

With Great Emergency Power...

Designing and Commissioning EPSS

Be Prepared or Be Paranoid

THINK. LISTEN. CREATE.®

Learning Objectives:

1. 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.
2. 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

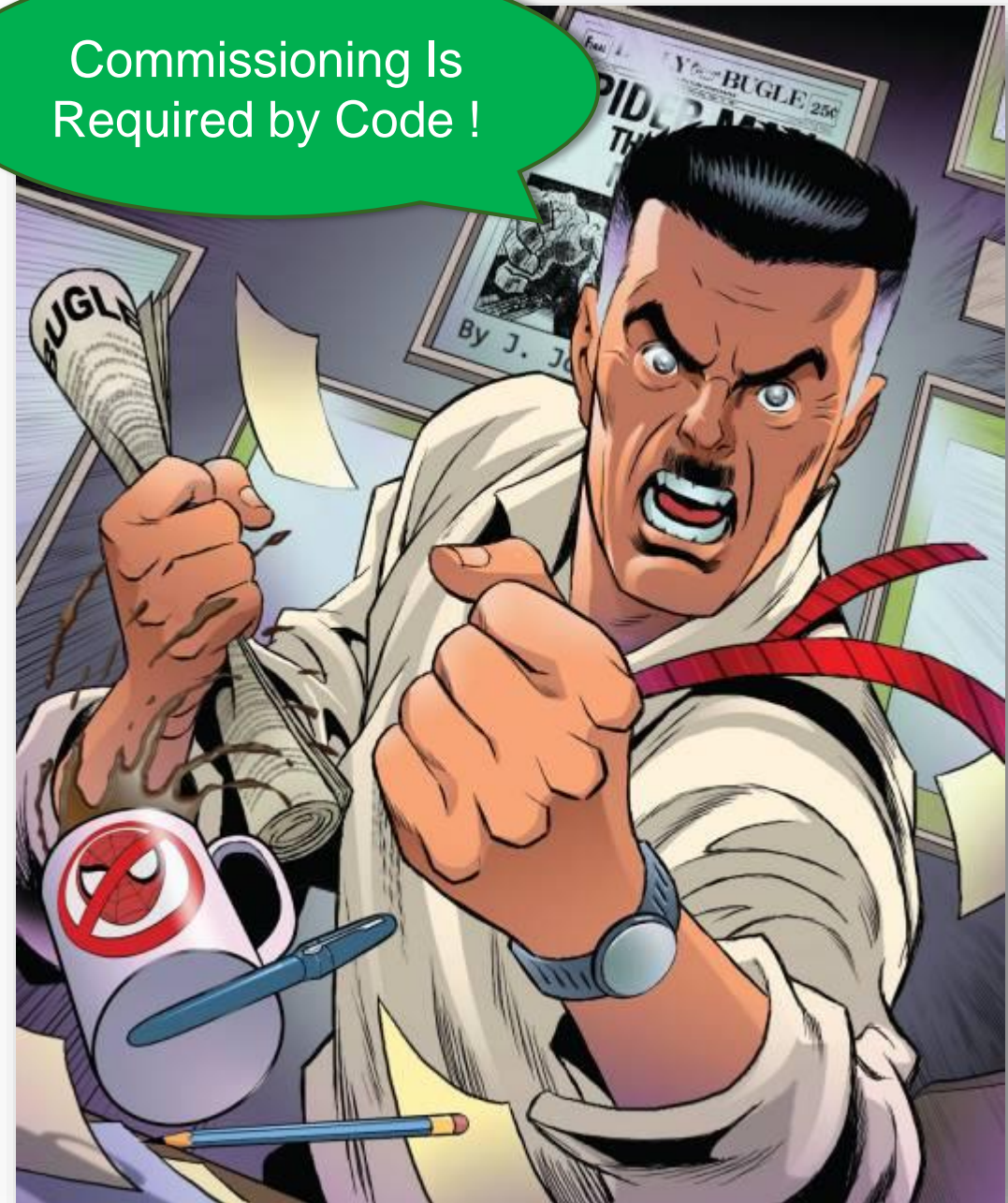
- Mechanical Systems (C408.2): >40 Tons Cooling, 600 MBH Heating
- Service Water Heating (C408.2): If Mech Cx is Required
- Lighting Controls (C408.3): All Projects.

Guidelines for Design and Construction of 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

Commissioning Is Required by Code !





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
5. 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

[illegible]

- CB
CM 16000TF
- DISCONNECT ALL WIRING FROM
EXISTING GENERATOR'S CIRCUIT BREAKER.
ABANDON KOHLER GENERATOR IN PLACE.

Ge

Enlarged plans
show the details.
Constructable!

FLOOR PLAN - ELECTRICAL NEW WORK

LIGHTING FIXTURE SCHEDULE									
TYPE	DESCRIPTION	MANUFACTURER	MODEL	VOLTAGE	REQUIRED LAMPS		VA		COMMENTS
					TYPE	QUANTITY			
JZE	4' LED STRIP FIXTURE WITH BATTERY PACK	EATON	45NLED-LD4-15L-LW-UNV-EL14W-LR35-CD-U	120 V	LED	PROVIDED WITH FIXTURE	41 VA		PROVIDE WITH CHAIN HANGER AS NEEDED.

- GENERAL LIGHTNING PROTECTION NOTES:**
1. PROVIDE COMPLETE LUL LISTED, LP CERTIFIED LIGHTNING PROTECTION SYSTEM IN FULL COMPLIANCE WITH THE LATEST EDITION OF NFPA 780 FOR NEW GENERATOR ENCLOSURE. THE SYSTEM SHALL INCLUDE ALL AIR TERMINALS, ROOF CONDUCTORS, DOWN CONDUCTORS SPACED NOT MORE THAN 100' APART AND GROUND RODS SPACED 6' ON 6' VERTICALLY DRIVE RODS. IF FEED DOWN CONDUCTOR, PROVIDE AIR TERMINALS ON ALL ROOF MOUNTED EQUIPMENT, AS REQUIRED. RING ALL METALLIC ROOFS WITHIN AREAS CALCULATED BY NFPA 780.
 2. ALL ROOF MOUNTED EQUIPMENT SHALL BE ALUMINUM. ALL DOWN CONDUCTORS AND GROUND RODS SHALL BE COPPER.
 3. SUBMIT COMPLETE SHOP DRAWINGS SHOWING ROOF LAYOUT, DOWN LOCATIONS, GROUND ROD LOCATIONS, ETC. AS WELL AS ALL CONNECTION DETAILS TO ENGINEER FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION. CONTRACTOR SHALL PERFORM ALL REQUIRED RESISTANCE AND CONTINUITY TESTING AFTER INSTALLATION IS COMPLETED.
 4. COORDINATE EXACT LOCATION OF ALL EQUIPMENT PRIOR TO INSTALLATION AND ROUGH-IN. FIELD LOCATIONS SHALL PREVAIL.

- ELECTRICAL KEYNOTES:**
- ① EXISTING ELECTRICAL PANEL USED ON THIS PROJECT.
 - ② COORDINATE EXACT CONDUIT ENTRY WITH PLACEMENT OF GENERATOR PRIOR TO TRACING.
 - ③ COORDINATE EXACT CONNECTION LOCATIONS FOR GENERATOR ACCESSORIES WITH GENERATOR MANUFACTURER.
 - ④ PROVIDE NEW BATTERY HEATER IF NOT PROVIDED WITH NEW (RELOCATED) GENERATOR.

SCHEDULE	
1	4' LED STRIP FIXTURE WITH BATTERY PACK
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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 EXISITNG. ONLY THE AUTOMATIC TRANSFER SWITCHES ARE NEW.

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:

1. PRE-PROGRAMMED ENGINE-START DELAY TIMER SHALL 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 3 TRANSFER 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 DURING THE TRANSFER
7. THE PARALLELED ENGINE-GENERATORS SHALL SHARE LOAD (APPROXIMATELY) EQUALLY.
8. ONCE NORMAL POWER IS RESTORED (PICKUP = 90% NOMINAL VOLTAGE), INITIATE RE-TRANSFER 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 UNEXPTED 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 SENSING SYSTEMS SHALL DETERMINE IF THE LOAD CAN BE CARRIED BY THE REMAINING ENGINE-GENERATORS AND IF THE ENTIRE LOAD CANNOT BE CARRIED, THE LOAD SHED SEQUENCE SHALL COMMENCE STARTING WITH PRIORITY 3 LOADS.

2. UPON UNEXPTED 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 AVAILABLE, 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-GENERATORS; IF THE LOAD CAN BE CARRIED BY THE REMAINING ENGINE-GENERATORS, THE PRIORITY 3 TRANSFER SWITCHES MAY BE MANUALLY RE-ADDED.
3. UPON UNEXPTED LOSS OF THREE OF THE FOUR EXISTING ENGINE-GENERATORS (CUTOUT = 85% OF NOMINAL VOLTAGE), THE PRIORITY 2 (CRITICAL BRANCH) TRANSFER SWITCHES SHALL BE AUTOMATICALLY TRANSFERRED TO CENTER POSITION. IF NORMAL POWER IS AVAILABLE, THEY SHALL ALSO BE AUTOMATICALLY CONNECTED OR HAVE BEEN READDED. THE EMERGENCY POWER DEMAND-LOAD SENSING SYSTEMS SHALL DETERMINE IF THE LOAD CAN BE CARRIED BY THE REMAINING ENGINE-GENERATORS; IF THE LOAD CAN BE CARRIED BY THE REMAINING ENGINE-GENERATORS, THE PRIORITY 2 AND PRIORITY 3 TRANSFER SWITCHES MAY BE 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 ENSURE THAT LIFE SAFETY AND CRITICAL BRANCH TRANSFER SWITCHES COME ONLINE WITHIN 10 SECONDS OF LOSS OF POWER.

LIFE SAFETY BRANCH TRANSFER SWITCHES

ENGINE START TIME DELAY:	1.0 SECONDS (ADJUSTABLE 0 - 6 SECONDS)
TRANSFER TO EMERGENCY TIME DELAY:	0 SECONDS (ADJUSTABLE 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 (POWER FAILURE MODE):	15 MINUTES (ADJUSTABLE 0 - 60 MINUTES)
RETRANSFER TO NORMAL TIME DELAY (TEST MODE):	30 SECONDS (ADJUSTABLE 0 - 10 HOURS)
UNLOADED RUNNING TIME DELAY FOR ENGINE COOL DOWN:	5 MINUTES (ADJUSTABLE 0 - 60 MINUTES)

ATS Settings



CRITICAL BRANCH TRANSFER SWITCHES

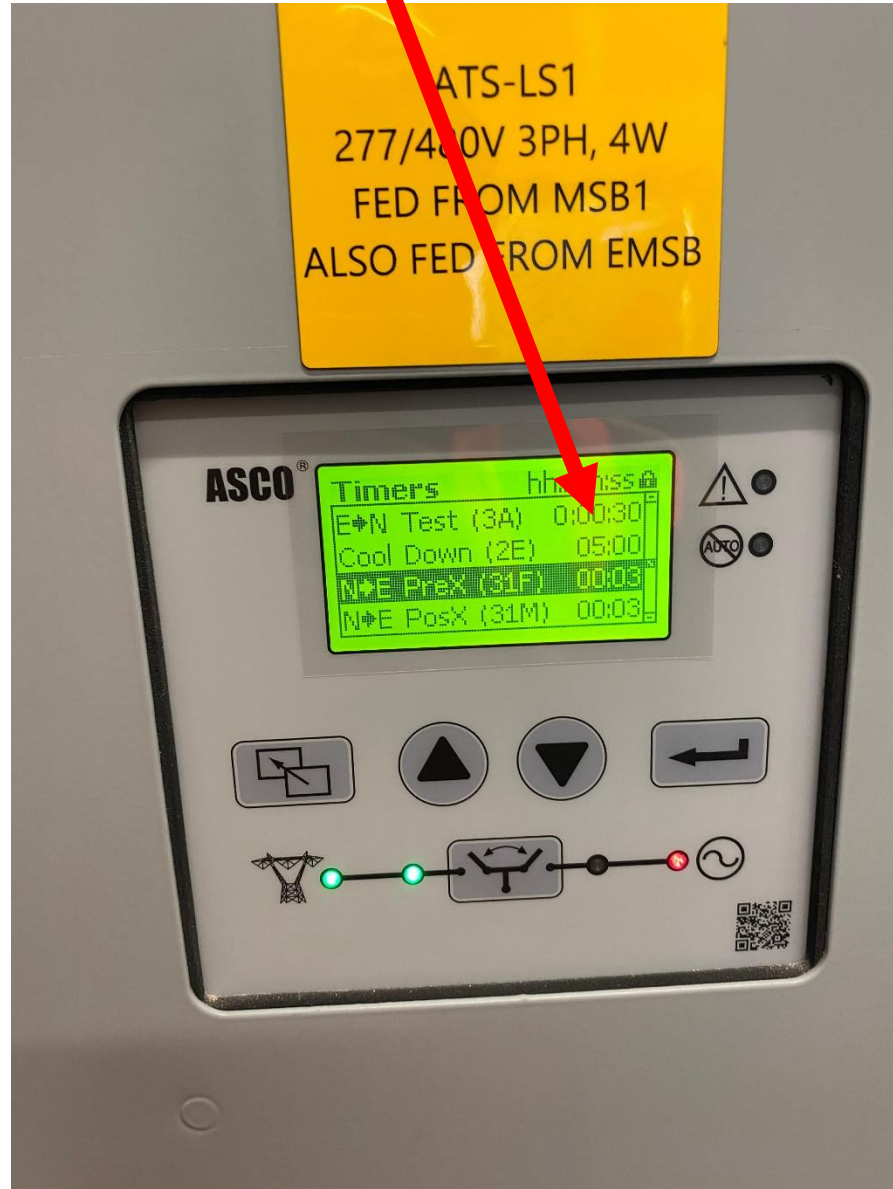
ENGINE START TIME DELAY:	1.0 SECONDS (ADJUSTABLE 0 - 6 SECONDS)
TRANSFER TO EMERGENCY TIME DELAY:	0 SECONDS (ADJUSTABLE 0 - 60 MINUTES)
EMERGENCY SOURCE STABILIZATION TIME DELAY:	0 SECONDS (ADJUSTABLE 0 - 6 SECONDS)
DELAYED TRANSITION LOAD DISCONNECT (CENTER POSITION) TIME DELAY:	NOT APPLICABLE
RETRANSFER TO NORMAL TIME DELAY (POWER FAILURE MODE):	15 MINUTES (ADJUSTABLE 0 - 60 MINUTES)
RETRANSFER TO NORMAL TIME DELAY (TEST MODE):	30 SECONDS (ADJUSTABLE 0 - 10 HOURS)
UNLOADED RUNNING TIME DELAY FOR ENGINE COOL DOWN:	5 MINUTES (ADJUSTABLE 0 - 60 MINUTES)

EQUIPMENT BRANCH TRANSFER SWITCHES

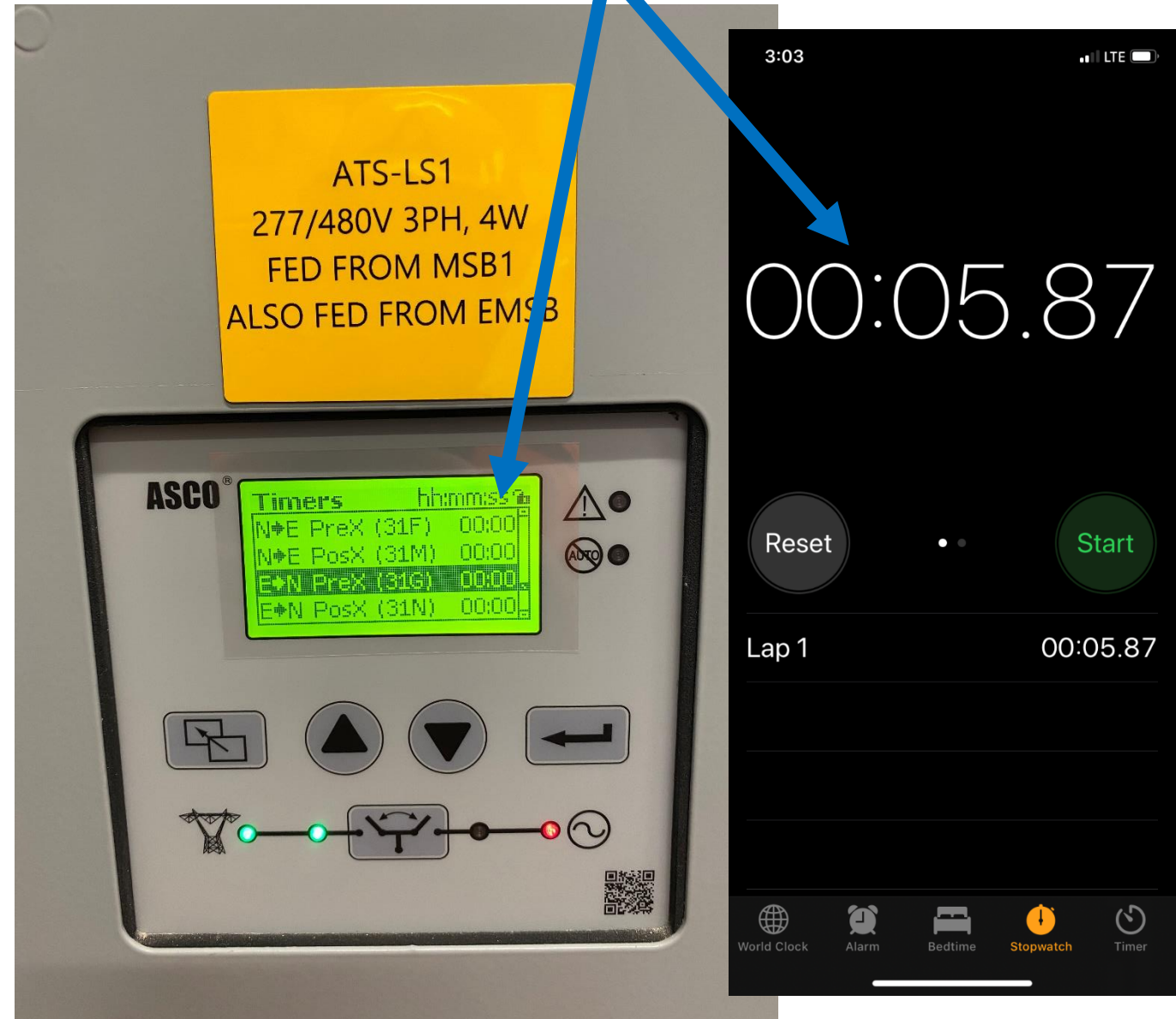
ENGINE START TIME DELAY:	1.0 SECONDS (ADJUSTABLE 0 - 6 SECONDS)
TRANSFER TO EMERGENCY TIME DELAY:	0 SECONDS (ADJUSTABLE 0 - 60 MINUTES)
EMERGENCY SOURCE STABILIZATION TIME DELAY:	0 SECONDS (ADJUSTABLE 0 - 6 SECONDS)
DELAYED TRANSITION LOAD DISCONNECT (CENTER POSITION) TIME DELAY:	30 SECONDS (ADJUSTABLE 0 - 5 MINS)
RETRANSFER TO NORMAL TIME DELAY (POWER FAILURE MODE):	15 MINUTES (ADJUSTABLE 0 - 60 MINUTES)
RETRANSFER TO NORMAL TIME DELAY (TEST MODE):	30 SECONDS (ADJUSTABLE 0 - 10 HOURS)
UNLOADED 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. (PROVIDE FOR ELEVATOR ATSS): 30 SECONDS* (ADJUSTABLE 0 - 5 MINS)
*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

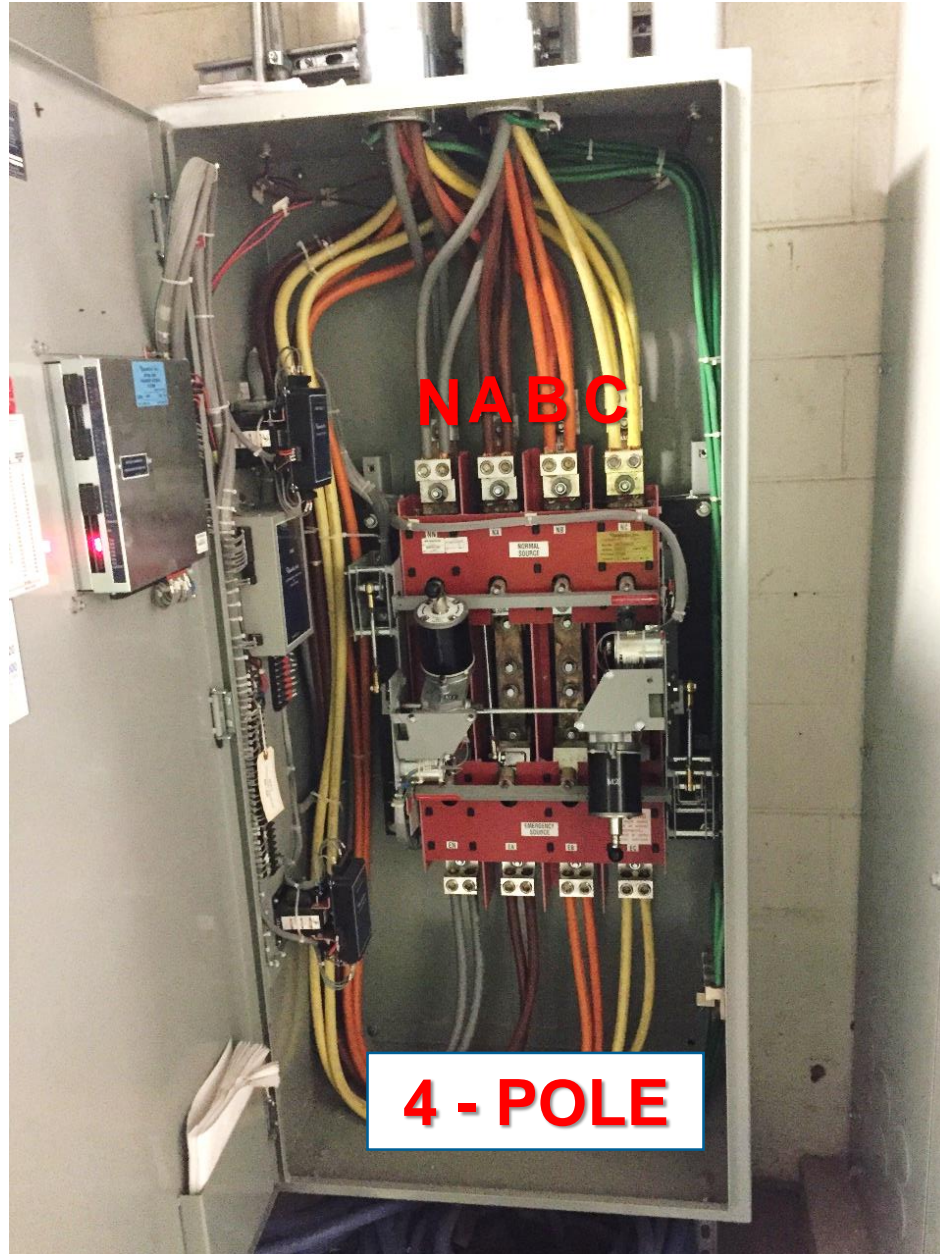


GROUNDING

Things to Consider:

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

4 Pole ATS vs 3 Pole ATS



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.

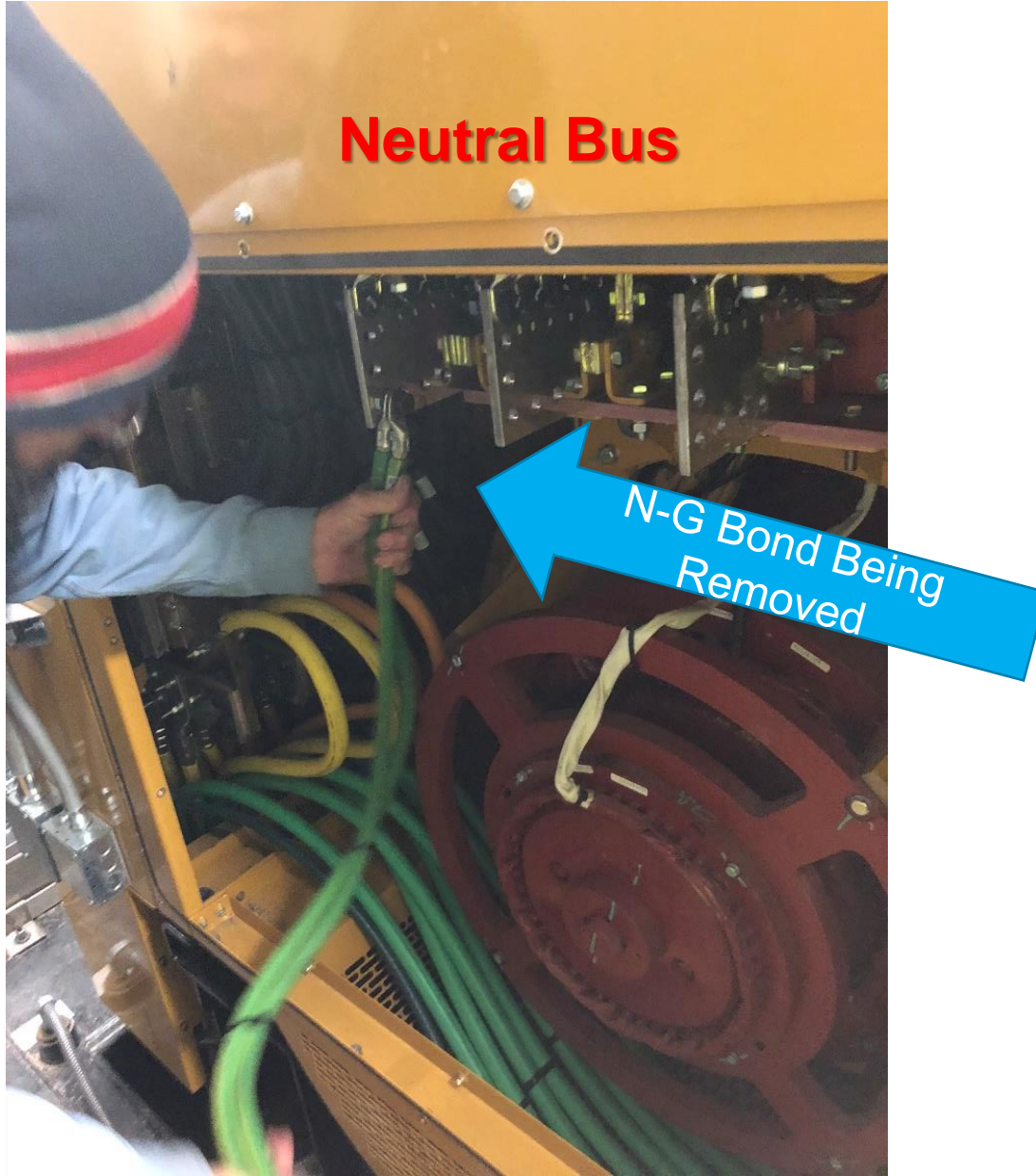
(B) Feeders. Where ground-fault protection is provided for operation of the service disconnecting means or feeder disconnecting means as specified by 230.95 or 215.10, an additional step of ground-fault protection shall be provided in all next level feeder disconnecting means downstream toward the load. 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?





Details Showed a Diesel Generator



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

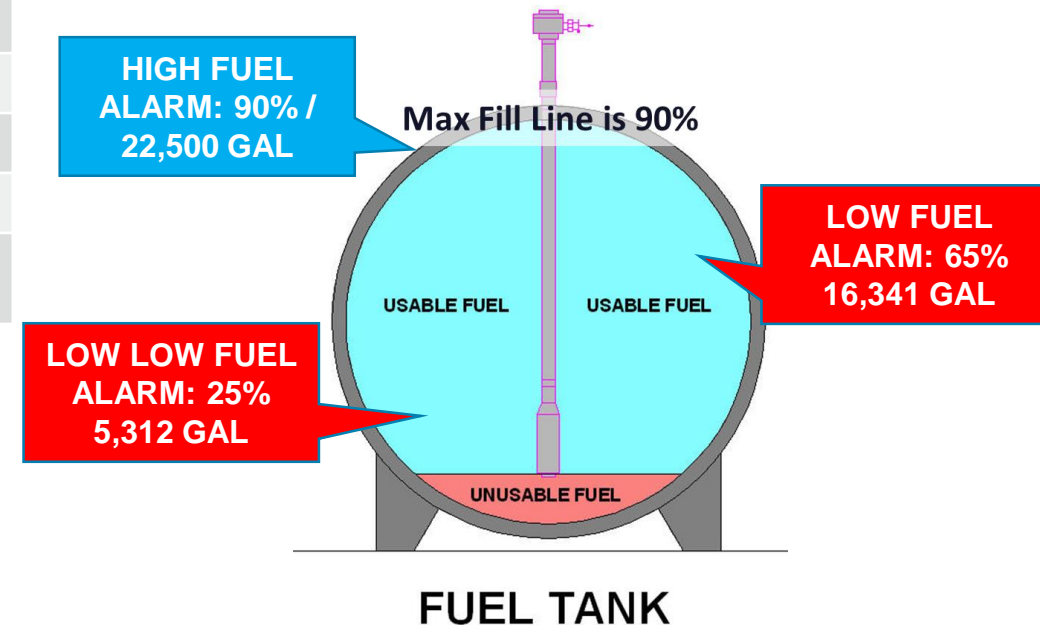
Step 2 – Determine Fuel Capacity

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:

Sequence of Operations!
(be clear about when supply and
return pumps turn on / off)

Have a Diagram!

Valves:
Isolation
Check
Solenoid

Day Tank / Pumps

Engine-Generator
(future provisions?)

Fill /
Monitoring
System

Hand Pump

Fuel Polishing System

Main Tank / Pumps

SEQUENCE OF OPERATIONS:

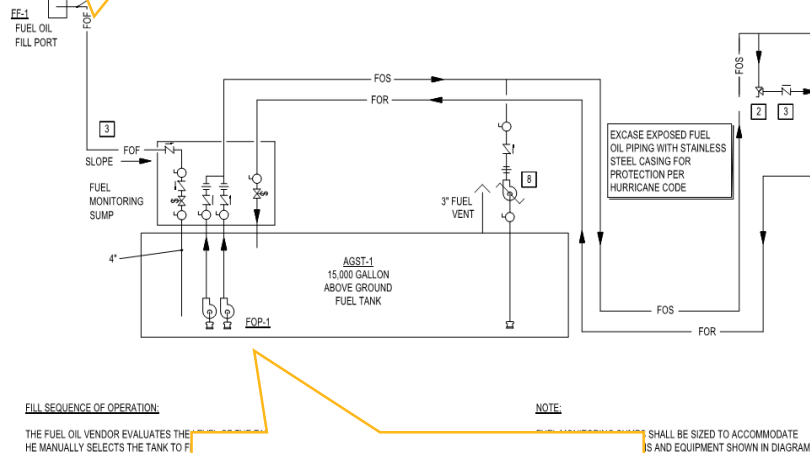
THE FUEL OIL SYSTEM CONSISTS OF THE FOLLOWING MAJOR COMPONENTS:
ONE 15,000 GALLON ABOVE GROUND FUEL TANK, NEW LEVEL MONITORING
LEAK DETECTION SYSTEM, PRIMARY/STANDBY/HAND FUEL OIL PUMP,
INTERCONNECTING FUEL OIL PIPING, GENERATOR DAY TANK WITH INTEGRAL
CONTROLS, DAY TANK OVERFLOW RETURN FUEL OIL PUMP, SHUT-OFF SOLENOID
VALVES, AND FUEL OIL SPECIALTIES/PUMPS PROVIDED WITH THE EMERGENCY
GENERATOR.

THE PRIMARY FUEL OIL PUMP IS ENERGIZED BY EITHER AN AUXILIARY CONTACT
OR A LOW LEVEL SWITCH IN THE GENERATOR DAY TANK. UPON ACTIVATION
OF THIS PUMP, FUEL OIL IS CIRCULATED TO THE DAY TANK. IF THE DAY TANK IS
FULL THE FUEL OIL PUMP AND ASSOCIATED SOLENOID VALVE SHALL CLOSE, PREVENTING
OVERFLOW OF THE DAY TANK.

SHOULD THE OPERATION OF THE PRIMARY FUEL OIL PUMP NOT SATISFY THE
NEEDS OF THE DAY TANK, A SECOND LOW LEVEL SWITCH IN THE DAY TANK WILL
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
RETURNED DIRECTLY TO THE MAIN TANK. SHOULD THE FUEL OIL SOLENOID
PROTECTING THE DAY TANK FROM OVERFILLING FAIL, A HIGH LEVEL SWITCH WILL START
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.
A SECOND HIGH LEVEL SWITCH WILL DISABLE BOTH THE PRIMARY AND STANDBY PUMPS
SHOULD THE LEVEL CONTINUE TO RISE.

ALL LEVEL SWITCHES IN BOTH THE DAY TANK AND FUEL OIL TANK SHALL BE
MONITORED REMOTELY. HIGH LEVELS, LOW LEVELS, AND LEAK DETECTION WILL
BE ALARMED. THE OVERFLOW BASIN FOR THE DAY TANK SHALL ALSO BE
EQUIPPED WITH A LIQUID DETECTOR TO ALARM OVERFLOW CONDITIONS.

ALL ALARMS WILL BE SENT TO THE BUILDING ALARM SYSTEM IN FAC CNTRL RM 1160.



FILL SEQUENCE OF OPERATION:

THE FUEL OIL VENDOR EVALUATES THE
HE MANUALLY SELECTS THE TANK TO F

NOTE:

SHALL BE SIZED TO ACCOMMODATE
IS AND EQUIPMENT SHOWN IN DIAGRAM.

FUEL OIL FLOW DIAGRAM

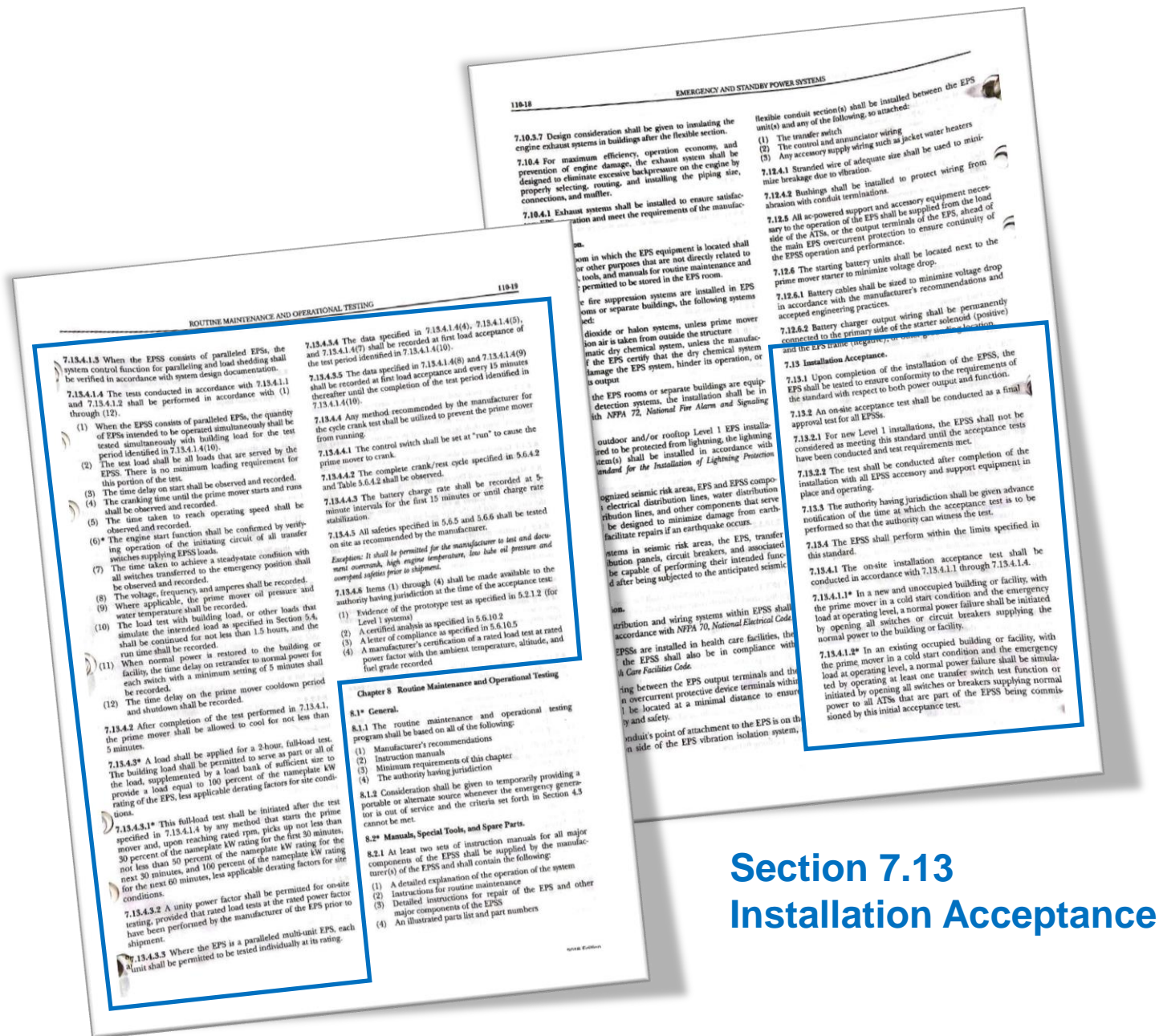
No Scale

Don't Forget the Fuel



HAVE A PLAN

But be ready to
change it...



Use

NFPA 110

as your guide.

Section 7.13 Installation Acceptance

TEST

#272 Emergency Power Supply System (EPSS)

TLC Engineering Solutions | ZZ Southwell Medical Hospital | 819002

SOUTHWELL

PASSED

93% Yes | 4% No | 2% N/A

1 ISSUE

Attempts

Attempt No. 1

PASSED

THE CONTRACTOR SHALL COMPLETE THE FOLLOWING CHECKLIST COMMENCING FUNCTIONAL PERFORMANCE TESTING

YES

 1 The system is complete and ready for testing

YES

 2 Prior performance has been verified by the contractor

YES

 3 Any outstanding items are noted as follows: TST-272-1

N/A

 4 List uploaded

YES

 5 Any outstanding items will require completion by the contractor

YES

 6 None of the outstanding items prevent testing

PRETESTING CHECKLIST

YES

 7 Verify and review start-up report for the system

N/A

 8 Verify and review factory and field test reports

YES

 9 Verify and review PFC for each ATS

YES

 10 ATS-Q1

YES

 11 ATS-Q2

YES

 12 ATS-Q3

YES

 13 ATS-C1

YES

 14 ATS-C2

YES

 15 ATS-S1

YES

 16 Verify and review PFC for Fuel System

EMERGENCY POWER SYSTEM FUNCTIONAL TESTING

YES

 17 Simulate power outage for at least 10 seconds

YES

 18 Verify generator starts.

YES

 19 Verify first generator closes to bus within 10 seconds

YES

 20 Verify 2nd generator closes to bus within 10 seconds

#272 Emergency Power Supply System (EPSS) | TLC Engineering Solutions | ZZ Southwell Medical Hospital | 819002

YES

 21 Repeat with Critical Branch ATS

YES

 22 Verify generator starts

YES

 23 Verify first generator closes to bus within specified time (10 seconds)

YES

 24 Verify 2nd generator closes to bus. Record Time. Both gens close in seconds

YES

 25 Repeat with at least one Equipment Branch ATS

YES

 26 Verify generator starts.

YES

 27 Verify first generator closes to bus within 10 seconds

YES

 28 Verify 2nd generator closes to bus. Record Time. Both gens close in seconds

YES

 29 Simulate power outage for each remaining branch

YES

 30 Verify engine start

YES

 31 Verify engine-generators online and ATS transfer

TRANSFER SWITCH FUNCTIONAL TEST PROCEDURE

SIMULATE POWER LOSS BY DISCONNECTING POWER FROM EACH TRANSFER SWITCH. ONCE LOADS HAVE BEEN TRANSFERRED TO THE NORMAL SIDE OF EACH TRANSFER SWITCH, RECORD THE FOLLOWING:

ATS-Q1

YES

 32 Verify Gen. Start

YES

 33 Record ATS transfer (sec)

YES

 34 Record retransfer to normal (sec) 26 sec (20 sec transfer delay)

ATS-Q2

YES

 35 Verify Gen. Start

YES

 36 Record ATS transfer (sec)

YES

 37 Record retransfer to normal (sec) 26 sec (20 sec transfer delay)

ATS-Q3

YES

 38 Verify Gen. Start

YES

 39 Record ATS transfer (sec)

YES

 40 Record retransfer to normal (sec) 26 sec (20 sec transfer delay)

ATS-C1

YES

 41 Verify Gen. Start

YES

 42 Record ATS transfer (sec)

YES

 43 Record retransfer to normal (sec) 26 sec (20 sec transfer delay)

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ATS-C2

YES

 44 Verify Gen. Start

YES

 45 Record ATS transfer (sec) 7 sec

YES

 46 Record retransfer to normal (sec) 26 sec (20 sec transfer delay)

ATS-S1

YES

 47 Verify Gen. Start

YES

 48 Record ATS transfer (sec) 26 sec (20 sec transfer delay)

YES

 49 Record retransfer to normal (sec) 26 sec (20 sec transfer delay)

LOAD SHED / LOAD PRIORITY TESTING

WITH BOTH ENGINE-GENERATORS RUNNING AND ALL ATSS SWITCHED TO EMERGENCY POWER, SHUT-DOWN ONE GENERATOR (OPEN GENERATOR BREAKER).

YES

 50 Note total load on emergency switchgear. Approx 500 kw total

YES

 51 Verify load-shed operation. (Priority 2 loads drop off line) Life Safety and Critical set as Essential - not shed. Equipment set as "priority 1" - shed on Demand only

YES

 52 Verify generators are sharing load equally.

YES

 53 Restore generator and verify re-adding of shed loads

YES

 54 Repeat test with other generator shut-down.

ALARM & ANNUNCIATION

YES

 55 All alarms verified for both Gen 1 and Gen 2, at generator, at remote annunciators in office and at nurse station, and at paralleling switchgear.

OVERCRANK

YES

 56 Control Panel shows visual indication

YES

 57 Shutdown of EPS

YES

 58 Remote audible alert

LOW WATER COOLANT TEMP. <70° F (21° C)

NO

 59 Control Panel shows visual indication Test could not be simulated.

NO

 60 Remote audible alert

HIGH ENGINE COOLANT TEMP PREALARM

YES

 61 Control Panel shows visual indication

YES

 62 Remote audible alert

HIGH ENGINE COOLANT TEMPERATURE

YES

 63 Control Panel shows visual indication

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TLC ENGINEERING

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TLC ENGINEERING

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TLC ENGINEERING

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?



Existing Conditions are... Existing

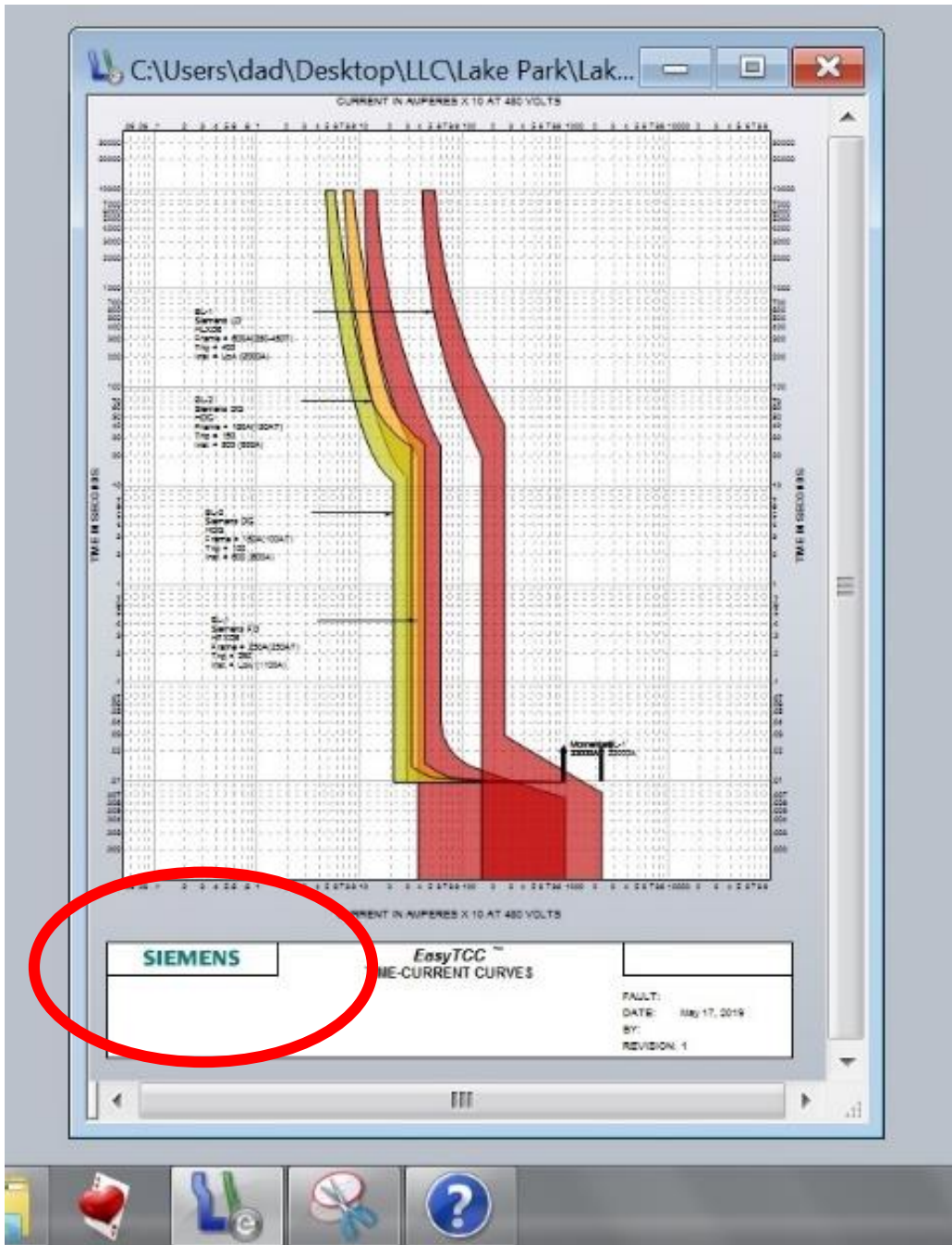




Existing Conditions are... Existing



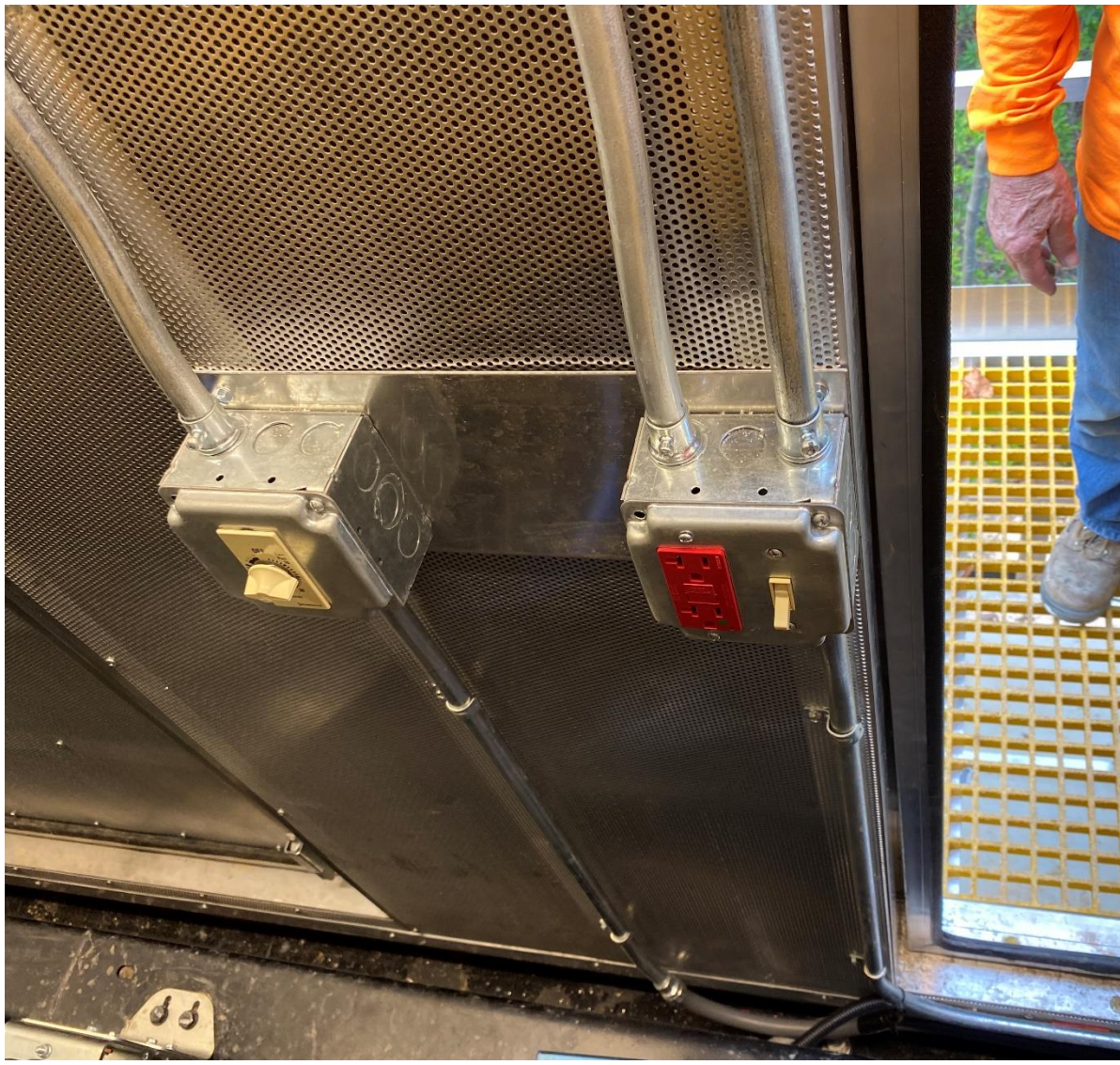


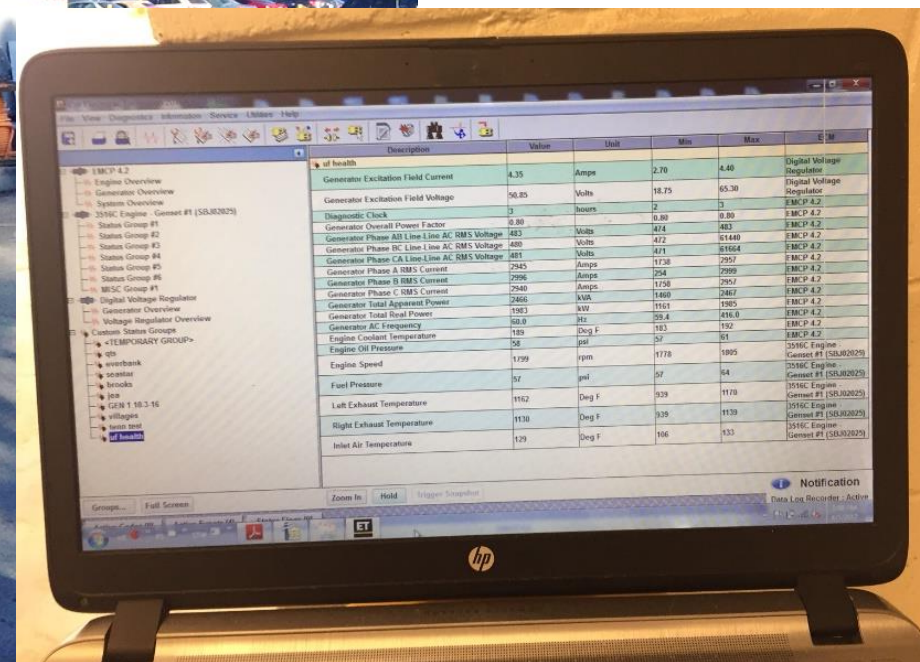










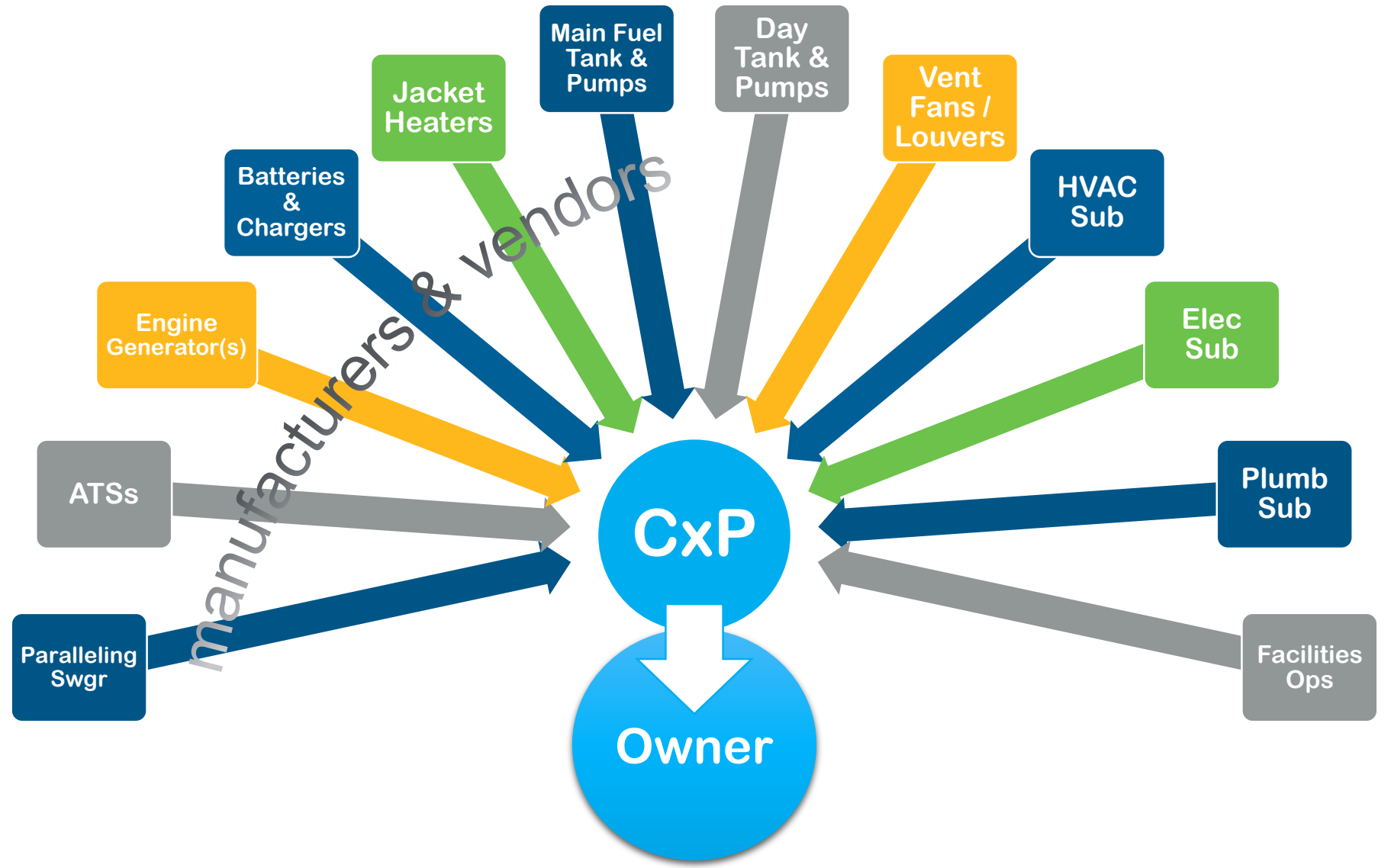




Ready for Commissioning / Ready for AHCA

1. Generator, housing, silencers, batteries, and annunciators installed
2. 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?





Vendors

Facility
Operations

Engineers

AHCA

SubContractors

Owner

CxP

IT TAKES A TEAM



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

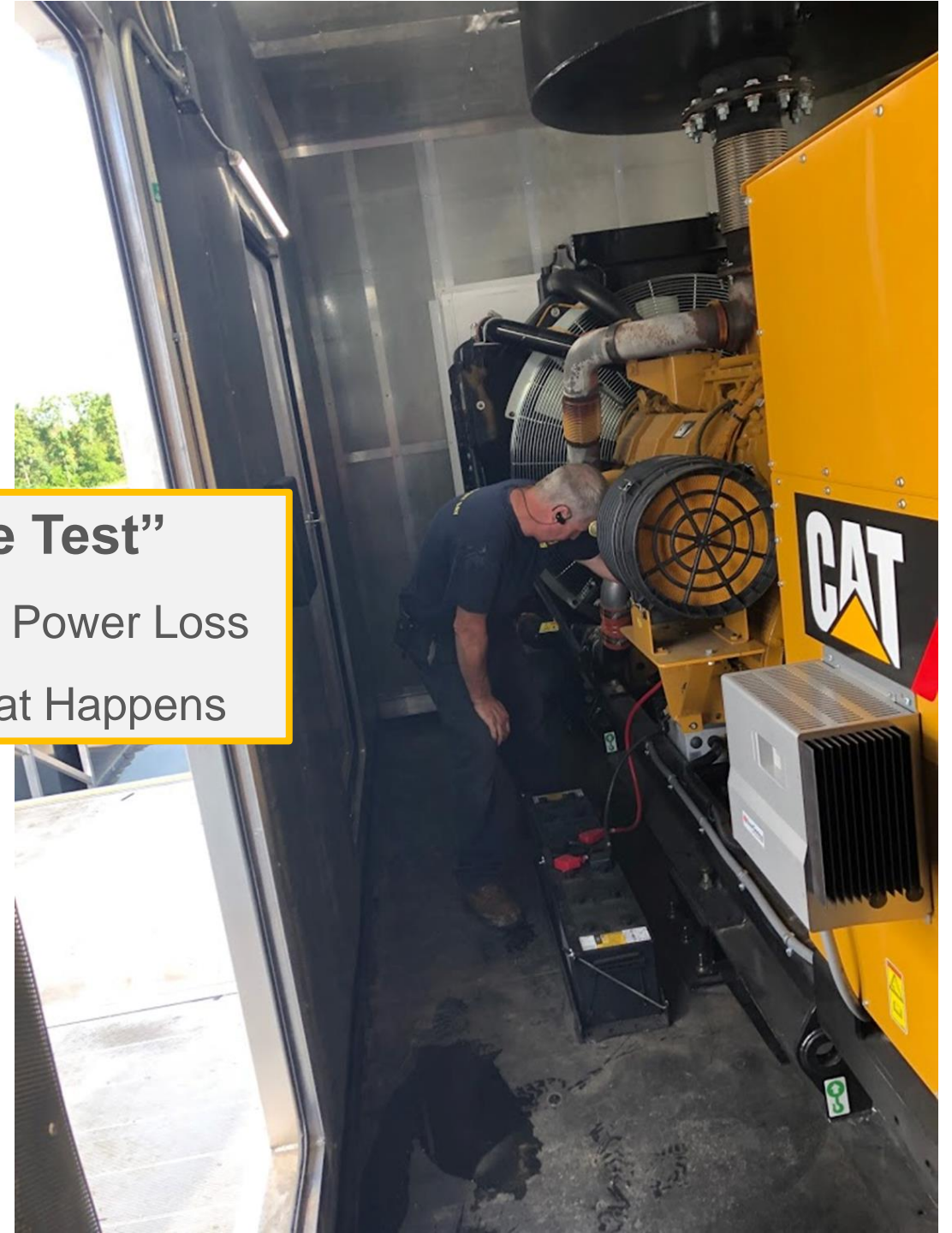
Paralleling Switchgear

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

“Black Site Test”

Step 1: Simulate Power Loss

Step 2: See What Happens

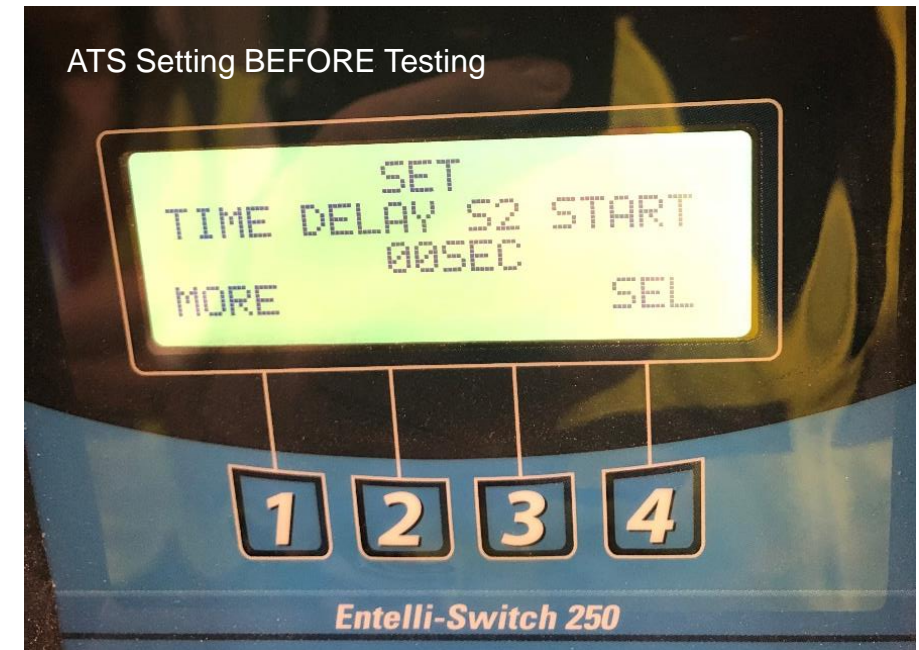


Shutdown, Testing, & Handover

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

Knowing What's Connected to Where:

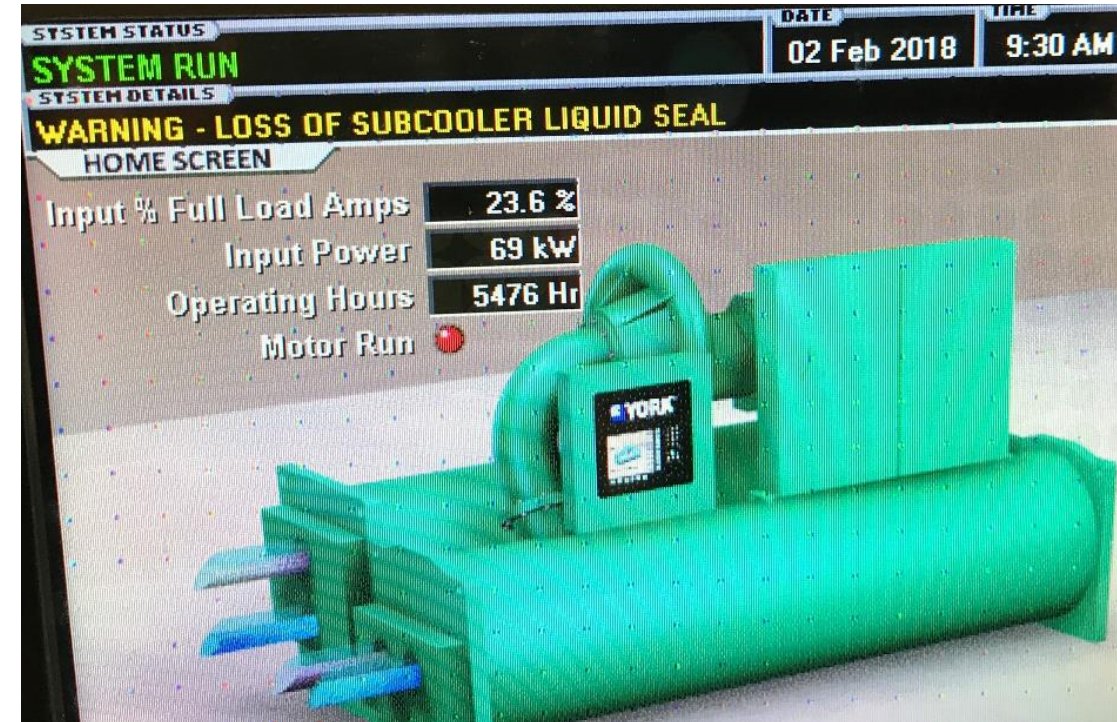
- Networks
- ORs
- HVAC
- Med-gas
- Support equipment



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)





QUESTIONS ?

