EXECUTIVE SUMMARY

Heat recovery is an essential energy-saving part of almost every process system, and the proper selection of materials for these systems is complex, yet crucial for satisfactory performance. Enhancing heat recovery in industrial systems is a direct and very efficient way to substantially improve energy utilization and lessen environmental impact. To gain enhanced heat recovery and improved reliability of such systems, challenging materials problems in the areas of strength and environmental degradation must be overcome. These challenging and complex materials problems require an integrated experimental, characterization, field evaluation, and modeling effort involving industry, research organizations, materials suppliers and component manufacturers. This proposed projects fits within the "R&D" type of projects identified in the call for proposals.

The proposed project will address materials improvements for enhanced heat recovery, reliability and competitiveness in two industries: Aluminum and Forest Products. The Aluminum and Forest Products Industry Technology Roadmaps specifically identify the need for fuel efficiency and cost effectiveness in melters and recovery boilers, respectively. The proposed project will concentrate on recuperators associated with aluminum melting furnaces and the superheater and wall tubes in black liquor recovery boilers. These are only two of a large number of heat recovery systems that have issues with the performance of components, but these two were identified because of the significant energy savings that could be realized from material improvements and associated increases in reliability. In addition, there are several common features for these two areas including flue gas temperatures, requirements for high duty cycle, and service in oxidizing and reducing environments. In both recuperators and primary air ports, there is an issue of local combustion and the effects of localized high temperature on the tubes. The recuperator and superheater tubes also have common issues of distortion and corrosion over a limited area.

The recuperators associated with aluminum melting furnaces utilize hot flue gas to preheat the combustion air for the burners that provide the heat to melt the aluminum. The centrifugally cast tubes used in the recuperators are exposed to oxygen depleted flue gas on the outside while ambient temperature air is fed into the tubes. These tubes have a relatively short lifetime that averages only about 7 months for the tubes on the leading side of the recuperator where bending, warping and thinning occur. The objective is to extend the life of recuperator tubes five-fold with the goal of substituting the new tube materials in existing recuperators and increasing their use to a larger fraction of aluminum melters.

Black liquor recovery boilers are an essential part of pulp and paper mills, but the current boilers are not especially efficient at recovering the heating value contained in the black liquor fuel. There are a number of materials issues that contribute to the limited efficiency of these boilers, and it has been estimated that resolution of these issues could result in an efficiency increase on the order of 1.5%. The most serious materials issues that need to be addressed are 1) corrosion and cracking of the co-extruded tubes that form the primary air port openings, 2) localized thinning of the carbon steel tubes in the mid-furnace area, and 3) bending, warping and accelerated thinning of the superheater tubes. The objective is to solve the limiting materials problems and ease adoption by industry to increase efficiency and plant reliability.

By determining the cause of tube degradation and identifying more reliable materials, this project will address the solicitation objective of improved technology to significantly improve efficiency in two very energy intensive industrial systems. If successful, the improvements in materials and operating changes could yield a savings of **~12 trillion Btu/yr** when implemented. This project will likely be followed by focused IOF projects addressing any remaining short-term materials issues and longer-term demonstrations