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

NO. : NC-646-D-137-S **DATE:** July 31, 2006 **PAGE:** 1 of 7

DEVICE TYPE: Laboratory Moisture Content System

MODEL No.: 4232

MANUFACTURER/DISTRIBUTOR: Troxler Electronic Laboratories
3008 Cornwallis Road
P.O. Box 12057
Research Triangle Park, NC 27709
(919) 549-8661

SEALED SOURCE MODEL DESIGNATION:	ISOTOPE:	MAXIMUM ACTIVITY:
Troxler Drawing No. A-105162 which covers: **QSA Global, Inc.** Model No. CVN.CY2 Capsule Type X.1 Special Form Certificate No. USA/0632/S	Cf-252	110 microcuries (4.07 MBq)
Troxler Drawing No. A-105862 which covers: Isotope Product Laboratories Model # HEG-252 Special Form Certificate No. USA/0632/S	Cf-252	110 microcuries (4.07 MBq)

LEAK TEST FREQUENCY: **12 months**

PRINCIPAL USE: (G) Portable Moisture Density Gauge

CUSTOM DEVICE: _____ YES **X** NO

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DEVICE TYPE: Laboratory Moisture Content System

DESCRIPTION:
The Model 4232 Laboratory Moisture Content Gauge is a semi-fixed[1], non-portable laboratory analysis device for measuring the water content of soils and other bulk material. The device design is based on the principal of neutron thermalization via collisions with atoms of similar mass and incorporates a doubly-encapsulated neutron-emitting Californium-252 radioactive source (neutron yield - 3.8×10^5 neutrons/sec.) and a series of four Helium-3 detector tubes. The device operation can be described as follows: fast neutrons, emitted from the source, traverse the test sample that has been placed inside the enclosed test chamber and are subsequently slowed down (thermalized) by collisions with Hydrogen atoms of the water in the test material. The thermal neutrons are then detected by the Helium-3 detectors and counted over a specified time period. Due to the inability of these detectors to detect fast neutrons, the number of thermalized neutrons counted is directly proportional to the number of water molecules present in the sample. The accompanying electronics then processes the count numbers and calculates the moisture content using operator-supplied information (i.e. mass of sample and calibration data).

The engineering of the device was based on a sealed source composed of a 100 µCi sample of Californium-252 in "special form". The radioactive material is contained in a doubly-encapsulated, stainless steel cylindrical vessel The serial numbers are stamped or engraved on the bottom surface, while other data can be found engraved on the cylindrical surface. The encapsulated materials meet internationally-accepted specifications for special form certification and ANSI test criteria for classification as ANSI-77C66545/77C66535 (**QSA Global, Inc** /Isotope Product Laboratories). Immediate source shielding is provided by a high-density polyethylene domed source holder wrapped with cadmium (ref. drawing #C-104574). The source capsule is secured in the holder by means of a threaded plug which is then covered with a "Caution Radioactive Material" label. The shielded source holder is then attached to the internal aluminum structure of the device with two(2) #6 steel screws. The sealed source is then in a fixed, permanent position in the device with no "on-off" mechanism or source shutter. This device is designed to be setup, calibrated, and used by non-radiologically trained laboratory personnel[2]. The overall outside dimensions of the device (excluding controller) measure 37cm (length) x 28cm (width) x 27cm (height).

Notes:

1.) By "semi-fixed" we mean - not permanently, physically secured (as with bolts,straps,cement,etc.) in the laboratory. However, once the device is set up for operation it should not be moved around in or removed from the laboratory except for the express purpose of:

   a.) repair of a broken or defective component by qualified personnel as specified later in this document,
   b.) resupply of the radioactive material by Troxler, or
   c.) transfer of the device from one laboratory to another laboratory both of which are under the authority of the licensee.

2.) Non-radiologically trained is defined to be - personnel whose education and training in

principles of radiation protection and radioactive materials do not extend beyond the scope of their Troxler training course.

DETAILS OF CONSTRUCTION:

The model 4232 is constructed from four basic materials: aluminum, cadmium, high-density polyethylene, and stainless steel. High density polyethylene is used in the construction of the source holder, the barrier surrounding the source holder in the top of the device, the sample chamber walls (thickness - 0.625") and floor (thickness - 0.600'-1.00"), and the base stand (thickness - 1.00"). Cadmium (0.015" thick) is used to shield the outside of the polyethylene source holder barrier and to line the inside walls of the device in such a fashion that no neutron emitted from the sealed source could leave the device with out passing through at least one thickness of cadmium. Stainless steel (thickness - 0.048") is used in the bottom of the sample chamber to cover the aluminum housing over the detectors, giving increased shielding in the direction of the emitted beam. Finally, aluminum is used as the main construction material in the fabrication of the rest of the device. This includes the device walls, top, and bottom; sample chamber interior faces; and other similar structures exterior to the device. A circular hole (0.150" in diameter) is cut into the top interior face plate of the chamber to act as the neutron beam exit port. The overall design and construction of the device renders the source housing immoveable and access to the radioactive material highly restricted. The entire device would have to be disassembled to gain access to the sealed source. Furthermore, the small sample chamber volume (10"x7.5"x4.5") precludes an operator from inadvertently being exposed.

LABELING:

The labeling for the Model 4232 complies with the requirements of 15A NCAC 11 .0300 and .1600. The model 4232 in the transport case qualifies as a "Yellow II" type package with a 0.4 transport index. The transport case is thus labeled on two (2) opposing sides as such, along with a US DOT 7A Type "A" label and a manufacturer's label showing the name and address of the manufacturer, the device model, and serial number.

DIAGRAM:

See Attachments 1 for approximate source location.

DEVICE TYPE: Laboratory Moisture Content System

CONDITIONS OF NORMAL USE:

The Model 4232 is designed to be used by non-radiologically trained laboratory personnel to measure moisture content in soils and other bulk material in a laboratory setting. The user will normally be near the device only for the specific task of loading/unloading of samples from the chamber. The frequency of this operation is dependent upon the number of samples to be examined and the number and length of the irradiation times. In addition, a six foot interface cable is used to connect the control unit and sample chamber thus allowing the user to position the control unit several feet from the sample chamber. The source capsule has a recommended working life of fifteen years. However, the sample chamber should be returned to Troxler every three years for source replacement due to the 2.65 year half-life of the Cf-252 isotope. The operator's controller does not have to be returned with the chamber as no recalibration of the electronics is necessary.

The device is designed for the following environments:

Operating temperature	-10°C to +70°C ambient
Pressure	Atmospheric
Vibration	Ranges from zero to mild (tested @ a displacement of 0.1" @ 12.5 Hz)
Corrosion	ranges from zero to corrosive
Fire	+130°C (to melt the polyethylene shielding surrounding the source)

PROTOTYPE TESTING:

The design of the model 4232 device incorporates technology developed, tested, and used in the manufacture of Troxler device models 3241 and 3242. The Model 4232 device utilizes this technology to the extent that it is exactly identical to the model 3242 device in design, construction materials, sealed source type and configuration, shielding, and other radiological safety features and differing only in the accompanying electronic computational package of the controller. During the technology development phase of the models 3241 and 3242, extensive prototype testing was performed. The results from these prototype tests indicate soundness in design and integrity of the radiological safety features of the devices under accidental conditions. From an engineering standpoint, the Model 4232 gauge would yield the same prototype testing results as the Model 3242 gauge and therefore these results are used to infer the engineering and radiological soundness of the 4232 device. In addition to prototype testing and analysis, the Model 4232 device in its transport case was subjected to and passed the testing requirements as specified in 49 CFR 173.465 to be classified and labeled as a Type "A" package .

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EXTERNAL RADIATION LEVELS:

See Attachment 2.

QUALITY ASSURANCE AND CONTROL:

Troxler Electronic Laboratories maintains a quality assurance and control program which has been deemed acceptable for licensing purposes by the North Carolina Radiation Protection Section. A copy of the program is on file with the Radiation Protection Section.

LIMITATIONS AND/OR OTHER CONSIDERATIONS OF USE:

Distribution - This device will be distributed as a specifically licensed device in accordance with the requirements of section .0300 of 15A NCAC 11 and/or applicable regulations of the NRC or an Agreement State. This shall not preclude the exportation of this device to a foreign entity following the applicable regulations.

Installation and Removal - The Model 4232 is designed for simple installation and removal by radiologically untrained personnel. The installation and removal of the device shall be performed following the applicable written instructions provided in the accompanying "Manual of Operation and Instruction". Any additional barriers that the end user wishes to install around the device can then be moved into place. Removal of the device is the reverse procedure for installation and is given in the "Manual of Operation and Instruction". The packing, shipping, and radiological surveying of a device to be returned to the manufacturer or another specifically licensed recipient shall be carried out so as to be in compliance with the applicable regulations pursuant to 49 CFR 173.

Leak Testing - Troxler Electronic Laboratories, Inc. maintains a customer leak test service using the Troxler model 3880 Leak Test Kit. The device shall be leak tested by the user following the instructions in the "Manual of Operation and Instruction" at intervals not to exceed **twelve** months using techniques capable of detecting the presence of 0.005 microcurie of removable radiation. If the level exceeds this limit, the device shall be returned to Troxler for repair/disposal following the instructions cited in the above section "Installation and Removal" and all applicable regulations pursuant to 49 CFR 173.

Servicing - The Troxler model 4232 contains no user-serviceable components. The controller, containing the scaler and associated data analysis electronics, will generally be returned to a Troxler Service Center for all servicing. The sample chamber which holds the radioactive source will be returned to Troxler Manufacturing for source replacement, servicing, repair, and/or disposal. In addition, all users shall attend the Troxler gauge users training course offered at Troxler prior to operating the device.

Operating and Safety Instructions - The device will be operated following the written operating and safety instructions given in the device manual, "Manual of Operation and Instruction".

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

Reviewer Note: This registration sheet and the information contained within the references shall not be changed without the written consent of the North Carolina Radiation Protection Section, Radioactive Materials Branch.

DOCUMENTATION:

The documentation enclosed with the device upon shipment to the user shall include the following:

1. manual of operation and instruction,
2. special form certificate,
3. type "A" package testing results,
4. a copy of the final leak test results made prior to packaging,
5. an emergency response information sheet,
6. Model 3242 gauge certificate,
7 Troxler transportation guide.

SAFETY ANALYSIS SUMMARY:

The design of the model 4232 makes the device safe to operate by radiologically untrained personnel. The inherent safety features of the device include: a doubly-encapsulated sealed source, which is inaccessible to the user; the use of cadmium shielding throughout the device to absorb thermal neutrons; small sample chamber; a physically small beam port to limit the beam size and to decrease the likelihood of operator exposure; high density polyethylene and aluminum barriers and walls; and location of the operator controller away from the sample chamber containing the radioactive material. The radiation profile for the device both in/out of the transport case show relatively low radiation levels that are acceptable per federal regulations for exposure (refer to radiation profile section). Therefore, based on the information cited above and technical information provided in the application attachments, we conclude that the Troxler model 4232 Laboratory Moisture Content Gauge meets and exceeds the requirements to be manufactured and distributed as a specifically licensed device as pursuant to applicable regulations listed in 15A NCAC 11.

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REFERENCES:

The following supporting documents are hereby incorporated by reference into this SS&D registry document:

1. All information and engineering drawings submitted by Troxler Electronic Laboratories in the application for a safety analysis of the Model 4232 in the gauge SS&D review file;

2. **Letter with attachments dated February 14, 2006, signed by Stephen A. Browne, R.S.O.**

ISSUING AGENCY:

This Sealed Source & Device registry certificate is hereby amended July 31, 2006.

Principal Reviewer:

J. Marion Eaddy III, Health Physicist — Date: July 31, 2006

Concurrence Reviewer:

Sharn M. Jeffries, Health Physicist — Date: July 31, 2006

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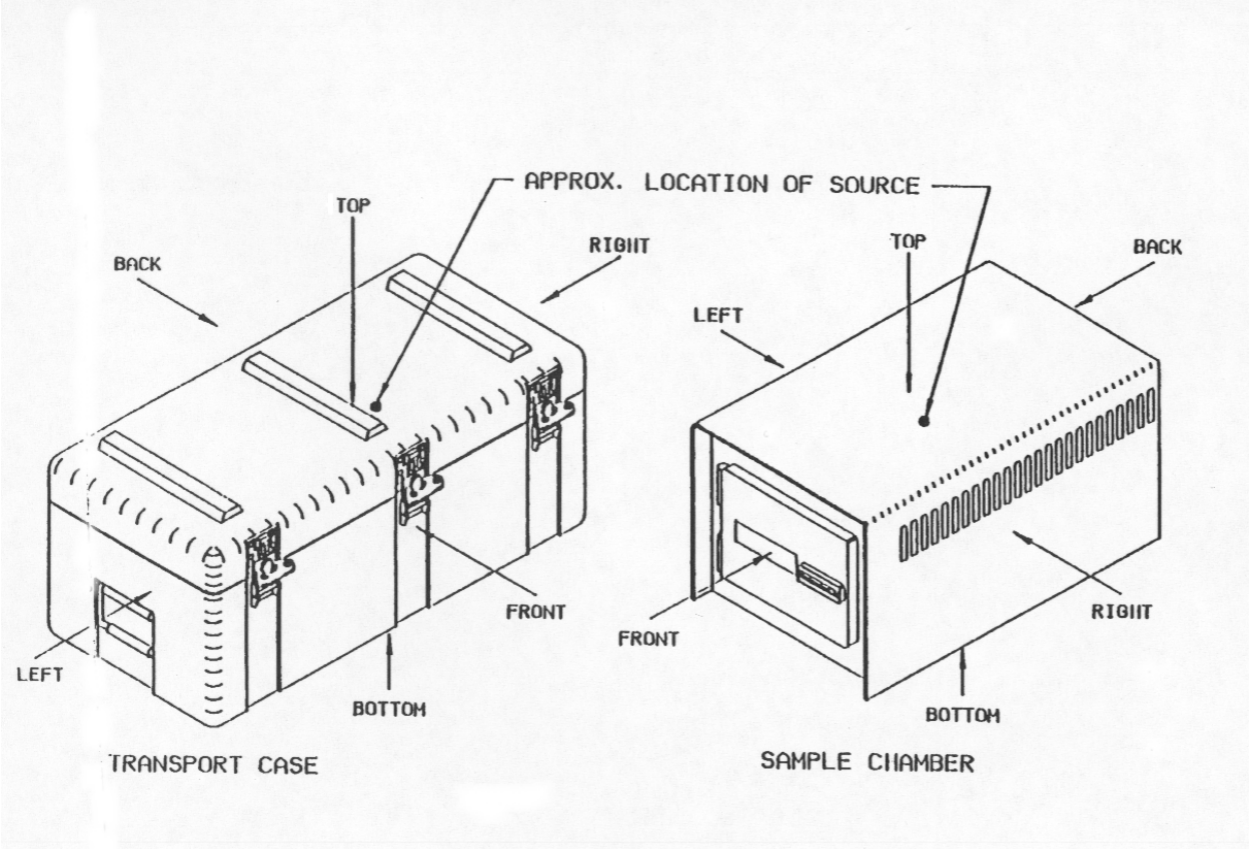
NO. : NC-646-D-137-S **DATE:** July 31, 2006 **ATTACHMENT:** 1 of 2

DEVICE TYPE: Laboratory Asphalt Content System

Attachment 1: Three Dimensional View of the 4232 Source Locations



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DEVICE TYPE: Laboratory Asphalt Content System

Attachment 2: Radiation Profile Information

Radiation Profile for 4232 Gauge

Location	Surface			5 cm			30 cm			100 cm		
	γ	η	γ+η	γ	η	γ+η	γ	η	γ+η	γ	η	γ+η
Top	3.2	*	3.2	1.6	*	1.6	0.25	1.5	1.75	0.05	0.4	0.45
Bottom	0.75	*	0.75	0.5	*	0.5	0.1	1.6	1.7	0.05	0.4	0.45
Left	0.9	*	0.9	0.6	*	0.6	0.1	1.7	1.8	0.02	0.3	0.3
Right	0.85	*	0.85	0.6	*	0.6	0.1	1.8	1.9	0.01	0.4	0.4
Front	1	*	1	0.6	*	0.6	0.1	1.5	1.6	0.03	0.4	0.4
Back	0.5	*	0.5	0.4	*	0.4	0.1	1.7	1.8	0.02	0.4	0.4

Radiation Profile for 4232 Gauge in Plastic Transport Case

Location	Surface			5 cm			30 cm			100 cm		
	γ	η	γ+η	γ	η	γ+η	γ	η	γ+η	γ	η	γ+η
Top	0.6	*	0.6	0.4	*	0.4	0.1	0.9	1	0.06	0.3	0.4
Bottom	0.45	*	0.45	0.4	*	.04	0.13	1.00	1.1	0.05	0.3	0.35
Left	0.1	*	0.1	0.1	*	0.1	0.07	0.8	0.9	0.05	0.3	0.35
Right	0.35	*	0.35	0.25	*	0.25	0.09	0.75	0.85	0.05	0.3	0.35
Front	0.35	*	0.35	0.3	*	0.3	0.15	1.3	1.45	0.05	0.3	0.35
Back	0.4	*	0.4	0.25	*	0.25	0.1	0.7	0.8	0.05	0.3	0.35

Notes:

1. Radiation measurements were for a gauge containing a nominal and a nominal 0.100 millicurie Californium-252 neutron source.
2. All radiation measurements are in millirems per hour.
3. Gamma (γ) measurements were obtained with a Ludlum 14C survey meter, calibrated April, 1994.
4. Neutron (η) measurements were obtained with a Eberline Model PNR-4 survey meter, calibrated January, 1995.
5. "*" denotes measurement not made because center of detector volume was greater than that distance from source
6. See Attachment 1 for profile orientation.