

With Great Emergency Power...

Designing and Commissioning EPSS

Be Prepared or Be Paranoid

THINK. LISTEN. CREATE.

Learning Objectives:

- Explain why commissioning of emergency power systems is essential to ensuring systems fully operational and reliable in order to maintain the health, safety and welfare of all patients, staff and visitors.
- Identify the most common points of failure of healthcare emergency power systems, discovered from lessons learned during the commissioning process.
- 3. Describe the importance of the engineer's sequences of operations in being able to test emergency power systems
- 4. Understand when emergency power system are ready for testing and the major step in functional testing of those systems





What do Commissioning Providers Do?



What my friends think I do



What my Dad thinks I do



What HVAC Guys Do



What my kids think I do



What I think I do



What I really do



HEADLINE: DON'T LOSE SLEEP, COMMISSION EPSS BEFORE AHCA SURVEY





IECC 2018 / FBC 2020 C408 Maintenance Information and Systems Commissioning

- Mechanical Systems (C408.2): >40 Tons Cooling, 600 MBH Heating
- Service Water Heating (C408.2): If Mech Cx is Required
- Lighting Controls (C408.3): All Projects.

Guidelines for Design and Constructionof Hospitals (2018)

Chapter 1.2 Planning, Design, Construction, and Commissioning Chapter 1.2-8: Requirements Include:

- 1.2-8.1.1 HVAC
- 1.2-8.1.2 Automatic temperature control
- 1.2-8.1.3 Domestic hot water
- 1.2-8.1.4 Fire alarm and fire protection systems (integration with other systems)
- 1.2-8.1.5 Essential Electrical Power Systems
- 1.2-8.1.6 Security systems









In 2019.... TLC Contracted by AHCA to support Nursing Home Generator Projects

TLC Performed:

187 Plan Reviews

202 Construction Surveys



Commissioning Providers

- Make sure Owner's Project Requirements are being met
- ➤ Ensure Engineer's Basis of Design is being met
- ➤ Test equipment to Verify Performance

AHCA Surveyors

- ➤ Make sure Facility is Meets Regulatory Requirements
- ➤ Ensure Engineer's Design meets
 Code Requirements
- > Test equipment to ensure Patient Safety

To Make Sure Everything is Constructed and Working The Way It's Supposed To

➤ Reference: Owner Requirements and Engineer of Record

> Reference: Code Requirements





Lessons Learned

Top Reasons Generators Fail

- 1. Battery Failure
- 2. Coolant Problems (Low or None)
- 3. Fuel or Oil Leaks
- 4. Fuel Issues / No Fuel / Contaminated Fuel
- Controls Issues / Not In Auto / No Start Signal
- 6. Overheating
- 7. Intake and Exhaust Debris

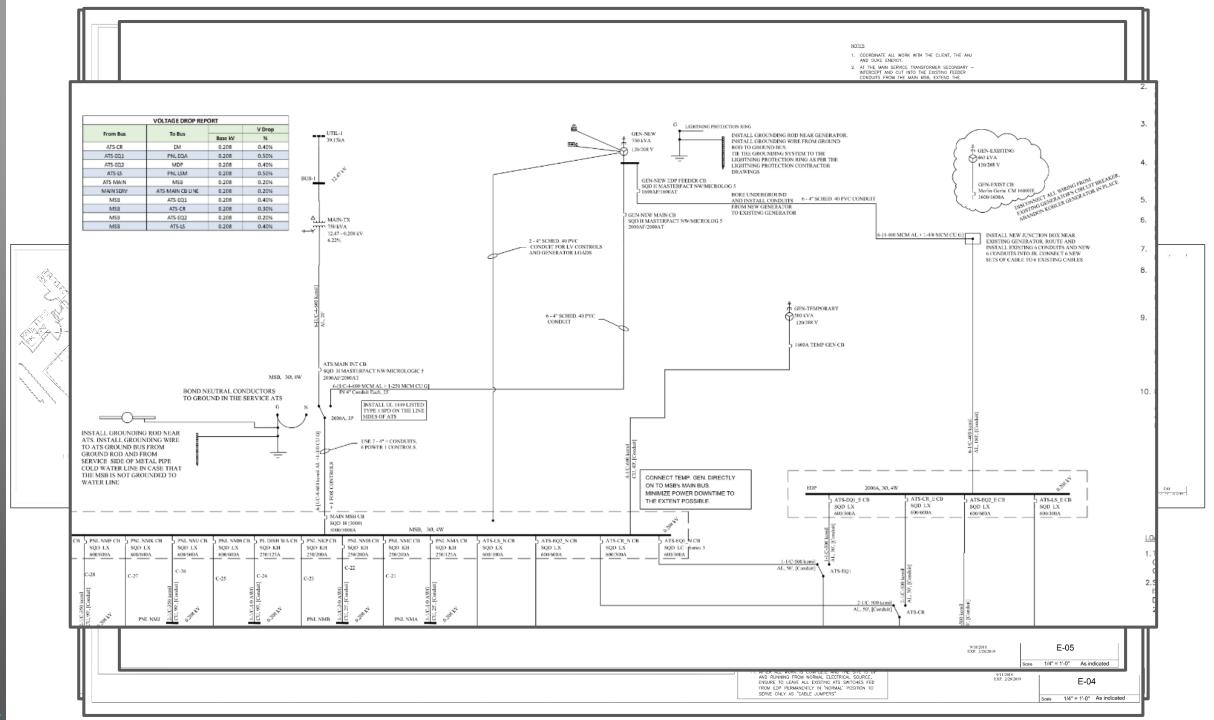
Look for possible

SINGLE POINTS OF FAILURE

During Design
During Installation
During Testing
During Operations



CONSTRUCTION DOCUMENTS (SHOULD) TELL A STORY



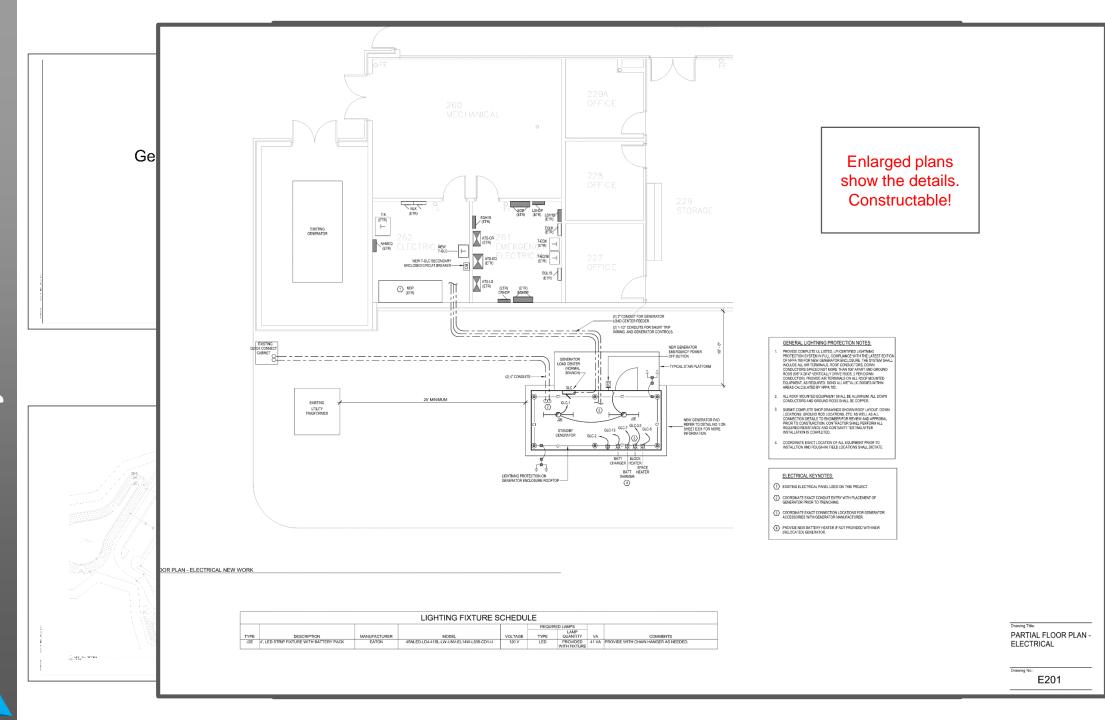


TABLE A PRODUCTION OF THE PROD

SEQUENCE OF OPERATIONS

- Common in HVAC
- Rarely Seem in Electrical
- Detailed sequence of operations
- Load shed sequences
- ATS time delay settings
- Often not specified in Contract Documents



Emergency Power Sequence of Operations (SOO)

"Upon Loss of **Utility Power...**"



AUTOMATIC TRANSFER SWITCH SEQUENCE OF OPERATION

THE FOLLOWING SEQUENCE OF OPERATION SHALL BE USED FOR PROGRAMING, SETUP AND TESTING OF ALL NEW AUTOMATIC TRANSFERSWITCHES, EXISTING AUTOMATIC TRANSFER SWITCHES AND EXISTING CUMMINS EMERGENCY POWER CONTROL SYSTEM.

NOTE: ALL FOUR ENGINE GENERATOR, PARALLELING GEAR, ALL ACCESSORIES, AND CONTROL EQUIPMENT ARE EXISTING. ONLY THE AUTOMATIC TRANSFER SWITCHES ARE

UPON LOSS OF NORMAL POWER - WHETHER VIA OPENING OF A NORMAL FEEDER BREAKER OR LOSS OF UTILITY POWER (CUTOUT = 85% OF NOMINAL VOLTAGE) - THE FOLLOWING SHALL OCCUR:

- PRE-PROGRAMMED ENGINE-START DELAY TIMER SHALLY START.
- 2. AFTER ENGINE START DELAY, ATS SHALL SEND START SIGNAL TO THE ENGINE-GENERATORS (VIA EXISTING HARD WIRED START SIGNAL WIRING)
- 3. ALL (4) FOUR EXISTING ENGINE-GENERATORS SHALL START, AND PARALLEL TO COMMON BUSS AS THEY REACH VOLTAGE, FREQUENCY AND SPEED.
- 4. ONCE THE FIRST ENGINE-GENERATOR COMES ON-LINE ALL PRIORITY 1 TRANSFER SWITCHES (LIFE SAFETY) SHALL AUTOMATICALLY TRANSFER FROM NORMAL POSITION TO EMERGENCY POSITION, WITHIN 10 SECONDS OF LOSS OF POWER.
- 5. ONCE THE SECOND ENGINE GENERATOR PARALLELS TO THE BUSS, ALL PRIORITY 2 TRANSFER SWITCHES (CRITICAL BRANCH) SHALL TRANSFER FROM NORMAL POSITION TO EMERGENCY POSITION, WITHIN 10 SECONDS OF LOSS OF POWER
- 6. ONCE THE THIRD ENGINE GENERATOR PARALLELS TO THE BUSS, ALL PRIORITY 3TRANSFER SWITCHES (EQUIPMENT BRANCH) SHALL TRANSFER FROM NORMAL POSITION TO EMERGENCY POSITION, EQUIPMENT BRANCH TRANSFER SWITCHES WITH A CENTER-POSITION TIME-DELAY SHALL SEQUENCE THRU THAT OPERATION
- 7. THE PARALLELED ENGINE-GENERATORS SHALL SHARE LOAD (APPROXIMATELY)
- 8. ONCE NORMAL POWER IS RESTORED (PICKUP = 90% NOMINAL VOLTAGE), INITIATE RE-TRANSER TO NORMAL TIME DELAY COUNTDOWN, TO ENSURE NORMAL POWER IS STABLE AND FULLY RESTORED.
- 9. ONCE COUNTDOWN IS COMPLETE, TRANSFER ALL ATSS FROM EMERGENCY TO NORMAL. EQUIPMENT BRANCH TRANSFER SWITCHES WITH A CENTER-POSITION TIME-DELAY SHALL SEQUENCE THRU THAT OPERATION DURING THE TRANSFER.
- 10. AFTER ALL TRANSFER SWITCHES ARE TRANSFERRED TO NORMAL POWER, INITIATE PER-PROGRAMMED ENGINE-COOL DOWN COUNT DOWN.

LOAD SHED SEQUENCE OF OPERATION

1. UPON UNEXPCTED LOSS OF ONE OF THE FOUR EXISTING ENGINE-GENERATORS, NO ACTION SHALL OCCUR; THE ENTIRE EPSS LOAD CAN BE SERVED WITH THREE

Load Shed Sequence



GENERATORS IN SERVICE, HOWEVER, THE EMERGENCY POWER DEMAND-LOAD GENERATORS IN SERVICE. HOWEVER, THE EMERGENCY POWER DEMAND-LOAD SENSING SYSTEMS SHALL DETERMINE IF THE LOAD CAN BE CARRIED BY THE REMAINING ENGINE-GENERATORS AND IF THE ENTIRE LOAD CANDOT BE CARRIED, THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENCE STARTING WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENTS WITH DOLORITY & LOAD THE LOAD SHED SECUENCE SHALL COMMENTS WITH DOLORITY & LOAD THE LOAD SHED SHED SHALL COMMENTS WITH THE SHALL REMAINING ENGINE-GENERATORS AND IF THE ENTIRE LOAD CANNOT BE CARRIED, THE LOAD SHED SEQUENCE SHALL COMMENCE STARTING WITH PRIORITY 3 LOADS.

- 2. UPON UNEXPCTED LOSS OF TWO OF THE FOUR EXISTING ENGINE-GENERATORS (CUTOUT 85% OF NOMINAL VOLTAGE). THE PRIORITY 3 (EQUIPMENT BRANCH) (TRANSFER SWITCHES SHALL BE AUTOMATICALLY TRANSFERRED TO CENTER POSITION. IF NORMAL POWER IS A VIAILABLE, ALL TRANSFER SWITCHES SHALL SWITCH TO NORMAL POWER IS A VIAILABLE, ALL TRANSFER SWITCHES SHALL SWITCH TO NORMAL POSITION. THE EMERGENCY POWER DEMAND-LOAD SENSING SYSTEMS SHALL DETERMINE IF THE LOAD CAN BE CARRIED BY THE REMAINING ENGINE-ENGINE-GENERATORS; IF THE LOAD CAN BE CARRIED BY THE REMAINING ENGINE-SYSTEMS SHALL DETERMINE IF THE LOAD CAN BE CARRIED BY THE REMAINING ENGINE-ENGINE-GENERATORS, IF THE LOAD CAN BE CARRIED BY THE REMAINING ENGINE-GENERATORS, THE PRIORITY 3 TRANSFER SWITCHES MAY BE MANUALLY RE-ARDER
- UPON UNEXPCTED LOSS OF THREE OF THE FOUR EXISTING ENGINE-GENERATORS 3. UPON UNEXPCTED LOSS OF THREE OF THE FOUR EXISTING ENGINE-GENERATORS CUTTOUT = 85% OF NOMINAL VOLTAGE). THE PRIORITY 2 (CRITICAL BRANCH) AUTOMATICALLY TRANSFERRED TO NORMAL STATEMENT OF THE S MANUALLY RE-ADDED.

AUTOMATIC TRANSFER SWITCH SETTINGS: ALL NEW AUTOMATIC TRANSFER SWITCHES SHALL BE PROGRAMMED WITH THE FOLLOWING TIME DELAY SETTINGS. SETTINGS MAY BE ADJUSTED DURING COMMISSIONING AND/OR AHCA TESTING TO EMSURE THAT LIFE SAFETY AND ORTHCAL BRANCH TRANSFER SWITCHES COME ONLINE WITHIN 10 SECONDS OF LOSS OF POWER.

LIFE SAFETY BRANCH TRANSFER SWITCHES

ENGINE START TIME DELAY:

1.0 SECONDS (AJUSTABLE 0 - 6 SECONDS) 0 SECONDS (AJUSTABLE 0 - 60 MINUTES)

EMERGENCY SOURCE STABILIZATION TIME DELAY: 0 SECONDS (ADJUSTABLE 0 - 6 SECONDS)

DELAYED TRANSITION LOAD DISCONNECT

(CENTER POSITION) TIME DELAY:

15 MINUTES (ADJUSTABLE 0 - 60 MINUTES)

RETRANSFER TO NORMAL TIME DELAY (POWER FAILURE MODE):

RETRANSFER TO NORMAL TIME DELAY

30 SECONDS (ADJUSTABLE 0 - 10 HOURS)

(TEST MODE): UNLOADED RUNNING TIME DELAY FOR 5 MINUTES (ADJUSTABLE 0 - 60 MINUTES)

ENGINE COOL DOWN:

ATS Settings



CRITICAL BRANCH TRANSFER SWITCHES

1.0 SECONDS (AJUSTABLE 0 - 6 SECONDS) ENGINE START TIME DELAY:

TRANSFER TO EMERGENCY TIME DELAY: 0 SECONDS (AJUSTABLE 0 - 60 MINUTES)

EMERGENCY SOURCE STABILIZATION TIME DELAY: 0 SECONDS (ADJUSTABLE 0 - 6 SECONDS)

DELAYED TRANSITION LOAD DISCONNECT (CENTER POSITION) TIME DELAY:

NOT APPLICABLE

RETRANSFER TO NORMAL TIME DELAY 15 MINUTES (ADJUSTABLE 0 - 60 MINUTES) (POWER FAILURE MODE):

RETRANSFER TO NORMAL TIME DELAY

30 SECONDS (ADJUSTABLE 0 - 10 HOURS) (TEST MODE):

UNLOADED RUNNING TIME DELAY FOR 5 MINUTES (ADJUSTABLE 0 - 60 MINUTES) ENGINE COOL DOWN:

EQUIPMENT BRANCH TRANSFER SWITCHES

ENGINE START TIME DELAY: 1.0 SECONDS (AJUSTABLE 0 - 6 SECONDS)

0 SECONDS (AJUSTABLE 0 - 60 MINUTES) TRANSFER TO EMERGENCY TIME DELAY:

EMERGENCY SOURCE STABILIZATION TIME DELAY: 0 SECONDS (ADJUSTABLE 0 - 6 SECONDS)

DELAYED TRANSITION LOAD DISCONNECT

30 SECONDS (ADJUSTABLE 0 - 5 MINS) (CENTER POSITION) TIME DELAY:

RETRANSFER TO NORMAL TIME DELAY

15 MINUTES (ADJUSTABLE 0 - 60 MINUTES)

RETRANSFER TO NORMAL TIME DELAY

30 SECONDS (ADJUSTABLE 0 - 10 HOURS)

LINE OADED RUNNING TIME DELAY FOR ENGINE COOL DOWN

5 MINUTES (ADJUSTABLE 0 - 60 MINUTES)

PRE/POST TRANSFER SIGNAL TIME DELAY. FOR SELECTIVE LOAD DISCONNECT WITH PROGRAMMABLE BYPASS ON SOURCE FAILURE.

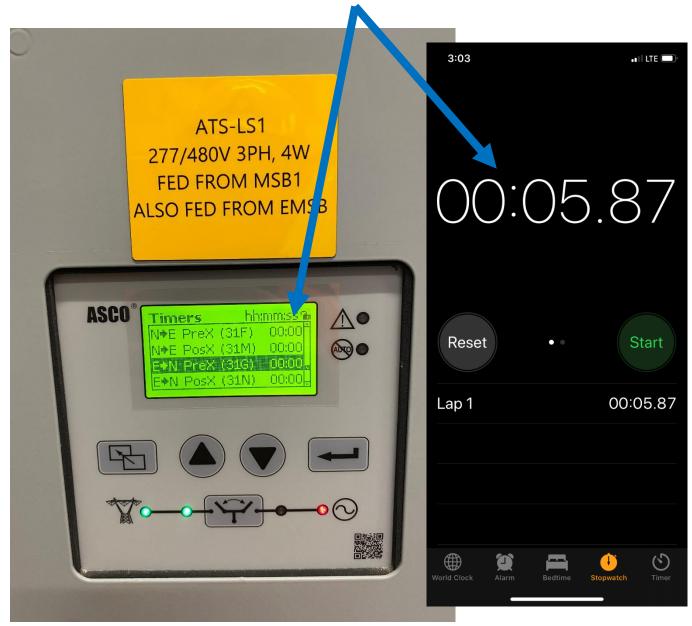
30 SECONDS* (ADJUSTABLE 0 - 5 MINS) (PROVIDE FOR ELEVATOR ATSS): *COORDINATE WITH HOSPITAL AND ELEVATOR VENDOR. THIS SIGNAL CAN BE USED TO DRIVE RELAY OR DT CONTACTS AS REQUIRED



What Happens When There's No Sequence of Operations



What Happens When There Is

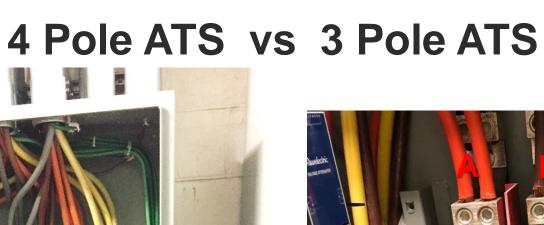


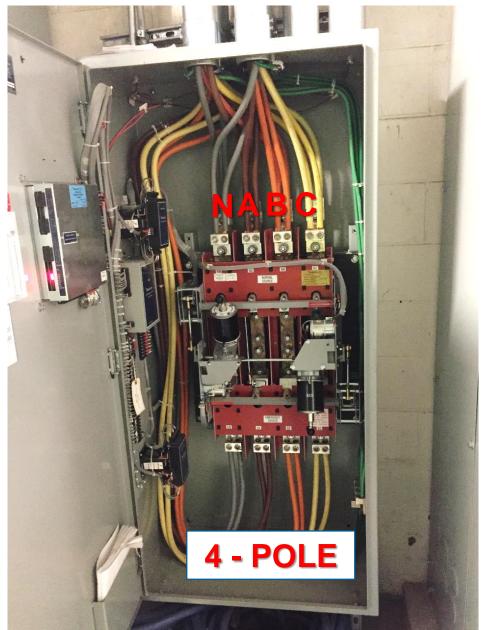


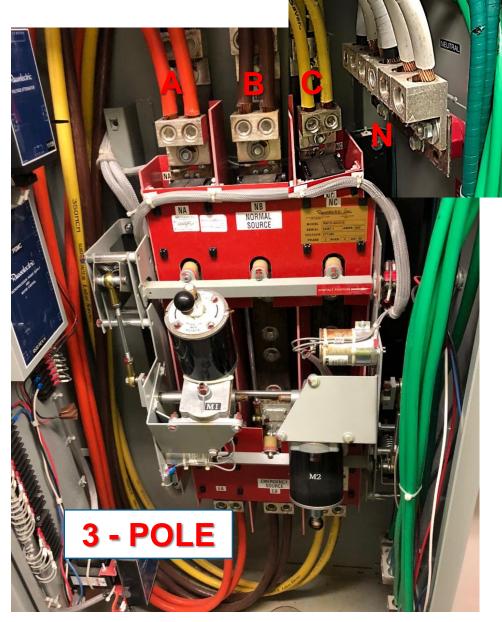
GROUNDING

Things to Consider:

- Separately Derived or Non-Separately Derived?
- Ground Fault Protection & Ground Fault Alarms
- 4 Pole vs 3 Pole Transfer Switches









Its All About the Ground Fault Alarms

- For 480V Generators sized 1000A or more, Ground Fault Alarm shall be provided
- Ground Fault Protection (Tripping) is not required
- Two Levels of Ground Fault Alarm is not required (This has sometimes been enforced incorrectly) – but it may be a good idea!
 - (Two Levels only required with GFP (tripping)

From NEC 700.6 (Signals)

(D) Ground Fault. To indicate a ground fault in solidly grounded wye emergency systems of more than 150 volts to ground and circuit-protective devices rated 1000 amperes or more. The sensor for the ground-fault signal devices shall be located at, or ahead of, the main system disconnecting means for the emergency source, and the maximum setting of the signal devices shall be for a ground-fault current of 1200 amperes. Instructions on the course of action to be taken in event of indicated ground fault shall be located at or near the sensor location.

Informational Note: For signals for generator sets, see NFPA 110-2013, Standard for Emergency and Standby Power Systems.

Automatic ground-fault protection is not required on emergency systems (see 700.27), because it could interrupt the system when it is needed. However, ground faults must be detected and indicated so that the ground fault can be cleared as soon as practical.

From NEC 700.27

700.27 Ground-Fault Protection of Equipment

The alternate source for emergency systems shall not be required to have ground-fault protection of equipment with automatic disconnecting means. Ground-fault indication of the emergency source shall be provided in accordance with 700.6(D) if ground-fault protection of equipment with automatic disconnecting means is not provided.

(B) Feeders. Where ground-fault protection is provided for operation of the service disconnecting means or feeder disconnecting means as specified by 230.95 or 215.10, an additional step of ground-fault protection shall be provided in all next level feeder disconnecting means downstream toward the load. Such protection shall consist of overcurrent devices and current transformers or other equivalent protective equipment that shall cause the feeder disconnecting means to open.

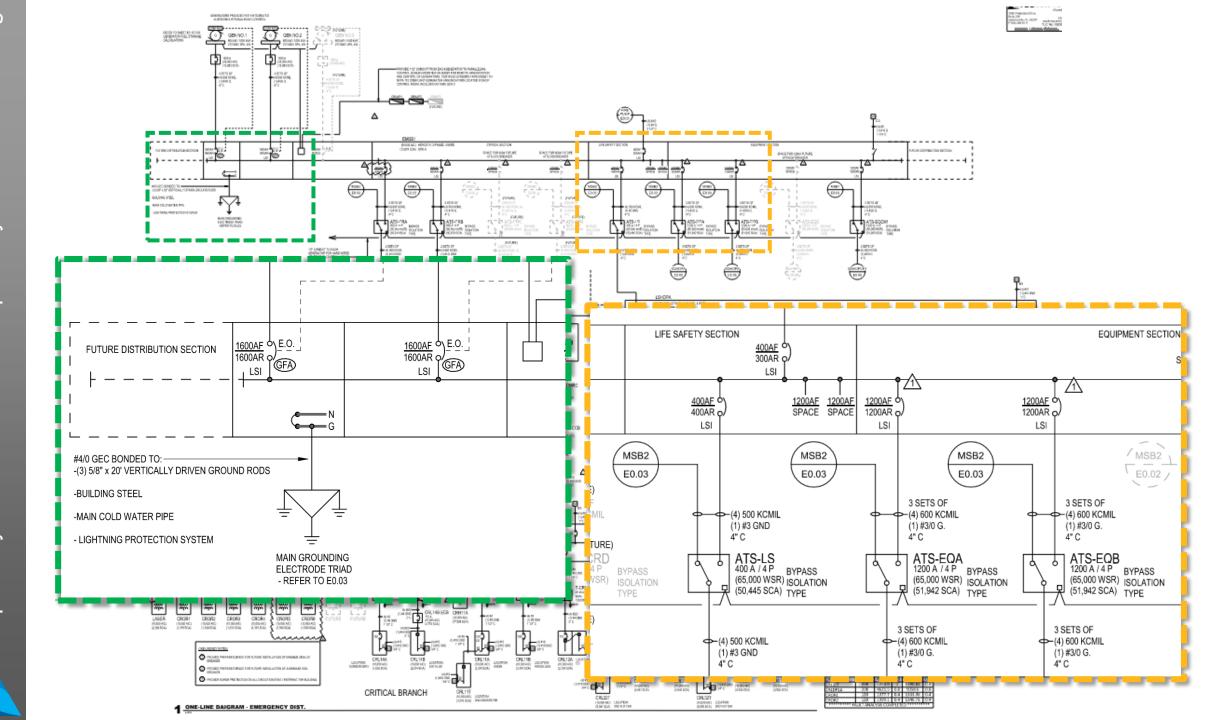


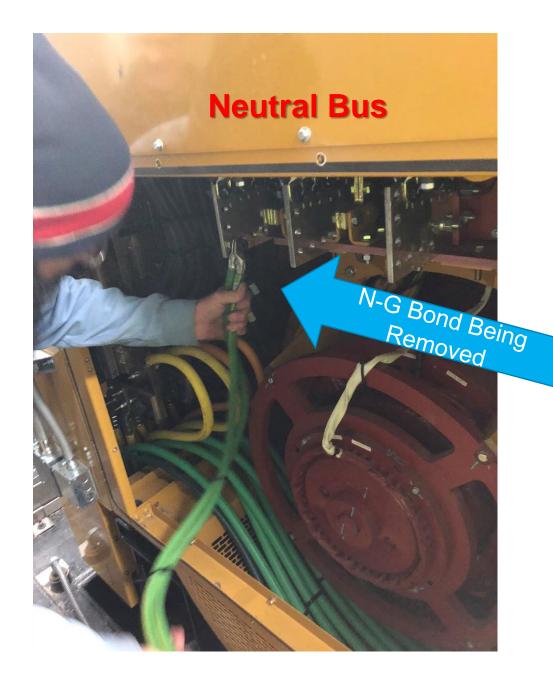
Should I have a Separately Derived Grounding System at the Generator? (and what does that even mean?)

Type of ATS	Type of Emergency Grounding System	What does it Mean?	Why
3 Pole ATS	non-separately derived system	Neutral and Ground are NOT bonded together at Generator	For 3 pole ATS, Neutral- Ground bond is never lost
4 Pole ATS	separately derived system	Neutral and Ground ARE bonded together at Generator	For 4 pole ATS, Neutral is switched. Neutral-Ground bond at normal service is not maintained when ATS is in emergency position

One or the other... Not Both!











DON'T FORGET THE FUEL!

Is Fuel Type Indicated?

Do fuel system details match fuel type for the project?

If diesel, is there on-site storage to meet the duration requirements?

Is tank size indicated?

Are there fuel calculations?

Is "useable fuel" amount used?

Are there low level alarm calculations?

Is there a **SEQUENCE OF OPERATION** for the fuel system?

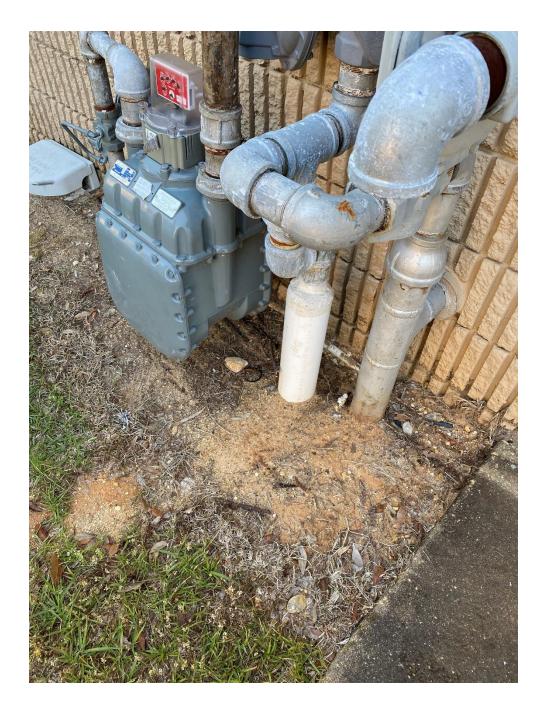














EPSS Fuel Required	
Generator Fuel Consumption per Hour @ 100% Load	104.8 GPH
Generator Fuel Consumption per Hour @75% Load	82.1 GPH
Fuel require per Generator for 64 Hours @ Full Load	6,707 Gallons
Fuel require per Generator for 72 Hours @ 75% Demand Load	5,911 Gallons
Worst Case Fuel required per Generator	6,707 Gallons
Required Useable Fuel Capacity (with 3 Generators running)	20,121 Gallons
TANK SIZE	
Fuel Tank Selection	25,000 Gallons
15% Unusable	-3750 Gallons
Usable Fuel in the Tank	21,250 Gallons
LOW LEVEL ALARM SETPOINT	
48 Hour Fuel Requirement: 104.8 GPH @100% x 3 Gens	15,091 Gallons
Unusable Fuel at Bottom of Tank (per manufacturer)	1,250 Gallons
Low Level Alarm Setpoint for 48 hours of Useable Fuel	16,341 Gallons / 65%

Plan for 5% of Un-Usable Fuel + 10% for the Max Fill Line

Example: (3) 1500kW Generators

Step 1 – Determine Fuel Required

64 Hours at 100 % Load or 72 Hours at actual demand load whichever is greater

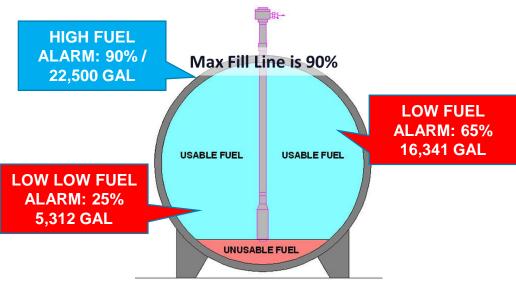
Step 2 – Determine Fuel Capacity

Tank Size – Unusable Fuel > Fuel Required

Step 3 Low Level Alarm Set Point

Calculate Level for 48 hours of Useable Fuel Remaining

Step 4 Put it On the Drawings!







Fuel System Diagram: Have a Diagram! Sequence of Operations! (be clear about when supply and return pumps turn on / off) SEQUENCE OF OPERATIONS: THE FUEL OIL SYSTEM CONSISTS OF THE FOLLOWING MAJOR COMPONENTS: ONE 15,000 GALLON ABOVE GROUND FUEL TANK, NEW LEVEL MONITORING LEAK DETECTION SYSTEM, PRIMARY/STANDBY/HAND FUEL OIL PUMP. Valves: INTERCONNECTING FUEL OIL PIPING, GENERATOR DAY TANK WITH INTEGRAL CONTROLS, DAY TANK OVERFLOW RETURN FUEL OIL PUMP, SHUT-OFF SOLENOID VALVES, AND FUEL OIL SPECIALTIES/PUMPS PROVIDED WITH THE EMERGENCY Isolation THE PRIMARY FUEL OIL PUMP IS ENERGIZED BY EITHER AN AUXILIARY CONTACT OR A LOW LEVEL SWITCH IN THE GENERATOR DAY TANK. LIPON ACTIVATION. Day Tank / Pumps OF THIS PUMP, FUEL OIL IS CIRCULATED TO THE DAY TANK. IF THE DAY TANK IS Check OVERFLOW OF THE DAY TANK SHOULD THE OPERATION OF THE PRIMARY FUEL OIL PUMP NOT SATISFY THE Solenoid ACTIVATE THE STANDBY FUEL OIL PUMP. ALL FUEL OIL TAKEN FROM THE DAY TANK TO THE GENERATOR THAT IS NOT CONSUMED BY THE GENERATOR WILL BE Fill / RETURNED DIRECTLY TO THE MAIN TANK. SHOULD THE FUEL OIL SOLENOID. THE FUEL OIL RETURN PUMP TO EVACUATE HIGH LEVELS OF FUEL OIL WITHIN THE DAY TANK. FUEL OIL WILL BE RETURNED TO THE ABOVE GROUND STORAGE TANKS. **Engine-Generator** Monitoring A SECOND HIGH LEVEL SWITCH WILL DISABLE BOTH THE PRIMARY AND STANDBY PUMPS ALL LEVEL SWITCHES IN BOTH THE DAY TANK AND FUEL OIL TANK SHALL BE (future provisions?) MONITORED REMOTELY. HIGH LEVELS, LOW LEVELS, AND LEAK DETECTION WILL System EQUIPPED WITH A LIQUID DETECTOR TO ALARM OVERFLOW CONDITIONS FILTER ASSEMBLY 4 16 11 4 ALL ALARMS WILL BE SENT TO THE BUILDING ALARM SYSTEM IN FAC CNTRL RM 1160 4 5 6 9 4 10 4 9 6 3 4 **Hand Pump** FF-1 FUEL OIL GENERATOR FILL PORT EXTERIOR OF BUILDING INTERIOR OF BUILDING 2 3 EXCASE EXPOSED FUEL ф ц ц ц OIL PIPING WITH STAINLES STEEL CASING FOR Fuel Polishing System SLOPE --3 PROTECTION PER HURRICANE CODE 4 7 3" FUEL VENT MONITORING 1 VENT THRU ROOF 9 BURNER PRESSURIZATION PUMP 2 PRESSURE RELIEF VALVE (SET AT 3 PSI) HIGH PRESSURE RELIEF VALVE 3 CHECK VALVE SOLENOID VALVE WITH MANUAL LIFT STEM (24 V. D.C. POWERED PRESSURE REGULATOR - SET TO 3 PSI ROM GENERATOR BATTERY 4 SHUT-OFF VALVE OVERFLOW RETURN PUMP 5 STRAINER WITH BLOW DOWN VALVE EMERGENCY FUEL SHUT-OFF SOLENOID FUEL OIL LEAK DETECTION SYSTEM SET TO CLOSE WITH 11 520 GALLONS 6 PRESSURE GAUGE WITH GAUGE COCK REMAINING IN MAIN FLIEL TANK EMERGENCY OVERFLOW VALVE AND CAP FOR FUTURE AUTOMATIC FLOW VALVE (SET AT 150.0 GPM) FILL SEQUENCE OF OPERATION: AUXILIARY HAND PUMP, PISTON TYPE, FUEL OIL METER (10,000 GAL. MIN. COUNT CAPACITY) 20 GALLONS PER 100 STROKES THE FUEL OIL VENDOR EVALUATES THE SHALL BE SIZED TO ACCOMMODATE Main Tank / Pumps **FUEL OIL FLOW DIAGRAM**

No Scale





HAVE A PLAN

But be ready to change it...

7.10.4.1 Exhaust systems shall be installed to ensure satisfac-

flexible conduit section(s) shall be installed between the EPS until the and any of the following, so arrached:

(1) The transfer malests:

 The transfer switch
 The control and annunciator wiring
 Any accessory supply wiring such as jacket water heaters
 any accessory supply wiring such as jacket. 7.12.4.1 Stranded wire of adequate size shall be used to mini-mue breakage due to vibration.

7.12.4.2 Bushings shall be installed to protect wiring from abrasion with conduit terminations.

1.125. All se-powered support and accessory equipment necessary to the operation of the EFs shall be supplied from the lost of the ATSs, or the output terminals of the EFs, shead of the ATSs, or the output terminals of the EFS, the and the main EFS overcurrent protection to ensure continuity of the EFSS operation and performance.

7.12.5 The starting battery units shall be located next to the prime mover starter to minimize voltage drop.

7.12.6.1 Battery cables shall be sized to minimize voltage drop *ALED-1 Nattery cables shall be sized to minimize virings such in accordance with the manufacturer's recommendations an accepted engineering practices.

7.12.6.2 Battery charger output wiring shall be permanently connected to the primary side of the starter solenoid (positive) to the primary side of the starter solenoid.

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. 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 mee.

7.13.2.2 The test shall be conducted after completion of the 7.13.2.2 The test shall be conducted uses completely installation with all EPSS accessory and support equipment in

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. 7.13.4 The EPSS shall perform within the limits specified in

7.13.4.1 The on-site installation acceptance test shall be 7.13.4.1 The on-site installation acceptance test shall conducted in accordance with 7.13.4.1.1 through 7.13.4.1.4.

7.13.4.1.1* In a new and unoccupied building or facility, with 7.1.3.4.1.1" 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.

7.13.4.1.2* In an existing occupied building or facility, with 7.13.4.1.2" In an existing occupied outlining or facility, with the prime mover in a cold start condition and the emergency the prime mover in a cold start community and the emergency load at operating level, a normal power failure shall be simulaload at operating levet, a normal power nature snail be simula-ted by operating at least one transfer switch test function or initiated to opening all switches or breakers supplying normal power to all ATSs that are part of the EPSS being commis-

7.13.4.1.3 When the EPSS consists of paralleled EPSs, the system control function for paralleling and load shedding shall be verified in accordance with system design documentation. 7.13.4.1.4 The tests conducted in accordance with 7.13.4.1.1 and 7.13.4.1.2 shall be performed in accordance with (1)

(1) When the EFSs consists of paralleled EFs, the quantity of FFs intended to be operated simultaneously shall be tested simultaneously shall be tested simultaneously shall be period defined and the state of the s

Testing

this portion of the test.

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

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 approximated and recorded.

observed and recorded.

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

whiches supplying Byshouth.

(7) The time taken is abelieve a tedepatate condition with all wittches under a chieve a tedepatate condition with all wittches under conted.

(8) The time taken is a chieve a tedepatate condition whall be observed frequency, and amperes shall be recorded.

(9) were applicable, the graine more of pressure and temperature shall be recorded and the pressure and the load test with buildings and one other loads that the load test with buildings as specified in Section 5.6, shall be continued for not less than 1.5 hours, and the run time shall be recorded.

anal be continued for not less than 1.5 hours, and the run time shall be recorded.

When normal power is restored to the building or early time delay on retransfer to normal power for earliet, the time delay on retransfer to normal power for early which with a minimum setting of 5 minutes shall each switch with a minimum setting of 5 minutes shall

each witte with a minimum.

be recorded.

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

7.13.4.3* A load shall be applied for a 2-hour, full-load test. 7.13.4.3° A load shall be applied for a 2-bour, full-load rest. The building load shall be permitted to serve as part or all of the load, supplemented by a load bank of sufficient size to produce a load equal to proceed to load equal to proceed a load equal to proceed a load equal to proceed a load equal to proceed to the manageplate kW and the load equal to proceed equal to proceed the load equal to proceed eq

7.13.4.5.1* This full-load test shall be initiated after the test 7.13.43.1* This full-load test shall be initiated after the rest species of 1,73.4.1.4 by any performance of the species of 1,73.4.1.4 by any performance of the species of the species

7.15.45.2 A unity power factor shall be permitted for onsite resting, provided that rated load teas at the rated power factor testing, provided that rated load teas at the rated power factor testing, provided that rated load teas at the rated power factor testing.

7,13.4.3.3 Where the EPS is a paralleled multi-unit EPS, each a funit shall be permitted to be tested individually at its rating.

7.13.4.3.4 The data specified in 7.35.4.1.4(4), 7.13.4.1.4(5), and 7.13.4.1.4(7) shall be recorded as first load acceptance of the test period identified in 7.13.4.1.4(10).

7.13.4.3.5 The data specified in 7.15.4.1.4(8) and 7.13.4.1.4(9) shall be recorded at first load acceptance and every 15 minutes thereafter until the completion of the test period identified in 7.13.4.1.4(1).

7.13.4.4 Any method recommended by the manufacturer for the cycle crank tent shall be utilized to prevent the prime mover

7.13.4.4.1 The control switch shall be set at "run" to cause the 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.

7.13.4.4.3 The battery charge rate shall be recorded at 5-minute intervals for the litst 15 minutes or until charge rate

7.13.4.5 All safeties specified in 5.6.5 and 5.6.5 shall be tested on site as recommended by the manufacturer.

Europhies: It shall be premitted for the manufacturer to test and docu-ment corrowals, high engine temperature, loss take oil pressure and correport suffices prior to phyment.

7.13.4.8 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)
A certified analysis as specified in 5.6.10.2

A certified analysis as specified in 5.6.10.2
 A letter of compilance as specified in 5.6.10.5
 A manufacture's certification of a rated load test at rated mover factor with the ambient temperature, altitude, and lord grade recorded

Chapter 8 Routine Maintenance and Operational Testing

8.1.1 The routine maintenance and operational testing program shall be based on all of the following:

Manufacturer's recommendations

Instruction manuals
Minimum requirements of this chapter
The authority having jurisdiction

8.1.2 Consideration shall be given to temporarily providing a portable or alternate source whenever the emergency genera-tor is out of service and the criteria set forth in Section 4.5

8.2* Manuals, Special Tools, and Spare Parts.

8.2.1 At least two sets of instruction manuals for all major components of the EPSS shall be supplied by the manufac-turer(s) of the EPSS and shall contain the following:

(1) A detailed explanation of the operation of the system

A detailed explanation of the operation of the system
 Instructions for routine maintenance
 Detailed instructions for repair of the EPS and other
 major components of the EPS

om in which the EFS equipment is located shall or other purposes that are not directly related to tools, and manuals for routine maintenance and permitted to be stored in the EFS room.

fire suppression systems are installed in EPS ms or separate buildings, the following systems

dioxide or halon systems, unless prime mover ion air is taken from outside the structure mair dry chemical system, unless the manufacture of the EFS certify that the dry chemical system handle to the terms of the nage the EPS system, hinder its operation, or

the EPS rooms or separate buildings are equip-detection systems, the installation shall be in ith NFPA 72, National Fire Alarm and Signating

outdoor and/or rooftop Level 1 EPS installa-ired to be protected from lightning, the lightning team(s) shall be installed in accordance with anderd for the Installation of Lightning Princeton

zed seismic risk areas, EPS and EPSS comp i electrical distribution lines, area and area compo-reportion lines, and other components that serve be designed to minimize damage from earth-facilitate repairs if an earthquake occurs.

stems in seismic risk areas, the EPS, transfer button panels, circuit breakers, and associated bec capable of performing their intended func-d after being subjected to the anticipated seismic

stribution and wiring systems within EPSS shall accordance with NFPA 70, National Electrical Code

EPSSs are installed in health care facilities, the the EPSS shall also be in compliance

ing between the EPS output terminals and the novercurrent protective device terminals within the located at a minimal distance to ensure

induit's point of attachment to the EPS is on the of the EPS vibration isolation sys

Use

NFPA 110

as your guide.

Section 7.13 **Installation Acceptance**

Selectivethor signatures above. 2. A year outstanding terms are noted at time. TSE 1/22-8 2. Letter band See 2. Verly and protein the protein selection of the selection of t	PASSED	93% Yes 4% No 2% N	I/A		1 ISSUE		
Attempt No. 1 1000000000000000000000000000000000		Γ	#272 Emerg	gency Power Supply System (EPSS) TLC Eng	ineering Solutions	s ZZ Southwell Medical Hospital 819002	
Alternot No. 1 2000 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 20 Very floor generator closes to bus within specified time (10 seconds) 12 Very floor generator closes to bus within specified time (10 seconds) 12 Very floor generator closes to bus within specified time (10 seconds) 12 Very floor generator closes to bus within specified time (10 seconds) 12 Very floor generator closes to bus within specified time (10 seconds) 12 Very floor generator genera			YES 21	Repeat with Critical Branch ATS			
Attempt No. 1 (2002) 1 The system to complete or mine to grow the complete or mine to the complete or	Attempts						
State Stat	Attempt N	No. 1 PASSED					
2 Per per performance has been very been serviced and reads by the special property of the special pro			YES 24		me.		
2 29 Very for generator actions. 2 30 Very for generator done size. 2 32 Very for generator croses to bus without Less Plant's Sec. 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	YES 1	The system is complete and ready	YES 25	Repeat with at least one Equipment Branch ATS			
Any conducting forms are noted Internet 15/2672	YES 2	Prior performance has been verifie			#272 Emerg	gency Power Supply System (EPSS) TLC Engineering Solutions ZZ Southwell Medical Hospital 819002	
List upbacked Li	YES 3				ATS-C2		
S			YES 28		YES 44	Verify Gen. Start	
Second Price outstanding terms pre- PRETESTING CHECKLIST **********************************					YES 45		
New Figure 2 of New Process of New	200	December 1997 Control of the Control	YES 29	Simulate power outage for each remaining tra		7 sec	
ATS-S1 TRANSFER SWITCH FUNCTIONAL TEST PROCED SMULLATE POWER LOSS BY DISCONMECTING PC EACH TRANSFER SWITCH FUNCTIONAL TEST PROCED SMULLATE POWER LOSS BY DISCONMECTING PC EACH TRANSFER SWITCH FUNCTIONAL TEST PROCED SMULLATE POWER LOSS BY DISCONMECTING PC EACH TRANSFER SWITCH FUNCTIONAL TEST PROCED SMULLATE POWER LOSS BY DISCONMECTING PC EACH TRANSFER SWITCH FUNCTION THE ATS-Q2 THE ATS-Q3 THE ATS-Q1 THE ATS-Q1 THE ATS-Q1 THE ATS-Q2 THE ATS-Q1			YES 30	Verify engine start	YES 46	Record retransfer to normal (sec)	
Number N					ATS-S1		
SMILL REPOWER CONS. OF TABLE WATER CONS. OF TABLE W					YES 47	1-1, -11	
## SREAKER TO THE WORMAL SIDE OF EACH TRAN ATS-Q1 12 ATS-Q3 13 ATS-C1 14 ATS-C1 15 ATS-C1 15 ATS-C1 15 ATS-C1 15 ATS-C1 16 Verify and review PFC for Fuel Symmetric delay of the state of the s			SIMULATE EACH TRA	POWER LOSS BY DISCONNECTING PO			
ATS-Q1 ATS-Q2			BREAKER	R) TO THE NORMAL SIDE OF EACH TRAN	YES 48		
Tests Printed on 077122021 Page 2 of 9 ATS-C1 12 ATS-C3 32 Verify Gen. Start 13 ATS-C1 14 ATS-C1 15 ATS-C1 15 ATS-C1 16 ATS-C1 17 Seminate power outge for at least 18 Verify and review PPC of Full Sys 18 Verify and review PPC of Full Sys 18 Verify generator starts. 19 Verify and represent or closes to comparation of the comparation of t	- CA. A.	0.0000000000000000000000000000000000000	ATS-Q1				
Record ATS transfer (sec) 13 ATS-C1 14 ATS-C2 15 ATS-S1 15 Verify and review PFC for Fuel Sy 16 Verify and review PFC for Fuel Sy 17 Simulate power outgage for at least 18 Verify generator closes to I 18 Genes paralleled and ATSs tra 18 Verify generator closes to I 29 sec (20 sec transfer delay) 19 Verify frag generator closes to I 29 sec (20 sec transfer delay) 10 Verify frag generator closes to I 29 sec (20 sec transfer delay) 10 Verify frag generator closes to I 29 sec (20 sec transfer delay) 11 Verify Genes paralleled and ATSs tra 11 Verify Genestar Closes to I 20 sec (20 sec transfer delay) 11 Verify Genestar Closes to I 21 sec (20 sec transfer delay) 21 sec (20 sec transfer delay) 22 sec (20 sec transfer delay) 23 sec (20 sec transfer delay) 24 sec (20 sec transfer delay) 25 sec (20 sec transfer delay) 26 sec (20 sec transfer delay) 27 sec (20 sec transfer delay) 28 sec (20 sec transfer delay) 29 Record ATS transfer (sec) 20 sec (20 sec transfer delay) 21 sec (20 sec transfer delay) 21 sec (20 sec transfer delay) 22 sec (20 sec transfer delay) 23 sec (20 sec transfer delay) 24 sec (20 sec transfer delay) 25 sec (20 sec transfer delay) 25 sec (20 sec transfer delay) 26 sec (20 sec transfer delay) 27 sec (20 sec transfer delay) 28 sec (20 sec transfer delay) 29 sec (20 sec transfer delay) 21 sec (20 sec transfer delay) 21 sec (20 sec transfer delay) 22 sec (20 sec transfer delay) 23 sec (20 sec transfer delay) 24 sec (20 sec transfer delay) 25 sec (20 sec transfer delay) 26 sec (20 sec transfer delay) 27 sec (20 sec transfer delay) 28 sec (20 sec tr			YES 32	Verify Gen. Start		(
Record retransfer to normal (sec) 28 sec (20 sec transfer delay) 16 Verify and review PFC for Fuel S 17 Simulate power outage for at least 18 Verify generator starts. 19 Verify first generator closes to 19 Record ATS transfer (sec) 28 sec (20 sec transfer delay) 19 Verify first generator closes to 19 Verify Gen	-		YES 33	Record ATS transfer (sec)			
ATS-Q2 ***********************************		ATS-C2	YES 34		ONE GEN	ERATOR (OPEN GENERATOR BREAKER).	
Werly Generator Close to Same Reverous State Server FC of rod of Same Reverous State		34-314-374-3-5	ATS-Q2		YES 50		
17 Simulate power outage for at lease 28 sec (28 sec transfer (sec) 28 sec (28 sec transfer delay)			YES 35	Verify Gen. Start			
18 Verify first generator clases to program and ATSs trainsfer (sec) 20 Verify first generator closes to program and and ATSs trainsfer (sec) 31 Verify Gen. Start 193 38 Verify Gen. Start 193 39 V	YES 17		YES 36		TES 51	Life Safety and Critical set as Essential - not shed.	
Verify first generator closes to Capture paralleled and ATSs training to paralleled by Verify digenerator closes to Verify and Section Section (section of Virizo2021 Page 2 of 9 ATS-C1 Verify and Percord ATS training (section of Virizo2021 Page 2 of 9 ATS-C1 Verify Gen. Start VES 42 Record ATS training (section of Virizo2021 Page 3 of 9 ATS-C1 VES 43 Record retraining to normal (section of Virizo2021 Page 3 of 9 ATS-C1 VES 44 Verify Gen. Start VES 55 Control Panel shows visual indication Tests Printed on 07/12/2021 Page 3 of 9 ATS-C1 VES 50 Control Panel shows visual indication Tests Printed on 07/12/2021 Page 3 of 9 ATS-C1 VES 50 Control Panel shows visual indication Test could not be simulated. VES 50 Control Panel shows visual indication Test could not be simulated. VES 50 Control Panel shows visual indication Test could not be simulated. VES 50 Control Panel shows visual indication Test could not be simulated. VES 50 Control Panel shows visual indication Test could not be simulated. VES 50 Control Panel shows visual indication Test could not be simulated.	YES 18	Verify generator starts.	VES 37	Record retransfer to normal (sec.)	YES 52	Verify generators are sharing load equally.	
Verify 2nd generator closes to Verify 2nd generator closes to 28 sec (20 sec (20 sec transfer (sec) 28 sec (20 sec transfer delay)) VIST 39 Record ATS transfer (sec) 28 sec (20 sec (20 sec transfer delay)) VIST 41 Verify Gen. Start VIST 34 Record retransfer to normal (sec) ATS-C1 VIST 34 Record ATS transfer (sec) 6 sec VIST 34 Record at transfer (sec) 6 sec VIST 34 Record ATS transfer (sec) 6 sec VIST 34 Record at transfer (sec) 6 sec VIST 34 Record at transfer (sec) 6 sec VIST 35 Record ATS transfer (sec) 6 sec VIST 36 Record ATS transfer (sec) 6 sec VIST 37 Shutdown of EPS VIST 58 Remote audible alert LOW WATER COOLANT TEMP - 70 F (21 °C) VIST 50 Remote audible alert HIGH ENGINE COOLANT TEMP PREALARM VIST 61 Centrol Panel shows visual indication VIST 62 Remote audible alert HIGH ENGINE COOLANT TEMP PREALARM VIST 61 Centrol Panel shows visual indication	YES 19			resort residents to resident (seed)			
Verify 2nd generator closes to 25 sec (20 sec transfer (sec) 47 Sec (20 sec transfer (sec) 47 Sec (21 sec transfer (sec) 48 Sec (21 sec transfer (sec) 48 Sec (21 sec transfer (sec) 49 Sec (21 sec transfer (sec) 59 At alarms verified for both Gen 1 and Gen 2, at generator, at remote annunciators in office and at nutse station, and at paralleling switchgear. OVERCRANK Tests Printed on 07/12/2021 Page 3 of 9 Tests P		Gens paralleled and ATSs trail		Verify Gen. Start	YES 54	Repeat test with other generator shut-down.	
Tests Printed on 07/12/2021 Page 2 of 9 Tests Printed on 07/12/2021 Page 3 of 9 Test could not be simulated.	YES 20	Verify 2nd generator closes to I			ALARM &	ANNUNCIATION	
ATS-C1 ATS-C1 ATS-C1 ATS-C2 ATS-C3 ATS-C3 ATS-C4 ATS-C4				26 sec (20 sec transfer delay)	YES 55	All alarms verified for both Gen 1 and Gen 2, at generator, at remote annunciators in office and at nutse station, and at	
ATS-C1 VES 41 Verify Gen. Start VES 42 Record ATS transfer (sec) 6 sec VES 43 Record retransfer to normal (sec) Tests Printed on 07/12/2021 Page 3 of 9 ATLC (**Normation**) Test Printed on 07/12/2021 Page 3 of 9 Ontrol Panel shows visual indication Test could not be simulated. VES 60 Control Panel shows visual indication Test could not be simulated. VES 61 Control Panel shows visual indication Test could not be simulated. VES 62 Remote audible alert HIGH ENGINE COOLANT TEMP PREALARM VES 61 Control Panel shows visual indication	_		YES 40	Record retransfer to normal (sec)			
Verify Gen. Start. Verify	TILC SE	20710/43	ATS-C1				
Record ATS transfer (sec) 6 sec 1 Second ATS transfer (sec) 1 Second retransfer to normal (sec) Tests Printed on 07/12/2021 Page 3 of 9 ATLC 95%/915596 1 Control Panel shows visual indication Test could not be simulated. 1 On Remote audible afert HIGH ENGINE COOLANT TEMP PREALARM 1 Second ATTLE PRINTED PRINT			YES 41	Verify Gen. Start			
LOW WATER COOLANT TEMP < 70 F (21 °C) Tests Printed on 07/12/2021 Page 3 of 9 ATLC 195/INTERING Test printed on 07/12/2021 Page 3 of 9 Test could not be simulated. 100 00 Remote audible alert HIGH ENGINE COOLANT TEMP PREALARM Test could not be simulated. 100 00 Remote audible alert HIGH ENGINE COOLANT TEMP PREALARM Test could not be simulated. 100 00 Remote audible alert HIGH ENGINE COOLANT TEMP PREALARM Test could not be simulated.			YES 42	200400000000000000000000000000000000000			
Tests Printed on 07/12/2021 Page 3 of 9 ATLC 199/INTERING On Panel shows visual indication Test could not be simulated. Test quick the simulated. Test out of the simulated.				6 sec			
Tests Printed on 07/12/2021 Page 3 of 9 Test could not be simulated. SO Remote audible alert HIGH ENGINE COOLANT TEMP PREALARM SES 61 Control Page 1 shows visual indication SES 62 Remote audible alert HIGH ENGINE COOLANT TEMPERATURE			YES 43	Record retransfer to normal (sec)			
TLC 195/011595 00 Remote audible alert HIGH ENGINE COOLANT TEMP PREALARM 100 10 Centrol Panel shows visual indication 100 Remote audible alert HIGH ENGINE COOLANT TEMPERATURE			Tests Drint	ad on 07/12/2021 Dags 2 of 0	NO 59		
HIGH ENGINE COOLANT TEMP PREALARM SES 61 Control Panel shows visual indication SES 62 Remote audible alert HIGH ENGINE COOLANT TEMPERATURE			-	TO THE STATE OF TH	NO 60		
Control Panel shows visual indication CES 62 Remote audible afert HIGH ENGINE COOLANT TEMPERATURE			A ILC	OCOTIONS:			
82 Remote audible alert HIGH ENGINE COOLANT TEMPERATURE		_					
HIGH ENGINE COOLANT TEMPERATURE							
63 Control Panel shows visual indication						Control Panel shows visual indication	
					Tosts I Print	led on 07/12/2021 Page 4 of 9	

Use the Cx Plan for its intended purpose... as the testing plan!

Project Information

Project Goals

Project Requirements, OPR, BOD

Team Member Information

Schedules

Start-up Checklists

Pre-Functional Tests

Functional Performance Tests





Commissioning Meetings

New Construction: Focus on Construction Team, Planning Construction Activities

Existing Facilities: Also Need to Focus on

- Phasing
- Planning Shutdowns
- Scheduling Tie-Ins
- After Hours Testing

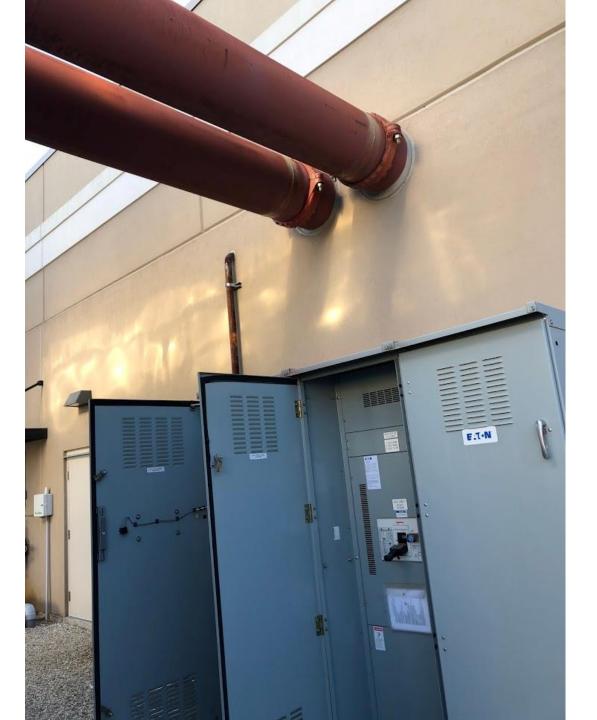
Design Criteria, SOO, Code Requirements define expectations

Cx Plan defines testing requirements, "Ready for Construction Phase Commissioning" expectations, Integrated systems testing procedures

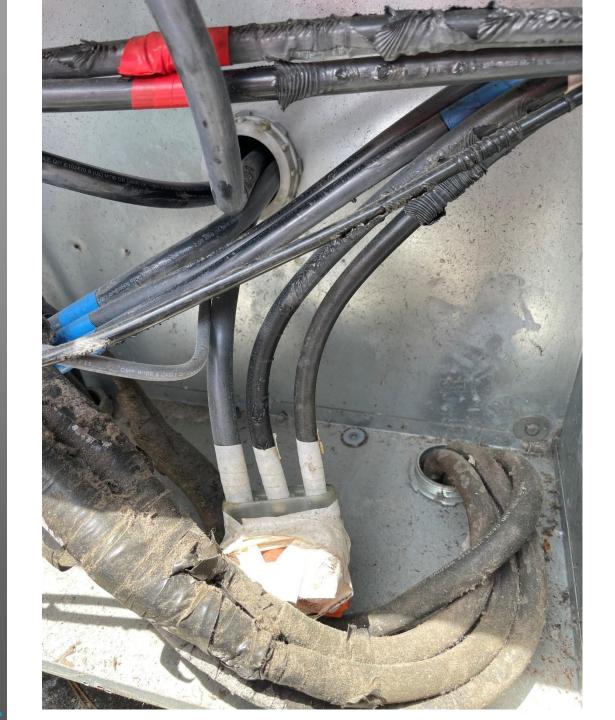


When is Ready, Ready?





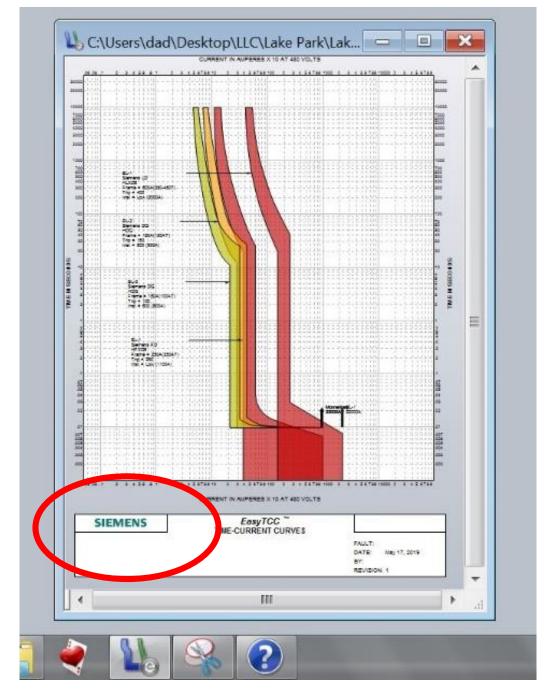








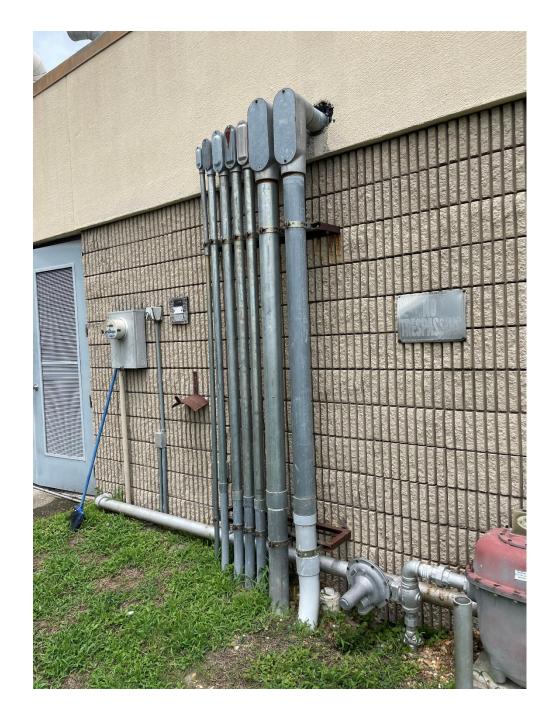


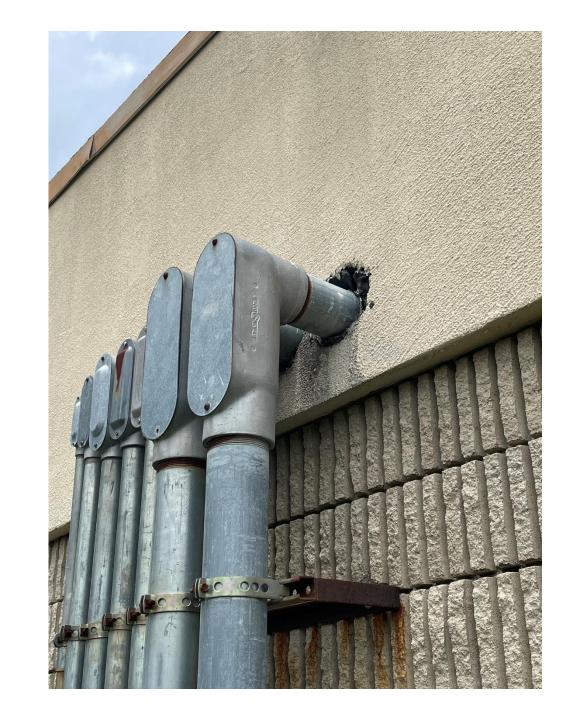
















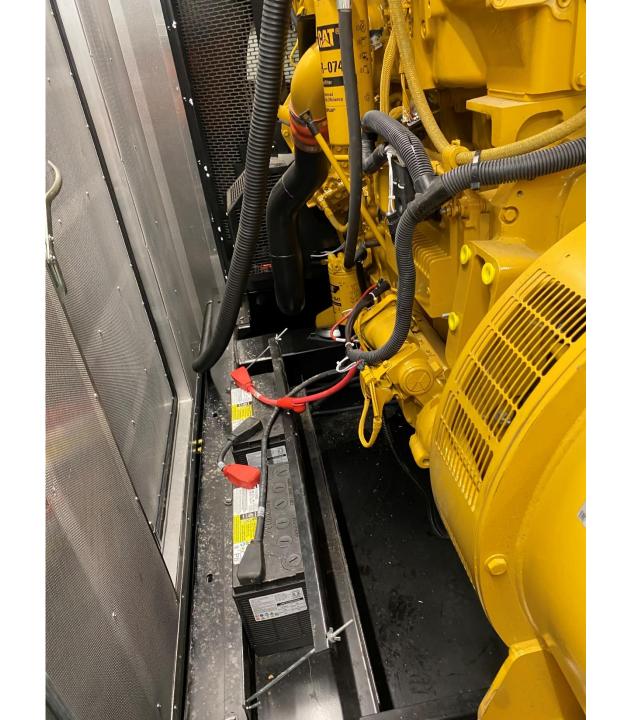


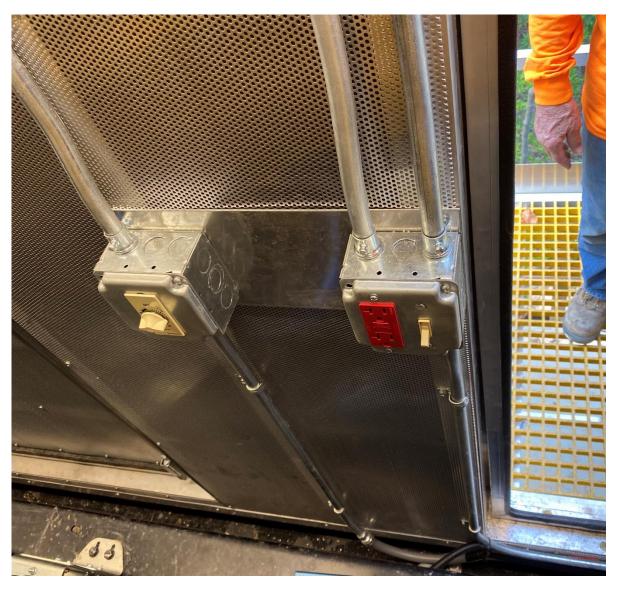


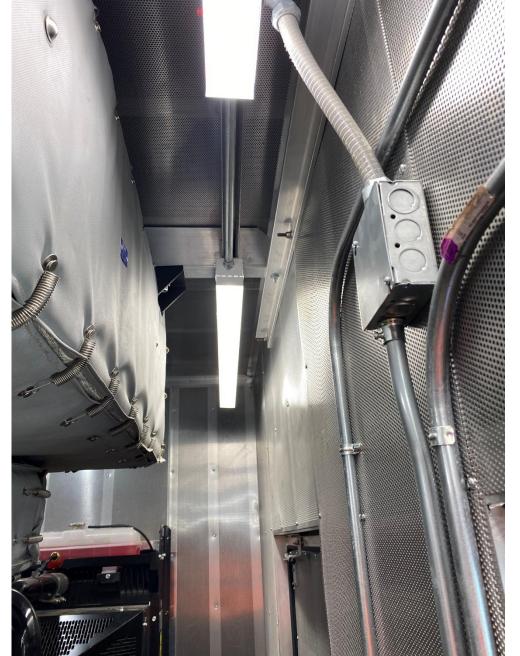




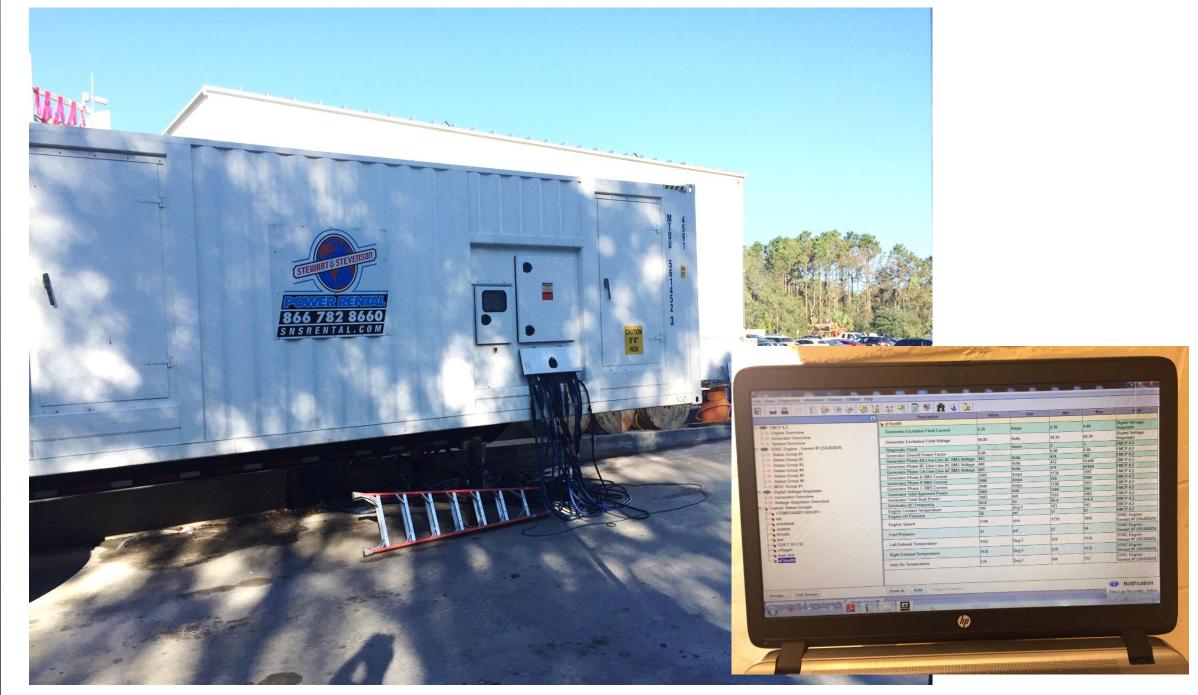














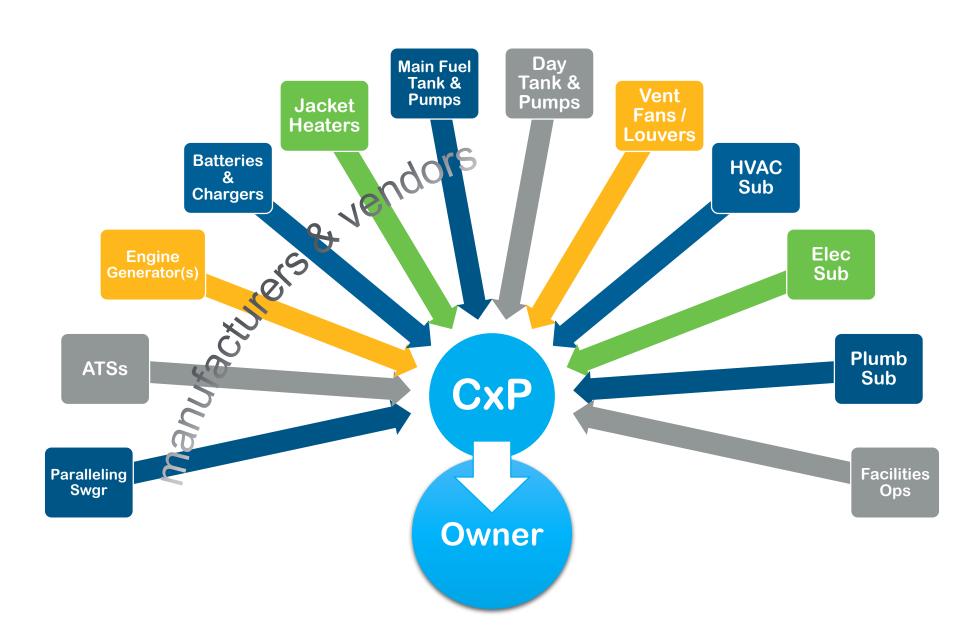


Ready for Commissioning / Ready for AHCA

- Generator, housing, silencers, batteries, and annunciators installed
- Feeders terminated, torqued, labeled, and document megger testing results. Reports submitted.
- 3. Grounding is complete. Tests/reports complete & submitted.
- 4. Louvers, dampers, air supply and exhaust systems are installed and operational.
- 5. All doors, walls, screens, etc. that make the generator room or enclosure are installed and complete.
- 6. Phase rotation verified to match the utility.
- 7. Utility voltage verified to be within an acceptable range for transfer.
- 8. NFPA 110 load bank test complete. Report submitted.
- 9. NFPA 110 compliant remote annunciator panels installed. Wiring run. Panel operation verified.
- 10. Fuel Systems installed, complete, tested.
- 11. Paralleling Switchgear / emergency switchboard installation complete.
- 12. All transfer switches installed, settings programmed.
- 13. Equipment connected to EPSS



Who Should Be There?







How We Test: Emergency Power

Engine-Generator:

- Visual Inspection
- Load Bank Test
- Simulated Power Loss to check start wiring
- Alarms and Remote Annunciators

Fuel Systems:

- Visual Inspection
- Main Fuel Tank & Pumps
- Day Tank Pumps
- Manual Pumps, Valves

Transfer Switches

- Settings Programmed
- Engine Start Wiring
- Test each ATS Individually

Paralleling Switchgear

- Verify Paralleling & Load Sharing
- Verify Load Shed / Load Add





Shutdown, Testing, & Handover

- Need good baselines
- Especially when Connecting to Existing Facility
- Document, Document!

Knowing What's Connected to Where:

- Networks
- ORs
- HVAC
- Med-gas
- Support equipment







The Cure for Paranoia - Integrated System Testing (IST)

We've testing everything individually... now lets test it all together

- Does HVAC system work properly on emergency power? Chillers? After return to normal power?
- Does FIRE ALARM SYSTEM work on emergency power? AHU shutdown? Damper Closing and Reopening?
- Do ELEVATORS run properly on emergency power? Recall? After return to normal power?
- UPS SYSTEMS? Large and Small?
- Are EMERGENCY COMMUNICATION SYSTMS functional?
- SECURITY / ACCESS CONTROL ?





The Cure for Paranoia - Integrated System Testing (IST)

- 1. Building Wide Power Shutdown
 - a. Verify All Generators Start
 - b. Verify All Transfer Switches Transfer
- 2. Turn off all but Life Safety power
 - a. Walk the building. Verify LS lighting, emergency communications, etc.
 - b. Test Fire Alarm System
 - c. Test Emergency Communications
 - d. Test/Verify Generator Accessories, Fuel Systems.
- 3. Turn on Critical / Emergency power
 - a. Walk the building. Verify misc loads and lighting are connected and operating.
 - b. Test / Verify Systems
- 4. Turn on Equipment power (HVAC, Elevators, etc)
 - a. Verify HVAC Operation AHUs, Chillers, Dampers, Controls, etc
 - b. Test AHU Shutdown with Fire Alarm
 - c. Verify Elevator Operation. Test Elevator Recall.
- 5. Return Normal Power, Verify ATS Re-Transfer
 - a. Walk the building, see if anything is "messed up"
 - b. Verify HVAC Operation (again)
 - c. Verify Elevator Operation (again)





