MGI Systems
Healthcare Facility Management Education

Designing Emergency Power Systems for Worst Case Scenarios

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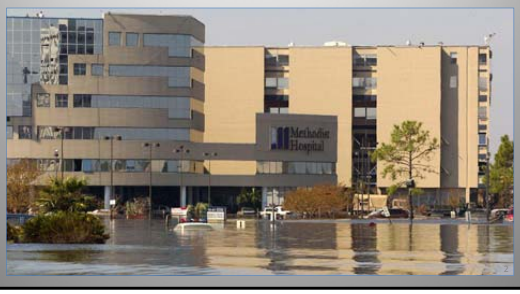
Electric - HVAC - Med Gas - Life Safety Code - Fire Alarm and Protection Systems - Plumbing

Designing Emergency Power Systems (EPSS) for Worst Case Scenarios

Lessons Learned from Katrina, Subsequent Lawsuits and the Courtroom



Decision Making Process

Pendleton Methodist

NFPA 110

Design, Maintenance, Testing & Record Keeping Considerations

Outline

I. Examining the LaCoste vs. Pendleton Memorial Methodist testimony
II. Reviewing lessons learned from the settlement
III. Discuss provisions for hardening a facility's EPSS
IV. Decide if the new paragraphs in the 2010 Edition of NFPA 110, *Emergency and Standby Power Systems* will improve reliability

Trial Began 12 January 2010

Three years before Hurricane Katrina inundated New Orleans, a senior executive at Pendleton Memorial Methodist Hospital assessed its vulnerability to the sort of flooding that had been long feared there.

"*The first question is, do we have generators placed to accommodate an emergency flood with 15 feet of water?" wrote Cameron B. Barr, then an executive vice president. "The answer to that question is no." One of the two main generators was located on a roof, he said, but another "would be nonfunctional at about two feet of flood water around the generator.*" New Orleans Times-Picayune

LaCoste vs. Pendleton Memorial

"*The family of Althea LaCoste, a 73-year-old patient who died in what her family's lawyers allege was sweltering heat after nurses spent hours pumping air into her lungs by hand in the pitch dark, is raising a potentially far-reaching legal question: How prepared do hospitals have to be for the worst possible circumstances?*" *New Orleans Times Picayune*

LaCoste vs. Pendleton Memorial

"Mrs. LaCoste's family alleges that the hospital was negligent for having inadequate emergency power systems, evacuation plans and floodwater protection. They say a fuel pump that failed after it was flooded caused the higher generator to shut down — an event they say could have been avoided if the hospital had invested less than $10,000 in a submersible pump." *New Orleans Times Picayune*

Plaintiff's Witness – Frank Painter

"Painter said Friday that Methodist could have opted for a 'standard submersible petroleum pump' that would work inside a larger ground tank to facilitate pumping to the generator. That's the solution for every gas station in Louisiana, in America' to send fuel upward, he said." *New Orleans Times-Picayune*

Building Housing Pump

Pump Location

Frank Painter's Recommendation

Install a submersible pump "in series" with the pump already in place.

SME Testimony for Defense

"Well, my thought about it is that it's based on theory, but it's not very well thought out, because what you have done is you have introduced another point of failure rather than making the system more reliable and more redundant, you have actually taken reliability and redundancy away because now you have got two things that can fail.

SME Testimony for Defense

And it would be very hard to predict how to design this system because, let's take an example of the submersible pump being active and the pump in the central [plant] being dead, okay. Now this pump has got to pump fuel through the down line pump, it's got to turn the impeller, it's got to turn the motor. And then it's got to send fuel up to the 6th floor.

SME Testimony for Defense

And I would not know how to make those calculations, because people don't pump pressure drop through dead pumps, okay. So it's not well thought out. It's theoretically possible. It's a prototype design. And it's one that I wouldn't even consider putting on one of my projects."

Opinion

The fact that the LaCoste case was actually allowed to be tried based on the theory that a submersible pump added in series would have prevented an EPSS failure, is a travesty. If a "case-merit review board", composed of engineers, could have reviewed the allegations, the case would have never gotten to the court room. Unfortunately, hundreds of thousands in legal fees were incurred .

Trial Ended on 26 January 2010

"What began two weeks ago as a potentially landmark wrongful-death trial testing the limits of hospitals' liability for disaster planning ended Tuesday with a confidential settlement in Orleans Parish Civil District Court, leaving the larger legal issues unresolved with a gaggle of similar cases awaiting future juries." New Orleans Times-Picayune

Joint Commission as an Advocate During Legal Proceedings

The Joint Commission, who accredited the hospital, did not volunteer to assist during the legal action even though they issued the facility a "passing grade".

Maybe the accreditation should have been issued with a caveat: "except in the case of a flood".

Pendleton Memorial Methodist Hospital wrongful death lawsuits sets a precedent for the design of new and existing EPSS

- ❑Defending in Place is situational
- ❑Value Engineering is out
- ❑Single points of failure are out
- ❑Redundancy is in
- ❑Location of components shouldn't be a secondary consideration
- ❑PM documentation shouldn't be water soluble
- ❑Education of staff is not optional

EPSS Components – Where to Locate?

- Fuel Tanks
- Day Tanks
- Generators
- Parallel Gear
- Circuit Breakers
- Distribution Panels
- Automatic Transfer Switches
- UPS
- Batteries and or Flywheel

Inside Waterline

Outside Waterline

Blue Pillar's Avise™ *digital* Energy Asset Management System

- *24/7/365 monitoring, command and control of critical power generation assets*
- *Asset, facility and multi-facility level insight into the status and readiness of assets*
- *Remote testing, monitoring, reporting and management of all EPSS components*
- *Browser-based "single-point" interface*

MGI Systems – What We Do

Facility Education Learning Management Systems

Emergency Power Systems Consulting and Commissioning

Arc Flash Studies

Energy Management Studies and Demand Response

Co-design, Finance, Build and Maintain CEPs

Queens Medical Center, Honolulu, HI – Trauma Center of the Pacific

Build an EPSS with N+1 total redundancy to parallel with any of our 3 -11,500v HECO feeders – without taking up any incoming producing real estate. And by the way, it must blend in with the surroundings, be easily serviced and make no noise.

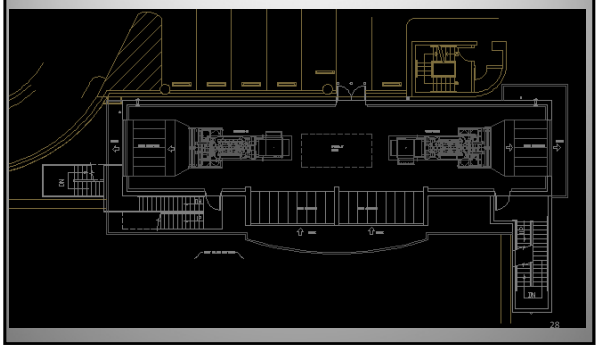
No problem

We Noticed This Driveway….

…So We Filled It Up with a CEP

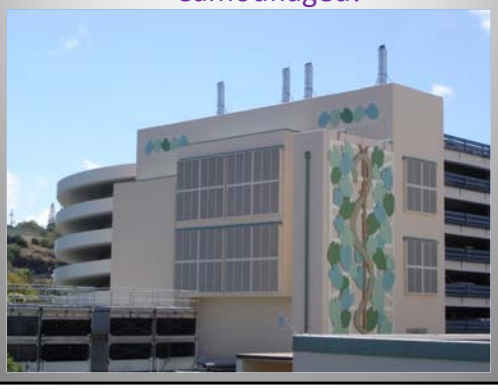
Blend with Environment, Easily Serviced and No Noise

3rd and 4th Floor - Generators

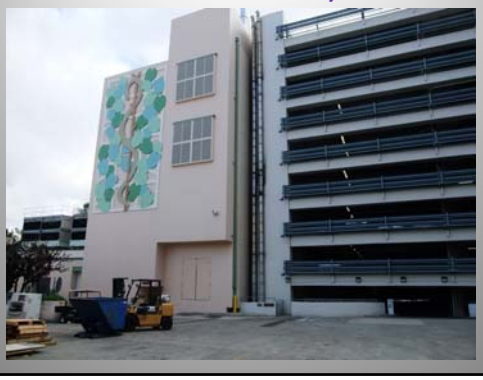


Back To Back Cats

Camouflaged!



Serviceability



Redundancy

	Tier I	Tier II	Tier III	Tier IV
Active Capacity Components to Support the IT Load	N	N+1	N+1	N After any Failure
Distribution Paths	1	1	1 Active and 1 Alternate	2 Simultaneously Active
Concurrently Maintainable	No	No	Yes	Yes
Fault Tolerance	No	No	No	Yes
Compartmentalization	No	No	No	Yes
Continuous Cooling	Load Density Dependent	Load Density Dependent	Load Density Dependent	Class A

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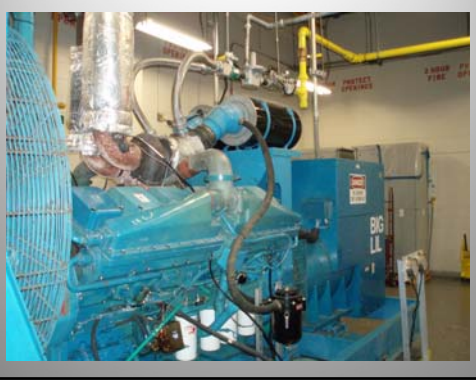
Gradual Increases of N

- 2 fuel pumps, and
- 2 circuit breakers fed from separate panels
- Spare breaker for pumps
- Added filtration
- Dual fuel
- Spare circuit breaker for normal and emergency feed breakers to ATSs
- Spare parts

Dual Fuel – Old Sets



Dual Fuel – New Sets

EPSS Maintenance and Testing NFPA 110, 2010 ed.

¶1.3: Application "This document applies to new installations of EPSSs, except that the requirements of Chapter 8 [maintenance and testing] shall apply to new and existing systems. Existing systems shall not be required to be modified to conform, except where the authority having jurisdiction determines that nonconformity presents a distinct hazard to life."

Monthly Loading Requirements NFPA 110, 2010 ed.

¶8.4.2: Diesel generator sets in service shall be exercised at least once monthly, for a minimum of 30 minutes, using one of the following methods:

(1) Loading that maintains the minimum exhaust gas temperatures as recommended by the manufacturer

(2) Under operating temperature conditions and at not less than 30 percent of the nameplate kW rating.

~~(3) If the engine cannot be loaded as required in (2) the engine shall be operated until the water temperature and the oil pressure have stabilized and then the test shall be terminated before the 30 minute time period expires.~~

10 Second Requirements NFPA 99, *2012* ed.

¶6.4.4.1.1.2 The 10-second criteria shall not apply during the monthly testing of an essential electrical system. If the 10-second criteria is not met during the monthly test, a process shall be provided to annually confirm the capability of the life safety and critical branches to comply with 4.4.3.1. Maintenance shall be performed in accordance with NFPA 110, *Emergency and Standby Power Systems*, Chapter 8.

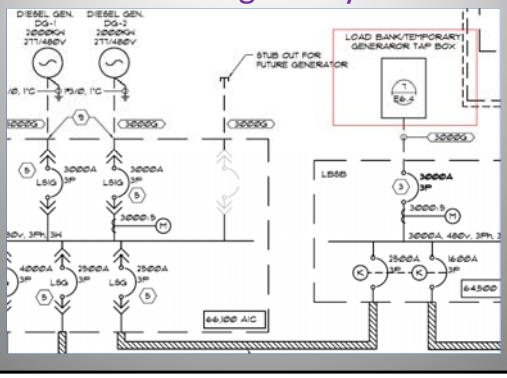
Annual Load Test – if Needed NFPA 110, 2010 ed.

¶ 8.4.2.3: Diesel-powered EPS installations that do not meet the requirements of 8.4.2 [monthly test] shall be exercised monthly with the available EPSS load, and shall be exercised annually with supplemental loads at not less than 50 percent of the EPS nameplate kW rating for 30 continuous minutes and at not less than 75 percent of the EPS nameplate kW rating for 1 continuous hour for a total test duration of not less than 1.5 hours.

No PPE = Permanent Tan

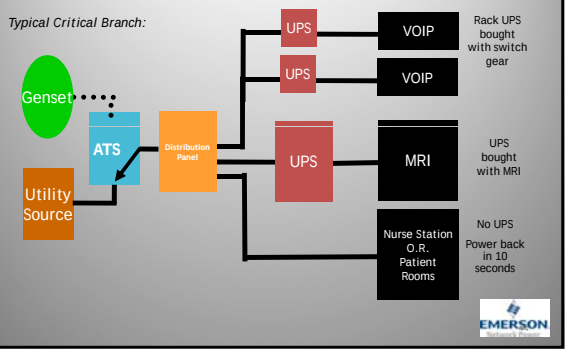
The Wrong Way

The Right Way

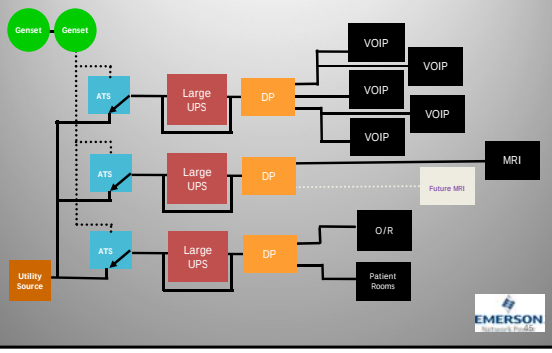


University of Michigan Medical Center

Decentralized UPS (old way)



Centralized (New Way)



UPS Strategy: Tradeoffs

	Decentralized UPS System	Centralized UPS System
Advantages	• UPS purchased with IT equipment • Appears to be cheap as costs are spread out on a per purchase basis	• Supports multiple critical systems • Energy efficient • Lower utility costs • Lower cooling costs • Lower system price • Ease of service, lower service costs • Sized for future kVA requirements
Disadvantages	• Higher system cost • Higher failure rate (MTBF) • Higher maintenance costs • UPS costs add up • Initial footprint smaller but overall space required much larger	• Equipment room space • Electrical infrastructure needed • Planning needed

EMERSON

7.13 Installation Acceptance

¶7.13.1 Upon completion of the installation of the EPSS, the EPS shall be tested to ensure conformity to the requirements of the standard with respect to both power output and function.

¶7.13.2 An on-site acceptance test shall be conducted as a final approval test for all EPSSs.

Acceptance Test Timing

¶7.13.2.1 For new Level 1 installations, the EPSS shall not be considered as meeting this standard until the acceptance tests have been conducted and test requirements met.

¶7.13.2.2 The test shall be conducted after completion of the installation with all EPSS accessory and support equipment in place and operating. [See NFPA 110, 8.3.2 and 8.3.2.1]

AHJ Notification

¶7.13.3 The authority having jurisdiction shall be given advance notification of the time at which the acceptance test is to be performed so that the authority can witness the test.

Performance Limits

¶7.13.4 The EPSS shall perform within the limits specified in this standard.

¶7.13.4.1 The on-site installation acceptance test shall be conducted in accordance with 7.13.4.1.1 through 7.13.4.1.3.

New and Unoccupied Buildings

¶7.13.4.1.1* In a new and unoccupied building or facility, with the prime mover in a cold start condition and the emergency load at operating level, a normal power failure shall be initiated by opening all switches or circuit breakers supplying the normal power to the building or facility.

*A.7.13.4.1.1 Cold start is typical standby condition under normal ambient conditions with coolant heaters functioning normally.

Existing Occupied Buildings

¶7.13.4.1.2* In an existing occupied building or facility, with the prime mover in a cold start condition and the emergency load at operating level, a normal power failure shall be simulated by operating at least one transfer switch test function or initiated by opening all switches or breakers supplying normal power to all ATSs that are part of the EPSS being commissioned by this initial acceptance test.

*A.7.13.4.1.2 Cold start is typical standby condition under normal ambient conditions with coolant heaters functioning normally.

Test #1 - Parameters

¶7.13.4.1.3 The tests conducted in accordance with 7.13.4.1.1 [new buildings] and 7.13.4.1.2 [existing buildings]shall be performed in accordance with (1) through (12).

Paralleled Generators

(1) When the EPSS consists of paralleled EPSs, the quantity of EPSs intended to be operated simultaneously shall be tested simultaneously with building load for the test period identified in 7.13.4.1.3(10).

Loads and Time Delay to Start

(2) The test load shall be all loads that are served by the EPSS. There is no minimum loading requirement for this portion of the test.

(3) The time delay on start shall be observed and recorded.

Cranking Time and Operating Speed

(4) The cranking time until the prime mover starts and runs shall be observed and recorded.

(5) The time taken to reach operating speed shall be observed and recorded.

Start Function & Steady-State

(6)*The engine start function shall be confirmed by verifying operation of the initiating circuit of all transfer switches supplying EPSS loads.

(7) The time taken to achieve a steady-state condition with all switches transferred to the emergency position shall be observed and recorded.

*A.7.13.4.1.3 (6) Verification of the engine start function can be accomplished by actual starting of the engine or by testing of the ATS start circuit.

Meter Recording

(8) The voltage, frequency, and amperes shall be recorded.

(9) Where applicable, the prime mover oil pressure and water temperature shall be recorded.

Test Time and Retransfer

(10) The load test with building load, or other loads that simulate the intended load as specified in Section 5.4, shall be continued for not less than 1.5 hours, and the run time shall be recorded.

(11) When normal power is restored to the building or facility, the time delay on retransfer to normal power for each switch with a minimum setting of 5 minutes shall be recorded.

Cooldown and Rest Period

(12) The time delay on the prime mover cooldown period and shutdown shall be recorded.

¶7.13.4.2 After completion of the test performed in 7.13.4.1, the prime mover shall be allowed to cool for not less than 5 minutes.

Test #2

¶7.13.4.3* A load shall be applied for a 2-hour, full-load test. The building load shall be permitted to serve as part or all of the load, supplemented by a load bank of sufficient size to provide a load equal to 100 percent of the nameplate kW rating of the EPS, less applicable derating factors for site conditions.

*A.7.13.4.3 Connection of the load bank (or a portable generator) is facilitated by providing permanently installed equipment or connection points such as spare circuit breakers or switches.

Test Initiation, Load and Duration

¶7.13.4.3.1 This full-load test shall be initiated after the test specified in 7.13.4.1.3 by any method that starts the prime mover and, upon reaching rated rpm, picks up not less than 30 percent of the nameplate kW rating for the first 30 minutes, not less than 50 percent of the nameplate kW rating for the next 30 minutes, and 100 percent of the nameplate kW rating for the next 60 minutes, less applicable derating factors for site conditions.

Unity Power Factor & Paralleled Units

¶7.13.4.3.2 A unity power factor shall be permitted for on-site testing, provided that rated load tests at the rated power factor have been performed by the manufacturer of the EPS prior to shipment.

¶7.13.4.3.3 Where the EPS is a paralleled multi-unit EPS, each unit shall be permitted to be tested individually at its rating.

Data Recording

¶7.13.4.3.4 The data specified in 7.13.4.1.3(4), (5), (7), (8), and (9) shall be recorded at first load acceptance and every 15 minutes thereafter until the completion of the test period identified in 7.13.4.1.3(10).

Crank Test

¶7.13.4.4 Any method recommended by the manufacturer for the cycle crank test shall be utilized to prevent the prime mover from running.

¶7.13.4.4.1 The control switch shall be set at "run" to cause the prime mover to crank.

¶7.13.4.4.2 The complete crank/rest cycle specified in 5.6.4.2 and Table 5.6.4.2 shall be observed.

Battery Charge Rate and Safeties

¶7.13.4.4.3 The battery charge rate shall be recorded at 5-minute intervals for the first 15 minutes or until charge rate stabilization.

¶7.13.4.5 All safeties specified in [NFPA 110] 5.6.5 and 5.6.6 shall be tested on site as recommended by the manufacturer.

Safety Test Exception

Exception: It shall be permitted for the manufacturer to test and document overcrank, high engine temperature, low lube oil pressure and overspeed safeties prior to shipment.

Documentation

¶7.13.4.6 Items (1) through (4) shall be made available to the authority having jurisdiction at the time of the acceptance test:

(1) Evidence of the prototype test as specified in 5.2.1.2 (for Level 1 systems)

(2) A certified analysis as specified in 5.6.10.2

(3) A letter of compliance as specified in 5.6.10.5

(4) A manufacturer's certification of a rated load test at rated power factor with the ambient temperature, altitude, and fuel grade recorded.

Best Practice: Combine Triennial Test With NFPA 110, 7.13"Re-Acceptance" Plan

- Prove the system will work under latest codes and standards for acceptance in case of lawsuit
- Compare and evaluate entire emergency electrical distribution system with latest codes and standards in case of lawsuit
- NFPA 110, 1.3, looms as the "gateway" to eliminating grandfather provisions

Triennial Testing
NFPA 110, 2010 ed.

¶8.4.9: Level 1 EPSS shall be tested at least once within every 36 months.

¶8.4.9.1: Level 1 EPSS shall be tested continuously for the duration of its assigned class (see Section 4.2) [Class X]

¶8.4.9.2: Where the assigned class is greater than 4 hours it shall be permitted to terminate the test after 4 continuous hours.

Triennial Testing (cont.)
NFPA 110, 2010 ed.

¶8.4.9.3 The test shall be initiated by operating at least one transfer switch test function and then by operating the test function of all remaining automatic transfer switches; or initiated by opening all switches or breakers supplying normal power to all automatic transfer switches that are part of the EPSS being tested.

¶8.4.9.4 A power interruption to non-EPSS loads shall not be required.

Triennial Testing (cont.)
NFPA 110, 2010 ed.

¶8.4.9.5 The minimum load for this test shall be as specified in 8.4.9.5.1, 8.4.9.5.2, or 8.4.9.5.3.

¶8.4.9.5.1 For a diesel-powered EPS, loading shall be not less than 30 percent of the nameplate kW rating of the EPS. A supplemental load bank shall be permitted to be used to meet or exceed the 30 percent requirement.

Triennial Testing (cont.) NFPA 110, 2010 ed.

¶8.4.9.5.2 For a diesel-powered EPS, loading that maintains the minimum exhaust gas temperatures as recommended by the manufacturer

¶8.4.9.5.3 For spark-ignited EPSs, loading shall be the available EPSS load.

Triennial Testing (cont.) NFPA 110, 2010 ed.

¶8.4.9.6 The test required in 8.4.9 shall be permitted to be combined with one of the monthly tests required by 8.4.2 and one of the annual tests required by 8.4.2.3 as a single test.

¶8.4.9.7 Where the test required in 8.4.9 is combined with the annual load bank test, the first three hours shall be at not less than the minimum loading required by 8.4.9.5 and the remaining hour shall be at not less than 75 percent of the nameplate kW rating of the EPS.

All Children's – St. Pete

Florida Hospital - Orlando

Sumter Regional Hospital
Sumter Co., Georgia

Complete Destruction

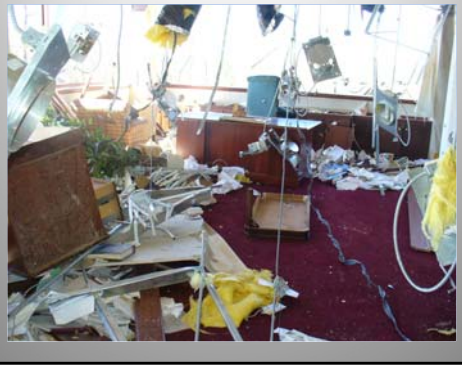
Flying Glass

Front Entrance

2x4 at 100+MPH

MOB

Corner Office



Education and Recognition

Education and Recognition

MGI Systems, Inc.

The professional designation of

Healthcare Facilities Master Specialist

is awarded to

Darayes Bharda

January 1, 2010

Certificate Date

Dan Chisholm, Jr.