

**OHIO COAL DEVELOPMENT OFFICE
ANNUAL PROJECT ABSTRACT
AS OF DECEMBER 2004**

1. **PROJECT SPONSOR:**
Energy Industries of Ohio
Park Plaza Center Suite 200
6100 Oak Tree Boulevard
Independence, OH 44131
2. **PROJECT MANAGER/TITLE:**
Robert M. Purgert, President
3. **OCDO GRANT NO.**
CDO/D-02-4
4. **PHONE:** 216-643-2952
EMAIL: Purgert@energyinohio.org
5. **PROJECT TITLE: "Evaluation of Weldability of Inconel 740 for the Ultra-Supercritical Boiler Project"**
6. **PROJECT TERM FROM:** 10/01/2003 **TO:** 10/31/2007
7. **PROJECT UPDATE** **--OR--** **FINAL REPORT** _____

8. **BUDGET:**

<u>CO-SPONSOR'S NAME</u>	<u>COST-SHARE</u>
OCDO	\$112,300
U.S. Department of Energy	\$449,198
Babcock & Wilcox	\$ 92,086
_____	\$ _____
_____	\$ _____
TOTAL PROJECT VALUE:	\$653,564

ABSTRACT

9. **OVERVIEW OF PROJECT & OBJECTIVES:**

Ultra-supercritical (USC) boiler designs employ higher hot gas path temperatures to increase efficiencies and achieve lower emission levels. To achieve this, boiler manufacturers must select materials possessing the required strength, heat, and corrosion resistance for long-term, reliable service at these elevated temperatures. However, it is equally important that components made of these higher-performance materials be able to be readily fabricated and repaired, Weldability or the ability to produce crack-free welded joints with acceptable properties after post-weld heat treatment (PWHT), is a key aspect which must be considered.

Inco 740, a nickel-based alloy, was one of six alloys were identified by the USC consortium for extensive mechanical property analysis. Preliminary investigations on Inco 740 produced an optimum heat treatment for creep-rupture strength which exceeds expectations based on prior reported data. However, there is no comprehensive data on the weldability of Inco 740, particularly in the thicknesses and joint configurations typical of candidate USC boiler designs.

Edison Welding Institute (EWI), through Babcock and Wilcox and the UltraSuperCritical Consortium (details outlined under grant CDO/D-00-20) was tasked to study the weldability of Inco 740. The main tasks of this effort are as follows:

- Subtask 1: Evaluate the heat affected zone (HAZ) liquation cracking susceptibility of Inconel 740
- Subtask 2: Evaluate the HAZ ductility dip cracking (DDC) susceptibility of Inconel 740
- Subtask 3: Evaluate the post-weld heat treatment cracking (PWHT) cracking susceptibility of Inconel 740 and made a comparison with other common Ni-based precipitation-hardenable alloys such as Inconel 718 and Waspaloy
- Subtask 4: Evaluate mechanical properties of Gleeble-simulated HAZs of Inconel 740 and of Inconel 740 welded plate joints in the PWHT condition.

10. WORK TO DATE & CONCLUSIONS:

Subtask 1- Evaluation of HAZ liquation cracking (Completed)

The results of the Gleeble hot-ductility testing and spot-Varestraint testing indicate that Inconel Alloy 740 is susceptible to liquation cracking in the HAZ.

Subtask 2 – Evaluation of HAZ DDC Susceptibility (Completed)

The susceptibility to HAZ DCC of Inconel Alloy 740 was evaluated using Gleeble hot-ductility testing. The results of the Gleeble hot-ductility testing indicates that Inconel Alloy 740 is not susceptible to DDC cracking.

11. PLANS FOR COMING YEAR:

Subtask 3 – Evaluation of PWHT Cracking Susceptibility (In Progress) The evaluation of the susceptibility of Inconel Alloy 740 to PWHT cracking is in progress using Gleeble stress-relaxation testing and high-temperature tensile testing. The susceptibility to PWHT cracking of Inconel Alloy 740 will be compared to that of Inconel Alloy 718 and Waspaloy which are commonly used Ni-based precipitation-hardening alloys.

Subtask 4.

- A. Evaluate mechanical properties of Gleeble-simulated HAZs in Inconel Alloy 740

B. Evaluate mechanical properties of full size welded joint

EWI plans to assist the USC consortium to develop strategies to address potential issues in welded fabrication. This may include modifications in Inco 740 alloy composition to improve weldability or changes in joint designs, weld process selection or welding procedures to mitigate weldability effects.

12. HIGHLIGHTS/ACCOMPLISHMENTS:

Based on the experimental work conducted up to date, the following results can be highlighted:

1. The tested heat of the Inconel Alloy 740 is susceptible to liquation cracking in the heat affected zone
2. This results has been shared with the boiler manufacturers to adjust the design of the welding procedure in order to obtained joints that are crack-free and that result in a higher structural integrity of equipments such as ultrasupercritical boilers (USB)

13. ARTICLES/PRESENTATIONS:

1. Publication of 1 or 2 papers is planned after conclusion of the project