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Commissioning Challenges for a Military Microgrid

IDEA Campus Energy 2018

PRESENTATION AGENDA

NSF Indian Head Microgrid

- Project Overview
- Commissioning
- Issues Found in Operation
- Recommissioning
- Recap

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PROJECT OVERVIEW

Primary Design Objectives

- Maintain Steam Production and Critical Load
- Support Grid-Connected & Islanded Modes

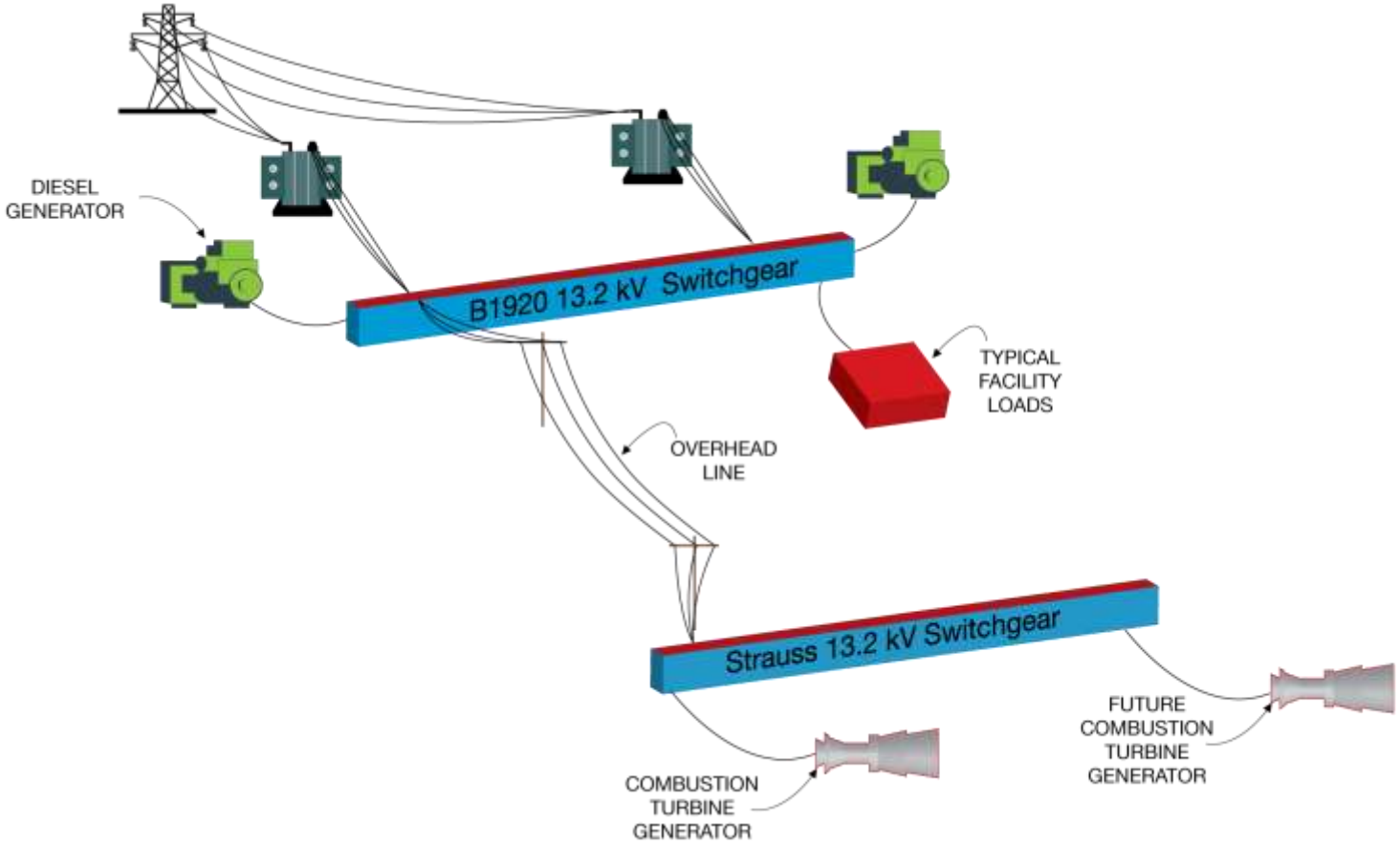
Requires Coordinated Automation and Protection Systems

Automation

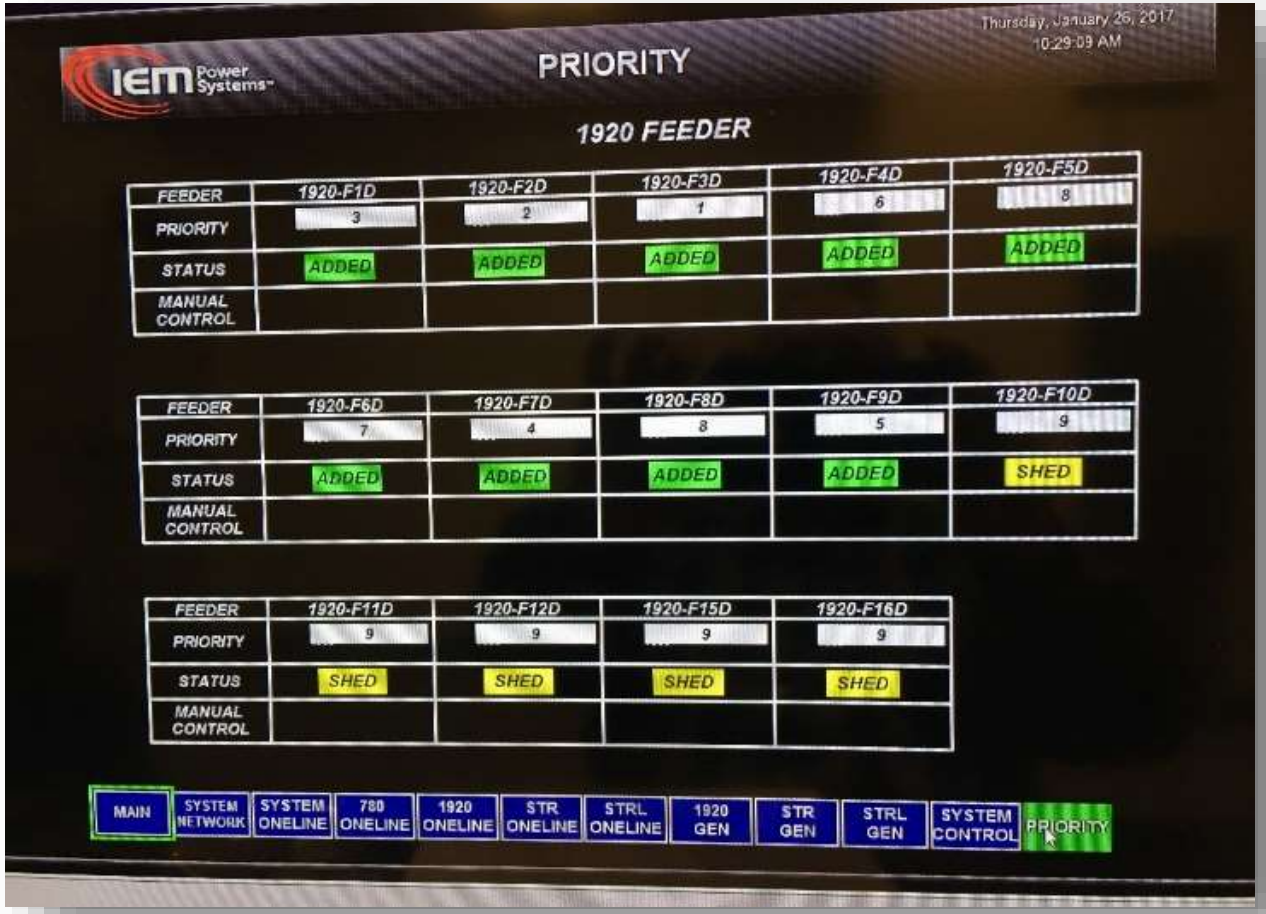
- Control Operation Modes
- Prioritized Load Shed/Load Add
- Load Sharing

Protective Relaying

- Typical Equipment Protection
- Utility Interconnection Requirements
- Island Detection

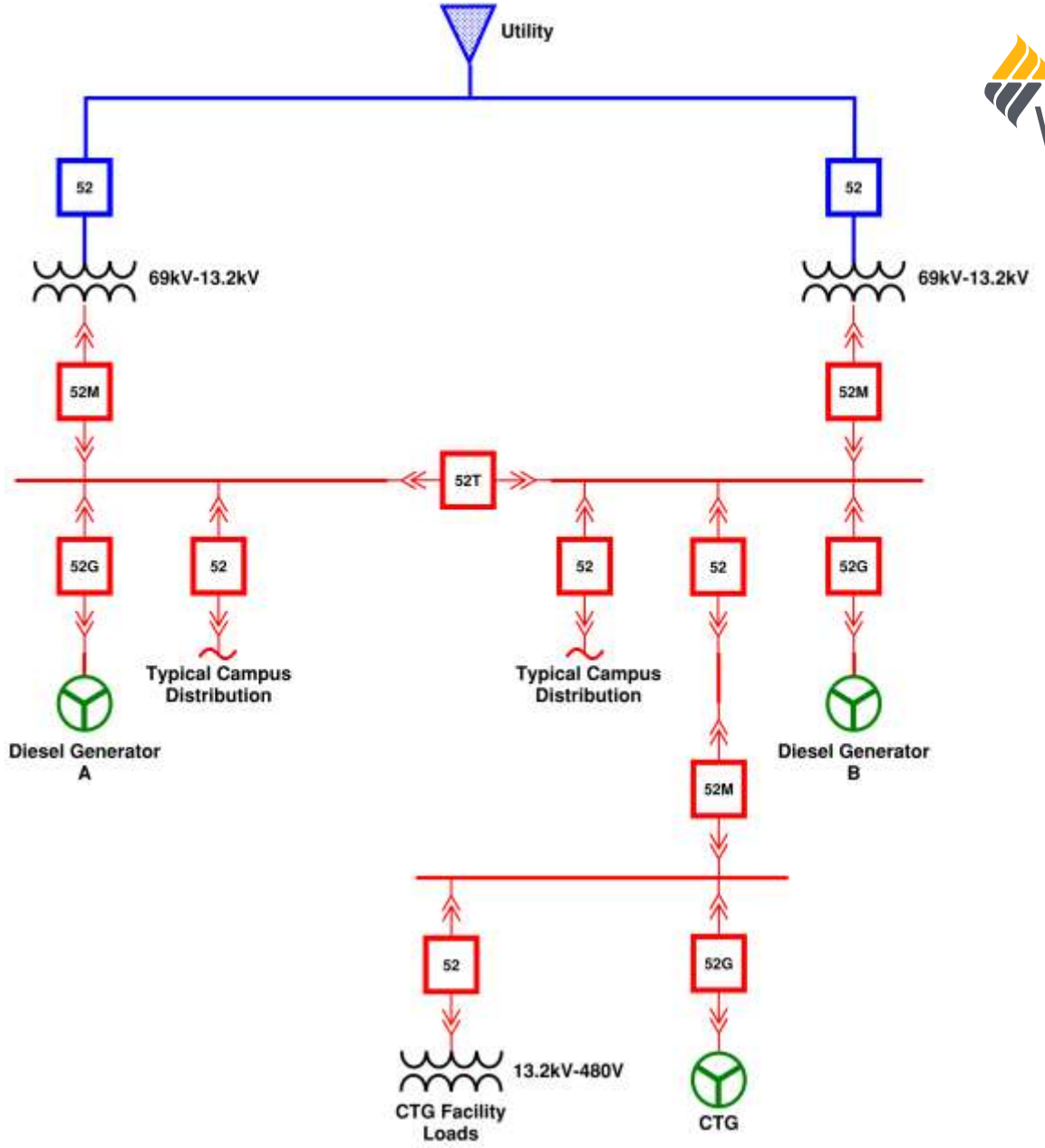


AUTOMATION


IEM Power Systems
PRIORITY
Thursday, January 26, 2017
10:29:09 AM
1920 FEEDER
FEEDER 1920-F1D 1920-F2D 1920-F3D 1920-F4D 1920-F5D
PRIORITY 3 2 1 6 8
STATUS ADDED ADDED ADDED ADDED ADDED
MANUAL CONTROL
FEEDER 1920-F6D 1920-F7D 1920-F8D 1920-F9D 1920-F10D
PRIORITY 7 4 8 5 9
STATUS ADDED ADDED ADDED ADDED SHED
MANUAL CONTROL
FEEDER 1920-F11D 1920-F12D 1920-F15D 1920-F16D
PRIORITY 9 9 9 9
STATUS SHED SHED SHED SHED
MANUAL CONTROL
MAIN
SYSTEM NETWORK
SYSTEM ONELINE
780 ONELINE
1920 ONELINE
STR ONELINE
STRL ONELINE
1920 GEN
STR GEN
STRL GEN
SYSTEM CONTROL
PRIORITY

13.2kV System Configuration

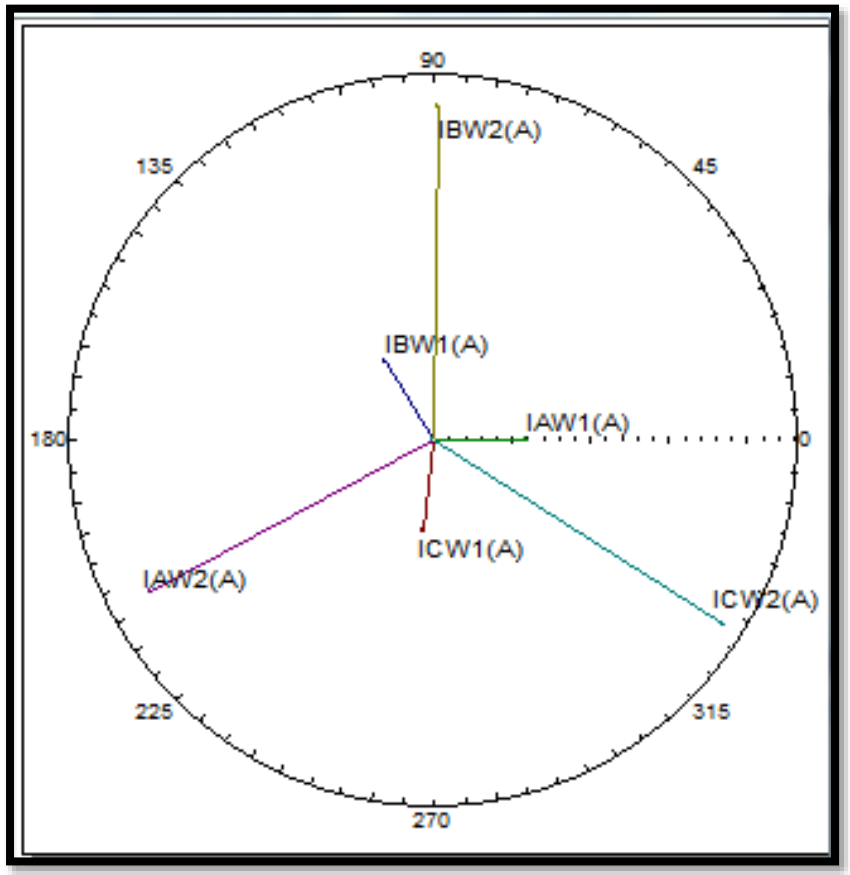
- Two 69-13.2kV Substation Transformers
- Two On-site Generation Locations
- Two 2.5MW Standby Generators
- One 4.6MW CTG/HRSG



COMMISSIONING

August 2015

- Could not Affect the Facility Loads. Test Arrangement was Not Final Arrangement
- Connected One 6.4 MW and One 4.2 MW to B1920 Switchgear to Simulate Facility Load
- Found and Repaired Wiring Issues
- Functional Test Plan Based on the Sequence of Operations Document
- Performance Tests Focused on Gas Operation



Phasor Diagram

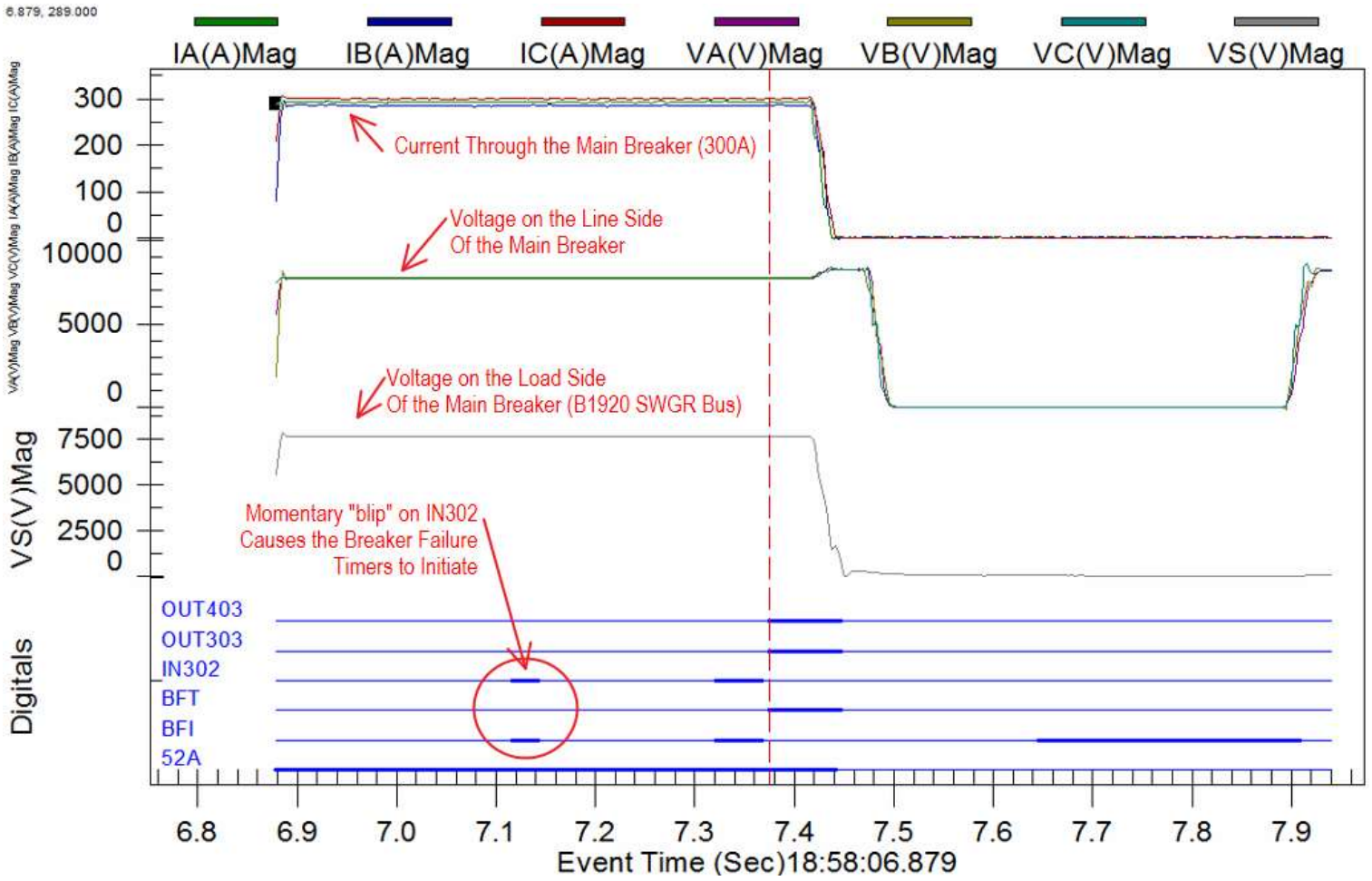
ISSUES FOUND IN OPERATION

SYSTEM HAS BEEN OPERATING FOR OVER TWO YEARS

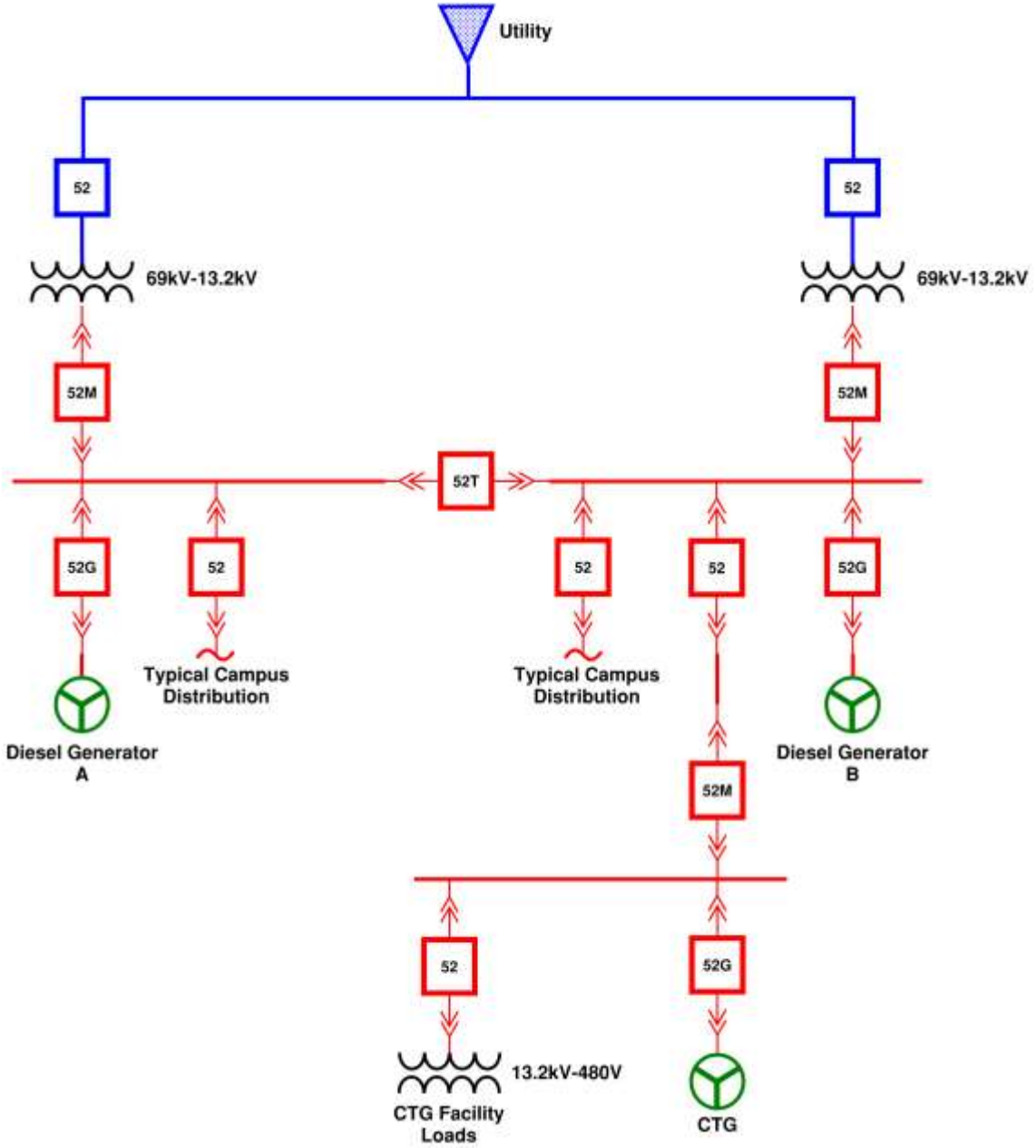
In this time the Client has reported any item that they see as a potential system issue allowing the team to provide guidance on the cause, implement corrections and advise on operation issues.

- False Breaker Failure
- Generation Assets Not Coming On-Line
- Fuel Oil System Shutdown
- CTG Tripping After a Loss of Utility

ISSUE: BREAKER FAILURE



UNINTENDED BREAKER FAILURE INITIATE SIGNAL

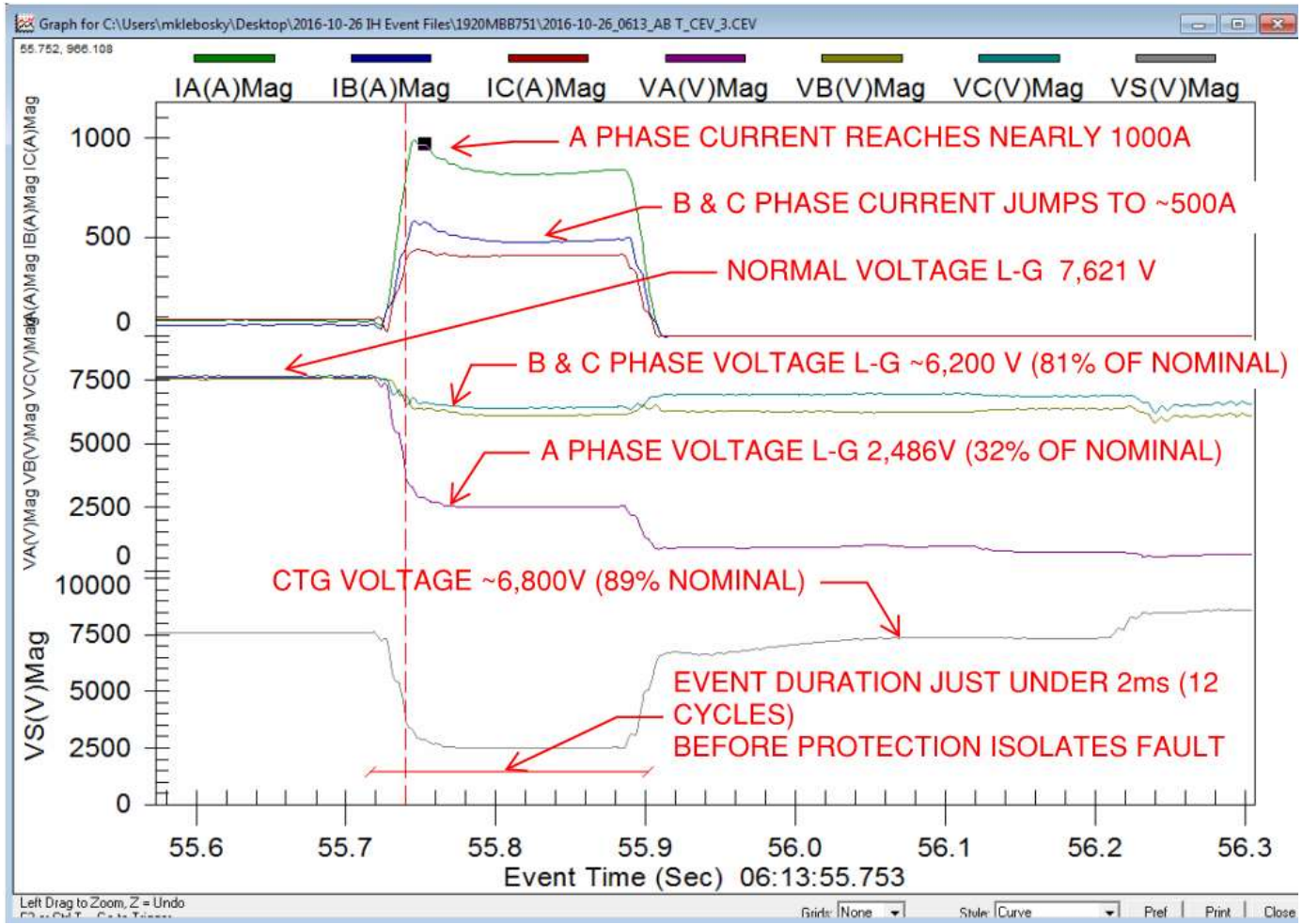

Utility
52
52
69kV-13.2kV
69kV-13.2kV
52M
52M
52T
52G
52
52
52
52G
Typical Campus Distribution
Typical Campus Distribution
Diesel Generator A
Diesel Generator B
52M
52
52G
13.2kV-480V
CTG Facility Loads
CTG

ISSUE: FUEL OIL SHUTDOWN

Solution

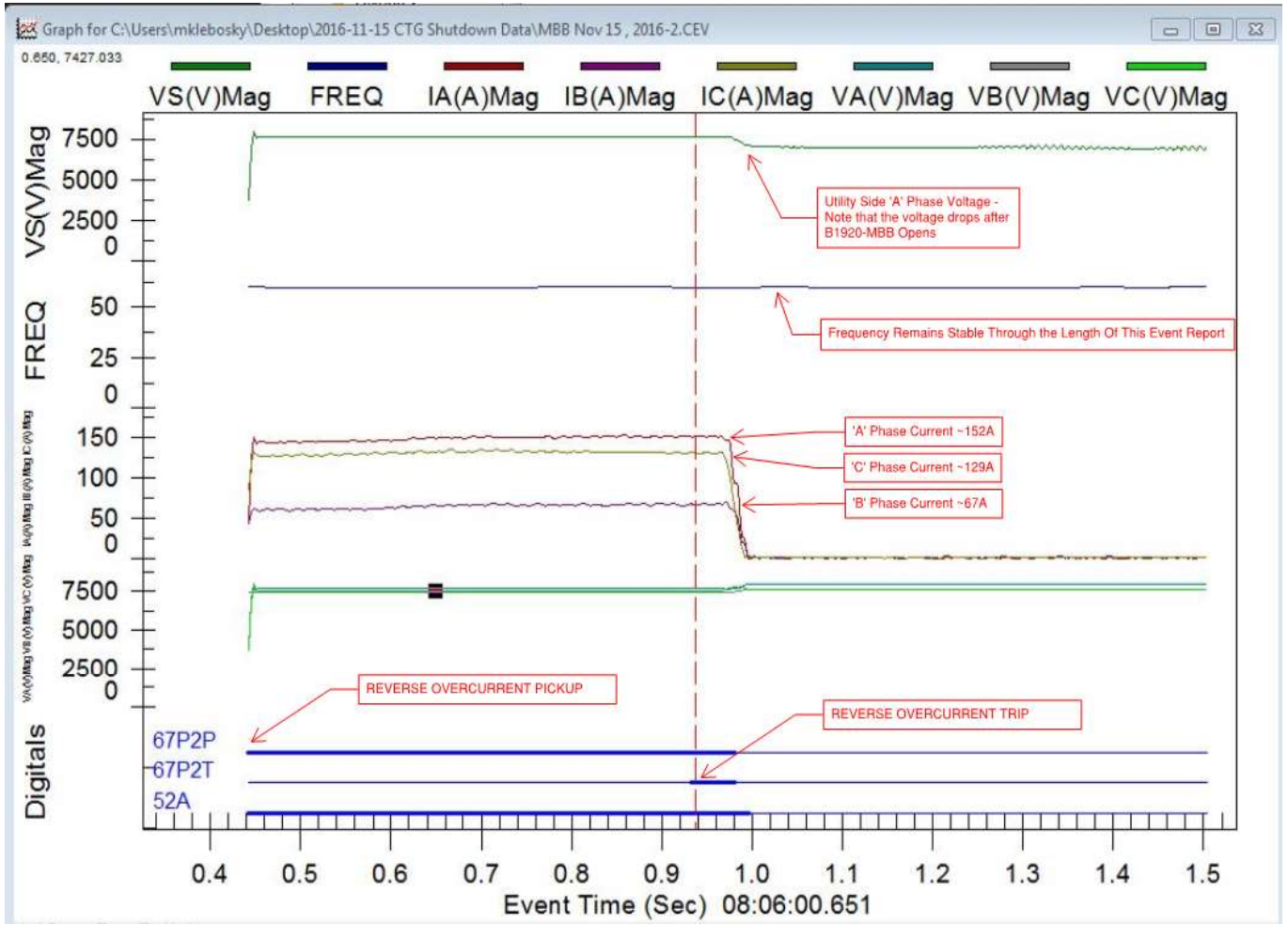
Identify Fail Safe Control Components and Supply them from a UPS Source

ISSUE: FUEL OIL SHUTDOWN



Distribution System Faults Caused Fail Safe Relays Involved in Fuel Oil System Protection to Drop Out Triggering the Emergency Shutdown

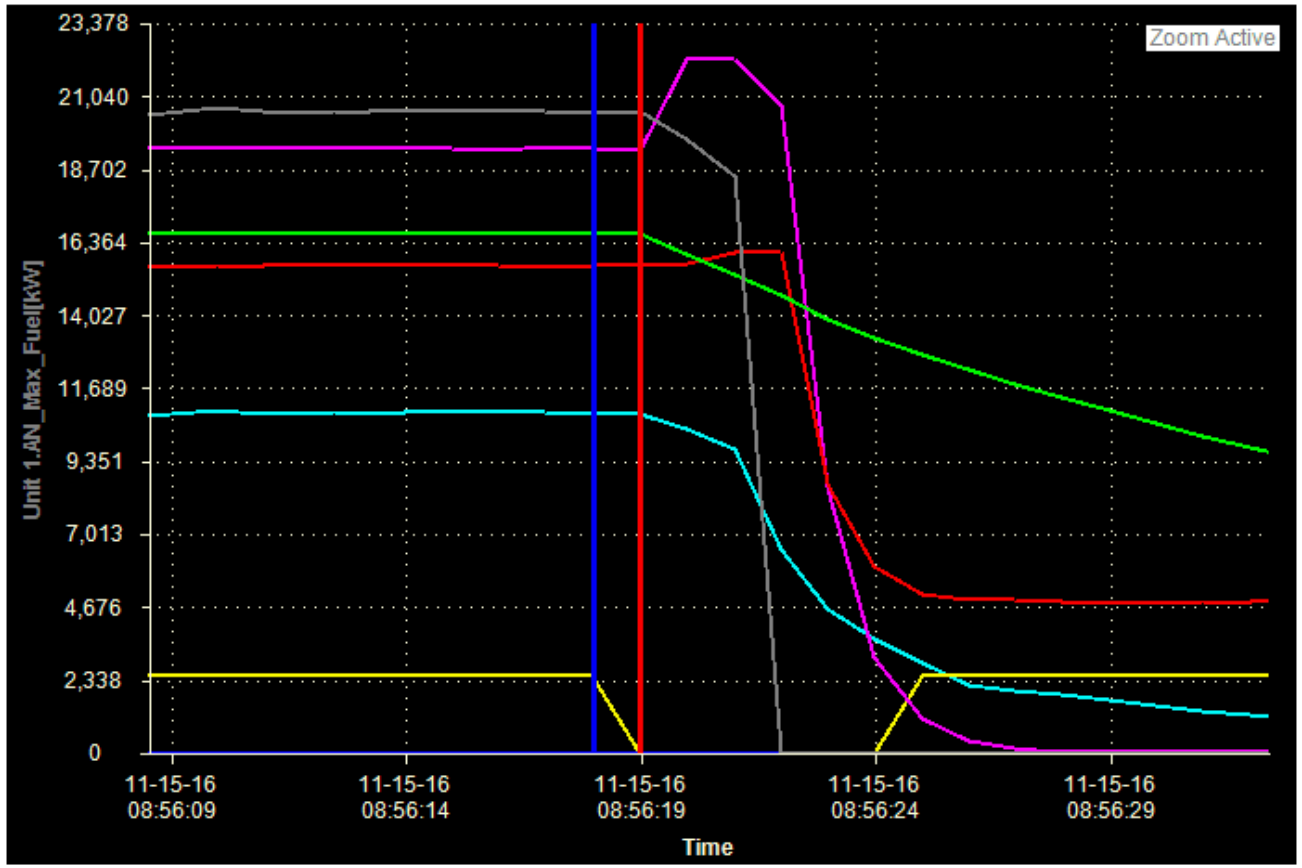
ISSUE: SYSTEM RECOVERY



NO SYSTEM RECOVERY ON REVERSE OVERCURRENT TRIP

ISSUE: CTG SHUTDOWN

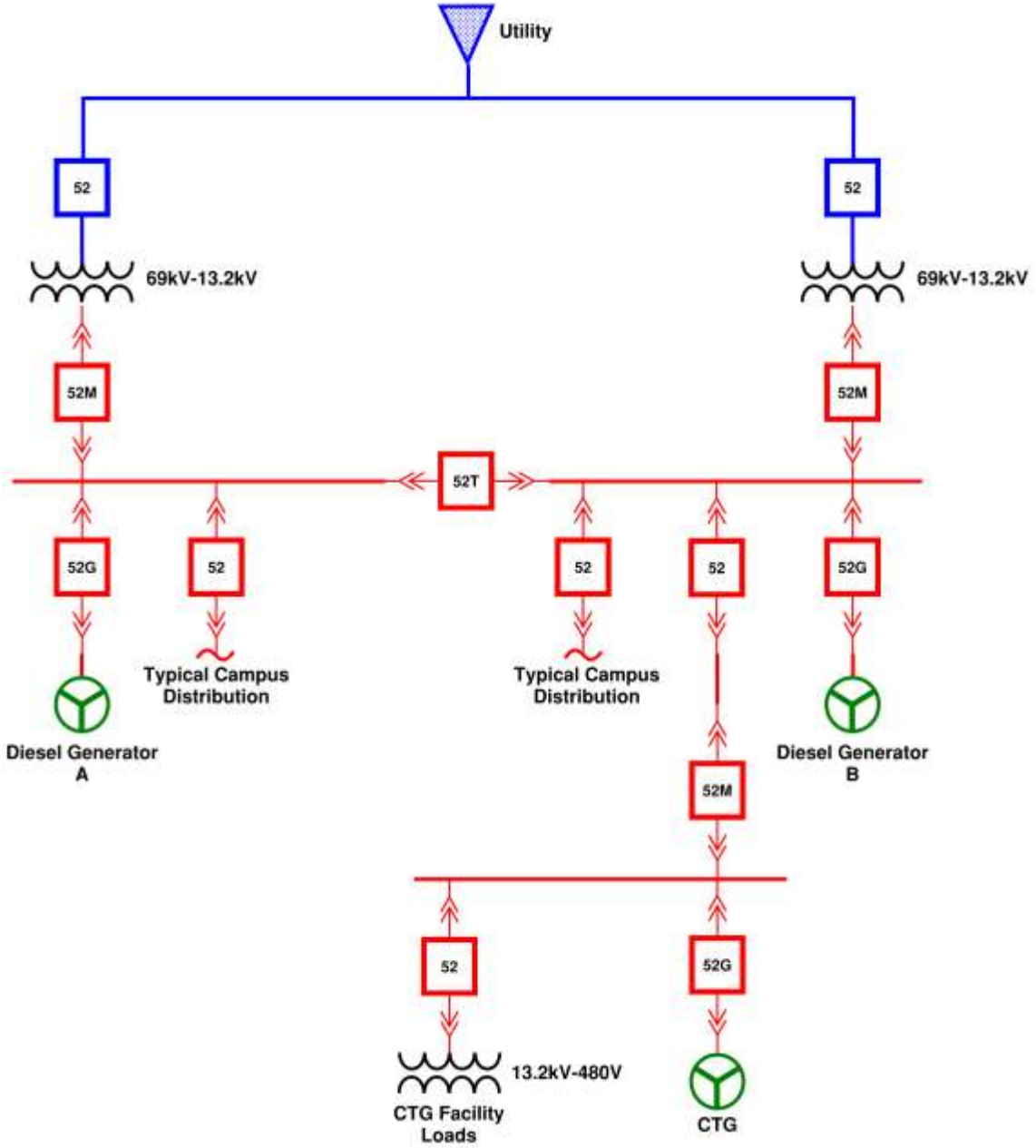
CTG TRIP ON LOSS OF UTILITY WHILE ON FUEL OIL



Short Description	Line	Blue Value	Red Value	Delta
Unit 1.AN_Max_Fuel[kW]		20,486	20,536	50.07
Unit 1.ST_kW_Max_Lim_Active		0.00	0.00	0.00
Unit 1.AN_Ngp[%]		99.97	100.0	0.0301
Unit 1.AN_T5_Average_Temperature[°F]		1,250	1,251	0.250
Unit 1.AN_Pcnt_Load[%]		93.13	92.96	-0.168
Unit 1.ST_Util_CB_Closed		1.000	0.00	-1.000
Unit 1.AN_Engine_Pcd[psig]		130.6	130.9	0.331

KF_Wf_Max_Fuel_Xn.Val	{...}	PCD
KF_Wf_Max_Fuel_Xn.Val[0]	0.0	
KF_Wf_Max_Fuel_Xn.Val[1]	20.0	
KF_Wf_Max_Fuel_Xn.Val[2]	40.0	
KF_Wf_Max_Fuel_Xn.Val[3]	60.0	
KF_Wf_Max_Fuel_Xn.Val[4]	160.0	
KF_Wf_Max_Fuel_Yn.Val	{...}	Wf_Max_kW
KF_Wf_Max_Fuel_Yn.Val[0]	1759.0	
KF_Wf_Max_Fuel_Yn.Val[1]	4561.0	
KF_Wf_Max_Fuel_Yn.Val[2]	7026.0	
KF_Wf_Max_Fuel_Yn.Val[3]	9800.0	
KF_Wf_Max_Fuel_Yn.Val[4]	24940.0	

PCD 130.6 / 20,536 wF_Kw @ UT-CB OPEN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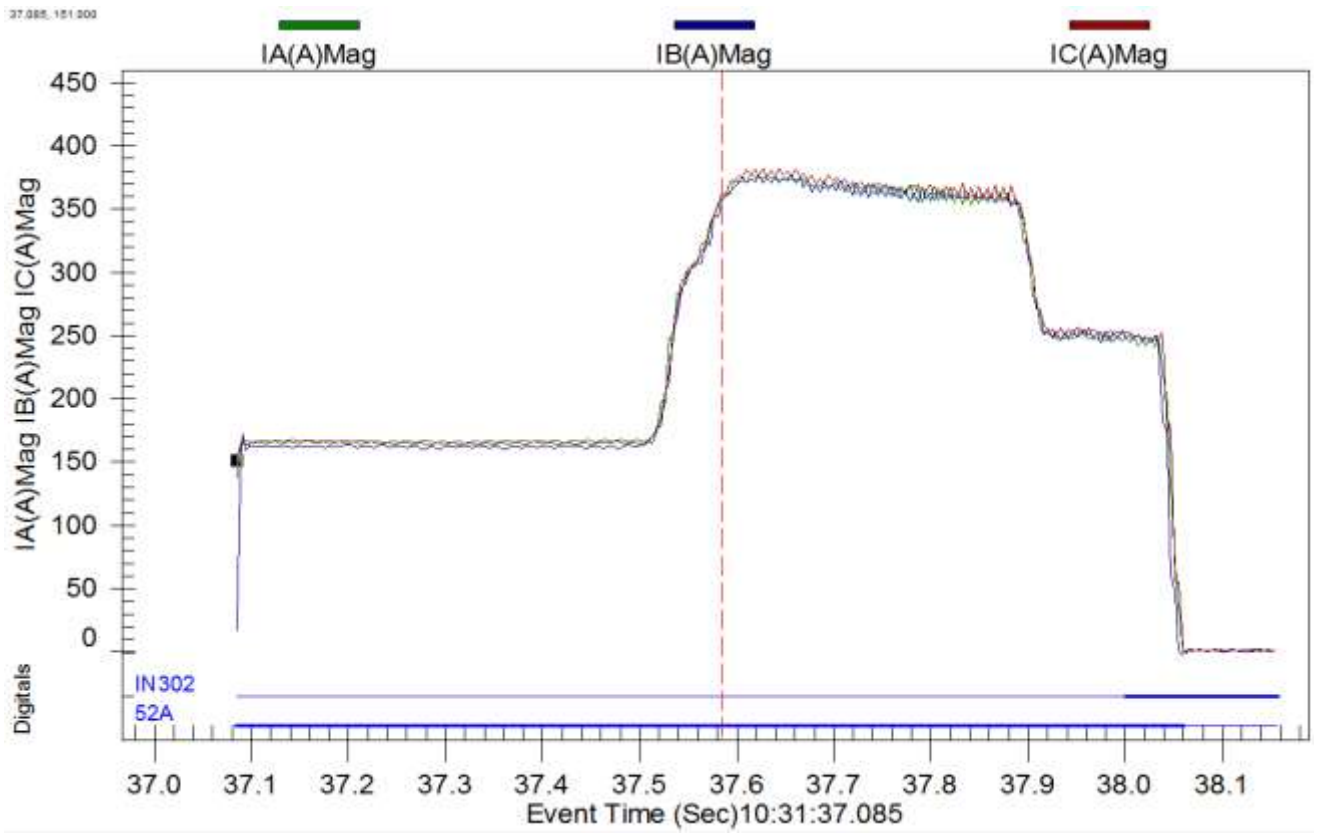
Typical Campus Distribution
Typical Campus Distribution
Diesel Generator A
Diesel Generator B
52M
52
52G
13.2kV-480V
CTG Facility Loads
CTG

RECOMMISSIONING

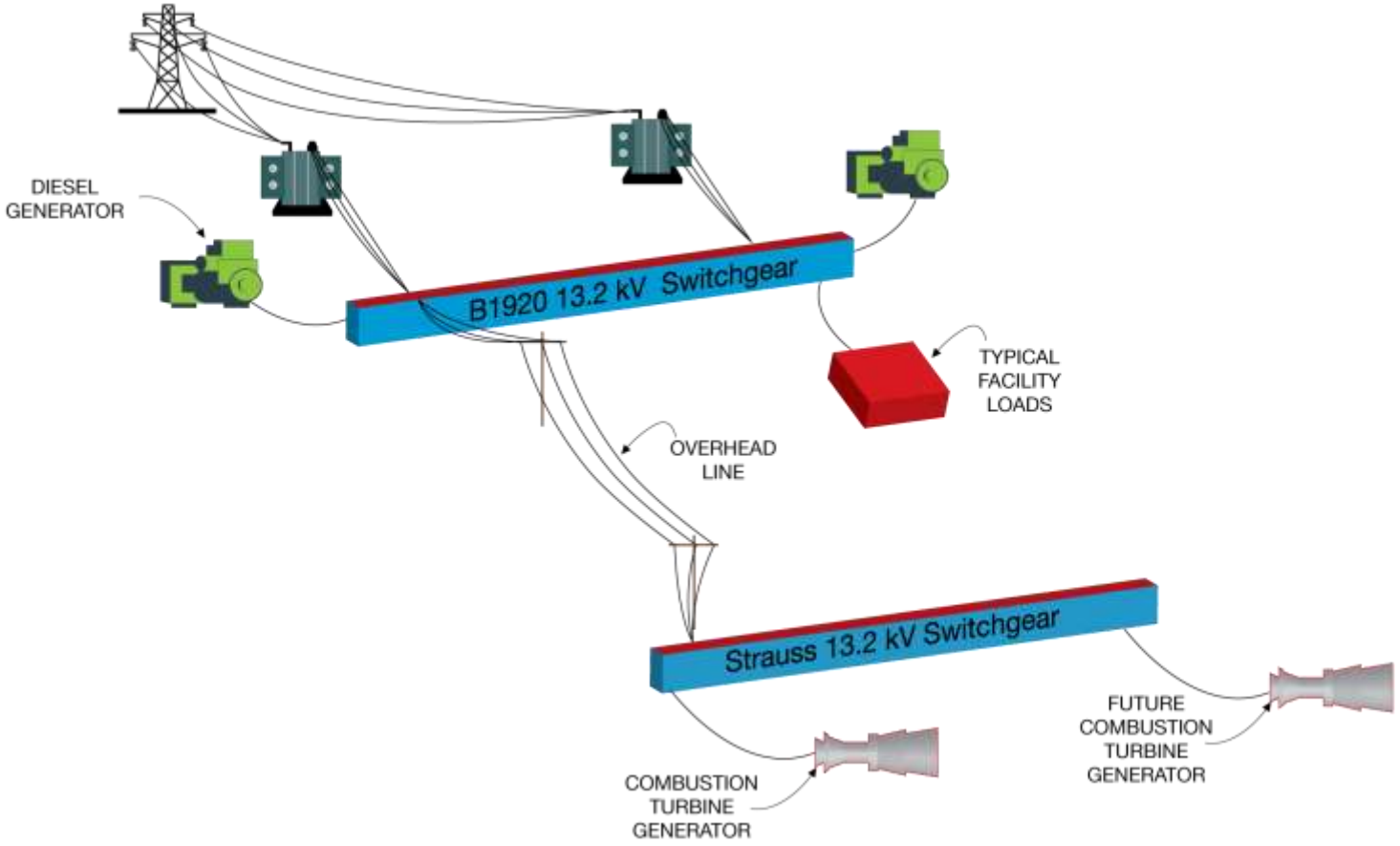
How did we prove the proposed updates work as intended?

- Develop and implement a test plan
- Utilize realistic and varying loading conditions
- Test occurred on actual system arrangement



RECAP

- Identified single points of failure that caused the system to drop offline.
  - Cable Interference
  - Fail-Safe Signals
- Identified and corrected automation modes that prevented recovery.
- Improved CTG isolation strategy to allow for faster recovery.



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Q & A

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