

Generator Design Optimization – Nuclear Power Plant Applications

August, 2008
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imagination at work



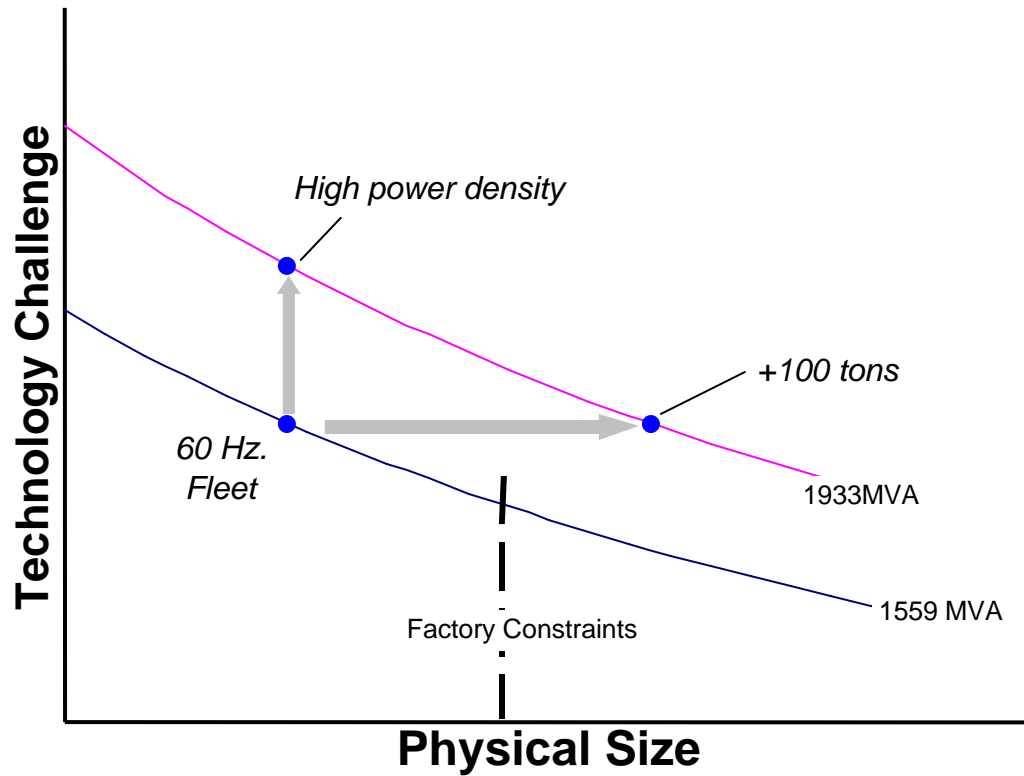
The Challenge

Design & manufacture a 4 Pole generator:

- At ~ 25% higher rating than current experience
- With 60 year expected life

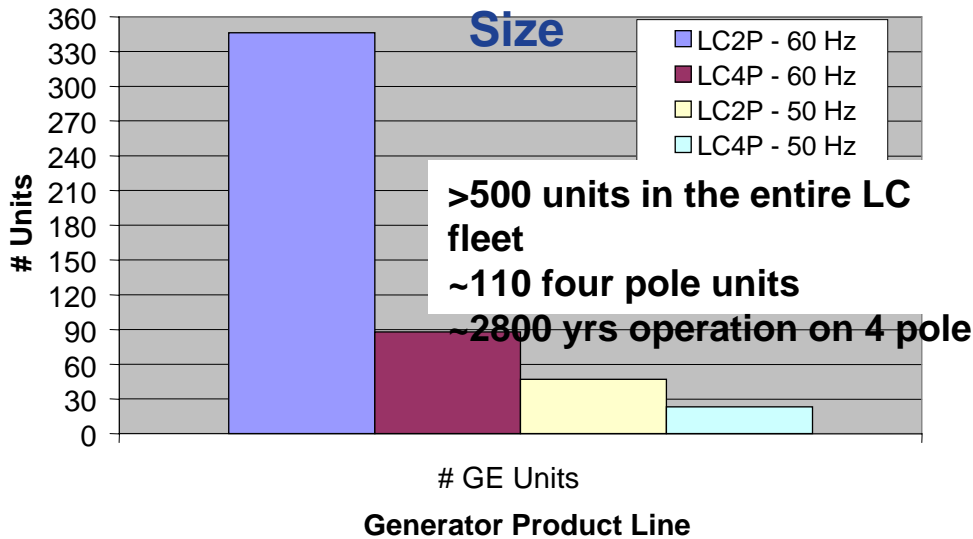
The Choices

- Higher Power Density ?
- Larger Physical Size ?

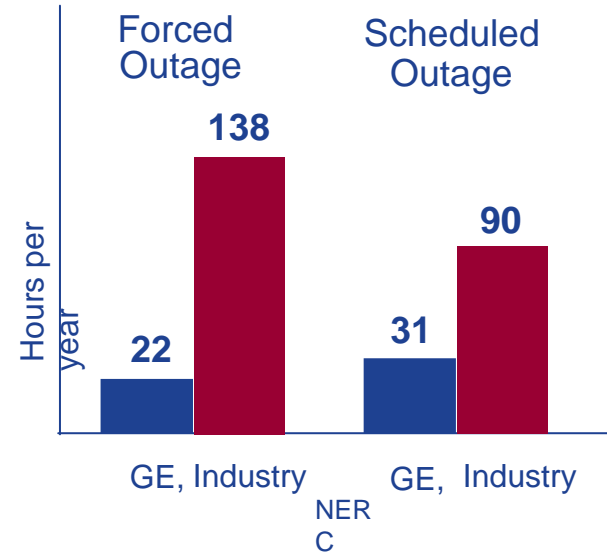


Build on Proven Generator Technology

GE Liquid Cooled Fleet



World class reliability & availability

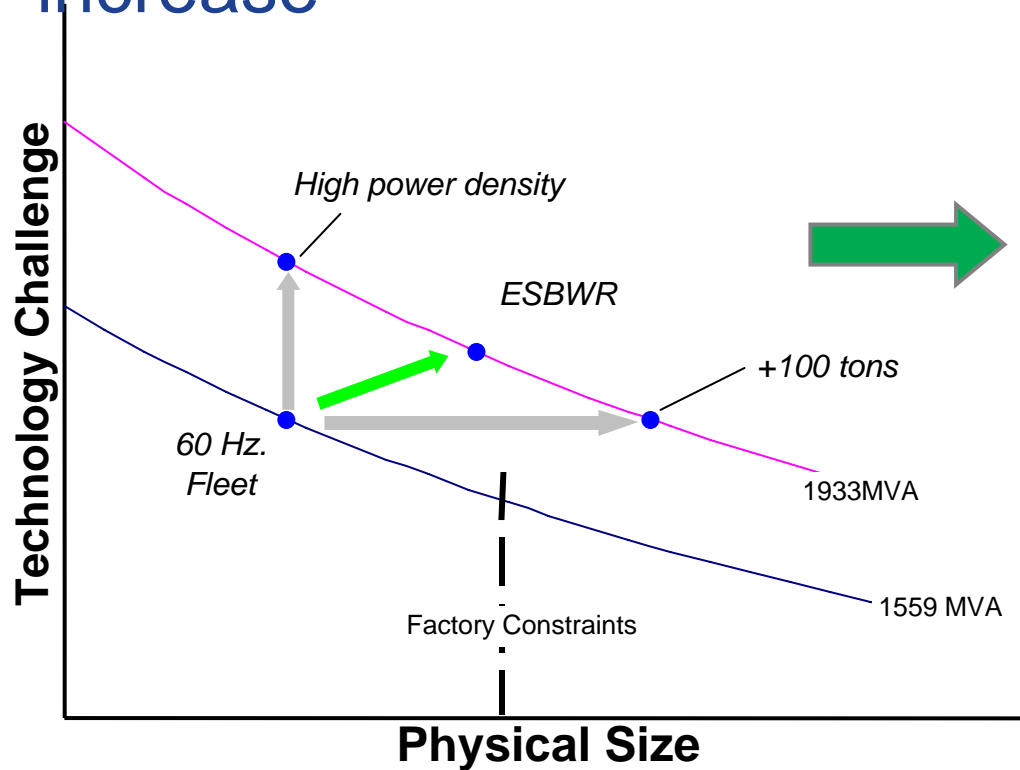


Top 10 MVA Rated 4-pole Running Experience

Country	Project Qty	Ship -1st Unit	MVA Rating	RPM	Frequency (Hz)
United States	3	1-Jan-78	1559	1800	60
Japan	2	30-Jun-94	1540	1500	50
United States	2	1-Dec-79	1450	1800	60
United States	1	1-Jan-77	1447	1800	60
United States	1	1-Mar-87	1439	1800	60

The Solution

ESBWR Generator ~+25% Output 10% size increase



ESBWR Generator Challenges

- +10 % Higher Terminal Currents
- +17% Torque Loads
- Factory Infrastructure limitations

The Result

Stator Design

- Optimized core-end profile
- End shield mounted bearing
- Robust core suspension
- Single ended output terminals

Armature Windings

- Micapal® Insulation System
- Advanced TetraLoc® End-winding support system
- Non phosphorous series loop brazes

Rotor Design

- Single piece forging
- Radial Flow Cooling

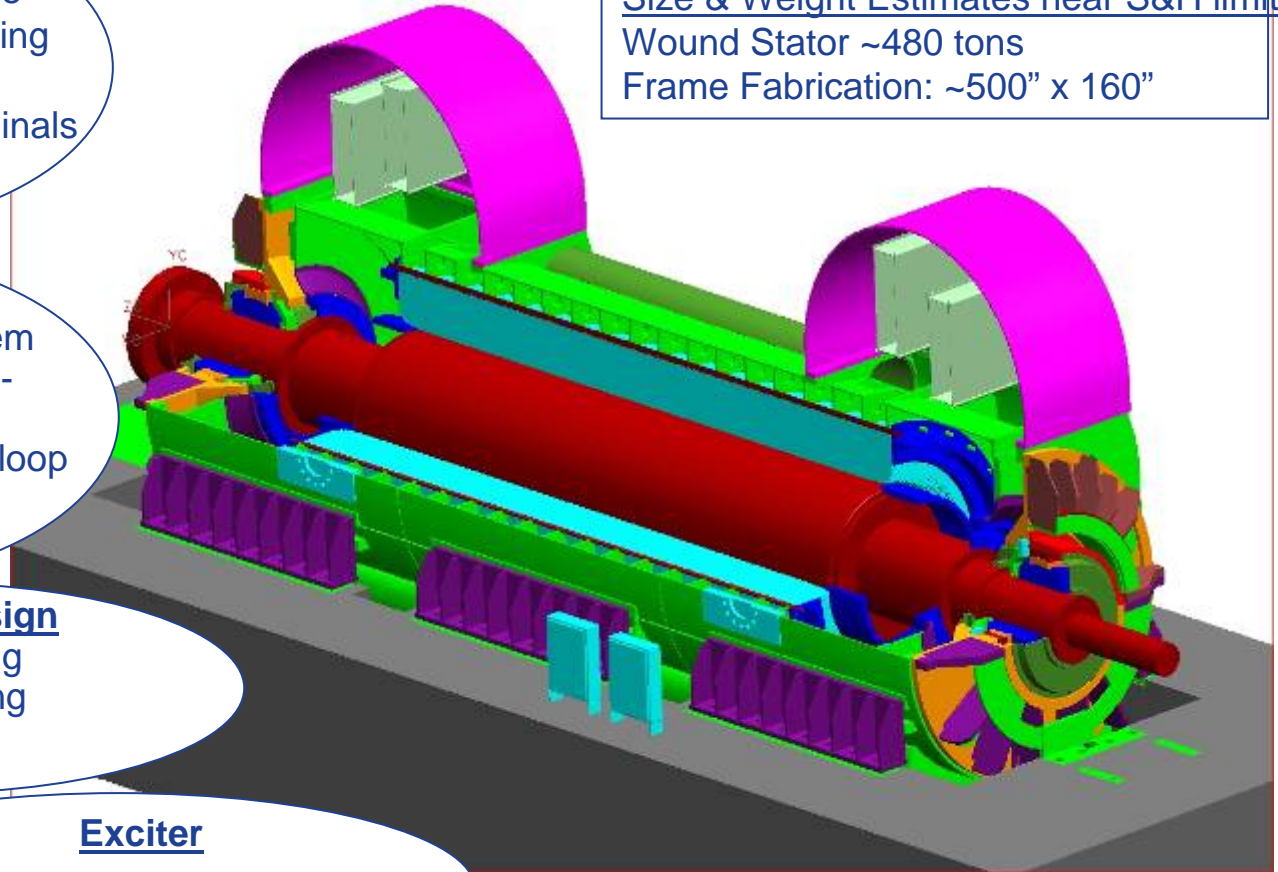
Exciter

- Static 4-Bridge Bus Fed EX2100
- Triple Redundant Controls

Size & Weight Estimates near S&H limits

Wound Stator ~480 tons

Frame Fabrication: ~500" x 160"



Risk Retirement

Proactive Risk Identification

- Identifying 60 year life issues now
- FMEA at all stages

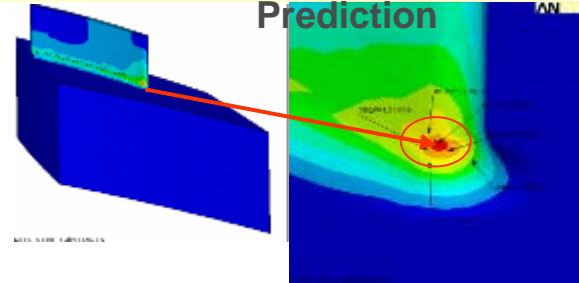
Mitigate known risks

- Electromagnetic, thermal, static, and Vibration analysis
- Component and factory test
- Manufacturing facility upgrade

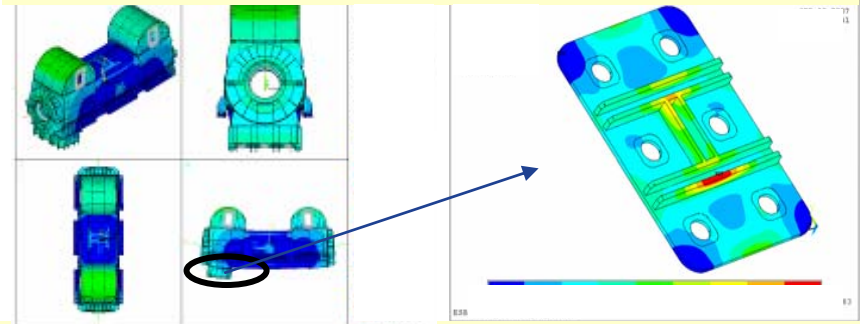
Understand critical design areas

- Core End Optimization
- Key bar voltages

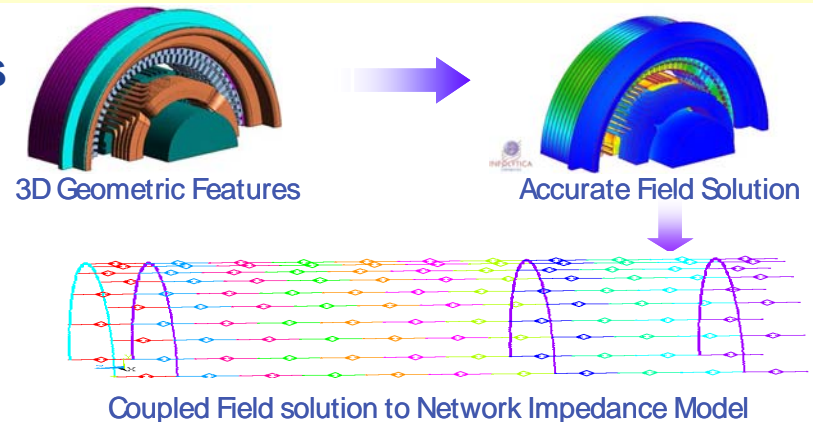
Model Refinement for accurate Life Prediction



FEM Tools to assess Top Risks



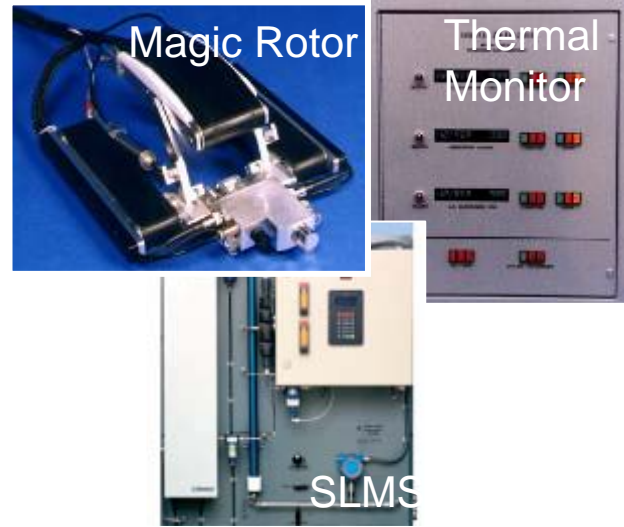
Methods to assess electromagnetic effects



Leverage Service Technology for Life Extension

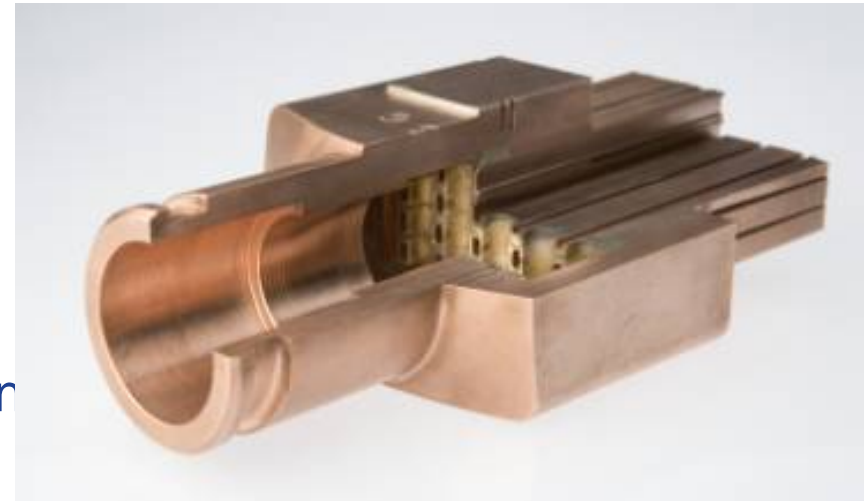
Enable outage interval extension

- SLMS-HP
- Advanced monitoring
- Robotic inspections

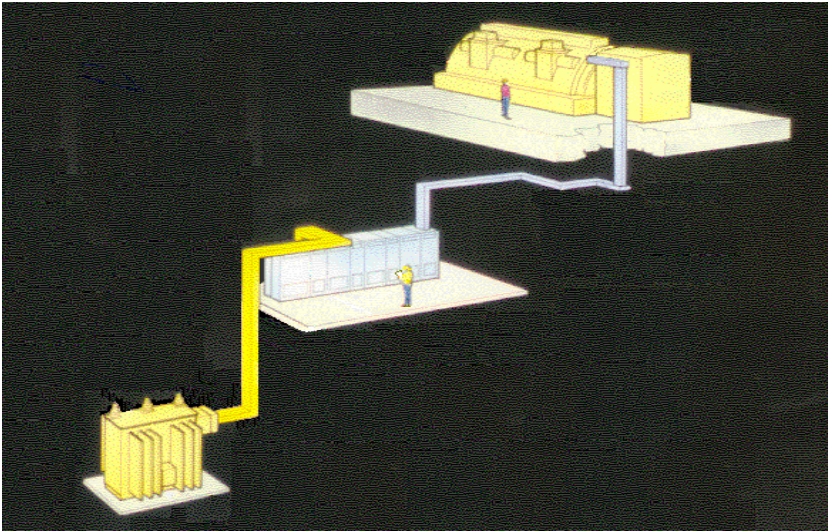


Minimize planned maintenance

- Leak-Free Stator bar braze
- Top Ripple Spring Wedge System
- TetraLoc[®] End-winding Support
- Robust Radial Cooled Field Windings



Static Bus-Fed Excitation System



Potential Power Transformer (PPT)

- Cast Coil
- Free Convection Cooled

Static Exciter (GE EX2100)

- Integrated Control System
- Fault Tolerant Design
 - TMR Control
 - N+1 Bridges (4)
- 6 pulse Rectifier Bridge
- Forced Air Cooled rated @ 40C (<80 dB)
- On-Line Maintenance (Bridge & Control)
- High Initial Response (160% ceiling, 2.0 RR)
- Power System Stabilizer (Integral of Acc. Power)

Benefit

- Improved Reliability and Availability
- Improved System Efficiency
- Lower Maintenance and Operating Cost
- Grid Performance

Summary

- **ESBWR Generator design established**
 - **Extending proven Technology to deliver ~+25% higher power for 10% increase in size**
 - **Leveraging advancements in services technology and analytical capability to add value and retire risks**
 - **No insurmountable technical challenges**
 - **Design driving lower life cycle costs**
- **Excitation System**
 - **Static Bus Excitation System enhanced reliability**
 - **High response for grid stability**

