

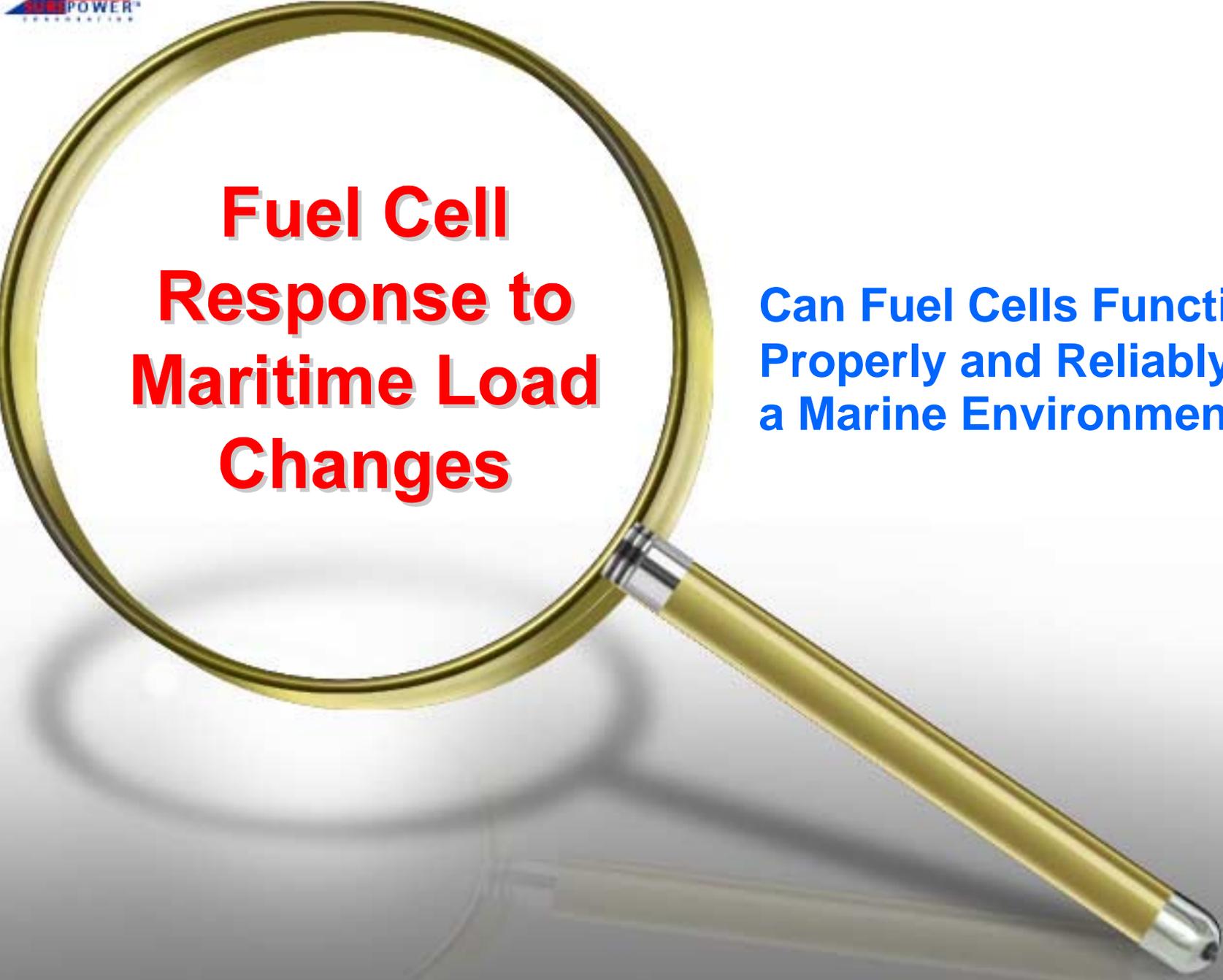


# **Maritime Demonstration Project**

**U.S. Maritime Administration**

**Workshop on Maritime Energy  
and Clean Emissions**

*Washington, DC  
January 30, 2002*



**Fuel Cell  
Response to  
Maritime Load  
Changes**

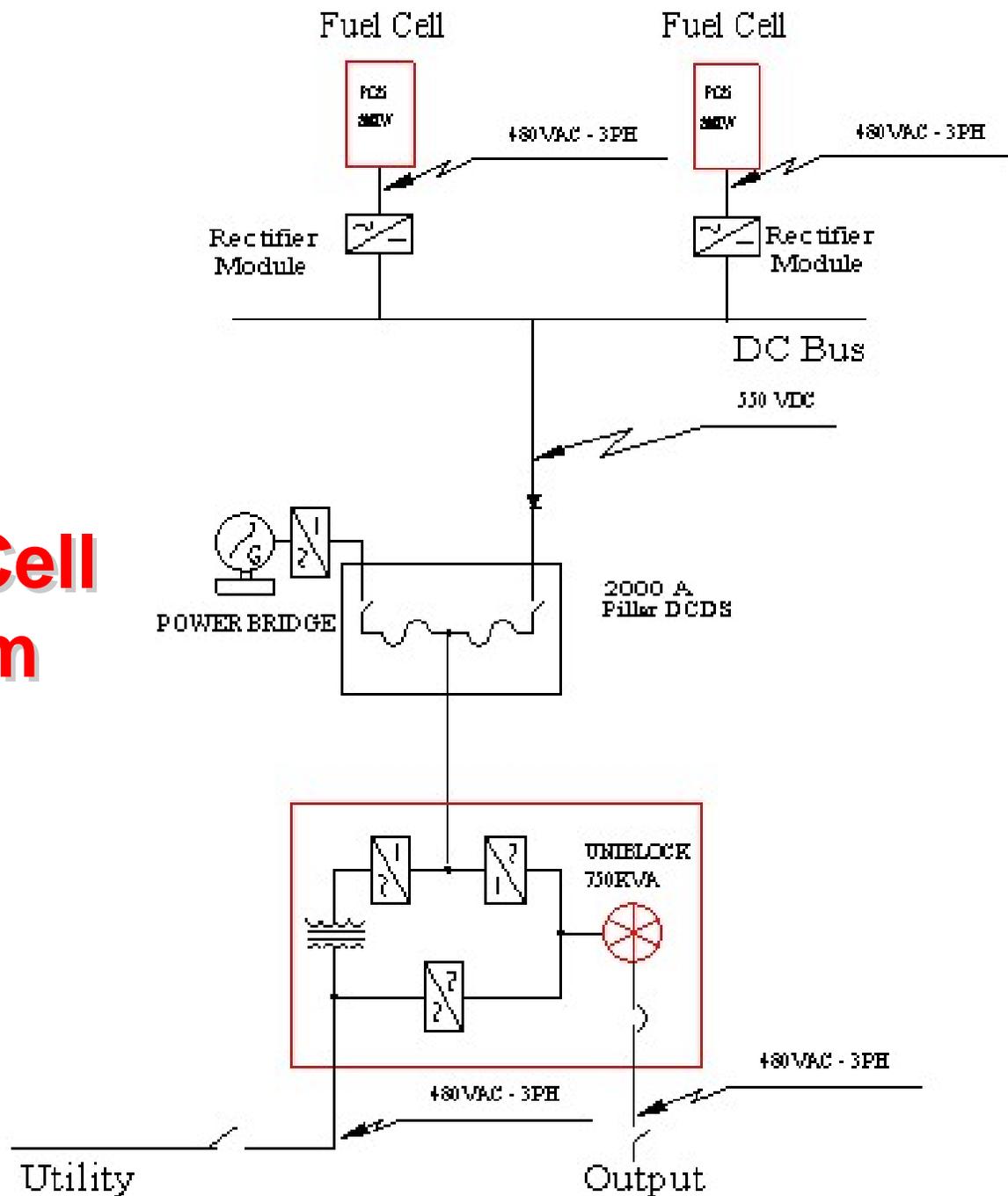
**Can Fuel Cells Function  
Properly and Reliably in  
a Marine Environment?**

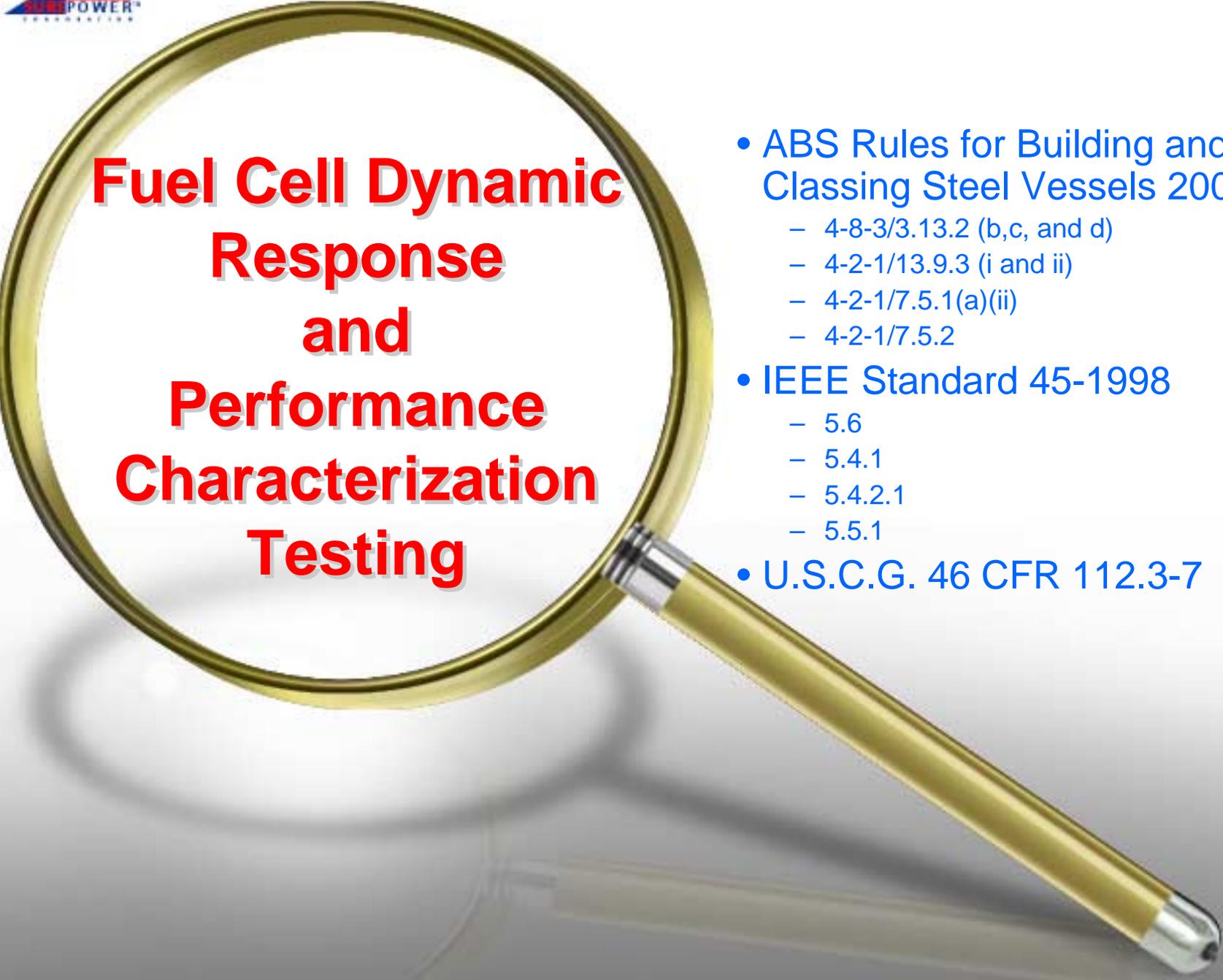
A large, golden magnifying glass is positioned over the text, with its handle extending towards the bottom right. The lens of the magnifying glass is centered over the main title text.

# **The Challenge! The Fuel Cell Is Not a Stiff Generating Source**

- Minimal fault clearing current
- Limited step load capability
- Limited ability to handle transients
- Minimal load unbalance capability
- No over load capacity
- Can't Black Start

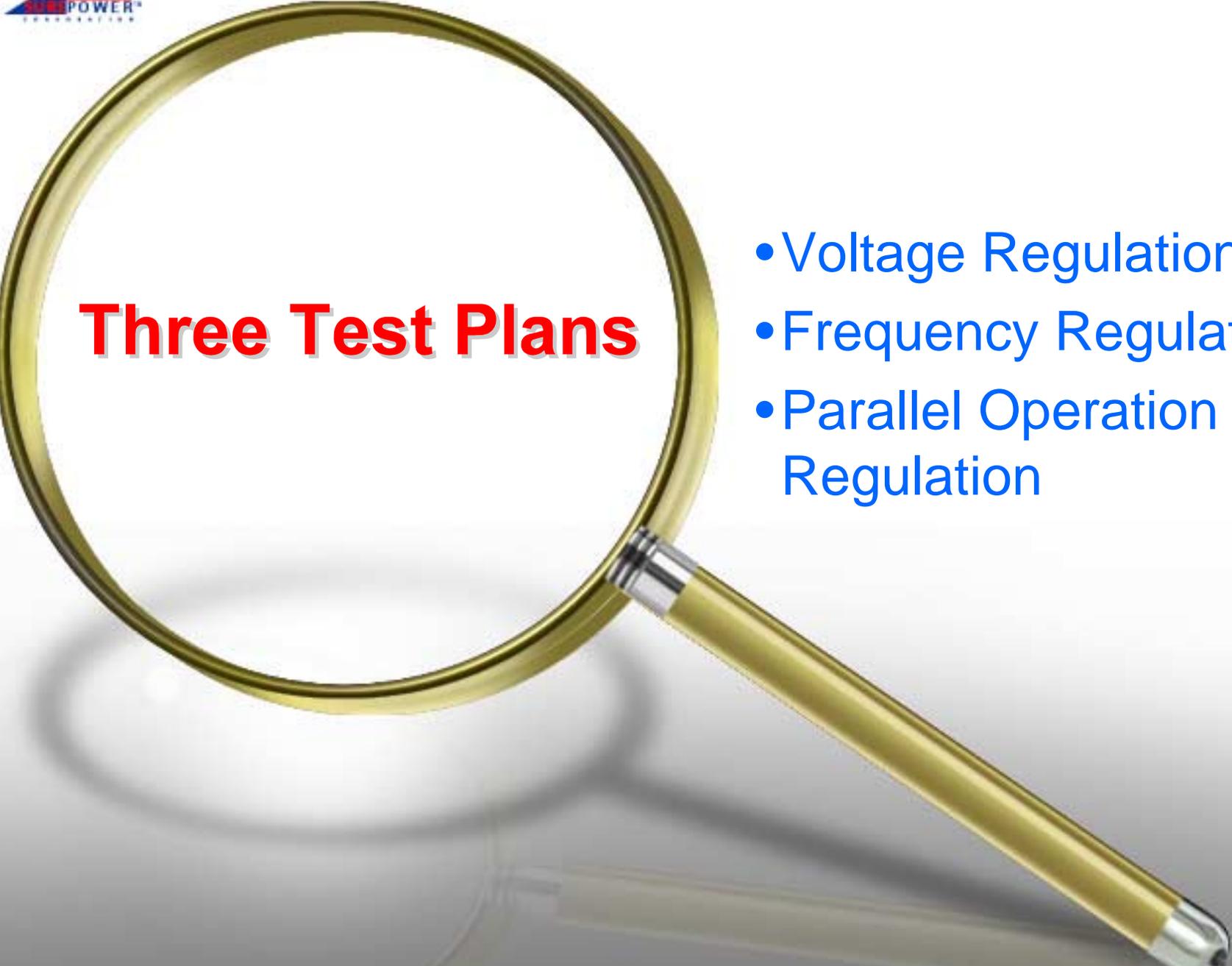
# A Viable Fuel Cell Power System



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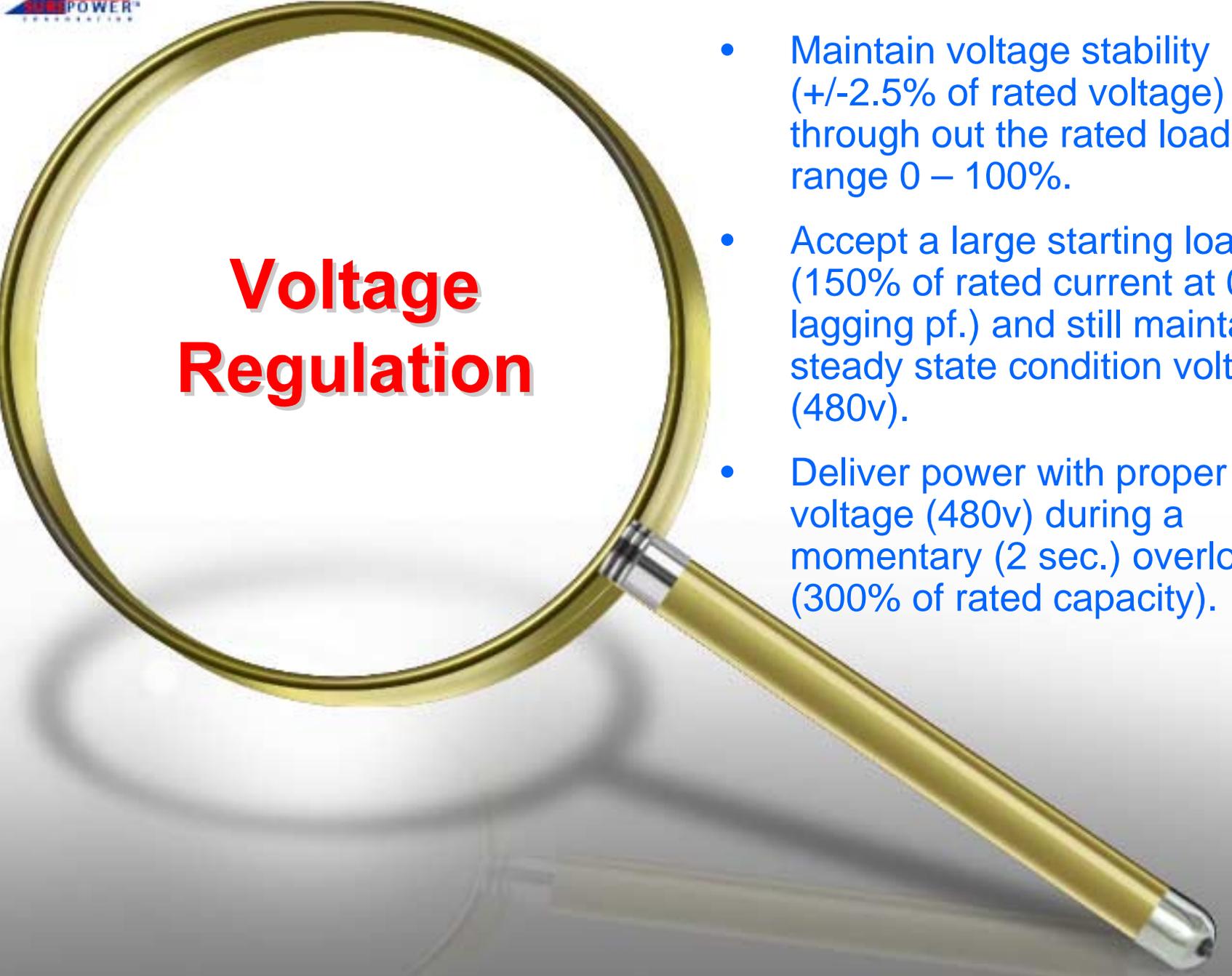
# Fuel Cell Dynamic Response and Performance Characterization Testing

- ABS Rules for Building and Classing Steel Vessels 2001
  - 4-8-3/3.13.2 (b,c, and d)
  - 4-2-1/13.9.3 (i and ii)
  - 4-2-1/7.5.1(a)(ii)
  - 4-2-1/7.5.2
- IEEE Standard 45-1998
  - 5.6
  - 5.4.1
  - 5.4.2.1
  - 5.5.1
- U.S.C.G. 46 CFR 112.3-7

A magnifying glass with a gold-colored frame and handle, positioned over the text. The handle is angled towards the bottom right, and the lens is centered over the title. The magnifying glass casts a soft shadow on the light gray background.

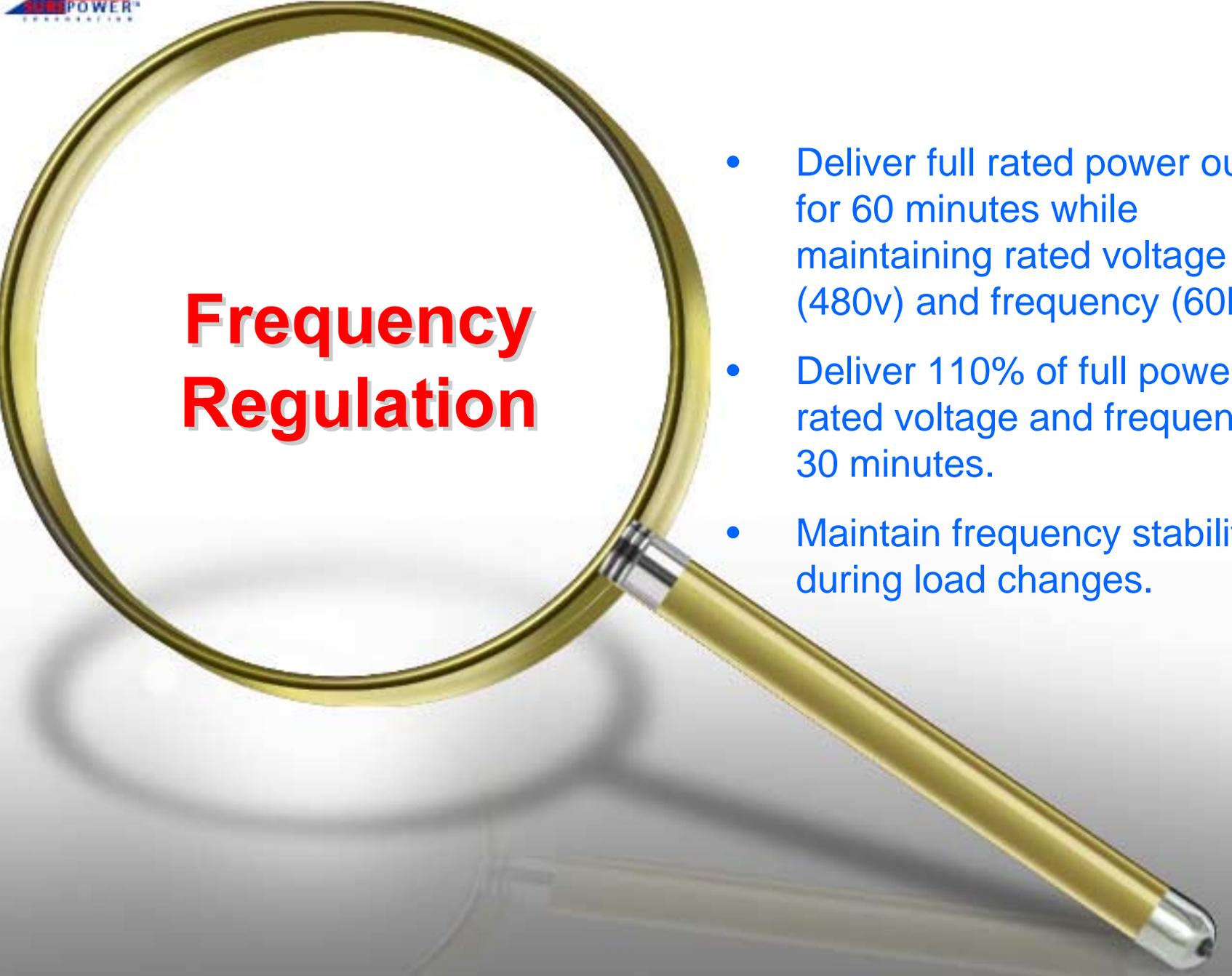
# Three Test Plans

- Voltage Regulation
- Frequency Regulation
- Parallel Operation Regulation

A large, golden magnifying glass is positioned over the text, with its handle extending towards the bottom right corner of the slide. The lens of the magnifying glass is centered over the title "Voltage Regulation".

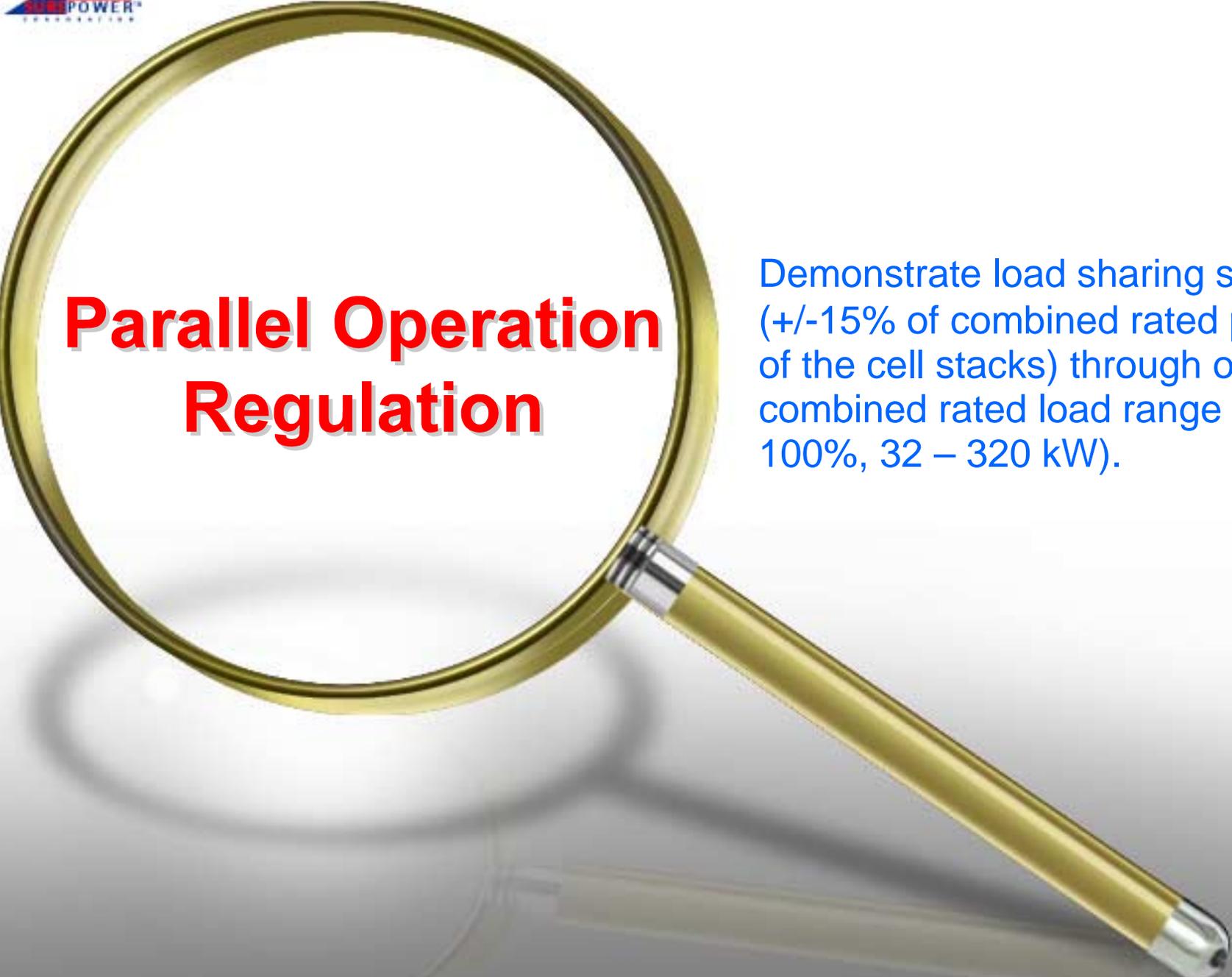
# Voltage Regulation

- Maintain voltage stability ( $\pm 2.5\%$  of rated voltage) through out the rated load range 0 – 100%.
- Accept a large starting load (150% of rated current at 0.4 lagging pf.) and still maintain a steady state condition voltage (480v).
- Deliver power with proper voltage (480v) during a momentary (2 sec.) overload (300% of rated capacity).

A large, golden magnifying glass is positioned over the text, with its handle extending towards the bottom right. The lens is focused on the title "Frequency Regulation".

# Frequency Regulation

- Deliver full rated power output for 60 minutes while maintaining rated voltage (480v) and frequency (60Hz).
- Deliver 110% of full power at rated voltage and frequency for 30 minutes.
- Maintain frequency stability during load changes.

A large, golden magnifying glass is positioned over the text, with its handle extending towards the bottom right. The lens is focused on the title text.

# Parallel Operation Regulation

Demonstrate load sharing stability ( $\pm 15\%$  of combined rated power of the cell stacks) through out the combined rated load range (20 – 100%, 32 – 320 kW).

A large magnifying glass with a gold frame and handle is positioned on the left side of the slide. The text "Project Status" is centered within the lens of the magnifying glass.

# Project Status

- Preliminary testing broke the test rig.
- Waited 8 weeks for replacement part.
- Final testing scheduled for week of March 4.