REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF SOURCE
(AMENDED IN ITS ENTIRETY)

NO: OH-0298-S-102-S Date: **April 3, 2009**

MODEL: FTC Model 100 series

MANUFACTURER/DISTRIBUTOR:

Frontier Technology Corporation
1641 Burnett Drive
P.O. Box 486
Xenia, OH 45385

ISOTOPE:	MAXIMUM ACTIVITY:
Californium-252	192 GBq (5.2 Ci, 10 mg)

LEAK TEST FREQUENCY: 6 months

PRINCIPLE USE:
(H) General Neutron Source
(F) Well Logging for Model 100S sub-series only excluding the Model 100ST

CUSTOM DEVICE: _____ Yes ___X___ No

DESCRIPTION:

The Frontier Technology Corporation (FTC) Model 100 Series neutron source is a family of doubly encapsulated Califonium-252 sources. Californium-252 in the form of Cf-Pd cermet or alloy is sealed inside a FTC model 10 series capsule by tungsten-inert-gas (TIG) welding. The completed and tested Model 10 series sealed source is then sealed inside an FTC Model 100 series outer capsule.

The basic Model 100 capsule is made of type 304L stainless steel and is 9.4 mm (0.370 inch) outside diameter by 32.5 mm (1.28 inches) in length. A 10/32 threaded stud is machined into the unwelded end of the capsule, bringing the overall length to 37.6 mm (1.48 inches). The model Z100 is identical to the Model 100 except that the capsule material is Zircalloy-2. These models are FTC's embodiment of the Savannah River Laboratory's SR-CF-100 series industrial source capsules.

The Model 100S and Model Z100S are shortened versions of the 100 and Z100 capsules, respectively, and each having a length (without stud) of 19.6 mm (0.77 inches). The model 100 and Z100 capsules have a cavity approximately 5.97 mm (0.235 inches) in diameter by 25.9 mm (1.020 inches) long that contains a Model 10 series source capsule.

A configuration having a zircalloy inner capsule and stainless steel outer capsule would have a model number prefix "ZS". Conversely, a configuration having a stainless steel inner capsule and zircalloy outer capsule would have a model number prefix "SZ".

Model number suffixes are added to indicate the following capsule design modifications:

"S" indicating the short capsule version
"NS" indicating "no stud" when a threaded stud is not added
"R" indicating the welded end of the FTC Model 10 was inserted first ("reverse" of normal orientation)
"MX" indicating other attachment devices in lieu of the 10-32 stud (ball stud, ball socket, clevis attachment, or clevis socket)
"ML" indicating a modified length extending the outer capsule to a maximum of 10.4 mm (0.410") equal to the source diameter to allow the use of threaded holes, ball socket or clevis socket within the extended portion of the capsule
"ST" indicating a stainless steel short version with thin wall with a 7.7 to 7.8 mm (0.303 to 0.307") outer diameter

DESCRIPTION: continued

A detailed description of the Model 100 series sources is presented in the following table.

Model	Inner capsule	Outer capsule	Threaded stud	Cf Limit
100 & 100R	304L Stainless	304L Stainless	Yes	10 mg
Z100 & Z100R	Zircalloy-2	Zircalloy-2	Yes	10 mg
100S & 100SR	304L Stainless	304L Stainless	Yes	4 mg
Z100 & Z100SR	Zircalloy-2	Zircalloy-2	Yes	4 mg
ZS100 & ZS100R	Zircalloy-2	304L Stainless	Yes	10 mg
SZ100 & SZ100R	304L Stainless	Zircalloy-2	Yes	10 mg
ZS100S & ZS100SR	Zircalloy-2	304L Stainless	Yes	4 mg
Z100S & Z100SR	304L Stainless	Zircalloy-2	Yes	4 mg
100NS & 100NSR	304L Stainless	304L Stainless	No	10 mg
Z100NS & Z100NSR	Zircalloy-2	Zircalloy-2	No	10 mg
100SNS & 100SNSR	304L Stainless	304L Stainless	No	4 mg
Z100SNS & Z100SNSR	Zircalloy-2	Zircalloy-2	No	4 mg
ZS100NS & ZS100NSR	Zircalloy-2	304L Stainless	No	10 mg
SZ100NS & SZ100NSR	304L Stainless	Zircalloy-2	No	10 mg
ZS100SNS & ZS100SNSR	Zircalloy-2	304L Stainless	No	4 mg
SZ100SNS & SZ100SNSR	304L Stainless	Zircalloy-2	No	4 mg
100ST & 100STR	304L Stainless	304L Stainless	No	4 mg

Where 10 mg = 192 GBq = 5.2 Ci and 4 mg = 76.8 GBq = 2.08 Ci.

LABELING:

The FTC Model 100 series sources are intended to be used either as encapsulated sources or as the inner capsule of multi-encapsulated sources. The Model 100 series capsules will be electro-etched, engraved, or imprinted with a unique serial number in the format FTC-CF-XXX, FTC-CF-ZXXX, FTC-CF-ZSXXX, or FTC-CF-SZXXX to identify the manufacturer, isotope, capsule material and unique serial number. The XXX represents a unique number that is assigned sequentially to FTC californium sources regardless of the model. No two californium sources will have the same three to five digit number represented by the XXX. The hyphens in the serial number are optional.

Capsules of the Model 100S series ("short") will also be electro-etched, engraved, or imprinted with the word "Radioactive", and all other capsules of the model 100 series ("long") will be electro-etched, engraved or imprinted with the words "Caution - Radioactive Material".

When used as the inner capsule of a multi-encapsulated source, the outer surface of the outermost sealed capsule shall be marked as specified above.

DIAGRAM:

Attachment 1 - FTC Model 100 series

CONDITIONS OF NORMAL USE:

The FTC Model 100 series neutron source is intended for various neutron source applications under environmental conditions that are not detrimental to the Type 304L or Zircalloy-2 capsule material. Typical uses may include neutron radiography, activation analysis, mineral exploration, process control by activation analysis and nuclear fuel rod scanning.

The useful life of the Model 100 series source is expected to be that period during which the neutron output is adequate for the intended use. The half-life of Californium-252 is 2.6 years. Tests on source designs to which the Model 100 series conforms shows that the source series will meet special form criteria at the time of manufacture. In addition, analysis of the Model 100 series source capsule shows that it will meet the Special Form heating test at the

CONDITIONS OF NORMAL USE: continued

time of manufacture and at any time within 30 years after manufacture, assuming that the capsule has not been subjected to chemical attack or physical abuse.

PROTOTYPE TESTING:

The FTC Model 100 series sources have been shown to meet Special Form criteria and ANSI N43.6-1977 based on the physical tests of equivalent source models. Life analyses were performed on the FTC Model 100 series sources using methods specified in ASME Pressure Vessel Code, Division I, Section III. The analyses show that the model 100 will pass the Special Form heating test at any time after sealing. The analyses assume infinite decay of the californium, and thereby assume maximum gas quantity within the capsule.

The Savannah River Laboratory conducted a ten-ton crush test and a 25,000 psi external pressure test on prototype SR-CF-100 sources of 304L stainless steel and Zircalloy-2. The test sources were flattened during the crush test that consisted of placing the source between two steel anvils and applying a load of ten tons, but did not leak after the test. No visible deformation resulted from subjecting test sources to 170 MPa (25,000 psi) of external hydrostatic pressure, nor did the test capsules leak following the test. Because of the similarity of the FTC Model 100 and Z100 source to the SR-CF-100 sources tested, the FTC Model 100 and Z100 will also pass these tests.

A special external pressure test conducted by the Southwest Research Institute on three prototype capsules shows that the 100S subseries would withstand 35,000 PSI at 200 degrees Celsius.

The shortened versions of the Model 100 and Z100 will have greater resistance to external pressure and/or crushing than the model tested and should pass these tests.

PROTOTYPE TESTING: continued

Model number	ANSI N43.6 classification
100, 100R, 100NS, 100NSR, 100MX, 100ML, 100RMX, 100RML	97E66644
100S, 100SR, 100SNS, 100SNSR, 100SMX, 100SML, 100SRMX, 100SRML	**97E6X644**
Z100, Z100R, Z100NS, Z100NSR, Z100MX, Z100ML, Z100RMX, Z100RML, ZS100	97E66344
Z100S, Z100SR, Z100SNS, Z100SNSR, Z100SMX, Z100SML, Z100SRMX, Z100SRML, ZS100S	97E66344
100ST, 100STR, SZ100, SZ100S	97E66543

EXTERNAL RADIATION LEVELS:

Maximum radiation levels per milligram of Cf-252 at 5 and 30 cm from the surface of the source are summarized in the table below. The levels reported in the table are based on the dose rates for an unshielded californium-252 point source as reported by the manufacturer and are adjusted for distance using the inverse-square relation.

Distance	5 cm (2")	30 cm (12")
Neutron dose rate	8.8 Sv/hr (880 Rem/hr)	240 mSv/hr (24 Rem/hr)
Gamma dose rate	0.64 Sv/hr (64 Rem/hr)	18 mSv/hr (1.8 Rem/hr)
Total dose rate	9.44 Sv/hr (944 Rem/hr)	260 mSv/hr (26 Rem/hr)

QUALITY ASSURANCE AND CONTROL:

Capsule components are made from traceable metals certified to meet the drawing specification. All hardware is examined for dimensions, fit, finish, and is cleaned prior to use. Welding is performed by the tungsten-inert-gas (TIG) method using a programmable welder and welding process previously proven to provide welds of proper penetration and quality for the particular capsule design. Each source is fabricated to a Manufacturing Order (MO) that specifies the californium content, Cf/Pd and material configuration, other internal components if any, and source serial number. The program also determines that the void volume within the source satisfies the minimum volume requirement for the particular californium loading and volume internals is verified before the MO is released for manufacture.

QUALITY ASSURANCE AND CONTROL: continued

After welding, each source will be leak tested using the Dry Wipe Test per paragraph A.2.1.2 of American National Standard N542-1977 "Sealed Radioactive Sources, Classification," NBS Handbook 126. Sources having less than 185 Bq (0.005 uCi) of removable contamination are acceptable and may be shipped to the customer.

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE:

License required, transfer and disposal - The source shall be distributed to persons specifically licensed by Ohio, an Agreement State or the NRC; or transferred in accordance with OAC 3701:1-40-19 [10 CFR 30.41 equivalent]; or exported in accordance with Nuclear Regulatory Commission regulations. The source shall be disposed at a specifically licensed disposal facility or by transfer.

Leak testing - these devices must be leak tested by a specific licensed person at intervals not to exceed 6 months, using techniques capable of detecting 185 Bq (5 nCi, 0.005 uCi) of removable contamination.

Handling - Due to the extremely high dose rates from the sources when unshielded, the sources should be handled only by experienced licensed personnel using adequate remote handling equipment and procedures.

Source Environmental Conditions - The sealed sources shall not be used under conditions that exceed their applicable ANSI ratings.

The sealed source classification of 97E66644 indicates that the source met the following test requirements without leaking.

Temperature-6	-40°C (-40°F) for 20 minutes, +800°C (1,472°F) for one hour, thermal shock to 20°C (68°F)
External Pressure-6	25 kN/m^2 (3.6 lb_f/in^2) absolute to 170 MN/m^2 (24,656 lb_f/in^2) absolute
Impact-6	dropped 20 kg (44 lb) from 1 m (3.28 ft)
Vibration-4	90 minute test time 25 to 80 Hz at 1.5 mm (.06") peak to peak amplitude and 80 to 2000 Hz at 20g
Puncture-4	drop 50 grams (1.76 oz) from 1 m (3.28 ft) onto source

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE: continued

The sealed source classification of 97E6X644 indicates that the source met the following test requirements without leaking.

Temperature-6	**-40°C (-40°F) for 20 minutes, +800°C (1,472°F) for one hour, thermal shock to 20°C (68°F)**
External Pressure-X	**4 hr test time, 241MN/m^2 (35,000 lb$_f$/in^2) @ 200°C (392°F)**
Impact-6	**dropped 20 kg (44 lb) from 1 m (3.28 ft)**
Vibration-4	**90 minute test time 25 to 80 Hz at 1.5 mm (.06") peak to peak amplitude and 80 to 2000 Hz at 20g**
Puncture-4	**drop 50 grams (1.76 oz) from 1 m (3.28 ft) onto source**

The sealed source classification of 97E66543 indicates that the source met the following test requirements without leaking.

Temperature-6	-40°C (-40°F) for 20 minutes, +800°C (1,472°F) for one hour, thermal shock to 20°C (68°F)
External Pressure-6	25 kN/m^2 (3.6 lb$_f$/in^2) absolute to 170 MN/m^2 (24,656 lb$_f$/in^2) absolute
Impact-5	dropped 5 kg (11 lb) from 1 meter (3.28 ft)
Vibration-4	90 minute test time 25 to 80 Hz at 1.5 mm (.06") peak to peak amplitude and 80 to 2000 Hz at 20g
Puncture-3	drop 10 grams (154 grain) from 1 m (3.28 ft) onto source

The sealed source classification of 97E66344 indicates that the source met the following test requirements without leaking.

Temperature-6	-40°C (-40°F) for 20 minutes, +800°C (1,472°F) for one hour, thermal shock to 20°C (68°F).
External Pressure-6	25 kN/m^2 (3.6 lb$_f$/in^2) absolute to 170 MN/m^2 (24,656 lb$_f$/in^2) absolute
Impact-3	dropped 200 grams (7 oz) from 1 m (3.28 ft)
Vibration-4	90 minute test time 25 to 80 Hz at 1.5 mm (.06") peak to peak amplitude and 80 to 2000 Hz at 20g
Puncture-4	drop 50 grams (1.76 oz) from 1 m (3.28 ft) onto source

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NO: OH-0298-S-102-S Date: **April 3, 2009**

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE: continued

This registration sheet and the information contained within the references shall not be changed without the written consent of the Department.

SAFETY ANALYSIS SUMMARY:

Based on review of the Model 100 series and the information and test data cited below, and its history, we continue to conclude that the device is acceptable for licensing purposes.

Furthermore, we continue to conclude that the device would be expected to maintain its containment integrity for normal conditions of use and accidental conditions that might occur during uses specified in this certificate.

REFERENCES:

The following supporting documents for the FTC Model 100 series are hereby incorporated by reference and are made a part of this registry document:

Letters with enclosures dated June 17, 1985, July 18, 1985, and September 11, 1986; and

Letter with enclosures dated November 12, 2004, and letter dated April 4, 2005; and

Letter with enclosures dated March 9, 2009.

ISSUING AGENCY:

Ohio Department of Health
Bureau of Radiation Protection

Date: April 3, 2009 Reviewer: Kenneth Barnhart
Kenneth Barnhart

Date: April 3, 2009 Concurrence: Shannon Dettmer
Shannon Dettmer

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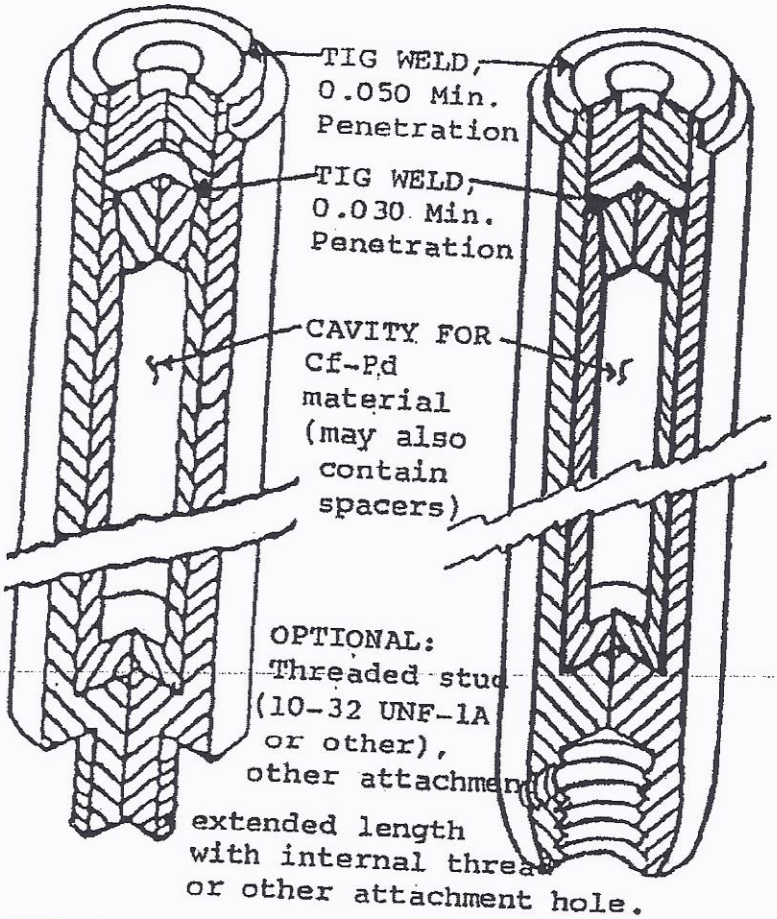
NO: OH-0298-S-102-S Date: April 3, 2009 Attachment: 1



LABELING: Each source is marked on the outside surface with the letters "FTC" to denote the manufacturer, "CF" to denote the contents as Cf-252, and a unique serial number. The letter "Z" preceeds the serial number when either or both capsules are Zircalloy-2.

FTC Model 100-Series
Standard Neutron Source