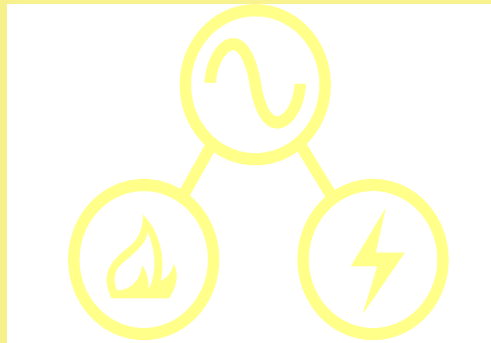


Fuel Cell Technology

PC25 Phosphoric Acid Cell Stack Life Cycle Performance

Samuel Logan, Jr.



LOGANEnergy

www.loganenergy.com

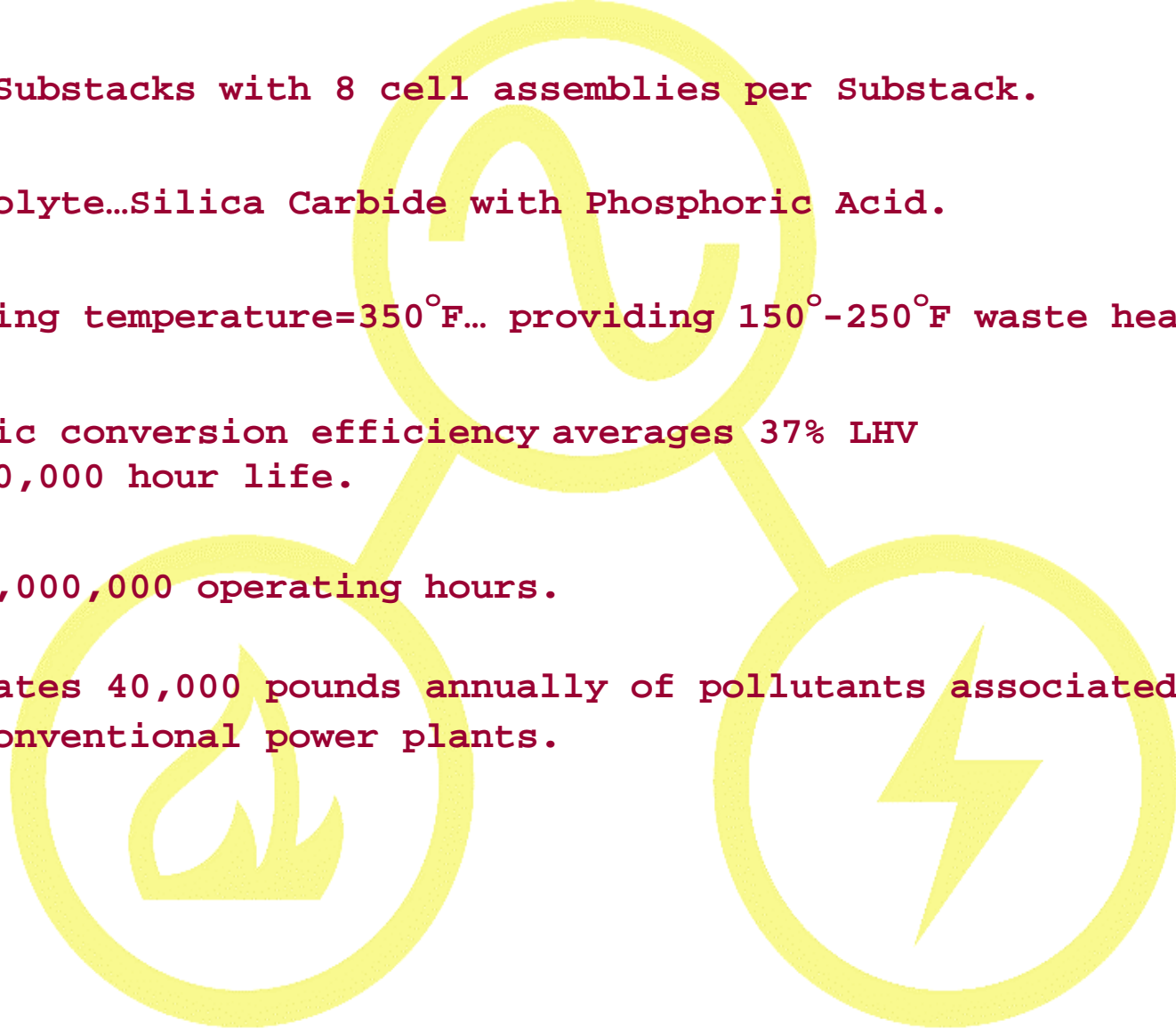
May 23, 2002

DER at Federal Facilities Workshop

Atlanta Marriott Marquis, Atlanta, GA

PC25 Phosphoric Acid Cell Stack Performance Specifications

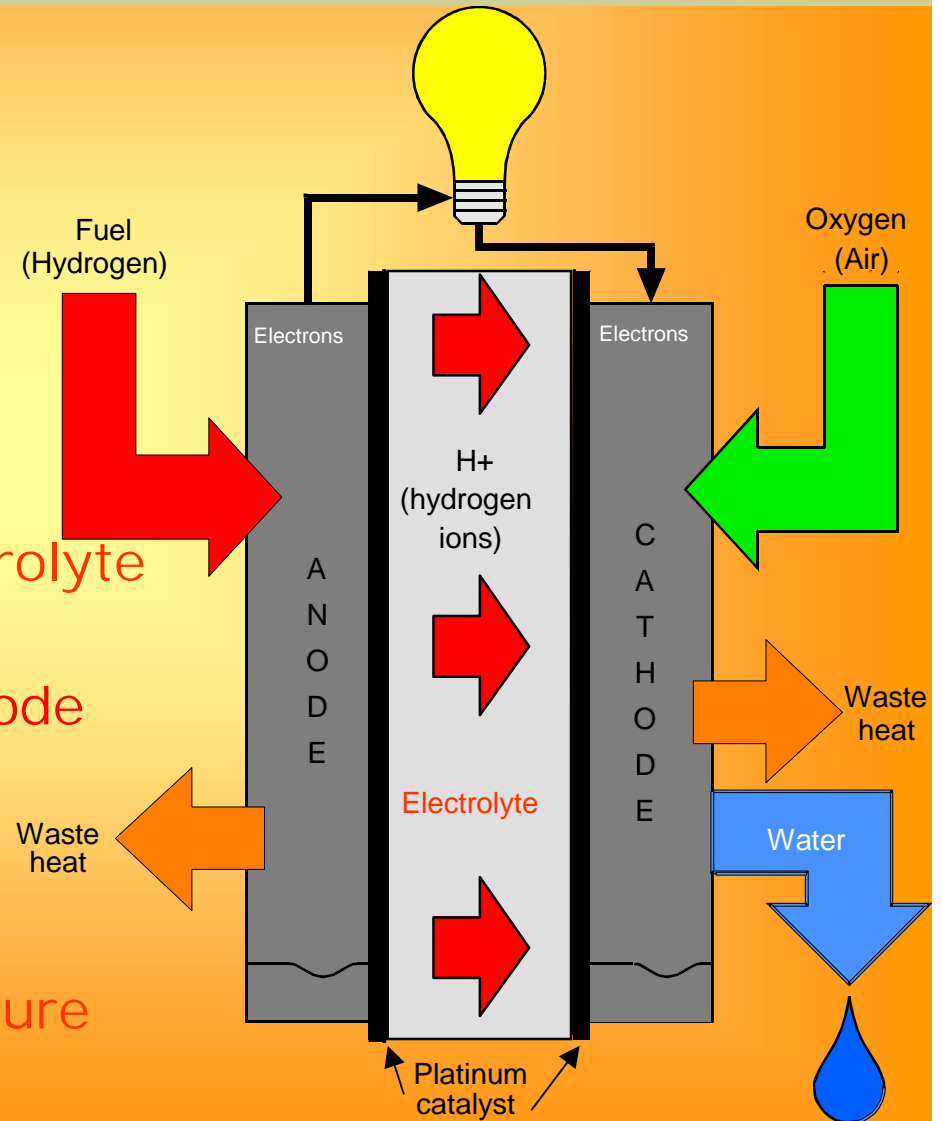
- ⚡ 32-34 Substacks with 8 cell assemblies per Substack.
- ⚡ Electrolyte...Silica Carbide with Phosphoric Acid.
- ⚡ Operating temperature=350°F... providing 150°-250°F waste heat.
- ⚡ Electric conversion efficiency averages 37% LHV over 40,000 hour life.
- ⚡ Over 5,000,000 operating hours.
- ⚡ Eliminates 40,000 pounds annually of pollutants associated with conventional power plants.



FUEL CELL TECHNOLOGY

Single Cell Chemistry

- ⚡ Electro-chemical reaction
- ⚡ Continuous H_2 fuel flow
- ⚡ H^- migration over conductor
- ⚡ H^+ penetration through electrolyte
- ⚡ H^+ / H^- recombination at cathode
- ⚡ Heat & H_2O by-products
- ⚡ "Green" environmental signature

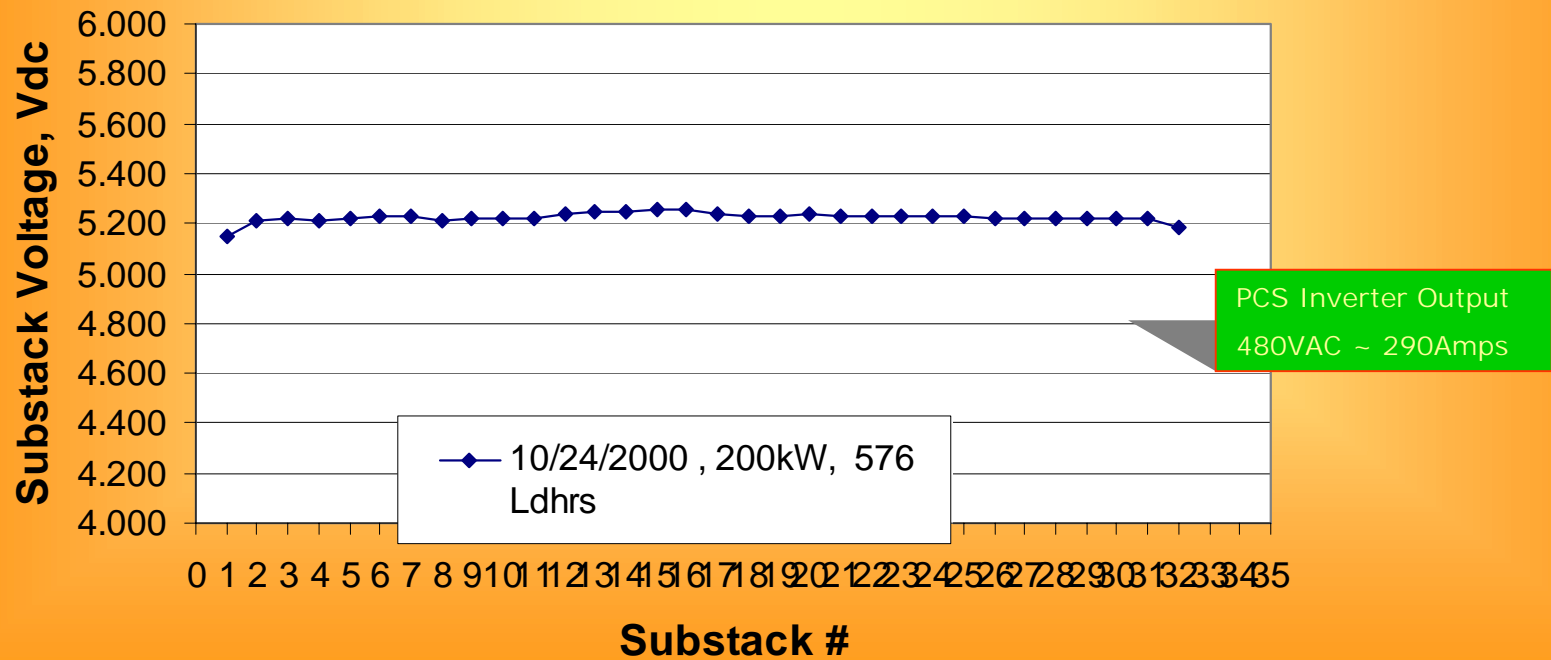


Phosphoric Acid Fuel Cell Substack Voltage Performance Measurement

PC25 Cell Stack
with 500 Load
hours

Date:----->	10/24/2000
Power Plant S/N: --->	9134
Location: ----->	LOGAN CUSTOMER
Load Hours: ----->	576
IDC: ----->	1381
VDC: ----->	167.2
kW: ----->	200

Substack Voltage Profile, S/N 9134 (Alcorn) CSA-

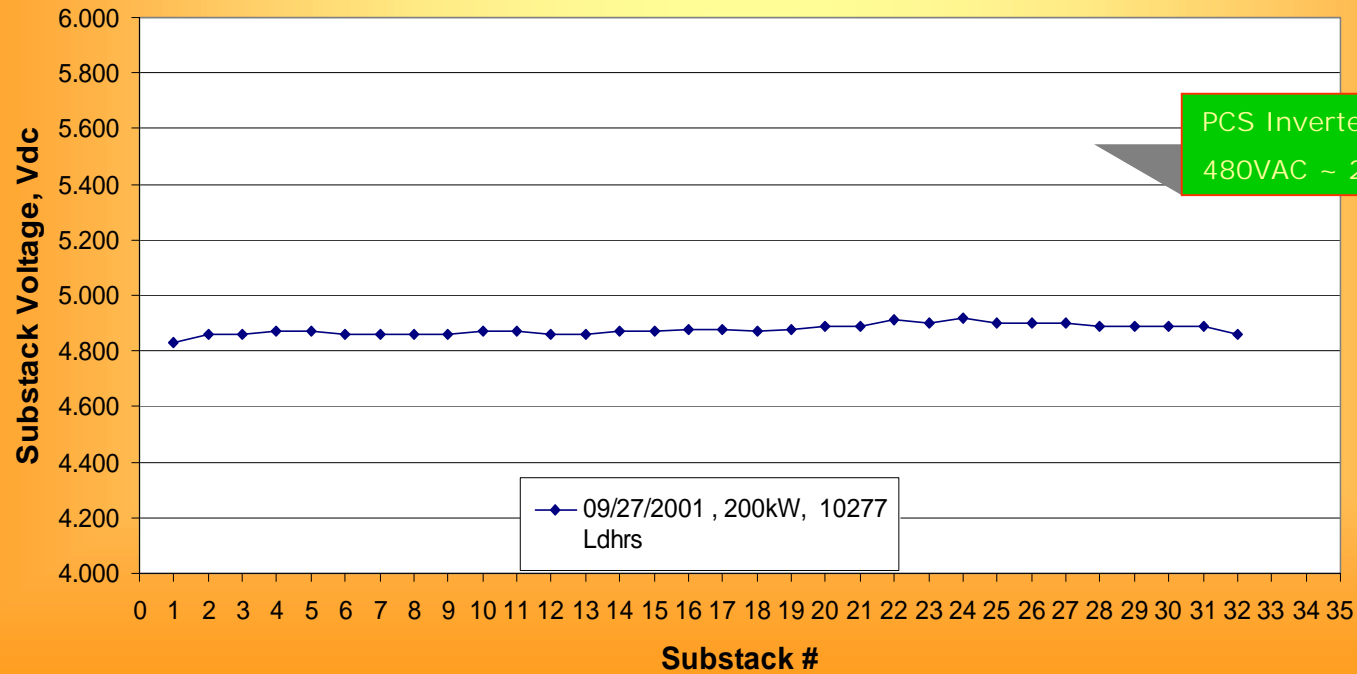


Phosphoric Acid Fuel Cell Substack Voltage Performance Measurement

PC25 Cell Stack with
10,000 Load hours

Date:----->	09/27/2001
Power Plant S/N: ---->	
Location: ----->	LOGAN Customer
Load Hours: ----->	10,277
IDC: ----->	1519
VDC: ----->	156.2
kW: ----->	200

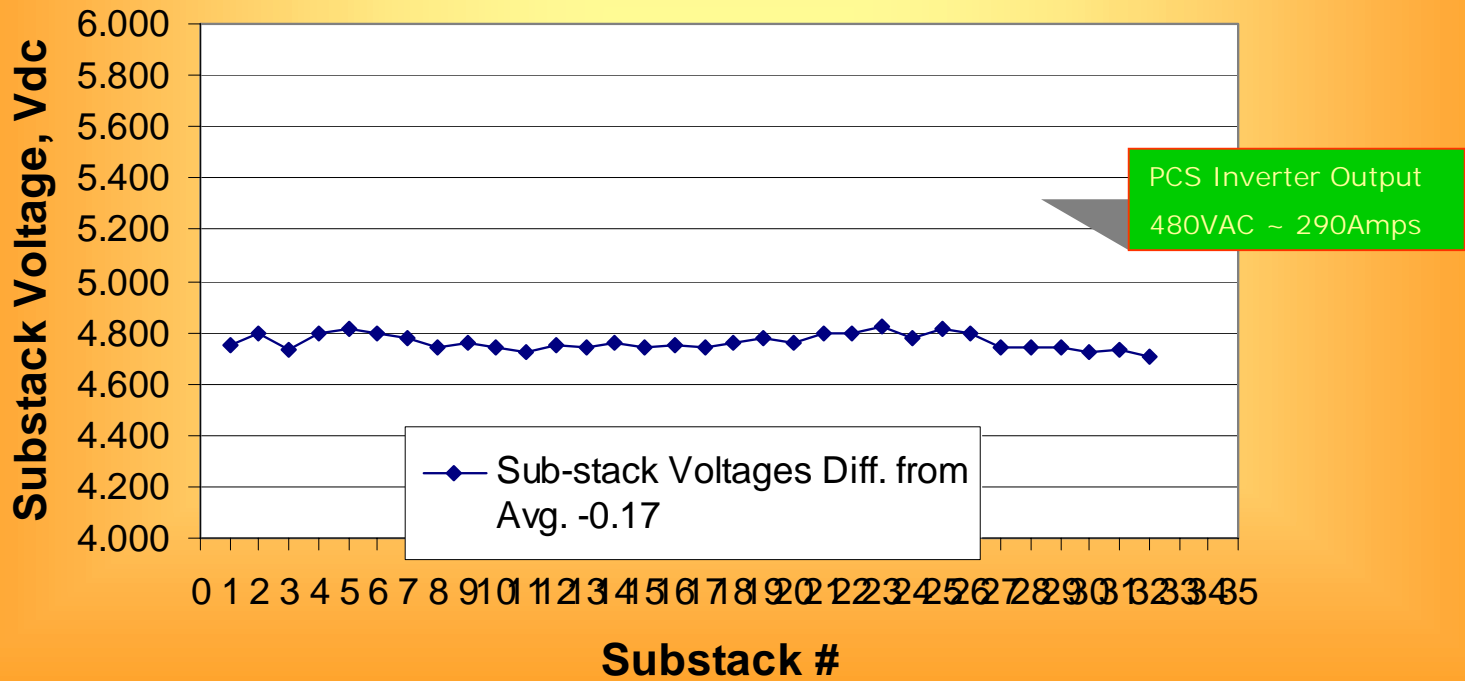
Substack Voltage Profile, S/N (LOGAN Customer) CSA-



Phosphoric Acid Fuel Cell Substack Voltage Performance Measurement

PC25 Cell Stack with
20,000 Load hours

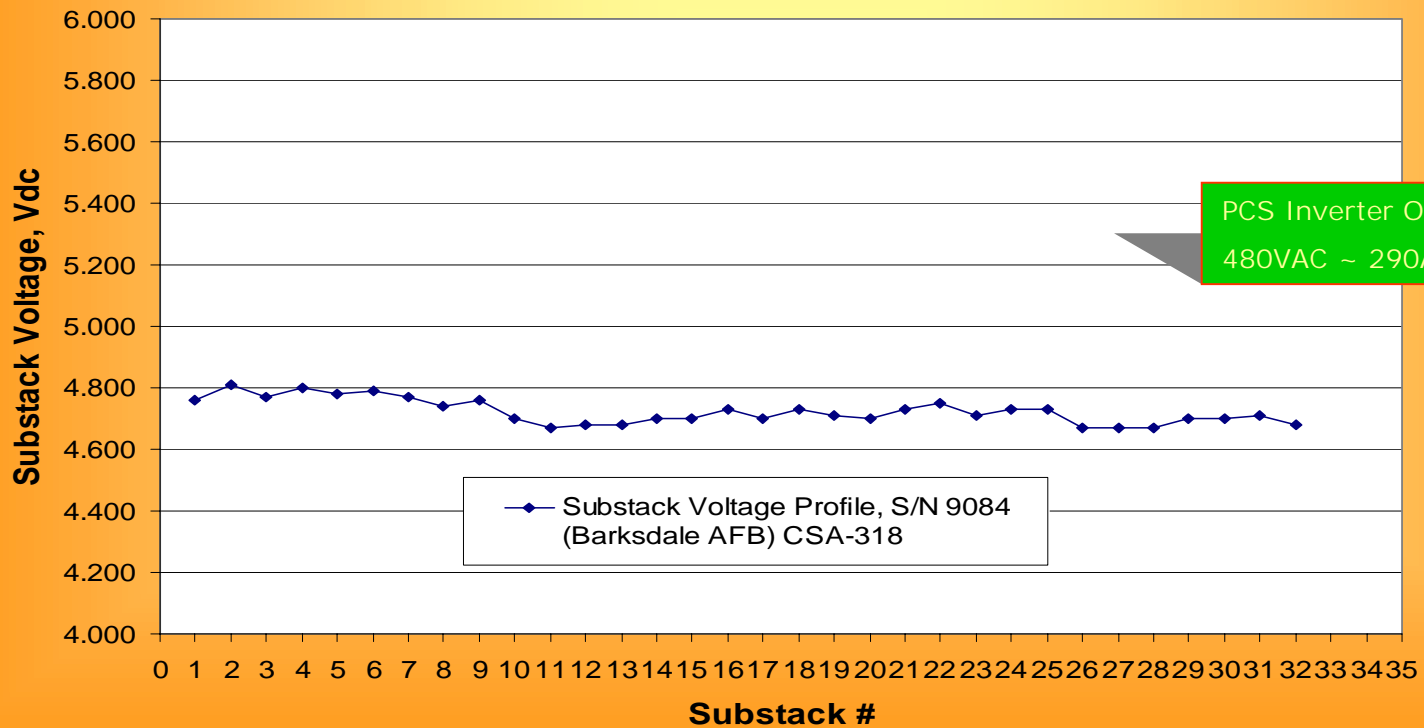
Date:----->	07/21/2000
Power Plant S/N: ---->	9084
Location: ----->	Barksdale AFB
Load Hours: ----->	19287
IDC: ----->	1493
VDC: ----->	152
KW: ----->	200



Phosphoric Acid Fuel Cell Substack Voltage Performance Measurement

Date:----->	04/20/2002
Power Plant S/N: ---->	9084
Location: ----->	Barksdale AFB
Load Hours: ----->	30,947
IDC: ----->	1357
VDC: ----->	152
kW: ----->	175

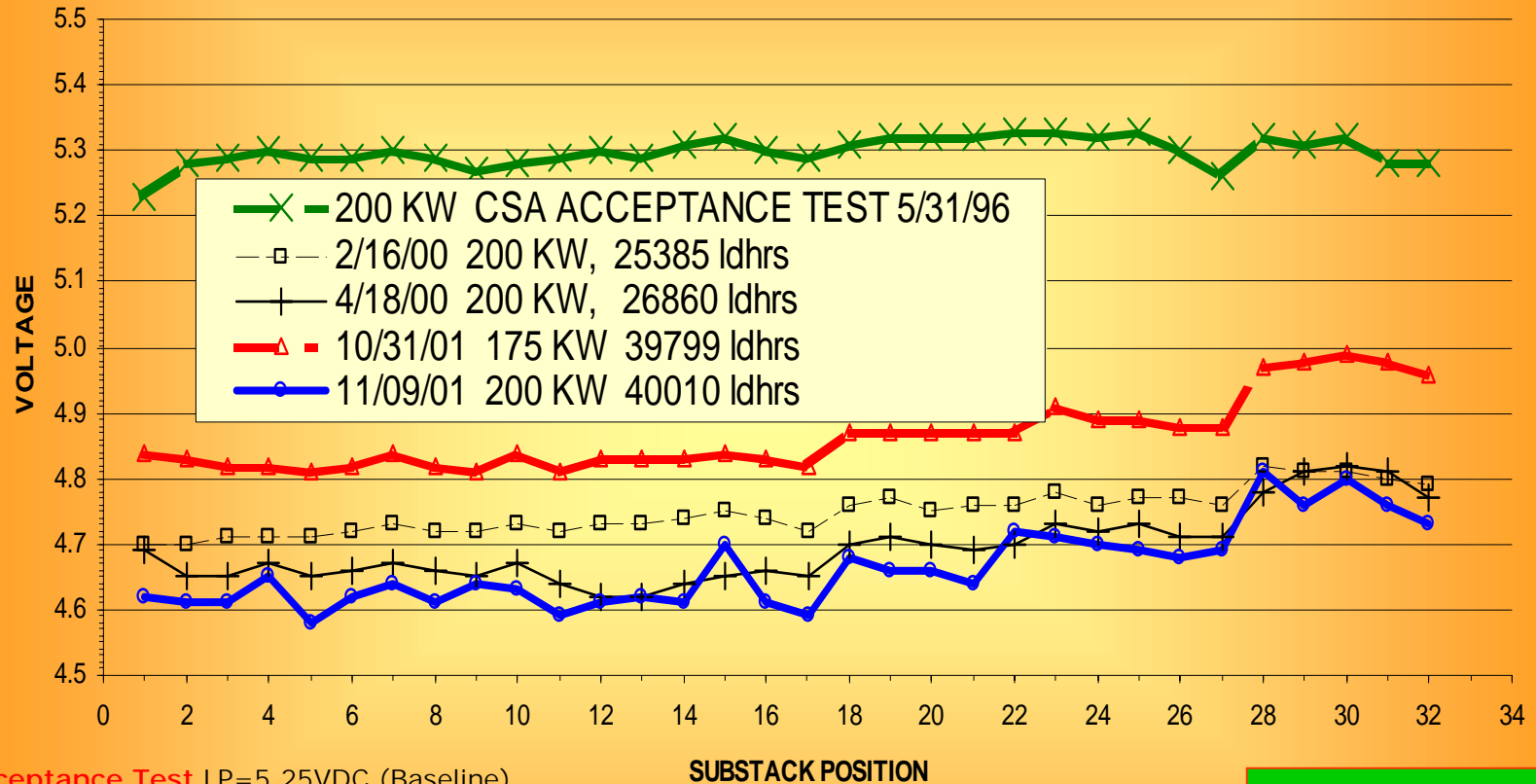
PC25 Cell Stack with
30,000 Load hours



PCS Inverter Output
480VAC ~ 290Amps

PC25C Cell Stack at 40,000 Hours With Comparative Profiles Over Last 15,000 Hours

PC25 MODEL C S/N---- CSA 328



Acceptance Test LP=5.25VDC (Baseline)

25,385 Load Hrs LP=4.80VDC (-8.6%)

26,868 Load Hrs LP=4.7VDC (-10.4%)

39,799 Load Hrs LP=4.62VDC (-12%)

40,010 Load Hrs LP=4.58VDC (-13%)

PCS Inverter Output
480VAC ~ 290Amps

PC25C Cell Stack Performance Risk Issues

Excessive acid evaporation/dry-out

- high coolant operating temperature
- excessive thermal cycles
- plugged coolers due to bad coolant water quality
- excessive reactant flows
- high anode to cathode cross pressure

Risk Horizon

short to long term
short to long term
can be short term
long term
short to long term

Catalyst activity loss / catalyst layer flooding

- contaminants/poisons with incoming reactant gases
- excess operating temperature
- no dummy load on shutdown
- inadequate nitrogen purge on start-up or shutdown

short to long term
short to long term
long term
long term

Carbon support corrosion

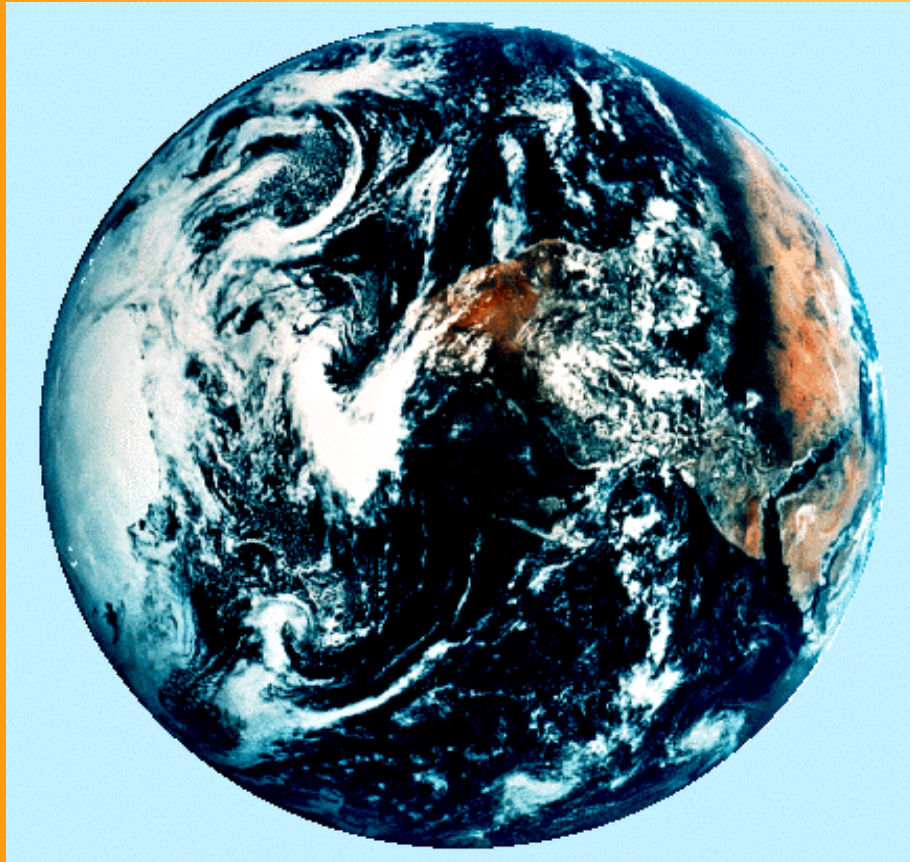
- high potential
- fuel starvation

can be short term
can be short term

Manifold Seal slip

- high reactant inlet pressures

short to long term



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