts, please specify the following information:

- Part number
- Part name
- Quantity

If there is a question concerning the part number, please provide your dealer with a complete description of the needed item.

When a Caterpillar engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. This information is described in this Operation and Maintenance Manual (Product Information Section).

Discuss the problem with the dealer. Inform the dealer about the conditions of the problem and the nature of the problem. Inform the dealer about when the problem occurs. This will help the dealer in troubleshooting the problem and solving the problem faster.

Reference Materials

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Reference Material

SMCS Code: 1000

The following literature can be obtained through any Caterpillar dealer.

Lubricants

- Special Publication, PEHP7041, “Data Sheet - Caterpillar Diesel Engine Oils (DEO) (CG-4) (International only)”
- Special Publication, PEHP1026, “Data Sheet - Caterpillar Diesel Engine Oil (DEO) (CF-4) (International only)”
- Special Publication, PEHP1027, “Data Sheet - Caterpillar Diesel Engine Oil (CD)”
- Special Publication, PEHP8038, “Data Sheet - Caterpillar Diesel Engine Oils (DEO) (CH-4) (North America and Australia)”
- Special Publication, PEWP9733, “Cat Fluids Selector Dial”
- Special Publication, PEWP3014, “Cat Fluids Selector Dial (International)”
- Special Publication, NEDG6022, “Data Sheet - Multipurpose Lithium Complex Grease (MPG)”
- Special Publication, PEHP0002, “Data Sheet - Multipurpose Lithium Complex Grease with Molybdenum (MPGM)”
- Special Publication, PEHP0017, “Data Sheet - Special Purpose Grease (SPG) Bearing Lubricant”
- Special Publication, NEHP5621, “How To Select The Right Grease For Any Job”
- Special Publication, PEHP6001, “How To Take A Good Oil Sample”
- Special Publication, SEBD0640, “Oil and Your Engine”
- Special Publications, PEDP7036, “SOS Fluids Analysis Cornerstone”

Fuels

- Special Publication, SEBD0717, “Diesel Fuels and Your Engine”

Coolants

- Special Publication, SEBD0970, “Coolant and Your Engine”
- Special Publication, PEHP4036, “Data Sheet-Extended Life Coolant”
- Special Publication, SEBD0518, “Knowing Your Cooling System”
- Special Publication, PEEP5027, “Label ELC Radiator Label”
- Special Publication, PEHP7057, “S·O·S Coolant Analysis”

Miscellaneous

- Service Manual, SENR1110, “3406C Industrial Engine”
- Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations”
- Special Publication, PECP6026, “One Safe Source”
- Special Publication, SEHS7654, “Alignment - General Instructions”
- Operation and Maintenance Manual, SEBU5898, “Cold Weather Recommendations”
- Special Instruction, SMHS7001, “Assembly of Fan Drive Pulley Assemblies”
- Special Instruction, SEHS7633, “Battery Test Procedure”
- Special Instruction, SEHS7332, “Do Not Operate Tag”
- Special Publication, SEBF8062, “Guideline for Reusable Parts - Cleaning and Inspection of Air Filters”
- Special Publication, SEBF8029, “Index of Publications for Reusable Parts and Salvage Operations”
- Special Publication, LEBH9324, “Industrial Application and Installation Guide”
- Service Manual, REG1139F, “Service Manual Contents Microfiche”
- Special Instruction, SEHS9031, “Storage Procedure for Caterpillar Products”

- Special Instruction, NENG2500, “Tools and Shop Products Guide”
- Specifications, SENR3130, “Torque Specifications”
- Special Instruction, SEHS7292, “Using the 5P-4150 Nozzle Testing Group”
- Special Instruction, SEHS8024, “Governor Adjusting Tool Group”
- Special Instruction, SEHS8094, “Using the Nozzle Puller Group”
- Special Instruction, SEHS8622, “Using the FT-1984 Air-To-Air Aftercooler Leak Test Group”

Emissions Warranty

This engine may be Certified and this engine may be covered by an Emissions Warranty. A detailed explanation of the Emissions Warranty that is applicable to Certified engines is found in Supplement, SEBU6981, “Federal Emissions Control Warranty Information”. The Engine is Certified if the engine has a special label that states that the engine is certified. A Caterpillar dealer can also inform you if the engine is Certified.

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Additional Reference Material

SMCS Code: 1000

The “EMA Lubricating Oils Data Book” can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult EMA at the following address:

Engine Manufacturers Associaton
401 N. Michigan Ave.
Chicago, IL, USA 60611
Telephone: (312) 644-6610 ext. 3626

The “Society of Automotive Engineers (SAE) Specifications” can be found in your SAE handbook. This publication can also be obtained from the following locations: local technological society, local library, and local college. If necessary, consult SAE at the following address:

SAE International
400 Commonwealth Drive
Warrendale, PA, USA 15096-0001
Telephone: (724) 776-4841

The “American Petroleum Institute Publication No. 1509” can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult API at the following address:

American Petroleum Institute
1220 L St. N.W.
Washington, DC, USA 20005
Telephone: (202) 682-8000

The International Organization for Standardization (ISO) offers information and customer service regarding international standards and standardizing activities. ISO can also supply information on the following subjects that are not controlled by ISO: national standards, regional standards, regulations, certification, and related activities. Consult the member of ISO in your country.

International Organization for Standardization (ISO)
1, rue de Varembé
Case postale 56
CH-1211 Genève 20
Switzerland
Telephone: +41 22 749 01 11
Facsimile: +41 22 733 34 30
E-mail: central@iso.ch
Web site: http://www.iso.ch

European classifications are established by the Counseil International Des Machines a Combustion (CIMAC) (International Council on Combustion Engines).

CIMAC Central Secretariat
Lyoner Strasse 18
60528 Frankfurt
Germany
Telephone: +49 69 6603 1567
Facsimile: +49 69 6603 1566

i00912149

Maintenance Records

SMCS Code: 1000

Caterpillar Inc. recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

- Determine operating costs.
- Establish maintenance schedules for other engines that are operated in the same environment.

- Show compliance with the required maintenance practices and maintenance intervals.

Maintenance records can be used for a variety of other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is well managed. Accurate maintenance records can help your Caterpillar dealer to fine tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Records should be kept for the following items:

Fuel Consumption – A record of fuel consumption is essential in order to determine when the load sensitive components should be inspected or repaired. Fuel consumption also determines overhaul intervals.

Service Hours – A record of service hours is essential to determine when the speed sensitive components should be inspected or repaired.

Documents – These items should be easy to obtain, and these items should be kept in the engine history file. All of the documents should show this information: date, service hours, fuel consumption, unit number, and engine serial number. The following types of documents should be kept as proof of maintenance or repair for warranty:

Keep the following types of documents as proof of maintenance for warranty. Also, keep these types of documents as proof of repair for warranty:

- Dealer work orders and itemized bills
- Owner's repair costs
- Owner's receipts
- Maintenance log

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Maintenance Log

SMCS Code: 1000

Table 36

Engine Model			**Customer Identifier**	
Serial Number			**Arrangement Number**	
Service Hours	**Quantity Of Fuel**	**Service Item**	**Date**	**Authorization**

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Product and Dealer Information

Note: For product identification plate locations, see the section “Product Identification Information” in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model: _____

Product Identification Number: _____

Engine Serial Number: _____

Transmission Serial Number: _____

Generator Serial Number: _____

Attachment Serial Numbers: _____

Attachment Information: _____

Customer Equipment Number: _____

Dealer Equipment Number: _____

Dealer Information

Name: _____ Branch: _____

Address: _____

_____

_____

	Dealer Contact	Phone Number	Hours
Sales:	_____	_____	_____
Parts:	_____	_____	_____
Service:	_____	_____	_____

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