TLC ENGINEERING SOLUTIONS®

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

Assemble !

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

Commissioning is Required By Code

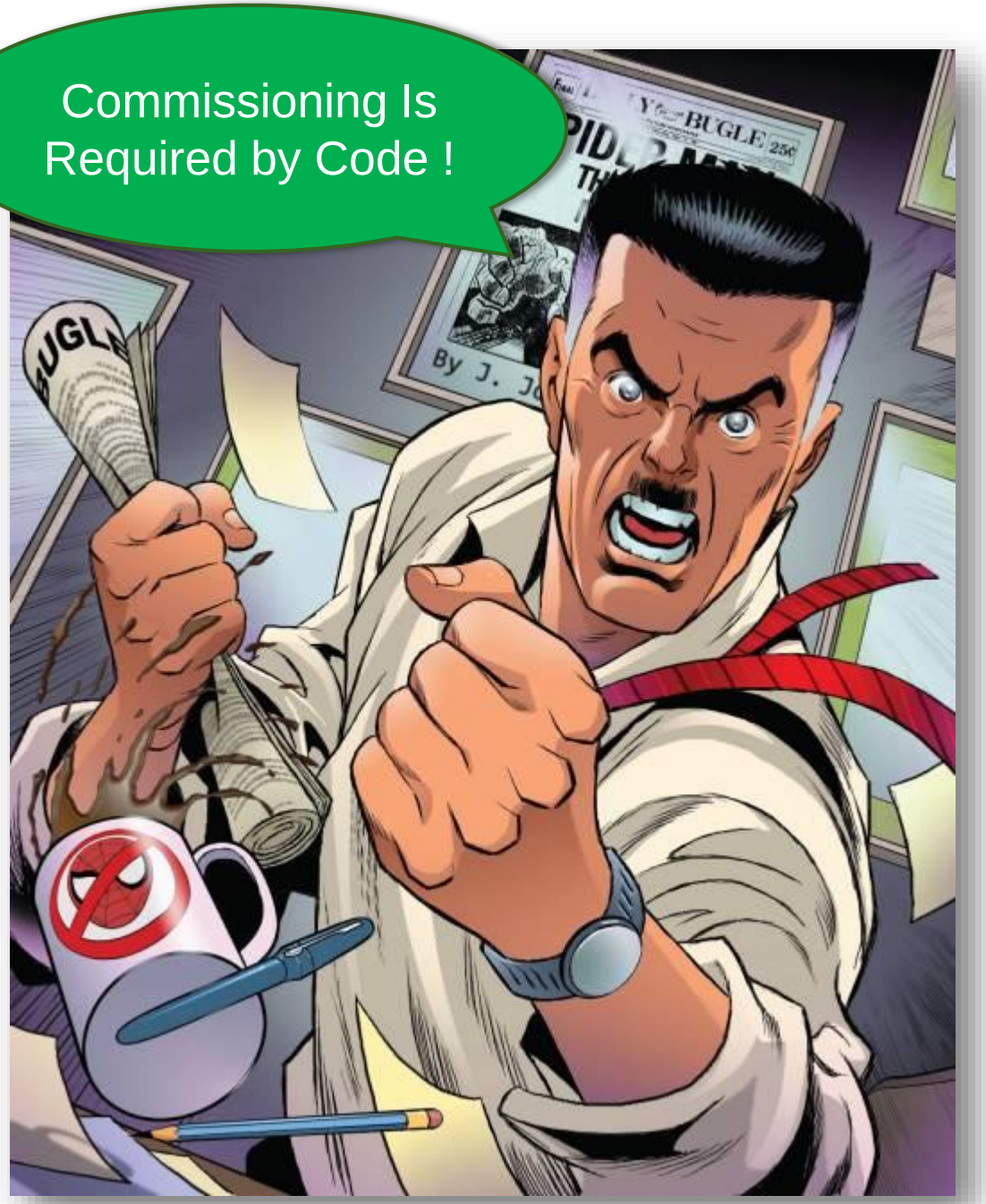
IECC 2018 / FBC 2020 C408 Maintenance Information and Systems Commissioning

- 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



Florida Nursing Home Generator Inspections

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

TLC Performed:

187 **Plan Reviews**

202 **Construction Surveys**

CxPs and AHCA Have Similar Goals

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

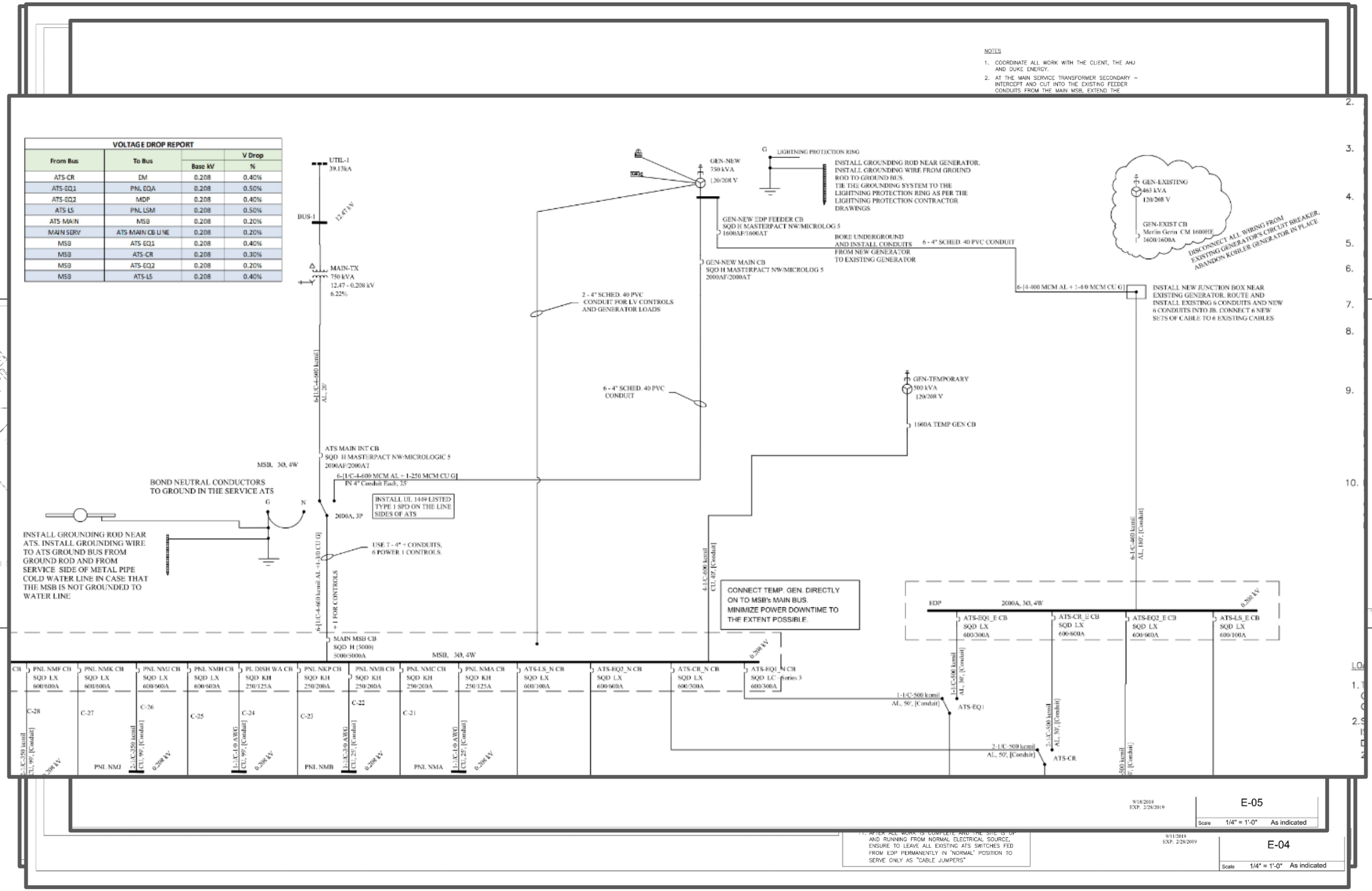
During Design

During Installation

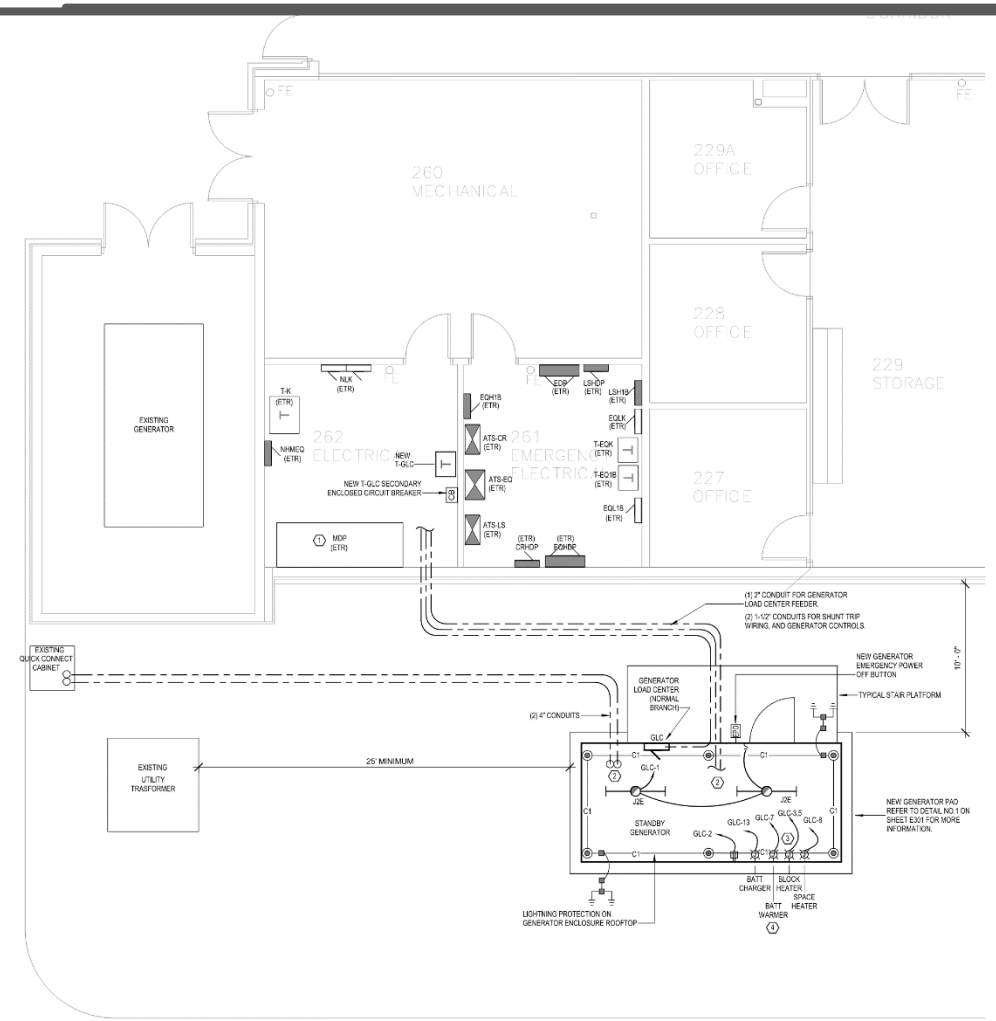
During Testing

During Operations

CONSTRUCTION DOCUMENTS (SHOULD) TELL A STORY



Tell The Story!



OOR PLAN - ELECTRICAL NEW WORK

Enlarged plans show the details. Constructable!

GENERAL LIGHTNING PROTECTION NOTES:

1. PROVIDE COMPLETE UL LISTED, LPI 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 (5/8" X 20'-0" VERTICALLY DRIVE RODS, 2 PER DOWN CONDUCTOR). PROVIDE AIR TERMINALS ON ALL ROOF MOUNTED EQUIPMENT, AS REQUIRED. BOND ALL METALLIC BODIES 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 SHOWN ROOF LAYOUT, DOWN LOCATIONS, GROUND ROD LOCATIONS, ETC. AS WELL AS ALL CONNECTION DETAILS TO ENGINEER FOR REVIEW AND APPROVAL PRIOR TO CONSTURCTION. CONTRACTOR SHALL PERFORM ALL REQUIRED RESISTANCE AND CONTUNITY TESTING AFTER INSTALLATION IS COMPLETED.
4. COORDINATE EXACT LOCATION OF ALL EQUIPMENT PRIOR TO INSTALLTION AND ROUGH-IN. FIELD LOCATIONS SHALL DICTATE.

ELECTRICAL KEYNOTES:

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

LIGHTING FIXTURE SCHEDULE

TYPE	DESCRIPTION	MANUFACTURER	MODEL	VOLTAGE	REQUIRED LAMPS		VA	COMMENTS
					TYPE	LAMP QUANTITY		
J2E	4', LED STRIP FIXTURE WITH BATTERY PACK	EATON	4SNLED-LD4-41SL-LW-UNV-EL14W-L835-CD1-U	120 V	LED	PROVIDED WITH FIXTURE	41 VA	PROVIDE WITH CHAIN HANGER AS NEEDED.

Drawing Title:
PARTIAL FLOOR PLAN - ELECTRICAL

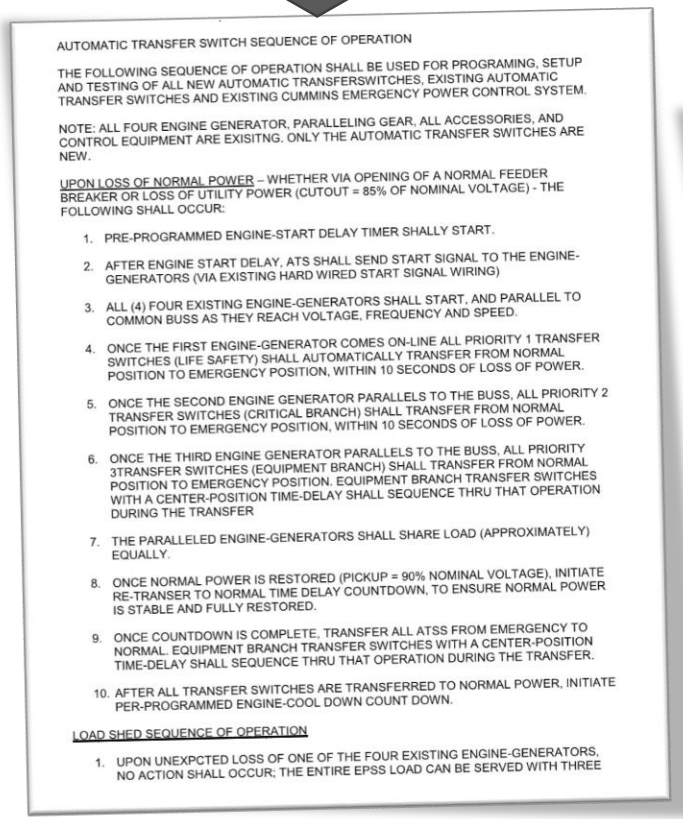
Drawing No.:
E201

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.

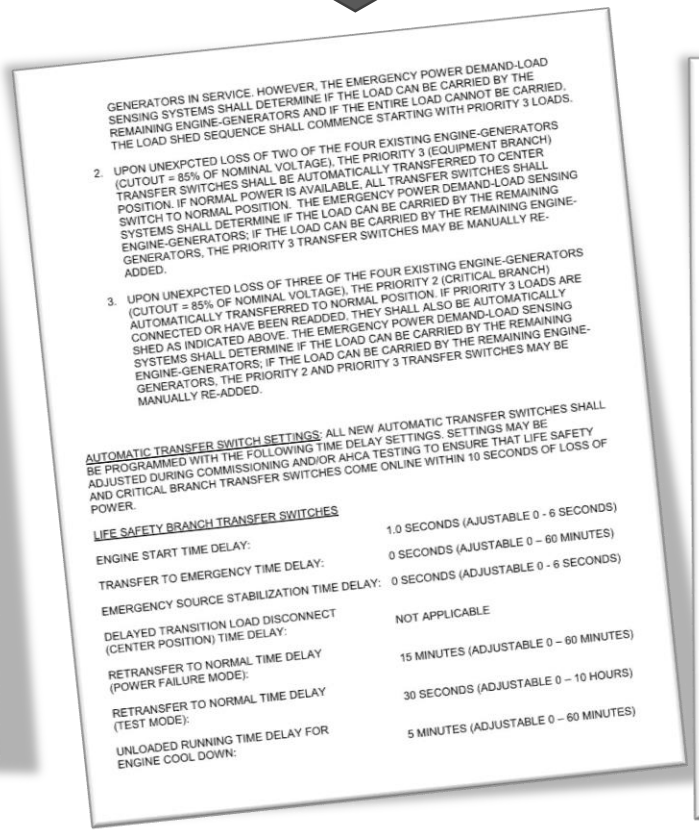
UPON LOSS OF NORMAL POWER – WHETHER VIA OPENING OF A NORMAL FEEDER BREAKER OR LOSS OF UTILITY POWER (CUTOUT = 85% OF NOMINAL VOLTAGE) - THE FOLLOWING SHALL OCCUR:

1. PRE-PROGRAMMED ENGINE-START DELAY TIMER 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 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-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 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.

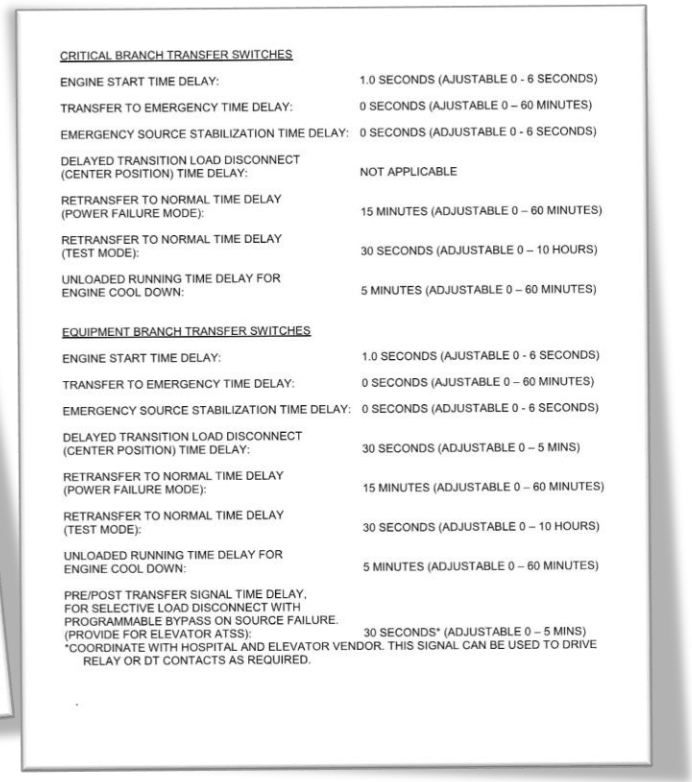
2. UPON UNEXPCTED LOSS OF TWO OF THE FOUR EXISTING ENGINE-GENERATORS (CUTOUT = 85% OF NOMINAL VOLTAGE), THE PRIORITY 3 (EQUIPMENT BRANCH) TRANSFER SWITCHES SHALL BE AUTOMATICALLY TRANSFERRED TO CENTER POSITION. IF NORMAL POWER IS AVAILABLE, ALL TRANSFER SWITCHES SHALL SWITCH TO NORMAL POSITION. THE EMERGENCY 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 UNEXPCTED LOSS OF THREE OF THE FOUR EXISTING ENGINE-GENERATORS (CUTOUT = 85% OF NOMINAL VOLTAGE), THE PRIORITY 2 (CRITICAL BRANCH) AUTOMATICALLY TRANSFERRED TO NORMAL POSITION. IF PRIORITY 3 LOADS ARE CONNECTED OR HAVE BEEN READDED, THEY SHALL ALSO BE AUTOMATICALLY SHED AS INDICATED ABOVE. 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 (AJUSTABLE 0 - 6 SECONDS)
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 (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

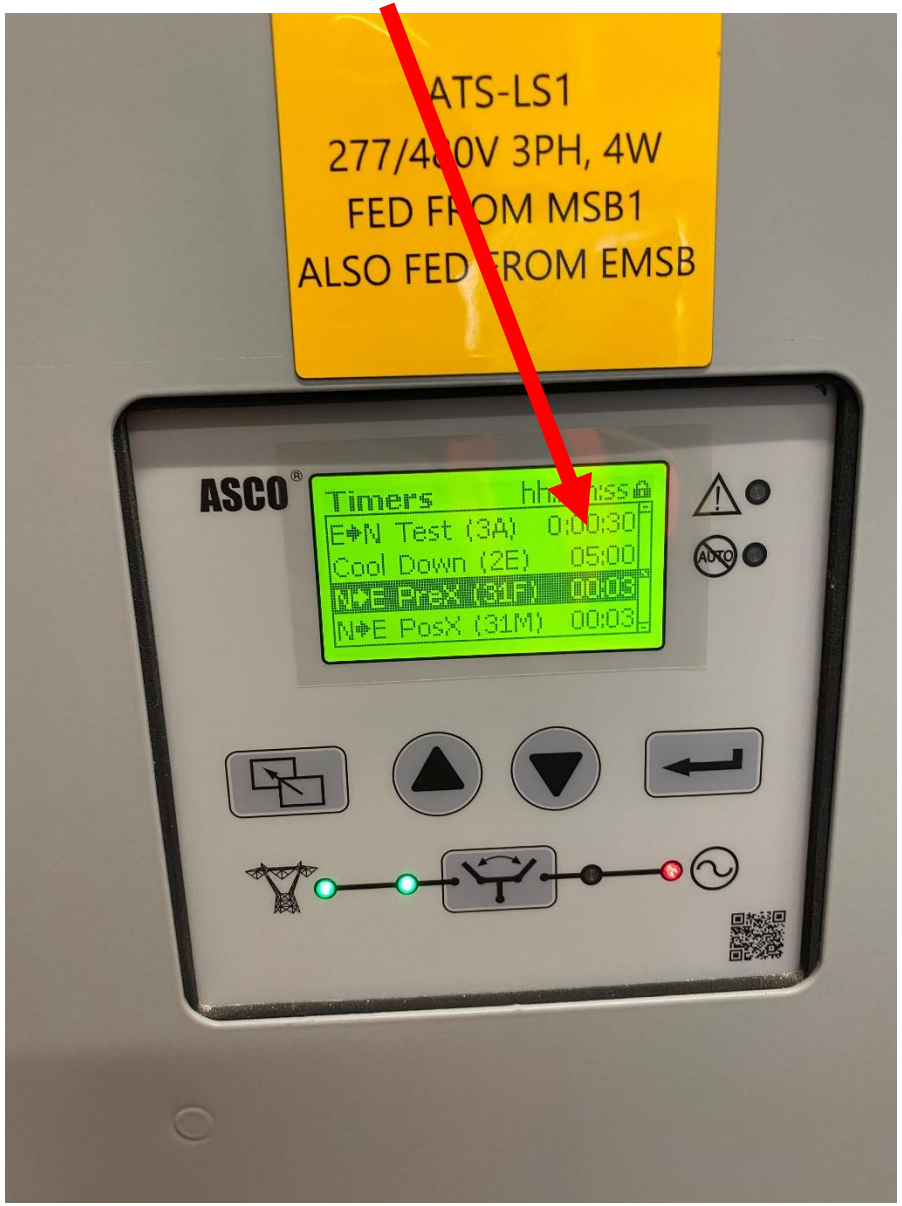
ENGINE START TIME DELAY:	1.0 SECONDS (AJUSTABLE 0 - 6 SECONDS)
TRANSFER TO EMERGENCY TIME DELAY:	0 SECONDS (AJUSTABLE 0 – 60 MINUTES)
EMERGENCY SOURCE STABILIZATION TIME DELAY:	0 SECONDS (ADJUSTABLE 0 - 6 SECONDS)
DELAYED TRANSITION LOAD DISCONNECT (CENTER POSITION) TIME DELAY:	NOT APPLICABLE
RETRANSFER TO NORMAL TIME DELAY (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

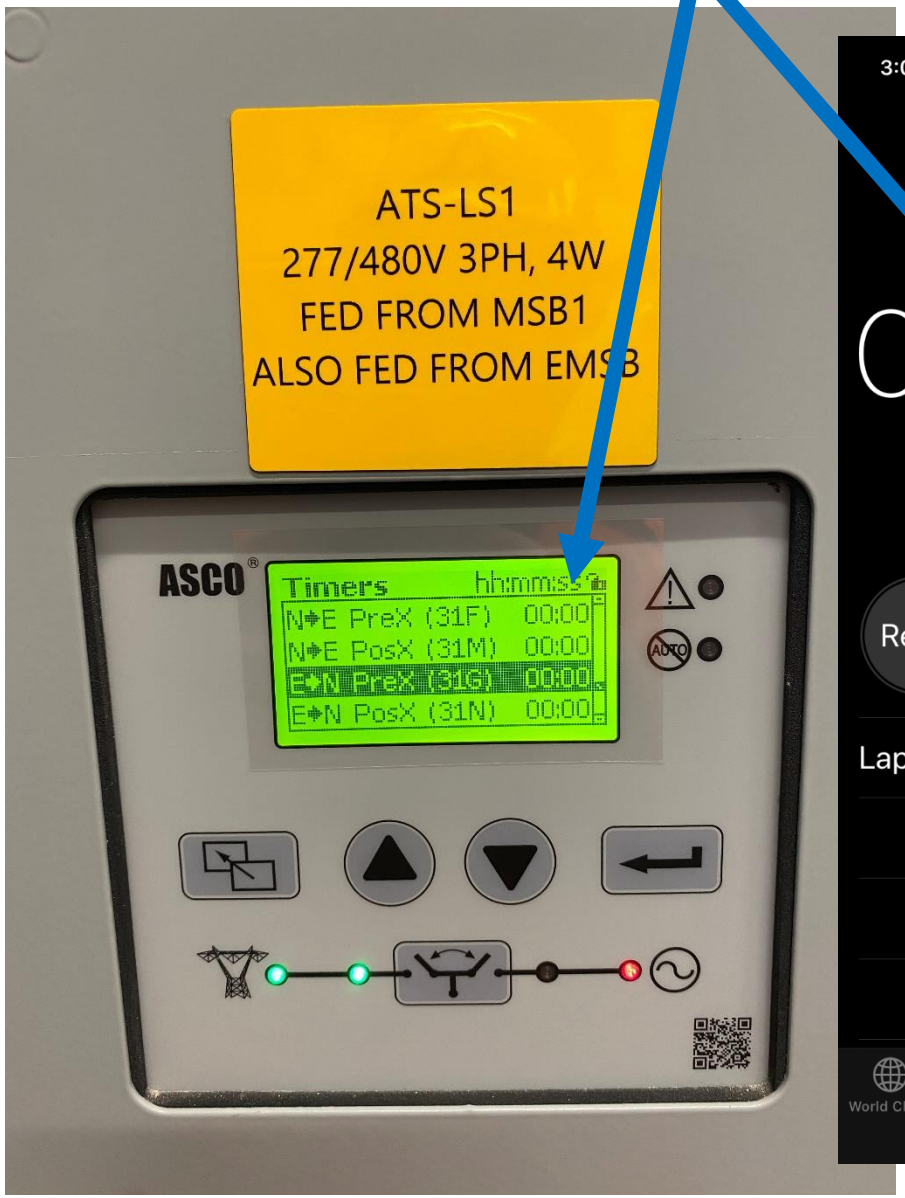
ENGINE START TIME DELAY:	1.0 SECONDS (AJUSTABLE 0 - 6 SECONDS)
TRANSFER TO EMERGENCY TIME DELAY:	0 SECONDS (AJUSTABLE 0 – 60 MINUTES)
EMERGENCY SOURCE STABILIZATION TIME DELAY:	0 SECONDS (ADJUSTABLE 0 - 6 SECONDS)
DELAYED TRANSITION LOAD DISCONNECT (CENTER POSITION) TIME DELAY:	30 SECONDS (ADJUSTABLE 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

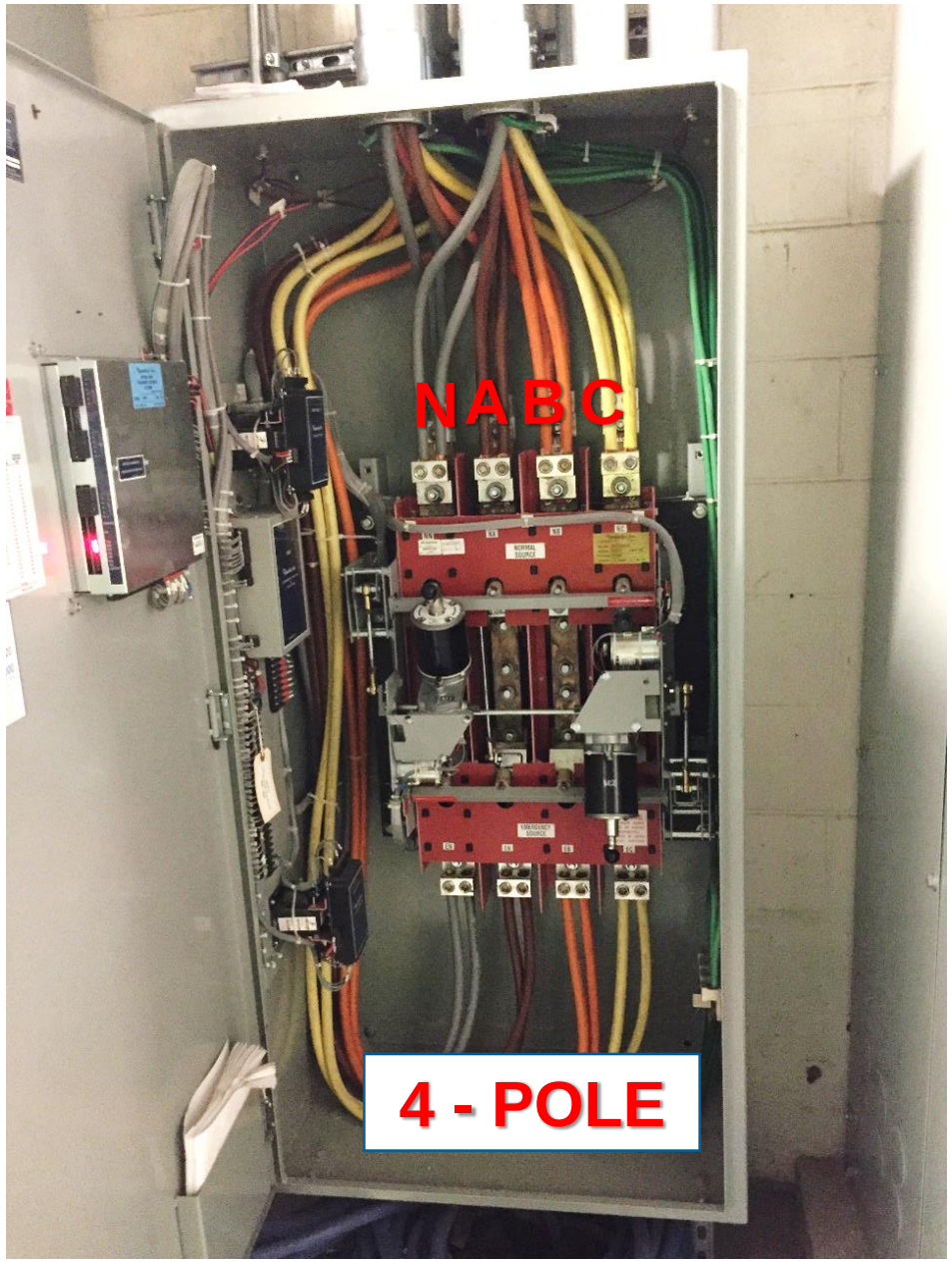


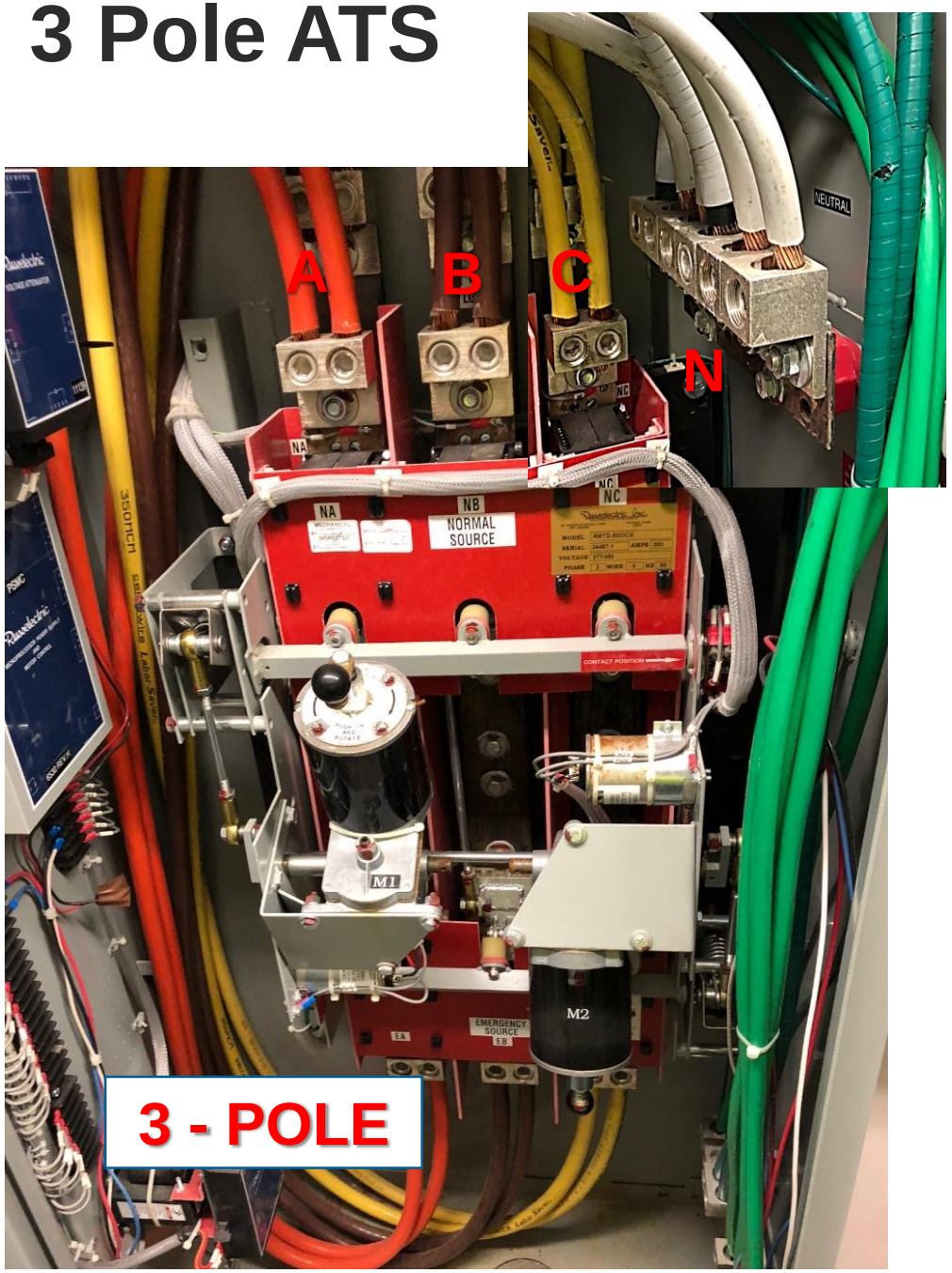
GROUNDING

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.

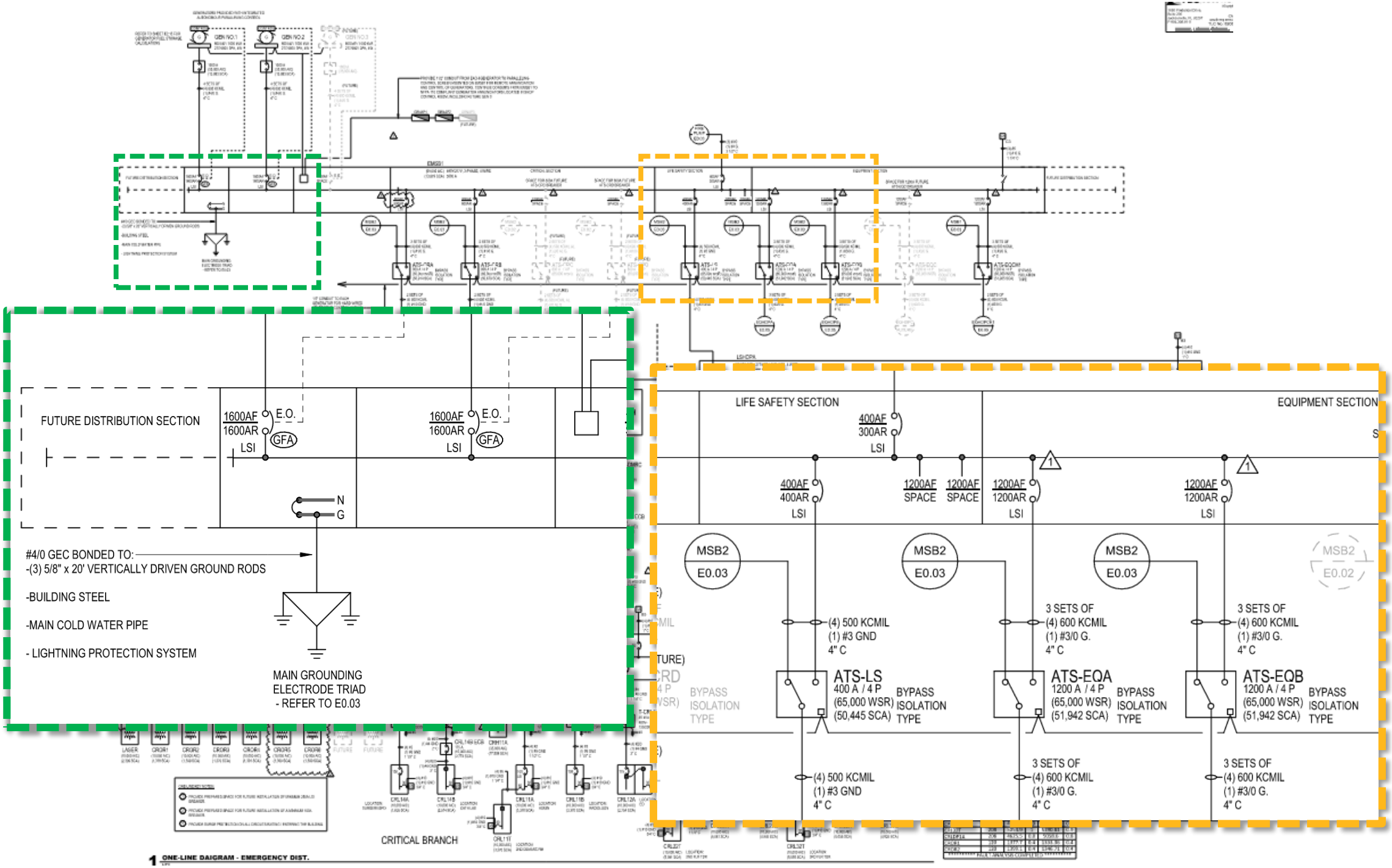
(B) Feeders. Where ground-fault protection is provided for operation of the service disconnecting means or feeder disconnecting means as specified by 230.95 or 215.10, an additional step of ground-fault protection shall be provided in all next level feeder disconnecting means downstream toward the load.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

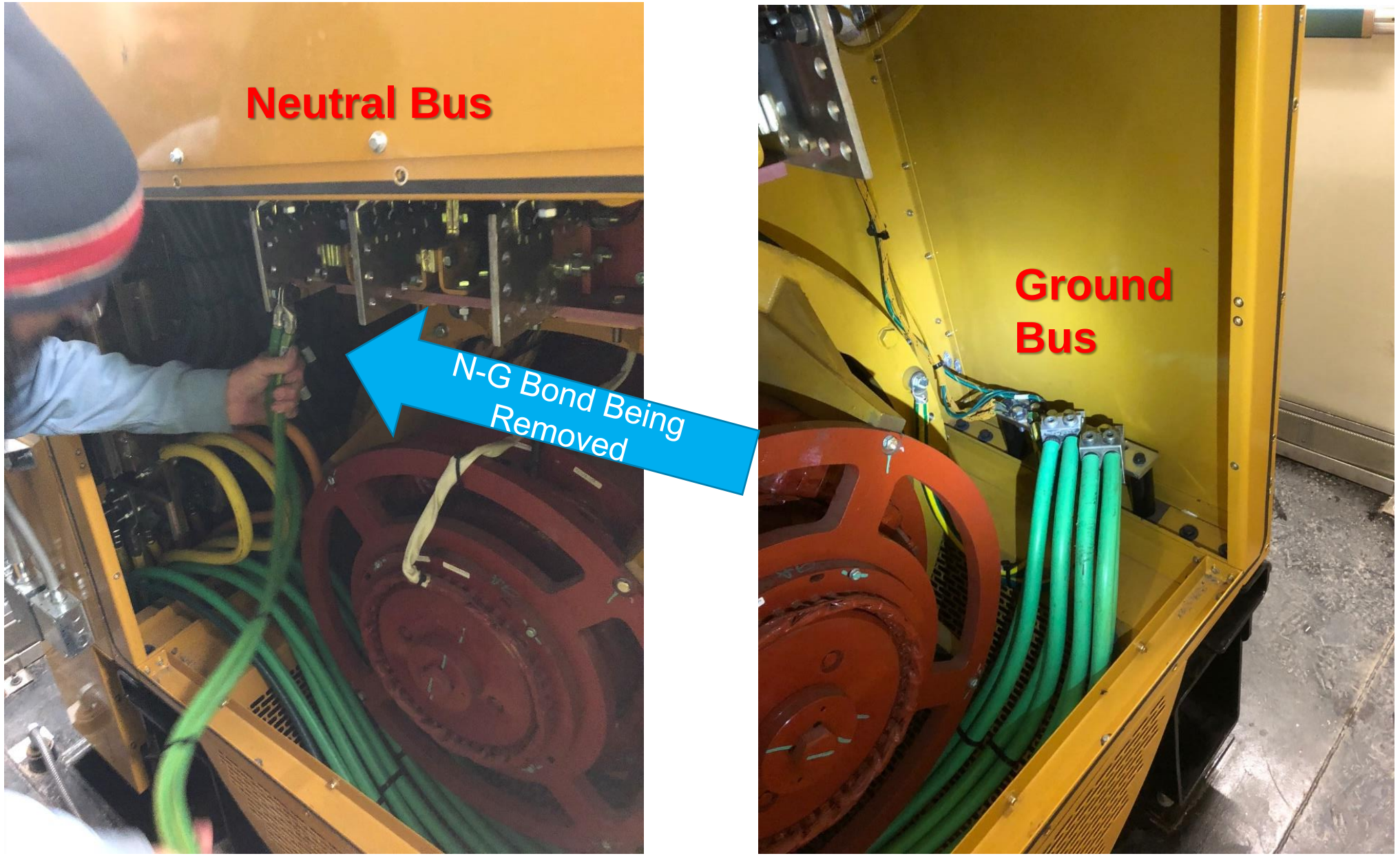
Type of ATS	Type of Emergency Grounding System	What does it Mean?	Why
3 Pole ATS	non-separately derived system	Neutral and Ground are NOT bonded together at Generator	For 3 pole ATS, Neutral-Ground bond is never lost
4 Pole ATS	separately derived system	Neutral and Ground ARE bonded together at Generator	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!

Separately Derived and Non-Separately Derived Grounding



Non-Separately Derived Grounding



DON’T FORGET THE FUEL !

Don’t Forget the Fuel

Is **Fuel <u>Type</u>** 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

Fuel Calcs

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

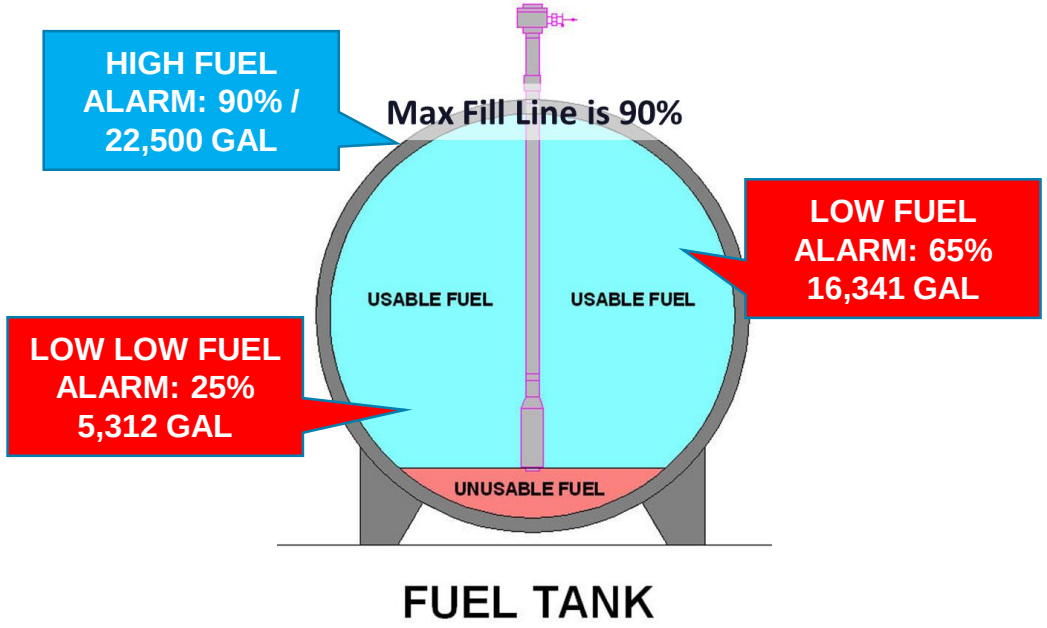
Step 2 – Determine Fuel Capacity

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:

Don't Forget the Fuel

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

Have a Diagram!

Valves:
Isolation
Check
Solenoid

Day Tank / Pumps

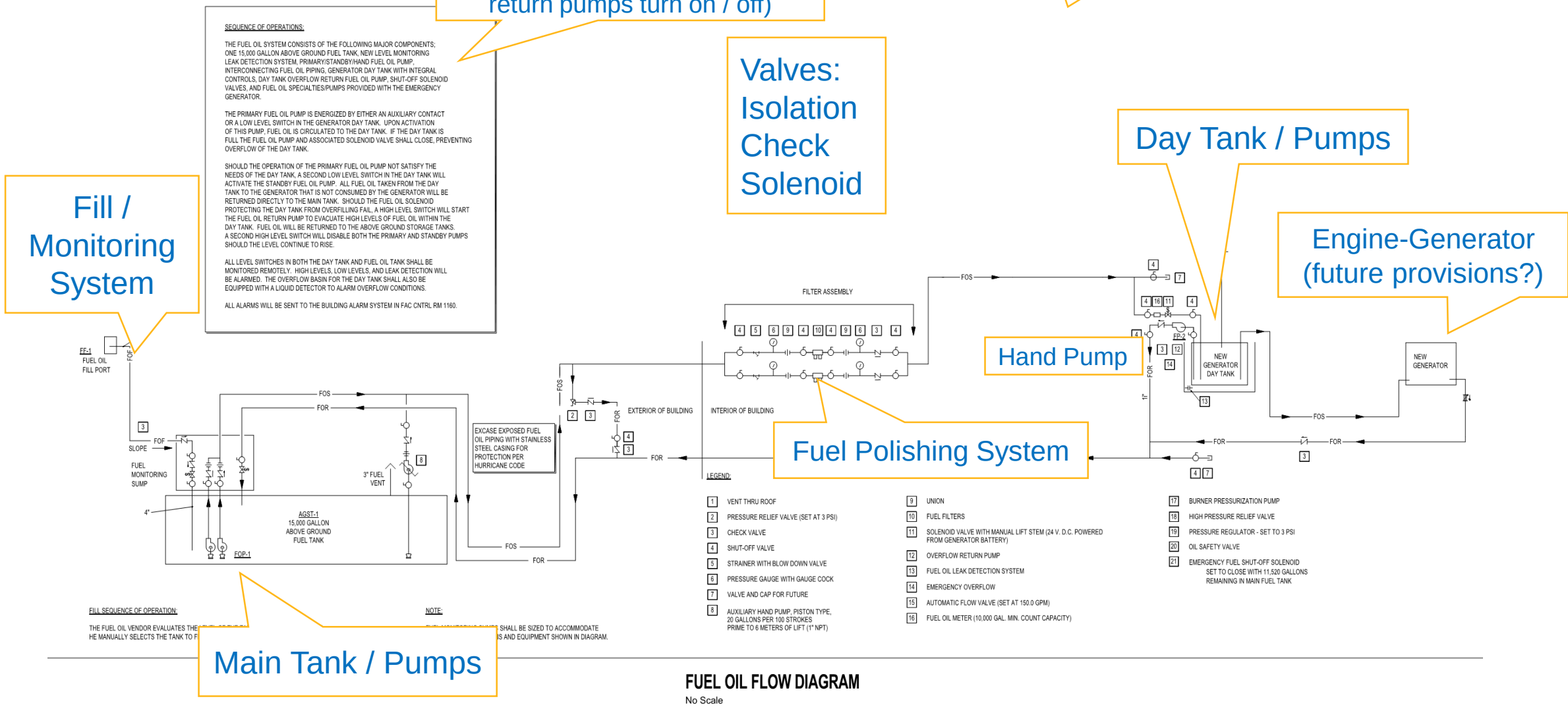
Fill / Monitoring System

Engine-Generator (future provisions?)

Hand Pump

Fuel Polishing System

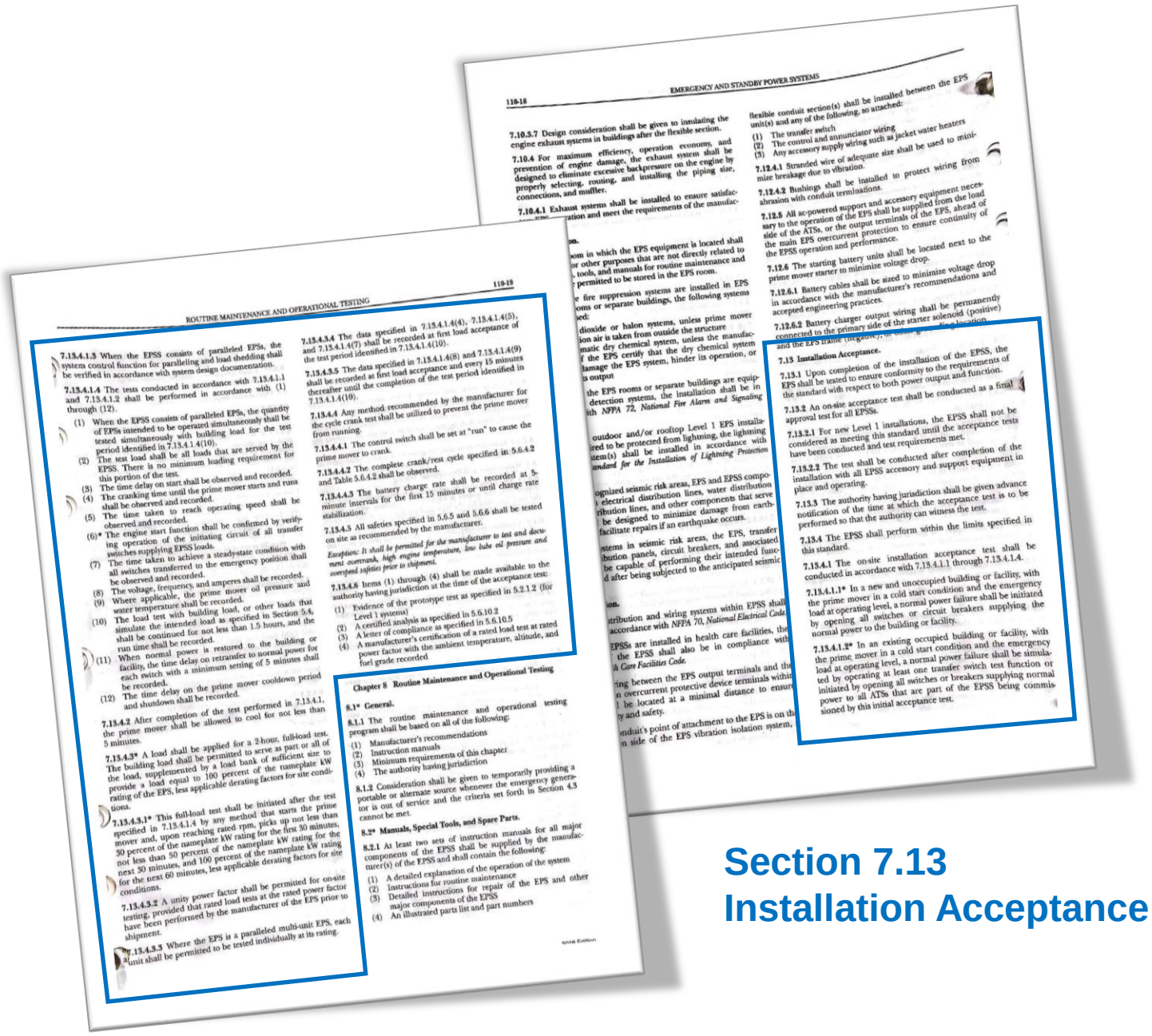
Main Tank / Pumps



HAVE A PLAN

But be ready to change it…

Acceptance Testing



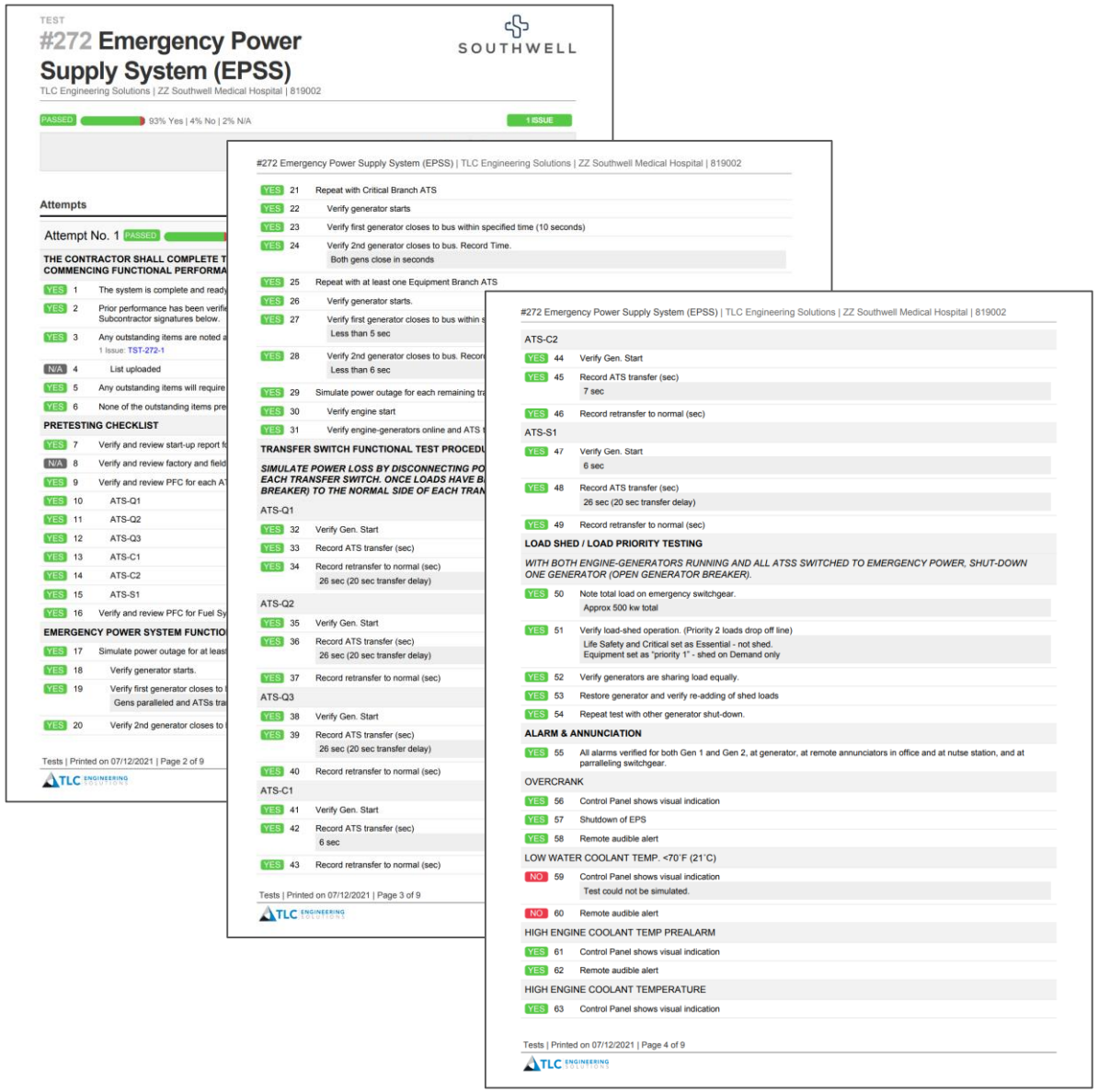
Use

NFPA 110

as your guide.

Section 7.13
Installation Acceptance

The Commissioning Plan is The Plan



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

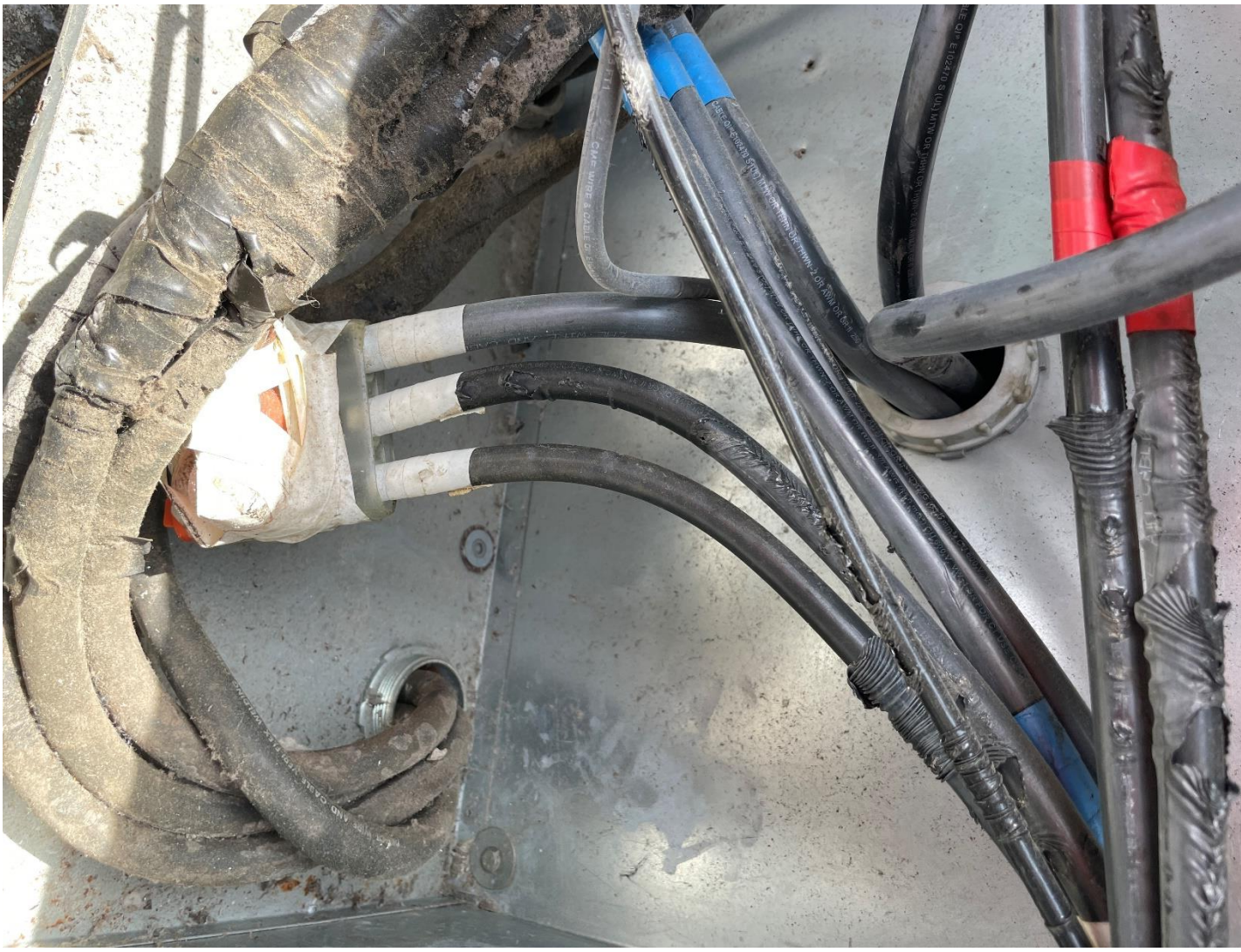
Design Criteria, SOO, Code Requirements define expectations

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

When is Ready, Ready?

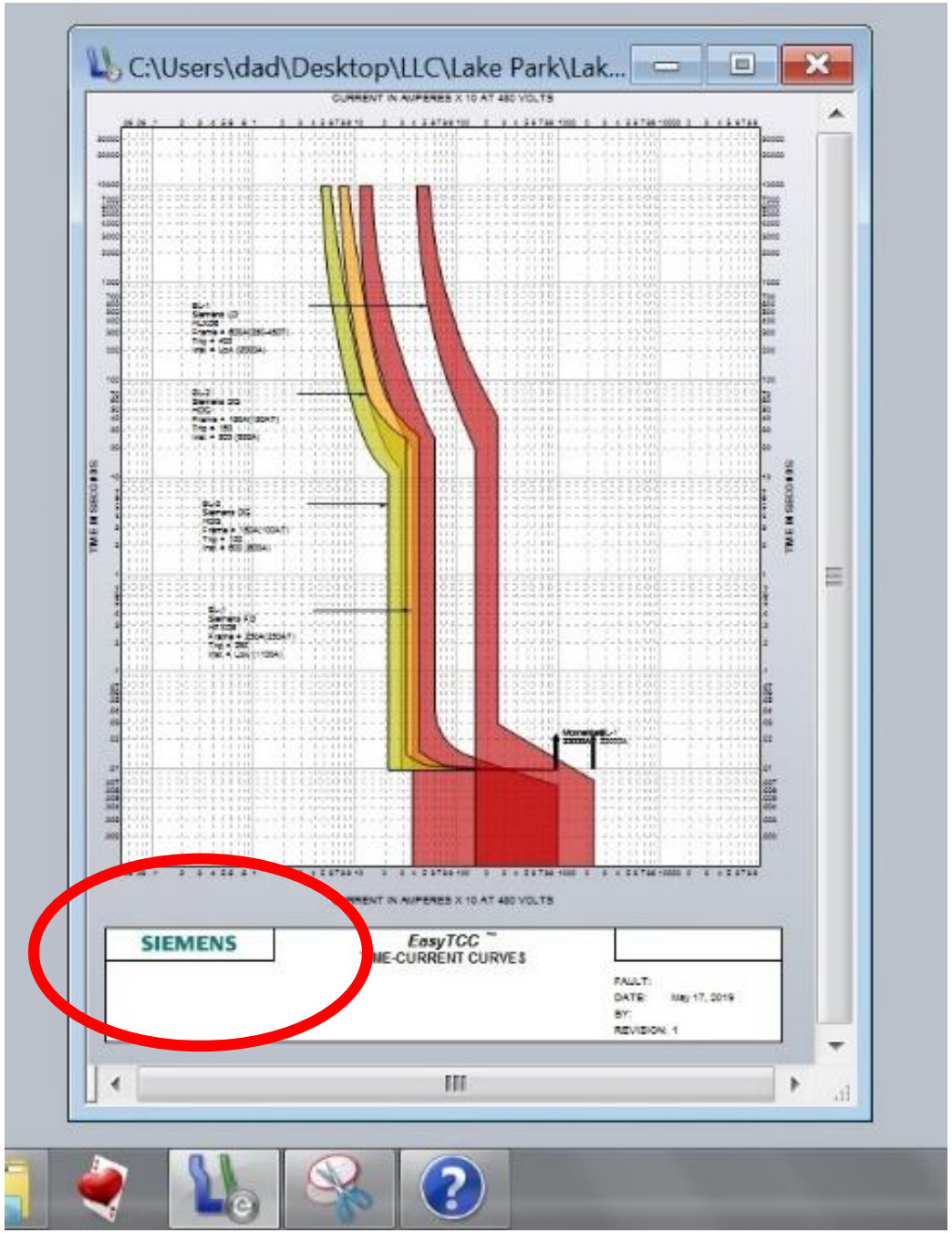
Existing Conditions are…Existing

Existing Conditions are…Existing



We’re Ready for Testing

Verify Installation

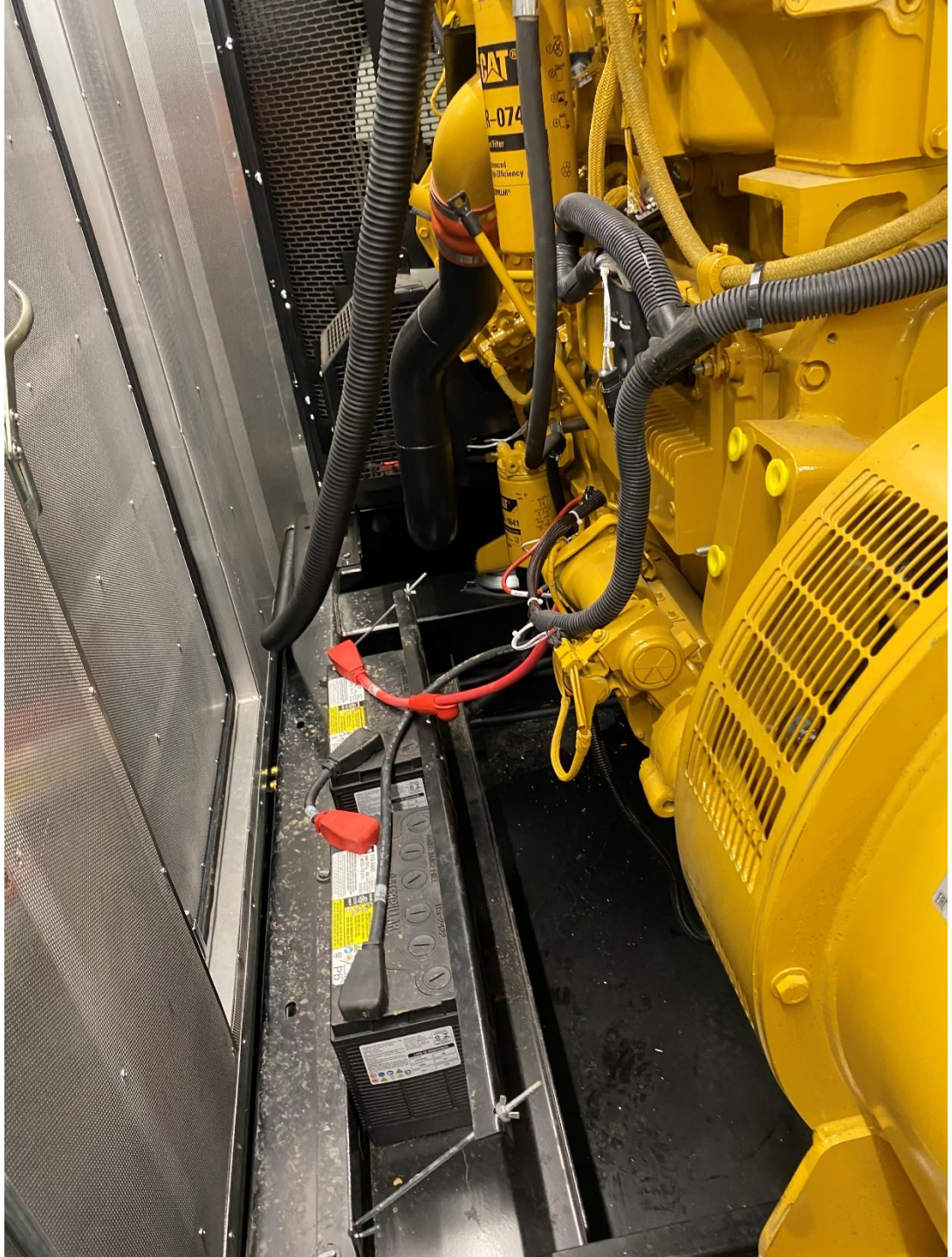


Means of Egress

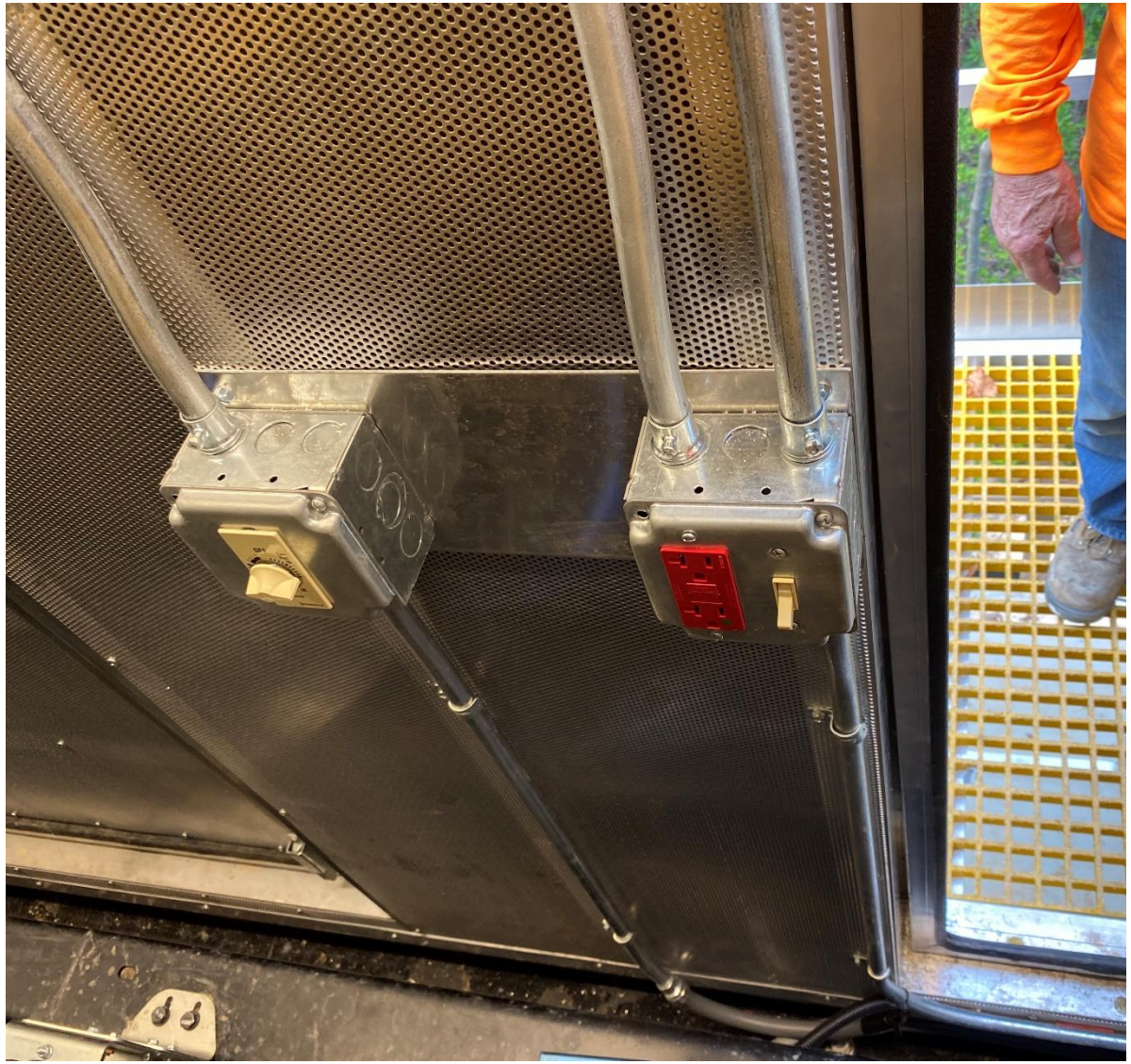
I’m No Architect but….

Accessibility

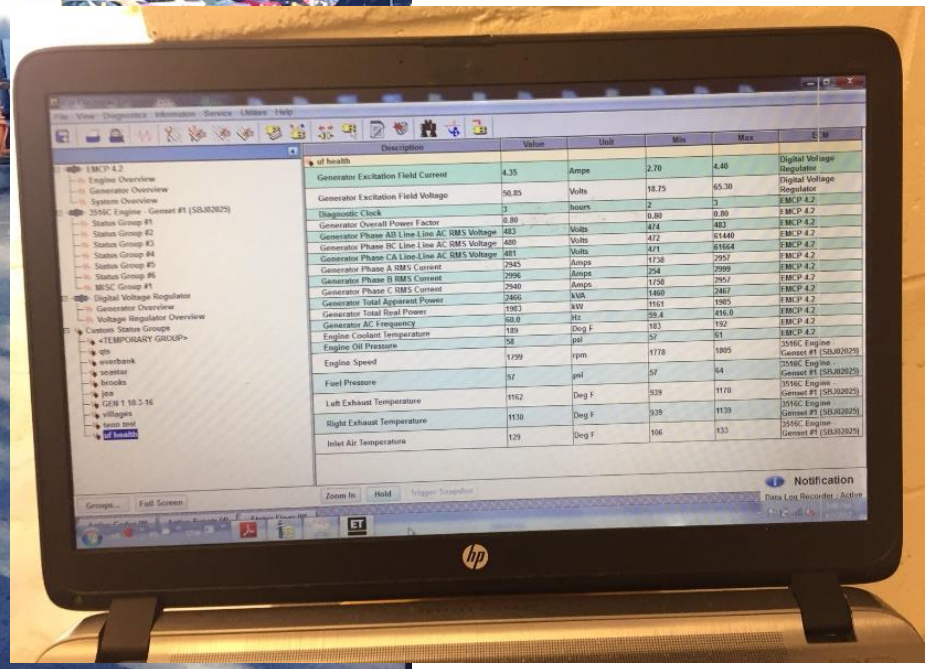
Verifying Installation



Verifying Installation



Load Bank Testing

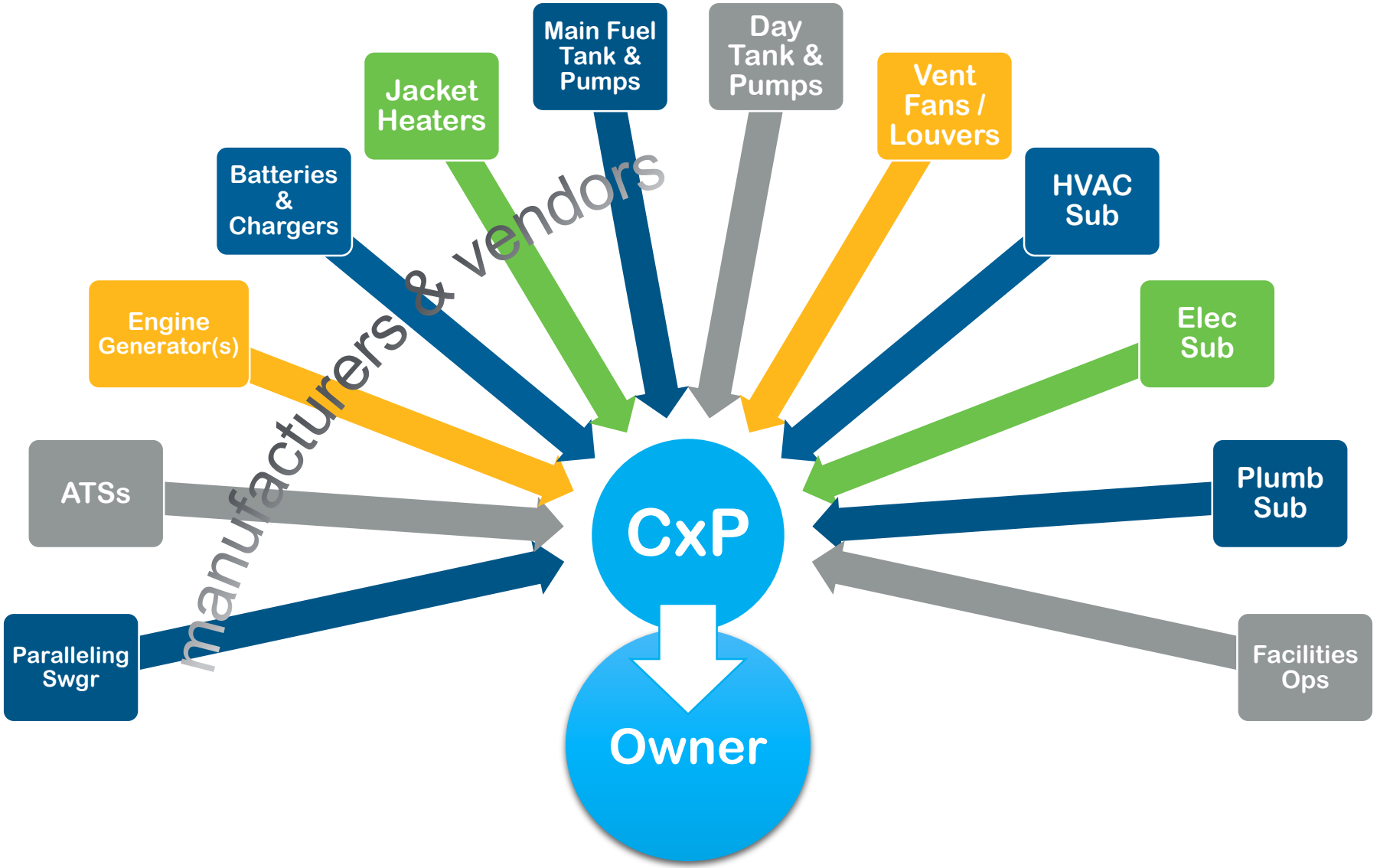


When is Ready, Ready?

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?



It Takes a Team


AHCA
Facility Operations
SubContractors
Engineers
Vendors
Owner
CxP
IT TAKES A TEAM

Acceptance Testing

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

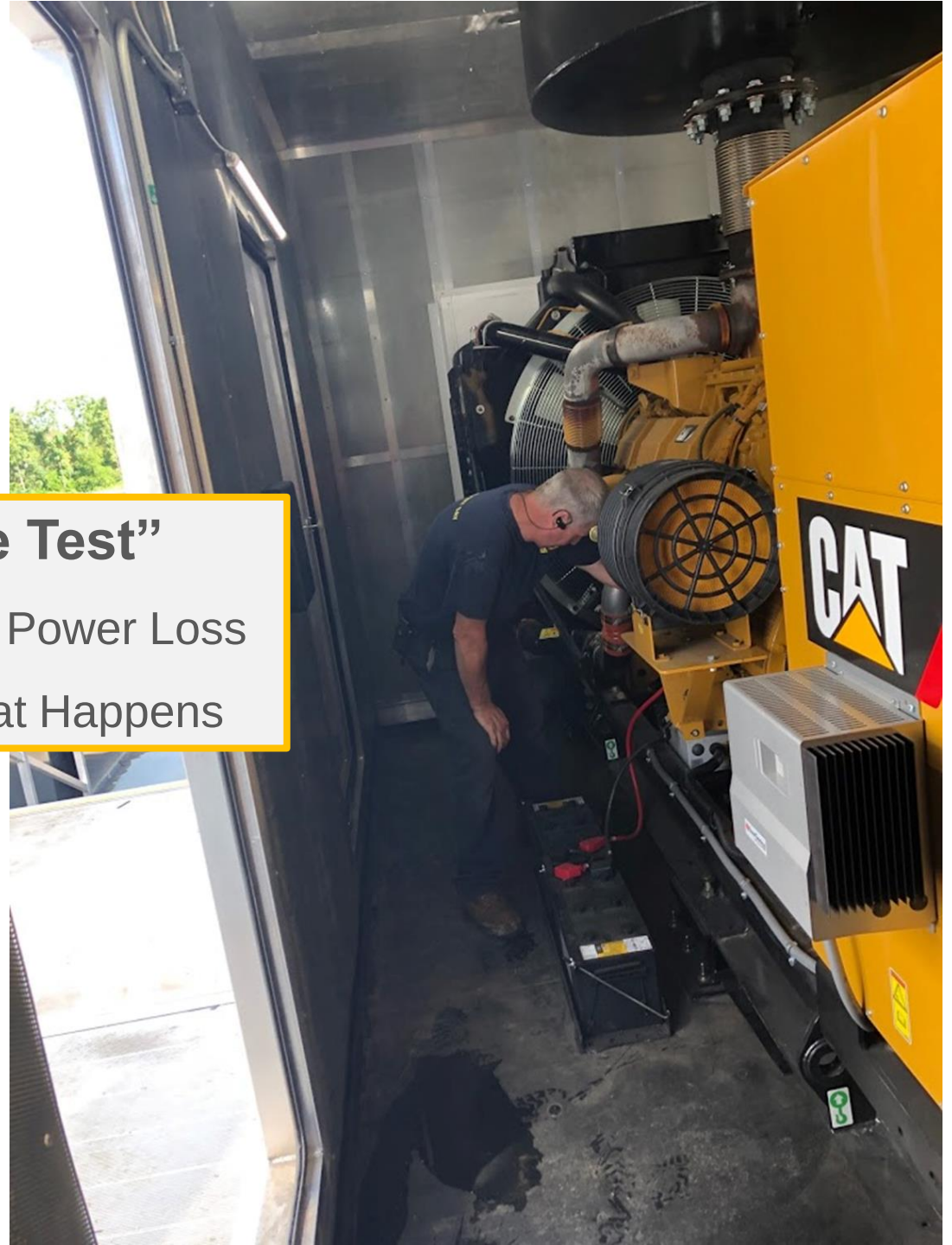
Paralleling Switchgear

- 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:

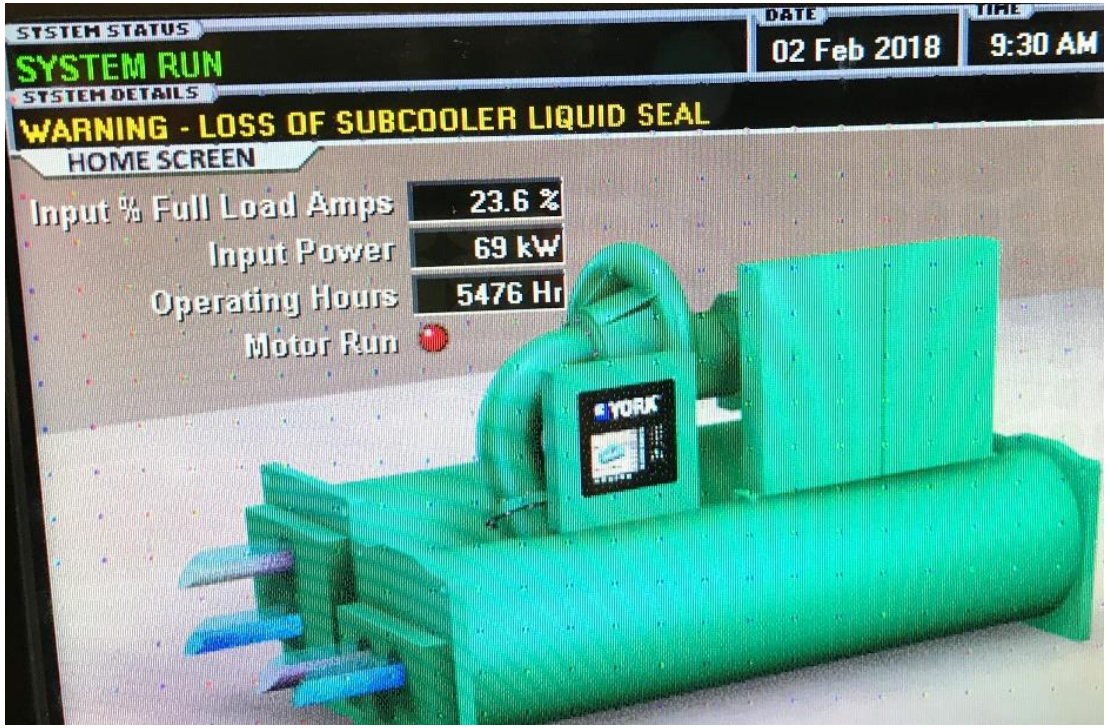
- Networks
- ORs
- HVAC
- Med-gas
- Support equipment

Integrated Systems Testing

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 ?