



DATA ACCEPTANCE PROGRAM

Laboratory Power Quality

Revision 11.0 – UL internal approver change. No changes to criteria

For Client Labs

Purpose

- To ensure laboratory test power sources are stable during the performance of testing and data collection.

Why is this requirement important?

- Laboratory test power sources can have a direct impact on test results, including accuracy, uncertainty and consistency
- Power conditions affecting test data on which certification decisions are based are required to be analyzed in accordance with ISO \ IEC 17025 paragraph 5.3.1: “Laboratory facilities for testing and/or calibration, including but not limited to energy sources, lighting and environmental conditions, shall be such as to facilitate correct performance of the tests and/or calibrations”.

Records

Certificates, Approval Forms, and Other Documentation

- Records demonstrating monitoring and control of laboratory test power sources specified by the testing requirements are to be acquired throughout the testing process for proof of compliance.

For WTDP -

- UL staff will review copies of the power quality analysis and will indicate compliance / non-compliance in the test data sheet package.

For other DAP programs (CTDP, TCP, TPTDP, and PPP) -

- Clients are to index and retain copies of power quality analysis and related documentation.
- In lieu of storage of paper copies of the documentation, these may be stored electronically.

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1. REQUIREMENTS:

- A. UL requires all labs that generate data used in certification decisions to comply with this document.

EXCEPTIONS:

1. Laboratories that evaluate non-electrical products are not required to conduct a Power Quality Analysis. Such as plastic and etc.
 2. Standards and/or tests methods which do not require a Power Quality Analysis and are documented as such in the UL Global Form datasheet packages, ultra link, etc.
- B. The power quality analysis (PQA) is to be performed at the point of test connection(s) every three years. The schedule may be planned such that circuits are analyzed at specific times within the **three-year cycle**, providing that all test circuits are evaluated within the three-year period. Local power conditions may require more frequent monitoring to assure power quality parameters are maintained.
- C. When the test circuit(s) are modified or repaired, a power quality analysis shall be performed prior to use. Consideration shall be made for changes to the circuits external to the facility. See Appendix A.
- D. The test equipment used in the Power Quality Analysis shall be calibrated by an accredited laboratory or in-house calibration See **(00-OP-C0038)** and shall meet the indicated accuracy requirements provided in **(00-OP-C0034)**
- E. Where requirements in this document depart from the requirements in IECCE Operational Procedure OD-5010 "Procedure for Measuring Laboratory Power Source Characteristics" the requirements in OD-5010 shall be applied for testing products under the IECCE CB Scheme. See http://www.iecee.org/ctl/operational/Operational_procedures.htm
- F. Consideration shall be made with regional power conditions such as periodic loss of mains power, voltage sags, voltage increases or other events that influence testing results. The conditions shall be reported to the local Laboratory Manager, or staff designated by the Laboratory Manager, for review. If the results of the power quality analysis exceed the specified tolerances at any point, the local Laboratory Manager, or staff designated by the Laboratory Manager, shall examine the power quality assessment results to determine acceptance or rejection.
- G. Records of the power quality analysis and the review of results shall be maintained by the laboratory. Retention time for the records are to be retained for 5 years from the date of the signature of the authorized signatory on the data package in which the last time the power source was used.

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2 Detailed Requirements:

- Clause 3: Circuits to be analyzed
- Clause 4: Use of Equipment Grounding Conductor (EGC)
- Clause 5: Variable Transformers
- Clause 6: Circuit Loading Techniques
- Clause 7: Voltage Regulation Test
- Clause 8: Power Supply Frequency
- Clause 9: Independence of Test Circuits
- Clause 10: Total Harmonic Distortion (THD)

Clause 3: Circuits to be Analyzed

3.1 If a product is intended to be connected to a branch circuit having the following nominal parameters a Power Quality Analysis must be conducted:

- 120V 60Hz up to 20A,
- 240V 60Hz up to 15A,
- 230V 50Hz up to 16A

Tolerances

- Nominal Voltage: +/- 3%
- Nominal Frequency: +/- 2%
- Total Harmonic Distortion: 5% max

Exception: THD values greater than the stated limits may be judged acceptable if agreed to by all parties involved, the rationale is documented and requirements of the test standard are maintained.

3.2 The analysis of poly-phased circuits shall be as indicated by the test standard. The results of the analysis shall be recorded and shall be available for review.

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Clause 4: Use of Equipment Grounding Conductor (EGC)

4.1 Where the Equipment Grounding Conductor is utilized in testing, test circuits used for testing products intended for use on North American 120V and 240V 60Hz branch circuits shall be evaluated as described in 4.2 through 4.5.

4.2 Measurement of the Line (L), Neutral (N) and Equipment Grounding Conductor (G) voltages are to be made to confirm that branch circuits are properly connected and the Equipment Grounding Conductor connection is functioning.

4.3 Measurements to be made are Line to Neutral voltage, Line to Equipment Grounding Conductor voltage and Neutral to Equipment Grounding Conductor voltage.

4.4 The open circuit voltage between Line and the Equipment Grounding Conductor, and the voltage between Line to Neutral shall be within 0.5 V. If the L-G voltage measurement does not equate to the L-N voltage, the Equipment Grounding Conductor and / or neutral, circuit connections may require service. Corrective action is required before proceeding with testing.

4.5 The measured open circuit voltage between Neutral and Equipment Grounding Conductor shall be 4 V or less. If N-G voltage measurement is 4V or greater, circuit resistance of the ground path may be too high or there may be too much leakage current on the Equipment Grounding Conductor. Investigation and corrective action is required before proceeding with testing.

NOTE - Where the test standard does not require the use of the Equipment Grounding Conductor in tests, it is recommended that this evaluation be made to improve safety measures for lab personnel and test equipment.

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Clause 5: Variable Transformers

- 5.1.1 When a variable transformer (tapped winding, autotransformer such as a Variac or Slidac) is utilized at any time during tests, analysis shall be made with the transformer in the test circuit.

Clause 6: Circuit Loading Techniques

- 6.1.1 Resistive Load – Resistive loading is the preferred method. Loading of the circuit is to be either the maximum rated capacity of the circuit protector, or the equivalent loading value of the test sample. If the loading is less than the test circuit protector rating, the test circuit shall be identified as having a limited range of use determined by the test load so it is readily apparent to the user.
- 6.2.1 Test Sample - The test sample may be used to load the test circuit. If the test sample loading is less than the test circuit protector rating, the test circuit shall be identified as having a limited range of use determined by the test sample load so it is readily apparent to the user.

Clause 7: Voltage Regulation Test

- 7.1 The open circuit voltage is to be monitored for a period of one hour.
- 7.2 A load is to be connected to the test power connection point.
- 7.2.1 The voltage is to be adjusted to the appropriate nominal value and the load is to be adjusted to draw the desired amperage of the supply at the rated nominal voltage.
- 7.2.2 Where a tapped transformer or autotransformer is used for voltage regulation, monitoring and adjustment as defined in 7.2.1 is permitted until the load and transformer heating have stabilized.
- 7.2.3 The voltage at the test connection is then measured. The loaded circuit is then to be monitored throughout a period of one hour. Refer to Appendix A. Where a transformer with manual adjustment is used, the Min/Max voltage value is to be recorded PRIOR to any voltage adjustment.

Clause 8: Power Supply Frequency

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- 8.1 Frequency analysis shall be performed where power sources utilize an oscillator device to generate the desired test power frequency.

NOTE - Power grids of industrialized countries provide acceptable frequency stability in most cases. See U.S. Department of Commerce “Electrical Current Abroad” to assist in determining if the domestic power source maintains a stable frequency.

Clause 9: Independence of Test Circuits

- 9.1 The independence of test circuit’s analysis shall be performed to determine the influence of other loads within the facility, such as heating/ cooling equipment, manufacturing systems, etc.
- 9.2 Any equipment that is connected to the laboratory power distribution system that could influence the power quality of a test circuit is to be operated during the PQA.
- 9.3 The lab may conduct the PQA at times that will have the least impact on operations providing that the conditions during analysis represent those encountered during typical testing periods.
- 9.4 The location selected for the analysis shall be the point(s) at the greatest electrical distance (wiring length) from the supply transformer or power converter being used to power the test circuit(s).

Clause 10: Total Harmonic Distortion (THD)

- 10.1 Prior to making harmonic measurements, a detail schematic of the power system being analyzed is to be reviewed. This information will allow single-point harmonic measurements to be made where multiple parallel (voltage) paths exist, reducing measurement time and the need to deploy multiple instruments. Refer to Appendix A.

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APPENDIX A FOR INFORMATION PURPOSES ONLY

External Circuits:

- Changes in the power distribution system characteristics external to the lab building may occur as a result of additional customers being added to the local power grid or due to connection of customers having large power demands - such as manufacturing facilities. Where growth increases the number of customer power connections or power demand, it is strongly recommended that monitoring of power quality inside the laboratory be performed on a more frequent basis.

Voltage Regulation:

- Where analog instruments are utilized in a manual process of monitoring voltage, observation periods of 5 minutes, or less, are highly recommended.
- Instruments having the ability to automatically capture minimum / maximum values are typically utilized at the instrument's designed data capture rate, though it is highly recommended that a capture rate of 5 minutes, or less, be used.

Notes for THD:

- Where IEC 61000-4-7 is applied to the instrument used in making harmonic measurements, an Instrument Class II rating is sufficient. *“Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto”*
- Where IEC 61000-4-7 is not applied, an instrument with capability to measure at least to the 20th harmonic is acceptable. THD instrument settings, including the filter window settings shall be recorded, to allow repeatability of future measurements. In the event the instrument filter settings are not accessible (or known) by the operator, the instrument manufacturer shall be consulted to determine the type of filter window utilized in the instrument.

Data Sheets:

- The following datasheets below are provided as a guidance tool to record your Power Quality Analysis. The use of these datasheets is **not a requirement**. The use of the report section in the OD-5010 “Procedure for Measuring Laboratory Power Source Characteristics” could also be used, or one developed by the Laboratory.

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TEST LOCATION:	
<input type="checkbox"/> WTDP	<input type="checkbox"/> CTDTP
<input type="checkbox"/> TCP	<input type="checkbox"/> TPTDP
Company Name	
Address	
DA File Number	

CLIENT INFORMATION	
Company Name	
Address	

AUDIT INFORMATION:	
<input type="checkbox"/> Description of Tests	Number of Circuits Tested:
<input type="checkbox"/> Tests Conducted by	
_____	_____
Printed name	Signature & Date

TEST EQUIPMENT INFORMATION

Inst. ID No.	Instrument Type	Function /Range	Last Cal. Date	Next Cal. Date

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Verification of Circuits

Method

The following items need to be conducted at the client's laboratory prior to starting the Power Quality Analysis.

[] Review Schematic of test laboratory and verify the number of power sources.

[] Verify each power source back to the disconnect (breaker). Use a voltage meter to ensure there is no voltage present once the circuit is broken. (or any other means to ensure the correct circuit is being evaluated)

[] Verify "ALL LOADS" (Cycling Equipment, if any) are documented for each power source used for testing.

Note: Cycling Equipment is considered to be any type of equipment that is placed on the same power source as that of the test source, which could potentially effect the measurements of the Power Quality Analysis. Examples of cycling equipment are as follows, but not limited to: HVAC Equipment, Manufacture's Machinery, Welding Equipment, and other test equipment.

Results

Number of Test Circuits =

Identify the Loads per each circuit -

<u>CIRCUIT IDENTIFICATION</u>	<u>LOAD TYPES</u>

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L-N; L-G; N-G Voltage Measurement Test

METHOD

Measuring the open circuit voltage between Line and Ground (L-G), Neutral and Ground (N-G), and Line and Neutral (L-N) are checked at each representative test bench outlet receptacle, or test power connection point.

Circuit Identification	Volts Line to Neutral	Volts Line to Equipment Ground	Volts Neutral to Equipment Ground

Results

The measured open circuit voltage between L-G is within (0.5 Volts) as that of L- N.

True _____ False _____

The measured open circuit voltage at N-G is 4 V or less

True _____ False _____

NOTE 1 - If the L-G voltage measurement is not within (0.5 V) as that of L-N voltage, the ground and / or neutral circuit connections may require service. Corrective action is required before proceeding with testing.

NOTE 2 - If N-G voltage measurement is 4V or greater, circuit resistance of the ground path may be too high. Investigation and corrective action is required before proceeding with testing.

NOTE 3 - Refer to the wiring diagram and floor plan for the location of the receptacle / power connection point.

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Voltage Regulation / Circuit Capacity Test

METHOD A

1. The open circuit voltage at the representative test bench receptacle / test power connection point is to be adjusted to the nominal value and recorded. **No further adjustments are to be made.**

METHOD B

2. A load is connected to the same outlet / test power connection point.
 - a. The voltage is to be adjusted to the appropriate nominal value and the load adjusted to draw the rated amperage of the supply and the load adjusted to draw the rated amperage of the supply at the nominal voltage.
 - b. The voltage at the test connection is then measured. The loaded circuit is then to be monitored and recorded throughout a one-hour period.
 - c. Where a manual variac / slidac is used, the value of the voltage adjustment made at each recommended 15 minute interval mark, is to be recorded. Min/Max values are recorded at each recommended interval **PRIOR** to voltage adjustment

RESULTS A

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Loading Condition	Method A - NO LOAD TEST				
Real Time					
Test Time (minutes)	T=0				T=60
Adjusted Nominal Voltage		-----	-----	-----	-----
Voltage (Min)	-----	-----	-----	-----	
Voltage (Max)	-----	-----	-----	-----	

The unloaded voltage regulation was calculated to be MAX of $((V_{oc\ max} - V_{nom}) / V_{nom}) \times 100 = \text{---}\%$
 $; ((V_{nom} - V_{oc\ min}) / V_{nom}) \times 100 = \text{---}\%$

The results comply with the voltage regulation requirement of $\pm 3\%$ (or the limit of _____ as specified in test standard _____) for unloaded condition

True _____ False _____

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RESULTS B

Loading Condition	Method B - LOAD TEST				
Real Time					
Test Time (minutes)	T=0	T=15	T=30	T=45	T=60
Amps (Load)					
Adjusted Nominal Voltage		-----	-----	-----	-----
Voltage (Min)	-----	-----	-----	-----	
Voltage (Max)	-----	-----	-----	-----	
Manual Adjustment Voltage (Min/Max)	-----				

The loaded voltage regulation was calculated to be MAX of $((V_{\text{loaded max}} - V_{\text{nom}}) / V_{\text{nom}}) \times 100 = \text{_____}\%$
; $((V_{\text{nom}} - V_{\text{loaded min}}) / V_{\text{nom}}) \times 100 = \text{_____}\%$

The results comply with the voltage regulation requirement of $\pm 3\%$ (or the limit of _____ as specified in test standard _____) for max. loaded condition:
True _____ False _____

Where manual adjustments were made to maintain the voltage value under load, provide the amount of adjustment required at each 15-minute interval over the one-hour monitoring period.

T 0 minutes = T 15 minutes = T 30 minutes = T 45 minutes = T 1 hour =

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Frequency Stability Test

METHOD

NOTE - In most cases, power grids in industrialized countries provide acceptable frequency stability. If it is determined that your domestic power source does maintain a stable frequency, at the value in which the testing occurs, Please provide in the comments below how you determined this acceptable frequency stability.

1. The frequency of the voltage (sinusoid) at the representative test bench receptacle / power connection point is to be measured under no load conditions and recorded.
2. A load is to be connected and adjusted to draw the rated supply amperage. The voltage is to be adjusted to the appropriate nominal value and the load adjusted to draw the rated amperage of the supply at the nominal voltage. Where a variac / slidac is used for voltage regulation, monitoring and adjustment as defined above is permitted until the load and variac heating have stabilized. The frequency of power source is to be measured and recorded (e.g. with a frequency counter or an oscilloscope). The circuit is to be loaded for one hour and the frequency under this loading condition is then to be measured again and recorded.

Results (1)

Loading Condition	NO LOAD TEST				
	T=0	T=15	T=30	T=45	T=60
Test Time (minutes)					
Frequency (Hz)		-----	-----	-----	-----

***Note - Some 50Hz 230V circuits are designed and limited to 10A maximum. Use this value when loading these circuits and make a notation in the "Remarks" column.**

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Results (2)

Loading Condition	LOAD TEST				
	T=0	T=15	T=30	T=45	T=60
Test Time (minutes)					
Frequency (Hz) (Max)		-----	-----	-----	
Frequency (Hz) (Min)		-----	-----	-----	

Frequency variation = MAX of $((F_{\text{loaded max}} - F_{\text{nom}}) / F_{\text{nom}}) \times 100 = \text{-----}\%$;
 $((F_{\text{nom}} - F_{\text{loaded min}}) / F_{\text{nom}}) \times 100 = \text{-----}\%$

The results comply with the frequency tolerance of $\pm 2.0\%$ (or the limit of _____ as specified in test standard _____) for max. frequency variation.
 (check one):

True _____ False _____

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Total Harmonic Distortion Test

METHOD

1. Using a Total Harmonic Distortion analyzer, the harmonic distortion of the voltage at the representative test bench receptacle / power connection point is to be measured under open circuit conditions.
2. The total harmonic distortion is measured with the test connection point loaded to the rated amperage. The circuit with this load was allowed to operate for one hour and the harmonic distortion under this loading condition was measured again.

***Note - Some 50Hz 220V circuits are designed and limited to 10A maximum. Use this value when loading these circuits and make a notation in the "Remarks" column.**

Results (1)

Loading Condition	NO LOAD TEST				
Real Time					
Test Time (minutes)	T=0	T=15	T=30	T=45	T=60
Total Harmonic Distortion %		-----	-----	-----	-----

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Results (2)

Loading Condition	LOAD TEST				
Real Time					
Test Time (minutes)	T=0	T=15	T=30	T=45	T=60
Total Harmonic Distortion %		-----	-----	-----	
Amps (Load)		-----	-----	-----	

Both the THD at open circuit and at max load condition comply with the THD of 5% (or the value_____specified in the test standard) maximum*. (check one):
 True _____ False _____

*THD values greater than 5.0% may be judged acceptable if agreed to by all parties involved, the rationale is documented and requirements of the test standard are maintained.

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Independence of Circuits

Where analysis of the facility wiring diagram indicates test circuits are connected to the same source of power as high demand switching loads such as air conditioning/ heating or manufacturing systems, the effect on test circuits from the cycling of this equipment is to be determined.

METHOD

1. The duration of this test is to be adjusted to allow high demand starting loads to cycle. The cycling may need to occur more than once to determine the effect, in magnitude and duration that the starting loads may have on the test circuits.
2. The voltage at each representative test location is to be measured under the normal conditions. (Make no changes to the environmental conditions)
3. The measurement is to be repeated with Cycling Equipment (Such as HVAC, and Manufacturing Equipment) turned off and on. **Make a note if these systems could not be turned off.**

RESULTS

Circuit Identification	T=0 thru T=30 Minutes - Voltage Normal Conditions		15 Minutes - Voltage with Cycling Equipment Off		15 Minutes - Voltage with Cycling Equipment On	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum

The voltage measured during high demand load conditions did not deviate from the normal conditions by more than $\pm 3\%$ (or the value specified in the test standard). True _____ False _____

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