**Objectives**

Design, fabricate, test and demonstrate in a commercial scale lignite-fired boiler a miniaturized high temperature multi-process, high-spatial-resolution monitoring system (mMPMS) for boiler optimization.

**mMPMS**

Real-time indication of tube surface conditions at key locations in the radiant section of a coal fired boiler based on electrochemical sensor that can provide metal loss rates, heat flux, metal surface temperature, and deposit thickness.

**Boiler Condition Monitoring using mMPMS**

- Metal wastage rate
- Heat flux
- Temperature
- Deposition

**Electrochemical Sensing Merits**

- There is no temperature compensation requirement
- Corrosion rate measurements
- Measurements are instantaneous and quantitative
- Temperature and heat flux are measured simultaneously and deposition rate can be estimated

**Approaches**

- Re-design and Construct Prototype Sensor Body
- Re-design and Fabrication of Data Processing Unit
- Construction of Power and Cooling Unit
- Additional Development of Data Processing Software
- Validation of Multi-Process Sensor in Pilot-scale Unit
- Full-scale Demonstration of System

**Demonstration Site**

Leland Olds Station located near Stanton, North Dakota

Two lignite-fired units with total generating capacity 669 MW

Plant is interested in ash management and boiler tuning

**Project Organization**

- **Prime Recipient**
  
  Bill Smith Engineering, LLC

- **Sub-Awardees**
  
  The University of Utah
  
  Basin Electric Power Cooperative
  
  DOE/NETL Project Manager: Mr. Omer Bakshi

- **Project Management**
  
  mMPMS Development
  
  Mechanism Derivation
  
  Computational Modeling
  
  Signal Conditioning and Data Communication Module Development

- **Prototype mMPMS**

  Developed and heat transfer calculation will assist to finalize the design prior to pilot- and full-scale testing

**REI Team’s Previous Work**

- Electrochemical sensing system has been applied to low and high temperature zones of the boiler to assess corrosion behavior in the boiler and waste-to-energy system, improve thermal efficiency of the boiler, and compare tube materials under ultra-supercritical steam condition and oxy-firing combustion
- EN-based system provides high sensitivity, real-time, on-line monitoring technology
- REI has developed corrosion rate correlations through EPRI and KEPRI projects that can assess the impacts of planned changes in combustion environment on fire-side corrosion

**Sensor Body**

Sensor body is designed to avoid any active cooling needs; heat transfer calculation provides guidance

**Heat Transfer Calculation**

Waterwall and Sensor Metal Surface Temperature

- Waterwall: 0.2 mm, 0.4 mm, 0.8 mm
- Sensor: 600°C, 800°C, 1000°C

**Benefits & Future Work**

A system of non-intrusive real-time sensors providing quantitative insight into several key indicators of boiler performance/maintenance will save individual plants tens of millions of dollars. Future efforts will include utilization of additional sensors throughout convective sections and backpass equipment as well as integration with advanced control approaches.