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Pacific Northwest Laboratory Monthly Report on the Strontium Heat Source Development Program, Division of Nuclear Research and Applications for February 1977

H. T. Fullam

March 1977

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Battelle
Pacific Northwest Laboratories

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PACIFIC NORTHWEST LABORATORY MONTHLY REPORT ON THE STRONTIUM HEAT SOURCE DEVELOPMENT PROGRAM, DIVISION OF NUCLEAR RESEARCH AND APPLICATIONS FOR FEBRUARY 1977

H. T. Fullam

March 1977

BATTELLE
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Richland, Washington 99352

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STRONTIUM HEAT SOURCE DEVELOPMENT PROGRAM

H. H. Van Tuyl, Program Manager
H. T. Fullam, Principal Investigator
D. G. Atteridge

At Hanford, strontium is separated from the high-level waste, converted to the fluoride, and doubly encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage take place in the Waste Encapsulation and Storage Facilities (WESF). The encapsulated strontium fluoride represents an economical source of ^{90}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 $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. The information needed for licensing can be divided into three general task areas:

Task 1 - Chemical and Physical Properties of $^{90}SrF_2$
Task 2 - $^{90}SrF_2$ Compatibility Studies
Task 3 - Capsule Qualification and Licensing

Efforts are proceeding concurrently on all three tasks to obtain the required information.

TASK 1 - CHEMICAL AND PHYSICAL PROPERTIES OF $^{90}SrF_2$ (H. T. Fullam)

No activity this month.

TASK 2 - $^{90}SrF_2$ COMPATIBILITY TESTS (H. T. Fullam)

Long-Term Compatibility Tests

The compatibility couples from the 6000 hr tests with $^{90}SrF_2$ have been sectioned and the test specimens recovered. The 36 metallography specimens (12 TZM, 12 Haynes Alloy 25 and 12 Hastelloy C-276) from the sectioned couples have been shipped to ORNL for metallographic examination and electron microprobe analysis. Tensile and Charpy specimens recovered from the test couples will also be shipped to ORNL for testing as soon as the shipping cask is returned from ORNL.

Supplemental Short-Term Tests

Metallographic examination of all specimens from the supplemental short-term tests has been completed. Estimates of metal attack based on the photomicrographs obtained are presented in Table 1. Evaluation of the results leads to the following conclusions:

- Overall metal attack did not increase appreciably with increasing exposure time; and several specimens tested for 4400 hr showed less attack than the equivalent 1500 hr specimen. The results are further indication that low level impurities in the SrF_2 (probably FeF_3 and CrF_3) are the principal cause of the metal attack, and they are consumed in a relatively short period of time.
- None of the iron, nickel, and cobalt base alloys tested are more resistant to fluoride attack than the Haynes Alloy 25 and Hastelloy C-276 which were evaluated in the initial short-term screening tests.
- None of the refractory metals tested are more resistant to fluoride attack than the TZM which was tested in the initial screening tests.
- Iridium, Ir-0.3% W and rhenium are more resistant to fluoride attack than the other materials tested (except tungsten which was evaluated in the initial tests).

A topical report summarizing all of the results of the supplemental short-term tests is now being prepared.

TASK 3 - CAPSULE QUALIFICATION AND LICENSING (D. G. Atteridge)

Heat Source Capsule Qualification Requirements

A cursory study into possible container damage from vibration during transportation indicates that the levels of vibration encountered during transportation are too low to excite any natural frequency of vibration response in the container. The problem of damage due to movement of the inner container in the outer container due to vibration encountered during transportation is currently being investigated.

TABLE 1. Estimated Attack of Test Specimens Exposed to Nonradioactive SrF_2[a] at 800°C

Material	Depth of Metal Affected,[b] mils: 1500 hours, Chemical Attack	1500 hours, Change in Microstructure	4400 Hours, Chemical Attack	4400 Hours, Change in Microstructure
Hastelloy C-276[c]	3	7	3	5
Haynes Alloy 25[c]	2	3	1	2
TZM[c]	1	0	1	<1
Hastelloy C-4	5	12	4	13
Hastelloy B	4	15	4	11
Hastelloy B-2	10	18	6	18
Hastelloy S	7	15	3	12
Haynes Alloy 556	5	6	5	7
Inconel 617	7	14	8	14
Inconel 671	15	25	20	20
Incoloy 800	8	0	7	0
Rene 41	10	14	11	13
Udimet 700	>25	0	>25	>25
Monel 400	5	8	6	6
Nickel 200	7	10	8	8
Ingot Iron	3	0	4	7
Ductile Cast Iron	CR	CR[d]	CR	CR
316L SS	6	0	22	0
JS 777	6	7	5	6
Copper	>25	0	>25	0
Titanium	>25	(e)	>25	(e)
Hafnalloy 2525	>25	(e)	CR	CR
Molybdenum	2	0	<1	<1
Niobium	3	2	2	2
Ta-10% W	10	0	2	0
Mo-50% Re	2	0	1	0
W-26% Re	2	0	1	0
Rhenium	<1	0	<1	0
Iridium	0	0	<<1	0
Ir-0.3% W	0	0	<<1	0
Platinum	>25	(e)	>25	(e)
Gold	>15	(e)	>15	(e)

(a) The SrF_2 contained impurities approximating those found in the WESF $^{90}SrF_2$

(b) Estimated from photomicrographs

(c) Tested as reference specimens

(d) CR - Complete Reaction

(e) Could not be estimated because of extensive chemical attack

Capsule Design

A preliminary "Safety Specification for Developmental Isotopic Heat Sources" document from NRA-ERDA and a "Nuclear Safety Program Plan for Sterling Isotope Power System" document from General Electric Company have recently been received. The documents are being reviewed for general isotope containment capsule requirements information and pertinent information will be included in the capsule design requirements.

Outer Capsule Material Selection

The impact machine has been installed and is currently undergoing calibration testing. The elevated temperature furnace equipment is nearing completion and will be tested in the near future.

Prototype Capsule Fabrication and Testing

The capsule containment chamber for the helium leak detector has been fabricated and attached to the leak detector (see Figure 1). The system is currently undergoing calibration testing and weld inspection.

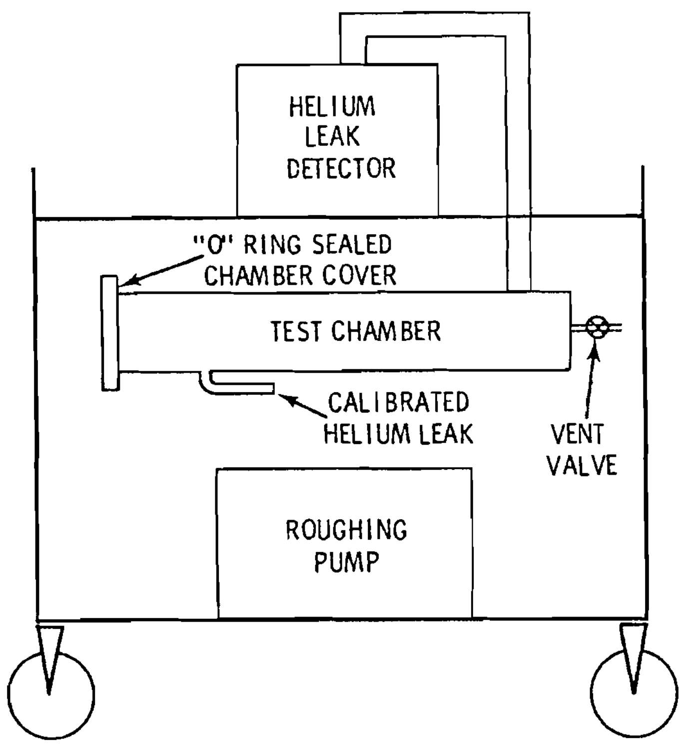

FIGURE 1. Schematic of Helium Leak Detection System Mounted on a Cart

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