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Portsmouth Naval Shipyard – History of a Microgrid

James B. Redden, P.E.
Vice President – Energy Assets

Troy Wilsey
Project Developer

History of the Cogeneration Plant

- Phase 1
  > Energy Efficiency
  > Boiler Upgrades
  > Distribution Upgrades
  > Turbine #1
- Phase 2
  > Turbine #2
  > Diesel Generators
- Phase 3
  > Water and Sewer Condensate Upgrades

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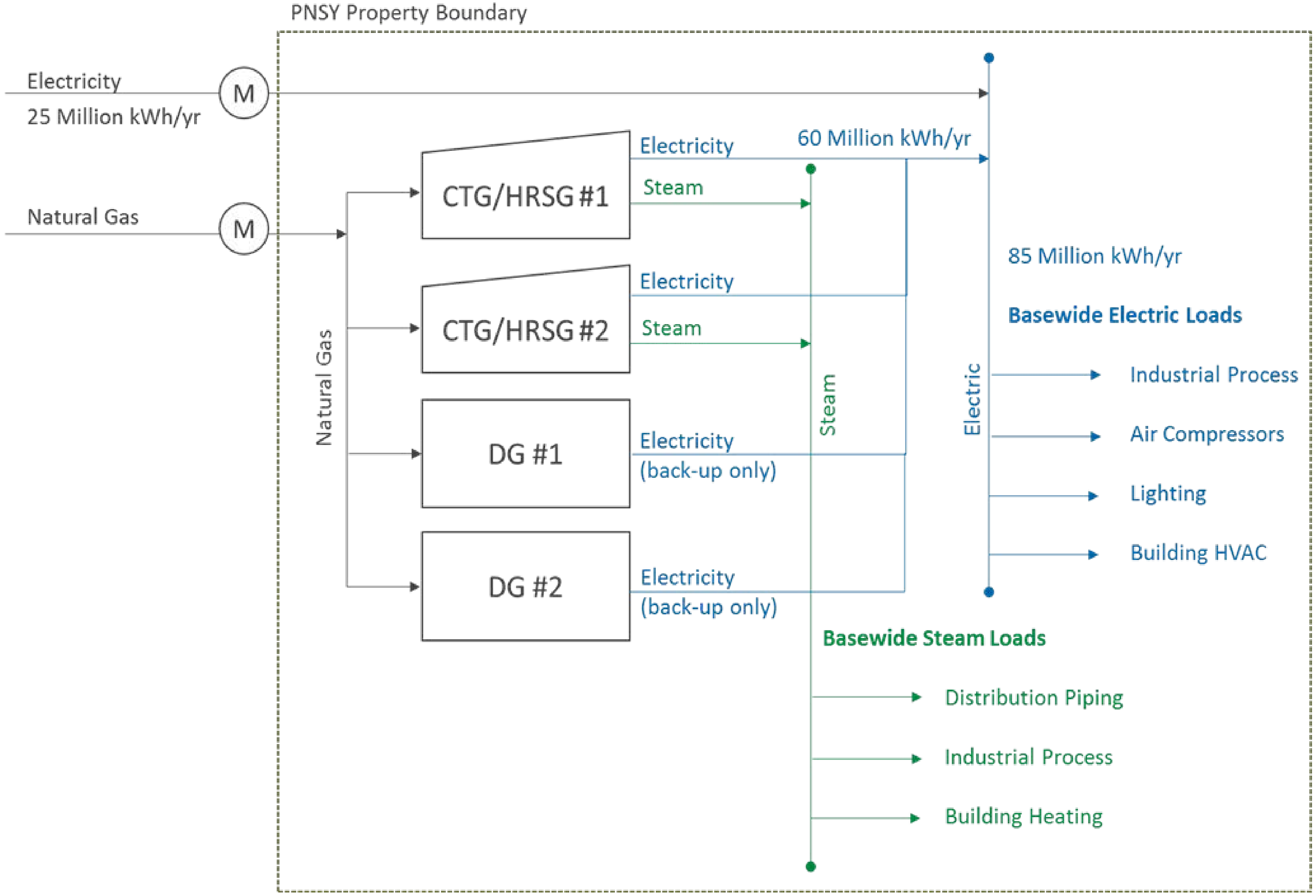
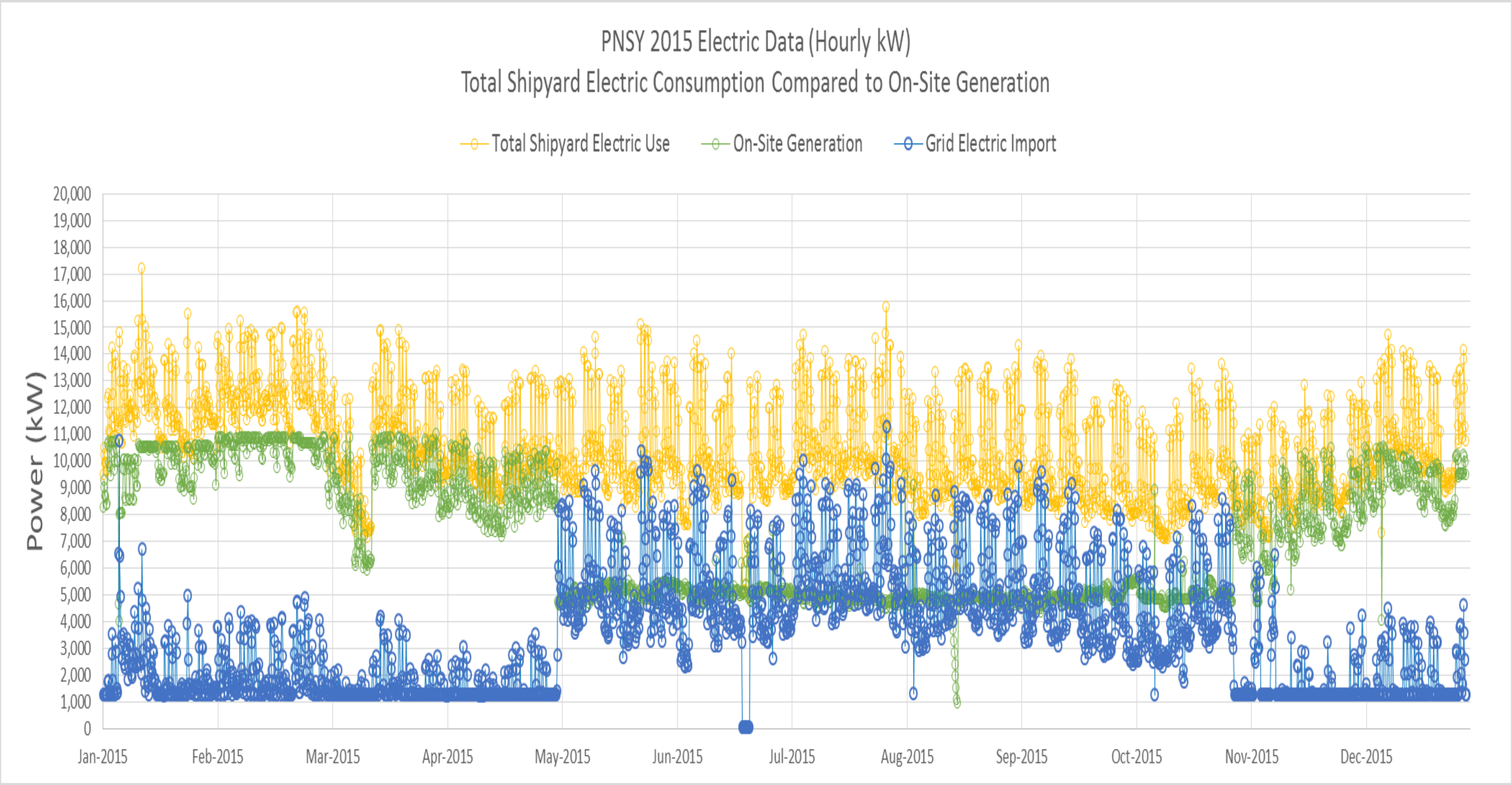
PNS Electric Supply



Shipyard Electrical Demand (kW)



Problem and Microgrid Solution

Problem:

- Shipyard CTG are overloaded when utility grid fails; trip off/on internal safeties
- Not taking full advantage of significant on-site generation capacity for critical loads
- Traditional load shedding schemes operate too slowly to save on-site generation

Solution:

- Very high speed load shedding is required to maintain gas turbine generation stability under fault conditions
- Microgrid Controls System (MCS) with intelligent fast load shedding

Major Benefits:

- Enhanced mission security at Shipyard
- Reduce substantial cost associated with lost production during power outages
- Reduces preemptive self-generation dispatching and associated emissions

The Project was supported by grant from DoD Environmental Security Technology Certification Program.

ESTCP

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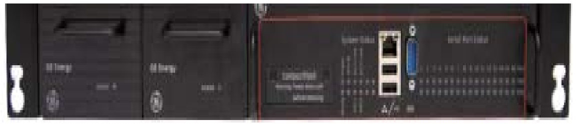
Technology/Methodology Description

- MCS / FLS
  - > GE C90 Plus
  - > F35 Feeder Protection Relays
  - > D400 Remote Terminal Unit
  - > GPS Controlled Clock
  - > MODBUS via Ethernet and Fiber

GE – C90 Plus

GE – F35

GE – D400



- BESS
  - > Battery, 580 kWh Li-Ion
  - > Inverter, 500 kW Bi-Directional
  - > Site Controller
  - > MPLS Network, ISO Router & RTU

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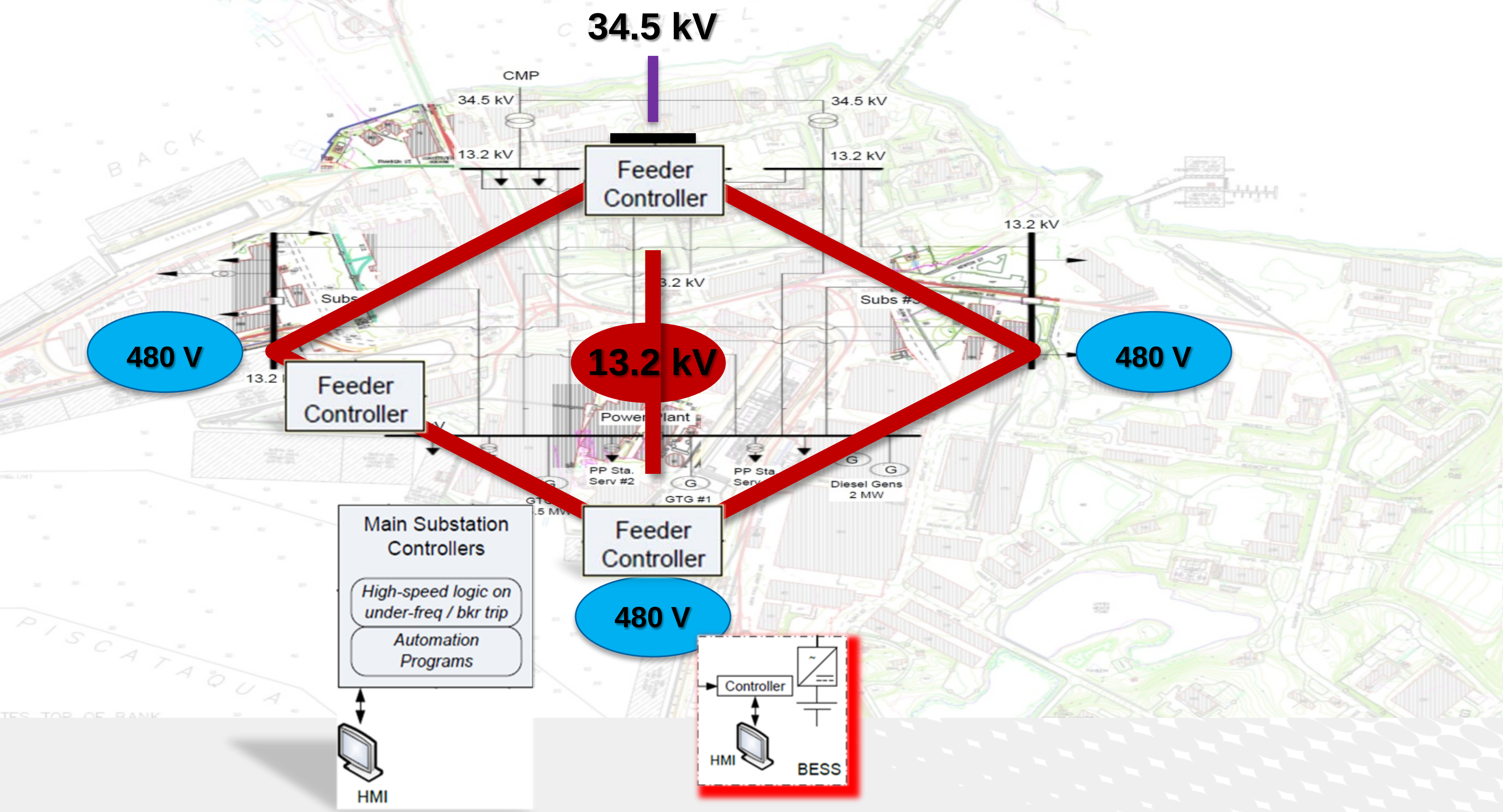
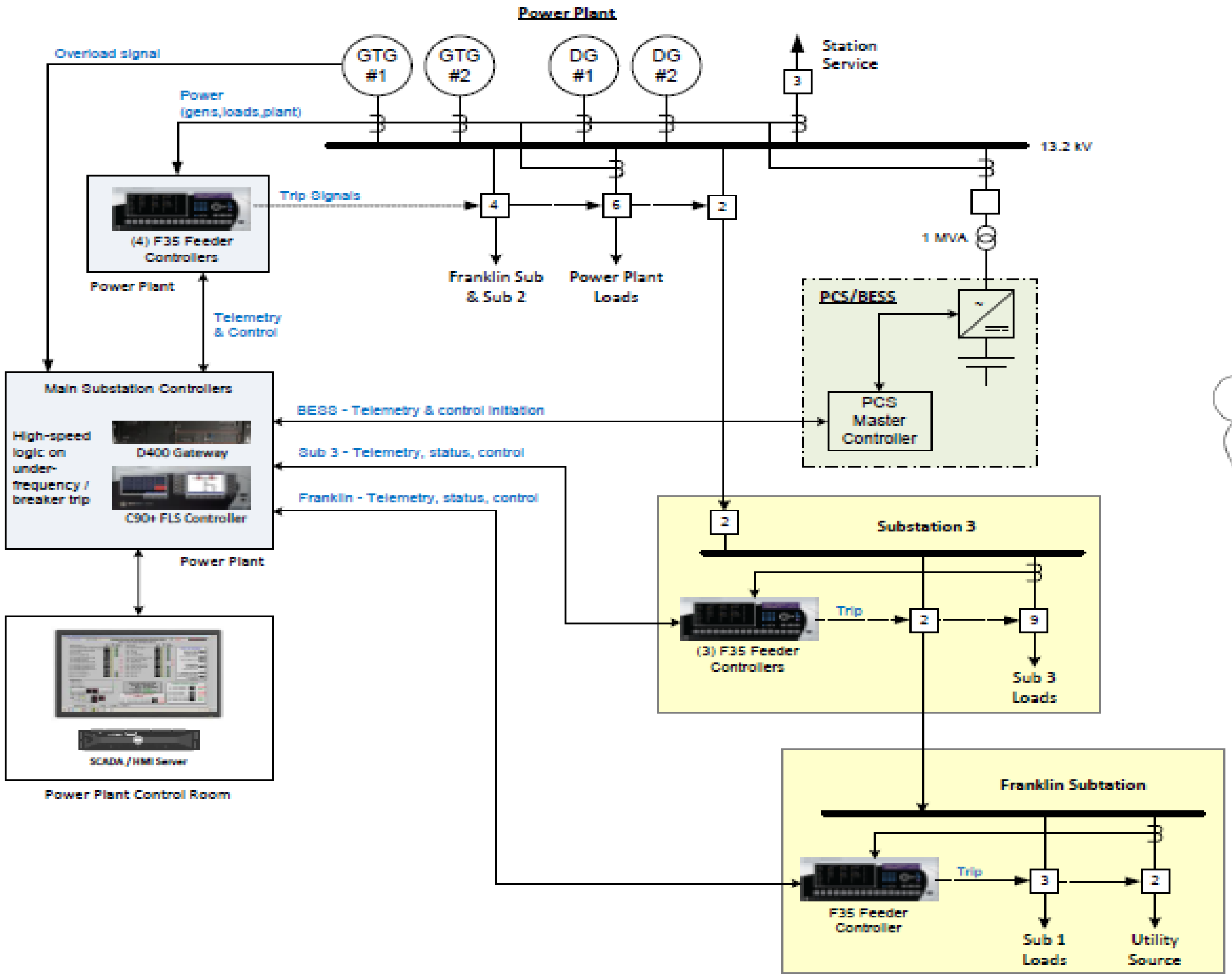
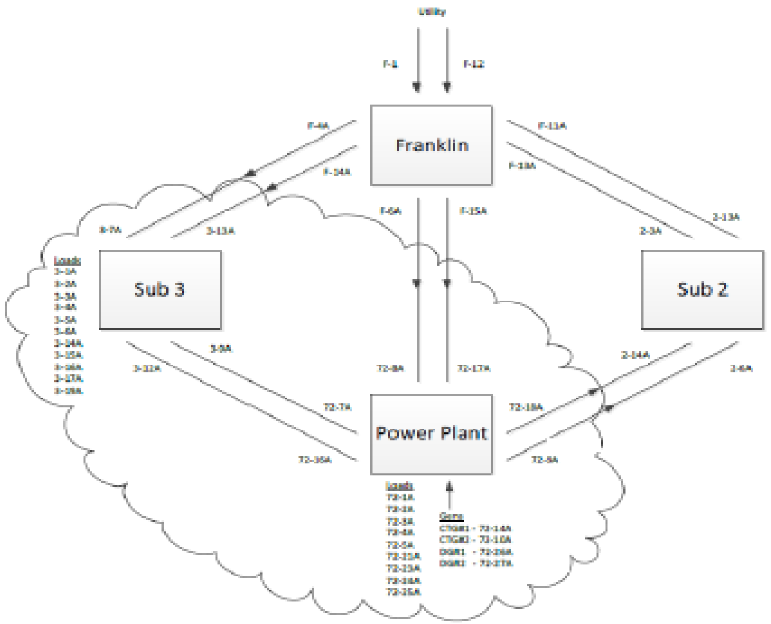


Portsmouth Naval Shipyard

Fast Load Shed System

Data and Control Scheme





Fast Load Shed Approach -- Example

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Priority No.	Load Served	kW
0	Never Shed (e.g. Power Plant Aux., Air Comp.)	3,000
1	Dry Dock #1	2,000
2	Dry Dock #2	1,200
3	Bldg.. 174	300
4	Weld Shop	500
5	Engineering Support Bldg..	700
. . . . .	. . . . .	. . . . .
24	Dry Dock #3 (Empty)	300
25	Substation 5	200
26	Bldg. 238	500
27	Substation 7	400
Total		**13,000**

Fast Load Shed Response Time

#	Action	Response Time (mS)
1	Loss of Utility (LOU) detected by Relay F-35-1 at incoming utility breaker	Time “0”
2	F-35-1 sends LOU signal to C90	<1 ms
3	Calculations by C90 to determine which loads to shed; send System Island command to F-35 Relays controlling load breakers	<1 ms
4	System Island command received at farthest F-35 breakers through fiber optic switches	1.2 ms
5	Load Shed command issued by F-35 relays	2.0 ms
6	Breakers Open	32 ms
	Total Time from LOU detection to Load Shed	**36.4 ms**

Performance Verification Testing

Simulation Testing

- Disable Tripping on Critical Feeders – Open Trip output on Test Switches
- Establish Summer and Winter Micro-grid Configurations
- Simulate a Loss of Power Initiation
- Outcome: Issues with load shed calculations. Corrections made and successfully retested.

Live Test

- Pull the plug on the utility. Observe Operation. Restore Distribution System
- Outcome: Performance as expected – Success !!
- New Question: What happens under actual fault conditions ??

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Performance Data – LIVE Events

Event 1 – June 21, 2016

> Major failure of Air Gap Switch just outside Shipyard on Utility pole; direct fault to ground on one phase
> Utility Breaker Opened initiating FLS per design
> CTG #2 Tripped on a ground fault protection . . .1 ms before Utility Breaker opened
> Shipyard went black

Event 2 – July 18, 2016

> Loss of Utility, line to ground fault on utility side
> Back-up Diesel Generators were operating on scheduled monthly run at time of LOU
> FLS operated and CTG maintained generation – Successful Event

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Performance Data – LIVE Events

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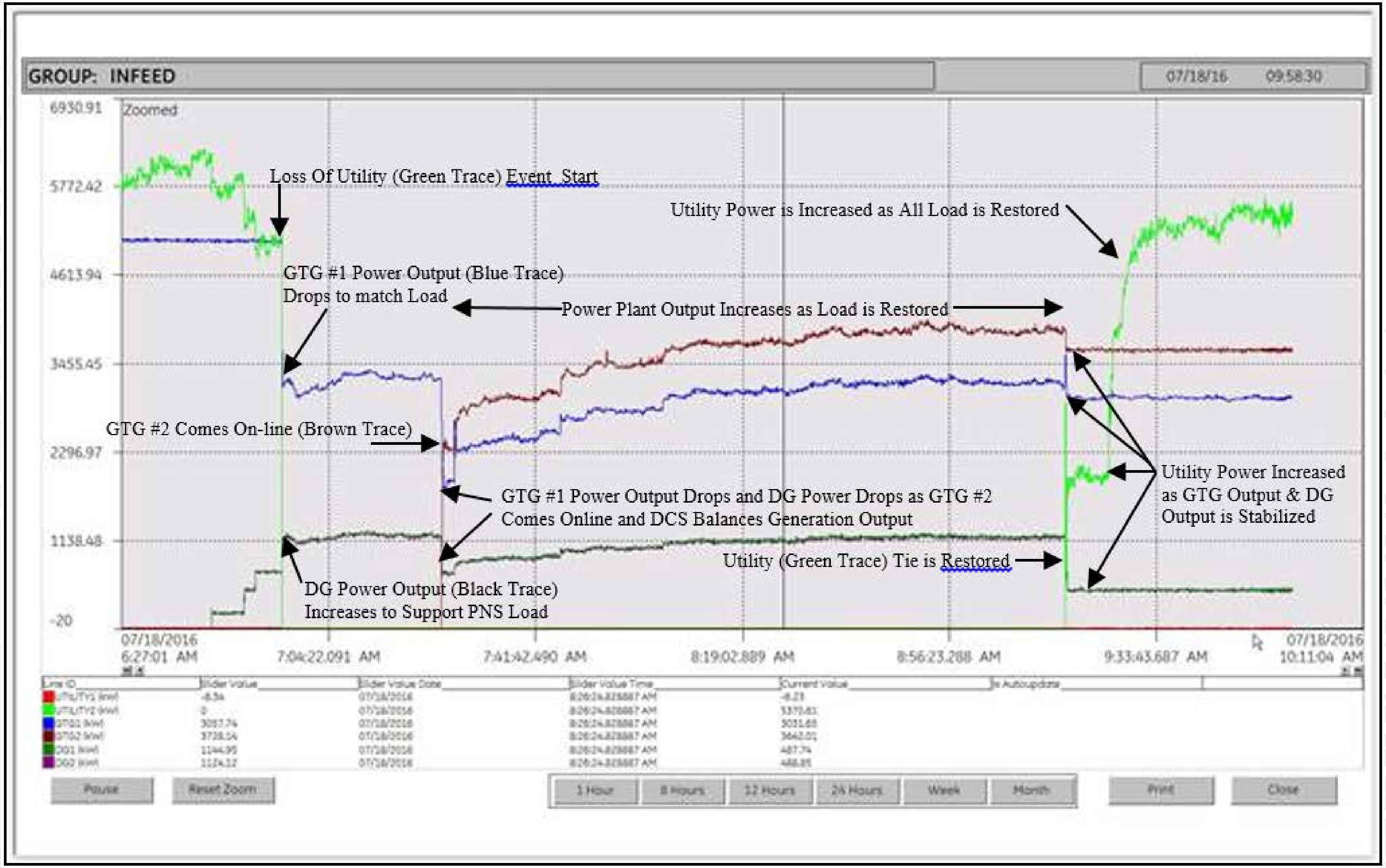

HMI Trend Display – July 18, 2016 LoU Event

Important Issues to Address

Identify Better Means for Initiating FLS

- Fast enough to protect generating assets
- Not so fast to produce nuisance trips

Ideas

- Trigger based on Central Maine Power (CMP) Utility Recloser
- Reverse power relay
- Review / coordination of settings between utility breaker and CTG controls

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Current and Future Phases

- Address tripping scheme
- Expand number of breakers under shed control
- Add more on-site generation to serve more loads
- Add substantial BESS to bridge to back-up diesel generators
- Potential use of expanded BESS capacity for participation in ISO-NE ancillary services market

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Thank You – Questions?

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