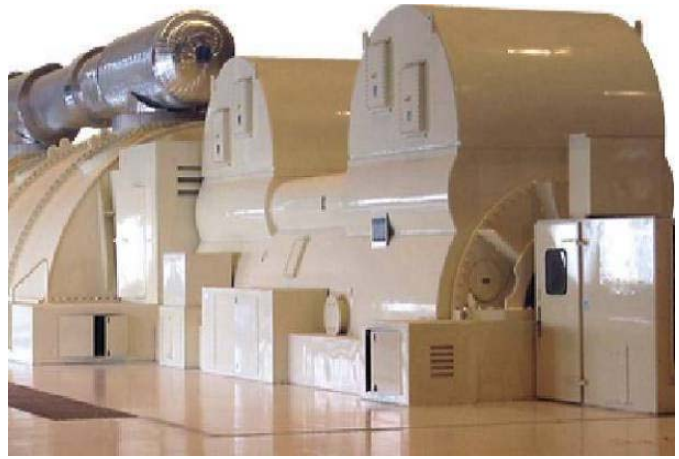
Generator Design Optimization – Nuclear Power Plant Applications



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imagination at work

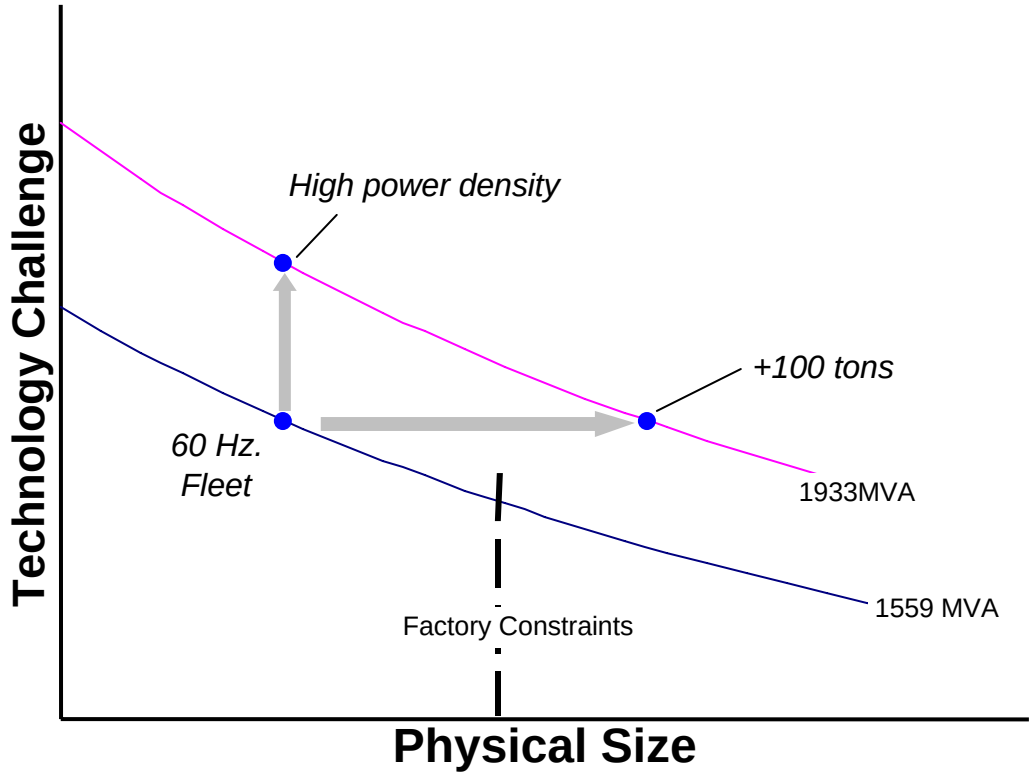
The Challenge

Design & manufacture a 4 Pole generator:

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

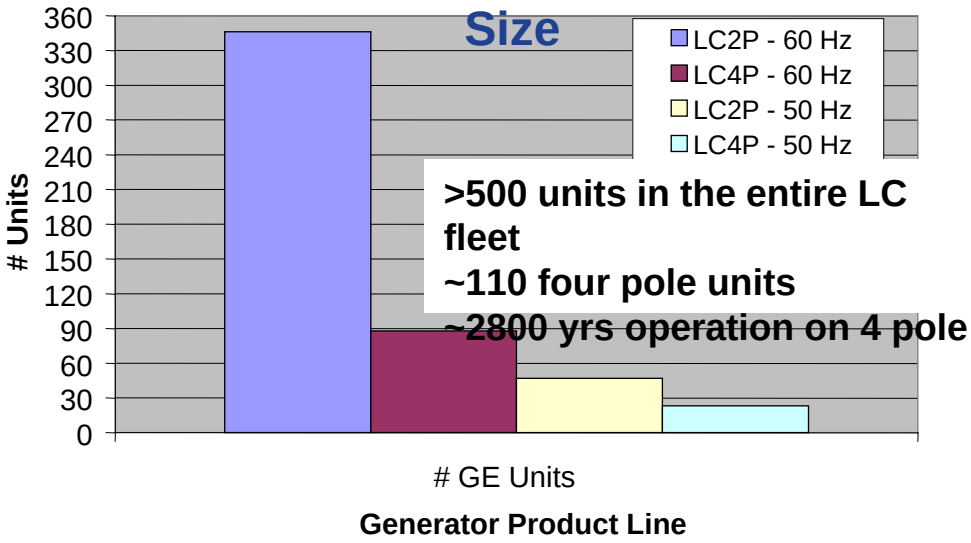
The Choices

- Higher Power Density ?
- Larger Physical Size ?

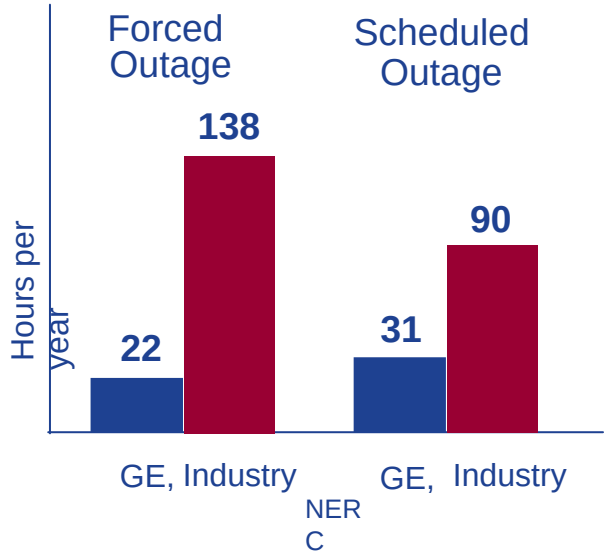


Build on Proven Generator Technology

GE Liquid Cooled Fleet Size



World class reliability & availability

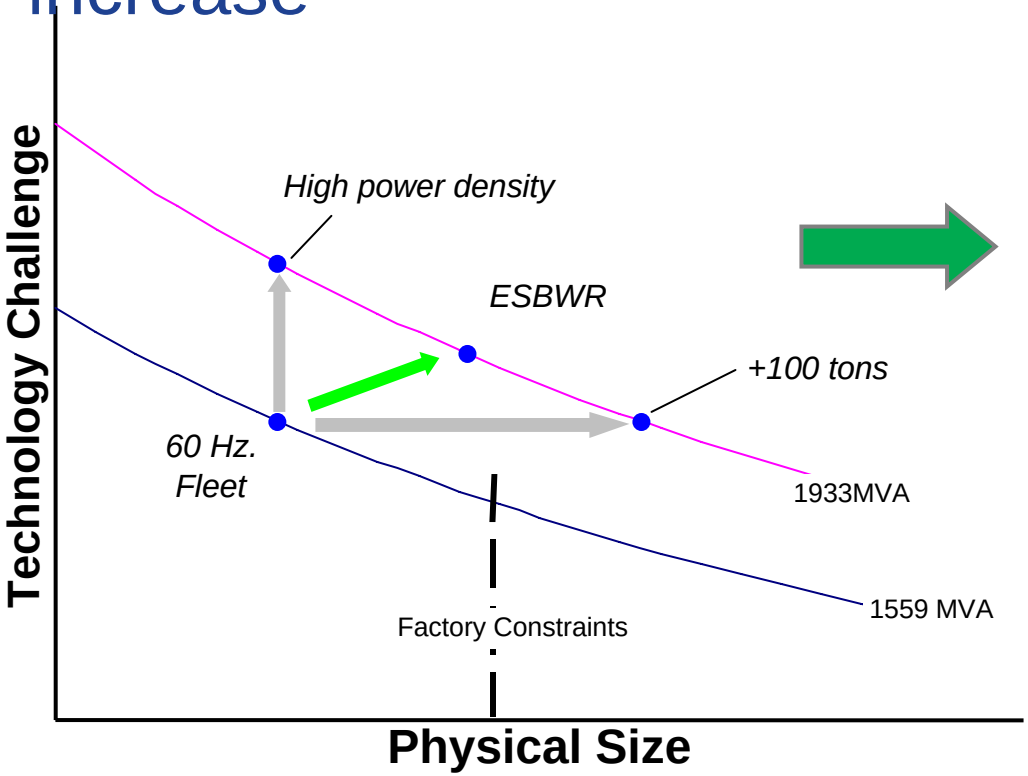


Top 10 MVA Rated 4-pole Running Experience

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

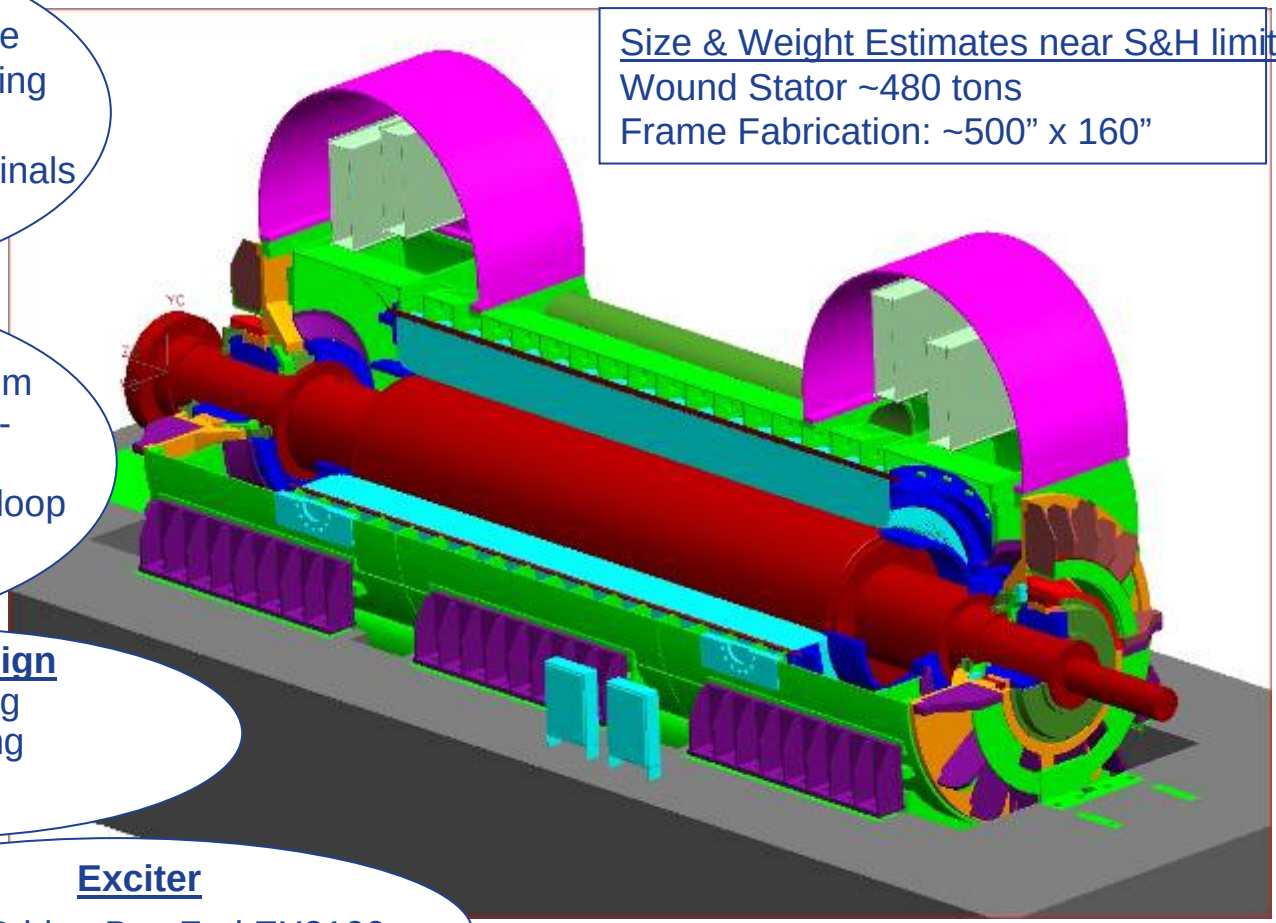
The Result

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”

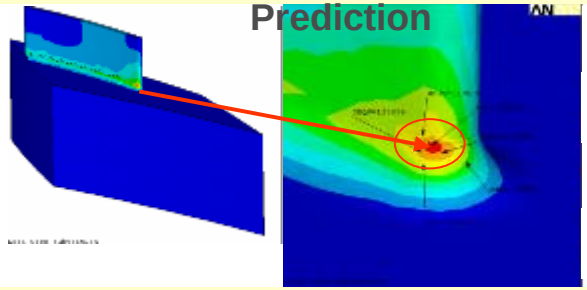
Risk Retirement

Proactive Risk Identification
- Identifying 60 year life issues now
- FMEA at all stages

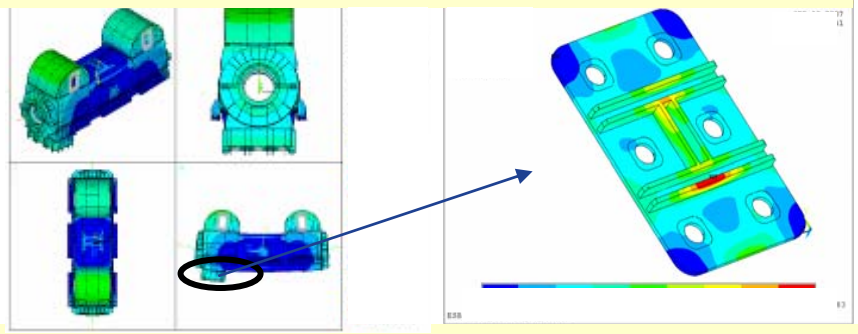
Mitigate known risks
- Electromagnetic, thermal, static, and Vibration analysis
- Component and factory test
- Manufacturing facility upgrade

Understand critical design areas
- Core End Optimization
- Key bar voltages

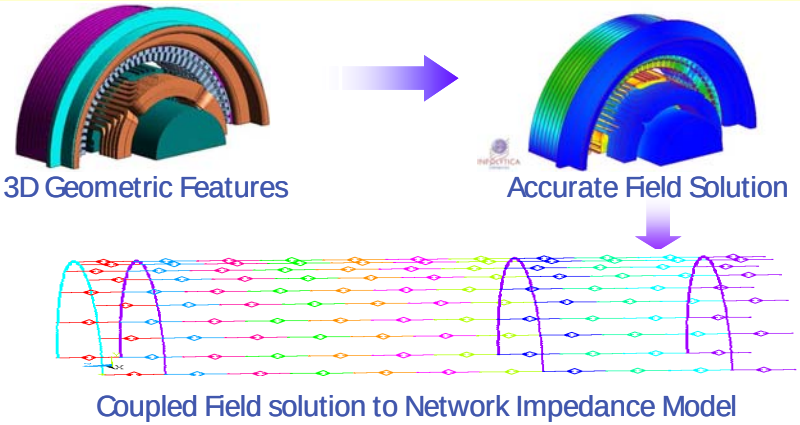
Model Refinement for accurate Life Prediction



FEM Tools to assess Top Risks



Methods to assess electromagnetic effects

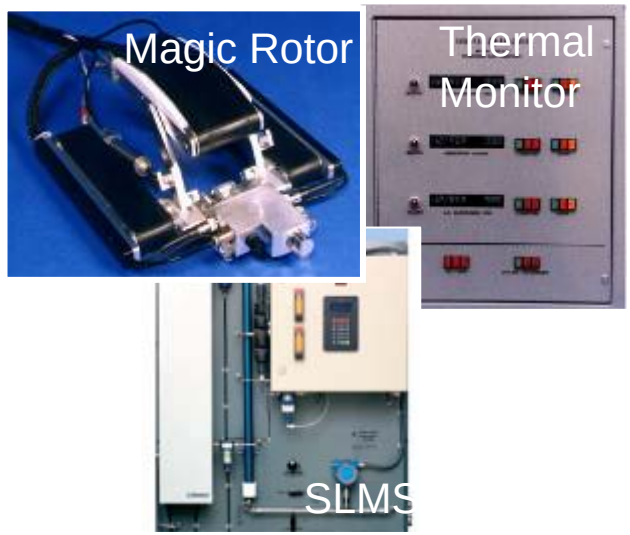


imagination at work

Leverage Service Technology for Life Extension

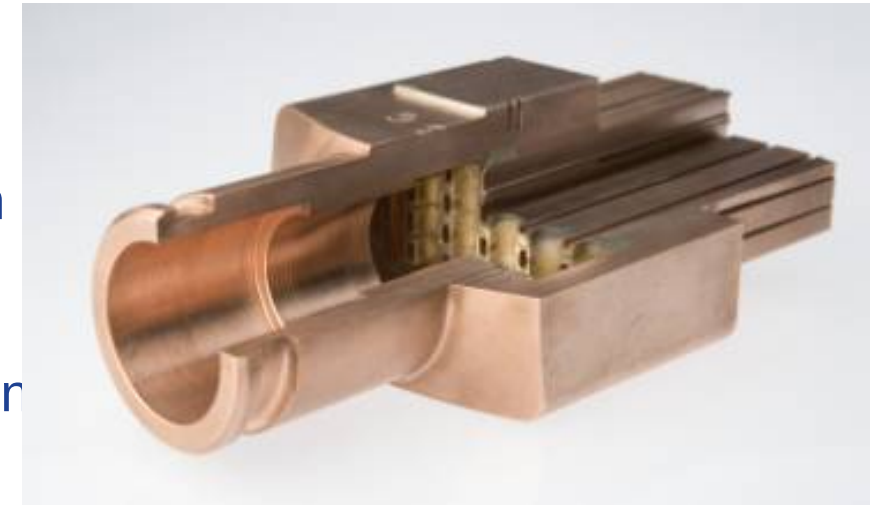
Enable outage interval extension

- SLMS-HP
- Advanced monitoring
- Robotic inspections

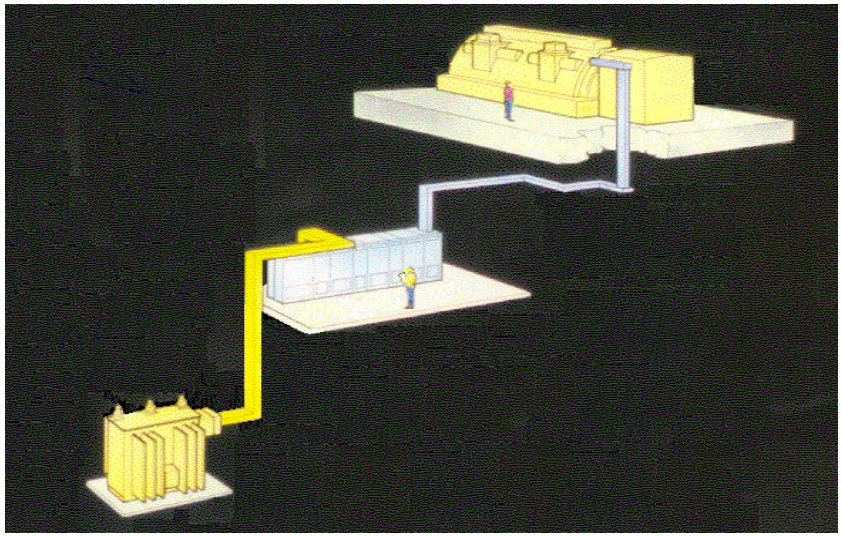


Minimize planned maintenance

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



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