

Functional Test

Project _____

FT-_____ EMERGENCY POWER SYSTEM (Comprehensive Test Version) Including Emergency Generator, ATS and UPS

Related Tests: _____

1. Participants

<u>Party</u>	<u>Participation</u>
_____	_____
_____	_____
_____	_____

Party filling out this form and witnessing testing _____
Dates of tests _____

2. Test Prerequisites

- a. The following have been started up and startup reports and prefunctional checklists submitted and approved ready for functional testing:
 - Emergency generator and ATS
 - UPS
- b. All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules and with debugging, loop tuning and sensor and device calibrations completed. _____

Controls Contractor Signature or Verbal
Date
- g. All A/E punchlist items for this equipment corrected.
- h. These functional test procedures reviewed and approved by installing contractor and vendors.
- i. Safeties and operating ranges reviewed.
- j. Test requirements and sequences of operation attached.
- o. Verify that generator gages and meters for voltage, amperage and frequency are calibrated to hand-held or analyzer instrument readings.
- p. Other misc. checks of the prefunctional checklist and startup reports completed successfully.
- q. Monitoring security company notified of test. Arrangements made to test UPS loads (or load bank).

Notes:

3. Testing Procedures and Record

Proced. No. & Spec. Seq. ID ¹	Req ID No. ²	Test Procedure ³ (including special conditions)	Expected and Actual Response ⁴ [Write ACTUAL response in brackets or circle]	Pass Y/N	Note #
Initial Procedures					
A		The contractor shall follow the following acceptance procedure with the engine cold and no connected load. With ATS switch in the manual position, open the ATS breaker. Restore ATS to automatic position and close ATS breaker.	Verify that power has been lost from each load served by emergency power.		
B		Connect Power Line Disturbance Monitor (PDM), Load Profiler and recording Multimeter to UPS and Backup Generator/ATS.			
Generator, ATS and Loads					
1		<u>Cold Start.</u> Open normal power breakers and immediately connect <u>full</u> load bank load capacity to ATS units. This connection must be made before engine generator is up to speed and transfer to E-power has been completed.	Observe the system's performance and record the following data using a Power Line Disturbance Monitor to monitor the transient responses. Compare to specifications.		
2		Measure time using PDM.	Time delay from power failure to engine start signal should be within _____ sec., [_____sec].		
3		Measure time using PDM.	Cranking time until prime-mover starts and runs should be within _____ sec., [_____sec].		
4		Measure time using PDM.	Time until engine-generator is at proper voltage and frequency should be within _____sec. [_____sec].		
5		Measure time using PDM.	Total time from power failure until ATS switch is on E-power should be within _____sec., [_____sec].		
6		Repeat procedures 1-5.	Document variances from specified performance.		

Notes:

Emergency Power and UPS System Functional Test FT-_____

1	2	3	4	5	6	7	8	9	10	11
Time	Volts	Amps	Hertz	Engine Coolant Temp.	Oil Press	Batt. Charge	Temp.@ Gen.	Temp.@ ATS Input (list ea. phase)	Temp.@ ATS Output (list ea. phase)	Note Number

Test Procedures Continued:

Proced. No. & Spec. Seq. ID ¹	Req ID No. ²	Test Procedure ³ (including special conditions)	Expected and Actual Response ⁴ [Write ACTUAL response in brackets or circle]	Pass Y/N	Note #
8		Disconnect load bank load from ATS, before transfer back to normal power. Restore normal power and record delay to normal power transfer. See Powerline Disturbance Monitor, channel A and B.	Delay to normal power should be _____ min., [_____ min.].		
9		Record neutral delay time or verify in-phase monitor is working by recording voltage differential between Engine Generator Power and Utility Power at the time of the transfer back to normal power. See Powerline Disturbance Monitor channel B Time	Neutral delay time should be _____ sec., [_____ sec.].		
10		Record engine cool-down time. (Engine continues to run after ATS transfer.)	Cool down time should be _____ min., [_____ min.].		

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11		After the cool-down timer has expired, start the engine-generator by opening the ATS normal input power circuit breaker. With the emergency bus energized, perform the adjacent step load tests, verifying that voltage and frequency remain within specified ranges during transition and that the frequency stability (rate of change) is acceptable. Observe and record frequency and voltage response using the Powerline Disturbance Monitor.	Specified frequency regulation range = +/- _____ Hz Specified voltage regulation range = +/- _____ V Specified frequency stability criteria: _____ Max. variance of: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;"><u>Step</u></th> <th style="text-align: left;"><u>Volt.</u></th> <th style="text-align: left;"><u>Freq.</u></th> <th style="text-align: left;"><u>Stabil.</u></th> <th style="text-align: left;"><u>OK</u></th> </tr> </thead> <tbody> <tr> <td>0-25%</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>0-50%</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>0-100%</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>100-50%</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>100-25%</td> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table>	<u>Step</u>	<u>Volt.</u>	<u>Freq.</u>	<u>Stabil.</u>	<u>OK</u>	0-25%	_____	_____	_____	_____	0-50%	_____	_____	_____	_____	0-100%	_____	_____	_____	_____	100-50%	_____	_____	_____	_____	100-25%	_____	_____	_____	_____		
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12		Connect full load bank load to ATS. Maintain power flow for 15 minutes, then take temperature readings with infrared meter looking for hot spots.	There should be no significant variations in temperature between phases. <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;"><u>Point</u></th> <th style="text-align: left;"><u>T1</u></th> <th style="text-align: left;"><u>T2</u></th> <th style="text-align: left;"><u>T3</u></th> </tr> </thead> <tbody> <tr> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table>	<u>Point</u>	<u>T1</u>	<u>T2</u>	<u>T3</u>	_____	_____	_____	_____																								
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13		Transfer load back to utility source. Maintain power flow for 15 minutes and take temperature readings with infrared meter looking for hot spots.	There should be no significant variations in temperature between phases. <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;"><u>Point</u></th> <th style="text-align: left;"><u>T1</u></th> <th style="text-align: left;"><u>T2</u></th> <th style="text-align: left;"><u>T3</u></th> </tr> </thead> <tbody> <tr> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table>	<u>Point</u>	<u>T1</u>	<u>T2</u>	<u>T3</u>	_____	_____	_____	_____																								
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14		<u>ATS TEST SWITCH.</u> Operate the ATS test switch and verify that the generator starts and the E-Power sequence is initiated. (Bypass the return to normal timer to accelerate the test sequence.)	Generator should start and E-power sequence initiated. Verify that total time to E-power meets that specified (see Procedure 5).																																
15		Safety interlocking will be demonstrated by trying to operate the ATS and controls in a deranged manner, if possible.	Alarms should be generated and E-power system go or remain off-line.																																

Notes:

Emergency Power and UPS System Functional Test FT-_____

Proced. No. & Spec. Seq. ID ¹	Req ID No. ²	Test Procedure³ (including special conditions)	Expected and Actual Response⁴ [Write ACTUAL response in brackets or circle]	Pass Y/N	Note #
16		Simulate all alarms, alarm contact operation and remote enunciator operation by jumping across alarms.	All alarms are properly annunciated in the remote panel.		
17		Check calibration of ATS digital readouts of frequency, current and volts against a calibrated instrument.	ATS values should be within the following tolerances: Hz: _____ [_____] Amps: _____ [_____] Volts: _____ [_____]		
UPS Test					
18		Connect the UPS to a load bank and leave the load bank off. Operate the UPS for 1/2 hour without load while monitoring UPS output with Power Line Disturbance Monitor and Load Profiler. Take a waveform and load profiler snapshot. Observe the variation in voltage, frequency, the total harmonic distortion (THD), and the wave form deviation.	Voltage variation should be within _____, [_____]. Frequency variation should be within _____, [_____]. THD should be less than 5%, [_____]%. Wave form deviation should be minimal.		
19		Bring the UPS to its 50% kW rating (balanced load) in 25% increments. Operate the UPS for 1 hour and monitor UPS Output.	Voltage variation should be within _____, [_____]. Frequency variation should be within _____, [_____]. THD should be less than 5%, [_____]%. Wave form deviation should be minimal.		

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20		<p>Bring load bank load up to 100% of rated kW (balanced) load and monitor UPS output for 2 continuous hours.</p> <p>Record all electrical distribution system connection temperatures using Infrared Gun.</p>	<p>Voltage variation should be within _____, [_____].</p> <p>Frequency variation should be within _____, [_____].</p> <p>THD should be less than 5%, [_____].</p> <p>Wave form deviation should be minimal.</p> <p>There should be no significant variations in temperature between phases:</p> <p>Point <u>T1</u> <u>T2</u> <u>T3</u></p>		

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21		<p>The UPS shall be subjected to 3 consecutive step load tests in each of the following categories:</p> <p>The UPS will be monitored and recorded for waveform deformation/harmonic content. Each of the four step tests shall be performed at 1 minute intervals, until 3 repetitions have been completed (i.e.. No load for approximately 15 seconds, 50% load for 15 seconds, no load for 15 seconds, etc....).</p> <p style="margin-left: 40px;">A) 0 to 25% B) 0 to 50% C) 0 to 100% D) 50 to 100% E) 50 to 125%</p> <p style="margin-left: 40px;">F) Run up to 100% Load and operate for 5 minutes, then run load up to 125% and hold for 10 minutes at 125%.</p>	<p>Verify that specified voltage dynamic regulation is met.</p> <p>Voltage overshoot (VO) should be within _____.</p> <p>Frequency overshoot (FO) should be within _____.</p> <p>THD should be less than 5%.</p> <p>Wave form deviation should be minimal.</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Step</th> <th style="text-align: center;"><u>VO</u></th> <th style="text-align: center;"><u>FO</u></th> <th style="text-align: center;"><u>THD</u></th> <th style="text-align: center;"><u>Wave</u></th> </tr> </thead> <tbody> <tr> <td>0-25%</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td>0-50%</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td>0-100%</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td>50-100%</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> <tr> <td>50-125%</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">_____</td> </tr> </tbody> </table> <p>F. _____</p> <p>Generator should power load and not transfer to battery.</p>	Step	<u>VO</u>	<u>FO</u>	<u>THD</u>	<u>Wave</u>	0-25%	_____	_____	_____	_____	0-50%	_____	_____	_____	_____	0-100%	_____	_____	_____	_____	50-100%	_____	_____	_____	_____	50-125%	_____	_____	_____	_____		
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22		Verify wiring connections and grounding is in compliance with NEC, espec. grounding and bonding of UPS and generator.	In compliance?																																
23		With the UPS loaded as stated in the previous test, the UPS INTERNAL manual maintenance bypass switch will be manually operated 2 consecutive times transferring the load between UPS power, alternate power, and back to UPS power. Switching shall occur at 2 minute intervals. Verify that specified voltage dynamic regulation is met during switching.	<p>Voltage variation should be within _____, [_____].</p> <p>Frequency variation should be within _____, [_____].</p> <p>THD should be less than 5%, [_____].</p> <p>Wave form deviation should be minimal.</p>																																

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24		With the UPS loaded as stated in the previous test, the UPS EXTERNAL manual maintenance bypass switch will be manually operated 2 consecutive times transferring the load between UPS power, alternate power, and back to UPS power. Switching shall occur at 2 minute intervals.	Voltage variation should be within _____, [_____]. Frequency variation should be within _____, [_____]. THD should be less than 5%, [_____%]. Wave form deviation should be minimal.		
25		Safety interlocking will be demonstrated by trying to operate the UPS and controls in a deranged manner, if possible.	Alarms should be generated and E-power system go or remain off-line.		
26		Simulate all alarms, alarm contact operation and remote enunciator operation by jumping across alarms.	All alarms are properly annunciated.		
27		Check calibration of UPS digital readouts of frequency, current and volts against a calibrated instrument.	UPS values should be within the following tolerances: Hz: _____ [_____] Amps: _____ [_____] Volts: _____ [_____]		
28		With the UPS loaded at 100%, UPS input power will be interrupted to simulate a power failure. The UPS Output will be monitored and recorded for RMS values, waveform deformation/harmonic content. The roll-off of battery potential shall be monitored, recorded and compared to the battery run time specification. All accessible battery terminations will be checked for temperature variations with an infrared tester.	The RMS values OK? Waveform deviation OK? THD less than 5%? [_____]. Battery discharge curve per spec? UPS shuts down at low batter string voltage threshold of _____ [_____].		
Integrated Building Test					
29		Prepare to operate all facility loads connected to the Backup Power Distribution System.			

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30		Reconnect Power to the UPS and with 100% output load on the UPS system and full battery recharge current (wait approximately 5 minutes to allow batteries to charge to support load during loss of power), proceed to step #15.			
31		<p>Test the function of all loads on emergency power, including UPS loads. Open the circuit breaker or fused disconnect serving the ATS to simulate a power failure on the feeder serving the ATS and Backup Power Distribution System.</p> <p>Verify that proper power is delivered to each device listed in the emergency panel schedules and that equipment directly wired functions properly. Record generator output with the Powerline Disturbance Monitor and a Load Profiler:</p>	<p>Generator should be running at less than 100% load, [_____].</p> <p>UPS loads should properly operate off generator and not transfer to battery power.</p>		
31a		a) Walk through building and observe that all emergency lighting is ON. Compare and reconcile with the prints, any areas that are unusually dark.	OK?		
31b		b) Using the emergency panel schedule, verify that any specialty emergency lighting is ON (oral surgery, telecom, engineer's room, electrical room, 2nd floor procedure room lights, elevators).	OK?		
31c		c) Go to each emergency power receptacle and verify proper power.	OK?		
31d		d) Go to each specialty load on emergency power and verify proper power and function.	OK?		
31d1		1. <u>Security panel.</u> Verify that it is functioning by heating the Security Co. stat in the Telecom room above its alarm setpoint (____80F) and having Security Co. fax the printout of the trouble report.	OK?		

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31d2		2. <u>Fire alarm panel</u> . Verify that it is functioning by initiating an alarm and then resetting.	OK?		
31d3		3. <u>Med-gas Alarm</u> . Derange the system and verify that an alarm was initiated.	OK?		
31d4		4. <u>Dental Chairs</u> in rms. _____ . Verify power to their outlets or try some functions.	OK?		
31d5		5. <u>Telecom HVAC</u> . Using a heat gun, increase the temperature at the FCU-2 stat 5F above its setpoint (_____ 77F). Observe FCU-2 and ACU-1 start and deliver cool air to the room. Remove heat and observe units cycle OFF.	OK?		
31d6		6. <u>UPS charger</u> . Using the analyzer, monitor and verify proper charging functions.	OK?		
31d7		7. <u>Telecom System</u> . Using the analyzer, monitor and verify proper operation of the system with a full load bank.	OK?		
31d8		8. <u>Elevator</u> . Test the elevator recall function under emergency power.	Elevator recalls per specified sequences.		
32		<u>UPS Monitored Alarms</u> . The following alarms are monitored by the Security Co. Verify their function by causing the alarm, recording the time and having Security Co. fax a copy of the alarm report. a) Electrical failure. Simulate an electrical failure or malfunction. b) Detection of power being switched to the UPS. Verify during one of the previous transfers. c) Low Battery. Simulate a low battery condition. d) Space temperature above alarm setpoint. Heat stat above setpoint.			

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33		Provide a written report comparing measurement data with factory and project specifications. Key measurements to be summarized in table format in a report. Note areas of compliance and non-compliance with specifications. Provide backup monitoring data to support conclusions, including UPS and Backup Generator Voltage, Frequency, Harmonics, Discharge Information, Battery Information, ATS Timing information. Provide copies of all test data in electronic form.			
34					
35	--	Return all changed control parameters and conditions to their pre-test values⁵	Check off in table of Section 2 above when completed		

¹Sequences of operation attached to this test.

²Mode or function ID being tested from testing requirements section of the project Specifications.

³Step-by-step procedures for manual testing, trend logging or data-logger monitoring.

⁴Include tolerances for a passing condition. Fill-in spaces or lines not in brackets denote sequence parameters still to be specified by the A/E, controls contractor or vendor. Write "Via BAS" for verifications of device position from BAS readout or "Via obs" for actual observation or from test instrument reading.

⁵Record any permanently changed parameter values and submit changes to Owner.

A SUMMARY OF DEFICIENCIES IDENTIFIED DURING TESTING IS ATTACHED

-- END OF TEST --

Notes: