AABC Commissioning Group

AIA Provider Number 50111116

Commissioning Electrical Systems in Mission Critical Facilities

Course Number: CXENERGY1914

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April 17, 2019

CxEnergy Conference Orlando 2019

Commissioning Electrical Systems in Mission Critical Facilities

Port Authority of NY & NJ – World Trade Center (WTC) Transportation HUB

Social Security Administration- National Support Center

April 17, 2019

Presented By:

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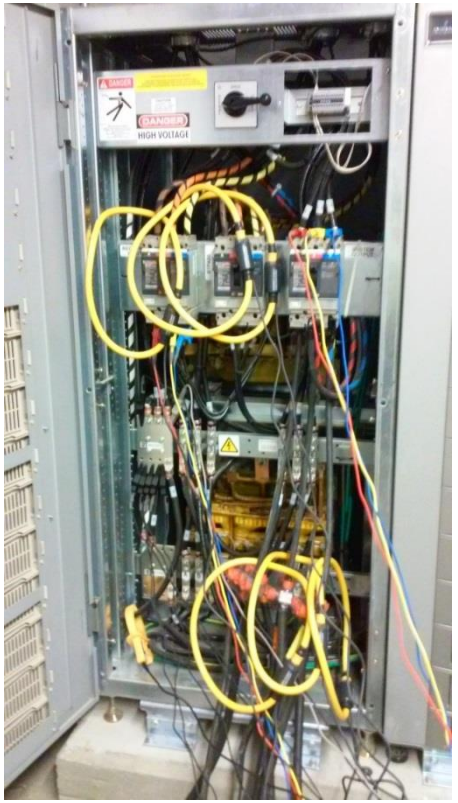
Safety Moment

- Hearing Protection
  - Environment can reach over 100dB during generator full-load testing

Source: OSHA.gov

- Flame Resistant Clothing
  - UPS door panel cannot close when the current transformers of a power quality meter are connected during full-load testing.



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Presentation Highlights

- **Background of Two Projects**
- **Challenges at the WTC Transportation Hub**
- **Challenges at the SSA NSC Data Center**
- **Test Methods and Testing Process**
- **Take-Away Issues**

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Challenges and Opportunities Presented by Electrical Commissioning

- Verification and review of NETA Results
- Verifying component functionality
- Verifying function of electrical systems
- Intra-system & Inter-system functionality verification
- Interaction of energy supply and load
- Functionality of all systems during transition from Normal to Standby Power and back to Normal Power.
- Parallel testing events that can occur during electrical commissioning

World Trade Center (WTC) Transportation Hub

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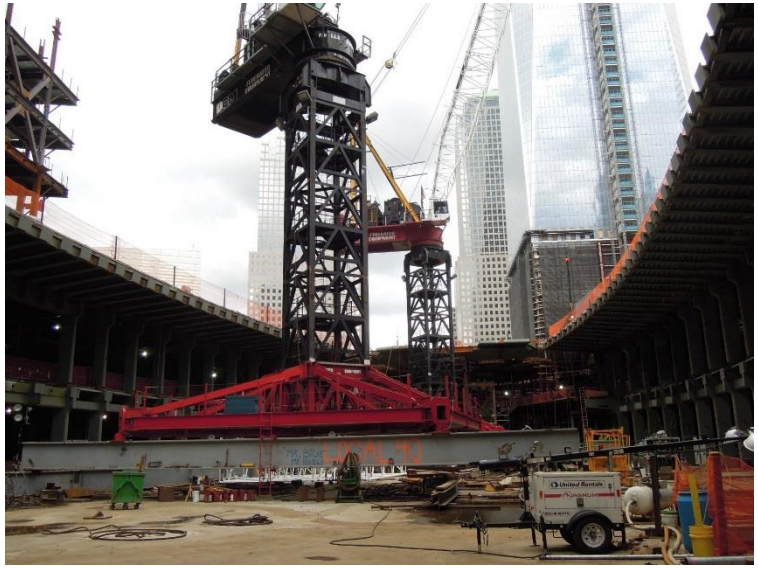
World Trade Center (WTC) Transportation Hub

- Known as the “Oculus”
- Center of an integrated network of underground pedestrian connections
- 800,000 square feet
- Connects visitors to
  - WTC Towers 1, 2, 3, and 4
  - 11 different NYC subway lines
  - PATH rail system
  - Brookfield Place
  - National September 11 Memorial & Museum
  - Battery Park City Ferry Terminal



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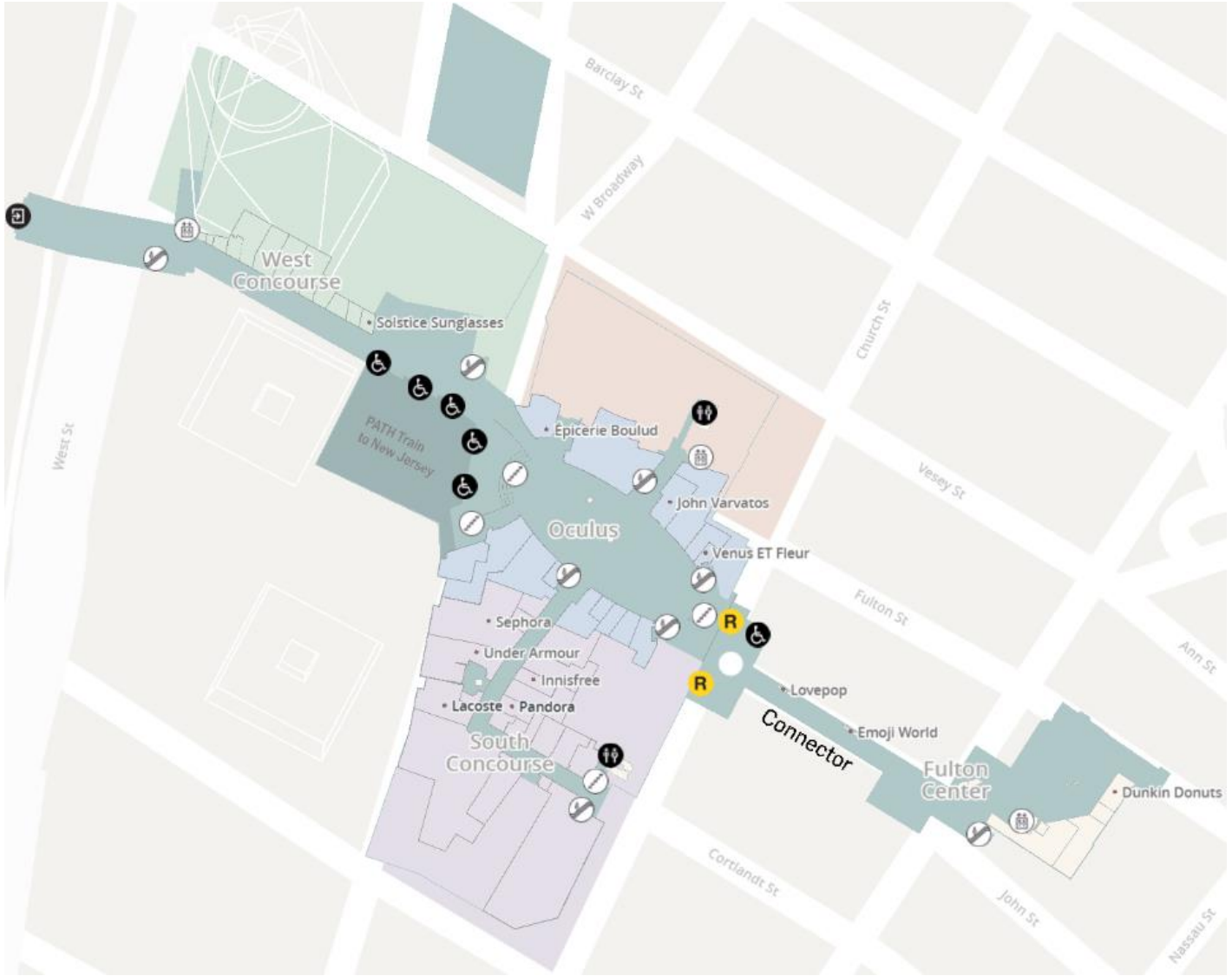
World Trade Center (WTC) Transportation Hub



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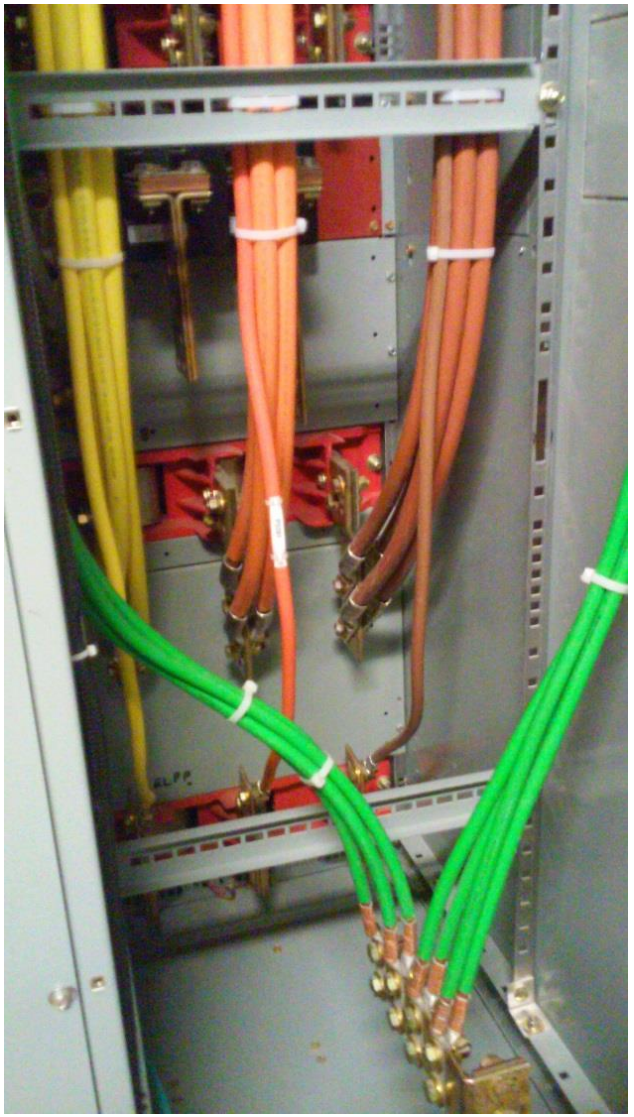
Fundamentals

- Equipment thoroughly cleaned
- Lock Out, Tag Out (LOTO)
- Integrity Tests
  - Visual
  - Mechanical
  - Electrical
    - Ground-Resistance
    - Insulation-Resistance
    - Over-Potential
    - Current Injection



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Examples of Fundamentals

Testing:

1. Contact Resistance

Acceptance Criteria _____ μΩ

Phase A: _____ μΩ **Phase B:** _____ μΩ **Phase C:** _____ μΩ

2. Insulation Resistance

Acceptance Criteria _____ MΩ Test Voltage _____ KV

Open	**A-A**		MΩ	**B-B**		MΩ	**C-C**	MΩ
Closed	**A-B**		MΩ	**B-C**		MΩ	**C-A**	MΩ
Closed	**A-G**		MΩ	**B-G**		MΩ	**C-G**	MΩ

3. Primary Current Injection:

	Settings		Test Current		Test Time		
	Pick-Up	Delay	% PU	Current	Phase A	Phase B	Phase C
LT							
ST							
Inst.	NA	NND					
Gnd.							

4. Secondary Current Injection:

	Settings		Test Current		Test Time		
	Pick-Up	Delay	% PU	Current	Phase A	Phase B	Phase C
LT							
ST							
Inst.	NA	NND					
Gnd.							

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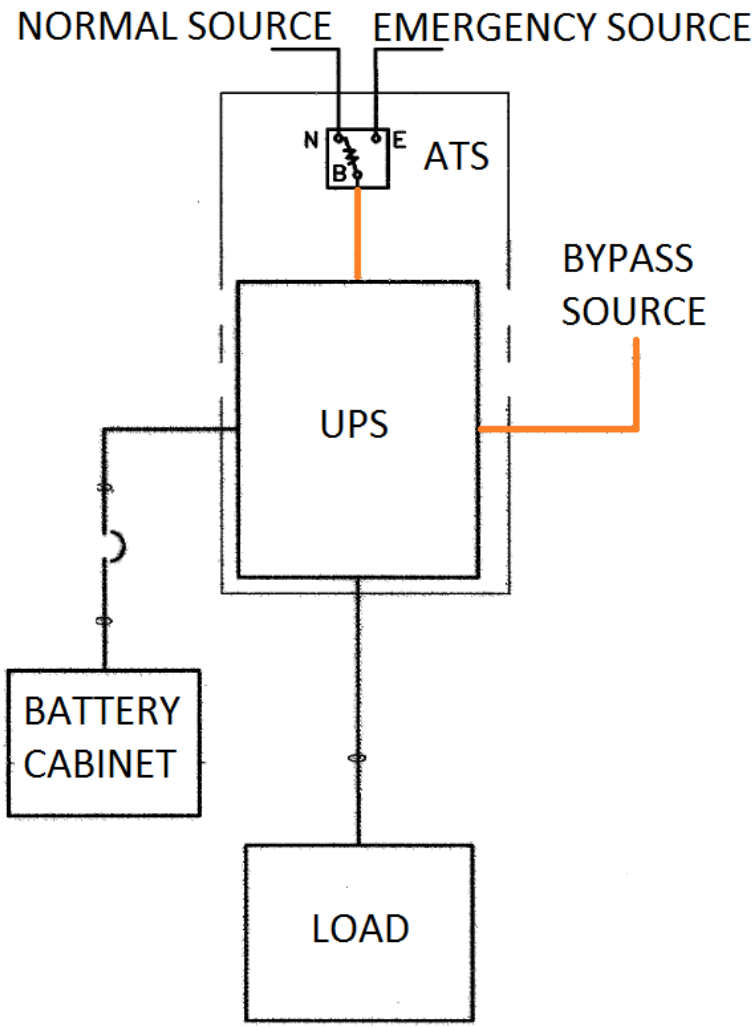
Uninterruptible Power Supply (UPS)

- The output of the ATS must be connected to the primary source input of the UPS, or the UPS load won't be protected with emergency power.



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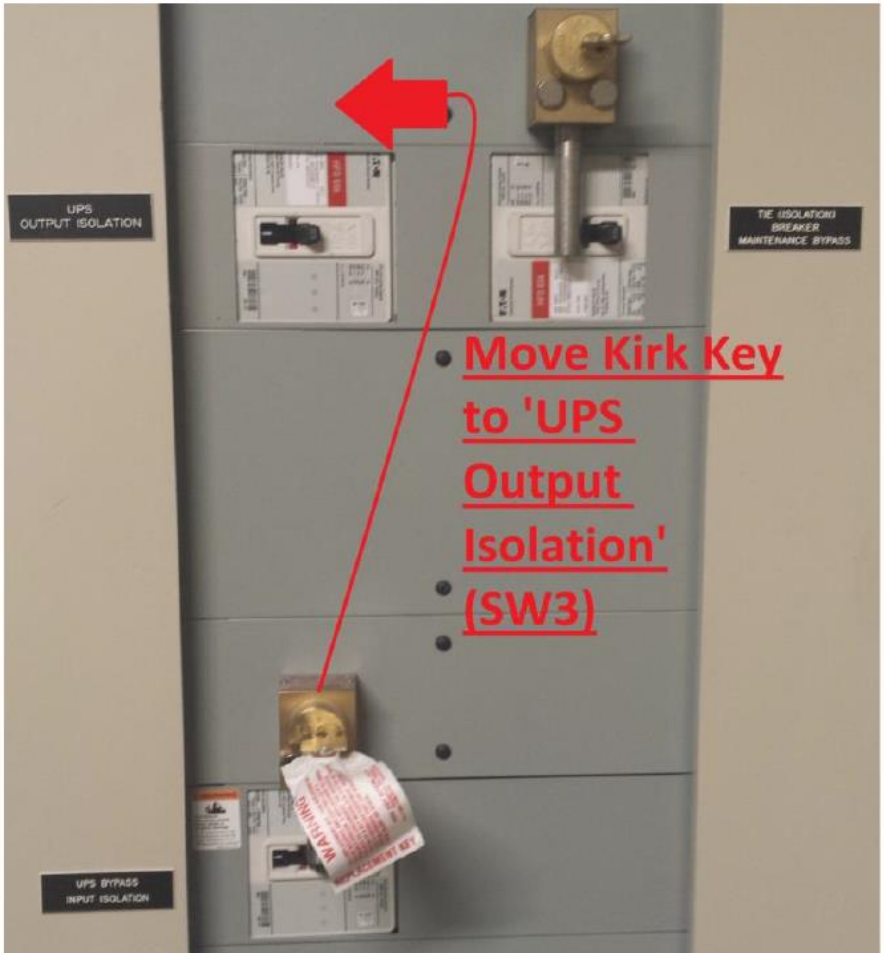
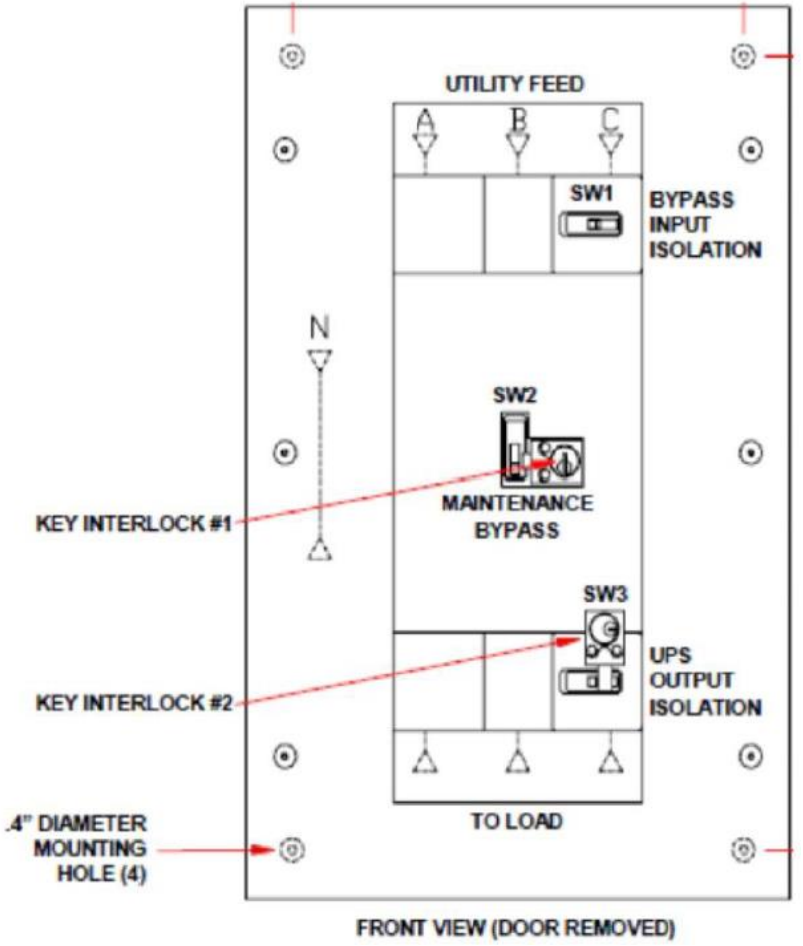
Kirk Key Interlock

- Incorrect installation will result in accidental outage of UPS downstream load





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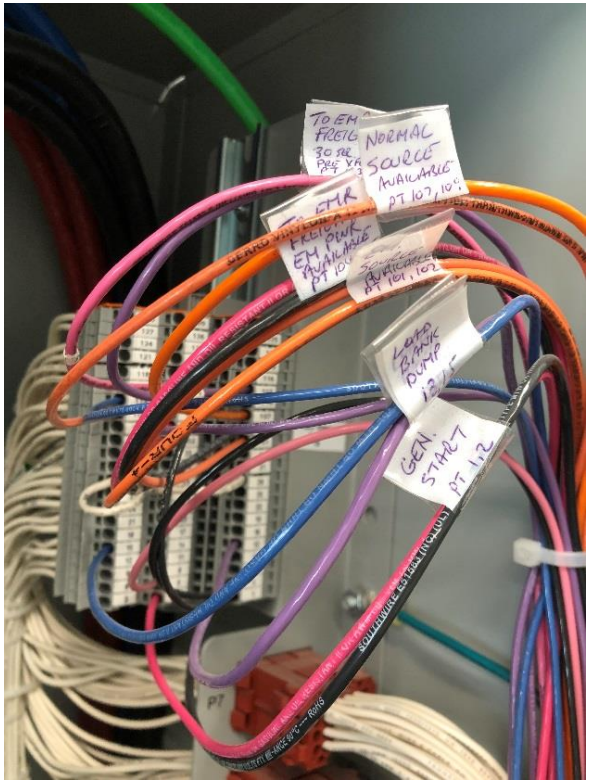
Automatic Transfer Switch (ATS)

- During functional testing, confirm signals to the following systems
  - Paralleling Switchgear
  - Elevator Controllers
  - SCADA
  - Fire Alarm



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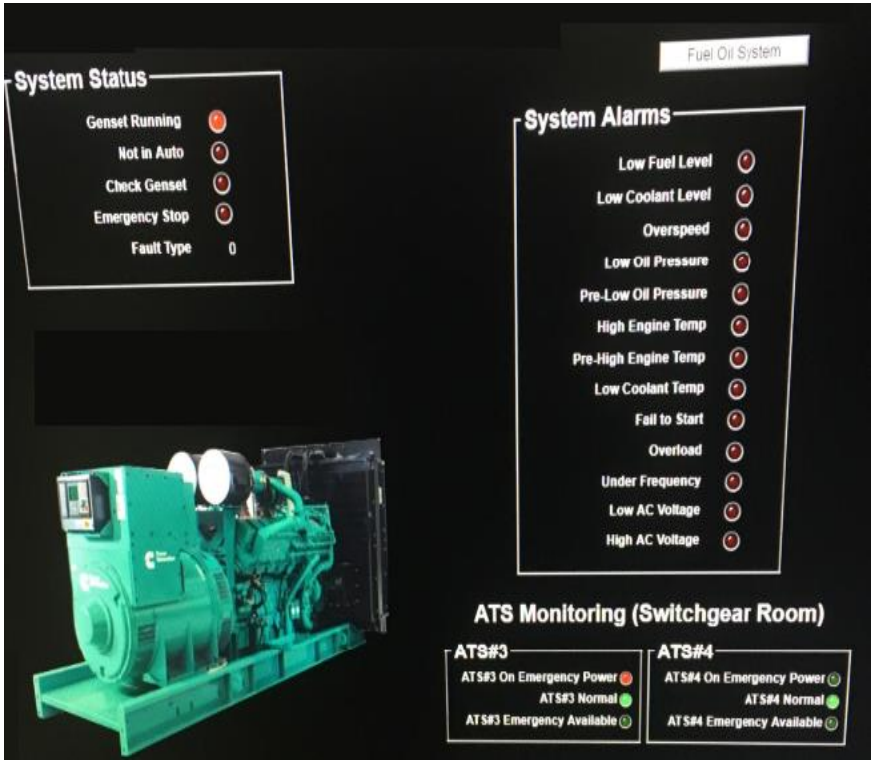
Diesel Generator & Paralleling Switchgear

- Full-load testing of each generator per NFPA 110
- Paralleling Switchgear Integration
- Testing of system alarms and interlocks



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Integrated System Testing (IST)

- Complexity requires logistical planning
- Communication is key
- Dry run of test ensures everyone's understanding of their role and responsibilities
- Black Start (Pull the Plug) Test
  - Facility successfully operates on emergency power
  - Load Shedding of ATS units, based upon ATS priority level
  - Bus Optimization of Paralleling Switchgear

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SSA NSC Project Background

- A Shovel Ready Project - Funded through ARRA
- Rural Site in Urbana, Maryland on 50 greenfield acres
- Three buildings commissioned-
  - Office Building
  - Data Center (main structure)
  - Security Building
- SSA is the Owner
- GSA managed the program
- 350,000 sf total facility size
- Jacobs performed CM and CxA

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Project Background- SSA Project Drivers

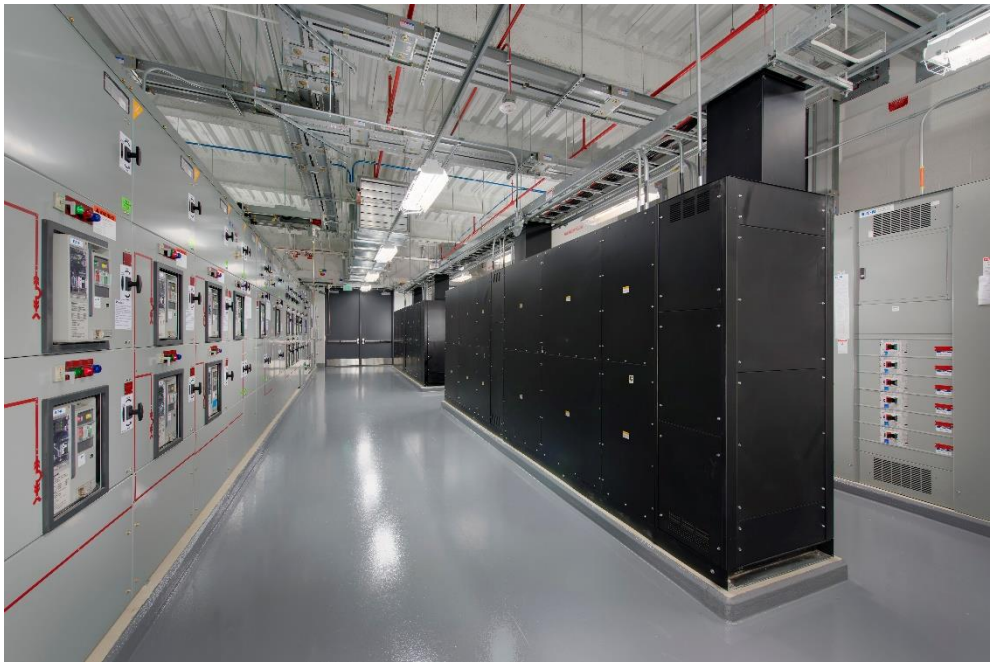
- Replace an obsolete existing Data Center infrastructure
- Consolidate existing SSA facilities
- Exceed industry standard metrics for maintenance and operations costs
- Protect from cyber threats
- Handle growing demand on the network, (e.g. electronic hearings).
- Meet Federal Government mandate for increased energy efficiency
- Modernize physical security infrastructure

Day One Facts and Figures

- 52,000 sf of white floor space
- 4800 tons total chilled water capacity (N+2)
- White Space: 6MW electrical capacity (2N) expandable to10MW installed standby power
- 20 minutes of Thermal Energy Storage
- Uptime Institute Tier III Certified

Electrical Commissioning: SSA NSC Data Center

- Focus on electrical commission of mission critical facilities using my experiences with the SSA NSC data center. What worked, what didn't
- Discuss the integration and combined test with other disciplines
- Complexities of testing mission critical facilities
- Uptime Institute required testing (Tier III)



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Communication

- Electrical Cx is not standalone and done in a vacuum
- The operation of the electrical systems need to be fully integrated with the operation of the mechanical systems to serve the critical areas of the facility
- 3 Cs of Mission Critical Cx:
  Communication, **C**oordination & **C**ooperation
- Early Involvement and Development of the Team
  - Electrical Contractor
  - Mechanical Contract
  - Construction Manager
  - Owner

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Early Involvement

- Early engagement of the commissioning agent is necessary:
  - start of project's concept design
  - design reviews and lessons learned to help with commissioning, aid in scheduling and be a future benefit for the owner.
- Coordination & Scheduling
  - Cx testing must be blended into the overall construction schedule, not just something that happens at the end. Traditionally the end date get later and later
  - Begin to embed Commissioning into the 1st schedule developed
  - Provide anticipated test durations to CM as soon as possible
  - Include setup and breakdown time is included for load banks
  - SSA also had the Uptime Verification testing to be scheduled after the commissioning

Design Reviews

- During resign reviews, make any recommendations to help facilitate the commissioning of the system
- IR inspection ports to facilitate IR scanning during commissioning, and for future use but the owner for preventive maintenance.
- Work closely with the Mechanical CxA and see where electrical can facilitate the mechanical commissioning and reduce testing time.

Stand Alone Testing

- Generators, UPSs, ATSs and Switchgear should be tested individually to a point by simulating the operation of related equipment. This will confirm operation parameters, transient response and sequencing within that piece of equipment.
- Test Generators and UPSs with inductive/resistive load bank to verify operating parameters.
- Understand what the transient parameters are and test to them. Is it step load response of full single 100% step response.
- ISO 8528 is a good reference if there is no performance criteria.

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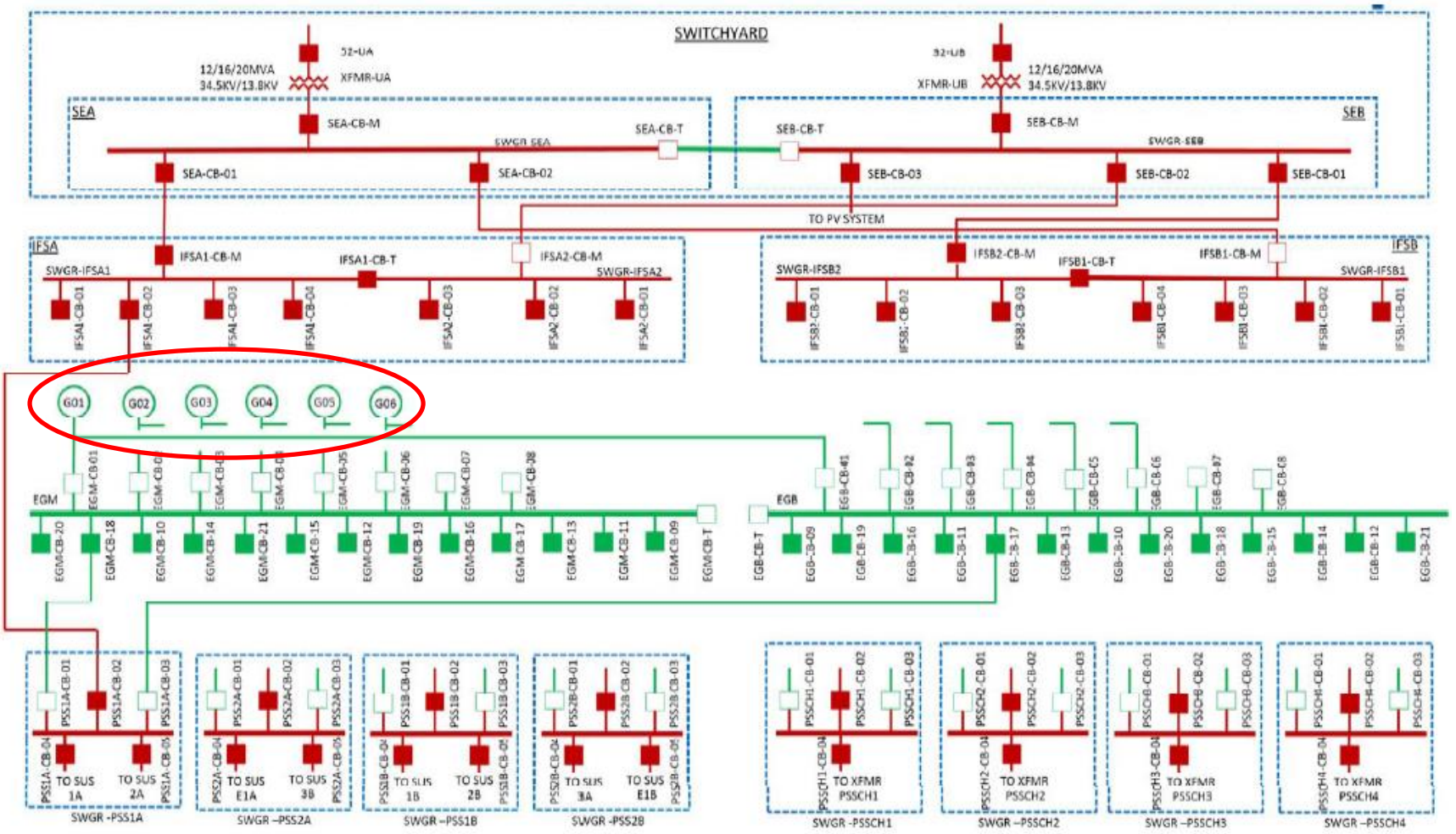
Combined Testing

- It is OK to combine testing of multiple systems or pieces of equipment together
  - Create “Mini ISTs”
  - Verify operation of downstream equipment
  - One of the most overlooked items is the recovery of downstream equipment after a power transition.
- Paralleling gear represents a unique challenge
  - Factor Testing: You can do things with generator and load simulators that may not be advisable in real life
  - Paralleling gear should be tested with generators and a load bank. Load Banks sufficient to handle full capacity
- Pretest any test Uptime Institute will wish to witness as part of any FPT, “Mini IST”, or IST during Cx (if applicable)

Electrical Block Diagram – SSA Tier III



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Load Bank Testing - FPT and IST

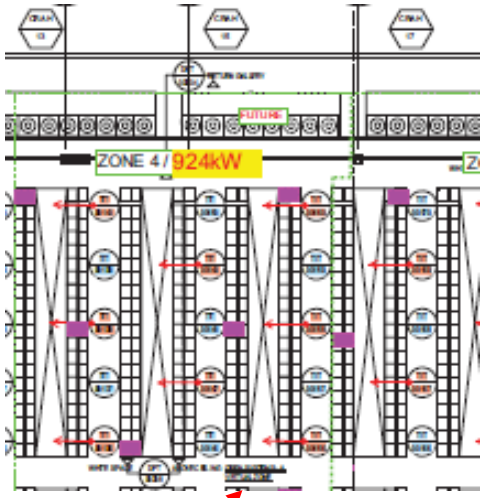
- Distributed load banks on the data floor – Simulates Actual operating conditions.
- This tests steady state and failover conditions both Mechanically and Electrically
- Scheduling setup and breakdown time must be anticipated.
- Allow additional time to step up and step down the individual load banks to desired settings during testing.

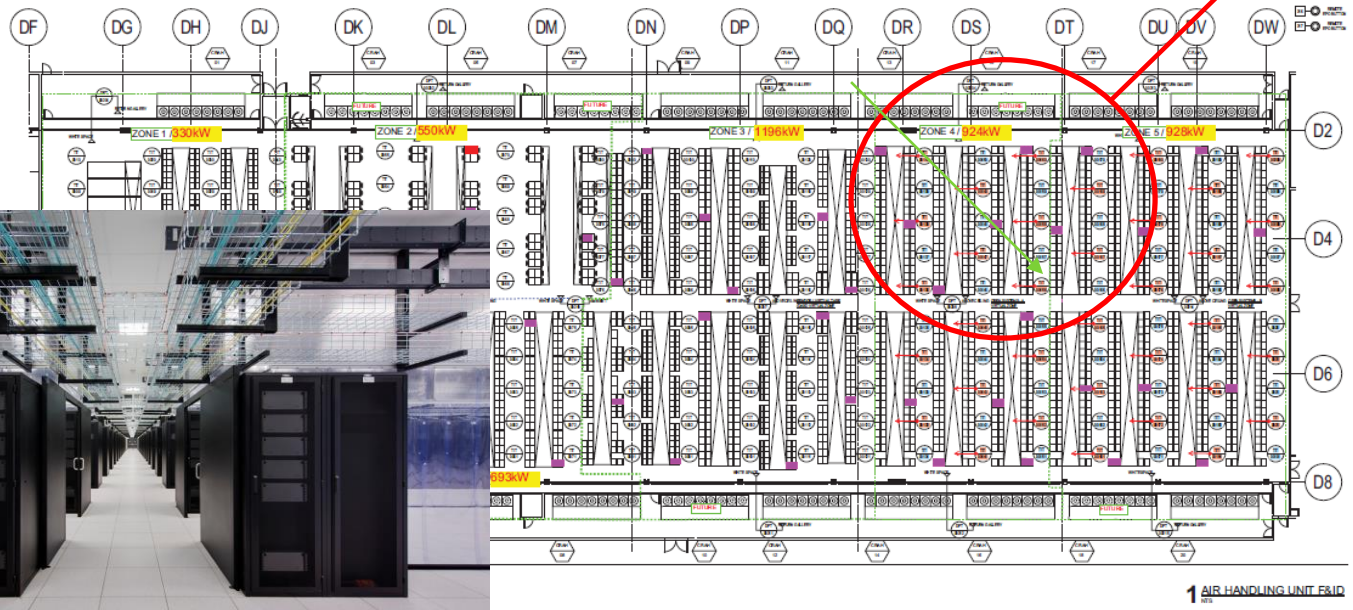
SSA - Load Bank Testing

- Portable load on the data center floor connected directly to the PDUs simulates actual power & heat load of Day 1 conditions up to full Day 2 buildout
- Water-cooled load banks can be used to simulate the water-cooled loads on the data floor.
- A caution when connecting air cooled load banks control power.
- Simulation of PUE (Power Usage Effectiveness) at various load profiles.

Full Hot Aisle Containment

- SSA Data center floor design used modified Hot Aisle Containment:
  - Racks vented directly to the hot aisle
  - Rack vented to Ceiling - Chimney design
  - Water cooled racks
- Creativity – needed for locating Load Banks.





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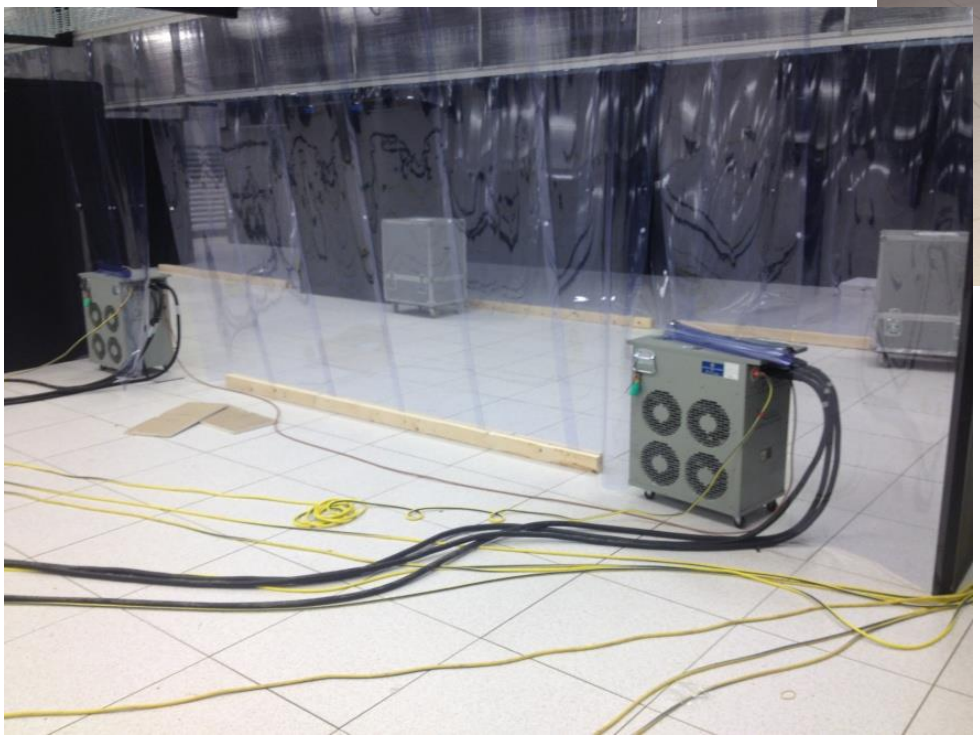
Load Bank Set Up Hot Aisle Containment.

- Racks were not installed at the time of testing
- Fully contained hot aisles were simulated



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Load Bank Set – Chimney Style Racks

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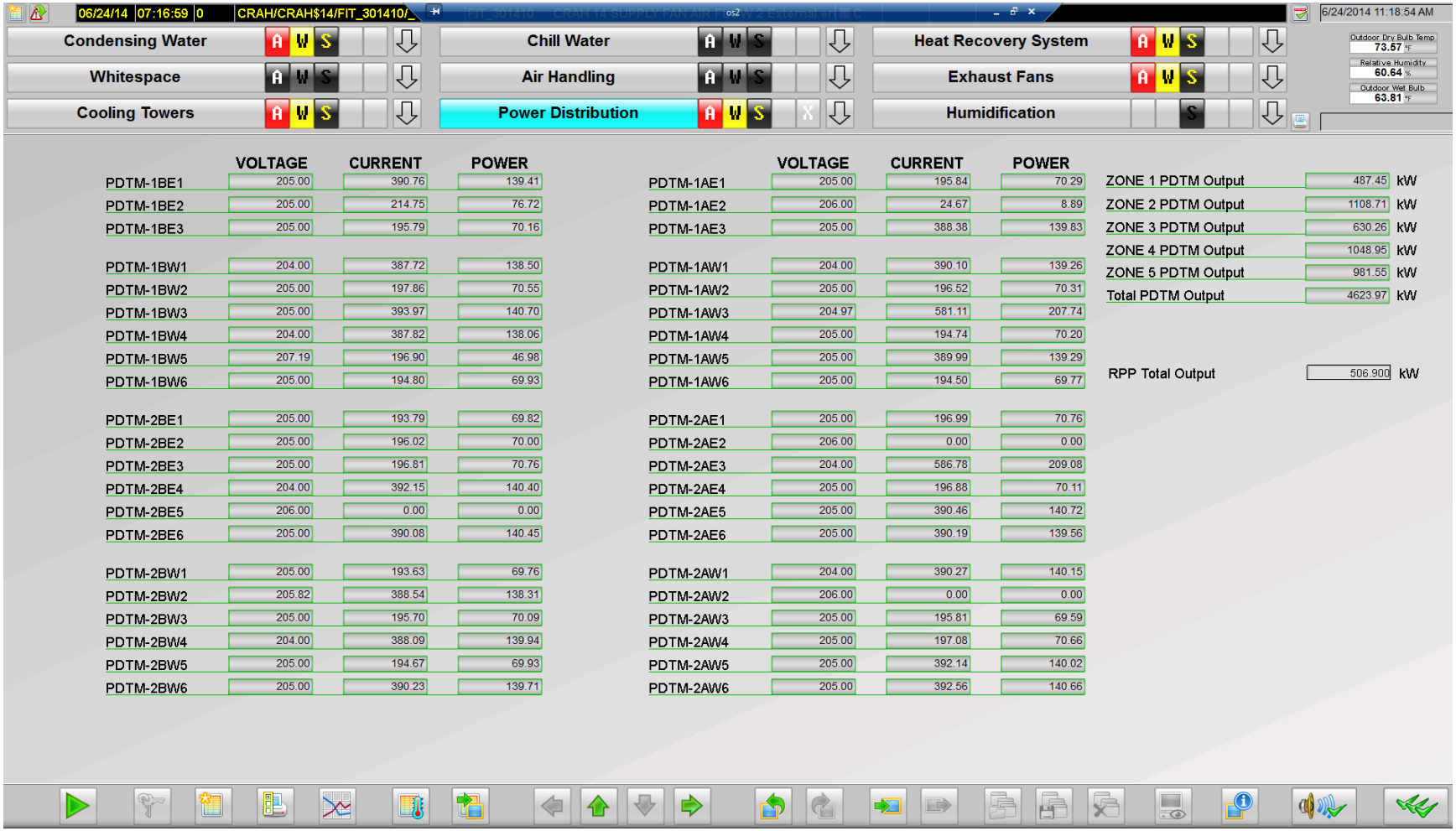
IST Challenges

- 100 separate IST tests, (+68 Uptime), ranging from thermal load change, full verification of thermal storage to electrical and mechanical failovers.
- IST tasks:
  - Set up and breakdown of load banks-Load Bank adjustment and settings
  - Thermal plant & thermal storage commissioning
  - Complete electrical redundancy
  - 24 hour burn in
  - Uptime Pre-Testing
  - Repeat of tests as required

- It is important to have all personal available so quick action can be taken when issues arise.

Load Bank Graphic Developed for IST Testing



	VOLTAGE	CURRENT	POWER
PDTM-1BE1	205.00	390.76	139.41
PDTM-1BE2	205.00	214.75	76.72
PDTM-1BE3	205.00	195.79	70.16
PDTM-1BW1	204.00	387.72	138.50
PDTM-1BW2	205.00	197.86	70.55
PDTM-1BW3	205.00	393.97	140.70
PDTM-1BW4	204.00	387.82	138.06
PDTM-1BW5	207.19	196.90	46.98
PDTM-1BW6	205.00	194.80	69.93
PDTM-2BE1	205.00	193.79	69.82
PDTM-2BE2	205.00	196.02	70.00
PDTM-2BE3	205.00	196.81	70.76
PDTM-2BE4	204.00	392.15	140.40
PDTM-2BE5	206.00	0.00	0.00
PDTM-2BE6	205.00	390.08	140.45
PDTM-2BW1	205.00	193.63	69.76
PDTM-2BW2	205.82	388.54	138.31
PDTM-2BW3	205.00	195.70	70.09
PDTM-2BW4	204.00	388.09	139.94
PDTM-2BW5	205.00	194.67	69.93
PDTM-2BW6	205.00	390.23	139.71

	VOLTAGE	CURRENT	POWER
PDTM-1AE1	205.00	195.84	70.29
PDTM-1AE2	206.00	24.67	8.89
PDTM-1AE3	205.00	388.38	139.83
PDTM-1AW1	204.00	390.10	139.26
PDTM-1AW2	205.00	196.52	70.31
PDTM-1AW3	204.97	581.11	207.74
PDTM-1AW4	205.00	194.74	70.20
PDTM-1AW5	205.00	389.99	139.29
PDTM-1AW6	205.00	194.50	69.77
PDTM-2AE1	205.00	196.99	70.76
PDTM-2AE2	206.00	0.00	0.00
PDTM-2AE3	204.00	586.78	209.08
PDTM-2AE4	205.00	196.88	70.11
PDTM-2AE5	205.00	390.46	140.72
PDTM-2AE6	205.00	390.19	139.56
PDTM-2AW1	204.00	390.27	140.15
PDTM-2AW2	206.00	0.00	0.00
PDTM-2AW3	205.00	195.81	69.59
PDTM-2AW4	205.00	197.08	70.66
PDTM-2AW5	205.00	392.14	140.02
PDTM-2AW6	205.00	392.56	140.66

ZONE 1 PDTM Output	487.45	kW
ZONE 2 PDTM Output	1108.71	kW
ZONE 3 PDTM Output	630.26	kW
ZONE 4 PDTM Output	1048.95	kW
ZONE 5 PDTM Output	981.55	kW
Total PDTM Output	4623.97	kW
RPP Total Output	506.900	kW

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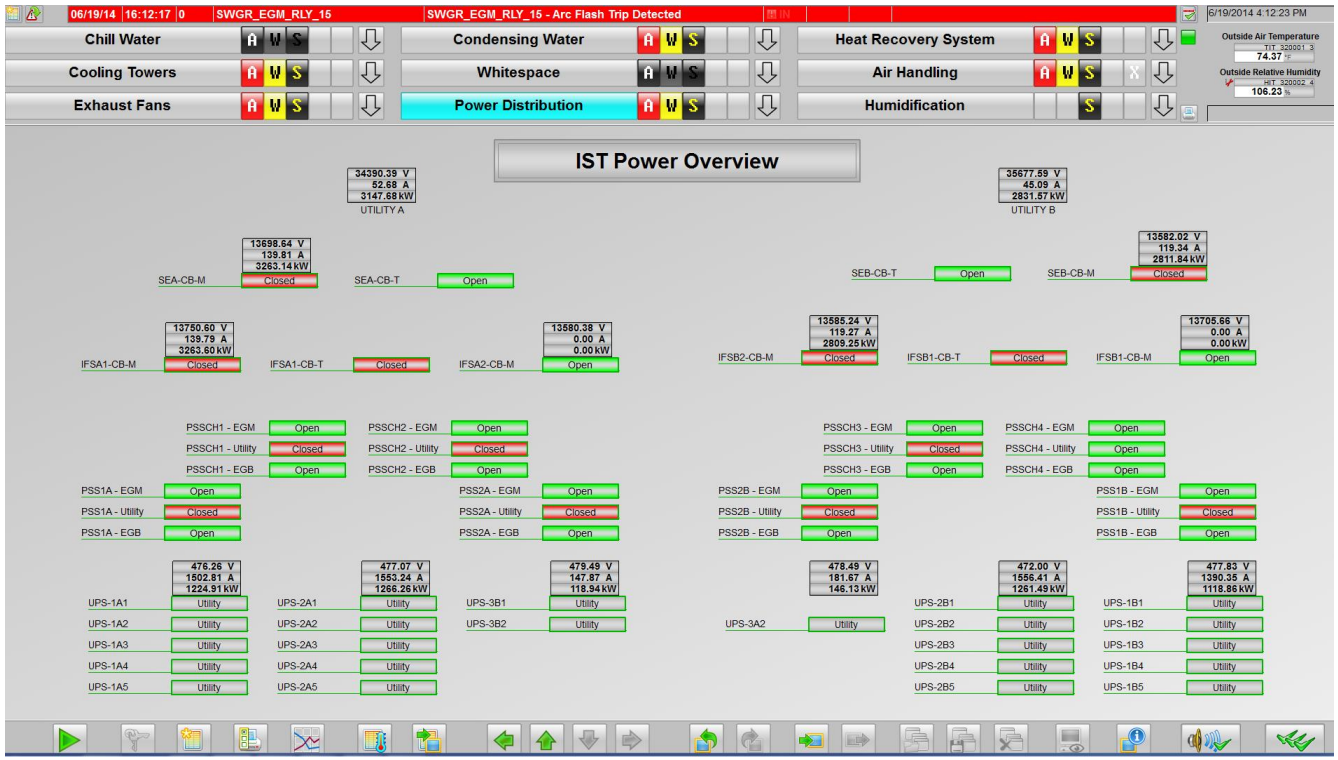
IST Challenges - Data Gathering

- Look for opportunities to develop custom graphic IST pages with pertinent data within the BAS or PCS control system to aid in the gathering of test data so you don't have to scroll thru pages of screens or have multiple personal stationed around the facility.
- Verifying expected PUE was a requirement, and a real time graphic was developed for doing that.



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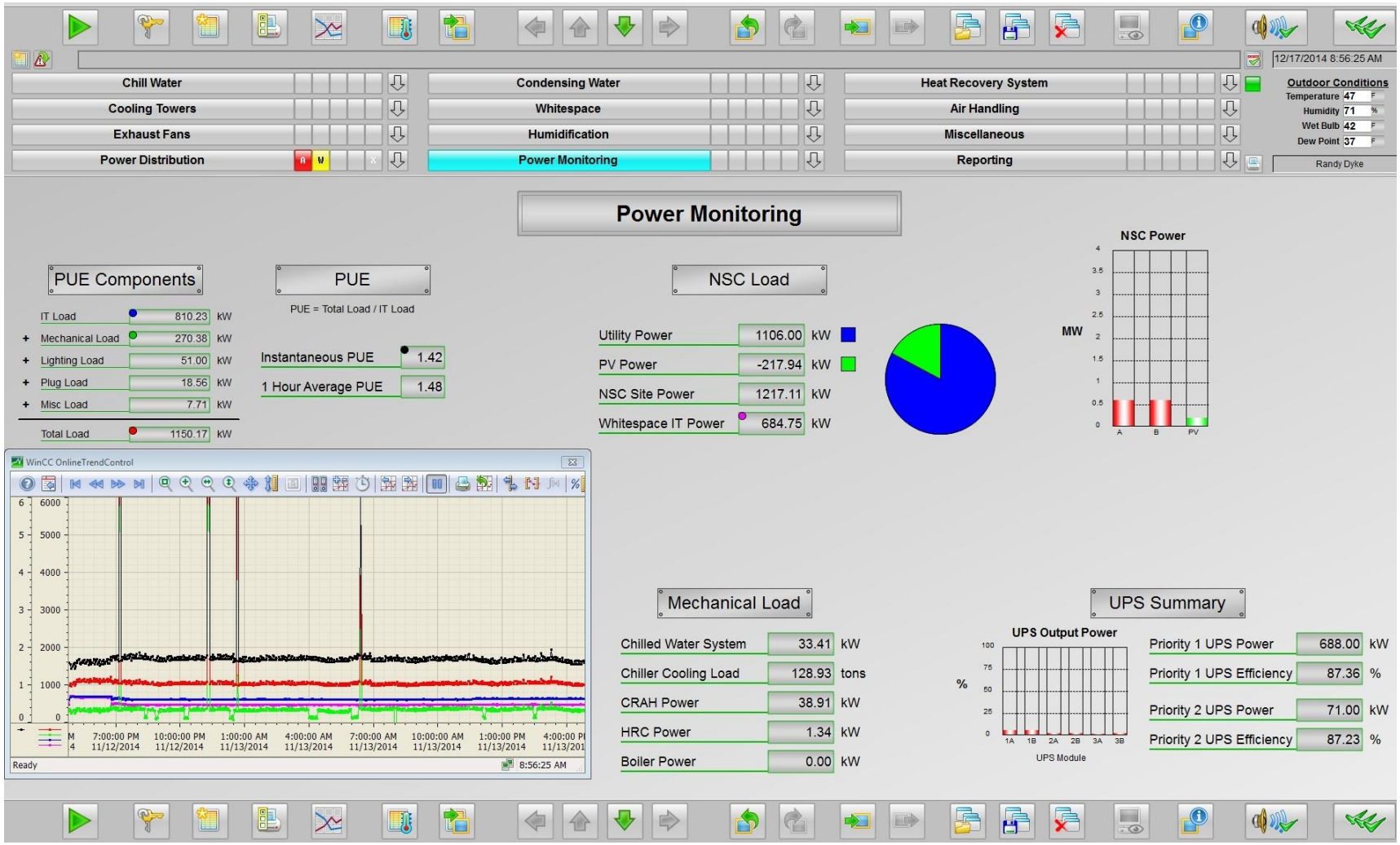
Specific Graphic in the PCS To Verify PUE



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Integrated Systems Test “Show Stoppers” List

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COMMISSIONING CORRECTIVE ISSUES REPORT (CIR)

CIR issues Log is part of the Cx close out documents and final Cx report.

PROJECT NAME: GSA/SSA NSC Data Center

										These Columns are Editable by the Contractor					Auto Fill Column No Entry	This Column is Editable by the Contractor
CIR #	System or Equipment	Test #	Test Section or Step	Corrective Issues Description/Cause	Recommendation	Implications	Priority (HIGH/ MODERATE/ LOW)	Date Opened	Opened By	Responsible Party	Target Date of Completion	Date Complete	Date Closed	Closed By	Status (OPEN/ COMPLETE/ CLOSED)	Action Taken/Resolution (Add Date and Initials when adding a comment) (yyyy mm-dd FML)
E003a-02 E0027	SWBD-3A1-ATS-CRAH02,16,12, 04	E003a-SWBD-3A1-ATS-CRAH02,16,12, 04 IFT	Prereq4	Arc Flash Labels not installed.	apply labels SCHEDULE VERIFICATION	life safety if distances and required PPE are not used	HIGH	24-Feb-2014	DJN	MC Dean			6/5/2014		OPEN	20270714 - This is a punchlist item. When the rooms are punched out this will be added. CLOSED
E003b-03 E0032	SWBD-3A2-ATS-CRAH08,14,20	E003b-SWBD-3A2-ATS-CRAH08,14,20 IFT	Prereq4	Arc Flash Labels not installed.	apply labels SCHEDULE VERIFICATION	life safety if distances and required PPE are not used	HIGH	24-Feb-2014	DJN	MC Dean			6/5/2014		OPEN	20270714 - This is a punchlist item. When the rooms are punched out this will be added. CLOSED
E003c-02 E0035	SWBD-3B1-ATS-CRAH01,19,13, 05	E003c-SWBD-3B1-ATS-CRAH01,19,13, 05 IFT	Prereq4	Arc Flash Labels not installed.	apply labels SCHEDULE VERIFICATION	life safety if distances and required PPE are not used	HIGH	24-Feb-2014	DJN	MC Dean			6/5/2014		OPEN	20270714 - This is a punchlist item. When the rooms are punched out this will be added. CLOSED
E003d-02 E0037	SWBD-3B2-ATS-CRAH11,09,17	E003d-SWBD-3B2-ATS-CRAH11,09,17 IFT	Prereq4	Arc Flash Labels not installed.	apply labels SCHEDULE VERIFICATION	life safety if distances and required PPE are not used	HIGH	24-Feb-2014	DJN	MC Dean			6/5/2014		OPEN	20270714 - This is a punchlist item. When the rooms are punched out this will be added. CLOSED
E003e-03 E0040	SWBD-3B3-ATS-SCWP1,4	E003e-SWBD-3B3-ATS-SCWP1,4 IFT	Prereq3	Arc Flash Labels not installed.	apply labels SCHEDULE VERIFICATION	life safety if distances and required PPE are not used	HIGH	24-Feb-2014	DJN	MC Dean			6/5/2014		OPEN	20270714 - This is a punchlist item. When the rooms are punched out this will be added. CLOSED
E003f-03 E0045	SWBD-3A3-ATS-SCWP2,3	E003f-SWBD-3A3-ATS-SCWP2,3 IFT	Prereq3	Arc Flash Labels not installed.	apply labels SCHEDULE VERIFICATION	life safety if distances and required PPE are not used	HIGH	24-Feb-2014	DJN	MC Dean			6/5/2014		OPEN	20270714 - This is a punchlist item. When the rooms are punched out this will be added. CLOSED
E003c-04	SWGR-PSS1A-SUS-2A	E003c_SWGR-PSS1A-SUS-2A	Prereq7	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	26-Mar-2014	DMR	MC Dean					OPEN	
E003c-05	SWGR-PSS1A-SUS-2A	E003c_SWGR-PSS1A-SUS-2A	8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	26-Mar-2014	DMR	MC Dean					OPEN	
E007a-04	SWGR-PSS2A-SUS-3A	E007a_SWGR-PSS2A-SUS-3A	Prereq7 & Step 8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	25-Mar-2014	DMR	MC Dean					OPEN	
E011d-02	UPS-2B-SWGR-2BOUT	E011d_UPS-2B-SWGR-2BOUT	Prereq5 & Step 8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	25-Mar-2014	DMR	MC Dean					OPEN	
E012b-02	UPS-3B-SWGR-3BOUT	E012b-UPS-3B-SWGR-3BOUT	Prereq5 & Step 8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	25-Mar-2014	DMR	MC Dean					OPEN	
E011a-02	UPS-1A-SWGR-1AOUT	E011a-UPS-1A-SWGR-1AOUT	Prereq5 & Step 8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	26-Mar-2014	DMR	MC Dean			6/5/2014		OPEN	CLOSED
E003a-04	SWGR-PSS1A-SUS-1A	E003a_SWGR-PSS1A-SUS-1A	Prereq7 & Step 8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	28-Mar-2014	DMR	MC Dean					OPEN	
E003b-04	SWGR-PSS1B-SUS-1B	E003b_SWGR-PSS1B-SUS-1B	Prereq7 & Step 8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	28-Mar-2014	DMR	MC Dean					OPEN	
E003b-07	SWGR-PSS1B-SUS-1B	E003b_SWGR-PSS1B-SUS-1B	Step 20, Table 1 Breaker 06	Ground fault setting is intermittent – It is understood that it is still an open PFC item. To be repaired by Eaton.	Repair Breaker. SCHEDULE VERIFICATION	Potential Inoperative Ground Fault Trip.	HIGH	28-Mar-2014	DMR	MC Dean					OPEN	
E003b-08	SWGR-PSS1B-SUS-1B	E003b_SWGR-PSS1B-SUS-1B	Steps 30 & 31, Table 3	Digital meter Comm Port defective and not communications to PCS was available.	Repair / Replace Meter and Communications to PCS. SCHEDULE VERIFICATION	No monitoring or Meter Functions.	HIGH	28-Mar-2014	DMR	MC Dean					OPEN	
E003b-09	SWGR-PSS1B-SUS-1B	E003b_SWGR-PSS1B-SUS-1B	Steps 30 & 31, Table 3	Digital meter Comm Port defective and not communications to PCS was available, along with the meter being completely inoperative	Repair / Replace Meter and Communications to PCS. SCHEDULE VERIFICATION	No monitoring or Meter Functions.	HIGH	28-Mar-2014	DMR	MC Dean					OPEN	
E008a-02	SWGR-PSS2A-SUS-E1A	E008a_SWGR-PSS2A-SUS-E1A	Prereq7 & Step 8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	28-Mar-2014	DMR	MC Dean					OPEN	
E008b-02	SWGR-PSS2B-SUS-E1B	E008_SWGR-PSS2B-SUS-E1B	Prereq7 & Step 8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	4-Apr-2014	DMR	MC Dean					OPEN	
E008b-03	SWGR-PSS2B-SUS-E1B	E008_SWGR-PSS2B-SUS-E1B	Steps 30 & 31, Table 3	When remotely opening then closing CB-01, the Breaker would immediately Trip.	Repair Breaker. SCHEDULE VERIFICATION	Faulty Breaker	HIGH	4-Apr-2014	DMR	MC Dean			6/5/2014		OPEN	CLOSED
E027a-03	SUS-E1A-SWBD-E1A	SUS-E1A-SWBD-E1A	Prereq7 & Step 9	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	4-Apr-2014	DMR	MC Dean					OPEN	
E027a-06	SUS-E1A-SWBD-E1A	SUS-E1A-SWBD-E1A	Table 1	It appears the Several NETA testing issues exist with these breakers as identified via several Taped Notes: Breakers 05, 06 & 17 = "High" or "Bad" Contact Resistance, Breaker 08 = "Cables Tested, Lugs should be replaced"	Make repairs to equipment, and complete start-Up. SCHEDULE VERIFICATION	Incomplete Start-Up, Potential defective equipment.	HIGH	4-Apr-2014	DMR	MC Dean					OPEN	
E027a-07	SUS-E1A-SWBD-E1A	SUS-E1A-SWBD-E1A	Table 2 & 3 MVS-01	Although PCS Communications could be verified initially, it was found during testing the test that once "Gateway" power was lost, for example the opening of SUS-E1A-CB-M, the ability to see the status of the switchboard on the PCS took an exceedingly long time to recover, (In excess of 10 Minutes), so that appropriate status and communications could not re-verified.	Increase update speed and correct communications issues any. SCHEDULE VERIFICATION	Unreliable Status Information.	HIGH	4-Apr-2014	DMR	MC Dean					OPEN	
E027b-03	SUS-E1B-SWBD-E1B	E027b_SUS-E1B-SWBD-E1B	Prereq7 & Step 9	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	4-Apr-2014	DMR	MC Dean					OPEN	
E027b-06	SUS-E1B-SWBD-E1B	E027b_SUS-E1B-SWBD-E1B	Table 2 & 3 MVS-01	Although PCS Communications could be verified initially, it was found during testing the test that once "Gateway" power was lost, for example the opening of SUS-E1B-CB-M, the ability to see the status of the switchboard on the PCS took an exceedingly long time to recover, (In excess of 10 Minutes), so that appropriate status and communications could not re-verified.	Increase update speed and correct communications issues any. SCHEDULE VERIFICATION	Unreliable Status Information.	HIGH	4-Apr-2014	DMR	MC Dean			6/5/2014		OPEN	
E014j-01	SUS-1B-UPS-1B5	E014j-SUS-1B-UPS-1B5	Prereq. 8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	30-Apr-2014	DMR	MC Dean					OPEN	CLOSED
E014k-02	SUS-3A-UPS-2A1	E014k-SUS-3A-UPS-2A1	Prereq. 8	Arc Flash Study Complete, but Arc Flash Labels currently not installed.	Install Arc Flash Labels.. SCHEDULE VERIFICATION	Required by Code, Safety Issue	HIGH	25-Apr-2014	DMR	MC Dean			6/5/2014		OPEN	CLOSED

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Conclusions:

- Commissioning Mission Critical facilities entails significant up-front planning.
  - Schedules must be realized and blended together
  - Must engage professionals in the conceptual phase
  - Goals must be realistic, balancing cost vs. performance decisions
- Teamwork & Integration
  - CM & CxA need to work closely so that projects delays are minimized, issues resolved, and the overall schedule is adhered to
- Testing was done with all team onboard & available
  - Issues could be quickly addressed, and testing continue

Thank You

Questions?

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CxEnergy Conference Orlando 2019

Commissioning Electrical Systems in Mission Critical Facilities

Port Authority of NY & NJ – World Trade Center (WTC) Transportation HUB

Social Security Administration- National Support Center

April 17, 2019

Presented By:

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