Real World Design Challenges

SAME Joint Engineer Training Symposium

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ch2m SM

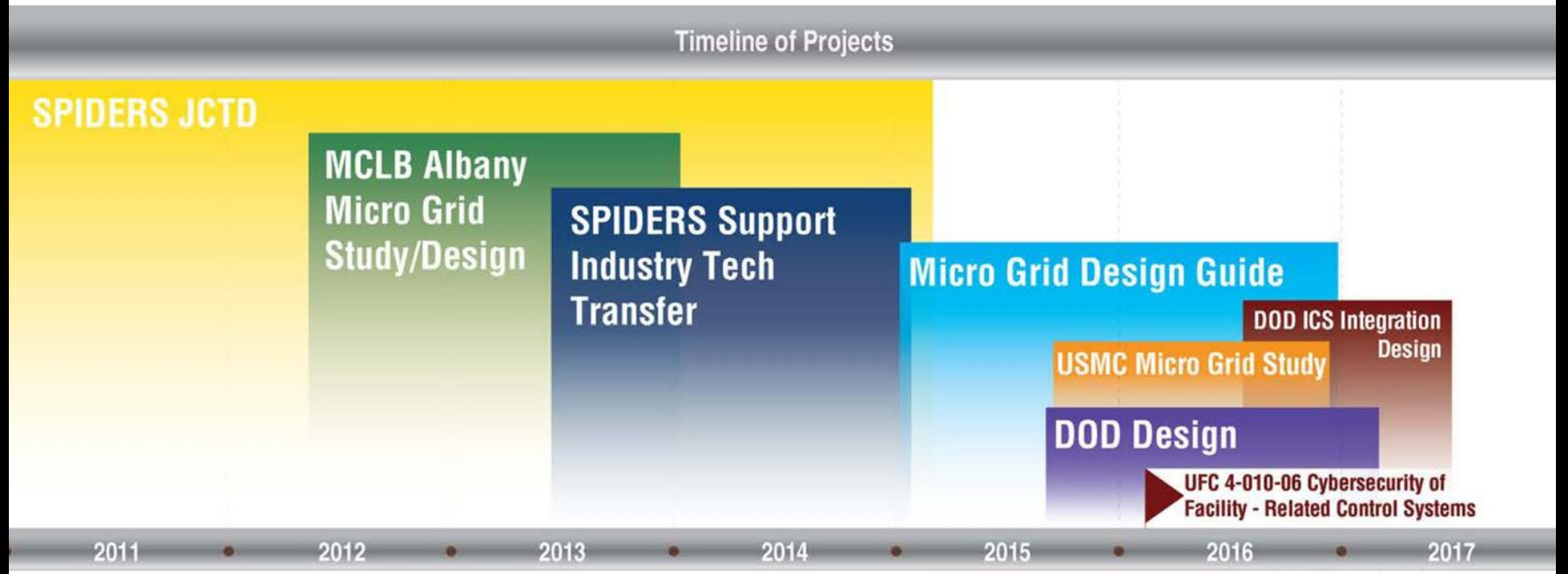
Resilience

DoDI 4170.11 Change 1, Effective March 16, 2016

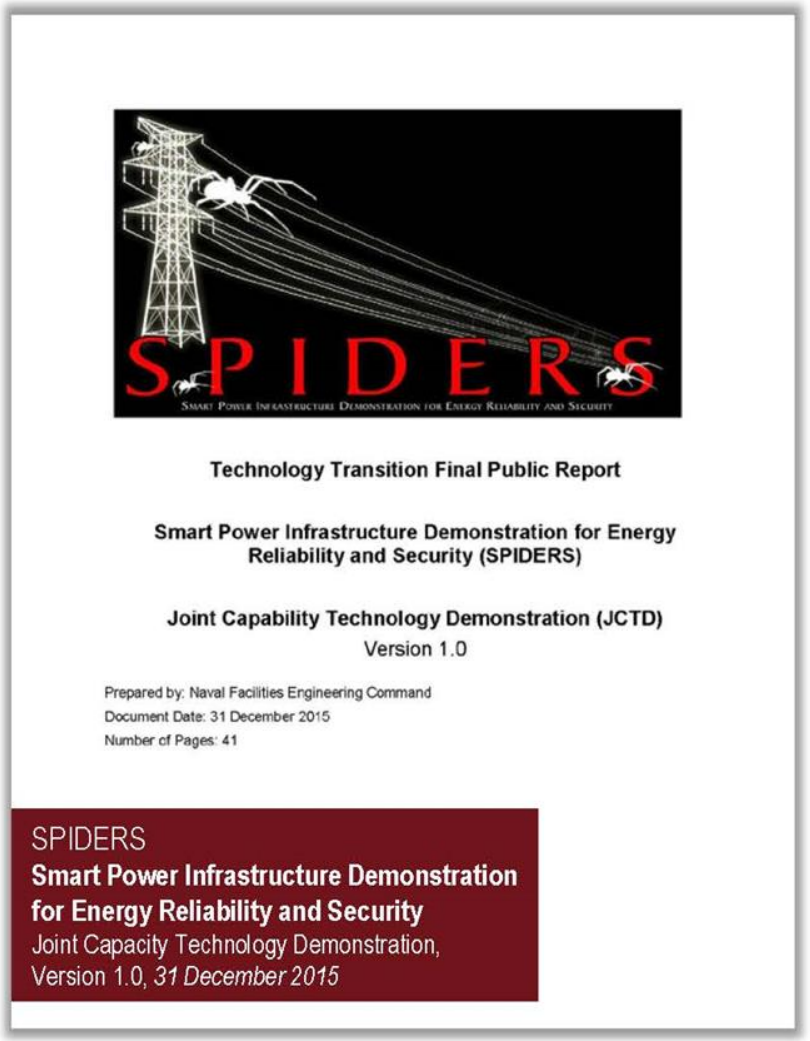
energy resilience*. The ability to prepare for and recover from energy disruptions that impact mission assurance on military installations.*

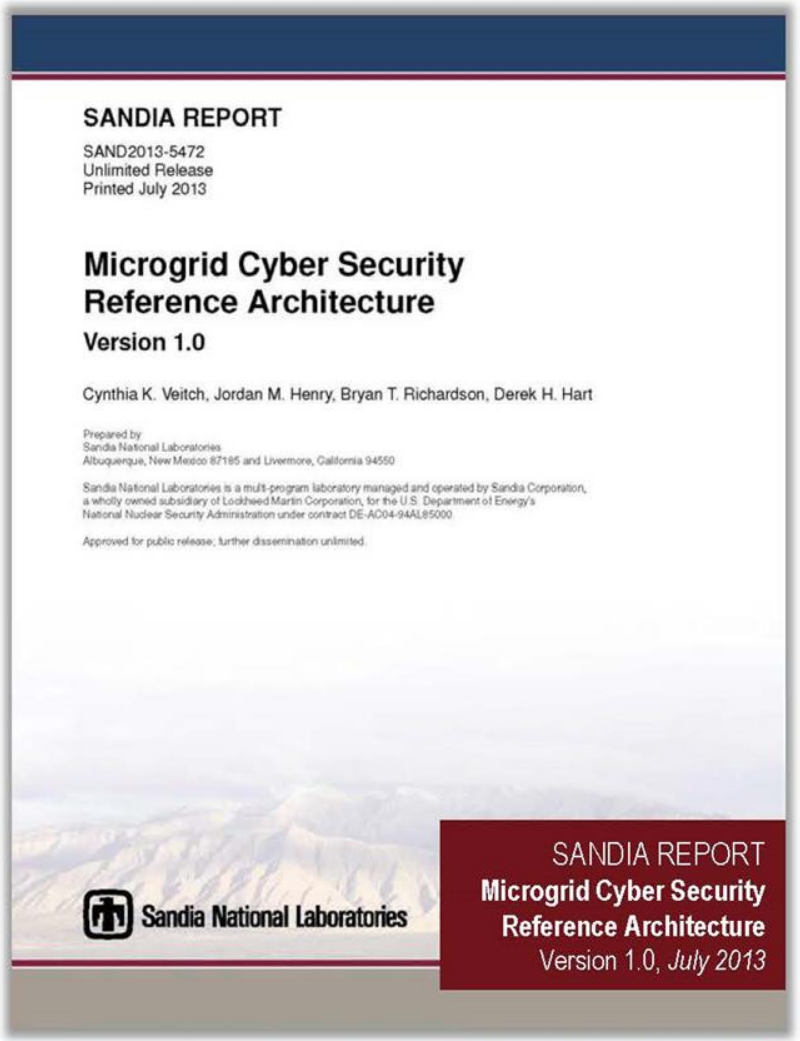
critical energy requirements. Critical mission operations on military installations or facilities that require a continuous supply of energy in the event of an energy disruption or emergency.

Timeline of Resilience Projects



Other Good Resources





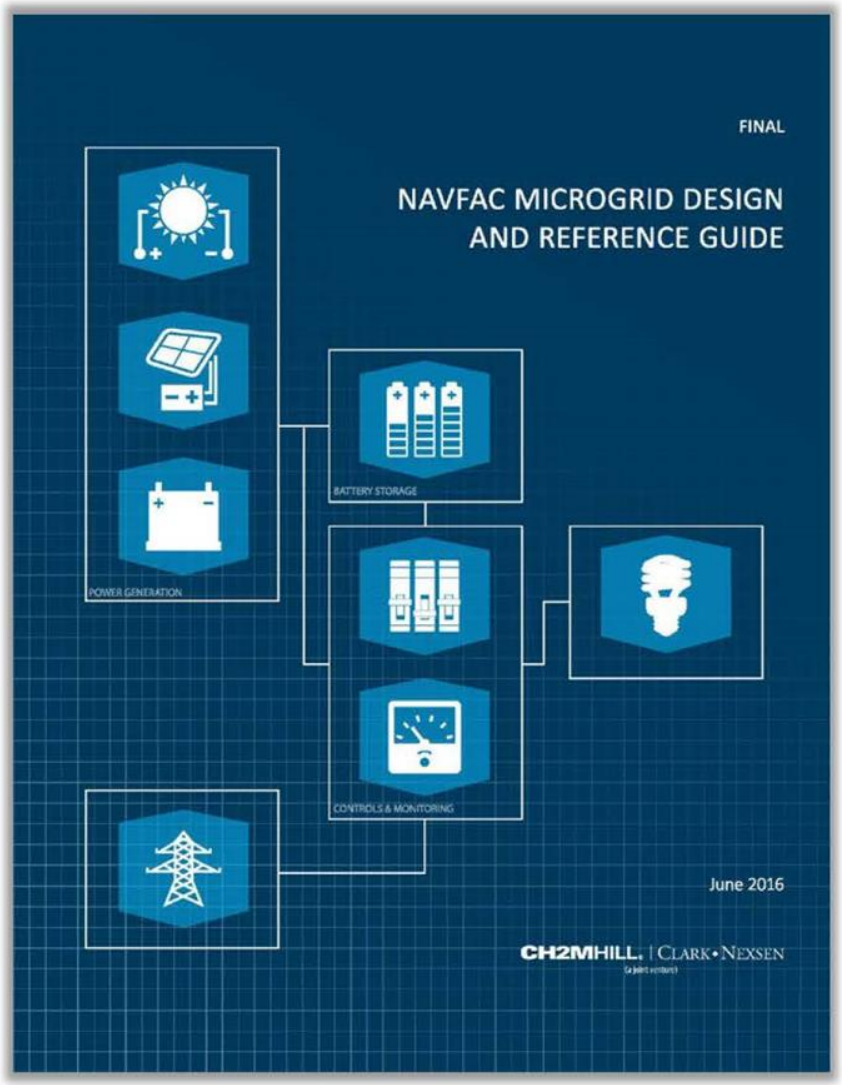
Other Good Resources



https://energy.gov/eere/femp/spiders-jctd-smart-cyber-secure-microgrids

Criteria Development/Design Guide

NAVFAC Microgrid Design and Reference Guide June 2016



NAVFAC Microgrid Design and Reference Guide June 2016 Table of Contents

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USMC Micro Grid Study

Large scale installation wide Micro Grid Study

“The focus is to determine how a microgrid (or microgrids) can be implemented to support energy surety and energy security.”

Key Focus Areas

- Facility/mission needs
- Facility loads, profiles, and priorities
- Distributed generation sources (existing and recommended)
- A control strategy (hardware and philosophy)
- Infrastructure limitations and recommended corrective action
- Legislation and Executive Orders

General Approach

- Field Investigation/data collection
- Multiple Charrettes
  - Energy Strategy/Feasibility Strategy
- Technical Report
  - Multiple DD 1391's developed
  - Other energy recommendations

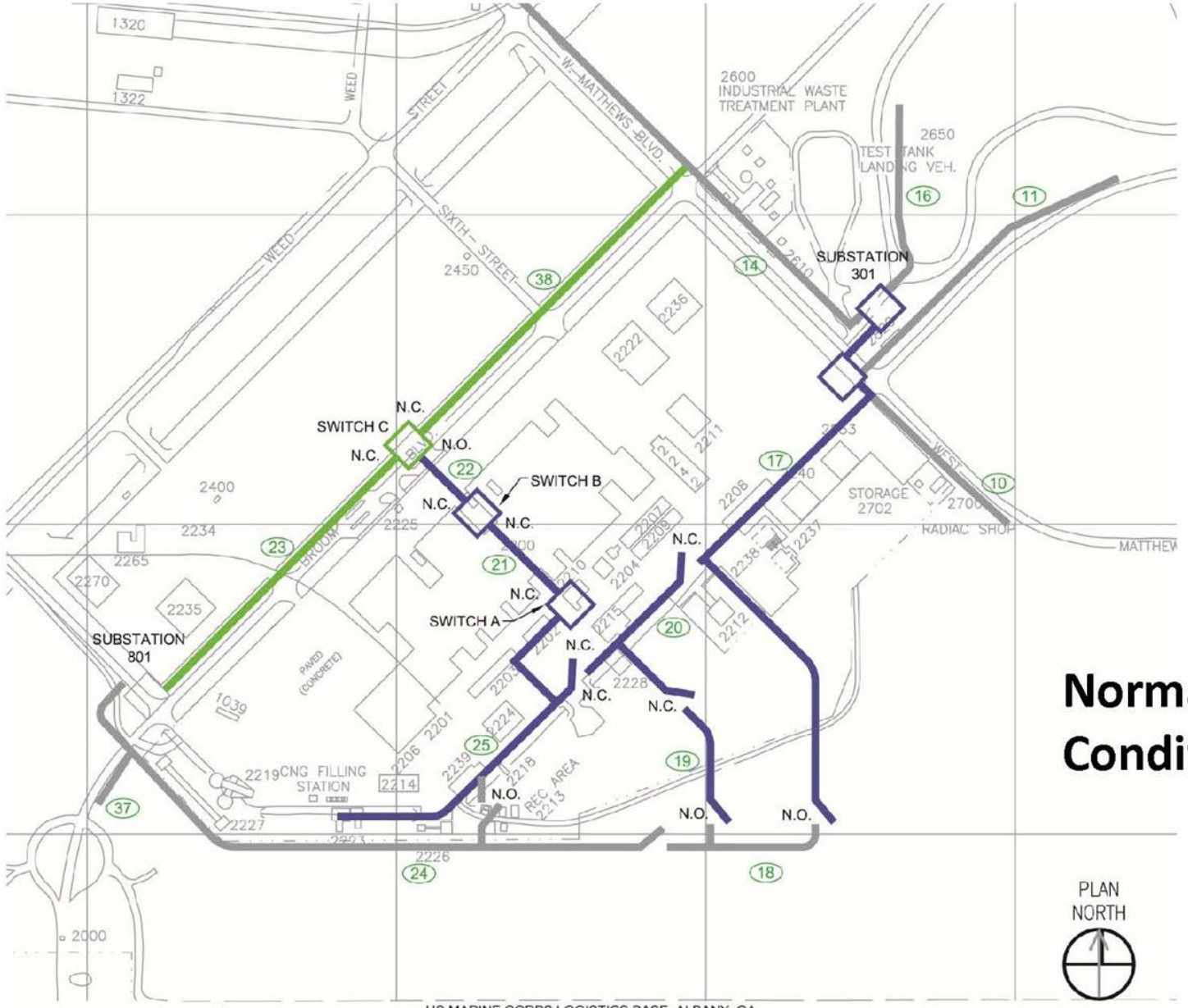
Key Lessons Learned

- Agree on the critical the loads!!!
- Base Planners are critical
  - Land availability/constraints
    - Renewables Operations Future Use
- Understand O&M impacts and costs
- Understand local codes/laws/policies/permitting
- Work closely with local utilities-critical stakeholders

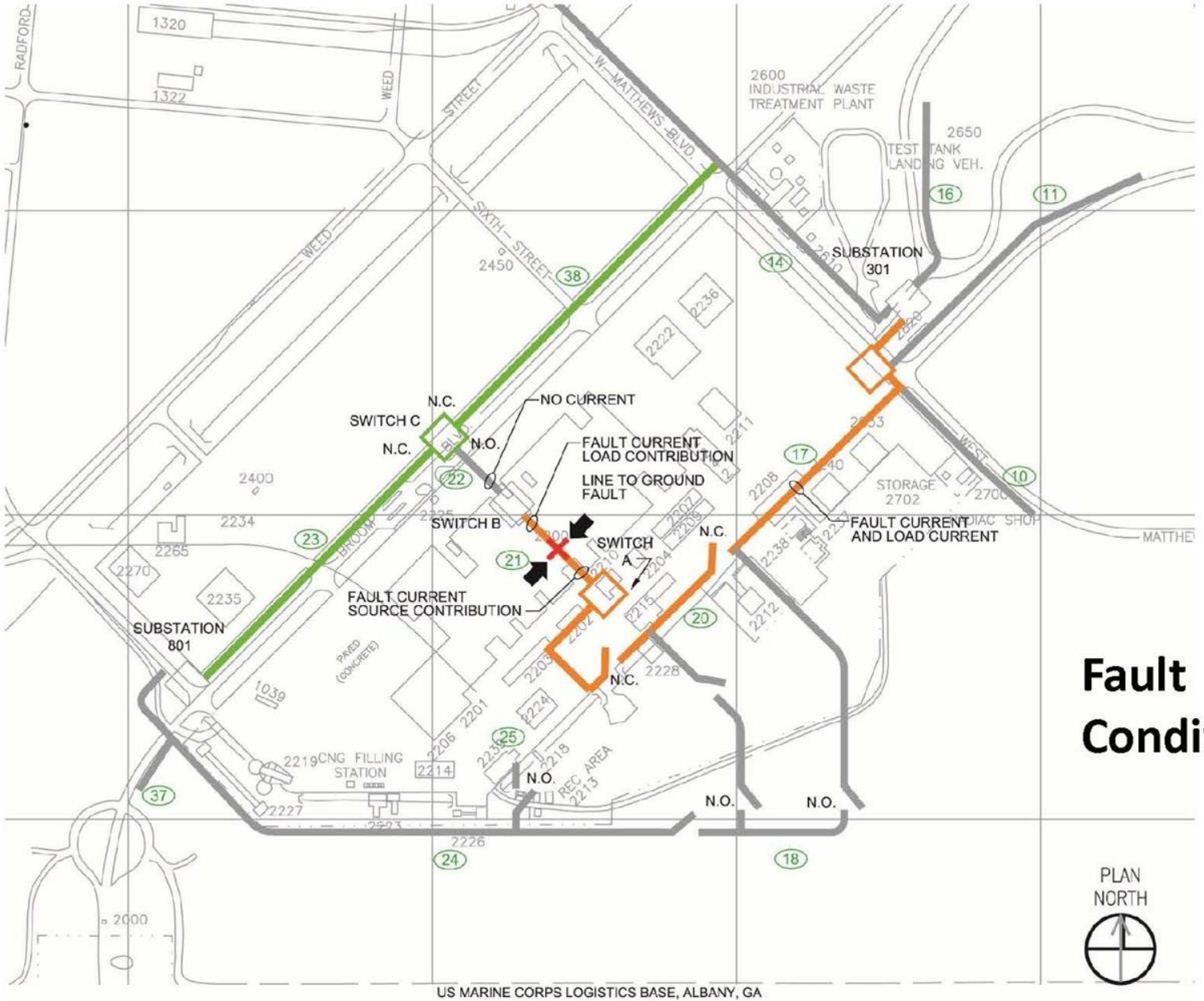
USMC Smart Grid
Master Plan/Design

Smart Grid Master Plan/Design

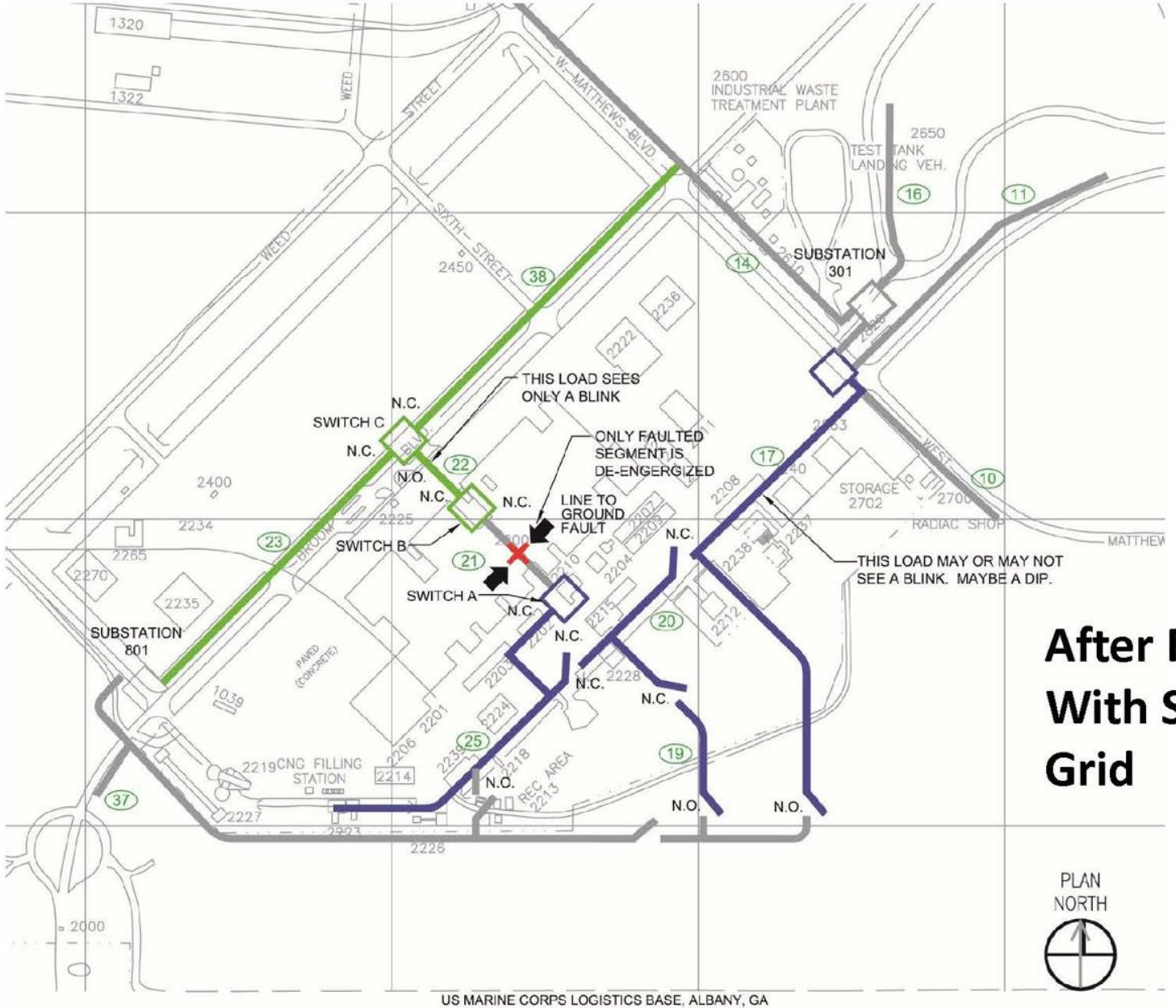
- Convert existing 12.47 kV power distribution system to smart grid/integrated SCADA
  - Main sub station
  - Land fill gas generators
  - Start/stop diesel generators
  - Fast load shedding capability
  - Future expansion to include 10 MW Bio Mass system and other future expansions



Normal Condition



Fault Condition



After Fault With Smart Grid

USMC Smart Grid Master Plan/Design Key Lessons Learned

- Balance between details/loads in design and security concerns about public access
- Constant change:
  - Technology
  - PENDING UFC changes; DIACAP to RMF
  - 1391 Definitions on minor construction vs repair

DOD Design Mission Critical Facility

Reliability

How much is enough?

- 5-9's: 99.999%
- 4-9's: 99.99%
- 3-9's: 99.9%

How much can you afford?

5 mins/yr downtime

52 mins/yr downtime

523 mins/yr downtime

RAM Analysis-
(reliability, availability, and maintainability)

- Reliability is defined as the probability of an item to perform required function under stated conditions for a specified period of time. Reliability is more accurately expressed as a probability of success over a given duration of time, and cycles (DoD, 2005)

RAM Analysis – Availability

- Availability – based on TM 5-698-1 (DoD, 2007), availability is defined as the percentage of time that a system is available to perform its required function(s). It is measured in a variety of ways, but it is principally a function of downtime. Availability can be used to describe a component or system, but it is most useful when describing the nature of a system of components working together.

Just a sample of the many components

λ = failure rate per year
MTTR = mean time to repair

Component	Function	Failure Rate λ (Failures/Year)	MTTR (Hour)	Reference
Utility (U)	Power source	0.166667	11	in Section 2.3.
MV Cable (per thousand feet) (MVC)	Routes electrical power from utility	0.000236	15.7	TM 5-698-5
MV Joint (each) (T3)	Electrical cable connects to equipment	0.002592	31	TM 5-698-5
Transformer, oil filled, 5MVA (XFMR)	Voltage stepdown	0.00524	1	TM 5-698-5
Termination, QTY 4 (T4)	Electrical cable connects to equipment	0.000508	4	TM 5-698-5
Termination, QTY 16 (T16)	Electrical cable connects to equipment	0.002032	4	TM 5-698-5
Termination, QTY 20 (T20)	Electrical cable connects to equipment	0.00254	4	TM 5-698-5
Termination, QTY 24 (T24)	Electrical cable connects to equipment	0.003048	4	TM 5-698-5
Termination, QTY 52 (T52)	Electrical cable connects to equipment	0.006604	4	TM 5-698-5
Termination, QTY 80 (T80)	Electrical cable connects to equipment	0.01016	4	TM 5-698-5
Breaker, drawout, >600A (B)	Provides protection from overcurrent	0.00308	1.4	TM 5-698-5
Breaker, fixed, <600A (CB)	Provides protection from overcurrent	0.00002	18.667	TM 5-698-5
Switchgear, <600V (SWGR)	Distributes power and houses breakers	0.00949	7.29	TM 5-698-5
Panelboard (PNL)	Distributes power through circuit breakers	0.00949	7.29	TM 5-698-5
Cable, <600V (per 1,000 feet) (C)	Routes electrical power to equipment	0.000007	8	TM 5-698-5
Generator, Diesel, 1.23MW, pkg (G)	Emergency long-term power source	0.58269	25.74	TM 5-698-5
Programmable Logic Controller Switchgear Controls (PLC)	Control system	0.01962	1.27	TM 5-698-5
Manual Controls	Manually starting a system	0.00015	2.11	TM 5-698-5
UPS	Emergency short-term power source	0.00092	8	TM 5-698-5
Static Transfer Switch (STS)	Switches load between two sources	0.00368	24	TM 5-698-5
Battery String (BAT)	Emergency short-term power source	0.00746	32.13	TM 5-698-5
Dry-Type Transformer (TR)	Voltage stepdown	0.00284	21.26	TM 5-698-5

RAM Analysis – Takeaways

- Lot's of O&M data required
- 1-2 components can drive the analysis and results
- "Existing" systems a challenge to make large improvements on reliability cost effectively
- Interaction between systems impacts
  - HVAC can impact Electrical – especially on renovations
- 5-9's are really expensive…focus and manage risk

Switchgear and Generator Sizing

- Electrical design requirements vs future expansion capability
  - Use standard commercially available equipment and components

Micro Grid - Key Takeaways

- Understand all the technical requirements
- Agree to the critical loads early!!!
- Stakeholder input and collaboration critical
  - What are priorities/impacts?
- Potential significant O&M impacts and costs
- Cyber…Cyber...Cyber…

Thank You

ch2m SM