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Long Island Bus Sodium Sulfur (NaS) Battery Storage Project

Yan Kishinevsky
New York Power Authority
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ACKNOWLEDGMENTS

- This project is part of the Joint Initiative between the New York State Energy Research and Development Authority (NYSERDA) and the Energy Storage Systems Program of the U.S. Department of Energy (DOE/ESS) through Sandia National Laboratories (SNL).

LI Bus Description, Issues, and Problems

- Natural gas refueling station for 220 buses
- 3 x 600 HP compressor load
- Dedicated LIPA feeder
- High on peak demand charges for four months
- Current 3–shift operation
- High electric bills and administrative charges

LI Bus Gas Compressor Site

LI Bus Goals and Objectives

- Achieve cost savings by
  - reducing peak demand charges
  - eliminating third shift
- Increase back up power for the entire facility
- Reduce peak demand on the heavily loaded utility grid

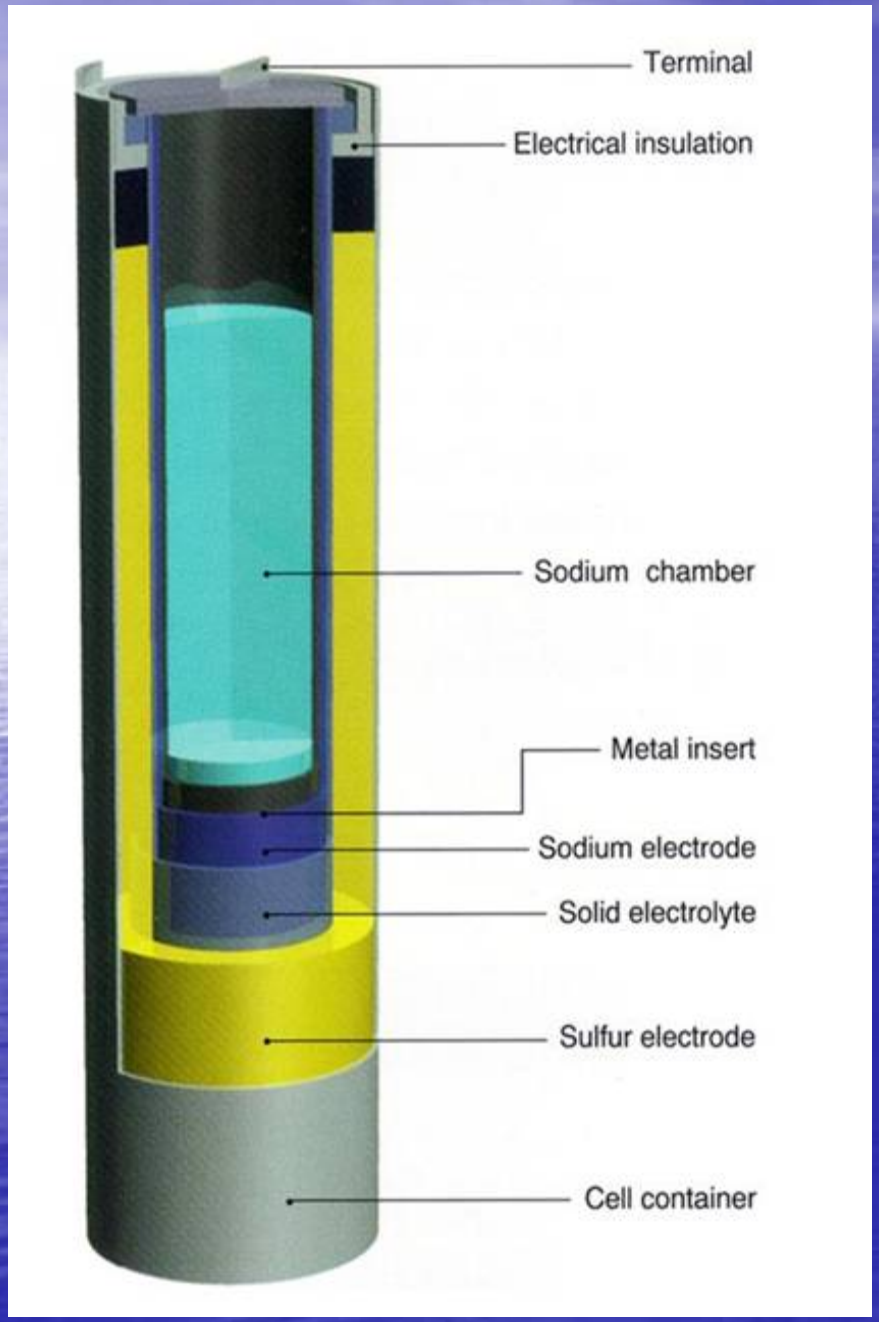
Battery Storage Solution

- 1.0 MW, 7.2 MW-hr NGK NaS battery
- Grid parallel configuration
- Automated load shift
- High system efficiency
- Low maintenance
- Low noise
- Zero emissions

Why NaS ?

Advantages over DG and other Batteries:

- Less Operation & Maintenance (O&M)
  - No moving parts, long service life
- Minimal Environmental Impact
  - No emissions, silent
- Versatility
  - Peak-shaving, load-leveling, and PQ mitigation
- Smaller Foot print
  - High Efficiency, Energy and Power Density



Single NaS Cell

- 300^{0}C internal operating temperature
- liquid sodium center electrode (neg)
- alumina solid electrolyte tube
- sulfur electrode (pos)

In a charged state, liquid elemental sodium fills the central reservoir. As the cell is discharged, the liquid sodium is channeled up and down through the narrow annuli between the outer surface of the sodium chamber, the metal safety tube and the beta alumina solid electrolyte. There, it disassociates to an electron which creates the current flow and a sodium ion that conducts through the beta alumina and reacts with the sulfur to form sodium polysulfide. The reverse occurs upon recharging.

Battery Module

- comprised of 320 individual battery cells
- picture shows cover removed
- Variable series and parallel arrays to yield module DC voltages of 64 or 128
- Sand packing used between the cells for structure and heat sink
- Thermal management using electric heaters and vacuum insulation to maintain a minimum operating temperature of 290^0C
- Standby loads about 3.4 kW during standby; however, internal heating during charging and discharging is adequate to maintain the operating temperature when the battery is used regularly.

NAS Battery Characteristics

Characteristics	Individual NaS Cell	NaS G50 Battery Modules
Nominal Voltage (dc)	2	64 or 128
Operating Temperature	290 to 360^{0}C	
Cell Arrangement ("s" series; "p" parallel)	Single	(8s x 5p) x 8s or (8s x 10p) x 4s
Electrical Protection	NA	Internal fuse within each 8s string
Rated AC Capacity	628 Ah	360 kWh ac
Rated AC Power	NA	50 kW ac
Projected Calendar & Cycle Life	15 years: 4500 to 90%, 2500 to 100% DOD cycles	
Avg DC Efficiency, %	90	85
Standby Heat Loss, kW	NA	3.4
Dimensions, mm (in)	515L x 91Φ (20.3L x 3.6Φ)	2,270W x 1,740D x 720H (89.4W x 68.5D x 28.4H)
Weight, kg (lb)	5.5 (12.1)	3500 (7920)

AEP and NYPA Project Comparisons

Attribute	AEP	NYPA
Purpose	Technology demonstration and testing using simulated load and PQ profiles	Avoid high peak demand charge for natural gas bus refueling station compressor load
Specs	100 kW, 700 kW-hrs 500 kW, 30 second PQ	1,000 kW Up to 7,200 kW-hrs
Operation	UPS and peak shave	Daily peak shave and Grid Backup
Configuration	Grid parallel, static switch disconnect	Grid parallel
Pulse Factor	5 X (500 kW for 30 seconds)	None
Commercial basis	R&D, Commercial prototype	Commercial Operation Extended warrantee Service contract

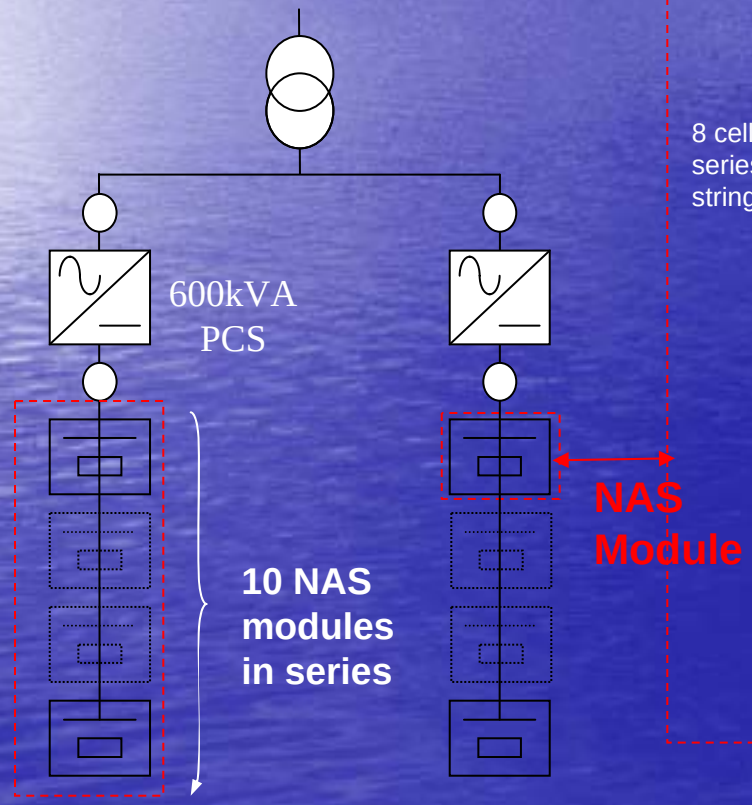
Project Team, Goals, and Objectives

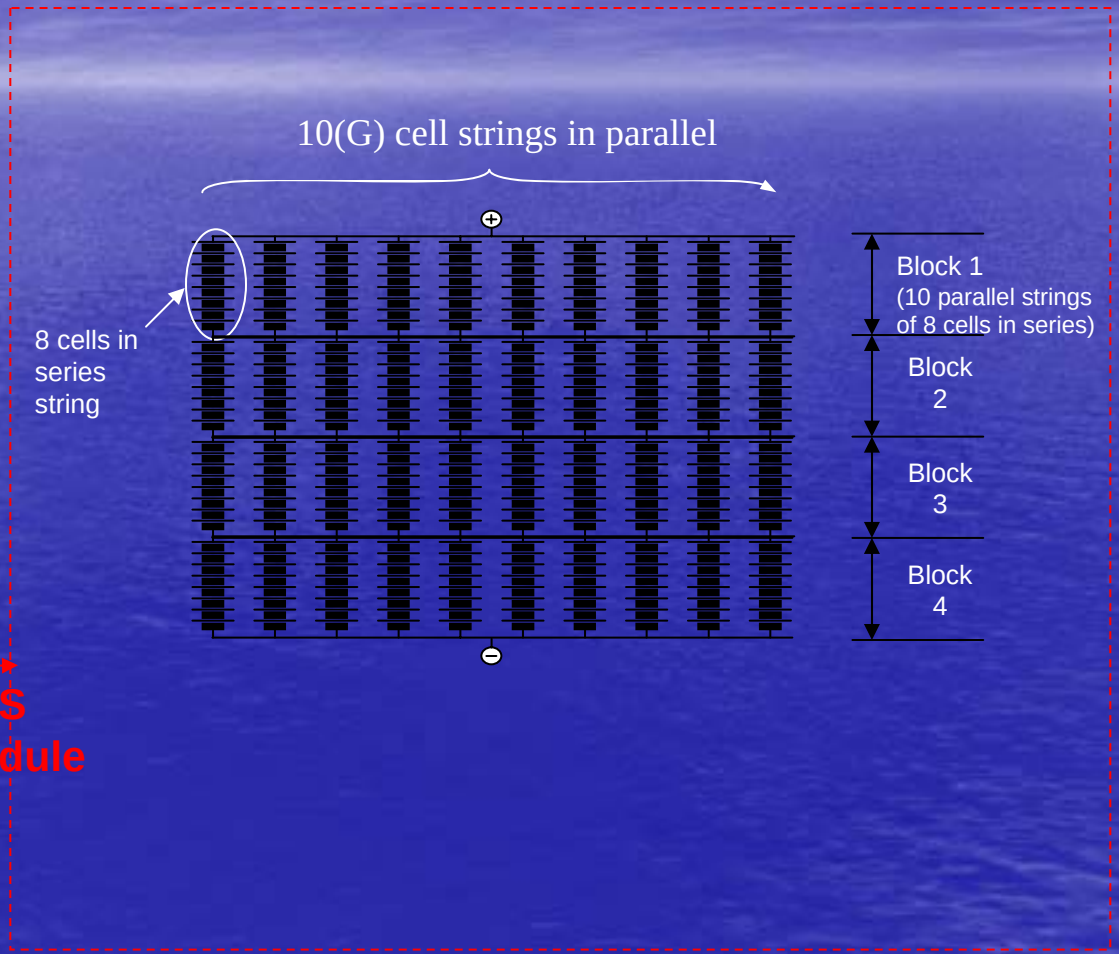
- New York Power Authority
- MTA/Long Island Bus – Host site, end user
- NGK Insulators, Inc. – NaS battery manufacturer
- ABB – Power System Conditioning, Controls & Integration
- DOE/NYSERDA – Performance monitoring
- EPRI

Demonstrate long term, commercial environment, high efficiency energy storage operation

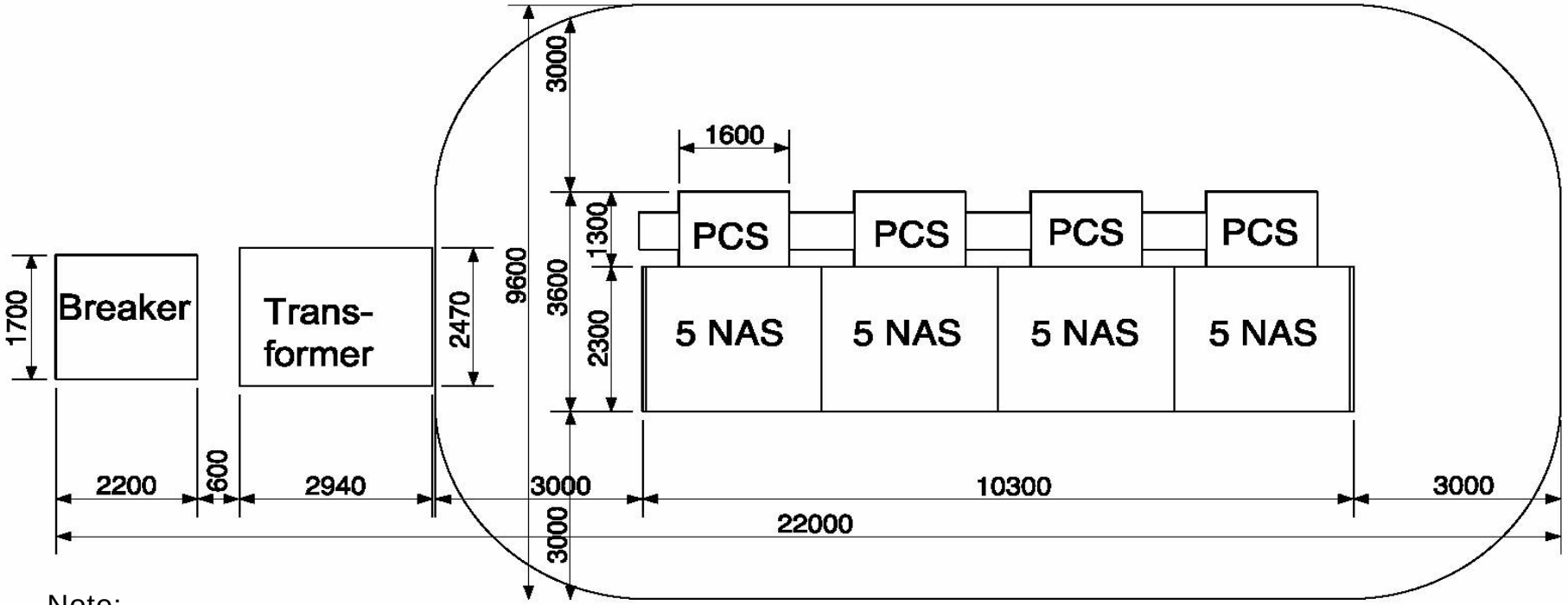
1MW NAS Module Configuration

Each NAS module is rated at 50 kW and consists of 320 strings configured as shown

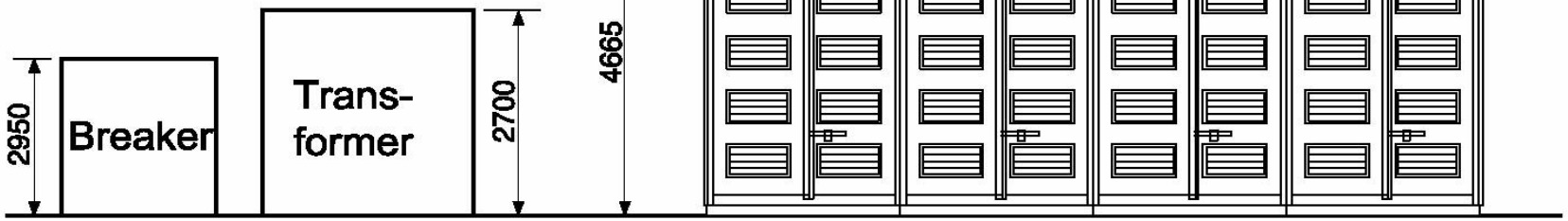




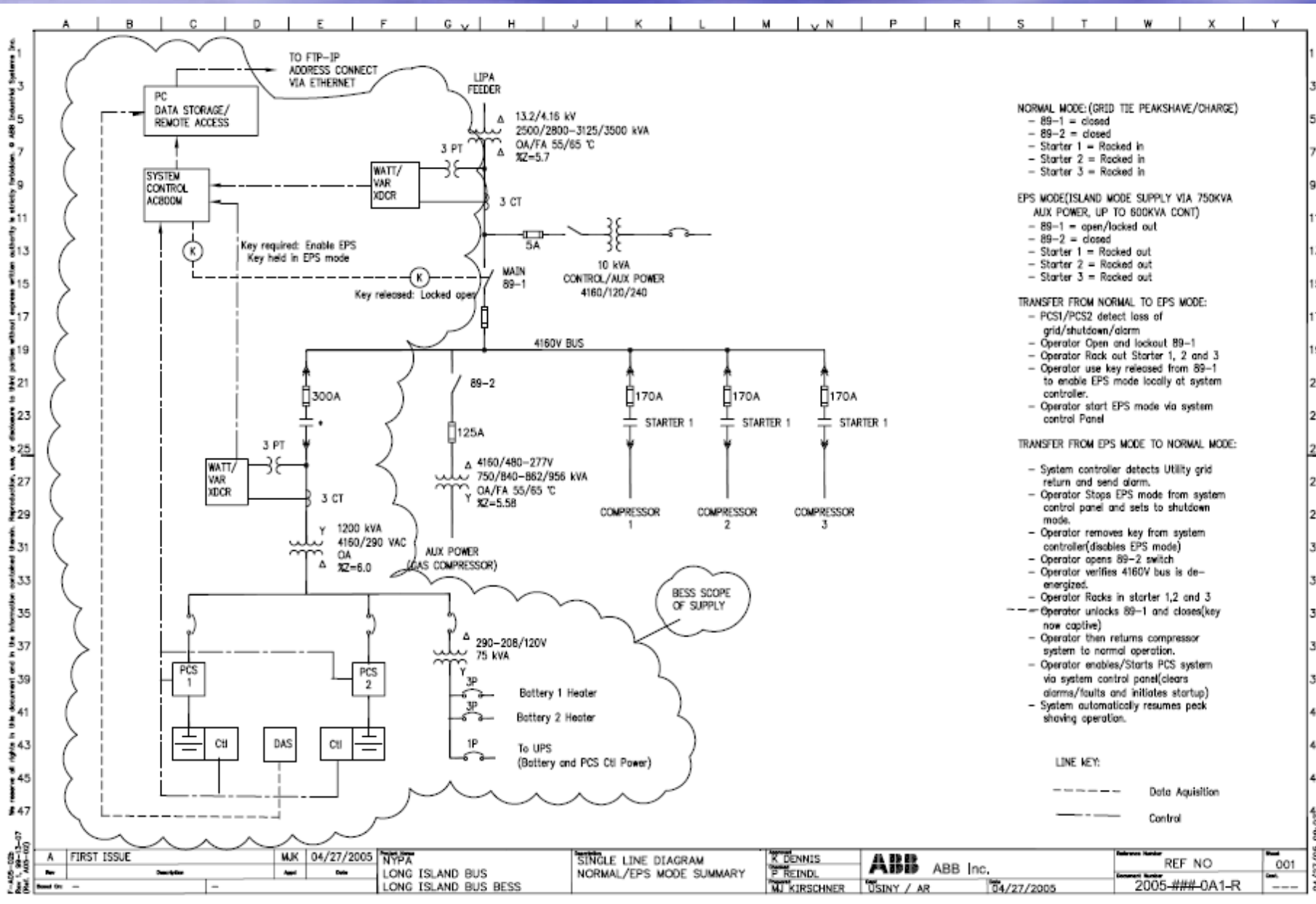
Preliminary System Layout



Note:
Power conversion system (PCS) breaker and transformer sized for PS module application, larger for PQ module applications.
Dimensions: (mm)



One Line Diagram

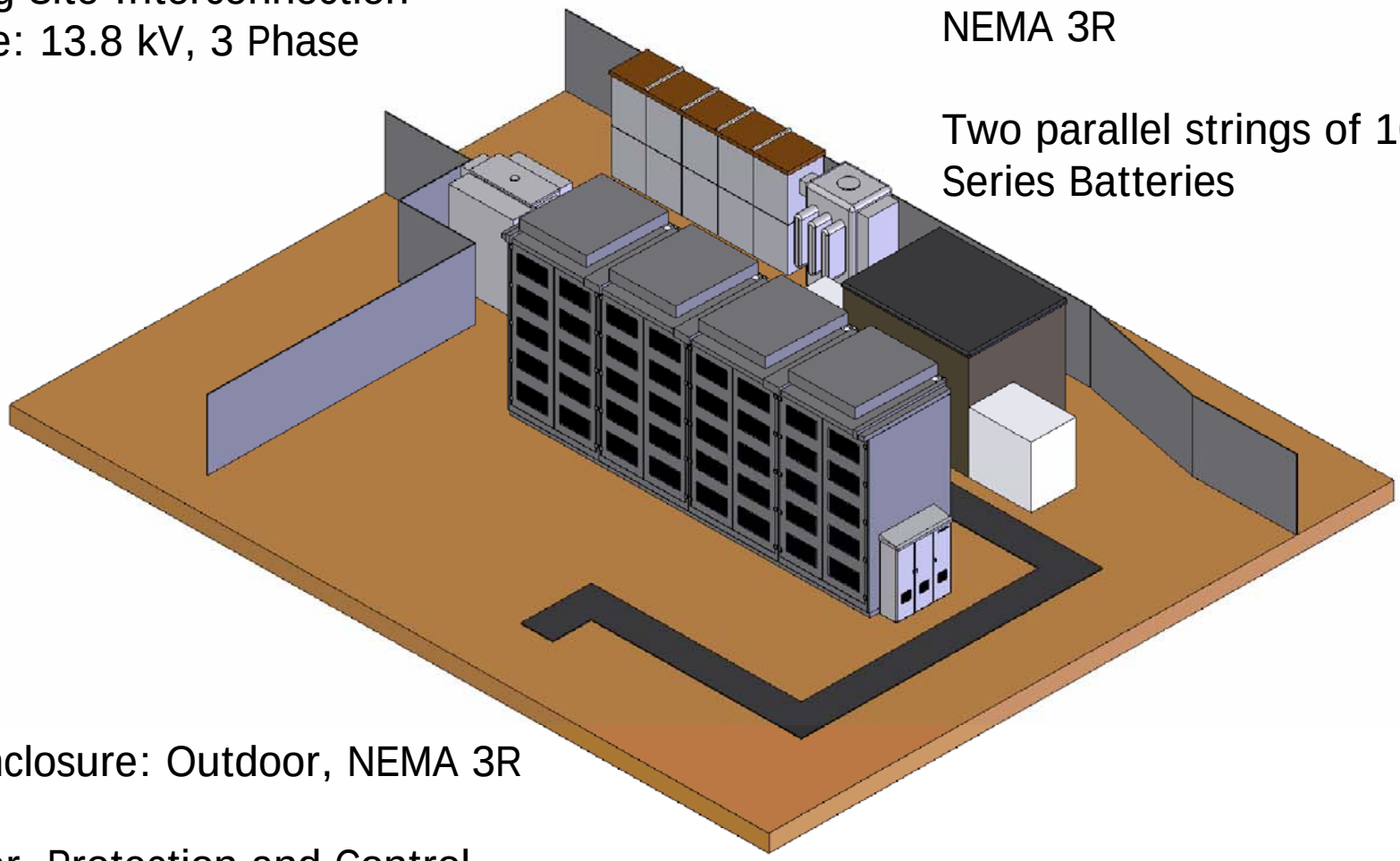


LI Bus NaS Project Layout

Existing Site Interconnection
Voltage: 13.8 kV, 3 Phase

Battery Enclosure: Outdoor, NEMA 3R

Two parallel strings of 10 Series Batteries



PCS Enclosure: Outdoor, NEMA 3R

Inverter, Protection and Control Interface

Large Shopping Center, March 2003
Purpose: Load Leveling
Specifications: 1,000kW×7hours, AC Voltage 6kV

Scope of Work

- Power Control System (PCS)
- Integration of PCS with the battery system
- Supply of Balance of Plant (BOP) equipment and enclosures
- Overall system integration with the grid and the load
- Installation, startup, training and commissioning of the system
- System documentation and O&M manuals
- O&M and performance warranty during 18 months demonstration period
- Option for the extension of O&M services

System Performance Monitoring

(Data Acquisition System will be provided by DOE)

- System operating state durations
- AC voltage and current
- DC voltage, current, state of charge, and internal temperatures
- Ambient temperatures
- Auxiliary loads
- System response times to changes in operating conditions
- Energy and power into and out of the system for each AC phase in the system

System Performance Monitoring (continued)

- System loads
- System duty cycle count
- System failures and problems
- System conversion efficiencies during full and part-load operation
- Losses during periods of standby
- System response to abnormal events
- Data uploaded daily to central server
- All data time stamped to 1 second, with 15 minute averaging

Project Financing and Schedule

Co-funding:

- DOE/NYSERDA
- EPRI
- CEATI
- LIPA
- APPA (pending)

- Schedule: Commissioning by mid-2006


QUESTIONS?