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REMOTE WELDING PROGRAM
FOR
ATLANTIC RICHFIELD HANFORD COMPANY'S
WASTE ENCAPSULATION AND STORAGE FACILITY

MASTER

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REMOTE WELDING PROGRAM
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John C. Wormeli

INTRODUCTION

The Atlantic Richfield Hanford Company (ARHCO) is responsible for managing the radioactive wastes currently being generated at the Atomic Energy Commission's Hanford reservation and also for stored wastes accumulated from prior production. The approach chosen for processing the high-level wastes includes the separation of the long-lived, high heat-producing radioisotopes, strontium-90 and cesium-137. After a 3-5 year decay period for short-lived fission products, the residual waste is evaporated to produce a salt cake for interim storage in underground tanks. The Atlantic Richfield Hanford Company is now building a plant to convert the stored nitrates into strontium fluoride and cesium chloride and doubly encapsulate these solid compounds for storage in deionized water.

Obviously, the individual capsules and welds must be of high integrity if the strontium and cesium are to be stored safely; thus, ARHCO has developed the encapsulation process with considerable emphasis on the use of optimum welding and nondestructive testing techniques. The welding and testing development programs were initiated in November 1969. A complete discussion of these programs and their development phases has been previously reported¹. This paper presents the considerations of the nondestructive testing program along with the features and capabilities which were incorporated into the welding equipment to enhance the remote operability while providing high integrity capsules.

WASTE ENCAPSULATION AND STORAGE FACILITY

The Waste Encapsulation and Storage Facility, as shown in Figure 1, consists of a new building addition to the existing Waste Processing Plant with seven shielded manipulator operated "hot cells" for the processing and encapsulation of the radioisotopes. An underground storage basin area is provided for storage of the finished capsules until final storage criteria have been formulated. The Encapsulation Facility is scheduled to be in operation in July 1973.

NONDESTRUCTIVE TESTING CONSIDERATIONS

Expectedly, the ultimate goal of this program is to provide radioisotope storage capsules of the highest possible quality. To insure the attainment of this goal, several nondestructive testing and inspection methods were incorporated early in the program. As shown in Figure 2, ultrasonic inspection plays the major role starting with the inspection of the raw material. Capsule tubing and end cap plates will be inspected ultrasonically prior to welding. Ultrasonic inspection and fluorescent penetrant inspection will be applied to the cold end cap welds prior to the placement of the capsules into the hot cells for loading. Helium leak testing will be applied to each complete inner capsule to determine material and weld integrity. Final inspection involves ultrasonic examination of the closure weld on the outer capsule. The ultrasonic testing program, including design of the remote testing tank and hardware for in-cell testing, was conducted by Pacific Northwest Laboratory (PNL)².

CAPSULE MATERIAL AND JOINT DESIGN

Because of the scarcity of construction material compatibility data for the SrF_2 and CsCl compounds, a comprehensive study for determining the most suitable capsule materials was conducted by PNL³. To date, the results for the SrF_2 compound indicate Haynes Alloy No. 25 and Hastelloy C-276 as being suitable capsule materials. Due to the more favorable machining and welding characteristics, Hastelloy C-276 was chosen for the SrF_2 capsules. For the CsCl capsules, type 316-L stainless steel was found to be the most suitable material at moderate cost.

The joint design which was found to be compatible with the ultrasonic inspection and welding programs is shown in Figure 3 along with the completed capsules. By standardizing dimension "A", only one ultrasonic standard is needed for each type of capsule, thereby minimizing calibration time. Dimension "A" was held to a minimum so that optimum ultrasonic resolution could be obtained. One of the ultrasonic inspection requirements was that the corner or edge of the cap not be melted away so that a complete scan of the joint interface could be made. The end cap has a machined step which provides concentric alignment of the cap to the capsule and allows for remote placement of the cap by the manipulator. This machined step also protects the backside of the weld from the atmosphere and eliminates the necessity of providing a back-up purge gas during welding. A minimum leak path requirement of 1T for each capsule necessitated that the end cap weld penetration be equivalent to the capsule wall thickness.

DEVELOPMENT OF PROGRAM PARAMETERS

Prior to the start of the welding development efforts, in-cell welding positions and capsule temperatures were defined. The physical nature of the SrF_2 and CsCl necessitates that the inner capsules be welded in the vertical position by a gas-tungsten-arc torch mounted in the horizontal position. The SrF_2 and CsCl outer capsules are welded in the horizontal position with the torch in the vertical position.

As shown in Figure 4, parameter development utilized a commercially available welding programmer in conjunction with a laboratory weld fixture. The fixture provided programmable rotational speed during welding and also permitted the welding of capsules in either the vertical or horizontal position. An additional requirement that had to be considered was elevated temperature welding. The radioactive decay of the isotopes results in a gradual, but substantial, temperature increase of the loaded capsules. Welding parameters, therefore, had to be established not only for cold end cap welds but also for end cap welds when the temperature of the capsule may be between 200-400°C depending on the particular isotope. To simulate this condition, an induction heater was used to provide various temperatures up to 500°C.

REMOTE WELDING CONSIDERATIONS

Upon finalizing of the various welding parameters, i.e., shielding gas, amperage and speed of rotation, the welding program efforts were directed to defining the mechanical and physical problems relating to remote capsule welding. Those problems considered to be significant and their solution are discussed below:

• Capsule Holding (centering)

Concentric alignment of the capsule with respect to the axis of the rotational fixture is perhaps the major concern in the effort to obtain full penetration welds without auxiliary arc voltage control methods.

The storage capsules are fabricated from seamless tubing without machining, except for square end preparation. While the purchase specifications for this tubing are rigid, the tube ovality may vary up to .030 inch. This ovality must be coped with in the determination of the choice of rotational fixture. It should be noted that a decision was made early in the program after considerable

study that arc voltage control either by electrical or mechanical means would be used only as an alternate to accurate rotational fixturing.

In considering a choice of fixtures, three-jaw and six-jaw chucks, as well as collet chucks, were considered. The method chosen involves the use of a unique nine-finger split collet which holds the capsule in two places. Actual test experience has demonstrated that this air-operated collet, shown in Figure 5, centers the slightly oval tubing considerably better than the conventional chucks. As shown graphically in Figure 6, the collet holds the capsule firmly in two places when actuated by an air cylinder. This eliminates the necessity of holding the bottom of the capsule which could create additional alignment problems due to slightly bowed (.020 inch per linear foot allowable) capsules.

Tungsten Electrode Replacement

During the preliminary trials of the weld fixture concepts in a mock-up hot cell, it was apparent that the commercially available gas-tungsten-arc torches do not readily lend themselves to tungsten replacement with manipulators. Because of this potential delay in production operations, a new torch design was developed and built for laboratory use. Figure 7 shows graphically the various components of the new torch and the manner by which the tip is replaced. The cam-operated lever is opened by the manipulator and the tip is pulled out of the dove-tail slide. Replacement of the new tip is done by sliding in the tip until it stops and moving the cam lever to the lock position. Figure 8 shows the remote operation of the Quick Change Torch which has demonstrated its compatibility for hot cell welding. The eroded or oxidized tungsten electrode within the tips can now be replaced at a more convenient location and during a slack production time.

Capsule Weld Surface Cleaning

Cleaning of the top surface of the capsule prior to placement of the end cap is a most important function. A clean surface is a surface which is free of foreign matter, oxides and radioactive compounds. Present indications are that the manipulator operator can provide the basic cleaning functions which involve the removal of loose or easily removed matter. In the case of the inner cesium chloride capsule, however, experimental tests indicate the molten salt tended to climb (by capillary action) the capsule wall,

thereby contaminating the weld surface. The adhesion of this salt to the type 316-L stainless steel capsule was similar to soft solder spillage on cold metal. Although this condition has been eliminated by placing a stainless steel O-ring inside the capsule, a remotely-operated cleaner was added to the weld station.

This remotely-operated cleaner attachment is shown in Figure 9. The cleaner is capable of holding a variety of tools used primarily for scraping when necessary. The remote cleaning device rotates at 20 rpm and moves downward with manipulator assistance. Upon release of the cleaner handle, the unit is returned to its upper position by compression springs.

IN-CELL WELDING EQUIPMENT

Four remote welding stations have been fabricated for the Waste Encapsulation and Storage Facility. Air and electrical power sources are involved in capsule holding and rotation, respectively. Figure 10 shows one of the remotely-operated vertical weld stations. While the primary function is to produce welds of high integrity on a reproducible basis, the weld station must also incorporate remotely changeable components as shown in Figure 11. The changing of the motor requires only a quarter turn of the locking nut and the disengagement of a Cannon-type plug for the electrical lead. Remote change-out of the air cylinder is easily accomplished by removing clevis pins on each end of the cylinder.

While considerable efforts have been expended to assure the use of proper materials for the hot cell environment, the measures taken to provide for remote replacement of components are considered necessary, due to both the uncertainties of radiation exposure and corrosive attack within the individual cells. Actual operational experience will determine the frequency of changeout for the specific components.

WELDING PROGRAMMER AND SYSTEM OPERATION

The in-cell welding stations are used in conjunction with a completely automatic, programmed welding system as shown in Figure 12. Two of these systems provide control of all programmed activities using prepunched cards which contain all of the pertinent weld functions and parameters as shown in Figure 13.

Once the card for a particular capsule is inserted into the card reader, the operator then controls the operation from the cell window with a remote pendant control. This control

indicates the essential variables and program phase by means of indicator lights.

During the welding cycle, permanent records of amperage, voltage, and speed of rotation are recorded. These weld traces in conjunction with helium leak testing and ultrasonic inspection records are evaluated for determining the quality and, hence, integrity of the capsule prior to acceptance for storage. Additional information of weld quality will be obtained from metallographic evaluation of cross-sections of weld samples taken on a regular basis.

ACKNOWLEDGMENT

The author wishes to express his appreciation to fellow employees, R. M. Fowler and G. J. Funnell, for their very able assistance in this welding development program.

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WASTE ENCAPSULATION FACILITY FLOOR PLAN

BATTELLE-NORTHWEST

PHOTOGRAPHY

PHOTO NO. 722163-2

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FIG. 1

RADIOACTIVE STORAGE CAPSULE WELDS AND NONDESTRUCTIVE TESTS

	SrF ₂	CsCL
LOAD	150 KCI	60 KCI
T.D.	75%	65%
^s TEMP. AIR	430°C	200°C
^s TEMP. WATER	71°C	58°C

CAPSULE DATA

CESIUM CHLORIDE

316L STAINLESS STEEL (UT)

.095 INNER WALL (UT)

.109 OUTER WALL (UT)

STRONTIUM FLUORIDE

HASTELLOY C-276 (UT)

.120 WALL (I & O UT)

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FIGURE NO. 2

TITLE

CAPSULE	MATERIAL	INNER WALL THICKNESS	OUTER WALL THICKNESS
Sr F ₂	HAST C276	0.120"	0.120"
CsCl	316-L S/S	0.095"	0.109"

Fig 3

FIGURE NO. 3

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FIGURE NO. 4

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FIGURE NO. 5

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QUICK CHANGE TORCH

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FIG 7

BATTELLE-NORTH

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FIGURE NO. 7

TITLE

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FIG 8

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FIGURE NO. 8

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FIG 9

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FIGURE NO. 9

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BATTELLE-NORTHWEST
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FIGURE NO. 10

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FIG 11

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FIGURE NO. 11

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AND STORAGE PROGRAM

FIGURE NO. 12

TITLE _____

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CARD PROGRAMMER

SUN VALLEY, CALIFORNIA

ARC CO.

WELD PROCEDURE 6

CESIUM CHLORIDE CAPSULE
HOT END WELD

ITEM NAME

ITEM	NAME
1	MOTOR DELAY TIME
2	CONSTANT SPEED R.P.M.
3	CONSTANT SPEED TIME
4	UP SLOPE SPEED R.P.M.
5	UP SLOPE SPEED TIME
6	RUN OUT RATE R.P.M.
7	RUN OUT TIME
8	INITIAL CURRENT 0-300 AMPS
9	INITIAL SLOPE TIME
10	WELD CURRENT 0-300 AMPS
11	FINISH SLOPE TIME
12	FINISH CURRENT 0-300 AMPS
13	PULSE HIGH CURRENT
14	PULSE HIGH TIME
15	PULSE LOW TIME
16	PULSE LOW CURRENT

0 10 20 30 40 50 60 70 80 90 100

0 10 20 30 40 50 60 70 80 90 100

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FIG 13

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FIGURE NO. 13

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