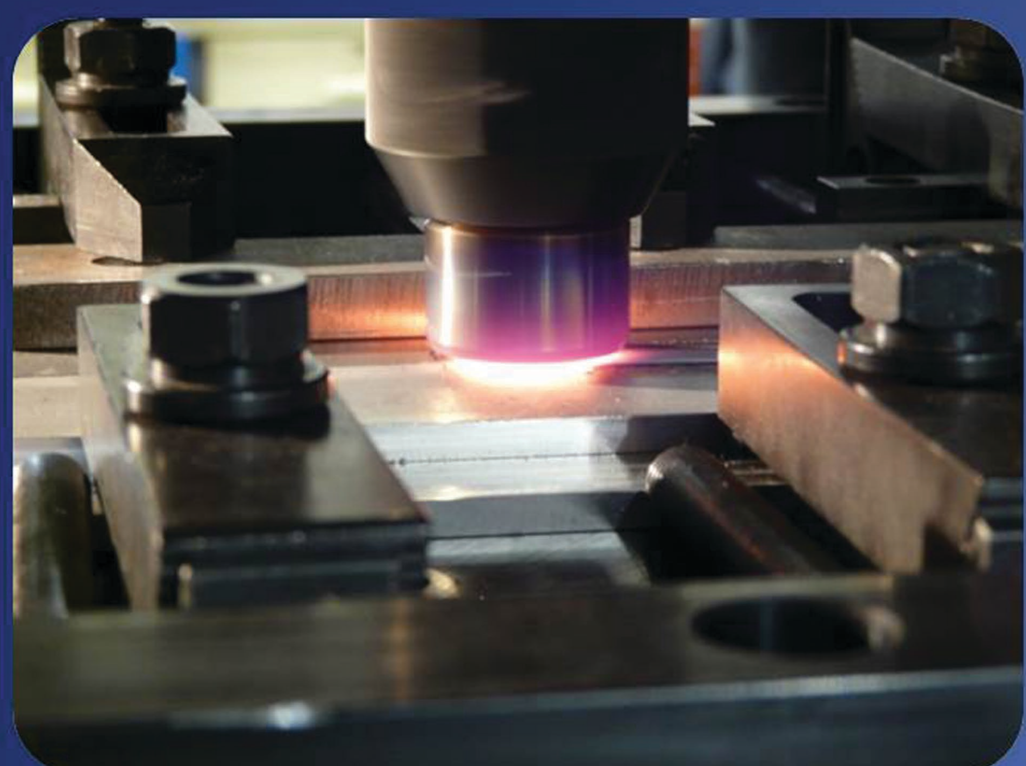
CROSSCUTTING TECHNOLOGY

NETL

High Performance Materials

Advanced Manufacturing for High Performance Structural & Functional Materials

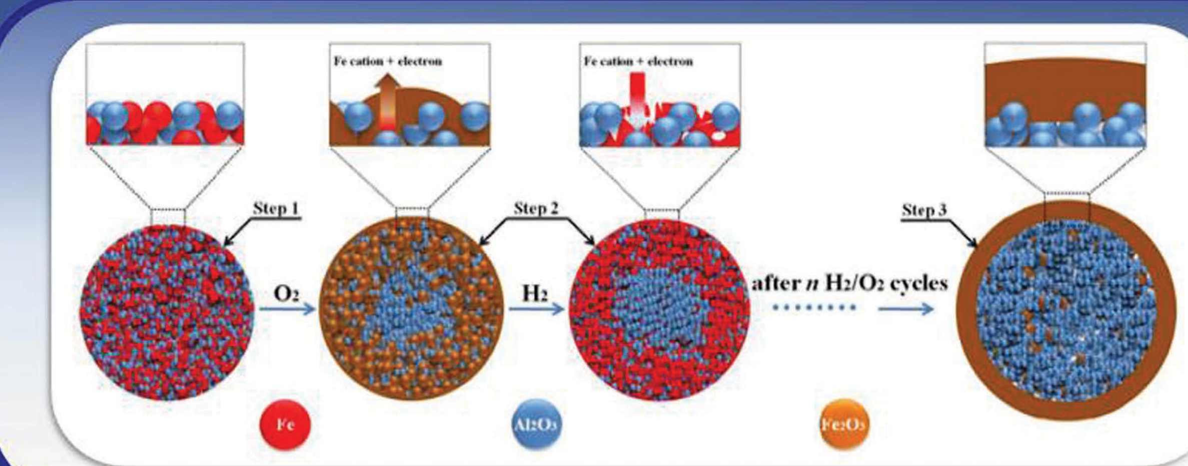


Friction stir welding of ¼" thick dispersion strengthened Sandvik APMT plate

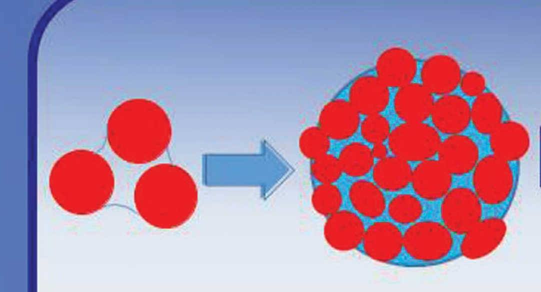
Advanced Manufacturing for High Performance Structural and Functional Materials: Advanced manufacturing provides technologies to fabricate, assemble and join components from high performance materials for advanced FE power generation technologies.

Functional Materials for Process Performance Improvements

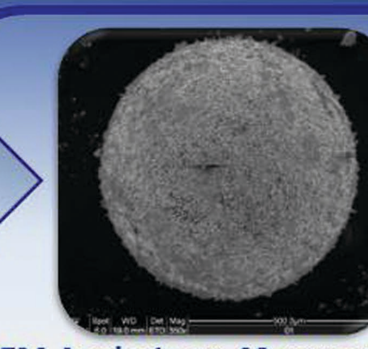
Functional Materials for Process Performance Improvements: Develop functional materials such as sorbents, coatings, catalysts, Chemical- Looping oxygen carriers, and high temperature thermo-electrics needed for advanced FE power generation technologies.



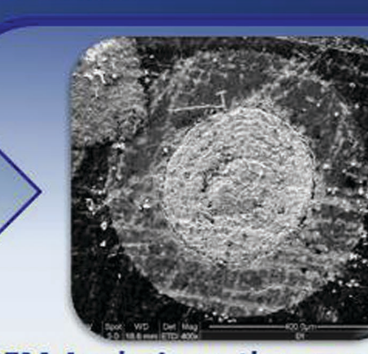
Oxidation and Reduction cycles: Ionic Diffusion



Microscopic View of Granulation



SEM Analysis on 40 percent iron oxide loading particle



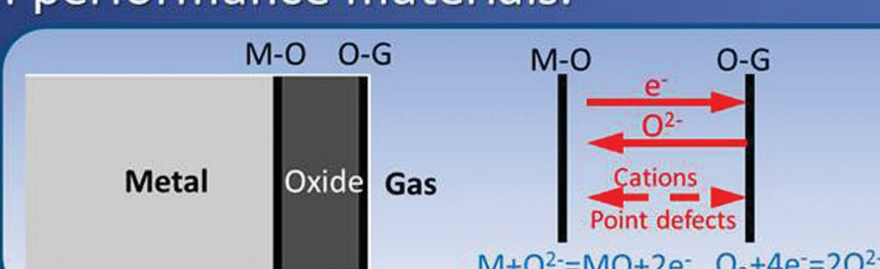
SEM Analysis on the cross-section of 40% iron loading particle.

Core-Shell Structured Oxygen Carrier for Chemical Looping Combustion

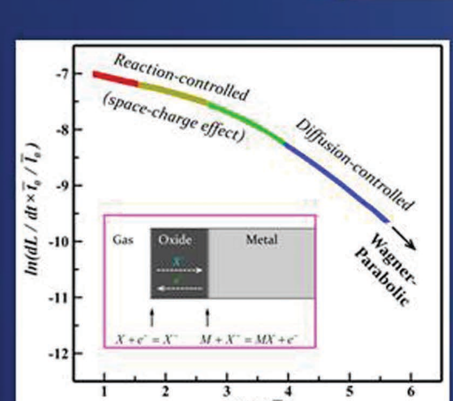
High-Performance Materials (HPM) focuses on materials that will lower the cost and improve the performance of existing and advanced fossil-based power-generation systems. There are four (4) research areas within HPM.

Computational Based Materials Design & Performance Prediction

Computational Based Materials Design and Performance Prediction will enable rapid design of new high performance materials, and provide validated models capable of simulating and predicting long-term performance of high performance materials.



- Chemical reaction
- Mass diffusion
- Charge interaction
- Moving boundary
- Microstructure heterogeneity
- Spallation due to misfit
- Multi-scale and multi-physics



M*ulti-scale simulation capability* **to solve the complex physics of the oxidation of metals transport of charged ions subject to interfacial reactions and long range electrostatic interactions**

Computational Simulation of Oxidation Rate of High Temperature Alloys

Advanced Structural Materials for Harsh Environments

Advanced Structural Materials for Harsh Environments: Develop advanced structural materials that are needed for the harsh operating environments (e.g., high temperature and pressure) of advanced FE power generation technologies.

Fabrication in Alstom Chattanooga, TN shop

Prior to Welding

Being Welded

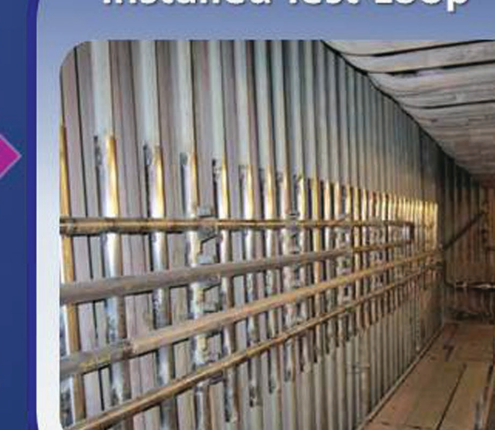
After Assembly

Materials included:
740H, CCA617, HR6W, Super 304H, Coating Overlays and Others

World's first steam oxidation/fireside corrosion test loop operating at 760°C (1400°F)

- Operated for over 5,000 hours above 760 deg C
- Initial evaluations of test samples show little to no metal oxidation or corrosion loss.

Installed Test Loop

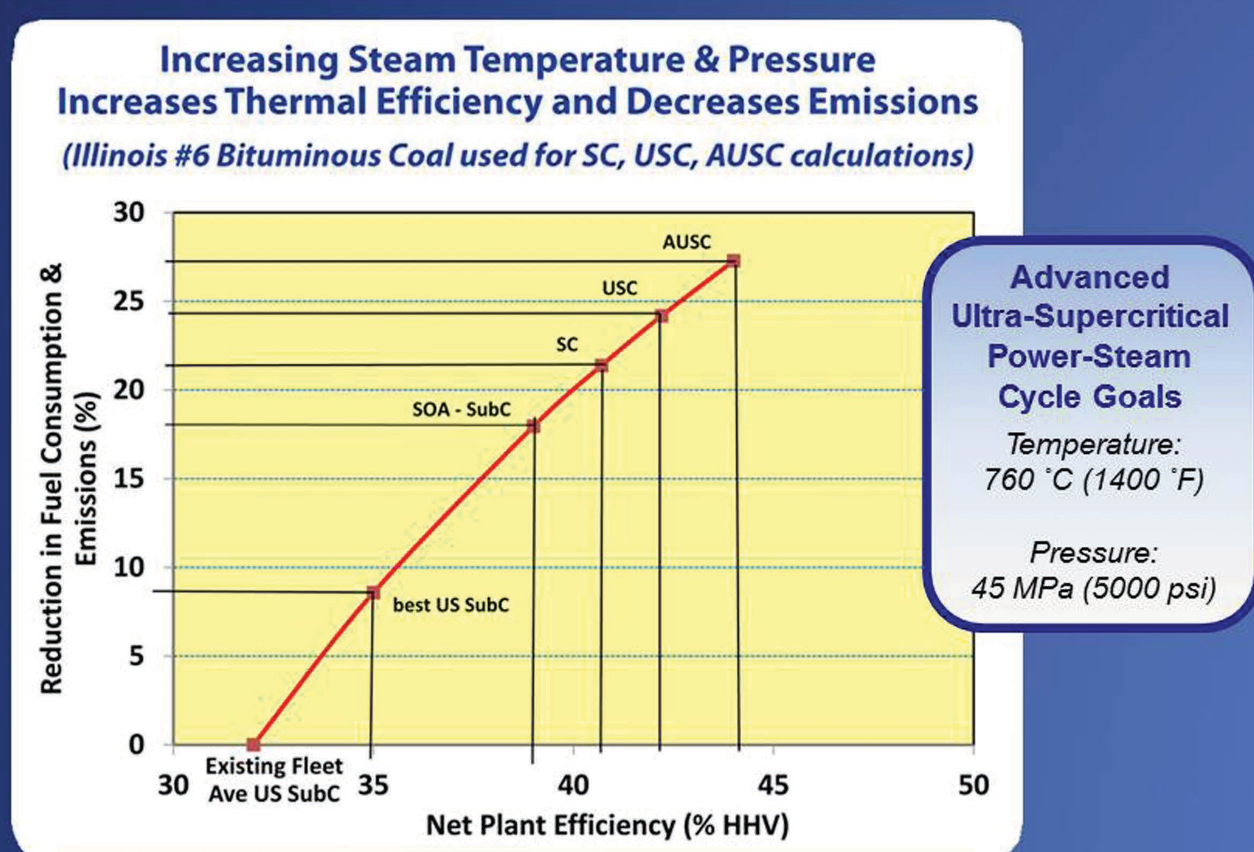


High Temperature Oxidation/Corrosion Test Loop for Advanced Structural Alloys

CROSSCUTTING TECHNOLOGY

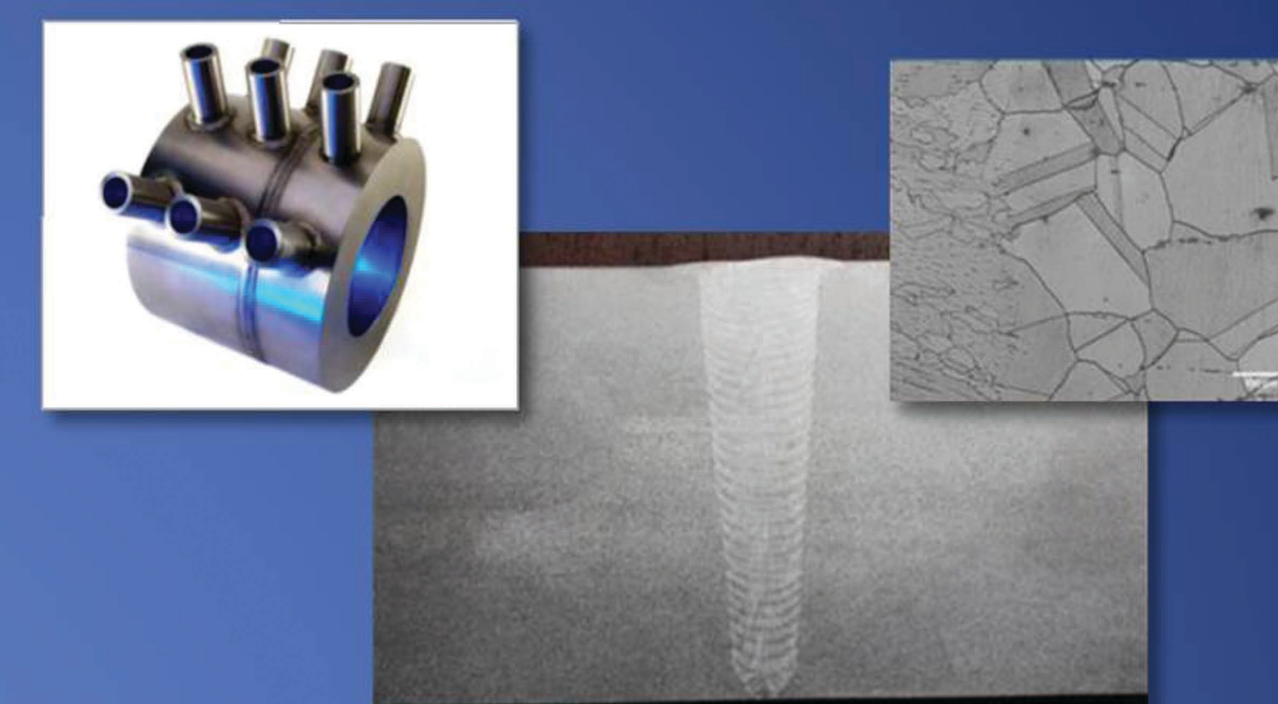
Crosscutting Research Program High Performance Materials: Advanced Ultra-Supercritical (AUSC) Consortium

The High-Performance Materials research area focuses on materials R&D that will lower the cost and improve the performance of advanced fossil-based power-generation systems. Advanced-Ultra-Supercritical (AUSC) technology will use advanced structural materials to achieve a step increase in the operating efficiency of coal fired power plants.



AUSC Consortium Members

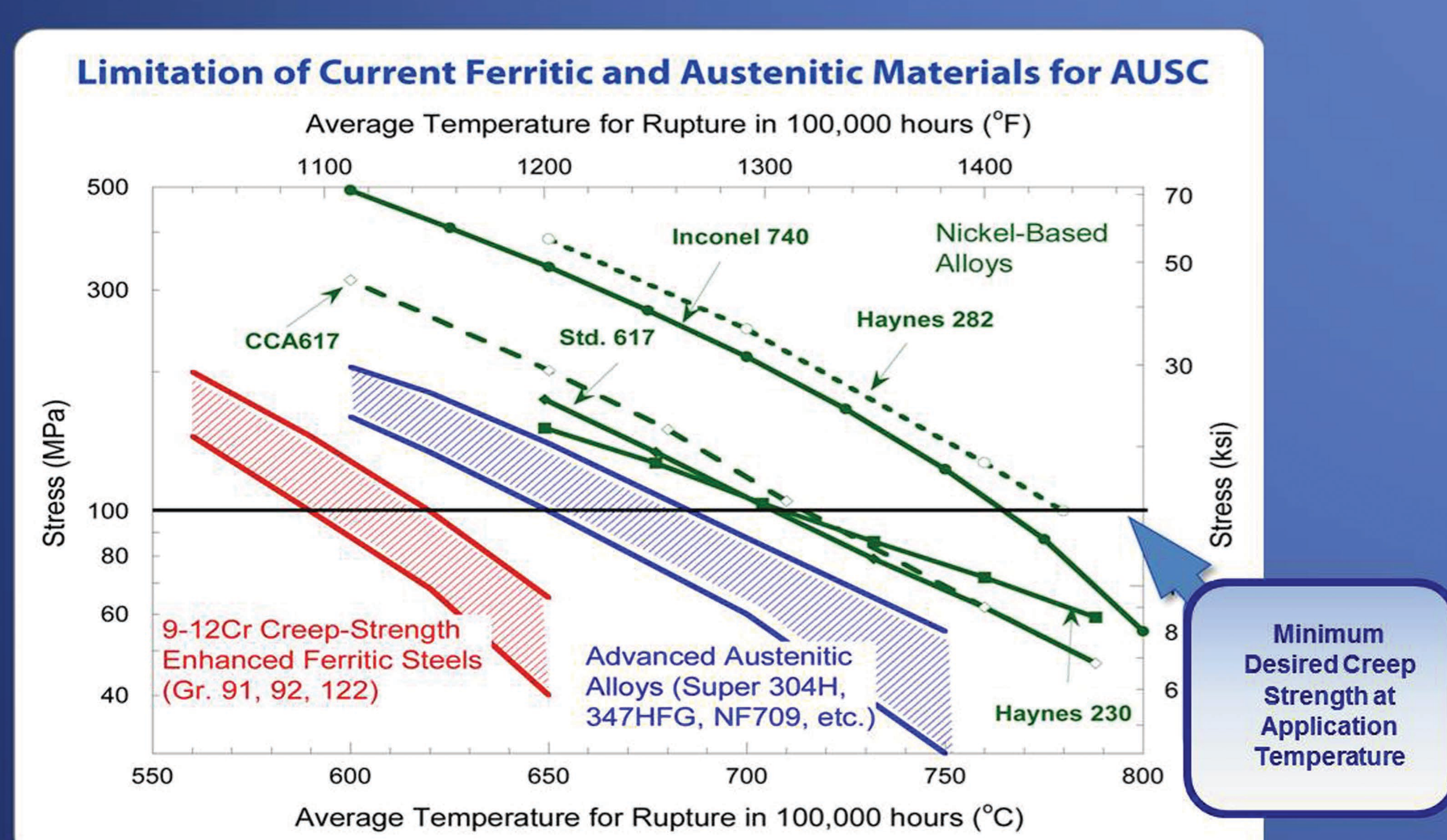
Laboratory scale tests were performed on the most promising alloys to determine relevant mechanical properties, resistance to steam-side oxidation and fire-side corrosion in boilers. The alloys were also tested for their fabricability, weldability, and castability.

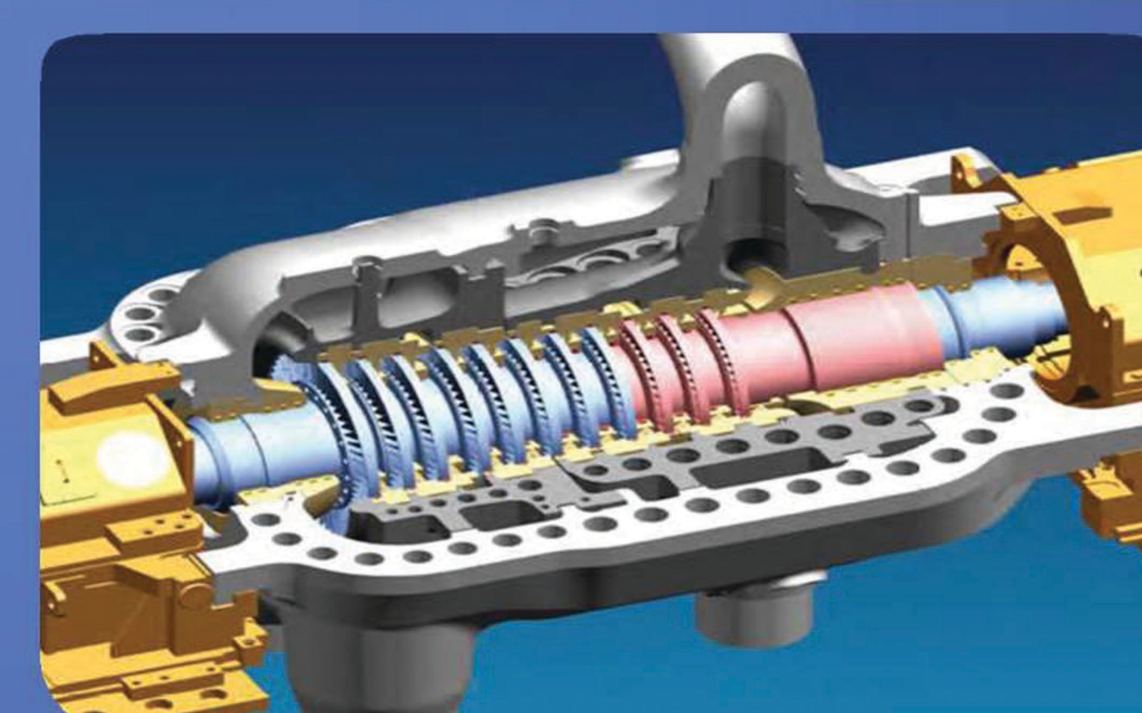


76mm (3") Wall Thickness Full Circumferential Pipe Weld in Inconel 740H

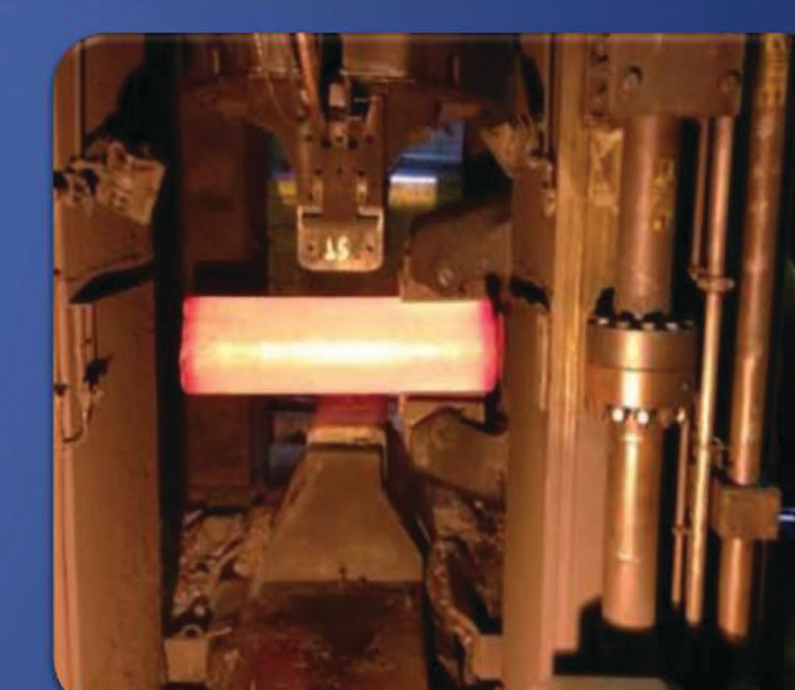
Research was also conducted on nickel superalloy materials for an AUSC steam turbine. Work focused on developing the specific methods for casting and forging these materials and determining the weldability, mechanical properties and repairability of the candidate alloys for turbine rotors, casings and valves.

The AUSC Consortium project focused on existing nickel super-alloys that are capable of operating at AUSC temperatures and pressure. Most of these nickel super-alloys were developed for use in gas turbines or jet engines.





HPSteam Turbine Design for Operation at 760 °C (1400 °F)



World's First Haynes 282 Triple Melt Ingot

Key on the achievements development of AUSC materials include:

- Completion of a long term combined fireside/ steam corrosion test loop installed in a coal fired boiler. Analyses of the exposed alloys indicate very good resistance to fireside corrosion during the test period.
- Development of welding methods for up to 3 inch thick sections of nickel superalloys
- ASME Code approval of Inconel 740 for use in power plant boilers and piping
- The first triple melt Haynes 282 forging ingot and the world's largest Haynes 282 valve body casting

U.S. DEPARTMENT OF ENERGY

STRATEGIC CENTER for COAL