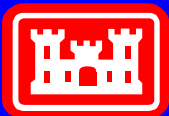


New Mexico Army National Guard PEM Demonstration Project

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University of Illinois
03 DEC 2007

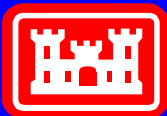


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Presentation Outline

- Intro to ERDC – CERL
- Past Fuel Cell Projects
- Fuel Cell and Hydrogen Basics
- NM Fuel Cell Demonstration
- Questions

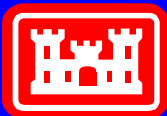
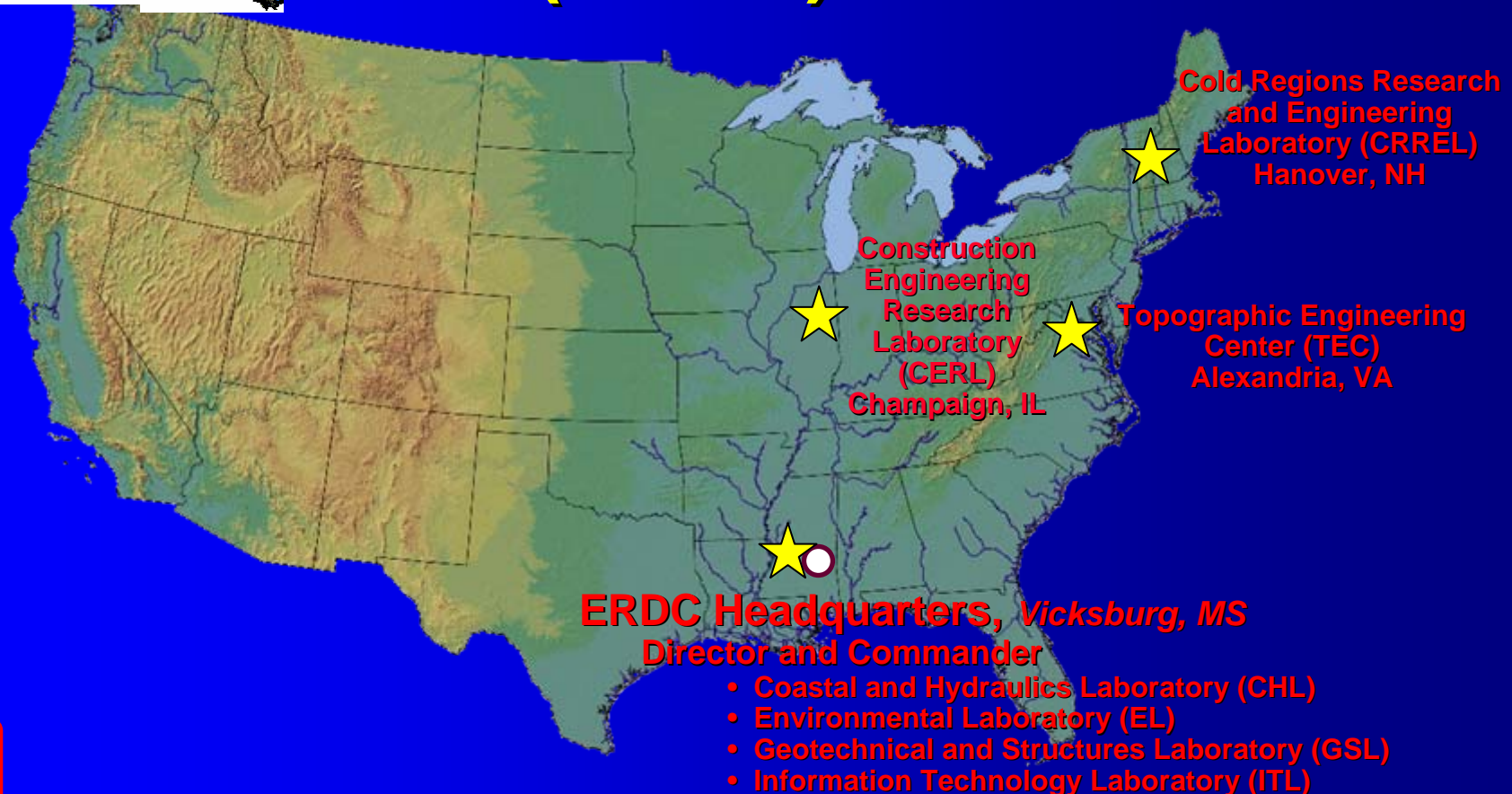




Engineer Research and Development Center (ERDC)



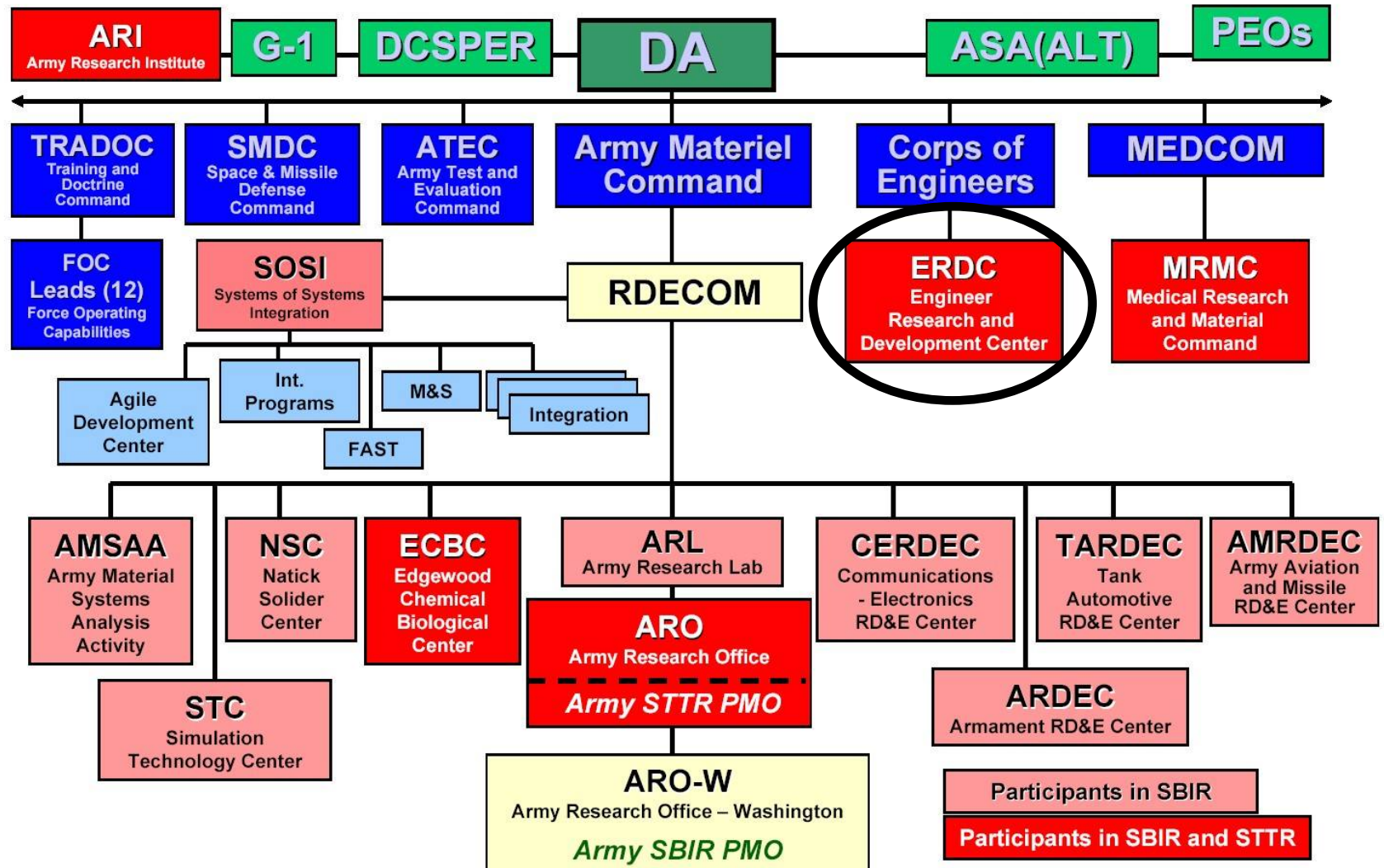
European
Research
Office



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ARMY R&D Organizations



DoD ERDC-CERL Fuel Cell Team



Dr. Tom Hartranft
Energy Branch Chief



Frank Holcomb
Electrical Engineer



Roch Ducey
Electrical Engineer



Nicholas Josefik
Mechanical Engineer



Scott Lux
Electrical Engineer



Dr. Chang Sohn
Mechanical Engineer



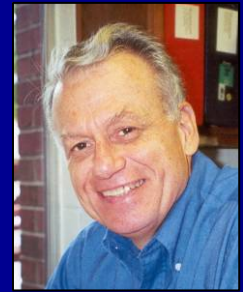
William Brown
Mechanical Engineer



Tarek Abdallah
Electrical Engineer



Joe Bush
Mechanical Engineer



Dr. Carl Feickert
Physicist



Rob Bernas
Graduate Student



Adam Hollinger
Graduate Student



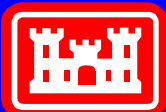
Stacy Gelber
Graduate Student



Wayne Weaver
Graduate Student



Kami Kates
Student Researcher



Soldiers, Families, and Civilians

Home to
the
Force



Power
Projection



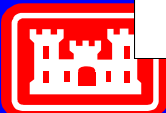
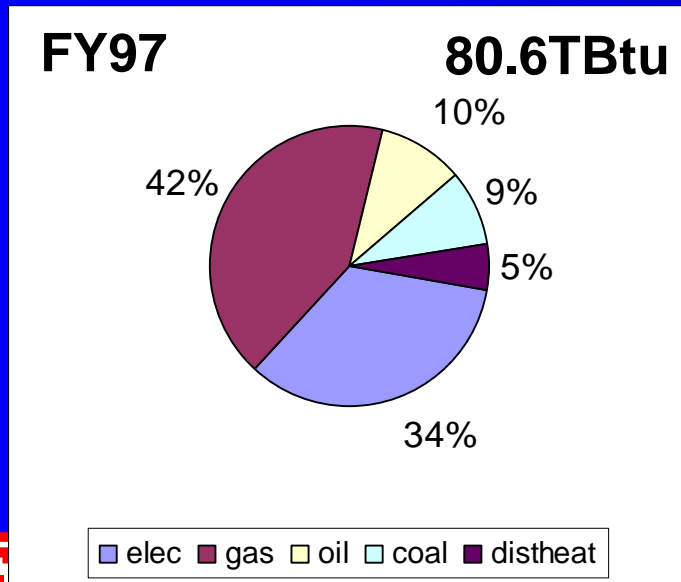
Work &
Training



... are our Customers!

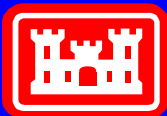
DoD Fuel Cell Technology Stationary Goals

- The Army Spends ~ \$1B Annually for Energy *
- Fixed Facilities Consume ~ 73% of this Energy
- DoD Environmental Compliance
- Energy Quality, Reliability, and Security



What is a Fuel Cell?

Fuel cells are electrochemical power generators with the potential for attaining very high electrical energy conversion efficiencies, while operating quietly with minimal polluting emissions. In addition, by-product thermal energy generated in the fuel cell is available for use for cogeneration of hot water or steam.



1839 – Sir William Grove discovers principle of fuel cell – “gas battery.”



1889 – Langer & Mond coin the term “fuel cell.”

1932 – Bacon develops H₂ - O₂ fuel cell

1969 – NASA launches Gemini 5, man
spacecraft with fuel cell.



1992 – UTC Fuel Cells offers “comm
available” 200 kW fuel

1994 – Daimler Chrysler unve
NECAR 1, first fuel cell

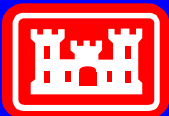


2006 – Residential Fuel Cells, Battery
Replacements, Hydrogen Economy, etc.

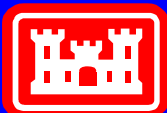
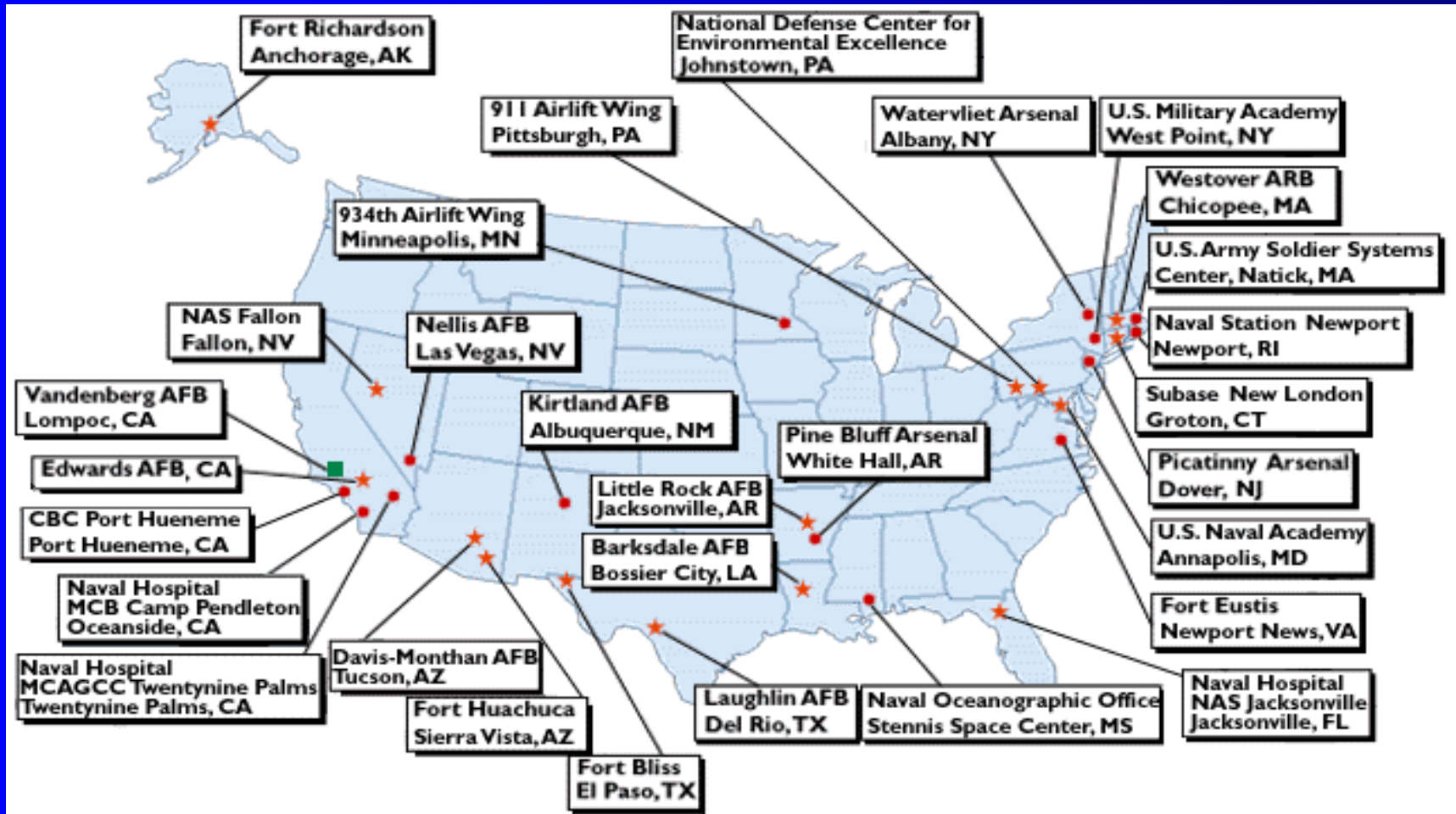


Is Hydrogen Safe?

- Hydrogen is non-toxic and evaporates immediately after a spill, unlike gasoline and oil
- The Hindenburg accident was not caused a hydrogen explosion.
- The extremely high heat and pressures needed for an H-bomb would never be found in a fuel cell or hydrogen storage device



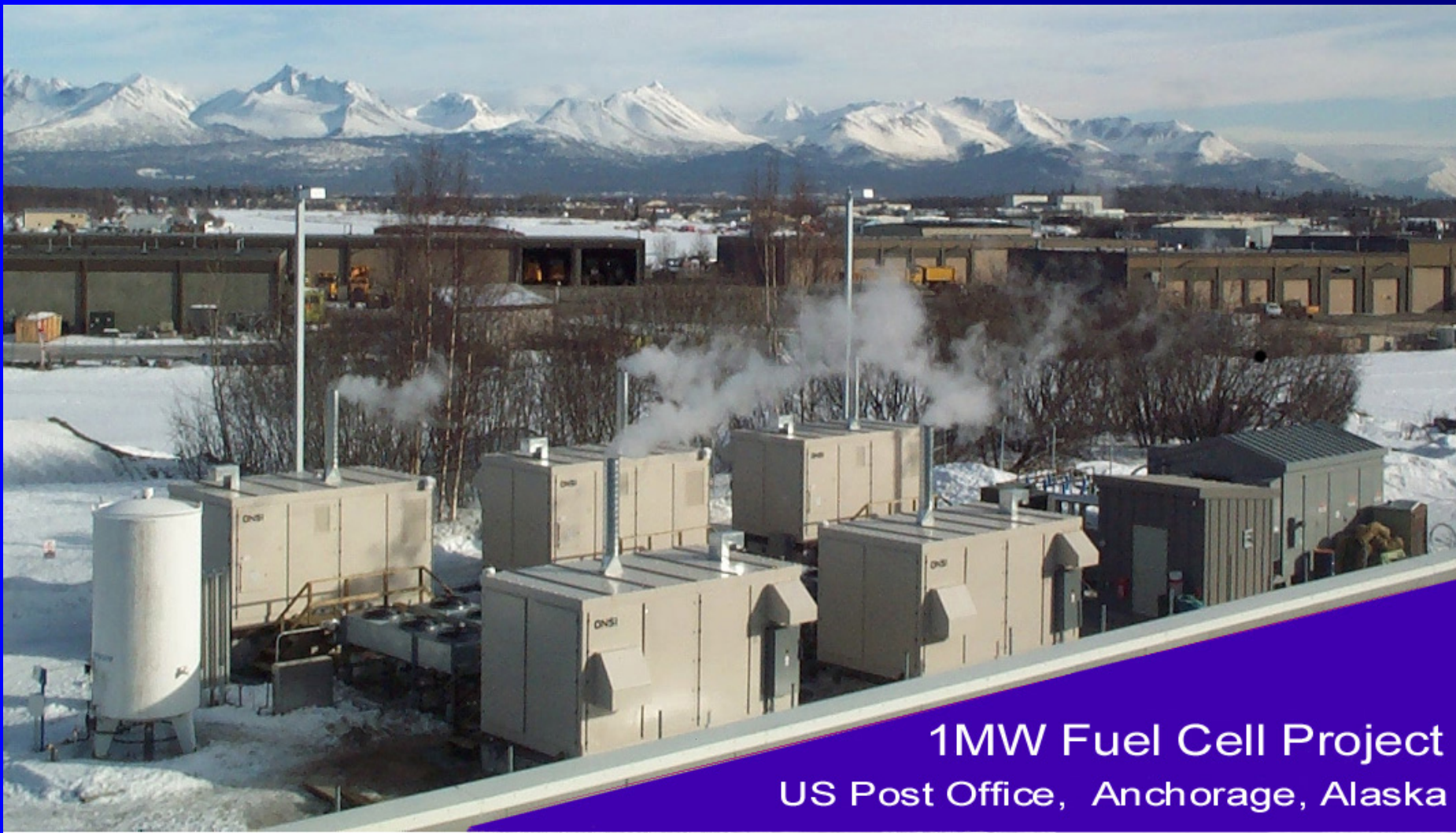
DoD PAFC Project Sites



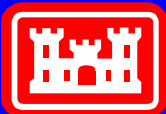
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- PC25A SITE
- PC25B SITE
- ★ PC25C SITE

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1MW Fuel Cell Project
US Post Office, Anchorage, Alaska

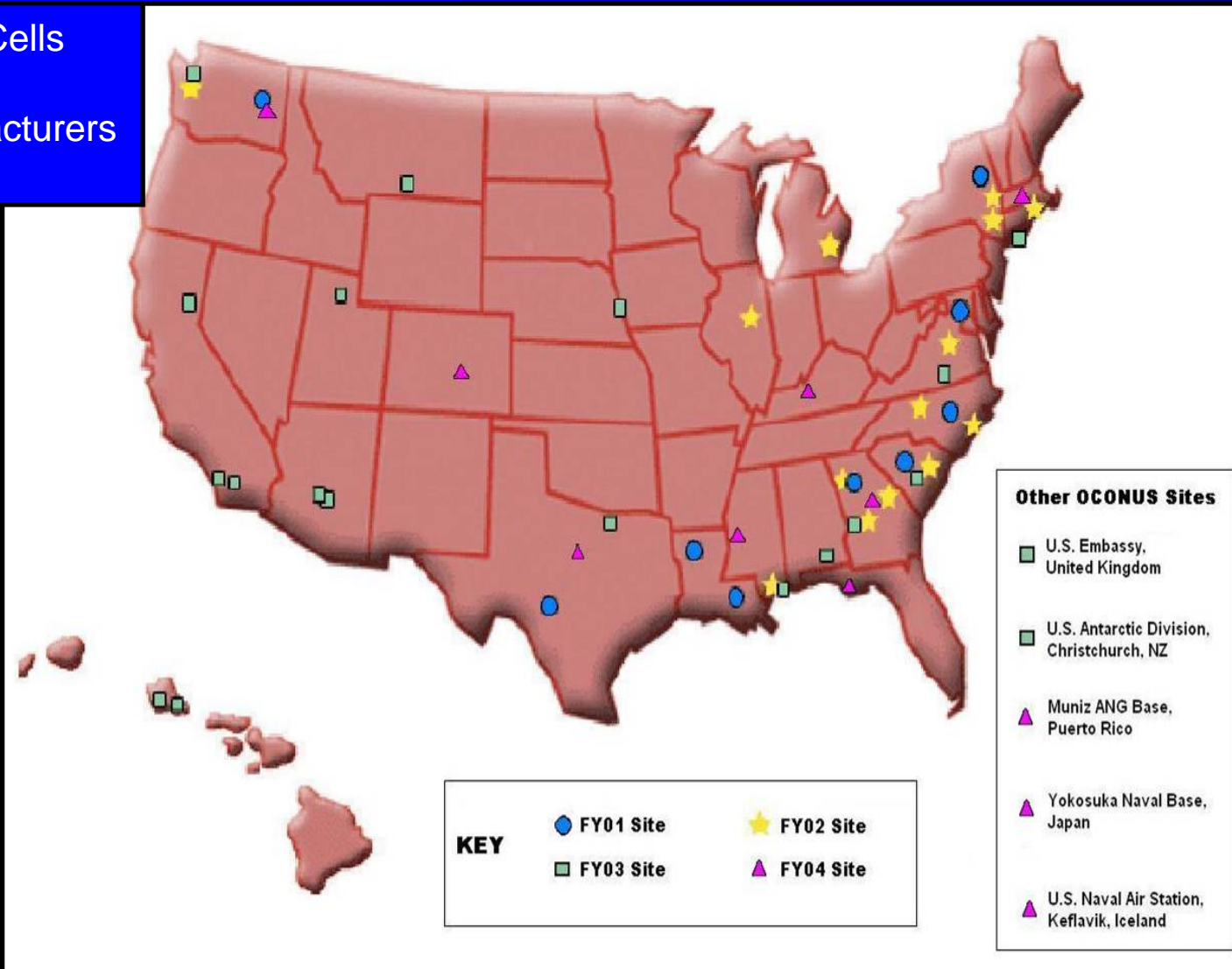


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FY01-FY04 Residential PEMFC Project Sites

91 Fuel Cells
56 Sites
5 Manufacturers



PEM Fuel Cell Demonstration Sites



**Watervliet Arsenal
Officer's Quarters**



**ERDC-CERL
Equipment Shed**



**USCG Facility
Maintenance Building**



**U.S. Border Patrol
Radio Repeater Station**



**Arizona State University
Army Reserve Building**

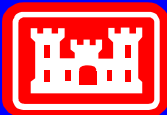


**Keflavik Airport, Iceland
Telecommunications Backup**

New Mexico Army National Guard PEM Demonstration Project



New Mexico DPS Emergency Management Center

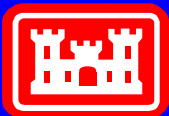


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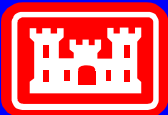
Demonstration Goals

- Conduct site visits at NMNG facilities and determine the best sites for installation of 20 fuel cell systems
- Establish system design and installation plan
- Generate test plans/procedures to demonstrate functionality of fuel cell systems
- Demonstrate and evaluate fuel cell systems as backup power provider at NMNG sites



GENCORE®

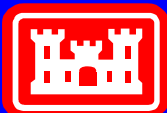
- Durable solution for extended backup
- Capable of replacing or augmenting batteries
- Maintains batteries at full charge during outage
- Predictable and scaleable run time
- Low maintenance
- Outdoor operation reduces facility modifications
- Small footprint
- Lightweight
- Environmentally friendly



Plug Power GenCore 5B

Fuel Cell Statistics

Product Characteristics		GenCore 5B
Performance Rated	Rated Net Output	0 to 5,000 W
	Adjustable Voltage	+46 to -56 Vdc (+48)
	Operating Voltage Range	+42 to +60 Vdc
	Operating Current Range	0 to 109 Amps
Fuel	Gaseous Hydrogen	99.95% Dry
	Supply Pressure	80 psig
	Fuel Consumption	40 slm at 3,000W
		75 slm at 5,000W
Operation	Ambient Temperature	-40 C to 46 C
	Relative Humidity	0% to 95% Non condensing
	Altitude	-197 ft to 6,000 ft
Physical Dimensions	Dimensions	44" H x 26" W x 24"D
	Weight	500 Lbs
Safety	Compliance	FCC Class A
		ANSI Z21.83
		UL Listed
		Telcordia GR 63, 78,487,1089
Emissions Water	Water Maximum	1.75 Liters per hour
	CO, CO2, NOx, SO2	<1ppm
	Audible Noise	60 dba @ 1m



GENCORE® TECHNOLOGY EVOLUTION

2003 – “Prototype” 5kW Unit:

- ❖ Indoor (Outdoor) siting
- ❖ UPS interface design
- ❖ Limited field trials

2007 – Product Refreshed

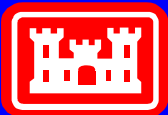
- ❖ 6 Technology Initiatives
- ❖ Enhanced service interface
- ❖ Reduced Cost
- ❖ FC-1 Compliant

2005 - GenCore:

- ❖ 60% decrease in material cost
- ❖ 40% decrease in size
- ❖ 60% decrease in weight
- ❖ 5 new market configurations
- ❖ NEBS/CE



Ultra-capacitors

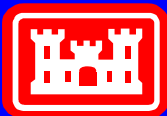


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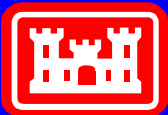
GenCore – How Does It Operate

- Similar to a solid state battery that continues providing DC Power while Hydrogen is available
- Always on and floats on the DC Buss like a battery
- Installed in parallel to existing battery strings or replaces battery strings
- Technician input sets float voltage, voltage drop for start, and time delay
- System starts power producing mode automatically and returns to standby automatically

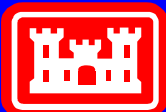


Hydrogen Supply Module (HSM)

- **Compressed Hydrogen**
 - Six Cylinders per Unit
 - 2400 PSI
 - ~ 60kWhrs of Fuel Storage
- **Daily Monitoring**
- **Replace Cylinders**
 - <500PSI
- **Fuel Consumption at 5kW**
 - ~ 1/2 Cylinder Per Hour



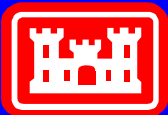
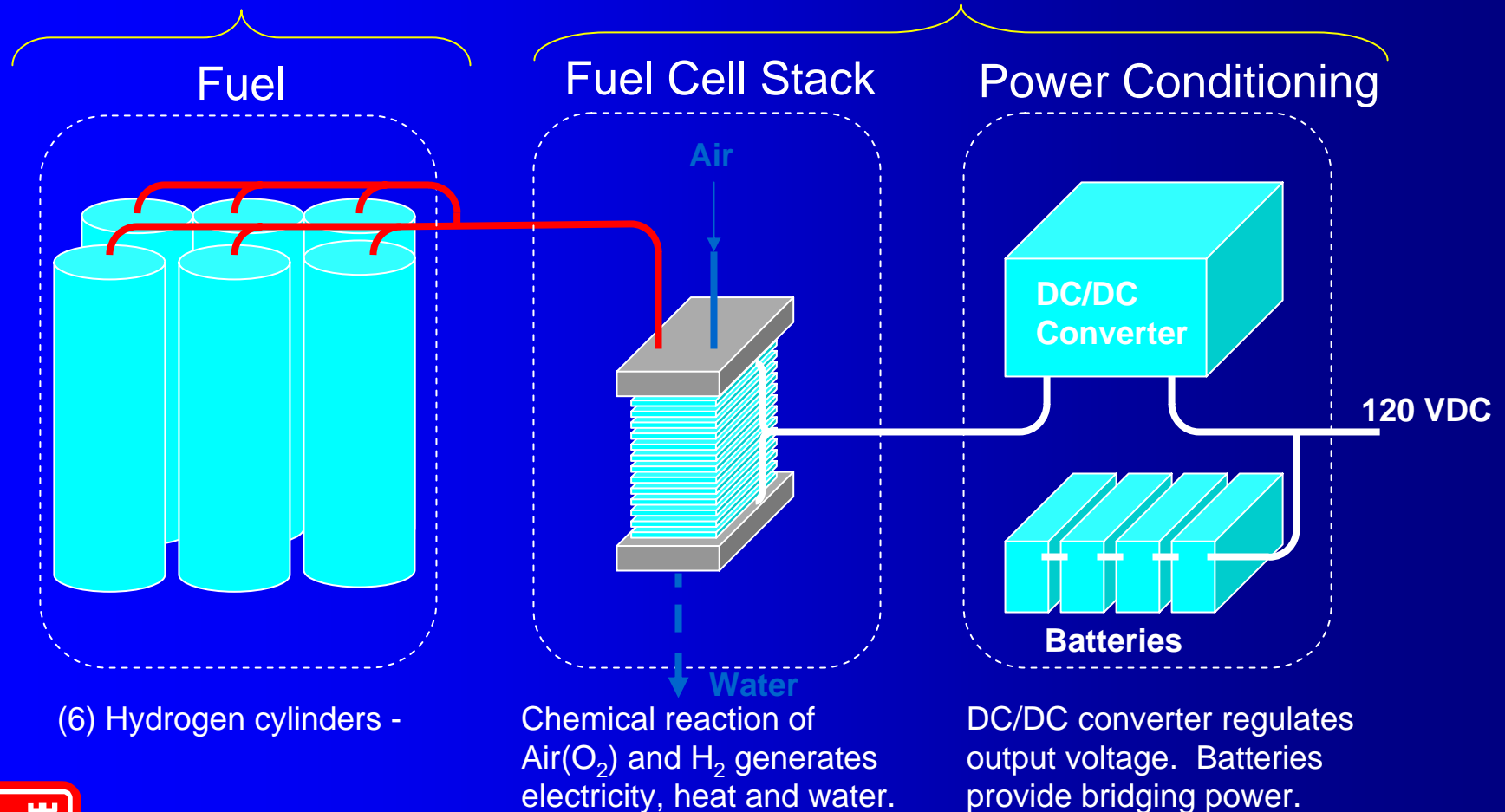
GenCore Details - H2 Storage



GENCORE POWER SOLUTION

Hydrogen Storage Module (HSM)

Power Generation Module (PGM)

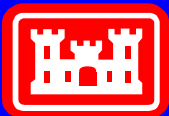


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INITIAL QUESTIONS FOR SITE SELECTION

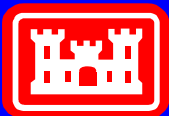
- What type of equipment is to be backed up? Does it require AC power?
- What is power usage by site?
- Can list be narrowed to those sites with 8-16 kW load?
- Are Phase 1 sites within ~60 mile radius of Albuquerque?
- Are all facilities easily accessible by road?
- Are standard building and electrical drawings available for the facilities?



INITIAL QUESTIONS FOR PROGRAM MANAGEMENT

To begin site preparation

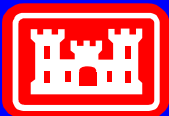
- Are there restrictions as to when contractors are allowed on site?
- What documentation is required for a contractor to gain access?
- Is there a preferred vendor list available?
- Is there a current maintenance (Electrical or HVAC) vendor that maintains/repairs these facilities?
- What is required if a service provider is not on the vendor list?
- Are permits required? Should not be as most State agencies are self permitting.
- Are there any special requirements for bringing Compressed gases on to the site?
- Will drawings be required before installations begin?



Fuel Cell Site Location

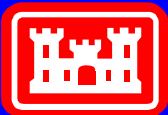
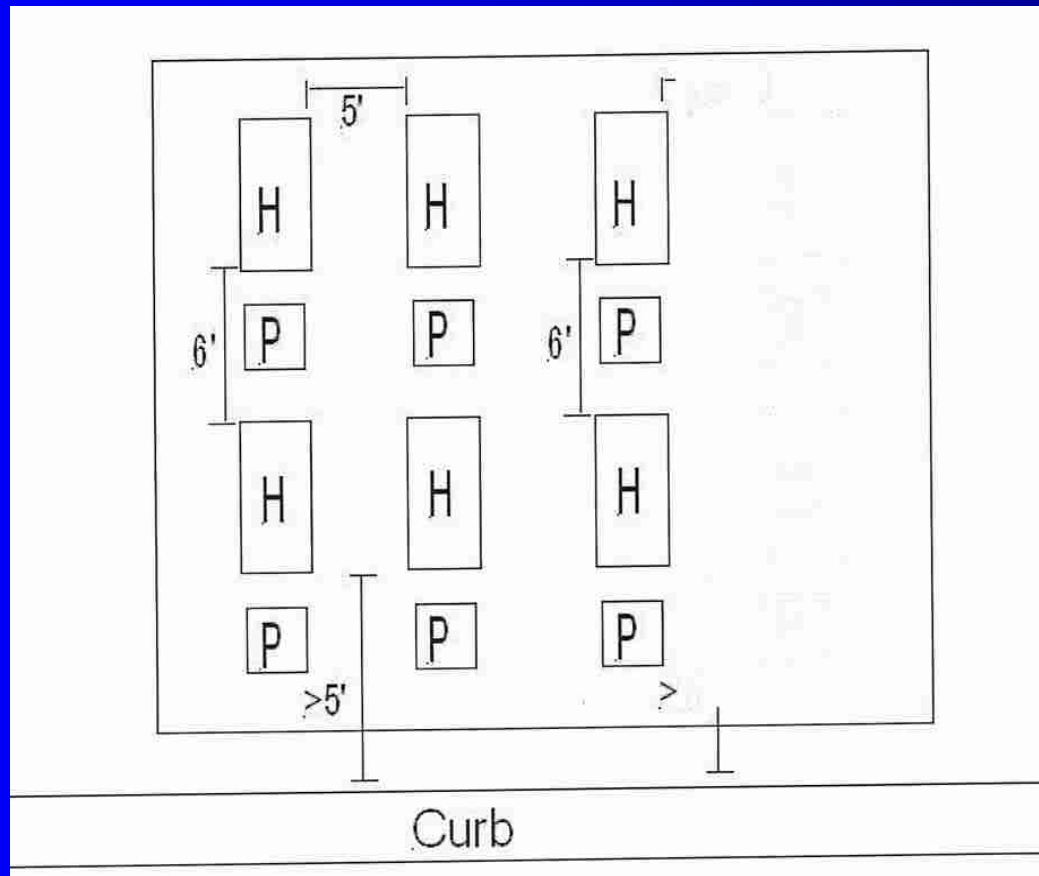
NM National Guard HQ Site – Santa Fe

- **Building #24**
 - 8 Fuel Cells
 - Loads
 - Computer Server Rooms
 - Lighting
 - Mobile Air Conditioning Unit
 - Dedicated Circuit Receptacles
- **Headquarters Building #10**
 - 4 Fuel Cells
 - Loads
 - Computer Server Rooms
 - Lighting
 - Dedicated AC Circuit Receptacles
- **PBX Building #10**
 - 2 Fuel Cells
 - Loads
 - DC Equipment Loads
 - Dedicated AC Circuit Receptacles
- **Airport**
 - 2 Fuel Cells
 - Loads
 - Computer Servers
 - Radio Equipment
 - Security System
 - Lighting



NM National Guard HQ Site Fuel Cell Pad Layout

Building 24



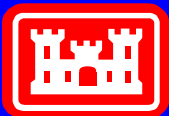
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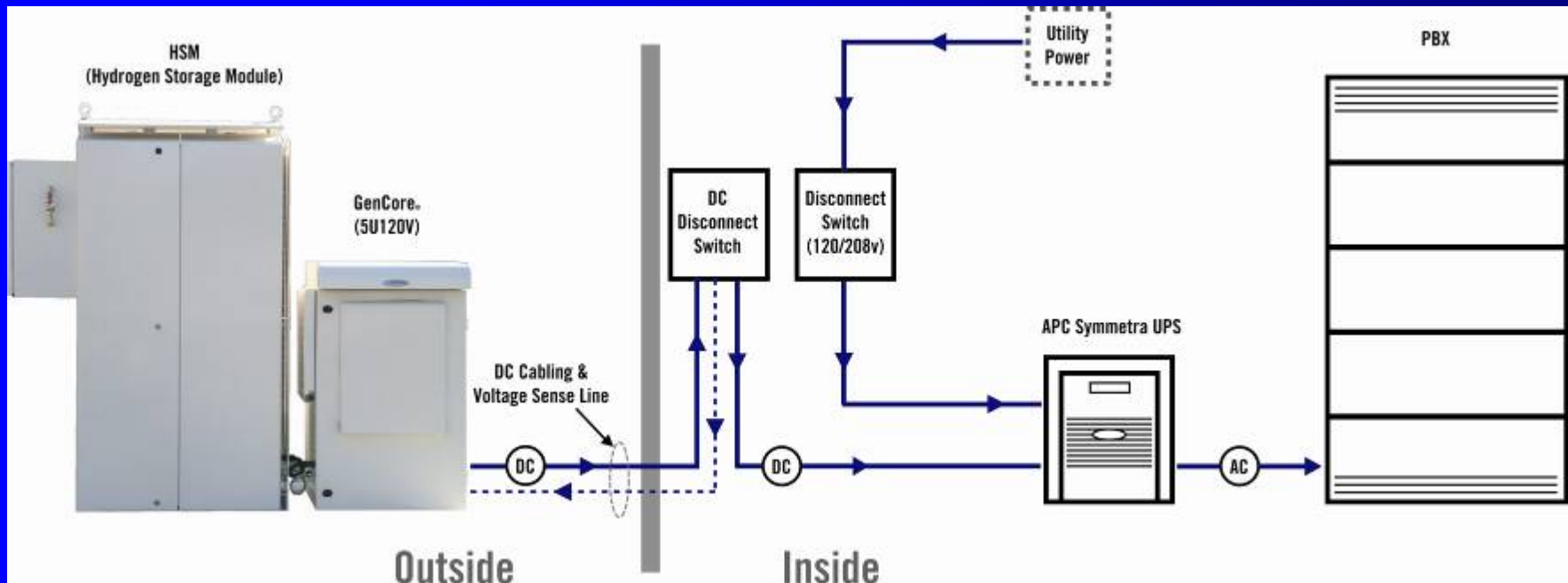
Fuel Cell Site Location

NM National Guard Site – Rio Rancho

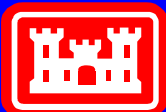
- **Rio Rancho Building**
 - **4 Fuel Cells**
 - **Loads**
 - **Computer Server Rooms**
 - **SIPR NETWORK**
 - **Command Conference Room**
 - **Lighting**
 - **IDS Security System**
 - **Dedicated Circuit Receptacles**



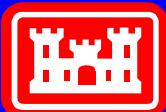
TYPICAL UPS INSTALLATION



GenCore systems extend the runtime of traditional UPS systems



Fuel Cell Installation

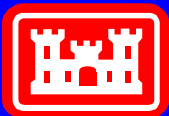


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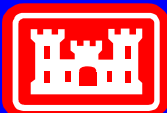
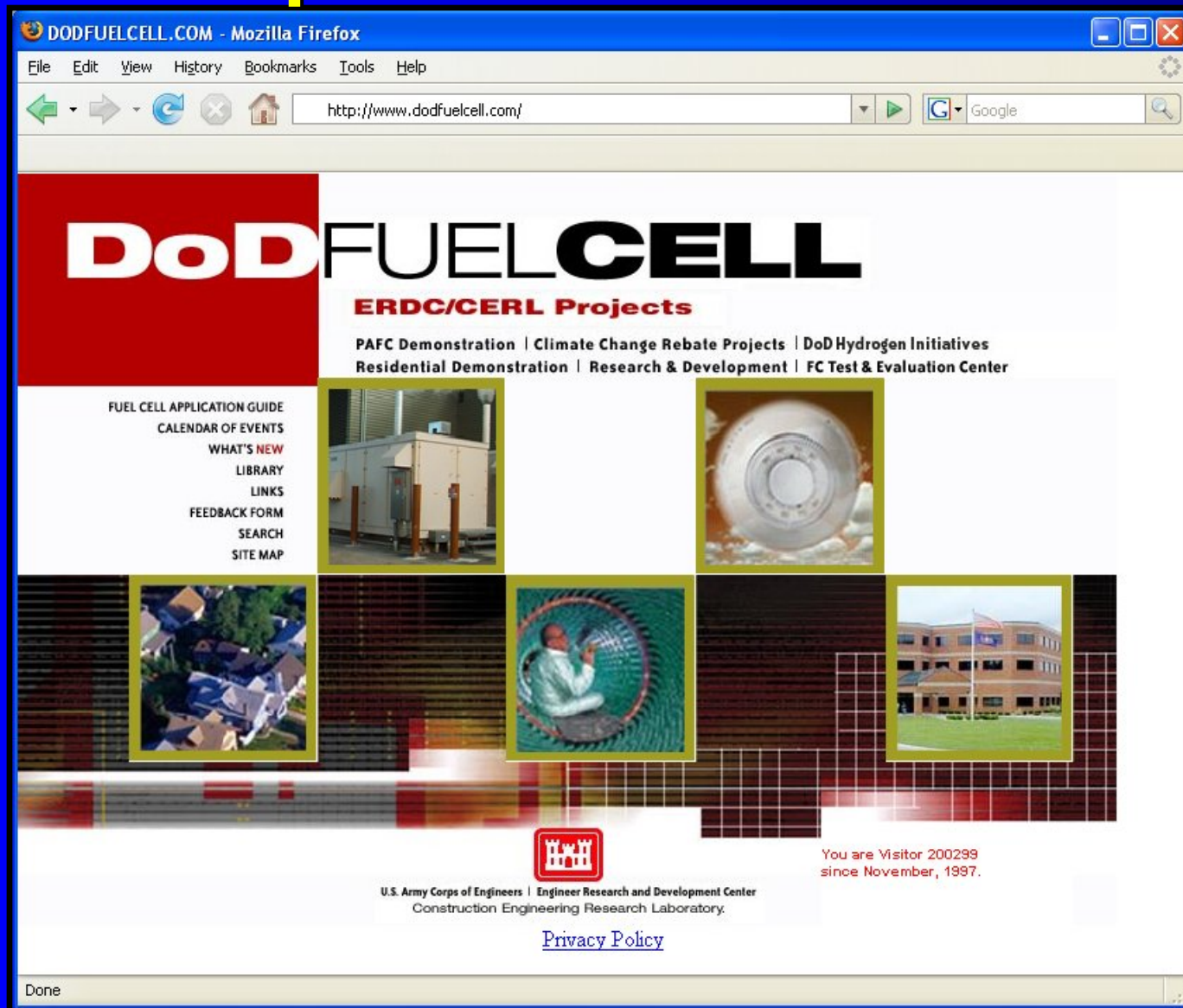
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Fuel Cell Operation and Monitoring

- Internal Data Logger
 - All Fuel Cells
 - 30 Days of Storage
 - Download by Technician
- Remote Monitoring
 - 5 Modems
 - 1 at Each Location
 - Retrieve All Events
- Monthly Conditioning
 - All Fuel Cells
- Forced Cycling
 - 5 Fuel Cells With Modems



http://dodfuelcell.com



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