UL Testing Report

Applicant: Nanov Display, Inc

Category: UL48, Outdoor Electric Messaging Signs

Test Location: 141 Flushing Ave Suite 705, Brooklyn, New York

Date: July 24th – July 26th, 2019

Attendees: Nazir Gouhary – UL Staff Engineer (Nazir.S.Gouhary@ul.com)

Mr. Myungkune Moon – Nanov Display, Vice President

Ms. Joselin Campoverde – Nanov Display, Tech Support

Christopher Guzowski & Damian Banner – Tech Support

Prepared by compliance@nanovdisplay.com

Tests Performed

INPUT TEST (normal & abnormal): The input test involves loading the product to its maximum load condition and measuring the input current. When the input power, input VA, and/or Power Factor are included on the rating plate, these values must also be measured.

Result: The input current measurement was normal and passed the test.

COMPONENT TEMPERATURE TEST: Individually & simultaneously track the temperature of each component to ensure heat on those parts do not exceed the safety range.

Result: The components in our units were well within the safety range.

DIELECTRIC VOLTAGE WITHSTAND TEST: The objective of the dielectric voltage withstand test is to establish the minimum level of electrical insulation necessary to prevent human contact with a potentially harmful voltage and resulting current. In addition, the dielectric voltage withstand test may reveal faults in mechanically damaged insulation or the presence of a foreign material (such as water) which may bridge the insulation. The dielectric voltage withstand test is also used on the manufacturing production line to identify material and workmanship defects in assembled devices.

Result: The electrical insulation was determined and passed safety criteria.

LOCKED ROTOR TEST: A blocked rotor test is conducted on an induction motor. From this test, short circuit current at normal voltage, power factor on short circuit, total leakage reactance, and starting torque of the motor can be found.

RAIN TEST: Test to ensure unit is waterproof (no interior droplet buildup) by simulating a downpour more extreme than that of a natural rainstorm. This test lasted for 4 hours, the first hour being with the units power off, the second hour with the power on and finally for the last 2 hours tested under various abnormal conditions.

Result: The engineers inspected the interior to find no water or moisture has penetrated to the inside.

BOND IMPEDANCE TEST: To test grounding function of EUT's metal casing or grounding parts are equipped with a good grounding function. This test is done to determine if it could act as a re-grounding protection function.

Result: Our units have a safe grounding function.

LEAKAGE CURRENT: One of the deadliest hazards to human life has a very simple name: “Leakage Current”. Leakage Current is the current that flows through a person when they touch an electrical product. Purpose of the Test is to measure the amount of current that passes through a person when that person touches an electrical product. The test method involves fully energizing and operating the product being tested as it is intended. While the product is energized, a “leakage current meter” is applied between the product and ground. The leakage current meter provides the “body circuit” representing the human body impedance (human body simulator) and the current measurement through the body circuit. Consider that the two leads for the leakage current meter act as the hands or hand and foot of a person. In this manner, the leakage current tester can be connected such that it simulates a person touching the product while also touching ground. The amount of leakage current is dependent upon several factors including the insulating materials in the product, the mains voltage, and whether the product has an EMI filter.

Result: The leakage current from our units was well within safety range.

ABNORMAL OPERATION TEST: This test is performed on the overall product to insure that during a foreseeable abnormal operating condition, there is no Risk of Shock or Risk of Fire. The product safety standards require that the product be suitably protected from shock and fire hazards in the event of any single fault condition (abnormal operating condition).

Result: Performed safely under abnormal circumstances and circumvented these potential vulnerabilities.

MAXIMUM OUTPUT VOLTAGE TEST: These requirements cover indoor and outdoor use Class 2 power supplies and battery chargers. These units utilize an isolating transformer and may incorporate components to provide an alternating- or direct-current output. Each output provides Class 2 power levels in accordance with the National Electrical Code, NFPA 70. Maximum output voltage does not exceed 42.4 V peak for alternating current, 60 V for continuous direct current.

Result: Maximum output voltage is within expected range.

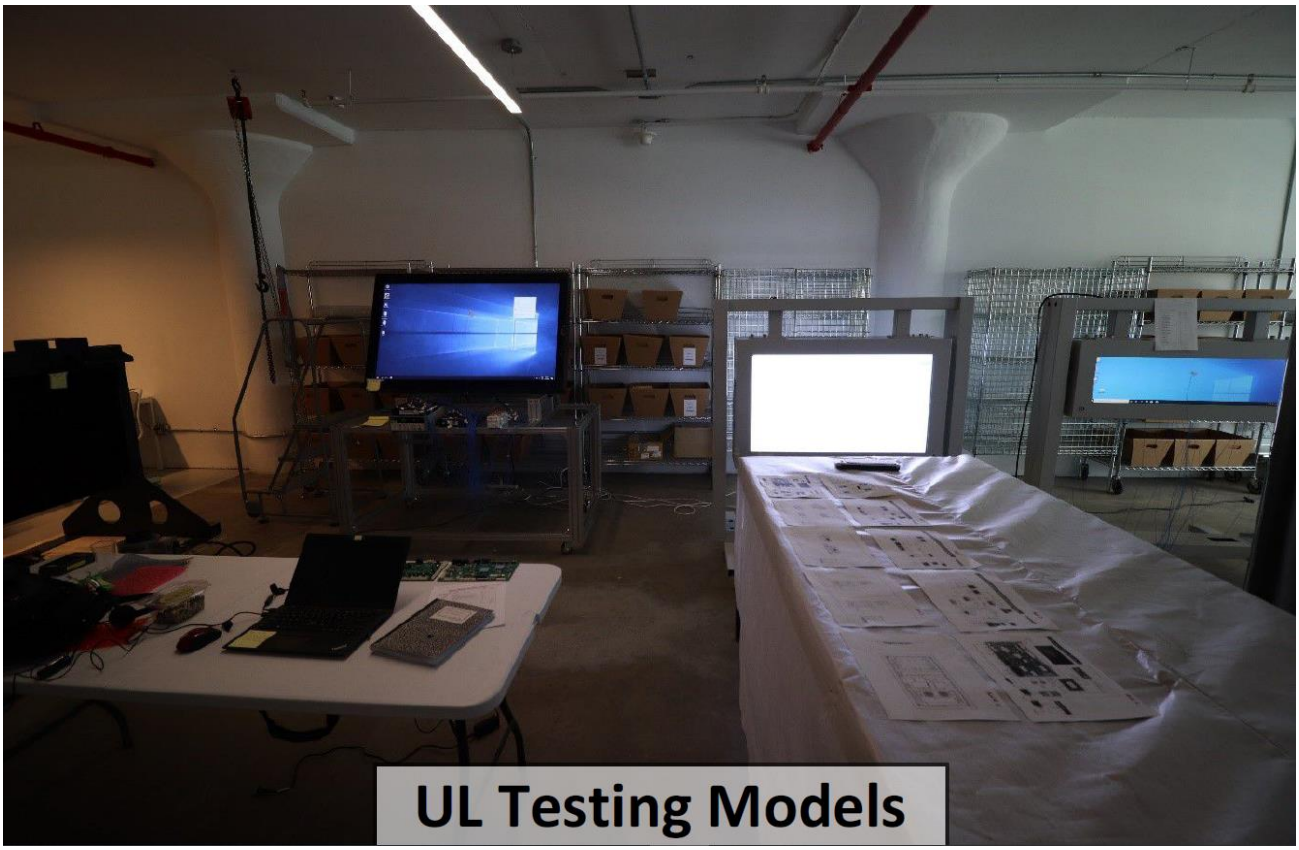
MAXIMUM OUTPUT CURRENT AND POWER TEST (Hi-Voltage): Test electricity overload by replicating the voltage power of a lightning strike (1500V) for a minute.

Result: The unit continued to work normally with no safety issue and encountered no problems.

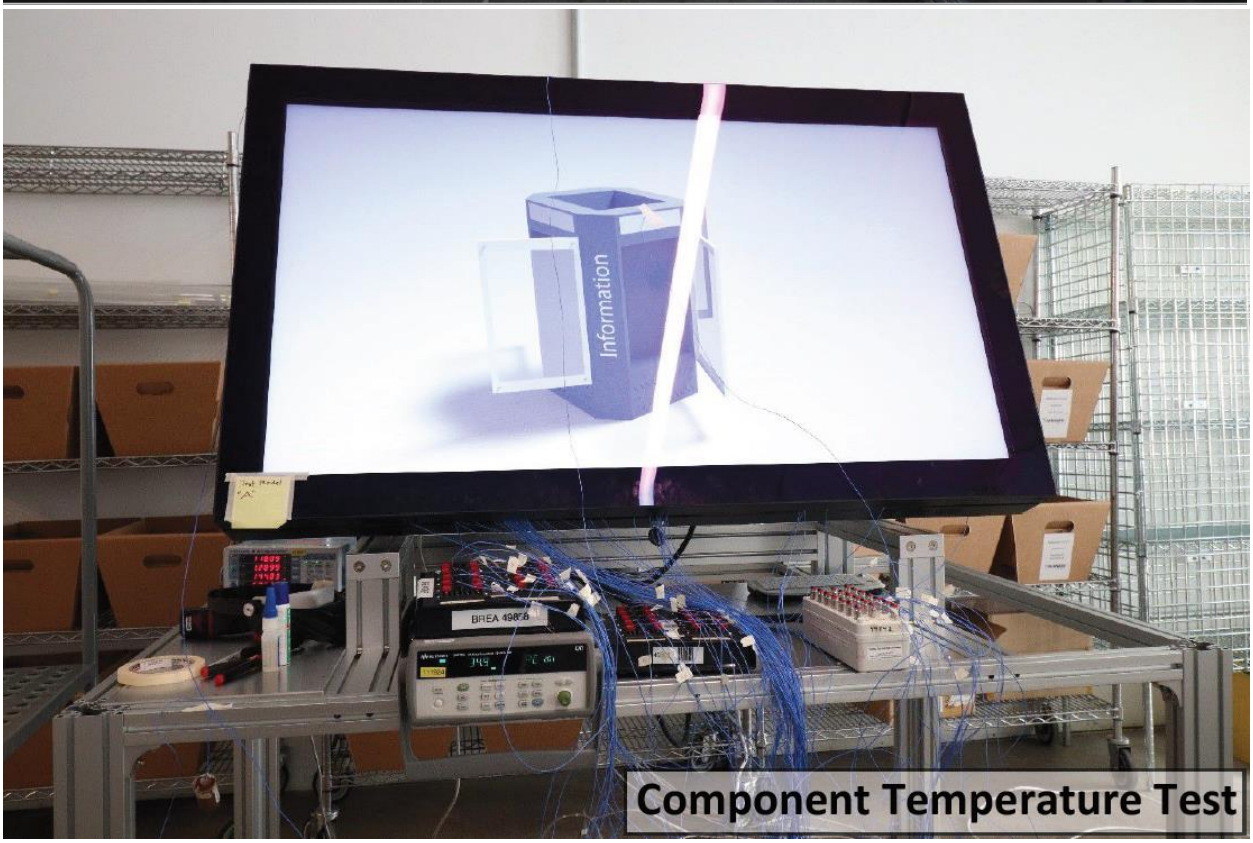
GLASS IMPACT TEST : Test to check the quality of glass for vandalism safety, without any damage to glass. Dropping a 5kg metal sphere from 1 meter height produces 49 Joules of energy which we dropped 3 times in the center, corner and side of our glass screen prototype.

Result: No damage to the glass, satisfying durability quality of IK 08

Overall Summary: Over the course of 4 days, two UL engineers rigorously test for three Nanov's outdoor units: NBSDM-460LC-105-SAN, NBSSM-5500LC-105-YYC & NBADH-428LC-124-SEA. On the final day our units performed well, showed satisfactory results and received their UL 48 certification.

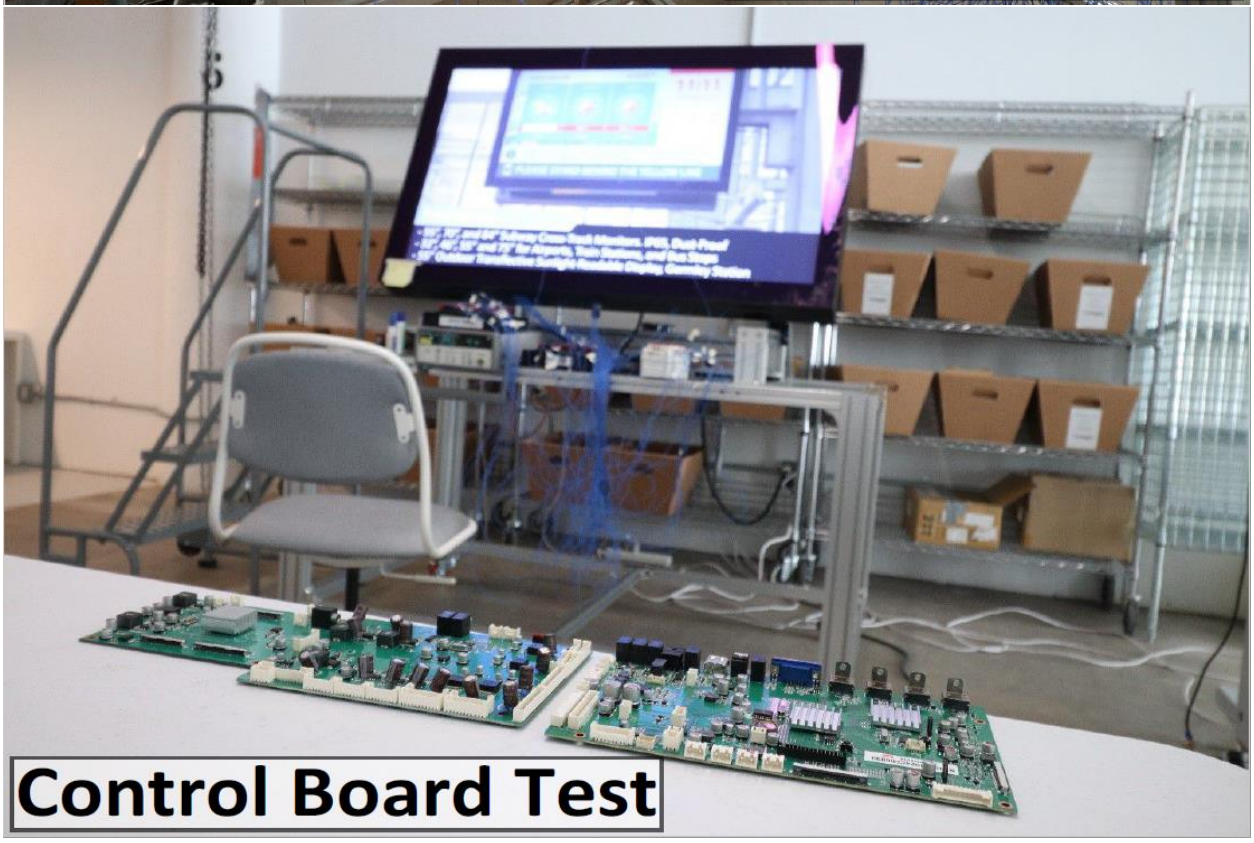


July 24th: Leakage Current test & Temperature of Components test



<u>July 25th:</u> Maximum Output Current & Power Test (Hi-Voltage) & Ball Drop test

July 26th: Dielectric test, Control Board test & Rain tests



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2 Hours of abnormal conditions

End Results: All the marks made by the UL engineers over the course of 4 days yielded satisfactory results and our tested units successfully passed all the tests. The UL Engineers were in particularly impressed by the fans and the design of the cooling/ heating system. The tested devices received UL Certification as well as 400sq ft of NANOV R&D facility for research and development testing conditions for next 3 years to come.

DATA ACCEPTANCE PROGRAM

LaboratoryPower Quality

TEST LOCATION:			
[X]WTDP	[]CTDP	[]TCP	[]TPTDP
Company Name	NANOV DISPLAY INC.		
Address	141 Flushing Ave Brooklyn Navy Yard Building 77 suite 705 Brooklyn, NY 11205		
DA File Number			

CLIENT INFORMATION	
Company Name	NANOV DISPLAY INC.
Address	1978 NW 82ND AVE MIAMI, FL, 33126 UNITED STATES OF AMERICA

AUDIT INFORMATION:		
[] Description of Tests	Number of Circuits Tested:	1
[X] Tests Conducted by	Miguel Interiano	2019-07-25
	Myungkune Moon	Jul 23, 2019
	Printed name	Signature & Date

TEST EQUIPMENT INFORMATION

Inst. ID No.	Instrument Type	Function /Range	Last Cal. Date	Next Cal. Date
135460	Fluke DMM	Auto	2019-02-28	2020-02-29
85921	Timer	Auto	2019-06-11	2020-06-30
156981	Wattmeter WT31	auto	2019-06-14	2020-06-30
122206	SD700 Barometer	Auto	2019-01-24	2020-01-31

Verification of Circuits

Method

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

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

[X] 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)

[X] 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 = 1

Identify the Loads per each circuit –

2019-07-23

CIRCUIT IDENTIFICATION	LOAD TYPES
UL-01	(2) HEAT GUNS

2019-07-23

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
UL-01	120.4	120.3	0.60

Lab. Ambient: 25°C, 37%Rh, 998mb

Results

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

True __X__ False _____

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

True __X__ 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.

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

2019-07-23

Loading Condition	Method A - NO LOAD TEST				
Real Time	10:15 AM	10:30 AM	10:45 AM	11:00 AM	11:15 AM
Test Time (minutes)	T=0	15	30	45	T=60
Adjusted Nominal Voltage	120.2	--------	--------	--------	--------
Voltage (Min)	--------	--------	--------	--------	119.9
Voltage (Max)	--------	--------	--------	--------	120.2

Lab. Ambient: 25°C, 37%Rh, 998mb

The unloaded voltage regulation was calculated to be MAX of $((V_{oc\ max} - V_{nom}) / V_{nom}) \times 100$ = 0.0 %
; $((V_{nom} - V_{oc\ min}) / V_{nom}) \times 100$= 0.249 %

The results comply with the voltage regulation requirement of ± 3% (or the limit of ____ as specified in test standard_____) for unloaded condition

True X False ____

2019-07-23

RESULTS B

Loading Condition	Method B - LOAD TEST				
Real Time	11:30 AM	11:45 AM	12:00 PM	12:15 PM	12:30 PM
Test Time (minutes)	T=0	T=15	T=30	T=45	T=60
Amps (Load)	20	20	20	20	20
Adjusted Nominal Voltage	120.0	--------	--------	--------	--------
Voltage (Min)	--------	--------	--------	--------	119.9
Voltage (Max)	--------	--------	--------	--------	120.3
Manual Adjustment Voltage (Min/Max)	--------	119.9	120.0	120.1	120.3

Lab. Ambient: 25°C, 37%Rh, 998mb

The loaded voltage regulation was calculated to be MAX of (($V_{loaded\ max}$ - V_{nom}) / V_{nom}) X 100 = 0.25 %
; ((V_{nom} - $V_{loaded\ min}$) / V_{nom}) X 100 = 0.083 %

The results comply with the voltage regulation requirement of ± 3% (or the limit of ____ as specified in test standard_____) for max. loaded condition:
True __X___ 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.

$T_{0\ minutes}$ = $T_{15\ minutes}$ = $T_{30\ minutes}$ = $T_{45\ minutes}$ = $T_{1\ hour}$ =

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)

2019-07-23

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

Lab. Ambient: 25°C, 37%Rh, 998mb
Use this value when loading these circuits and make a notation in the "Remarks" column.

Results (2)

2019-07-23

Loading Condition	LOAD TEST				
Test Time (minutes)	T=0	T=15	T=30	T=45	T=60
Frequency (Hz) (Max)	60	--------	--------	--------	60
Frequency (Hz) (Min)	59	--------	--------	--------	59

Lab. Ambient: 25°C, 37%Rh, 998mb

Frequency variation = MAX of (($F_{loaded\ max}$ - F_{nom}) / F_{nom}) X 100) = __0__ % ;
((F_{nom} - $F_{loaded\ min}$) / F_{nom}) X 100 = __1.66__ %

The results comply with the frequency tolerance of ±2.0% (or the limit of _____as specified in test standard_____) for max. frequency variation. (check one):

True __X__ False _____

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)

2019-07-23

Loading Condition	NO LOAD TEST				
Real Time	10:15 AM	10:30 AM	10:45 AM	11:00 AM	11:15 AM
Test Time (minutes)	T=0	T=15	T=30	T=45	T=60
Total Harmonic Distortion %	0.942	--------	--------	--------	--------

Lab. Ambient: 25°C, 37%Rh, 998mb

Results (2)

2019-07-23

Loading Condition	LOAD TEST				
Real Time	11:30 AM	11:45 AM	12:00 PM	12:15 PM	12:30 PM
Test Time (minutes)	T=0	T=15	T=30	T=45	T=60
Total Harmonic Distortion %	2.0	--------	--------	--------	1.99
Amps (Load)	20	--------	--------	--------	20

Lab. Ambient: 25°C, 37%Rh, 998mb

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 __X__ 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.

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

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

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

Note: Test not applicable since circuit used for testing is dedicated test circuit. M.I. 2019-07-23

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NANOV

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