UK/US Collaboration in Energy R&D: Clean Coal Technology

Advanced Materials Program

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Outline

- Background
- Why Collaborate?
- Collaboration Framework
- Phase 1 Tasks - Outputs and Benefits
- Plans for Phase 2

Background 1

- MOU Renewal
  - Under discussion 1999 - 2000
  - Signed 6th November 2000
  - Materials identified as a priority topic for collaboration
- DOE/DTI Workshop
  - Held in Knoxville, Tennessee in June 2001
  - Workshop identified many topics of common interest where collaboration would be possible
  - Text for Implementing Arrangement revised
  - Materials, Virtual Plant Demonstration, Near-zero Emission Power Plants, CO_2 Capture & Sequestration, Distributed Generation listed as ‘tasks’ to be developed

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Background 2

- Implementing Arrangement for Fossil Energy RTD
  - Signed 10th March 2003
  - Sets a framework for collaborative ‘tasks’ with named UK and US leaders
  - Followed up with workshop at NETL, Pittsburgh in June 2003
  - Agreed to proceed with collaborative tasks on Materials and Virtual Plant Simulation
  - Draft tasks prepared at the workshop
- Framework for Materials Collaborative Task
  - Contributions from nationally-funded public domain research
  - Task proposals define equitable research collaboration
  - Detailed work program aligning UK and US activities to maximise exchanges and benefits
  - Exchange and sharing methodology based on EU COST Program
- Collaboration starts April 2004

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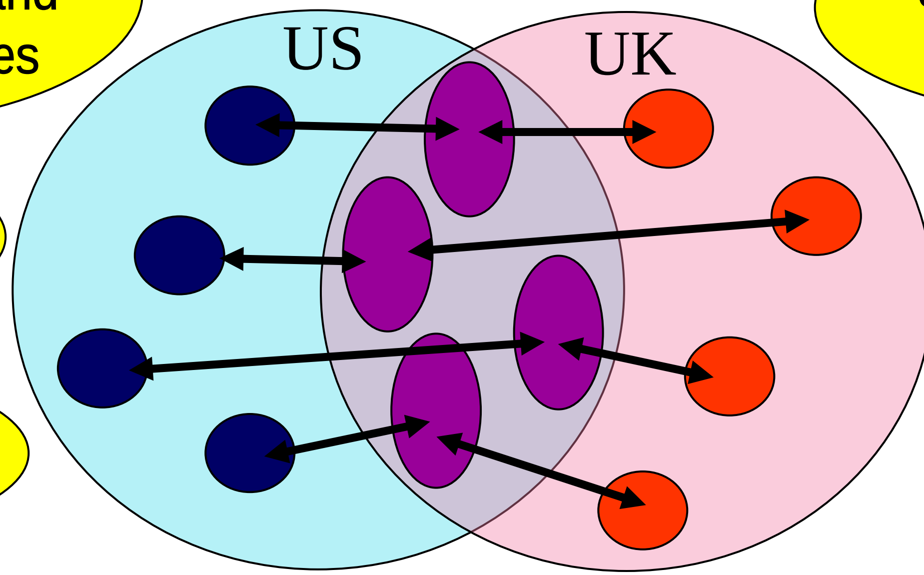
Why Collaborate?

Improved vision of industrial needs and national strategies

Increased specialist knowledge pool

Highly cost effective - small extra cost

Critical review of methods & results



Access to unique facilities

Reduced risk of wasted effort

Improved confidence in outputs

Less time to develop design & modelling capability

Improved quantity & quality of data

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EU COST Program

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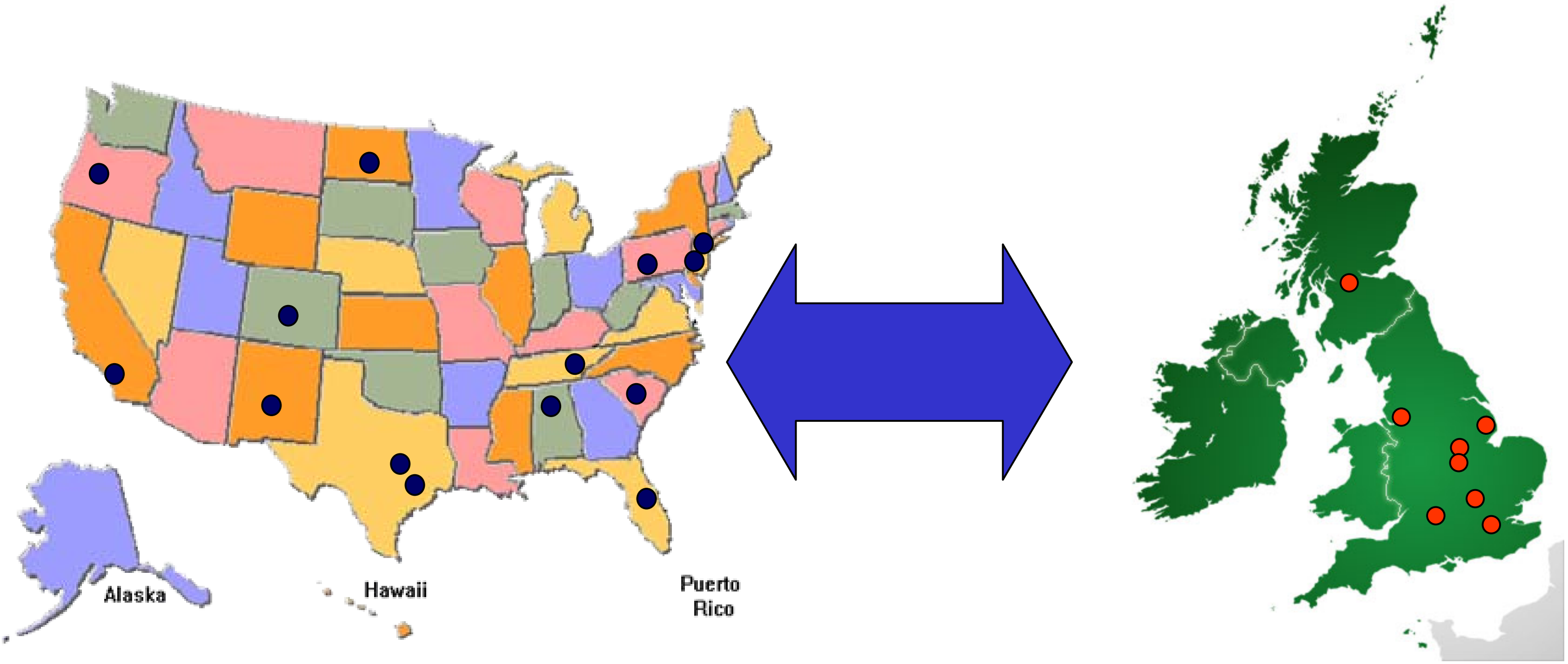
cost

UK/US Collaboration on Advanced Materials



Phase 1 Tasks

All tasks aimed at increased plant efficiency and reduced emissions

- Steam Oxidation
- Boiler Corrosion & Monitoring
- Gas Turbines Fired on Syngas and Other Fuel Gases
- Oxide Dispersion-Strengthened (ODS) Alloys
- Standards & Databases

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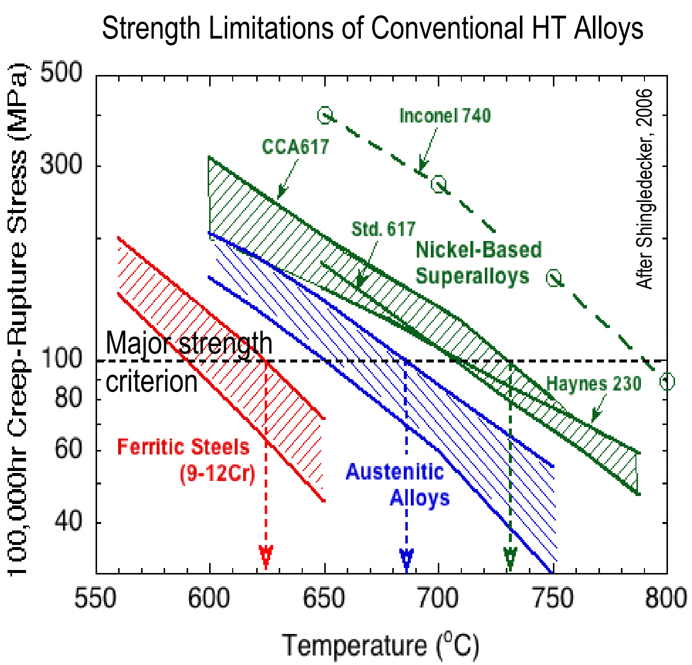
Steam Oxidation

Why?

- Advanced steam cycles = increased efficiency = increased temperature
- New alloys needed to achieve these goals
- Need basis for confident service life prediction

Challenges

- Higher temperatures = reduced lifetime
- No reliable design data
- Potential failure modes unknown



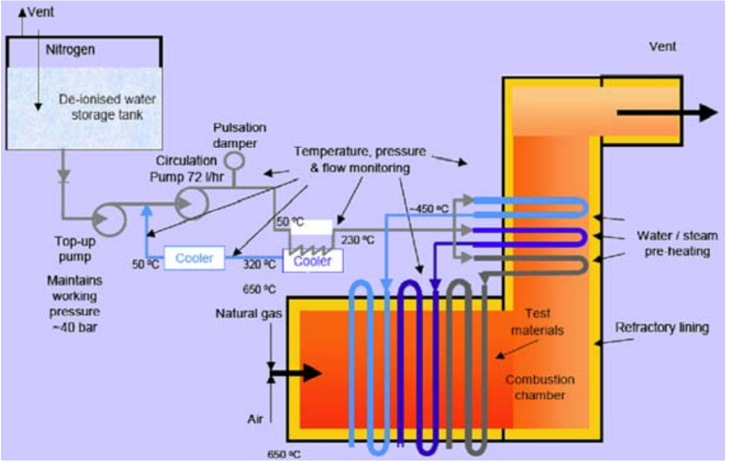
Steam Oxidation

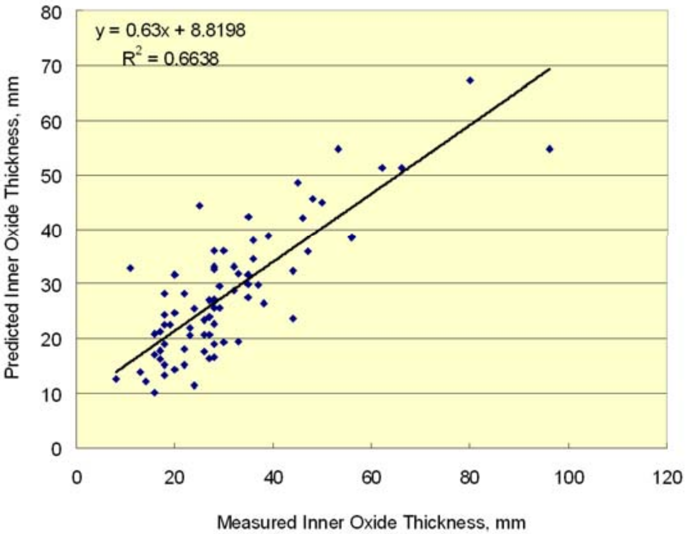
Outputs & Benefits

- New testing capabilities
- >1m hours of specimen exposures
- Tools for data qualification & extrapolation
- New degradation models

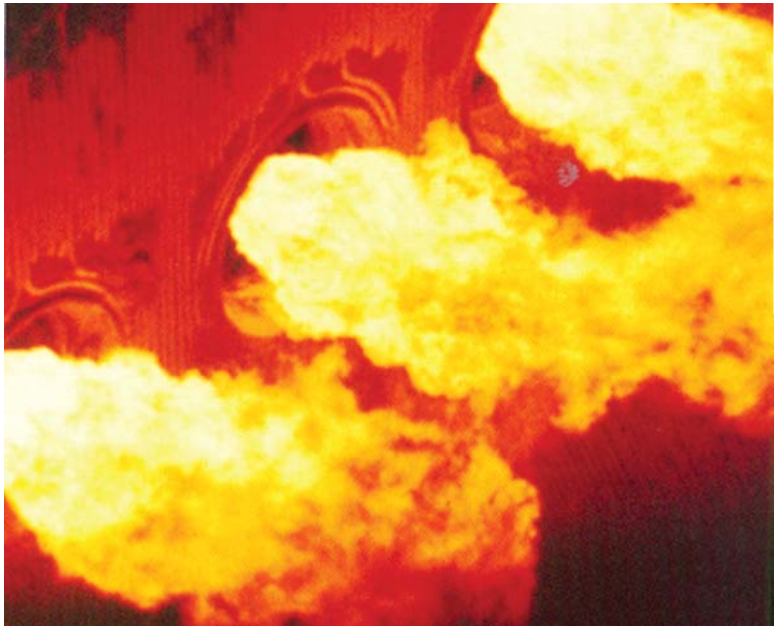
Proposed Work Plan (Phase 2)

- Standardized testing approach
- Correlate lab. data to plant experience
- Lifetime model development





Boiler Corrosion & Monitoring



Why?

- Alternative fuels, emission controls, advanced cycles increase operating risks
- Understand impact on materials performance
- On-line condition monitoring to improve plant operation

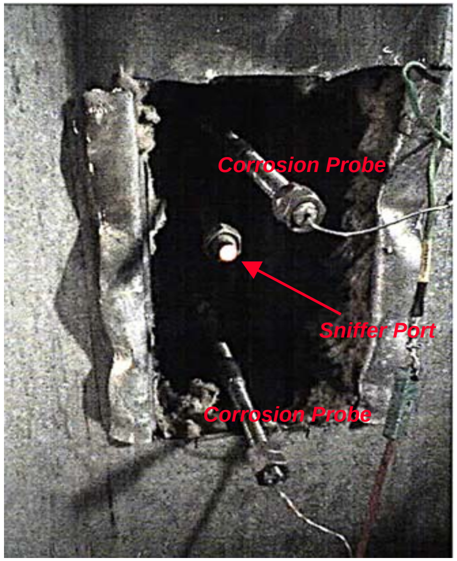
Challenges

- Quantify specific fuel effects on materials behavior
- Develop reliable monitoring techniques
- Correlate lab. data to plant experience

Boiler Corrosion & Monitoring

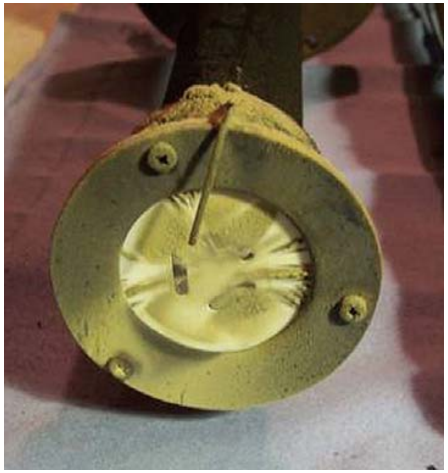
Outputs & Benefits

- Ranked alloys in simulated operating environments
- Established limitations of current probe designs
- Identified approaches for monitoring probe design improvements



Proposed Work Plan (Phase 2)

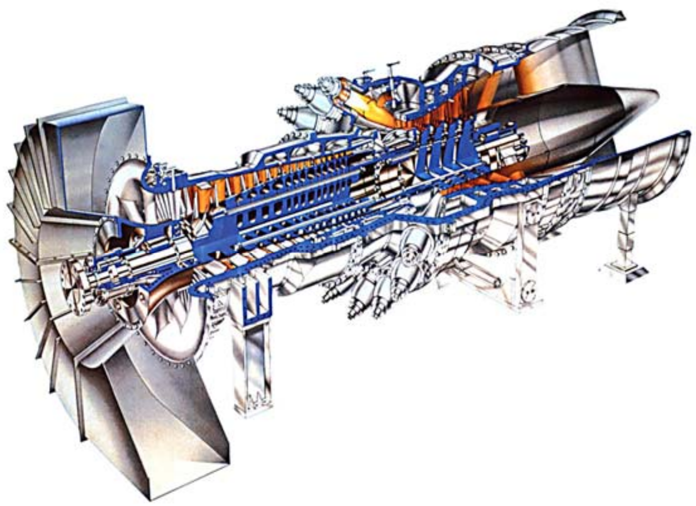
- Advanced lab. testing procedures
- Further development of corrosion monitoring probes (electrochemical)
- Emphasis on oxy-firing, co-firing, advanced cycles



Gas Turbines Fired on Syngas and other Fuel Gases

<u>Why?</u>

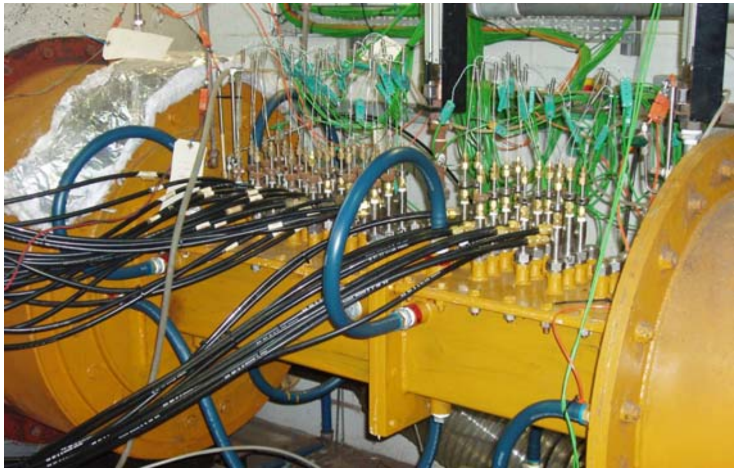
- Enable the use of SOA GTs with fuels derived from gasification of coal and/or biomass
- Understand impact on critical hot gas path components
- Ensure reliable operation and reduce risk



<u>Challenges</u>

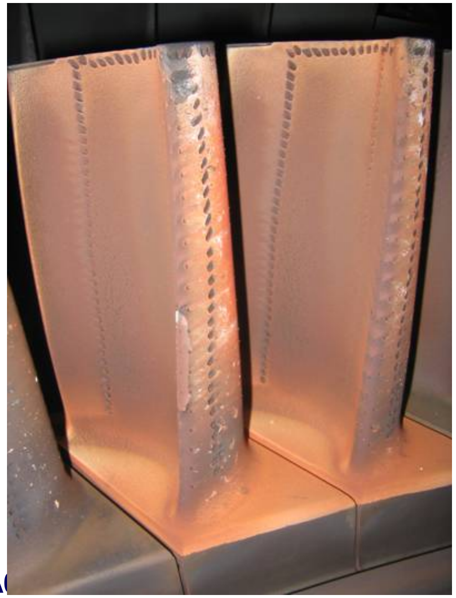
- Understand and predict threat from these combustion environments
- Provide a versatile simulation testing facility
- Quantify impact on alloy and coating performance
- Identify cost-effective alloy and coating combinations to reduce operational risks

Gas Turbines Fired on Syngas and other Fuel Gases



Outputs & Benefits

- Demonstrated ability to correctly simulate plant environments
- >650,000h of specimen exposures
- Validated predictions of damage modes
- Predicted component lives for plant systems



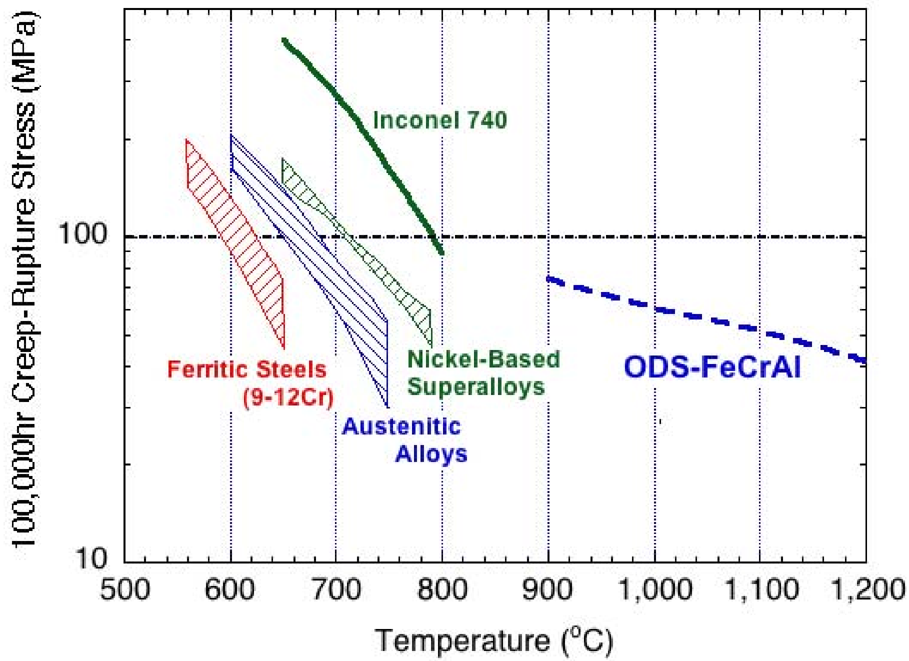
Proposed Work Plan (Phase 2)

- Expansion of life predictions to new systems
- Generation of input for GT life prediction models
- Integration with advanced NDE techniques

ODS Alloys

<u>Why?</u>

- Class of materials with exceptional characteristics, but challenges to practical application
- Opportunity for step change in performance of existing and new plant components



<u>Challenges</u>

- Need for better joining techniques
- Processing for improving strength of tubes
- Improved oxidation resistance

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ODS Alloys

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Outputs & Benefits

- Identified viable joining techniques
- Commercial processing routes for strength improvement
- Identified coating for improved high-temperature service life

- Proposed Work Plan (Phase 2)
- Qualify *new commercial ODS alloy*
- Alternative processing routes for strength improvement
- Fabricate demonstration components
- Explore novel process for making components from ODS alloys

Standards & Databases

Why?

- Need test results from different partners to be directly comparable
- Need ability to share and compare data and testing methods among different laboratories

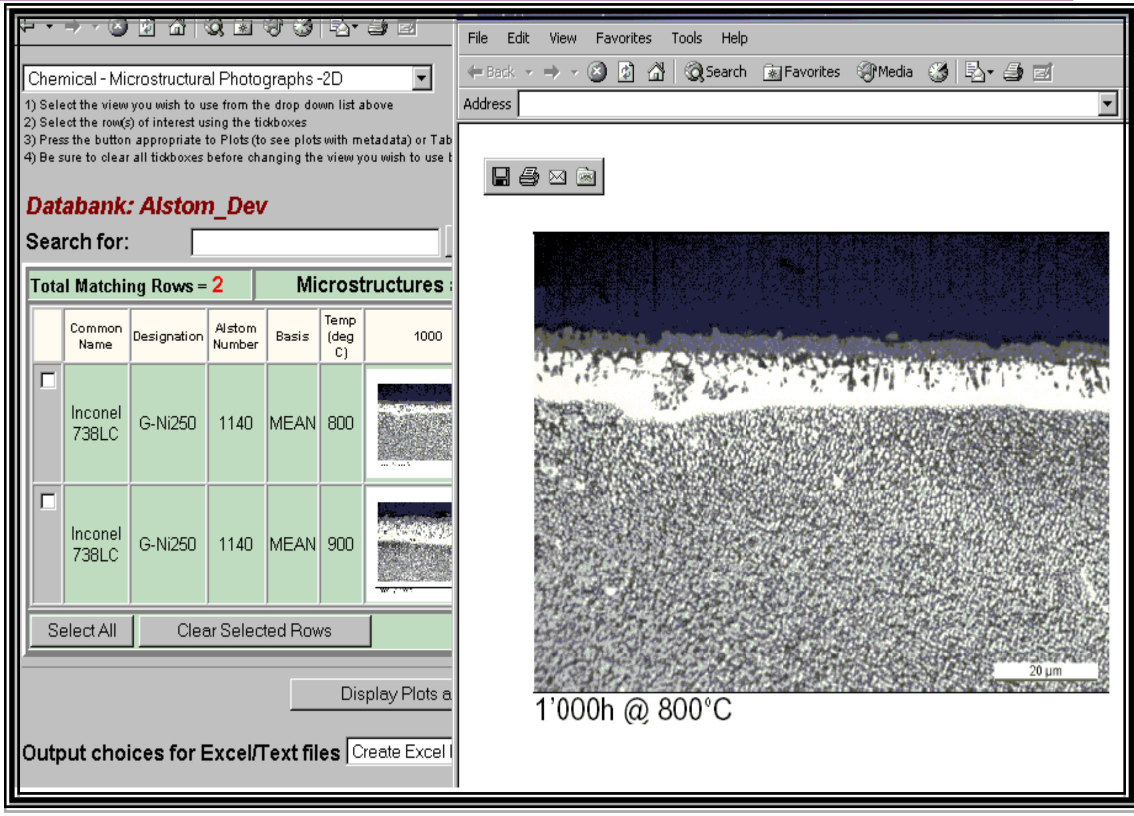
Challenges

- System for data collection, analysis, and exchange
- Ensure full and consistent record keeping
- Enable full, future replication of testing

Standards & Databases

Outputs & Benefits

- Identified sources of differences in data among tests by partners
- Standardized approaches
- Developed a full-featured database
- Provided secure, central access to all partners



Proposed Work Plan (Phase 2)

- Task completed, separate future activities not required

Summary of Phase 1 Experience

- Accelerated progress in complex areas
- Extensive and faster data development
- Effective working relationships to face new challenges
- Shared experience improves outputs and reduces risks
- Awareness of current testing limitations
- Formulation of new approaches
- Effective benchmarking and data qualification
- Improved awareness of industrial needs and national priorities

Approved Phase 2 Tasks

- Steam Oxidation
- Materials for Advanced Boilers and Oxy-Combustion Systems
- Gas Turbine Materials Life Assessment and Non-Destructive Evaluation
- Oxide Dispersion-Strengthened Alloys

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More Information

USDOE FE Materials Conference – 12-14 May 2009

UK-US Collaboration on Fossil Energy R&D - Advanced Materials

Thank you for your attention

http://us-uk.fossil.energy.gov/