



**Essroc**  
Italcementi Group

1826 South Queen Street  
P.O. Box 885  
Martinsburg, WV 25402

Tel (304) 260 1800  
Fax (304) 267 2617

Capitol Cement Corporation  
1826 South Queen Street  
Martinsburg, WV 25401

To:  
Security and Industrial Branch  
Division of Nuclear Material Safety  
U.S. Nuclear Regulatory Commission, Region I  
475 Allendale Road  
King of Prussia, PA 19406-1415  
Donna M. Janda Tel.:610-337-5000 Fax:610-337-5269  
Ref.: Amendment to License Number  
47-11451-01 (Amendment No. 12)

*MMSB3*

2007 OCT 14 AM 10:31  
RECEIVED  
REGION I

August 16, 2007

Hello Ms. Janda,

We hereby are requesting an amendment to our Materials License No. 47-11451-01 (Amendment No.12) Expiration date of February 28, 2014, Docket No. 030-06692, to include Californium Cf-252; and a change to the posted PO Box address.

Our equipment Thermo Gamma Metrics Model CBX Cross-Belt Elemental Analyzer is a PGNA (Prompt Gamma Neutron Activation Analysis) elemental analyzer used by industries where the chemical and physical analysis of bulk materials must be determined for environmental compliance, material quality compliance, process control and process optimization. Materials pass through the device on a conveyor belt. The CBX analyzer is completely automatic in operation and has no moving parts. No personnel are required to be in any location near the enclosure at any time during operation except for source leak testing and for brief, occasional inspections of the material-handling tunnel.

The unit houses Cf-252 sources and photon radiation detectors. The sources are made by two manufactures: Frontier Technologies and QSA Global, Inc. (former AEA Technology or Amersham). Sources are leak tested in accordance with ANSI N542-1977, and are classified as C64545 or E66363 (Frontier sources). Attached are the Sealed Source Device Registries for each of these companies as well as the Sealed Source Device Registry for the Thermo Gamma Metrics CBX.

Our unit will have a nominal load of 38 micrograms (20.41 millicuries) of Cf-252, or a matching pair of 19 micrograms (10.21 millicuries). The unit is design to take a maximum of six sources for a total of 80 micrograms (42.96 millicuries) but for replenishment purposes we propose 8 sources with a total of 80 micrograms.

The access panel on the device will be always locked to prevent unauthorized access to the Cf-252 sources. Only Thermo Gamma Metrics or our licensee personnel may access the interior of the device. Total dose to users is conservatively estimated to be less than 24 mrem in a year.

*141066*

**NMSS/RGN1 MATERIALS-002**



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Personnel involved with the operation of the analyzer will complete a Training Course given by Thermo Gamma Metrics at the time of Installation and Commissioning as per the following:

- I. Atomic Structure and Radioactivity (1 hr)
  - A. Particulate (Alpha, Beta, Neutron)
  - B. Electromagnetic (X and Gamma)
  - C. Decay, Half-Life
  - D. Interaction of radiation with matter
  
- II. Radiation Dose Units and Terminology (.5 hr)
  
- III. Working with Radiation/ALARA (.5 hr)
  - A. Time
  - B. Distance (Including Inverse Square Law)
  - C. Shielding (Including Half-Value Layers)
  
- IV. Biological Effects (.5 hr)
  - A. Exposure vs. Contamination
  - B. Short Term Effects
  - C. Long Term Effects
  - D. Background Radiation
  
- V. Licensing/Regulations (.5 hr)
  - A. Types of Licenses
  - B. Dose Limits, Monitoring Requirements
  - C. Leak Testing, Surveys, Inventory, Shutter Check, Posting, Labeling
  - D. Installation, Relocation, Maintenance, Repair - who is authorized?
  - E. Records
  
- VI. Operating and Emergency Procedures (.5 hr)
  
- VI. Quiz and Review (.5 hr)

Should you have further questions let us know and we will be pleased to answer them.

Best Regards,

Mark Andrews  
Radiation Safety Officer, (304) 260-1827

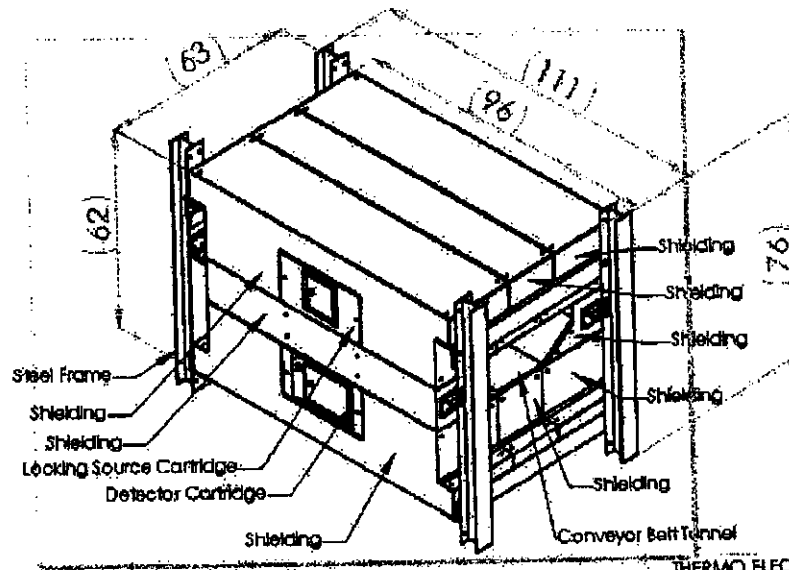
REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
 SAFETY EVALUATION OF DEVICE  
 (AMENDED IN ITS ENTIRETY)

NO.: CA-0305-D-113-S

DATE: December 14, 2006

ATTACHMENT 1 OF 12

Attachment 1 – Isometric Drawing Of Model CBX Device



THERMO ELECTRON  
 GAMMA-METRICS  
 CIR DEVICE REGISTRY ATTACHMENT  
 CONFIGURATION: HYDRO-008/004  
 ALL DIMENSIONS IN INCHES  
 NO SCALE PAGE 12 OF 21

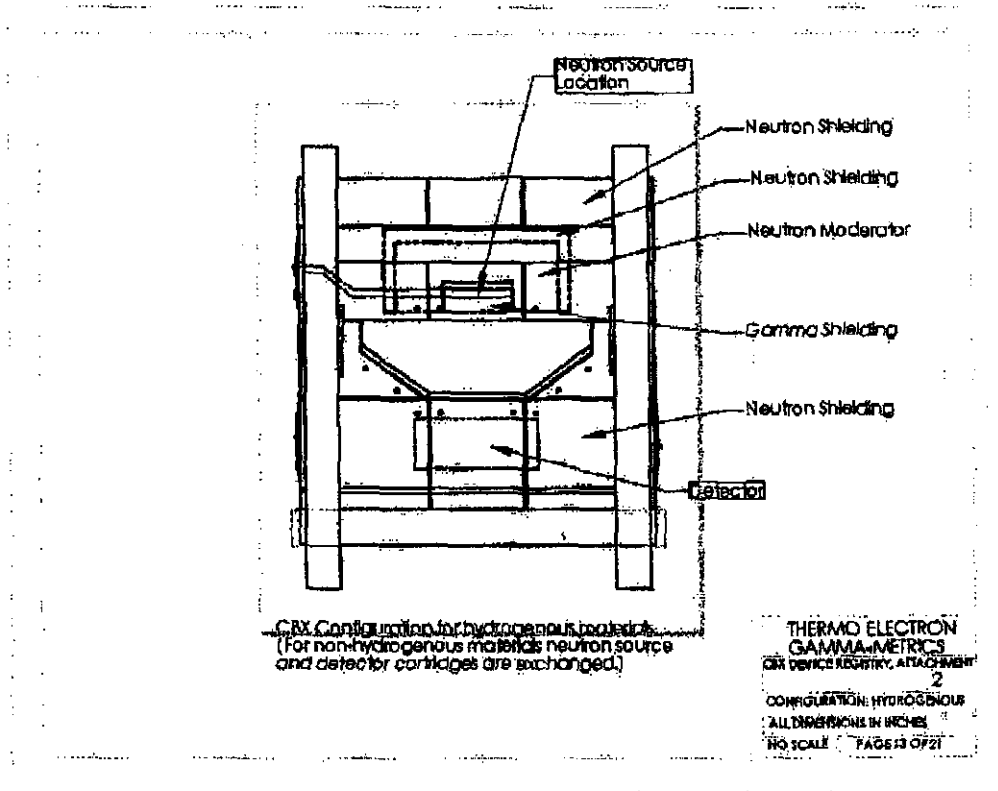
**REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
SAFETY EVALUATION OF DEVICE  
(AMENDED IN ITS ENTIRETY)**

NO. CA-0305-D-113-S

DATE: December 14, 2006

ATTACHMENT 2 OF 12

**Attachment 2 – Front View Of Model CBX Device**



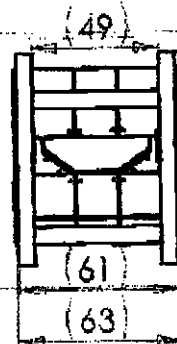
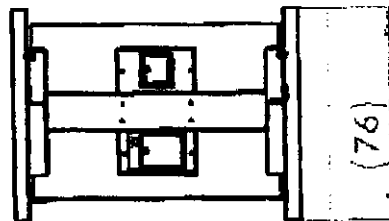
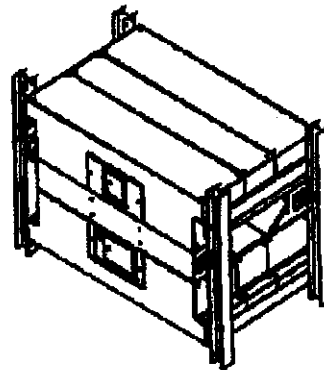
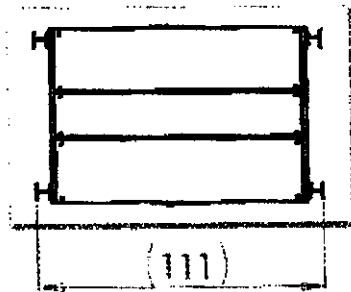
REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
SAFETY EVALUATION OF DEVICE  
(AMENDED IN ITS ENTIRETY)

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DATE: December 14, 2006

ATTACHMENT 3 OF 12

Attachment 3 – Orthogonal Drawing Of Model CBX Device (Hydrogenous)



THERMO ELECTRON  
GAMMA-METRICS  
SEE DEVICE REGISTRY, ATTACHMENT  
3A  
CONFIGURATION: HYDROGENOUS  
ALL DIMENSIONS IN INCHES  
NO SCALE PAGE 14 OF 21

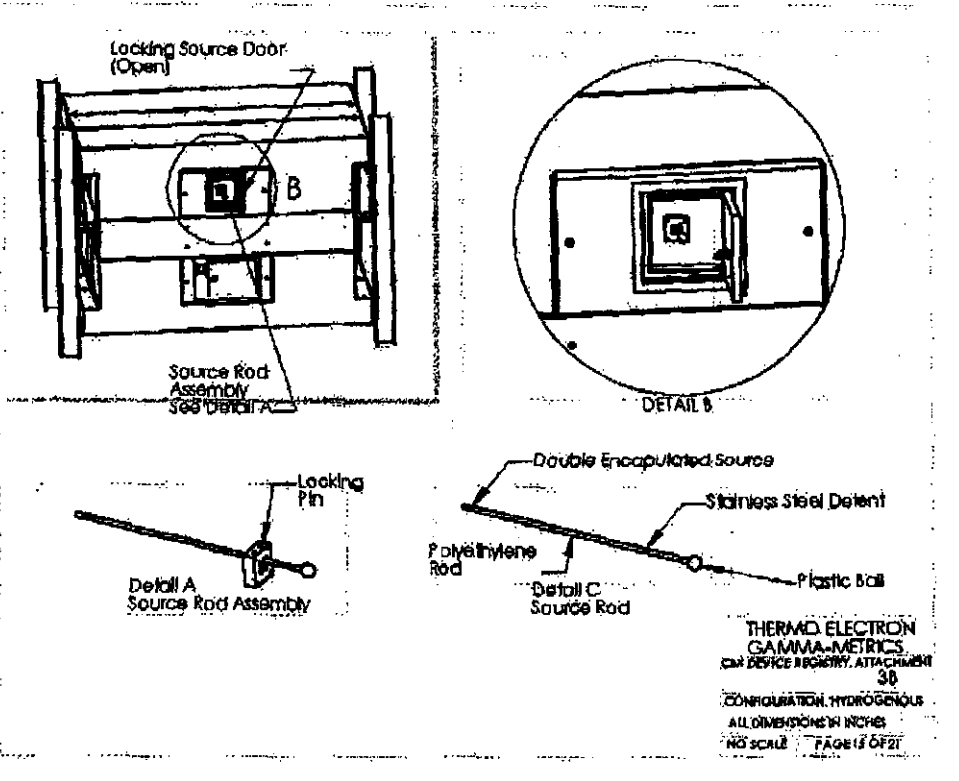
**REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
SAFETY EVALUATION OF DEVICE  
(AMENDED IN ITS ENTIRETY)**

NO.: CA-0305-D-113-S

DATE: December 14, 2006

ATTACHMENT 4 OF 12

**Attachment 4 – Source Rod Placement Details Of Model CBX Device**



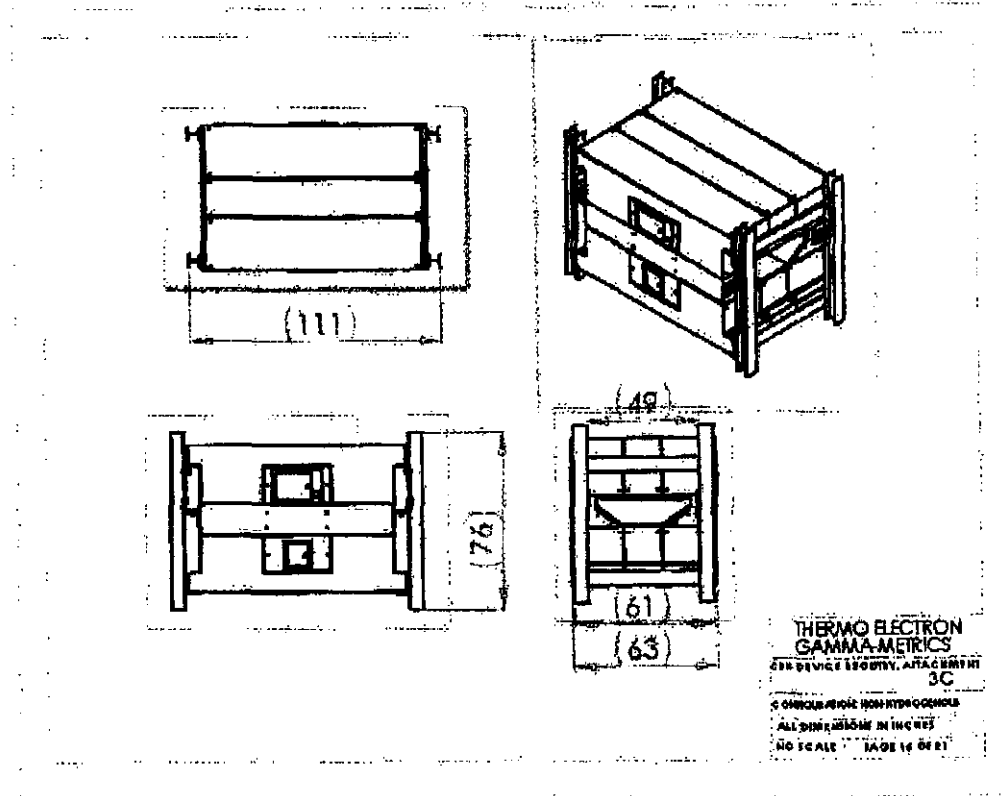
REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
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ATTACHMENT 5 OF 12

Attachment 5 – Engineering Drawings Of The Model CBX Device



REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
SAFETY EVALUATION OF DEVICE  
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ATTACHMENT 6 OF 12

Attachment 6 - Labeling Placards For The Model CBX Device

**Thermo**  
ELECTRON CORPORATION


THE RECEIPT, POSSESSION, USE, AND TRANSFER OF THIS DEVICE, MODEL \_\_\_\_\_, SERIAL NO. \_\_\_\_\_, ARE SUBJECT TO A GENERAL LICENSE OR THE EQUIVALENT AND THE REGULATIONS OF THE U.S. NRC OR OF A STATE WITH WHICH THE NRC HAS ENTERED INTO AN AGREEMENT FOR THE EXERCISE OF REGULATORY AUTHORITY.

ISOTOPE: CF-252  
ACTIVITY: \_\_\_\_\_  
DATE OF ASSAY: \_\_\_\_\_

THIS DEVICE SHALL BE LEAK TESTED BY A SPECIFIC LICENSEE AT INTERVALS NOT TO EXCEED 6 MONTHS.

THIS LABEL SHALL BE MAINTAINED ON THE DEVICE IN A LEGIBLE CONDITION. REMOVAL OF THIS LABEL IS PROHIBITED.

CAUTION - RADIOACTIVE MATERIAL




**Thermo** Gamma-Metrics  
5788 PACIFIC CENTER BLVD.  
SAN DIEGO, CA 92121  
(858) 450-9811

**Thermo**  
ELECTRON CORPORATION

REMOVAL OF THIS LABEL IS PROHIBITED

CAUTION - RADIOACTIVE MATERIALS

ACCESS PROHIBITED



REMOVAL OF THIS LABEL PROHIBITED

CAUTION  
ACCESS PROHIBITED  
RESTRICTED AREA



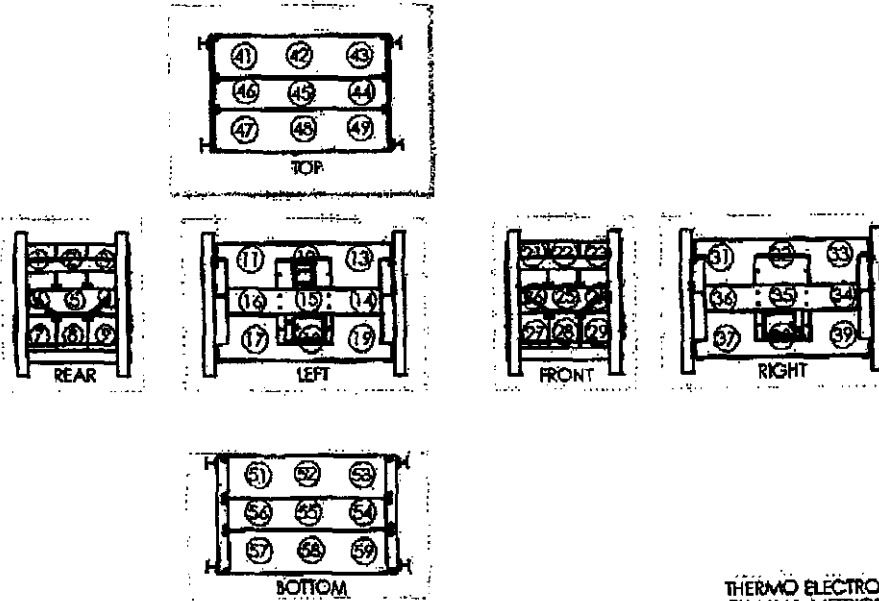
REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
 SAFETY EVALUATION OF DEVICE  
 (AMENDED IN ITS ENTIRETY)

NO.: CA-0305-D-113-S

DATE: December 14, 2006

ATTACHMENT 7 OF 12

Attachment 7 – Measurement Locations For The Model CBX Device



THERMO ELECTRON  
 GAMMA-METRICS  
 CBX DEVICE REGISTRY, ATTACHMENT  
 5  
 CONFORMATION: HYDROGENOUS  
 ALL DIMENSIONS IN INCHES  
 NO SCALE PAGE 10 OF 21

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

**NO.:** CA-0305-D-113-S

**DATE:** December 14, 2006

**ATTACHMENT 8 OF 12**

**Attachment 8 – Results Of Radiation Survey For A CBX Configured For Hydrogenous  
Materials On A 1000 mm Conveyor Belt With 38 micrograms of Cf-252**

**Date:** September 10-11, 2002

**Device:** CBX1000 (Coal)

**Gamma + Neutron Total Dose Rates Near Analyzer (38 µg Cf-252)**

Loc.	Conveyor Belt with 0" Material [mrem/hr]		Conveyor Belt with 6" Material [mrem/hr]	
	30 cm	100 cm	30 cm	100 cm
1	0.70	1.44	0.58	0.70
2	0.80	1.68	0.71	0.90
3	0.76	1.43	0.58	0.76
4	6.60	1.57	4.28	1.29
5	12.89	2.96	5.84	1.68
6	7.07	1.76	4.03	1.35
7	0.82	1.24	0.38	0.38
8	1.90	5.76	0.49	0.46
9	0.76	1.33	0.39	0.41
11	0.33	0.44	0.35	0.20
12	0.83	0.62	0.81	0.33
13	0.37	0.39	0.36	0.21
14	0.45	0.24	0.36	0.23
15	0.69	0.32	0.65	0.36
16	0.40	0.25	0.35	0.23
17	0.40	0.33	0.23	0.25
18	0.80	0.37	0.56	0.25
19	0.37	0.27	0.24	0.22
21	0.73	1.47	0.63	0.80
22	0.83	1.76	0.65	0.83
23	0.74	1.44	0.62	0.87
24	7.01	1.99	2.11	1.57
25	12.68	3.07	3.57	1.88
26	6.71	2.31	3.11	2.05
27	0.92	2.18	0.42	0.38
28	1.98	4.76	0.47	0.40
29	0.91	2.19	0.41	0.39
31	0.34	0.21	0.32	0.21
32	0.74	0.34	0.71	0.44
33	0.30	0.23	0.31	0.18
34	0.39	0.22	0.33	0.18
35	0.57	0.28	0.89	0.29
36	0.31	0.20	0.35	0.23
37	0.26	0.17	0.26	0.24
38	0.90	0.30	0.67	0.38
39	0.25	0.22	0.25	0.21

Loc.	Conveyor Belt with 0" Material [mrem/hr]		Conveyor Belt with 6" Material [mrem/hr]	
	30 cm	100 cm	30 cm	100 cm
41	0.30	0.31	0.33	0.30
42	1.10	0.50	0.98	0.57
43	0.34	0.33	1.06	0.26
44	0.41	0.31	0.62	0.37
45	1.81	0.83	2.50	0.73
46	0.40	0.32	0.65	0.38
47	0.31	0.33	0.36	0.28
48	1.15	0.49	0.95	0.63
49	0.33	0.29	0.34	0.33
51	0.19	0.18	0.18	0.12
52	0.26	0.17	0.26	0.15
53	0.23		0.17	0.13
54	0.23		0.21	0.15
55	0.28	0.17	0.25	0.16
56	0.22	0.15	0.20	0.13
57	0.21		0.15	0.14
58	0.25		0.23	0.18
59	0.22		0.16	0.13

**Sealed Source Information**

Type	S/N	Strength (µg)
Cf-252	Z1404	19.28
Cf-252	Z1406	19.06

Equipment: E600 #01955      Cal. Due: 3/7/03  
 Equipment: SHP270 #00455      Cal. Due: 12/28/02  
 Equipment: NP-2 #NP 984501      Cal. Due: 12/10/02

D. Peck \_\_\_\_\_      D. Posner \_\_\_\_\_  
 Test Engineer      RSO  
 Date of Review \_\_\_\_\_      Date of Review \_\_\_\_\_

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

NO.: CA-0305-D-113-S

DATE: December 14, 2006

ATTACHMENT 9 OF 12

**Attachment 9 – Results Of Radiation Survey For A CBX Configured For Low-Hydrogenous Materials On A 1000 mm Conveyor Belt With 38 micrograms of Cf-252**

Date: September 12, 14, 2002 Device: CBX1000 (Cement)  
Gamma + Neutron Total Dose Rates Near Analyzer (38 µg Cf-252)

	Conveyor Belt with 0" Material		Conveyor Belt with 6" Material	
	[mrem/hr]		[mrem/hr]	
	30 cm	100 cm	30 cm	100 cm
1	0.83	1.01	0.29	0.30
2	1.26	2.17	0.32	0.39
3	0.90	1.76	0.31	0.27
4	6.01	1.48	1.13	0.57
5	7.58	2.02	1.57	0.66
6	5.40	1.61	1.28	0.62
7	0.40	0.77	0.39	0.28
8	0.61	0.69	0.37	0.35
9	0.44	0.84	0.34	0.36
11	0.25	0.20	0.31	0.30
12	0.73	0.29	0.67	0.37
13	0.30	0.21	0.34	0.29
14	0.40	0.27	0.41	0.31
15	0.60	0.41	0.78	0.45
16	0.38	0.25	0.36	0.33
17	0.34	0.21	0.34	0.30
18	1.00	0.40	1.17	0.59
19	0.32	0.21	0.28	0.24
21	0.67	1.78	0.23	0.35
22	1.04	2.16	0.28	0.40
23	0.84	1.84	0.28	0.33
24	4.04	1.31	1.14	0.56
25	6.97	1.65	1.23	0.49
26	4.28	1.38	1.38	0.59
27	0.59	0.68	0.35	0.30
28	1.17	0.89	0.41	0.32
29	0.60	0.66	0.30	0.25
31	0.28	0.18	0.45	0.33
32	0.75	0.26	0.68	0.52
33	0.32	0.20	0.36	0.41
34	0.30	0.21	0.36	0.33
35	0.84	0.33	0.94	0.48
36	0.27	0.22	0.39	0.41
37	0.23	0.17	0.35	0.35
38	0.61	0.38	0.79	0.43
39	0.28	0.15	0.40	0.43

	Conveyor Belt with 0" Material		Conveyor Belt with 6" Material	
	[mrem/hr]		[mrem/hr]	
	30 cm	100 cm	30 cm	100 cm
41	0.24	0.12	0.25	0.18
42	0.24	0.12	0.24	0.22
43	0.16	0.12	0.31	0.30
44	0.21	0.09	0.26	0.29
45	0.22	0.15	0.26	0.17
46	0.24	0.13	0.27	0.19
47	0.18	0.12	0.22	0.20
48	0.25	0.15	0.26	0.25
49	0.21	0.13	0.24	0.20
51	0.28	0.34	0.41	0.33
52	1.01	0.58	1.22	0.71
53	0.34	0.34	0.28	0.34
54	0.55	0.42	0.51	0.42
55	2.22	0.83	1.97	0.83
56	0.51	0.40	0.59	0.41
57	0.36	0.36	0.38	0.27
58	1.23	0.65	1.41	0.66
59	0.35	0.39	0.36	0.44

Sealed Source Information

Type	S/N	Strength [µg]
Cf-252	Z1404	19.28
Cf-252	Z1406	19.06

Equipment: EB00 #01955 Cal. Due: 3/7/03  
Equipment: SHP270 #00455 Cal. Due: 12/28/02  
Equipment: NP-2 #NP 984501 Cal. Due: 12/10/02

D. Peck \_\_\_\_\_ D. Posner \_\_\_\_\_  
Test Engineer \_\_\_\_\_ RSO \_\_\_\_\_  
Date of Review \_\_\_\_\_ Date of Review \_\_\_\_\_

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

NO.: CA-0305-D-113-S

DATE: December 14, 2006

ATTACHMENT 11 OF 12

Attachment 11 – Results Of Radiation Survey For A CBX Configured For Hydrogenous  
Materials On 72" Conveyor Belt With 40.9 micrograms of Cf-252

Date: September 27-28, 2003

Device: CBX (Eos)

Gamma + Neutron Total Dose Rates Near Analyzer (40.9 µg Cf-252)

Loc.	Conveyor Belt with 6" Material [µR/hr]		Conveyor Belt with 6" Material [µR/hr]	
	30 cm	100 cm	30 cm	100 cm
1	2.40	1.72	0.45	0.28
2	3.85	2.73	0.60	0.40
3	3.27	1.75	0.52	0.29
4	2.18	2.78	0.58	0.35
5	17.92	3.75	2.01	1.28
6	2.21	2.98	0.57	0.73
7	1.79	0.31	0.25	0.43
8	2.17	18.85	0.57	0.80
9	2.23	0.83	0.27	0.37
11	0.25	0.18	0.21	0.15
12	0.27	0.20	0.32	0.15
13	0.21	0.15	0.23	0.14
14	0.22	0.14	0.17	0.13
15	0.23	0.15	0.27	0.14
16	0.21	0.14	0.18	0.13
17	0.18	1.03	0.12	0.12
18	0.20	0.14	0.20	0.12
19	0.15	0.14	0.13	0.12
21	0.71	1.94	0.20	0.74
22	1.28	2.41	1.00	0.93
23	3.05	2.06	0.73	0.67
24	11.58	0.25	1.20	1.54
25	20.31	0.85	2.09	0.94
29	10.11	0.40	1.98	1.78
27	2.01	0.84	0.23	0.43
28	2.18	11.28	0.25	0.47
29	1.79	0.30	0.27	0.44
31	0.18	0.12	0.27	0.14
32	0.24	0.18	0.29	0.18
33	0.14	0.13	0.28	0.18
34	0.22	0.12	0.22	0.14
35	0.30	0.12	0.23	0.15
36	0.22	0.10	0.20	0.14
37	0.17	0.13	0.18	0.14
38	0.23	0.19	0.18	0.14
39	0.18	0.14	0.16	0.12

Loc.	Conveyor Belt with 6" Material [µR/hr]		Conveyor Belt with 6" Material [µR/hr]	
	30 cm	100 cm	30 cm	100 cm
41	0.22	0.20	0.27	0.28
42	0.25	0.31	0.45	0.30
43	0.24	0.20	0.20	0.28
44	0.45	0.30	0.35	0.24
45	1.48	0.55	2.13	0.93
46	0.40	0.30	0.43	0.38
47	0.26	0.23	0.25	0.26
48	0.43	0.25	0.47	0.21
49	0.24	0.21	0.20	0.28

Sealed Source Information

Type	S/N	Strength (µg)
Cf-252	Z1407	14.2
Cf-252	Z1748	13.12
Cf-252	Z1780	13.58
Sum:		40.9

Equipment: E600 #01865 Calibration Due: 4/9/2004  
 Equipment: SF-P270 #00455 Calibration Due: 1/23/2004  
 Equipment: NP-2 #NP 884501 Calibration Due: 4/13/2004

Test Engineer: D. Peck

Test Engineer

RSD: D. Posner

RSD

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

NO.: CA-0305-D-113-S

DATE: December 14, 2006

ATTACHMENT 12 OF 12

**Attachment 12 - Results Of Radiation Survey For A CBX Configured For Low  
Hydrogenous Materials On 72" Conveyor Belt With 80.9 micrograms of Cf-252**

Date: 8-24-08 thru 8-26-08

Device: CBX4 (Cement)

Gamma + Neutron Total Dose Rates Near Analyzer (25 µg Cf-252)

Loc.	Conveyor Belt with 0" Material [µR/hr]		Conveyor Belt with 6" Material [µR/hr]	
	30 cm	100 cm	30 cm	100 cm
1	8.35	8.72	1.08	0.88
2	18.29	8.27	1.19	1.00
3	10.48	8.88	1.06	0.75
4	8.89	4.77	1.40	0.81
5	14.89	8.22	1.77	0.71
6	7.58	4.91	1.69	0.63
7	1.71	2.02	0.88	0.39
8	2.85	2.41	0.87	0.59
9	1.45	2.13	0.82	0.44
11	0.30	0.29	0.33	0.18
12	0.71	0.22	0.46	0.21
13	0.34	0.21	0.27	0.19
14	0.27	0.22	0.21	0.18
15	0.35	0.28	0.28	0.20
16	0.34	0.23	0.26	0.17
17	0.26	0.23	0.25	0.15
18	0.33	0.22	0.44	0.20
19	0.28	0.21	0.28	0.15
21	10.69	6.85	1.17	0.71
22	14.16	7.46	1.13	1.48
23	11.08	8.13	1.10	0.81
24	5.28	2.82	0.90	0.78
25	12.28	4.58	1.34	0.75
26	7.05	2.88	1.23	0.81
27	1.82	1.36	0.85	0.45
28	2.48	2.54	0.77	0.44
29	1.50	1.43	0.76	0.38
31	0.39	0.23	0.35	0.23
32	0.90	0.29	0.45	0.19
33	0.40	0.25	0.27	0.25
34	0.29	0.21	0.25	0.22
35	0.30	0.21	0.45	0.28
36	8.44	0.20	0.30	0.23
37	0.24	0.16	0.32	0.22
38	0.35	0.27	0.25	0.18
39	0.27	0.18	0.32	0.22

Loc.	Conveyor Belt with 0" Material [µR/hr]		Conveyor Belt with 6" Material [µR/hr]	
	30 cm	100 cm	30 cm	100 cm
41	0.38	0.22	0.28	0.22
42	0.22	0.21	0.28	0.23
43	0.26	0.22	0.27	0.25
44	0.29	0.25	0.32	0.28
45	0.41	0.27	0.50	0.31
46	0.43	0.34	0.48	0.27
47	0.28	0.21	0.31	0.23
48	0.28	0.22	0.33	0.21
49	0.29	0.23	0.29	0.25

**Sealed Source Information**

Type	S/N	Strength (µg)
Cf-252	Z2032	39.58
Cf-252	Z2031	36.63
Cf-252	Z1089	4.69
Sum		80.9

Equipment: E800 #01865 Calibration Due: 4/9/2004  
 Equipment: SHP270 #00455 Calibration Due: 1/23/2004  
 Equipment: NP-2 #NP 884501 Calibration Due: 4/18/2004

Test Engineer: D. Peck

Test Engineer

RSD: D. Fosner

RSD

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

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DEVICE TYPE: Neutron Source

MODEL:

FTC Model 10 series  
(10, 10S, Z10, Z10S)

MANUFACTURER/DISTRIBUTOR:

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

ISOTOPE:

Californium-252

MAXIMUM ACTIVITY:

192 GBq (5.2 Ci, 10 mg)

LEAK TEST FREQUENCY:

6 months

PRINCIPLE USE:

(H) General Neutron Source

CUSTOM DEVICE:

Yes  No

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
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DEVICE TYPE: Neutron Source

DESCRIPTION:

The Frontier Technology Corporation (FTC) Model 10 neutron source series is a family of four singly encapsulated Californium-252 sources. Californium-252 in the form of CfPd cermet or alloy is sealed inside a type 304L stainless steel Zircalloy-2 capsule by tungsten-inert-gas (TIG) fusion welding.

The basic Model 10 source uses a Type 304L stainless steel capsule made to FTC drawing A10010-AA00. The Model Z10 has dimension identical to the Model 10, but uses a zircalloy-2 capsule made to FTC drawing A10010-ZA00. The Models 10S and Z10S are shortened versions of the Models 10 and Z10 respectively, and are made to FTC drawings A10010-AB00 and A10010-ZB00 respectively.

External dimensions of the Models 10 and Z10 are 5.5 mm (0.217 inches) in diameter and 24.6 mm (0.97 inches) long. External dimensions of the Models 10S and Z10S are 5.5 mm (0.217 inches) in diameter and 11.9 mm (0.47 inches) long.

The internal cavity may also contain stainless steel, copper, ceramic or zircalloy spacers to position the active material provided that the minimum void volume requirements of FTC are maintained. Minimum seal weld penetration is 0.76 mm (0.030 inches).

The Model 10 and Z10 are FTC's embodiment of the Savannah River Laboratory's Series SR-Cf-1X, in Type 304L and Zircalloy-2, respectively.

The source model specific activity limits and materials of construction are tabulated below.

<u>Model</u>	<u>Material</u>	<u>Maximum Cf Activity</u>
10	304L stainless steel	192 GBq (10 mg, 5.2 Ci)
10S	304L stainless steel	76.8 GBq (4 mg, 2.1 Ci)
Z10	Zircalloy-2	192 GBq (10 mg, 5.2 Ci)
Z10S	Zircalloy-2	76.8 GBq (4 mg, 2.1 Ci)

The manufacturer certifies that the sealed sources meet the special form qualifications.

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DEVICE TYPE: Neutron Source

LABELING:

The FTC Model 10 series neutron source is intended to be used either as a singly encapsulated source or as the inner capsule of a multi-encapsulated source. When used as a singly encapsulated source the capsule will be electro-etched, engraved or imprinted with a unique serial number in the format of FTC-CF-XXX, FTC-CF-XXXX, FTC-CF-XXXXX, FTC-CF-ZXXX, FTC-ZXXX, or FTC-CF-ZXXXXX (or these formats without hyphens) to identify the manufacturer, isotope, zircalloy as the capsule material ("Z") and unique number. The capsule will also be electro-etched, engraved or imprinted with the words CAUTION RADIOACTIVE MATERIALS. When the 12 mm (0.47 inch) length capsule is used it will be denoted as a Model 10S or Z10S (short) source. These capsules will be marked with the word RADIOACTIVE. When used as the inner capsule of a multi-encapsulated source, the outer surface of the outermost capsule shall be marked as specified above.

DIAGRAM:

Attachment 1 - FTC Model 10 Series

CONDITIONS OF NORMAL USE:

The FTC Model 10 series is intended for various neutron source applications under environmental conditions that are not detrimental to type 304L stainless steel or Zircaloy-2 capsule material. Typical uses include neutron radiography, activation analysis, process control by activation analysis and nuclear fuel rod scanning. For some applications such as those requiring a source of very small physical dimensions the Model 10 series may be used by itself.

The useful life of the Model 10 source is expected to be that period during which the neutron output is adequate for the intended use. Californium-252 has a half-life of 2.6 years. Tests of sources to which the Model 10 series conforms show that it will meet the Special Form criteria at the time of manufacture. In addition, analysis of the Model 10 capsule shows that it will meet the special form heating test at the 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.



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DEVICE TYPE: Neutron Source

PROTOTYPE TESTING:

The FTC Model 10 series is equivalent to the Savannah River SR-CF-1X primary capsule. Special Form tests were performed at the Savannah River Laboratory showing that the SR-CF-1X and therefore the FTC Model 10 series source meets Special Form criteria at the time of manufacture. ANSI tests were performed by Savannah River Laboratory and/or Monsanto Research Corporation for classification in accordance with ANSI N510-1968. In addition, analysis was performed on the FTC Model 10 series capsule using methods specified in the ASME Pressure Vessel Code. This analysis shows that for the californium quantity and void volume limits stated in this document that the FTC Model 10 series sources are able to pass the special form heating test at any time after sealing.

The sealed sources meet the following ANSI N43.6 classifications:

<u>Model</u>	<u>Classification</u>
10, 10S	97E66543
Z10, Z10S	97E66344

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.

<u>Distance</u>	<u>5 cm (2")</u>	<u>30 cm (12")</u>
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

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DEVICE TYPE: Neutron Source

QUALITY ASSURANCE AND CONTROL: continued

penetration and quality for the particular capsule design. Each source is fabricated to a Manufacturing Order (MO) that specifies the californium content, Cf/Pd 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.

After welding, each source will be leak tested using the Dry Wipe Test per paragraph A.2.1.1 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 - The source 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 - These sources exhibit very high dose rates when unshielded. The source should only be handled by experienced licensed personnel using adequate remote handling equipment and procedures.

Stainless Steel Source Environmental Conditions - The source shall not be subjected to conditions that exceed the ANSI N43.6 classification of 97E66543 or used in conditions that are detrimental to the 304L stainless steel capsule. The source classification indicates that the source met the following test requirements without leaking.

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DEVICE TYPE: Neutron Source

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE: continued

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 <sup>2</sup> (3.6 lb <sub>f</sub> /in <sup>2</sup> ) absolute to 170 MN/m <sup>2</sup> (24,656 lb <sub>f</sub> /in <sup>2</sup> ) 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

Zircalloy-2 Source Environmental Conditions - The source shall not be subjected to conditions that exceed the ANSI N43.6 classification of 97E66344 or used in conditions that are detrimental to the Zircalloy-2 capsule. The source classification 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 <sup>2</sup> (3.6 lb <sub>f</sub> /in <sup>2</sup> ) absolute to 170 MN/m <sup>2</sup> (24,656 lb <sub>f</sub> /in <sup>2</sup> ) 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

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

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DEVICE TYPE: Neutron Source

SAFETY ANALYSIS SUMMARY:

Based on review of the Model 10 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 10 series are hereby incorporated by reference and are made a part of this registry document:

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

Amendment request dated November 12, 2004 with enclosures, and letter dated April 4, 2005.

ISSUING AGENCY:

Ohio Department of Health  
Bureau of Radiation Protection

Date: 5-31-05

Reviewer:

Karl Von Ahn

Karl Von Ahn, RRPT

Date: 5-31-05

Concurrence:

Shannon Dettmer

Shannon Dettmer, Health Physicist

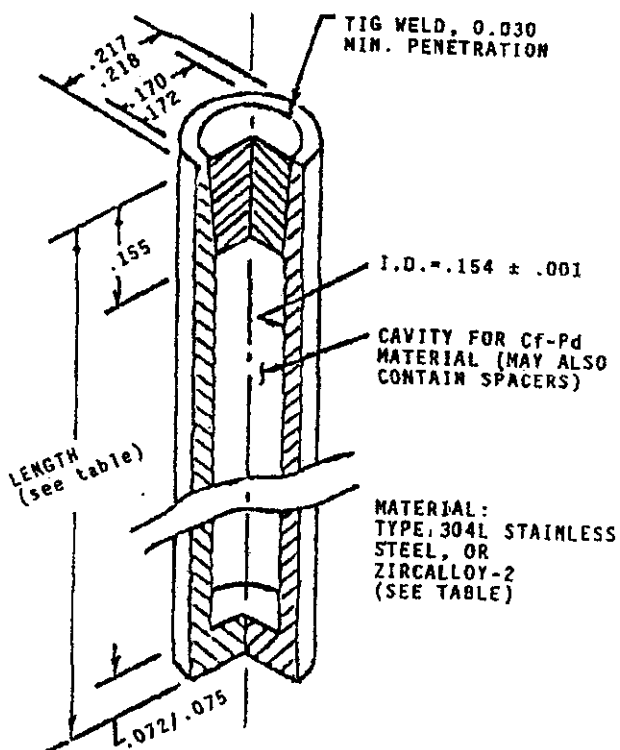
REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
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Attachment: 1

FTC MODEL 10 SERIES - Standard Neutron Source



DIMENSIONS IN INCHES  
 (FOR REFERENCE)

MODEL DESCRIPTION CHART

MODEL	LENGTH(inches)	MATERIAL	Cf LIMIT
10	0.970/0.980	304L Stainless Steel	10 mg.
10S	0.465/0.475	304L Stainless Steel	4 mg.
Z10	0.970/0.980	Zircalloy-2	10 mg.
Z10S	0.465/0.475	Zircalloy-2	4 mg.

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MODEL:

FTC Model 100 series

MANUFACTURER/DISTRIBUTOR:

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

ISOTOPE:

Californium-252

MAXIMUM ACTIVITY:

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

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DESCRIPTION:

The Frontier Technology Corporation (FTC) Model 100 Series neutron source is a family of doubly encapsulated Californium-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

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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.



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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

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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.

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.

Model number	ANSI N43.6 classification
100, 100R, 100NS, 100NSR, 100MX, 100ML, 100RMX, 100RML	97E66644
100S, 100SR, 100SNS, 100SNSR, 100SMX, 100SML, 100SRMX, 100SRML	97E66644
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

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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.

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.

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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 <sup>2</sup> (3.6 lb <sub>f</sub> /in <sup>2</sup> ) absolute to 170 MN/m <sup>2</sup> (24,656 lb <sub>f</sub> /in <sup>2</sup> ) 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

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LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE: continued

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 <sup>2</sup> (3.6 lb <sub>f</sub> /in <sup>2</sup> ) absolute to 170 MN/m <sup>2</sup> (24,656 lb <sub>f</sub> /in <sup>2</sup> ) 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 <sup>2</sup> (3.6 lb <sub>f</sub> /in <sup>2</sup> ) absolute to 170 MN/m <sup>2</sup> (24,656 lb <sub>f</sub> /in <sup>2</sup> ) 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

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.

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

NO: OH-0298-S-102-S

Date: May 25, 2005

Page: 9 of 9

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.

ISSUING AGENCY:

Ohio Department of Health  
Bureau of Radiation Protection

Date: 5-25-05 Reviewer: Karl Von Ahn  
Karl Von Ahn, RRPT

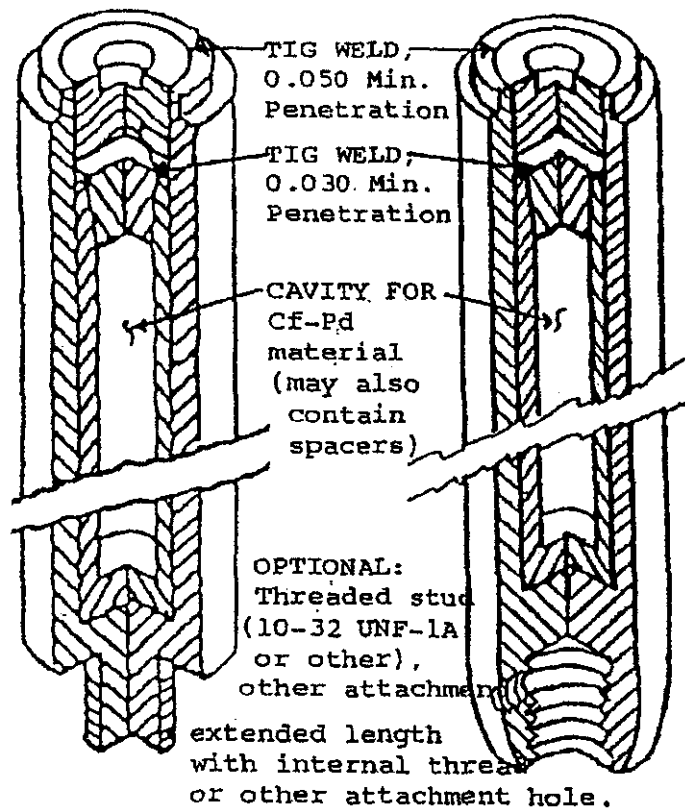
Date: 5-25-05 Concurrence: Shannon Dettmer  
Shannon Dettmer, Health Physicist

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

NO: OH-0298-S-102-S

Date: May 25, 2005

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" precedes the serial number when either or both capsules are Zircalloy-2.

FTC Model 100-Series  
Standard Neutron Source

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

NO.: CA-0305-D-113-S

DATE: December 14, 2006

PAGE 1 OF 8

DEVICE TYPE: Cross-Belt Elemental Analyzer

MODEL: CBX

MANUFACTURER/DISTRIBUTOR:

Thermo Electron Corporation  
10010 Mesa Rim  
San Diego, Ca 92121  
(858) 450-9811 (voice)  
(858) 546-1734 (fax)

SEALED SOURCE MODEL DESIGNATION:

Frontier Technology Corp.  
Model: 100 Series  
ANSI/ISO Classification 77E66343

**QSA Global, Inc. (Formerly AEA  
Technology and Amersham Corporation)**  
Model: CVN-CYn Series  
ANSI/ISO minimum classification:  
(See SSD # MA-1059-S-271-S)

ISOTOPE:

Californium-252  
(hydrogenous materials)

Californium-252  
(low hydrogenous materials)

MAXIMUM ACTIVITY:

Total of 40  $\mu$ g, 21 mCi (0.78 GBq) +15%/-0%  
in up to six sources

Total of 80  $\mu$ g, 42 mCi (1.56 GBq) +/-5%  
in up to six sources

LEAK TEST FREQUENCY:

6 Months

PRINCIPAL USE:

(H) General Neutron Source Applications

CUSTOM DEVICE:

YES  NO



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

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DEVICE TYPE: Cross-Belt Elemental Analyzer

DESCRIPTION:

The Thermo Electron Model CBX Cross-Belt Elemental Analyzer is a PGNA (Prompt Gamma Neutron Activation Analysis) elemental analyzer designed for continuous use by industries where the chemical and physical analysis of bulk materials must be determined for purposes such as environmental compliance, material quality compliance, process control and process optimization. Materials pass through the device on a conveyor belt. An isometric drawing of the Model CBX device is provided in Attachment 1, a front view of the device is shown in Attachment 2. An engineering drawing of the Model CBX device including dimensions is provided in Attachment 3.

The unit houses Cf-252 sources and photon radiation detectors. The sources are from Frontier Technology, QSA Global Inc. (Formerly AEA Technology or Amersham). Sources are leak tested in accordance with ANSI N542-1977, and are classified as C64545 or E66343 (Frontier sources). During operation, material to be analyzed enters the analyzer on a conveyor belt that traverses the analyzer. The CBX analyzer is completely automatic in operation and has no moving parts. No personnel are required to be in any location near the enclosure at any time during operation except for source leak testing and for brief, occasional inspections of the material-handling tunnel.

The sources are secured within a special housing (see source cartridge description below and Attachment 3) while the detectors are held within a detector cartridge (see detector cartridge description below). The CBX may be configured either with the source cartridge above or below the conveyor belt.

The Model CBX has been designed to accommodate varying conveyor belt widths. There is sufficient clearance between the conveyor belt and the device as well as additional safety features that it is unlikely that the conveyor belt or any product on the belt would rub or strike the fiberglass cover in such a way as to cause damage to the radiation shielding.

Throughout the analyzer a combination of neutron shielding and high-Z metallic gamma ray shielding encased in a fiberglass shell provides biological shielding and reduces the average external radiation dose equivalent rates to less than 0.5 mRem per 1 hour at 30 cm on the top, bottom and sides of the analyzer. Areas near the belt at the openings of the shield assembly are the locations of highest dose levels and will be restricted from personnel access by the conveyor belt and add-on barriers when needed. Generally the ends of the analyzer average about 8 mrem per hour at 30 cm in the measured worst case.

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

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PAGE 3 OF 8

DEVICE TYPE: Cross-Belt Elemental Analyzer

DESCRIPTION (Continued):

The CBX analyzer consists of the following major components:

- Shielding Modules (half above the conveyor belt, half below)
- One Source Cartridge
- One Detector Cartridge
- Two Side Blocks
- Frame

There are two types of shielding modules. Depending upon the width of the conveyor belt passing through the analyzer, the modules are used to ensure all external regions to the side, above and below the analyzer are adequately shielded for radiation protection. The modules are made of a fiberglass shell and are filled with borated hydrocarbon to provide biological shielding. The modules have components integrated into their design to provide the analyzer the structural properties needed to support the analyzer weight.

The source and detector cartridges are made of a fiberglass shell. The source cartridge contains a moderating/shielding structure. The source cartridge is designed to maintain the correct geometry of the neutron source(s) with respect to the detector(s) during operation. No shutter mechanism is required. Source removal is accomplished only through a locked access door. The door lock is manual and not dependent on power. The detector cartridge is comprised of borated hydrocarbon and other neutron shielding materials.

The side blocks are made of a fiberglass shell and are filled with borated hydrocarbon to provide biological shielding outside the analyzer. The analyzer's components are supported by an external frame. All components are firmly attached to other analyzer components and/or the frame.

Since the CBX analyzer is comprised of modules and cartridges constructed from fiberglass, the only metal-to-metal contact is between the bolts used to bolt the analyzer modules and cartridges to the support frame. The frame is protected by a protective barrier and the bolts are stainless steel. Therefore, corrosion is not expected to be a concern.

LABELING:

The Model CBX analyzer is labeled according to 10 CFR 20.1901. Copies of the labels are provided in Attachment 6. The label contains the radiation symbol, isotope, activity, model number, serial number, name of distributor and the words "CAUTION - RADIOACTIVE MATERIALS".

Each label bears the statement "Removal Of This Label Is Prohibited." The labels are made of 28-gauge, type 304 stainless steel with black lettering etched 0.003 inches deep. Labels and lettering are sized appropriately, easily visible and accessible to users. The labels indicate the

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
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PAGE 4 OF 8

DEVICE TYPE: *Cross-Belt Elemental Analyzer*

LABELING (Continued):

model number, serial number, isotope, activity, manufacturer and data of assay. All labels and are permanently attached by rivets, screws and/or adhesive to the device.

DIAGRAM:

- Attachment 1: Isometric Drawing of Model CBX Device
- Attachment 2: Front View of Model CBX Device
- Attachment 3: Orthogonal Drawing of Model CBX Device (Hydrogenous)
- Attachment 4: Source Rod Placement Details of Model CBX Device
- Attachment 5: Orthogonal Drawing of Model CBX Device (Low Hydrogenous)
- Attachment 6: Labels
- Attachment 7: Measurement Locations for Radiation Survey
- Attachment 8: Radiation Survey - Hydrogenous (40 micrograms Cf-252)
- Attachment 9: Radiation Survey - Low Hydrogenous (38 micrograms Cf-252)
- Attachment 10: Radiation Survey - Low Hydrogenous (80 micrograms Cf-252)
- Attachment 11: Radiation Survey - Hydrogenous (40.9 micrograms Cf-252)
- Attachment 12: Radiation Survey - Low Hydrogenous (80.9 micrograms Cf-252)

CONDITIONS OF NORMAL USE:

The working life of the Model CBX analyzer is 10 years, unrelated to the decay of the Cf-252. Upon successful inspection, maintenance and upgrade by Thermo Electron personnel, the working life of the device may be extended for an additional ten years. Thermo Electron recommends that the sources be exchanged 4 – 5 times over a ten year period due to decay of the Cf-252. The Cf-252 sources are kept dry and otherwise protected from the industrial environment by an enclosed housing. The access door to the Cf-252 sources is always locked to prevent unauthorized entry.

At the end of the working life of the device, the sources will be removed and returned to the manufacturer.

The Model CBX is designed for use in outdoor industrial environments. The analyzer is designed to withstand a wide spectrum of weather conditions: snow, ice, and wind. It is capable of tolerating a wide temperature range of 50°C to -40°C.

The Thermo Electron Model CBX Cross-Belt Elemental Analyzer is adaptable to many industrial applications. Signals from the radiation detector(s) are transmitted to an information processing station. Data conditioning and interpretation will determine various properties of materials passing through the analyzer. This information will be acted upon by the user for a variety of process control and optimization activities depending upon the specific application and site.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
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PAGE 5 OF 8

DEVICE TYPE: Cross-Belt Elemental Analyzer

CONDITIONS OF NORMAL USE (Continued):

The analyzer will be shipped by common carrier. Radioactive sources will be shipped separately in the manufacturer shipping casks by common carrier. Installation of the sources shall be performed by authorized Thermo Electron personnel.

The fiberglass and coated frame structures are resistant to corrosion/vibration mechanisms typically encountered in industrial bulk material handling applications for which the Model CBX is intended.

PROTOTYPE TESTING/HISTORICAL USE:

Thermo Electron personnel have performed radiation surveys of the Model CBX configured as a hydrogenous material analyzer and as a low hydrogenous material analyzer. For both cases, measurements were performed with an empty conveyor belt and with a belt loaded to typical operating levels with appropriate materials. Measurements were performed with the maximum source loadings of 40 and 80 micrograms of Cf-252 respectively.

By design, the Model CBX is comparable to the Thermo Gamma-Metrics Model CB-MP and CB-GN (Registry Number CA0305D109B). The operational history of these analyzer units sums to more than 300 unit-years. There have been no instances of damage or other problems with these analyzer devices that are related to radiation safety. Engineering analysis of actual temperature, vibration and impact cases has demonstrated the devices suitability for the proposed operational conditions

Due to the neutron shielding material and to the materials of construction, a fire test was not performed.

EXTERNAL RADIATION LEVELS:

Thermo Electron reports that the total gamma and neutron dose rates at 30 cm for both configurations are generally in the range 0.3 to 3.0 mRem/hr. Dose rates exceed 3 mRem/hr at 30 cm near the analyzer's tunnel entrances and in their immediate surroundings. Generally, these areas are inaccessible when the analyzer is installed.

A map of the radiation measurement locations for the device radiation survey is provided in Attachment 7. The results of the measurements for the Model CBX in the hydrogenous configuration empty and with material may be found in Attachment 8, the results for the analyzer in the low hydrogenous configuration empty and with material may be found in Attachment 9. To demonstrate expected radiation levels for the low hydrogenous configuration, which may be loaded with up to 80 micrograms of Cf-252, the measured results are presented in Attachment 10. Generally the highest radiation levels occur with the low hydrogenous configuration fully loaded with the maximum load of Cf-252 with an empty conveyor belt.

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PAGE 6 OF 8

DEVICE TYPE: Cross-Belt Elemental Analyzer

EXTERNAL RADIATION LEVELS (Continued):

A radiation area, as defined in 10 CFR 20.1003 (dose equivalent in excess of 5 mrem in 1 hour at 30 cm) is produced by this device; therefore, this device shall be permanently posted with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA." Pursuant to 10 CFR 20.1003, each licensee shall conduct operations such that the dose in any unrestricted area from external sources shall not exceed 2 mrem in any one hour.

In order to implement ALARA concerns, access to areas around the device that exceed 2 mrem in any one hour is restricted by physical barriers or by the conveyor belt itself. The physical barriers extend as needed up to 2 meters outward from the two faces of the device that have the openings for the belt to pass through. These barriers run parallel to the conveyor belt.

Normal personnel occupancy for this device is less than 0.25 hour per day at a distance of one meter or more from the side of the device. Total dose to users, therefore, is conservatively estimated to be less than 24 mrem in a year. Persons usually stay clear of the device during operations since the moving conveyor belt presents a safety hazard.

A Model CBX analyzer will normally be loaded with up to 40 micrograms of Cf-252 for hydrogenous material applications.

A Model CBX analyzer will normally be loaded with up to 80 micrograms of Cf-252 for low-hydrogenous material applications.

The Cf-252 loading tolerance for the CBX is +15%/-0% for source loading up to 70 micrograms of Cf-252. For source loading above 70 micrograms, the Cf-252 loading tolerance for the CBX is +/-5%.

QUALITY ASSURANCE:

Thermo Electron (formerly referred to as Thermo Gamma-Metrics and Gamma-Metrics) has previously provided a written summary of the Quality Assurance and Control Program that has been deemed acceptable for licensing purposes by the California Department of Health Services. A copy of the program is on file with the California Department of Health Services.

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE:

- The Model CBX analyzer shall be distributed to specific licensees of the NRC, Agreement State or Licensing State.
- Handling, storage, use, transfer and disposal: To be determined by the licensing authority or as required by 10 CFR 31.5 or Agreement or Licensing State Equivalent.

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES  
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DEVICE TYPE: Cross-Belt Elemental Analyzer

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE (Continued):

- The sources within the device shall be leak tested prior to initial use and at intervals not to exceed six (6) month intervals using techniques capable of detecting 185 Bq (0.005 microcuries) of removable contamination. The device shall be leak tested only by a person holding a specific license pursuant to 10 CFR 30 and 10 CFR 32 or from an Agreement State or Licensing State to perform such activities. Leak test results shall be provided to the generally or specifically licensed user.
- The specifically licensed user is authorized to perform quarterly maintenance for belt tension and belt alignment and semi-annual inspection for slide plate wear. Maintenance and inspection work shall be performed using procedures provided by Thermo Electron.
- The specifically licensed user shall operate the device using procedures provided in the Operating Procedures Manual. No other use is authorized.
- The device shall be installed and tested for proper operation of the source access door locking mechanism, safety warning components, labels, external radiation levels, and leak tested by Thermo Electron or other persons specifically licensed by the NRC or an Agreement State.
- The access panel on the device shall always be locked to prevent unauthorized access to the Cf-252 sources. Only Thermo Electron or other specific licensee personnel may access the interior of the device.
- The sources shall not be subjected to conditions that exceed their ANSI classified specifications.
- The device shall not be subjected to environmental conditions that exceed its ANSI N538-1979 classification of ANSI 24-142-142-R1.
- After installation, the area around the device shall be surveyed and a copy of the survey report shall be provided to the generally or specifically licensed user. A restricted area shall be established and maintained where the total dose rates exceed 2 mrem in any one hour.
- Emergency Procedures: A fire could substantially compromise the shielding, therefore specific emergency procedures should be described and posted.
- Source replacement due to decay shall only be performed by Thermo Electron or other specifically licensed persons.

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

NO.: CA-0305-D-113-S

DATE: December 14, 2006

PAGE 8 OF 8

DEVICE TYPE: Cross-Belt Elemental Analyzer

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE (Continued):

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

SAFETY ANALYSIS SUMMARY:

In the event that a fire destroys the shielding, the sources should maintain integrity due to their own ANSI classification (C64545 or E66343) that exceeds those required for the intended use .

Based upon our review of the information and test data presented in the Attachments, we conclude that the Model CBX is acceptable for licensing purposes.

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

REFERENCES:

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

Thermo Electron's application dated September 9, 2002 with enclosures thereto.

Thermo Electron's letter dated March 7, 2003, with enclosures thereto.

Thermo Electron's e-mail dated October 2, 2003, and facsimile dated October 8, 2003 with enclosures thereto.

Thermo Electron's email dated December 5, 2005.

Thermo Electron's letter dated November 9, 2006.

ISSUING AGENCY:

California Department of Health Services

Date: December 14, 2006

Reviewer:

John G. Fassell for  
Mina Goeders, Ph.D.

Date: December 14, 2006

Concurrence:

John G. Fassell  
John G. Fassell, C.H.P.

This is to acknowledge the receipt of your letter/application dated

8/14/2007 <sup>(RECEIVED)</sup> 9/14/2007, and to inform you that the initial processing which includes an administrative review has been performed.

AMEND. 47-11451-CX  
There were no administrative omissions. Your application was assigned to a technical reviewer. Please note that the technical review may identify additional omissions or require additional information.

Please provide to this office within 30 days of your receipt of this card

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A copy of your action has been forwarded to our License Fee & Accounts Receivable Branch, who will contact you separately if there is a fee issue involved.

Your action has been assigned **Mail Control Number** 141066.  
When calling to inquire about this action, please refer to this control number.  
You may call us on (610) 337-5398, or 337-5260.

NRC FORM 532 (R1)  
(6-96)

Sincerely,  
Licensing Assistance Team Leader