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TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

1110 Chestnut Street Tower II

March 9, 1982

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U.S. NUCLEAR REG. COMMISSION NMSS MAIL SECTION

Mr. Earl Wright
U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safeguards
Division of Fuels Cycle and Material Safety
Washington, DC 20555

Dear Mr. Wright:

CONTINUOUS ONLINE NUCLEAR ANALYZER OF COAL (CONAC) BYPRODUCT MATERIAL LICENSE APPLICATION CONTROL NO. 81-97

As discussed in the telephone conversation between Gary R. MacDonald of my staff and you on February 17, enclosed is information needed to answer questions you raised while reviewing the CONAC byproduct material license application.

Information on the Californium 252 Sealed Source--The Savannah River source is a Model SR-CF-100 series consisting of a frit (90-percent platinum, 10-percent rhodium) containing Californium-252 oxide (Cf_2O_3). The source uses a platinum 10-percent rhodium inner and a zircaloy-2 outer encapsulation and is described in the enclosed IAEA Certificate and the October 1973 U.S. Atomic Energy Commission's report.

Additional drawings--We have included three additional annotated drawings of the sulfurmeter assembly (D-SM-SS-00-001, sheet 2 and 3, issue B and D-SM-SS-00-001, sheet 4, issue C). These drawings are taken from the sulfurmeter that was originally build for Detroit Edison. The mechanics are the same for the CONAC.

Narrative and Photo Description--Enclosed are two photos to aid in visualizing the CONAC. Photo No. 1 shows a full view of the CONAC. It measures 25 feet long by 14 feet high at the input hopper and weighs approximately 14 tons. As indicated in the conceptual drawings sent with the original application and pictured to the right in Photo No. 1, coal enters the system through the input hopper and is gravity fed and leveled to an uniform depth by an adjustable gate. The coal is then measured for moisture content by conveying the coal on a moving belt past a microwave moisture meter. Coal flow rates are derived from the mass sensor monitor which uses a standard density gauge with a tachometer located next to it. Adjacent to the tachometer is the Californium-252 source module (center, Photo No. 2). The coal is irradiated by neutrons emitted by the Californium from beneath the belt, and the gamma ray detectors are positioned above the source and coal. These gammas are sorted by energy using a multichannel analyzer. A computer then determines coal constituent analysis.

30-19463

Mr. Earl Wright March 9, 1982

If you have further questions or need more explanation, please call Mr. MacDonald or me at FTS 858-5675.

Sincerely,

J. B. Brellenthin

J. B. Brellenthin, Chief
Environmental Support Staff

Enclosures

DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
WASHINGTON, D.C. 20590

IAEA CERTIFICATE OF COMPETENT AUTHORITY

Special Form Radioactive Material Encapsulation

REFER TO:

Certificate Number USA/0018/S
(Revision 2)

This certifies that the encapsulated source, as described, when loaded with the authorized radioactive contents, has been demonstrated to meet the regulatory requirements for special form radioactive material as prescribed in IAEA[1] and USA[2] Regulations for the transport of radioactive materials.

I. Source Description - The source described by this certificate is identified as Model SR-CF-100 as described in Savannah River Laboratory's report "Description of ^{252}CF Sources" (Rev. 2/8/71). The inner capsule consists of a right cylinder of platinum-10 wt% rhodium alloy, 0.217 inches in diameter and 0.972 inches long, with a wall thickness of 0.044 inches and with fusion welded end plugs. The outer capsule consists of a right cylinder of stainless steel or zircaloy-2, 0.370 inches in diameter and 1.48 inches long, with a wall thickness of 0.068 inches and with a fusion welded end plug.

II. Radioactive Contents - The authorized radioactive contents of this source consist of not more than 5.2 Ci (10 mg) of Californium-252 as oxide.

III. This certificate, unless renewed, expires February 28, 1983.

This certificate is issued in accordance with Marginal C-6.1 of the IAEA Regulations and in response to the December 6, 1979, petition by the U.S. Department of Energy, Aiken, South Carolina.

Certified by:

R R Rawl (signature) January 11, 1980
(Date)

Richard R. Rawl
Designated U.S. Competent Authority for the International Transportation of Radioactive Materials
Office of Hazardous Materials Regulation
Materials Transportation Bureau
U.S. Department of Transportation
Washington, D.C. 20590

(Continued)

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[1] "Safety Series No. 6, Regulations for the Safe Transport of Radioactive Materials, 1967 Edition" published by the International Atomic Energy Agency (IAEA), Vienna, Austria.

[2] Title 49, Code of Federal Regulations, Part 170-178, USA.

Original issued in response to the December 6, 1972, and January 17, 1973, petitions by Gulf Oil Corporation, San Diego, California.

Revision 1 issued to extend expiration date in response to the November 24, 1976, petition by the Energy Research and Development Administration, Washington, D.C.

Revision 2 issued to extend expiration date in response to the December 6, 1979, petition by the Department of Energy, Aiken, South Carolina.

Input Hopper

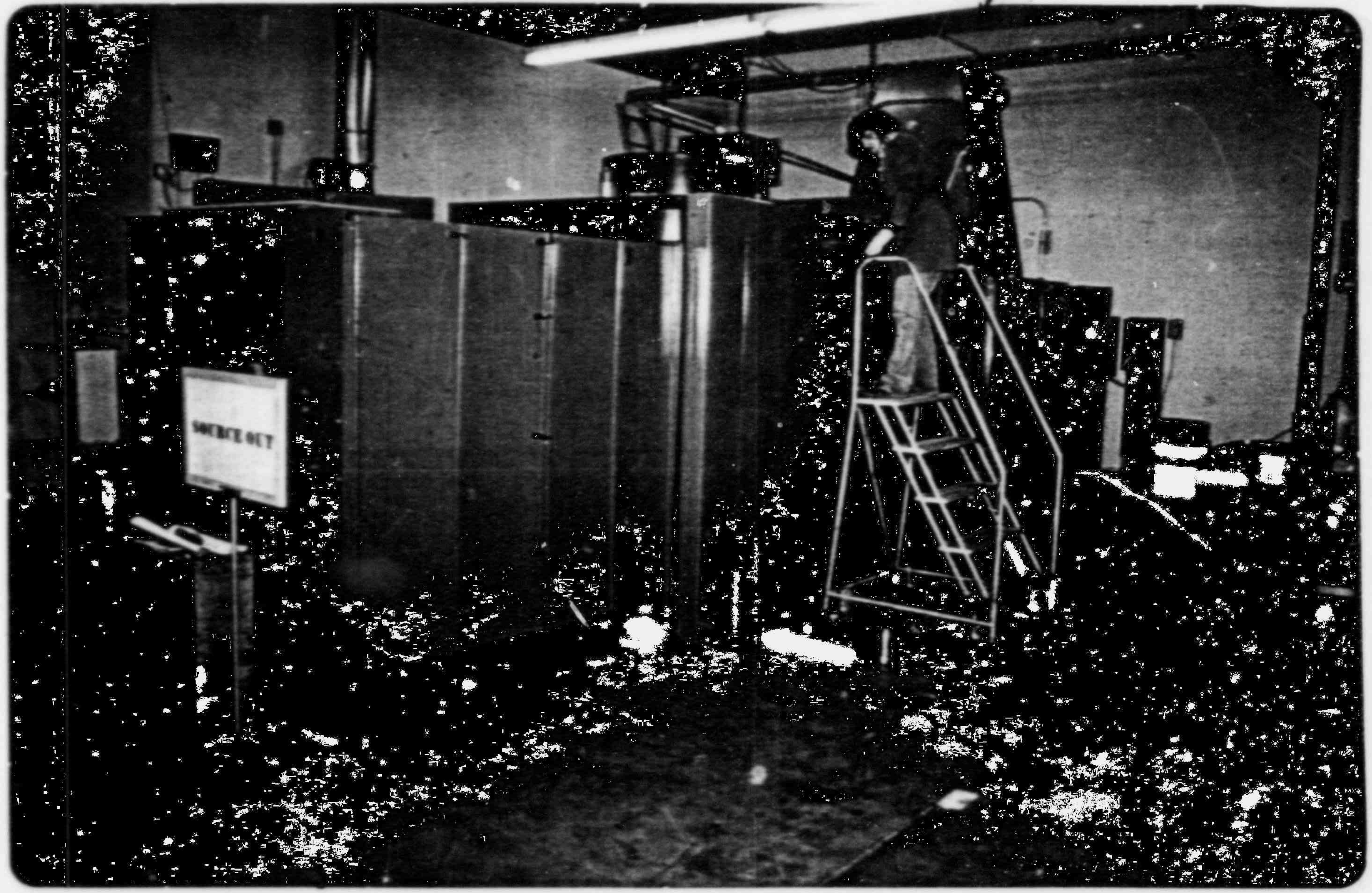


Photo 1

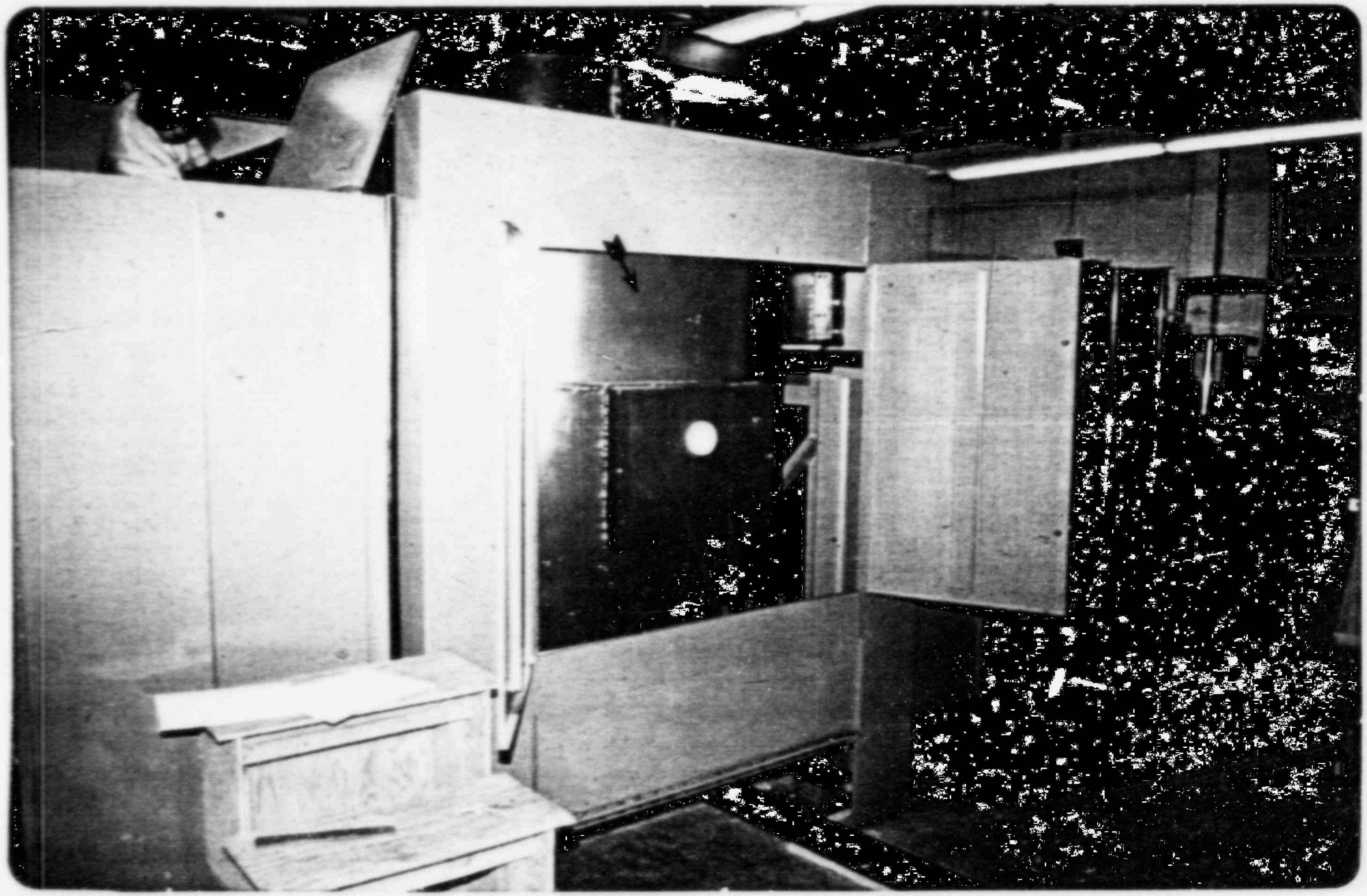


Photo 2

^{252}Cf SOURCE AND SHIPPING CAPSULE ASSEMBLY DESIGN AND TEST INFORMATION

This document is a compilation of information related to the design and testing of Savannah River ^{252}Cf industrial sources and ^{252}Cf shipping packages updated as a result of the availability for sale of $Pd-Cf_2O_3$ cermet wire. Included in this compilation are the following publications:

1. Specifications for $Pd-Cf_2O_3$ Cermet Pellets and Wire
2. Industrial Sources, SR-Cf-100 Series, Appendix B
3. ^{252}Cf Shipping Capsule Assembly, SR-Cf-1000 Series, Appendix C
4. Primary Capsule, SR-Cf-XX Series, Appendix D
5. Primary Capsule, SR-Cf-1X Series, Appendix E

The primary capsule of SR-Cf-XX series design is generally used for containment of Cf_2O_3 but may also be used for containment of $Pd-Cf_2O_3$ source forms. Item 4, which defines this capsule design, is included in this compilation for reference purposes.

U. S. Atomic Energy Commission
Savannah River Operations Office
P.O. Box A, Aiken, S. C. 29801

October 1973

PRODUCT DESCRIPTION

SPECIFICATIONS FOR Pd-Cf_2O_3 CERMET PELLETS AND WIRE

In addition to the Cf_2O_3 previously provided, ^{252}Cf is available for sale to encapsulators in the form of cermet pellets or wire consisting of a uniform distribution of ^{252}Cf oxide particles in a palladium metal matrix. The pellets will be made to a specified ^{252}Cf content, whereas, measured lengths of wire can be cut from stock to obtain sources of different sizes. Cermet provides the encapsulator physically contained ^{252}Cf, with reduced contamination potential compared to that characteristic of handling oxide. ^{252}Cf loss or waste is reduced substantially. These factors are expected to simplify the processes and equipment required for encapsulation.

Palladium was selected as the matrix material for the following reasons. Palladium is a noble metal, providing a high degree of containment in various chemical, atmospheric, and thermal environments. It is relatively unaffected by immersion in water or heating in air, and melts at 1552°C. Of the noble metals, palladium has the lowest cross section for neutron capture and produces the least delayed and prompt gamma rays that might interfere in applications of neutron activation analysis. Palladium is very ductile, and can be readily formed into wire or other shapes. Should the ^{252}Cf need to be recovered, palladium dissolves in concentrated nitric acid. The separation of ^{252}Cf and palladium by ion exchange techniques has been demonstrated.

A process has been developed to uniformly admix ^{252}Cf as oxide with palladium metal. Pellets for direct use, or for rolling into wire, are made by pressing and sintering. Wire is annealed at 800°C to a dead soft condition before packaging; unannealed wire that offers greater stiffness is available on request. Wire rolled to the highest concentration (500 μg/inch) has a smearable surface contamination of $\sim 10^6$ alpha disintegrations per minute, a factor of $\sim 10^6$ lower than the total alpha inventory in the wire.

Specifications

The product specifications are shown in Table I. Combinations of the three concentration levels in the wire should allow fabrication of sources from about 2 μg to 2000 μg or larger within ±10% of the nominal ^{252}Cf requirement. However, other loadings and shapes may be accommodated on special order.

Uniformity is measured by densitometer analyses of gamma autoradiographs of the finished wire. Uniformity generally is within ±5% of the average ^{252}Cf concentration. This allows a reasonable tolerance in cutting to length to yield a maximum error of ±10% in individual sources. ^{252}Cf levels and uniformity data on lengths of wire cut shorter than 0.5 inch may not meet these specifications because of cutting precision and end effects. Lengths of six inches or longer may be accommodated on special order. Total ^{252}Cf is assayed to ±3% by neutron counting in a calibrated fission counter. Terbium is added as a carrier to precipitate ^{252}Cf quantitatively.

Appendix B (continued)

2. External Loading Tests

The two worst conditions to which the source is likely to be subjected are: a) crushing by a heavy object such as the shipping cask; and b) collapse under hydrostatic pressure, such as the capsule would experience in deep-well or deep-sea environment.

a) Crush Test

A large shipping cask for several milligrams of ^{252}Cf may weigh as much as 20 tons. Assuming half the weight of the cask might come to rest on the capsule, prototype sources were placed between stainless steel anvils loaded with a total of 10 tons, removed and pressurized with helium at 300 psi for 30 minutes, then tested for leaks with a helium leak detector. At a lower detection limit of 1×10^{-8} standard cubic centimeters of helium per second, no leaks were detected. A photograph of a prototype source after test is shown in Figure B-1.

b) Hydrostatic Compression Test

The hydrostatic pressure at 10 miles depth in a bore hole is about 25,000 psi. Test capsules were subjected to 25,000 psi helium pressure without measurable deformation, and then tested for leaks with a helium leak detector whose lower detection limit is 1.0×10^{-8} standard cubic centimeters of helium per second. No leaks were detected.

3. Additional Tests

The integrity of the source construction and seal welds was demonstrated by successfully subjecting the secondary capsule to tests simulating expected adverse service conditions as specified in AEC Manual, Chapter 0529-05, Safety Standards for the Packaging of Radioactive and Fissile Materials, Annex 4, as described below.

a) Free Drop - A free drop through a distance of 30 feet onto a flat essentially unyielding horizontal surface, striking the surface in such a position as to suffer maximum damage.

b) Percussion - Impact of the flat circular end of a 1-inch diameter steel rod weighing 3 pounds, dropped through a distance of 40 inches. The capsule or material shall be placed on a sheet of lead, of hardness number 3.5

to 4.5 on the Vickers scale, and not more than 1 inch thick, supported by a smooth essentially unyielding surface.

c) Heating - Heating in air to a temperature of 1475°F (800°C) and remaining at the temperature for a period of 10 minutes.

d) Immersion - Immersion for 24 hours in water at room temperature. The water shall be at pH 6-pH 8, with a maximum conductivity of 10 micromhos per centimeter.

After each of the four tests the test capsule was externally pressurized with 300 psi helium and helium leak tested. At a lower detection limit of 1×10^{-8} standard cubic centimeters of helium per second no leaks were detected.

F. Quality Control Procedures

The process for fabrication of sources was described in Section D. Quality control aspects of the process steps are discussed in the following paragraphs.

1. Californium Assay and Analyses

Quality control for the californium is accomplished by measurement of the neutron emission rate of an aliquot of the starting material and analyses for isotopic content (Section C) and chemical purity. The neutron emission rate is assayed in a fission counter. Isotope content is measured by mass spectrometry and chemical purity by spark source mass spectrometry. The completed assembly is leak tested, decontaminated and assayed before packaging and shipping.

2. Inspecting Capsule Components

Prior to cleaning, capsule components are inspected for dimensional accuracy and machining flaws.

3. Cleaning Capsule Components Prior to Use

All metal components used in californium source fabrication are thoroughly degreased and cleaned prior to use to remove cutting oil, grease, fingerprints, and dirt. Presence of these materials could cause pressure buildup during capsule sealing or the formation of undesirable products due to long-term radiolytic degradation inside the source. The following cleaning procedure is used for metal components of the system.

Appendix B (continued)

a) Soak the component for 10 minutes in clean acetone in a new or very clean vessel.

b) Remove the component from acetone with clean forceps and allow to air-dry for a few minutes.

c) Soak component for 10 minutes in clean absolute ethyl alcohol.

d) Rinse in clean acetone.

e) Air-dry in a dessicator for at least 30 minutes or dry on a lintless towel.

f) Store the clean, dry components in clean glass vials.

4. Welding Control

The plug in the outer capsule is seal-welded with an argon-shielded or helium-shielded tungsten electrode DC arc. The capsule is rotated under the automatically controlled arc to produce a minimum weld penetration of 0.050 inch (Figure B-2). The welded capsule is helium leak tested and decontaminated to a level of less than 9 d/m α and 10 c/m β-γ transferable radioactivity as determined by a wipe test.

5. Helium Leak Testing

Sealed capsules are pressurized in 300 psi helium for 30 minutes. Leak tests are performed on individual capsules in a helium leak detector whose lower detection limit is 1.0×10^{-8} standard cubic centimeters of helium per second. All capsules must show no detectable leak.

G. Labeling

Standard industrial sources for the Model SR-Cf-100 sources are identified by the engraved designation "SR-Cf-101," "SR-Cf-102," through "SR-Cf-999" as illustrated in Figure B-3. Each source is provided with an information sheet listing pertinent construction, test, and calibration data as shown in the attached Information Sheet.

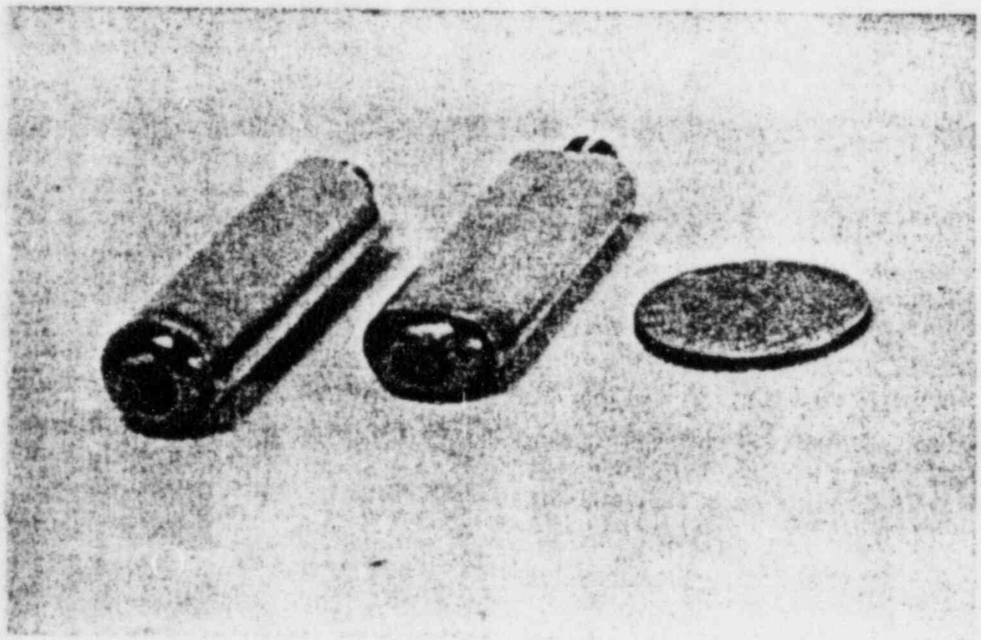


FIGURE B-1. Welded Outer Capsule Before and After 20,000-lb Crush Test

Appendix B (continued)

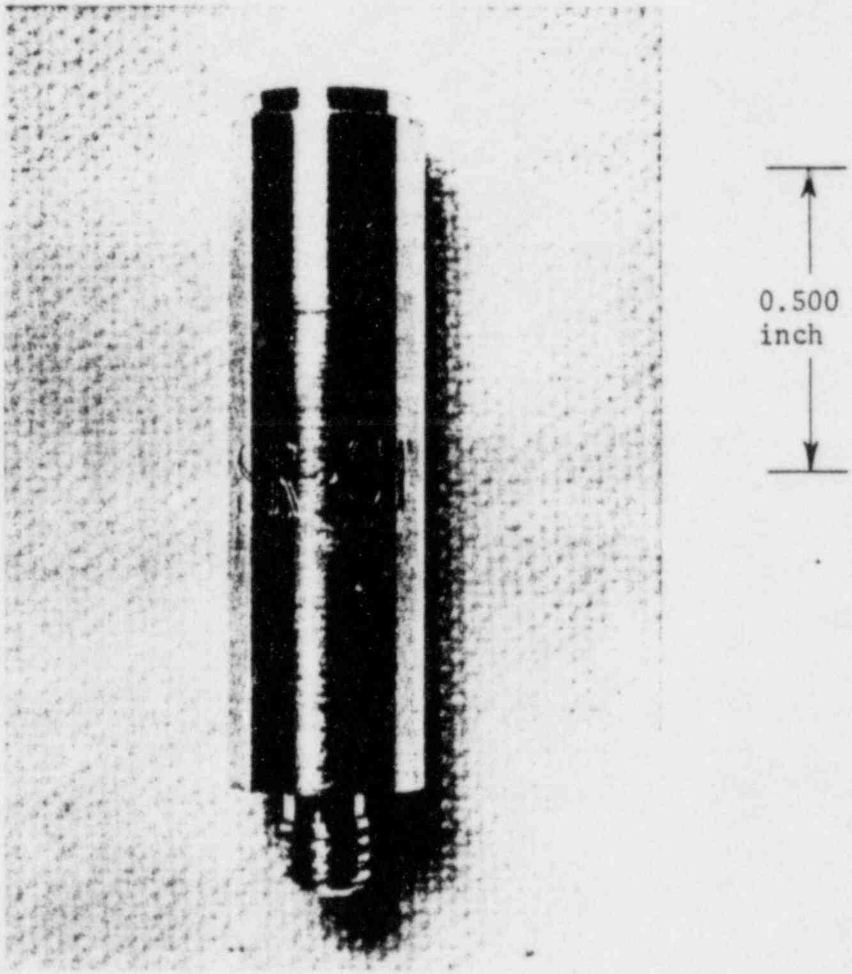
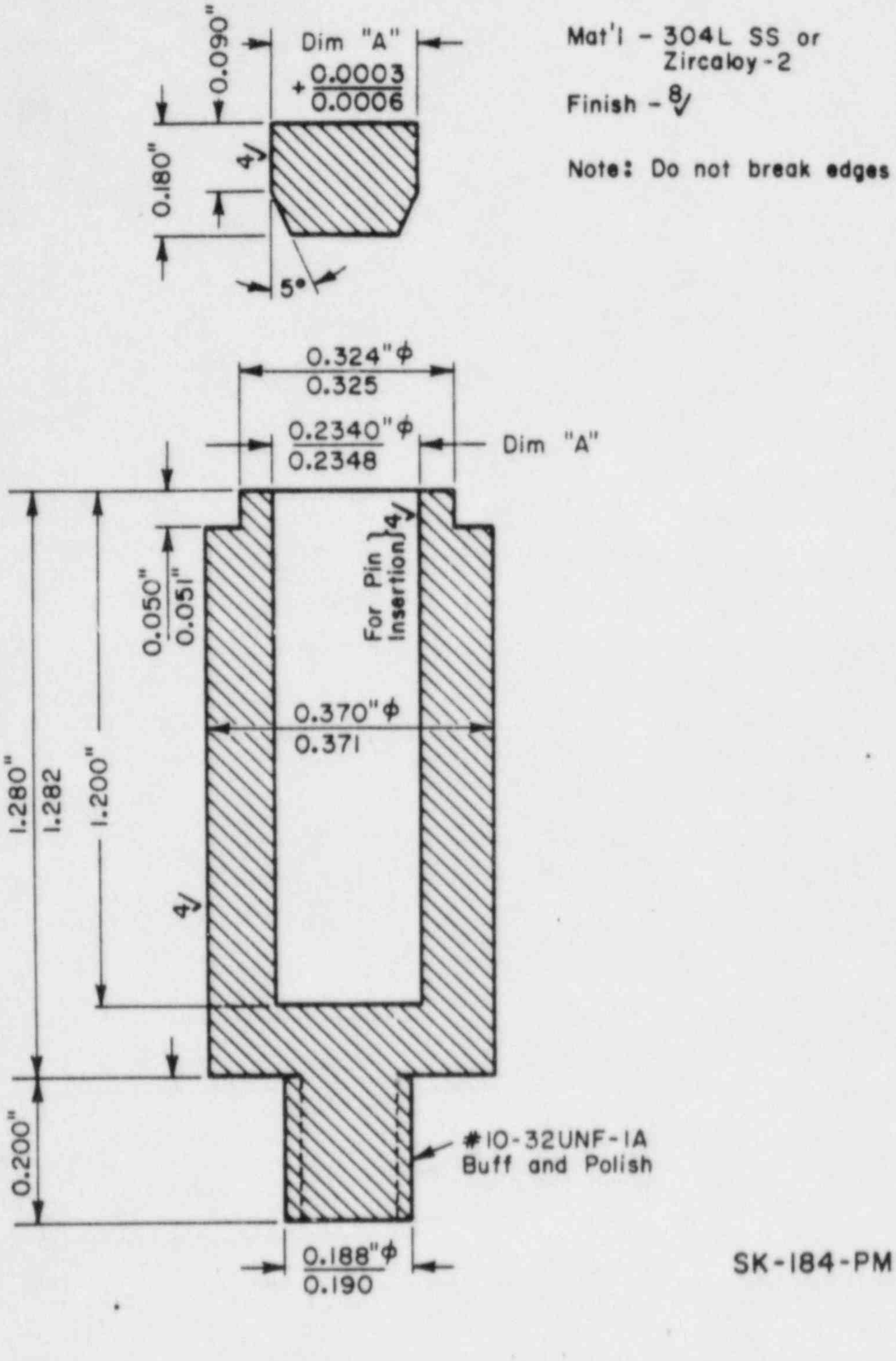


FIGURE B-3 Labeling

Typical ^{252}Cf-100 Series
Outer Capsule



SR-Cf-100 SERIES · SECONDARY CAPSULE

Calculated Heat Transfer and Strength Characteristics Of 100 Series Capsules for Oxide Sources of ^{252}Cf

Primary Capsule Material(1)	Pt-10% Rh
Source strength, mg ^{252}Cf	20
Heat generation, watts	0.8
Adiabatic temperature rise of primary capsule, °C/min	38
ΔT between sheath and air, °C	59
Gas pressure in primary capsule after infinite alpha decay	
at 0 °C gas temperature, psia	374
at 25 °C gas temperature, psia	408
at 800 °C gas temperature, psia	1,471
Rupture pressure in primary capsule	
at 25 °C capsule temperature, psi	14,500
at 800 °C capsule temperature, psi	6,400

Secondary Capsule Material(2)	Zircaloy-2	304L SST
Gas pressure in secondary capsule if primary leaks after infinite decay		
at 0 °C gas temperature, psia	147	160
at 25 °C gas temperature, psia	160	160
at 800 °C gas temperature, psia	577	577
Rupture pressure in secondary capsule		
at 25°C capsule temperature, psi	17,900	23,800
at 800 °C capsule temperature, psi	5,900	2,300

NOTES: (1) Primary capsule is Series 100 shown in Figure 5.

(2) Secondary capsule is Series 100 shown in Figure 6.

EGWright/dah
DRAFT #1
9/28/79

CONTENT OF APPLICATION FOR CUSTOM LICENSING OF DEVICES

The applicant shall submit sufficient information regarding each type of model of device for the evaluation of that device. Such information shall include:

1. Identification

   Identify the radioactive source(s) and the device, respectively, by type, model number, or other specific model designation.

2. Proposed Use

   Describe the proposed use of the device and identify the environments and operating conditions expected during normal conditions of use.

   Include descriptions of the types of users, locations of use, possibilities of use as a component in other products, and circumstances of normal use. In addition, describe probable effects of severe conditions, including accidents and fires, and possible diversion from intended use.

3. Radioactive Material

   (a) If the sealed source is registered with NRC or an Agreement State, specify the manufacturer, model number, isotope and maximum activity for each source to be incorporated into a device.

   (b) If the source design has not been registered with NRC or an Agreement State, provide the information outlined in Standard Format for Health and Safety Review and Registration of Sealed Sources, dated July 24, 1979.

No info on Savannah River model SRCL(1902)

4. Construction

(a) Submit engineering drawings of the source housing, identifying all materials of construction, dimensions, methods of fabrication and means of incorporating the radioactive material.

(b) Include a detailed description of all special design features which protect the radioactive material from abuse and minimize the radiation hazards. Describe in sufficient detail so that the nature, function, and method of operation are clearly defined.

5. Human Access

Describe the degree of access of human beings to the device during normal handling and use.

6. Labeling and Instructions for Use

Submit facsimilies of the labeling or marking to be placed on each device, and copies of instructions for safe use and handling of the device.

7. Availability of Services

Submit information stating who will perform the following services. (If these services will be performed by someone other than the device manufacturer, provide a description of his training and experience and the procrdures for performing the services.)

(a) Installation and relocation

(b) Initial radiation survey

(c) Leak testing

(d) Repair, periodic maintenance, and shutter checks

(e) Source exchange

(f) Emergency procedures, and

(g) Disposal

8. Safety Analysis

A safety analysis based on the evaluation of the ability of the custom design to withstand the normal conditions of handling, use, and storage including corrosion, vibration, impact, and the probable effects on containment and shielding of abnormally severe conditions, such as explosion and fire.

9. Test Results on Finished Device

These tests shall verify that the finished device meets specifications furnished to the NRC. The applicant shall specify the name, training, and experience of the person who will perform the tests. In addition he shall describe the procedures and equipment to be used in performing the tests. As a minimum the following tests shall be conducted:

(a) Radiation profiles (isodose curves e.g. dose rates at 5 cms, 30 cms, and 100 cms) of the custom device with shutter(s) in the open and closed position(s). Radiation levels should be measured using the maximum activity of each kind of radioactive material expected to be used in the device. A description of the method used to measure the radiation levels should be included:

(b) Visual or other inspections to determine if cracks, voids or other manufacturing defects exist.

(c) Shutter or beam control operations.

(d) Leak test

NRC FORM 218 (4-76) NRCM 0240

U.S. NUCLEAR REGULATORY COMMISSION

TELEPHONE OR VERBAL CONVERSATION RECORD

DATE	2/17/82
TIME	☐ A.M. ☐ P.M.

☐ INCOMING CALL ☒ OUTGOING CALL ☐ VISIT

	OFFICE/ADDRESS	PHONE NUMBER	EXTENSION
PERSON CALLING: Earl Wright			
PERSON CALLED: Gary Macdonald	TVA control 09505	8-858-5675	

CONVERSATION

SUBJECT: Application for CONAC control 09505 C 81-97

SUMMARY

Ask Mr MacDonald for the following:

- legible dwgs with materials of const / dimensions
- Narrative description of Device and photos.
- He told me the unit will be installed in the same room as the RSM (our control C 81-81) thus environmental factors will be the same.
- Asked for clarification of the SR model designation SRCL (1902) No info in our files
- He told me the unit has been built. and is now undergoing tests in California by SAI

Earl M Wright

REFERRED TO:

ACTION REQUESTED

☐ ADVISE ME OF ACTION TAKEN.

INITIALS

DATE

ACTION TAKEN

INITIALS

DATE