Harry Nelson
4/18/2008

The californium source in our prototype is known as ULS-87, and was assayed at 8.94×10^6 neutrons/sec on 7/11/1974. This implies about 4 micrograms of ^{252}Cf, assuming pure ^{252}Cf, on that date; there are about 2.3×10^6 neutrons/sec/microgram. Working through until today, this would imply about 380 fissions/sec and 1400 neutrons/sec today from ^{252}Cf, and then roughly another 60 fissions/sec and 200 neutrons/sec from the daughter ^{248}Cm, for about 1600 neutrons/sec total.

The key numbers for ^{252}Cf are a half-life of 2.645 years, a spontaneous fission branching ratio of 3.1%, and 3.67 neutrons/fission; for ^{248}Cm a half-life of 3.4×10^5y, a spontaneous fission branching ratio of 8.4%, and 3.4(? assumption) neutrons/fission.

Some additional detail about this source was provided by Chris Marcus of Oak Ridge. The source itself is a `cermet' of $PdCf_2O_3$. He says that the Cf is 70-80% ^{252}Cf, and >19% ^{249}Cf + ^{250}Cf + ^{251}Cf. I presume this is by mass. So a reasonable guess is that the 4 micrograms of ^{252}Cf amounts to 75% of the total Cf, and that about 8% of the total, or 0.44 micrograms, is ^{250}Cf.

On 7/11/74 about 5000 neutrons/sec would then come from ^{250}Cf, which is an insignificant portion of the 8.94×10^6 neutrons/sec measured at that time. Today, however, there would be about 900 neutrons/sec from ^{250}Cf.

The key numbers for ^{250}Cf are a half-life of 13.1 years, a spontaneous fission branching ratio of 0.077%, and 3.51 neutrons/fission.

Thus the total neutron flux from ULS-87 is thus about 2500 neutrons/second, which is comprised of 1400 neutrons/second from ^{252}Cf, 200 neutrons/second from the daughter ^{248}Cm, and about 900 neutrons/second from ^{250}Cf.

We see about 1000 neutrons/sec in the prototype. One would crudely conclude that we have roughly 40% efficiency, which is actually quite good.

Details about this source, including its size and capsule, are in the attached source sheets. Initially I had requested the smaller second source, USS-6, described on the second page of the attached sheets, and my original numbers were based on its activity. I checked today with the source pail, and indeed, we have ULS-87.

^{252}Cf UNIVERSITY NEUTRON SOURCE INFORMATION

Date 7-12-7[redacted]

SOURCE FABRICATED FOR: University of California, Santa Barbara ULS - 87

Source Type University Long Source No. [redacted]

Primary Source Encapsulation		Secondary Container	
No. of Source Capsules	1	Container Material	SS
Capsule Material	90% Pt - 10% Ir	External Diameter	4.76 ± 0.10 mm
Inner Capsule Wall Thickness	0.25 ± 0.012 mm	External Length	48.50 ± 0.50 mm
Outer Capsule Wall Thickness	0.50 ± 0.012 mm	Active Length	15.00 ± 0.50 mm
Closure Material	"Braze 560"	Closure Material	TIG Fusion Weld

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CLOSURE TEST

Method

Each source capsule is decontaminated after closure until all exterior surfaces are free of transferable contamination as determined by a wipe test. After decontamination the capsule is immersed in a helium atmosphere with a pressure of at least 30 pounds per square inch for a period of 30 minutes, then transferred to a helium leak detector. The leak detector has a minimum sensitivity of 2.8×10^{-8} cc helium per second.

Test Date

The finished source was found free of detectable leaks on 7-11-74.

SOURCE STRENGTH

Calibration

The source described above has been calibrated at the Savannah River Laboratory by comparing its strength to that of a ^{252}Cf source calibrated by the National Bureau of Standards. The comparison is made by counting on a BF_3 Neutron Detector. The ^{252}Cf content of the source is the effective or net californium content calculated from the emission rate and is given in equivalent weight units assuming 2.311×10^6 neutrons per second per microgram of ^{252}Cf. Therefore, corrections for self absorption of neutrons in the capsule walls and isotopic content of californium are unnecessary by the source user.

Strength

The neutron emission rate of this source was found to be 8.935 $\times 10^6$ neutrons per second with a standard error of ± 3.0% an effective ^{252}Cf content of [redacted] with a standard error of ± 3.0% on 7-11-74.

S. Mirshak / RJH

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^{252}Cf NEUTRON SOURCE INFORMATION

Date January 11, 1971

SOURCE FABRICATED FOR: University of California, Santa Barbara

Source Type University Source (Short)

Source Identification Number uss-6 [redacted]

Exterior Length 33.02 mm

Inner Capsule Wall Thickness 0.10 mm

Outer Capsule Wall Thickness 0.15 mm

SS Capsule Wall Thickness 1.59 mm

Capsule Material 90% Pt - 10% Ir enclosed in SS

External Diameter 4.76 mm

Closure Material "Braze 541"

Closure Material "Braze 560"

Closure Material TIG Fusion Weld

CLOSURE TEST

Method Each source capsule is decontaminated after closure until all exterior surfaces are free of transferable contamination as determined by a wipe test. After decontamination the capsule is immersed in a helium atmosphere with a pressure of at least 30 pounds per square inch for a period of 30 minutes, then transferred to a helium leak detector. The leak detector has a minimum sensitivity of 2.8×10^{-8} cc helium per second.

Test Date The finished source was found free of detectable leaks on ________.

SOURCE STRENGTH

Calibration The source described above has been calibrated at the Savannah River Laboratory by comparing its strength to that of a ^{252}Cf source calibrated by the National Bureau of Standards. The neutron emission rate of each source is determined by immersing the source in a manganese sulfate bath, then measuring the induced manganese activity by gamma spectrometry. The neutron emission rate stated for each source is the measured emission rate in the bath. The ^{252}Cf content of the source is the effective or net californium content calculated from the emission rate and is given in equivalent weight units assuming 2.311×10^{6} neutrons per second per microgram of ^{252}Cf. Therefore, corrections for self absorption of neutrons in the capsule walls and isotopic content of californium are unnecessary by the source user.

Strength The neutron emission rate of this source was found to be 1.236×10^{6} neutrons per second with a standard error of ±3.0% an effective ^{252}Cf content of [redacted] μg with a standard error of ±3.0% on 9-3070.

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