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## DESIGN OF A WELDING AND INSPECTION SYSTEM FOR WASTE PACKAGE CLOSURE

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### I. INTRODUCTION

This work reported here was done to provide a conceptual design for a robotic welding and inspection system for the Yucca Mountain Repository waste package closure system. The welding and inspection system is intended to make the various closure welds that seal and/or structurally join the lids to the waste package vessels. The welding and inspection system will also perform surface and volumetric inspections of the various closure welds and has the means to repair closure welds, if required. The system is designed to perform these various activities remotely, without the necessity of having personnel in the closure cell.

### II. DESCRIPTION

The work began by developing a statement of the operational and performance requirements for the waste package closure system. From these requirements, subtler performance requirements were developed for the robotic welding and inspection system. Next, a study was conducted of several alternative approaches to the design of the system. These approaches included (a) two cell-mounted robotic arms, (b) two coordinate gantry machine-mounted robotic arms, (c) a center pivot machine, and (d) a concentric track machine. A design configuration based on the concentric track machine concept was identified that meets the functional

requirements for the system while best satisfying the design issues. Specific design guidelines were then developed. Finally, several prototype components of the system have been designed, built, and tested.

### III. RESULTS

The welding and inspection system is designed to consist of two articulated-arm radiation-hardened robots mounted on a large-diameter traversing ring. This allows the two robots to access all points on the top of the waste package with a set of end effectors. Each robot has four end effectors for welding, ultrasonic inspection, eddy current inspection, and dressing (wire brushing and grinding) of the closure welds. The welding end effectors, Figures 1 and 2, show the visual inspection and waste package temperature measurement capabilities. The welding and inspection system is mounted concentrically with a large-diameter hole in the closure cell floor. The waste package is placed underneath and nominally concentric to this hole. The welding and inspection system can retract from the hole, thus providing accesses to the waste package by various other closure cell systems for placing lids, purging, and backfilling the waste package with helium, leak testing, and component identification. This paper presents the design of the welding and inspection system, describes the end effectors, discusses the control system, and presents the results of component tests, including welding trials.

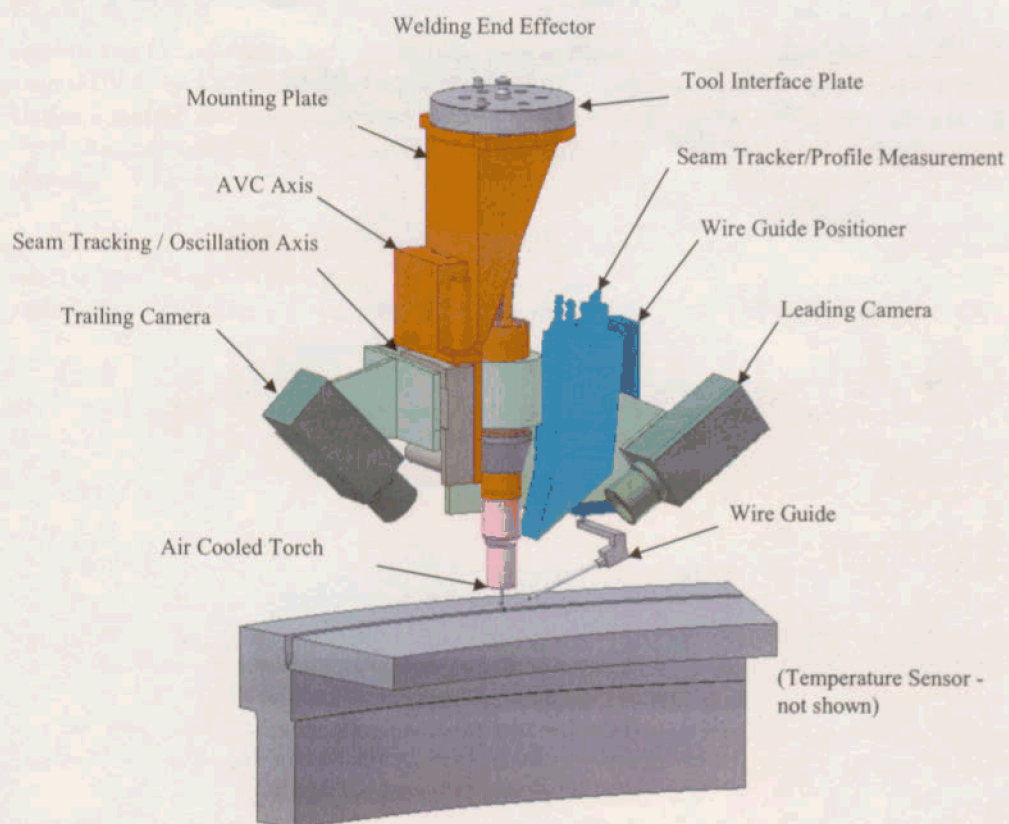


Figure 1. Solid model of welding end effector, showing various components.

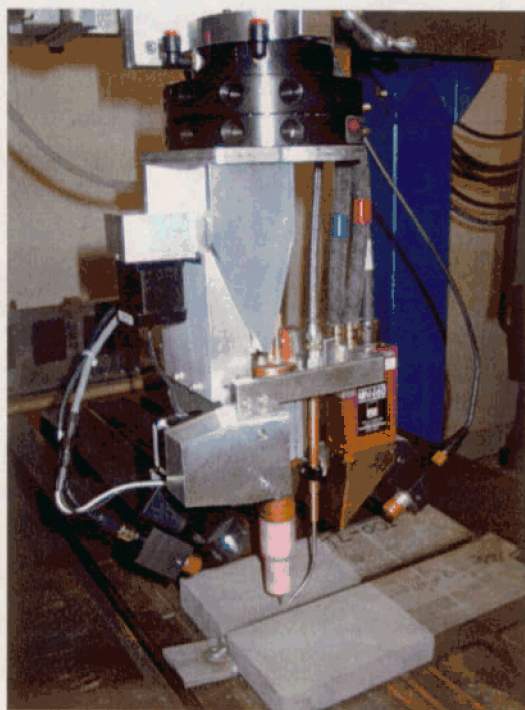


Figure 2. Actual welding end effector mounted on a Cartesian robot for welding trials.