Pacific Northwest Laboratory
Monthly Report to
Advanced Nuclear Energy Systems,
Space and Special Purposes Division
for November 1975

December 1975

Prepared for the U.S. Energy
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PACIFIC NORTHWEST LABORATORY MONTHLY REPORT
TO ADVANCED NUCLEAR ENERGY SYSTEMS, SPACE
AND SPECIAL PURPOSES DIVISION
FOR NOVEMBER 1975

by

H. T. Fullam

December 1975

Battelle
Pacific Northwest Laboratories
Richland, Washington 99352
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STRONTIUM HEAT SOURCE DEVELOPMENT PROGRAM

At Hanford, strontium will be separated from the high-level waste, then converted to the fluoride, and doubly encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage will take place in the Waste Encapsulation and Storage Facilities (WESF). This encapsulated strontium fluoride represents an economical source of $^{90}\text{Sr}$ if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}\text{SrF}_2$ heat sources and specifically the WESF $^{90}\text{SrF}_2$ capsules. The information needed for licensing can be divided into three general areas:

1. Long-term $\text{SrF}_2$ compatibility data.
2. Chemical and physical property data on $^{90}\text{SrF}_2$.
3. Capsule property data such as external corrosion resistance, crush strength, etc.

The current program is designed to provide the required information.

LONG-TERM COMPATIBILITY STUDIES

The fuel-grade $^{90}\text{SrF}_2$, required for the long-term compatibility tests, has been prepared by ARHC0 at WESF. The preliminary analysis indicates that the $^{90}\text{SrF}_2$ has a purity of approximately 95 wt%. When the $^{90}\text{SrF}_2$ was loose-packed in its Hastelloy C-276 capsules, each capsule held about 1.5 kg of fluoride instead of the anticipated 1.1 kg. Therefore, only five capsules were loaded with loose-packed powder to provide the required 7 kg of fluoride. The $^{90}\text{SrF}_2$ will be shipped to PNL about the first week of December.
All of the hardware required for preparation of the compatibility test couples has been fabricated. Preparation of the $^{90}\text{SrF}_2$ test couples will begin as soon as the fluoride is received from ARHCO. Fabrication of the nonradioactive SrF$_2$ test couples will begin as soon as the $^{90}\text{SrF}_2$ has been thoroughly analyzed and nonradioactive SrF$_2$ of similar composition can be prepared.

Testing of two full-size WESF $^{90}\text{SrF}_2$ capsules is planned. Each capsule will be held in a special container and allowed to self-heat to approximately 800°C. The tests will last for 6 and 12 months. After testing, the capsules will be sectioned and examined to determine the extent of metal-fluoride interaction. A prototype container has been fabricated and tested with an electrically heated dummy WESF capsule. A sketch of the container is shown in Figure 1. The unit is provided with three movable thermocouples which measure the surface temperature of the outer jacket of the WESF capsule at various locations. The container and capsule are placed in a horizontal position, and the thermocouples measure the surface temperature at the top, bottom and mid-point of the capsule (see Figure 1). The thermocouples can be moved longitudinally to measure the surface temperature along the length of the capsule. Tests with the dummy capsule showed a significant temperature gradient between the center and ends of the capsule due to uneven heat losses. At a power input of 1000 watts, equivalent to a fuel-grade WESF $^{90}\text{SrF}_2$ capsule, the inner capsule surface temperature varied from 816 to 787°C between the center and ends of the capsule. Since the desired interface temperature was 800°C, the container appears to be adequate for the tests. A second unit of similar design is now being fabricated. Testing of the WESF capsules will start in January.

THERMAL AGING OF HASTELLOY C-4

Charpy V notch specimens of Hastelloy C-4 are being aged at 600, 800, 900 and 1000°C for periods up to 30,000 hr to determine the effect of time and temperature on the impact strength of the alloy. The original specimen
FIGURE 1. Container to Hold Full Size WESF $^{90}$SrF$_2$ Capsule
size corresponded to the standard ASTM 10 mm square design (ASTM-E-23). Evaluation of 1000-hr test specimens showed that the impact strength of most specimens exceeded the capacity of the Baldwin Charpy impact testor, which had a rated capacity of 240 ft-lb (see BNWL-1845-16 for details). Therefore, to obtain meaningful data the specimen thickness was reduced to 0.145 in. Results obtained with specimens of reduced thickness, after aging for 1000 hr, are shown in Table 1. The results are unusual in that the impact strength of specimens aged at 900 and 1000°C exceeded that of the "as received" material which had been solution heat-treated at 1950°F and rapid quenched. Micrographs are now being obtained of the test specimens to determine the effects of thermal aging on the microstructure of the alloy.

TABLE 1. The Effect of Thermal Aging for 1000 hr on the Impact Strength of Hastelloy C-4

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<th>Aging Temperature °C</th>
<th>Room Temperature</th>
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<tr>
<td>As-Received</td>
<td>61.8</td>
<td>64.2</td>
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<tr>
<td>600</td>
<td>38</td>
<td>41</td>
</tr>
<tr>
<td>800</td>
<td>56.1</td>
<td>59.0</td>
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<tr>
<td>900</td>
<td>76.3</td>
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<td>1000</td>
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