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U.S. Program for Advanced Ultrasupercritical (A-USC) Coal Fired Power Plants

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McIlvaine Company "Hot Topic" Webcast: Next Generation of Coal Combustion Technologies

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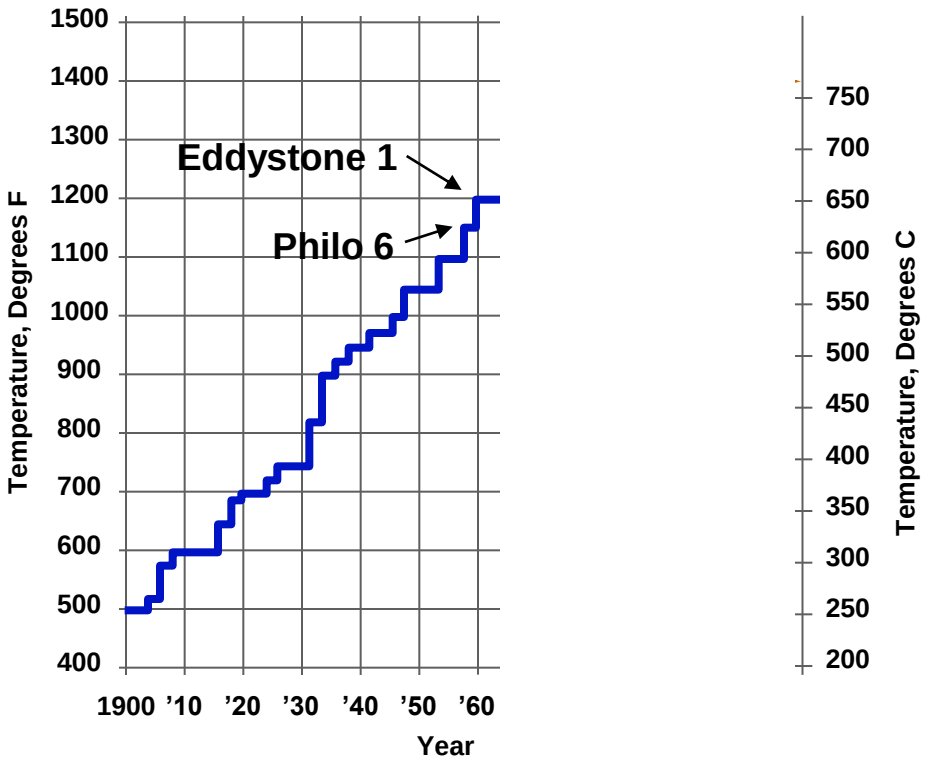
Definitions

Nomenclature	Conditions	Net Plant Efficiency	Net Plant Heat Rate (HHV)
Subcritical	2400 psig (16.5 MPa) 1050ºF/1050ºF (565ºC/565ºC)	35%	9751 Btu/kWh
Supercritical (SC)	>3600 psig (24.8 MPa) 1050ºF/1075ºF (565ºC/585ºC)	38%	8981 Btu/kWh
Ultrasupercritical (USC)	>3600 psig (24.8 MPa) 1100ºF/1150ºF (593ºC/621ºC) and above	>42%	8126 Btu/kWh
"Advanced" UltraSupercritical (A-USC)	5000 psig (34.5 MPa) 1250ºF (677ºC) and above	>45%	7757 Btu/kWh

Materials for A-USC Coal Power Plants – U.S. Department of Energy (DOE) and Ohio Funded Project



Maximum Steam Turbine Inlet Temperature History

- During 1st 60 years of the 20th century, steam turbine temperatures rose from 500 F to 1200 F
  - Thermal efficiency rose from 4% to 40% (HHV)
- Eddystone experienced several materials issues
  - Derated from 1200 F to 1135 F
- No improvements for 50 years!

Provides 20% lower CO_2 emissions than existing fleet average

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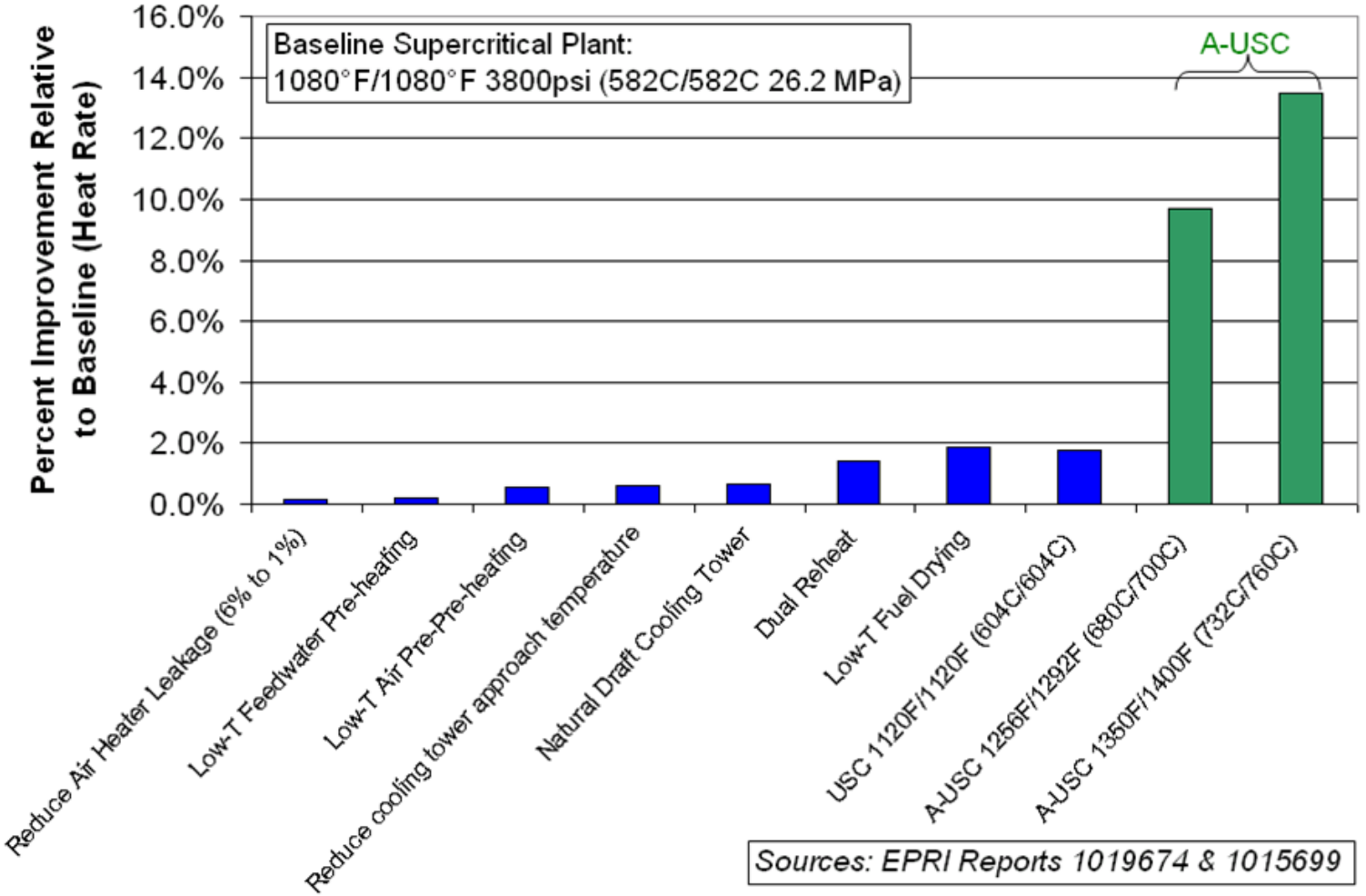
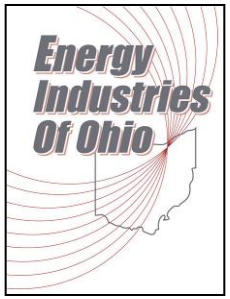
Heat Rate Improvement Technologies



Acknowledgements: U.S. DOE / Ohio Coal Development Office (OCDO) A-USC Steam Boiler and Turbine Consortia

U.S. DEPARTMENT OF ENERGY

MAKING OHIO COAL THE CLEAN CHOICE



Federal – State – National Laboratory

Non Profit – For Profit

Cost Sharing Consortium

ALSTOM

B&W

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FOSTER WHEELER

imagination at work

Babcock Power Inc.

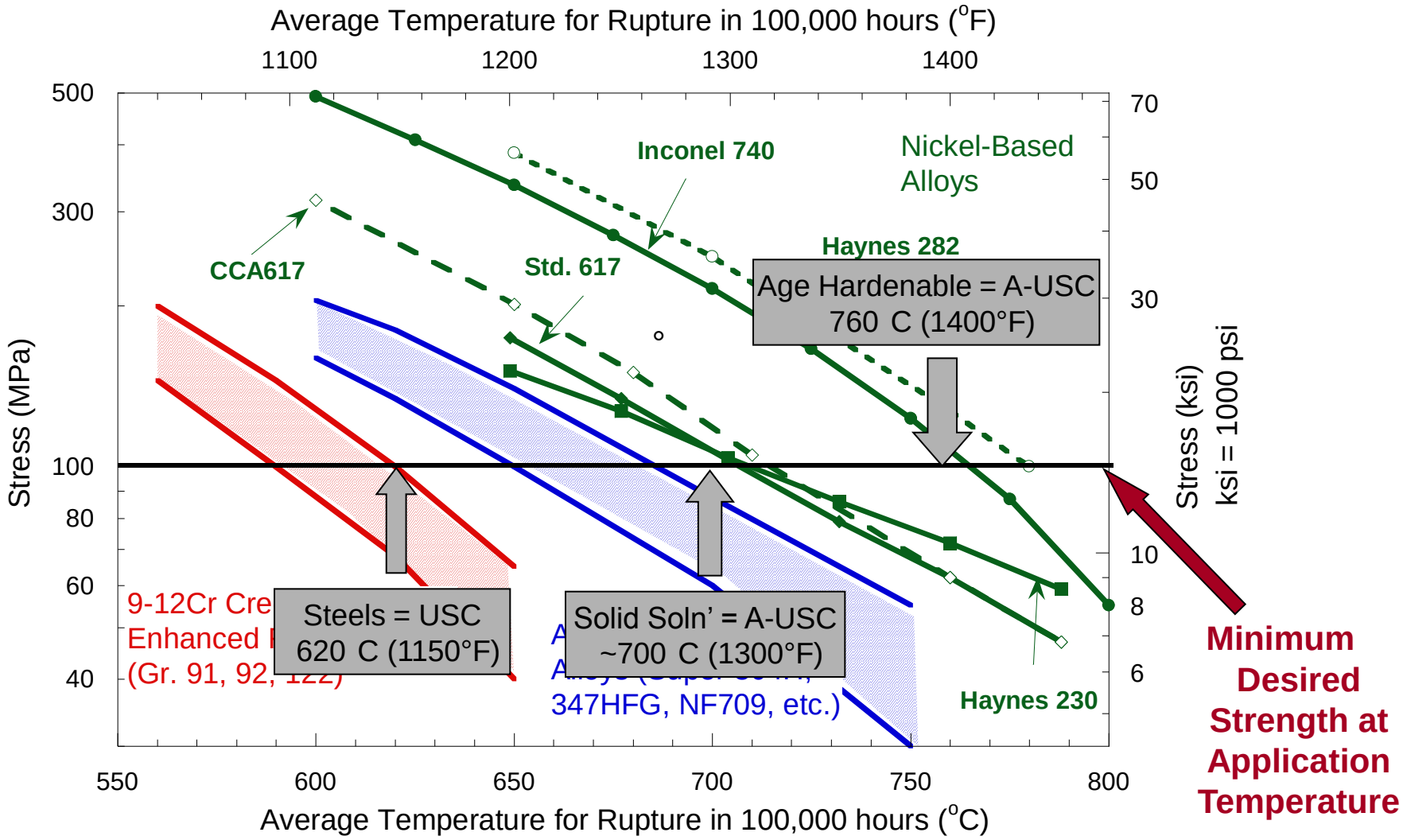
RILEYPower
A Babcock Power Inc. Company

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Primary Technical Goals of the U.S. A-USC Materials Program

- Materials Technology Evaluation
  - Focus on **nickel-based alloys**
  - Development of fabrication and joining technology for new alloys
- Unique Conditions for U.S. Program Considerations
  - Higher temperatures than European Program (760 C versus 700 C) means **additional alloys** are being evaluated
  - Corrosion resistance for **U.S. coals**
  - Data for **ASME code** acceptance of new materials
  - Phase II Boiler work includes **Oxycombustion**

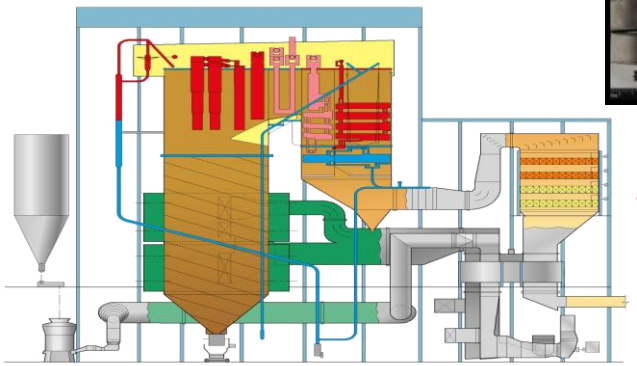
Materials Limit the Current Technology



U.S. DOE – OCDO Advanced USC Project

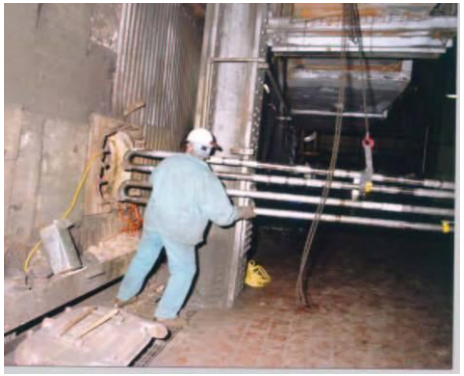
Accomplishments over the past 10 years

General design studies show favorable economics



Fabrication Processes

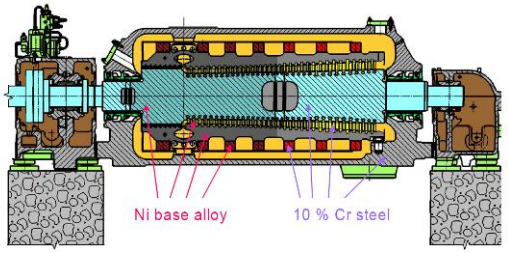
Welding Technology Developments



Steam-Side Oxidation

Fireside Corrosion (High-Sulfur Coal & In-Plant Testing)

HP Turbine Concept



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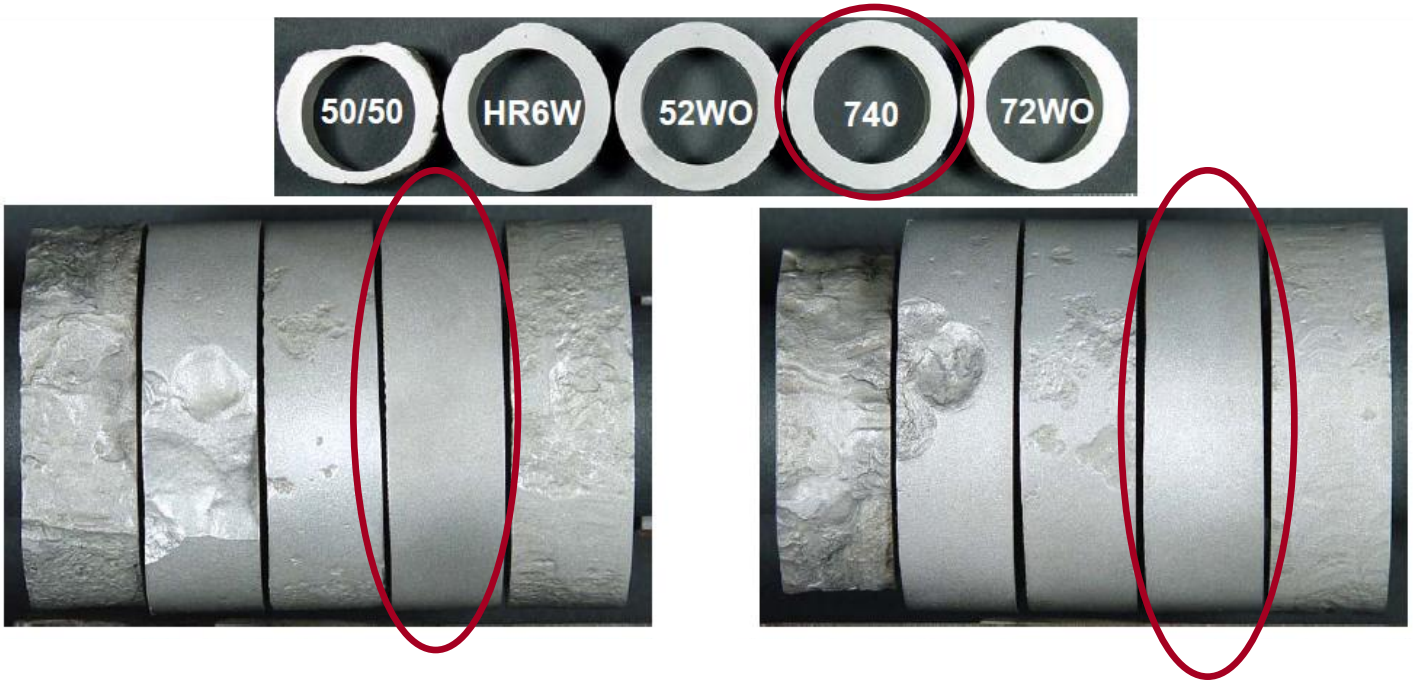
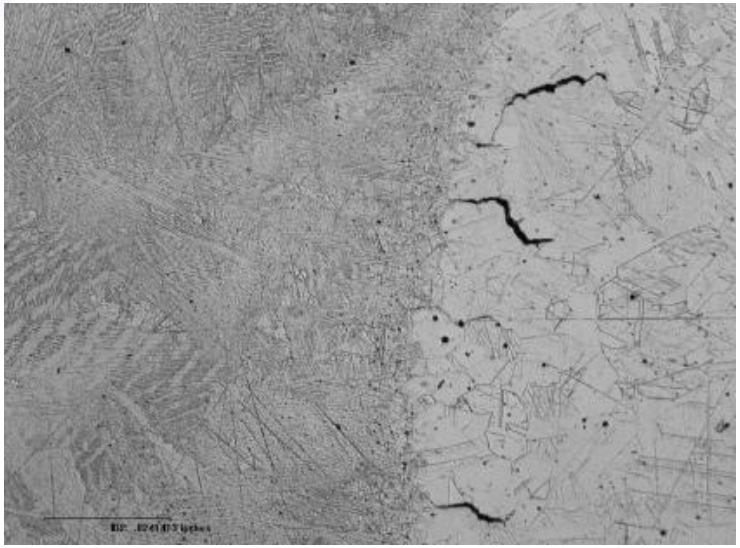
Successes: Air-cooled Probes

Cleaned surface of an air-cooled probe exposed for 2 years in a coal-fired boiler at A-USC temperatures



Inconel 740 shows lower wastage than a high-chromium cladding (50/50), a 23% Cr wrought alloy (HR6W), and weld overlays (WO)

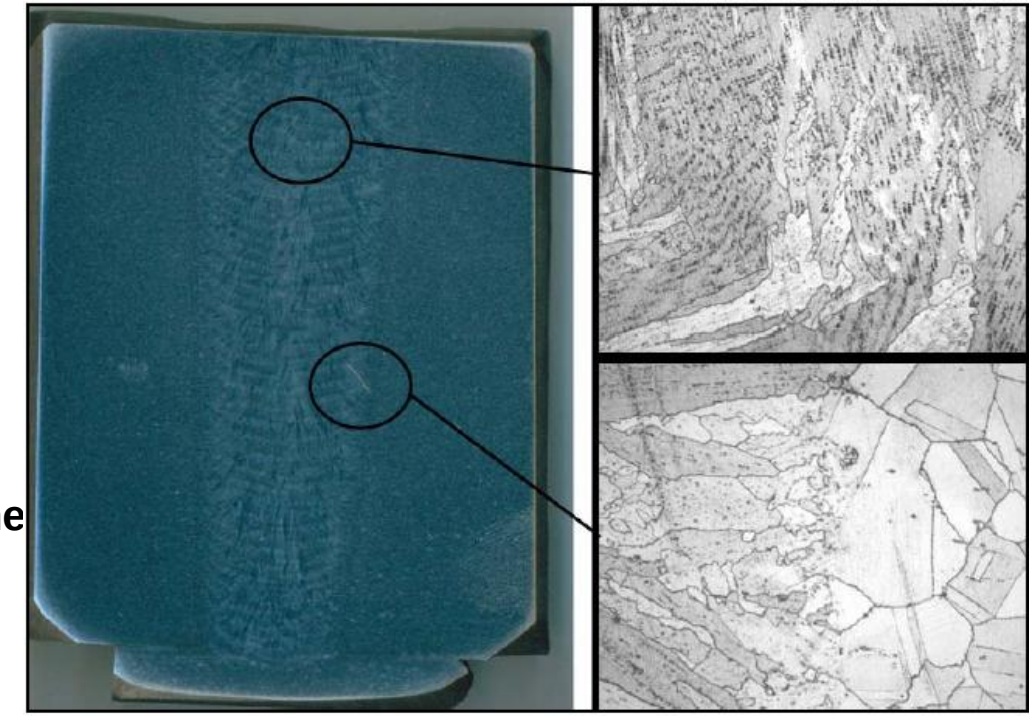
Successes: Welding Technology



Original Inconel 740 weld trials
(Liquation cracking in heat affected zone

Consortium Research

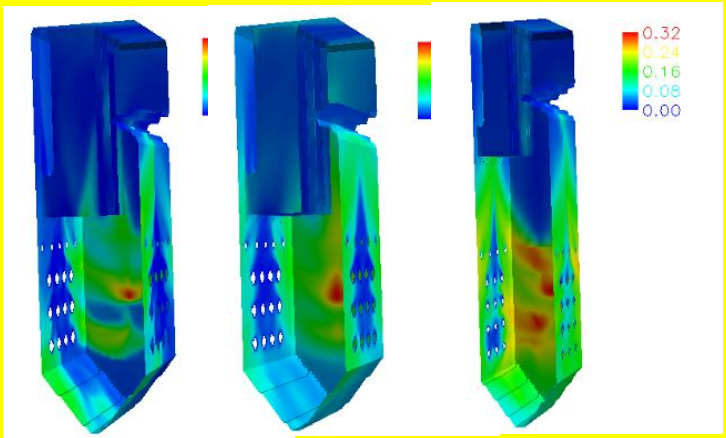
Today: Repeatable 3” (75-mm) thick Inconel 740 welds without cracking



Consortium research has demonstrated revolutionary progress in nickel-based alloy welding

A-USC Research & Development (R&D)

- Current Boiler & Turbine Materials R&D
  - Effect of **oxycombustion** on materials
  - Improved weld/weldment performance
  - Code approval of new alloys
  - Long-term high-temperature material property databases
  - Production of larger forgings
  - Scale-up and repair of nickel-based castings



Air , Low O_2 , High O_2

April 7 – Workshop in Washington, DC

Hotel Monaco

"Events" on EPRI.com for more information

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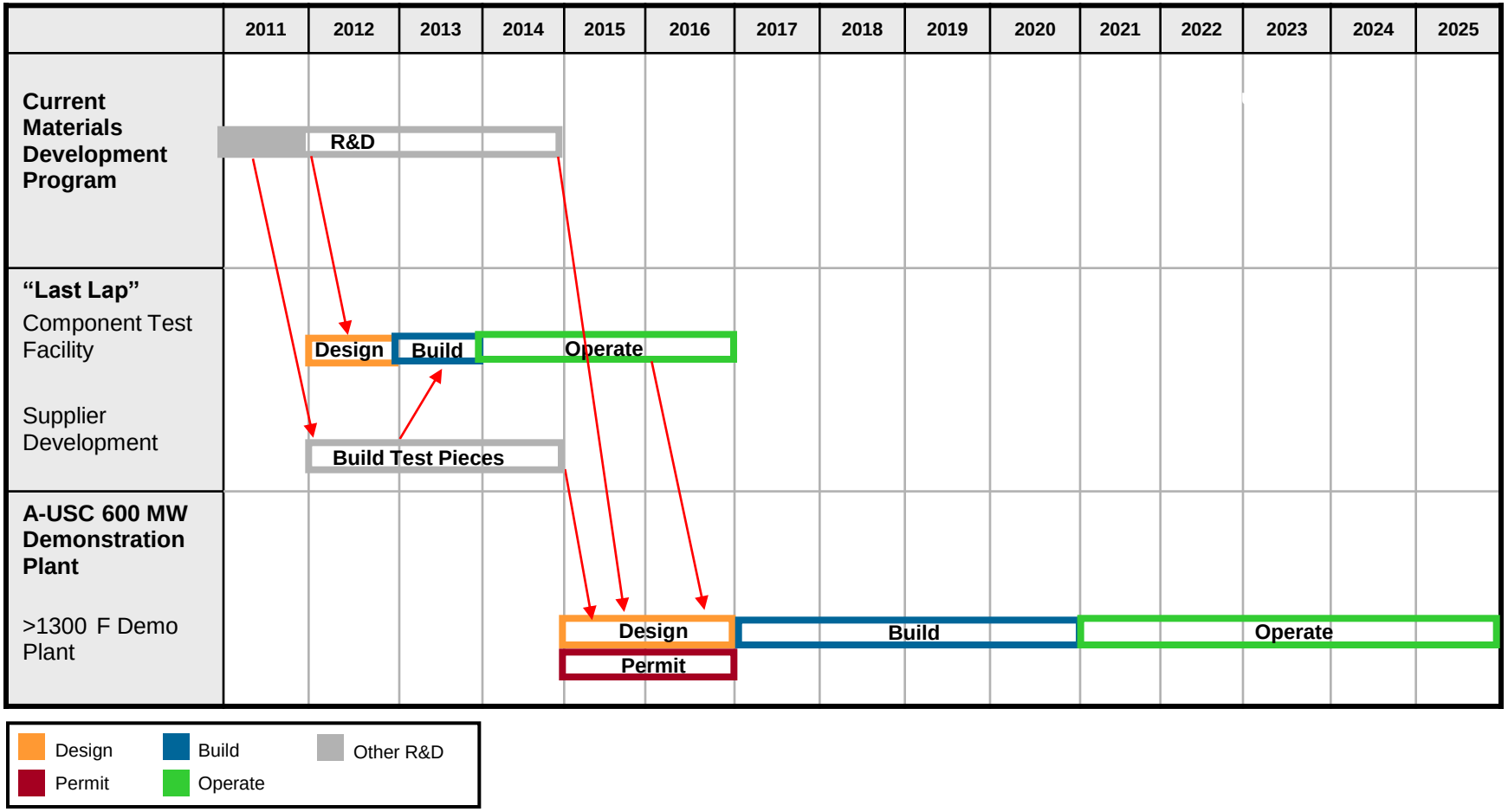
Timelines of Advanced USC Development



Provides 5 Years of Commercial-scale Experience by 2025

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Together…Shaping the Future of Electricity