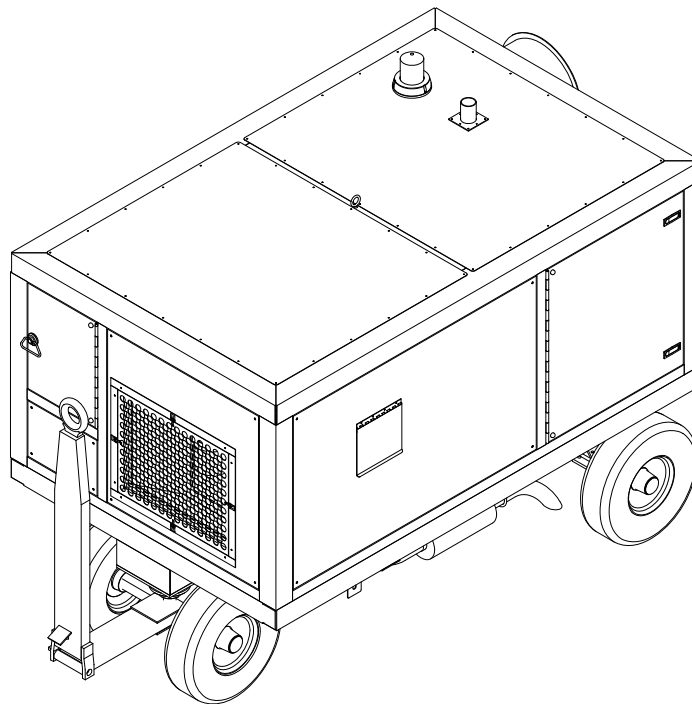

TECHNICAL MANUAL

OPERATION AND MAINTENANCE INSTRUCTIONS WITH
ILLUSTRATED PARTS BREAKDOWN

5050D AIRCRAFT HEATER



11001 US Hwy. 41 North • Palmetto, FL., 34221 **air-a-plane**
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CALIFORNIA

Proposition 65 Warning

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



**TRILECTRON
INDUSTRIES**

5050D Aircraft Heater

**MANUAL NO:
5050D-TL-DZ-00**

NOV. 6, 2007

RECORD OF CHANGES

This manual is published by Trilectron Industries, Palmetto, Florida. Please log changes to your manuals as they are inserted, indicating the date of the change and the date the change is inserted in the manual. If any changes or pages are missing, contact Trilectron Industries, for additional copies.

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INTRODUCTION

1. GENERAL:

This manual uses information supplied to the Technical Publications Department by the Engineering and Production Departments at the time of publication. Every effort was made to include the most accurate and up-to-date information at the time of publication. However, no warranty is made, expressed or implied, as to the accuracy of this manual. Use the manual as a guide. Errors, if any, may be corrected in future editions of this manual if they are brought to the attention of either the Engineering or Technical Publications Departments.

2. CONTENTS:

This Technical Manual presents general data pertinent to the operation, servicing and maintenance on aircraft ground support equipment manufactured by Trilectron Industries, Inc. Specific equipment nomenclature is normally presented in **bold** print for emphasis. Placarded text is normally presented in **BOLD CAPS**. This manual is arranged in Chapters and Sections. The contents of each are described briefly as follows:

Chapter 1 - General Information and Operating Instructions

Section 1-1 - Description: This section provides unit descriptive overview and pertinent information on the major unit components installed by the manufacturer.

Section 1-2 - Operation: Provides basic operations procedures and includes step-by-step inspection, normal operation, and emergency procedures.

Section 1-3 - Specifications and Capabilities: Lists the unit's dimensions; weight, and other pertinent unit performance specifications.

Section 1-4 - Shipping/Receiving: Provides information required to prepare the unit for shipping and for initial inspections at receiving facility.

Section 1-5 - Storage: Provides procedures for preparing the unit for short- and long-term periods of time under varying climatic conditions.

Chapter 2 - Maintenance

Section 2-1 - Servicing: Provides periodic maintenance schedules and procedures.

Section 2-2 - Troubleshooting: Provides unit fault/failure conditions, probable causes, and recommended corrective actions. This section includes all appropriate electrical and refrigeration diagrams/schematics.

Section 2-3 - Removal/Installation: Provides procedures and precautions for removing and installing components.

Section 2-4 - Adjustments and Test: Provides procedures and methods for perform field test and system/component adjustments.

Section 2-5 - Cleaning and Painting: Provides procedures and methods for cleaning and painting the unit/components.

Chapter 3 - Overhaul/Major Repair

This chapter provides information for unit and component overhaul/repair. Sections may be included as required for major systems/subsystems.

Chapter 4 - Illustrated Parts List

Section 4-1 - List of Vendors: Provides list of component vendors' addresses.

Section 4-2 - Numerical Index: Provides index of all parts installed on the unit.

Section 4-3 - Detailed Parts List: Provides illustrations, drawings, depictions, and instructions for locating and ordering replaceable parts/ components.

Chapter 5 - Manufacturers' Appendices: Contains available manuals, instruction bulletins, and illustrated parts lists issued by component original equipment manufacturers (OEMs).

3. UNIT CONFIGURATION:

Refer to the Unit Configuration Matrix and Specifications in Section 1-3 of this manual as required for a listing of options purchased with this equipment.

WARRANTY

TRILECTRON INDUSTRIES
PALMETTO, FLORIDA 34221

1. TRILECTRON INDUSTRIES (hereinafter called TRILECTRON) warrants that each new and unused TRILECTRON Equipment, (hereinafter called the PRODUCT) is of good workmanship and is free from mechanical defects, provided that (1) the PRODUCT is installed and operated in accordance with the printed instructions of TRILECTRON, (2) the PRODUCT is used under the normal operating conditions for which it is designed, (3) the PRODUCT is not subjected to misuse, negligence or accident, and (4) the PRODUCT receives proper care, lubrication, protection, and maintenance under the supervision of trained personnel.
2. This warranty expires 15 months after shipment by TRILECTRON to the first user, or 12 months after installation, whichever first occurs.
3. This warranty does not apply to: primary and secondary switch contacts, carbon brushes, fuses, bulbs, and filters unless found to be defective prior to use. Ground hose fittings, hose adapter, air delivery hoses, cables and plugs are not included as part of this warranty with the exception that these components will comply with all applicable specifications at the time of delivery of the unit.
4. TRILECTRON DOES NOT WARRANT THE FOLLOWING COMPONENTS: Compressors, pumps, valves and other mechanical or electrical accessories, generators, engines, engine components; such as: starters, alternators, regulators, governors, etc., and cable retrieving devices. Many of the foregoing components are warranted directly by the manufacturer to the first user and serviced by a worldwide network of distributors and others authorized to handle claims for component manufacturers. A first user's claim should be presented directly to such an authorized component service outlet. In the event any component manufacturer has warranted its component to TRILECTRON and will not deal directly with a first user then TRILECTRON will cooperate with the first user in the presentation of a claim to such manufacturer. Under NO circumstances does TRILECTRON assume any liability for any warranty claim against or warranty work done by or in behalf of any manufacturer of the foregoing components.
5. TRILECTRON warrants any closed refrigerant system to be leak free at the time of shipment from the factory. TRILECTRON extends no warranty with respect to the loss of refrigerant gases or oils.
6. This warranty is extended by TRILECTRON only to the purchaser of new PRODUCTS from TRILECTRON or one of its authorized distributors. The PRODUCTS purchased under this warranty are intended for use exclusively by the buyer and his employees and by no other persons and, therefore, there shall be no third party beneficiary to this warranty.
7. A claim of defects in any PRODUCT covered by this warranty is subject to TRILECTRON factory inspection and judgment. TRILECTRON'S liability is limited to repair of any defects found by TRILECTRON to exist, or at TRILECTRON'S option the replacement of the defective product, F.O.B. factory, after the defective product has been returned by the purchaser at its expense to TRILECTRON'S shipping place. Replacement and exchange parts will be warranted for the remainder of the original Warranty, or for a period of ninety (90) days, whichever is greater.
8. UNDER NO CIRCUMSTANCES whatsoever shall TRILECTRON and its authorized distributors be liable for any special or consequential damages, whether based on lost goodwill, lost resale profits, work stoppage impairment of other goods or otherwise, and whether arising out of breach of any express or implied warranty, breach of contract, negligence or otherwise, except only in the case of personal injury as may be required by applicable law.
9. Continued use of the PRODUCT(S) after discovery of a defect VOIDS ALL WARRANTIES.
10. Except as authorized in writing, this warranty does not cover any equipment that has been altered by any party other than TRILECTRON.
11. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF. TRILECTRON MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.
12. TRILECTRON neither assumes nor authorizes any person to assume for TRILECTRON any liability in connection with the PRODUCTS sold, and there are no oral agreements or warranties collateral to or affecting this written Warranty. This warranty and all undertakings of TRILECTRON thereunder shall be governed by the laws of the State of Florida, United States of America.

WARNING

AT ALL TIMES, SAFETY MUST BE CONSIDERED AN IMPORTANT FACTOR IN THE INSTALLATION, SERVICING AND OPERATION OF THE PRODUCT, AND SKILLED, TECHNICALLY QUALIFIED PERSONNEL SHOULD ALWAYS BE EMPLOYED FOR SUCH TASKS.

NOTE

The Warranty included in this manual is the standard Trilectron Industries. Equipment Warranty. Additional or Special Warranties may apply in accordance with the final sales contract agreement. This manual may be issued to multiple users/operators to support several fielded units produced under different sales contract agreements. In all cases, the Warranties in the final sales contract agreement apply and may modify portions of the standard Warranty.

Warranty Inquiries:**Customer Support Coordinator**

In the USA: Telephone 1-877-874-5622, FAX 1-877-874-5321

Outside the USA: Telephone 1-941-721-1092, Fax 1-941-721-1091

E-mail: tics@itwgsegroup.com

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CHAPTER 1 — GENERAL INFORMATION & OPERATING INSTRUCTIONS

SECTION 1 — DESCRIPTION

1. GENERAL

The 5050D is a self-contained, trailer mounted heating unit designed for comfort conditioning of aircraft cabins. The unit is enclosed in a weather resistant housing with convenient access to major components and systems. 5050D is manufactured by Trilelectron Industries, Palmetto, Florida, U.S.A.

The 5050D produces up to 400,000 Btu/hr heat output with a 120° F (heat) over ambient temperature. Airflow is rated at 250 Lbs./min. with a static pressure of 21" WG. Actual heat output varies depending on engine speed.

There is a towbar on the front (FWD) of the unit and a Control Panel and discharge air duct on the rear (AFT). Access doors/panels on the left and right sides of the cart provide service access to interior components.

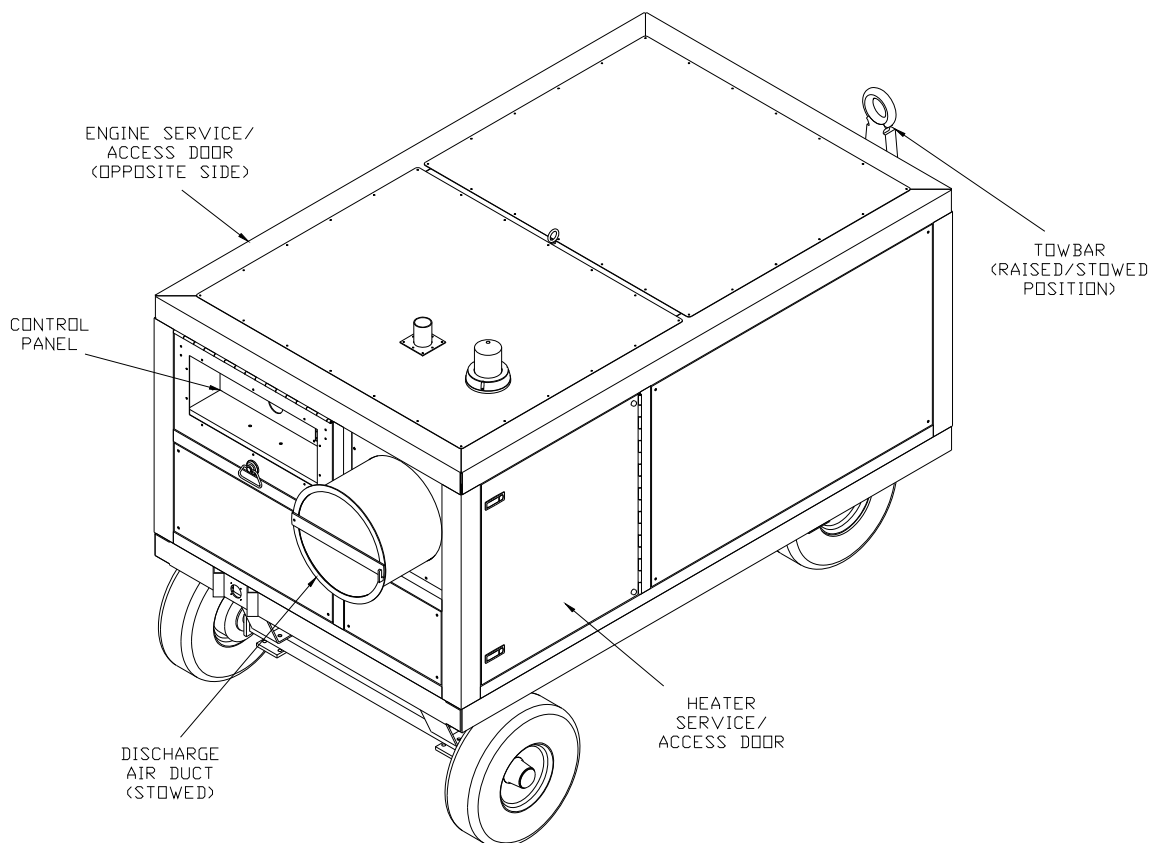


Figure 1. 5050D Aircraft Heater (Typical)

A. Sequence of Operation

A single-stage blower assembly, directly coupled to the four-cylinder industrial engine, produces the airflow for comfort conditioning. The heat output is proportional to the engine's operating speed. Air is heated on the intake side of the airflow duct before entering the blower through a series of heat exchangers that transfer heat from the engine operation to

the airflow. The discharge side of the blower is connected to the air-delivery hose which connects to the aircraft with a standard 8-inch coupling.

To start the Diesel engine use the keyed rotary ignition switch on the Operator Control Panel. (See Figure 3.) Once started, the blower draws ambient air into the duct through the air intake filter. Ambient air passes over the engine's heat exchanger coil; heat from the engine's operation is then transferred from the recirculated lubrication oil to the air flow. The heated air then passes through the exhaust heat exchanger where heat from the engine's exhaust is transferred to the airflow before entering the pressure blower.

Upon entering the blower, the blower's heat-of-compression adds additional heat. A regenerative tube assembly directs a portion of the discharge air back into the intake. The remaining heated air passes through the discharge-delivery duct to the aircraft. Recirculation of the discharge air maintains pressure control while adding 10° to 15° Fahrenheit to the discharge air temperature.

B. Major Components and Systems

(1) Structural Envelope

WARNING

TO PREVENT EXPOSING PERSONNEL TO UNNECESSARY HAZARDS AND ALLOWING FOREIGN OBJECTS TO ENTER THE UNIT, DO NOT OPERATE THE UNIT WITH ACCESS DOORS OPEN, PANELS REMOVED OR THE UNIT IN OPERATION.

A weather-resistant steel housing protects the 5050D Aircraft Heater and provides convenient access to major components through doors and panels. The doors have easy-to-operate latches that provide secure closure when the unit is operating.

There is an access panel to the Operator Control Panel. A Plexiglas® window allows instrument viewing without opening the panel. A rotary latch secures the panel and gas-filled strut assemblies hold the panel in the up position for operator access to controls.

To facilitate service, the body frame is removable from the chassis. Removal of body frame is not necessary when performing routine maintenance and service. If the body must be removed, refer to instructions in Chapter 2 of this manual.

(2) Heat System

(a) Diesel Engine

The 5050D uses a Deutz Diesel four-cylinder engine as the heat source for comfort conditioning. Heat exchangers transfer the heat from the engine exhaust and the engine oil to the airflow system for delivery to the aircraft. For more detailed information concerning the Diesel engine, refer to the engine manufacturer's manuals supplied in Chapter 5 of this manual.

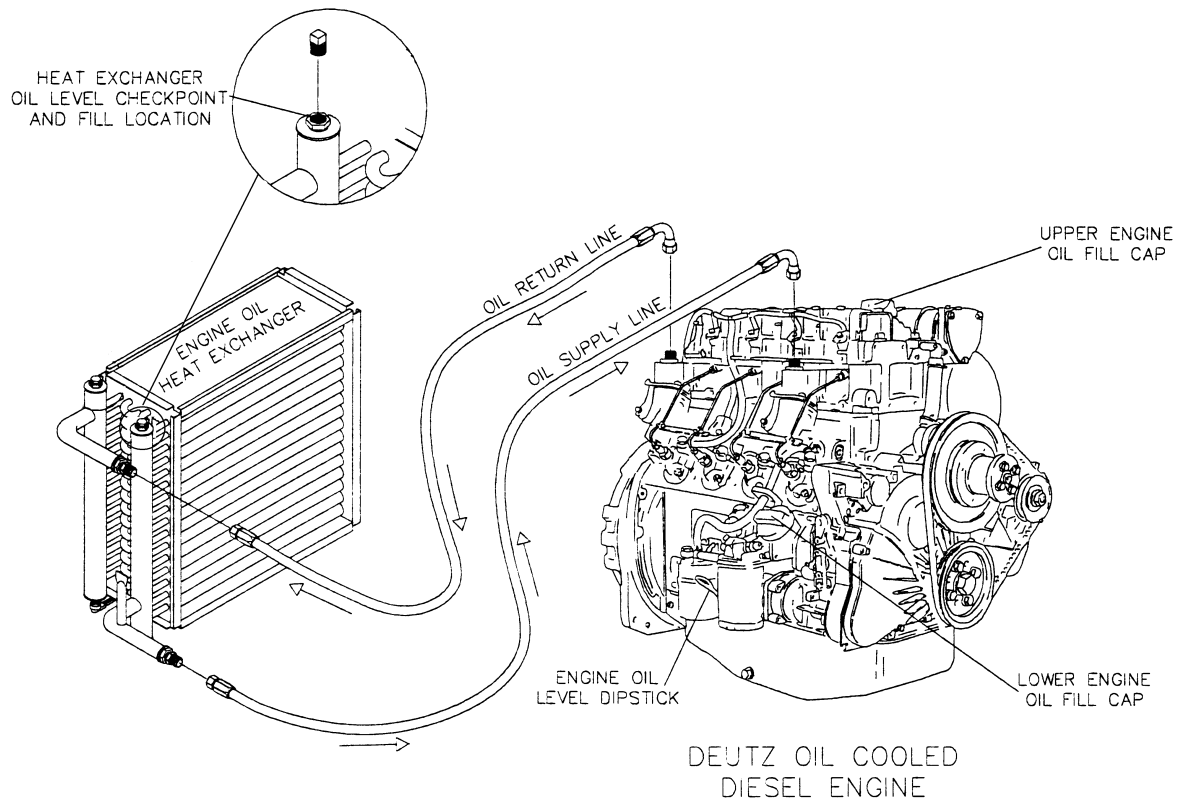
(b) Exhaust Heat Exchanger

Exhaust gasses produced by the Diesel engine's operation pass through the exhaust heat exchanger before entering the muffler and being discharged. Transferred heat is then added to the intake airflow. The exhaust heat exchanger is constructed of

stainless steel tubing covered by aluminum fins. The coil is located in the airflow duct directly behind the heat exchanger.

(c) Oil Heat Exchanger (See Figure 2.)

The 5050D has an oil heat exchanger through which the engine crankcase oil is circulated. Heated air circulates through the intake airflow which in turn cools the oil before it reenters the engine crankcase. The oil heat exchanger consists of copper tubing covered by aluminum fins. A fill plug fitted into the header pipe of the oil heat exchanger provides access and measurement of oil level in the system.



Note: Oil must be added at both the heat exchanger oil fill and at the engine crankcase oil fill.
Check engine oil level at both the heat exchanger and at the engine crankcase.
Maintain oil level to top of heat exchanger at fill plug.
Use SAE 5W-30 ADI/CD motor oil only.

Figure 2. Oil Heat Exchanger

(3) Airflow System

(a) Blower

The 5050D uses a centrifugal blower-wheel directly driven by the Diesel engine. The blower-wheel bolts directly to the flywheel at the rear of the engine and is enclosed in a steel blower housing. The blower draws intake air through the center of the blower-wheel and discharges it through the openings in the outer edge of the wheel. The blower-wheel is fashioned of cast aluminum and is precision balanced.

(b) Air Intake Filter

The washable, aluminum air intake filter is located in the front of the unit at the entrance to the air intake box. To access the filter, unfasten the panel holding clips, remove the cover panel, and lift the filter from the filter rack. Refer to Chapter 2-1 for instructions on servicing the air intake filter.

CAUTION

THE AIR INTAKE FILTER IS ESSENTIAL TO THE PROPER OPERATION AND LONGEVITY OF THIS EQUIPMENT. DO NOT ATTEMPT TO OPERATE THE UNIT WITHOUT A PROPERLY INSTALLED AIR FILTER.

(4) Air Regenerative Tube

The air-regenerative tube routes a portion of the discharge air from the blower back into the air intake box. This steel tube fits along the top of the airflow duct. This helps increase the discharge air temperature by preheating the air entering the airflow system.

(5) Fuel System**CAUTION**

USE ONLY DIESEL FUEL IN THIS EQUIPMENT. USE OF OTHER FUEL TYPES MAY CAUSE ENGINE AND FUEL SYSTEM MALFUNCTIONS.

(a) Fuel Tank

The 5050D is equipped with a 52 gallon (196.8 liters) diesel fuel tank which provides approximately 12.5 hours of continuous operation. (Fuel consumption will vary with engine operating speed.) The fuel tank is located on the left hand side of the cart.

(b) Fuel Level Gauge

The fuel tank is fitted with a mechanical, float-type, analog fuel level gage. The fuel gage may be read with the unit on or off as it is not connected to the unit's electrical system. Fuel gage is accessed by opening fuel fill door on the cart left forward side. The gage is located directly behind the fuel filler cap.

(c) Low Fuel Warning and Shutdown System

The 5050D has a low-fuel warning and shutdown system to alert the operator to the presence of a low-fuel condition and stop the engine before losing prime in the fuel pump.

When the fuel drops below a preset level, a sensor in the fuel tank illuminates the LOW FUEL WARNING light on the Control Panel. When fuel shutdown level is reached, an intermittent horn (mounted at the rear of the relay panel) sounds, the operational fault beacon illuminates, and the unit shuts down.

(6) Electrical System

The 5050D contains electrical system components / circuits that facilitate and control the various phases of operation. This section is not intended to explain the electrical system in complete detail but to highlight the major electrical assemblies and their key components. For a complete parts listing refer to the Illustrated Parts Breakdown, Section 4-3. For the wiring schematic for the electrical system refer to Section 2-2.

(7) Control Panel

The control panel is the primary point of use for operation of the 5050D. Most of the function, status indicators, and operator controls are located on the panel. The control panel controls and indicators are illustrated in Figure 3.

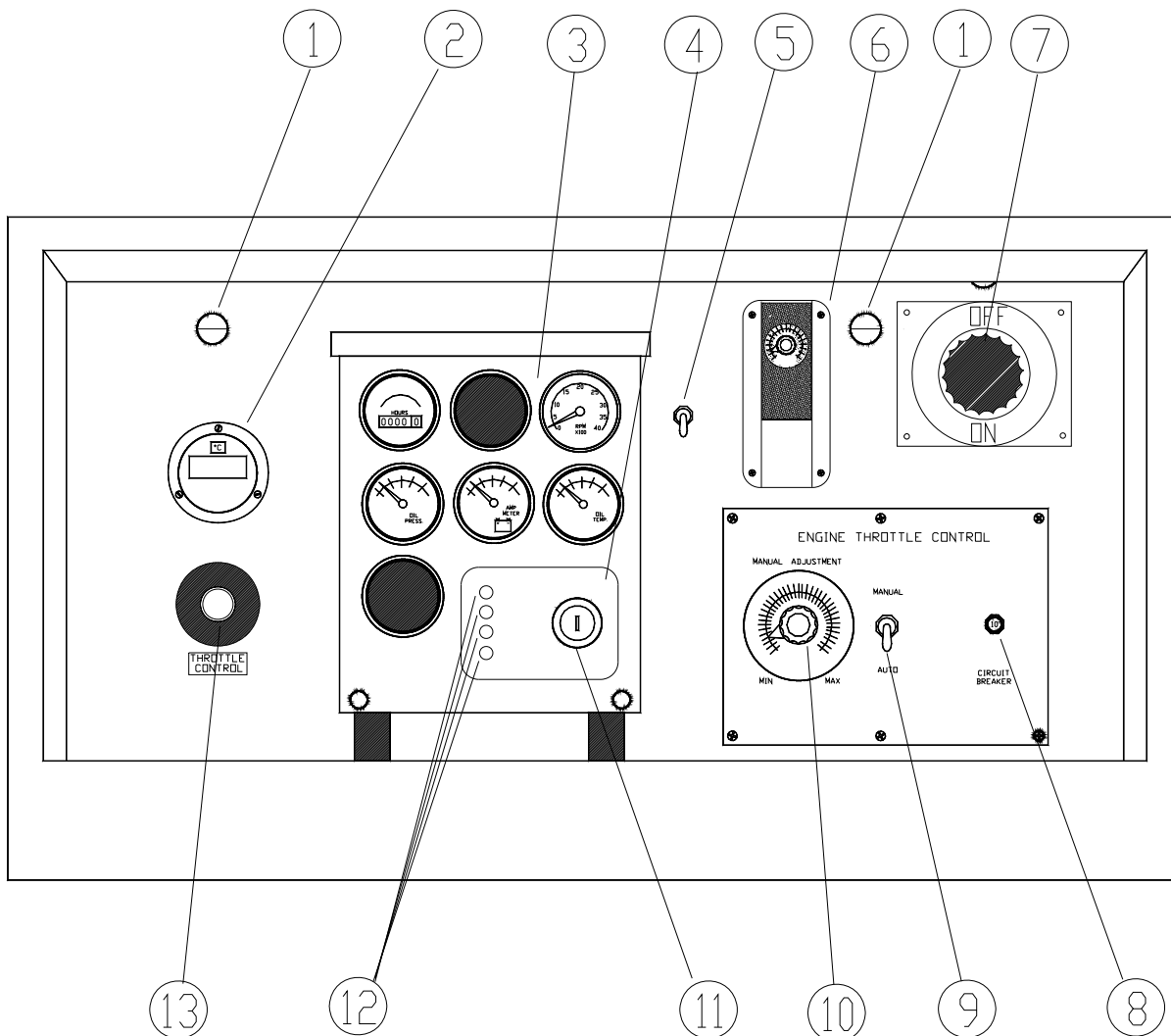
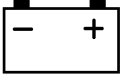
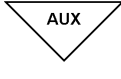
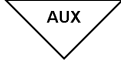


Figure 3. Control Panel Assembly - Controls And Indicators

Table 1: Control Panel Assembly - Controls and Indicators

Figure 3 Item No.	Description	Function
1	Panel Lights (DS1 and DS2)	Used for night time operation.
2	°C (or °F) Temperature gauge (M1)	Digitally indicates discharge air temperature. Operates in conjunction with remote temperature sensor (TSEN2). Duct temperature exceeding 73.8°C (165°F) will shut down unit.
3	Engine Control Panel: ENGINE HOURS RPM X 100 PSI Oil Pressure Gauge Battery Voltage Gauge °F Temperature Gauge	Houses engine controls and Annunciator Indicator sub-panel. Elapsed time meter. Displays the total number of hours the unit has been in service. Engine speed indication. 1500 RPM is idle speed. 3300 RPM is maximum engine speed. Engine oil pressure indication 0 to 80 pound per square inch (psi). Where 20 psi is typical operating pressure. Displays output voltage of battery charging system Engine operating temperature gauge
4	Annunciator Indicator Sub-Panel:	Mounts indicator lights and Ignition control switch
5	PANEL LAMPS switch (S2)	Turns panel lamps (DS1 and DS2) ON or OFF.
6	NOT USED	
7	ON/OFF Battery disconnect switch (S1) (OPTIONAL)	Removes battery power from unit. Primarily used during maintenance and storage.
8	OPTIONAL CIRCUIT BREAKER (CB2) (Only Units W/Auto-Throttle Control)	Control power protection - 10 Ampere
9	OPTIONAL MANUAL/AUTO selector switch (Only Units W/Auto-Throttle Control)	Allows operator to select between automatic engine speed control or manual throttle operation.
10	OPTIONAL MANUAL ADJUSTMENT potentiometer (POT1)(Only Units W/Auto-Throttle Control)	An engine speed control potentiometer for manually setting engine speed and heat output.
11	AUTO START (Not Used) OFF RUN START Ignition Mode Switch	OFF - No battery power applied to ignition circuit. RUN - Applies power to ignition circuit and glow plugs, inhibits starter motor START - Engages starter motor.

Table 1: Control Panel Assembly - Controls and Indicators (Continued)

Figure 3 Item No.	Description	Function
12	Annunciator lights:  Battery Symbol  Glow Plug Symbol  LOW FUEL  LOW OIL	When ON, indicates battery circuit fault. When ON, indicates glow plugs warming up. When ON, indicates low engine fuel warning and/or shutdown level reached. When ON, indicates low engine oil level.
13	THROTTLE CONTROL (Only on units with Manual Throttle control)	Mechanically sets engine speed.

(8) Relay Panel

The relay panel contains components related to low-fuel shutdown, engine starting, and temperature setpoint regulation; optional installations may include automatic temperature control on the relay panels. The relay panel is located directly beneath the control panel behind an exterior cover panel.

NOTE:

Adjustable engine/unit controls are factory-set for optimum performance. Field adjustment is not required except as a result of component failure or replacement. Refer to Section 2-3.

C. Safety Cutoffs**NOTE:**

Engine fault monitoring is suppressed during the first 30 seconds of operation to allow fluid levels and sensors to acquire operational levels and measurements.

The 5050D is equipped with safety cutoff switches. The switches illuminate a flashing operational beacon and shut down the unit in the event of:

- Over-temperature condition in the discharge air - above 165°F (74°C)
- Low Oil Level

The engine control functions include shutdown protection in the event of:

- High Engine Oil Temperature (above 130° C / 266° F)
- Low Engine Oil Pressure (below 10 psi)
- Low Fuel

For the protection of the aircraft, the unit shuts down if the discharge air temperatures are in excess of 165°F (74°C). The discharge air temperature setpoint is adjustable from the

temperature controller on the relay panel.

D. Block Heater/Oil Heater

A block heater keeps the engine oil warm when the unit is not in use. This prevents damage to the engine from freezing coolant and aids in starting the engine in low ambient temperature conditions. The block heater is located on the mainframe adjacent to the engine. Oil-cooled engines may be fitted with an oil heater placed at the bottom of the oil heat exchanger coil.

The block heater or oil heater is electrically powered. The block heater's connection to external power is via a three-prong receptacle located on the outside of the mainframe, below the control panel, and protected by a flip-up cover.

SECTION 2 — Operation

1. GENERAL

This section contains operational information on the 5050D Aircraft Heater. Operators of the 5050D unit must read all instructions before attempting to operate the unit.

Given below are the operating instructions for the 5050D Aircraft Heater. Following these instructions is imperative for the safety of personnel and the protection of the equipment.

Before using this equipment for the first time, be sure that all personnel involved in the operation and maintenance of the unit read and understand this manual completely.

WARNING:

PROLONGED EXPOSURE TO HAZARDOUS NOISE MAY RESULT IN PERMANENT HEARING LOSS. ALWAYS WEAR EAR-PROTECTION DEVICES WHEN WORKING WITHIN A CLOSE PROXIMITY OF THIS EQUIPMENT.

2. PREPARATION FOR USE

Carry out the following steps before starting the engine.

NOTE:

For first time operation of the unit refer to Chapter 1-4 Shipping/Receiving for initial inspection and preparation for use procedure. If the unit has been in extended storage, refer to Chapter 1-5 (Storage) before performing the preoperational inspection.

A. Preoperational Inspection:

Prior to first operation of the day, inspect the unit to ensure safe and reliable operation.

Perform the preoperational inspection as follows:

(1) Unit Physical Inspection:

Visually inspect for defects, i.e., integrity of common hardware; such as tubing, harnesses, wiring, conduits, frame and chassis.

(2) Unit Interior Inspection:

Open the unit access doors and inspect the following items located in the unit interior:

(a) Check engine oil level:

Open the engine access doors. Remove engine oil dipstick and check oil level mark on dipstick. Add oil to bring level up to "H" (Full) mark.

(b) Engine coolant (oil) level:

Coolant level is set at factory, if necessary check level using procedures found in Section 2-1.

(c) Engine Assembly:

Visually inspect fuel lines and fittings for evidence of fuel leakage. Inspect valve covers, oil pan, and cylinder block for evidence of oil leakage.

Check for loose hardware and foreign objects that may be drawn into the

conditioned air intake filters during operation.
Close the unit's access doors.

WARNING:

**NEVER ENTER THE INTERIOR OF THE UNIT WHILE UNIT IS IN OPERATION.
DO NOT STEP ON OR GRAB HOLD OF WIRING OR PIPING.**

CAUTION:

NEVER OPERATE THE ENGINE WITH THE OIL LEVEL BELOW THE "L" (LOW) MARK OR ABOVE THE "H" (HIGH) MARK. WAIT AT LEAST 5 MINUTES AFTER SHUTTING OFF THE ENGINE TO CHECK THE OIL. THIS ALLOWS TIME FOR THE OIL TO DRAIN TO THE OIL PAN.

- (3) Check engine fuel level (when unit is not running) by observing fuel level gage mounted next to fuel fill port. (See Figure 1.)

WARNING:

NEVER SMOKE OR ALLOW AN OPEN FLAME WITHIN THE IMMEDIATE VICINITY OF THE UNIT WHILE SERVICING FUEL. NEVER SERVICE UNIT WITH THE ENGINE OPERATING. FAILURE TO COMPLY MAY RESULT IN FUEL FIRE AND/OR FUEL EXPLOSION CAUSING SEVERE EQUIPMENT DAMAGE AND/OR SEVERE INJURY, EVEN DEATH TO PERSONNEL.

WARNING:

TO PREVENT SPARKING BETWEEN FILLER NOZZLE AND FUEL TANK, ALWAYS MAINTAIN METAL TO METAL CONTACT BETWEEN FILLER AND FUEL TANK. GROUND UNIT TO A CERTIFIED GROUND POINT.

- (4) Service with diesel fuel as required. The fuel tank drains from the tank's bottom.



Figure 1. Fuel Level Gage & Fill Port

B. Setup

- (1) Position the cart near the aircraft within reach of the extended air-delivery hose. Do not allow the air-delivery hose to becoming kinked or twisted.
- (2) Open a cargo or passenger door on the aircraft.
- (3) Connect the air-delivery hose.
- (4) If required by local procedures, disconnect tow bar from vehicle and engage parking brake by raising the tow bar upward until it locks in place.
- (5) Start the Air Craft Heater unit.

NOTE:

Fully lowering the tow bar (to within approximately 6 inches above ground level) engages the parking brake.

- (6) Open the hose storage door and pull the entire length of hose out of the storage tube.

WARNING:

TO PREVENT EXHAUST GAS ENTRY INTO AIRCRAFT PASSENGER AREAS, DO NOT POSITION THE UNIT WHERE EXHAUST GASSES FROM NEARBY VEHICLES OR EQUIPMENT CAN ENTER THE AIR INTAKE FILTER.

C. Connecting Heating Duct To Aircraft**WARNING:**

THIS UNIT PRODUCES HIGH-VOLUME, LOW-PRESSURE AIR. ENSURE THAT THE PCA SERVICE COUPLING IS SECURED TO THE AIRCRAFT. SERVICE AIR-DELIVERY HOSE MAY DETACH FROM AIRCRAFT WHILE UNIT IS IN OPERATION, CAUSING INJURY TO PERSONNEL AND OR TO EQUIPMENT OR AIRCRAFT.

CAUTION:

THIS UNIT IS CAPABLE OF OVER-PRESSURIZING SMALL AIRCRAFT.

- (1) Remove heater hose from storage located at the side of the unit. Attach the Pre-Conditioned Air (PCA) service coupling to aircraft. This unit produces high volume low pressure air. Make sure the service air-delivery duct is securely fastened to the aircraft. If the service air-delivery hose detaches from the aircraft when the heater is started, injury to personnel or damage to equipment or aircraft may result.

CAUTION:

STRAIGHTEN THE HEATER HOSE TO PREVENT SEVERE BENDS OR KINKS THAT WOULD IMPEDE OR BLOCK THE AIR FLOW. FAILURE TO COMPLY MAY CAUSE THE HOT AIR SERVICE HOSE TO RUPTURE OR PREVENT AN ADEQUATE SUPPLY OF AIR FLOW TO THE AIRCRAFT.

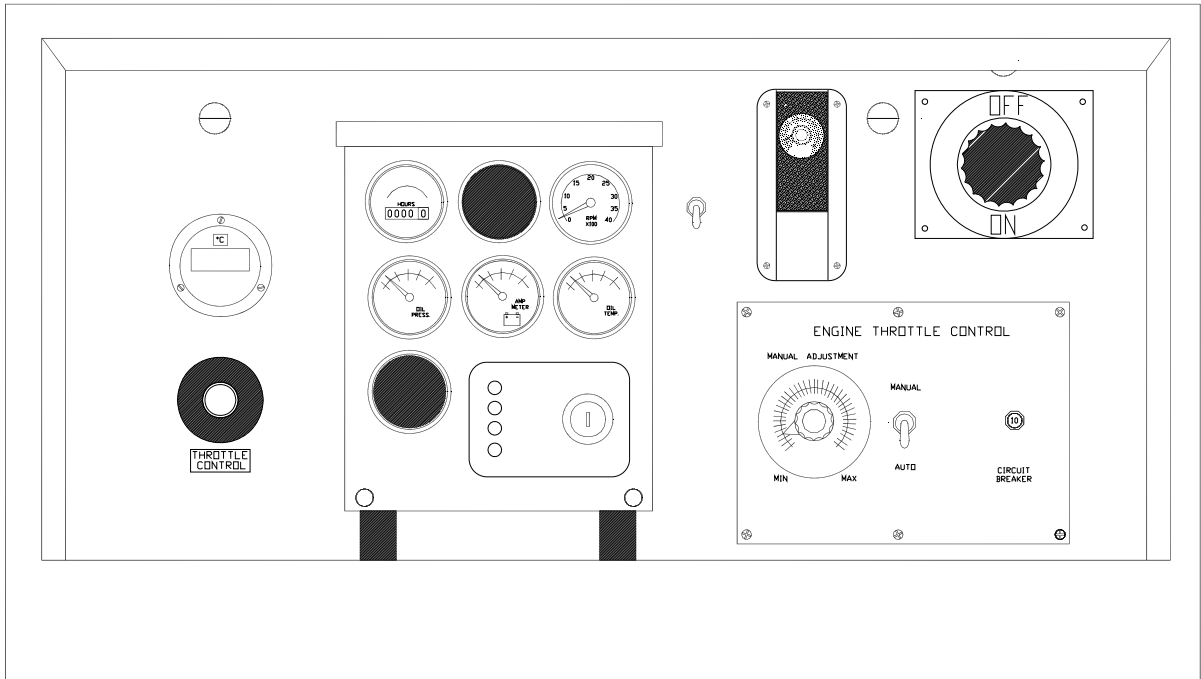


Figure 2. Operator Control Panel

3. HEATER OPERATING INSTRUCTIONS

WARNING:

HEATER AIR HOSE MUST BE CONNECTED TO AIRCRAFT BEFORE AND DURING OPERATION. DO NOT RUN UNIT WITH HEATER AIR HOSE OBSTRUCTED.

A. To Start-Unit. (Figure. 2, Section 1-2 and Figure 16, section 4-3):

- (1) Open throttle control approximately 1/2 inch (12.5mm).
- (2) Rotate unit **OFF/ RUN/START** switch to **RUN**. Glow plug indicator panel light next the **RUN** switch illuminates ON. When glow plug indicator goes OUT, rotate **OFF/RUN/ START** switch to **START**, until engine starts, then release **START** switch back to **RUN** position.
- (3) Allow unit to idle (at 1500 RPM) for approximately two minutes before choosing desired speed.

B. Diesel Engine Shut-down.

- (1) Select **MANUAL** mode or turn temperature control fully COUNTERCLOCKWISE, engine speed drops to 1500 RPM.
- (2) Rotate **OFF/RUN/START** switch to **OFF**.
- (3) Disconnect and stow air-delivery hose.

C. Important Notes.

CAUTION:

FAILURE TO REDUCE ENGINE SPEED TO IDLE BEFORE STOPPING THE UNIT COULD RESULT IN SEVERE DAMAGE TO THE ENGINE.

- (1) MAXIMUM ENGINE SPEED: 2800 RPM.
- (2) Unit shuts down and AMBER beacon flashes.
 - (A) Discharge air duct temperature exceeding 74°C (165°F)
 - (B) low engine oil pressure
 - (C) high engine oil temperature
- (3) Red AUX 1 panel light and optional LOW FUEL beacon light flashes, unit runs for approximately 30 minutes then shuts down.
 - (A) Low fuel condition

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SECTION 3 — Specifications & Capabilities

1. GENERAL

- Length (overall): 96 inches (243.8 cm)
- Width (overall) 60 inches (152.4 cm)
- Height (overall) 67 inches (170 cm)
- Weight (approximate): 3,700 lbs (1678kg. (trailer mounted)
- Fuel capacity: 52 U.S. gallons (197 liters)
- Fuel Type: Diesel ASTM D975-88; 1-D and 2-D
- Crankcase oil (Deutz® oil cooled engine): 13 gallons (49 LT)
- Engine: 4 Cylinder Industrial Diesel
- Oil type: API (American Petroleum Institute) SAE 5W-30 CF-4, CG-4, CH-4
- Operating temperature: -40°F to +65°F (-40°C to 18°C)
- Storage temperature: -40°F to 150°F (-40°C to 65.5°C)

2. STRUCTURE

- Steel frame trailer assembly
- Aluminum canopy
- Steel fuel tank with Protecto-Seal® fuel cap.
- Enclosure: Aluminum - panel canopy with doors for service access, welded steel frame.
- Removable air intake filters.
- Hose storage compartment.
- Operational fault beacon.
- Low fuel warning (Optional beacon).
- Low fuel shutdown.

3. HEATING SYSTEM

- Heat Source
 - Exhaust heat exchange: Air-to-air
 - Coolant heat exchange: Oil-to-air or coolant-to-air

4. PERFORMANCE

- Heating capacity: 400,000 BTU/hr.
- Ambient conditions:
 - Operating temperatures -30°F to 165°F (-34.4°C to 73.9°C)
 - Altitude: To 6000 feet (1828 M)
- Air Output (subject to ambient conditions)
 - Volume/Temperature:
 - 250 lbs ppm (6.98 kPa)
 - Maximum static pressure up to 28 inches WG.
 - Delivered air temperature 120°F (48.9°C) over ambient (typical)
- Running Time: 12.5 hours continuous per full tank of fuel.

5. ELECTRICAL DATA

- Battery Supply: Two (2) each 12V, 850 CCA heavy duty
- Control Voltage: 12 Volts DC
- Engine Starter Voltage: 12 Volts DC
- Overload Protection: Circuit breakers (manual reset)

6. UNIT CONFIGURATION MATRIX

The Unit Configuration Matrix (Refer to Table 1) includes a cross-reference of unit serial numbers and configuration options. (Contact Trilectron Industries Technical Services for configuration information for units with serial numbers not listed below.)

Table 1: Unit Configuration Matrix

Serial #/ Model	Engine ¹ / Throttle Controls	Base Assembly	Options ²	Electrical Schematics ³
Stock Units 5050-TL-DZ-00 SO226-705	Deutz / Manual	22739B w/Oil Heat Exchanger	30' Hose (AA6121 Connector (AA6073)	22487 Rev D
Notes: 1. Refer to manufacturers' data in Chapter 5 2. Refer to Section 4-3, Illustrated Parts List 3. Refer to Section 2-2, Troubleshooting				

SECTION 4 — Shipping And Receiving

1. GENERAL

When shipped domestically, the 5050d Aircraft Heater unit does not require crating or a solid external container. The unit is shipped fully assembled.

2. PREPARATION FOR SHIPMENT

A. Unit Preparation. (Reference Figure 3 and Table 1 of Section 1-1)

- (1) Disable all electrical power by disconnecting battery terminals. (OPTIONAL) Or, if equipped, on Control Panel, set BATTERY DISCONNECT switch (S1) to OFF.
- (2) Pull all circuit breakers to the OFF position.
- (3) Cover fresh air intake grille and aircraft adaptor outlet with plastic to prevent debris from entering the airflow system.
- (4) Ensure all doors and panels are securely fastened. (Reference Section 4-3).
- (5) If the unit is to be transported by cargo ship, apply an anti corrosion transit coat over the entire exterior surface of the unit.
- (6) Secure the tow bar in the up position.
- (7) The unit may be lifted using spreader bars or a forklift capable of lifting 10,000 lbs. When using spreader bars, place the bars under the unit with cables going from the spreader bars over the top of the unit.
- (8) Place the air-delivery hose in its storage compartment and secure with rope or other tie-downs.

CAUTION:

THE UNIT SHOULD NEVER BE SHIPPED WITH FUEL TANK FULL. EXPANSION OF FUEL DURING HEAT OF DAY MAY CAUSE FUEL TO OVERFLOW. DRAIN TANK COMPLETELY.

- (9) Drain fuel tank completely. Inspect fuel tank cap for proper seal and security.

CAUTION:

UNDER NO CIRCUMSTANCES SHOULD THE UNIT BE ANCHORED BY PASSING BANDS OR CABLES OVER THE SUPERSTRUCTURE. ANCHOR BY ATTACHMENT TO THE TRAILER CHASSIS ONLY.

B. Shipping Covers:

- (1) The unit should be covered with waterproof canvas or polyethylene material to prevent the entry of natural elements into the electrical and instrument areas.
- (2) The application of the covering material should be accomplished without the formation of water pockets or interference with the mobility of the unit. The covering material should be of sufficient strength to preclude rupture or tearing when exposed to conditions encountered during transportation.

3. RECEIVING

A. Initial Inspection

- (1) If the unit has been crated or encased in an envelope of weather resistant material,

uncrate or remove the covering.

- (2) Thoroughly inspect the exterior of the housing for any damage which may have occurred during shipment. Open all doors and re-close, checking latches for proper operation.
- (3) Inspect all instrument glasses and indicator light lenses for evidence of cracks or damage.
- (4) Open interior access door and inspect interior of unit for security of components. Check fuel system for leaks. Check electrical wiring for breaks or exposed wiring.
- (5) Check coolant hoses for evidence of leakage.
- (6) Check the entire unit for loose connections, parts, bolts, nuts or other hardware that may have been loosened during transit. Secure, repair, and report all discrepancies.
- (7) Remove the air-delivery duct from its storage compartment. Inspect air duct assembly for damage.

B. Initial Servicing:

CAUTION:

BEFORE CONNECTING BATTERIES, MAKE SURE THE IGNITION SWITCH ON THE ENGINE PANEL IS IN THE OFF POSITION.

- (1) Connect the batteries as follows:
 - (a) From the unit connect the positive terminal lead (Red) to the available positive terminal on the appropriate battery and tighten.
 - (b) Connect the negative terminal lead (Black) to the available negative terminal on the appropriate battery and tighten. (Two individual 12V batteries, connected in parallel, supply the system 12VDC power supply).
 - (c) (OPTIONAL) If equipped, on Control Panel, set BATTERY DISCONNECT switch (S1) to ON.
- (2) Check engine oil level. Do not operate unit if oil level is below the "L" (low) mark on the dip stick. Service with oil until oil level is at the "H" (Full) mark. Refer to engine literature for proper oil grade. Refer to Chapter 2-1, Servicing, for additional details.

SECTION 5 — Storage

1. GENERAL

This section provides instructions for preparing the heater unit for both short and long term storage. When the heater is to be stored or removed from operation, use the following procedures to protect the internal and external parts.

2. PREPARATION FOR STORAGE

A. Short Term Storage (less than 3 months):

The following steps are recommended if the heater is to be placed out of service for three months or less. Prepare the unit for storage as soon as possible after being removed from service.

- (1) Place the unit on blocks to prevent dry rotting of the tires.
- (2) Disable all electrical power by disconnecting the battery terminals. (OPTIONAL) If equipped, on Control Panel, set BATTERY DISCONNECT switch (S1) to OFF.
- (3) Pull all circuit breakers to the OFF position.
- (4) Follow instructions provided in the manufacturer's publication in the back of this book regarding preparation of the engine for storage.
- (5) Close all access doors and covers to minimize build-up of foreign particles in the unit.
- (6) Store the unit in a dry building.
- (7) Cover the unit with a tarpaulin to prevent debris from entering the unit.

B. Long Term Storage:

Special precautions are necessary to protect the heater from rust and corrosion. Store the unit in a building that is heated during winter months.

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CHAPTER 2 — Maintenance

SECTION 1 — Servicing

1. INTRODUCTION

This section contains instructions for Servicing, Inspecting, and Preventive Maintenance on the 5050D Aircraft Heater unit. The 5050D provides reliable operation while requiring a minimum of service and maintenance. This chapter contains information on servicing and maintaining the unit for optimum performance. For detailed service and maintenance procedures for the engine refer to the manufacturer's publication at the back of this manual.

2. GENERAL

To ensure the unit is kept in correct operating condition, inspect and maintain the unit on a regular basis. Proper cleaning of air filter at recommended intervals helps in preventing damage or failure of the unit, and provide optimum performance.

Overhaul Intervals: Under normal operating conditions and proper preventive maintenance practices, the heater will provide years of service, typically 7,000 to 10,000 hours (depending upon local conditions).

A. Engine Oil Change Schedule (Refer to Table 1).

Inspection schedules indicated in Table 1 are based on average operating conditions. More frequent changes of oil and air filters are necessary under severe operating conditions. Severe operating conditions include but are not limited to: operating in dry, hot, dusty climates (desert), areas of high humidity (tropical), excessive periods of heavy load or frequent intermittent operations. Refer to the Diesel Manual in Section 5 of this manual.

WARNING:

ALWAYS DISABLE THE 5050D UNIT WHEN PERFORMING SERVICE OR MAINTENANCE. TO PREVENT ACCIDENTAL STARTING, DISCONNECT THE NEGATIVE BATTERY CABLE. PULL ALL CIRCUIT BREAKERS TO THE OFF POSITION. PLACE A WARNING TAG ON THE UNIT TO INDICATE THAT SERVICE IS BEING PERFORMED AND NOT TO START THE UNIT

B. Tools and Equipment.

Certain common tools are required to perform routine preventative maintenance and the servicing procedures outlined in this manual. The following tools are recommended for use when servicing the unit.

- Open-end wrench set (SAE & metric)
- Socket set, 3/8" or 1/2 drive ratchet (SAE & metric)
- Adjustable wrench, 10"
- Screwdriver set, slotted and Phillips
- Allen wrench set

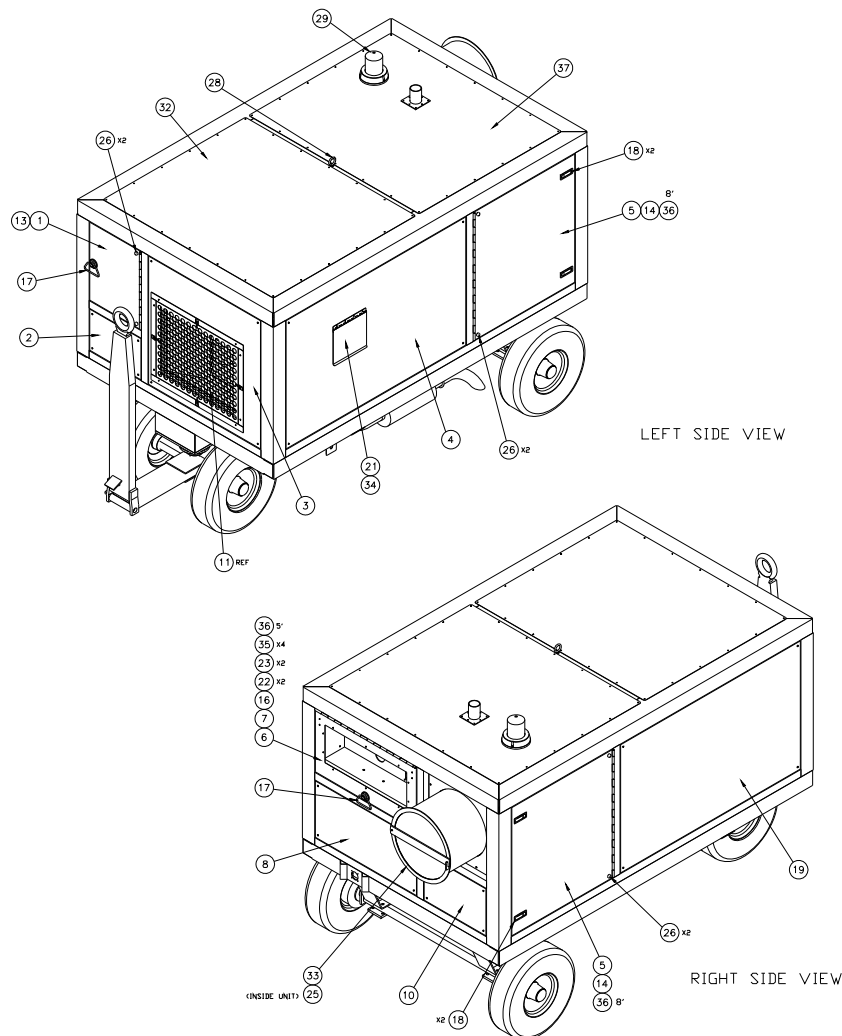


Figure 1. 5050D Doors and Panels. Ref. Section 4-3.

C. Body Frame Removal. (Reference Figure 1).

To facilitate service access, the unit's body frame is removable from the chassis. Removal of the body frame is not necessary when performing most maintenance and servicing tasks. It is required when overhauling the engine or replacing major airflow system components. Remove the body frame as follows.

- (1) Remove the heat exchanger access panel on the left side of the unit.
- (2) Loosen the band clamp which fastens the air-delivery hose to the exit duct.
- (3) Open the hose storage door and carefully remove hose from hose storage tube.
- (4) Remove air intake cap from roof of unit.
- (5) Disconnect two wires connecting roof mounted amber light. Removal of light

assembly from the roof is not necessary.

- (6) Remove four bolts from corners of the mainframe.
- (7) Remove four screws between body frame and control panel.
- (8) Loosen two screws on the control panel slides.
- (9) Slide control panel towards rear of unit (approximately two inches -50mm.)

CAUTION:

USE EXTREME CAUTION WHEN REMOVING THE BODY FRAME. DO NOT DAMAGE COMPONENTS OR WIRING HARNESES ON THE CHASSIS.

- (10) Using a crane or hoist, lift the body frame off the chassis using lifting ring in center of unit roof.
- (11) Installation is the reverse of removal.

D. Air Filter Replacement.

CAUTION:

DO NOT OPERATE THE UNIT WITHOUT THE AIR FILTER AND RETAINING PANEL IN PLACE.

The 5050D uses a washable aluminum filter that must be kept clean for the unit's proper operation. Clean or replace the air intake filter at specified intervals, as shown in the maintenance table.

CAUTION:

MAKE SURE THE ENGINE AND THE BLOWER HAVE STOPPED BEFORE REMOVING AIR-INTAKE FILTER AND CANNOT BE STARTED. DISCONNECT THE NEGATIVE BATTERY CABLE. PULL ALL CIRCUIT BREAKERS TO THE OFF POSITION. PLACE A WARNING TAG ON THE UNIT TO INDICATE THAT SERVICE IS BEING PERFORMED AND NOT TO START THE UNIT.

- (1) Lift the retaining clips located around the air intake panel away from the panel.
- (2) Remove the air intake panel from body frame.
- (3) Swing top of air intake filter toward you and lift the intake filter out of the filter rack.
- (4) Install new air intake filter cartridge into the filter rack.
- (5) Place air intake panel over the air filter cartridge.
- (6) Swing the retaining clips toward the air intake panel to hold it in place.

The air filter cartridge can be cleaned using a high pressure sprayer and suitable solvent. Do not attempt to clean the air filter cartridge while it is installed in the unit. Always remove it before cleaning. When the air filter cartridge can no longer be cleaned it should be replaced.

E. Checking and Adding Engine Oil.

The Deutz oil-cooled engine in the Model 5050 Aircraft Heater Unit circulates crankcase oil through the oil heat exchanger thus providing cooling and lubrication for the engine. The engine oil also serves as an additional heat source for discharge airflow delivery. (See Figure 2)

CAUTION:

SINCE THE HEAT EXCHANGER IS MOUNTED HIGHER THAN THE ENGINE CRANKCASE, A FALSE OIL LEVEL READING AT THE CRANKCASE MAY RESULT DUE TO OIL MIGRATION FROM THE HEAT EXCHANGER TO THE CRANKCASE. CHECK PROPER OIL LEVEL AT THE CRANKCASE DIP STICK AND HEAT EXCHANGER SIGHT GLASS.

- (1) If the oil level is below the sight glass when unit is OFF, and the engine crankcase dip stick shows oil level below or just to the FULL mark, but not higher, add oil (no more than two (2) quarts [2 liters] at a time) to the engine crank case. Recheck oil level at the crank case. Oil level on a cold engine should normally read just above (i.e., approximately 2 quarts [2 liters] above) the FULL mark.
- (2) If oil level is below the sight glass when unit is OFF, and above the FULL mark on the dip stick:
 - (a) Start and run the engine for approximately five (5) minutes at normal (idle) speed (about 1500 rpm).
 - (b) Shut engine OFF and check the following within five (5) minutes of engine shutdown:
 - Check engine level at dip stick. Crankcase oil level should show FULL. If oil level is below FULL, add one (1) quart [1 liter] of oil.
 - Check oil level on heat exchanger sight glass. If sight glass shows FULL, no additional oil is needed. If sight glass is less than FULL and engine crankcase is FULL, add one (1) quart [1 liter] oil to engine crankcase.
 - When properly serviced, both engine crankcase dip stick and heat exchanger sight glass show oil levels no higher than the FULL marks within five (5) minutes of warm engine shutdown.

NOTE::

The 5050 Aircraft Heater Unit is protected with a Low Oil Level Switch which automatically shuts down the unit if oil level is two (2) or more quarts [2 or more liters] low. Low oil level is indicated by a red flashing light on the unit canopy.

- (3) When adding oil under a LOW OIL LEVEL condition, add no more than two (2) quarts [2 liters] of oil at a time and recheck oil levels as above.

CAUTION:

OIL MAY BE ADDED EITHER AT THE ENGINE CRANKCASE LOCATION(S) OR BY REMOVING THE OIL FILL PORT PLUG ON THE HEAT EXCHANGER (SEE FIGURE 2). THE HEAT EXCHANGER IS UNDER HIGH PRESSURE. ENSURE THE FILL PORT PLUG IS PROPERLY TIGHTENED BEFORE STARTING THE ENGINE.

- (4) When oil needs changing, drain it from both the coolant heat exchanger and the engine crankcase. Refer to the maintenance table for recommended oil change intervals. Refer to Chapter 1, Section 3 Technical Specifications for the required amount of oil. When changing the oil, proceed as follows.

- (a) Run engine a few minutes to warm up the oil then turn off of engine.
- (b) Drain oil from oil heat exchanger and engine crankcase (See Figure 2.).
- (c) When oil has drained, replace the drain plugs in the heat exchanger and engine.
- (d) Add SAE 5W-30 motor oil to heat exchanger until oil level reaches the top of the heat exchanger header pipe.
- (e) Add SAE 5W-30 motor oil to engine crankcase until oil level reaches FULL mark on dipstick.
- (f) Close oil fill caps on engine and replace dipstick into oil heat exchanger header.
- (g) Run engine for five minutes, shutdown, and check oil level at heat exchanger and engine.
- (h) Add oil as needed until proper levels are detected at heat exchanger and engine crankcase.

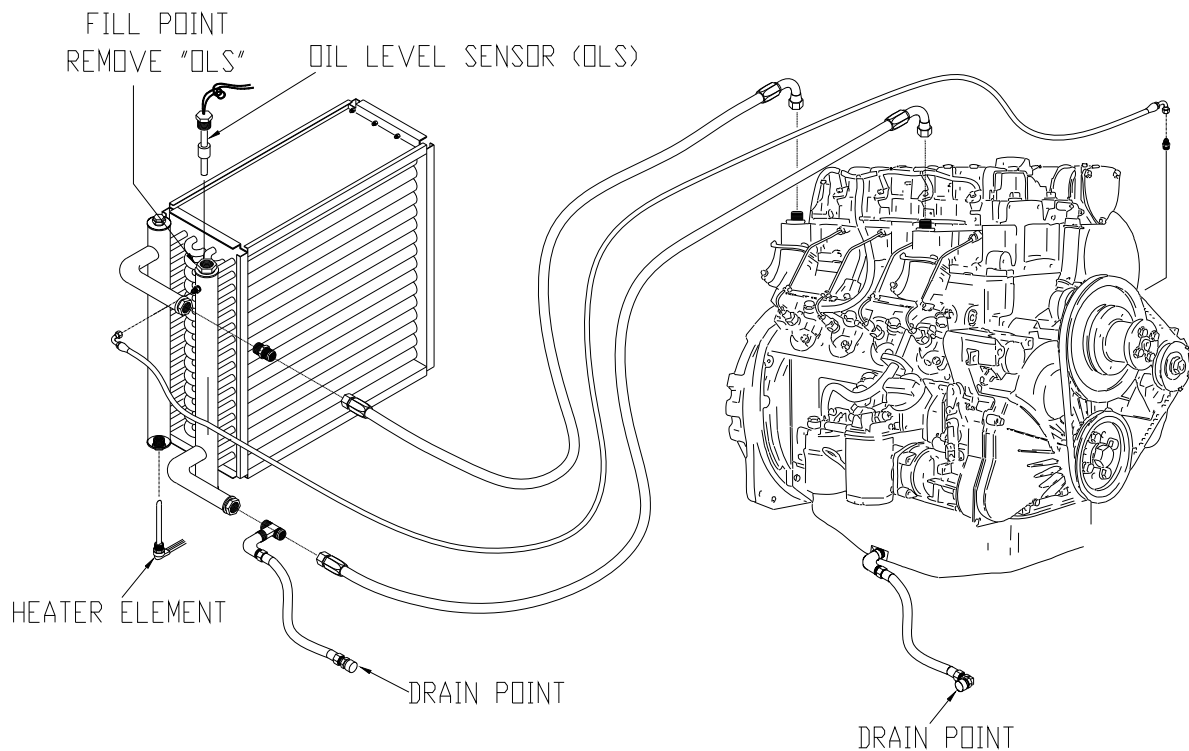


Figure 2. Oil Drain And Fill Points

3. FUEL RECOMMENDATIONS / SPECIFICATIONS.

Refer to the engine literature listed in Chapter 5 of this publication for engine fuel specifications and requirements.

4. INSPECTION (See Table 1).

Establish and maintain a periodic Preventive Maintenance Inspection Schedule. Table 1 is a suggested inspection/check schedule. The criteria listed meets the minimum requirements necessary to ensure safe reliable service under normal operating conditions. Modify it as required to meet varying operating and environmental conditions.

WARNING:

USE EXTREME CAUTION WHEN PERFORMING SERVICE INSPECTIONS WITHIN THE UNIT WHILE THE ENGINE IS RUNNING. DO NOT WEAR LOOSE CLOTHING OR JEWELRY. NEVER SERVICE THE UNIT ALONE – ALWAYS HAVE A SAFETY PERSON PRESENT DURING SERVICING OPERATIONS. FAILURE TO FOLLOW THIS PRECAUTION COULD RESULT IN SERIOUS INJURY OR DEATH.

NOTE:

Change engine oil and filter after the first 150 hours of use, then after every 250 hours of use or every six months, whichever is the most frequent.

Table 1: Preventive Maintenance Inspection Schedule (Engine Related)

Engine Related Systems	Daily	100 HR	250 HR	300 HR	500 HR	1500 HR
1. Inspect for leaks	X					
2. Check oil level	X					
3. Change oil & filter every 250 hrs run time or 6 months (Which ever occurs first)			X		X	X
4. Valve Clearance				X		
5. V-Belt(s) Apply pressure midway between belt pulleys. Belt should deflect 10-15 mm. Adjust tension as needed.			X		X	X
Engine Cooling System						
1. Inspect for leaks	X					
2. Inspect oil heat exchanger for cleanliness		X	X	X	X	X
Air Intake System						
1. Inspect for leaks	X					
2. Inspect for air restrictions	X					
3. Inspect for corrosion		X	X	X	X	X
4. Change air filter element. Clean or replace as necessary.			X		X	
Fuel System						
1. Inspect for leaks	X					
2. Drain water from primary fuel filter	X					
3. Change fuel filters						
4. Drain sediment from tank					X	X
Exhaust System						
1. Inspect for leaks					X	
2. Inspect system for restrictions					X	
3. Inspect clamps for tightness					X	
4. Inspect for corrosion					X	
5. Inspect muffler for security		X	X	X	X	X

Table 1: Preventive Maintenance Inspection Schedule (Engine Related) (Continued)

Engine Related Systems	Daily	100 HR	250 HR	300 HR	500 HR	1500 HR
Engine Electrical System (when batteries are provided)						
1. Inspect that battery electrolyte level covers plates		X	X	X	X	X
2. Check battery state of charge		X	X	X	X	X
3. Inspect battery hold-down	X					
4. Inspect battery terminal for security	X					
Unit Chassis						
1. Inspect doors and hinges for damage. Lubricate hinges		X	X	X	X	X
2. Inspect unit for loose nuts, bolts, and missing hardware	X					
3. Running Gear						X
4. Wheel Axles		X	X	X	X	X

SECTION 2 — Troubleshooting

1. GENERAL

This section contains troubleshooting information which shall serve in locating and correcting operating troubles (or malfunctions) which may develop in the unit. Each malfunction for an individual component, unit or system, is followed by a list of tests or inspections. Use the troubleshooting section to help determine probable causes and corrective action to be taken.

Inspections, tests and corrective actions should be performed in the order listed. Troubleshooting is a logical and systematic process of determining and correcting a malfunction's cause. The process begins with verification of the malfunction. This may often involve an operational check-out of the unit. After the trouble has been verified, identify all components in the circuit whose failure could cause the symptoms observed during the operational check-out. The technician should start by checking those items which are highest in probability of causing the problem. Inspect and test each component, until the exact cause of the problem is determined and corrected.

WARNING:

USE EXTREME CARE TO AVOID CONTACT WITH HIGH VOLTAGE LEADS AT ALL TIMES. REMOVE ALL JEWELRY, SUCH AS RINGS, WATCHES, CHAINS, ETC., THAT COULD COME INTO CONTACT WITH EXPOSED LEADS AND WIRES. FAILURE TO COMPLY MAY RESULT IN ELECTRICAL SHOCK OR DEATH, AND / OR CAUSE DAMAGE TO EQUIPMENT.

WARNING:

EAR PROTECTION DEVICES MUST BE WORN WHEN IN THE IMMEDIATE VICINITY OF THIS UNIT DURING OPERATION. REPEATED EXPOSURE TO HAZARDOUS NOISE CAN CAUSE PERMANENT HEARING LOSS.

2. TROUBLESHOOTING CHART

This troubleshooting chart (See Table 1) lists information under three headings as follows:

- Symptom
- Probable Cause
- Remedy

A. Use of the Troubleshooting Chart.

If the cause of a trouble is uncommon and cannot be located using the chart, a good place to start your checks is at the last known source of power or proper operation. Then proceed by checking each component in the circuit/system thoroughly. Use the schematics and diagrams at the end of this section. Electrical components in the troubleshooting chart (such as S1, T1, etc.), are identified by a noun name and a corresponding symbol to identify the item on schematic diagrams. It is assumed that wiring and connections in defective circuits have been thoroughly checked before condemning any component(s).

B. Support Test Equipment Required.

Multimeter (Simpson 260 VOM or equivalent): Required for basic troubleshooting. At least two jumper leads with alligator clips and test prods are required.

Thermometer: Used for checking operating temperatures within the range of -40 to 160°F (-40 to 71.1°C).

C. Component Failure.

Stop the unit immediately should any component fail. Practically all failures give some warning to the operator before the component fails and causes damage to the unit.

Equipment has been saved because alert operators heed warning signs such as a sudden rise in temperature, unusual noises, etc., and immediately shutdown the unit.

3. SCHEMATICS AND WIRING DIAGRAMS

This troubleshooting section incorporates the schematic diagram for use by the technician. It should be used in conjunction with the troubleshooting chart. Reference: Figure 1. 5050D Aircraft Heater Schematic Diagram, Drawing 22487

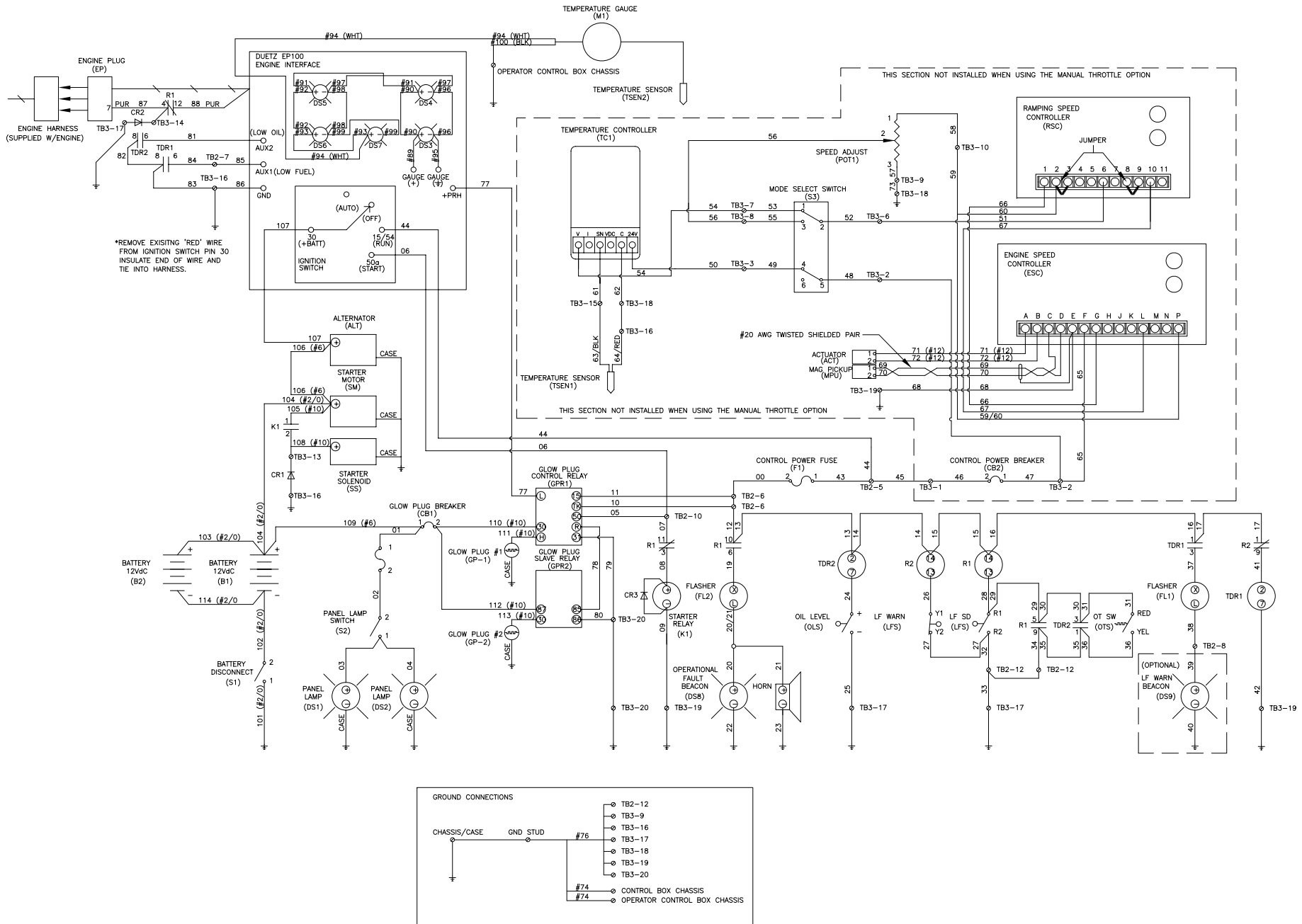
Table 1: Troubleshooting Chart

Symptom	Probable Cause	Remedy
Engine does not crank.	Loose battery cable	Check and tighten
	Defective Battery	Test battery. Charge or replace as necessary.
	Defective Starter	Check ground connection, solenoid, starter motor. Repair or replace.
Engine cranks but does not start	A safety has been activated	Check safety override switch. Check for activated safeties (oil, low fuel).
	Faulty safety sensor	Check and replace.
	Faulty fuel solenoid	Check and replace.
Hard starting	Defective glow plugs	Check and replace.
	Engine too cold	Use block heater when engine is not in use.
Reduced airflow	Obstruction of blower intake	Check blower intake and filter.
	Blocked or damaged air delivery hose	Ensure air delivery hose is not kinked or torn.
	Ruptured flex plenum	Check flex plenum for leaks or tears. Replace if damaged.
Noxious fumes in aircraft cabin	Exhaust from nearby equipment entering intake filter	Move equipment away from unit air intake.
	Fumes leaking into airflow system	Check for leaks in exhaust heat exchanger, oil heat exchanger, or holes in flex plenum. Repair as required.

Table 1: Troubleshooting Chart

Symptom	Probable Cause	Remedy
Unit shuts down	Safeties have been activated during unit operation Engine High Oil (or Water) Temperature	Check safeties and system monitors (oil, overtemp, low fuel, etc.) - Check oil/water level. Check for leaks. Repair leaks and add oil/coolant as required. - Check/change oil/coolant filter elements - Check oil level switch (OLS). Replace as required. - Ensure oil/water pump operations. Replace as required.
	Engine Low Oil Pressure	- Check oil level. Check for leaks. Repair leaks and add oil as required. - Check/replace engine oil pressure switch (OPS; refer to engine manufacturer's data in Chapter 5)
	Engine Low Oil Level	- Check oil level. Check for leaks. Repair leaks and add oil as required. - Check/replace oil level sending unit
	High Duct Temperature	- Check inlet/discharge airflow for blockages - Ensure proper engine/blower operation (Refer to Section 2-3, Adjustments) - Check/replace duct temperature sensor
	Low Fuel Warning or Shut-down	- Add fuel and recheck. - Check/replace Low Fuel warning switch (LFS) - Check/replace TDR1. Ensure time delay DIP switches properly set (Refer to Section 2-3, Adjustments)

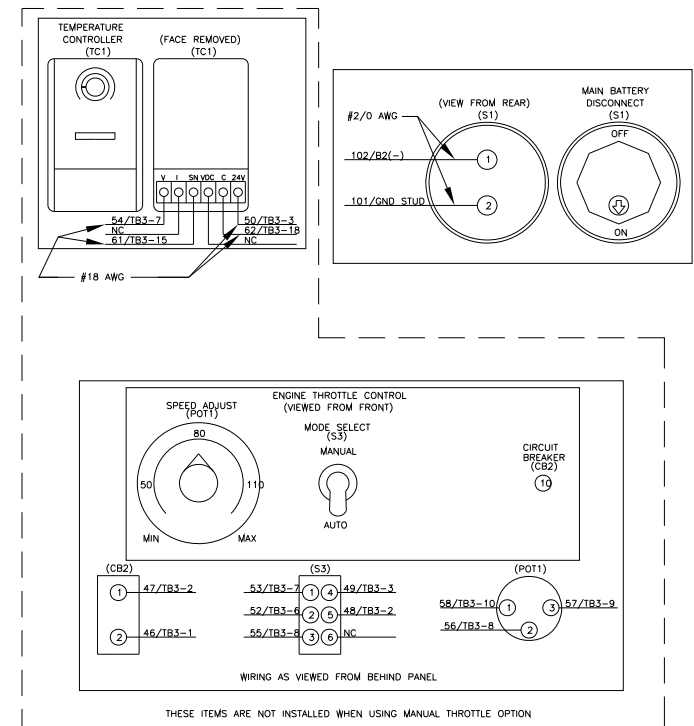
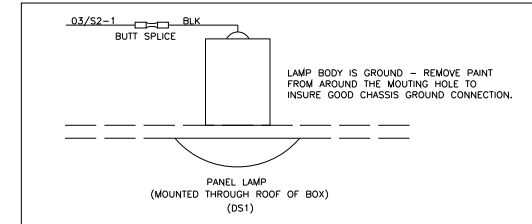
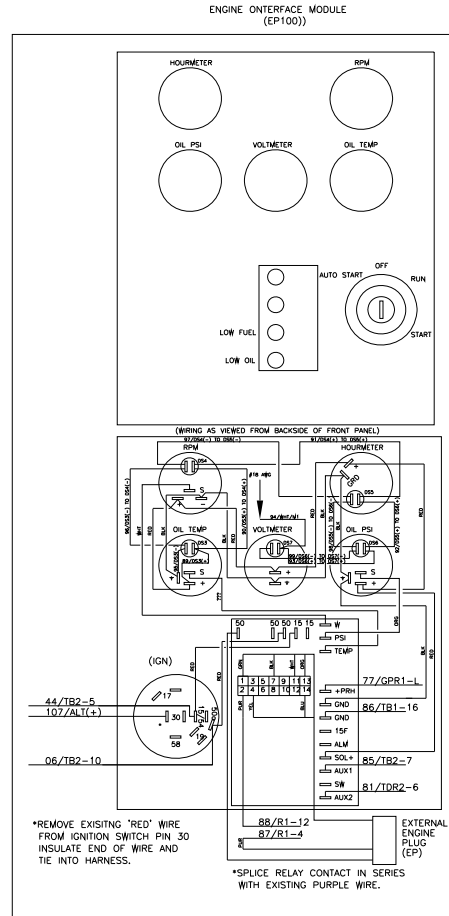
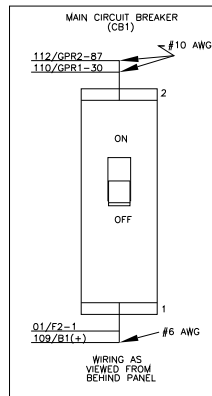
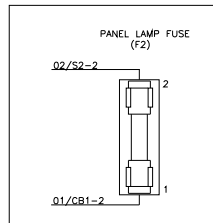
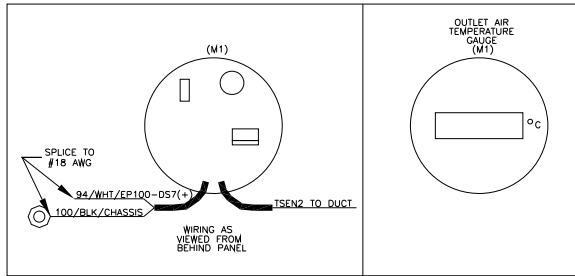
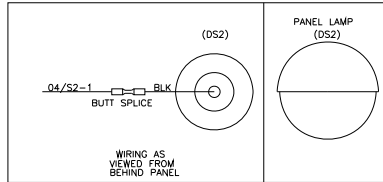
5050D Aircraft Heater



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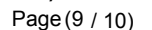
5050D Aircraft Heater

75/GND STUD
OPERATOR'S BOX GROUND
(USE ANY UNPAINTED BOLT)



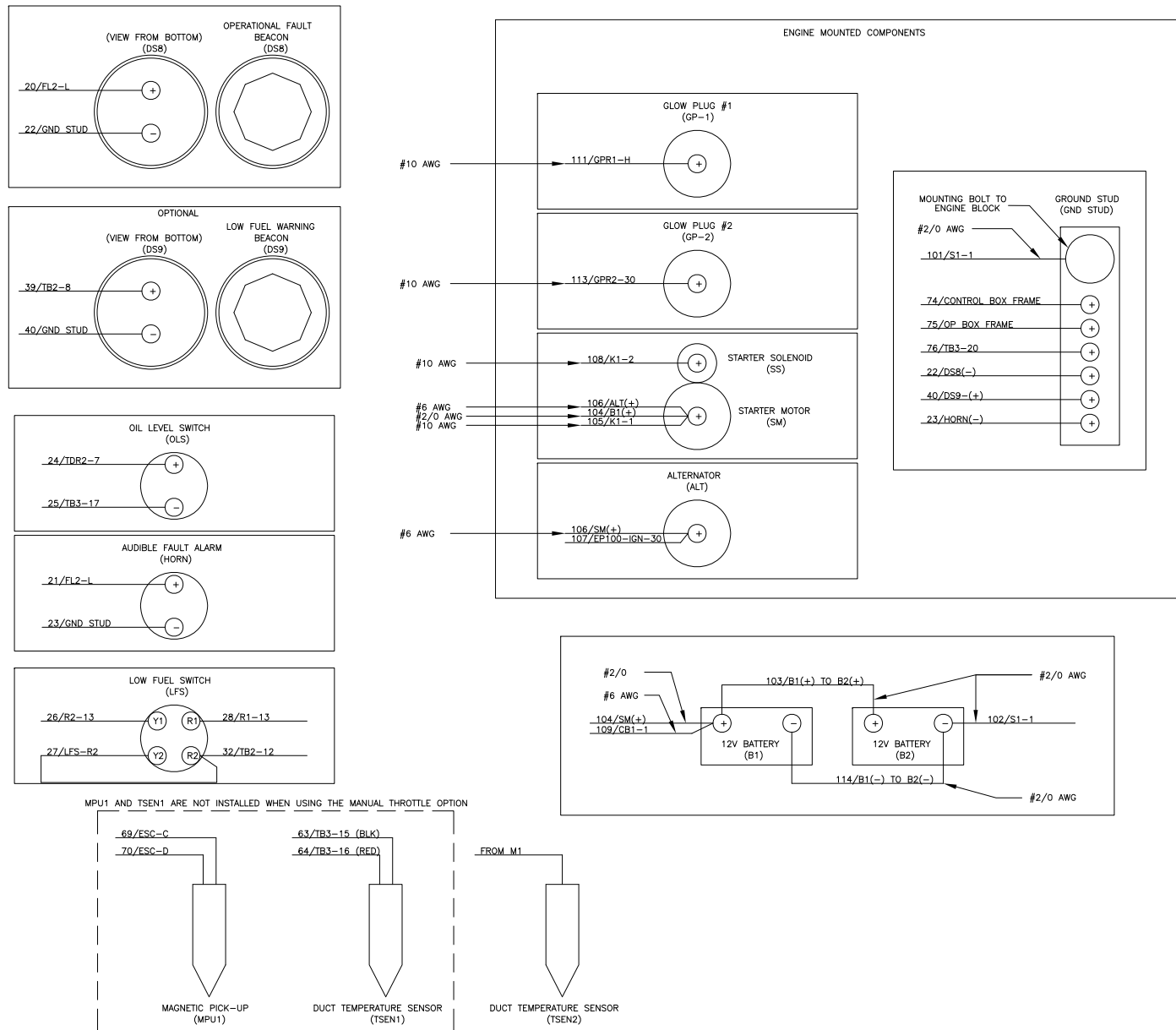
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INDUSTRIES



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5050D Aircraft Heater



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SECTION 3 — Adjustments

1. ADJUSTMENT DESCRIPTIONS: ELECTRICAL

All temperature control settings in the 5050D Aircraft Heater are factory set and should not need adjustment in the field unless equipment has been replaced.

A. Time Delay Settings.

The following time delay modules are located on the Relay Panel Assembly (See Figure 1.):

Table 1: Relay Panel Assembly Adjustments

Device	Setting
Time Delay Relay (TDR1)	This relay is set for 3 minutes.
Time Delay Relay (TDR2)	This relay is set for 3 minutes.
Over Temperature Switch (OTS)	Factory set for 165°F (73.8°C) trip point

B. Over Temperature Safety Shutoff (See Figure 1.)

The output delivery air temperature shall not exceed 165°F (73.8°C). The setpoint for the Overtemp Safety Shutoff (OTS) is factory set at 165°F (73.8°C). The OTS setpoint should not be changed in the field except for testing purposes. After tests are complete, the setpoint must be returned to the factory setting.

(1) Setpoint Adjustment

- Adjust the setpoint by rotating the adjusting screw to desired temperature.

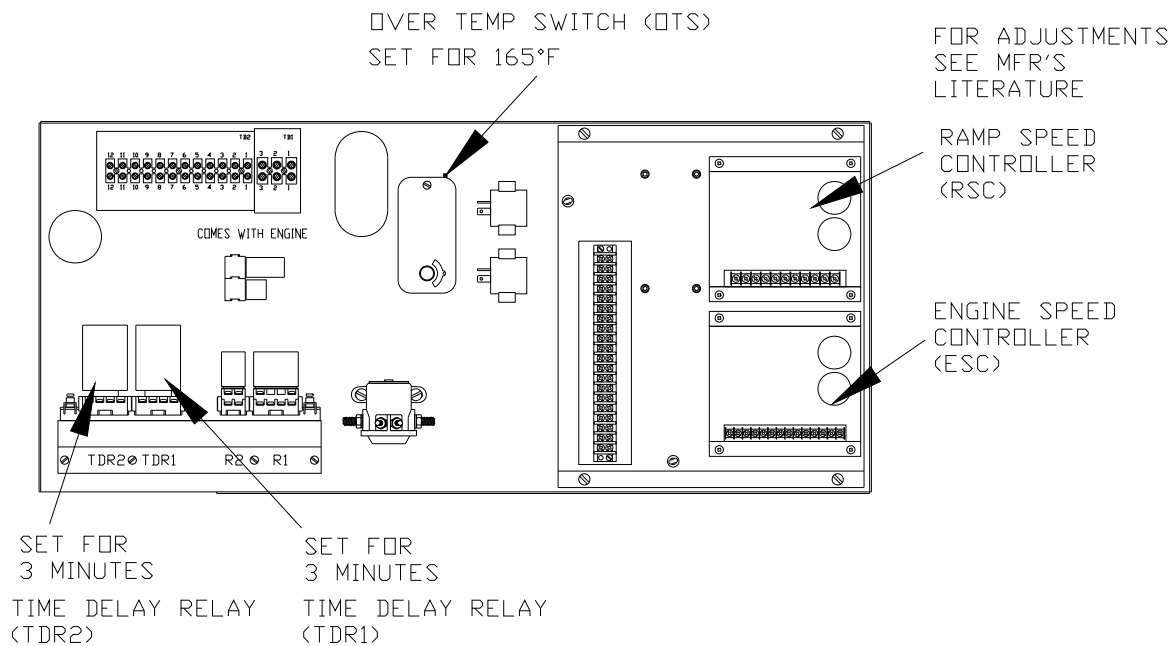


Figure 1. Relay Panel Assembly - Adjustments
(Note: RSC and ESC do not apply to these units)

CHAPTER 3 — Overhaul/Major Repair

SECTION 1 — Major Repair

1. GENERAL

Under normal operating conditions and proper preventive maintenance, the 5050D Aircraft Heater should provide excellent service for a period of 7,000 to 10,000 hours (depending on local conditions) before needing overhaul or replacement of the unit's major components.

Chapter 5 of this manual contains original manufacturer's reference data. Rebuild of the 5050D Aircraft Heater can, under most circumstances, be accomplished in any well equipped ground support equipment maintenance facility.

Normal maintenance, repair, and replacement procedures will maintain the remainder of the components of this system in a serviceable condition.

Contact Trilectron Industries for specific instructions concerning major overhaul of this unit.

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CHAPTER 4 — Illustrated Parts List

SECTION 1 — CAGE Codes/Vendor Name & Address

Table 1: Commercial and Government Entity (CAGE) Code Listing

CAGE Code	Vendor Name & Address
01276	AEROQUIP CORP., 1225 W. Main St., Van Wert, OH. 45891
03007	GUDEN, H.A. CO. INC., P.O. Box 146, Ronkonkoma, NY. 11779-0146
04034	IMO INDUSTRIES INC. (GEMS), 1 Cowles Rd., Plainville, CT. 06062-1107
09393	SOLARTRON CORP, Anaheim, CA 92800
12867	TRILECTRON INDUSTRIES, INC., 11001 U.S. Hwy 41 North, Palmetto, FL 34221
12965	LORD CORP, INDUSTRIAL PROD. DIV., 126 Grant St., Cambridge Springs, PA 17520
18265	DONALDSON CO., INC., 1400 West 9th St., Minneapolis, MN 55431
22938	PROTOTYPE DEVELOPMENT INC.(PDI), 7750 Hub Parkway, Cleveland, OH 44125-5709
29281	HALL INDUSTRIES INC, 201-03 East Carson St., Pittsburg, PA 15219
31361	WOODWARD GOVERNOR CO., 1000 E. Drake R., FT. Collins, CO 80525
50831	JOHNSON CONTROLS INC., P.O. Box 423, Milwaukee, WI 53201
55752	PARKER-HANNIFAN CORP. (RACOR), P.O. Box 3208, Modesto, CA 95353
59150	ENGINEER PRODUCTS CO. P.O. Box 598, Waterloo, IA 50704-0598
67189	OSBURN ASSOCIATES INC. 11931 SR 93N LOGAN, OH 43138 - 0912
71400	BUSSMAN, DIV. COOPER INDUSTRIES, P.O. Box 14460, St. Louis, MO 63178
74821	IDEAL CLAMP MFG. CO., 3200 Parker Drive, St. Augustine, FL 32084
75382	KULKA (DAYLIGHT) ELEC. CORP., 520 S. Fulton Ave., MT. Vernon, NY 43050
75915	LITTLE FUSE TRACOR INC., 800 E. Northwest Hwy, Des Plaines, IL 60016-3049
76281	MELRATH GASKET, 2901 W. Hunting Park Ave., Philadelphia, PA 19129-3099
76474	MORSE INDUSTRIAL CORP., 620 So. Aurora St., Ithaca, NY 14850-5726
76700	NELSON DIVISION, P.O. Box 428, Stoughton, WI 52589
79221	NELSON DIVISION, P.O. Box 428, Stoughton, WI 52589
94222	SOUTHCO FASTENERS, 210 N. Brinton Lake Rd., Concord, PA 19182
98473	VIRGINIA ELECTRONICS CO INC., 1017-15101 Interlachen Dr., Silver Spring, MD 20906
0AAR4	NEWARK ELECTRONICS, 4801 N. Ravenswood Ave., Chicago, IL. 60640
0AT39	BRIERTON ENGINEERING, INC., Rt.2, 1200 S. Buckeye, Abilene, KS 67410

Table 1: Commercial and Government Entity (CAGE) Code Listing (Continued)

CAGE Code	Vendor Name & Address
0BXW5	GOVERNORS AMERICA CORP., 720 Silver St., Agawam, MA 01001
0KVE6	MCMaster-CARR SUPPLY, 6100 Fulton Ind. BLVD., Atlanta, GA 30336
0P2F7	POLYMER TECH., 7006 Pencader Dr., Newark, DE 19702
0RR12	RUBBER & ACCESSORIES INC., 2120 Edgewood Dr. South, Lakeland, FL 33803
0SMN2	J & B AVIATION SERVICES, INC., 2860 Cordelia Rd., Suite 170, PO Box 27, Fairfield, CA 94533-0727
0W357	PDI GROUND SUPPORT SYSTEMS INC., 5905 Grant Ave., Cleveland, OH 44105
1FJ15	AMATOM ELECTRONIC HARDWARE, 445 Blake St., New Haven, CT 06515
1H123	AERO HARDWARE, 4301 N.W. 36Th St., Miami Springs, FL 33166-7396
2E279	TRUCK-LITE CO INC., Falconer, NY 14733
4L990	RACOR INDUSTRIES, INC. P.O. Box 3208, Modesto, CA 95353
5W026	HYDRAULIC SUPPLY CO., 7200 E. Buffalo Ave., Tampa, FL 33619-1130
6V625	NAPA AUTOMOTIVE PARTS CO., 3389 E. Main St., Columbus, OH 43213-2744
7A013	CENTRAL DIESEL INC., 1422 Commerce Rd., Richmond, VA 23224-7526
7W514	GOODYEAR RUBBER PRODS., 329 McCarthy Hwy., Newark, NJ 07114
8K511	RAYBRO ELEC. SUPPLIES, P.O. Box 1351, Tampa, FL 33601
9B248	PARKER HANNIFIN CORP., 2445 S. 25TH Ave., Broadview, IL 60153-3891
9K537	DELCO ELECTRONICS DIV., General Motors Corp., Downey, CA
HRMTG	HERMITAGE DISTRIBUTORS INC., 1 Hermitage Way, Glen Allen, VA 23060
OXFRD	OXFORD MFG., Ravenswood Dr., Selma, AL 36701
THERM	THERMO-TEC, P.O. Box 946, Berea, OH 44017

CHAPTER 4 — Illustrated Parts List

SECTION 2 — Numerical Index

Part Number	Figure Number/Item	Part Number	Figure Number/Item	Part Number	Figure Number/Item
08378	11-14	22705	18-17	22543A REV C	14-
10364	18-12	22717	14-27	22544A Rev B	15-
10536	1-21	22770	13-4	22546 REV A	10-
16931	16-2	22771	8-25	22547 REV C	8-
16933	16-3	23202	1-16	22548 REV A	13-
21326	8-34	23203	1-14	22549 REV B	11-
22075	18-7	23204	1-13	22550A REV B	1-
22076	18-14	23211	1-37	22551A REV B	10-
22079	18-9	23257	2-1	22713A	14-24
22197	18-8	25624	-1-38	22713B	14-25
22198	18-2	26169	18-11	22713C	15-35
22503	18-16	(See Figure 17)		22713D	14-35
22547	1-11	11902B	17-10	22713E	15-33
22552	1-20	1N0015	10-17	22713F	15-34
22700	17-6	22516 REV B	17-	22713G	14-30
22701	10-9	22540A Rev C	18-	22713H	15-32
22702	10-10	22541 REV D	9-	22713J	15-39
22703	10-11	22542A Rev C	7-	22713K	15-29

Part Number	Figure Number/Item	Part Number	Figure Number/Item	Part Number	Figure Number/Item
22713L	14-26	BA0009	-16-5	D22-209	14-6
22713M	15-30	BA5005	16-1	D24-112	15-9
22713N	15-31	C16-57-03	11-1	D24-114	15-8
22713R	15-36	C16-58-05	11-2	D24-206-20	15-23
22713S	14-28	C16-59-03	11-8	D25-06	14-4
22713U	14-29	C16-96	8-1	D25-253	14-9
22713V	14-36	CO5524	15-15	D25-258	9-18
22713W	14-31	CY0015	11-6	D25-86	14-5
22737 REV A	16-	CY0035	10-14	D26-186-01	10-7
23362A	14-39	CY5035	11-7	D26-74	15-4
23362B	14-40	CY5056	10-28	D29-135-10	14-3
25548 Rev -	2-	CY5065	7-2	D29-136	14-2
A01-18-06	8-15	CY5110	8-16	D30-89	15-27
A03-158-50	9-1	CY5111	7-5	E33-81	-12-5
A03-158-60	9-2	D20-132-02	15-13	E33-82	9-10
A5185	4-8	D20-138-02	15-16	EB5224	-10-10
AA0011	14-37	D20-138-04	15-6	EB5225	-10-11
AA0011	15-5	D20-140-02	15-17	EB5316	11-10
AA5361	14-7	D20-140-04	15-7	EB5815	11-9
AA6007	7-3	D20-151	15-14	EB5837	11-12
AA6008	7-4	D20-152	15-18	EB5838	11-13
AA6073	7-1	D20-164-01	15-12	ED5064	17-11
AA6121	7-6	D20-60	15-2	EG5030	17-3
AH5110	11-5	D21-181	14-20	ET5049	10-5

Part Number	Figure Number/Item	Part Number	Figure Number/Item	Part Number	Figure Number/Item
ET5155	-10-12	FU0006	14-21	H56-469	18-18
F15010	10-16	FU0006	15-25	H56-718	15-28
FH5007	14-22	FU5101	14-38	H57-18-71	14-23
FH5007	15-26	G44-125	12-1	H58-04	10-6
FI0042	10-15	G44-125	17-1	HRFCBI	11-17
FI0047	9-22	G44-125-101	-12-6	HRFCC1	11-18
FI0058	10-12	G44-125-101	17-2	HRHBC1	8-41
FI0065	10-13	G44-125-21	10-2	HV5252	8-36
FI0074	9-15	G44-125-21	-12-7	HWFO63	11-16
FI0074	17-8	G44-125-23	12-2	IL5272	18-4
FI0077	17-9	G44-125-24	12-3	IL5273	18-10
FI5096	9-7	G44-125-25	12-4	IN0026	1-27
FI5159	17-4	G44-125-27	-12-8	IN5095	1-36
FI5190	9-24	G44-125-35	14-8	IN5103	10-22
FI5190	17-5	G44-132	8-22	IWGBB1	13-7
FI5589	10-27	G45-26-03	13-3	IYE025	8-37
FI5704	9-14	G45-26-05	8-18	IYG030	13-6
FI5704	17-7	G45-79	13-1	J61-116-02	10-4
FI5880	17-12	G45-80	13-2	J61-12-18	10-8
FL0014	10-26	G49-29	11-3	J61-123	10-24
FL0028	9-23	G49-44-01	11-4	J61-38-01	10-1
FM0002	9-20	H51-67	1-6	J61-72	10-19
FM0002	10-25	H56-321-1	15-10	K66-132-01	8-11
FM0003	9-21	H56-321-2	15-11	K66-134	8-7

Part Number	Figure Number/Item	Part Number	Figure Number/Item	Part Number	Figure Number/Item
K66-137	8-6	M76-226-12	1-3	NOT USED	9-3
K66-164	8-10	M76-226-13	1-2	NOT USED	9-4
K66-307	8-8	M76-226-15	1-19	NOT USED	9-6
K67-147	8-4	M76-278-01	1-1	NOT USED	9-8
K67-197	1-25	M76-278-07	1-7	NOT USED	9-9
K67-70	8-3	M76-278-08	1-8	NOT USED	9-11
K68-162	8-17	M76-278-09	1-9	NOT USED	9-12
K68-163	8-13	M76-278-10	1-10	NOT USED	9-13
K68-172	8-5	M76-864-01	15-1	NOT USED	9-17
K68-184	8-2	M76-864-02	14-1	NOT USED	10-9
K68-196	8-9	ME0011	-12-9	P84-18	1-29
K68-213	8-14	ME5070	11-11	P84-18-01	15-3
K68-346	8-20	MS1120	15-24	PX5072	8-40
K68-387	8-21	NA5095	18-5	PX5514	9-16
K68-439	1-33	NA5102	18-6	Q88-192-02	10-1
KH0011	1-28	NA5103	18-3	Q88-299	10-7
KH5061	1-34	NOT USED	1-12	Q88-314-01	10-2
KH5256	1-35	NOT USED	1-30	Q88-317-01	10-3
KH5306	11-15	NOT USED	1-31	Q88-317-02	10-4
KH5387	1-15	NOT USED	8-12	Q88-57	10-8
M76-225-02	1-32	NOT USED	8-28	R91-73	8-26
M76-226-04	1-4	NOT USED	8-29	R91-76-548	8-31
M76-226-10	1-5	NOT USED	8-30	R93-110	1-22
M76-226-11	8-33	NOT USED	8-32	R93-53	1-24

Part Number	Figure Number/Item	Part Number	Figure Number/Item	Part Number	Figure Number/Item
R93-53	8-35	TA5091	5-24	TA5819	5-3
R93-61	1-17	TA5096	4-5	TA5952	5-2
R93-65	1-18	TA5096	5-5	TA6030	5-10
R94-166-15.5	10-18	TA5122	5-11	TA6053	5-23
R94-356-01	9-5	TA5153	5-20	TA6057	6-
R94-382-01	9-19	TA5154	5-19	TA6111A	2-2
R94-49-10	10-23	TA5155	5-18	TA6111A	3-
R96-170	8-24	TA5160	5-16	VM5002	1-26
R96-278	8-23	TA5167	5-17	VM5023	8-19
R96-294	10-6	TA5183	4-7	VM5024	13-5
R96-337	10-20	TA5183	5-13	WI0002	-16-4
R96-338	10-21	TA5184	4-6	WL0020	-16-6
R96-814	1-23	TA5184	5-14	WL5026	-16-7
R96-912	10-3	TA5185	5-15		
R96-A18	15-19	TA5187	4-4		
R96-A26	8-38	TA5192	4-3		
R96-A27	8-39	TA5192	5-4		
S98-32	8-27	TA5194	4-9		
SB5017	10-5	TA5194	5-9		
SL0030	-16-9	TA5195	4-2		
SL5006	-16-8	TA5195	5-7		
SL5030	-16-10	TA5196	5-12		
TA5066	5-	TA5817	5-8		
TA5079	6-5	TA5818	5-6		

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SECTION 3 — DETAILED PARTS LIST

1. EXPLANATION OF COLUMNS

A. Figure/Item No. column:

Figure / Item No. column lists the figure on which the item is shown and the item number assigned to the detailed part. Items listed but not illustrated are preceded by a dash (–).

B. TI Part Number column:

TI Part Number column lists the Trilectron Industries, part number assigned and required to procure the part from Trilectron.

C. Vendor Part Number:

Lists the vendor's part number for purchased parts.

D. CAGE:

Lists the vendor's government assigned Commercial And Government Entity (CAGE) code number.

E. Airline Part Number:

Column is provided for the user to insert their system part number.

F. Nomenclature column:

Nomenclature column presents the complete item name required for identification or procurement. Abbreviations used are in accordance with United States Military Standard MIL-STD 12D.

G. Units Per Assembly column:

Units Per Assembly column provides the total quantity of the listed component utilized for that assembly.

2. INSTRUCTIONS FOR ORDERING PARTS – Direct all inquiries to:

Trilectron Industries
11001 US Hwy. 41 North
Palmetto, Florida 34221 U.S.A.
Telephone (941) 721-1023
Fax (941) 723-3160
E-mail: tisales@itwgsegroup.com

Warranty Inquiries:

Customer Support Coordinator

In the USA: Telephone 1-877-874-5322, FAX 1-877-874-5321
Outside the USA: Telephone 1-941-721-1093, Fax 1-941-721-1091
E-mail: cs@itwgsegroup.com

Important Facts: *When ordering, give the serial number of the unit; model number; full description of the part and the quantity required; and the Illustrated Parts List Figure and Item number from this manual. Give shipping method preferred.*

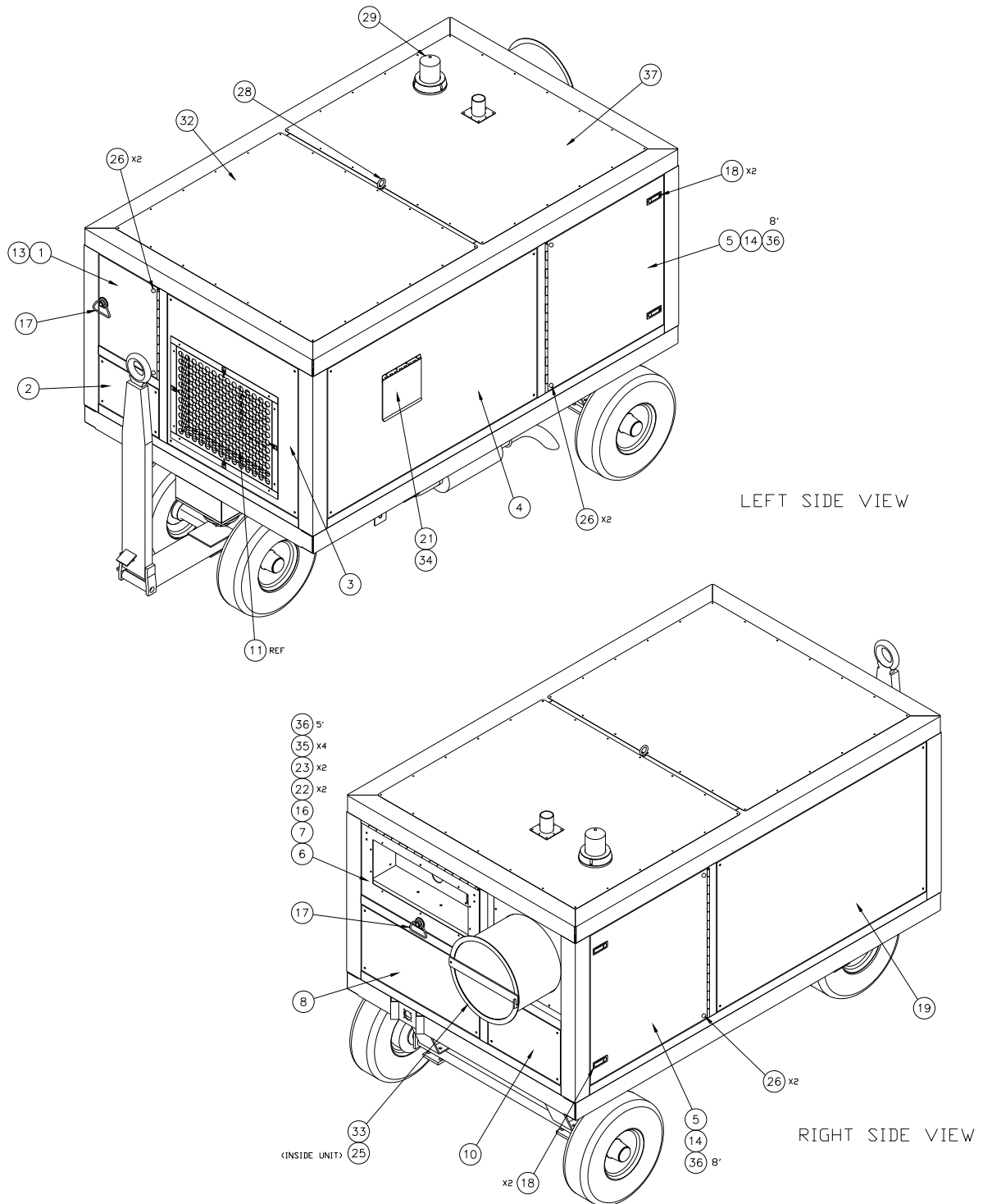


Figure 1. Doors And Panels

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
1-	22550A REV B		12867		DOORS AND PANELS.	.REF
1-1	M76-278-01		12867		DOOR, FUEL FILLER ACCESS	1
1-2	M76-226-13		12867		PANEL, BODY CLOSURE	1
1-3	M76-226-12		12867		PANEL, AIR INTAKE	1
1-4	M76-226-04		12867		PANEL, HEAT EXCHANGER ACCESS	1
1-5	M76-226-10		12867		DOOR, INTERIOR ACCESS	2
1-6	H51-67		12867		COVER, PLEXIGLASS	1
1-7	M76-278-07		12867		DOOR, CONTROL PANEL ACCESS	1
1-8	M76-278-08		12867		PANEL, BELOW CONTROL PANEL	1
1-9	M76-278-09		12867		DOOR, STORAGE ACCESS (OPTION)	1
1-10	M76-278-10		12867		PANEL, BELOW HOSE STORAGE	1
1-11	22547		12867		AIR FLOW SYSTEM	.REF
(See Figure 8)						
1-12	NOT USED					
1-13	23204		12867		HINGE, FUEL FILL DOOR	1
1-14	23203		12867		HINGE, INTERIOR ACCESS DOOR	2
1-15	KH5387		12867		HINGE, HOSE STORAGE BOX (OPTION)	1
1-16	23202		12867		HINGE, CONTROL PANEL DOOR	1
1-17	R93-61	68-80-302-20	94222		LATCH, BAIL HANDLE	2
1-18	R93-65	C2-32-35-3	94222		LATCH, RAISED TRIGGER, CHROME FINISH	4
1-19	M76-226-15		12867		PANEL, FUEL TANK ACCESS	1
1-20	22552		12867		BOTTOM SKINS & RUNNING GEAR (OPTION)	1
1-21	10536		12867		ACCESS DOOR	1
1-22	R93-110	616-02621	12867		CYLINDER, PRESSURE, LIFT	2
1-23	R96-814		12867		BRACKET, REINFORCEMENT	2
1-24	R93-53		12867		RETAINER, SNAP ACTION (OPTION)	4
1-25	K67-197		12867		TUBE, HOSE STORAGE	1
1-26	VM5002	9541K2 25/PK	0KVE6		BUMPER, RUBBER DOME, 3/4 DIA x 3/8 #8-32	6
1-27	IN0026	PAF 100 NUB4	0P2F7		INSULATION, 1" FOAM x 32" x 72"	AR
1-28	KH0011	EB23	12867		EYEBOLT, HOIST, SHOULDER, 3/8-16	1
1-29	P84-18		12867		LIGHT, FLASHING EMERGENCY	1
1-30	NOT USED					
1-31	NOT USED					
1-32	M76-225-02		12867		PANEL, ROOF, FORWARD	1
1-33	K68-439		12867		HOSE STORAGE EXTENSION	1
1-34	KH5061	02-10-202-10	94222		CATCH, MAGNETIC SNAP-IN	1
1-35	KH5256	9416K71	0KVE6		BALL, SOCKET END FITTING	4
1-36	IN5095	31401	0RR12		SPONGE, CLOSED CELL, 1/8" THK X 1" X FT	.21
1-37	23211		12867		PANEL, ROOF, REAR	1
1-38	25624		12867		FRAME, BODY 5050	1

- INDICATES ITEM NOT SHOWN

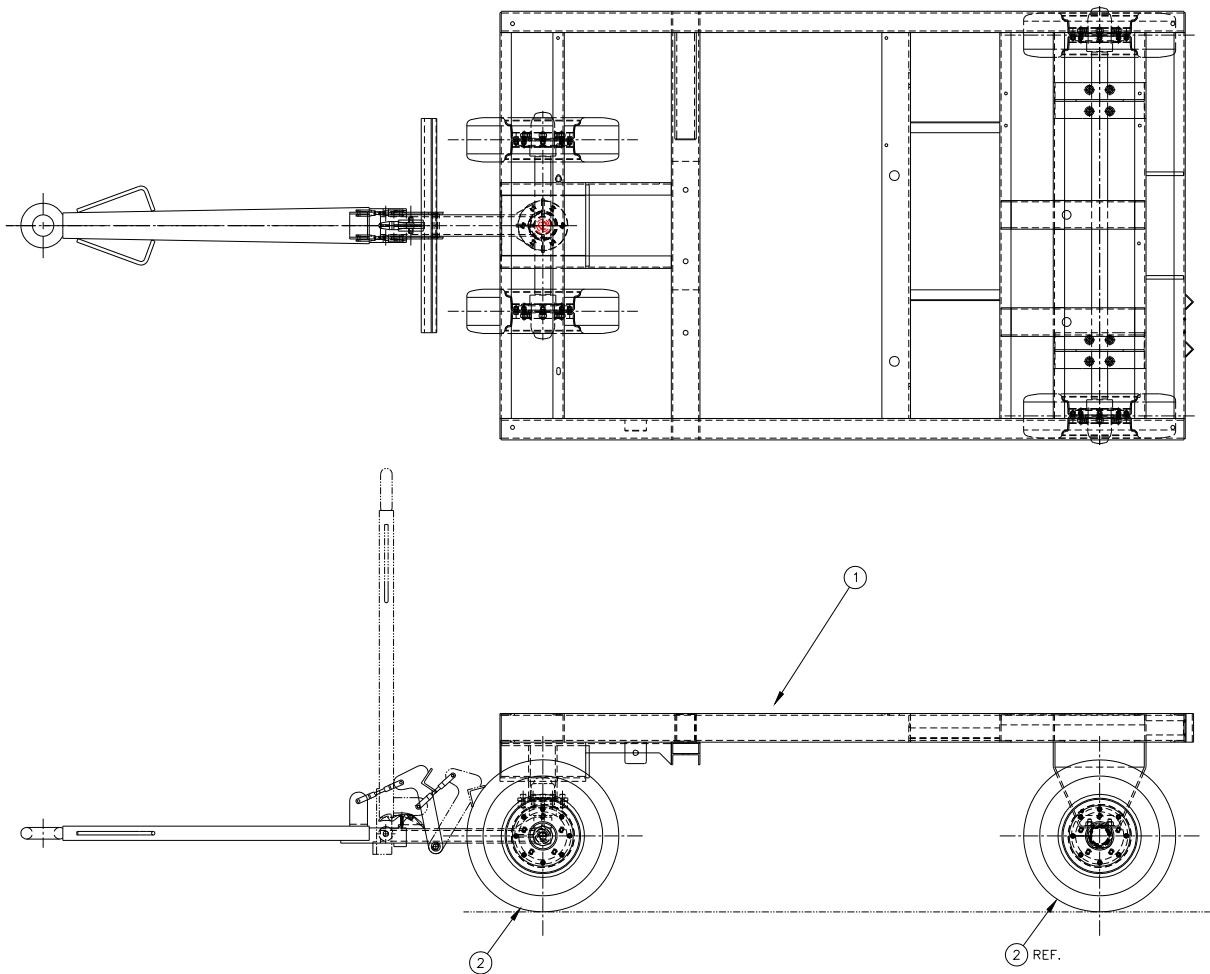


Figure 2. Frame / Running Gear Assembly

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
2-	25548 Rev -		12867		CHASSIS w/FRAME, RUNNING GEAR	REF
					& TIRES for 5050 heater	
2-1	23257		12867		MAIN FRAME	1
2-2	TA6111A		OXFRD		RUNNING GEAR, MECH FRONT BRAKE.	1

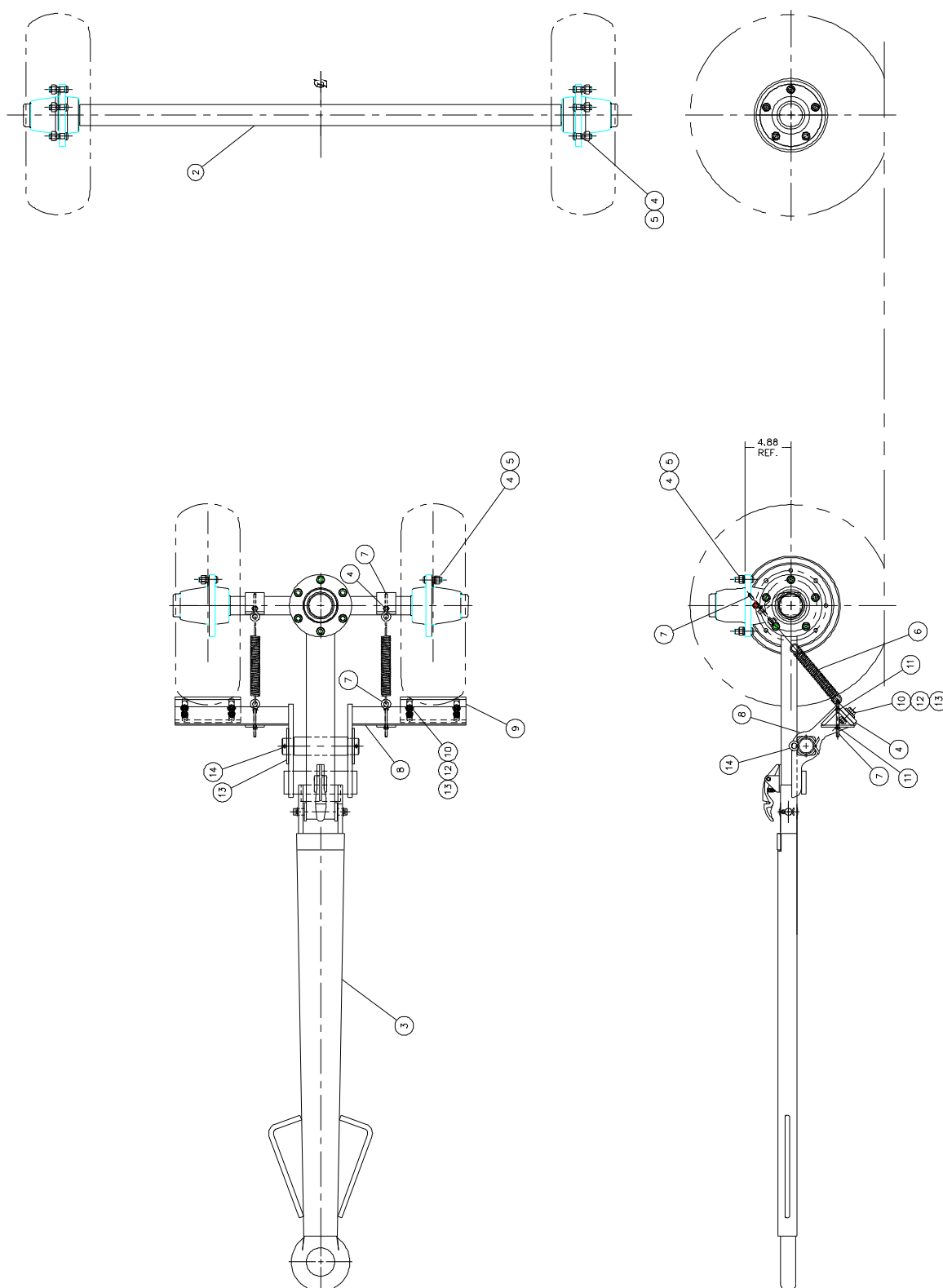


Figure 3. Four-Wheel Running Gear

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
3-	TA6111A . . .	F33-A	0W357		FOUR WHEEL RUNNING GEAR (See Figure 2)	REF
3-1		F6-2006	0W357		FRONT AXLE ASSY (See Figure 5)	1
3-2		15-2146	0W357		REAR AXLE ASSY (See Figure 4)	1
3-3		56-3502	0W357		DRAWBAR ASSY (See Figure 6)	1
3-4		4700-5	0W357		LOCKWASHER	26
3-5		4601-6	0W357		NUT, HEX, 1/2-20	26
3-6		4008	0W357		SPRING	2
3-7		4935	0W357		EYE BOLT	4
3-8		4303-10	0W357		LEVER WELDMENT	2
3-9		4303-11	0W357		ADJUSTING PLATE	2
3-10		4901-84	0W357		HEX HD BOLT 1/2-13	4
3-11		4601-4	0W357		NUT, HEX, 1/4-20	6
3-12		4701-5	0W357		1/2 FLAT WASHER	4
3-12		4701-26	0W357		1.75 FLAT WASHER	2
3-12		4800-16	0W357		COTTER PIN	2

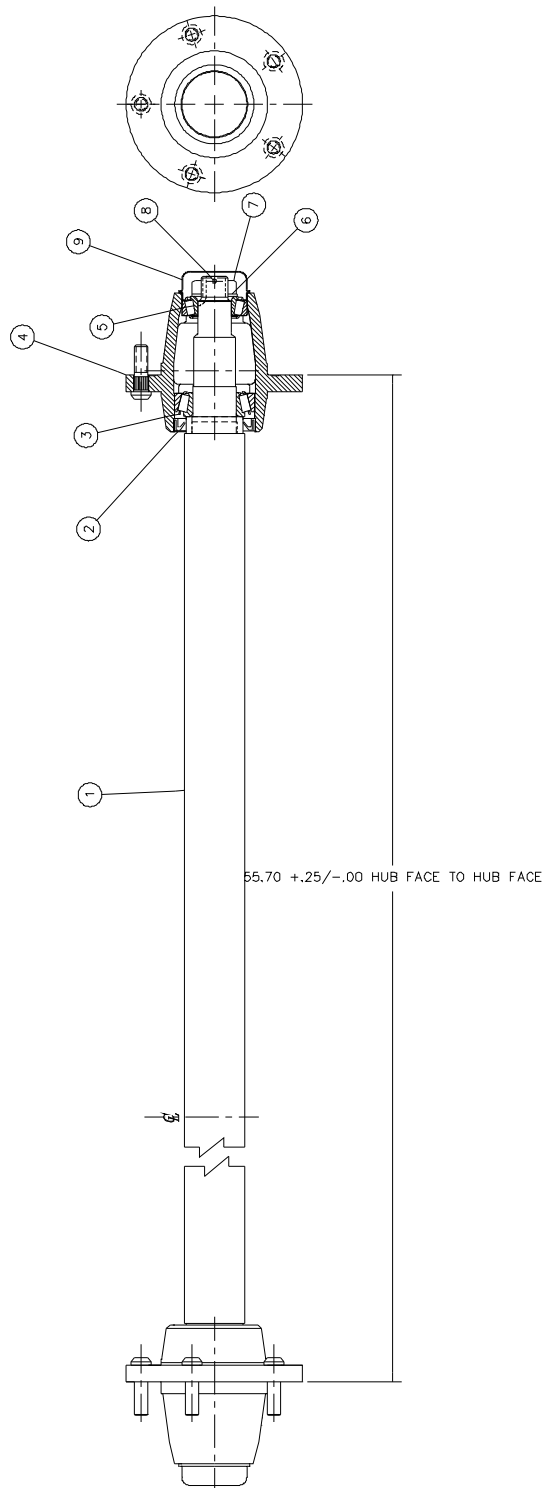


Figure 4. Rear Axle Assembly

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
4-		15-2146	0W357		REAR AXLE ASSEMBLY (See Figure 3)	REF
4-1		15-2146-3	0W357		REAR AXLE BEAM ASSY	1
4-2	TA5195	6311	0W357		SEAL, GREASE	2
4-3	TA5192	6057	0W357		BEARING CONE (INNER)	2
4-4	TA5187	3603-1	0W357		HUB SUB-ASSEMBLY	2
4-5	TA5096	6058	0W357		CONE, BEARING	2
4-6	TA5184	4702-2	0W357		SPINDLE KEY WASHER	2
4-7	TA5183	4600-2	0W357		NUT, JAM, 1-14, HEX SLOTTED	2
4-8	A5185	4800-5	0W357		COTTER PIN (MS24665-360)	2
4-9	TA5194	6312	0W357		GREASE CAP	2

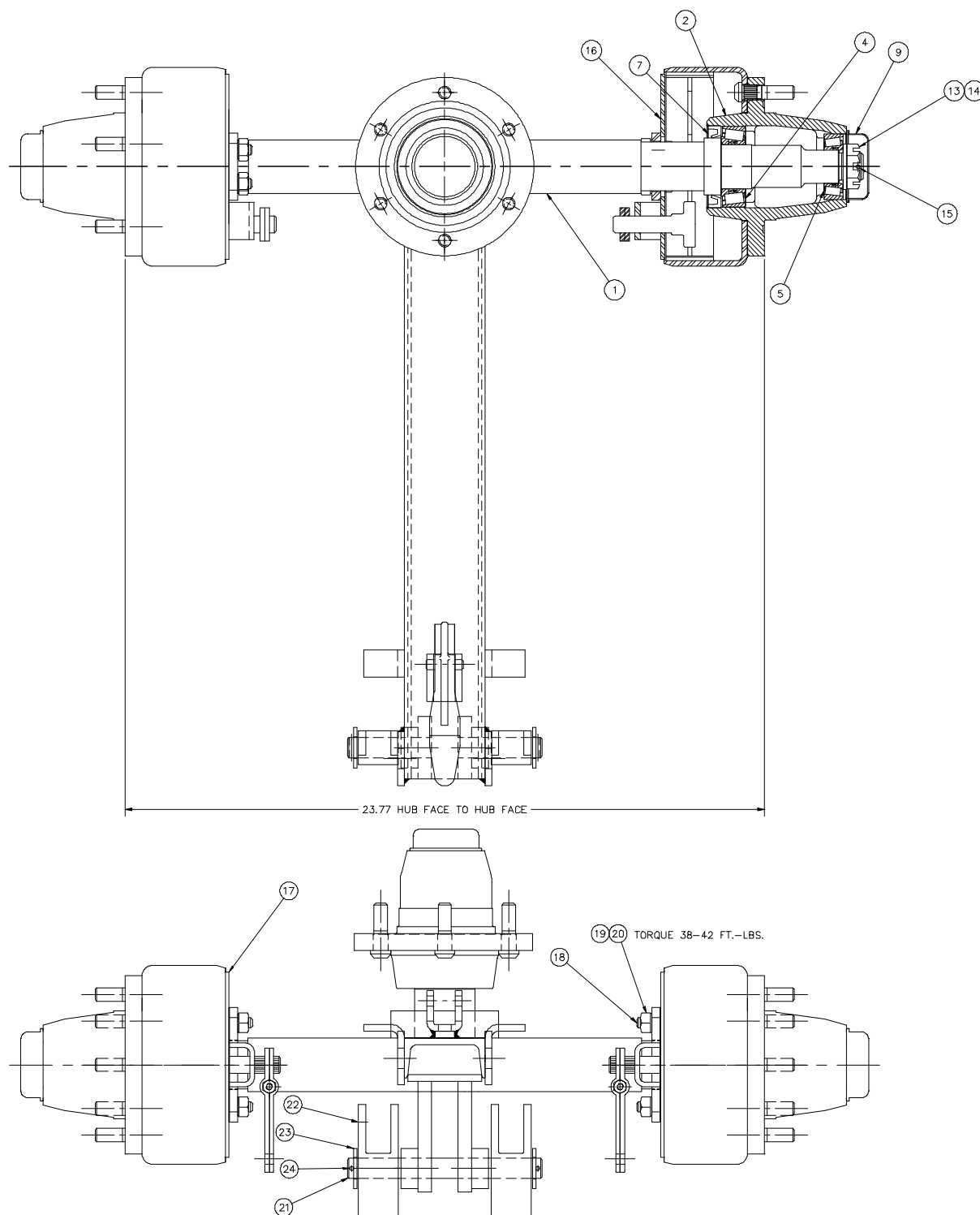


Figure 5. Front Axle Assembly (Sheet 1 of 2)

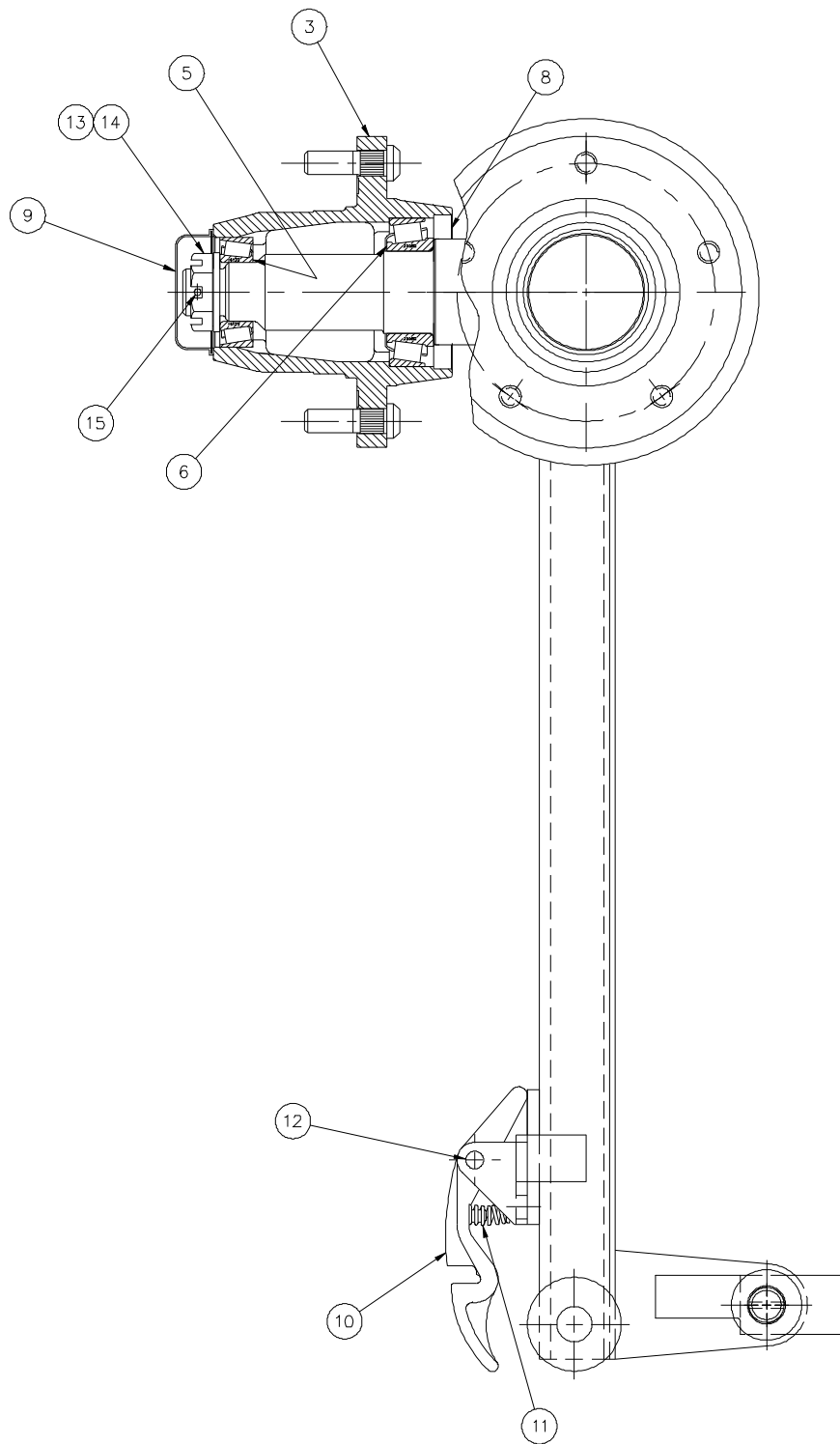


Figure 5. Front Axle Assembly (Sheet 2 of 2)

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
5-	TA5066	F6-2006	0W357		FRONT AXLE ASSEMBLY	REF
					(See Figure 3)	
5-1		F6-2006-2	0W357		AXLE BEAM WELDMENT	1
5-2	TA5952	3612-2	0W357		HUB SUB-ASSEMBLY	2
5-3	TA5819	3603-21	0W357		HUB SUB-ASSEMBLY	1
5-4	TA5192	6057	0W357		BEARING CONE (INNER)	2
5-5	TA5096	6058	0W357		BEARING CONE (OUTER)	3
5-6	TA5818	6062	0W357		BEARING CONE (INNER)	1
5-7	TA5195	6311	0W357		GREASE SEAL	2
5-8	TA5817	6309	0W357		GREASE SEAL	1
5-9	TA5194	6312	0W357		GREASE CAP	3
5-10	TA6030	3855-2	0W357		LATCH PEDAL	1
5-11	TA5122	4006	0W357		COIL, SPRING	1
5-12	TA5196	5000-5	0W357		ROLL PIN	1
5-13	TA5183	4600-2	0W357		HEX SLOTTED JAM NUT, 1-14	3
5-14	TA5184	4702-2	0W357		SPINDLE KEY WASHER	3
5-15	TA5185	4800-5	0W357		COTTER PIN	3
5-16	TA5160	4-8209	0W357		BRAKE ASSY	2
5-17	TA5167	8210	0W357		DUST SHIELD	2
5-18	TA5155	4901-7	0W357		BOLT, HEX HD, 3/8-24	8
5-19	TA5154	4700-4	0W357		WASHER, LK	8
5-20	TA5153	4601-47	0W357		NUT, HEX, 3/8-24	8
5-21		5910-84	0W357		CROSS SHAFT	1
5-22		4525	0W357		BAR, ROCKER	2
5-23	TA6053	4701-1	0W357		WASHER	2
5-24	TA5091	4800-8	0W357		COTTER PIN, 1/8 X 1.25	2

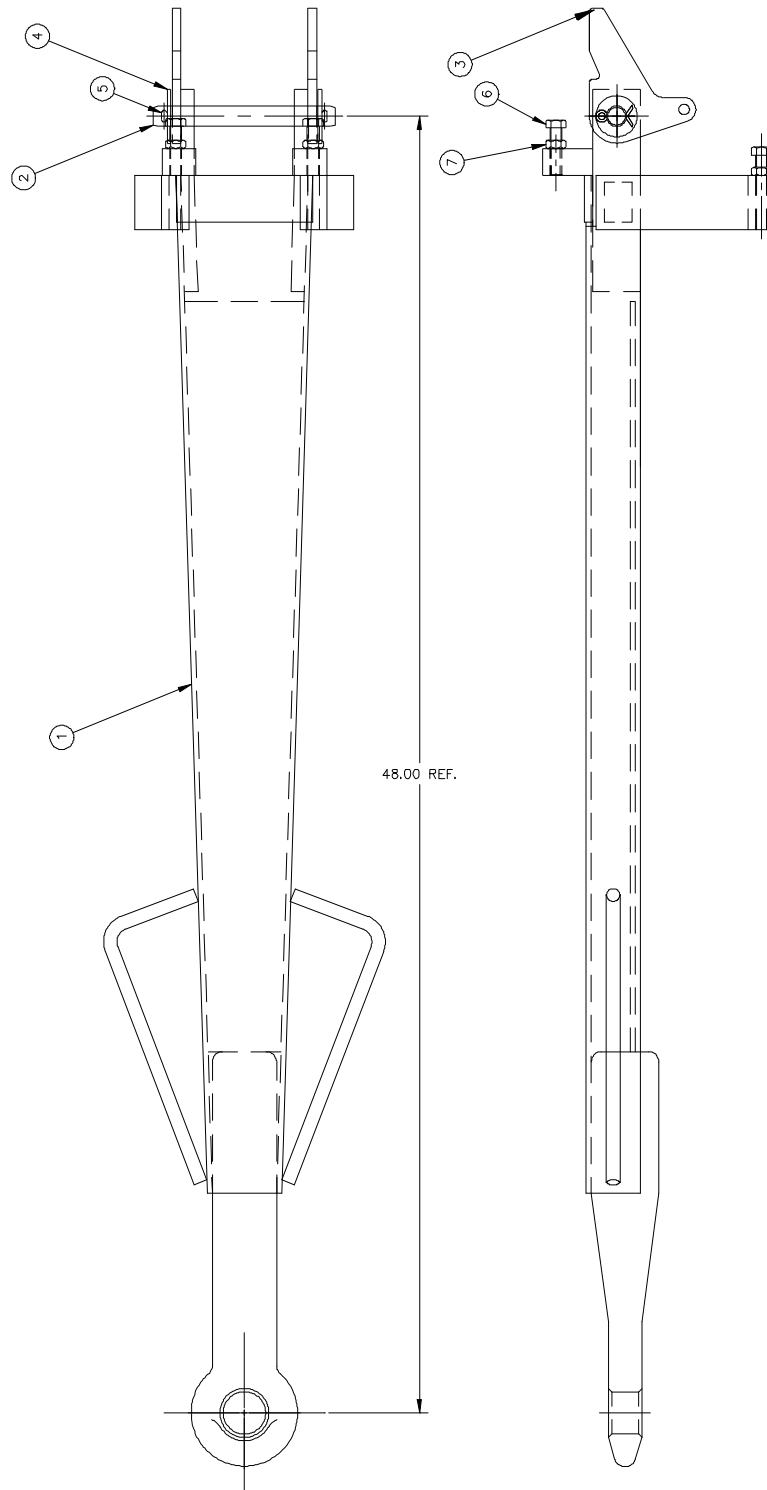


Figure 6. Drawbar Assembly

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
6-	TA6057	56-3502	0W357		DRAWBAR ASSEMBLY..... (See Figure 3)	1
6-1		3502-79	0W357		DRAWBAR WELDMENT.	1
6-2		5416-4.	0W357		PIN, HINGE	1
6-3		4515-2.	0W357		BRAKE LINK	2
6-4		4701-1.	0W357		WASHER.	2
6-5	TA5079	4800-6.	0W357		PIN, COTTER	2
6-6		4901-107.	0W357		BOLT, HEX HD, 7/16-20 X 1.75	4
6-7		4601-19	0W357		NUT, HEX, 7/16-20.	4

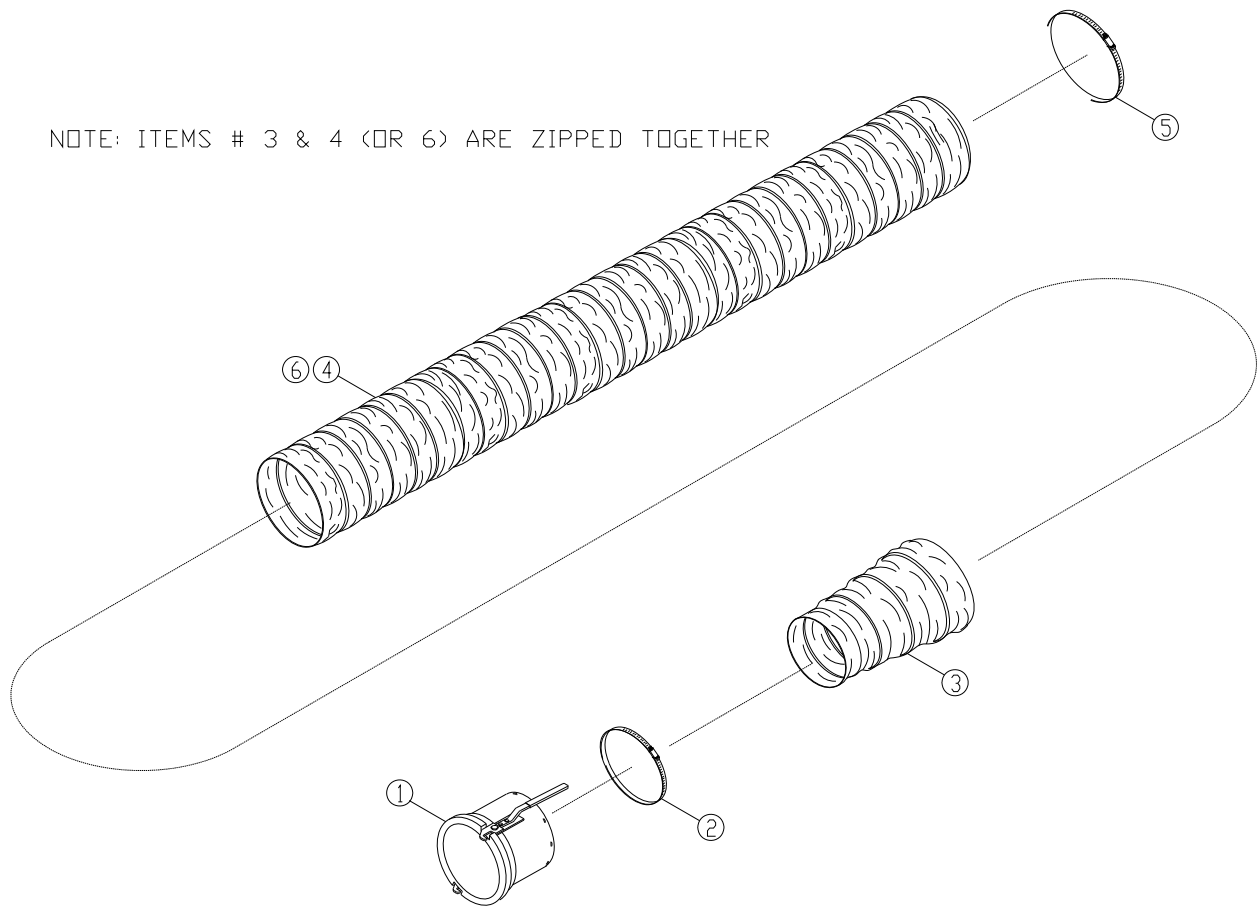


Figure 7. Heater Hose Assembly

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
7-	22542A Rev C		12867		HEATER HOSE ASSEMBLY	1
7-1	AA6073	JB 728	0SMN2		CONNECTOR, J&B DUCT NYLON PCA ACU.	1
7-2	CY5065	63128/ 03302	74821		CLAMP, 8" DIA	1
7-3	AA6007	31137	0RR12		DUCT, TAPER, SPIRAL, UNINSUL, 12" x 8" x 36"	1
7-4	AA6008	31135	0RR12		DUCT, SPIRAL, UNINSUL, SCUFF, 12" x 20FT (OPTIONAL - 20' DUCTS)	REF
7-5	CY5111	63224	0RR12		CLAMP, HOSE, 12"	1
7-6	AA6121		0RR12		DUCT, SPIRAL, UNINSUL, 12" x 30FT, SCUFF. (OPTIONAL - 30' DUCTS)	1

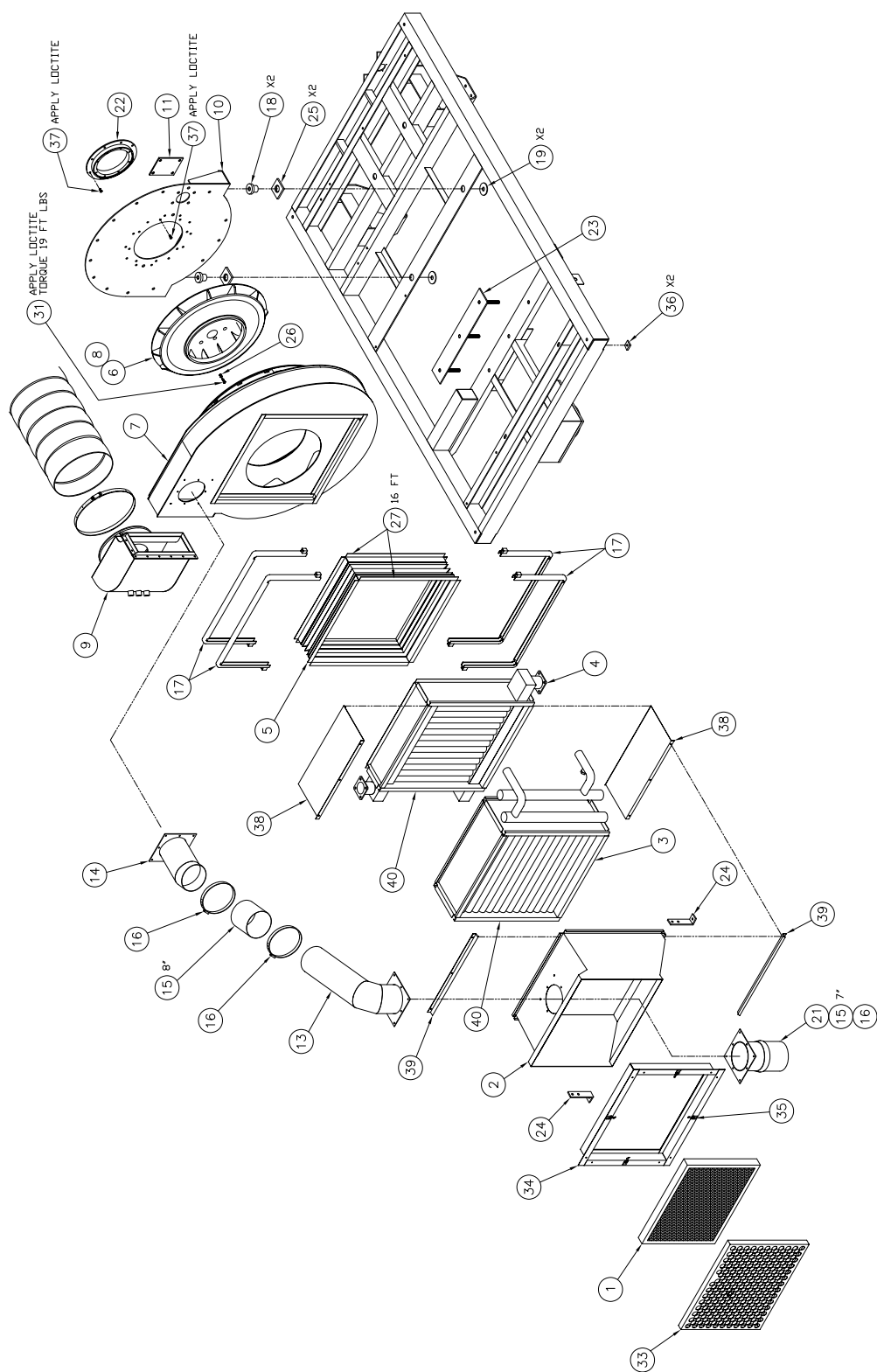


Figure 8. Air Flow System (Sheet 1 of 2)

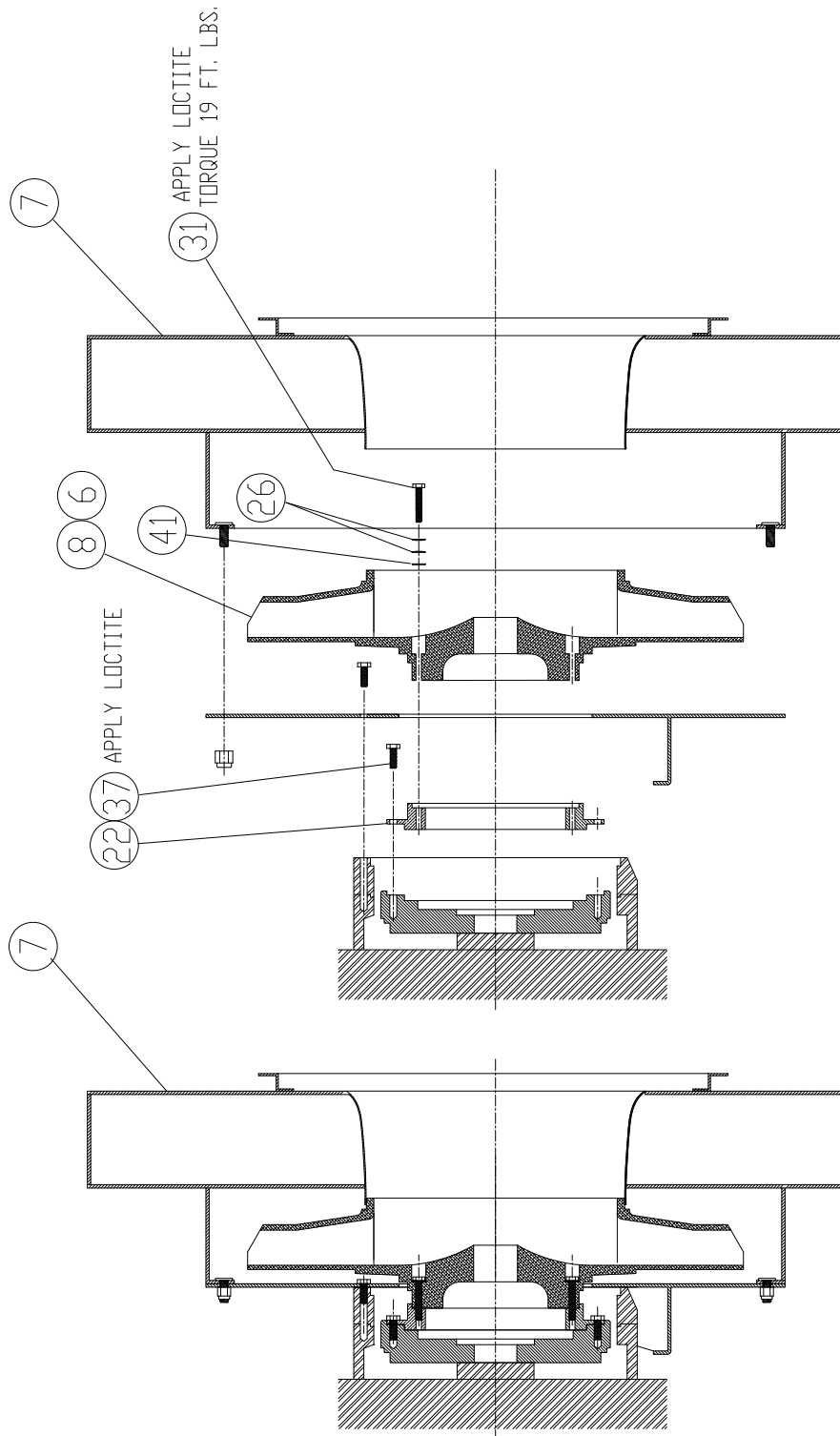


Figure 8. Air Flow System (Sheet 2 of 2)

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
8-	22547 REV C		12867		AIR FLOW SYSTEM	REF
8-1	C16-96		12867		FILTER, AIR, WASHABLE	1
8-2	K68-184		12867		INTAKE, FRESH AIR	1
8-3	K67-70	B50-8598	12867		COIL, HEAT EXCHANGER, OIL/WATER (MOD)	1
8-4	K67-147		12867		HEAT EXCHANGER ASSEMBLY	1
8-5	K68-172		12867		PLENUM ASSEMBLY, AIR INLET	1
8-6	K66-137		12867		CASTING, BLOWER WHEEL	1
8-7	K66-134		12867		HOUSING, BLOWER	1
8-8	K66-307		12867		WHEEL, BLOWER CAST ALUMINUM	1
8-9	K68-196		12867		DUCT, EXIT	1
8-10	K66-164		12867		PLATE, ADAPTING	1
8-11	K66-132-01		12867		PLATE, COVER, BALANCING HOLE	1
8-12	NOT USED					
8-13	K68-163		12867		REGENERATIVE SYSTEM	1
8-14	K68-213		12867		DUCT, REGENERATIVE	1
8-15	A01-18-06		12867		HOSE, BLUE PVC, FL, 12"	1
8-16	CY5110	#63188	0RR12		CLAMP	2
8-17	K68-162		12867		CLAMP, "U"	2
8-18	G45-26-05	CBA24-500-1	12965		MOUNT, VIBRATION, CENTER BOND (REAR)	2
8-19	VM5023	J-2049-67	12965		SNUBBING WASHER, REAR (FOR FIND 18)	2
8-20	K68-346		12867		INLET BAFFLE ASSEMBLY	REF
8-21	K68-387		12867		EXTENSION, REGENERATIVE TUBE	1
8-22	G44-132		12867		ADAPTER PLATE	1
8-23	R96-278		12867		ADJUSTABLE MOUNT	1
8-24	R96-170		12867		BRACKET, FRESH AIR INTAKE	2
8-25	22771		12867		SPACER, ENGINE MOUNT	2
8-26	R91-73		12867		WASHERS, CONICAL SPRING, 5/16"	16
8-27	S98-32	4104	12867		FOAM, URETHANE, SCOTCH	AR
8-28	NOT USED					
8-29	NOT USED					
8-30	NOT USED					
8-31	R91-76-548		12867		BOLT, 8-1,25 X 70MM, GR9	8
8-32	NOT USED					
8-33	M76-226-11		12867		COVER, FILTER, AIR INTAKE	1
8-34	21326		12867		RACK, FILTER AIR INTAKE	1
8-35	R93-53	A-5	12867		RETAINER, SNAP ACTION	4
8-36	HV5252	91152A031	0KVE6		SQUARE BEVELED WASHER, 3/8" HOLE DIA.	2
8-37	IYE025		12867		BOLT, HEX HD, M10-1.50 X 25MM	20
8-38	R96-A26		12867		CLAMP, LG, COIL	2
8-39	R96-A27		12867		CLAMP, SHT, COIL	2
8-40	PX5072		12867		MASTIC CAULKING, #8 SILICONIZED, TUBE	1
8-41	HRHBC1		12867		WASHER, FLAT 5/16"	

- ITEM NOT ILLUSTRATED

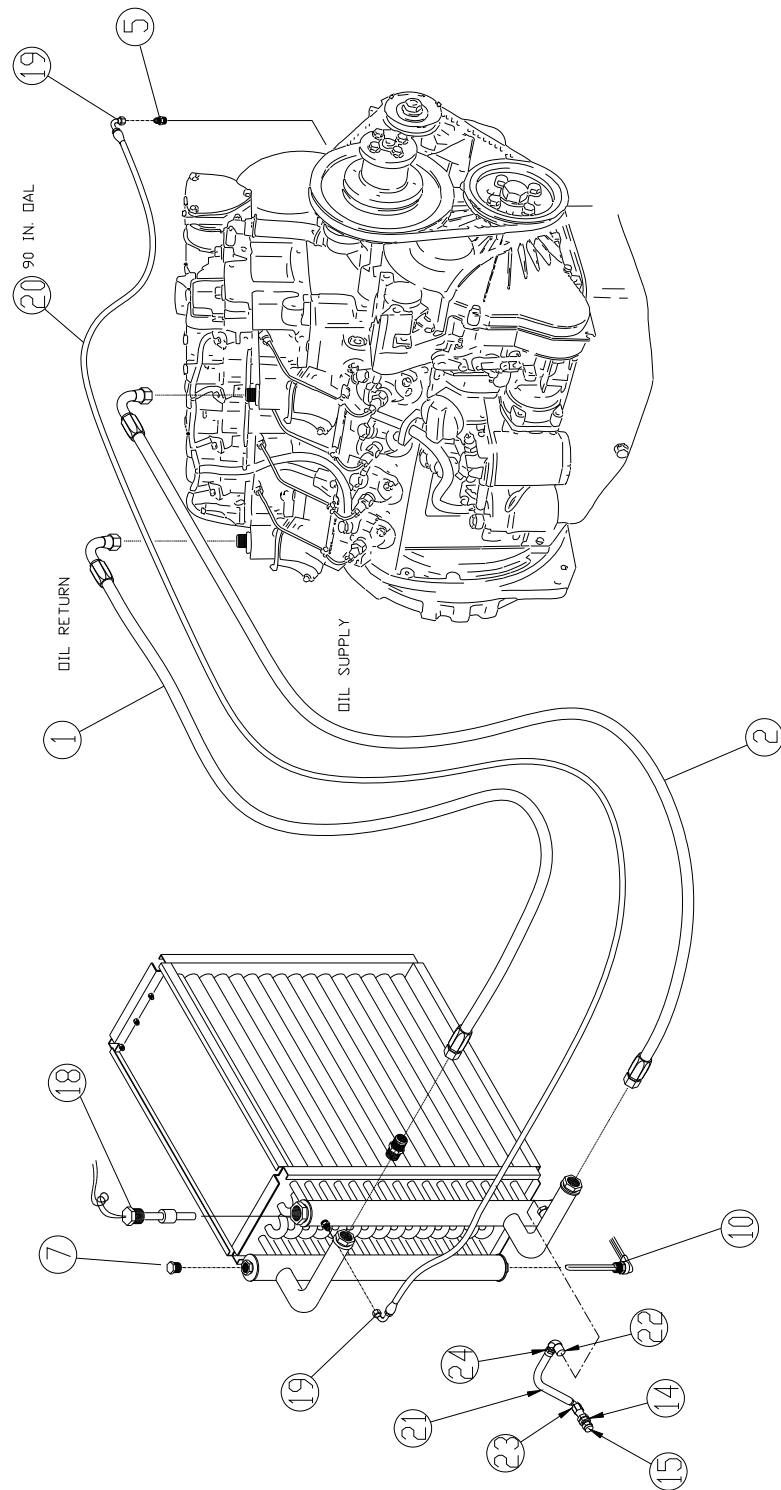


Figure 9. Oil Cooling System

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
9-	22541 REV D		12867		OIL COOLING SYSTEM	REF
9-1	A03-158-50	206063912121250	9B248		HOSE ASSEMBLY, OIL, UPPER (RETURN)	1
9-2	A03-158-60	206063912121260	9B248		HOSE ASSEMBLY, OIL, LOWER (SUPPLY)	1
9-3	NOT USED					
9-4	NOT USED					
9-5	R94-356-01	JM0410	12867		ADAPTER, MALE JIC TO MALE	1
9-6	NOT USED					
9-7	FI5096	2082-20S	1H123		PIPE PLUG, 1-1/4"	1
9-8	NOT USED					
9-9	NOT USED					
9-10	E33-82		12867		HEATER, 300W, 240VAC	1
9-11	NOT USED					
9-12	NOT USED					
9-13	NOT USED					
9-14	FI5704	2041-8-8S	1H123		ADAPTER, 37° FLR, 3/4-16x3/4-16 1/2"OD	1
9-15	FI0074	210292-8S	1H123		CAP NUT, 1/2"	1
9-16	PX5514		12867		OIL, 5W-30, ADI/CD, QT.	7
9-17	NOT USED					
9-18	D25-258	178591	04034		SWITCH, OIL LEVEL SENSOR	1
9-19	R94-382-01	37982-4-4	12867		ELBOW, SWIVEL, AQP, SOCKLESS	2
9-20	FM0002	FC332-04	5W026		HOSE, #4, FT	7
9-21	FM0003	FC332-08	5W026		HOSE, 1/2" AQP SOCKETLESS, FT	1
9-22	FI0047	2024-8-8S	5W026		ELBOW, 1/2 MPT TO 3/4 FLARE	1
9-23	FL0028	191321-8S	5W026		FITTING 90 DEG. ELBOW SOCKETLESS	1
9-24	FI5190	4797-8B	5W026		ADAPTER, HOSE END#8, 3/4-16 THD	1

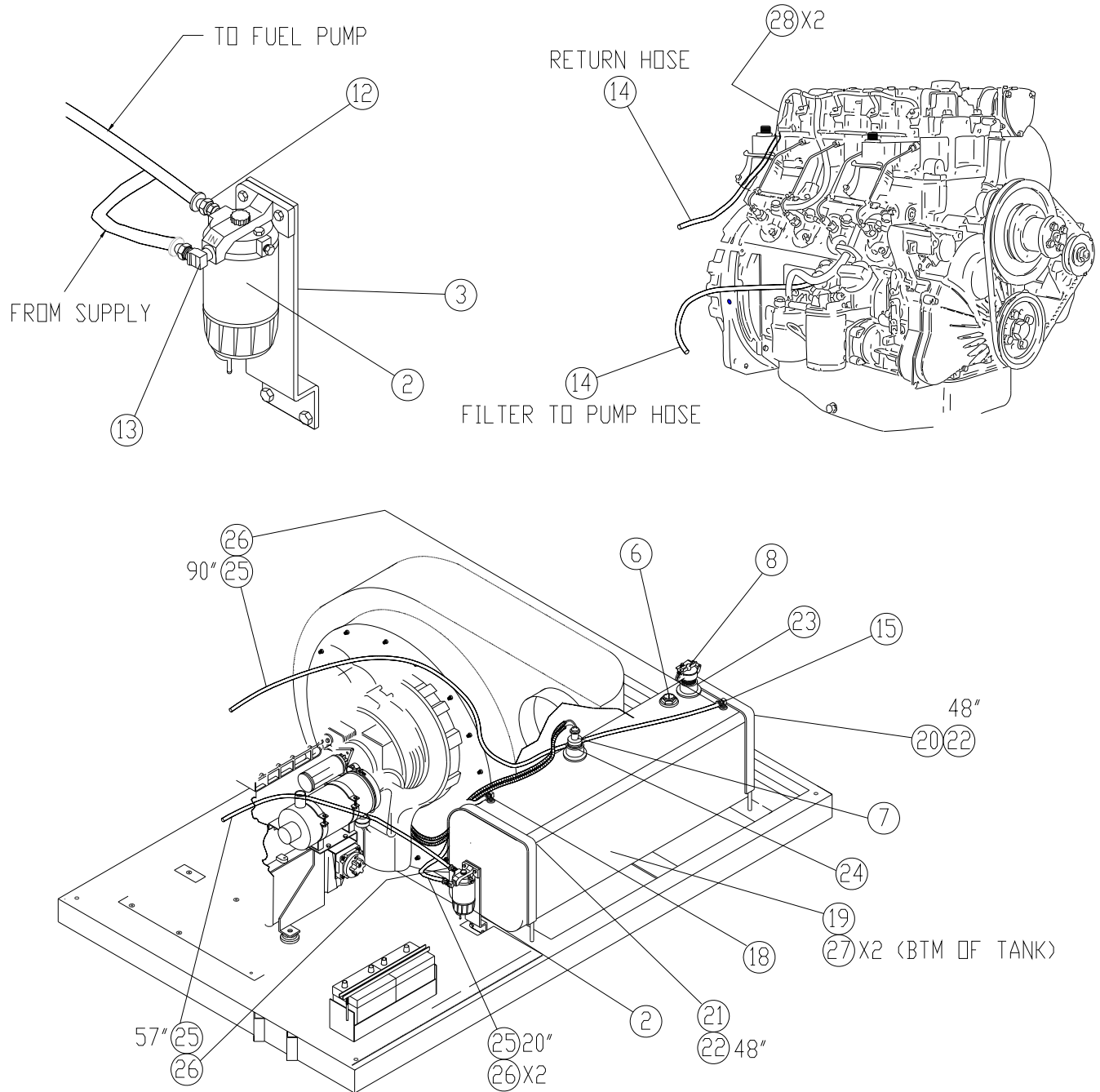


Figure 11. Fuel System Assembly

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
11-	22551A REV B		12867		FUEL SYSTEM ASSEMBLY (w/STRAPS)	1
11-1	J61-38-01		12867		FUEL TANK ASSEMBLY (w/BRACKETS)	1
11-2	G44-125-21	220R	55752		FILTER, FUEL WATER SEPARATOR	1
11-3	R96-912		12867		BRACKET, FUEL WATER SEPARATOR	1
11-4	J61-116-02		12867		BRACKET, TANK HOLD DOWN (OPTION)	2
11-5	SB5017		12867		THREADED ROD, 6.8 FT	1
11-6	H58-04	CLS 2-23-00	09393		GAUGE, FUEL LEVEL	1
11-7	D26-186-01	190846 / 166735	04034		SWITCH, FUEL LEVEL	1
11-8	J61-12-18	1274-39	12867		CAP, FILL, FUEL TANK (Protecto-Seal®)	1
11-9	22701		12867		FUEL LINE HOSE, SUPPLY TO FILTER	1
11-10	22702		12867		FUEL LINE HOSE, FILTER TO PUMP	1
11-11	22703		12867		FUEL LINE HOSE, RETURN	1
11-12	FI0058	2021-4-4S	1H123		ADAPTER, 1/4 MPT TO 7/16 FLARE	1
11-13	FI0065	2024-4-4S	1H123		ELBOW, 90°, 1/4 MPT TO 7/16 FLARE	1
11-14	CY0035	705-1107	6V626		CLAMP, HOSE #4	2
11-15	FI0042	2024-6-4S	1H123		ELBOW, 90°, 3/8 MPT TO 7/16 FLARE	1
11-16	F15010	2081-12-6S	1H123		REDUCER, EXT/INT PIPE, 3/4 TO 3/8 (OPTION)	2
11-17	1N0015	41-1264-28	7W514		NEOPRENE STRIP, 2' X 15' (OPTION)	1
11-18	R94-166-15.5		12867		FUEL INLET PICKUP	1
11-19	J61-72		12867		FUEL TANK (w/STRAPS)	1
11-20	R96-337		12867		STRAP, FUEL TANK	1
11-21	R96-338		12867		STRAP, FUEL TANK	1
11-22	IN5103		12867		STRIP, RUBBER, 2"W x 1/8" THK X 8 FT	1
11-23	R94-49-10		12867		NIPPLE, 2-1/2" PIPE	1
11-24	J61-123		12867		ADAPTER, FUEL LEVEL SWITCH	1
11-25	FM0002	FC332-04	5W026		HOSE, #4, 14 FT	1
11-26	FL0014	4797-4B	5W026		FITTING, SWVL, 7/16-20 X #4 HOSE	4
11-27	FI5589	2082-4S	5W026		PLUG, EXTERNAL PIPE, 1/4-18	2
11-28	CY5056	900729-1	5W026		CLAMP, #4	2

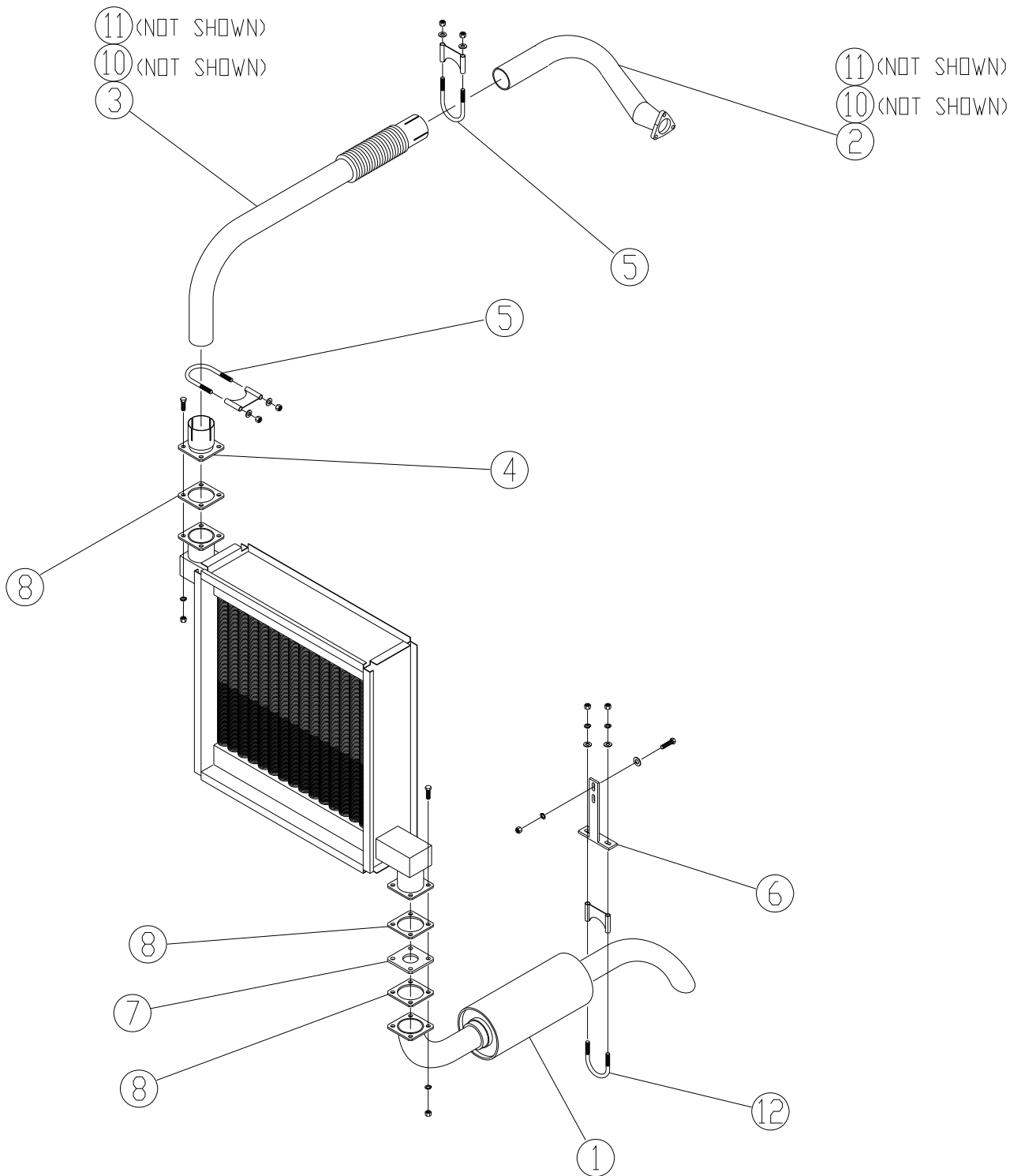


Figure 10. Exhaust System

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
10-	22546 REV A		12867		EXHAUST SYSTEM	REF
10-1	Q88-192-02		12867		EXHAUST PIPE	1
10-2	Q88-314-01		12867		EXHAUST PIPE ASSY TO ENGINE	1
10-3	Q88-317-01		12867		EXHAUST PIPE TO HEAT EXCHANGER	1
10-4	Q88-317-02		12867		EXHUAUST PIPE CONNECTOR	1
10-5	ET5049	P20-6405	76700		CLAMP, GUILLLOTINE, 2-1/2"	2
10-6	R96-294		12867		BRACKET, HANGER	1
10-7	Q88-299		12867		PLATE, BACK PRESSURE	1
10-8	Q88-57	#10849	76281		GASKET, EXHAUST FLANGE	3
10-9	NOT USED					
-10-10	EB5224	11002	THERM.		EXHAUST TAPE, 2" X 1/16" X 50 FT	1
-10-11	EB5225	13001	THERM.		SNAP STRAP TIE WRAPS	1
-10-12	ET5155	P20-6407	76700		CLAMP, GUILLLOTINE, 3"	1

- ITEM NOT ILLUSTRATED

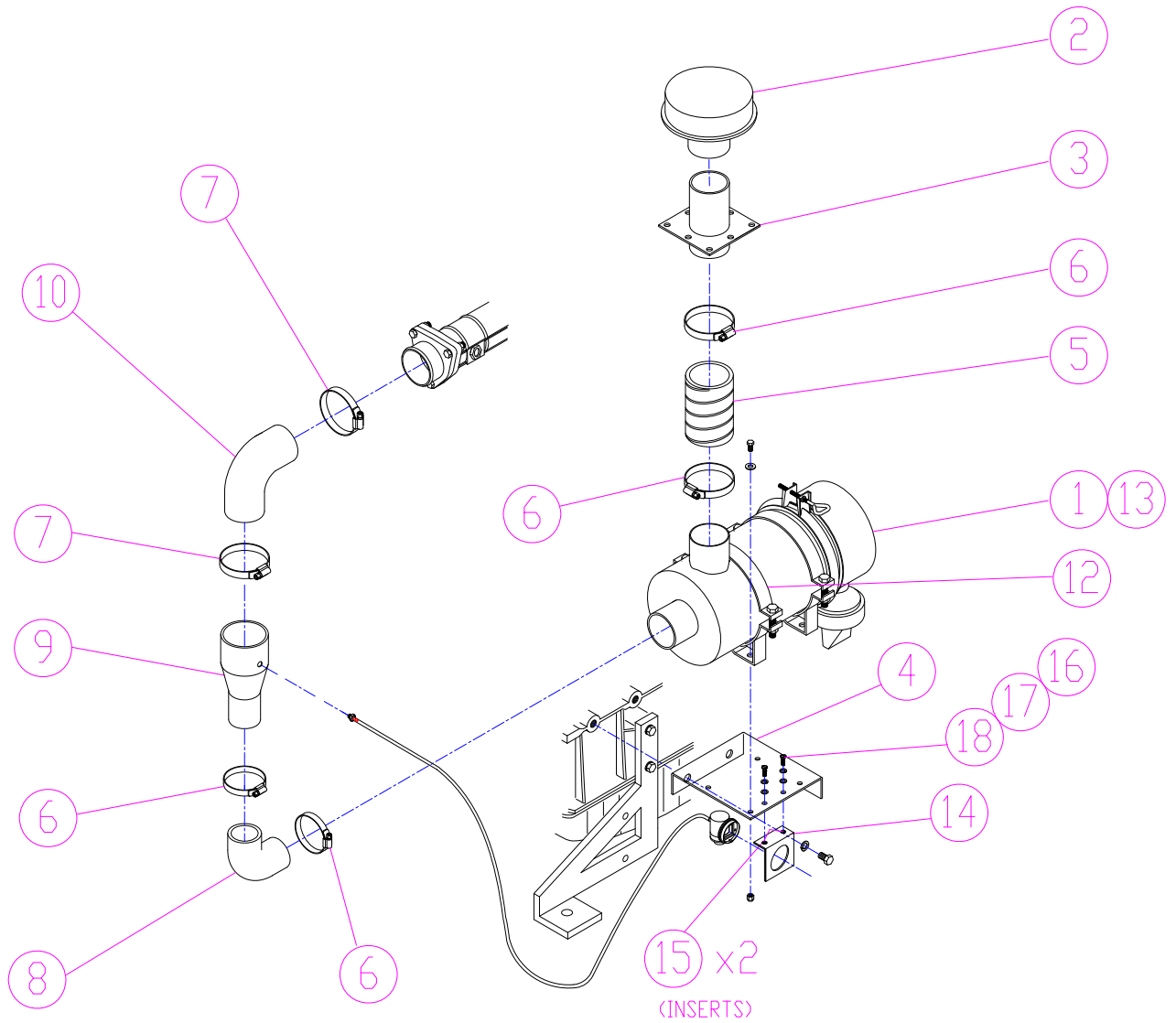


Figure 11. Air Intake Assembly

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
11-	22549 REV B		12867		AIR INTAKE ASSEMBLY	1
11-1	C16-57-03	FWG06-5008	18265		ELEMENT, AIR CLEANER	1
11-2	C16-58-05	GAX00-1966	18265		AIR INLET HOOD	1
11-3	G49-29		12867		CONNECTOR, AIR INTAKE	1
11-4	G49-44-01		12867		BRACKET, AIR INTAKE	1
11-5	AH5110	70-262	0RR12		HOSE, COOLANT, 2.62ID x 19", 351PSI	1
11-6	CY0015	705-1020	6V626		CLAMP, HOSE 1-1/8" to 3", LOWER ELBOW HOSE	4
11-7	CY5035	89580K	76700		CLAMP, HOSE, T-BOLT, 3.0" ID, UPPER ELBOW	2
11-8	C16-59-03		12867		ADAPTER, RUBBER	1
11-9	EB5815	89253A	76700		REDUCER, 3" TO 2.5"	1
11-10	EB5316	89818K	76700		ADAPTER, RUBBER	1
11-11	ME5070	X002251	18265		FILTER MINDER®, DIFF PRESS INDICATOR	1
11-12	EB5837	Q27177	76700		MOUNTING BAND, AIR FILTER	2
11-13	EB5838	70079N	76700		ELEMENT, AIR FILTER	.REF
11-14	08378		12867		BRACKET, FILTER	1
11-15	KH5306		12867		INSERT, THD. 10-32	2
11-16	HWFO63		12867		SCREW, PHL PH, MSS SS, 10-32 X 5/8"	2
11-17	HRFCBI		12867		LOCKWASHER, MEDIUM SPLIT, #10, SS	2
11-18	HRFCC1		12867		FLAT WASHER, #10, S.S.	2

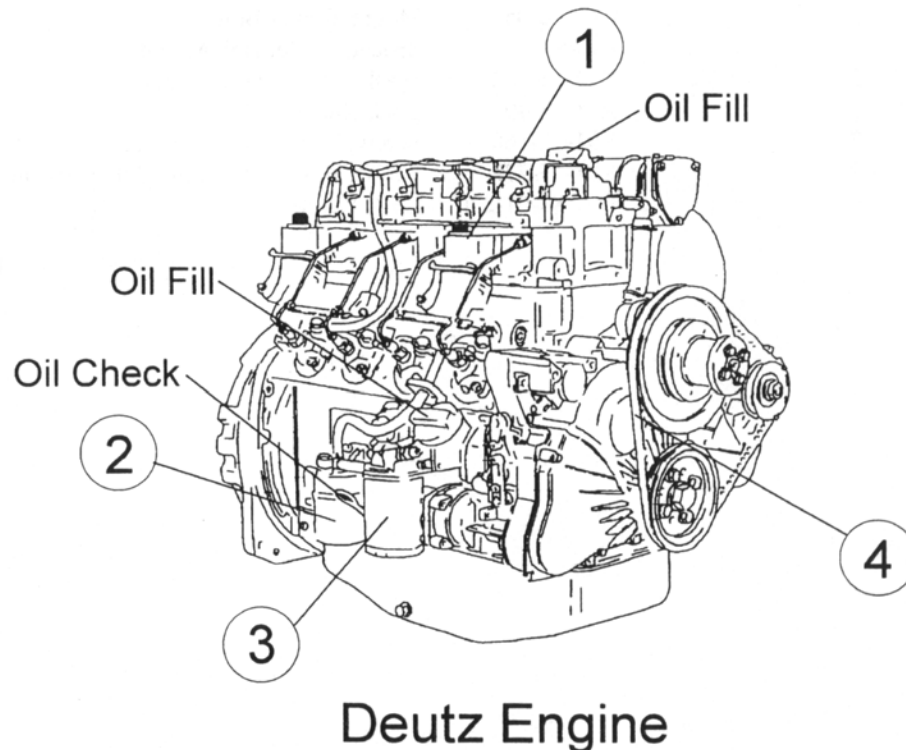


Figure 12. Engine Sub-Assembly (Deutz Engine)

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
12-			12867		ENGINE SUB-ASSEMBLY	REF
12-1	G44-125	F4L1011F	12867		ENGINE, DIESEL, OIL COOLED	1
12-2	G44-125-23	1174696	12867		ELEMENT, FILTER, FUEL	1
12-3	G44-125-24		12867		ELEMENT, FILTER, OIL	1
12-4	G44-125-25		12867		FAN BELT	1
-12-5	E33-81	8609683	7A013		OIL PAN HEATER - OIL DRAIN (See Figure 17)	1
-12-6	G44-125-101		12867		COVER PLATE, FLYWHEEL HOUSING	1
-12-7	G44-125-21	220R	4L990		SEPARATOR, WATER, FUEL WATER	1
-12-8	G44-125-27		12867		BRACKET, THROTTLE CABLE	1
-12-9	ME0011	N68501-00225	59150		FILTER MINDER, WITH HOSE	1

- ITEM NOT ILLUSTRATED

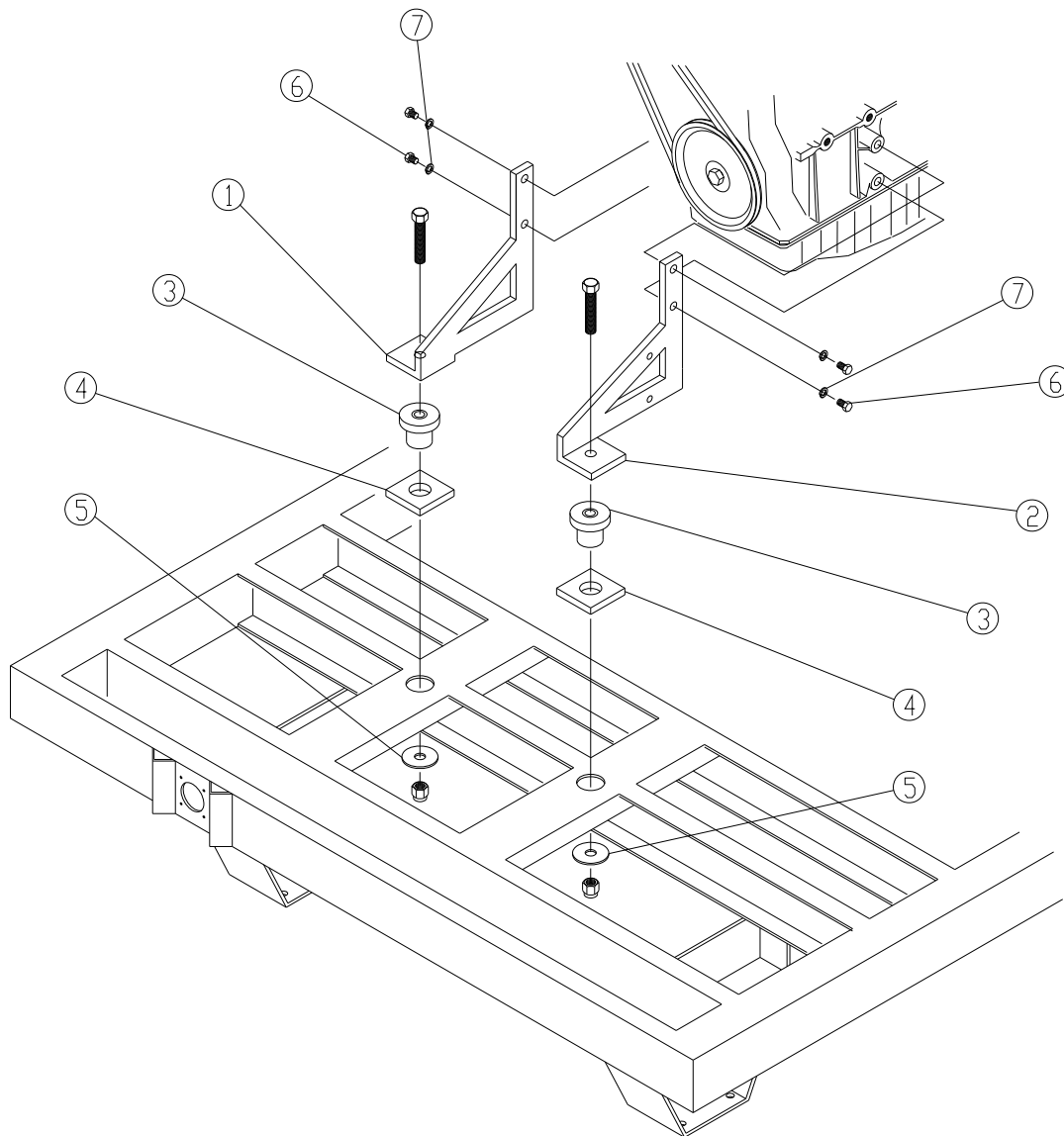


Figure 13. Engine Mount Assembly (Deutz Engine)

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
13-	22548 REV A.		12867		ENGINE MOUNT ASSEMBLY	1
13-1	G45-79.		12867		MOUNT, ENGINE, LEFT SIDE	1
13-2	G45-80.		12867		MOUNT, ENGINE, RIGHT SIDE	1
13-3	G45-26-03.		12867		FRONT MOUNT	2
13-4	22770		12867		SPACER, ENGINE MOUNT	2
13-5	VM5024	J-2049-65	12965		TAIL WASHER, FRONT	2
13-6	IYG030		12867		BOLT, HEX HD, M14-2.0x30mm, GR10.9	2
13-7	IWGGB1		12867		WASHER, LK, SPLIT, M14.	2

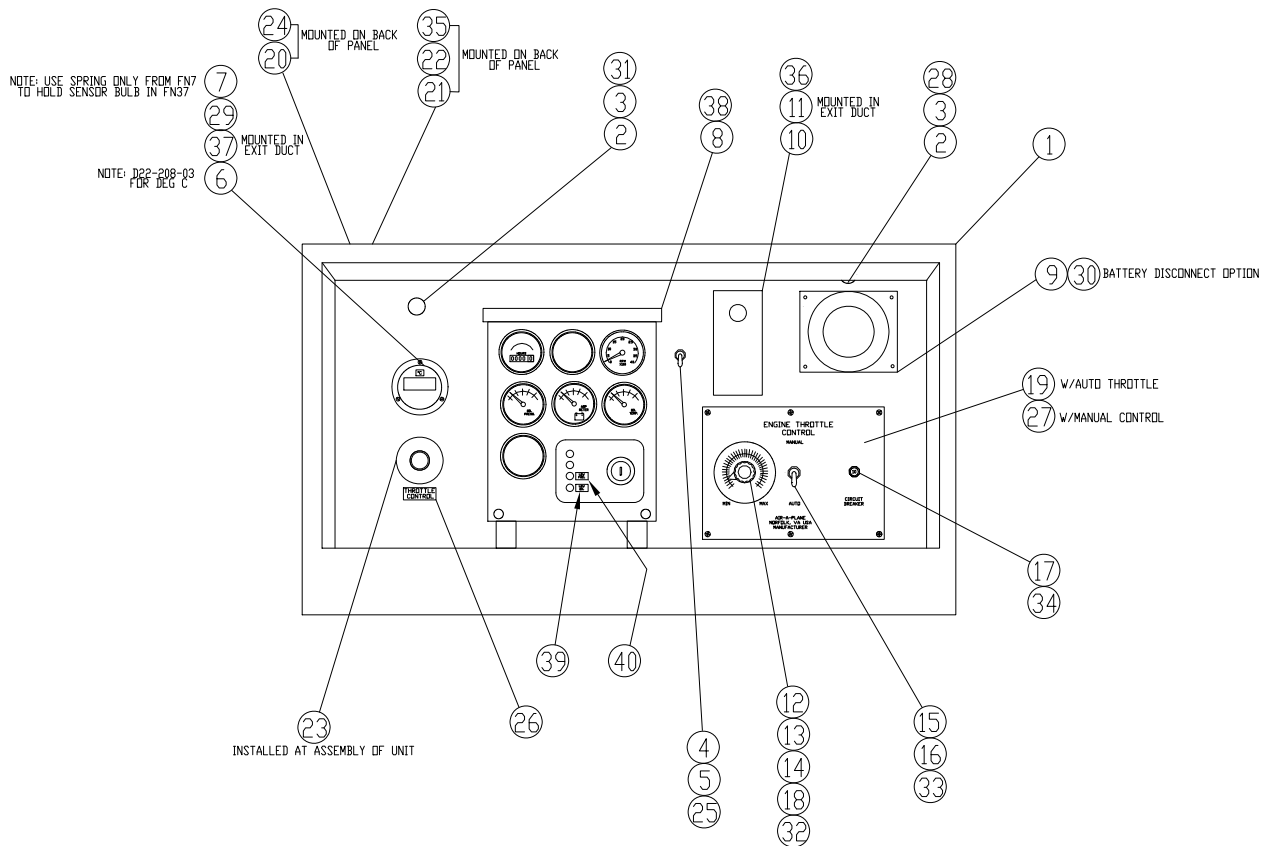


Figure 14. Control Panel Assembly

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
14- . . .	22543A REV C		12867		CONTROL PANEL ASSY, w/MANUAL CNTRLs	.REF
14-1 . . .	M76-864-02		12867		BOX, INSTRUMENT PANEL	1
14-2 . . .	D29-136	60101-5	12867		LAMP, BAYONET BASE	2
14-3 . . .	D29-135-10		12867		LAMP, SC BAYONET, MINIATURE	.REF
14-4 . . .	D25-06	11TS15-2	0AAR4		SWITCH, TOGGLE, MAINTAINED	1
14-5 . . .	D25-86	35060-BU	12867		BOOT, SWITCH, TOGGLE, RUBBER	1
14-6 . . .	D22-209	TI300-12-AAP-01	50831		THERMOMETER, DIGITAL, 12VAC/DC, °F, 30FT	1
14-7 . . .	AA5361	WEL11A-601R	50831		SENSOR, WELL	1
14-8 . . .	G44-125-35		12867		PANEL, CONTROL	1
14-9 . . .	D25-253		12867		BATTERY DISCONNECT	.REF
14-10 TO 14-19. . . NOT USED						
14-20 . .	D21-181	S271-K63	12867		BREAKER, CIRCUIT, 63A	1
14-21 . .	FU0006	AGC-15	71400		FUSE, 15 AMP. 32V, 1/4 x 1-1/4	1
14-22 . .	FH5007	354812G-Y 20 AMP	75915		FUSE BLOCK, 20A	1
14-23 . .	H57-18-71		12867		CABLE, THROTTLE CONTROL	.REF
14-24 . .	22713A		12867		LABEL, CB1	1
14-25 . .	22713B		12867		LABEL, S2	1
14-26 . .	22713L		12867		LABEL, "THROTTLE CONTROL"	1
14-27 . .	22717		12867		PLATE, COVER	1
14-28 . .	22713S		12867		LABEL, DS1	1
14-29 . .	22713U		12867		LABEL, M1	1
14-30 . .	22713G		12867		LABEL S1	.REF
14-31 . .	22713W		12867		LABEL, DS2	1
14-32	NOT USED					
14-33	NOT USED					
14-34	NOT USED					
14-35 . .	22713D		12867		LABEL, F2	1
14-36 . .	22713V		12867		LABEL, TC1	1
14-37 . .	AA0011	WEL14A-602R	50831		BULB WELL, TEMP, 250DEG F, 4-15/16 LG	1
14-38 . .	FU5101	ATM-15 / 97F7593	71400		FUSE, FAST ACTING, AUTO TYPE, 15A, 32V	.REF
14-39 . .	23362A		12867		LABEL, LOW FUEL	1
14-40 . .	23362B		12867		LABEL, 140 THROTTLE CONTROL ASSY	1

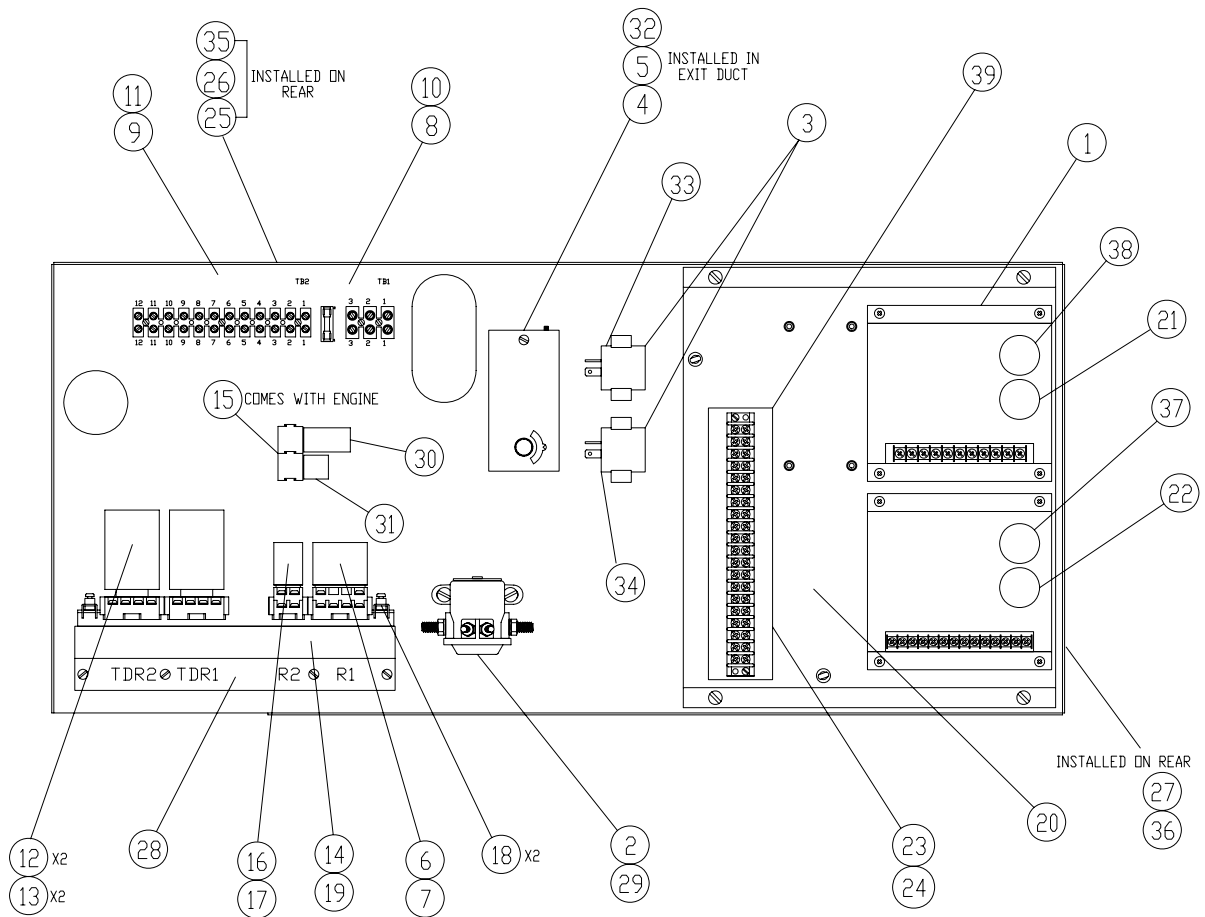


Figure 15. Relay Panel Assembly

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
15-	22544A Rev B		12867		RELAY PANEL ASSY (MANUAL CNTRLs)	REF
15-1	M76-864-01		12867		BOX, RELAY PANEL	1
15-2	D20-60	SS581	12867		RELAY (K1)	1
15-3	P84-18-01	552	2E279		FLASHER, EMERGENCY LIGHT (FL1,2)	2
15-4	D26-74	A19ABC-44C	50831		SWITCH, TEMPERATURE (OTS)	1
15-5	AA0011	WEL14A-602R	50831		BULBWELL	1
15-6	D20-138-04	SH4B-05	HRMTG		BASE, RELAY, DIN RAIL SNAP	1
15-7	D20-140-04	RH4B-U-DC12V	HRMTG		RELAY, BLADE TYPE (R1)	1
15-8	D24-114	21-340-6253.0	0AAR4		STRIP, TERMINAL (TB1)	1
15-9	D24-112	21-331-6253	0AAR4		STRIP, TERMINAL (TB2)	1
15-10	H56-321-1		12867		LABEL, TERMINAL BLOCK 3 TERMINALS	1
15-11	H56-321-2		12867		LABEL, TERMINAL BLOCK 12 TERMINAL	1
15-12	D20-164-01	SR2P-06	HRMTG		BASE, RELAY, DIN RAIL SNAP	2
15-13	D20-132-02	TDM12DL	HRMTG		RELAY, DELAY ON MAKE, 8 PIN (TDR1, 2)	2
15-14	D20-151	BND1000	HRMTG		RAIL MOUNTING	1
15-15	CO5524	0427-1983	7A013		BASE KIT, GLOW PLUG RELAY	1
15-16	D20-138-02	SH2B-05	12867		BASE, RELAY, DIN RAIL SNAP	2
15-17	D20-140-02	RH2B-U-DC12V	12867		RELAY, BLADE TYPE	2
15-18	D20-152	BNL-5	12867		CLIP, END	2
15-19	R96-A18		12867		BRACKET	1
15-20	NOT USED					
15-21	NOT USED1					
15-22	NOT USED					
15-23	D24-206-20	77020	98473		BLOCK, TERMINAL, BARRIER(TB3)	1
15-24	MS1120	MS600-20-1A	75382		MARKER STRIP	1
15-25	FU0006	AGC-15	71400		FUSE, 15A. 32V, 1/4 x 1-1/4 (F1)	1
15-26	FH5007	354812G-Y 20 AMP	75915		FUSE BLOCK, 20A	1
15-27	D30-89	1936	9K537		HORN, WARNING SYSTEM	1
15-28	H56-718		12867		LABEL, RELAY	1
15-29	22713K		12867		LABEL, K1	1
15-30	22713M		12867		LABEL, GPR1	1
15-31	22713N		12867		LABEL, GPR2	1
15-32	22713H		12867		LABEL, OTS	1
15-33	22713E		12867		LABEL, FL1	1
15-34	22713F		12867		LABEL, FL2	1
15-35	22713C		12867		LABEL, F1	1
15-36	22713R		12867		LABEL, HORN	1
15-37	NOT USED1					
15-38	NOT USED1					
15-39	22713J		12867		LABEL, TB3	1

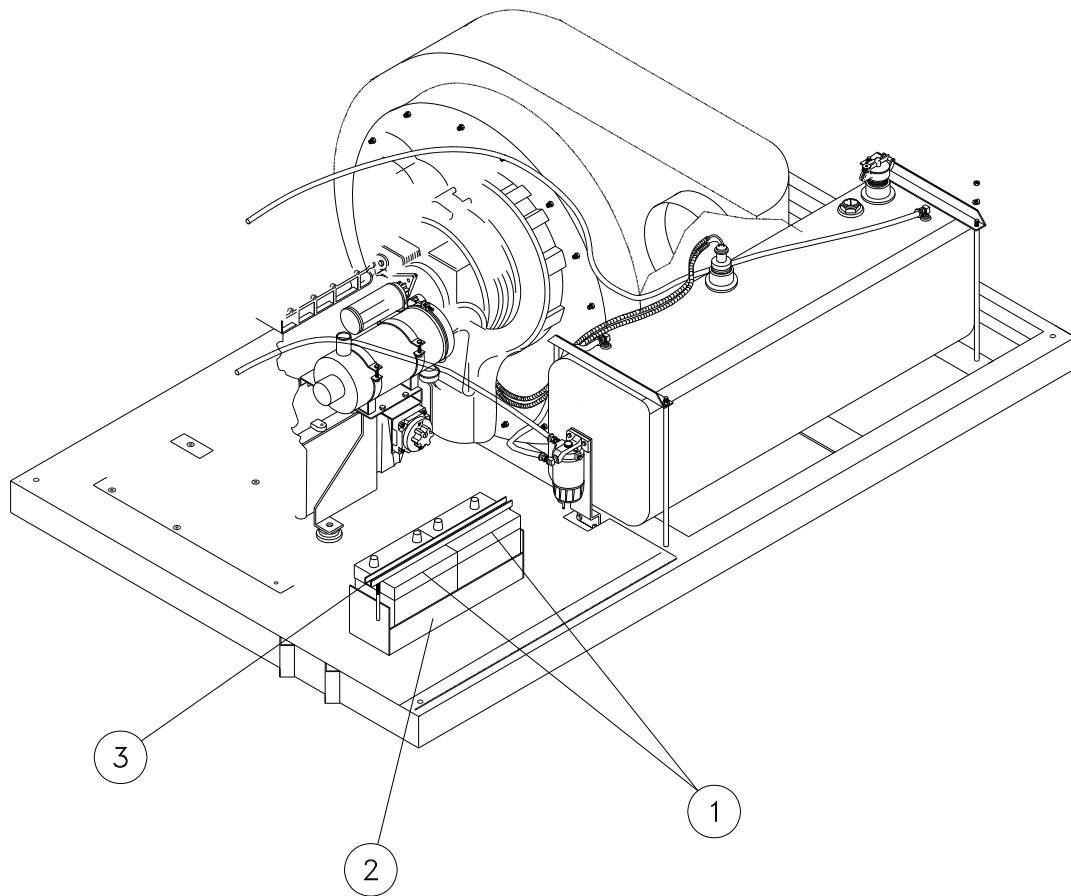


Figure 16. Battery Installation

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
16- . . .	22737 REV A		12867		BATTERY INSTALLATION	REF
16-1 . . .	BA5005				BATTERY, GROUP 34, 850CCA @0°F	2
16-2 . . .	16931		12867		BATTERY BOX MOUNTING	1
16-3 . . .	16933		12867		BATTERY HOLD DOWN	1
-16-4 . .	WI0002		12867		CABLE, 600V, BLK, 2/0 WELDING, 9.17 FT	1
-16-5 . .	BA0009		12867		BATTERY CONNECTOR	4
-16-6 . .	WL0020		12867		LUG, TERMINAL, 2/0, 5/16"	6
-16-7 . .	WL5026		12867		LUG, TERMINAL, 2/0, 3/8"	2
-16-8 . .	SL5006		12867		TUBING, SHRINK, RED, .67 FT	1
-16-9 . .	SL0030		12867		TUBING, SHRINK, BLK, .67 FT	1
-16-10 .	SL5030		12867		PROTECTOR, HARNESS, 5/8"	1

- ITEM NOT ILLUSTRATED

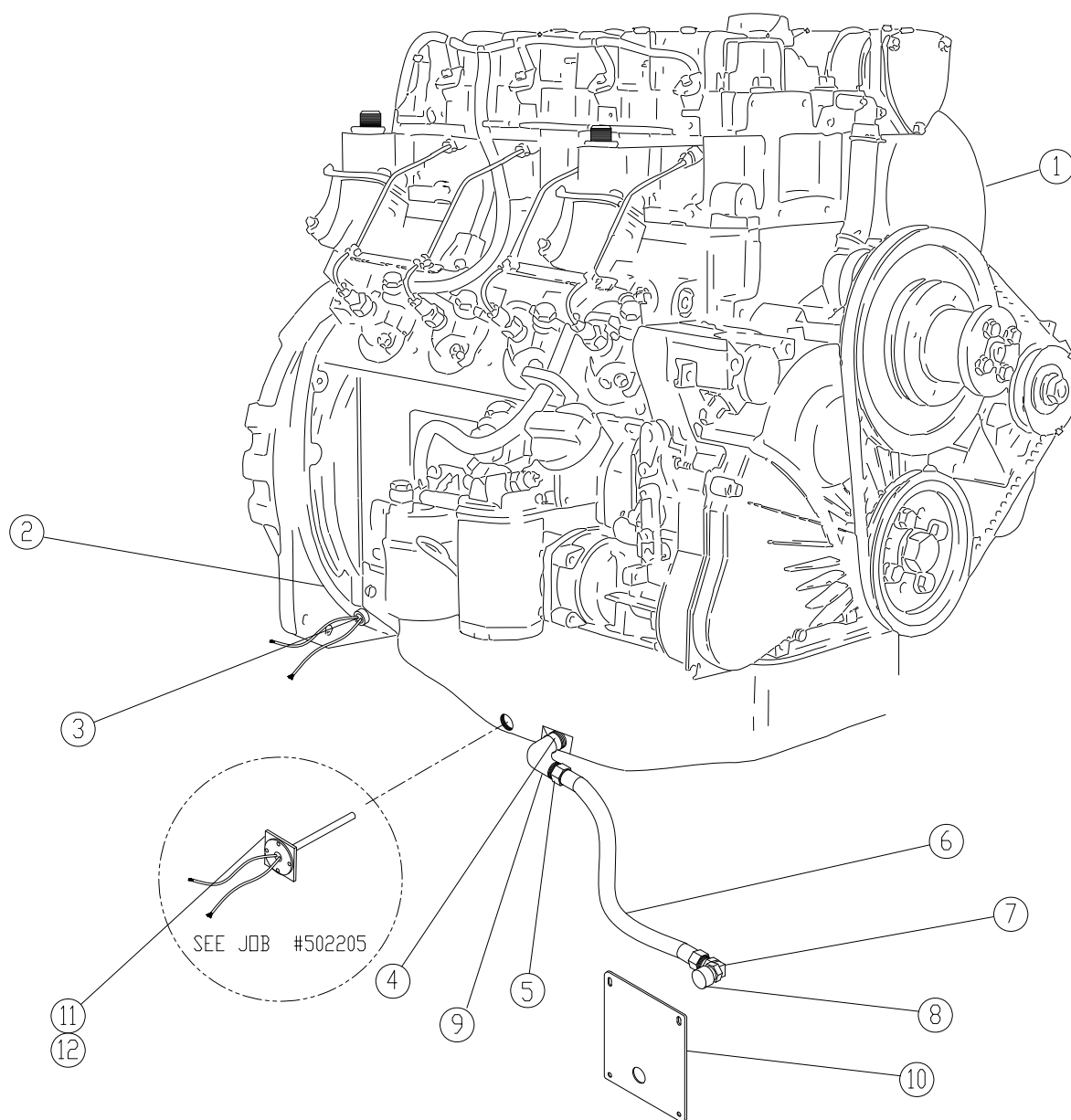


Figure 17. Oil Pan Heater- Oil Drain (Optional)

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
17- . . .	22516 REV B		12867		OIL PAN HEATER - OIL DRAIN (OPTIONAL) (See Figure 12)	REF
17-1 . . .	G44-125	F4L1011F			ENGINE, DEUTZ DIESEL, OIL COOLED (See Figure 12)	REF
17-2 . . .	G44-125-101		12867		COVER PLATE, FLYWHEEL HOUSING	1
17-3 . . .	EG5030	MSP-6721	0BXW5		MAGNETIC PICK-UP	1
17-4 . . .	FI5159	GG308-NP08-18	1H123		ADAPTER, METRIC, 3/4-16	1
17-5 . . .	FI5190	4797-8B	1H123		ADAPTER, HOSE END#8, 3/4-16 THD	1
17-6 . . .	22700		12867		HOSE ASSEMBLY	1
17-7 . . .	FI5704	2041-8-8S	01276		ADAPTER, 37° FLR, 3/4-16x3/4-16 1/2"OD	1
17-8 . . .	FI0074	210292-8S	01276		CAP NUT, 1/2"	1
17-9 . . .	FI0077	2071-8-8S	01276		ELBOW, 3/4 SWIVEL TO 3/4 FLARE	1
17-10 . .	11902B		12867		COVER PLATE, OIL PAN	1
17-11 . .	ED5064	G5E16-BC12	79221		HEATER, CARTRIDGE, 200W, 240VAC (OPTIONAL)	1
17-12 . .	FI5880	8555-P-18	01276		PLUG, M18 x 1.5, STEEL (OPTIONAL)	1

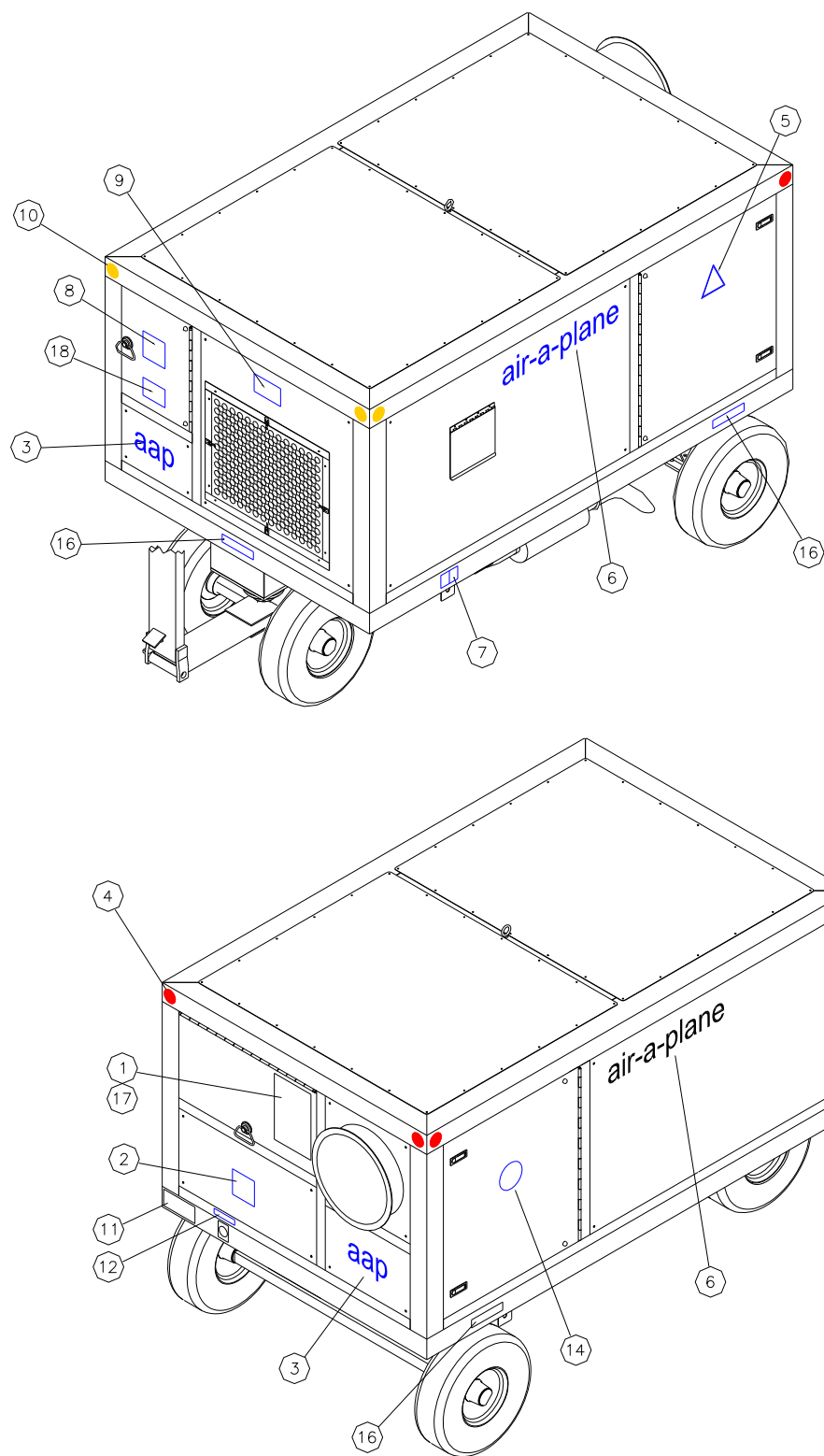


Figure 18. Labels

FIG. ITEM NO.	TI PART NO.	VENDOR PART NO.	CAGE	AIRLINE PART NO.	NOMENCLATURE	UNITS PER ASSY
18-	22540A Rev C		12867		LOGOS AND LABELS	REF
18-1	NOT USED					
18-2	22198		12867		LABEL, MULTIPLE HAZARD, READ MANUAL	1
18-3	NA5103		12867		LOGO, "aap" AIR-A-PLANE 4x10"	2
18-4	IL5272	3M, 75-0301-0069-9	67189		REFLECTOR, RED, 3" RND	4
18-5	NA5095		12867		LABEL, DANGER ROTATING PARTS,	1
18-6	NA5102		12867		LOGO, AIR-A-PLANE 4 x 24"	2
18-7	22075		12867		LABEL, ENG OIL DRAIN	1
18-8	22197		12867		LABEL, DIESEL FUEL PICTOGRAM	1
18-9	22079		12867		LABEL, PICTOGRAM-TOW SPEED/TIP	1
18-10	IL5273	3M, 75-0301-0068-1	67189		REFLECTOR, AMBER, 3" RND	4
18-11	26169		12867		DATA PLATE, 5050 HEATER	1
18-12	10364		12867		PLACARD, BLOCK HEATER 120V	1
18-13	NOT USED					
18-14	22076		12867		LABEL, PICTOGRAM-CONSULT SERVICE MANUAL	1
18-15	NOT USED					
18-16	22503		12867		LABEL, 60PSI/4.1 BAR, PICTOGRAM	3
18-17	22705		12867		OPERATING INSTR (MANUAL CNTRL)	1
18-18	H56-469		12867		LABEL, AIR-A-PLANE ADDRESS	1

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CHAPTER 5 — Manufacturers' Appendices

Table Of Contents

1. GENERAL

This chapter contains Vendor's / OEM literature for components / assemblies used in the manufacture of the unit. This information is provided to assist the user in the operation, disassembly, and repair of the individual component or assembly.

Literature for optional equipment provided for informational purposes only.

2. CONTENTS

Engine Literature:

- Deutz® - Operation Manual B/FL 1011F / B/FM 1011F (P/N 0297 7343)
- Deutz® - Spare Parts Catalogue B/FL 1011F/FT (P/N 0297 7793)
- Deutz® - EP-100-G Series Installation Instructions for Panels
- Racor® - 220/225R Fuel Filter/Water Separator (Brochure #7238)

Control Literature -Units W/Auto Throttle:

Johnson Controls, Inc.® - A19 Series Temperature Control (Bulletin A19)

Johnson Controls, Inc.® - A350A/B Electronic Temperature Control (Bulletin A350)

Governors of America® - ESD 5111 Speed Control Unit (Bulletin PITI 1000)

Governors of America® - RSC671 Speed Ramping Control Unit (Bulletin PIB 4020) 1000

Woodward® - EPG Electrically Powered Governors Installation Manual
(Manual 82329H)

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A19 Series Temperature Controls For Refrigeration With NEMA 1 Enclosure

Application

These controls are designed to cover a broad range of general purpose operating temperature control applications in the refrigeration, air conditioning and heating field with a minimum number of models. Typical applications are: frozen food cases, display cases, beverage coolers, milk coolers, walk-in boxes, water chillers, etc.

Various control ranges are available to cover working temperatures from -30 to 225°F (-35 to 105°C). Closed tank fittings and bulb wells are available for immersion applications.

Single-stage controls less enclosure and two-stage controls with or without enclosure also are available. Contact the nearest Johnson Controls office or contact Customer Service.

Specifications

Case Material	.062" (1.6mm) Cold Rolled Steel
Conduit Opening	7/8" Diameter Hole for 1/2" Conduit
Contact Unit	Snap-Acting Contacts in Dusttight Enclosure
Cover Material	.025" (0.6mm) Cold Rolled Steel
Finish	Gray Baked Enamel
Shipping Weight	Individual Pack 1 lb (0.45 kg)
	Overpack of 50 55 lb (25 kg)
Terminal Screws	No. 8-32 x 1/4" Binder Head with Cup Washers

Range and Differential Specifications

Range °F °C	Differential °F °C			Bulb Size In. mm	Max. Ambient °F °C (1)
	Adjustable	Standard (Fixed)	Close (Fixed)		
-30 to 50	5 to 20	5	2.5	.375 x 4	140
-35 to 10	2.8 to 11.1	2.8	1.4	9.5 x 102	60
-30 to 100	3 to 12	3	1.5	.375 x 4	140
-35 to 40	1.7 to 6.7	1.7	0.8	9.5 x 102	60
-20 to 60	5 to 20	5	2.5	.375 x 4	140
-6 to 15	2.8 to 11.2	2.8	1.4	9.4 x 102	60
20 to 80	3.5 to 14	3.5	1.75	.375 x 5	140
-5 to 28	1.9 to 7.8	1.9	0.97	9.5 x 127	60
25 to 225	7 to 28	7	3.5	.375 x 3	275
-3 to 105	3.9 to 15.6	3.9	1.9	9.5 x 76	135
30 to 50	4 to 16	4	2	.375 x 2.625	190
0 to 10	2.2 to 8.9	2.2	1.1	9.5 x 67	88
30 to 110	3.5 to 14	3.5	1.75	.375 x 5	140
0 to 43	1.9 to 7.8	1.9	0.97	9.5 x 127	60
40 to 90	3.5 to 14	3.5	1.75	.375 x 6	140
5 to 32	1.9 to 7.8	1.9	0.97	9.5 x 152	60
50 to 130	3.5 to 14	3.5	1.75	.375 x 5	170
10 to 55	1.9 to 7.8	1.9	0.97	9.5 x 127	77

- (1) Maximum bulb temperature which the element can withstand at infrequent intervals during life of control, such as shipping conditions. This is not the temperature which the control can withstand on repeat cycles. Maximum ambient temperature around control case is 140°F (60°C).

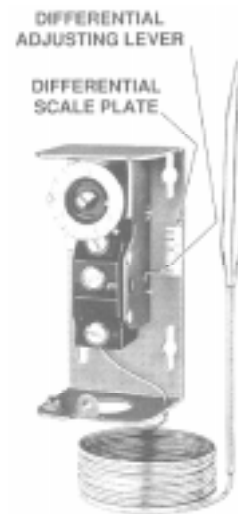


Fig. 1: Interior of an A19 with differential adjustment. Differential adjustment is concealed when cover is on control.

All Series A19 temperature controls are designed for use *only* as operating controls. Where an operating control failure would result in personal injury and/or loss of property, it is the responsibility of the installer to add devices (safety, limit controls) or systems (alarm, supervisory systems) that protect against, or warn of, control failure.

Features

- Compact general purpose temperature controls with a wide selection of models.
- Dependability -- precision snap-acting contacts in dusttight enclosure and liquid filled sensing element are field proven.
- Precision "repeat" accuracy which is unaffected by barometric pressure and cross ambient temperature problems.
- Concealed differential adjustment discourages unauthorized adjustment changes.
- Extremely close differentials -- fixed or adjustable.
- "Trip-free" manual reset -- reset must be *pressed and released* before operation will resume. Contacts cannot be blocked in the closed position.

General Description

These compact controls are supplied with fixed or adjustable differential. Controls supplied with adjustable differential have an internal scale plate indicating increments of differential.

Knob range adjustment and visible scale are standard. Models are available with a knob for field convertible adjustment. These models are



Fig. 2: The A19 with external range adjustment.

supplied with a snap-in plug in the cover for concealed screwdriver slot adjustment. A bulb mounting clip with sheet metal screw is supplied with remote bulb models. A special designed, field-proven liquid filled sensing element provides precision "repeat" accuracy which is unaffected by barometric pressure and cross ambient temperature problems.

The A19ACA and A19ADB controls lockout requiring that reset be pressed and released before operation will resume. All other controls in the series are automatic recycling.

Optional Constructions

Ambient Compensation

Available on fixed differential and manual reset models at extra cost, if required.

Capillary Length

Standard is 6 feet (1.8 m). Optional lengths are 10 feet (3m), 15 feet (4.6 m) and 20 feet (6.1m). Quantity orders.

Mounting Brackets

Optional at extra cost.

Electrical Rating Tables

Standard Differential

Volts, AC	120	208	240
Full Load Amps.	16.0	9.2	8.0
Locked Rotor Amps	96.0	55.2	48.0
Non-Inductive or Resistance Load Amps. † (Not Lamp Loads)	22 Amps. 120 to 277 VAC		
Pilot Duty — 125 VA, 24 to 600 VAC			
†SPST rating			

Standard Differential With Lockout

Volts, AC	120	208	240
Full Load Amps.	16.0	9.2	8.0
Locked Rotor Amps.	96.0	55.2	48.0
Non-Inductive or Resistance Load Amps. (Not Lamp Loads)	16.0	9.2	8.0
Pilot Duty --- 125 VA, 24 to 600 VAC			

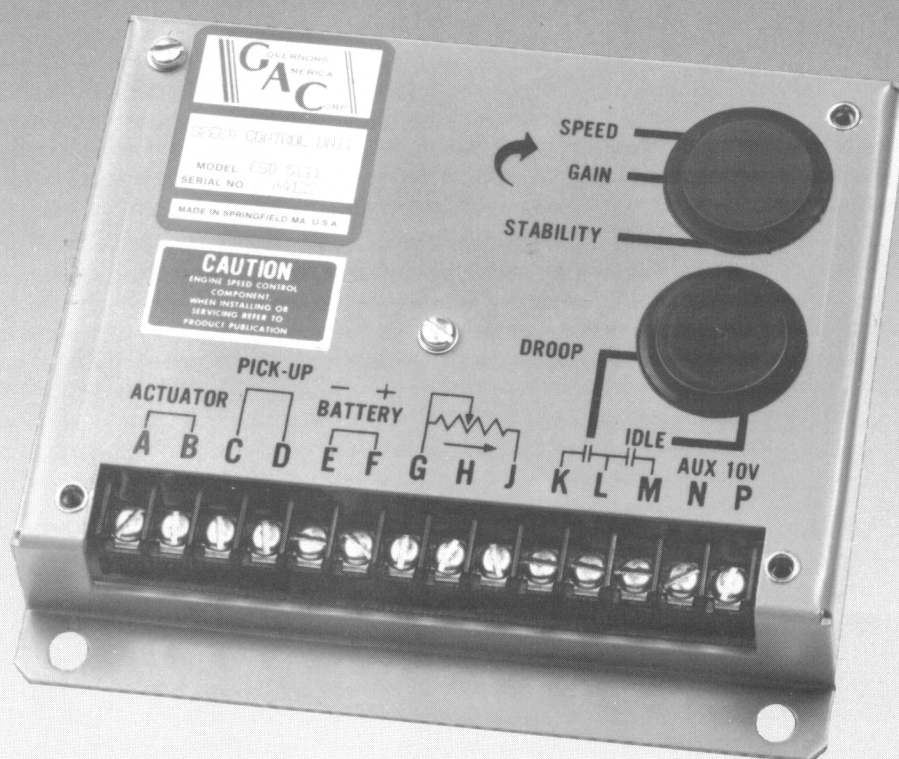
Close Differential

Volts, AC	120	208	240
Full Load Amps.	6.0	3.4	3.0
Locked Rotor Amps.	36.0	20.4	18.0
Non-Inductive or Resistance Load Amps. (Not Lamp Loads)	10 Amps. 24 to 277 VAC		
Pilot Duty — 125 VA, 24 to 277 VAC			



ENGINE GOVERNING SYSTEMS

ESD 5111 SERIES



SPEED CONTROL UNIT



GOVERNORS AMERICA CORP. • 720 Silver St. • Agawam, MA 01001, USA • (413) 786-5600

ESD 5111 SERIES SPEED CONTROL UNIT

PRODUCT
TECHNICAL
INFORMATION

PTI 1000

FEBRUARY 1992

INTRODUCTION

The ESD 5111 Series speed control unit is an all electronic device designed to control engine speed with fast and precise response to transient load changes. This closed loop control, when connected to a proportional electric actuator and supplied with a magnetic speed sensor signal, will control a wide variety of engines in an isochronous or droop mode. It is designed for high reliability and built ruggedly to withstand the engine environment.

Simplicity of installation and adjustment was foremost in the design. Two noninteracting performance controls allow near optimum response to be easily obtained.

Other features include; adjustable droop and idle operation, inputs for accessories used in multi-engine or special applications, protection against reverse battery voltage and transient voltages, and fail-safe design in the event of loss of speed sensor signal or battery supply.

DESCRIPTION

Engine speed information for the speed control unit is usually received from a magnetic speed sensor. Any other signal generating device may be used provided the generated frequency is proportional to engine speed and meets the voltage input and frequency range specification. The speed sensor is typically mounted in close proximity to an engine driven ferrous gear, usually the engine ring gear. As the teeth of the gear pass the magnetic sensor, a signal is generated which is proportional to engine speed.

Signal strength must be within the range of the input amplifier. An amplitude of 0.5 to 120 volts RMS is required to allow the unit to function within its design specifications. The speed signal is applied to Terminals C and D of the speed control unit. Between these terminals there is an input impedance of over 33,000 ohms. Terminal D is internally connected to Terminal E, battery negative.

When a speed sensor signal is received by the controller, the signal is amplified and shaped by an internal circuit to provide an analog speed signal. If the speed sensor monitor does not detect a speed sensor signal in a period of not longer than 0.1 second, the output circuit of the speed control unit will turn off all current to the actuator.

A summing circuit receives the speed sensor signal along with the speed adjust set point input. The speed range has a ratio of 7:1 and is adjusted with a 25 turn potentiometer. The output from the summing circuit is the input to the dynamic control section of the speed control unit. The dynamic control circuit, of which the gain and stability adjustments are part, has a control function that will provide isochronous and stable performance for most engine types and fuel systems.

The speed control unit output circuit is influenced by the integral gain and stability performance adjustments. The governor system sensitivity is increased with clockwise rotation of the gain adjustment. The gain adjustment has a non-linear range of 33:1. The stability adjustment, when advanced clockwise, increases the time rate of response of the governor system to match the various time constants of a wide variety of engines. Since the speed control unit is a P I D device, the "D", derivative portion can be varied when required (See Instability section).

During engine cranking, the actuator is fully energized and moves to the maximum fuel position. The actuator will remain in that state during engine cranking and acceleration. While the engine is at steady load, the actuator will be energized with sufficient current to maintain the governor speed setpoint.

The output circuit provides switching current at a frequency of about 500 Hz to drive the actuator. Since the switching frequency is well beyond the natural frequency of the actuator, there is no visible motion of the actuator output shaft. Switching the output transistor reduces its internal power dissipation for efficient power control. The output circuit can provide current of up to 10 amps continuous at 25°C at battery voltages up to 40 VDC to drive an actuator. The actuator responds to the average current to position the engine fuel control lever.

In standard operation, the speed control unit performance is isochronous. Droop governing can be selected by connecting Terminals K and L and the percent of droop governing can be varied with the integral droop adjustment control. The droop range can be doubled by connecting Terminals G and H.

The speed control unit has several performance and protection features which enhance the governor system. A speed anticipation circuit minimizes speed overshoot on engine start-up or when large increments of load are applied to the engine. Engine idle speed can be remotely selected and is adjustable. Accessory inputs to achieve variable speed operation and multi-engine control can be accepted by the ESD 5111 speed control unit from GAC load sharing modules, automatic synchronizers, ramp generators and other accessory engine control modules. Protection against reverse battery voltage and transient voltages is provided. The design is fail-safe in the event of loss of speed sensor signal or battery supply.

The ESD 5111 Series speed control units are compatible with GOVERNORS AMERICA CORP. proportional electric actuators as well as those from other manufacturers.

SPECIFICATIONS

PERFORMANCE

Isochronous Operation / Steady State Stability	± 0.25% or better
Speed Range/Governor	1K – 7.5K Hz continuous
Speed Drift With Temperature	± 1% maximum
Idle Adjust CW	Min. 1200 Hz. Below set speed
Idle Adjust CCW	Min. 4100 Hz. Below set speed
Droop Range	1 – 5% regulation*
Droop Adj. Max (H-G and K-L Jumpered)	875 Hz., ± 75 Hz. per 1.0 A change
Droop Adj. Min. (H-G Open, K-L Jumpered)	15 Hz., ± 6 Hz. per 1.0 A change
Speed Trim Range	± 200 Hz.
Remote Variable Speed Range	500 - 7.5K Hz. or any part thereof
Terminal Sensitivity	
J	100 Hz., ± 15 Hz / Volt @ 5.0 K impedance
L	735 Hz., ± 60 Hz / Volt @ 65 K impedance
N	148 Hz., ± 10 Hz / Volt @ 1 Meg. impedance
P	10 VDC Supply @ 20 ma Max.

ENVIRONMENTAL

Ambient Operating Temperature Range	– 40° to +180°F (– 40° to +85°C)
Relative Humidity	up to 95%
All Surface Finishes	Fungus proof & corrosion resistant

INPUT POWER

Supply	10 to 40 VDC Battery Systems (transient & reverse voltage protected)**
Polarity	Negative ground (case isolated)
Power Consumption	50 ma continuous plus actuator current
Maximum Actuator Current at 25°C (77°F)	10 Amps continuous
Speed Sensor Signal	0.5-120 Volts RMS

RELIABILITY

Vibration	5 G @ 20-500 Hz.
Testing	Functionally tested.

PHYSICAL

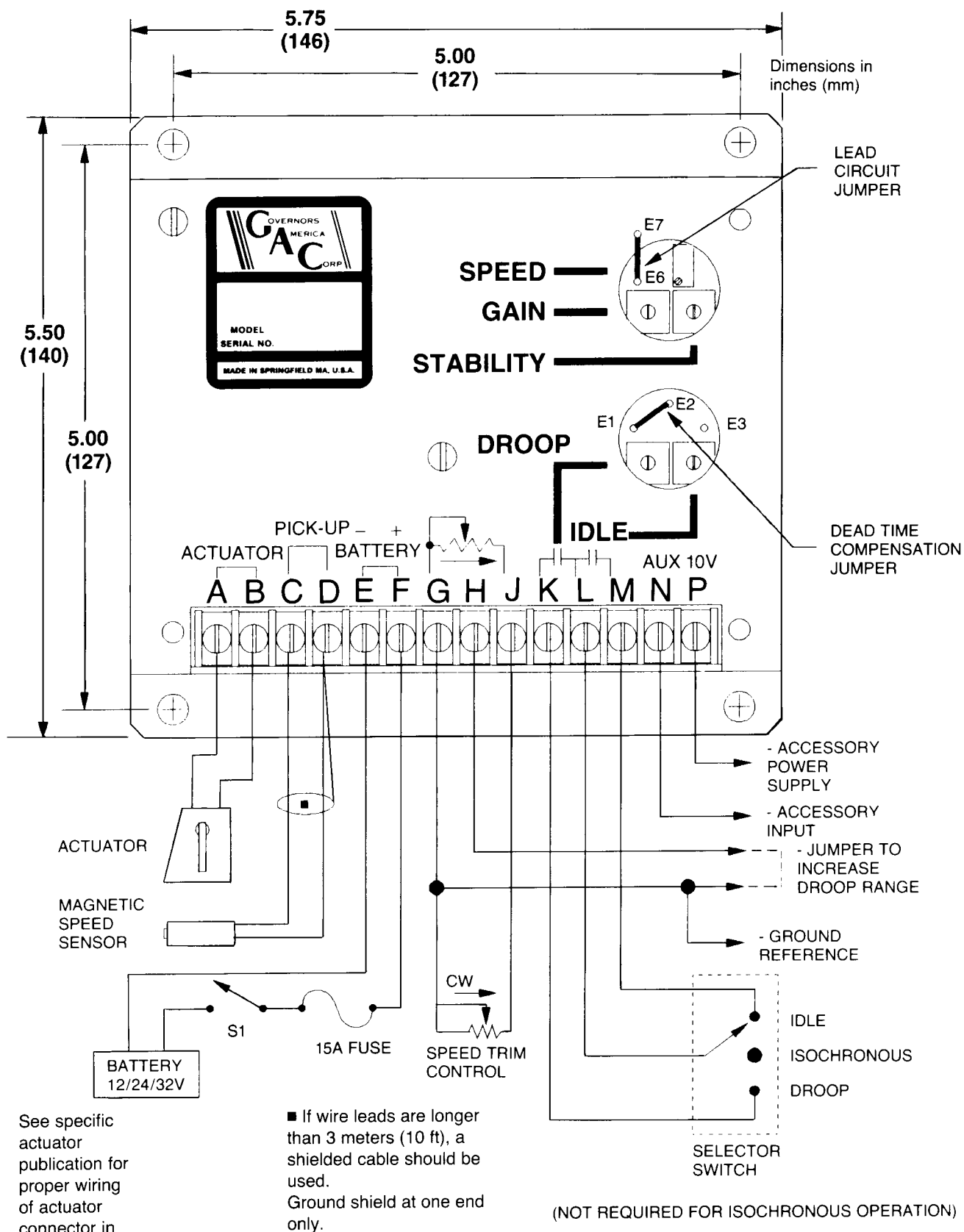
Dimensions	See outline (Diagram 1)
Weight	1.2 lbs. (545 grams)
Mounting	Any position, vertical preferred

*Droop is based on a speed sensor frequency of 4000 Hz. and an actuator current change of 1 amp from no load to full load. Applications with higher speed sensor signal will experience less percentage of droop. Applications with more actuator current change will experience higher percentages of droop. See droop description for specific details on operation of droop ranges.

**Protected against reverse voltage by a series diode. A 15 amp fuse must be installed in the positive battery lead.

DIAGRAM 1

ESD 5111 WIRING/OUTLINE



Accessory Input

The AUXiliary Terminal N accepts input signals from load sharing units, auto synchronizers, and other governor system accessories. GAC accessories are directly connected to this terminal. It is recommended that this connection from accessories be shielded as it is a sensitive input terminal.

If the auto synchronizer is used alone, not in conjunction with a load sharing module, a 3 M ohm resistor should be connected between Terminals N and P. This is required to match the voltage levels between the speed control unit and the synchronizer.

When an accessory is connected to Terminal N, the speed will decrease and the speed adjust pot will have to be reset. When operating at the upper end of the control unit frequency range, a jumper or frequency trim control may be required between Terminals G and J to increase the frequency range of the unit above 7000 Hz pickup frequency.

Accessory Supply

The + 10 volt regulated supply, Terminal P, can be utilized to provide power to GAC governor system accessories. Up to 20 ma of current can be drawn from this supply. Ground reference is Terminal G.

Wide Range Variable Speed

Simple and effective remote variable speed can be obtained with the ESD 5111 Series speed control unit.

A single remote speed adjustment potentiometer can be used to adjust the engine speed continuously over a specific speed range. Select the desired speed range and the corresponding potentiometer value. (Refer to TABLE 1.) If the exact range cannot be found, select the next higher range potentiometer. An additional fixed resistor may be placed across the potentiometer to obtain the exact desired range. Connect the speed range potentiometer as shown in Diagram 2.

To maintain engine stability at the minimum speed setting, a small amount of droop can be added using the **DROOP** adjustment. At the maximum speed setting the governor performance will be isochronous, regardless of the droop adjustment setting.

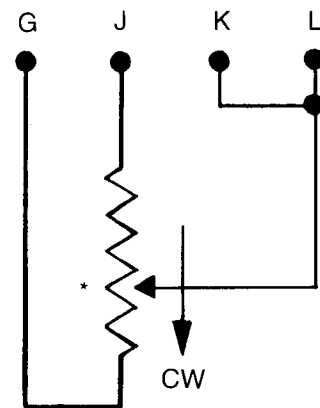
Contact the factory for assistance if difficulty is experienced in obtaining the desired variable speed governing performance.

TABLE 1

VARIABLE SPEED RANGE POTENTIOMETER VALUE

Speed Range	Potentiometer Value
900 Hz.	1K
2,400 Hz.	5K
3,000 Hz.	10K
3,500 Hz.	25K
3,700 Hz.	50K

DIAGRAM 2



*Select Proper Potentiometer Value From Table 1

APPLICATION AND INSTALLATION INFORMATION

The speed control unit is rugged enough to be placed in a control cabinet or engine mounted enclosure with other dedicated control equipment. If water, mist, or condensation may come in contact with the controller, it should be mounted vertically. This will allow the fluid to drain away from the speed control unit.

Extreme heat should be avoided.

WARNING

An overspeed shutdown device, independent of the governor system, should be provided to prevent loss of engine control which may cause personal injury or equipment damage.

WIRING

Basic electrical connections are illustrated in Diagram 2. Actuator and battery connections to Terminals A, B, E, and F should be #16 AWG (1.3 mm sq.) or larger. Long cables require an increased wire size to minimize voltage drops.

The battery positive (+) input, Terminal F, should be fused for 15 amps as illustrated.

Magnetic speed sensor connections to Terminals C and D **MUST BE TWISTED AND/OR SHIELDED** for their entire length. The speed sensor cable shield should only be connected to Terminal D. The shield should be insulated to insure no other part of the shield comes in contact with engine ground, otherwise stray signals may be introduced into the speed control unit. With the engine stopped, adjust the gap between the magnetic speed sensor and the ring gear teeth. The gap should not be any smaller than 0.020 in. (0.45 mm). Usually, backing out the speed sensor $\frac{3}{4}$ turn after touching the ring gear tooth will achieve a satisfactory air gap. The magnetic speed sensor voltage should be at least 1 VAC RMS during cranking.

ADJUSTMENTS

Before Starting Engine

Check to insure the **GAIN** and **STABILITY** adjustments, and if applied, the external **SPEED TRIM CONTROL** are set to mid position.

Start Engine

The controller is factory set to operate at approximately engine idle speed. (1000 HZ. speed sensor signal)

Crank the engine with D.C. power applied to the governor system. The actuator will energize to the maximum fuel position until the engine starts. The governor system should control the engine at a low idle speed. If the

engine is unstable after starting, turn the **GAIN** and **STABILITY** adjustments counterclockwise until the engine is stable.

Governor Speed Setting

The governed speed set point is increased by clockwise rotation of the **SPEED** adjustment control. Remote speed adjustment can be obtained with an optional Speed Trim Control. (See Diagram 2)

Governor Performance

Once the engine is at operating speed and at no load, the following governor performance adjustment can be made.

A. Rotate the **GAIN** adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment $\frac{1}{8}$ of a turn further counterclockwise to insure stable performance.

B. Rotate the **STABILITY** adjustment clockwise until instability develops. Gradually move the adjustment counterclockwise until stability returns. Move the adjustment $\frac{1}{8}$ of a turn further counterclockwise to insure stable performance.

C. Gain and stability adjustments may require minor changes after engine load is applied. Normally, adjustments made at no load achieve satisfactory performance. A strip chart recorder can be used to further optimize the adjustments.

If instability cannot be corrected or further performance improvements are required, refer to section on SYSTEM TROUBLESHOOTING.

Idle Speed Setting

After the governor speed setting has been adjusted, place the optional external selector switch in the "IDLE" position. The idle speed set point is increased by clockwise rotation of the **IDLE** adjustment control. When the engine is at idle speed, the speed control unit applies droop to the governor system to insure stable operation.

Speed Droop Operation

Droop is typically used for the paralleling of engine driven generators.

Place the optional external selector switch in the "DROOP" position. Droop is increased by clockwise rotation of the **DROOP** adjustment control. When in droop operation, the engine speed will decrease as engine load increases. The actual percentage of droop is based on the actuator current change from engine no load to full load. A wide range of droop is available with the internal control. If more droop is required, a jumper between Terminals G and H can be added to double the droop available. Droop level requirements above 10% are unusual.

If droop levels experienced are higher or lower than those required, contact the factory for assistance.

After the droop level has been adjusted, the rated engine speed setting may need to be reset. Check the engine speed and adjust the speed setting accordingly.

SYSTEM TROUBLESHOOTING

System Inoperative

If the engine governing system does not function, the fault may be determined by performing the voltage tests described in Steps 1, 2, 3, and 4. (+) and (−) refer to meter polarity. Should normal values be indicated as a result of following the troubleshooting steps, the fault may be with the actuator or the wiring to the actuator. See actuator publication for testing details. Tests are performed with battery power on, engine off except where noted.

Step	Terminals	Normal Reading	Probable Cause of Abnormal Reading
1	F(+) & E(−)	Battery Supply Voltage	1. DC battery power not connected. Check for blown fuse. 2. Low battery voltage. 3. Wiring error.
2	C & E	1.0 VAC RMS min., while cranking	1. Gap between speed sensor and gear teeth too great. Check gap. 2. Improper or defective wiring to the speed sensor. Resistance between Terminals C and D should be 30 to 300 ohms. 3. Defective speed sensor.
3	P(+) & G(−)	10 VDC, Internal Supply	1. Short on Terminal P. (This will cause a defective unit.) 2. Defective speed control.
4	F(+) & A(−)	1.5 - 2.5 VDC while cranking	1. SPEED adjustment set too low. 2. Wiring error to actuator. 3. Defective speed control. 4. Defective actuator.

Unsatisfactory Performance

If the governing system functions poorly, perform the following tests

Symptom	Test	Probable Fault
Engine overspeeds	1. Measure the DC voltage between Terminals A & F on the speed control unit. 2. <u>Do Not Crank</u>. Apply DC power to the governor system.	1. If the voltage reading is 1.5 to 2.5 VDC, a) SPEED adjustment set above desired speed. b) Defective speed control unit. 2. If the voltage reading is above 2.5 VDC, a) Actuator or linkage binding. 3. If the voltage reading is below 1.5 VDC, a) Defective speed control unit 4. Overspeed set point too low. 1. Actuator goes to full fuel. Then, Disconnect speed sensor at Terminals C & D. If actuator still at full fuel - speed control unit defective. If actuator at minimum fuel position - erroneous speed signal. Check speed sensor cable.
Actuator does not energize fully	1. Measure the voltage at the battery while cranking. 2. Momentarily connect Terminals A and F. The actuator should move to the full fuel position.	1. If the voltage is less than 8V for a 12v system, or 16V for a 24V system, replace the battery if it is weak or undersized. 1. Actuator or battery wiring in error. 2. Actuator or linkage binding. 3. Defective actuator.
Engine remains below desired governed speed.	1. Measure the actuator output, Terminals A & B, while running under governor control.	1. If voltage measurement is within 2 volts or more of the battery supply voltage, then fuel control restricted from reaching full fuel position. Possibly due to mechanical governor, carburetor spring, linkage alignment or interference. 2. If not, increase speed setting.

SYSTEM TROUBLESHOOTING

Insufficient Magnetic Speed Sensor Signal

A strong magnetic speed sensor signal will eliminate the possibility of missed or extra pulses. The speed control unit will govern well with 0.5 volts RMS speed sensor signal. A speed sensor signal of 3 volts RMS or greater at governed speed is recommended. Measurement of the signal is made at Terminals C and D.

The amplitude of the speed sensor signal can be raised by reducing the gap between the speed sensor tip and the engine ring gear. The gap should not be any smaller than 0.020 in. (0.45 mm). Usually, backing the speed sensor out by $\frac{3}{4}$ turn after touching the ring gear tooth will achieve a satisfactory air gap.

Electromagnetic Interference (EMI)

EMI SUSCEPTIBILITY occurs when electrical fields from outside sources cause the governor to function unsatisfactorily. Magnetos, battery chargers, radio transmitters, solid state ignition devices, and regulators are typical emitters of EMI.

The speed control has filters to eliminate most interference. If it is suspected that RF fields are causing the governor to operate improperly, shield all cables and connect all shields to one common point on the case of the control unit with a short jumper from Terminal E to that point on the case. Mount the control to a metal backing plate and be sure that the plate is tied to a ground plane.

EMI RADIATION - The speed control unit also generates some EMI in its output circuit. For applications where EMI is a critical concern, shield the battery and actuator leads and ground the backing plate to a ground plane. Consult the factory for further information as EMI is usually a case by case problem.

Instability

Instability in a closed loop governor control system can be described as two general types. **PERIODIC** appears to be sinusoidal and at a regular rate. **NON-PERIODIC** is a random wandering or an occasional deviation from a steady state band for no apparent reason.

The **PERIODIC** type can be further classified as a fast or slow instability. Fast instability is a 3 Hz. or faster irregularity of the speed and is usually a jitter. Slow periodic instability is below 3 Hz., can be very slow, and is sometimes violent.

If fast instability occurs, this is typically the governor responding to engine firings. Raising the engine speed increases the frequency of instability and vice versa. If this is the case, cutting the jumper from E1 to E2 will reduce this tendency. In extreme cases, the removal of the E1 to E2 jumper may not take all the jitter out of the system. A second jumper, E6 to E7, may be removed to further stabilize the system. Post locations are illustrated in Diagram 1. Interference from powerful electrical signals can also be the cause. Turn off the battery chargers or other electrical equipment to see if the symptom disappears.

Slow instability can have many causes. Adjustment of the GAIN and STABILITY usually cures most situations by matching the speed control unit to the engine dynamics. If this is unsuccessful, the dead time compensation can be

modified. Add a capacitor from posts E2 to E3 (negative on E2). Post locations are illustrated in Diagram 1. Start with 10 mfd and increase until instability is eliminated. The control system can also be optimized for best performance by following this procedure.

If slow instability is unaffected by this procedure, evaluate the fuel system and engine performance. Check the fuel system linkage for binding, high friction, or poor linkage. Be sure to check during engine operation. Also look at the engine fuel system. Irregularities with carburetion or fuel injection systems can change engine power even with a constant throttle setting. This can result in speed deviations beyond the control of the governor system. Adding a small amount of droop can help stabilize the system for troubleshooting.

NON-PERIODIC instability should respond to the GAIN control. If increasing the gain reduces the instability, then the problem is probably with the engine. Higher gain allows the governor to respond faster and correct for the disturbance. Look for engine misfirings, an erratic fuel system, or load changes on the engine generator set voltage regulator. If the throttle is slightly erratic, but performance is fast, removing the jumper from E6 to E7 will tend to steady the system.

If unsuccessful in solving instability, contact the factory for assistance.



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ENGINE GOVERNING SYSTEMS

PRODUCT
INFORMATION
BULLETIN

PIB4020

MARCH 1992

RSC 671 SPEED RAMPING CONTROL

INTRODUCTION

The RSC671 Speed Ramping Control is a full time, linear electronic speed setting module. The function of the RSC671 is to smoothly accelerate and decelerate an engine at independantly adjustable rates. Ramping of speed is useful in limiting the smoke and noise generally associated with a step change in engine speed.

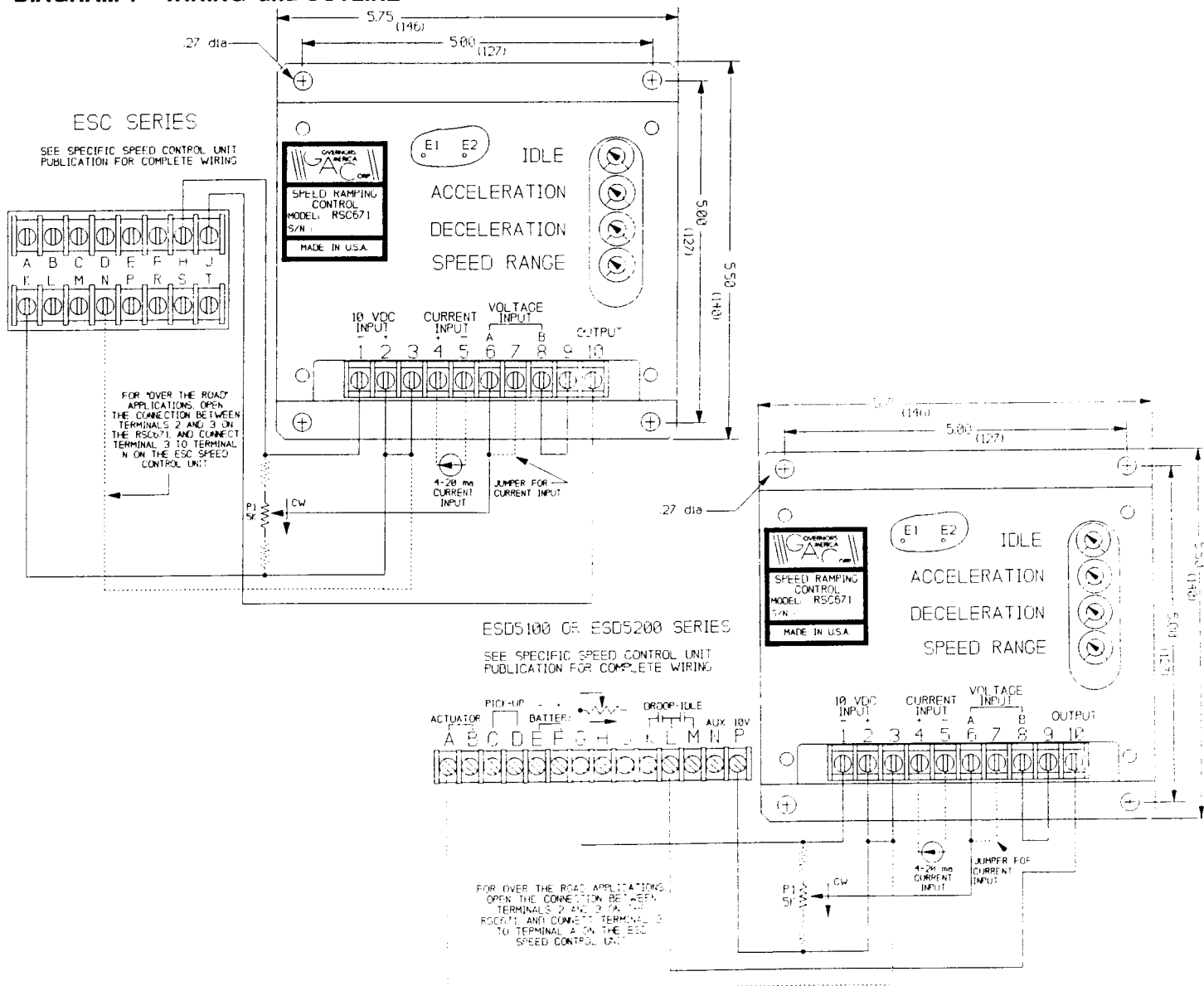
Applications include variable speed engine drives, wide speed range pumping systems, and special vehicles that require controlled speed acceleration and deceleration.

The RSC671 accepts speed setting signals from an external voltage source, potentiometer, or a 4-20 ma process control source. Contact GAC for 0-20 ma applications.

Adjustments are provided for acceleration rate, deceleration rate, idle speed, and maximum speed. The RSC671 is compatible with ESC, ESD5100, and ESD5200 Series speed control units from GAC.

The following procedure applies to a majority of applications. Contact GAC for non-standard installations.

DIAGRAM 1 WIRING and OUTLINE



INSTALLATION

The RSC671 is built ruggedly and should be installed near its matching speed control unit. If water, mist, or condensation can come in contact with the unit, it should be mounted vertically to allow moisture to drain away.

APPLICATION to ESC SPEED CONTROL UNITS

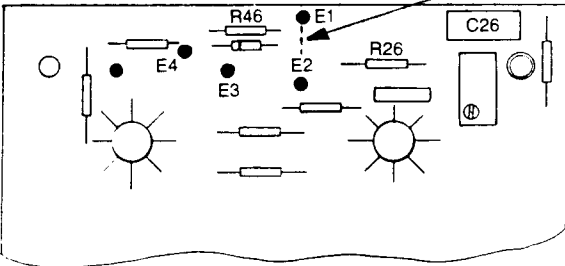
All ESC Series speed control units, except -17 and -26 versions, must be modified for use with an RSC671. Modify the units as follows:

- 1.) Remove the six screws that hold the ESC circuit board in its case. Five are on the underside of the unit, and one is on top near the SPEED adjust.
- 2.) Lift the case to one side to gain access to the section of the circuit board farthest from the connector.
- 3.) Locate posts E1 and E2 at the top middle of the ESC circuit board (see Diagram 2) and solder a wire link between them.
- 4.) Reassemble the speed control unit.

This modification changes the sensitivity of Terminal J on the ESC from -40 Hz/volt to -1100 Hz/volt.

DIAGRAM 2

Add Jumper



WIRING

The 10 VDC supply required to operate the RSC671 is obtained from the speed control unit. See Diagram 1 for wiring.

ESC Series Terminals K (+) and H (-) on the ESC are connected to Terminals 2 (+) and 1 (-) on the RSC671 respectively. The output from the RSC671, Terminal 10, is connected to Terminal J of the ESC speed control unit.

If the RSC671 is used for an over the road application, connect its Terminal 3 to Terminal N of the ESC speed control unit. Otherwise, connect a jumper wire between Terminals 2 and 3 of the RSC671.

ESD5100 and ESD5200 Series Terminals P (+) and G (-) on the ESD are connected to Terminals 2 (+) and 1 (-) on the RSC671 respectively. The output from the RSC671, Terminal 10, is connected to Terminal L on the ESD speed control unit.

If the RSC671 is used for an over the road application, connect its Terminal 3 to Terminal A of the ESD speed control unit. Otherwise, connect a jumper wire between Terminals 2 and 3 of the RSC671.

ADJUSTMENTS

ESC Series The SPEED adjustment on the ESC speed control unit must be set to the engine idle speed before the connection to Terminal 10 of the RSC671 is made.

ESD Series The SPEED adjustment on the ESD speed control unit must be set to the rated engine speed before the connection to Terminal 10 of the RSC671 is made.

After this adjustment, connect Terminal 10 of the RSC671.

Speed Setting by Voltage Control

Terminal 6 of the RSC671 is the voltage input for speed control. An increase in voltage to Terminal 6 causes an increase in the governor speed setting. For a given voltage change at Terminal 6, a range of voltage change will occur at Terminal 10 based on the IDLE and SPEED RANGE settings of the RSC671. The input impedance of Terminal 6 is greater than 10K ohms.

A potentiometer is a convenient source of voltage input to Terminal 6. Resistors at one end, the other, or both ends of the potentiometer may be required to obtain speed ranges beyond those available with the IDLE and SPEED RANGE adjustments.

Set the idle speed by applying 0 volts to Terminal 6 and adjusting the IDLE on the RSC671 for the desired speed.

The SPEED RANGE adjustment is used to match a given voltage to a desired speed. For example, 5 VDC can be made to request 2100 RPM. An input voltage range of from 0 - 0.5 to 0 - 10 VDC will cover most speed ranges.

Apply the input voltage corresponding to the maximum speed and adjust the SPEED RANGE until this speed is reached. The idle speed may need to be readjusted, then recheck the maximum speed.

Speed Setting by 4-20 ma Current Control

If a current input is used to set the speed, connect the positive (+) source to Terminal 4 and the negative (-) to Terminal 5. A jumper wire must be connected between Terminals 6 and 7. No other connection must be made to Terminal 6. The sink impedance of the current input is less than 100 ohms.

Set the input to 4 ma and adjust the IDLE for the desired speed. Increase the current input to 20 ma and adjust the SPEED RANGE for the maximum speed. The idle speed may need to be readjusted, then recheck the maximum speed.

Ramp Time Adjustment

Ramp time is controlled by the ACCELERATION and DECELERATION adjustments of the RSC671. Adjust each for the desired ramp times. A clockwise adjustment decreases the ramp time.

If a longer ramp time is required, a 30K resistor may be connected between posts E1 and E2 of the RSC671 to double the ramp time. Remove the screws that hold the circuit board in the case to access posts E1 and E2. See Diagram 1 for post locations.



**EPG Electrically
Powered
Governors**

**Models 512/524/1712/1724
without Position Feedback**

Installation Manual

WOODWARD GOVERNOR COMPANY

Manual 82329H



WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown device(s), that operates totally independently of the prime mover control device(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled device(s) fail.



CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.



CAUTION

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

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Chapter 1

General Information

Each Woodward Electrically Powered Governor (EPG) system includes three basic parts:

- A magnetic pickup (MPU) which senses engine speed from an engine-driven gear.
- A speed control which receives the speed signal from the MPU, compares it to a reference signal, and generates a control signal which the control sends to the actuator.
- An actuator which receives the signal from the control and positions its output shaft according to this signal. The output shaft is linked to the fuel control.

There are two models of EPG controls:

- The isochronous speed control, which is available with start-fuel limit, or dual dynamics
- The droop speed control, which includes a load sensor and provides droop control for generator sets.

Different actuator sizes are available for different work output requirements. Models of all but the largest output (4024) are available for either 12 or 24 volt systems.

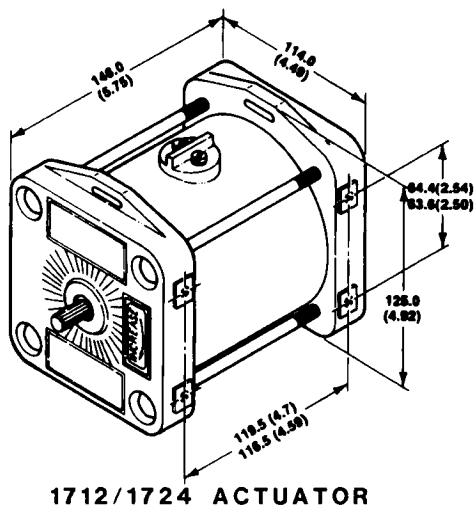
Associated Publications

Manual	Title
82313	<i>Generator Load Sensor</i>
25070	<i>Electric Governor Installation Guide</i>
82510	<i>Magnetic Pickups & Proximity Switches for Electric Governors</i>
82042	<i>4024 EPG</i>
82493	<i>Isochronous EPG</i>
82327	<i>EPG with Droop</i>
82476	<i>Ramp Generator</i>

Product Spec.	Title
04106	<i>Electrically Powered Governors</i>
82043	<i>4024 Electrically Powered Governor</i>
82314	<i>Generator Load Sensor</i>

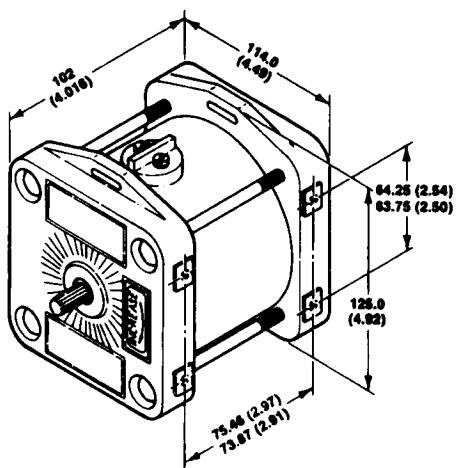
EPG Models

<u>Model</u>	<u>Battery Voltage</u>	<u>Work Output</u>
512	10–16	0.7 J (0.5 ft-lb)
524	20–32	1.0 J (0.75 ft-lb)
1712	10–16	1.6 J (1.2 ft-lb)
1724	20–32	2.3 J (1.7 ft-lb)
4024	18–32	5.4 J (4.0 ft-lb)

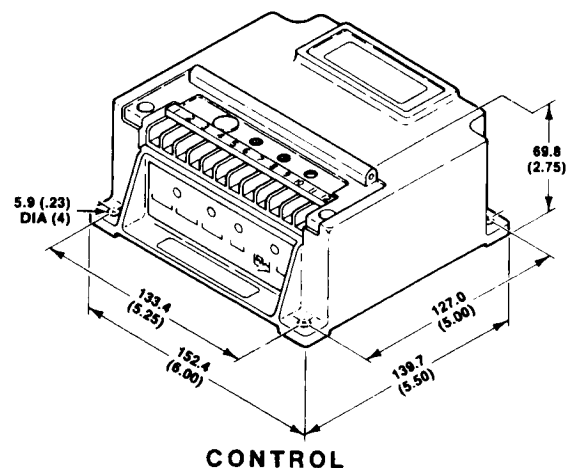


1712/1724 ACTUATOR

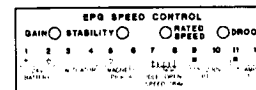
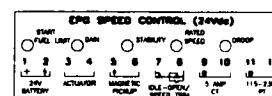
NOTE: INCHES SHOWN IN PARENTHESES



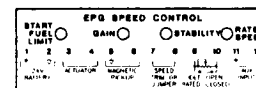
512/524 ACTUATOR



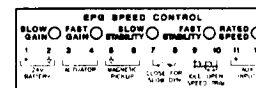
CONTROL



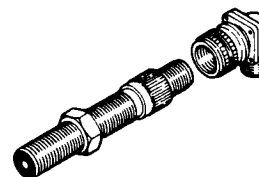
DROOP



ISOCRONOUS



DUAL DYNAMICS



MAGNETIC PICKUP

MOUNTING SCREWS

512/24 & 1712/24—0.250-20 (inch) thread. Minimum mounting screw engagement should be 9.5 mm (0.375 inch). Torque screws to 9–11 N·m (80–100 lb-in).

4024—0.375-18 (inch) thread. Minimum mounting screw engagement 13 mm (0.500 inch). Torque screws to 9–11 N·m (80–100 lb-in).

Figure 1-1. EPG Control and Actuators

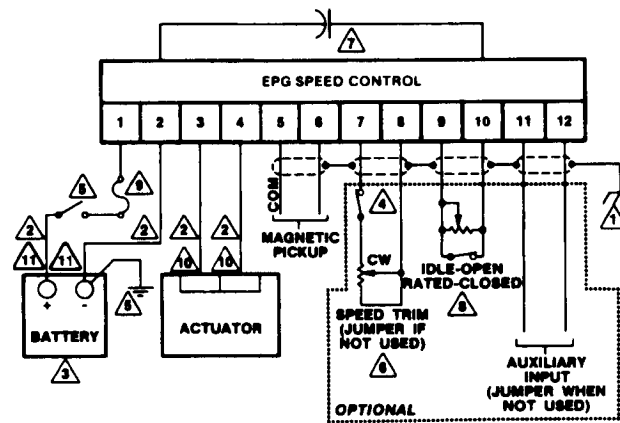


Figure 1-2. Wiring Diagram (Isochronous EPG)

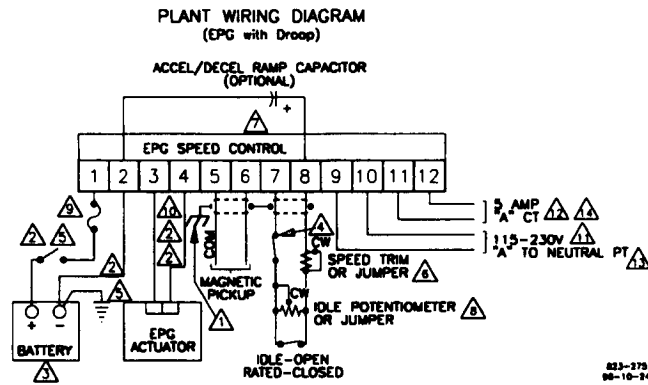


Figure 1-3. Wiring Diagram (EPG with Droop)

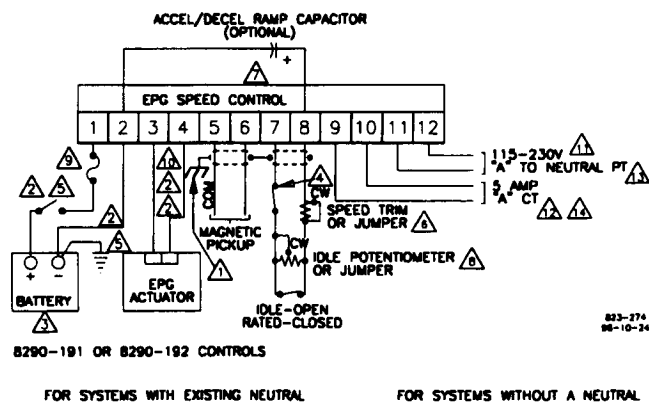


Figure 1-4. Wiring Diagram (EPG Models 8290-191, -192)

Wiring Diagram Notes

1. Shielded wires to be twisted pairs or twisted 3-conductor, grounded at one end only.
2. 4 or 2 mm² (12 or 14 AWG) stranded wire, must be as short as possible. Total of distance from battery to control, and from control to actuator, to be as short as possible (see maximum length in chart).
3. Voltage source must be 18 to 30 Vdc.
4. Open for minimum fuel. Do not use either the minimum fuel option, or disconnect the actuator leads, or disconnect the power to the control as part of any emergency stop sequence.
5. For positive ground systems, switch and fuse to be located in series with battery (–) and terminal 2. Positive (+) terminal becomes chassis ground. Leads from battery to terminals 1 and 2 must be direct and not pass through distribution points.
6. Approximate speed change with trim potentiometer:
±2.5% using a 1 kΩ potentiometer
±5% using a 2 kΩ potentiometer
7. About one second ramp time per 50 μF. Capacitor specification: 200 μF maximum, 15 WVdc minimum, less than 30 μAdc leakage current over temperature range.
8. Idle range about 25% to 200% of rated, using 50 k potentiometer. For fixed idle, calculate the value of the resistor:

$$R = 17 \text{ k Ohm} \left(\frac{\text{Rated Speed}}{\text{Idle Speed}} \right) - 1$$

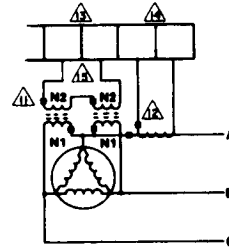
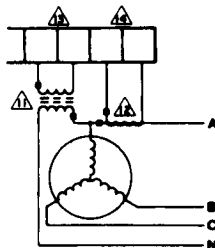
9. 512/24 and 1712/24 use a 10 A fuse. 4024 uses a 15 A fuse (3 AG or GBB type).
10. Polarity not important.
11. With a balanced load and unity power factor (PF=1), the current transformer should be wired in the correct potential leg, and must be be phased at the control so the potential at terminal 9 to 10 is in phase with the CT from terminal 11 to 12.
12. Power source current transformers should be sized to produce a 5 A secondary current, with maximum generator current. CT burden is essentially 0 VA.
13. Absolute minimum signal must be 95 Vrms. Absolute maximum signal must be 260 Vrms. Potential transformer burden is 20 kA.
14. This control contains an internal current transformer. This transformer must be connected across the power source transformer whenever the unit is running to prevent lethal high voltage from developing on leads to these terminals.
15. On systems without a neutral, the voltage at terminal 9 to 10 is 1.73 times N1/N1 times the line-to-line voltage.

Maximum Wiring Length Chart

System Voltage	Maximum Wire Length	
	2 mm ² (14 AWG)	4 mm ² (12 AWG)
12 V (512/1712)	3 m (10 ft)	6 m (20 ft)
24 V (524/1724)	11 m (35 ft)	23 m (75 ft)
4024	N/A	6.7 m (22 ft)

Wire Harness Part Numbers

Harness Part Number	Harness Lengths		
	MPU	Actuator	Battery
8924-621	10 ft (3 m)	15 ft (4.6 m)	15 ft (4.6 m)
8924-620	10 ft (3 m)	25 ft (7.6 m)	25 ft (7.6 m)



Chapter 2

Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).
2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
3. Keep plastic, vinyl, and styrofoam materials (such as plastic or styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.
4. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
 - Do not touch any part of the PCB except the edges.
 - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
 - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Chapter 3

Installation and Troubleshooting

Installation

Speed Control

The speed control box should be mounted on the control panel, often on the same skid as the engine. It is *not* designed for installation on the engine. Provide space for adjustment, wiring access, and ventilation. Choose a location that protects the control from being bumped and that the wiring harness will reach. The installation should allow for adequate air circulation to the control box and have an ambient temperature of -40 to $+75$ °C (-40 to $+167$ °F).

Actuator

Install the actuator solidly, and install a linkage with the correct configuration to provide an almost linear relationship between change of actuator position and change in engine power output. In most cases use about 2/3 of the actuator rotation between minimum and maximum fuel. The engine fuel control usually provides the minimum and maximum stops. The minimum and maximum stops on the actuator may be used, if necessary (see Figure 3-1). If the actuator is controlling the speed-setting shaft of a mechanical governor, use the actuator stops to limit the travel of the linkage. Set the minimum stop for 5% below rated speed at no load, and set the maximum stop for rated speed plus 3% more than the droop of the governor. The actuator is designed to operate in ambient temperatures of -40 to $+82$ °C (-40 to $+180$ °F). Installation should avoid sources of excessive heat.

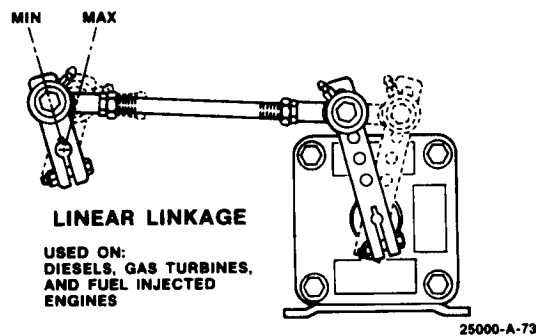
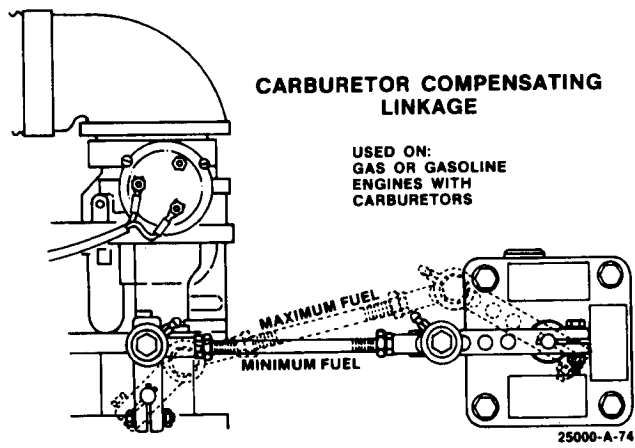


CAUTION

Do not pressure wash sealed bearings, you may force dirt inside them, shortening their life. If the actuator is exposed to weather, mount it with the clockwise end higher, if possible.

Magnetic Pickup (MPU)

Install the magnetic pickup on a rigid bracket or housing so its tip is near an engine-driven gear. This gear must be made of a ferrous material that reacts to a magnetic field. Adjust the MPU for 0.25 to 1.0 mm (0.010 to 0.040 inch) between the gear and the MPU at the closest point.



CONTROLLING A MECHANICAL GOVERNOR

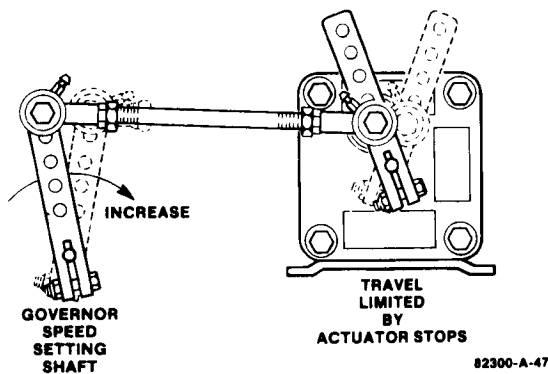


Figure 3-1. Actuator Linkages

Electrical Connections

Connect the system as shown in the appropriate wiring diagram (Figures 1-2, 1-3, 1-4). See the appropriate manual for wiring of accessories. Connect the speed control to system ground.

Shields

Use twisted-pair, shielded wire where the wiring diagram shows. Each shield must be grounded only at the end nearest the control. Do *not* ground both ends of a shield. Tie all shields to the same ground point. When passing a shield through a terminal block, connect the shield to its own terminal. Do not ground the shield at the terminal block. Do not solder to braided shields.



CAUTION

Damage to the speed control will occur if the battery is disconnected while the alternator or battery charging device is energized and connected to the control.

Installation Check and Troubleshooting

All Units

To verify correct system operation after installation and any time trouble occurs, do the following checks in the order given. Disconnect all accessories. Leave the IDLE/RATED switch or jumper connected. On isochronous EPGs, jumper terminal 7 to terminal 8, and terminal 11 to terminal 12. On EPGs with droop, leave terminals 9, 10, 11, and 12 disconnected with CT and PT wires properly secured for safety. On EPGs with dual dynamics, leave terminals 7 and 8 open to select primary (fast) dynamics.

If the system does not respond as indicated, find the fault and correct it.

1. Check electrical connections:
Correct?
Tight?
2. Magnetic Pickup:
Correctly adjusted?
Tight?
Resistance of 50–350 Ω ?
3. Close the IDLE/RATED switch (or install a jumper).
4. Turn the governor power on: (Do *not* start the engine or turbine.)
Fuse OK?
Actuator shaft settles in minimum fuel position?
5. Battery Voltage:
10 to 16 Vdc for model 512, 1712?
20 to 32 Vdc for model 524, 1724, 4024?

Gain and Stability

6. Set the IDLE potentiometer (pot) (if used) to mid-position.
7. Set the RATED speed pot fully counterclockwise (to minimum speed setting).
8. Set the GAIN and STABILITY pots to mid-position.
9. Set START FUEL LIMIT clockwise (if applicable).
10. Start the engine or turbine, following manufacturer's instructions.



WARNING

TO PROTECT AGAINST POSSIBLE PERSONAL INJURY, LOSS OF LIFE, and/or PROPERTY DAMAGE WHEN STARTING the engine, turbine, or other type of prime mover, BE PREPARED TO MAKE AN EMERGENCY SHUTDOWN to protect against runaway or overspeed should the mechanical-hydraulic governor(s), or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the control devices fail.

Verify:

- MPU voltage between terminals 5 and 6 at least 1.5 Vrms while cranking? (For small gears, it may be necessary to decrease the MPU clearance). Do not decrease below 0.25 mm (.010 inches).
 - Actuator should go to maximum fuel position when the starter turns engine or turbine. (If applicable, Start Fuel Limit must be fully clockwise.)
 - When the engine or turbine starts and comes to speed, the actuator arm should move toward minimum-fuel position.
11. Adjust the GAIN pot to the stable region between low-frequency and high-frequency oscillation.
 12. If there is a low-frequency oscillation which does not stop when the GAIN pot is adjusted, turn the STABILITY pot slightly clockwise and try the GAIN pot adjustment again. Continue adjusting the STABILITY pot slightly clockwise, then readjusting the GAIN pot, until the engine runs at a steady speed.

If there is a high-frequency oscillation which will not stop, even when the GAIN pot is fully counterclockwise, adjust the STABILITY pot slightly counterclockwise until the high-frequency oscillation stops.

Speed Settings

13. Adjust the RATED SPEED pot for the desired rated speed.
14. Set the IDLE SPEED pot for the desired idle speed.
15. Close the IDLE/RATED switch.
16. Adjust transient response. Simulate a transient by manually bumping the linkage.

To decrease settling time (may increase ringing) after a transient, turn the GAIN pot clockwise slightly, then turn the STABILITY pot as required to eliminate oscillation and to obtain desired response. Repeat if necessary.

To decrease ringing (will increase settling time) after a transient, turn the GAIN pot counterclockwise slightly, then turn the STABILITY pot as required to eliminate oscillation and obtain desired response. Repeat if necessary.

17. Select alternate dynamics and alternate fuel, if applicable. Repeat this step as necessary.

This completes the check of units without droop. For units with droop, do the following additional steps.

Droop Adjustment (only for units with droop)



NOTE

The EPG Load Sensor Module cannot be used with the EPG model that has internal droop.

For Isolated Load

1. Connect the PT wires to terminals 9 and 10 and the CT wires to terminals 11 and 12. Verify correct polarity (see the wiring diagram).
2. Adjust the RATED SPEED pot for rated speed with no load.
3. Apply 100% rated load or available load.



WARNING

If engine speed increases when load is applied, there is danger of death, personal injury, or damage to equipment. Be prepared to control the engine or turbine manually by forcing the actuator arm toward the minimum-fuel position. If engine speed does increase with load, reverse either the PT or CT input wires.

4. Adjust the DROOP pot to give a speed of:

$$\text{Rated Speed} - \frac{\% \text{Droop} \times \text{Rated Speed}}{100\%} \times \frac{\% \text{Load}}{100\%}$$

Example 1:

The generator set is a 60 Hz unit with an isolated load. If the desired droop is 5% and the generator set can be run at 100% load, then the speed at full load would be 57 Hz.

Example 2:

It is again desired to set the droop of the same generator set to 5%, but this time the generator set cannot be run at 100% load. The generator set is therefore run at 50% load and the speed (in step 3) would be 58.5 Hz.

Example 3:

The generator set is a 60 Hz unit that will be paralleled with an infinite bus. If the desired droop is 5% and the generator set can be run at 100% load, the speed at which the generator is run (in step 2) would be 63 Hz.

Example 4:

It is again desired to set the droop of the same generator set to 5%, but this time the generator set cannot be run at 100% load. It has been decided to run the generator set at 50% load, so the speed (in step 2) at which the generator set is run would be 61.5 Hz. In step 7, the DROOP pot is then turned counterclockwise only until the load is 50%.

Paralleled with Infinite Bus

1. Run the generator set unloaded at rated speed.
2. Adjust the RATED SPEED pot to give a speed of:

$$\text{Rated Speed} - \frac{\% \text{Droop} \times \text{Rated Speed}}{100\%} \times \frac{\% \text{Load}}{100\%}$$
3. Mark the position of the pot and return to rated speed.
4. Turn the DROOP pot fully clockwise (for maximum droop).
5. Synchronize the generator to, and parallel it with, the bus.
6. Return the RATED SPEED pot to the mark made in step 3.
7. Turn the DROOP pot counterclockwise (decreasing droop) until load is 100% (or the desired % of load).

Chapter 4

Repair and Replacement

Introduction

Identification

If any part of the electronic control is to be returned to Woodward Governor Company for repair, attach a tag to the part with the following information:

- name and location where the control is installed;
- complete Woodward Governor Company part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.



CAUTION

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward Governor Company Manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Packing a Complete Control

Use the following materials when returning a complete control:

- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

Additional Instructions

When returning equipment to Woodward, please telephone and ask for the Customer Service Department. They will help expedite the processing of your order through our distributors or local service facility.

Replacement Parts Information

When ordering replacement parts for electronic controls, include the following information:

- the part number(s) (XXXX-XXX) that is on the enclosure nameplate;
- the unit serial number, which is also on the nameplate.

How to Contact Woodward

Use the following address when shipping or corresponding:

Woodward Governor Company
Industrial Controls Group
PO Box 3800
3800 North Wilson Ave
Loveland CO 80539-3800

TELEPHONE: (970) 663-3900 (24 hours a day)
FAX: (970) 962-7050

There is also information and e-mail addresses on Woodward's Internet (World Wide Web) home page:

<http://www.woodward.com>

Other Service Facilities

Contact Woodward Governor Company, Customer Service Department for the name of your nearest Woodward distributor or service facility.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

General

Your Name _____
Site Location _____
Phone Number _____
Fax Number _____

Engine Information

Engine Model Number _____
Manufacturer _____
Number of Cylinders _____
Type of Fuel _____
Rating _____
Application _____

Governor Information

Please list all Woodward governors, actuators, and electronic controls in your system:

Woodward Governor Part Number and Revision Letter

Control Description or Governor Type

Serial Number _____

Woodward Governor Part Number and Revision Letter

Control Description or Governor Type

Serial Number _____

Woodward Governor Part Number and Revision Letter

Control Description or Governor Type

Serial Number _____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

We appreciate your comments about the content of our publications.

Please send comments to:

**Woodward Governor Company
Attention: Technical Publications
PO Box 1519
Fort Collins CO 80522-1519, USA**

Please include the manual number from the front cover of this publication.



Industrial Controls

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UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES

SAE Grade and Head Markings	1 or 2 ^b NO MARK 	5 	5.1 	5.2 	8 	8.2 
SAE Grade and Nut Markings	2 NO MARK 	5  	8  			

Size	Grade 1				Grade 2 ^b				Grade 5, 5.1, or 5.2				Grade 8 or 8.2			
	Lubricated ^a		Dry ^a		Lubricated ^a		Dry ^a		Lubricated ^a		Dry ^a		Lubricated ^a		Dry ^a	
	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft
1/4	3.7	2.8	4.7	3.5	8	4.5	7.5	5.5	9.5	7	12	9	13.5	10	17	12.5
5/16	7.7	5.5	10	7	12	9	15	11	20	15	25	18	28	21	35	26
3/8	14	10	17	13	22	16	27	20	35	26	44	33	50	36	63	46
7/16	22	16	28	20	35	26	44	32	55	41	70	52	80	58	100	75
1/2	33	25	42	31	53	39	67	50	85	63	110	80	120	90	150	115
9/16	48	36	60	45	75	56	95	70	125	90	155	115	175	130	225	160
5/8	67	50	85	62	105	78	135	100	170	125	215	160	215	160	300	225
3/4	120	87	150	110	190	140	240	175	300	225	375	280	425	310	550	400
7/8	190	140	240	175	190	140	240	175	490	360	625	450	700	500	875	650
1	290	210	360	270	290	210	360	270	725	540	925	675	1050	750	1300	975
1-1/8	470	300	510	375	470	300	510	375	900	675	1150	850	1450	1075	1850	1350
1-1/4	570	425	725	530	570	425	725	530	1300	950	1650	1200	2050	1500	2600	1950
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2150	1550	2700	2000	3400	2550
1-1/2	1000	725	1250	925	990	725	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

^a "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.

^b Grade 2 applies for hex cap screws (not hex bolts) up to 152 mm (6-in.) long. Grade 1 applies for hex cap screws over 152 mm (6-in.) long, and for all other types of bolts and screws of any length.

Fasteners should be replaced with the same or higher grade. If higher grade fasteners are used, these should only be tightened to the strength of the original.

Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

METRIC BOLT AND CAP SCREW TORQUE VALUES

Property Class and Head Markings	4.8	8.8	9.8	10.9	12.9
	  	  	 	 	  
Property Class and Nut Markings	5	10	10	12	
	  	  	  	  	

Size ¹	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated ^a		Dry ^a		Lubricated ^a		Dry ^a		Lubricated ^a		Dry ^a		Lubricated ^a		Dry ^a	
	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft
M6	4.8	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	190
M16	100	73	125	92	190	140	240	175	275	200	350	225	320	240	400	300
M18	135	100	175	125	260	195	330	250	375	275	475	350	440	325	560	410
M20	190	140	240	180	375	275	475	350	530	400	675	500	625	460	800	580
M22	260	190	330	250	510	375	650	475	725	540	925	675	850	625	1075	800
M24	330	250	425	310	650	475	825	600	925	675	1150	850	1075	800	1350	1000
M27	490	360	625	450	950	700	1200	875	1350	1000	1700	1250	1600	1150	2000	1500
M30	675	490	850	625	1300	950	1650	1200	1850	1350	2300	1700	2150	1600	2700	2000
M33	900	675	1150	850	1750	1300	220	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical property class.

Fasteners should be replaced with the same or higher property class. If higher property class fasteners are used, these should only be tightened to the strength of the original.

^a "Lubricated means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry means plain or zinc plated without any lubrication.

Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

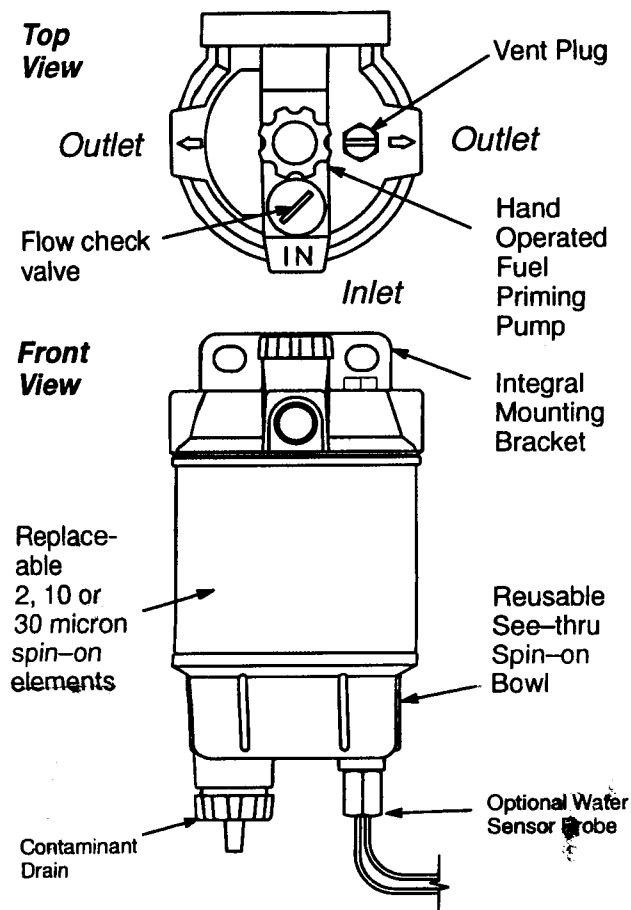
Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

220/225R Spin-on Series Fuel Filter/Water Separators for Diesel Engines

RACOR
Parker Hannifin Corporation
Racor Division
P.O. Box 3208, 3400 Finch Rd.
Modesto, CA 95353 USA
209/521-7860 / 800/344-3286
FAX 209/529-3278



Filtration



Racor's 220 / 225R Fuel Filter/Water Separators are specifically designed to handle today's tough diesel filtration problems. These units feature a standard in-head fuel priming pump and are different from one another only in flow capacity and element size.

These units should be used on the suction (vacuum) side of the fuel transfer pump (and are permitted for use up to 7 PSI of head pressure). The die-cast aluminum mounting head features two outlets and one inlet for installation to most fuel systems. The fuel ports are standard SAEJ476 1/4"-18 NPTF (tapered dryseal pipe thread). Call factory for optional port threads. Many varieties of fittings are available from Racor or hardware dealers. (Fittings may not be supplied with this unit).

A vent plug is fitted to easily evacuate trapped air, making fuel priming of the filter an easy, no-mess experience.

Engines will benefit from near 100% water separation and fuel filtration with Racor's proprietary *Aquabloc*™ water repelling media. The replaceable spin-on filter elements are available in 2, 10 and 30 micron ratings.

The reusable see-through contaminant collection bowl allows the operator to check contamination build-up at a glance. The contaminant drain is opened by rotating the knob counterclockwise (if facing the bowl bottom side).

OPTIONAL FEATURES:

An available option for non-marine applications is a water sensor probe which alerts the operator when it's time to drain the see-thru bowl. (The probe must be used with a 12 or 24 vdc powered Water Detection Kit. See *Accessories* for available models). For use with diesel fuel systems, only.

Additionally, a metal bowl is available for severe service, heavy duty or marine applications. This bowl features a 3/8"NPT drain plug which may be replaced by UL LISTED drain valve (refer to parts list).

For marine applications, specify the Model 220RMAM or 225RMAM. These units are UL Marine Listed and USCG Accepted.

PART NUMBER IDENTIFICATION

The example below illustrates how part numbers are constructed.

225R	M	P	-10
220R = 30 GPH	Metal bowl. (Omit if not desired)	Water Sensor Probe.	Filter Micron Rating: 2 is standard and does not need to be specified if desired.
225R = 45 GPH	Specify MAM for Marine applications	(Omit if not desired) For see-thru bowl only	For 10 or 30 micron filtration, specify: -10 or -30

SPECIFICATIONS

MODEL		220R	225R
Maximum Flow Rate	GPH LPH	30 114	45 170
Replacement Element		R24 Series	R26 Series
Fuel Ports (SAEJ476)	NPT	1/4"	1/4"
Clean Pressure	PSI	0.38	0.61
Drop*	kPa	2.64	4.21
Height	in. mm	8 203	9.5 241
Width	in. mm	4 102	4 102
Depth	in. mm	4 102	4 102
Weight, Dry	lbs. kgs.	1.8 .80	2 .90
Operating Temp.		- 40° / +255°F / - 40° / +121°C	

* Specifications result from tests conducted at the maximum flow rate.

INSTALLATION INSTRUCTIONS

LOCATION: The Racor 220 / 225 models should be located on the suction (vacuum) side of the fuel transfer pump for optimum water separation efficiency. The unit may be permitted for use up to 7 PSI of head pressure.

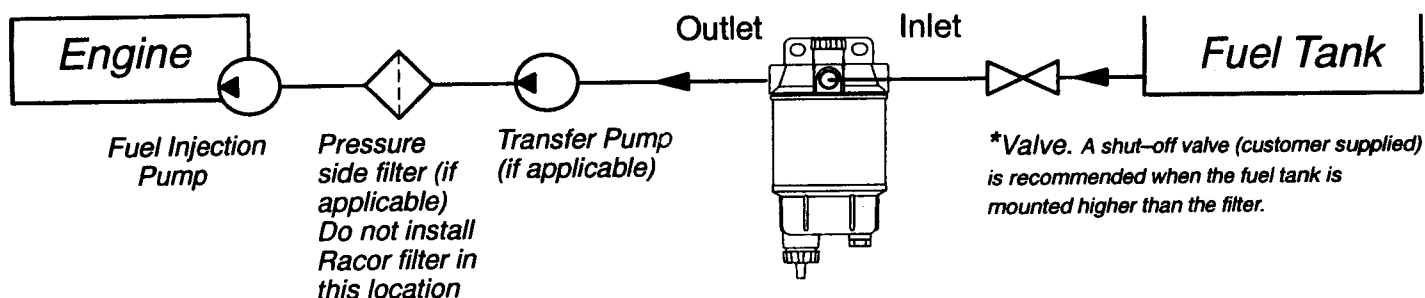
FILTRATION: Primary (30 micron), Secondary (10 micron) or Final (2 micron).

The first filter downstream from the fuel tank to the engine is a primary filter. Typically this filter is rated for 30 microns and catches the largest contaminants (a 10 micron filter may also be used). Between this filter and the engine is a secondary filter (optional) or a final filter (required) and should be rated for 10 or 2 micron, respectively. If using only one filter in the fuel filtration system, a 2 micron filter is recommended for maximum protection.

NOTE: Pressure side final filters, if applicable, should be serviced and left in place.

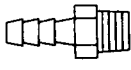
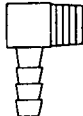
BEFORE INSTALLING THE UNIT:

1. Ensure fuel port fittings are in hand along with fuel line, hardware and all needed tools and materials.
2. Maintain a safe working environment. The engine must be off and obtain good ventilation and lighting.
Do not smoke or allow open flames near the installation. Eye protection is recommended and have fluid 'drip' pans and absorbant shop cloths available to anticipate spills.
3. The chosen mounting location should allow adequate room below the unit for servicing requirements (i.e., draining water, replacing elements).
4. Pipe thread sealing paste is recommended on port fitting connections. Do not use pipe tape.



Typical Diesel Suction (vacuum) Side Installation

BRASS 1/4"NPT FITTINGS CHART

Description	Hose I.D.	Part Number	Qty.
Hose Barb H 	1/4"	RK 30815	2
	3/8"	30926	1
	5/16"	30927	1
Elbow Hose Barb H 	3/8"	30928	1
	5/16"	30929	1

OPERATING INSTRUCTIONS

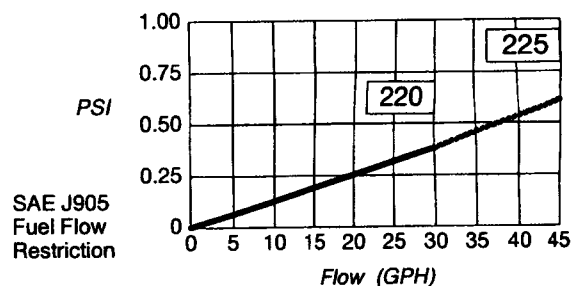
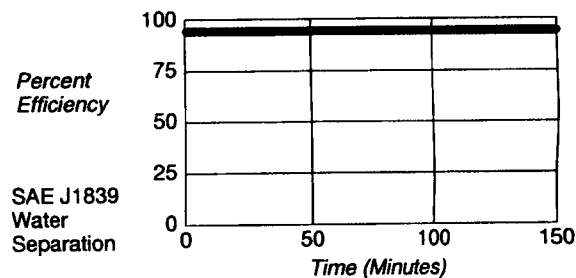
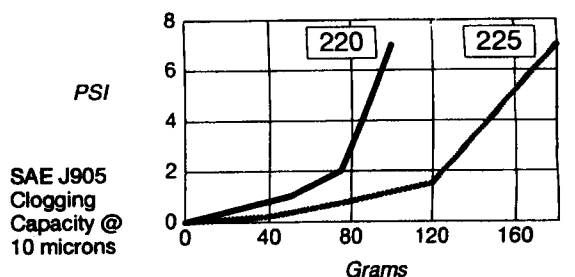
PRIMING. Loosen the vent plug. Operate the primer pump until fuel purges at the vent plug. Close the vent plug, start the engine and check for leaks. Correct as necessary with the engine off.

TROUBLESHOOTING PROCEDURES

A major cause of power loss or hard starting is the result of an air leak. If your unit will not prime or fails to hold prime, first check that the vent plug and drain valve are properly closed and that the element and bowl are snugly tightened.

Check fitting connections and ensure the fuel lines are not pinched or clogged with contaminants. If problems persist and the element is new, call your Racor Distributor or Racor Customer Service for assistance.

PERFORMANCE INFORMATION



INSTALLING OPTIONAL FEATURES

NOTE: RACOR ELECTRICAL OPTIONS ARE FOR USE WITH NON-MARINE DIESEL FUEL, APPLICATIONS ONLY.

WATER SENSOR.

Racor 220 / 225R Series units can be specified with a water sensor probe when used in conjunction with the see-thru bowl. The probe senses continuity values and **must** be used with a special electronic detection module to function properly. Due to the various models available, the detection modules are sold separately. Installation instructions are supplied with each kit. See *Accessories* for part numbers.

For those units purchased complete with the water sensing package, follow the diagram below to install this feature.
(Note: some components shown are customer supplied).

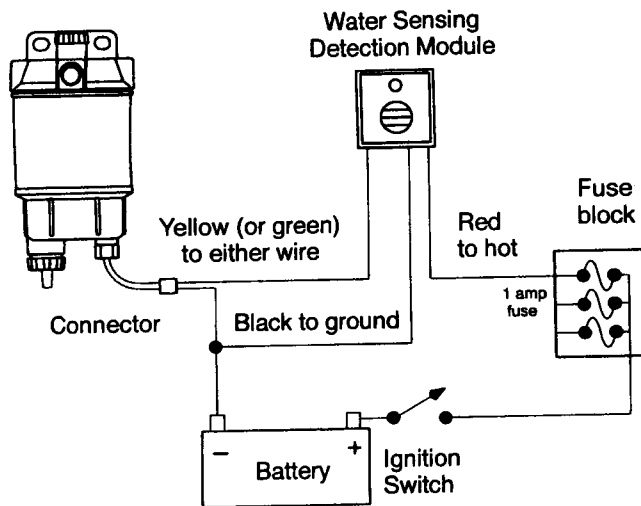


Diagram for RK12870
or RK12871 underdash type kits

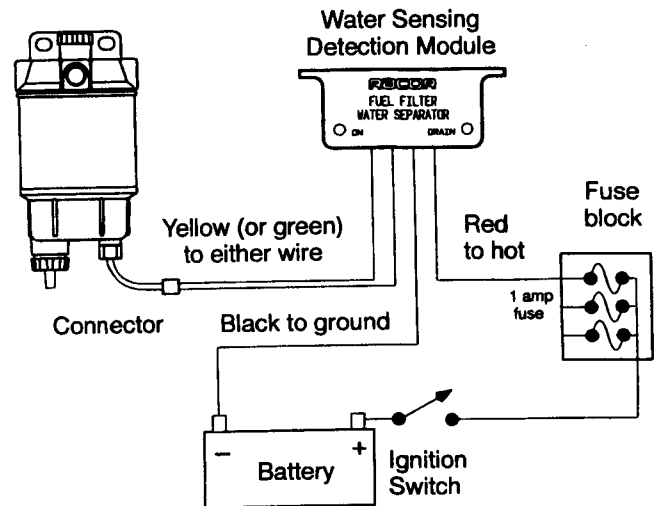


Diagram for RK20725 (underdash,
shown) or RK20726 (gauge type) kits

SERVICE

Frequency of water draining or element replacement is determined by the contamination levels present in diesel fuel.

DRAINING THE COLLECTION BOWL.

Water is heavier than diesel fuel and will settle to the bottom of the bowl and appear different in color. The bowl must be drained before contaminants reach the bottom of the element or when the Water Detector Module (if equipped) indicates it's time to 'drain water'. Inspect or drain the collection bowl of water daily.

1. Open the drain and operate the pump to drain off contaminants. Close the drain.

ELEMENT REPLACEMENT.

Element replacement frequency is determined by the contamination level in diesel fuels. Fuel flow to the engine becomes restricted as the element slowly plugs with contaminants, resulting in noticeable power loss and/or hard starting.

Replace the element every 10,000 miles, every 500 hours of operation, every other oil change, annually or if a power loss is noticed, which ever comes first. If a vacuum gauge has been installed on the outlet side of the filter, change the element between 6 to 10 inches of mercury (restriction). The actual measurement varies in different fuel systems.

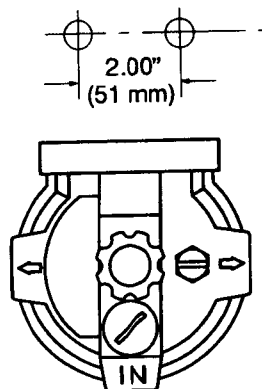
Note: Always carry an extra element as one tankful of excessively contaminated fuel can plug a filter.

1. Drain off some fuel by loosening the vent plug and opening the drain valve.
2. Disconnect the water sensor connector, if equipped.
3. Spin the element and bowl off together. Remove the bowl and clean the O-ring gland.
4. Apply a coating of clean fuel or motor oil to the new O-ring and element seal. Spin the bowl onto the new element and then spin them both onto the filter head snugly by hand only. DO NOT USE TOOLS TO TIGHTEN!
5. Connect the water sensor connector, if equipped.
6. With the vent plug still loosened, operate the primer pump until fuel purges at the vent plug. Close the vent plug, start the engine and check for leaks. Correct as necessary with the engine off.

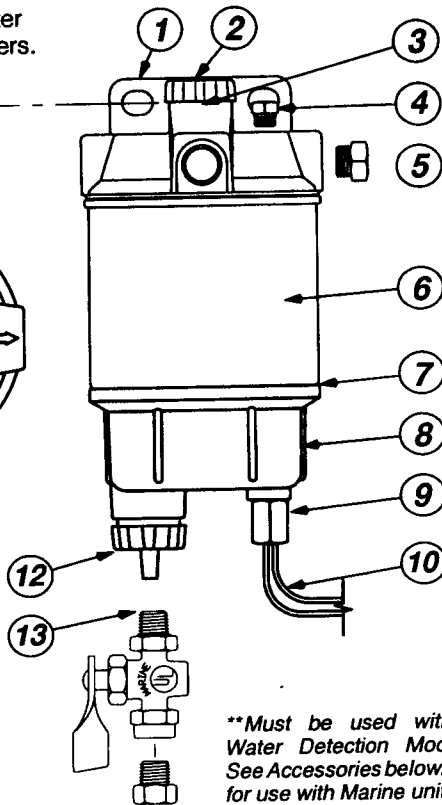
NOTE: The priming pump is intended for priming fuel into the Racor filter only and not the entire fuel system.

REPLACEMENT PARTS LIST

5/16" (8 mm) diameter clearance for fasteners.



Head top view.
Fuel ports are
1/4"-18 NPTF
(SAEJ476)



****Must be used with a Water Detection Module. See Accessories below. Not for use with Marine units.**

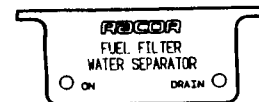
Item/Part No.	Description	Qty.
1 RK20046	Head, 1/4"-18 NPTF Ports	1
2 RK20025	Primer Pump Assembly	1
3 RK20011	Check Ball and Plastic Cap	1
RK20742	Metal Check Ball Cap (Marine)	1
4 RK20179	Plastic Vent Plug, 3/8"-16	1
RK10110	Metal Vent Plug, 3/8"-16 (Marine)	1
5 RK12041	Metal Plug, 1/4"-18 NPTF	1
6 R24S	220R, 2 mic. Replacement Element	1
R24SUL	220RMAM, 2 mic. Element (Marine)	1
R24T	220R, 10 mic. Replacement Element	1
R24P	220R, 30 mic. Replacement Element	1
R26S	225R, 2 mic. Replacement Element	1
R26SUL	225RMAM, 2 mic. Element (Marine)	1
R26T	225R, 10 mic. Replacement Element	1
R26P	225R, 30 mic. Replacement Element	1
7 RK22244	Bowl O-ring (not shown)	1
8 RK20135	See-thru Bowl Assembly	1
RK20357	Metal Bowl, 3/8"NPT Drain Plug (Marine)	1
9 RK20022	Metal Plug, 1/2"-20	1
10 RK21069	Water Sensor Probe**	1
12 RK20076	Drain Knob and Seals Kit	1
01SP-6S	Metal Plug, 3/8"NPT (Marine)	1
13 RK19492	Diesel Marine Shut-off Valve (for #RK20357 metal bowls only)	1
RK20075	Complete Gasket/O-ring Kit	1
7238	Installation Instruction Sheet	1

ACCESSORIES

Accessory kits are for use with diesel fuel only. Order kits from your Racor dealer.

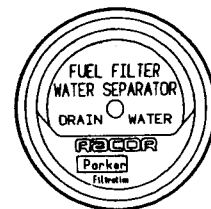
Water Detection Kit # RK20725

This 12 vdc under dash module illuminates an LED when power is on and then when water is detected. The 'DRAIN' LED will remain illuminated until the water is drained below the probe tips. The unit automatically resets. Hardware and instructions included. Wire/terminals are customer supplied. Measures 2 3/4" by 1" by 1 1/2" deep.



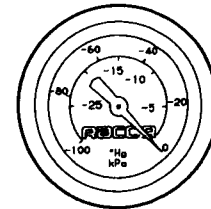
Water Detection Kit # RK20726

This 2" diameter gauge type module is ideal for in-dash applications. The corrosion resistant body is waterproof from the face side and may be used with 12 or 24 vdc electrical systems. The unit illuminates an LED and sounds a momentary buzzer at every 'power-up' and then when water is detected. The unit automatically resets. Hardware and instructions are included however, wire and terminals are customer supplied. Fits standard 2 1/16" diameter panel openings. Measures 2 1/4" (major) diameter by 3 1/8" deep (to end of threaded connector studs).



Gauge-Type Element Restriction Monitor Kit #1606B

This 2" diameter gauge is also ideal for in-dash applications. Fuel flow to the engine becomes restricted as the element slowly plugs with contaminants. The gauge monitors the filter restriction and informs the operator of filter condition anytime the engine is running. Hardware and instructions included however, plated steel 'Tee' and vacuum tubing not supplied. These items may be ordered from your Racor dealer.



WARNING The following statement is required pursuant to Proposition 65 applicable in the State of California: "This product may contain a chemical known to the State of California to cause cancer." **WARNING** Failure or improper selection or improper use of the products and/or systems described herein or related items can cause death, personal injury and property damage. This document and other information from Parker Hannifin Corporation, its subsidiaries and authorized distributors provide product and/or system options for further investigation by users having technical expertise. It is important that you analyze all aspects of your application and review the information concerning the product or system in the current product catalog. Due to the variety of operation conditions and applications for these products or systems, the user, through its own analysis and testing, is solely responsible for making the final selection of the products and systems and assuring that all performance, safety and warning requirements of the applications are met. The products described herein, including with limitation, product features, specifications, designs, availability and pricing, are subject to change by Parker Hannifin Corporation and its subsidiaries at any time without notice.

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EP-100-G SERIES INSTALLATION INSTRUCTIONS FOR PANELS INSTALLED ON DEUTZ ENGINES

GENERAL: The Deutz panel was designed for: Reliability, ease of installation and for flexibility. The panel can be quickly adapted from one Deutz engine model to another simply by installing different wire harnesses also known as a pigtail. All panels for Deutz 1011, 912/913 and 1012/1013 series are manufactured alike with the exception of the pigtail and that the 1012/1013 engines utilizes a water temperature verses the oil temperature gauge. Also available for the 912/913 series engine only is a pump spec panel which utilizes a mechanical oil pressure and cylinder head temperature switch gauges.

PANEL INSTALLATION:

1. **Mount panel** to flywheel housing utilizing the vibration isolated mounting bracket or remote mount the panel without the bracket in a desired location. Engine mounting brackets are available in two designs (1) for 912/913 and (2) for 1011F Engines
Note: Installing isolation mounts in a twist will cause mounts to self destruct.
2. **Apply corrosion protection to all terminals.** In order to reduce corrosion each panel utilizes zinc plated terminals which under normal operation conditions will protect against corrosion. Applications which could be subjected to corrosive elements such as: fertilizer, high sulfur content in the water, road salt and even soap which is often used to clean equipment can deteriorate the entire electrical network. Prior to installation make sure all terminals and receptacles are (1) covered with a non conductive dielectric grease or corrosion preventive lubricant or (2) the white and yellow receptacle can also be completely sealed with a cold fusion shrink tape which bonds itself chemically and mechanically to form a durable seal against moisture. This tape is applied by stretching the tape about three times its normal length while wrapping the tape around the receptacles remembering to overlap each wrap at least one-half tape width. Break tape to end wrap. Tape will bond to itself completely after 24 hours. (3) Also recommended is to cover all outside terminals on the engine with liquid electrical tape which is applied with a brush and is available in most automotive stores. Note: The rear white & yellow connector can be moved inside the panel enclosure by using an optional rear entry plate which closes off the rear connectors opening.
3. **Install pigtail.** Disconnect the battery and install pigtail to the back of the panel by connecting the two 8 position housings on the wire harness to the appropriate color coded receptacle that have position numbers as viewed from the outside of the panel. In order to protect internal components each panel is equipped with an internal 15A fuse, however installing an additional 40A fuse as close as possible to the battery is highly recommended. Remote mounted panels may require an extended wire harness which LOFA can make available in almost any length.
4. **Panels equipped with voltmeters require a 6 AWG battery charge wire.** This wire is installed to terminal 30 of the starter motor and to the terminal B+ on the alternator. This charge wire will eliminate all high amperage from entering the panel. Some Deutz engines may already have this charge wire installed on the engine. Deutz 1012/1013 engines have two possible charge wires available which depends on the engine configuration (standard charge wire Part # 25103 or integrated cooling charge wire part # 25104). The 6 AWG charge wire for the 1012/1013 engines are not supplied with the panel and needs to be ordered separately from Deutz Corporation.
5. **High Voltage spikes** up to 1000V or more can occur momentarily when a relay or solenoid is switched off. Relay contacts, electronics etc. can be damaged or malfunctions can occur if these spikes reach the electrical network without suppression. It is highly recommended to install a **1N4007** diode as close as possible to high amperage solenoids. Please note installing the diode in the incorrect direction will damage the diode and will not suppress high voltage spikes. The ring marking on one side of the diode indicates side which should be connected to the positive current of the solenoid. The opposite side should then be connected to the negative side of the solenoid. Note: Fuel cut-off solenoid valves on 912/913 series engines do not require a diode due to the low amperage draw.
6. **Calibrating the tachometer:** Remove panel face-plate and start engine. Using a hand-held tachometer set the engine speed to 1800 RPM. A small insulated screwdriver should be used to adjust the potentiometer located on the side of the gauge until gauge reads 1800 RPM. The total range of adjustment is one complete turn (½ turn to the left and ½ turn to the right). Some tachometers may require an additional setting of three dip switches. These dip switches on a 6 pole pair alternator should be adjusted "Off" "On" "Off" When looking at the back of the tachometer with the terminals facing down the dip switch setting should be "Up" "Down" "Up".
7. **Shutdown solenoid:** The shutdown systems used on Deutz engines are wired "ETR" energized to run. Deutz 1011 and 1012/1013 series engine are already equipped with a 3.5A solenoid. The Deutz 912/913 engines frequently uses a fuel cutoff solenoid which requires a check valve installed on the injector nozzle closes to the flywheel. This check valve prevents feedback from the fuel return line; however shutting down the engine with this type of solenoid will be delayed due to the fuel in the lines. Deutz 912/913 applications requiring instant shutdown should install a three wire rack lever type shutdown solenoid. Due to the high amperage required to pull the solenoid the pull wire should be connected to the heavy duty starter motor terminal. The hold wire requires very little current and should be connect to the solenoid + wire of the panel and the third wire should be connected to engine ground.

8. The **shutdown switches** on the Deutz engine are all "Normally Open (N/O)" with the exception of the oil pressure switch which is "Normally Closed" (N/C). The oil pressure switch opens when engine is running and has pressure. The v-belt switch on the 912/913 engine series has the ability to be wired in two ways either "N/C" or "N/O". Changing this v-belt setting can be easily accomplished by opening the v-belt connector which is located while facing the flywheel on the left side of the engine and exchanging wires #1 and #2. On newer engines this change is made by the manufacturer. Each panel is equipped with an alternator failure shutdown. Adding additional shutdowns to the panel can be easily accomplished by routing a ground contact switch wire to any of the yellow panel shutdown wires.
9. **Selection of oil pressure switch:** For Variable speed applications all Deutz engines will require a 0.5 bar (7 psi) switch point pressure switch. For constant speed applications contact engine manufacturer for the correct oil pressure switch selection.
10. **Pegging of the 80 psi oil pressure gauge** is common in the industry and has no negative effect since a pressure gauge is used primarily to measure low oil pressure which indicates engine wear.
11. **Voltmeter Verses Ammeter:** In order to eliminate high amperage, each panel is equipped with a voltmeter for battery charge indications. **Caution** should be taken on applications requiring an ammeter since the high amperage runs through the rear panel receptacle which could cause problems under weak battery conditions while jump starting. Ammeter installation should utilize a 6 AWG wire size entering the panel through the 1" opening located on the back-side of each panel.
12. **Maintenance:** This panel is not designed to be sprayed with high pressure waters systems and will only promotes corrosion of the electrical system. Terminals and battery charge bulbs may require periodic spraying with contact cleaner for trouble free operations.

TROUBLE SHOOTING:

Engine does not stay running.

Make certain v-belt failure switch is wired normally open (only on 912/913 engine series)

Make certain panel has a good ground

Make certain solenoid - has a good ground

Make certain switch wires are not touching ground

Make certain 5W 47 Ohm resistor is intact

Engine will not shutdown

Make certain that there are no loose shutdown wires

Make certain shutdown switches on engine is operational

WARRANTY POLICY:

LOFA Industries, Inc. guarantees each panel and components therein for a period of two year from date of purchase and will replace defective parts within this two year period. Defects caused by corrosive compounds are not covered. Should individual components fail, LOFA Industries, Inc. will only warranty the failed parts for replacement.

W A R N I N G!
DO NOT ACTIVATE ENGINE RUN SOLENOID WITHOUT FIRST
INSTALLING DIODES

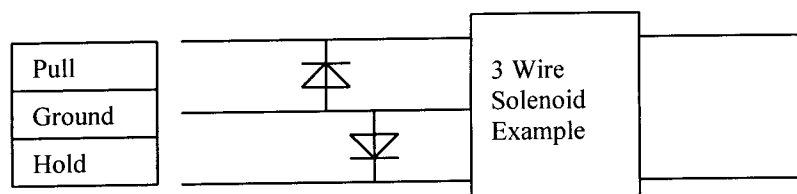
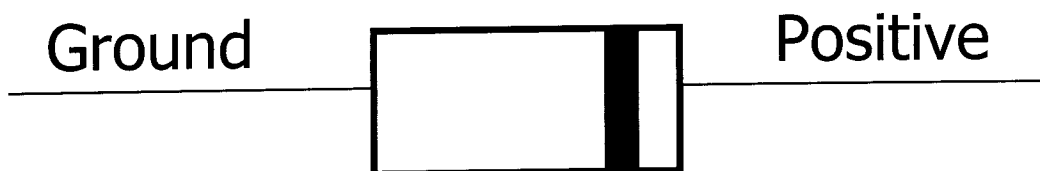
REDUCING VOLTAGE SPIKES:

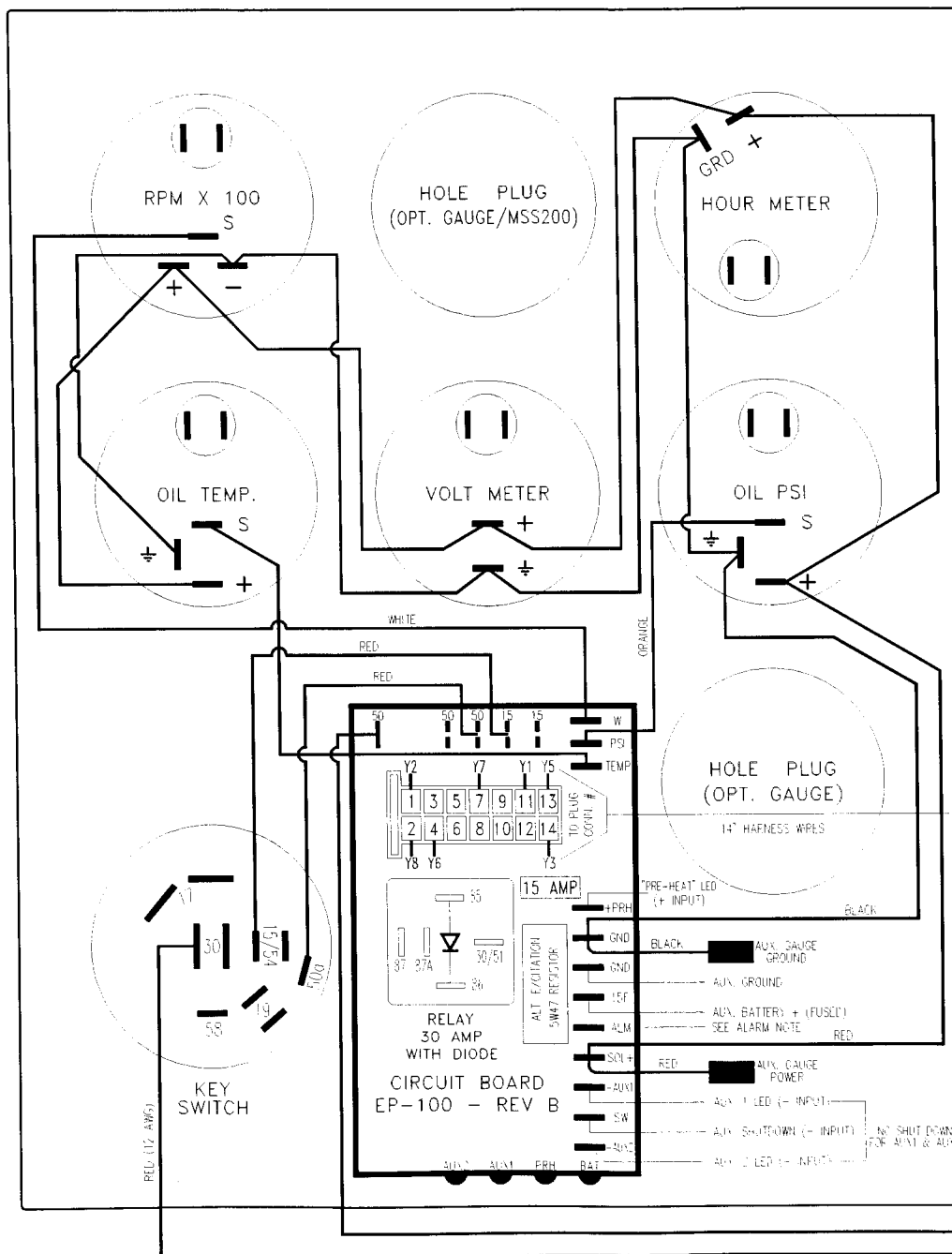
High Voltage spikes up to 1000V or more can occur momentarily when a relay or solenoid is switched off. Relay contacts, electronics etc. can be damaged or malfunctions can occur if these spikes reach the electrical network without suppression. A **1N4007** diode should be used when using any of LOFA's products. Please install this diode as close as possible to the solenoid per the below diagram. Please note installing the diode incorrectly or reversing the batteries polarity will damage the diode. For your convenience please find enclosed 1N4007 diodes.

Install diodes in the following locations:

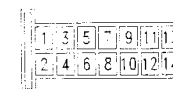
- 2 Wire Shutdown Solenoids (Positive Pull Wire Only)
- 3 Wire Shutdown Solenoid (Positive Pull And Hold Wires)
- Fuel Shut-off Solenoids (Positive Pull Wire)
- Other Applications Such As Hydraulic Solenoid System Also Require A Diode On The Positive Pull Wire
- Use Relays Equipped With Diodes Only

FREE WHEELING DIODE
1N4007



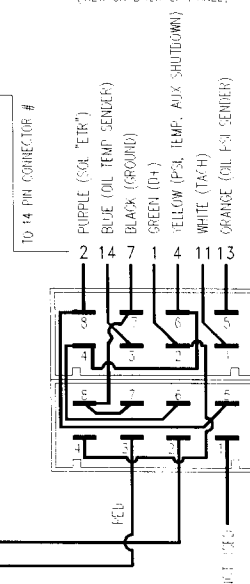


AMP 14 PIN CONNECTOR



- 1 - D+ ALTERNATOR (GREEN)
- 2 - SOLENOID "ETR" (PURPLE)
- 3 - SHUTDOWN (- INPUT/YELLOW)
- 4 - SHUTDOWN 2 (- INPUT/YELLOW)
- 5 - SHUTDOWN (- INPUT/YELLOW)
- 6 - SHUTDOWN 1 (- INPUT/YELLOW)
- 7 - GROUND (BLACK)
- 8 - GROUND (BLACK)
- 9 - 50 STARTER MOTOR
- 10 - AUX. BATTERY + (FUSED)
- 11 - TACHOMETER FREQUENCY (WHITE)
- 12 - PRE-HEAT CONTROL
- 13 - OIL PRESSURE SENDER (ORANGE)
- 14 - OIL TEMPERATURE SENDER (LT. BLUE)

PLUG CONNECTOR (VIEW ON BACK OF PANEL)



ALARM FUNCTION

1. ALM IS A (-) GROUND (OUTPUT SIGNAL)
2. ALM ACTIVATES FOR 1 SECOND WHEN THE KEY IS TURNED ON
3. ALM ACTIVATES WHEN THE ENGINE SHUTS DOWN DUE TO A FAILURE
4. ALM DEACTIVATES WHEN THE KEY IS TURNED OFF

YELLOW (Y)

WHITE (W)

LOFA
INDUSTRIES, INC.

MANUFACTURER OF QUALITY ENGINE COMPONENTS

660 HEMBREE PARKWAY
SUITE 110

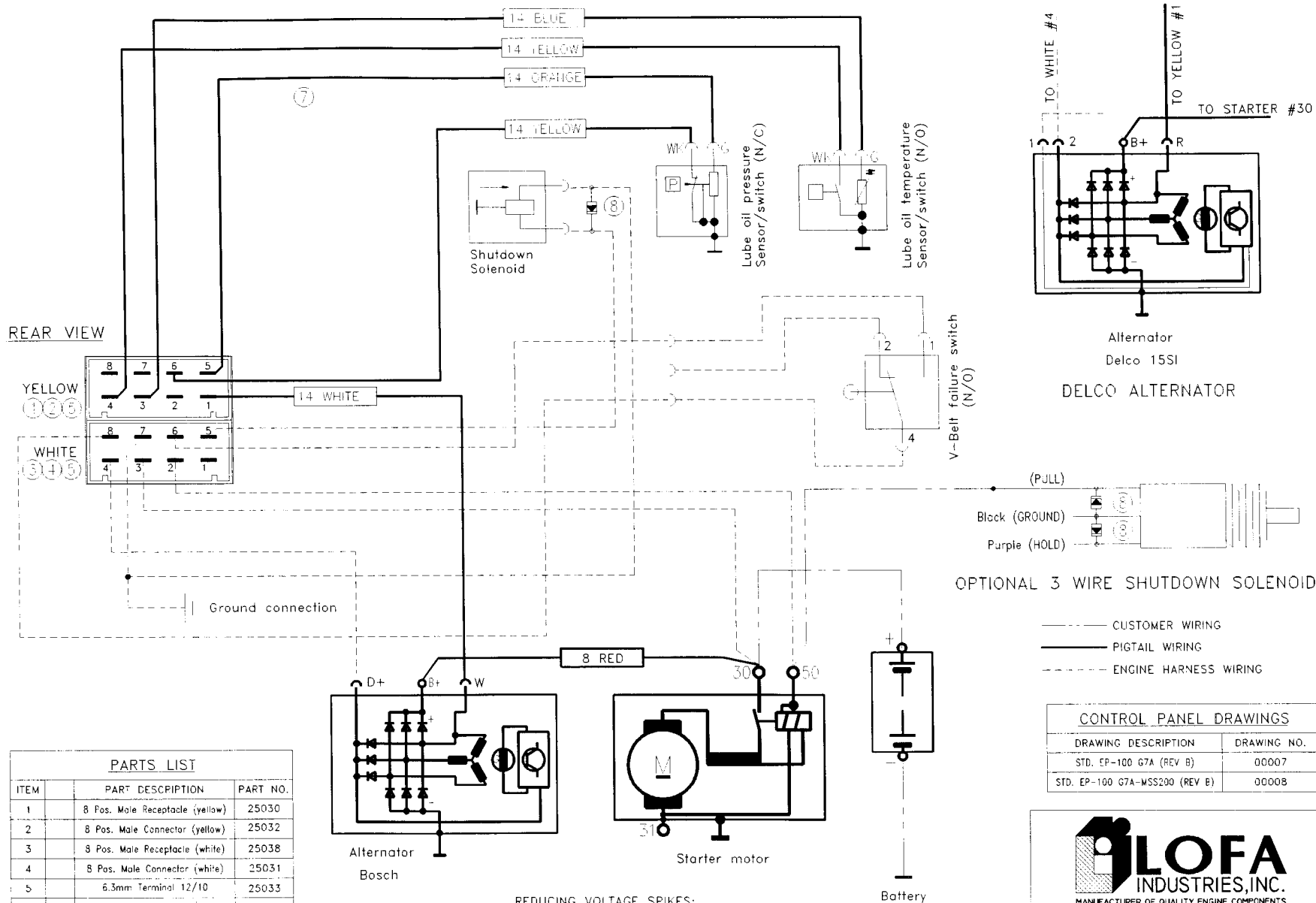
ROSWELL, GA 30076

PH: (770) 569-9828

8-11 EP-100 - REV B

PANEL WIRING

SIZE	PAGE	DATE	REV
A	1	00007	1-1



PARTS LIST

ITEM	PART DESCRIPTION	PART NO.
1	8 Pos. Male Receptacle (yellow)	25030
2	8 Pos. Male Connector (yellow)	25032
3	8 Pos. Male Receptacle (white)	25038
4	8 Pos. Male Connector (white)	25031
5	6.3mm Terminal 12/10	25033
6	6.3mm Terminal 6/4	25041
7	9/12/813 Pigtail - 20"	25004
8	8 AWG Battery Charge Wire	
8	Diode 1N4007	

REDUCING VOLTAGE SPIKES:

High Voltage spikes up to 1000V or more can occur momentarily when a relay or solenoid is switched off. Relay contacts, electronics etc. can be damaged or malfunctions can occur if these spikes reach the electrical network without suppression. A 1N4007 diode should be used when using any of LOFA's products. Please install this diode as close as possible to the solenoid. Please note installing the diode incorrectly or reversing the batteries polarity will damage the diode.

CONTROL PANEL DRAWINGS

DRAWING DESCRIPTION	DRAWING NO.
STD. EP-100 G7A (REV B)	00007
STD. EP-100 G7A-MSS200 (REV B)	00008

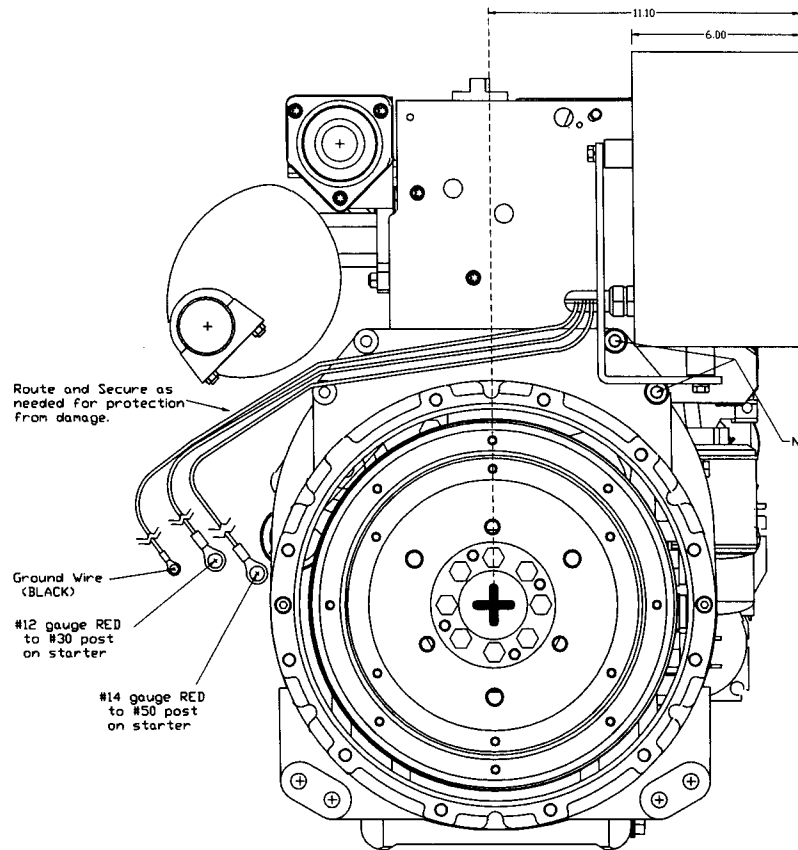
LOFA
INDUSTRIES, INC.
MANUFACTURER OF QUALITY ENGINE COMPONENTS

660 HEMBREE PARKWAY
SUITE 110
ROSWELL, GA 30076
PH: (770) 569-9825

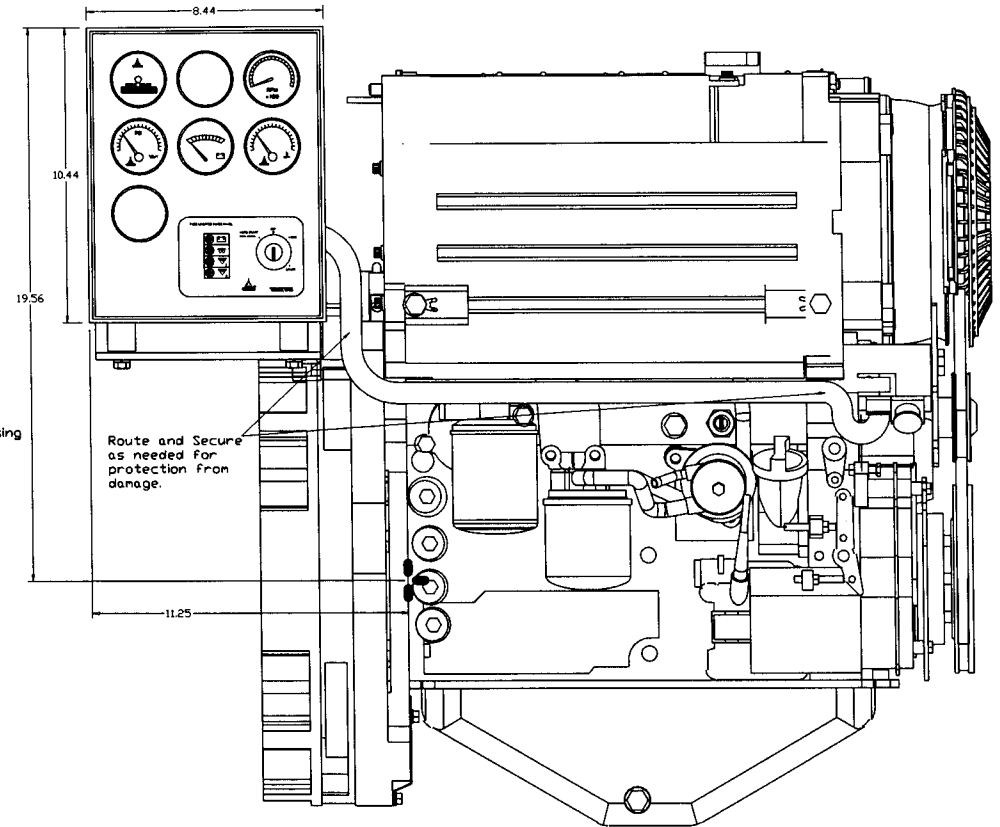
STD. EP-100 G7A - 80 AMP 12V
PANEL & ENGINE WIRING

SIZE	DATE	DRAWING NO.	SHEET	REV
A	5/1/01	00010	1 OF 1	

INSTRUMENT PANEL INSTALLATION INSTRUCTIONS

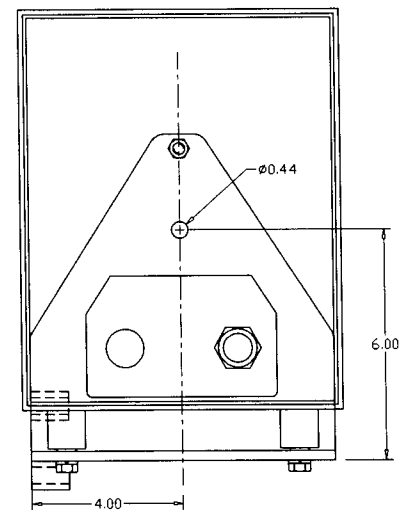
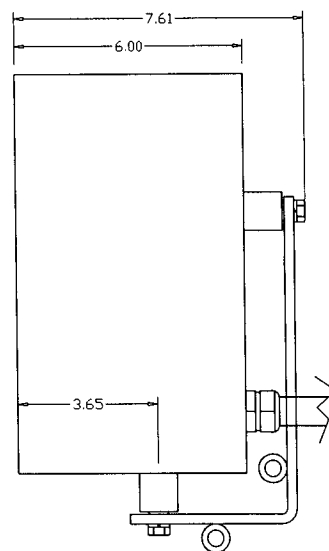
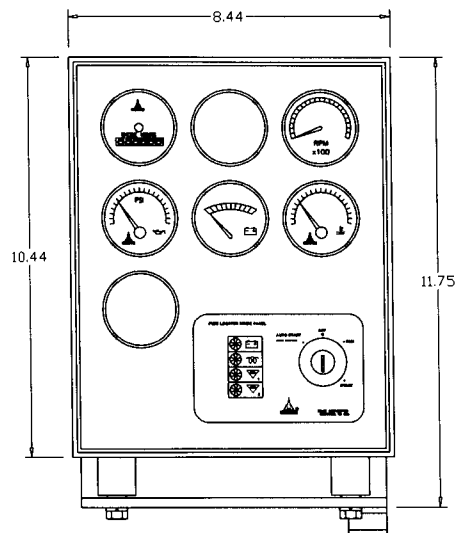


Note: Mount instrument panel on rear housing service side using supplied spacers, cap screws, flat washers, and lock washers.

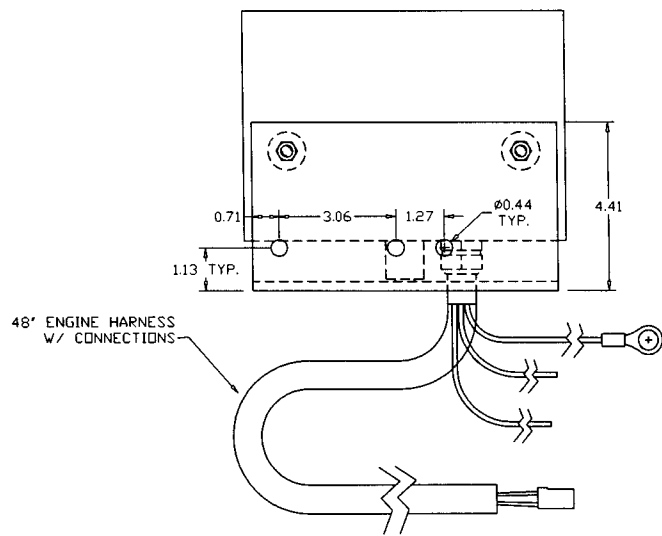
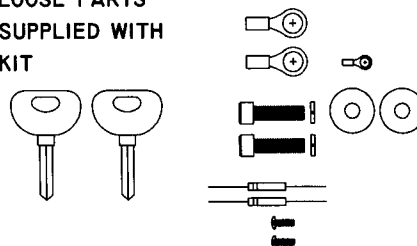


TACHOMETER MUST BE CALIBRATED USING A REFERENCE TACHOMETER

THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION AND SHALL NOT BE USED, REPRODUCED OR DISCLOSED WITHOUT THE WRITTEN CONSENT OF DEUTZ CORPORATION.		UNLESS OTHERWISE SPECIFIED	
CORNERS PER DIN 6784	GEOMETRIC TOLERANCES PER ISO 1101 AND DIN 7167	SURFACE TEXTURE PER ISO 1302	
VENDOR	999-0503 (1011F/2011)		
PAS 08/21/01	GENERAL TOLERANCES		
CHECKED	DATE		
SHEET	FOR ORDER		
1	35-00007		
TITLE		WIRING SCHEMA	
DRAWING		ASSEMBLY INSTRUCTIONS	
DEUTZ CORPORATION ATLANTA, GA USA		DCI034	
NO. ECN REVISION #	DATE	BY	REPLACES



LOOSE PARTS SUPPLIED WITH KIT



THIS DRAWING CONTAINS CONFIDENTIAL INFORMATION AND SHALL NOT BE USED, REPRODUCED OR DISCLOSED WITHOUT THE WRITTEN CONSENT OF DEUTZ CORPORATION.		UNLESS OTHERWISE SPECIFIED	
CORNERS PER DIN 6784	GEOMETRIC TOLERANCES PER ISO 1101 AND DIN 7167	SURFACE TEXTURE PER ISO 1302	
VENDOR		PROJECT/ASSEMBLY: 999-0503 (1011F/2011)	
DATE	DATE	GENERAL TOLERANCES	SCALE
PAS 08/17/01	DATE	0.1	0.1
CHECKED	DATE	0.001	0.001
A 35-00007		NA	
TITLE		DRAWING	
GAUGE PANEL SPEC.		DCI031	
DEUTZ CORPORATION ATLANTA, GA USA		REPLACES 999-0233	