

# Technical Service Information



TSI-06-08-05

**Date:** October, 2006

**Subject File:** ELECTRICAL

**Subject:** High Voltage Circuits (Greater than 50 Volts) on International® Trucks and Buses

## DESCRIPTION

**! WARNING** – To avoid property damage, personal injury or death refer to the manufacturer's service information before working on any high voltage equipment. By definition high voltage circuits and components contain voltage levels that may cause equipment damage, electrical shock and/or electrocution if handled incorrectly.

Only a trained technician may perform service inside high voltage components. If you work around or maintain high voltage circuits, please seek high voltage training.

**NOTE** – The intent of this document IS to provide some basic guidelines when working on or around International® vehicles that are equipped with high voltage electrical equipment and circuits. For specific instructions, maintenance, or service information on specific equipment or options refer to the service manuals for the specified truck models and component(s). It IS NOT the intent of this document to provide detailed service instructions for high voltage equipment and circuits.

High voltage systems require the maintainer to be familiar with two types of electrical systems.

- **DC (Direct Current)**  
Most DC systems on today's trucks use 12 Volt negative ground. Some systems can store DC electricity in batteries with operating voltages as high as 600 DC volts.
- **AC (Alternating Current)**  
The main difference between AC and DC systems is that the voltage levels in DC systems remain constant while the voltage levels in AC systems are constantly changing. When measuring an AC system, it is important to know that the average voltage is zero and that is why **A VOLTMETER SET TO DC WILL NOT INDICATE THE PRESENCE OF AN AC VOLTAGE WHEN CONNECTED TO AN AC CIRCUIT!**

High Voltage can be lethal. Always refer to the manufacturer of the high voltage component when maintenance or repairs are needed. In most cases, diagnostics and repair are performed after the high voltage circuits are disabled. If you work around or maintain high voltage circuits, please seek high voltage training.

## DESCRIPTION (CONT.)



**WARNING** – To avoid property damage, personal injury or death, circuits must be checked using a voltmeter for the presence of both dc and ac voltages. A voltmeter set to dc will not indicate the presence of an ac voltage when connected to an ac circuit! Contacting an unknown ac or dc voltage may cause equipment damage, electrical shock and/or electrocution.

Only a trained technician may perform service inside high voltage components. If you work around or maintain high voltage circuits, please seek high voltage training.

### Understanding high voltage equipment and circuits on International® products

Some examples of high voltage equipment that can be encountered on products include:

#### — **Auxiliary Power Units (APUs)**

APUs are basically small diesel powered generator units that are integrated into the vehicle electrical system. APUs are utilized in combination with inverters and battery chargers. APUs are often set up to automatically start when the electrical management system deems it necessary to maintain battery charge or electrical demand requires it.

**NOTE: APU high voltage wiring may NOT be marked for easy identification as high voltage.**

#### — **Shore Power**

Shore power is a connection from a vehicle to an external 120 volt AC power source. The vehicle is equipped with an exterior receptacle that allows connection to an external “shore” power source.

**NOTE: High voltage shore power wiring may NOT be marked for easy identification as high voltage.**

#### — **Inverters**

Inverters are electronic devices used to change DC (Direct Current) into AC (Alternating Current). Some inverters contain converters that also convert AC to DC for battery charging or running 12V equipment.

**NOTE: High voltage wiring for Inverters may NOT be marked for easy identification as high voltage.**

#### — **Hybrid Electric Vehicles (HEVs)**

HEVs combine internal combustion engines with high voltage batteries, electric motors, and inverters to offer higher fuel efficiency and lower emissions without compromising power, range, and convenient fueling of conventional vehicles. Regardless of the HEV design, high electrical voltages and currents are present.

**NOTE: The industry standard for high voltage cables are for the cables to be covered in ORANGE CONDUIT.**

If orange conduit is observed on a vehicle, please review the safety precautions for that system.

### How to identify high voltage circuits

High voltage circuits are not always connected with large wires. The best way to identify high voltage equipment or circuits is to be familiar with the equipment and circuit diagrams as well as to look for high voltage warning labels and orange conduit. Inspect the vehicle for any equipment or circuits added after the truck was built (owner/operators may add high voltage components such as inverters or APUs).

All electrical circuits associated with APUs, shore power, inverters, and HEVs should be considered high voltage. The standard for high voltage cabling on HEVs is orange. APUs, Inverters, shore power, and cabin 110/120V outlet wiring may not indicate high voltage by visual inspection (they may not be marked and are NOT orange in color).

## DESCRIPTION (CONT.)

### Servicing International® products

The following steps outline the appropriate method to follow to identify and address any maintenance or service on International® products with factory installed high voltage equipment.

1. Complete related training prior to attempting to identify and service any high voltage system.
2. Review the line-set ticket provided with the vehicle or from ISIS and identify all high voltage components. Inspect the vehicle for any equipment or circuits added after the truck was built (owner/operators may add high voltage components such as inverters or APUs that could be live and powering circuits in the vehicle **EVEN WITH THE IGNITION OFF AND THE BATTERIES DISCONNECTED**).
3. Refer to manufacturer's service publications for identified high voltage components.
4. Physically locate high voltage components on the vehicle and disable them according to manufacturer's instructions (some components may require a waiting period or special procedures to discharge the voltage completely).
5. Use Best Work Practices (see below) when performing work on electrical systems.

### Best Work Practices



**WARNING – To avoid personal injury or death, permit only trained responsible and capable persons to operate or maintain the equipment. Carelessly operating or neglecting maintenance despite the safe design of any vehicle and its high voltage equipment may result in personal injury or death.**

**The danger of injury through electrical shock is possible whenever electrical power is present. Most fatal injuries result from high-voltage exposure; however, people can sustain severe injuries from low voltage power if it has a high current flow.**

- Be aware of ALL high voltage equipment on the vehicle; review line-set/build ticket and the owner and service manuals of high voltage equipment BEFORE starting any work.
- When working on this equipment, remain alert at all times. Never work on the equipment when you are physically or mentally fatigued and never work alone near high voltage equipment.
- Always stand on an insulated, dry surface when working on any electrical circuit. Do not handle any kind of electrical device while standing in water, while barefoot, or while hands or feet are wet.
- Always work in an adequately illuminated area.
- Always use appropriate protective equipment: insulated gloves, rubber gloves, goggles/face shield, safety shoes, protective clothing, and insulated tools when working on electrical components/circuits of the vehicle.
- Never wear jewelry when working on this equipment. Jewelry can conduct electricity resulting in electric shock or burns, and may get caught in moving components causing injury.
- When working on vehicles that have high voltage devices or equipment, use appropriate alerting techniques in plain view to warn people that may be in the general area and to prevent inadvertent activation of any disabled high voltage circuit(s) during service: safety signs, safety symbols, tags, barricades, cones, etc.

## DESCRIPTION (CONT.)

- Keep a fire extinguisher close by at all times. Extinguishers rated “ABC” by the National Fire Protection Association are appropriate for use on the electrical system. Make sure the extinguisher is properly charged and be familiar with its use. If you have any question pertaining to fire extinguishers, consult your local fire department.
- Ensure that the high voltage power, high voltage power generating equipment, and high voltage storage devices are disconnected, locked out, or otherwise disabled BEFORE working on or around the vehicle, its electrical circuits, or components. Unless disabled, Auxiliary Power Units (APUs) may start at any time without warning; when this occurs, the circuits associated with the APU become energized with potentially lethal high voltage. Some components may require a waiting period or special procedures to discharge the voltage completely.
- Use an appropriate electrical tester and procedures to confirm that the power is disconnected BEFORE performing any work on or near any high voltage components/circuits.
- Exercise caution around output circuits even when the input power is off. Parallel power sources and energy storage devices can still be dangerous. Be familiar with the high voltage equipment installed on the vehicle. Some systems contain high voltage condensers that may require time to discharge after power is removed.
- After disconnecting or exposing a high-voltage connector or terminal, insulate it immediately using insulation tape.
- After completion of any electrical work, BEFORE restoring the power, verify that parts and or tools are removed from the work area and that the fasteners are firmly tightened to the specified torque and the connectors are correctly connected.
- Voltage can be fatal at levels greater than 60 volts. High voltage can jump a larger air gap than low voltage. If contact is made with high voltage it may not be possible to simply “let go”.
- Towing a HEV with its drive wheels on the ground may cause the motor to generate electricity. Consult your operator’s/owner’s manual for proper towing procedures.
- If a high voltage fuse or circuit protection device trips, do not re-energize the circuit until it has been determined that the circuit is safe. See manufacturers troubleshooting procedures before servicing a high voltage system.
- Reference OSHA Regulations as necessary and applicable.

### High Voltage Feature Codes

The following is a listing of High Voltage feature codes released for production at the date of release of this TSI. This listing does not include feature codes for block heaters, oil pan heaters, and shore power circuits which require connection to a 120V external power source.

08WES – Inverter (PowerPack 1)

60AAC – Inverter (PowerPack 3)

12WTK – Auxiliary Power Unit

10HEV – Hybrid Electric Vehicle ID

**NOTE – Additional high voltage equipment may be retrofitted or added by body builders or owners and operators after a truck is built.**