

# Functional Test

Project \_\_\_\_\_

## FT-\_\_\_\_ EMERGENCY POWER SYSTEM (Short Test Version, less rigorous UPS test) 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
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- 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 load profiler 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 <sup>1</sup>	Req ID No. <sup>2</sup>	Test Procedure <sup>3</sup> (including special conditions)	Expected and Actual Response <sup>4</sup> [Write ACTUAL response in brackets or circle]	Pass Y/N	Note #
<b>Initial Procedures</b>					
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.			
<b>Generator, ATS and Loads</b>					
1		<b>Cold Start.</b> 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		OPTIONAL: Repeat procedures 1-5.	Document variances from specified performance.		

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7		<p><b>Full Load Test.</b></p> <p>Continue generator operation. Record voltage and amperage of each phase and frequency using a load profile monitor, not generator gages; engine coolant temperature, oil pressure, and battery charge rate at 5 minute intervals for a period of one hour.</p> <p>OPTIONAL: Measure the temperature of all generator and ATS connections using a laser guided infrared temperature meter, Raytech or approved.</p>			

**Performance Criteria for Data in Table Below (by Column number).**

- |                       |  |
|-----------------------|--|
| 1) 5 minute intervals | 7) Batt. Charge:_____  |
| 2) Volts:_____        | 8) Ambient temperature: none   |
| 3) Hertz:_____        | 9) ATS Contacts Input Temp.: Note any significant variances between phases.  |
| 4) Amps:_____         | 10) ATS Contacts Output Temp.: Note any significant variances between phases |
| 5) Coolant T:_____    |  |
| 6) Oil pressure:_____ |  |

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

Notes:

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**Test Procedures Continued:**

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8		Disconnect load bank load from ATS, before transfer back to normal power. Restore normal power and record delay to normal power transfer.	Delay to normal power should be _____ min., [_____ min.].		
9		Record neutral delay time (if applicable) 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.	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		<p><b><u>Step Load Tests.</u></b></p> <p>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.</p> <p>Tune generator governor output to meet adjacent specifications. Document.</p>	<p>Specified frequency regulation range = +/- _____ Hz</p> <p>Specified voltage regulation range = +/- _____ V</p> <p>Specified frequency stability criteria: _____.</p> <p>Max. variance of:</p> <table border="1"> <thead> <tr> <th>Step</th> <th>Volt.</th> <th>Freq.</th> <th>Stabil. OK</th> </tr> </thead> <tbody> <tr> <td>0-25%</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>0-50%</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>0-100%</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>100-50%</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>100-25%</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table> <p>Governor tuned to meet specs.</p>	Step	Volt.	Freq.	Stabil. OK	0-25%	_____	_____	_____	0-50%	_____	_____	_____	0-100%	_____	_____	_____	100-50%	_____	_____	_____	100-25%	_____	_____	_____		
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12		<p>OPTIONAL: Connect full load bank load to ATS. Maintain power flow for 15 minutes, then take temperature readings with infrared meter looking for hot spots.</p>	<p>There should be no significant variations in temperature between phases.</p> <table border="1"> <thead> <tr> <th>Point</th> <th>T1</th> <th>T2</th> <th>T3</th> </tr> </thead> <tbody> <tr> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table>	Point	T1	T2	T3	_____	_____	_____	_____																		
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_____	_____	_____	_____																										
13		<p>OPTIONAL: Transfer load back to utility source. Maintain power flow for 15 minutes and take temperature readings with infrared meter looking for hot spots.</p>	<p>There should be no significant variations in temperature between phases.</p> <table border="1"> <thead> <tr> <th>Point</th> <th>T1</th> <th>T2</th> <th>T3</th> </tr> </thead> <tbody> <tr> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table>	Point	T1	T2	T3	_____	_____	_____	_____																		
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14		<p><b><u>ATS TEST SWITCH.</u></b> 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.)</p>	<p>Generator should start and E-power sequence initiated. Verify that total time to E-power meets that specified (see Procedure 5).</p>																										
15		<p>OPTIONAL: Safety interlocking will be demonstrated by trying to operate the ATS and controls in a deranged manner, if possible.</p>	<p>Alarms should be generated and E-power system go or remain off-line.</p>																										

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16		a) Simulate all alarms, alarm contact operation and remote enunciator operation by jumping across alarm contacts at ATS and generator. b) Verify any alarms to the BAS or other remote monitoring sites.	a) All alarms are properly annunciated in the remote panel.  b) Alarms received by BAS and remote sites.		
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: _____ [_____]		
<b>UPS and Integrated Building Test</b>					
18		Prepare to operate all facility loads connected to the backup power system, including UPS loads. Connect load profiler to generator system. Begin operating as many of the emergency loads as possible (both UPS and other). (If UPS loads cannot be tested live, install a full load bank on the UPS.) With ATS, generator and UPS in normal auto mode, cut power to emergency loads. Do not load bank generator.	Observe the generator start and ATS switch to generator power.		
19		With the generator providing power for actual building loads, tune generator governor output to meet adjacent specifications and for optimal compatibility with UPS. Document results..	Specified frequency regulation range = +/- _____ Hz Specified voltage regulation range = +/- _____ V Specified frequency stability criteria: _____ Final max. variance during building test: Volt.      Freq.      Stabil. OK _____ _____ Governor tuned to meet specs.		

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20		<p><b>UPS</b></p> <p>Connect load profiler to UPS and monitor the UPS load voltage, frequency and amperage with load profiler, through transition (dynamic) and at steady state.</p>	<p>Verify UPS goes back to generator power (off battery and stays off), per spec.</p> <p>Verify that specified voltage dynamic regulation is met:</p> <p>Dynamic voltage overshoot should be within _____; Actual: _____.</p> <p>Steady-state voltage variation should be within +/- _____; Actual: _____</p> <p>Frequency overshoot should be within _____; Actual: _____</p> <p>THD should be less than 5%.</p> <p>Wave form deviation should be minimal.</p>		
20a		<p>Measure the amperage of each phase off the UPS. Verify that they are balanced.</p>	<p>Phase A = [_____]</p> <p>Phase B = [_____]</p> <p>Phase C = [_____]</p> <p>Phase imbalance is within ____%?</p>		
21		<p>Tune UPS opening and closing of frequency window and slew rate.</p>	<p>UPS tuned.</p>		
22		<p>Simulate all alarms, alarm contact operation and remote enunciator operation by jumping across alarms. List.</p>	<p>All alarms are properly annunciated.</p>		
23		<p>Change ATS to manual and cut emergency power to UPS. Monitor UPS. Allow batteries to drain 25% or more.</p>	<p>Observe that loaded UPS provides sufficient power.</p>		
24		<p>Restore emergency power to UPS.</p>	<p>Verify that UPS is charging properly from the generator.</p>		
25		<p>Verify function of UPS bypasses.</p>	<p>Bypasses function per spec.</p>		
26		<p>Check calibration of UPS digital readouts of frequency, current and volts against a calibrated instrument.</p>	<p>UPS values should be within the following tolerances:</p> <p>Hz: _____ [_____]</p> <p>Amps: _____ [_____]</p> <p>Volts: _____ [_____]</p>		

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27		<p><b><u>Building Test</u></b></p> <p>Continuing from above, with generator, ATS and UPS in auto and E-power circuit open, test the function of all loads on emergency power, including UPS loads.</p> <p>Verify that proper power is delivered to each device listed in the emergency panel schedules and that equipment directly wired functions properly.</p> <p>Monitor generator output manually every 15 minutes (voltage, amperage, frequency).</p>	<p>Generator should be running at less than 100% load, [_____ %].</p> <p>UPS loads should properly operate from generator and not transfer to battery power.</p> <p style="text-align: center;">Generator</p> <table border="0" style="width: 100%;"> <tr> <td style="text-align: left;"><u>Time</u></td> <td style="text-align: center;"><u>Volts</u></td> <td style="text-align: center;"><u>Amps</u></td> <td style="text-align: center;"><u>Hz</u></td> </tr> </table>	<u>Time</u>	<u>Volts</u>	<u>Amps</u>	<u>Hz</u>		
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28		Walk through building and observe that all emergency lighting is ON. Compare and reconcile with the prints, any areas that are unusually dark.	All loads are properly serviced with power. Full listing and checkoff is attached.						
29		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).	All loads are properly serviced with power. Full listing and checkoff is attached.						
30		Go to each emergency power receptacle and verify proper power.	OK?						
31		Go to each specialty load on emergency power and verify proper power and function:							
31a		a. Security panel. 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?						
31b		b. Fire alarm panel. Verify that it is functioning by initiating an alarm and then resetting.	OK?						

Notes:



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31c		c. Med-gas alarm. Derange the system and verify that an alarm was initiated.	OK?		
31d		d. Dental chairs in rms. _____ . Verify power to their outlets or try some functions.	OK?		
31e		e. <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?		
31f		f. <u>Telecom System</u> . Verify that telecom loads are functioning properly under emergency power (unless UPS had to be load banked).	OK?		
31g		g. <u>Elevator</u> . Test the elevator recall function under emergency power.	Elevator recalls per specified sequences.		
32		<p><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.</p> <p>a) Electrical failure. Simulate an electrical failure or malfunction.</p> <p>b) Detection of power being switched to the UPS. Verify during one of the previous transfers.</p> <p>c) Low Battery. Simulate a low battery condition.</p> <p>d) Space temperature above alarm setpoint. Heat stat above setpoint.</p>	OK?		

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33		As necessary, provide any attachments and a written report beyond this test form comparing measurement data with factory and project specifications, in areas that do not comply or where additional documentation or explanation is necessary.			
34	--	<b>Return all changed control parameters and conditions to their pre-test values<sup>5</sup></b>			

<sup>1</sup>Sequences of operation attached to this test.

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

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

<sup>4</sup>Include 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.

<sup>5</sup>Record any permanently changed parameter values and submit changes to Owner.

A SUMMARY OF DEFICIENCIES IDENTIFIED DURING TESTING IS ATTACHED

**-- END OF TEST --**

Notes: