



WSDOT Test Method T 430

Test Method for Uninterruptible Power Supply (UPS) System Compliance Inspection and Test Procedure

1. Scope

The purpose of this test method is to provide a documented method for the steps involved with the inspection and testing of an Uninterruptible Power Supply (UPS) system.

2. Reference Documents

- WSDOT *General Special Provisions* 8-20.2(9-29.13).OPT1.GR8
- WSDOT *General Special Provisions* 8-20.3(14).OPT1.GR8
- NEMA Standards Publication PE-1, Uninterruptible Power Systems (UPS) – Specification and Performance Verification
- IEC Standards Publication 62040-3: Uninterruptible Power Systems (UPS) – Method of specifying the performance and test requirements
- IEEE Standards Publication 1188 – Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) batteries for Stationary Applications

3. Safety

Use proper lifting techniques whenever handling equipment, parts, or batteries.

Always assume electrical connections or conductors are live. Exercise caution when working with electrical connections as high voltages could be present. Wear insulating gloves and use insulated tools when working with any electrical connections.

Batteries should be handled with extreme care as they can cause severe injury. Spilled electrolyte can destroy clothing, burn skin, or cause blindness. Always wear eye protection and wear rubber gloves when working with batteries.

4. Apparatus

DATAQ Instruments model DI-718B Data Logger or device capable of simultaneously logging ac load Voltage, UPS Battery set dc input current, UPS Battery set dc input Voltage, and UPS Battery set temperature.

Simpson model 06713 current shunt or device capable of providing a current measurement range up to 100 Amperes through a 50 millivolt conversion drop.

DATAQ Instruments WinDAQ software or software capable of accessing and processing playback of logged data from the data logger. Through linear interpolation, this data will be used to produce a test report detailing calculated operational duration and power efficiencies based on different load values.

Passive load designed to operate on 120 V_{ac}. Power rating shall vary based on Contract Documents.

5. Procedure

5.1 Incoming Inspection

When the Uninterruptible Power Supply (UPS) Cabinet arrives for testing, the contractor representative (typically the contractor's vendor) should have an appointment scheduled. Within seven (7) calendar days of arrival, the contractor representative shall assemble and demonstrate the Uninterruptible Power Supply (UPS) Cabinet. If assembly is not completed within these seven (7) calendar days, disposition of the Uninterruptible Power Supply (UPS) Cabinet is at the discretion of the Electrical Materials Laboratory personnel. Inspect the Uninterruptible Power Supply (UPS) Cabinet, battery set, and any accessories for damage during shipping. Note any deficiencies.

5.2 Notify Project Office

Notify the project office and the contractor of the receipt of the Uninterruptible Power Supply (UPS) system. Note all Points-of-Contact who shall be copied on all communications and test results for this project

5.3 Assess Uninterruptible Power Supply (UPS) System Compliance

The Uninterruptible Power Supply (UPS) System shall be inspected to ensure that it is in compliance with General Special Provisions and Contract Documents. Ensure that all of the required equipment is installed per these General Special Provisions and Contract Documents. In the event of a conflict, Contract Documents take precedence over the General Special Provisions. At a minimum, the following items shall be inspected against the Contract Documents and General Special Provisions:

1. Cabinet Construction (cabinet type, door lock type, lighting type, etc.)
2. System Components (controller type, battery type, accessories, etc.)
3. System Documentation (serial numbers, drawings, component manuals, etc.)

5.4 Assess Uninterruptible Power Supply (UPS) System Performance

5.4.1 Setup

The contractor representative shall provide all work necessary to assemble the UPS system at the State Materials Laboratory. Upon delivery, the battery set shall be installed and the UPS system shall be made fully operational by the contractor representative.

Two sets of data will be recorded for the duration of this test, one manually recorded and one automatically recorded via Data Logger. Once the UPS system is fully operational, the Data Logger shall be installed to monitor operation while under load. The following parameters shall be monitored: ac load Voltage, UPS battery set dc current, UPS battery set dc Voltage, and UPS battery set temperature. Power down the UPS system. Connect the ac load Voltage monitor in parallel with the ac test load. Do not connect the ac test load to the UPS cabinet at this time. Install a current shunt in series with the negative line of the UPS battery set. Connect the UPS battery set dc current monitor across the series current shunt between the UPS battery set and the UPS cabinet. Connect the UPS dc Voltage monitor across the UPS battery set terminals. Finally, connect the UPS battery set temperature monitor to the case of the upstream-most UPS battery. Power up the UPS system.

Manually recording of data shall be performed at regular intervals during this test. This data will be taken from the UPS system Inverter Display. The following items are to be recorded:

- VIN (line Voltage in to the Inverter in V_{rms})
- VOUT (output Voltage from the inverter to the test load in V_{rms})
- IOUT AC (output current from the Inverter to the test load in A_{ac})
- BATT TEMP (battery temperature in degrees Celsius)
- FREQ IN (line frequency in to the Inverter in Hertz)
- OUTPUT PWR (output power from the Inverter to the test load in Watts)
- BATT VOLT (battery Voltage to the Inverter in V_{dc})
- CHGR CUR (battery charging current in A_{dc})
- kWh (accumulated output energy in kilo-Watthours)
- Remain Tm (remaining battery runtime in hours and minutes)

5.4.2 Test Execution

Allow the UPS cabinet to fully charge the UPS battery set prior to test. The UPS battery set is considered fully charged when the charging current is less than 500 milliAmperes and the battery set Voltage is $53.5 \pm 0.5 V_{dc}$.

Verify the UPS system is not connected to a load, that it is connected to both line input and the UPS battery set, and the system is operational. The system is now at its initial condition. Start the Data Logger for automatically recorded data and take note of the first set of Inverter Display readings for manually recorded data.

Connect the test load to the UPS system and verify the load is operating. The size of the test load shall be specified in the Contract Documents. With the test load connected, disconnect the line input to the UPS system. The UPS system shall switch from line input operation to battery operation with no interruption of power to the test load. The system is now at its test condition. Take note of the next set of Inverter Display readings for manually recorded data. Continue to manually record Inverter Display readings at regular intervals until the UPS system powers down (this occurs when battery Voltage reaches $42.0 \pm 0.5 V_{dc}$).

5.4.3 Test Completion

After the UPS system powers down, stop the Data Logger and disconnect the test load. Disconnect all Data Logger monitors from the UPS system. Reconnect the line input to the system and allow the UPS battery set to fully charge. Note the time required for the UPS battery set to fully charge.

After the UPS battery set is fully charged, remove all laboratory equipment and prepare the UPS system for shipment. Return all test equipment to their proper storage location.

6. Report

Compile the manually recorded data into a spreadsheet for evaluation. Use the Data Logger software to compile automatically recorded data into plots for each of the channels monitored. Using linear interpolation, calculate the operational duration and power efficiencies for different load values. The data recorded between the two methods should reasonably align with each other.

Inspect the plots detailing the ac load Voltage (Output Voltage), UPS battery set dc current (Batteries Current), UPS battery set dc Voltage (Batteries Voltage), and UPS battery set temperature (Batteries Temperature). There shall be no spikes or drops (glitches) observed in the plots throughout the duration of the test. The plot values shall be within the battery manufacturer's recommended values in order for the test to be considered successful. The operational duration (Battery Life) shall be within the battery manufacturer's recommended values in order for the test to be considered successful.

Record any deficiency that does not meet the above minimum requirements. Report any corrective actions taken on the test report. The overall test result shall be recorded as a "Pass" or "Fail" for test T 430 in MATS.

Performance Exam Checklist

Method T 430 Checklist

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Participant Name: _____ Exam Date: _____

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

| Procedure Element | Trial 1 | Trial 2 |
|--------------------|---------|---------|
| 1. Setup | _____ | _____ |
| 2. Test Execution | _____ | _____ |
| 3. Test Completion | _____ | _____ |
| 4. Report | _____ | _____ |

Comments: First Attempt: Pass _____ Fail _____ Second Attempt: Pass _____ Fail _____

Examiner Signature: _____ WAQTC #: _____

