

# Advance 7765 / Nilfisk CR1500

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## Service Manual

### Advance 7765 Models:

- 56514925 (Variable Dump Gas)
- 56514926 (Variable Dump LP)
- 56514927 (Variable Dump Diesel)
- 56514928 (Manual Dump Gas)
- 56514929 (Manual Dump LP GM3.0L)
- 56514930 (Manual Dump Diesel S4Q2)
- 56514931 (Variable Dump LP)

### Nilfisk CR1500 Models:

- 56514850 (Variable Dump Gas)
- 56514852 (Variable Dump LP)
- 56514854 (Variable Dump Diesel))

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## General Information

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### General Machine Description

#### Machine Configurations

The Advance 7765 and Nilfisk CR1500 machines are industrial automatic rider sweeper/scrubbers with multiple sweep/scrub single-pass coverage. The 7765 and CR1500 are all-hydraulically operated and are equipped with power steering.

The machines are powered by a 3.0 liter, 86-hp GM gasoline or liquid propane gas (LPG) engine, or a 2.5 liter, 47.3-hp Mitsubishi diesel.

The 7765 machines are available in two different hopper configurations; a manual dump (MD) model and a variable dump (VD) model. The CR1500 machines are only available in the variable dump configuration.

- The manual dump models have a smaller, fixed hopper. A manual dump lever opens the hopper to empty the hopper onto the floor below the machine.
- The variable dump models use a hydraulic cylinder to raise the hopper for emptying into a dumpster or other receptacle. A separate hydraulic cylinder opens and closes the hopper dump door. Variable dump models are also equipped with a hopper filter, dust control motor and impeller, and filter shaker motor.

#### Hydraulic System

The engine drives two hydraulic pumps that power the machine systems. All of the motors on the machine are hydraulic except for the electric filter shaker motor.

- The 1.24 cubic inches per revolution (CIR) drive pump is a variable-displacement pump that powers the rear wheel drive motor for propulsion.
- The dual-displacement auxiliary gear pump includes two separate 1.02 CIR pumping elements in one unit that power the other machine work functions.

The scrub deck position, scrub brush motors, main broom motor, side broom motor, recovery vacuum motor, hopper vacuum fan motor and squeegee position are all controlled by hydraulic solenoid valves actuated by switches on the instrument panel.

The hopper lift and dump door hydraulic cylinders are controlled by mechanically-actuated hydraulic valves.

#### Drive and Steering Systems

The foot-activated directional control (drive) pedal controls the hydraulic oil flow from the variable-displacement pump to the hydraulic rear wheel drive motor to determine machine speed and direction. A hydroback (newer models) or mechanical centering device (older models) returns the pedal to the neutral position when the pedal is released.

The power steering unit controls the oil flow to the hydraulic steering cylinder. The steering cylinder moves a rack that turns a spur gear to steer the rear drive wheel.

## Solution System

The Solution System uses gravity feed to deliver the solution to the scrub brushes. A ball valve, actuated by a mechanical solution control lever and linkage, controls the solution flow. The solution flow is continuously-variable from no flow to approximately 1¼ GPM [6.6 LPM] at the low setting, and to approximately 3½ GPM [13.2 LPM] at the high setting.

- The standard (non-recycling) Solution System delivers solution from the solution tank to the brushes. The squeegee system picks up the water from the floor and the squeegee vacuum fan directs it into the recovery tank. If detergent is to be used in the standard system, it must be mixed manually into the solution in the solution tank.
- The ESP/Recycle option uses a solution pump to transfer filtered recovered water from the recovery tank to the solution tank. A detergent pump adds detergent from a separate detergent tank into the solution supply line to the scrub brushes. The detergent flow rate is adjusted with the **DETERGENT FLOW** knob on the instrument panel.

## Scrub System

The Scrub System uses three disc scrub brushes and has two selectable scrub pressures.

- The “normal” scrub setting provides approximately 252 lbs [114 kg] of scrub brush pressure.
- The “heavy” scrub setting provides approximately 600 lbs [272 kg.] of scrub brush pressure.

The scrub brushes are powered by individual hydraulic motors. A hydraulic cylinder extends and retracts the scrub deck and controls the scrub pressure.

## Squeegee System

The Accu-Track™ squeegee system picks up the wastewater from the floor and directs it into the vacuum hose, which then carries the wastewater into the recovery tank. The squeegee assembly is designed to follow the scrub path accurately even in tight turns.

A hydraulic cylinder raises and lowers the squeegee.

A proximity switch adjacent to the accelerator/directional control pedal raises the squeegee if the squeegee is lowered and the pedal is moved to the reverse position.

## Recovery System

The recovery vacuum motor creates a vacuum and sufficient airflow to convey used cleaning solution from the rear squeegee into the recovery tank.

On models equipped with the ESP/Recycle option, a solution transfer pump in the recovery tank pumps filtered water from the recovery tank to the solution tank to extend the scrub time. The solution transfer pump is controlled by a float switch in the recovery tank.



## **Main Sweep System**

The Main Sweep System uses a 50" [106.6 mm] long by 14" [35.5 cm] diameter cylindrical main broom to sweep dust and debris into the hopper in front of the scrub brushes. The main broom is powered by a hydraulic motor and is raised and lowered manually via the main broom lift control lever and mechanical linkage. There are two main broom sweep positions.

- The normal "sweep" position produces a 2"-3" [5-8 cm] broom pattern.
- The "float" position is used for heavy sweeping or when sweeping extremely uneven surfaces, and produces a 4"-5" [10-13 cm] broom pattern.

## **Side Sweep System (optional)**

The Side Sweep System uses a 24" diameter rotary broom to sweep dirt and debris into the path of the main broom. The Side Sweep System is standard on variable dump models and optional on manual dump models.

The side broom is powered by a hydraulic motor, and is raised and lowered manually via the side broom lift knob and cable.

## **Dust Control System (variable dump models only)**

The Dust Control System uses an impeller fan, driven by a hydraulic motor, to pull air from the hopper and through a baffle system and filter to minimize the dust generated from sweeping. A pre-clean flap restricts the heavier dust particles to an area below the filter. The lighter dust particles are trapped in the filter. An electric shaker motor, controlled by a switch on the instrument panel, vibrates the filter assembly to shake the fine dust from the filter to restore airflow for effective dust control, and to prolong filter life.

## **Service Manual Purpose and Application**

This Service Manual is a technical resource designed to aid service personnel in maintaining and repairing the Advance 7765 / Nilfisk CR1500 Sweeper/Scrubbers to ensure optimum performance and long service life. Please read it thoroughly before servicing your machine.

## Other Reference Manuals and Information Sources

### Nilfisk-Advance Publications

| Model Name     | Model Number   | Instructions for Use Form Number   | Parts List Form Number |
|----------------|--|--|------------------------|
| Advance 7765   | <ul style="list-style-type: none"> <li>• 56514925 (VD Gas)</li> <li>• 56514926 (VD LP)</li> <li>• 56514927 (VD Diesel)</li> <li>• 56514928 (MD Gas)</li> <li>• 56514929 (MD LP GM3.0L)</li> <li>• 56514930 (MD Diesel S4Q2)</li> <li>• 56514931 (VD LP)</li> </ul> | 56041801 - English and Spanish   | 56042525               |
| Nilfisk CR1500 | <ul style="list-style-type: none"> <li>• 56514850 (VD Gas)</li> <li>• 56514852 (VD LP)</li> <li>• 56514854 (VD Diesel)</li> </ul>  | 56041714: DA, NO, SV, FI<br>56041715: DE, FR, NL, RU<br>56041716: ES, PT, IT, GR<br>56041717: ET, LV, LT, SL<br>56041718: SK, CS, PL, HU<br>56041719: US, TR | 56042488               |

These manuals can be found on the following Nilfisk-Advance's electronic supported databases:

- Nilfisk-Advance Dealer Customer Zone
- Advance website: [www.advance-us.com](http://www.advance-us.com)
- Nilfisk website: [www.nilfisk.com](http://www.nilfisk.com)
- EzParts service/parts CD-ROM

### Engine Manufacturers' Technical Manuals

|                          | Manual Name   | Publication Number     |
|--------------------------|---|------------------------|
| GM 3.0L Gasoline and LPG | PSI Operation and Maintenance Manual                              | 36100007/<br>REV020703 |
|                          | PSI Tier 3 Certified Mobile Diagnostic and Troubleshooting Manual | PSITIER3 - G           |

## Diagnostic and Service Tools

In addition to a full set of metric and standard tools, the following items are required in order to successfully and quickly perform troubleshooting and repair of Nilfisk-Advance Industrial floor cleaning equipment.

- Digital voltmeter (DVM) with DC current clamp
- Hydrometer
- Battery load tester for checking 12V batteries
- Automotive fuel pressure test gauge (used on gasoline engines)
- Set of torque wrenches

These tools are also available from Nilfisk-Advance, Inc.:

- PSI engine service kit, p/n 56109084; includes an LPG Test Kit, p/n 56504450, and a Diagnostic Communication Cable and software, p/n 56305647



PSI LPG test kit, p/n 56504450

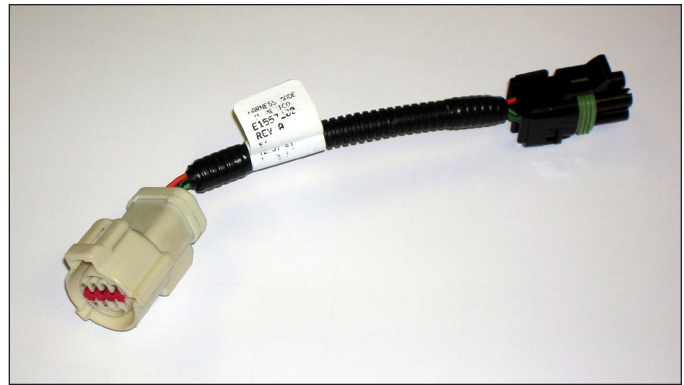


PSI engine service kit, p/n 56109084



Diagnostic Communication Cable and software,  
p/n 56305647

- PSI diagnostics cable, 4-pin – 8-pin (Generation 1 old style), p/n 56109083



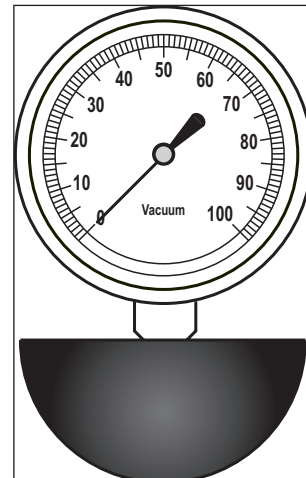
PSI diagnostics cable, 4-pin – 8-pin (Generation 1 old style), p/n 56109083

- Hydraulic test gauge w/connector, 3000 psi range, p/n 56504516



Hydraulic test gauge w/connector 3000 psi range, p/n 56504516

- Vacuum water lift gauge, p/n 56205281.





## Conventions

All references to right, left, front and rear in this manual are as seen from the Operator's seat position.

## Parts and Service

Repairs should be performed by an Authorized Nilfisk-Advance Service Center that employs factory-trained service personnel and maintains an inventory of Nilfisk-Advance original replacement parts and accessories.

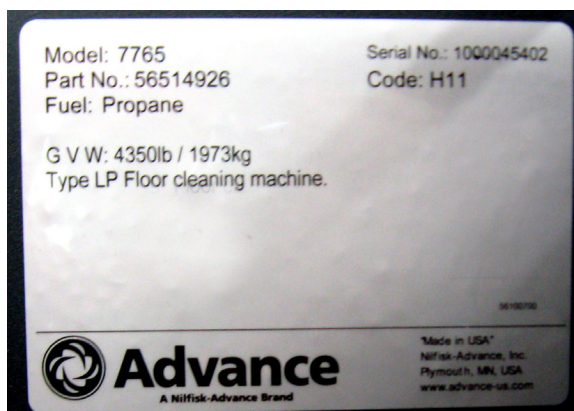
Call the Nilfisk-Advance Dealer named below for repair parts or service. Please specify the Model Number (same as the Part Number) and Serial Number when discussing your machine.

(Dealer, affix service sticker here.)

## Nameplate

The Model Number and Serial Number of the machine are shown on the **Nameplate** located on the front of the hydraulic reservoir enclosure, to the right and below the Operator seat.

This information is needed when ordering repair parts for the machine.



## Cautions and Warning Symbols

Nilfisk-Advance uses the symbols below to signal potentially dangerous conditions. Read this information carefully and take the necessary steps to protect personnel and property.



**Danger!** *Is used to warn of immediate hazards that will cause severe personal injury or death.*



**Warning!** *Is used to call attention to a situation that could cause severe personal injury.*



**Caution!** *Is used to call attention to a situation that could cause minor personal injury or damage to the machine or other property.*



**Read all instructions before using.**

## General Safety Instructions



**Danger!** *This machine emits exhaust gases (carbon monoxide) that can cause serious injury or death. Always provide adequate ventilation when using the machine.*



**Warning!** *Be sure to follow these safety precautions to avoid situations that could cause severe personal injury.*

- This machine should only be used by properly-trained and authorized personnel.
- While on ramps or inclines, avoid sudden stops when loaded. Avoid abrupt sharp turns. Use low speed down hills. Clean only while ascending (driving up) the ramp.
- Keep sparks, flame and smoking materials away from the battery. Explosive gases are vented during normal operation.
- Charging the battery produces highly-explosive hydrogen gas. Charge the battery only in well-ventilated areas away from open flame. Do not smoke while charging the battery.
- Remove all jewelry when working near electrical components.
- Turn the Key Switch off (O) and disconnect the battery before servicing electrical components.
- Never work underneath a machine without safety blocks or stands to support the machine.
- Do not dispense flammable cleaning agents, operate the machine on or near these agents, or operate in areas where flammable liquids exist.
- To avoid hydraulic oil injection or injury, always wear appropriate clothing and eye protection when working with or near any hydraulic system.



- Only use the brushes provided with the machine or those specified in the Instructions for Use. The use of other brushes may impair safety.



**Caution!** *Be sure to follow these safety precautions to avoid situations that could cause personal injury, damage to property or equipment damage.*

- This machine is not approved for use on public paths or roads.
- This machine is not suitable for picking up hazardous dust.
- Use care when using scarifier discs and grinding stones. Nilfisk-Advance will not be held responsible for any damage to floor surfaces caused by scarifiers or grinding stones.
- When operating this machine, ensure that individuals in close proximity are not endangered.
- Before performing any service function, carefully read all instructions pertaining to that function.
- Do not leave the machine unattended without first turning the Key Switch off (O), removing the key and securing the machine.
- Apply the parking brake before exiting the Operator's seat.
- Turn the Key Switch off (O) and remove the key before changing the brushes, and before opening any access panels.
- Take precautions to prevent hair, jewelry or loose clothing from becoming caught in moving parts.
- Use caution when steering and/or operating this machine in below-freezing temperature conditions. Any water in the solution or recovery tanks, or in the hose lines could freeze, causing damage to valves and fittings. Flush with windshield washer fluid.
- Do not use on surfaces having a gradient exceeding 14.1% (8°) in transport or 10.5% (6°) while cleaning.
- All doors and covers are to be positioned as indicated in the instruction manual before using the machine.



**Caution!** *Do not pressure-wash the operator instrument panel, electrical components or the engine compartment area.*

## Hopper Safety Lock Arm (variable dump only)

To prevent the hopper from dropping unexpectedly and causing injury, always engage the **Safety Lock Arm** before working under the hopper. The **Safety Lock Arm** is mounted to the right side of the frame and swings up to align with and support the bottom of the hopper as shown.



**Warning!** *Never work under the hopper without first engaging the Safety Lock Arm.*

After the work under the hopper is complete, swing the **Safety Lock Arm** back down to its disengaged position.



## Jacking the Machine



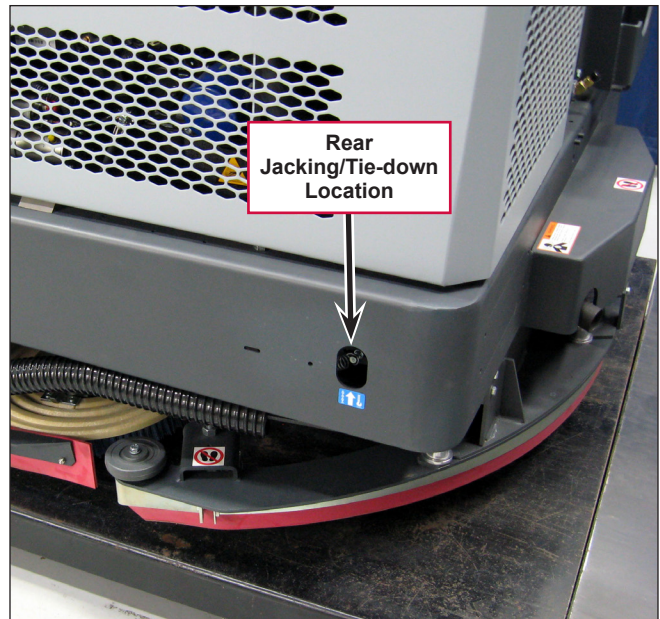
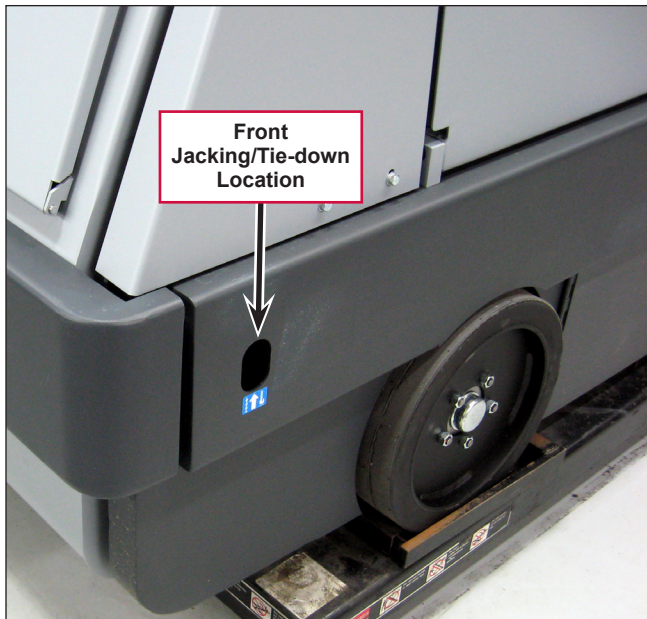
**Warning!** Never work under a machine without safety stands or blocks to support the machine. When jacking the machine, do so at the designated Tie Down/Jacking Locations as shown below.

## Transporting the Machine



**Caution!** Before transporting the machine on an open truck or trailer, make sure the machine is tied down securely at the designated Tie Down/Jacking Locations shown below, all access doors and covers are secured (tape and strap as needed) and the parking brake is engaged.

The jacking and tie down locations are identified with a decal on the body panel.

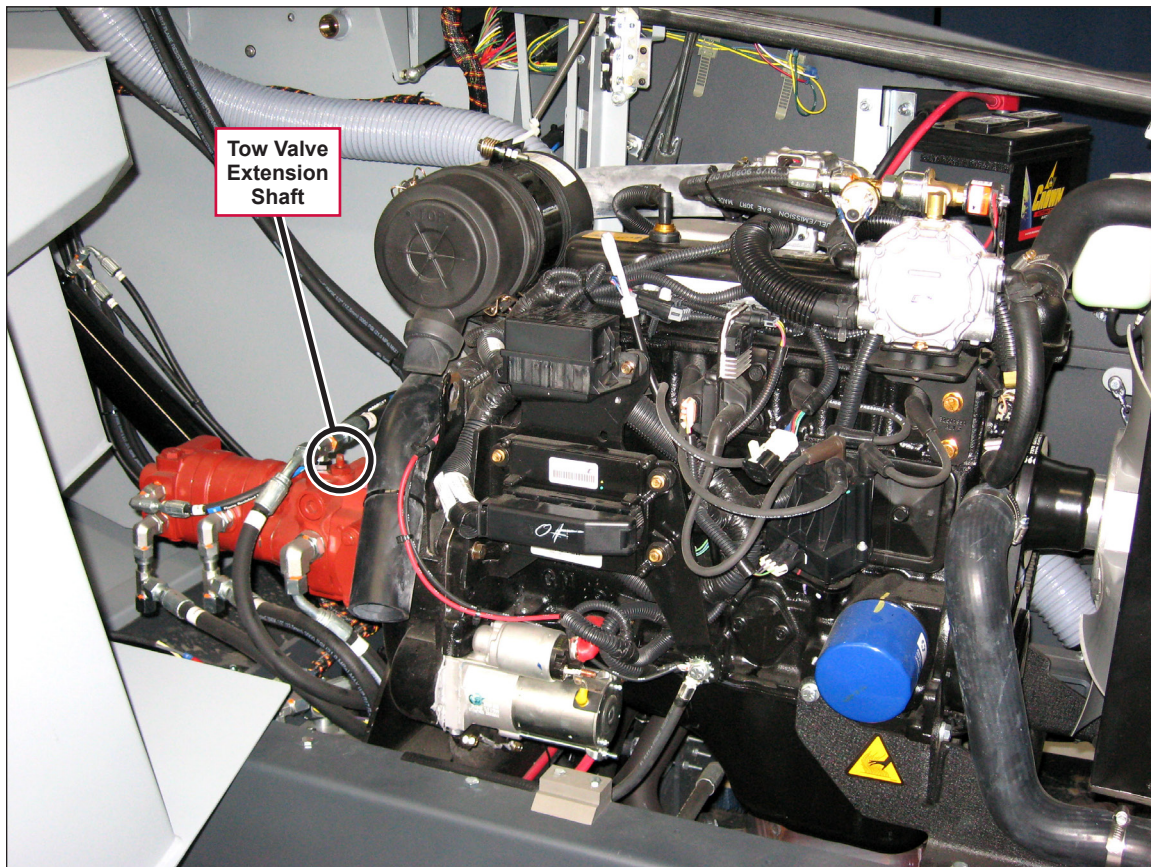




## Towing or Pushing the Machine



**Caution!** The machine's hydrostatic wheel drive pump is equipped with a tow (bypass) valve that opens the hydraulic circuit to the wheel drive motor. This allows the wheel drive motor to "freewheel" when the machine is being towed/pushed short distances without the use of the engine. The tow valve is controlled by the Tow Valve Extension Shaft, located on top of the drive pump just in front of the engine.



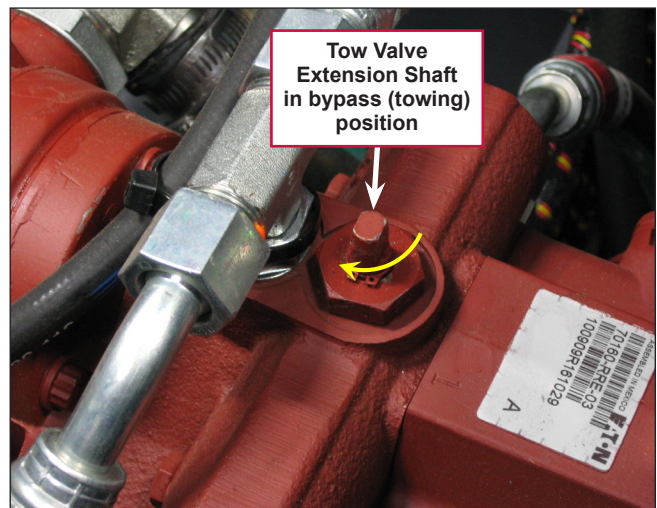
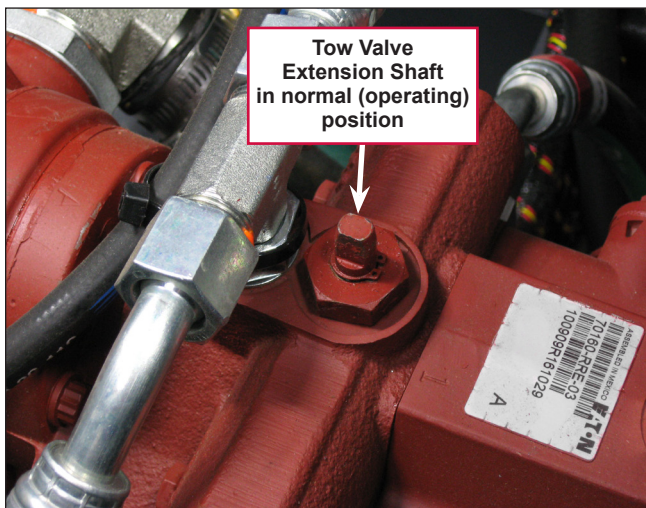
To open the hydraulic circuit to the wheel drive motor for towing, turn the Tow Valve Extension Shaft 90° to the bypass position (flats on the Shaft parallel to the front axle).

After towing, turn Tow Valve Extension Shaft 90° to the normal operating position (flats on the Shaft parallel to the pump centerline).

Note that if the tow valve is left in the open (free-wheeling) position, the wheel drive pump can't efficiently propel the machine in forward or reverse. Attempting to operate the machine with the tow valve in the bypass (towing) position can cause overheating of the hydraulic system and/or reduced operating performance.

Tow or push the machine no faster than a normal walking pace (2-3 miles per hour/ 3-5 kilometers per hour), and for no farther than 300 feet [100 meters]. Towing or pushing the machine farther than 300 feet [100 meters] can cause machine damage.

If the machine is to be moved farther than 300 feet [100 meters], raise the rear drive wheel off the floor and place on a suitable transport dolly.



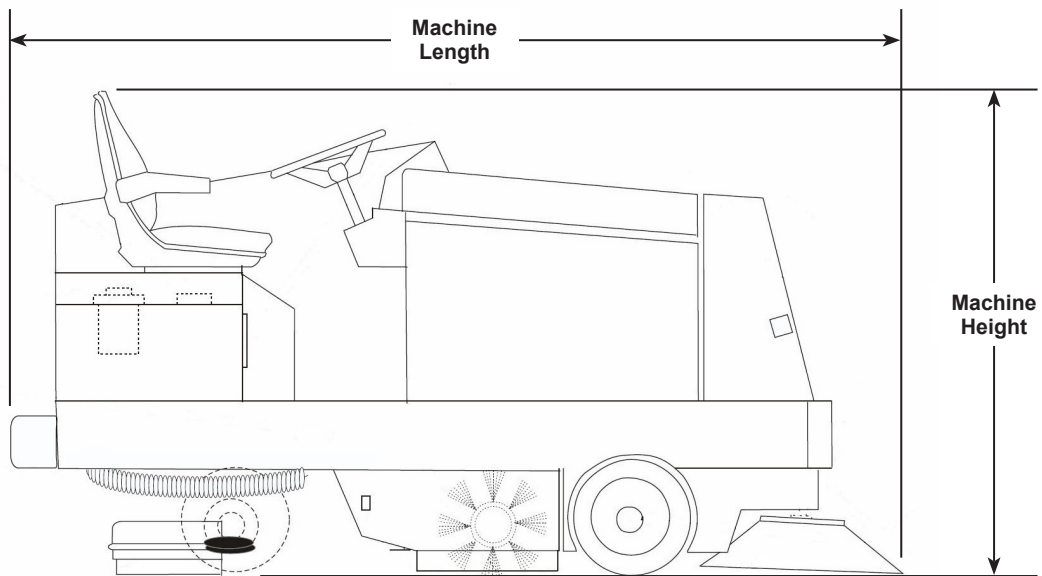
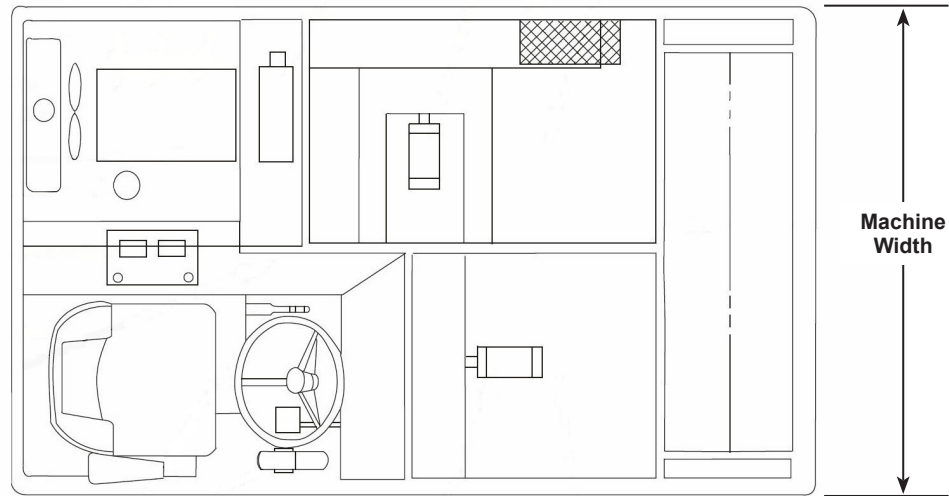
## Technical Specifications

### General Specifications

|  |   |  |
|--|---|--|
| Engines                                      | 3.0 L, 86 hp GM MPFI gasoline (petrol)                          |  |
|  | 3.0 L, 86 hp GM MPFI liquid propane (LPG)                       |  |
|  | 2.5 L, 47.3 hp Mitsubishi diesel                                |  |
| Length                                       | 107 in [272 cm]   |  |
| Width  | 59 in [150 cm]  |  |
| Height                                       | 61.5 in [156 cm]  |  |
| Height (with overhead guard)                 | 85.5 in [217 cm]  |  |
| Total Weight                                 | Variable Dump Models – 4,350 lbs [1,973 Kg]                     |  |
|  | Manual Dump Models – 3,900 lbs [1,769 Kg]                       |  |
| Scrubbing Path                               | 54 in [137 cm]  |  |
| Scrub Brush Pressure                         | Normal – 252 lbs [114 kg]                                       |  |
|  | Heavy – 600 lbs [272 kg]  |  |
| Scrub Brush Diameter (3)                     | 18 in [45 cm]   |  |
| Solution and Recover Tank Capacity           | 100 gal. [378.5 L] each   |  |
| Solution Flow Rates                          | Continuously variable   | Off (solution level pulled back to off position) |
|  |   | Approximately 1¼ GPM [6.6 LPM] at low setting    |
|  |   | Approximately 3½ GPM [13.2 LPM] at high setting  |
| Sweeping Path                                | Variable Dump Models – 60 in [152 cm]                           |  |
|  | Manual Dump Models – 50 in [127 cm]                             |  |
| Main Broom                                   | 50 in [127 cm] long, 14 in [35.5 cm] dia.                       |  |
| Side Broom (optional on Manual Dump Models)  | 24 in [61 cm]   |  |
| Dust Filter                                  | Variable Dump Models – 107 ft <sup>2</sup> [10 m <sup>2</sup> ] |  |
|  | Manual Dump Models – N/A  |  |
| Hopper Capacity                              | Variable Dump Models – 16 ft <sup>3</sup> [453 L]               |  |
|  | Manual Dump Models – 6 ft <sup>3</sup> [170 L]                  |  |
| Vacuum Fan                                   | Hydraulically driven, high volume                               |  |
| Vacuum Lift (minimum)                        | 30" [76 cm]   |  |
| U-turn Aisle Width                           | 120 in [305 cm]   |  |
| Turning Radius (left or right)               | 82 in [208 cm]  |  |
| Transport Ground Clearance                   | 2.6 in [6.6 cm]   |  |
| Sound Pressure Level (ISO 11201)             | 87 dB (A)   |  |
| Sound Power Level (ISO 3744)                 | L <sub>WA</sub> 109.0   |  |
| Vibrations at the Hand Controls (ISO 5349-1) | 0.70 m/s <sup>2</sup>   |  |
| Vibrations at the Seat (EN 1032)             | 0.20 m/s <sup>2</sup>   |  |



### Overall Dimensions



## Engine and Machine Performance

|                         |                            |                 |
|-------------------------|----------------------------|-----------------|
| Engine speeds           | 3.0 L GM (gasoline and LP) | Low - 850 RPM   |
|                         |                            | High - 2000 RPM |
|                         | Mitsubishi Diesel          | Low - 950 RPM   |
|                         |                            | High - 2050 RPM |
| Transport speed forward | 115 RPM                    |                 |
| Transport speed reverse | 75 RPM                     |                 |
| Gradeability            | Transport – 14.1% (8°)     |                 |
|                         | Cleaning – 10.5% (6°)      |                 |

## Fastener Torque Specifications

| Standard Torque Specifications (unless otherwise specified) | Size  | Plated Steel | Stainless Steel |
|---|-------|--------------|-----------------|
|   | #10   | 42 in.-lb.   | 28 in.-lb.      |
|   | 1/4"  | 100 in.-lb.  | 67 in.-lb.      |
|   | 5/16" | 17 ft.-lb.   | 11 ft.-lb.      |
|   | 3/8"  | 31 ft.-lb.   | 20 ft.-lb.      |
|   | 1/2"  | 75 ft.-lb.   | 50 ft.-lb.      |
|   | 3/4"  | 270 ft.-lb.  | 180 ft.-lb.     |
|   | M5    | 61 in.-lb.   | 36 in.-lb.      |
|   | M6    | 9 ft.-lb.    | 62 in.-lb.      |
|   | M8    | 22 ft.-lb.   | 13 ft.-lb.      |
|   | M10   | 44 ft.-lb.   | 25 ft.-lb.      |
|   | M12   | 70 ft.-lb.   | 40 ft.-lb.      |

## Maintenance

Keep the machine in top condition by closely following the maintenance schedule. Maintenance intervals given are for average operating conditions. Machines used in severe environments may require service more often. In general:

- Keep the fuel tank filled (gasoline and diesel). This helps to reduce condensation and moisture entering the fuel system.
- Refer to the engine service manual for recommended engine service intervals and procedures.



**Caution!** Do not pressure-wash the operator instrument panel, electrical components or engine compartment area.

## Recommended Service Materials

- Engine Oil (refer to your engine manual)
- Hydraulic oil – Mobil Multi Purpose ATF or equivalent Dexron III fluid
- Manufacturer-recommended coolant (antifreeze) 50/50 mix
- Lithium-base grease
- Loctite® (or equivalent) thread sealant in the appropriate grades
- Anti-seize compound

## Maintenance Schedules



*Note: Refer to the **Maintenance Item Locations** drawing following the **Maintenance Schedules**.*

### Daily Maintenance

| Maintenance Item                   | Location Number | Procedure  |
|------------------------------------|-----------------|--|
| Engine                             | 2               | Check the engine oil level   |
|                                    | 13              | Check the engine coolant level   |
|                                    | 4               | Check for coolant leaks, radiator core blockage  |
|                                    | 11              | Check the air cleaner  |
|                                    | 9               | Check for LP/diesel odor at connections  |
|                                    | 10              | Check the water separator (diesel, if so equipped)   |
| Hydraulic system                   | 3               | Check the oil level in the hydraulic oil reservoir   |
|                                    |                 | Check for any hydraulic leaks  |
|                                    | 12              | Check the hydraulic oil filter   |
| Recovery tank                      | 16              | Drain and clean the inside of the tank; flush with clean water                               |
|                                    | 16              | Check the cover perimeter gasket for damage/wear   |
| Hopper                             | 1               | Clean the hopper panel filter and inspect for damage (VD only)                               |
|                                    | 7               | Check the clean side of the panel filter for leakage (VD only)                               |
| Scrub brushes                      | 6, 18           | Check for debris wrapped around the brushes/brooms, and for damage/wear; adjust as necessary |
| Main and side brooms               |                 |  |
| Main broom chamber                 | 5               | Check all flaps for wear or damage   |
| Parking brake and foot pedal brake | 8               | Check for correct operation of brakes; adjust as needed                                      |

**Weekly Maintenance/Every 50 Hours**

| Maintenance Item        | Location Number  | Procedure   |
|-------------------------|--|---|
| Engine                  | 25   | Change crankcase oil (new or reconditioned diesel)                            |
|                         | 26   | Change oil filter (new or reconditioned diesel)                               |
|                         | 20   | Check the fan belt tension and tighten as necessary                           |
|                         | Perform recommended engine maintenance (see applicable engine manual). |   |
| Battery                 | 21   | Check the battery electrolyte level (unless it is a maintenance-free battery) |
|                         | 21   | Check the battery cables and connections                                      |
| Solution tank           | 14   | Clean the solution tank   |
|                         | 15   | Clean the pump inlet strainer   |
| Recovery tank           | 16   | Clean the recovery tank and tank lid  |
|                         | 17   | Clean the solution inlet filter (ESP/Recycle option only)                     |
| Scrub Brushes           | 18   | Check for wear and damage   |
| Main broom              | 23   | Check for wear and damage   |
|                         | 23   | Rotate end-for-end  |
| Rear and side squeegees | 19   | Check for wear and damage   |
| Hydraulic hoses         | 22   | Check for wear, cuts or leakage   |
| Hopper                  | 24   | Clean or replace the hopper panel filter (Variable Dump only)                 |

**Maintenance Every 100 Hours**

| Maintenance Item                    | Location Number  | Procedure   |
|-------------------------------------|--|---|
| Engine                              | Perform recommended engine maintenance (see applicable engine manual). |   |
| Drive wheel and steering components | 27   | Make sure to grease the fittings on the rear wheel support and on the steering rack guide. (Refer to the <b>Steering System</b> section and the Parts List.)  |
| Front wheel bearings                | 28   | Lubricate   |
| All moving joints                   | 29   | Lubricate   |
| Brake pads                          | 30   | Check for wear and adjust as necessary. (Refer to the <b>Wheel System, Non-traction</b> section and the Parts List.)  |
| Bushings                            | 31   | Lubricate all bushings with Loctite® Silver Grade Anti-Seize compound. Note that the bushings are located on the steering, scrub deck lift, squeegee lift, main broom lift, both threaded ends of the throttle cable and on the variable dump door cylinders. (Refer to the relevant sections in this manual and the Parts List.) |

**Maintenance Every 200 Hours**

| Maintenance Item | Location Number | Procedure                                  |
|------------------|-----------------|--|
| Engine           | 25              | Change the crankcase oil (Gas and LPG)     |
|                  | 26              | Change the engine oil filter (Gas and LPG) |

**Maintenance Every 250 Hours**

| Maintenance Item | Location Number  | Procedure  |
|------------------|--|--|
| Engine           | 25   | Change the crankcase oil (diesel)                      |
|                  | 26   | Change the engine oil filter (diesel)                  |
|                  | 34   | Replace the air filter element                         |
|                  | 35   | Flush the radiator coolant system                      |
|                  | 36   | Clean or replace the spark plugs (Gas/LPG only)        |
|                  | 37   | Check the distributor cap and wires (Gas/LPG only)     |
|                  | 38   | Clean and lubricate the governor linkage (diesel only) |
|                  | 39   | Replace the fuel filter                                |
|                  | Perform any additional recommended engine maintenance (see engine manual if applicable).                   |  |
|                  | Inspect and drain any oil buildup from the LP fuel system electronic pressure regulator (EPR), (LPG only). |  |
| Hydraulic system | 40   | Replace the hydraulic filter element                   |
| Squeegee casters | 32   | Lubricate  |
| Solution tank    | 14   | Clean the solution tank                                |
|                  | 33   | Clean the pump inlet strainer                          |

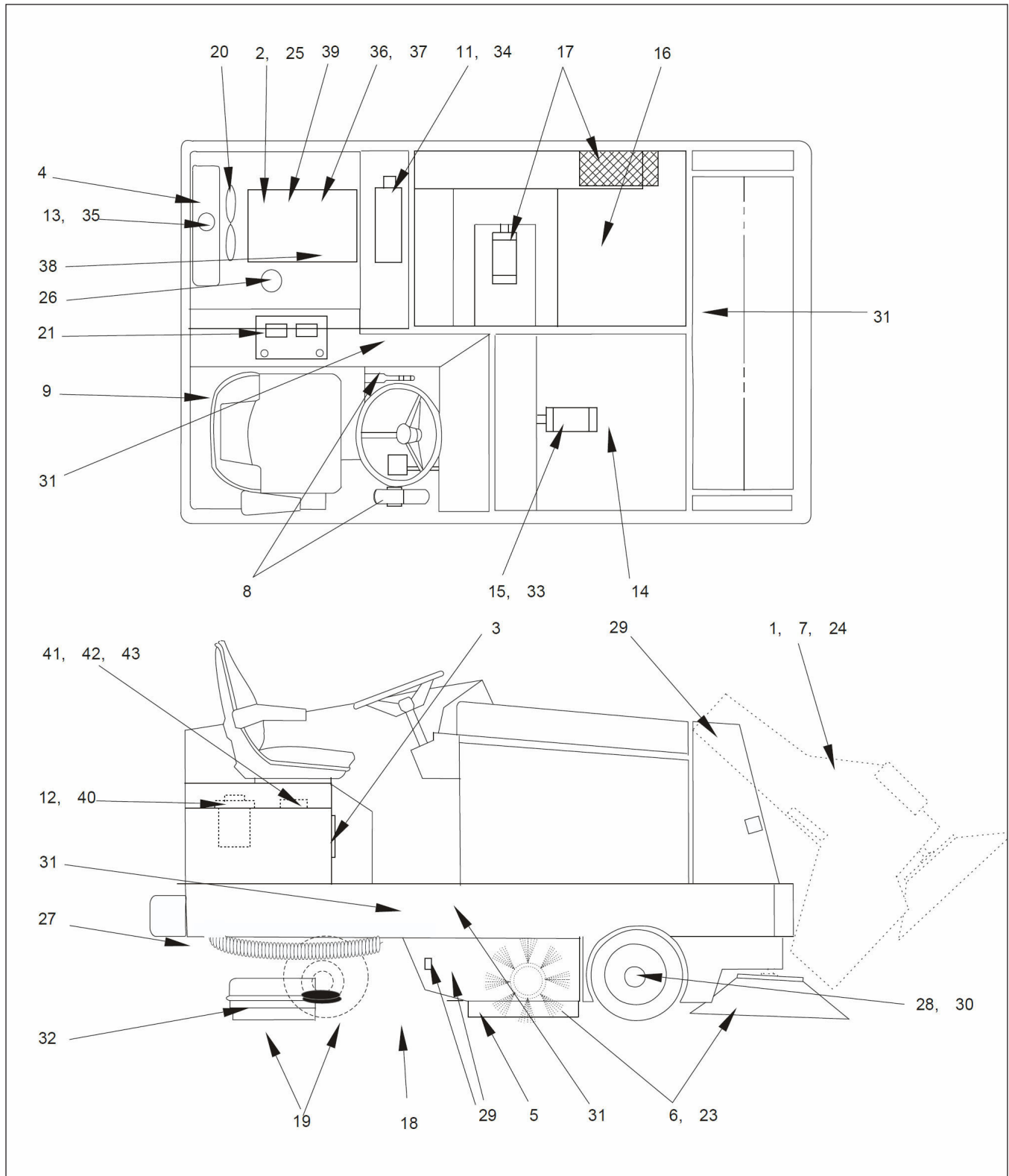
**Maintenance Every 400 Hours**

| Maintenance Item | Location Number  | Procedure                           |
|------------------|--|-------------------------------------|
| Engine           | Perform any additional recommended engine maintenance (see engine manual if applicable). |                                     |
| Hydraulic system | 41   | Clean the hydraulic reservoir       |
|                  | 42   | Clean the hydraulic intake strainer |
|                  | 43   | Change the hydraulic fluid          |



**\*Note:** The engine maintenance schedule shown lists the recommended engine service intervals. Refer to the **Other Reference Manuals and Information Sources/Engine Manufacturers' Technical Manuals** section for list of available engine manufacturers' service manuals. Refer to these manuals for more complete maintenance and service information and instructions.

### Maintenance Item Locations





### Lubrication Locations



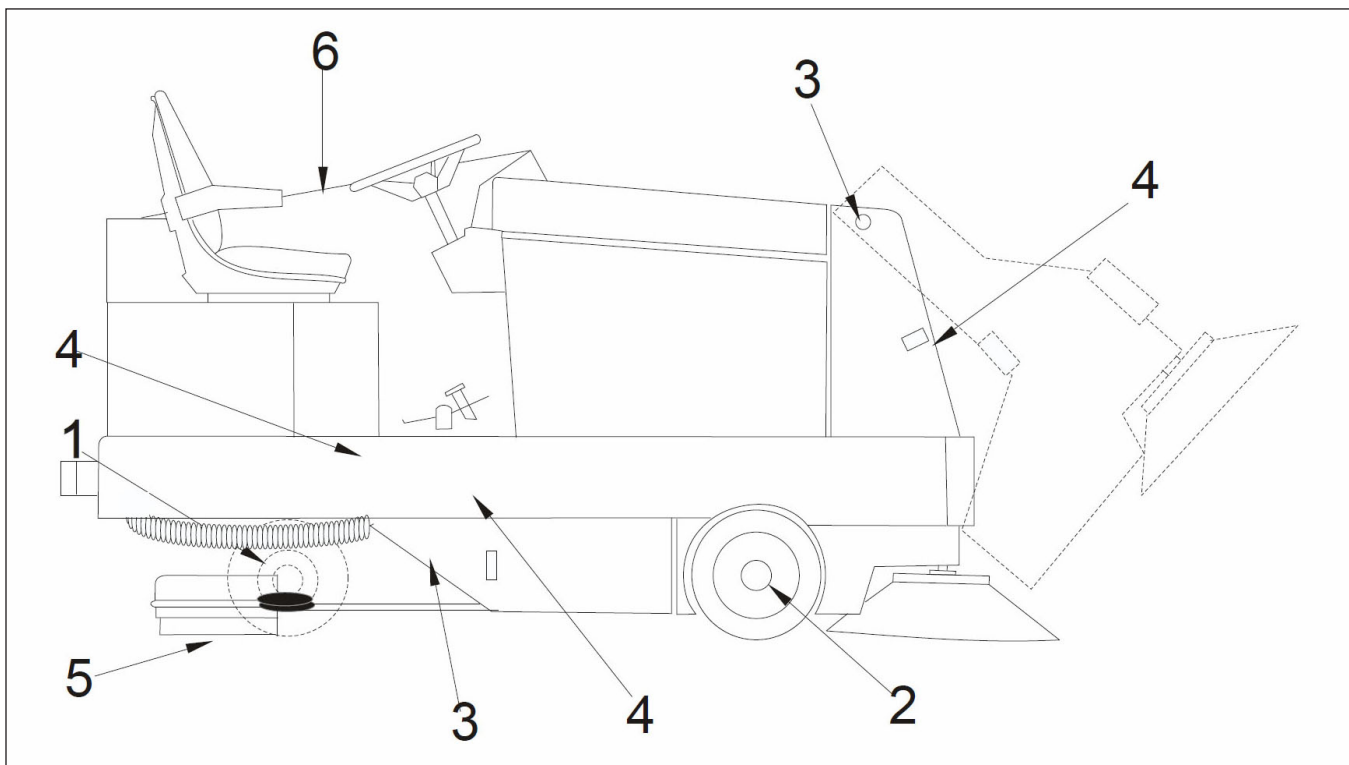
**Note:** Use a good grade multipurpose grease. Avoid using too much grease.

#### Lubrication Every 100 Hours

| Location Number | Procedure   |
|-----------------|---|
| 1               | Lubricate the drive wheel swivel, wheel bearings and steering rack guide  |
| 2               | Lubricate the front wheel bearings  |
| 3               | Lubricate all moving joints   |
| 4               | Lubricate all bushings with Loctite® Silver Grade Anti-Seize compound. Note that the bushings are located on the steering, scrub deck lift, squeegee lift, main broom lift, both threaded ends of the throttle cable and on the variable dump door cylinders. (Refer to the relevant sections in this manual and the Parts List.) |

#### Lubrication Every 250 Hours

| Location Number | Procedure  |
|-----------------|--|
| 5               | Lubricate the squeegee casters                         |
| 6               | Clean and lubricate the governor linkage (diesel only) |



**Advance 7765 and Nilfisk CR1500  
PM Checklist**

**Customer** \_\_\_\_\_  
**Address** \_\_\_\_\_  
**City** \_\_\_\_\_ **St** \_\_\_\_\_ **Zip** \_\_\_\_\_  
**Model** \_\_\_\_\_ **Serial** \_\_\_\_\_ **Hours** \_\_\_\_\_

**Defect Codes**  
**A** needs adjustment  
**B** binding  
**C** dirty or contaminated  
**D** damaged, bent or torn  
**L** leaks  
**M** missing  
**W** worn out

| Ref | OPERATIONAL INSPECTION ITEMS   | OK | Defect Codes<br>(circle) | Does<br>Not<br>Work |
|-----|--|----|--------------------------|---------------------|
| 1   | Engine low speed: GM - 800 RPM, Mitsubishi - 950                               |    | A rough                  |                     |
| 2   | Operational speed (run switch setting): GM - 2000 RPM, Mitsubishi - 2050 RPM   |    | A low power              |                     |
| 3   | Drive pedal linkage (check for forward/reverse drive and any neutral creep)    |    | A B                      |                     |
| 4   | Drive system performance (max. forward speed) – 115 RPM                        |    | Noisy sluggish           |                     |
| 5   | Brakes (check both service and parking)  |    | A B W                    |                     |
| 6   | Steering   |    | excessive play           |                     |
| 7   | Side sweep broom raise/lower (if equipped)                                     |    | A B                      |                     |
| 8   | Side broom on/off  |    | B L                      |                     |
| 9   | Scrub deck (raise/lower)   |    | <---->                   |                     |
| 10  | Scrub brushes on/off   |    | L                        |                     |
| 11  | Scrub Brush pressure settings (normal and heavy)                               |    | A B                      |                     |
| 12  | Solution control (on/off and flow volume)                                      |    | A L                      |                     |
| 13  | Detergent solution pump (ESP/Recycle option only)                              |    | L                        |                     |
| 14  | Squeegee system (raise/lower and auto lift in reverse)                         |    | <---->                   |                     |
| 15  | Vacuum system performance (sealed water lift 30" [76 cm] @ rated engine speed) |    | C L                      |                     |
| 16  | Headlights, gauges and (optional) accessories                                  |    | <---->                   |                     |
| 17  | Seat adjustment lever  |    | <---->                   |                     |

| Ref | VISUAL INSPECTION ITEMS                                       | Comments             | OK | Defect Codes<br>(circle) | Does<br>Not<br>Work |
|-----|---|----------------------|----|--------------------------|---------------------|
| 18  | Main broom motor  |                      |    | B L                      |                     |
| 19  | Main broom bristles   | min. length 3 inches |    | A B D W                  |                     |
| 20  | Side broom motor  |                      |    | B L                      |                     |
| 21  | Scrub brush motors (3)  |                      |    | B L                      |                     |
| 22  | Scrub brushes, check for wear and rotate                      | min. length ½ inch   |    | D W                      |                     |
| 23  | Scrub deck housing and door skirts                            |                      |    | C D W                    |                     |
| 24  | Solution pump (ESP/Recycle option only)                       |                      |    | C L W                    |                     |
| 25  | Solution tank, delivery hoses and pump inlet strainer         | clean strainer       |    | C L M                    |                     |
| 26  | Solution tank drain plug assembly and drain hose              |                      |    | C D L M                  |                     |
| 27  | Vacuum fan motor and vacuum hose                              |                      |    | C L D                    |                     |
| 28  | Recovery tank lid gasket                                      |                      |    | B C L                    |                     |
| 29  | Recovery tank float switch                                    |                      |    | D L W                    |                     |
| 30  | Recovery tank drain plug assembly and drain hose              |                      |    | C D L M                  |                     |
| 31  | Recovery tank solution inlet filter (ESP/Recycle option only) | clean filter         |    | C L D                    |                     |
| 32  | Squeegee vacuum hose  | back flush           |    | C D L                    |                     |

| Ref | VISUAL INSPECTION ITEMS (continued)  | Comments                                       | OK | Defect Codes (circle) | Does Not Work |
|-----|--|--|----|-----------------------|---------------|
| 33  | Squeegee tool and blades   | clean and rotate                               |    | C D W                 |               |
| 34  | Squeegee casters, leveler adjustment knob and linkage                                  | grease   |    | C W                   |               |
| 35  | Hydraulic lift cylinders (scrub deck and squeegee)                                     |  |    | B L                   |               |
| 36  | Hopper lift and dump hydraulic cylinders   |  |    | B L                   |               |
| 37  | Battery  | clean and water                                |    | C                     |               |
| 38  | Engine, oil level, hoses and belts   |  |    | C D L                 |               |
| 39  | Engine air cleaner element (inner and outer)   | check service indicator                        |    | C L                   |               |
| 40  | Engine coolant level   | fill at reservoir                              |    | C L                   |               |
| 41  | Radiator and oil cooler core blockage  | clean  |    | C D L                 |               |
| 42  | Hydraulic oil reservoir level - Mobil Multi Purpose ATF or equivalent Dexron III fluid | check sight gauge                              |    | C L                   |               |
| 43  | Hydraulic system hoses and fittings  |  |    | D L                   |               |
| 44  | Hydraulic system filter  |  |    | C L                   |               |
| 45  | Wheel drive pump tow (bypass) valve  |  |    | B D                   |               |
| 46  | Drive and accessory pumps  |  |    | L                     |               |
| 47  | Foot pedal/drive pump forward/reverse controls   |  |    | A B D                 |               |
| 48  | Gasoline/Diesel fuel tank, filter and lines  |  |    | C L W                 |               |
| 49  | LP tank, hoses and fittings  |  |    | L W                   |               |
| 50  | LP fuel filter   | service life 400 Hrs                           |    | C                     |               |
| 51  | LPG vaporizer  | Remove oil buildup every 150 hours or 120 days |    | C                     |               |
| 52  | LP fuel regulator, lock-off valve and hoses  |  |    | L                     |               |
| 53  | Diesel glow plug function light  | hard starting                                  |    | <---->                |               |
| 54  | Gasoline and Diesel fuel tank strainer   | yearly   |    | C                     |               |
| 55  | Brake cable and parking brake pedal  |  |    | A B                   |               |
| 56  | Circuit breaker panel (reset circuit breakers as necessary)                            |  |    | <---->                |               |
| 57  | Drive wheel (check lug nut torque 100 ft-lbs/135 Nm)                                   |  |    | A                     |               |
| 58  | Drive wheel motor, steer spindle, rack and cylinder                                    | grease pinion and rack                         |    | D L W                 |               |
| 59  | Front and rear tires   | tread wear                                     |    | C W                   |               |
| 60  | Hopper   | clean  |    | C                     |               |

**Note: For additional service information see the Service Manual, form number 56043160, and Instructions for Use, form number 56041801 (7765); or 56041714, 56041715, 56041716, 56041717, 56041718 and 56041719 (CR1500).**

**Defect Codes**      **A** needs adjustment      **C** dirty or contaminated      **M** missing  
**B** binding      **D** damaged, bent or torn      **W** worn out  
**L** leaks

WORK COMPLETED BY:

ACKNOWLEDGED BY:

\_\_\_\_\_  
Service Technician Signature

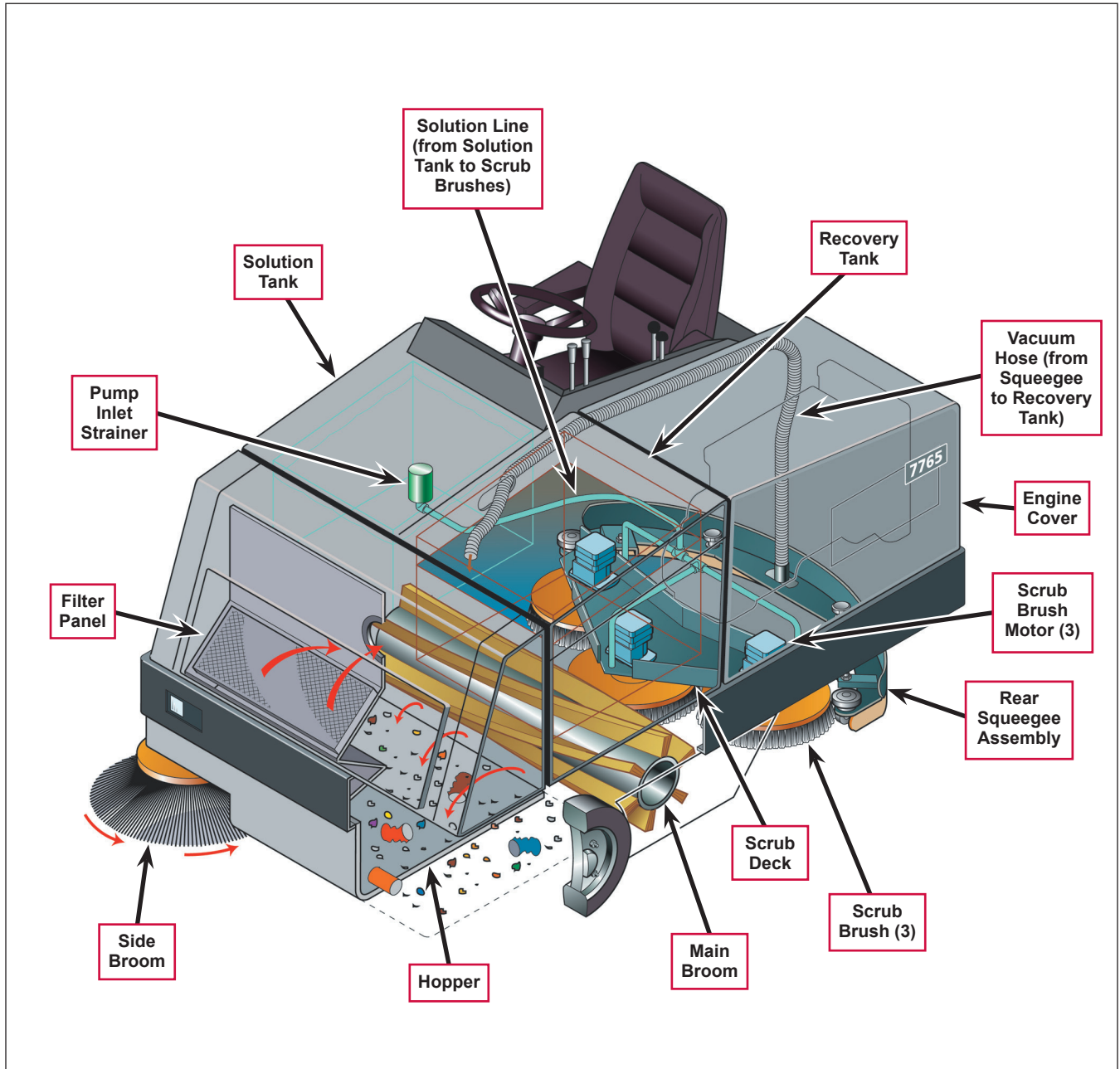
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Date

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Customer Signature

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Date

## General Machine Overview

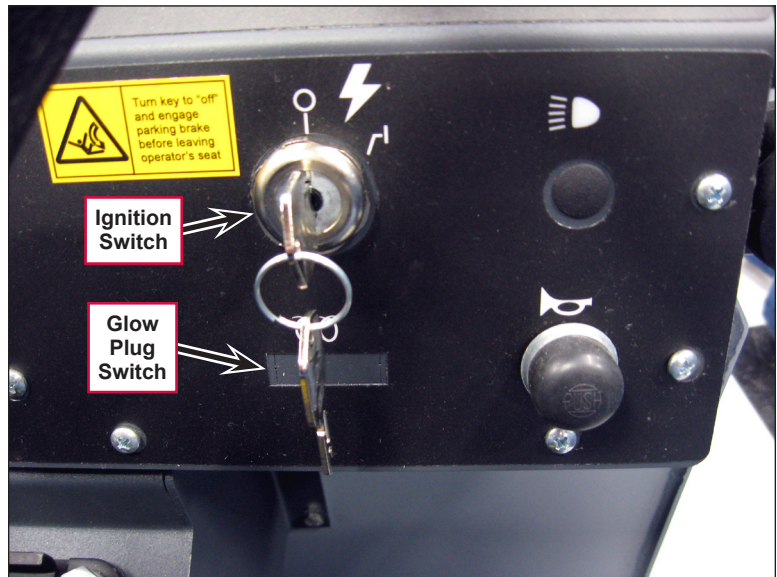
### Major Machine Components



## Machine Controls

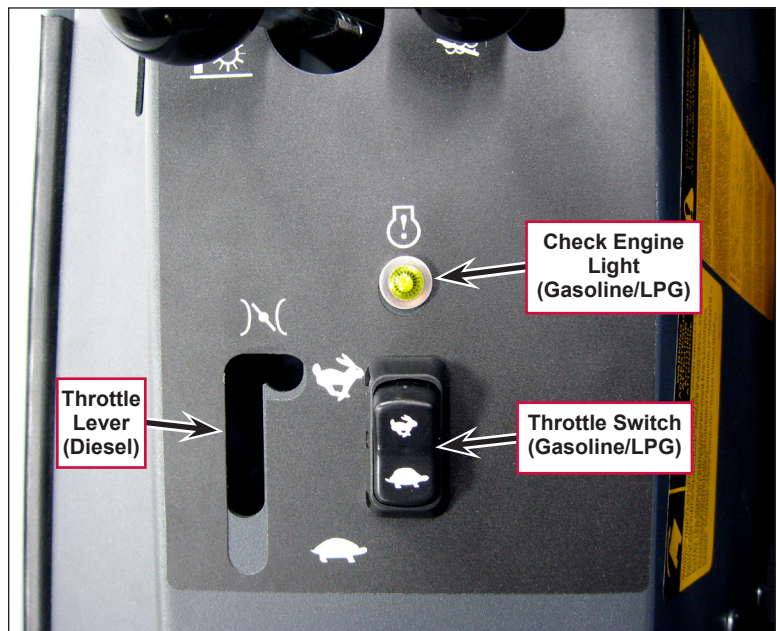
### Engine Controls

- **Ignition Switch** – main power/ignition switch, functions as follows:
  - Turning the key to the full clockwise “start” position will start the engine. Note that this is a momentary position and the key will return to the “ignition on” position when released.
  - When the key is in the “ignition on” position, the engine will run and the horn, light options, turn signals and instrument panel gauges will operate.
  - When the key is turned to the center “off” position, the engine will shut off, but the horn and light options will still operate.



- **Glow Plug Switch** – (location only shown), diesel only.

- **Throttle Switch (Gasoline/LPG)** – toggles the engine between idle (turtle icon) and operating speed (rabbit icon).
- **Throttle Lever (Diesel)** – (location only shown) sets the engine speed from idle (turtle icon) to operating speed (rabbit icon).
- **Check Engine Light (Gasoline/LPG)** – lights to alert Operator of a problem with the engine.

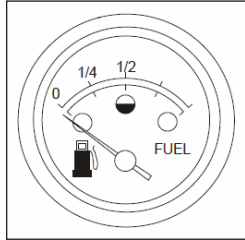




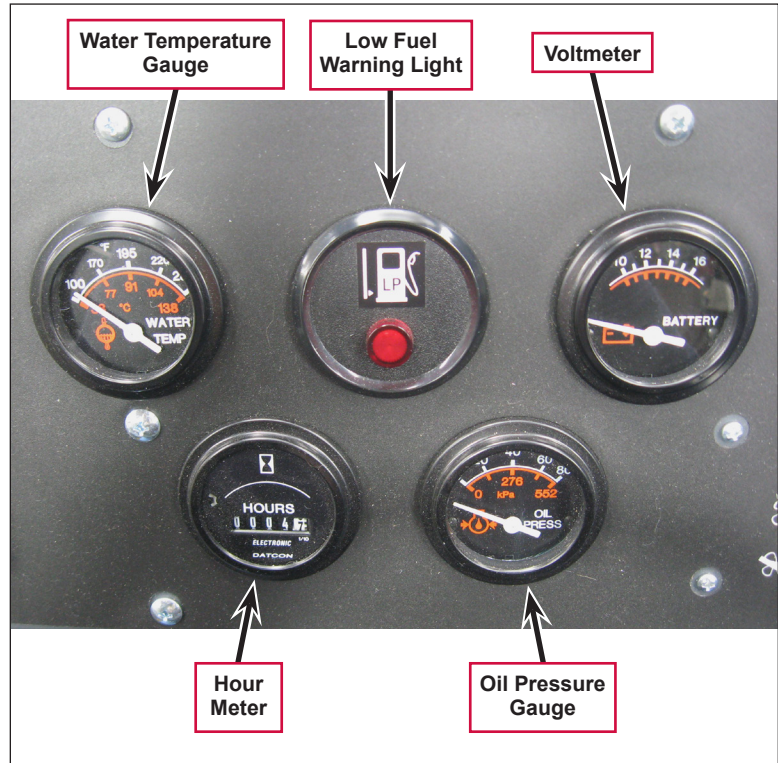
**Gauges and Meters**

- **Water Temperature Gauge** – displays the engine coolant temperature.
- **Low Fuel Warning Light** – (LPG only) indicates a low-fuel condition.

Note that gas and diesel models have a fuel gauge with an indicator needle.



- **Voltmeter** – displays the battery charge level.
- **Hour Meter** – displays the accumulated machine run time.
- **Oil Pressure Gauge** – displays the engine oil pressure in psi.

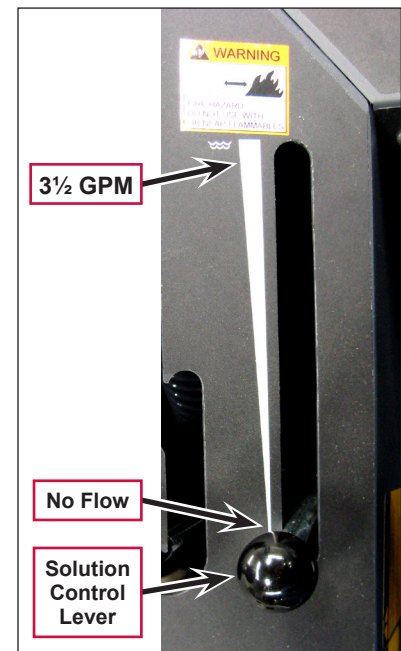


**Solution Control and Indicator**

- **Solution Control Lever** – controls the solution flow via a mechanical linkage connected to a ball valve in the solution supply line. The solution flow rate is continuously variable from **No Flow (Solution Control Lever by the narrow white line)** to a maximum of **3½ GPM (Solution Control Lever by the wide white line)**.



**Note:** Unless the machine is equipped with the Solution Off in Neutral Option, the solution system will put solution onto the floor regardless of whether or not the machine is driving forward or backward.



- **Low Solution Warning Light** – lights to indicate that the solution tank is empty.



Low Solution Warning Light

**ESP/Recycle Option Controls and Indicators**

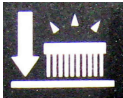
- **Recycling System ON/OFF** switch – switches the optional ESP/Recycling system on and off.
- **High Solution** – lights to indicate that the water level in the solution tank is too high.
- **Low Detergent** – lights to indicate that the detergent level in the detergent tank is low.
- **Detergent Flow** – controls the detergent flow rate. Note that this control is a rheostat (two-terminal potentiometer) that varies the voltage to the detergent pump to control the pump speed/detergent output.



**Scrub System Controls**

- **Scrub Brush Lift Switch** – controls the scrub deck and scrub brush motors as follows.

- Pressing the switch to the “lower” position will lower the scrub deck and switch on the three scrub brush motors.



- Pressing the switch to the “raise” position will raise the scrub deck and switch off the three scrub brush motors.

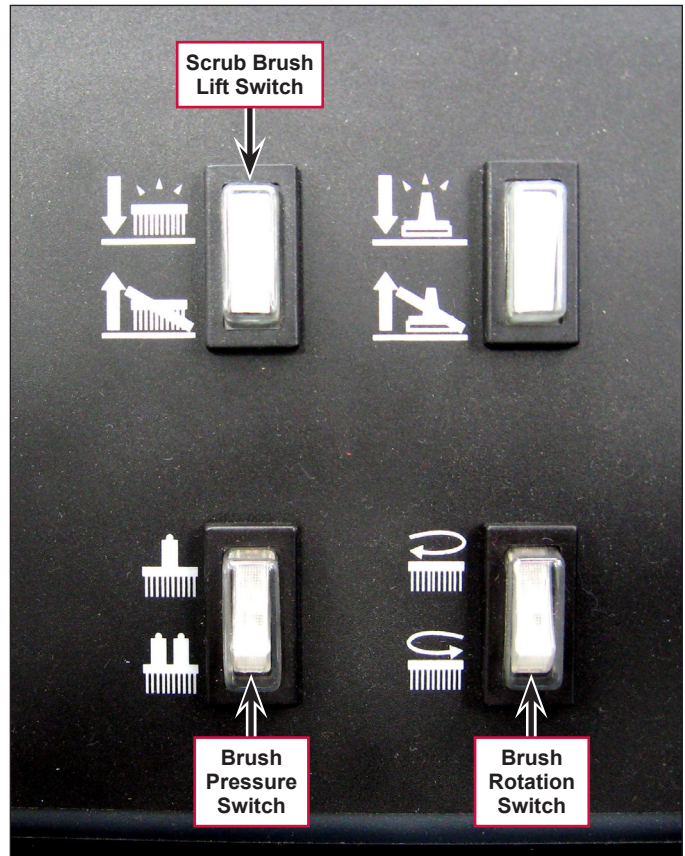


- **Brush Pressure Switch** – controls the scrub deck pressure as follows. Note this switch will only function with the **Scrub Brush Lift Switch** in the “lower” position, and will light when the “heavy” scrub pressure is selected.

- Pressing the switch to the “single-bar” position will select the “normal” scrub pressure.



- Pressing the switch to the “two-bar” position will select the “heavy” scrub pressure.





- **Brush Rotation Switch** – controls the scrub brush rotation direction as follows. Note that this switch will only function with the **Scrub Brush Lift Switch** in the “lower” position, and will light when set to the lower (reverse) position.

- Pressing the switch to the upper position will run the scrub brushes in the forward direction.



- Pressing the switch to the lower position will run the scrub brushes in the reverse direction.



### Squeegee and Recovery System Controls

- **Squeegee Blade Switch** – controls the squeegee and recovery vacuum motor as follows.

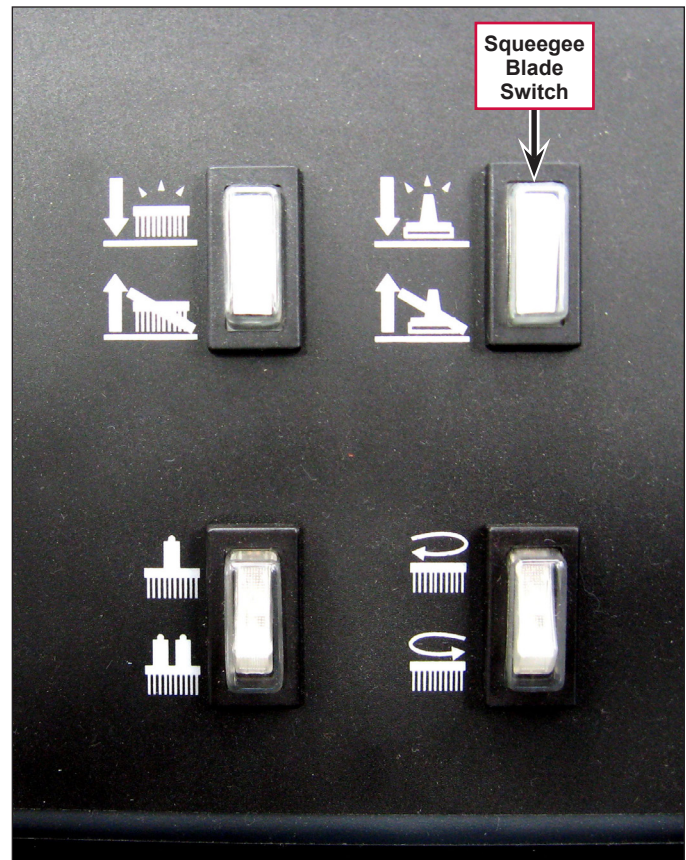
- Pressing the switch to the “lower” position will lower the squeegee and switch on the recovery system vacuum motor.



- Pressing the switch to the “raise” position will raise the squeegee and switch off the recovery system vacuum fan motor.



**Note:** A proximity switch adjacent to the drive foot pedal will automatically raise the squeegee and shut off the vacuum motor when the pedal is moved to the reverse position.



- **High Recovery Warning Light** – lights approximately five minutes before the recovery tank is full to allow time to complete the scrubbing cycle before the float switch shuts off the vacuum to the recovery tank.



**High Recovery Warning Light**

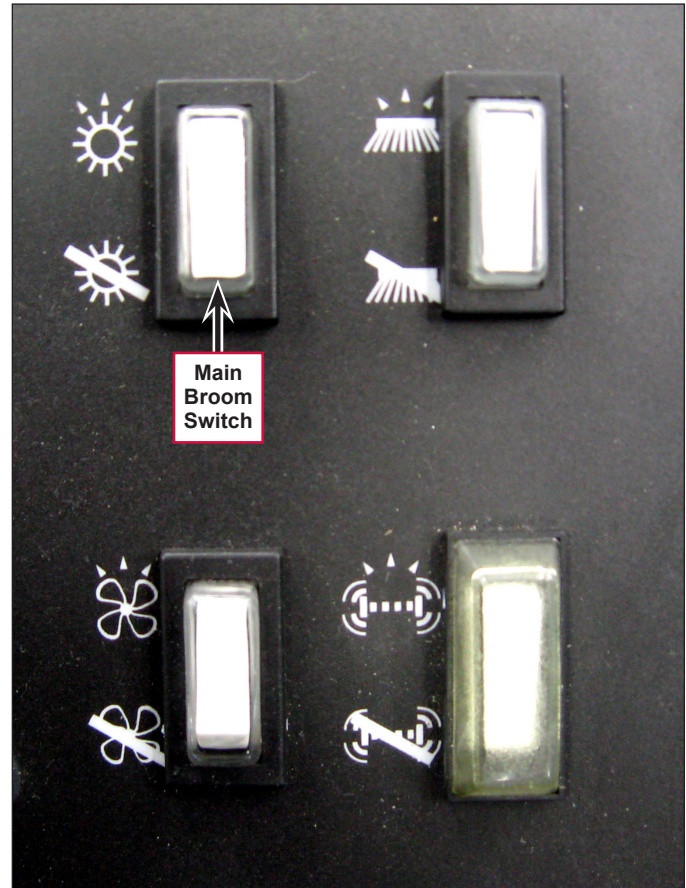
## Main Broom Controls

- **Main Broom Switch** – switches the main broom motor on and off as follows:

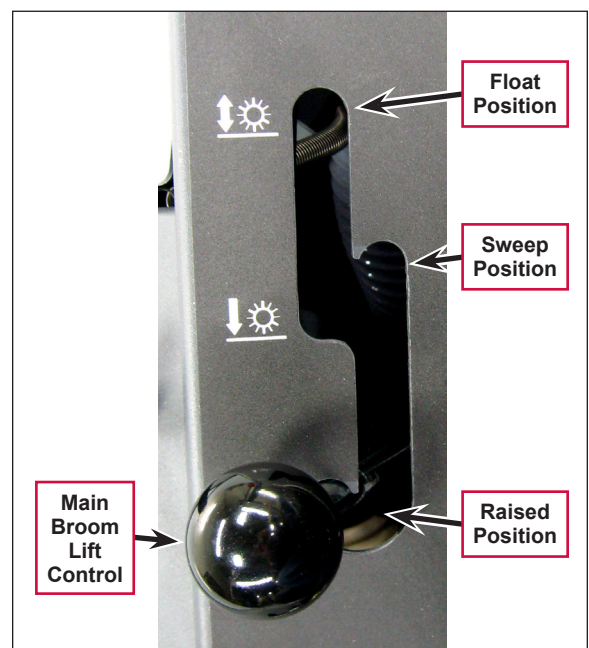
- Pressing the switch to the “on” (upper) position will switch on the main broom.



- Pressing the switch to the “off” (lower) position will switch off the main broom.





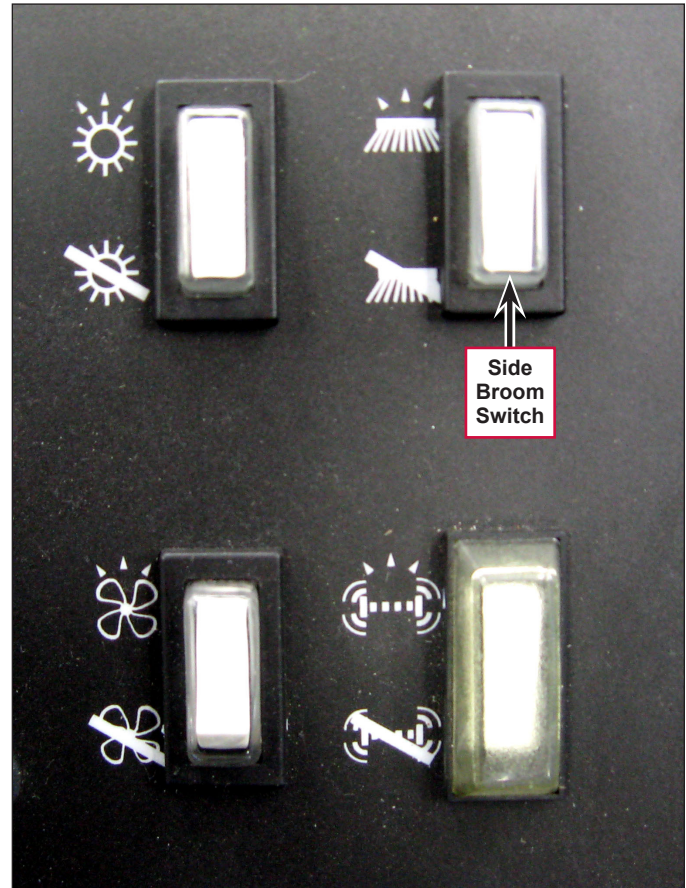
- **Main Broom Lift Control** – this lever lowers and raises the main broom, via a mechanical linkage, to the following three positions:
  - Moving the **Main Broom Lift Control** to the **Float Position** will allow the main broom to “float” on the floor under its own weight. This setting produces a 4”-5” [10-13 cm] broom pattern and is used for heavy sweeping or irregular surfaces.
  - Moving the **Main Broom Lift Control** to the **Sweep Position** lowers the main broom to the normal sweep position and produces a 2”-3” [5-8 cm] broom pattern.
  - Moving the **Main Broom Lift Control** to the **Raised Position** lifts the main broom up off of the floor.



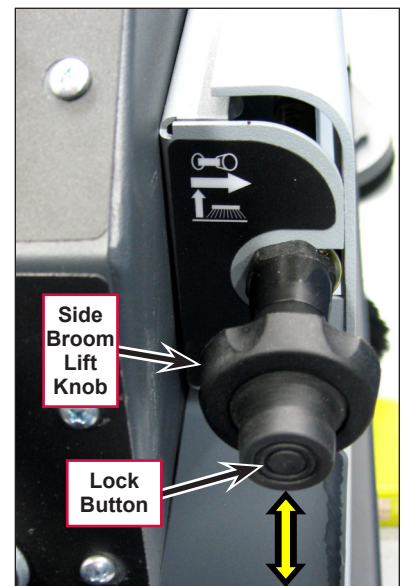


### Side Broom Controls

- **Side Broom Switch** – switches the side broom motor on and off as follows:
  - Pressing the switch to the “on” (upper) position will switch on the side broom.
 
  - Pressing the switch to the “off” (lower) position will switch off the side broom.
 

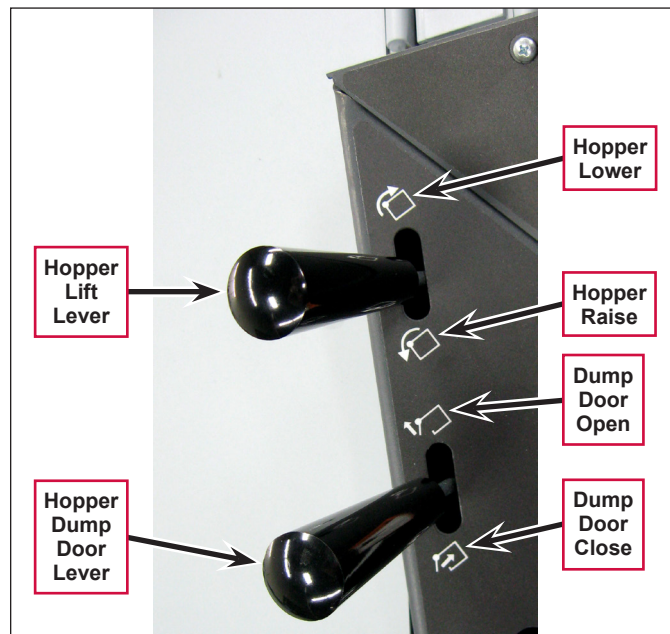


- **Side Broom Lift** – raises and lowers the side broom via a cable actuated by the **Side Broom Lift Knob**.
  - To raise the side broom, press the **Lock Button**, pull the **Side Broom Lift Knob**, then release the **Lock Button**.
  - To lower the side broom, press the **Lock Button**, push the **Side Broom Lift Knob** forward, then release the **Lock Button**.







### Hopper Controls (Variable Dump models)

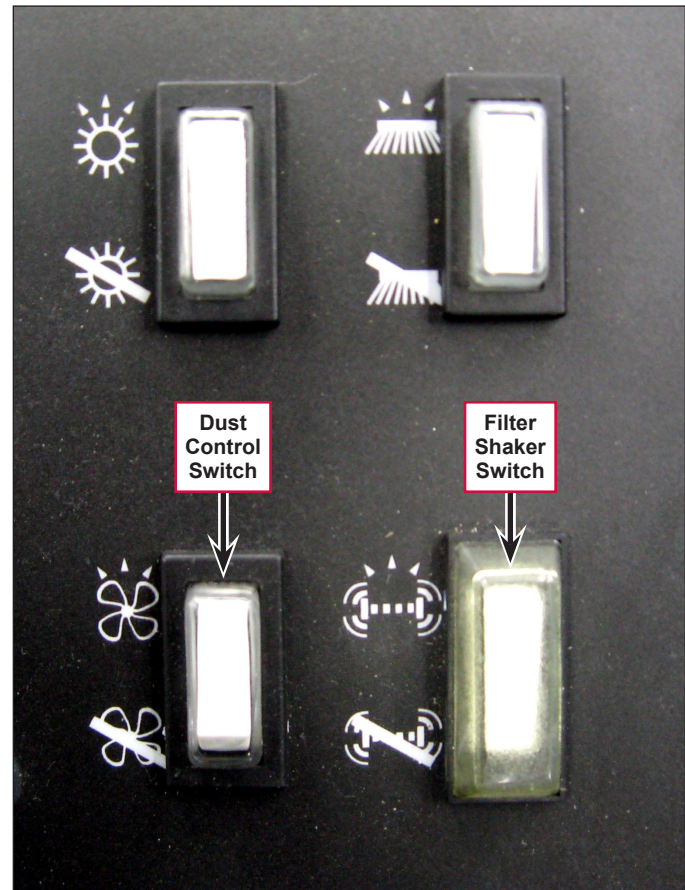
- **Hopper Lift Lever** – mechanically actuates the hydraulic valves for the hopper lift cylinder to raise and lower the hopper as follows:
  - Moving the **Hopper Lift Lever** to the **Hopper Raise** position will raise the hopper.
  - Moving the **Hopper Lift Lever** to the **Hopper Lower** position will lower the hopper.
  
- **Hopper Dump Door Lever** – mechanically actuates the hydraulic valves for the dump door cylinder to open and close the hopper dump door as follows:
  - Moving the **Hopper Dump Door Lever** to the **Dump Door Open** position will open the hopper dump door.
  - Moving the **Hopper Dump Door Lever** to the **Dump Door Close** position will close the hopper dump door.



**Note:** The main broom, side broom, dust control motor and filter shaker will turn off automatically when the hopper is dumping and/or the dump door is in the closed position.

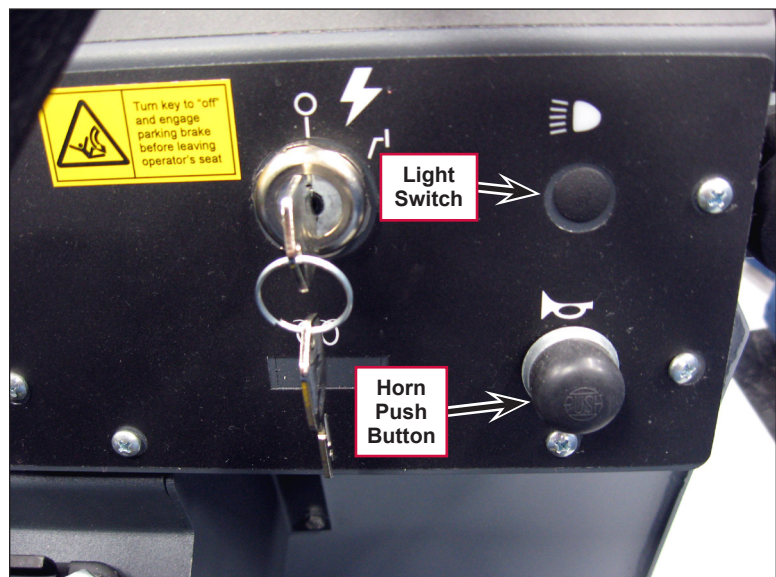
### Dust Control and Filter Shaker Controls (Variable Dump models)

- **Dust Control Switch** – wet sweep bypass (optional on VD machines); switches the hydraulic dust control vacuum fan motor on and off as follows:
  - Pressing the switch to the “on” (upper) position will switch on the dust control motor whenever the main broom is also operating.
 
  - Pressing the switch to the “off” (lower) position will switch off the dust control motor.
 
- **Filter Shaker Switch** – switches the electric filter shaker motor on and off as follows:
  - Pressing the switch to the “on” (upper) position will switch on the shaker motor.
 
  - Pressing the switch to the “off” (lower) position will switch off the shaker motor.
 



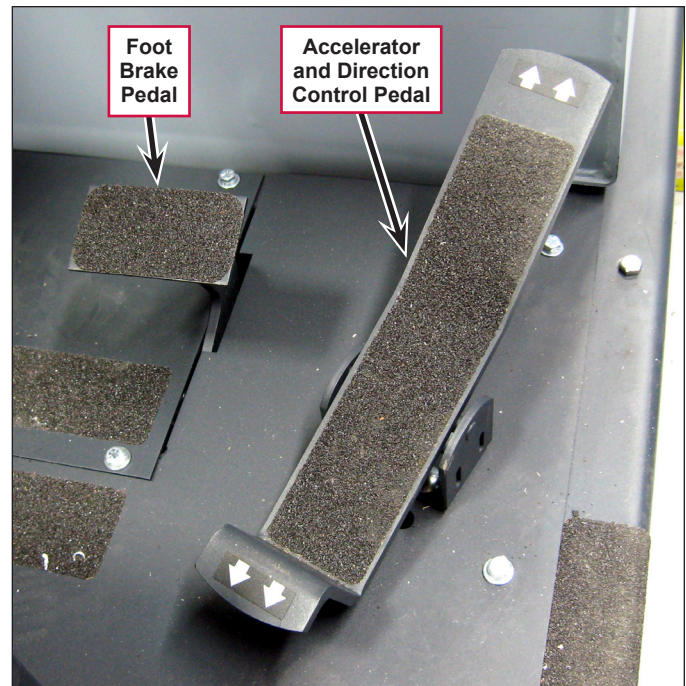
### Miscellaneous Controls

- **Horn Push Button** – sounds the horn when pressed.
- **Light Switch** – (location only shown) switches on the head lights, tail lights and instrument lights (if the machine is so equipped).
- **Turn Signal** – (optional, not shown). The turn signal lever is located on the steering column and works the same as automotive turn signals; forward on the lever for right and back on the lever for left. The four-way flashers will activate when the turn signal lever is pulled out.

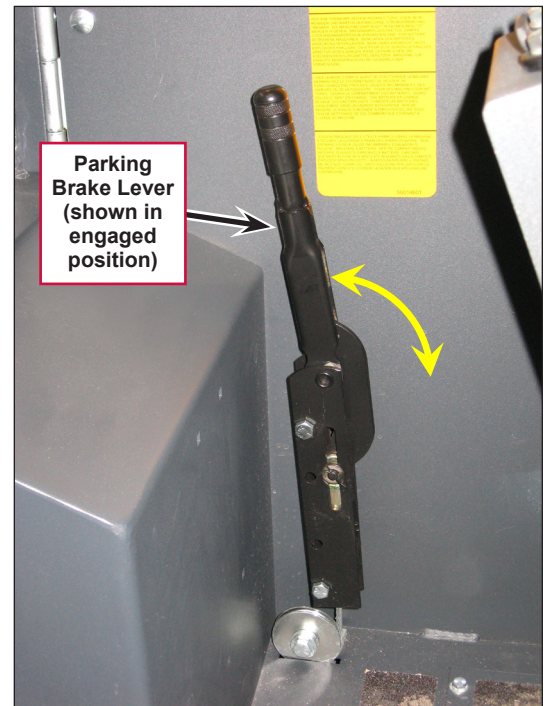




- **Foot Brake Pedal** – actuates the front wheel brakes mechanically when depressed.
- **Accelerator and Directional Control Pedal** – controls the machine direction and speed.



- **Parking Brake Lever** – raising the **Parking Brake Lever** to the upright position will “lock” the **Foot Brake Pedal** in the down position.



## Dust Control System

### Functional Description

#### Overview

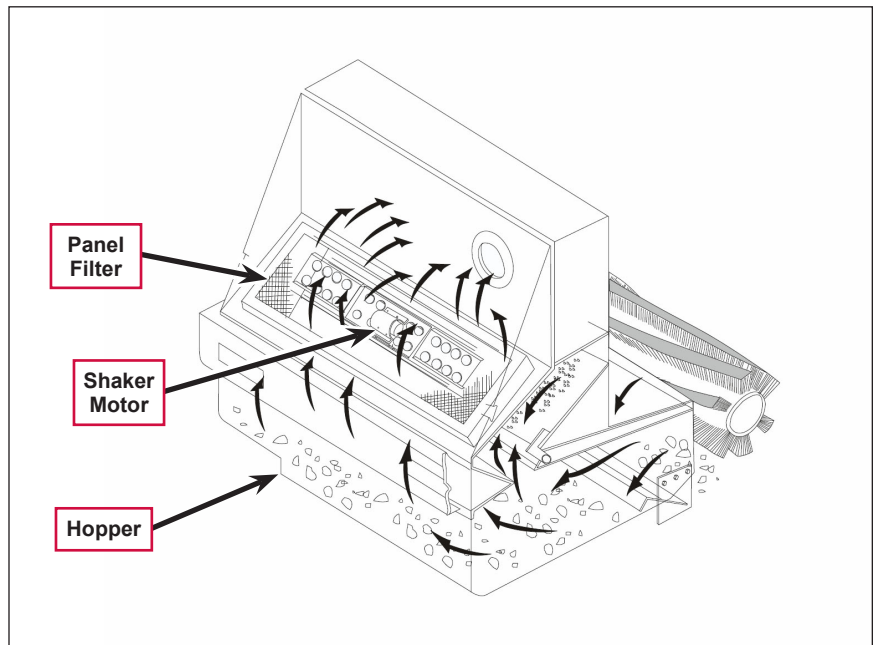
The dust control system is installed on variable dump machines only, and reduces the dust in the air that is generated while sweeping.

The hydraulic dust control vacuum fan motor drives an impeller that pulls the air and dust up from the **Hopper** and through a **Panel Filter**. (The curved black arrows show the airflow.) The **Panel Filter** traps the fine dust particles to minimize the dust in the air around the machine.

An electric **Shaker Motor**, controlled by the filter shaker switch on the instrument panel, vibrates the **Panel Filter** to dislodge dust clogging the **Panel Filter** to minimize maintenance and extend **Panel Filter** life.

Note that the **Hopper** and hopper door must be closed for the dust control motor and **Shaker Motor** to operate.

Refer to the **Hopper System** section for additional information.



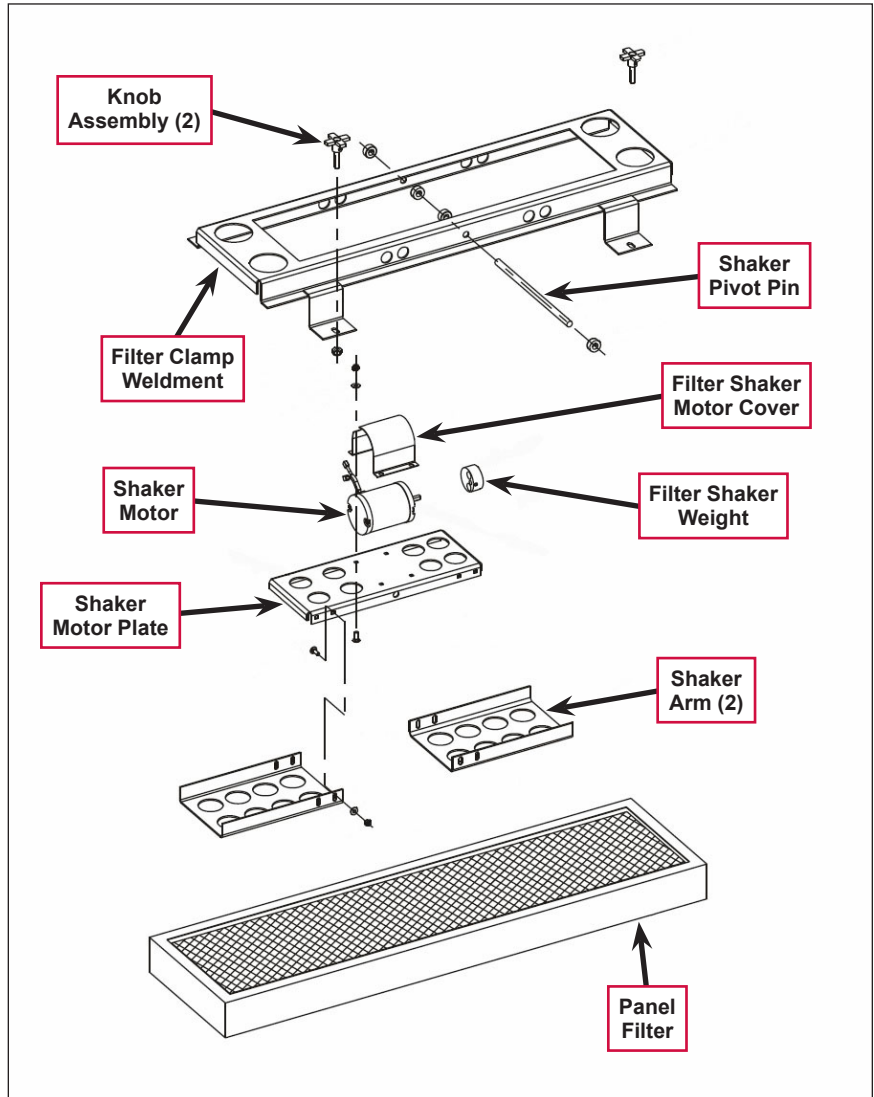
### Filter Assembly

The **Filter Shaker Motor Cover** fastens to the **Shaker Motor Plate** and holds the **Shaker Motor** in place.

The **Shaker Motor** rotates the **Filter Shaker Weight** which vibrates the **Shaker Motor Plate** and attached **Shaker Arms**. The **Shaker Arms** transfer the vibration to the **Panel Filter**.

The **Shaker Pivot Pin** suspends the **Shaker Motor Plate** and attached **Shaker Motor** and **Shaker Arms** on the **Filter Clamp Weldment**. This pivoting mounting provides a degree of rotational movement on the **Shaker Pivot Pin** to allow the generated vibration to be transferred to the **Panel Filter**.

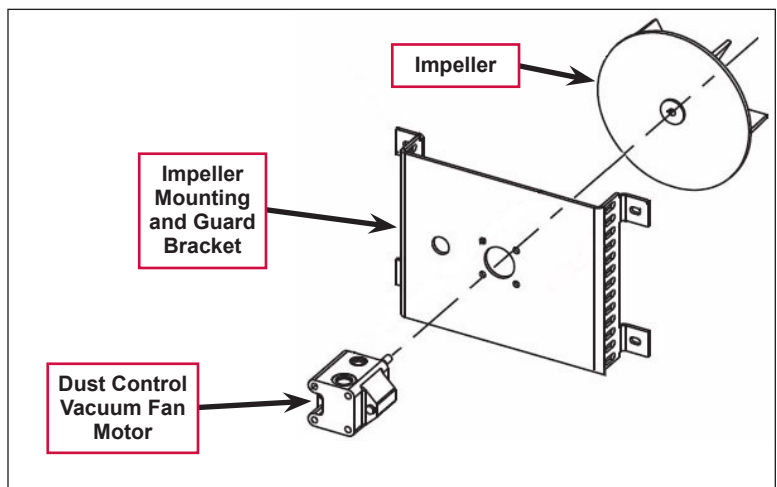
The two **Knob Assemblies** fasten the **Filter Clamp Weldment** and attached components to the horizontal support plate on the front of the hopper.



### Dust Control Vacuum Fan Motor Assembly

The hydraulic **Dust Control Vacuum Fan Motor** drives the **Impeller** which creates the airflow through the hopper and **Panel Filter**.

The **Dust Control Vacuum Fan Motor** is fastened to the **Impeller Mounting and Guard Bracket**. The **Impeller Mounting and Guard Bracket** is mounted on the rear of the hopper.

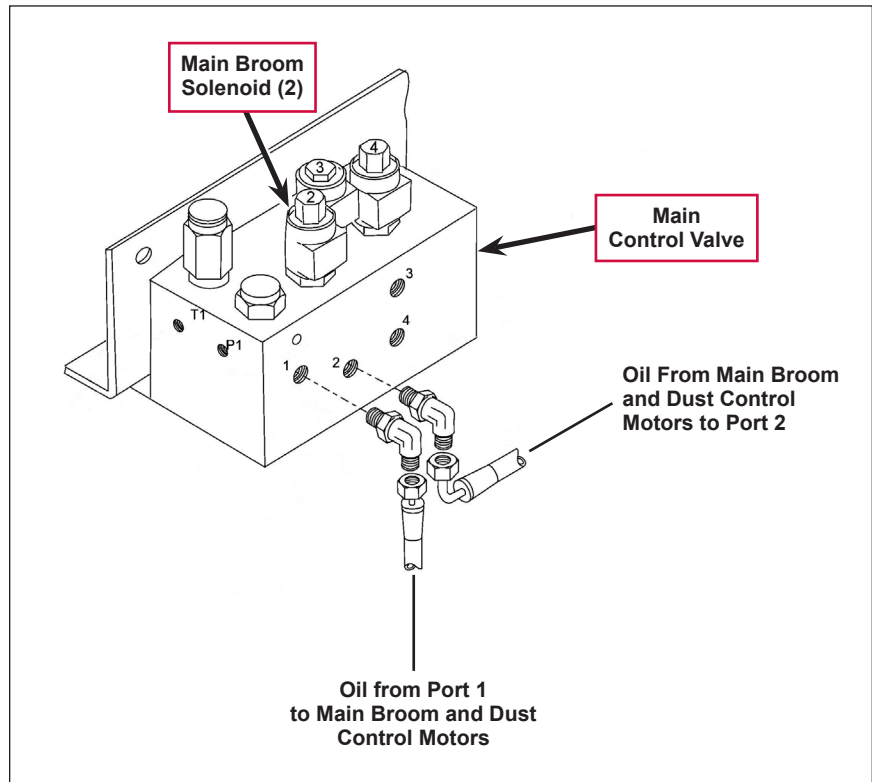




## Dust Control Motor Valves

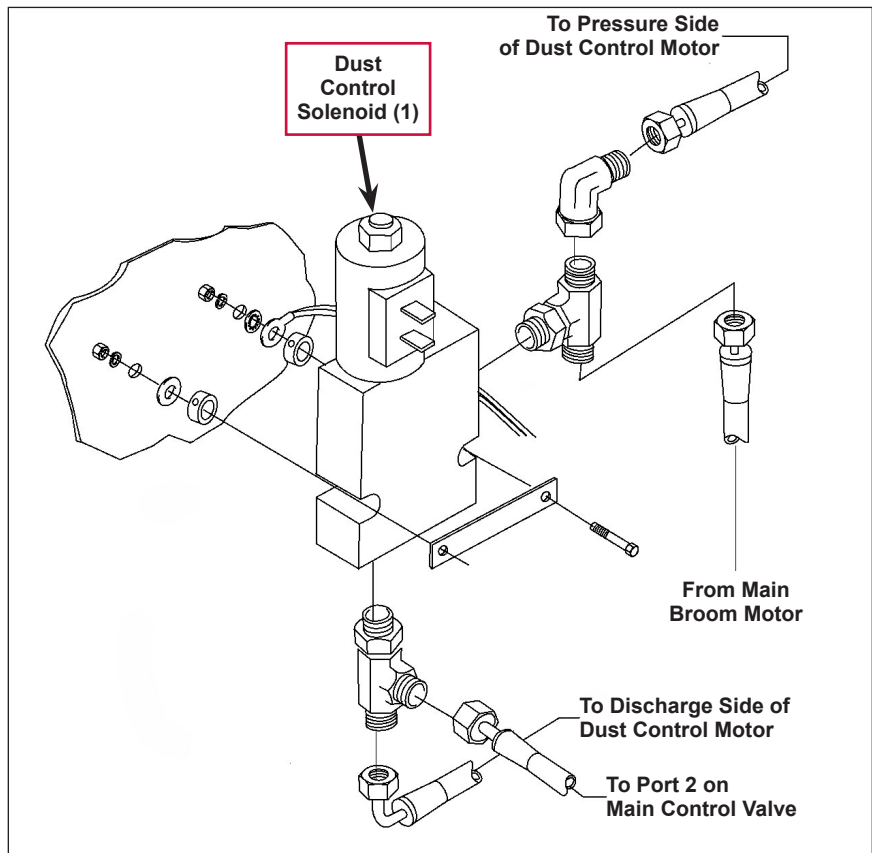
The **Main Broom Solenoid (2)** on the **Main Control Valve** controls the supply of hydraulic oil to the main broom and dust control vacuum fan motors.

When the **Main Broom Solenoid (2)** is energized it closes to direct the oil flow through **Port 1** on the **Main Control Valve**. The oil is directed through the main broom motor and dust control motor, then returns to **Port 2** on the **Main Control Valve**.

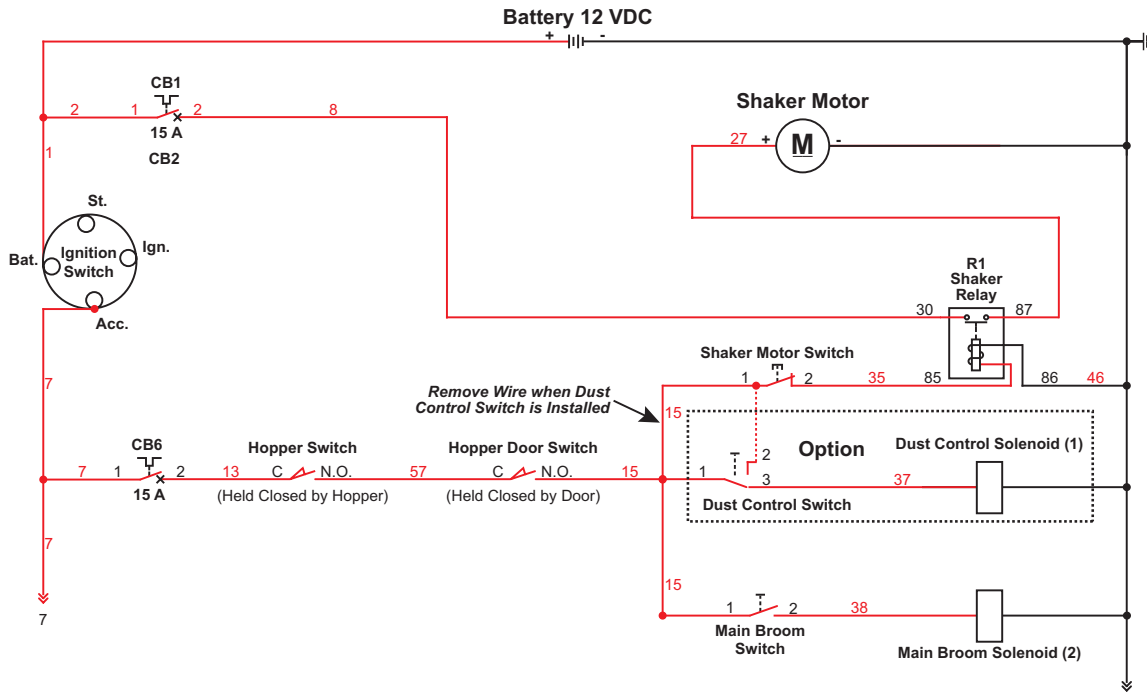


Machines equipped with the Wet Sweep Bypass Option have an additional **Dust Control Solenoid (1)** valve. The Wet Sweep Bypass Option allows you to operate the main broom with the dust control motor off.

- When the **Dust Control Solenoid (1)** valve is de-energized (open) it allows the hydraulic oil to flow from the discharge side of the main broom motor, through the **Dust Control Solenoid (1)** valve and to **Port 2** on the **Main Control Valve**, bypassing the dust control motor.
- When the **Dust Control Solenoid (1)** is energized it closes to direct the oil flow from the main broom motor through the dust control motor. The oil then returns to **Port 2** on the **Main Control Valve**.



### Dust Control System Wiring Diagram



### Electrical Circuit Description

The **Main Broom Solenoid (2)** controls the hydraulic oil flow to both the main broom motor and the dust control vacuum fan motor. The dust control motor will run when the **Ignition Switch** is on and the Operator turns on the **Main Broom Switch** on the instrument panel.

If the machine is equipped with the Wet Sweep Bypass Option:

- Setting the **Dust Control Switch** to the off position will de-energize the **Dust Control Solenoid (1)** to its normally-open position. This allows the oil to flow through the **Dust Control Solenoid (1)** valve and bypass the vacuum fan motor.
- Setting the **Dust Control Switch** to the on position will energize the **Dust Control Solenoid (1)** to its closed position. This directs the oil to the dust control motor.

Note that the **Hopper Switch** and the **Hopper Door Switch** must both be closed for the dust control vacuum fan motor, main broom motor and **Shaker Motor** to operate.

### Shaker Motor Nominal Conditions

|      | Filter Shaker Switch On | Filter Shaker Switch Off |
|------|-------------------------|--------------------------|
| Wire | Voltage                 | Voltage                  |
| 2    | B+ Voltage              | B+ Voltage               |
| 7    | B+ Voltage              | B+ Voltage               |
| 8    | B+ Voltage              | B+ Voltage               |
| 13   | B+ Voltage              | B+ Voltage               |
| 15   | B+ Voltage (note 1)     | B+ Voltage (note 1)      |

|             | Filter Shaker Switch On | Filter Shaker Switch Off |
|-------------|-------------------------|--------------------------|
| 27          | B+ Voltage              | 0 Volts(Off)             |
| 35          | B+ Voltage              | 0 Volts(Off)             |
| 57          | B+ Voltage (note 1)     | B+ Voltage (note 1)      |
| 46 (ground) | 0 Volts(Off)            | 0 Volts(Off)             |

Note 1: Conditions with Hopper Door fully open (indicated by Wire 57 = B+ Voltage) and Hopper fully down (indicated by wires 57 and 15 = B+ Voltage)

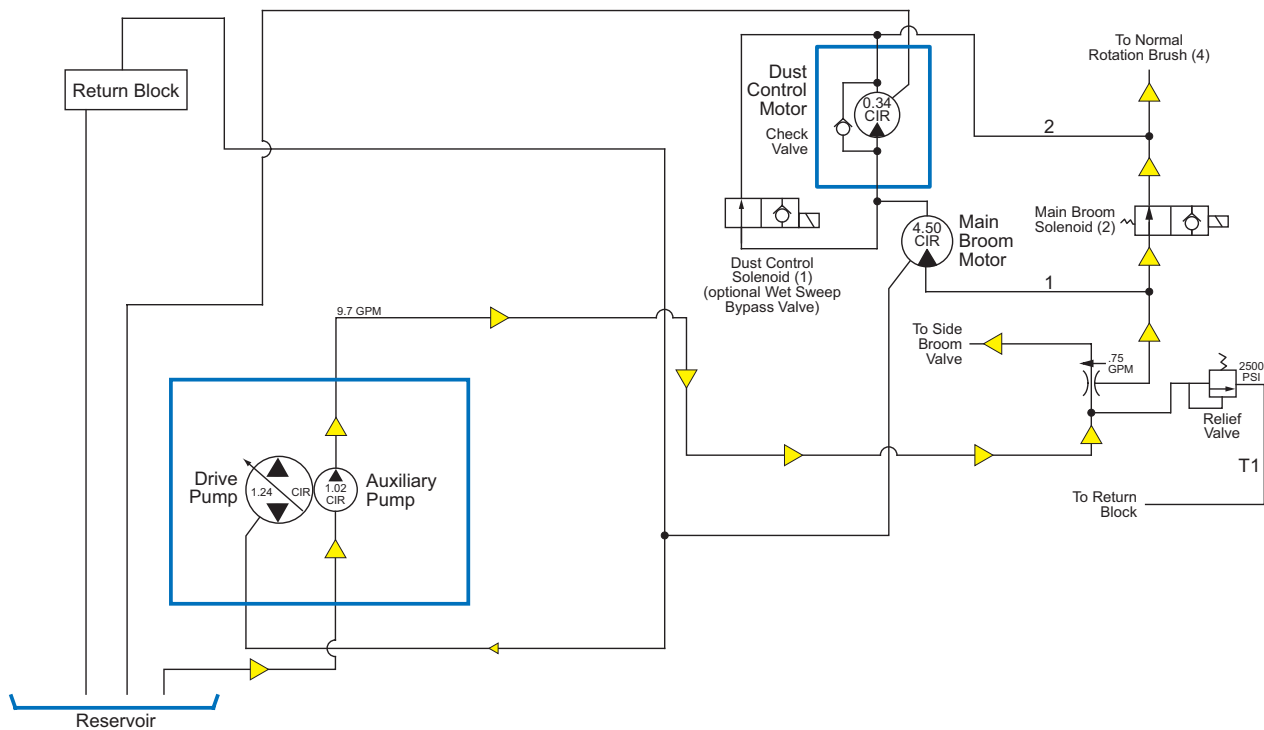
### Dust Control System Hydraulic Diagrams



**Note:** On machines not equipped with the Wet Sweep Bypass Option, the dust control vacuum fan motor will run whenever the main broom motor is running.

On machines equipped with the Wet Sweep Bypass Option, the dust control vacuum fan motor can be switched off independent of the main broom motor by switching off the Dust Control Switch.

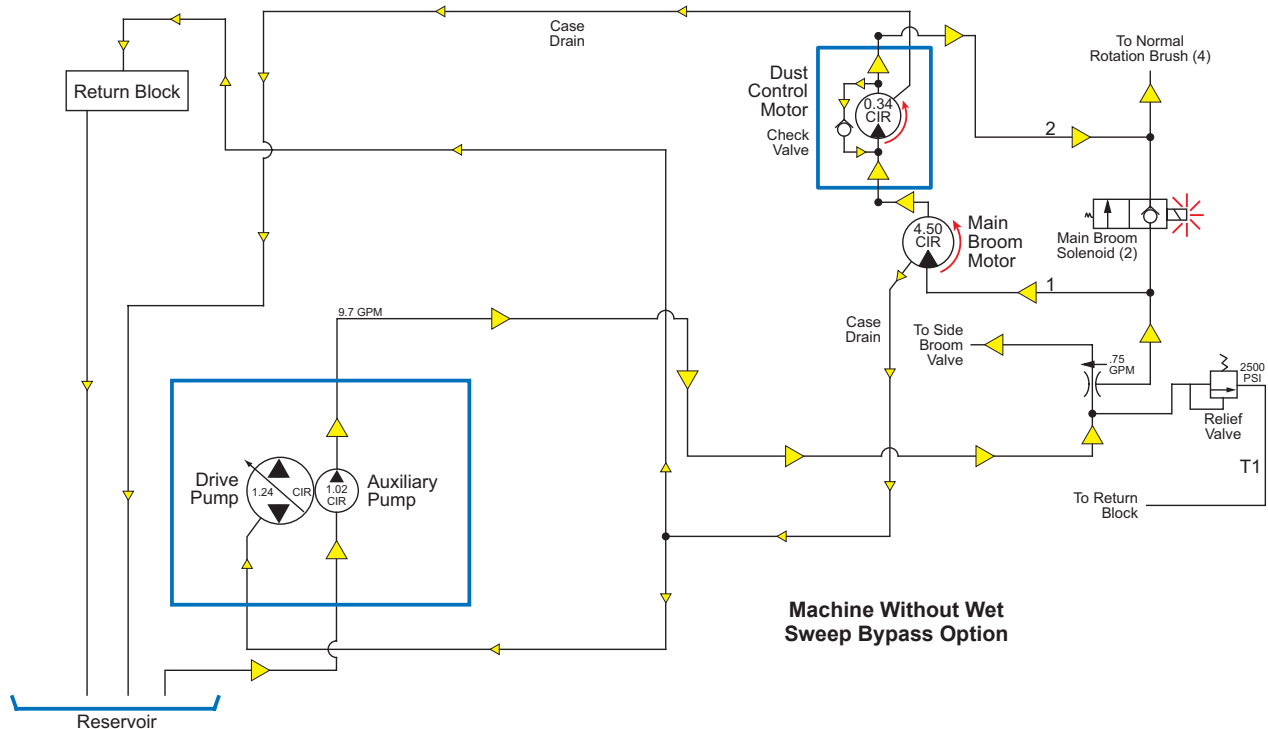
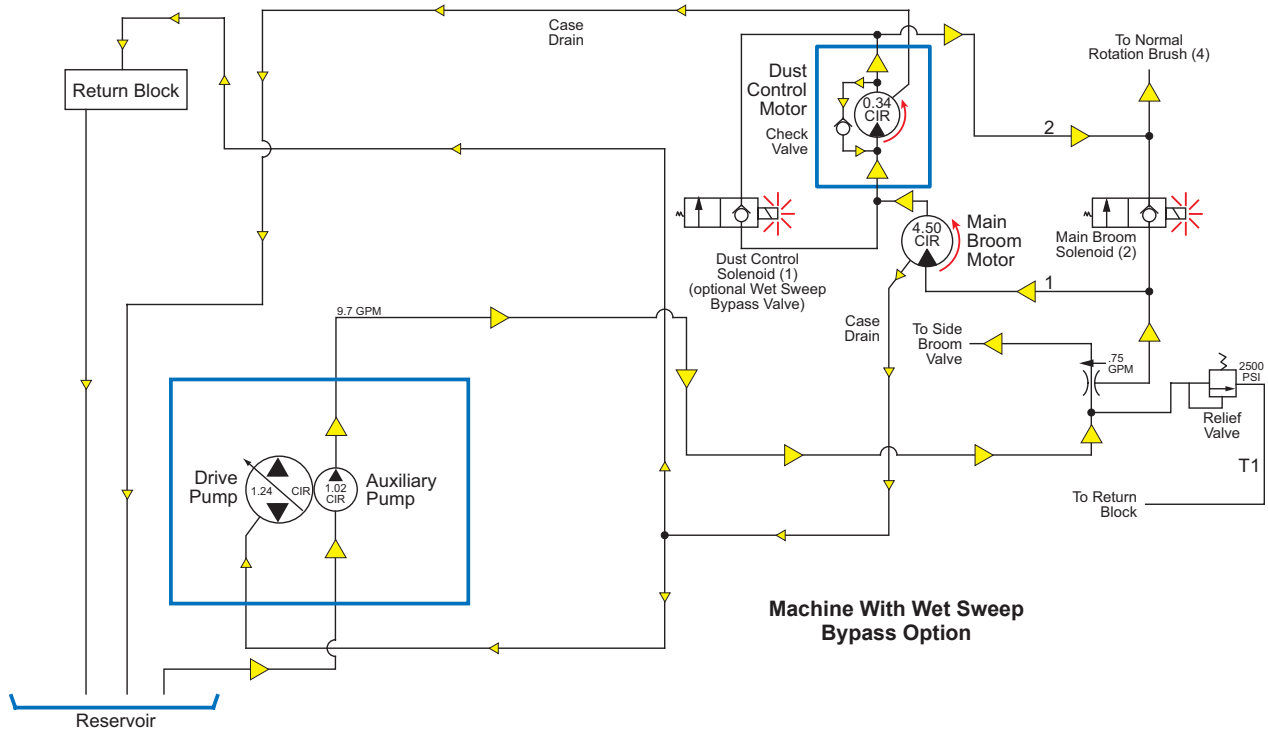
### Main Broom and Dust Control Motors Off



When the **Main Broom Motor** and **Dust Control Motor** are off, the **Main Broom Solenoid (2)** is de-energized (open). This allows the hydraulic oil to flow from the **Auxiliary Pump**, through the non-priority leg of the priority flow divider, through the open **Main Broom Solenoid (2)** valve and to the **Normal Rotation Brush (4)** solenoid valve. This bypasses both the **Main Broom Motor** and the **Dust Control Motor**.

Note that the oil flow path is the same whether or not the machine is equipped with the **Dust Control Solenoid (1)** that is included with the Wet Sweep Bypass Option.

Main Broom and Dust Control Motors On

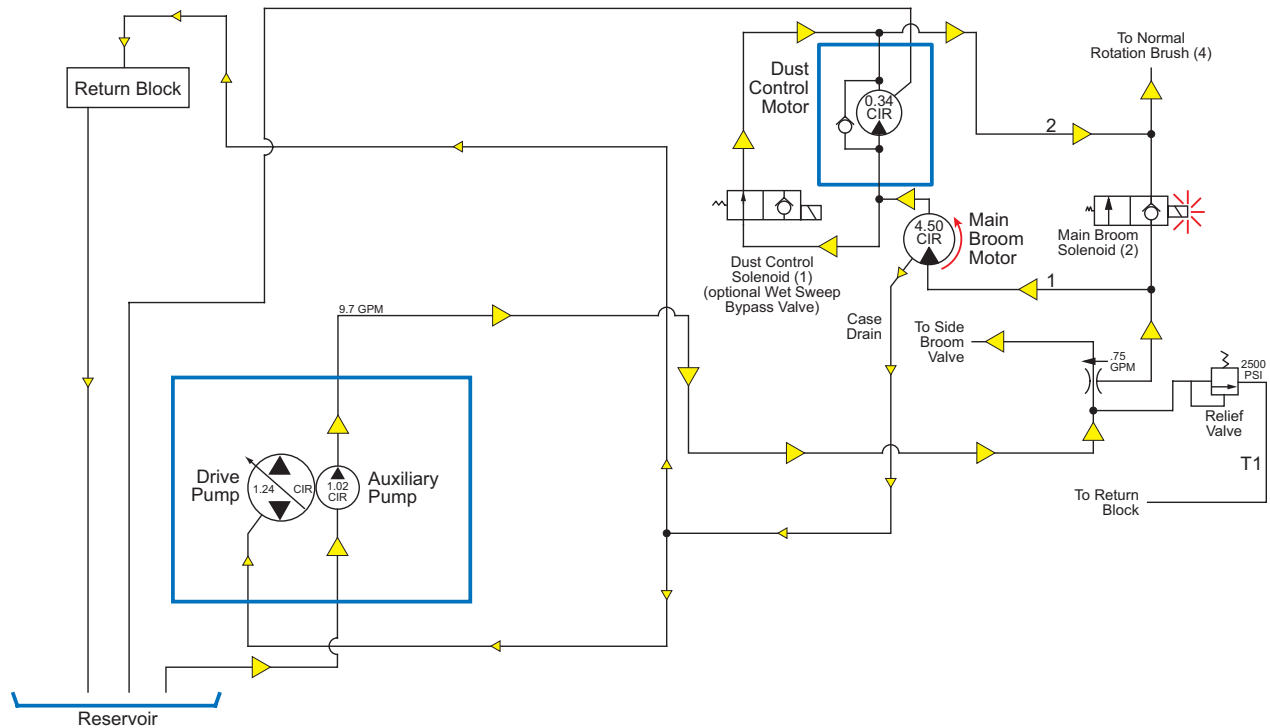


When the **Main Broom Motor** and **Dust Control Motor** are running, the **Main Broom Solenoid (2)** is energized (blocked). This allows the hydraulic oil to flow from the **Auxiliary Pump**, through the priority flow divider, then to the **Main Broom Motor**. The oil from the discharge side of the **Main Broom Motor** is then directed to the **Dust Control Motor**. If the machine is equipped with the Wet Sweep Bypass Option (top drawing) and the Dust Control Switch is set to on, the **Dust Control Solenoid (1)** will be energized to direct the oil from the **Main Broom Motor** to the **Dust Control Motor**.

The **Check Valve** allows oil to circulate from the high-pressure side to the low-pressure side of the **Dust Control Motor** when the **Dust Control Motor** is switched off. This allows the high-speed **Dust Control Motor** to “coast” down and reduce its speed more gradually when it is shut off.

The **Case Drain** from **Dust Control Motor** goes directly back to reservoir.

### Main Broom Motor On and Dust Control Motor Off (with Wet Sweep Bypass Option)



If the machine is equipped with the Wet Sweep Bypass Option, switching the Dust Control Switch to off while the Main Broom switch is on will run the **Main Broom Motor** but will switch off the **Dust Control Motor**.

In this case, the **Main Broom Solenoid (2)** is energized (blocked). This allows the hydraulic oil to flow from the **Auxiliary Pump**, through the priority flow divider, then to the **Main Broom Motor**. The **Dust Control Solenoid (1)** will be de-energized (open) to allow the oil from the discharge side of the **Main Broom Motor** to bypass the **Dust Control Motor** and flow to the **Normal Rotation Brush (4)** solenoid valve.

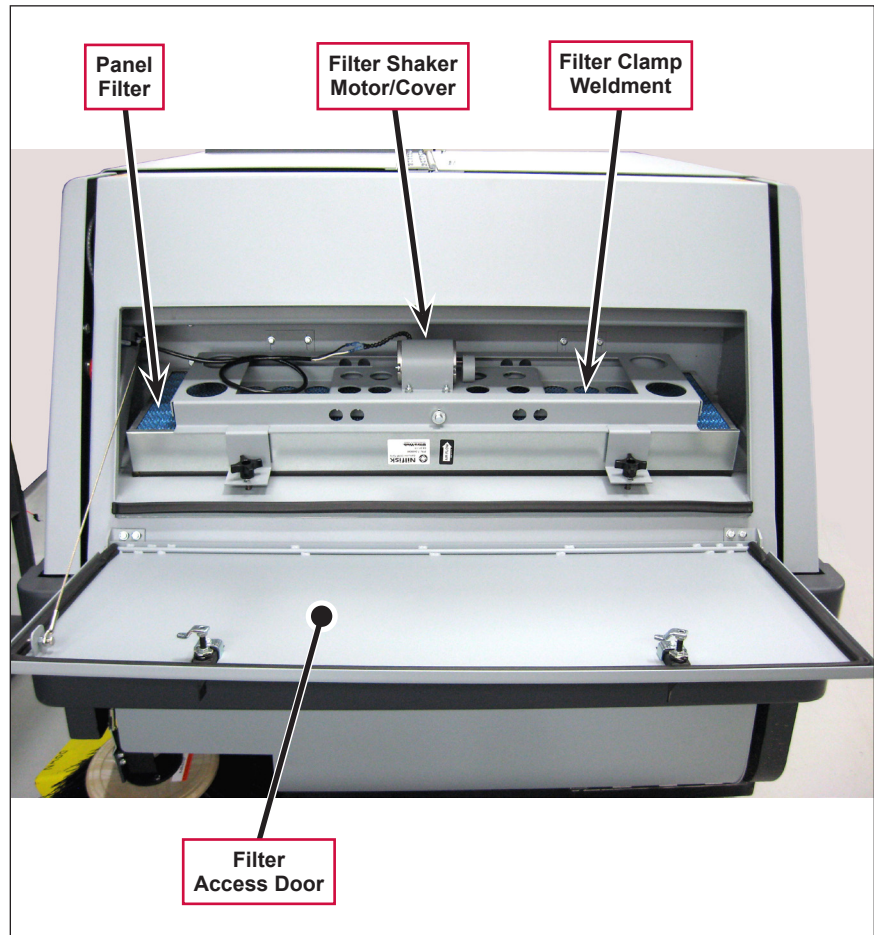
## Component Locations

The following components are included in this section:

- Panel Filter/Filter Shaker Motor/Cover
- Filter Clamp Weldment
- Dust Control Vacuum Fan Motor/Impeller Assembly
- Main Broom Solenoid
- Dust Control Solenoid

The **Panel Filter**, **Filter Clamp Weldment** and **Filter Shaker Motor/Cover** are located behind the **Filter Access Door** on the front of the machine.

The **Filter Shaker Motor/Cover**, shaker motor plate and shaker arms are attached to the shaker motor plate, which is held to the **Filter Clamp Weldment** by the shaker pivot pin.





The **Dust Control Vacuum Fan Motor** is fastened to the **Impeller Mounting and Guard Bracket**. The impeller is attached to the output shaft on the **Dust Control Vacuum Fan Motor**.

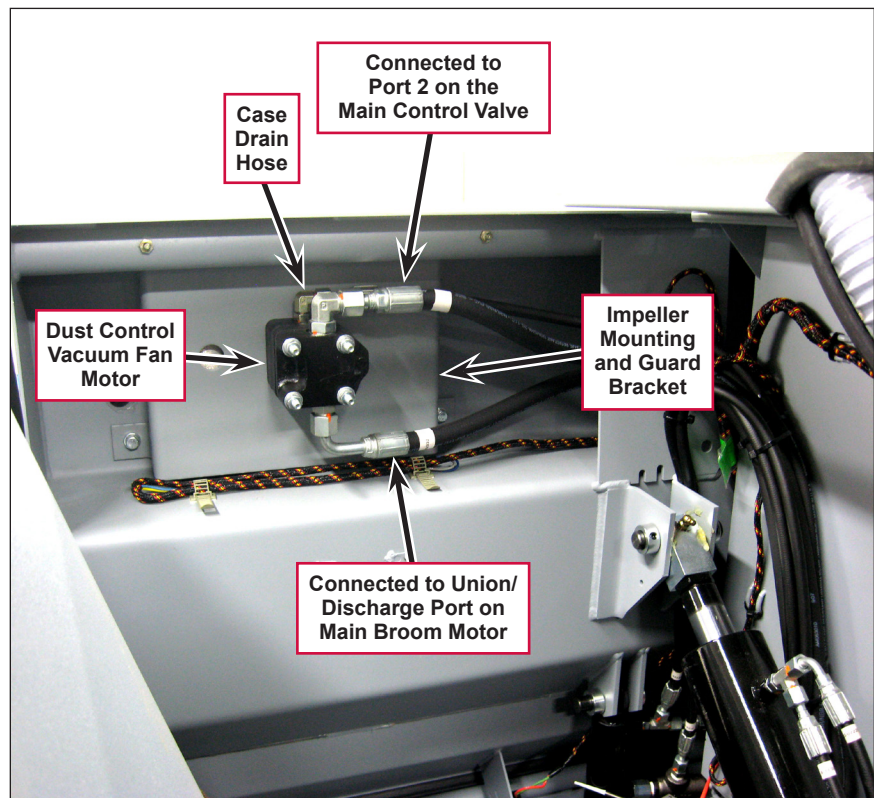
The **Impeller Mounting and Guard Bracket** is mounted to the rear of the hopper.

To access the **Dust Control Vacuum Fan Motor**, tilt the recovery tank out away from the machine.

The **Case Drain Hose** is connected to the hydraulic reservoir.

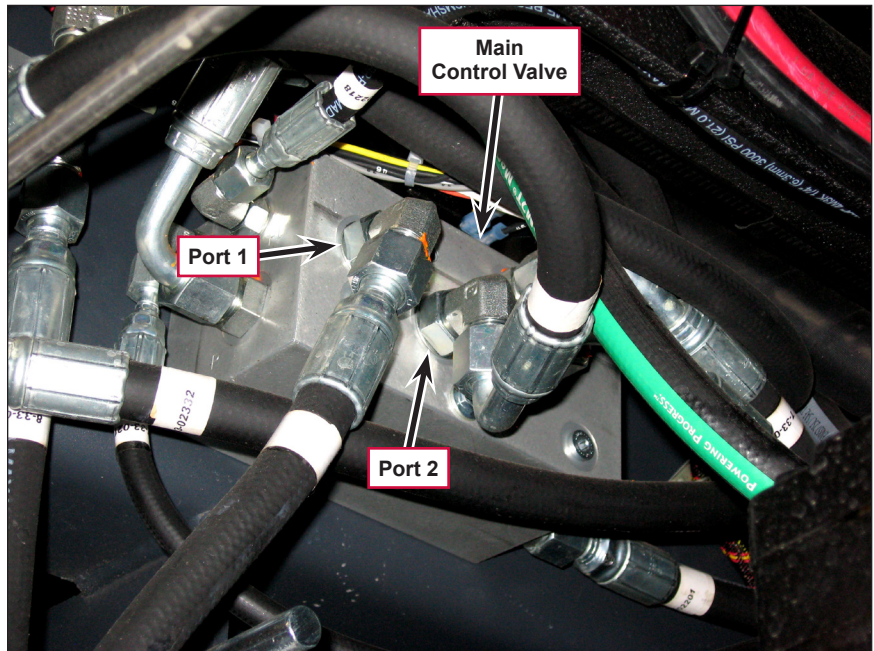
The top hydraulic hose is connected to port 2 on the main control valve.

The bottom hydraulic hose is connected to a union, which is connected to the discharge port on the main broom motor.



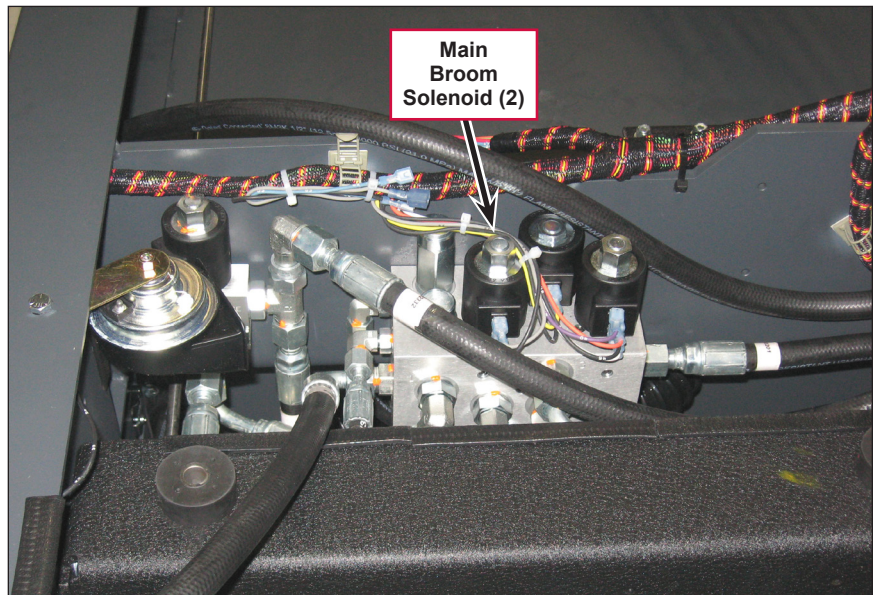


The **Main Broom Solenoid (2)** is part of the **Main Control Valve**. The **Main Control Valve** is mounted on the underside of the machine, in front of and to the left of the scrub deck.



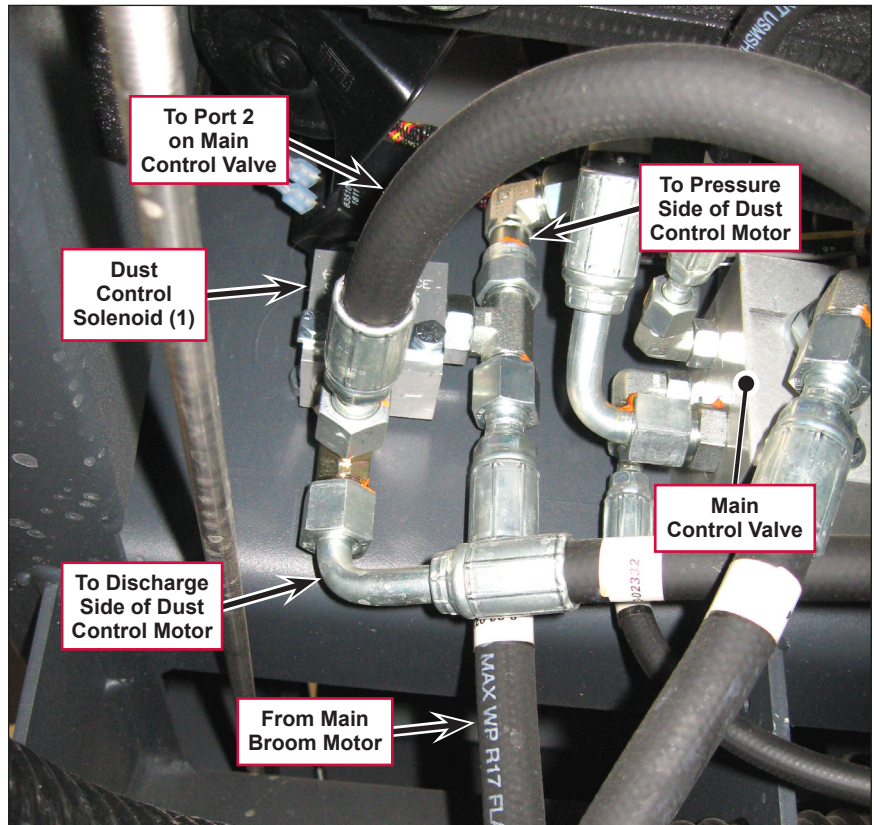
**Main Control Valve**  
(bottom view - shown mounted in assembled machine)

When the **Main Broom Solenoid (2)** is energized it closes to direct the oil flow through **Port 1** on the **Main Control Valve**. The oil is directed through the main broom motor and dust control motor, then returns to **Port 2** on the **Main Control Valve**.



**Main Control Valve**  
(top view - shown while machine is being assembled)

The **Dust Control Solenoid (1)** (Wet Sweep Bypass Valve) is included with the Wet Sweep Bypass Option and is mounted to the left of the **Main Control Valve**.

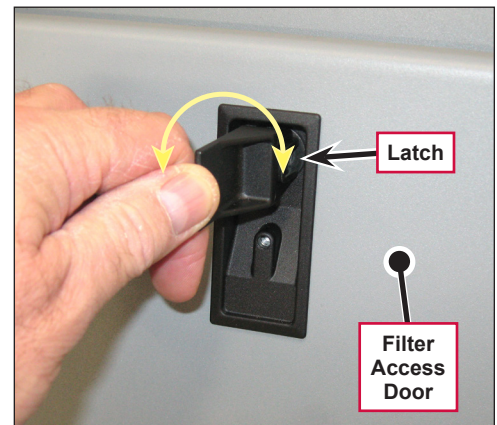


## Dust Control Filter Maintenance



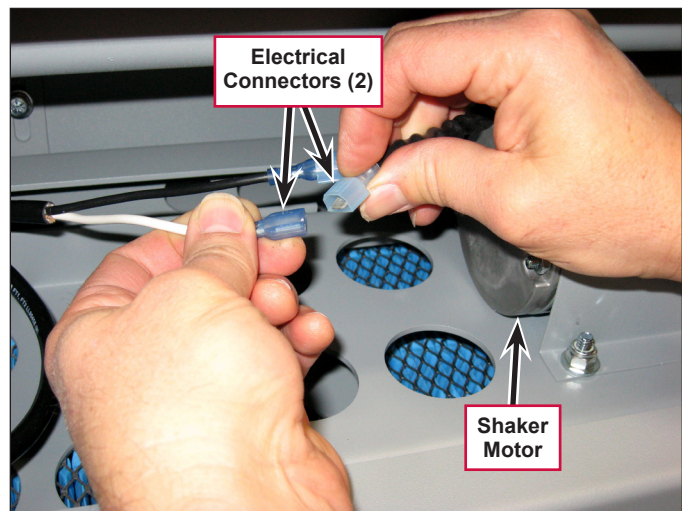
**Warning!** *Wear a protective mask to prevent inhaling dust while servicing the filter.  
Wear eye protection while servicing the filter.*

1. Lift and rotate the **Latches**, then tilt down the **Filter Access Door**.





2. Disconnect the **Electrical Connectors** from the **Shaker Motor**. Note that you may need to cut the wire tie holding the wires to the filter clamp weldment to do this.



3. Loosen the two **Knobs**, then remove the **Filter Clamp Weldment** and attached shaker motor assembly, shaker motor plate and shaker arms from the machine.
4. Remove the panel filter from the machine,
5.
  - Check the dirty side of the filter for a heavy dirt buildup. If the filter is lightly coated (1/16-inch thick) with dirt and the pleats in the filter are not filled with dirt, cleaning is not necessary.
  - If there is a heavy coating of dirt on the filter, clean the filter by following one of the three methods listed below:



**Caution!** *Be careful not to puncture the filter while cleaning.*



#### **Method "A"**

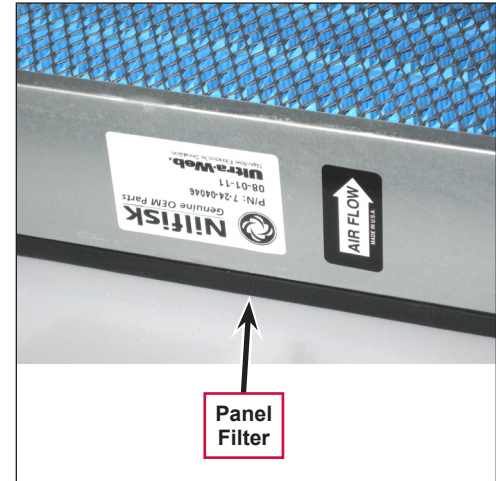
- a. Vacuum any loose dust from the filter.
- b. Gently tap the filter against a flat surface (with the dirty side down) to remove loose dust and dirt.

#### **Method "B"**

- a. Vacuum any loose dust from the filter.
- b. Blow compressed air (maximum pressure 100 psi) into the clean side of the filter (in the opposite direction of the airflow).

**Method “C”**

- a. Vacuum any loose dust from the filter.
  - b. Soak the filter in warm water for 15 minutes, then rinse it under a gentle stream of water (maximum pressure 40 psi).
  - c. Let the filter dry *completely* before putting it back into the machine.
6. Inspect the gasket around the **Panel Filter**. If the gasket is torn or damaged, replace the **Panel Filter**.
  7. Reinstall the **Panel Filter** into the machine. Make sure the **AIRFLOW** arrow is pointing up.
  8. Reinstall the filter clamp weldment and attached shaker motor assembly, shaker motor plate and shaker arms into the machine. Note that the two vertical tabs on the filter clamp weldment must fit into the matching slots in the rear clamps mounted on the rear of the filter enclosure.
  9. Reinstall and tighten the two knobs.
  10. Reconnect the electrical connectors to the shaker motor. Tie the wires to the filter clamp weldment as necessary.
  11. Close the filter access door and secure the two latches.



## Troubleshooting

| Problem  | Cause   | Correction  |
|--|---|---|
| Dust not being removed effectively from the air.   | Vacuum leak(s) due to: <ul style="list-style-type: none"> <li>Damaged panel filter or panel filter gasket.</li> <li>Damaged hopper access door gasket.</li> </ul> | <ul style="list-style-type: none"> <li>Check the panel filter and gasket and replace as necessary.</li> <li>Check the hopper access door gasket and replace as necessary.</li> </ul>  |
| Dust Control Motor not running.  | The Dust Control Switch is set to off (Wet Sweep Bypass Option only).   | Switch on the Dust Control Switch.  |
|  | Circuit breaker CB6 is tripped.   | Reset the circuit breaker.  |
|  | No voltage to the Main Broom Solenoid valve.  | <ul style="list-style-type: none"> <li>Check for continuity through the hopper and hopper door “whisker” switches when the hopper is down and the hopper door is closed. Repair the wiring or replace the switch(es) as necessary.</li> <li>Check the Main Broom Switch function and repair/replace as necessary.</li> <li>Check the wiring from the Main Broom Switch to the Main Broom Solenoid valve. There should be 0 volts to the solenoid when the main broom and dust control motors are off, and 12 VDC to the solenoid when the motors are on.</li> </ul> |
| The Shaker Motor will not run.   | Main Broom Solenoid valve not operating correctly.  | Check the solenoid coil resistance. If not 7.2 ohms $\pm 10\%$ , replace the coil. Also see the <b><i>Dust Control System Wiring Diagram</i></b> .  |
|  | Circuit breaker CB6 is tripped.   | Reset the circuit breaker.  |
| Dust control motor runs even though the Dust Control Switch is off (Wet Sweep Bypass Option only). | No voltage to the Shaker Motor Relay R1.  | <ul style="list-style-type: none"> <li>Check for continuity through the hopper and hopper door “whisker” switches when the hopper is down and the hopper door is closed. Repair the wiring or replace the switch(es) as necessary.</li> <li>Check the Shaker Motor Relay R1 contacts and coil resistance. If the coil resistance is not 80-90 ohms, replace the relay.</li> <li>If there is voltage to the Shaker Motor, replace the Shaker Motor.</li> </ul>   |
|  | No voltage to the Dust Control Solenoid (Wet Sweep Bypass) valve.   | <ul style="list-style-type: none"> <li>Check the Dust Control Switch function and repair/replace as necessary.</li> <li>Check the wiring from the Dust Control Switch to the Dust Control Solenoid (Wet Sweep Bypass) valve. There should be 0 volts to the solenoid when the dust control motor is off and 12 VDC to the solenoid when the motor is on.</li> </ul>   |
|  | Dust Control Solenoid (Wet Sweep Bypass) valve not operating correctly.   | Check the solenoid coil resistance. If not 7.2 ohms $\pm 10\%$ , replace the coil. Also see the <b><i>Dust Control System Wiring Diagram</i></b> .  |

## Specifications

| Component  | Specifications                             |
|--|--|
| <b>Dust Control Vacuum Fan Motor</b>   | Displacement – 0.00149 gal/rev; 0.3442 CIR |
| <b>Main Broom Solenoid (2) Valve</b><br><b>Dust Control Solenoid (1) Valve</b> | Voltage – 12 volts                         |
|  | Nominal Coil Resistance – 7.2 Ohms         |
|  | Initial current draw – 1.67 amps           |
| <b>Shaker Motor</b>  | Voltage – 12 volts                         |
| <b>Shaker Relay R1</b>   | Coil Resistance – $85 \pm 5$ Ohms          |



# Electrical System

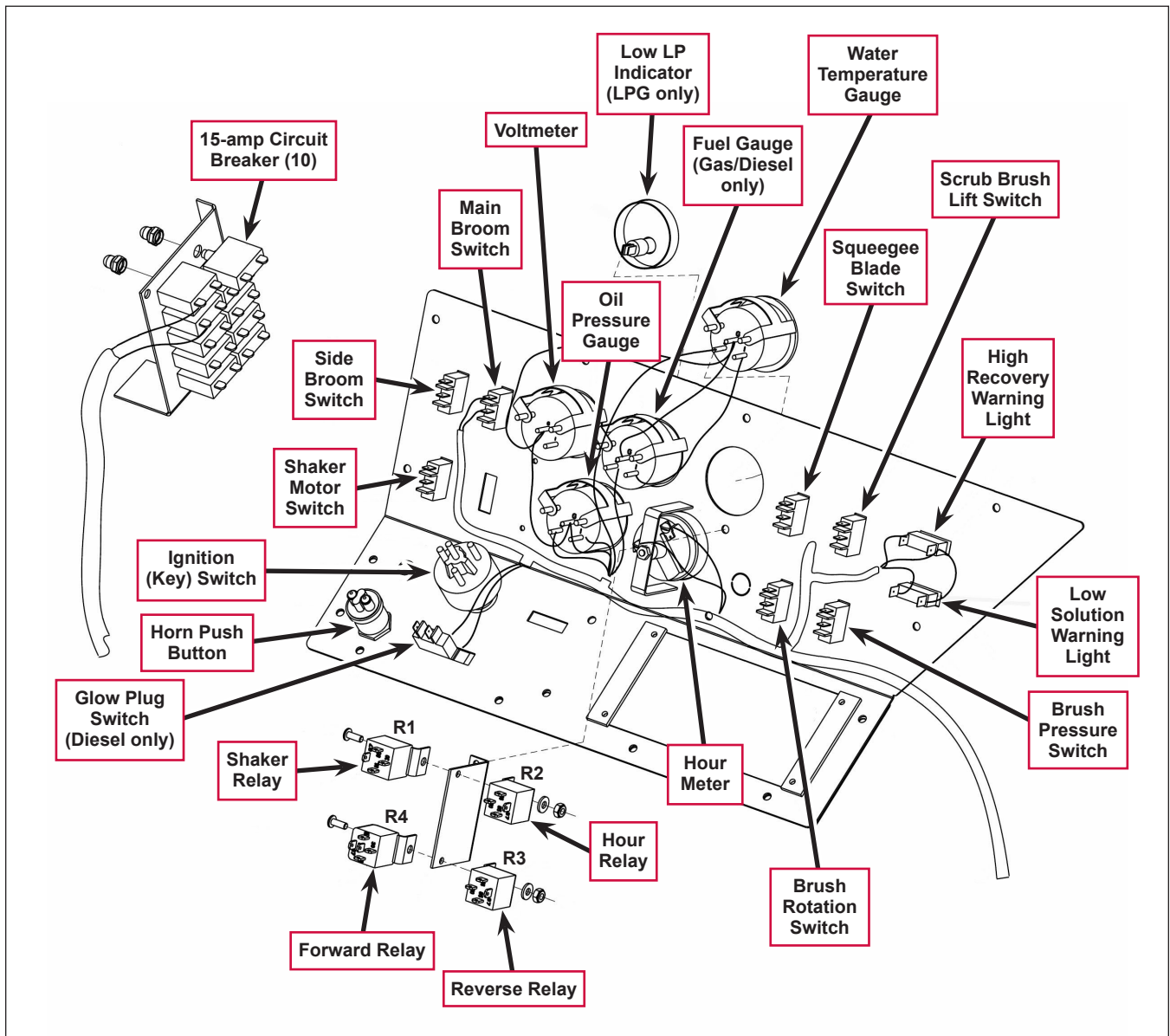
## Functional Description

### Overview

The electrical system consists of the switches, gauges and relays on the instrument panel, the circuit breakers, the drive pedal proximity sensors and the battery. Note that the hydraulic solenoid valves and engine electrical components are described in the corresponding sections of this manual.

### Instrument Panel and Circuit Breakers

The instrument panel houses the gauges, lights, switches and relays that monitor and control the various machine systems. The 10 15-amp **Circuit Breakers** are mounted to the right of the instrument panel.



### Foot Pedal Proximity Switches

The **Foot Pedal Proximity Switches** are proximity sensors that actuate the forward and reverse relays (R4 and R3 respectively). The forward and reverse relays enable and disable the various machine functions that are related to the direction in which the machine is traveling.

- When the **Foot Pedal** is moved to the forward-drive position, it actuates the rear **Foot Pedal Proximity Switch** which actuates the Forward Relay R4.
- When the **Foot Pedal** is moved to the reverse-drive position, it actuates the front **Foot Pedal Proximity Switch** which actuates the Reverse Relay R3.



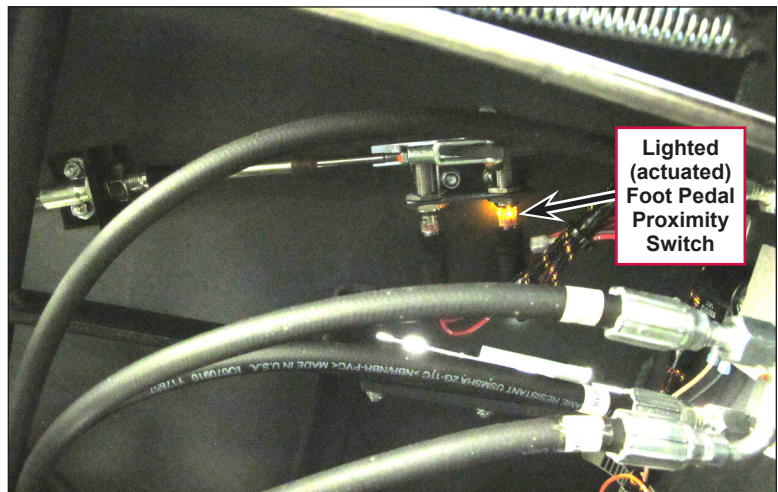
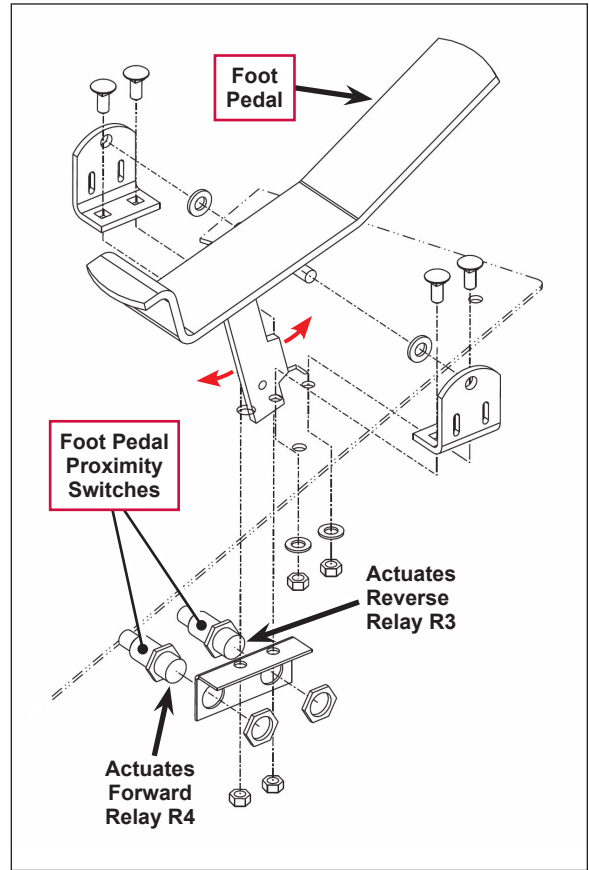
- Note:**
- The **Foot Pedal Proximity Switch** that actuates the forward relay is referred to as the **Drive Pedal Forward Sensor** on the electrical ladder diagram.
  - The **Foot Pedal Proximity Switch** that actuates the reverse relay is referred to as the **Drive Pedal Reverse Sensor** on the electrical ladder diagram.



**Note:** The drawing shown here is for the GM engines. The configuration for the Mitsubishi diesels varies slightly.



**Note:** The **Foot Pedal Proximity Switches** will light when actuated (closed).

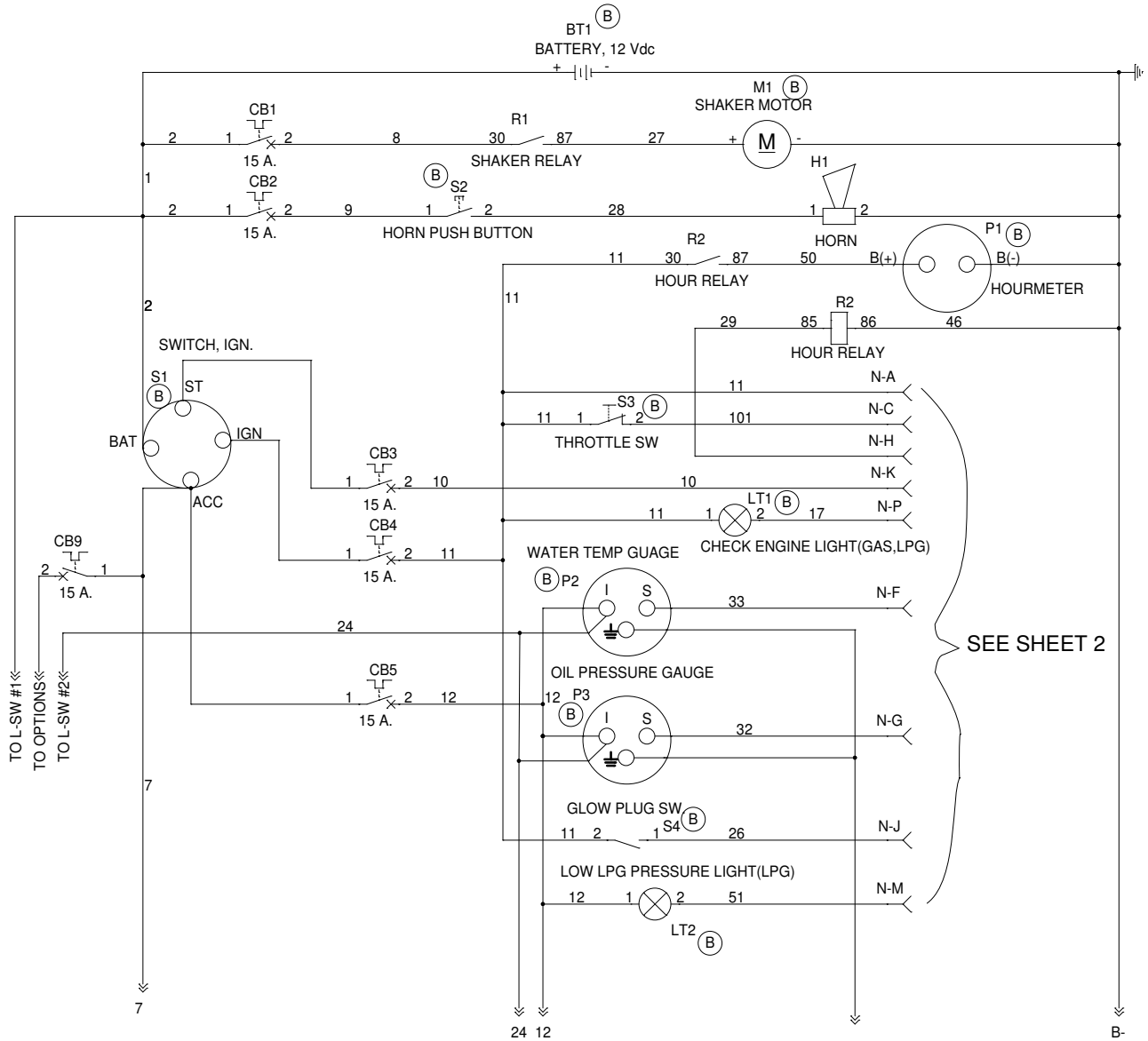


## Electrical Ladder Diagrams

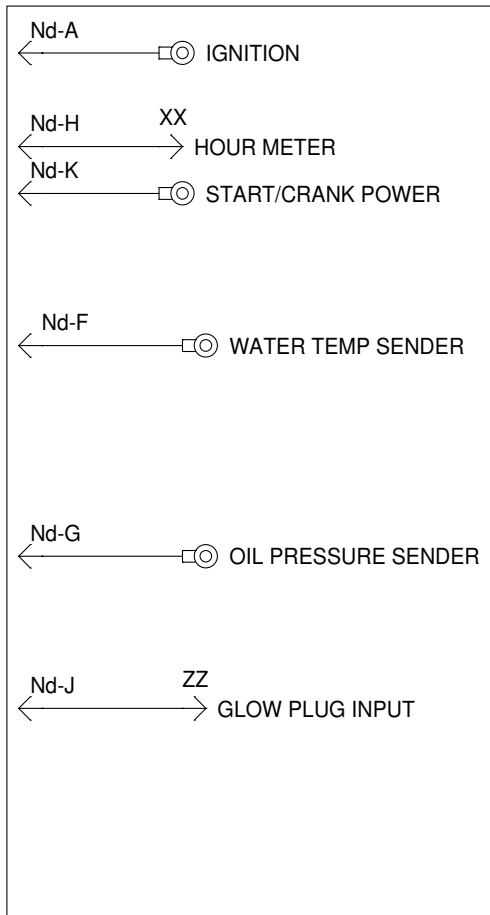


**Note:** Refer to the individual machine system sections for the system ladder diagrams and circuit descriptions.

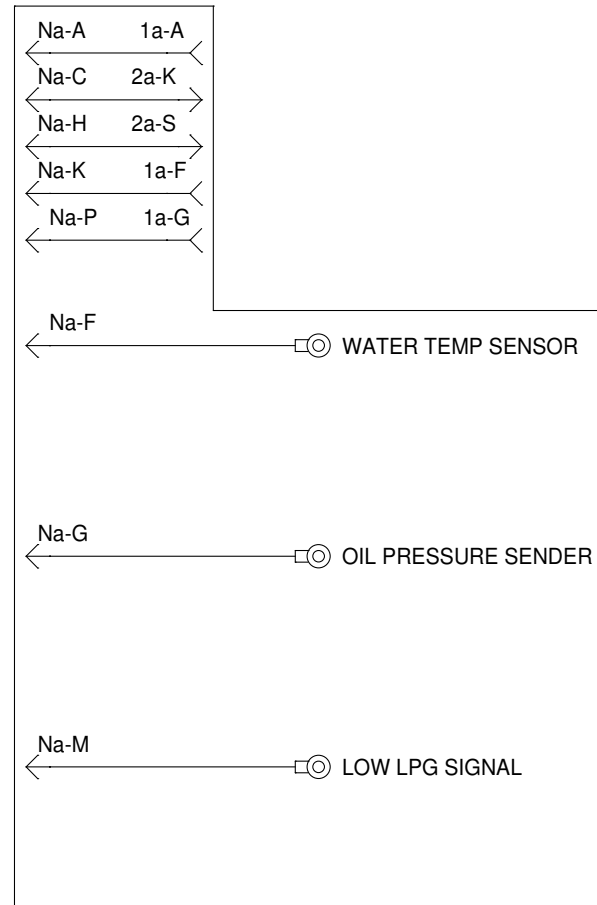
### Electrical Ladder Diagram, p/n 56382653, Rev. B, Page 1



Electrical Ladder Diagram, p/n 56382653, Rev. B, Page 2

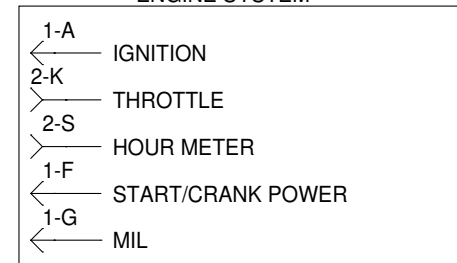


ENGINE SYSTEM  
S4Q2 DIESEL  
0895-136



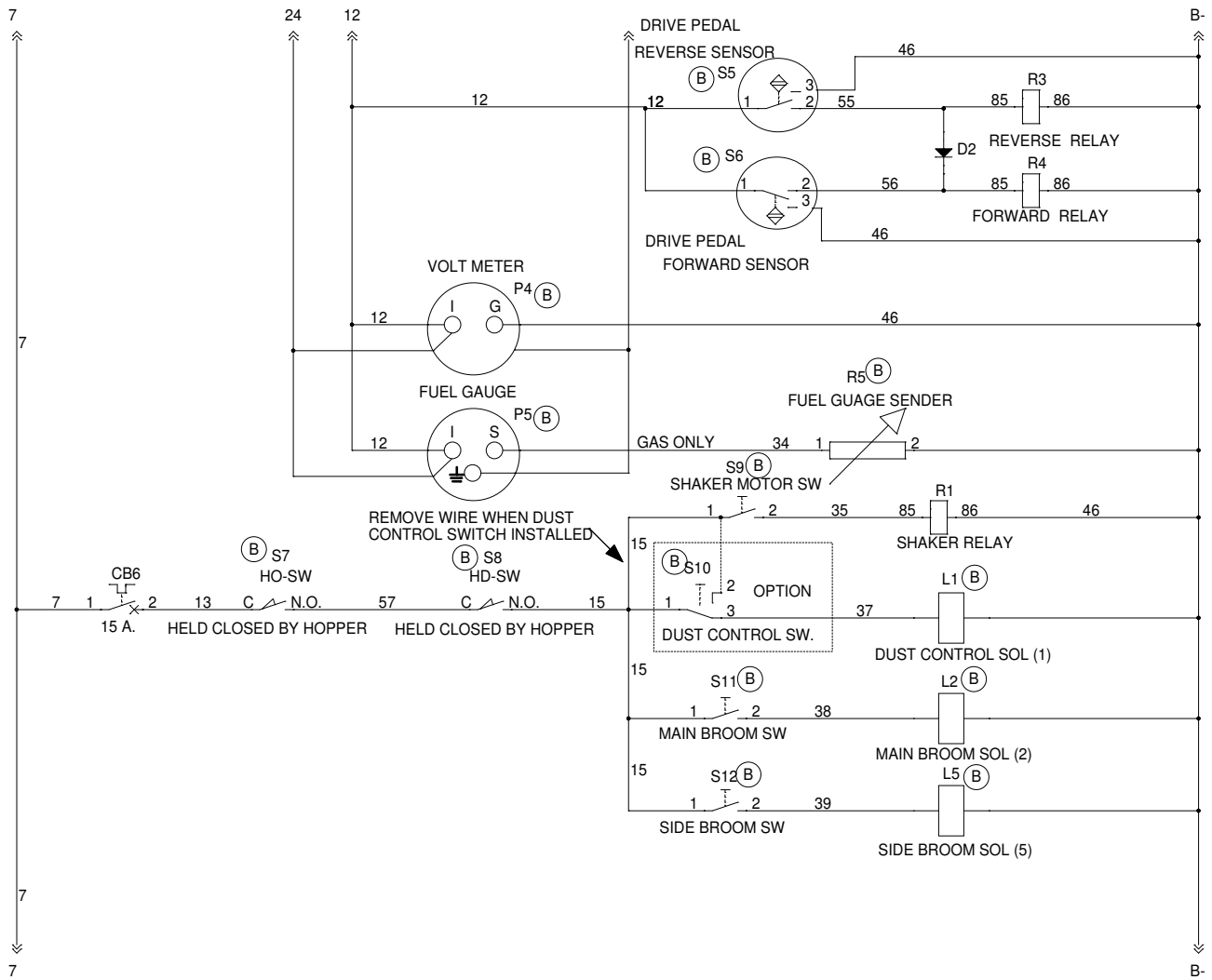
INTER FACE HARNESS GAS & LPG  
0795-220

GM 3.0 GAS & LPG  
ENGINE SYSTEM



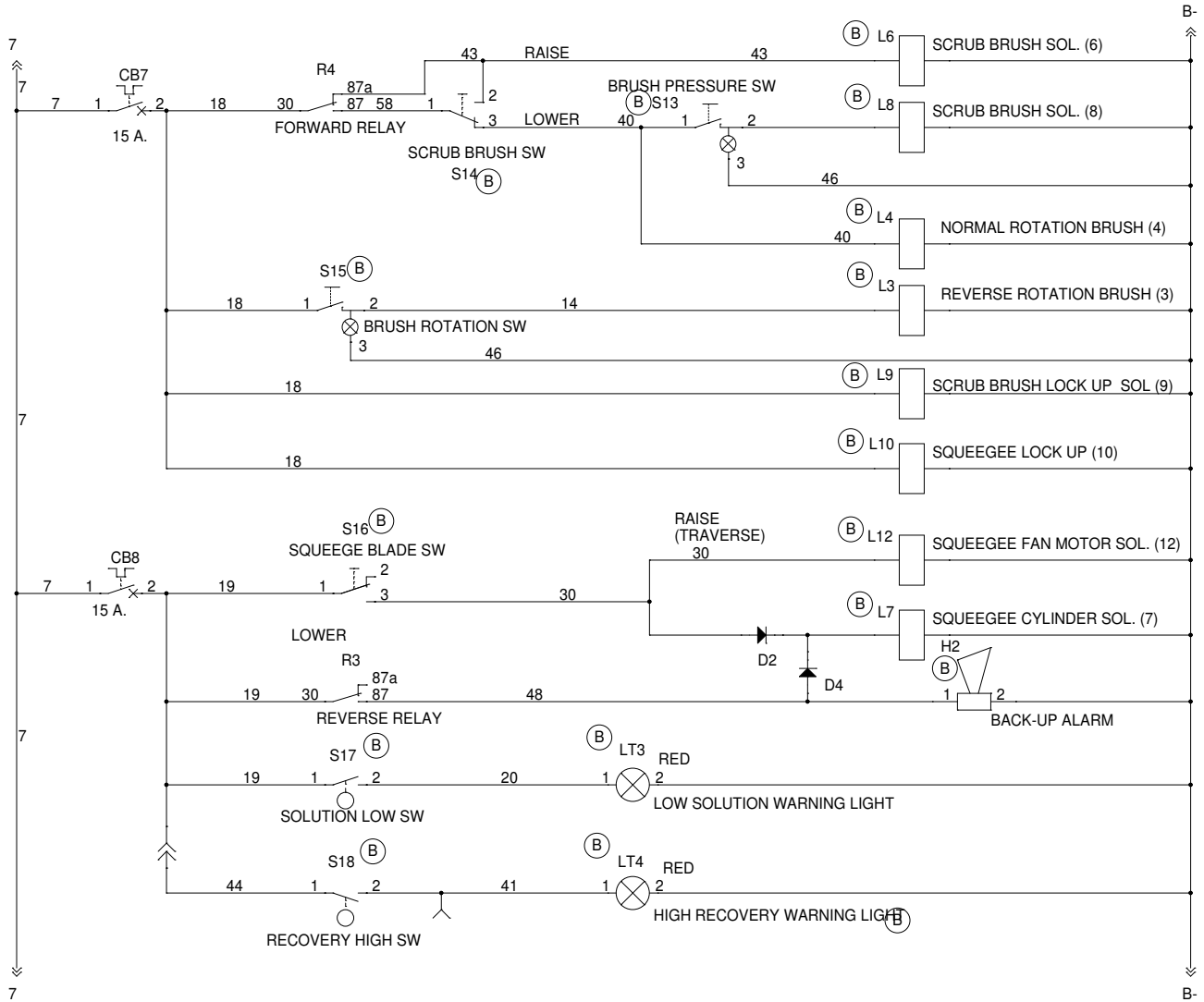
REFERENCE DRAWINGS:  
56380221, 56380222

Electrical Ladder Diagram, p/n 56382653, Rev. B, Page 3





Electrical Ladder Diagram, p/n 56382653, Rev. B, Page 4

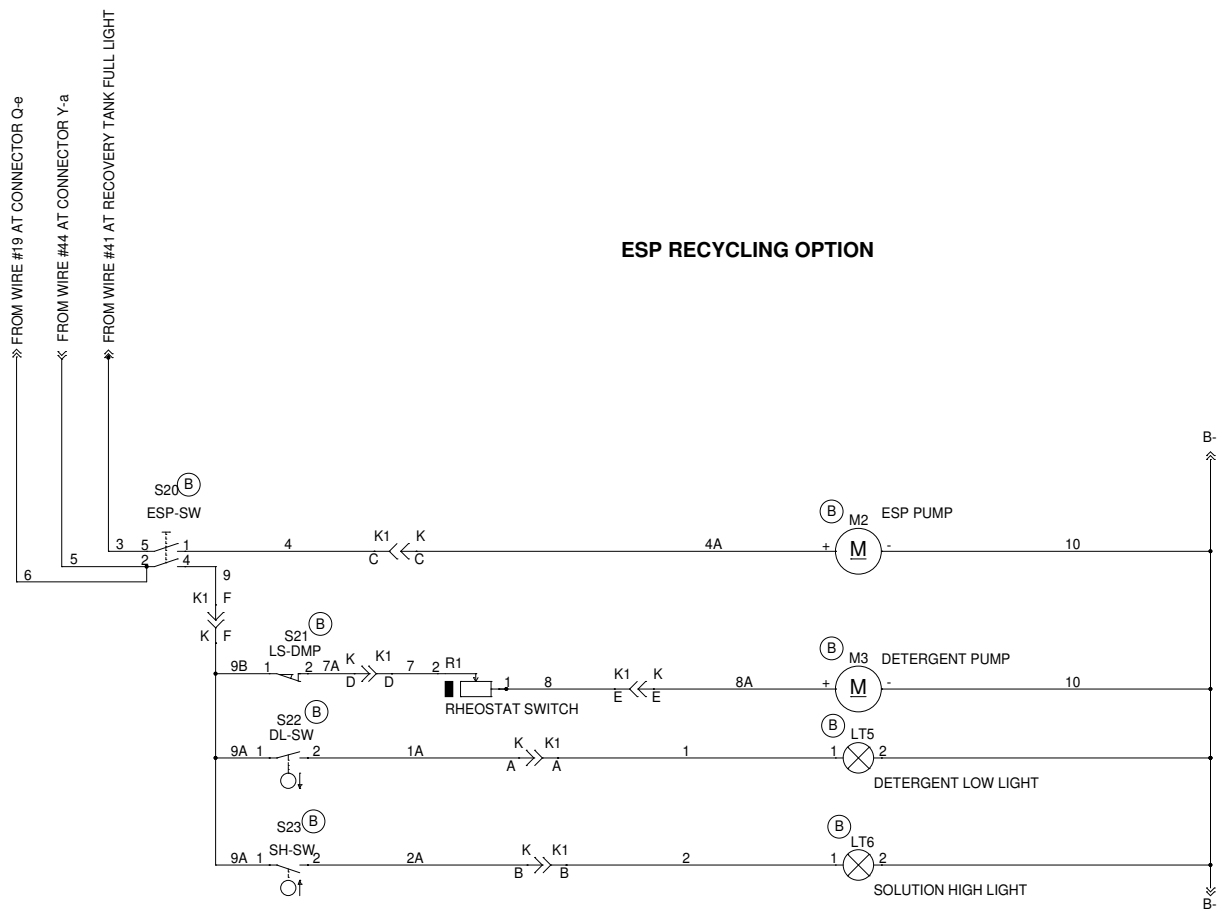




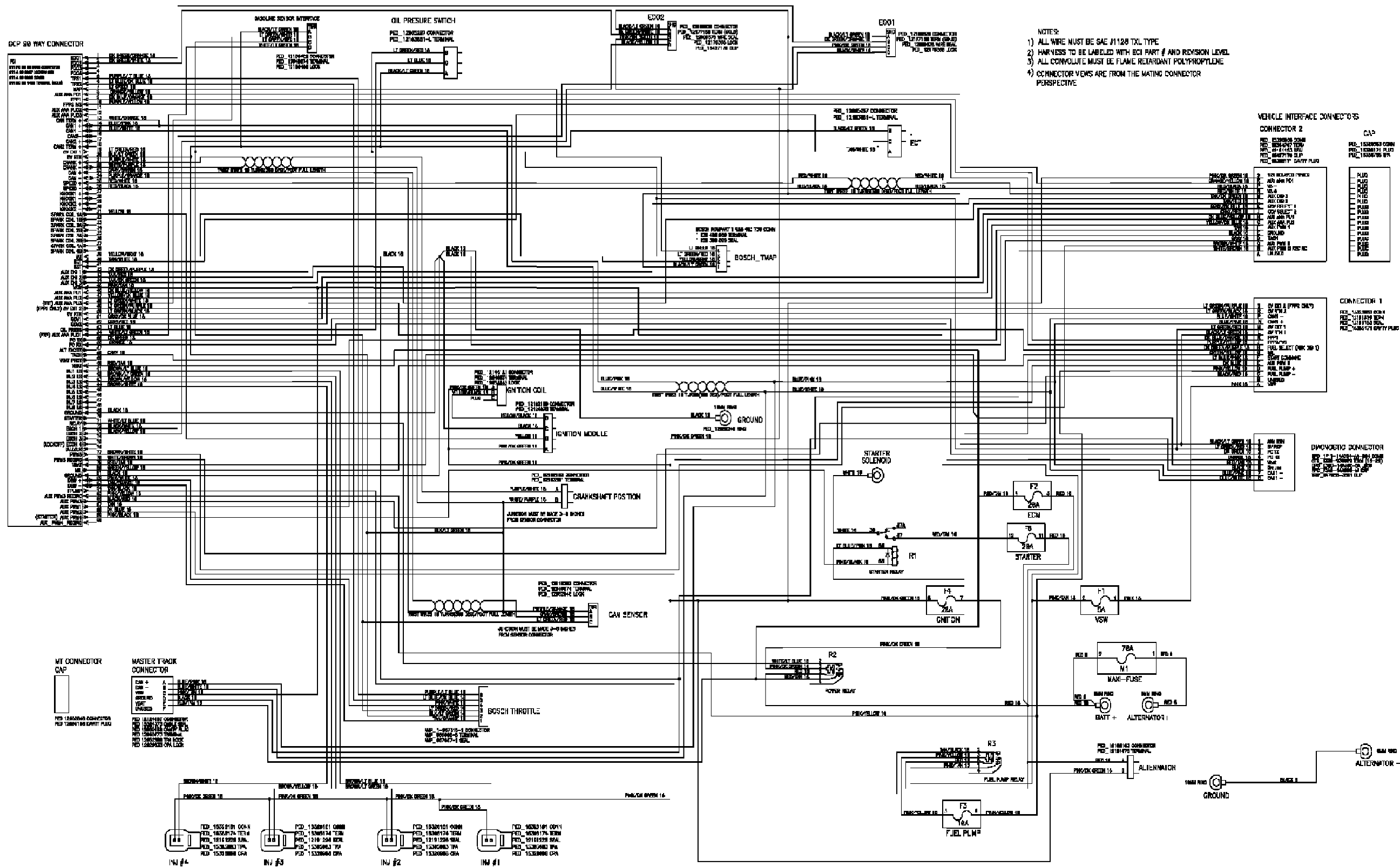
**Note:** Page 5 of this Electrical Ladder Diagram does not pertain to the machines covered in this Service Manual and has been omitted.

### Electrical Ladder Diagram, p/n 56382653, Rev. B, Page 6

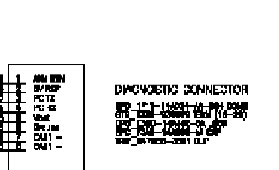
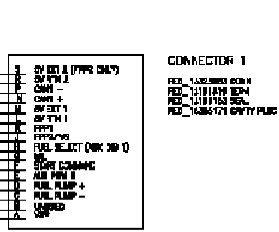
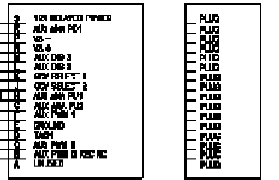
#### INSTRUMENT PANEL HARNESS 0795-186

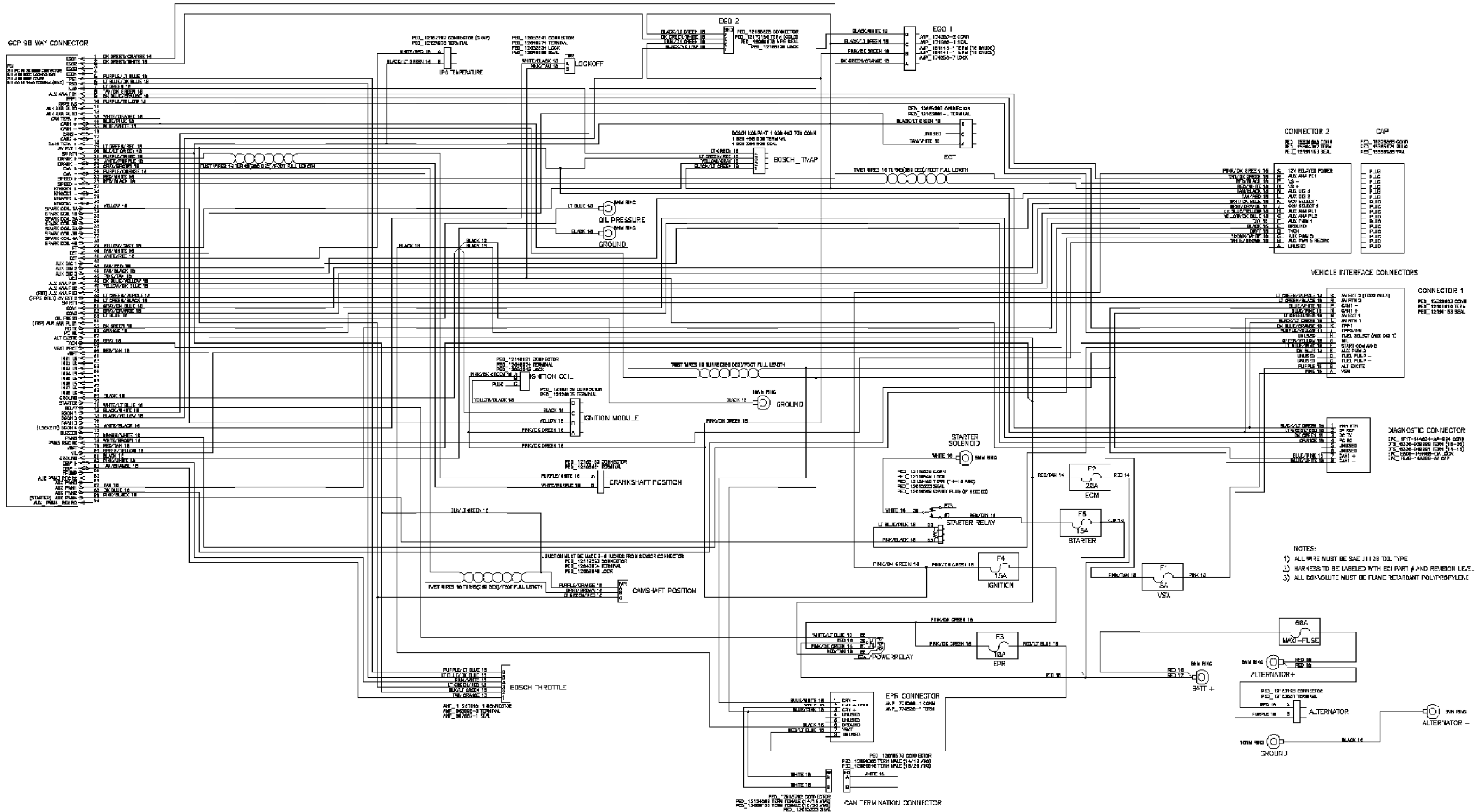


Engine Harness - GM 3.0L Gas, p/n 56380222



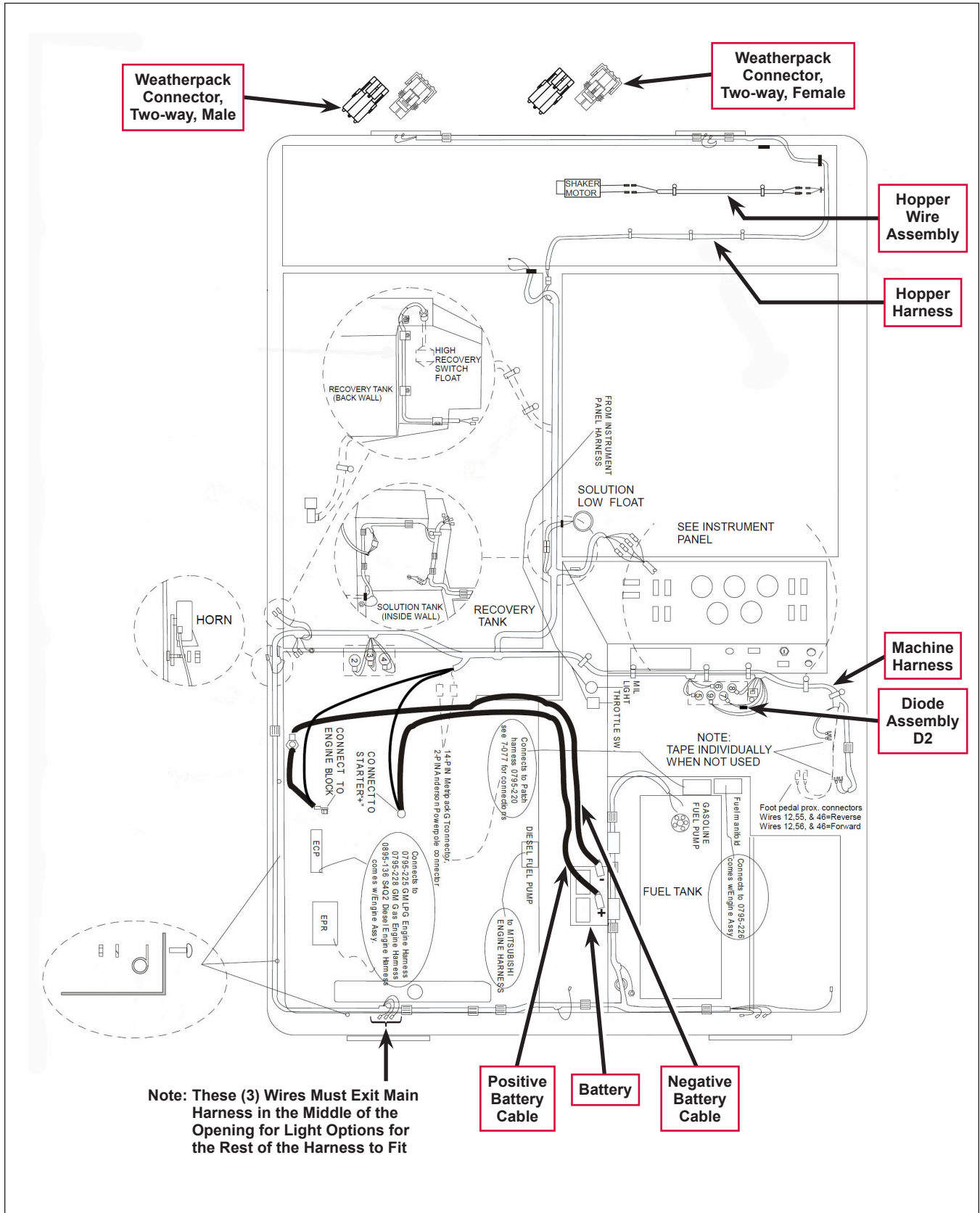
- NOTES:
- 1) ALL WIRE MUST BE SAE J1128 TXL TYPE
  - 2) HARNESS TO BE LABELED WITH ECI PART # AND REVISION LEVEL
  - 3) ALL CONDUIT MUST BE FLAME RETARDANT POLYPROPYLENE
  - 4) CONNECTOR VIEWS ARE FROM THE MATING CONNECTOR PERSPECTIVE





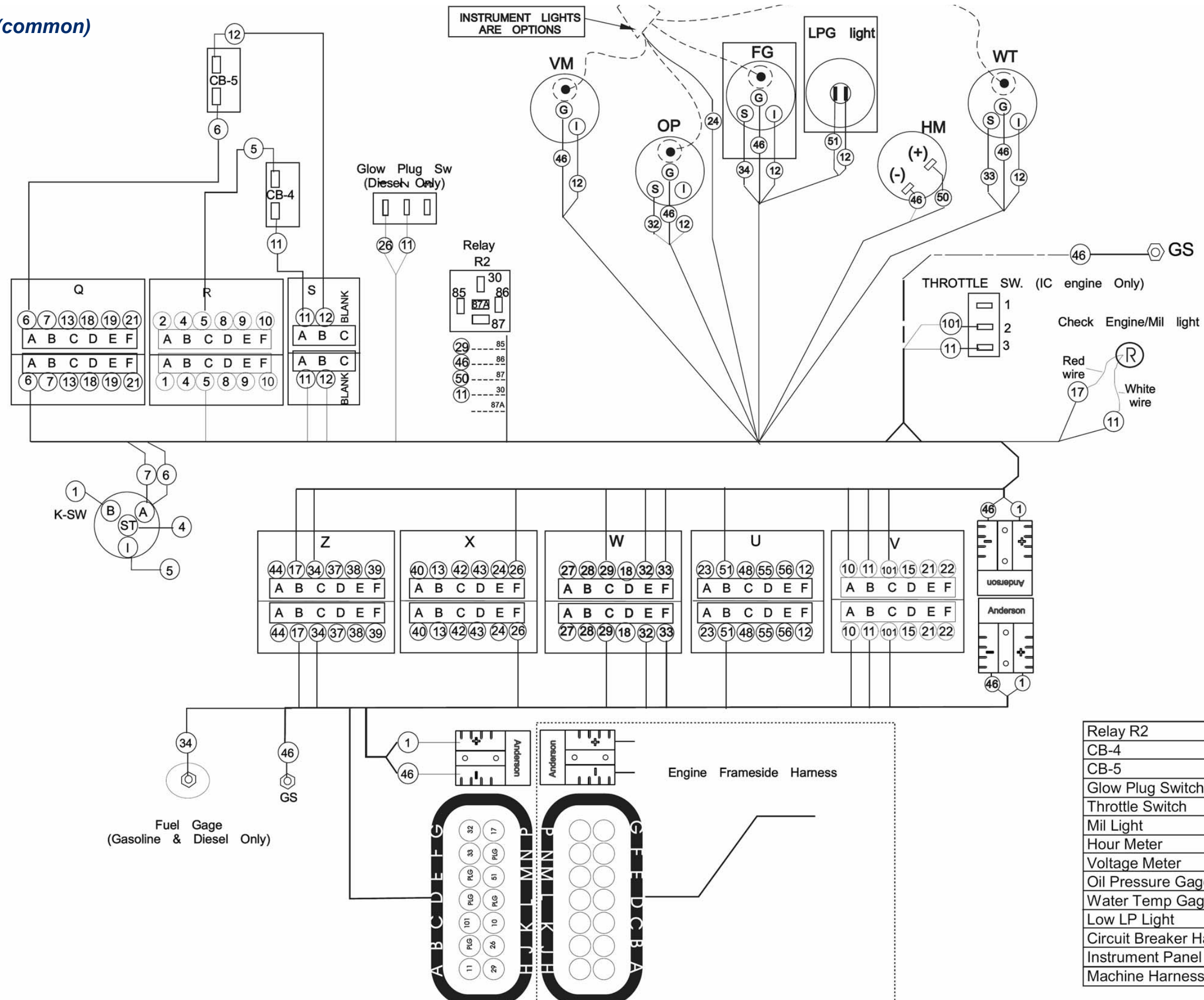
NOTES:  
 1) ALL WIRES MUST BE SAE J1122B TOOL TYPE  
 2) HARNESS TO BE LABELED WITH ECU PART # AND REVISION LEVEL  
 3) ALL DIELECTRIC MUST BE FLAME RETARDANT POLYPROPYLENE

# Machine Harness Routing Diagram – Gas, LP and Diesel



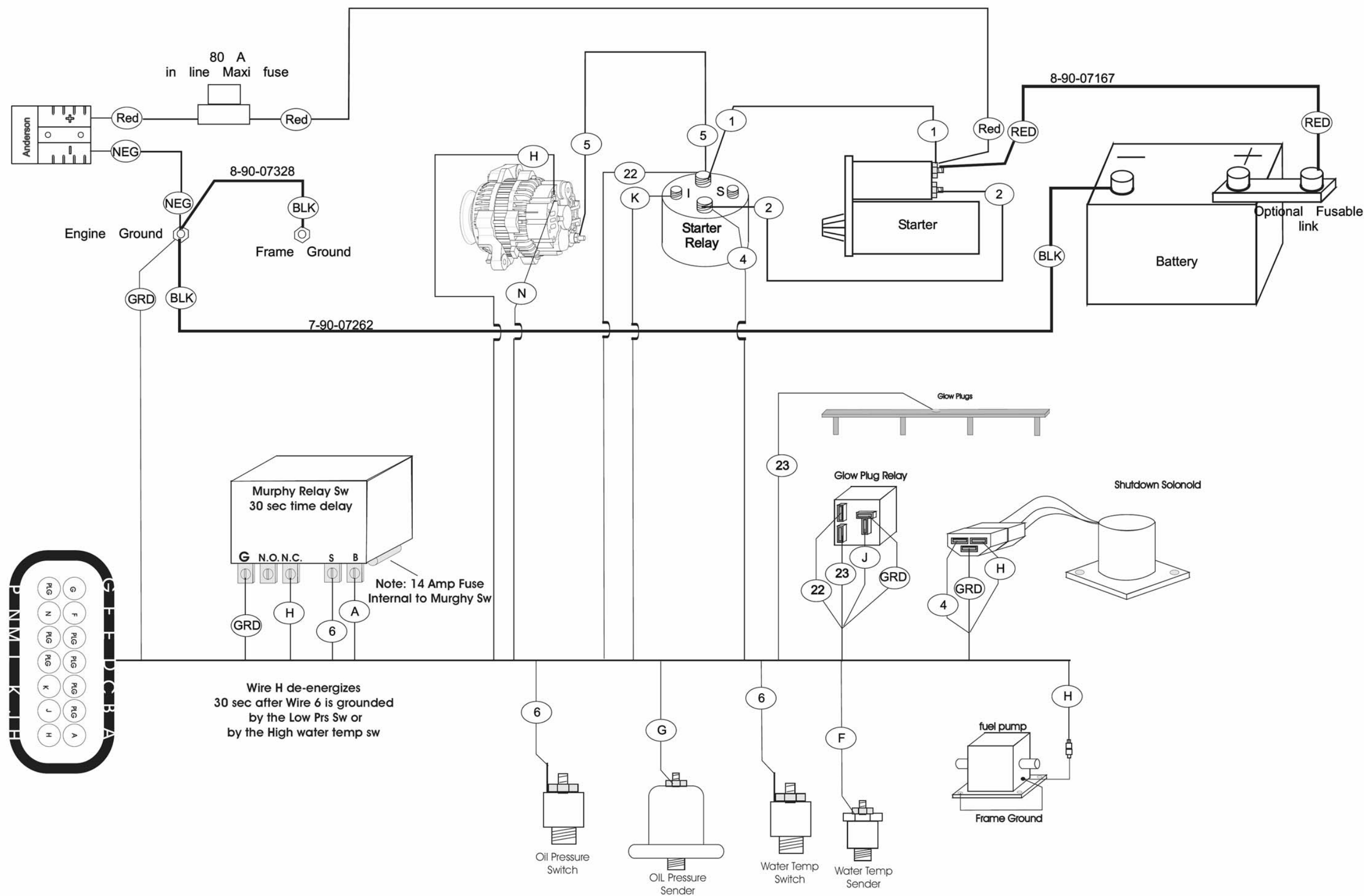


Engine System (common)

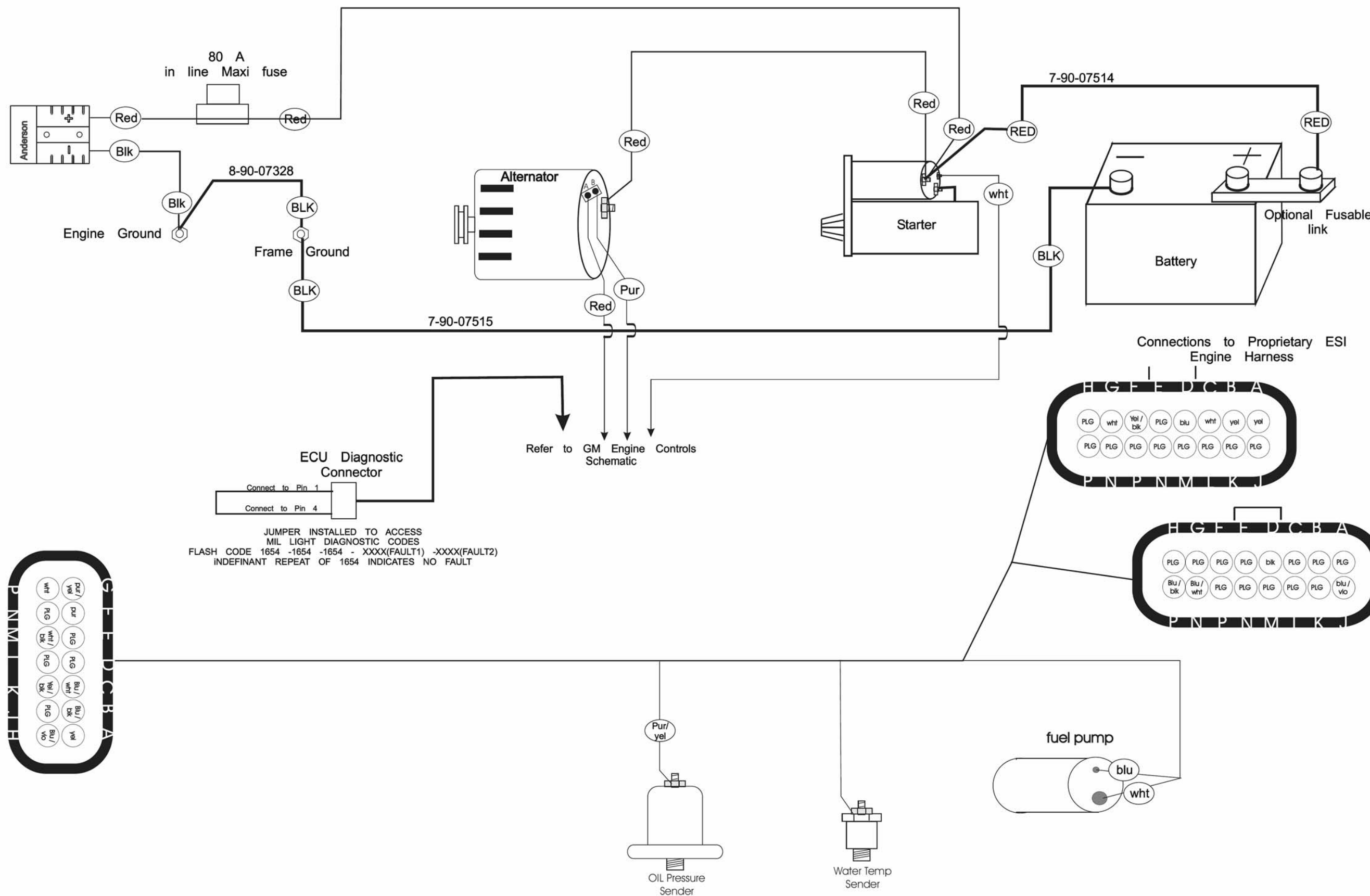


|                          |            |
|--------------------------|------------|
| Relay R2                 | 8-64-00012 |
| CB-4                     | 8-64-00008 |
| CB-5                     | 8-64-00008 |
| Glow Plug Switch         | 8-82-00045 |
| Throttle Switch          | 2-00-05827 |
| Mil Light                | 7-11-04065 |
| Hour Meter               | 8-48-05023 |
| Voltage Meter            | 8-48-00016 |
| Oil Pressure Gage        | 8-48-05027 |
| Water Temp Gage          | 8-48-05028 |
| Low LP Light             | 7-11-04035 |
| Circuit Breaker Harness  | 0795-111   |
| Instrument Panel Harness | 0795-186   |
| Machine Harness          | 0795-185   |

Engine Frame Side System – Mitsubishi Diesel

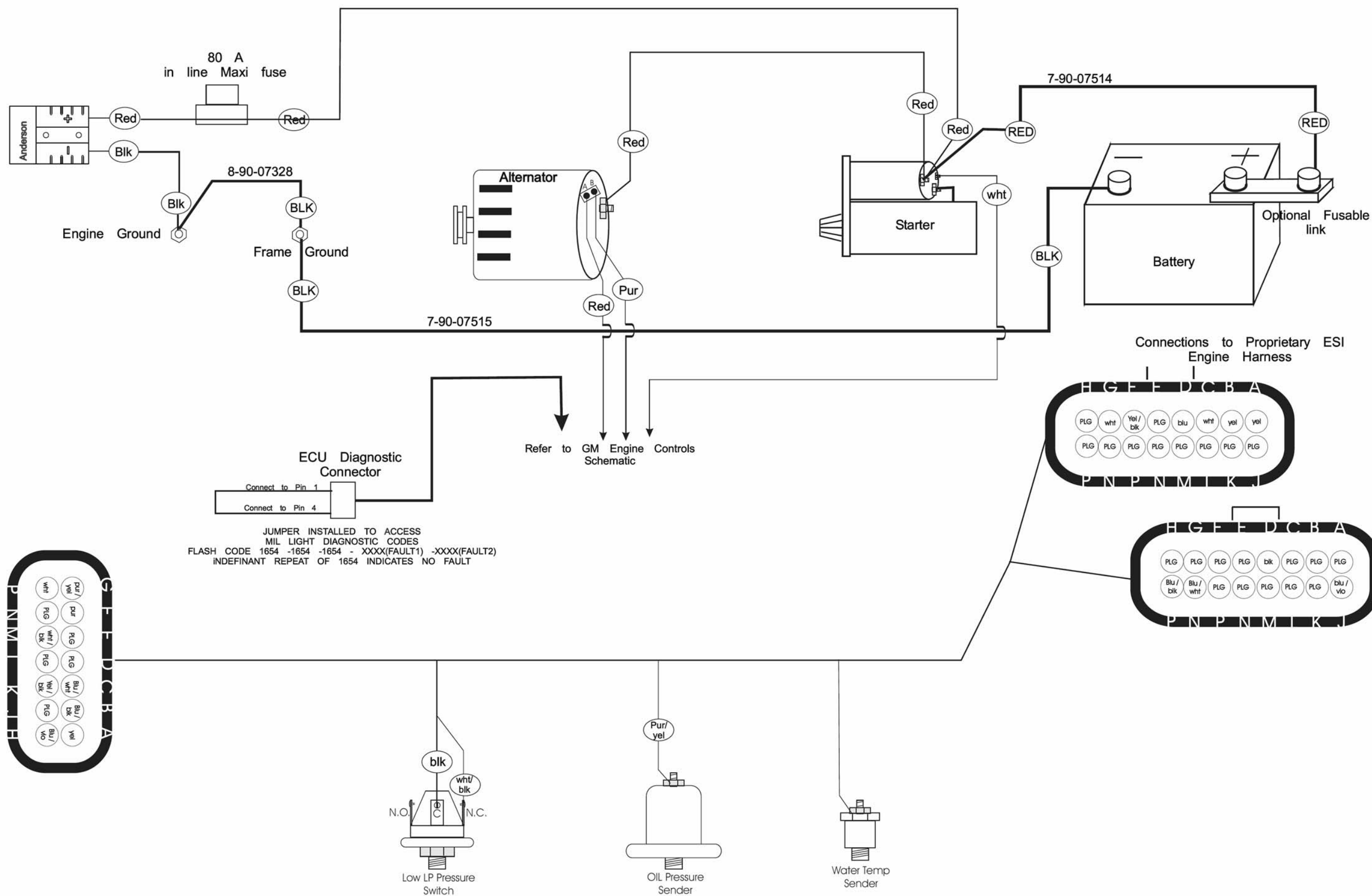


Engine Frame Side System – GM Gas

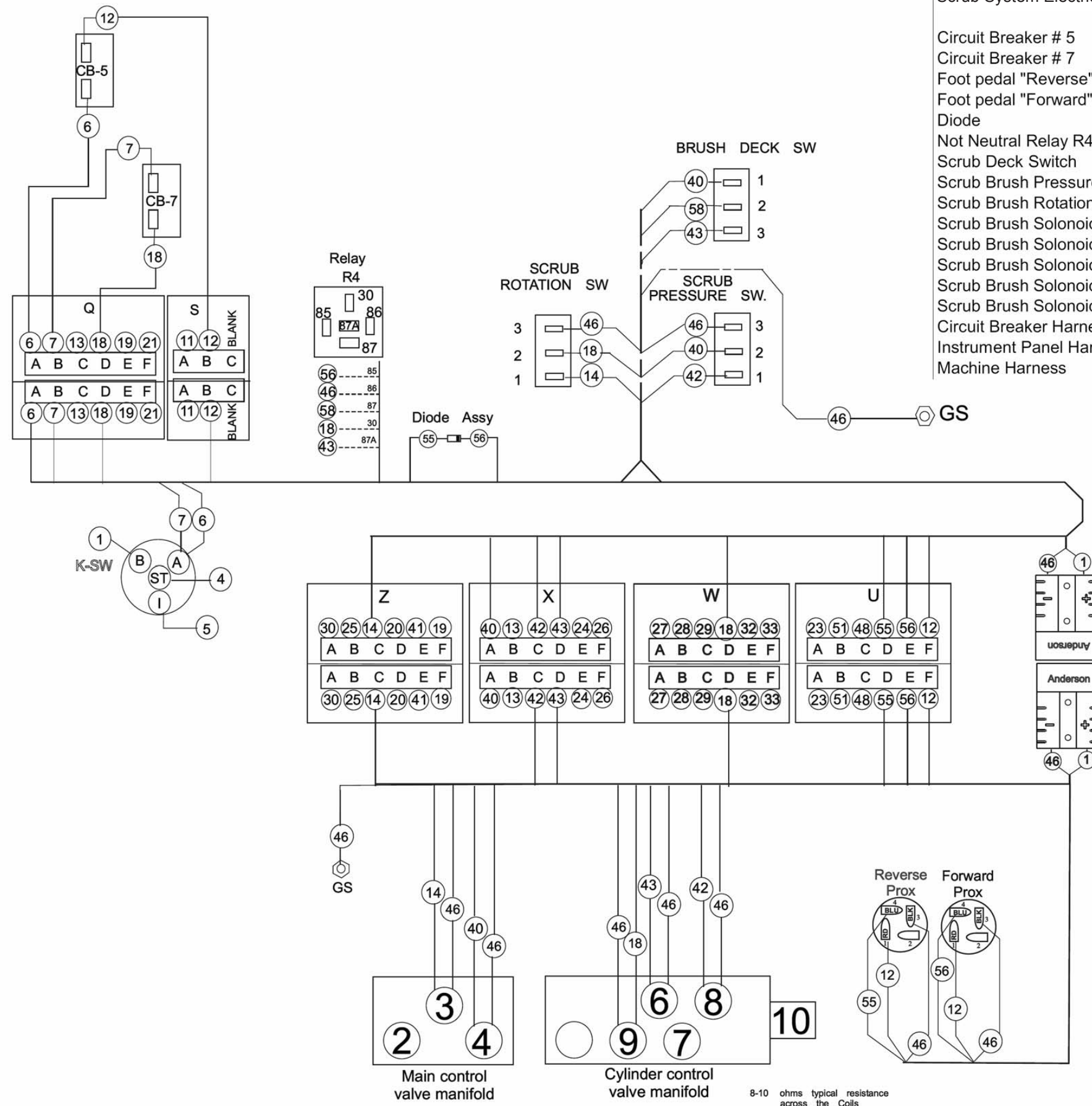




### Engine Frame Side System – GM LPG



### Scrub System Electrical System



Scrub System Electrical Components

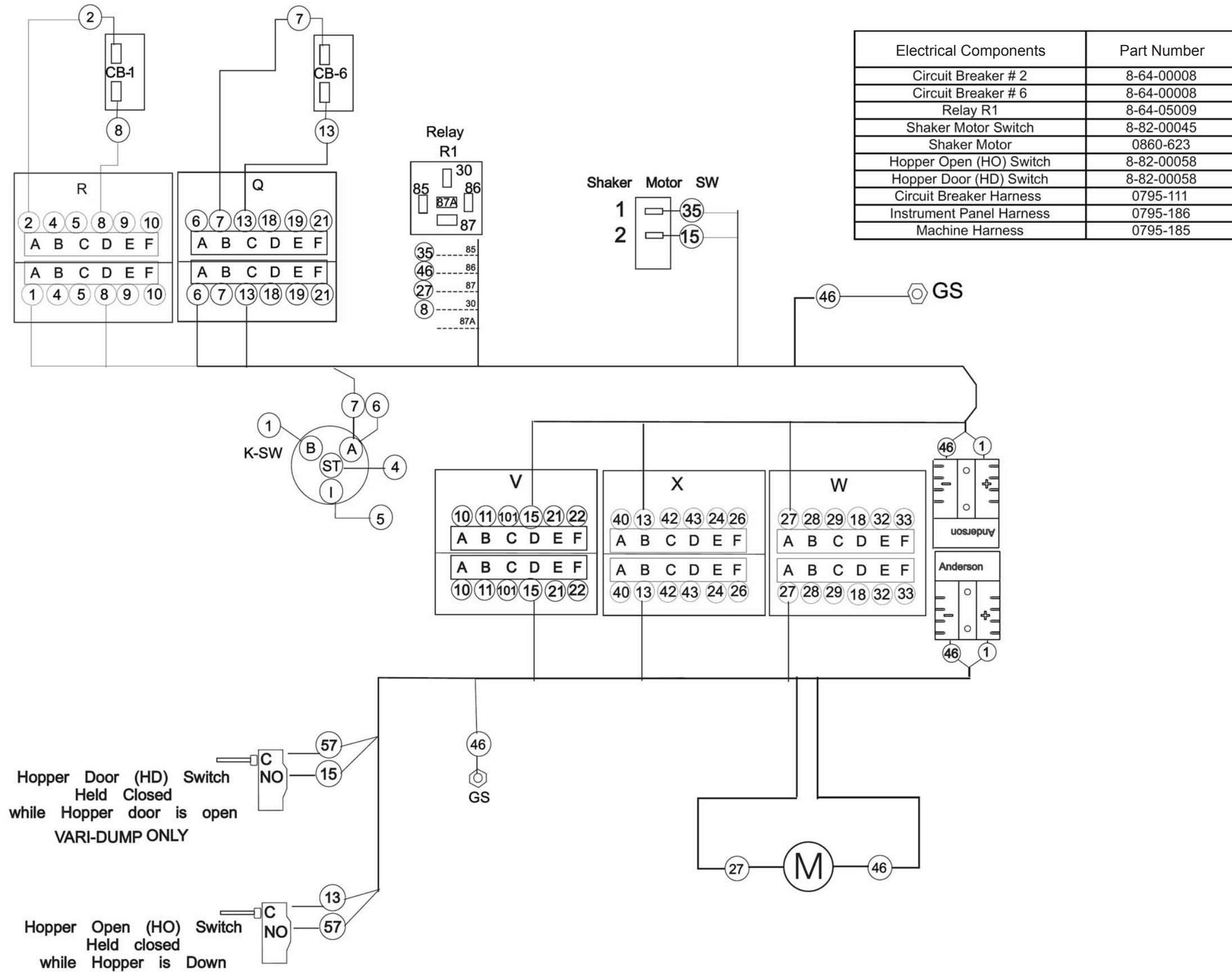
Part Number

|                                       |                                     |
|---------------------------------------|-------------------------------------|
| Circuit Breaker # 5                   | 8-64-00008                          |
| Circuit Breaker # 7                   | 8-64-00008                          |
| Foot pedal "Reverse" Proximity Switch | 7-82-00047                          |
| Foot pedal "Forward" Proximity Switch | 7-82-00047                          |
| Diode                                 | 0775-281                            |
| Not Neutral Relay R4                  | 8-64-05009                          |
| Scrub Deck Switch                     | 7-82-00020                          |
| Scrub Brush Pressure Switch           | 7-82-00019                          |
| Scrub Brush Rotation Sw               | 7-82-00019                          |
| Scrub Brush Solenoid Coil S-6         | 7-14-07004- Part of Assy 7-88-00069 |
| Scrub Brush Solenoid Coil S-8         | 7-14-07004- Part of Assy 7-88-00069 |
| Scrub Brush Solenoid Coil S-3         | 7-14-07005 -Part of Assy 7-88-00071 |
| Scrub Brush Solenoid Coil S-4         | 7-14-07005 -Part of Assy 7-88-00071 |
| Scrub Brush Solenoid Coil S-9         | 7-14-07004- Part of Assy 7-88-00069 |
| Circuit Breaker Harness               | 0795-111                            |
| Instrument Panel Harness              | 0795-186                            |
| Machine Harness                       | 0795-185                            |

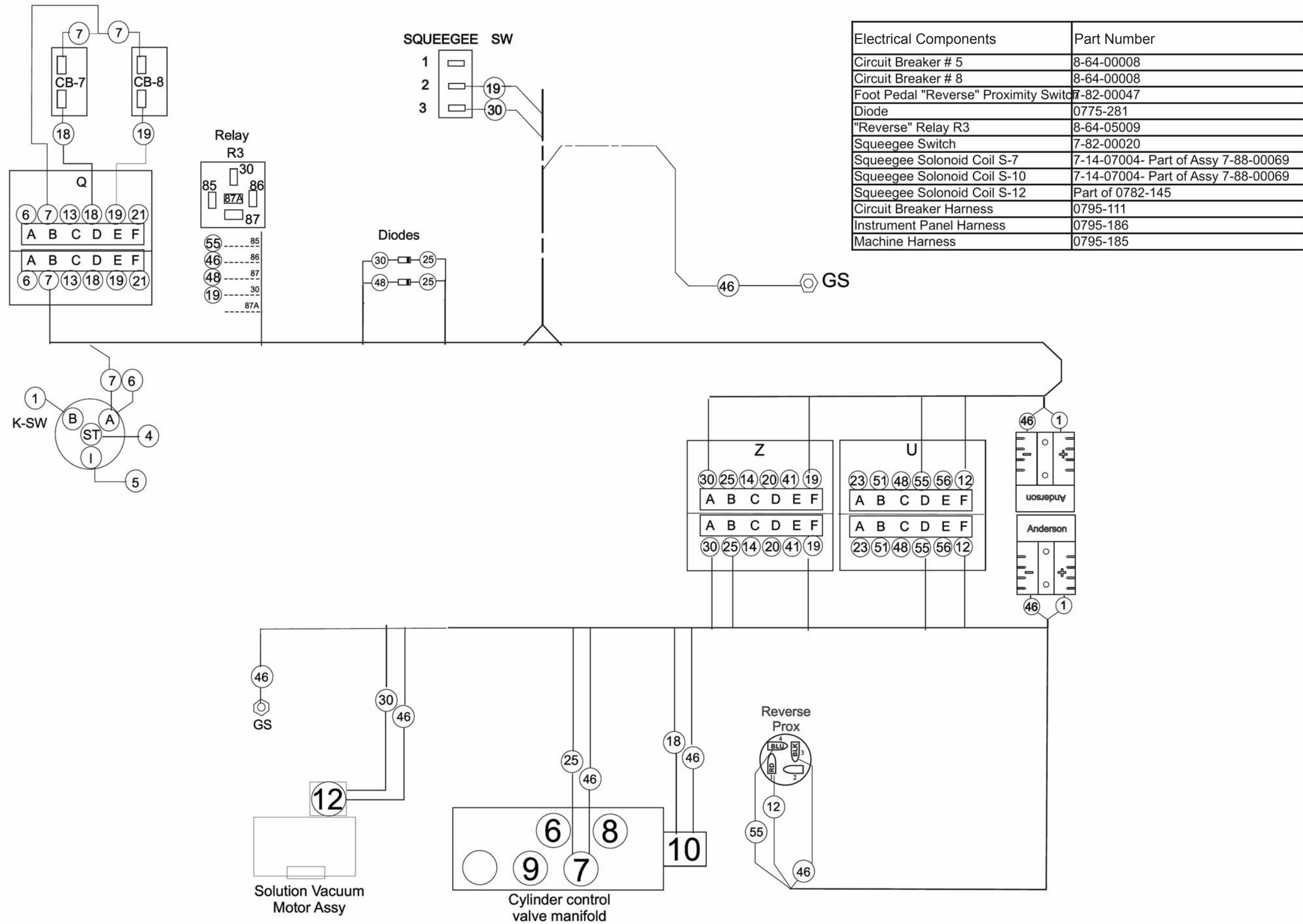
8-10 ohms typical resistance across the Coils



### Shaker Motor and Hopper Electrical System



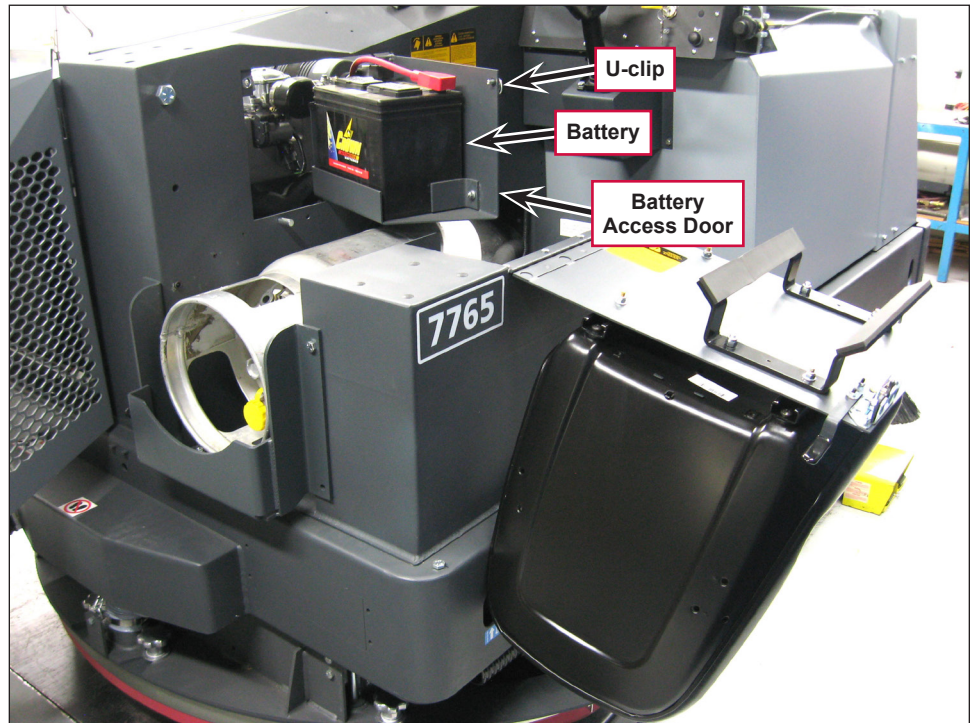
### Squeegee and Vacuum Fan Motor Electrical System



## Component Locations

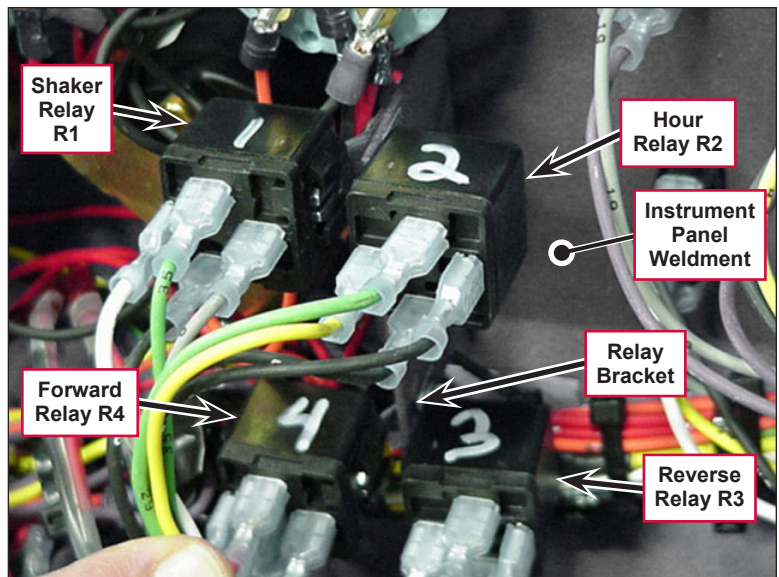
### Battery

The **Battery** sits on the swing-out **Battery Access Door**. To access the **Battery**, flip the seat over, rotate the **U-clip** and swing open the **Battery Access Door**.



### Relays

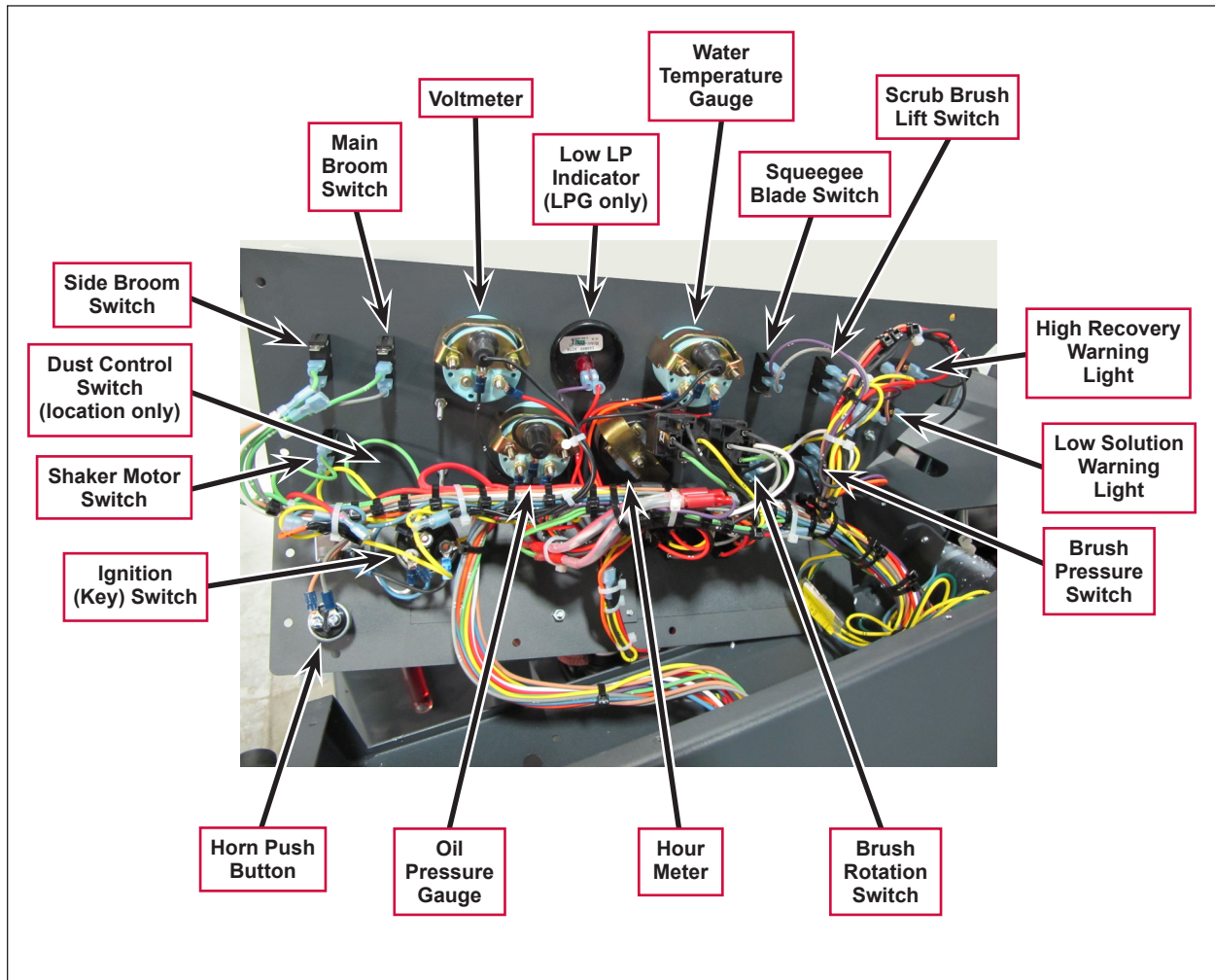
The four **Relays** are mounted onto the **Bracket Relay** which is fastened to the back of the **Instrument Panel Weldment**.





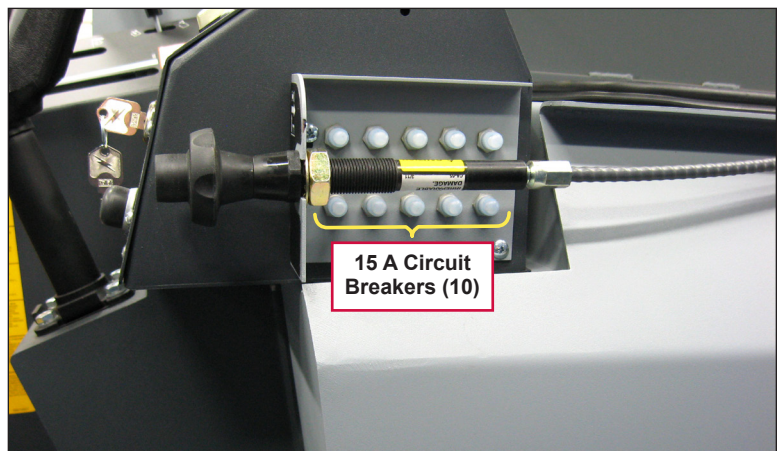
### Instrument Panel

The gauges, lights and switches are mounted to the instrument panel.



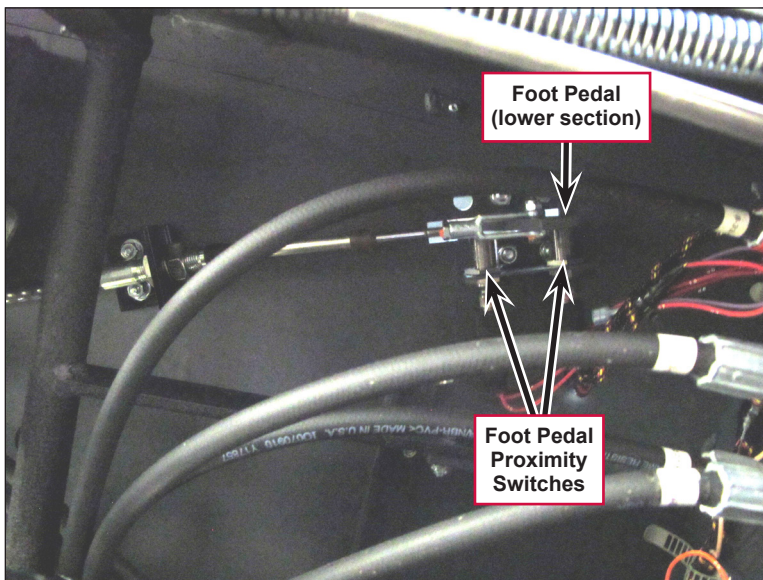
### Circuit Breakers

The 10 15-amp **Circuit Breakers** are mounted to the right of the instrument panel. To access the **Circuit Breakers**, open the solution tank cover.



### Foot Pedal Proximity Switches

The **Foot Pedal Proximity Switches** (sensors) are mounted adjacent to the bottom section of the **Foot Pedal**, underneath the floor of the Operator compartment.



### Troubleshooting

| Problem                 | Cause                         | Correction   |
|-------------------------|-------------------------------|--|
| No power to the machine | Discharged battery.           | Check the battery voltage and charge as necessary.   |
|                         | Poor battery connection(s).   | Check the battery cables, terminals and connections and tighten/repair/replace as necessary. |
|                         | Battery needs to be replaced. | Perform a load test on the battery and replace if necessary.                                 |



*Note: Refer to the individual machine system sections for electrical troubleshooting procedures.*

### Specifications

#### Component Specifications

| Component                  | Specifications                        |
|----------------------------|---------------------------------------|
| SPDT Relay (R4)            | Operating Current – 140 mA            |
| SPST Relay (R1, R2 and R3) | Nominal Coil Resistance – 85 ± 5 ohms |



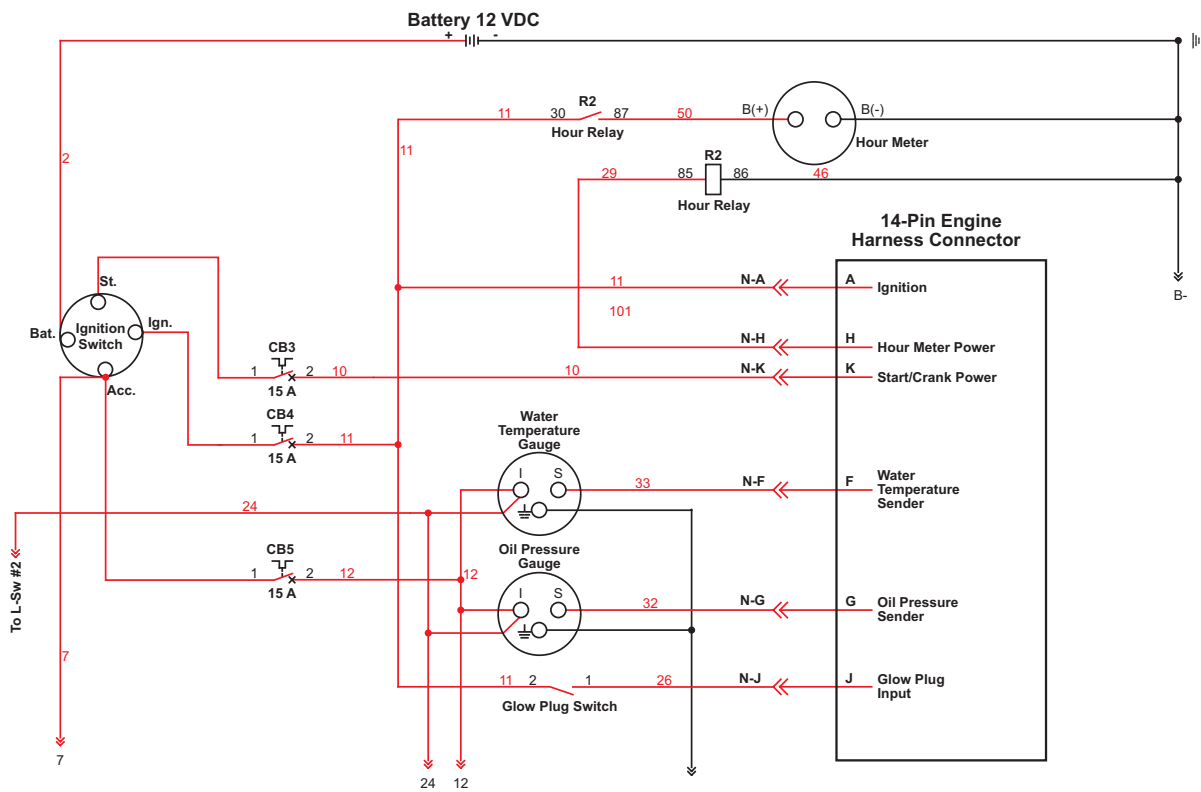
# Engine System, Diesel

## Functional Description

### Overview

The diesel 7765/CR1500 machines use a Mitsubishi four-cylinder diesel engine to power the two hydraulic pumps that run the machine drive wheel, scrub/sweep systems, vacuum fan motor, the scrub/sweep and squeegee lift actuators and the steering system. A *Bosch* throttle type fuel injection pump controls the fuel quantity to maintain the selected RPM or shut the engine off.

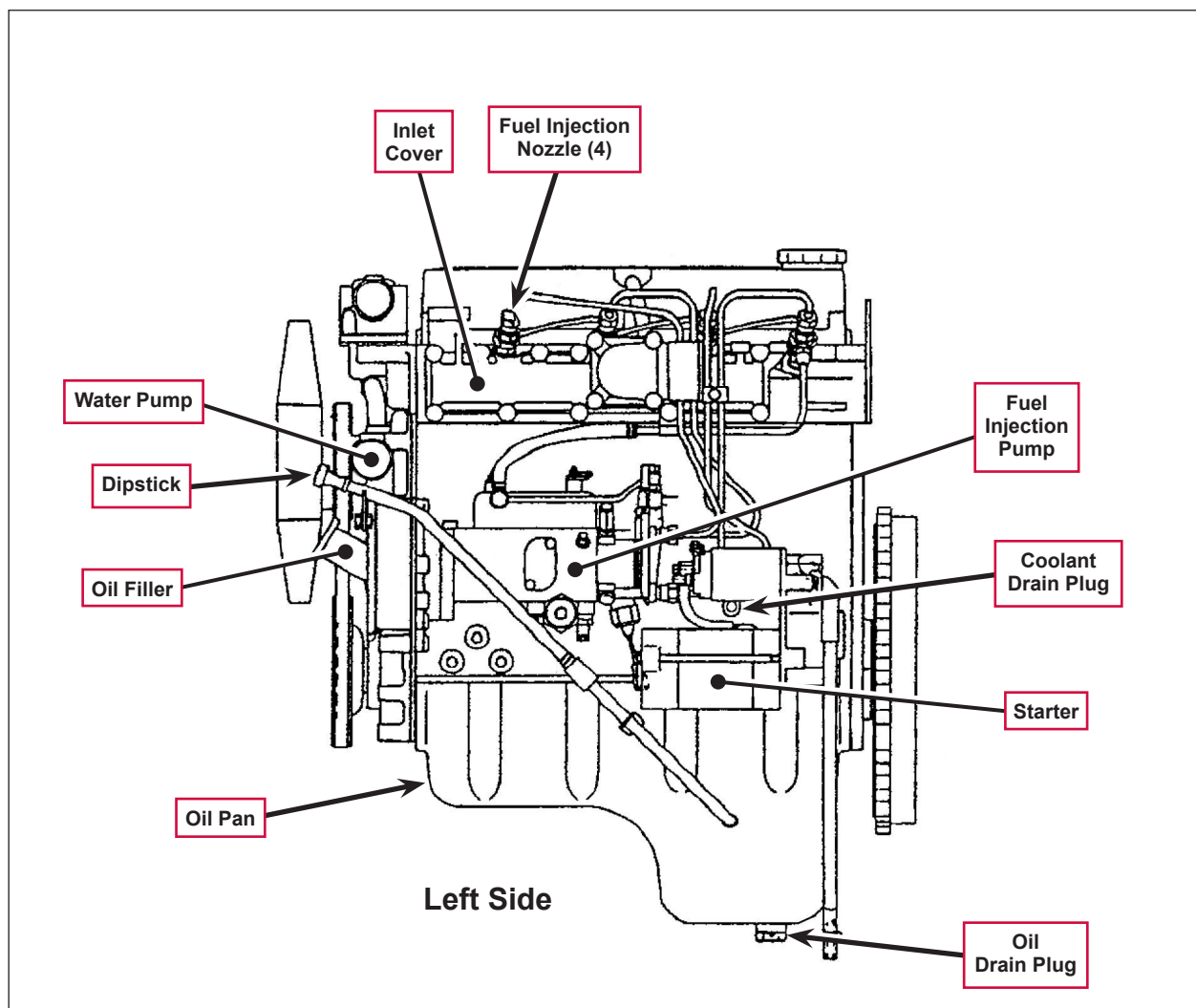
### Diesel Engine Wiring Diagram

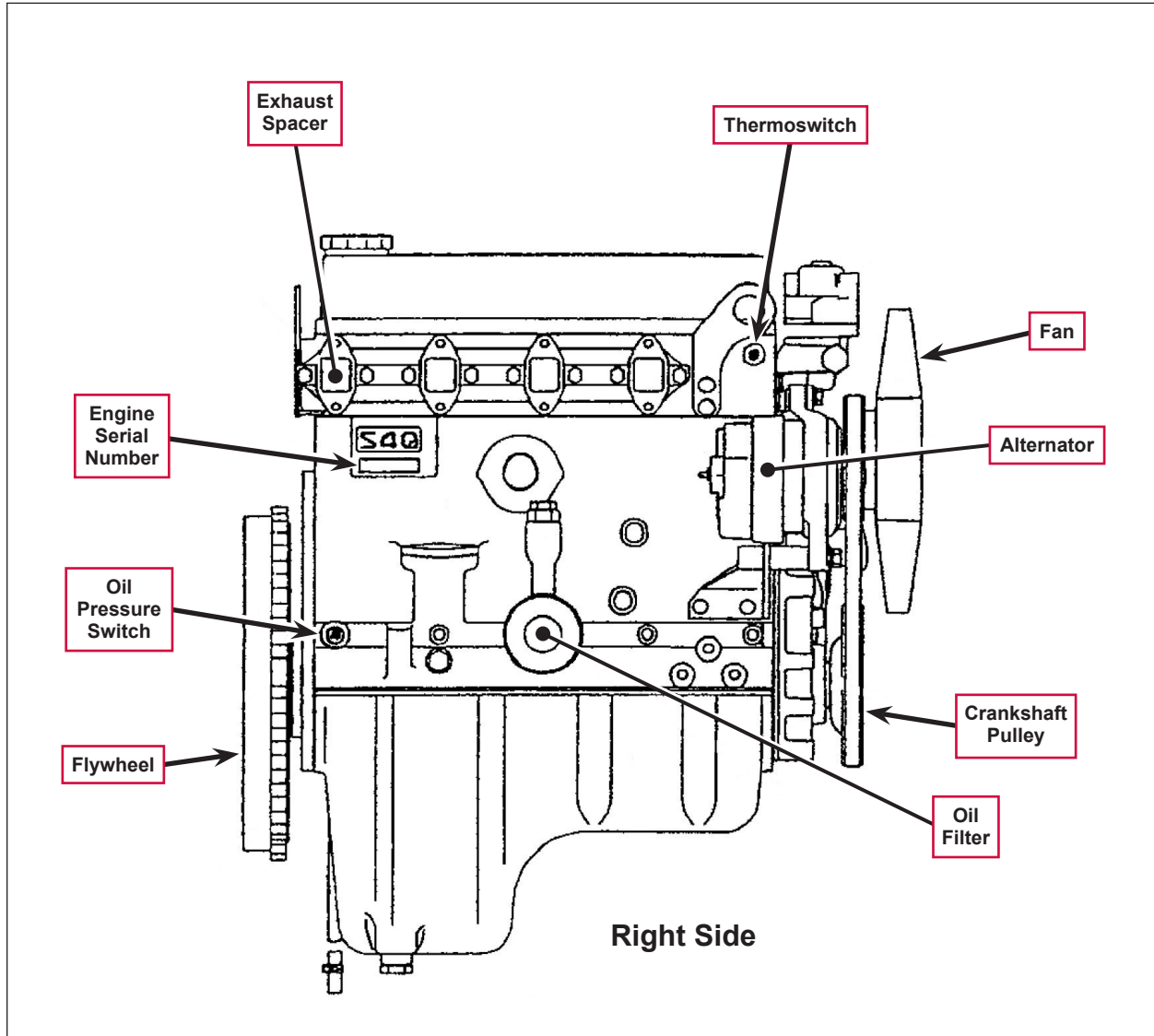


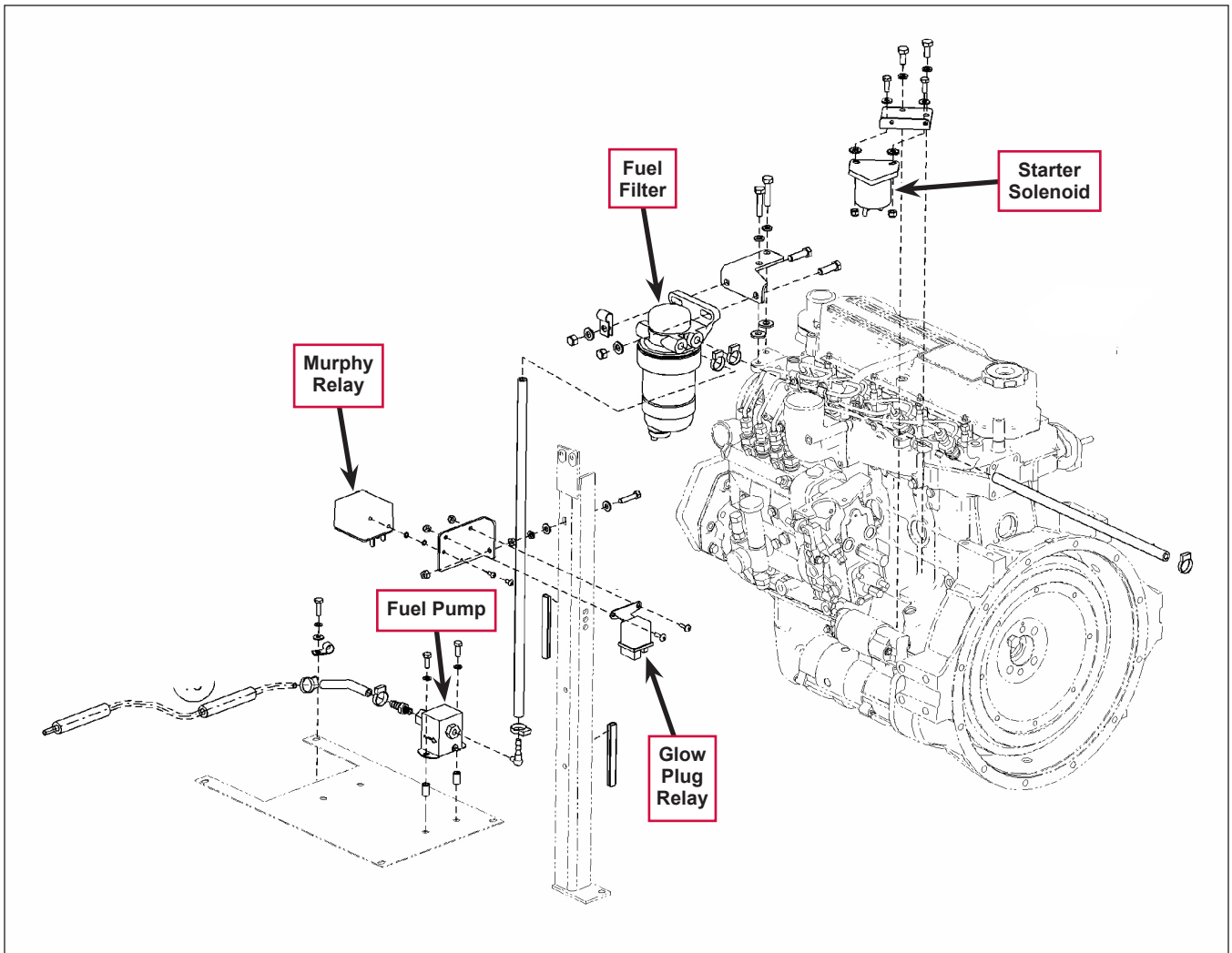
## Circuit Description

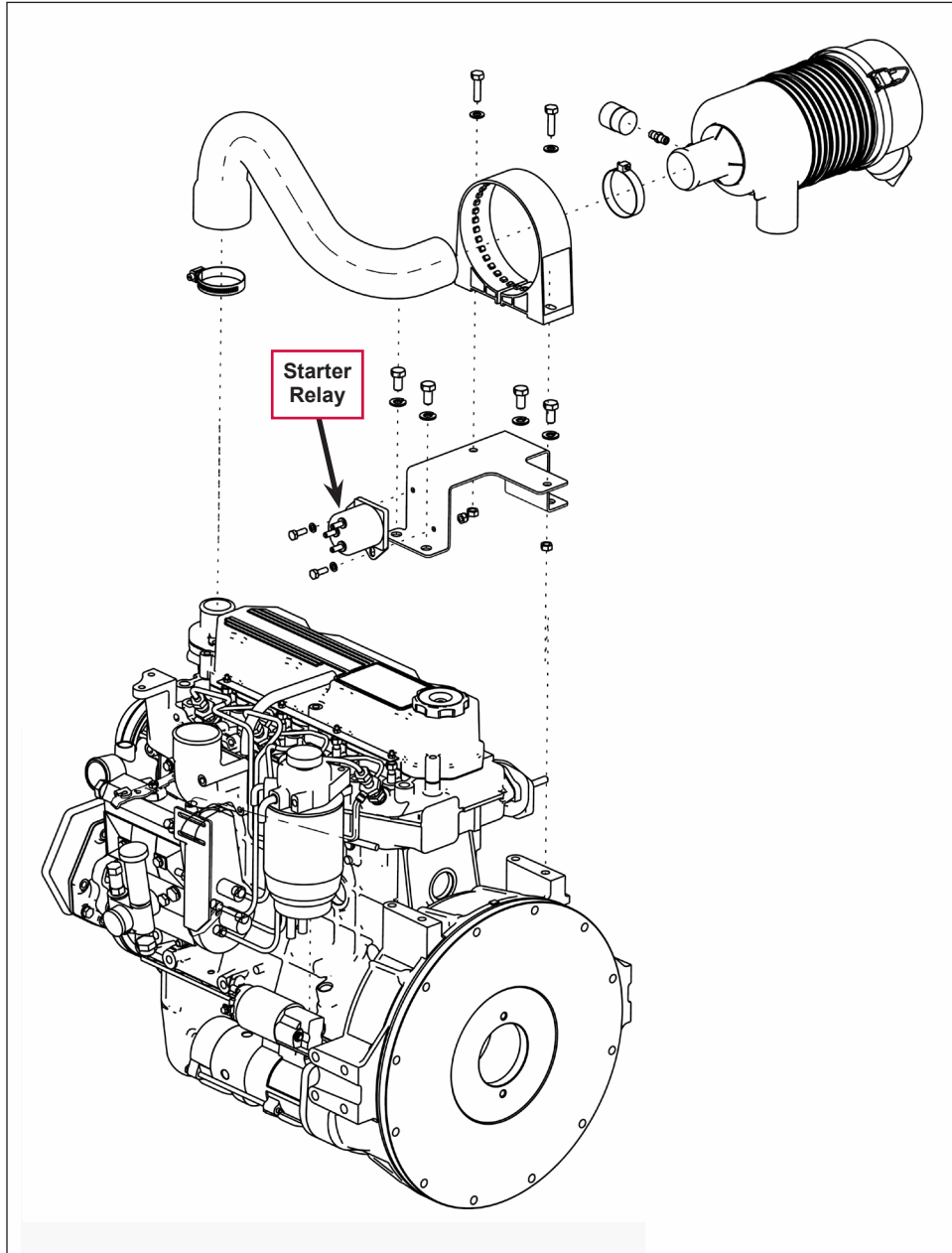
- For the engine to start:
  - The **Ignition Switch** must provide positive voltage to the **Ignition terminal A** on the **14-pin Engine Harness Connector**, and to the **Glow Plug Switch**.
  - The **Glow Plug Switch** must be closed to provide positive voltage to the **Glow Plug Input terminal J** on the **14-pin Engine Harness Connector**.
  - The **St.** (start) terminal on the **Ignition Switch** must provide positive voltage to the **Start/Crank Power terminal K** on the **14-pin Engine Harness Connector**.
- For the engine to run, the coolant temperature and oil pressure must be within acceptable parameters.

## Component Locations











## Maintenance and Adjustments



**Warning!** Before performing any machine maintenance or adjustments, make sure the parking brake is engaged, key switch is off and the key is removed from the machine.

### Engine Oil

Check the engine oil level when the machine is parked on a level surface and the engine is cool. Change the engine oil and oil filter after the first 50 hours of operation, then every 250 service hours after that. Use CF, CF-4 or CG-4 oil meeting API specifications and suited temperatures.

\* **Important:** Refer to the **Diesel Lubricating Oil Note** below for further diesel oil recommendations. Refer to the engine manufacturer's service manuals for oil capacities and additional engine specifications. Replace the oil filter with every oil change.

| Temperature Range              | Oil Weight        |
|--------------------------------|-------------------|
| Above 77 °F (25 °C)            | SAE 30 or 10W-30  |
| 32 °F to 77 °F (0 °C to 25 °C) | SAE 20 or 10W-30  |
| Below 32 °F (0 °C)             | SAE 10W or 10W-30 |

#### \* Diesel Lubricating Oil Note:

With the emission control now in effect, the CF-4 and CG-4 lubricating oils have been developed for use with a low-sulfur fuel used in on-road vehicle engines. When an off-road vehicle engine runs on a high-sulfur fuel, it is advisable to employ the CF, CD or CE lubricating oil with a high total base number. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals.

| Lubricating Oil class | Fuel | Low sulfur (0.5 % ≥) | High sulfur | Remarks |
|-----------------------|------|----------------------|-------------|---------|
|                       | CF   |                      | O           | O       |
| CF-4                  |      | O                    | X           |         |
| CG-4                  |      | O                    | X           |         |

O = Recommended X = Not Recommended

### Engine Coolant

#### Checking Engine Coolant



**Caution!** Do not remove the radiator cap when the engine is hot.

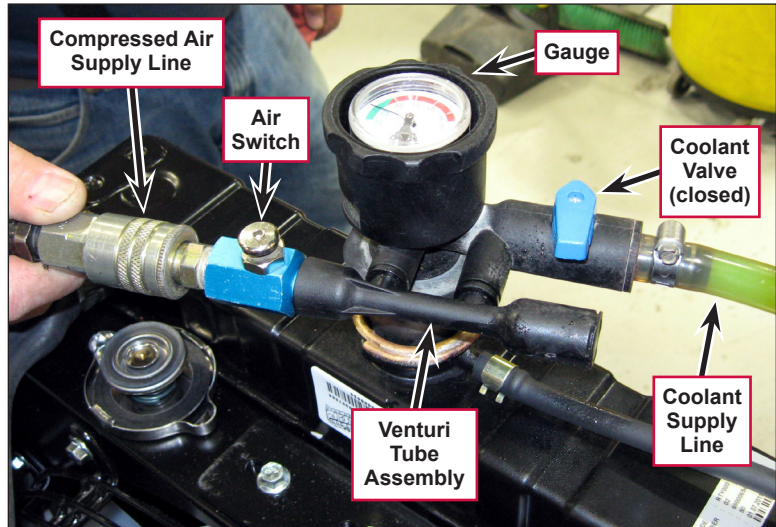
To check the engine coolant level, open the engine cover and observe the coolant level in the coolant overflow tank. If the level is low, add a 50/50 mix of water and the recommended type antifreeze. Clean the radiator and oil cooler exteriors every 150 hours by washing with low-pressure water or using compressed air.

## Replacing Engine Coolant

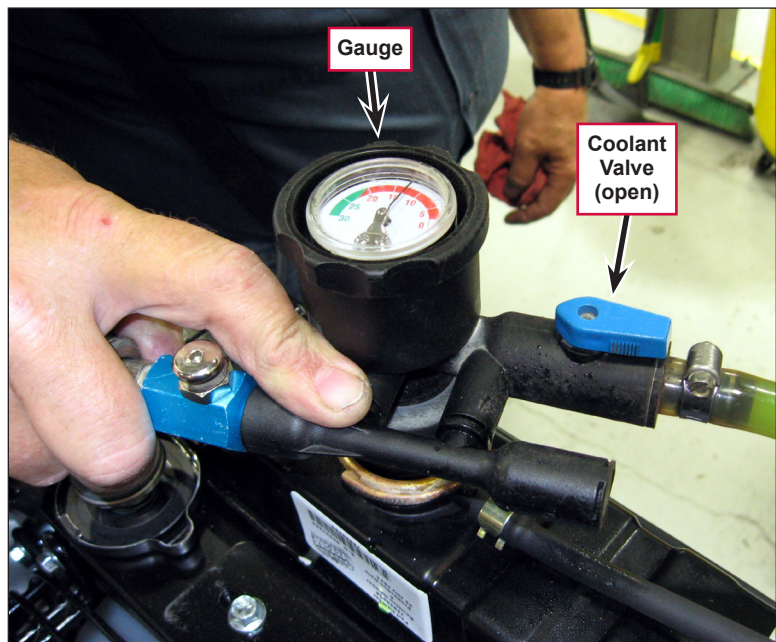
One possible cause of engine overheating is trapped air in the cooling system. It's recommended that you use a Cooling System Tool when changing the engine coolant. The Cooling System Tool pulls a vacuum on the cooling system prior to filling to prevent air from being trapped in the cooling system.

Note that there are several types of Cooling System Tools. The following instructions describe how to use a typical type of tool. Refer to the operating instructions included with your particular tool if different than the example shown here.

1. Connect a **Compressed Air Supply Line** to the fitting on the Cooling System Tool.
2. Connect the **Coolant Supply Line** to the Cooling System Tool. Make sure the **Coolant Valve** is closed.
3. Insert and hold the Cooling System Tool onto the radiator filler neck, then press the **Air Switch**. The compressed air travelling through the **Venturi Tube Assembly** will pull a vacuum on the cooling system to remove air from the system.
4. Once the vacuum reading on the **Gauge** reaches approximately 25 on the green scale, release the **Air Switch**. Note that this also a good opportunity to check for cooling system leaks,
5. Continue to hold the Cooling System Tool onto the radiator filler neck and open the **Coolant Valve** to allow coolant to flow into the radiator.
6. Once the pressure on the **Gauge** reaches approximately 5 on the red scale and the radiator is almost full, shut off the **Coolant Valve** and remove the Cooling System Tool from the radiator filler neck.
7. Top off the radiator and overflow tank as necessary.



Removing the Air from the Cooling System with Cooling System Tool



Filling Cooling System with Coolant

## Engine Air Filter Maintenance

Check the engine air Filter Service Indicator before each use of the machine. Do not service the air filter unless the red flag is visible in the service indicator.



**Caution!** When servicing the engine air filter elements, use extreme care to prevent loose dust from entering the engine. Dust can severely damage the engine.

The engine air filter contains a primary (outer) and a safety (inner) filter element. The primary element can be cleaned twice before being replaced.

The safety element should be replaced every third time that the primary filter element is replaced. Never attempt to clean the inner safety element.

To clean the primary filter element:

1. Unlatch the two clips at the end of the air filter and remove the end housing.
2. Pull the primary element out.
3. Clean the element with compressed air (maximum pressure 100 psi) or wash it with water (maximum pressure 40 psi). **Do not** put the element back into the canister until it is completely dry.

## Troubleshooting



**Note:** Also refer to the Operation Manual for the Mitsubishi Diesel Engine, S4Q, S4Q2, for additional troubleshooting information and procedures.

### General Troubleshooting

| Problem                    | Cause   | Correction   |
|----------------------------|---|--|
| The engine will not crank. | No power to pin K on the 14-pin Engine Harness Connector. | <ul style="list-style-type: none"> <li>• Check circuit breaker CB3 and reset if necessary.</li> <li>• Check the continuity from the Ignition Switch to pin K on the 14-pin Engine Harness Connector and repair as necessary.</li> </ul>  |
| The engine will not start. | No power to pin J on the 14-pin Engine Harness Connector. | <ul style="list-style-type: none"> <li>• Check circuit breaker CB4 and reset if necessary.</li> <li>• Check the continuity from the Ignition Switch to the Glow Plug Switch and repair as necessary.</li> <li>• Check the continuity from the Glow Plug Switch to pin J on the 14-pin Engine Harness Connector and repair as necessary.</li> </ul> |
|                            | No power to pin A on the 14-pin Engine Harness Connector. | <ul style="list-style-type: none"> <li>• Check circuit breaker CB4 and reset if necessary.</li> <li>• Check the continuity from the Ignition Switch to A on the 14-pin Engine Harness Connector and repair as necessary.</li> </ul>  |

| Problem   | Cause   | Correction   |
|---|---|--|
| The engine will not start (continued).              | The Murphy relay is not sending voltage to the fuel pump.           | <ul style="list-style-type: none"> <li>• Check the wiring to the Murphy relay, and from the Murphy relay to the fuel pump (wire H) and correct as necessary.</li> <li>• Check the Murphy relay for correct function and replace if necessary.</li> <li>• Check wire 6 on the Murphy relay for connection to ground. If wire 6 is grounded, check the oil pressure switch, water temperature switch and associated wiring for correct function and replace as necessary.</li> </ul> |
| The engine stops running, check engine light is on. | The coolant temperature is too high.                                | Refer to the <b>Engine Overheating Problems</b> section below.   |
|   | The oil pressure has dropped below the minimum acceptable pressure. | Refer to the <b>Loss of Oil Pressure Protection</b> section below.   |

### Engine Overheating Problems

When the water temperature switch senses that the coolant temperature is too high, it grounds out wire 6 to the Murphy relay. After 30 seconds the Murphy relay switches off the voltage to the fuel pump to stop the engine.

Use the checklist below as a guide to thoroughly check the engine cooling system.

- Check the coolant level in the overflow tank and radiator.
- Inspect and clean the radiator and hydraulic oil cooler.
- Check for correct operation of the belt-driven engine cooling fan (slippage).
- Check to see that the engine thermostat opens.
- Check for correct water pump operation.
- Check the engine crankcase oil level.
- Check for air trapped in the cooling system. (Refer to the **Engine Coolant/Replacing Engine Coolant** section.)
- Check the water temperature switch for correct function as replace if necessary.

## Loss of Oil Pressure Protection

When the oil pressure switch senses that the oil pressure has dropped below the minimum acceptable pressure, it grounds out wire 6 to the Murphy relay. After 30 seconds the Murphy relay switches off the voltage to the fuel pump to stop the engine.

Check for possible causes for low oil pressure such as:

- Engine crankcase level is low.
- Incorrect oil viscosity.
- Fault in oil pressure switch.
- Excessive engine wear or defective internal oil pump (relief valve)

## Specifications

| Mitsubishi S4Q2 Diesel     |  |                             |
|----------------------------|--|-----------------------------|
| <b>Engine Type</b>         | Water cooled, four-cylinder, four-stroke diesel engine |                             |
| <b>Displacement</b>        | 153 cubic inches [2.505 L]                             |                             |
| <b>Bore and Stroke</b>     | 3.46" x 4.06" [88 mm x 103 mm]                         |                             |
| <b>Compression Ratio</b>   | 22:1   |                             |
| <b>Engine Firing Order</b> | 1-3-4-2  |                             |
| <b>Rotation</b>            | Counterclockwise (as viewed from the flywheel end)     |                             |
| <b>Fuel System</b>         | Fuel Injector Pump                                     | Bosch Throttle Type         |
|                            | Fuel Filter  | Cartridge Type              |
|                            | Fuel Injection Nozzle                                  | Throttle Type               |
|                            | Injection Pressure (valve opening pressure)            | 120-130 kgf/cm <sup>2</sup> |
|                            |  | 1,706-1,848 psi             |
|                            |  | 11,768-12,749 kPa           |



| Mitsubishi S4Q2 Diesel    |  |  |
|---------------------------|--|--|
| <b>Lubrication System</b> | Type                                   | Force Feed                             |
|                           | Engine Oil                             | API Service Classification CC          |
|                           | Engine Oil Capacity                    | Oil Pan – 1.8 US gallons [7 L]         |
|                           |  | Complete System – 2.1 US gallons [8 L] |
| Oil Filter                | Cartridge Type w/built-in bypass valve |  |
| <b>Cooling System</b>     | Type                                   | Pressure                               |
|                           | Capacity (complete system)             | 1 US gallon [3.7 L]                    |

### Special Tools

|                     |  |
|---------------------|--|
| Cooling System Tool |  |
|---------------------|--|

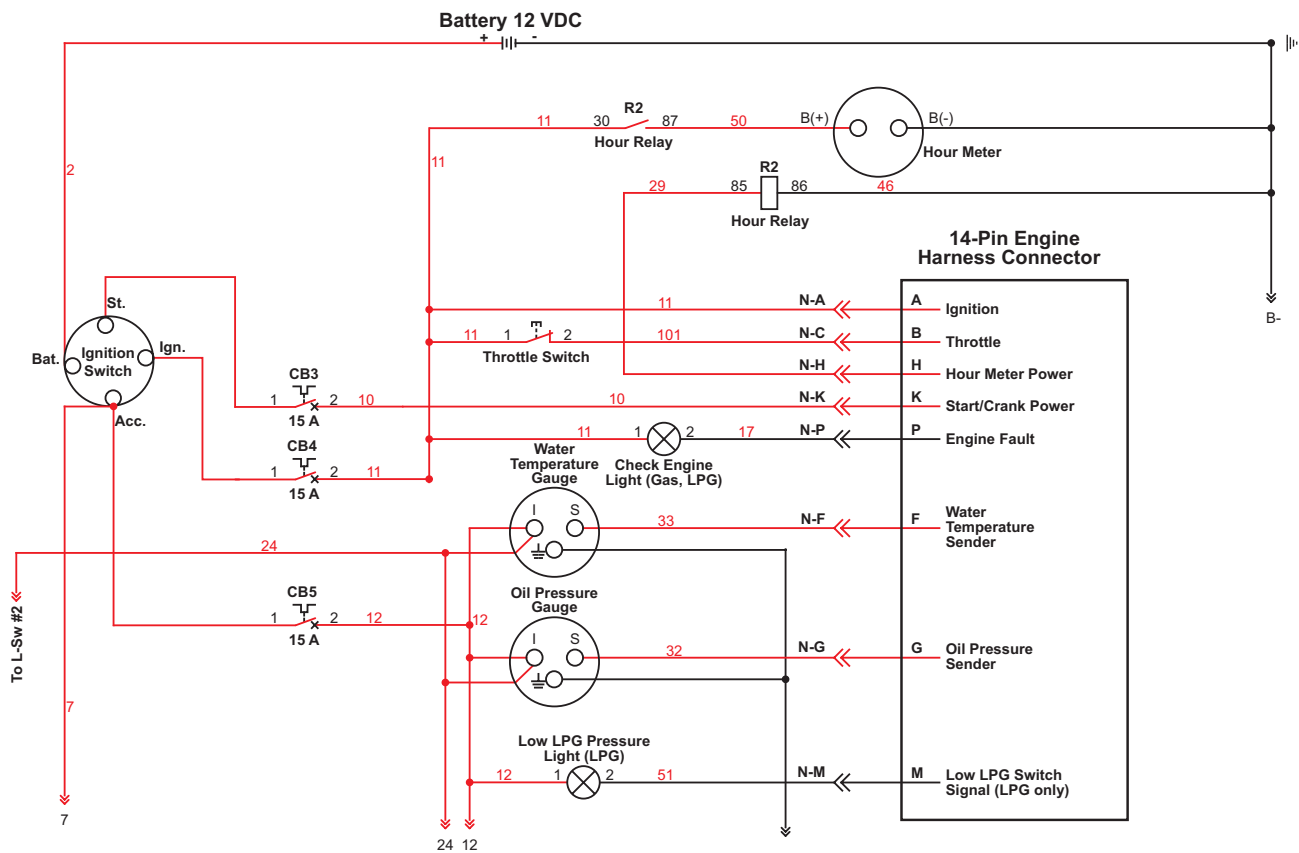
# Engine System, Gasoline/LPG

## Functional Description

### Overview

The gasoline (petrol) and LPG 7765/CR1500 machines use a four-cylinder 3.0L GM engine to power the two hydraulic pumps that run the machine drive wheel, scrub brushes, squeegee vacuum fan motor, side and main brooms, steering system, and the scrub deck and squeegee deck lift cylinders. Gasoline engines use fuel injectors. The LPG engine uses an electronically-controlled vaporizer/pressure regulator.

### GM Engine Wiring Diagram



## Circuit Description

- For the engine to start:
  - The **Ignition Switch** must provide positive voltage to the **Ignition terminal A** on the **14-pin Engine Harness Connector**.
  - The **St. (start)** terminal on the **Ignition Switch** must provide positive voltage to the **Start/Crank Power terminal K** on the **14-pin Engine Harness Connector**.
- For the engine to run, the coolant temperature and oil pressure must be within acceptable parameters.

## GM 3.0L Gasoline Fuel System Description

This engine is equipped with a fuel injector rail that does not have a pressure regulator or a return circuit to the fuel tank. Fuel pressure for this engine is regulated by the engine's Engine Control Module (ECM). The ECM receives fuel pressure and temperature feedback from the gasoline fuel sensor manifold and uses this information to control the ground side of the fuel pump.

Fuel pressure is regulated by the ECM pulse width modulating (PWM) the fuel pump. The fuel pressure and temperature sensor manifold has a return or "bleed" circuit that connects back to the equipment fuel tank. This circuit is used to bleed off any vapor that develops in the line and returns a small amount of fuel to the tank.

The fuel comes from the fuel tank and passes through the fuel pump. Fuel exits the fuel pump, passes through the filter and then enters the fuel pressure and temperature manifold assembly. Fuel flows through the feed circuit and is delivered to the fuel injector rail. Fuel that enters the bleed circuits through the bypass valve in the manifold is returned to the fuel tank.

## GM 3.0L LPG Fuel System Description

The fuel system on LPG engines includes a Direct Electronic Pressure Regulator (DEPR), air/fuel mixer, Electronic Throttle Control (ETC) device and an Engine Control Module (ECM).

An Electric Fuel lock-off valve, consisting of a 12 volt solenoid and a normally-closed valve, opens during cranking and engine run cycles. The ECM controls the voltage to the Electric Fuel lock-off valve.

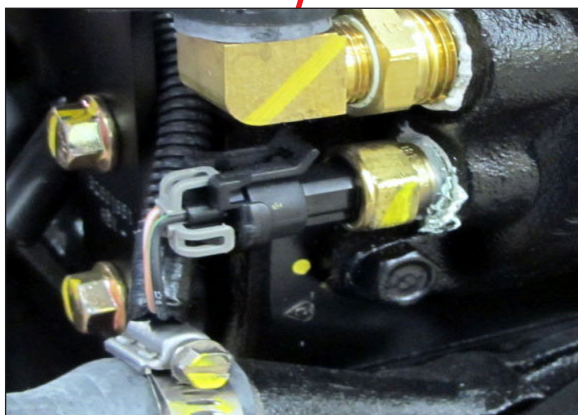
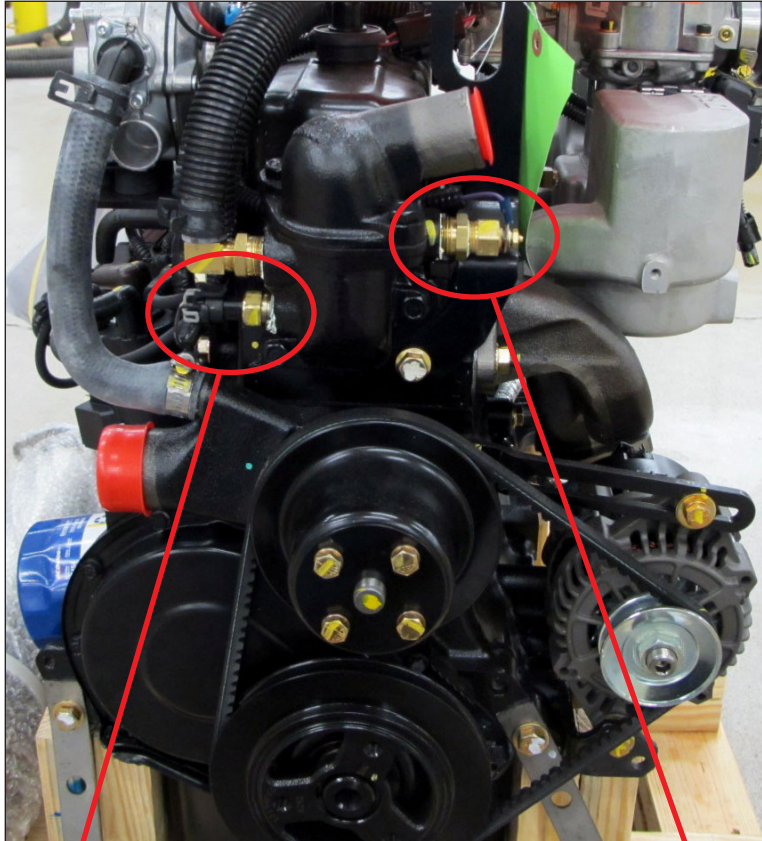
The DEPR is an electromechanical fuel pressure regulator that communicates with the ECM to regulate the fuel pressure. The air/fuel mixer is a self-contained air-fuel metering device that is mounted in the air stream ahead of the throttle control device. The ECM and the ETC control the engine speed.



**Note:** For a more detailed and thorough description of the LPG fuel system, refer to the PSI Tier 3 Certified Mobile Diagnostic and Troubleshooting Manual, publication number PSITIER3 - G.

## Component Locations

### LPG and Gasoline



ECT (Engine Coolant Temperature) Sensor



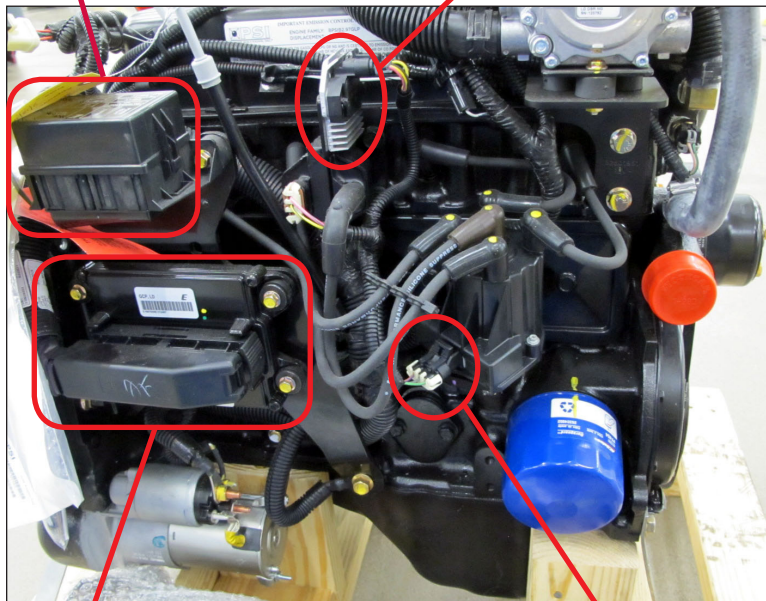
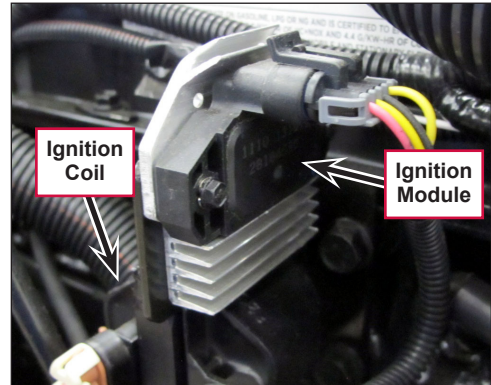
Engine Coolant Switch



Engine Fuse Box



Ignition Coil and Ignition Module

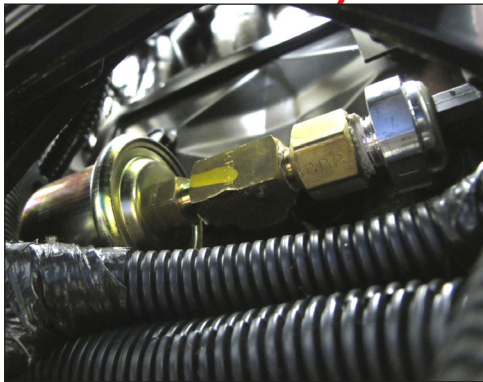
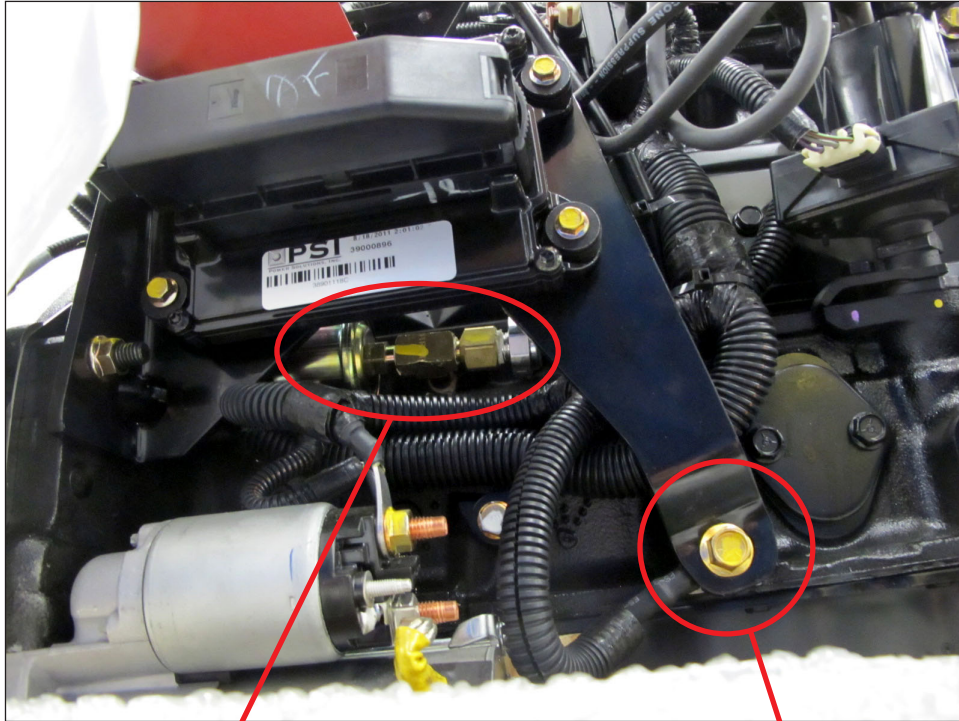


Engine Control Module

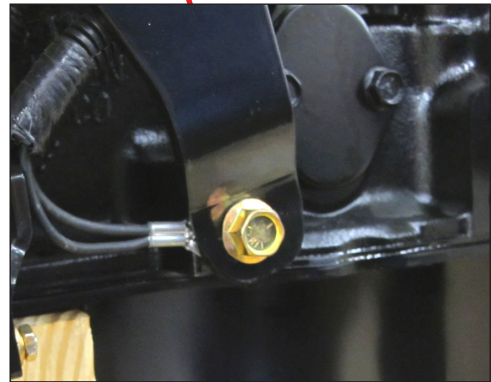


Cam Sensor





Oil Pressure Sensor

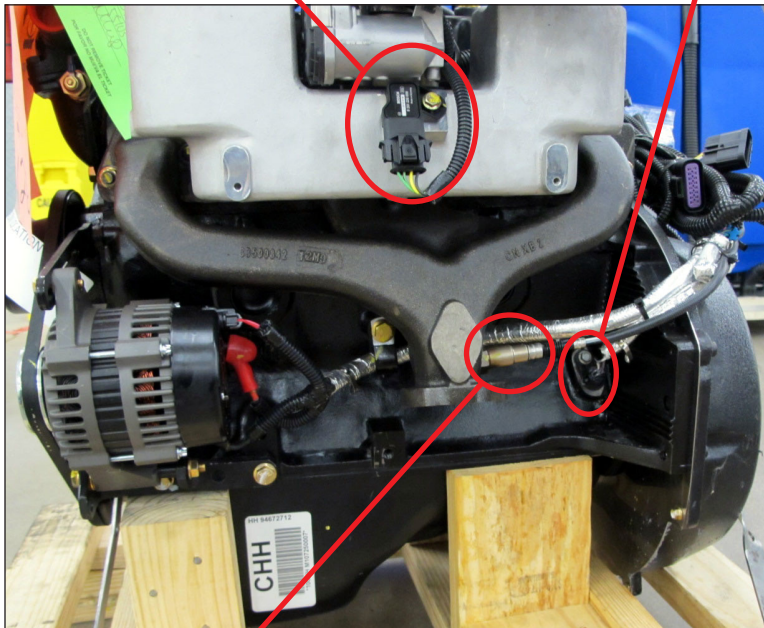
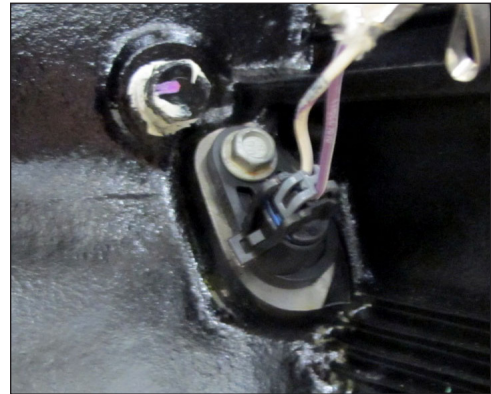


Ground Connection

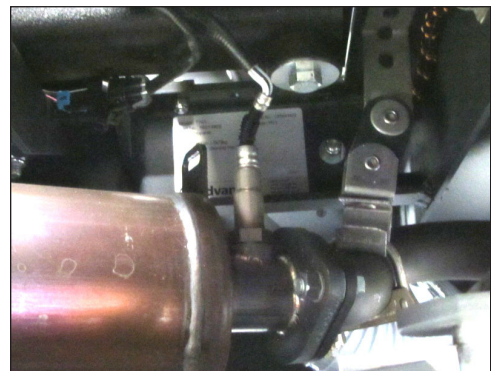
Temperature/Manifold Absolute Pressure (TMAP) Sensor



Crank Position Sensor



Upstream (Pre-CAT) O<sub>2</sub> Sensor

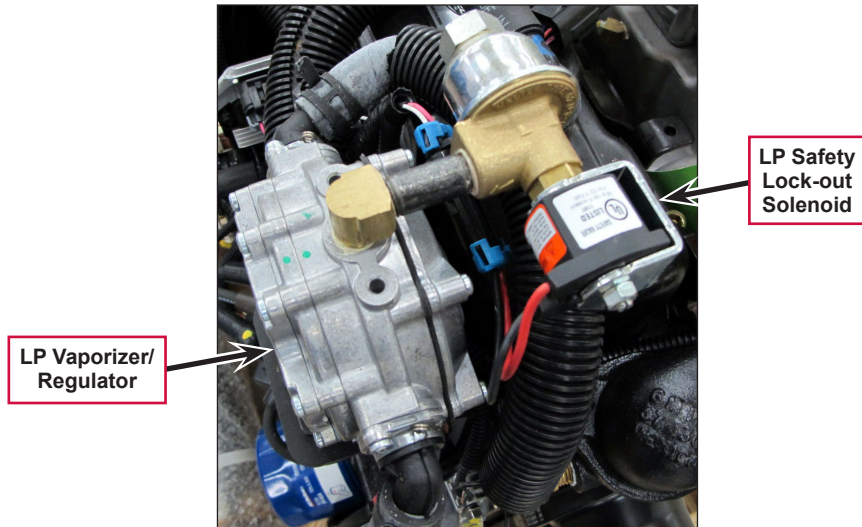


Downstream (Post-CAT) O<sub>2</sub> Sensor (shown on machine)

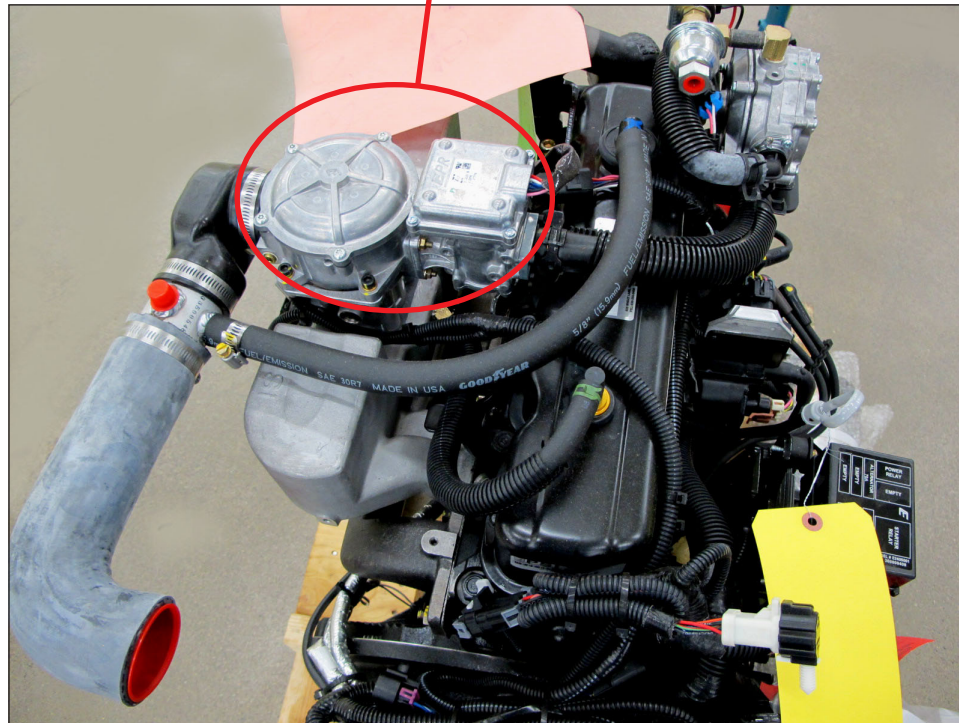
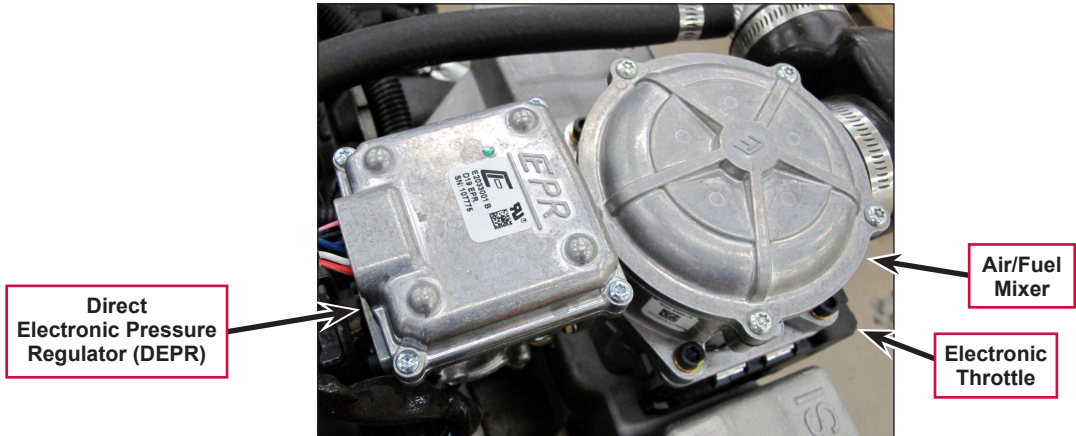


LPG

LP Vaporizer/Regulator,  
LP Safety Lock-out Solenoid

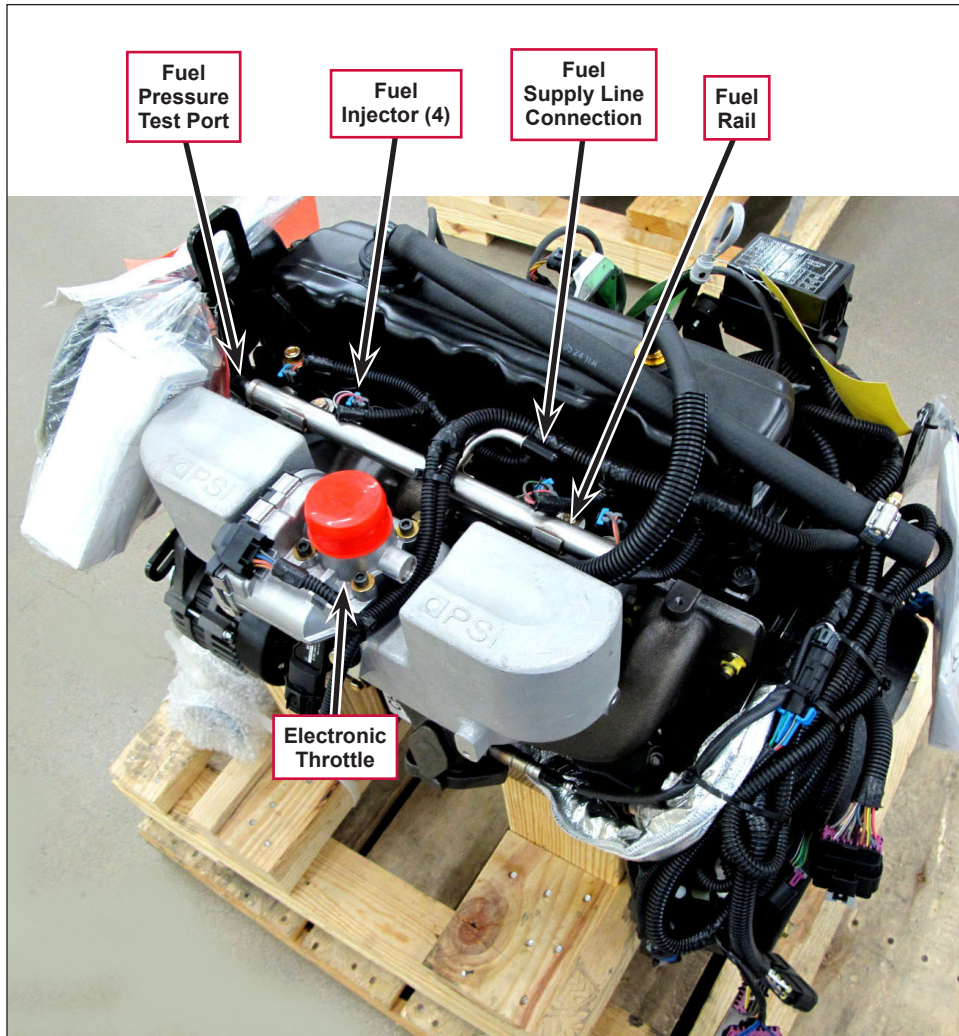


Direct Electronic Pressure Regulator (DEPR)  
and Air/Fuel Mixer



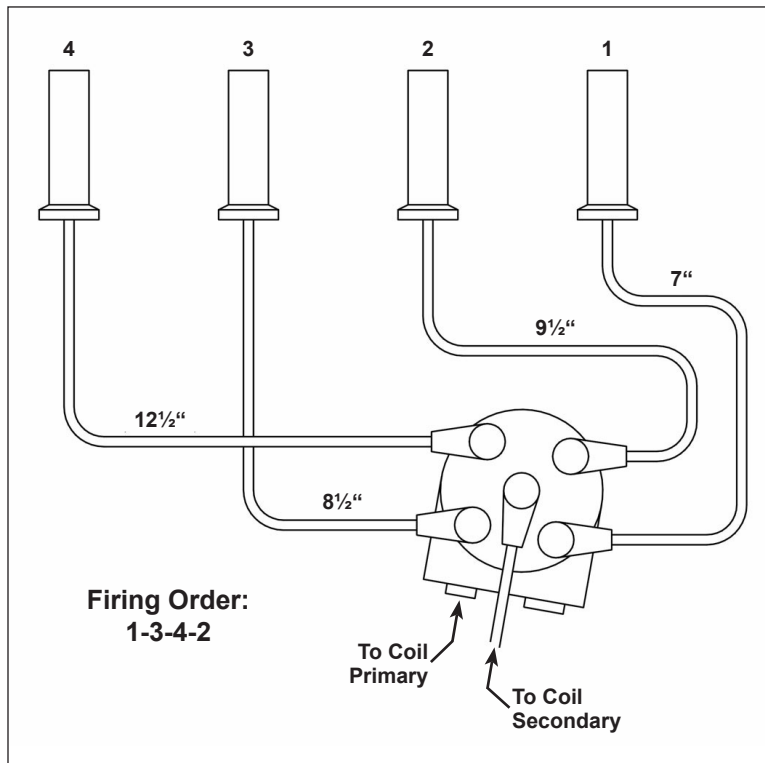


## Gasoline





### Firing Order and Plug Wire Routing



### Maintenance and Adjustments



**Warning!** Before performing any machine maintenance or adjustments, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.

### Engine Oil

Check the engine oil level when the machine is parked on a level surface and the engine is cool. Change the engine oil after the first 35 hours of operation and every 150 hours after that. Use any SF or SG rated oil meeting API specifications and suited to seasonal temperatures. Refer to the engine manufacturer’s service manuals for oil capacities and additional engine specifications. Replace the oil filter with every oil change.

| Temperature Range   | Oil Weight |
|---------------------|------------|
| Above 60° F (15° C) | SAE 10W-30 |
| Below 60° F (15° C) | SAE 5W-30  |

## Engine Coolant

### Checking Engine Coolant



**Caution!** Do not remove the radiator cap when the engine is hot.

To check the engine coolant level, open the engine cover and observe the coolant level in the coolant overflow tank. If the level is low, add a 50/50 mix of water and the recommended type antifreeze. Clean the radiator and oil cooler exteriors every 150 hours by washing with low-pressure water or using compressed air.



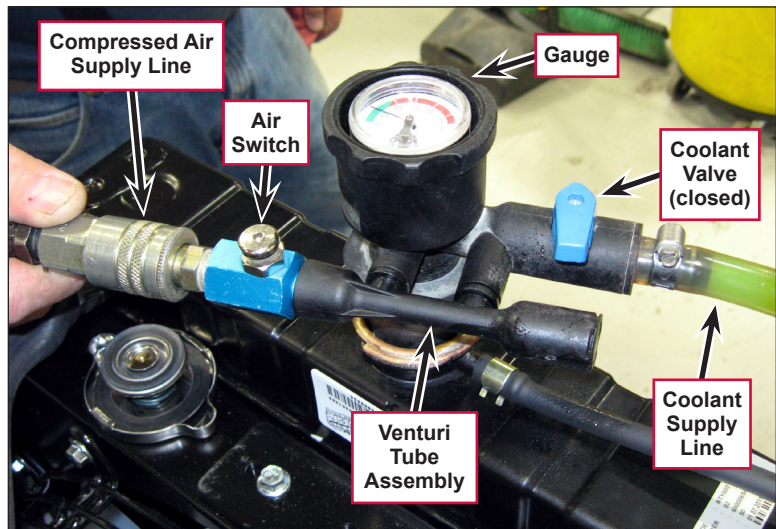
**Service Note:** The oil cooler tips out for easy cleaning.

### Replacing Engine Coolant

One possible cause of engine overheating is trapped air in the cooling system. It's recommended that you use a Cooling System Tool when changing the engine coolant. The Cooling System Tool pulls a vacuum on the cooling system prior to filling to prevent air from being trapped in the cooling system.

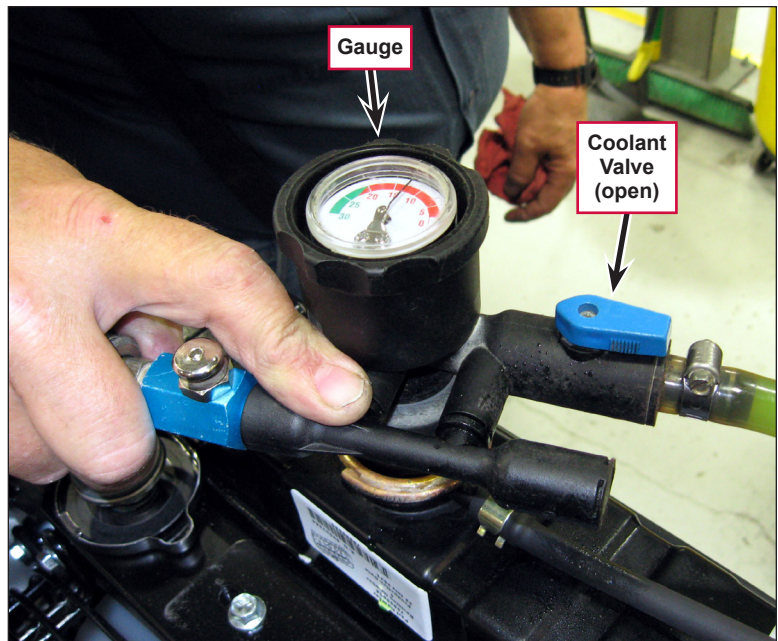
Note that there are several types of Cooling System Tools. The following instructions describe how to use a typical type of tool. Refer to the operating instructions included with your particular tool if different than the example shown here.

1. Connect a **Compressed Air Supply Line** to the fitting on the Cooling System Tool.
2. Connect the **Coolant Supply Line** to the Cooling System Tool. Make sure the **Coolant Valve** is closed.
3. Insert and hold the Cooling System Tool onto the radiator filler neck, then press the **Air Switch**. The compressed air travelling through the **Venturi Tube Assembly** will pull a vacuum on the cooling system to remove air from the system.
4. Once the vacuum reading on the **Gauge** reaches approximately 25 on the green scale, release the **Air Switch**. Note that this also a good opportunity to check for cooling system leaks,



Removing the Air from the Cooling System with Cooling System Tool

- Continue to hold the Cooling System Tool onto the radiator filler neck and open the **Coolant Valve** to allow coolant to flow into the radiator.
- Once the pressure on the **Gauge** reaches approximately 5 on the red scale and the radiator is almost full, shut off the **Coolant Valve** and remove the Cooling System Tool from the radiator filler neck.
- Top off the radiator and overflow tank as necessary.



Filling Cooling System with Coolant

## Engine Air Filter Maintenance



**Caution!** When servicing the engine air filter elements, use extreme care to prevent loose dust from entering the engine. Dust can severely damage the engine.

**Service the air cleaner more frequently under severe dusty or dirty conditions.**

- Remove the primary air cleaner element from the air cleaner assembly and inspect the element for foreign material restrictions or signs of excessive wear or damage. Replace the element if necessary.
- Remove all dust and foreign matter from the air cleaner housing.
- Reinstall the air cleaner element.
- Reinstall the air cleaner cup, then securely fasten the retaining clips

## Troubleshooting



**Note:** Also refer to the PSI Tier 3 Certified Mobile Diagnostic and Troubleshooting Manual, publication number PSITIER3 - G, for additional troubleshooting information and procedures.

### General Troubleshooting

| Problem   | Cause  | Correction   |
|---|--|--|
| The engine will not crank.                          | No power to pin K on the 14-pin Engine Harness Connector.                | <ul style="list-style-type: none"> <li>• Check circuit breaker CB3 and reset if necessary.</li> <li>• Check the continuity from the Ignition Switch to pin K on the 14-pin Engine Harness Connector and repair as necessary.</li> </ul>                                      |
| The engine will not start.                          | No power to pin A on the 14-pin Engine Harness Connector.                | <ul style="list-style-type: none"> <li>• Check circuit breaker CB4 and reset if necessary.</li> <li>• Check the continuity from the Ignition Switch to pin A on the 14-pin Engine Harness Connector and repair as necessary.</li> </ul>                                      |
| Engine will not run at high speed (2000 RPM)        | Loss of run signal from the Throttle Switch.                             | <ul style="list-style-type: none"> <li>• Check that a voltage signal is being sent to the engine control when the Throttle Switch is set to operating speed.</li> <li>• Check the continuity through the Throttle Switch and connections and repair as necessary.</li> </ul> |
| The engine stops running, check engine light is on. | The coolant temperature is too high.                                     | Refer to the <b>Engine Overheating Problems</b> section below.   |
|   | The oil pressure has dropped below 6 psi @1000 RPM or 18 psi @ 2000 RPM. | Refer to the <b>Loss of Oil Pressure Protection</b> section below.   |

### Engine Overheating Problems

Use the checklist below as a guide to thoroughly check the engine cooling system.

- Check the coolant level in the overflow tank and radiator.
- Inspect and clean the radiator and hydraulic oil cooler.
- Check for correct operation of the belt-driven engine cooling fan (slippage).
- Check to see that the engine thermostat opens.
- Check for correct water pump operation.
- Check the engine crankcase oil level.
- Check for air trapped in the cooling system. (Refer to the **Engine Coolant/Replacing Engine Coolant** section.)
- Check the water temperature switch for correct function as replace if necessary.

## Loss of Oil Pressure Protection

The engine will shut down if the oil pressure drops below 6 psi at 1000 RPM, or below 18 psi at 2000 RPM. Check for possible causes for low oil pressure such as:

- Engine crankcase level is low.
- Incorrect oil viscosity.
- Fault in oil pressure switch.
- Excessive engine wear or defective internal oil pump (relief valve)

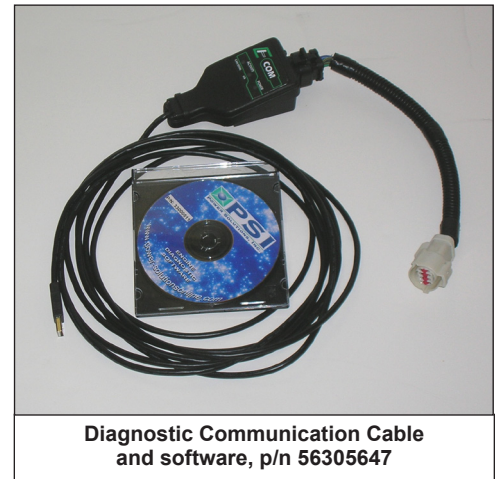
## Engine Diagnostics

### To Access the Engine Diagnostic Information Using the Controller Interface Kit and a PC

The Diagnostic Communications Cable and Software Kit (p/n 56305647) allows you to connect a laptop PC to the engine to view the various engine parameters, configuration settings and error codes, and displays the engine software and hardware information.

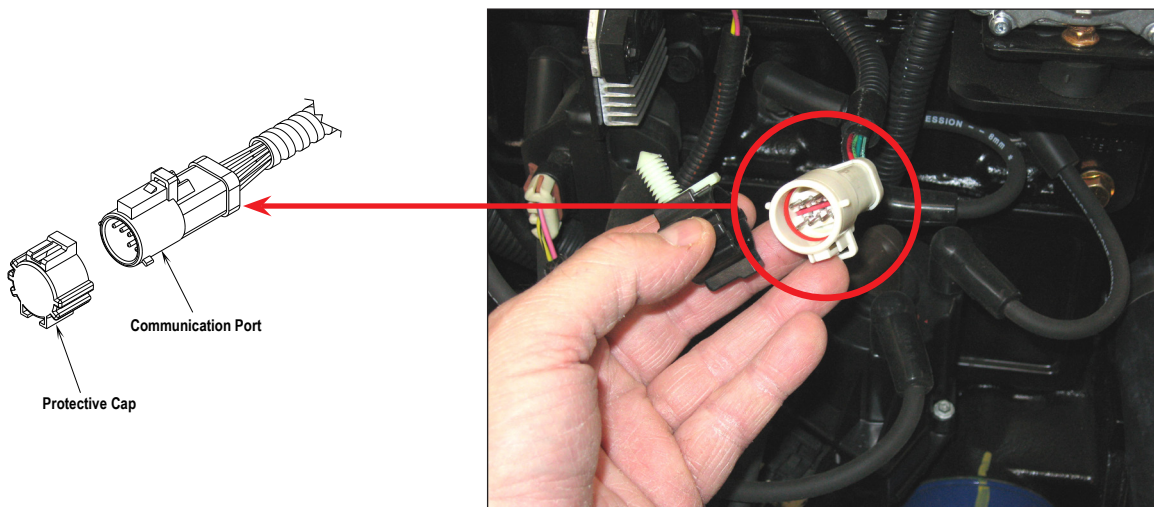
Note that this is the preferred way to view the engine diagnostic information. To use the Controller Interface Kit:

1. Install the software from the provided CD onto your PC.
2. Connect the USB connector on the kit cable to a USB port in your PC.



Diagnostic Communication Cable and software, p/n 56305647

3. Remove the **Protective Cap**, then connect the kit cable to the **Communication Port** on the engine.





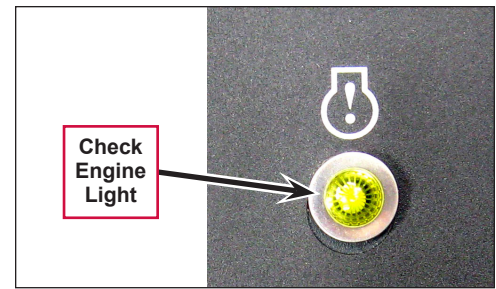
Note that the minimum system requirements for the software in the Diagnostic Communications Cable and Software Kit are as follows:

- Windows® XP, 2000 or 98SE (Second Edition) operating system
- Minimum processor speed – Pentium® II 450 MHz
- Minimum RAM requirements:
  - Windows® XP – 256 MB
  - Windows® 2000 – 128 MB
  - Windows® 98SE – 128 MB
- At least one available RS232 serial or USB port. Note that the USB driver does not support Windows 98 SE.



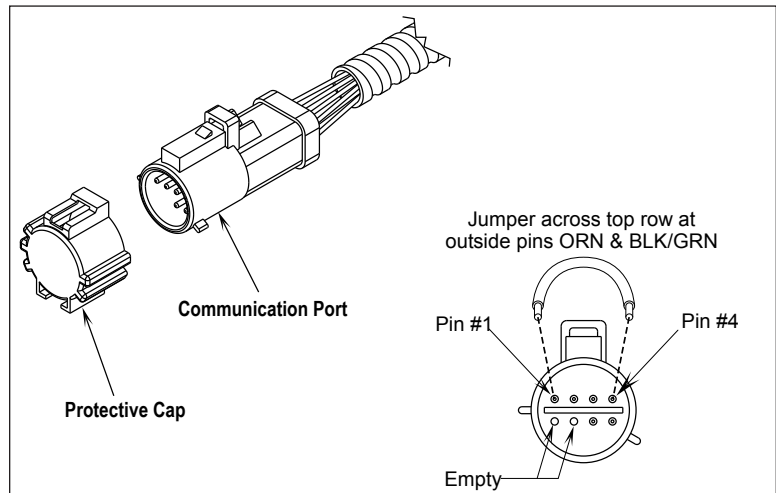
### To Access the Engine DTC Error Codes Manually

You can access the engine DTC (diagnostic test code) error codes manually without using a Controller Interface Kit and PC. The codes will be shown through a sequence of blinks on the **Check Engine Light** (also referred to as the malfunction indicator lamp or MIL).



To access the codes:

1. Remove the **Protective Cap** from the **Communication Port** on the engine.
2. Use a wire to jumper **Pin #1** to **Pin #4** as shown.



3. Turn the key switch to the on position. You can now read the error codes by observing the blinks on the **Check Engine Light**. Be ready to write down any codes that may be stored.



**Note:** The light will always blink “1-6-5-4” three times at the beginning and at the end of the error code number display series.

For example, error code “116”, indicating an ECT (engine coolant temperature) high-voltage condition, would be indicated as follows:

- a. The light will show one blink, a short pause, six blinks, a short pause, five blinks, a short pause, then four blinks. Note that this 1-6-5-4 sequence is not an error code, but will be repeated three times to indicate the beginning of the error code number display series.
- b. The light will show the first actual error code (116 in this example) with one blink, a short pause, one blink, a short pause, then six blinks. This 1-1-6 sequence will be repeated three times, then the light will blink the next error code number sequence in the series (if present).
  - If no DTC codes are found, the **Check Engine Light** will continue to flash the 1-6-5-4 sequence only.
  - If one of the numbers in the DTC code is zero (0), the zero will be represented as a short pause (no flash).
- c. When all of the error code number sequences have been displayed, the light will blink the 1-6-5-4 sequence three times again to indicate the end of the error code number series.
- d. The light will then repeat steps a through c above.

**Diagnostic Trouble Code (DTC) Chart – Sorted by DTC Number**

| Description   | DTC Set 2 |       | Description   | DTC Set 2 |       |
|---|-----------|-------|---|-----------|-------|
|   | SPN-2     | FMI-2 |   | SPN-2     | FMI-2 |
| DTC 11: Intake cam / distributor position error             | 520800    | 7     | DTC 268: Injector 3 coil shorted                        | 653       | 6     |
| DTC 16: Crank and/or cam could not synchronize during start | 636       | 8     | DTC 270: Injector 4 open or short to ground             | 654       | 5     |
| DTC 24: Exhaust cam position error                          | 520801    | 7     | DTC 271: Injector 4 coil shorted                        | 654       | 6     |
| DTC 87 Fuel pressure lower than expected                    | 94        | 1     | DTC 273: Injector 5 open or short to ground             | 655       | 5     |
| DTC 88 Fuel pressure higher than expected                   | 94        | 0     | DTC 274: Injector 5 coil shorted                        | 655       | 6     |
| DTC 91: FP low voltage                                      | 94        | 4     | DTC 276: Injector 6 open or short to ground             | 656       | 5     |
| DTC 92: FP high voltage                                     | 94        | 3     | DTC 277: Injector 6 coil shorted                        | 656       | 6     |
| DTC 107: MAP voltage low                                    | 106       | 4     | DTC 279: Injector 7 open or short to ground             | 657       | 5     |
| DTC 108: MAP pressure high                                  | 106       | 16    | DTC 280: Injector 7 coil shorted                        | 657       | 6     |
| DTC 111: IAT higher than expected stage 1                   | 105       | 15    | DTC 282: Injector 8 open or short to ground             | 658       | 5     |
| DTC 112: IAT voltage low                                    | 105       | 4     | DTC 283: Injector 8 coil shorted                        | 658       | 6     |
| DTC 113: IAT voltage high                                   | 105       | 3     | DTC 285: Injector 9 open or short to ground             | 659       | 5     |
| DTC 116: ECT higher than expected stage 1                   | 110       | 15    | DTC 286: Injector 9 coil shorted                        | 659       | 6     |
| DTC 117: ECT voltage low                                    | 110       | 4     | DTC 288: Injector 10 open or short to ground            | 660       | 5     |
| DTC 118: ECT voltage high                                   | 110       | 3     | DTC 289: Injector 10 coil shorted                       | 660       | 6     |
| DTC 121: TPS1-2 lower than expected                         | 51        | 1     | DTC 1631: PWM1-Gauge1 open / ground short               | 697       | 5     |
| DTC 122: TPS1 voltage low                                   | 51        | 4     | DTC 299: Boost control underboost failure               | 1692      | 1     |
| DTC 123: TPS1 voltage high                                  | 51        | 3     | DTC 301: Cylinder 1 emissions/catalyst damaging misfire | 1323      | 31    |
| DTC 127: IAT higher than expected stage 2                   | 105       | 0     | DTC 302: Cylinder 2 emissions/catalyst damaging misfire | 1324      | 31    |
| DTC 129: BP pressure low                                    | 108       | 1     | DTC 303: Cylinder 3 emissions/catalyst damaging misfire | 1325      | 31    |
| DTC 134: EGO1 open / lazy                                   | 724       | 10    | DTC 304: Cylinder 4 emissions/catalyst damaging misfire | 1326      | 31    |
| DTC 140: EGO3 open / lazy                                   | 520209    | 10    | DTC 305: Cylinder 5 emissions/catalyst damaging misfire | 1327      | 31    |
| DTC 154: EGO2 open / lazy                                   | 520208    | 10    | DTC 306: Cylinder 6 emissions/catalyst damaging misfire | 1328      | 31    |
| DTC 160: EGO4 open / lazy                                   | 520210    | 10    | DTC 307: Cylinder 7 emissions/catalyst damaging misfire | 1329      | 31    |
| DTC 171: Adaptive-learn gasoline bank1 high                 | 520200    | 0     | DTC 308: Cylinder 8 emissions/catalyst damaging misfire | 1330      | 31    |
| DTC 172: Adaptive-learn gasoline bank1 low                  | 520200    | 1     | DTC 326: Knock1 excessive or erratic signal             | 731       | 2     |
| DTC 174: Adaptive-learn gasoline bank2 high                 | 520201    | 0     | DTC 327: Knock1 sensor open or not present              | 731       | 4     |
| DTC 175: Adaptive-learn gasoline bank2 low                  | 520201    | 1     | DTC 331: Knock2 excessive or erratic signal             | 520241    | 2     |
| DTC 182: FT low voltage                                     | 174       | 4     | DTC 332: Knock2 sensor open or not present              | 520241    | 4     |
| DTC 183: FT high voltage                                    | 174       | 3     | DTC 336: CRANK input signal noise                       | 636       | 2     |
| DTC 187: Gaseous fuel temperature sender low voltage        | 520240    | 4     | DTC 337: Crank signal loss                              | 636       | 4     |
| DTC 188: Gaseous fuel temperature sender high voltage       | 520240    | 3     | DTC 341: CAM input signal noise                         | 723       | 2     |
| DTC 217: ECT higher than expected stage 2                   | 110       | 0     | DTC 342: Loss of CAM input signal                       | 723       | 4     |
| DTC 219: RPM higher than max allowed govern speed           | 515       | 15    | DTC 359: Fuel run-out longer than expected              | 1239      | 7     |
| DTC 221: TPS1-2 higher than expected                        | 51        | 0     | DTC 420: Catalyst inactive on gasoline (Bank 1)         | 520211    | 10    |
| DTC 222: TPS2 voltage low                                   | 520251    | 4     | DTC 430: Catalyst inactive on gasoline (Bank 2)         | 520212    | 10    |
| DTC 223: TPS2 voltage high                                  | 520251    | 3     | DTC 502: Roadspeed input loss of signal                 | 84        | 1     |
| DTC 234: Boost control overboost failure                    | 1692      | 0     | DTC 508: IAC ground short                               | 520252    | 6     |
| DTC 236: TIP active   | 1692      | 2     | DTC 509: IAC coil open/short                            | 520252    | 5     |
| DTC 237: TIP low voltage                                    | 1127      | 4     | DTC 520: Oil pressure sender low pressure stage 1       | 100       | 18    |
| DTC 238: TIP high voltage                                   | 1127      | 3     | DTC 521: Oil pressure sender high pressure              | 100       | 0     |
| DTC 261: Injector 1 open or short to ground                 | 651       | 5     | DTC 522: Oil pressure sender low voltage                | 100       | 4     |
| DTC 262: Injector 1 coil shorted                            | 651       | 6     | DTC 523: Oil pressure sender high voltage               | 100       | 3     |
| DTC 264: Injector 2 open or short to ground                 | 652       | 5     | DTC 524: Oil pressure low                               | 100       | 1     |
| DTC 265: Injector 2 coil shorted                            | 652       | 6     | DTC 562: Vbat voltage low                               | 168       | 17    |
| DTC 267: Injector 3 open or short to ground                 | 653       | 5     | DTC 563: Vbat voltage high                              | 168       | 15    |

| Description   | DTC Set 2 |       | Description   | DTC Set 2 |       |
|---|-----------|-------|---|-----------|-------|
|   | SPN-2     | FMI-2 |   | SPN-2     | FMI-2 |
| DTC 601: Microprocessor failure - FLASH                       | 628       | 13    | DTC 1175: MegaJector voltage supply low                 | 520260    | 4     |
| DTC 604: Microprocessor failure - RAM                         | 630       | 12    | DTC 1176: MegaJector internal actuator fault detection  | 520260    | 12    |
| DTC 606: Microprocessor failure - COP                         | 629       | 31    | DTC 1177: MegaJector internal circuitry fault detection | 520260    | 12    |
| DTC 615: Start relay coil open                                | 1321      | 5     | DTC 1178: MegaJector internal comm fault detection      | 520260    | 12    |
| DTC 616: Start relay ground short                             | 1321      | 4     | DTC 1182: Fuel impurity level high                      | 520401    | 0     |
| DTC 617: Start relay coil short to power                      | 1321      | 3     | DTC 1183: MegaJector autozero / lockoff failure         | 520803    | 31    |
| DTC 627: Fuel pump relay coil open                            | 1348      | 5     | DTC 1311: Cylinder 1 misfire detected                   | 1323      | 11    |
| DTC 628: Fuel-pump high-side open or short to ground          | 1347      | 5     | DTC 1312: Cylinder 2 misfire detected                   | 1324      | 11    |
| DTC 628: Fuel pump relay control ground short                 | 1348      | 4     | DTC 1313: Cylinder 3 misfire detected                   | 1325      | 11    |
| DTC 629: Fuel-pump high-side short to power                   | 1347      | 6     | DTC 1314: Cylinder 4 misfire detected                   | 1326      | 11    |
| DTC 629: Fuel pump relay coil short to power                  | 1348      | 3     | DTC 1315: Cylinder 5 misfire detected                   | 1327      | 11    |
| DTC 642: Sensor supply voltage 1 low                          | 1079      | 4     | DTC 1316: Cylinder 6 misfire detected                   | 1328      | 11    |
| DTC 643: Sensor supply voltage 1 high                         | 1079      | 3     | DTC 1317: Cylinder 7 misfire detected                   | 1329      | 11    |
| DTC 650: MIL open   | 1213      | 5     | DTC 1318: Cylinder 8 misfire detected                   | 1330      | 11    |
| DTC 652: Sensor supply voltage 2 low                          | 1080      | 4     | DTC 1411: EMWT1 voltage high                            | 441       | 3     |
| DTC 653: Sensor supply voltage 2 high                         | 1080      | 3     | DTC 1412: EMWT2 voltage high                            | 442       | 3     |
| DTC 685: Power relay coil open                                | 1485      | 5     | DTC 1413: EMWT1 voltage low                             | 441       | 4     |
| DTC 686: Power relay ground short                             | 1485      | 4     | DTC 1414: EMWT2 voltage low                             | 442       | 4     |
| DTC 687: Power relay coil short to power                      | 1485      | 3     | DTC 1415: EMWT1 higher than expected stage 1            | 441       | 15    |
| DTC 916: Shift actuator feedback out-of-range                 | 520226    | 3     | DTC 1416: EMWT2 higher than expected stage 1            | 442       | 15    |
| DTC 919: Shift unable to reach desired gear                   | 520226    | 7     | DTC 1417: EMWT1 higher than expected stage 2            | 441       | 0     |
| DTC 920: Shift actuator or drive circuit failed               | 520226    | 31    | DTC 1418: EMWT2 higher than expected stage 2            | 442       | 0     |
| DTC 1111: RPM above fuel rev limit level                      | 515       | 16    | DTC 1419: ERWT1 voltage high                            | 443       | 3     |
| DTC 1112: RPM above spark rev limit level                     | 515       | 0     | DTC 1420: ERWT2 voltage high                            | 444       | 3     |
| DTC 1121: FPP1/2 simultaneous voltages out-of-range (redundan | 91        | 31    | DTC 1421: ERWT1 voltage low                             | 443       | 4     |
| DTC 1122: FPP1/2 do not match each other or IVS (redundancy l | 520250    | 31    | DTC 1422: ERWT2 voltage low                             | 444       | 4     |
| DTC 1131: WGP voltage high                                    | 1192      | 3     | DTC 1423: ERWT1 higher than expected stage 1            | 443       | 15    |
| DTC 1132: WGP voltage low                                     | 1192      | 4     | DTC 1424: ERWT2 higher than expected stage 1            | 444       | 15    |
| DTC 1151: Closed-loop LPG high                                | 520206    | 0     | DTC 1425: ERWT1 higher than expected stage 2            | 443       | 0     |
| DTC 1152: Closed-loop LPG low                                 | 520206    | 1     | DTC 1426: ERWT2 higher than expected stage 2            | 444       | 0     |
| DTC 1153: Closed-loop NG high                                 | 520207    | 0     | DTC 1511: AUX analog Pull-Up 1 high voltage             | 520216    | 3     |
| DTC 1154: Closed-loop NG low                                  | 520207    | 1     | DTC 1512: AUX analog Pull-Up 1 low voltage              | 520216    | 4     |
| DTC 1155: Closed-loop gasoline bank1 high                     | 520204    | 0     | DTC 1513: AUX analog Pull-Up 2 high voltage             | 520217    | 3     |
| DTC 1156: Closed-loop gasoline bank1 low                      | 520204    | 1     | DTC 1514: AUX analog Pull-Up 2 low voltage              | 520217    | 4     |
| DTC 1157: Closed-loop gasoline bank2 high                     | 520205    | 0     | DTC 1515: AUX analog Pull-Down 1 high voltage           | 520215    | 3     |
| DTC 1158: Closed-loop gasoline bank2 low                      | 520205    | 1     | DTC 1516: AUX analog Pull-Down 1 low voltage            | 520215    | 4     |
| DTC 1161: Adaptive-learn LPG high                             | 520202    | 0     | DTC 1517: AUX analog Pull-Up 3 high voltage             | 520218    | 3     |
| DTC 1162: Adaptive-learn LPG low                              | 520202    | 1     | DTC 1518: AUX analog Pull-Up 3 low voltage              | 520218    | 4     |
| DTC 1163: Adaptive-learn NG high                              | 520203    | 0     | DTC 1521: CHT higher than expected stage 1              | 110       | 16    |
| DTC 1164: Adaptive-learn NG low                               | 520203    | 1     | DTC 1522: CHT higher than expected stage 2              | 110       | 0     |
| DTC 1165: Catalyst inactive on LPG                            | 520213    | 10    | DTC 1531: Gov1/2/3 interlock failure                    | 520270    | 31    |
| DTC 1166: Catalyst inactive on NG                             | 520214    | 10    | DTC 1541: AUX analog Pull-Up/Down 1 high voltage        | 520219    | 3     |
| DTC 1171: MegaJector delivery pressure higher than expected   | 520260    | 0     | DTC 1542: AUX analog Pull-Up/Down 1 low voltage         | 520219    | 4     |
| DTC 1172: MegaJector delivery pressure lower than expected    | 520260    | 1     | DTC 1543: AUX analog Pull-Up/Down 2 high voltage        | 520220    | 3     |
| DTC 1173: MegaJector comm lost                                | 520260    | 31    | DTC 1544: AUX analog Pull-Up/Down 2 low voltage         | 520220    | 4     |
| DTC 1174: MegaJector voltage supply high                      | 520260    | 3     | DTC 1545: AUX analog Pull-Up/Down 3 high voltage        | 520221    | 3     |