**Y-12 DEVELOPMENT ORGANIZATION
TECHNICAL PROGRESS REPORT**

Part 9 - Summaries

Compiled by
W. D. Babb

Period Ending November 15, 1993

Prepared by the
Oak Ridge Y-12 Plant
P.O. Box 2009, Oak Ridge, Tennessee 37831-8169
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

HIGHLIGHTS

ASSEMBLY TECHNOLOGY/COMPATIBILITY AND SURVEILLANCE - PART 4

Conduit Fabrication—GEM Magnet Superconducting Super Collider

The Oak Ridge Y-12 Plant is under contract to perform work for the Superconducting Super Collider Laboratory and has been asked to develop manufacturing processes for components of the gammas, electrons, muons (GEM) detector. A 272-ft conduit was made for a test at the University of Wisconsin. (Page 6)

CERAMICS/PLASTICS/CARBON MATERIALS DEVELOPMENT - PART 5

Nongraphite Uranium Casting

Foundry testing with ceramic systems and the thermal can setups have indicated the importance of the overall stack position in the furnace in minimizing the thermal differentials through the ceramic crucible. Further testing of ceramic compositions with minimal-ledge, slotted housings showed that no leakage or cracking results, and run times can be like those for graphite systems. (Page 7)

INSTRUMENTATION AND EVALUATION TECHNOLOGY - PART 8

An Expert System for Assessing the Relative Importance of Maintenance Work Requests

The Maintenance Importance Generator (MIG) program for prioritizing Maintenance Work Requests (MWRs) has been in production use for more than a year. The MIG program systematically and uniformly applies Y-12 Plant and Department of Energy (DOE) policy concerning prioritization of work and has been officially designated as the mechanism for doing so. (Page 9)

CONTENTS

SUMMARIES

METAL PROCESSING - PART 3	6
Evaluations of Uranium-Rhenium and Uranium-Rhenium-Titanium Alloys	6
Consolidation of Zircaloy-4 End-Crops by Induction Melting	6
ASSEMBLY TECHNOLOGY/COMPATIBILITY AND SURVEILLANCE -	
PART 4	6
Conduit Fabrication—GEM Magnet Superconducting Super Collider	6
CERAMICS/PLASTICS/CARBON MATERIALS DEVELOPMENT - PART 5	7
Microcellular, Poly(acrylonitrile) Carbon Foam	7
Nongraphite Uranium Casting	7
Microwave Heating of Materials	7
INSTRUMENTATION AND EVALUATION TECHNOLOGY - PART 8	8
Ultratrace Uranium Monitors	8
Airborne Beryllium Monitors	8
Advanced Technology for Oralloy Recovery Instrumentation and Controls	8
Nondestructive X-ray Microanalysis	9
Evaluation of the Effects of Varying Penetration on Acoustic Emission Produced by Electron-Beam Welding of D-38 Step Joints	9
An Expert System for Assessing the Relative Importance of Maintenance Work Requests	9

SUMMARIES

METAL PROCESSING - PART 3

Evaluations of Uranium-Rhenium and Uranium-Rhenium-Titanium Alloys

An initial evaluation of processing characteristics and tensile properties of the uranium-rhenium (U-Re) and uranium-rhenium-titanium (U-Re-Ti) alloy systems was performed. The U-Re-Ti system is superior to the U-Re system in that the titanium-containing alloys are less sensitive to quench cracking and have a better response to aging. A high tensile yield strength (150 ksi) with 12.5% elongation was obtained with a U-0.9Re-0.5Ti alloy. Also, a tensile yield strength of 117 ksi with 20% elongation was obtained with a U-0.5Re-0.5Ti alloy. Optimization of aging treatments should improve the tensile properties of both of these alloys.

Consolidation of Zircaloy-4 End-Crops by Induction Melting

The Oak Ridge Y-12 Plant is investigating the use of induction melting as a method of consolidating Zircaloy-4, a zirconium alloy used in the fabrication of submarine nuclear reactor cores. Knolls Atomic Power Laboratory furnished about 4000 lb of typical core material, also known as hardware, for use in evaluating induction melting as a method of consolidation. Three ingots were produced by the induction melting of hardware in a graphite crucible that was protected by a laminated coating specifically developed for this application. This report includes a description of both the equipment and the crucible coating materials used for this project, a discussion of results, and a production assessment of using this technique for full-scale consolidation.

ASSEMBLY TECHNOLOGY/COMPATIBILITY AND SURVEILLANCE - PART 4

Conduit Fabrication—GEM Magnet Superconducting Super Collider

The Super Collider is a high-energy scientific instrument composed of a 53-mile-long ring of proton accelerators designed to collide protons and evaluate the emanating particles. The Oak Ridge Y-12 Plant is under contract to perform work for the Superconducting Super Collider Laboratory and has been asked to develop manufacturing processes for components of the gammas, electrons, muons (GEM) detector.

Three welded subassemblies are involved in the fabrication of these conductors. The superconducting cable is enclosed in a stainless steel conduit, which is then enclosed in an aluminum sheath. The ends of the conductor are terminated with a connector assembly joined to the superconductor, the conduit, and the sheath.

Initially, the conduit weld was to be a single-pass, autogenous gas-tungsten arc weld. A great effort was made to get full penetration without root reinforcement on the inside of the tube. After being unable to meet all of the weld requirements with an autogenous weld, the development effort was shifted to making the weld using an automatic gas-tungsten arc tube welding head with an integral wire feeder. Because reinforcement at the root continued to be a problem, the weld was made in two passes. To achieve the desired weld reinforcement on the outside of the tube, a two-pass welding procedure was developed in which an autogenous pass is used to join the tube ends with the necessary minimum pushthrough on

the inside of the tube and filler metal is supplied during the second pass. This two-pass weld required a weld joint with a flat butt for the root pass and a V-groove for the filler metal pass. A 272-ft conduit was made using this two-pass welding procedure for a test at the University of Wisconsin.

CERAMICS/PLASTICS/CARBON MATERIALS DEVELOPMENT - PART 5

Microcellular, Poly(acrylonitrile) Carbon Foam

The Oak Ridge Y-12 Plant has had considerable success producing 1-cm-thick, microporous, perforated poly(acrylonitrile) or PAN carbon filters. Propylene carbonate/PAN gels possess good properties that allow it to be easily cast and removed from a "bed of nails" fixture. The open geometry of the casting allows rapid solvent exchange and extraction. Initial studies indicate that the gel may be crosslinked in the melt phase and that the propylene carbonate may be exchanged with water and freeze-dried, thereby significantly reducing processing time and concomitant costs of production. Of the 12 castings made at the Y-12 Plant, 7 thick filters were carbonized, activated, and shipped to Sandia National Laboratories, California.

Nongraphite Uranium Casting

Foundry testing with ceramic systems and the thermal can setups have indicated the importance of the overall stack position in the furnace in minimizing the thermal differentials through the ceramic crucible. Further testing of ceramic compositions (Cerox 1400: 59 wt % silicon carbide, 35 wt % alumina, and 5 wt % silica) with minimal-ledge, slotted housings showed that no leakage or cracking results, and run times can be like those for graphite systems.

Test-bar evaluation through Cooperative Research and Development Agreement No. Y-1292-0079 with Blasch Precision Ceramics, Inc., and Surface Alloys, Inc., indicated that strengths were normal with minimal TRIBOCOR additions. The bars all interacted to some extent with the silica component of the ceramic. Ways of reducing silica interactions with TRIBOCOR are being explored.

Ceramic and thermal can materials for operating at all size levels in the H-1 Foundry are now available, and testing is in progress. Both two-piece and one-piece TRIBOCOR crucibles for the intermediate-size production furnaces are on order. These and other TRIBOCOR crucibles will be evaluated for noncarbon usage.

Argon lance studies with chips of uranium 6 wt % niobium alloy indicate a great improvement in casting yield—from 88.8% without the argon to 95.1% with the argon.

Microwave Heating of Materials

Efforts to increase the uniformity of sintering of boron carbide pellets during microwaving at temperatures $>2000^{\circ}\text{C}$ have involved pressing insulating material around the pellets or coating the pellets with high-emissivity material. The insulation/casketing schemes seem still to be a key to densification; a boron carbide pellet was densified to 96% with a coating of flake graphite/boron nitride mixture.

Efforts to eliminate high-carbon binders (i.e., Varcum) have led to sintering of impurity-free pellets of nitric acid-leached boron carbide using a 1 wt % level of hydroxypropyl cellulose (low-carbon-yield organic) binder.

The variable frequency microwave unit is being upgraded to allow high-vacuum processing. Also, the Advanced Manufacturing Project system is being upgraded to allow regular use of the 28-GHz capability.

INSTRUMENTATION AND EVALUATION TECHNOLOGY - PART 8

Ultratrace Uranium Monitors

Two prototype analyzers based on time-resolved, laser-induced luminescence were built to determine uranium in aqueous media at environmental concentration levels. The first instrument is designed to be portable. The second instrument is designed to be housed permanently in an environment monitoring house. Each instrument has the sensitivity to analyze low-level process streams and effluent with a detection limit of 50 ng/L. Greater analytical sensitivity can be achieved if necessary. Modification of the apparatus for use as a dedicated air or urine analyzer is possible. Linearity over four orders of magnitude in concentration was demonstrated with similar equipment.

Airborne Beryllium Monitors

An analyzer based on laser-induced, time-resolved luminescence is being developed to determine airborne beryllium. The instrument will have the sensitivity to perform analyses at concentration levels regulated by the National Institute for Occupational Safety and Health and the Occupational Safety and Health Administration. The instrument is being designed for continuous monitoring of workplace air. Modification of the apparatus should enable its use as an exhaust stack monitor. The basic operation of the analytical system has been determined. Linearity over four orders of magnitude in concentration has been demonstrated. The expected beryllium monitor will have a detection limit below 200 pg. This detection-limit level is low enough to allow the instrument to emulate (unattended) the conventional 8-h time-weighted average methods in real time. The next steps are to build a prototype instrument and to initiate field testing.

Advanced Technology for Oralloy Recovery Instrumentation and Controls

The Saltless Direct Oxide Reduction (SDOR) process is being developed by the Y-12 Plant under the Advanced Technology for Oralloy Recovery (ATOR) project. Development of SDOR technology is a high priority of the Y-12 Plant because it will eliminate anhydrous hydrofluoric acid and by-product waste streams, which are characteristic of our current uranium recovery process. A portion of ATOR funds is devoted to automation of the SDOR process.

This report presents the SDOR automation efforts with emphasis on the conceptual design of the consolidation and dissolution unit processes. The consolidation furnace design uses tower water to remove heat from inner cooling loops. The design uses heat exchangers that isolate the large volumes of tower water from the enriched uranium process. Direct use of water for cooling the furnace induction coil (one inner loop) was made possible by limiting the volume of water to a critically safe amount. The novel design removes water from the furnace automatically if a coil failure occurs. This report also discusses cooling of the crucible. A prototype of the dissolution process was made, and initial tests showed that good mixing occurs with the design.

Nondestructive X-ray Microanalysis

A new specimen manipulator for the X-ray microprobe was installed and tested. The manipulator uses dc motors with shaft encoders for movement of the specimen stages. Testing of the system showed improved linearity and the potential for higher speeds when compared with the old system, which used stepper motors. A computer simulation of the transport of X rays through glass capillaries was studied to decide what improvements might be possible with changes in glass capillary design and production. The implications were that significant beam-flux improvements might be obtained if improvements could be made in the geometrical perfection and smoothness of the capillaries.

Evaluation of the Effects of Varying Penetration on Acoustic Emission Produced by Electron-Beam Welding of D-38 Step Joints

Experiments were performed to evaluate the effects of variable penetration on acoustic emission (AE) produced during electron-beam welding of depleted uranium (D-38) step joints. Penetration was varied by setting discrete current levels, continuously changing the weld current, and intermittently switching the current on and off. Linear changes in weld current produced corresponding linear changes in weld penetration. In general, AE increased with weld current but reached a steady-state value before steady-state current production. No steady decrease in AE occurred when current was decreased steadily. In both rising and falling current welds, no characteristic AE behavior was observed that would herald the arrival of the beam at the weldment step landing. During interrupted current welds, distinct steps in Average Signal Level value occurred when the current was stopped and started. The results imply that in real welding applications, detection of rapid transients, but not gradual changes, in weld penetration should be possible.

An Expert System for Assessing the Relative Importance of Maintenance Work Requests

The Maintenance Importance Generator (MIG) program for prioritizing Maintenance Work Requests (MWRs) has been in production use for more than a year. The MIG program systematically and uniformly applies Y-12 Plant and Department of Energy (DOE) policy concerning prioritization of work and has been officially designated as the mechanism for doing so. The MIG program also captures and applies the knowledge and best practices of many experienced maintenance workers. Up to 40,000 MWRs are prioritized or updated weekly, and the maintenance supervisors receive prioritized work-pending lists. The MIG program has aided Maintenance significantly in coping with the high volume of DOE, Occupational Safety and Health Administration, Environmental Protection Agency, Tiger Team, Technical Safety Audits, and other audit demands and has received favorable comments. This scheme for prioritization represents a first in the Nuclear Weapons Complex (NWC) and continues to draw interest from other NWC installations.

A major revision of the Maintenance data base was completed August 19, 1992, consequently requiring a major revision in the MIG program to be completed at the same time. The Job Type and Job Category codes changed, as did relative importance. Compliance items (e.g., Safety, Safeguards, and Computer Security) all changed along with their relative mapping into the MIG scale. A major tie was made with the plant Risk-Based Priority System (RBPS), which is a method for ranking audit findings. Any work done against an audit finding receives MIG weight based on its relative RBPS ranking. Many new permit flags and awaiting-conditions flags were added. Two data streams now exist, one for planned

jobs and one for unplanned jobs, thus requiring two runs of the MIG program rather than one run each day. The data streams and all MIG operations have been moved to the Maintenance Data Management System VAX computer in Building 9208.

METRIC CONVERSIONS

Distribution

Allied Signal - Kansas City Division

Hofmann, J. W.

Stoltz, D. L.

Department of Energy - Albuquerque

Nonnuclear Technology Branch, WQD

Nuclear Technology Branch, WQD

Department of Energy - Oak Ridge

Carpenter, P. A.

Spence, R. J.

EG&G - Mound Applied Technologies

Records Management

EG&G - Rocky Flats Plant

Manager, Document Control-CCDM

Lawrence Livermore National Laboratory

Clough, R. E.

Copeland, A. B.

Hanabee, J. E.

Technical Information Division

Los Alamos National Laboratory

Casey, H.

Flaugh, H. F.

Gunderson, T. C.

Hanson, E. M.

Hecker, S. S.

Hill, G. G.

Larson, T. E.

Miller, D. G.

Parkinson, J. L.

Report Library

Ruminer, J. J.

Shafer, B. P.

Martin Marietta Specialities Components, Inc.

Taylor, S. L. (Document Control)

Oak Ridge Y-12 Plant

Bowers, G. L.
Garber, J. W.
Lee, A. K./DOE-OSTI
Morrow, M. K.
Northcutt, W. G., Jr.
Post, D. W.
Sissom, D. T.
Stout, J. D.
Y-12 Central Files (Y-12RC)
9202 File Point

Sandia National Laboratories - California

Cull, E. T.
Hiles, L. A.
Lindner, D. L.
Technical Library

Sandia National Laboratories - New Mexico

Hines, W. C.
Lane, T. B.

Westinghouse - Savannah River Plant

Knight, J. R.

**DATE
FILMED**

5/17/94

END