Y-12

Y-2467-3

OAK RIDGE
Y-12
PLANT

MARTIN MARIETTA

Y-12 DEVELOPMENT ORGANIZATION TECHNICAL PROGRESS REPORT

Part 3 - Metal Processing

Period Ending September 1, 1994

MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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Date of Issue: February 8, 1995 Y-2467-3

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Compiled by
W. G. Northcutt, Jr.

Period Ending September 1, 1994

Prepared by the
Oak Ridge Y-12 Plant
P.O. Box 2009, Oak Ridge, Tennessee 37831-8169
managed by
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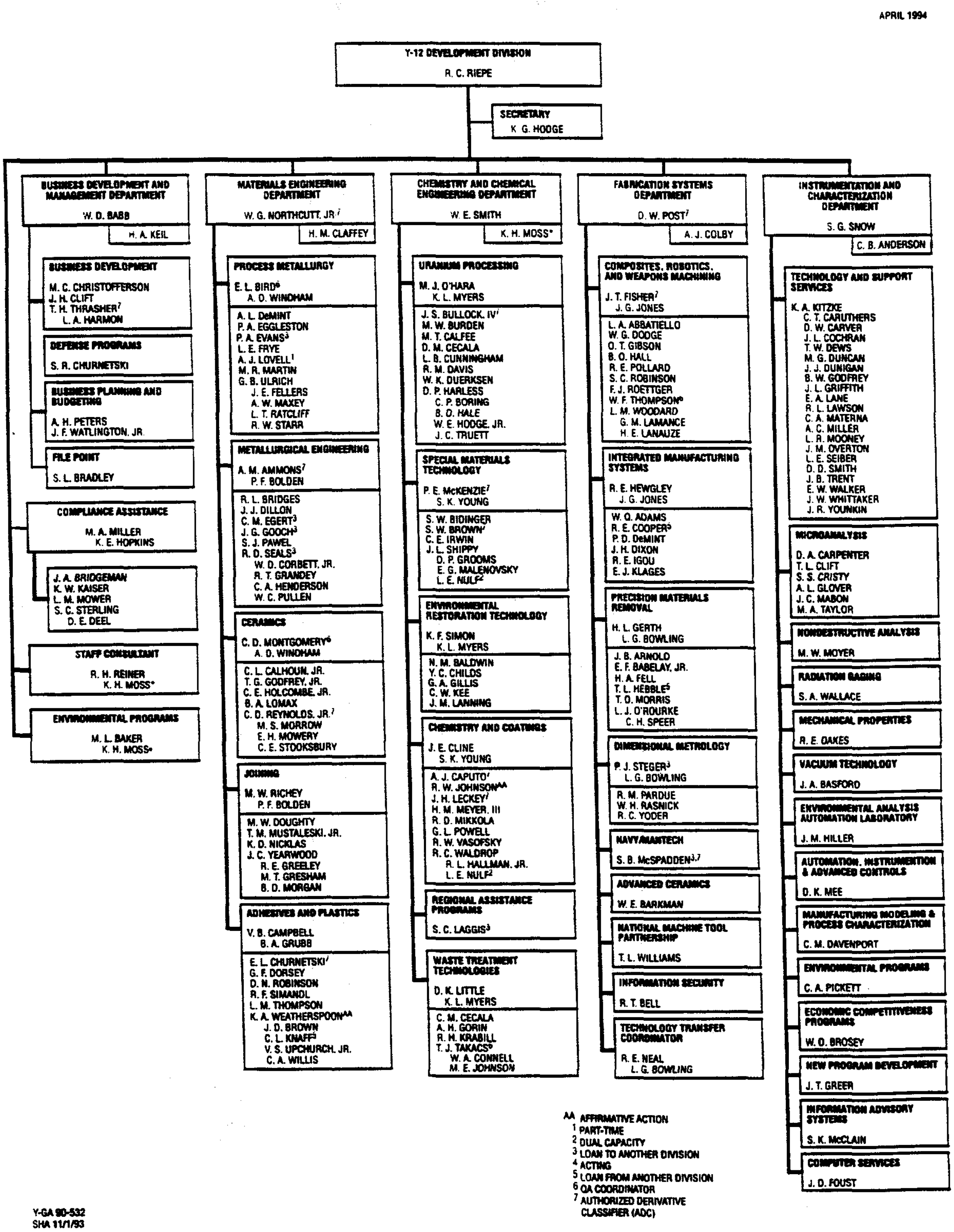
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HIGHLIGHTS

ALUMINUM-URANIUM ALLOY CASTING

The authors melted and cast an aluminum-uranium (Al-U) alloy by vacuum induction melting (VIM) prealloyed buttons made by arc melting. The resulting alloy casting displayed a large compositional gradient from top to bottom. (Page 6)

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METAL PROCESSING

ALUMINUM-URANIUM ALLOY CASTING

A. L. DeMint and A. W. Maxey

Summary

The authors melted and cast an aluminum-uranium (Al-U) alloy by vacuum induction melting (VIM) prealloyed buttons made by arc melting. The resulting alloy casting displayed a large compositional gradient from top to bottom.

Introduction

The Y-12 Plant Laboratory requested a series of Al-U alloys to serve as standards for assaying shipments that would be received from the Westinghouse Savannah River Company site. The alloys ranged from pure aluminum to ~63 wt % aluminum in uranium and were required to contain precise amounts of uranium and aluminum. Since the "real" alloys were to contain enriched uranium, the casting method was tested on depleted uranium. The alloy with the highest uranium content (37%) was chosen to prove out the system.

Standard metal casting operations that involve pouring the metal always generate a skull (material left behind in the crucible) and therefore were not used because of the precise weight requirement. Powder metallurgy processes produce parts as homogeneous as the starting powders can be blended, and losses are insignificant; however, the need for enriched uranium restricted the fabricating operations to arc melting and induction melting.

Uranium and aluminum form several intermetallic compounds, the most refractory of which melts at 1620°C (UAl_2: ~19 wt % aluminum). In comelting pure aluminum and uranium, one would expect to pass through all of these phases until the metal becomes homogeneous. If the comelting is carried out below 1620°C, formation of UAl_2 would delay the homogenization of the alloy. The mold washes used for induction melting uranium begin to break down at 1450°C; therefore, they would not be an effective barrier against carbon at the temperature required for good mixing.

The authors chose arc melting as the means for prealloying the material because much higher temperatures are achieved with arc melting, and the molten pool is contained by a solid film of the material being melted in a chilled copper cup. The prealloyed "buttons" could then be used as the charge for induction melting.

Presentation of Experimental Work

To test the process for fabricating the alloys, the authors made one casting of roughly 37 wt % uranium. They comelted the uranium and aluminum in an arc furnace in 400-g batches. They melted each batch, or button, two to three times and turned it over between melts to encourage better mixing of the two metals. They then loaded the buttons into a closed-bottom, graphite crucible, heated it to 1200°C, and allowed it to solidify. (This composition should melt at ~1080°C).

Results and Discussion

The authors sampled the resulting casting for uranium to check homogeneity. The sampling revealed that the top of the casting contained 23.5 wt % uranium, and the bottom (an average of two samples) contained 42.4 wt % uranium.

Although each button contained 36.5% uranium, these analyses show that the solidified casting was inhomogeneous. If the buttons were homogenous, the segregation occurred during induction melting, and this method may not be feasible for making Al-U alloys. If the buttons were not homogeneous, perhaps arc melting the buttons more times would have helped. Bottom pouring the Al-U melt into a mold for faster cooling could also help prevent segregation.

Future Work

When the original problem was re-examined, the authors decided that the incoming alloy could be sampled extensively and used as standard material, eliminating the need for casting fresh alloy. No future work is planned.

References

None.

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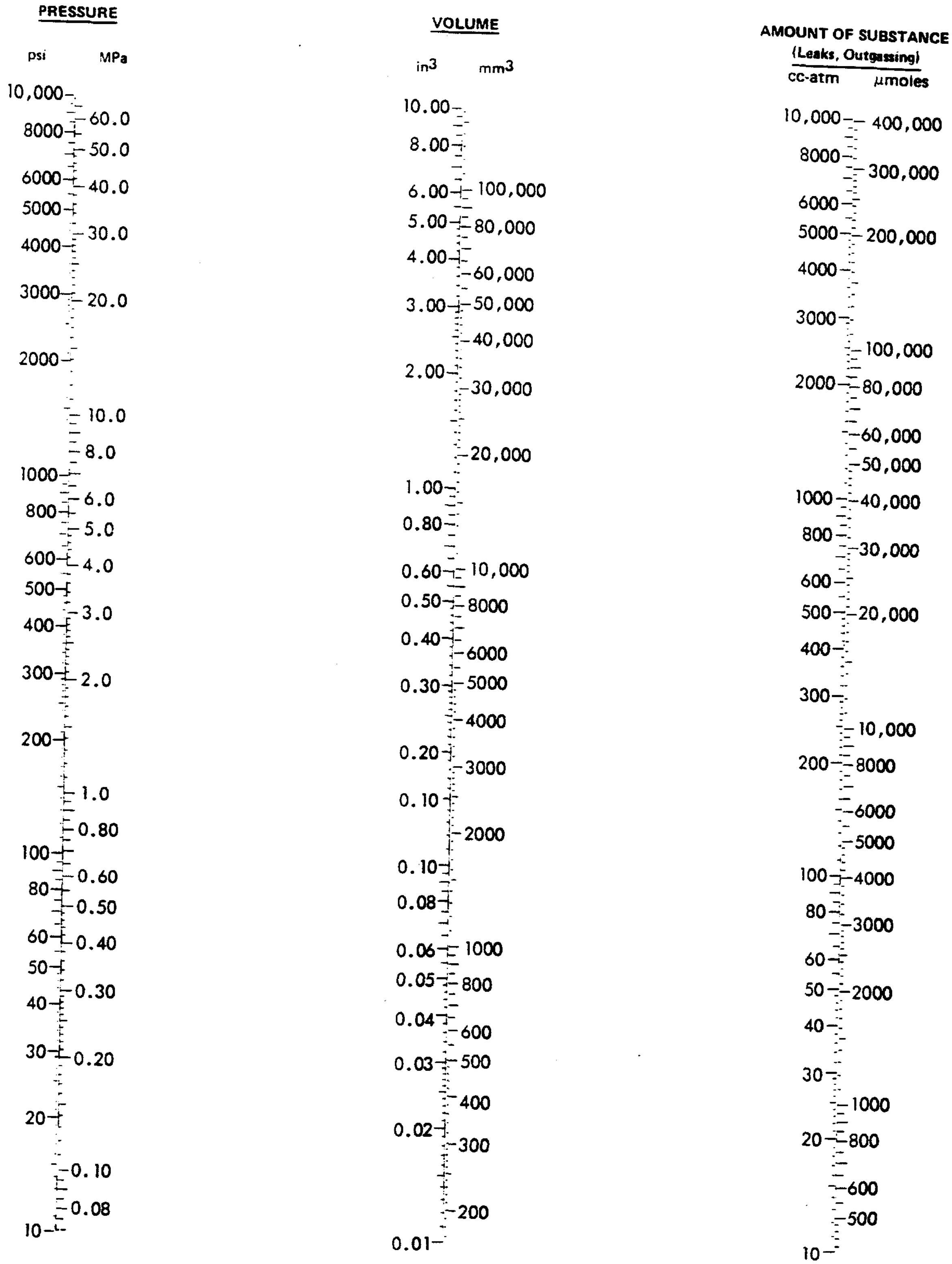

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