NCDENR

NORTH CAROLINA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES

DIVISION OF RADIATION PROTECTION

JAMES B. HUNT JR.
GOVERNOR

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SECRETARY

RICHARD M. FRY
DIRECTOR

MEMORANDUM

TO: William Troxler, Jr., Vice President
Troxler Electronic Laboratories, Inc.

Stephen A. Browne, Corporate R.S.O.
Troxler Electronic Laboratories

Fredrick Sturz, Section Chief
Sealed Source Safety Section
United States Nuclear Regulatory Commission

FROM: jrh J. Robin Haden, Chief, Radioactive Materials Section
North Carolina Division of Radiation Protection

DATE: March 15, 2000

SUBJECT: Transmittal of Sealed Source and Device Registration Sheets for Troxler Electronic Laboratories.

Enclosed please find a copy of the following Sealed Source and Device Registry Certificate which amends pages 1 and 6:

NC-646-D-138-S Model 3450 RoadReader Plus

NI:5502
non public AVAIL

3825 BARRETT DR. RALEIGH, NORTH CAROLINA 27609-7221
PHONE 919-571-4141 FAX 919-571-4148

REGISTRY OF RADIOACTIVE SEALED SOURCES AND DEVICES
SAFETY EVALUATION OF DEVICE
AMENDED PAGES 1 & 6

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DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

MODEL: 3450

MANUFACTURER/DISTRIBUTOR: Troxler Electronic Laboratories, Inc.
3008 Cornwallis Road
P.O. Box 12057
Research Triangle Park, NC 27709

SEALED SOURCE MODEL DESIGNATION:	ISOTOPE	MAXIMUM ACTIVITY:
Amersham Corporation Model # AMNV.997 Capsule type: X.1 Special Form Certificate # GB/7/S-85	Am-241:Be	44 mCi (1.63 GBq)
Model # CDCW556 Capsule type: X.1218 Special Form Certificate # GB/353/S-85	Cs-137	9 mCi (333 MBq)
Isotope Product Laboratories **Model # HEG-137** Capsule type: 3024 Special Form Certificate # USA/0356/S	Cs-137	9 mCi (333 MBq)

LEAK TEST FREQUENCY: 6 Months

PRINCIPAL USE: (G) Moisture/Density Measurement of Construction and Paving Materials

CUSTOM DEVICE: _____ YES __X__ NO

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DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

DESCRIPTION:

The model 3450 RoadReader Plus Moisture/Density Gauge is a portable gauge designed to measure the bulk density and moisture content of *in situ* soil, cement concrete, and asphalt concrete. The device design for the measurement of moisture content is based on the principal of neutron thermalization via collisions with atoms of similar mass and incorporates a doubly-encapsulated neutron-emitting Americium 241:Beryllium radioactive source (neutron yield -6.0 x 10^4 neutrons/sec. - minimum) and a single Helium-3 detector tube. The device operation can be described as follows: fast neutrons, emitted from the source, penetrate the test material beneath the gauge 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 an algorithm internally stored in the gauge.

The device design for the density measurement is based on the principal of Compton scattering of photons. The measurement is made using either a "backscatter" mode whereby the source rod tip is essentially flush with the surface of the test material or a "direct transmission" mode with the source rod tip inserted into the test material. The gamma emitting radioactive material is located in a sealed source inside of the source rod tip. The emitted gamma photons that traverse the test material or that are scattered by the material, depending on the measurement mode employed, are detected using four (4) Geiger tubes located in the gauge base. The photons are counted over a specified time period and the counts converted to a density measurement based on an internally stored calibration.

The engineering of the device was based on the use of two (2) separate sealed sources one composed of a 40 mCi (±10%) sample of Americium 241:Beryllium and one composed of an 8 mCi (±10%) sample of Cesium-137, both in "special form." The gauge can utilize either the Amersham or IPL Cesium-137 sources listed above. The Amersham source is composed of a 0.110" long cylindrical cesium-137 ceramic pellet having a diameter of 0.110" singly encapsulated with a ceramic spacer in a 316L stainless steel cylindrical capsule. The capsule is capped and sealed by fusion welding. The source serial number is then engraved on one of the end faces of the capsule. The IPL source is composed of a 0.125" diameter cylindrical cesium-137 ceramic pellet that is encapsulated in a 304/304L stainless steel cylindrical capsule and fusion welded closed. This capsule is then placed inside of a slightly larger 304/304L stainless steel cylindrical capsule that is also fusion welded closed. The source serial number is then engraved on one of the end faces of the outer capsule. The encapsulated materials meet internationally-accepted specifications for special form certification and ANSI test criteria for classification as ANSI-77C64444/77C66535, respectively (Amersham/Isotope Products).

The Model 3450 gauge utilizes an Amersham neutron emitting Americium-241:Beryllium sealed source in a model X.1 capsule. The source is composed of a mixture of americium oxide and beryllium metal encapsulated in a stainless steel vessel that is arc welded closed. This vessel is then placed inverted into a

DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

DESCRIPTION (continued):

second stainless steel vessel of slightly larger dimensions and arc welded closed. The doubly encapsulated source measures 0.394" long and has a 0.307" diameter. The source serial number is stamped or engraved on one of the end faces and other pertinent data may be engraved on the cylindrical surface. The encapsulated material meet internationally-accepted specifications for special form certification and ANSI test criteria for classification as ANSI-77C54444.

Immediate source shielding for the cesium-137 sources and the Am-241:Be source is provided by a 1.75" diameter cylindrical tungsten shield and a 1.20" diameter cylindrical lead shield, respectively, both located inside of the gauge body. This gauge does not employ a shutter mechanism per se but rather uses an indexed securing rod/trigger mechanism to secure the source rod at various positions and a tungsten block in the gauge base as a moveable shield. (Refer to "Details of Construction" below) This device is designed to be used by construction personnel trained in radiological safety by the gauge manufacturer or an equivalent licensed entity. The overall outside dimensions of the gauge measure as follows:

16.18" (length)	24.05" (height with 12" source rod)
9.00" (width)	20.05" (height with 8" source rod).

DETAILS OF CONSTRUCTION:

The Model 3450 Moisture/Density gauge employs: 1) an immovable neutron emitting sealed source; and 2) a gamma emitting sealed source housed in a moveable source rod that can be extended out and retracted back into the gauge body for measurement and storage, respectively. The Model 3450 can accommodate either an eight (8") inch or twelve (12") inch long source rod. The moveable source rod contains the sealed source and some immediate shielding. Both source rods are constructed as follows: The bottom of a 0.625" diameter 630 stainless steel source rod is machined out to receive a 0.30" diameter stainless steel spring and a 0.448" diameter, 0.250" thick cylindrical tungsten plug in that order. A 0.725" long 420 stainless steel source cup having a 0.625" diameter is machined out to receive the sealed source and a 0.309" diameter, 0.330" thick stainless steel spacer. A 304 stainless steel weld filler ring is placed over the end of the source cup and the cup screwed into the source rod and fusion welded. This configuration renders the sealed source inaccessible to the user. The only way to retrieve the radioactive source is by the destruction of the rod assembly.

The neutron source is secured in the gauge by the following: The sealed source is housed in a 0.50" diameter threaded stainless steel source cup. The stainless steel source cup/source subassembly is then inverted, placed on top of a 0.062" thick lead disk and screwed into a cylindrical aluminum source holder. The holder is then attached to the gauge base with two (2) 10-32 stainless steel screws. A 0.90" high hollow cylindrical lead shield having a 0.70" inner diameter and 1.20" outer diameter is placed over the aluminum source holder. The lead shield and aluminum source holder are then covered with an aluminum plate. The neutron source is immobile and inaccessible to gauge users.

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SAFETY EVALUATION OF DEVICE
AMENDED PAGES 1 & 6

DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

DETAILS OF CONSTRUCTION (continued):

The gauge body is constructed mostly of aluminum and has cast lead and cadmium inserts added for the purpose of additional shielding and enhancement of radiation detection performance. Immediate shielding of the source rod is provided by a 3.000" high, 1.750" diameter cylindrical tungsten block. A 0.750" hole is machined through the block to provide shielding for the active area of the source rod when it is in the safe position. This thru-hole houses a 0.375" high, 0.626" inside diameter bronze bearing for guiding the source rod. Below the tungsten shielding block is a tungsten sliding block that provides shielding for the rod in the safe storage position and permits movement of the rod to the various measurement positions. The loaded source rod is secured to the source rod handle with a tamper resistant pin. This assembly is inserted into the gauge body and tungsten block and secured with a securing rod that is anchored to the gauge body and passes up through the source rod handle. A tamper resistant cap is then placed over the securing rod protruding from the handle. A 0.188" thick aluminum plate having a 0.77" diameter thru hole is secured to the bottom of the gauge. This plate acts as both an access panel for cleaning the sliding block mechanism and as an exit port for the source rod when performing measurements. The gauge body is covered with a molded plastic top shell and secured with screws.

The model 3450 gauge has two on/off indicators, one mechanical and one electrical. The on/off indicators are: 1) mechanical - a visual verification that the handle is at the top of the securing rod and that the handle does not move when pressure is applied to it; and 2) electrical - a resistive strip is attached to the indexed securing rod and is monitored by an electrical pickup in the gauge. This feature is part of a circuit loop that monitors electrical resistance as a function of source rod position. The gauge mathematically correlates the measured resistance to a source rod position and then shows the relative location of the source rod on the LED display.

The on/off mechanism is integrated into the gauge handle and securing rod. The securing rod is indexed with notches at fixed intervals for the purpose of holding the source rod in place at various measurement depths. A spring loaded trigger in the gauge handle holds the source rod in these indexed positions. In order to move the source rod down, out of the gauge, the trigger must be depressed for the handle to disengage the notches. The overall mechanism is designed so that the trigger must be engaged by the user in order for the source rod to be moved downward but does not have to be engaged to retract the source rod upward. This design feature provides for the full retraction of the source rod back into the safe position in the gauge body automatically before the gauge can be picked up and moved.

LABELING:

The Model 3450 gauge is labeled in accordance with 15A NCAC 11.0328 & 11 .1626. Attachment A of this document shows the positions and types of labels.

DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

LABELING (continued):

The first label is affixed by pressure sensitive adhesive backing to the top of the source rod handle and contains the following information about the radioactive sealed source:

a.) type and quantity of radioactive material,
b.) the sealed source serial number,
c.) radioactive material assay date,
d.) manufacturer's name, and
e.) the label warnings, "DO NOT REMOVE" and "CAUTION - RADIOACTIVE MATERIAL" along with the radioactive Trefoil symbol.

A second label is attached to the rear of the gauge base on the right-hand side with drive screws and contains the following information:

a.) type and quantity of radioactive material,
b.) manufacturer's name and address,
c.) the label warnings, "DO NOT REMOVE" and "CAUTION - RADIOACTIVE MATERIAL" along with the radioactive Trefoil symbol.

A third label is affixed by pressure sensitive adhesive backing to the left-hand side of the plastic top shell and contains information to remind the user of the next calibration and wipe test due date.

A nameplate is attached to the rear of the gauge base on the left-hand side with drive screws and contains the following information:

a.) the gauge type and model number,
b.) the gauge serial number,
c.) the manufacturer's name and address, and
d.) patent information.

The Model 3450 gauge in its transport cases qualifies as a "Yellow II" Type A package with a 0.3 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.

DIAGRAMS:

Attachment B to this registry certificate is a drawing of the gauge and its type A container showing the approximate location of the source and the orientations used in the radiation profile of the gauge.

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DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

CONDITIONS OF NORMAL USE:

The Model 3450 gauge is designed to be used by trained personnel to measure the bulk density and moisture content of soils, aggregates, and paving materials at a construction site. The user will normally be near the device only for the time period necessary to set up the gauge and perform the measurement. The frequency of this operation will be dependent upon the number of measurements needed per the specific site. The gauge has a recommended working life in excess of thirty (30) years due to the long half-lives of the Cs-137 (30 yr.) and Am-241:Be (433 yr.) sealed sources. However, the gauge should be returned to Troxler every five years for a thorough manufacturer's inspection of the gauge to include an extensive inspection of the extendable source rod and its pertinent welds.

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	$^{+}$660°C (to melt aluminum base and source rod tower structure)

EXTERNAL RADIATION LEVELS:

Attachment C to this certificate shows the radiation profiles for the Model 3450 gauge showing the gamma dose rates and neutron dose rates (where applicable) at the surface, 5 cm, 30 cm, and 100 cm both in and out of the transport case. Attachment B indicates the relative positions of the sealed sources both for the gauge and in the transport case.

QUALITY ASSURANCE & QUALITY CONTROL:

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

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DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

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.

Leak Testing: The device shall be leak tested by the user following the instructions in the "Manual of Operation and Instruction" at intervals not to exceed six (6) months using techniques capable of detecting the presence of 0.005 microcurie of removable contamination. If the level exceeds this limit, the device shall immediately remove the source from service and arrange for repair/disposal of the source. Troxler Electronic Laboratories, Inc. maintains a customer leak test service.

Servicing: The Model 3450 gauge requires periodic maintenance of two specific gauge components by the gauge user: 1) the scraper/sliding block mechanism that moves when the source rod is moved to the measurement position requires periodic cleaning and lubrication and 2) the source rod bearings require lubrication. The maintenance of these components should be performed according to the manufacturer's instructions located in the "Manual of Operation and Instruction". In addition, the gauges should be returned to Troxler every five years for a thorough manufacturer's inspection of the gauge to include an extensive inspection of the extendable source rod and its pertinent welds. Servicing of the source rod, including but not limited to source replacement, general servicing, repair, and/or disposal, shall be done by the manufacturer or another appropriately licensed facility.

Dosimetry: All authorized users of these gauges should wear personnel dosimetry (film badges or TLD) in accordance with NRC or Agreement State regulations. The dosimetry used should be developed and the results reported in accordance with statements and/or conditions in the licensee's specific license.

Operating & Safety Instructions: The device will be operated following the written operating and safety instructions given in the device manual, "Manual of Operation and Instruction". The licensee should never attempt to remove the source rod from the gauge unless specifically authorized to do so by license condition.

Training: Use of these gauge models is limited to individuals who have completed the manufacturer's or equivalently approved training class in the basic principles of radiation safety and the proper use of these gauges.

Use: 1) The source rod shall not be driven into the test material or be subjected to a driving force from a hammer or similar object. The drill rod accessory shall first be used to prepare a measurement hole for the source rod and then the gauge positioned over the hole such that the source rod can be easily inserted into the test material.

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DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

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

2) Any time the gauge is not being used to make a measurement or is not under the physical surveillance of the operator, the source rod should be locked in the safe position.

3) The operator should periodically inspect the source rod release mechanism and the gauge in general for loose and worn components. If any damaged components are found, the gauge should be returned immediately to the manufacturer for servicing.

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

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 Electronics Laboratories, Inc. as the application for a safety analysis of the Model 3450 gauge and currently contained in the gauge SS&D review file;
2) The Manual of Operation and Instruction for the Model 3450 gauge;
3) Testing results for the classification of the Type "A" package for the Model 3450 gauge;
4) Test results from prototype testing carried out on the Model 3450 gauge;
5) Letter with attachments dated December 03, 1998, signed by Stephen A. Browne, Corporate Radiation Safety Officer
6) **Letter dated February 25, 2000, signed by Stephen A. Browne, Corporate Radiation Safety Officer**

ISSUING AGENCY: North Carolina Division of Radiation Protection, Radioactive Materials Section

This Sealed Source & Device registry certificate is hereby amended March 14, 2000.

Principal Reviewer:

J. Marion Eaddy, III

J. Marion Eaddy, III, Health Physicist Date: 14 March 2000

Concurrence Reviewer:

Gerald A. Speight

Gerald A. Speight, Health Physicist Date: March 15, 2000

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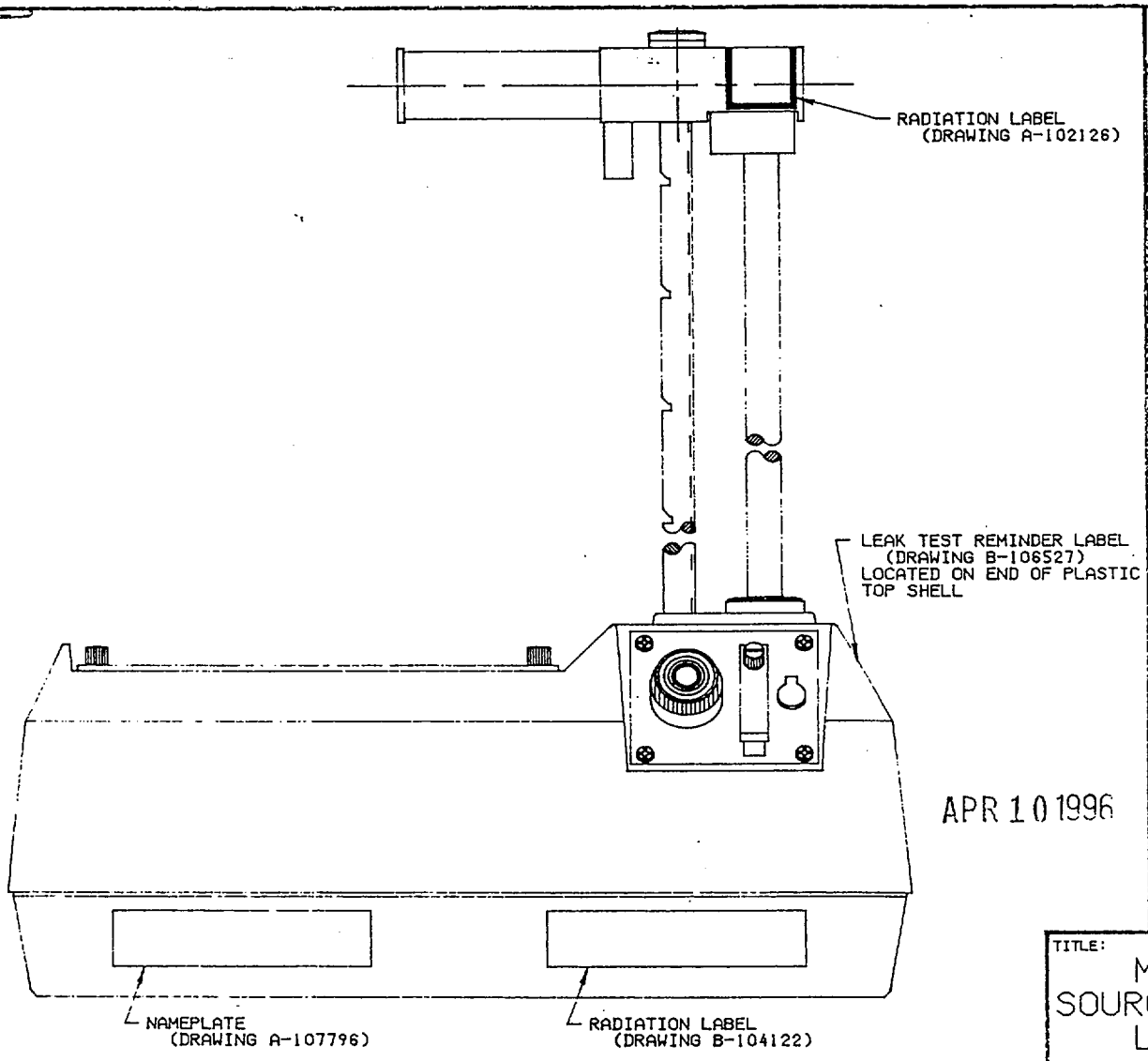
DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

Attachment A: **Model 3450 Label Locations**



APR 10 1996

DWG NO. A-107868

DRN. BY	ENGR.	APPR.
AWJ 01 31 96		

REV.	ECO	INI.	DATE

MATERIAL:

USED ON:

OVERALL TOLERANCES:

TITLE: MODEL 3450 SOURCES & LABELS LOCATIONS

TROXLER ELECTRONIC LABORATORIES, INC. | SHEET 2 OF 2 | SCALE: NTS | DWG NO. A-107868 | REV B

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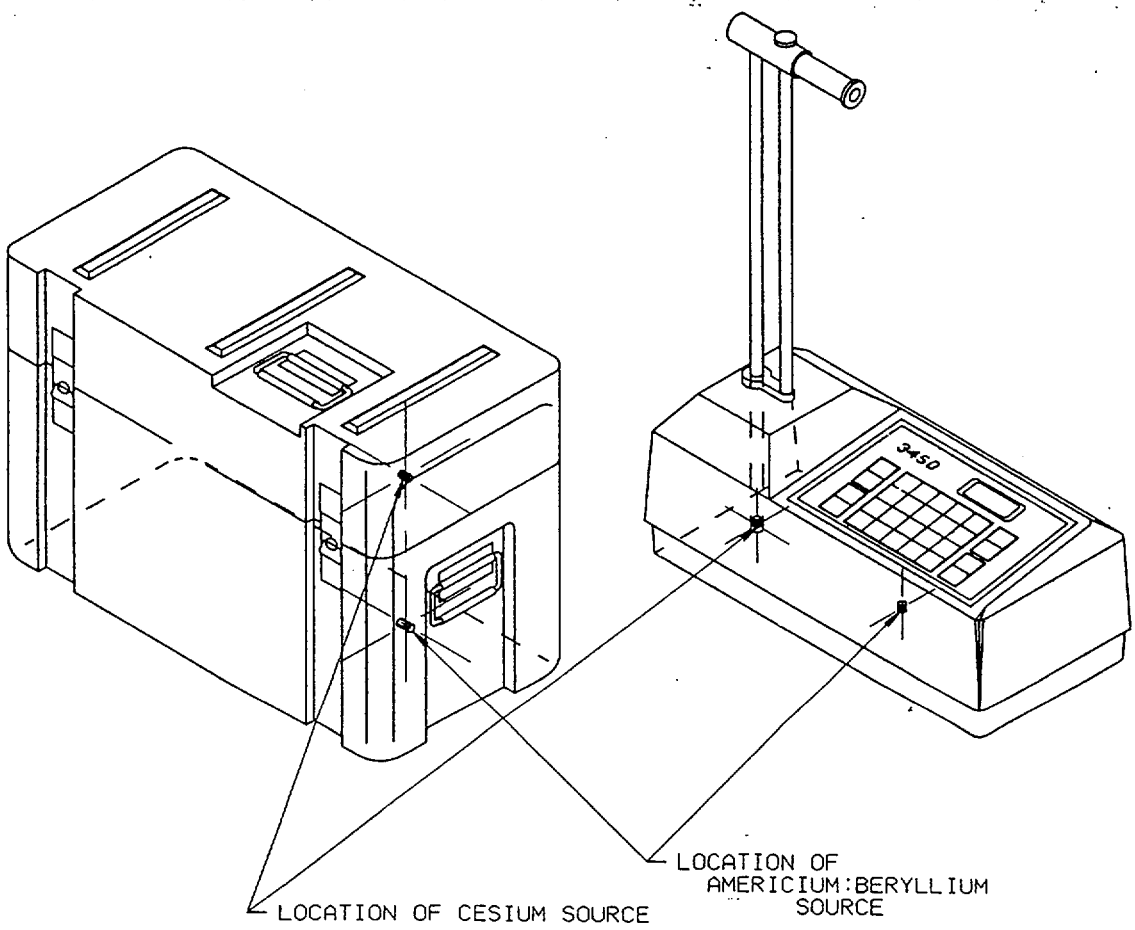
DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

ATTACHMENT B: **Model 3450 Relative Source Positions in Gauge and Transport Case**



DWG NO. A-107993

DRN. BY	ENGR.	APPR.
AWJ 10 15 96	10/15/96	

REV.	ECO	INI.	DATE

MATERIAL:

USED ON:

OVERALL TOLERANCES:

OCT 16 1996

TITLE: 3450 SOURCE LOCATIONS (3-D VIEW)

TROXLER ELECTRONIC LABORATORIES, INC. | SHEET 1 OF 1 | SCALE: NTS | DWG NO. A-107993 | REV A

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DEVICE TYPE: RoadReader Plus Moisture/Density Gauge

Attachment C: **Radiation Profiles for 3450 Gauge and Gauge in Plastic Transport Case**

Radiation Profile for 3450 Gauge

Location[6]	Surface		5 cm		30 cm		100 cm	
	gamma	neutron	gamma	neutron	gamma	neutron	gamma	neutron
Top	N/A	N/A	3.0	N/A	1.1	0.35	§	0.1
Bottom	N/A	N/A	1.35	N/A	0.45	0.5	0.85	§
Left	N/A	N/A	7.0	N/A	0.9	0.1	0.13	§
Right	N/A	N/A	0.8	N/A	0.2	§	§	§
Front	N/A	N/A	6.0	N/A	1.6	0.35	0.3	§
Back	N/A	N/A	5.5	N/A	1.4	0.35	0.3	0.1

Radiation Profile for 3450 Gauge in Plastic Transport Case

Location[6]	Surface		5 cm		30 cm		100 cm	
	gamma	neutron	gamma	neutron	gamma	neutron	gamma	neutron
Top	N/A	N/A	4.0	N/A	0.6	0.1	0.1	§
Bottom	N/A	N/A	0.6	N/A	0.25	0.35	§	0.1
Left	N/A	N/A	0.12	N/A	§	0.1	§	§
Right	N/A	N/A	3.5	N/A	0.5	0.8	§	0.1
Front	N/A	N/A	5	N/A	1.1	0.25	0.2	0.1
Back	N/A	N/A	3.5	N/A	0.9	0.25	0.15	0.1

Notes:

1. Radiation measurements were of a gauge containing a nominal 8 millicuries Cesium-137 gamma source and a nominal 40 millicuries Americium-241:Beryllium neutron source.
2. All radiation measurements are in millirem(s) per hour.
3. Gamma measurements were taken with a Bicron Micro Rem survey meter, Serial No. B464Y, calibrated in February, 1998.
4. Neutron measurements were taken with an NRC NP-2 survey meter, Serial No. 183404, calibrated in February 1998.
5. "§" denotes a radiation measurement of less than 0.1 millirem per hour
6. Orientation of the gauge in the transport case is as follows:
   a. Back of the gauge to the front of the case;
   b. Bottom of the gauge to the right side of the case; and
   c. Top of the gauge to the left side of the case.