SENSOR TECHNOLOGY ENGINEERING, INC.

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Handheld Radiation Monitor (HRM)

User's Manual

Document H401
Revision D
12 November, 2020

SENSOR TECHNOLOGY ENGINEERING, INC.

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Handheld Radiation Monitor (HRM)

DESCRIPTION

The HRM is a small, self contained gamma ray and thermal neutron radiation detector for use in the interdiction and location of nuclear materials. It was specifically designed to be easily used by trained security forces and emergency responders. The high sensitivity of the instrument is made possible by the use of a miniature photomultiplier tube and solid state scintillation detector combined with a small high pressure Helium-3 filled proportional counter. The HRM is the size of a flashlight, and is intended to be handheld or worn on the operator's belt in the nylon holster provided. When gamma rays or neutrons are detected at levels significantly above the natural background, the unit quickly alerts the operator by either sounding an audio alarm or vibrating, and lighting the single digit LED displays. The operator can easily locate the radiation source using the duty-cycle based audio alarm or vibration, and the single digit LED displays. The HRM can operate continuously for one month on a commonly available 2/3 A size, 3 volt Lithium camera battery.

SPECIFICATIONS

Gamma-ray Detector Type: Cesium Iodide Scintillator

Gamma-ray Detector Size: 0.5 inch diameter (1.3 cm)
1.5 inches long (3.8 cm)

Gamma-ray Detector sensitivity: Typically 2.2 cps per microR/hr (^{137}Cs gamma)

Neutron Detector Type: Helium-3, 8.3 atmospheres absolute (122 psia)

Neutron Detector Size: 0.75 inch diameter (1.9 cm) x 4.8 inches long (12.2 cm), 1.81 in^3 (active volume)

Neutron Detector sensitivity: Typically 10.5 cps/nv

Size: 8.3 inches long (21.1 cm)
2.0 inches wide (5.1 cm)
1.2 inches thick (3.0 cm)

Weight: 13 oz. (369g) with battery

Battery: 3 volt lithium size 2/3 A, 1 month continuous operation

Operating Temperature Range: 5 to122 degrees F (-15 to 50 degrees C)

Storage Temperature Range: -10 to 122 degrees F (-23 to 50 degrees C)

Alarm type: Single digit, 7 segment red LED displays (one each for neutron and gamma ray) Duty cycle based audio tone, Duty cycle based vibrator, Real time blue LED for neutrons detected

Gamma-ray Low Energy Cutoff: approximately 45 KeV

Integration Time (Response time): less than one second

Search capability: Duty cycle based audio tone or duty-cycle based vibrator, and two single digit red LED display.

Waterproof to 66 ft.

OPERATION

The HRM is activated by a three-position rotary switch located on the end of the case (see fig. 1). The center position turns the instrument OFF, the vibrate position powers the instrument ON and enables the vibrator alarm (disables audio), and the audio position powers the instrument ON and enables the audio alarm (disables vibrator).

The UPDATE switch located on the front face updates the radiation background value to the average of the past 6 seconds when the UPDATE button is pressed. The single digit red LED displays shows gamma -ray and neutron alarm levels and instrument diagnostics data. Table 1 shows the display symbols and their meanings.

When the instrument is first powered up, the middle segment of the gamma-ray (G) single digit LED display flashes while a self test is conducted. At the successful conclusion of the self test the outer segments of the display will light in a counterclockwise circle for 6 seconds while the instrument measures the ambient gamma-ray radiation background. After the background radiation level has been measured, the HRM calculates an alarm trip level and the display then goes blank. The instrument is now ready for use. (Note: It is very important to not turn on the HRM in a location where there might be a radiation source.) The HRM is now measuring the ambient radioactivity and will alarm if the detected radiation exceeds the calculated alarm level. Every twenty seconds the “period” on the gamma ray display will flash to let the operator know that the HRM is operating properly. The gamma radiation sensor is located on the upper left side of the package.

The neutron detector does not require a background measurement. The blue LED, located next to the neutron (N) single digit LED display, will flash each time a neutron is detected. This will occur on average about once every minute or two, but can occasionally happen several times per minute. When the flash occurs, it will be accompanied by an audio beep or a vibration depending on the setting of the three position rotary switch. The neutron sensor is located on the lower left side of the package.

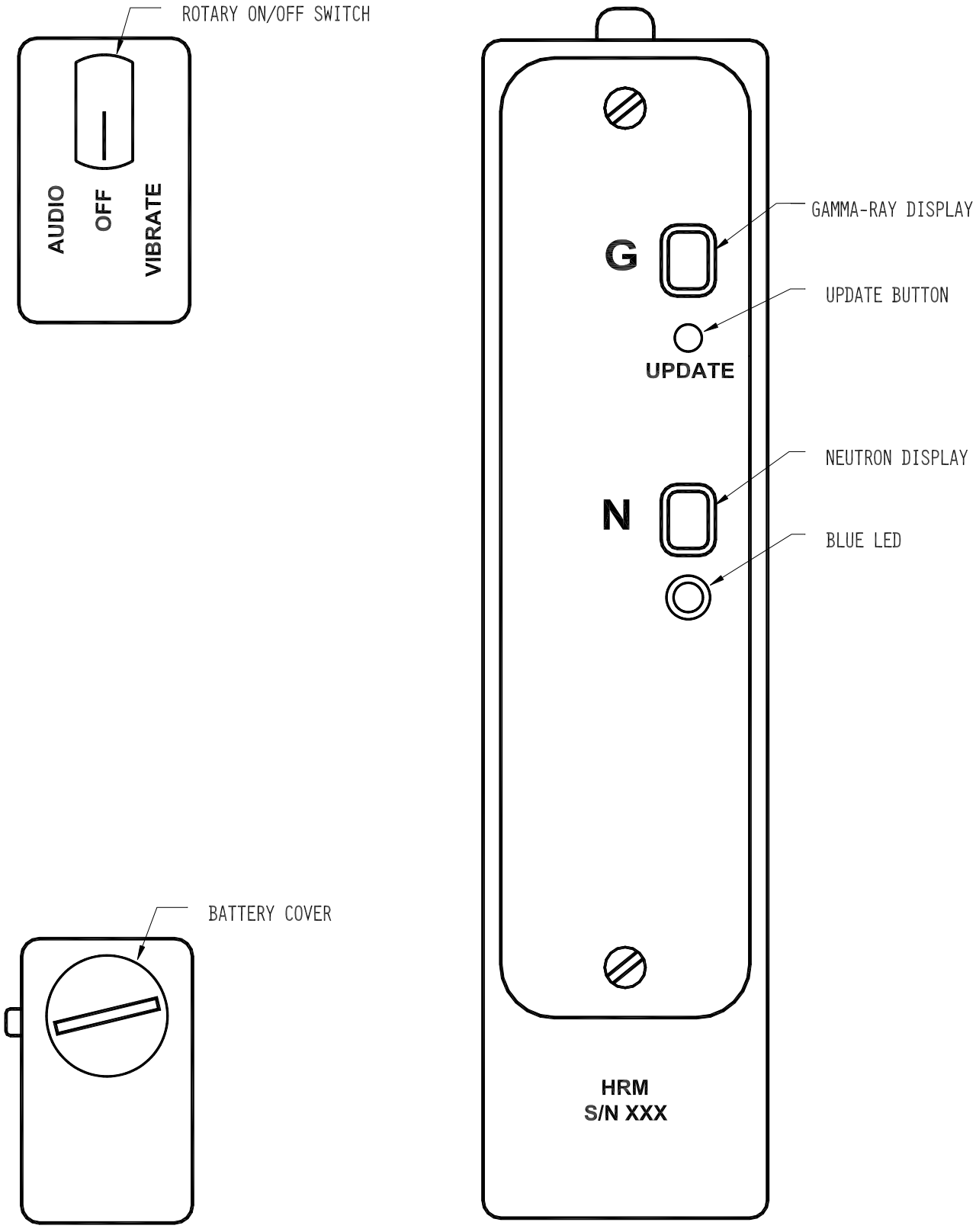

ROTARY ON/OFF SWITCH
AUDIO
OFF
VIBRATE
GAMMA-RAY DISPLAY
G
UPDATE BUTTON
UPDATE
NEUTRON DISPLAY
N
BLUE LED
BATTERY COVER
HRM
S/N XXX

Figure 1

Alarms

When the detected gamma-ray radiation level exceeds the stored background level by a significant amount, the HRM will alarm. The alarm is indicated by a numeric display value, and either an audio tone or a vibration, depending on which option the operator has chosen. As the HRM is moved closer to the radiation source, the duty-cycle (duration) of the audio or vibration will increase and the value of the single digit display will increase. The digits can range in value from 1 - 9. The values of 1 - 9 are a visual indication of the duty-cycle of the audio tone and the vibration. No gamma-ray radiation dose or dose rate data can be inferred from the display or alarms.

When the detected neutron radiation level exceeds the programmed trip level, the HRM will alarm. The alarm is indicated by a numeric display value, and either an audio tone or a vibration, depending on which option the operator has chosen. As the HRM is moved closer to the radiation source, the duty-cycle (duration) of the audio or vibration will increase and the value of the single digit display will increase. The digits can range in value from 1 - 9. The values of 1 - 9 are a visual indication of the duty-cycle of the audio tone and the vibration. No thermal neutron radiation dose or dose rate data can be inferred from the display or alarms. Table 1 shows neutron detector countrate vs. HRM display value.

When gamma rays and neutrons are detected at the same time, the vibrate and audio alarms will alarm on the gamma-ray data. The displays always operate independently.

Neutron Display	Neutron Detector Countrate (cps)
1	6-12
2	13-18
3	19-24
4	25-34
5	35-49
6	50-70
7	71-98
8	99-138
9	>138

Table 1

Update Button

The gamma-ray radiation background level may change up or down as the operator moves from one physical location to another. When the UPDATE button is pressed, the gamma-ray alarm trip level is recalculated using data from the previous 6 seconds. The UPDATE button should be pressed;

1. Whenever a “U” appears on the single digit LED display

2. When the HRM alarms randomly after having moved to an area of higher background radiation (e.g.- after moving from wood building to brick or concrete building).

3. To increase the dynamic range of the HRM. When the instrument is near a radiation source, the display and alarm duty-cycle may go to the maximum. Pressing the UPDATE button in this situation will artificially raise the gamma-ray background level and desensitize the instrument to allow the operator to more exactly locate the gamma-ray source. For strong sources, this “updating” procedure may need to be repeated several times.

Searching for a Source

Prior to conducting a search for radiation sources, it is important to check the function of the HRM with check sources (if available). To conduct a search with the HRM, cover the search area at a speed of about 2 feet per second or slower. Try to get within a few feet of every object in the search area. To search a specific object, move at a constant speed and try to keep the HRM within a few inches of the surface of the object. The duty-cycle based alarms and visual displays and the $1/R^2$ behavior of ionizing radiation will guide the operator to the radiation source. When conducting a search, remember that the radiation source may be above or below the operator, not just in the horizontal plane.

If a gamma-ray radiation field higher than approximately 12 mR/hr (measured at 662 KeV) is encountered, the HRM will display a “9” and maximize the duty-cycle of the alarm. The “9” will blink at a low rate. Pressing the UPDATE switch will have no effect on the display or the duty-cycle of the alarm. The HRM has been designed and optimized for interdiction and search, and is <u>not</u> intended for health physics applications.

The microcontrollers in the HRM constantly monitor the health of the instrument. If a failure is found, the gamma-ray display will show an “H” for “Help”. If an “H” appears, at a minimum the gamma-ray portion of the instrument is non-operational and should be sent in for maintenance.

BATTERY

The HRM uses one 3 volt lithium, 2/3A size camera battery. We recommend the Duracell DL123 or the Kodak equivalent. In routine operation with few alarms, the battery will power the unit continuously for one month.

A low battery condition is indicated when the gamma-ray single digit LED display flashes an “L” every 20 seconds, instead of a “.” .

To change the battery, unscrew the battery cover with a screwdriver or coin (see figure 1). Remove the battery and insert a fresh one, positive end first. Check the battery cover o-ring for proper sealing surfaces. Coat with silicone grease if dry. If replacement is required, the o-ring is size 2-018. Screw on the battery cover until it firmly seats. Do not over tighten.

If the battery is inserted backwards, there will be no damage to the instrument, however, the instrument will not operate. Dispose the old battery properly.

MAINTENANCE AND CALIBRATION

WARNING - HIGH VOLTAGE: Do not open the electronics compartment - there are no user serviceable parts inside.

It is a good practice to periodically check the operation of the HRM against a known small check source. A typical check source could be a lantern mantle, 1 microCi 241Am (such as a typical battery powered smoke detector), or 1 microCi 137 Cs. The best gamma-ray check source to use on the HRM is a 1 microCi 241Am. These types of sources will only check the gamma-ray detector in the HRM. To check the neutron detector, observe the natural background neutrons about once per minute @ sea level, 2-3 times per minute @ 7500 feet or use a neutron source (not commonly available).

SHIPPING

The neutron detector installed in the HRM (Handheld Radiation Monitor) consists of a very small stainless steel tube of the gas Helium-3. The gas is pressurized to 122 psia. Because the tube is pressurized, the tube (and thus the HRM) is considered by USDOT to be a hazardous material for shipping purposes.

Sensor Technology Engineering, Inc. (STE) has been granted USDOT Approval CA-9906010 under 49CFR § 173.4, the "Small Quantity Exception", to allow the shipment of the HRM as hand carry or checked baggage on commercial passenger aircraft providing that all the provisions of CA-9906010 are met. The interior volume of the pressurized tube of Helium-3 in the HRM is 1.00 fluid ounces (1.8 in^3, 29.66 ml), and in compliance with CA-9906010.

STE has designed, fabricated, and tested a reusable shipping package that can be used to satisfy the requirements of CA-9906010. The reusable shipping package, STE part number H101, is constructed of foam, black nylon cloth, hook and loop fastener, nylon webbing, and nylon quick connect type buckles.

One shipping package and a copy of CA-9906010 will be provided by STE with each HRM. This shipping package is referred to in CA-9906010 as an "inner package". In order to conform to CA-9906010, only one HRM may be packed into an "inner package". The outside of the "inner package" is marked with the statement "THIS PACKAGE CONFORMS TO 49 CFR 173.4". Do not take the HRM out of the "inner package" during transportation. No more than ten inner packages may be placed into an over pack. An over pack is an outer package such as a cardboard box, or a suitcase.

The "finished package" referred to in section 5(b)(3) of CA-9906010, can be one "inner package", or ten or less "inner packages" in an over pack. According to CA-9906010, the finished package is considered suitable for hand carried or checked baggage.

A copy of CA-9906010 must be maintained at each facility from which shipments are offered for transportation. A copy of CA-9906010 must be made available to the carrier upon request. It is suggested that a copy of CA-9906010 accompany the shipment.

STATEMENT OF WARRANTY

Sensor Technology Engineering, Inc. warrants this product to be free of defects due to workmanship, material, and design for a period of twelve months from the date of delivery. The calibration of this product is warranted to be within its specified accuracy limits at the time of shipment. In the event of instrument failure, notify Sensor Technology Engineering, Inc. to determine if repair, recalibration, or replacement is required.

This warranty excludes the replacement of photomultiplier tubes and scintillation crystals which are broken due to excessive physical abuse or used for purposes other than intended.

There are no warranties, expressed or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description. If the product does not perform as warranted herein, the purchaser's sole remedy shall be repair or replacement, at the option of Sensor Technology Engineering, Inc.. In no event will Sensor Technology Engineering, Inc. be liable for damages, lost revenue, lost wages, or any other incidental or consequential damages arising from the purchase, use or inability to use this product.

Note: all specifications subject to change without notice

Table 1 - DISPLAY SYMBOLS

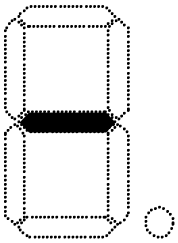
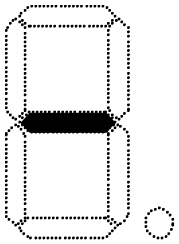
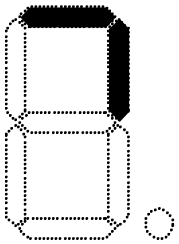
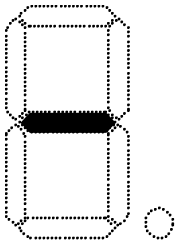
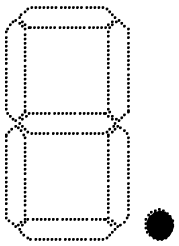
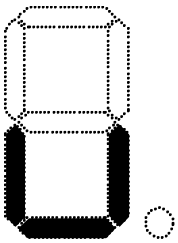
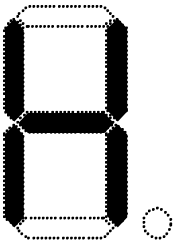
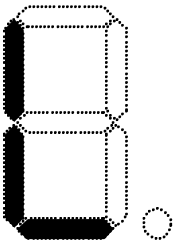
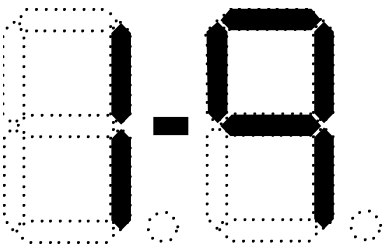
DISPLAY	EXPLANATION	OPERATOR ACTION
 FLASHING	Power-up self tests being performed	None
	Power-up self tests failed	Try replacing battery. If that fails, unit is non-operational. Return for maintenance.
 ROTATING	Measuring radiation background during power-up.	None
 Momentary	UPDATE switch is being pressed.	None
 FLASHING EVERY 20 SEC	Operation OK	None

TABLE 1 - (Con't)

DISPLAY	EXPLANATION	OPERATOR ACTION
	UPDATE, the current Radiation level is less than 25% of the stored background level.	Press the UPDATE switch
	Help. Failure detected during operation.	Unit non-operational. Return for maintenance.
 FLASHING EVERY 20 SEC.	Low Battery voltage.	Replace the battery.
	Alarms. Radiation level detected over the stored background level.	Locate the radiation source.

APPENDIX

U.S. Department
of Transportation

Research and
Special Programs
Administration

400 Seventh Street, S.W.
Washington, D.C. 20590

APPROVAL CA-9906010
ISSUED BY THE COMPETENT AUTHORITY OF THE UNITED STATES

1. **APPROVAL HOLDER:** Sensor Technology Engineering, Inc.
Santa Barbara, CA

2. **REGULATORY AUTHORITY:** 49 CFR § 173.4(c) and Part 1; Chapter 1, Paragraph 1.1.1 of the International Civil Aviation Organization Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO TI)- Approval for small quantity packaging.

3. **SYNOPSIS:** Sensor Technology Engineering is authorized to offer for transportation or transport the materials described in paragraph 5(a) in accordance with the provisions of this approval.

4. **BASIS:** This approval is issued in response to Sensor Technology Engineering's application dated June 9, 1999.

5. **PERIOD OF VALIDITY AND CONDITIONS OF APPROVAL:** This approval shall remain valid until terminated by the Associate Administrator for Hazardous Materials Safety. This approval does not provide relief from any requirements of the Hazardous Materials Regulations (49 CFR Parts 171-180) except as specified herein.

(a) Approved Materials: Only the following material(s) may be transported under the terms of this approval.

Proper Shipping Name / Hazardous Materials Description	Hazard Class/ Division	Identification Number	Packing Group
Compressed Gases, n.o.s. (Helium-3)	2.2	UN1956	None

(b) Packaging:

(1) The hazardous materials must be packaged stainless steel tubes (with a maximum volume of 30 ml) and a maximum internal pressure of 200 PSIG.

(2) The tube are installed in handheld radiation monitors, and packaged one per inner package with a maximum of 10 inner packages in an overpack.

(3) The finished package is considered suitable for hand carried or checked baggage.

(c) Testing: Each inner package must conform with the applicable test requirements of 49 CFR §§ 173.4, 173.24, 173.24a and 173.27(c). The compressive load test specified in 178.606(c) is not considered applicable.

6. **MODES OF TRANSPORTATION AUTHORIZED**: Motor vehicle, rail freight, cargo vessel, cargo aircraft and passenger aircraft.

7. **SPECIAL PROVISIONS**:

(a) A copy of this approval must be maintained at each facility from which shipments are offered for transportation under the terms of this approval and made available to the carrier upon request.

(b) Any person who offers for transportation or transports the above described package(s) may do so under the authority of this approval if all requirements and conditions of this approval are met.

8. **GENERAL PROVISIONS**:

(a) Failure by any person to comply with the terms and conditions of this approval and the Hazardous Materials Regulations, 49 CFR Parts 171-180, may result in the suspension or revocation of that person's authority to use this approval. Failure to comply may also subject that person to penalties prescribed by 49 U.S.C. § 5123 and 5124. This approval may be modified, suspended or terminated in its entirety if that action is justified in light of changes in circumstances, including additional information not available when this approval was issued. Unless immediate modification, suspension or termination is necessary to avoid imminent material harm to person or property, before action is taken, that person will be notified and provided with an opportunity to show why the proposed action should not be taken.

(b) Each "Hazmat employee", as defined in 49 CFR § 171.8, who performs a function subject to this approval must be provided training on the requirements and conditions of this approval in addition to the training required by 49 CFR §§ 172.700 through 172.704.

Issued at Washington, D.C.

JUN 22 1999
(DATE)

Alan I. Roberts
Associate Administrator
for Hazardous Materials Safety

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Research and Special Programs Administration, Department of Transportation, Washington, D.C. 20590. Attention DHM-30
PO: RDT(99)

April 15, 2010

U.S. Department
of Transportation

East Building, PHH-30
1200 New Jersey Avenue S.E.
Washington, D.C. 20590

**Pipeline and Hazardous
Materials Safety Administration**

DOT-SP 9880
(ELEVENTH REVISION)

EXPIRATION DATE: January 31, 2014

(FOR RENEWAL, SEE 49 CFR § 107.109)

1. GRANTEE: GE Reuter-Stokes, Inc.
Twinsburg, OH

2. PURPOSE AND LIMITATIONS:

a. This special permit authorizes the manufacture, marking, sale and use of non-DOT specification containers described as hermetically-sealed electron tube devices for the transportation in commerce of the materials authorized by this special permit. This special permit provides no relief from the Hazardous Materials Regulations (HMR) other than as specifically stated herein. The most recent revision supersedes all previous revisions.

b. The safety analyses performed in development of this special permit only considered the hazards and risks associated with transportation in commerce.

3. REGULATORY SYSTEM AFFECTED: 49 CFR Parts 106, 107 and 171-180.

4. REGULATIONS FROM WHICH EXEMPTED: 49 CFR § 173.302a in that a non-DOT specification container is not authorized, except as specified herein, and Subparts E and F of Part 172 in that labeling and placarding is not required when air transportation is not involved.

5. BASIS: This special permit is based on the application of GE Reuter-Stokes, Inc., dated February 28, 2010, submitted in accordance with § 107.109 and § 107.105 and the public proceeding thereon.

6. HAZARDOUS MATERIALS (49 CFR § 172.101):

Hazardous Materials Description			
Proper Shipping Name	**Hazard Class/ Division**	**Identi-fication Number**	**Packing Group**
Argon, compressed	2.2	UN1006	N/A
Carbon dioxide	2.2	UN1013	N/A
Helium, compressed	2.2	UN1046	N/A
Krypton, compressed	2.2	UN1056	N/A
Neon, compressed	2.2	UN1065	N/A
Nitrogen, compressed	2.2	UN1066	N/A
Tetrafluoromethane	2.2	UN1982	N/A
Xenon, compressed	2.2	UN2036	N/A
Compressed gas, n.o.s. (mixtures of the gases listed above, with or without 5% or less methane)	2.2	UN1956	N/A

7. SAFETY CONTROL MEASURES: Prescribed packagings are non-DOT specification, metal, single trip, inside containers, described as hermetically sealed electron tube radiation sensors. The radiation sensors have diameters from 1/4 inch to 6 inches, volumes from 7.22 cubic inches to 320 cubic inches water capacity, and design (operating) pressures up to 440 psig. Each radiation sensor is designed and constructed in accordance with G.E. Reuter-Stokes Technical Specification number ER-Q-0050-6, Rev. B dated April 29, 2005 on file with the Office of Hazardous Materials Special Permits and Approvals (OHMSPA). The radiation sensor must be shipped in a strong outside packaging capable of withstanding one drop test from a height of four feet in the orientation most likely to fail (e.g., on the connector end) without breakage of the radiation sensor or rupture of the outside packaging. The design burst pressure of the radiation sensor must be:

a. Three times the design pressure if equipped with a relief device; or

b. Four times the design pressure if not equipped with a relief device.

8. SPECIAL PROVISIONS:

a. In accordance with the provisions of paragraph (b) of § 173.22a, persons may use the packaging authorized by this special permit for the transportation of the hazardous materials specified in paragraph 6, only in conformance with the terms of this special permit.

b. A person who is not a holder of this special permit, but receives a package covered by this special permit, may reoffer it for transportation provided no modifications or changes are made to the package and it is offered for transportation in conformance with this special permit and the HMR.

c. A current copy of this special permit must be maintained at each facility where the package is manufactured under this special permit. It must be made available to a DOT representative upon request.

d. If repackaged, packagings used to ship larger equipment containing radiation sensors covered by this special permit must be in strong outside packagings providing equivalent protection for the devices as specified in paragraph 7 above.

e. Each packaging (i.e., radiation sensor) manufactured under the authority of this special permit must be either (1) marked with the name of the manufacturer and location (city and state) of the facility at which it is manufactured or (2) marked with a registration symbol designated by the Office of Hazardous Materials Special Permits and Approvals for a specific manufacturing facility.

f. Except when offered for transportation by air:

1. Packages covered by this special permit are excepted from labeling requirements of 49 CFR Part 172.

2. Shipments are not subject to the placarding requirements of Subpart F of 49 CFR Part 172.

9. MODES OF TRANSPORTATION AUTHORIZED: Motor vehicle, rail freight, cargo vessel, cargo aircraft only, and passenger-carrying aircraft.

10. MODAL REQUIREMENTS: A current copy of this special permit must be carried aboard each cargo vessel and aircraft used to transport packages covered by this special permit. The shipper must furnish a current copy of this special permit to the air carrier before or at the time the shipment is tendered.

11. COMPLIANCE: Failure by a person to comply with any of the following may result in suspension or revocation of this special permit and penalties prescribed by the Federal hazardous materials transportation law, 49 U.S.C. 5101 et seq:

- All terms and conditions prescribed in this special permit and the Hazardous Materials Regulations, 49 CFR Parts 171-180.
- Persons operating under the terms of this special permit must comply with the security plan requirement in Subpart I of Part 172 of the HMR, when applicable.
- Registration required by § 107.601 et seq., when applicable.

Each "Hazmat employee", as defined in § 171.8, who performs a function subject to this special permit must receive training on the requirements and conditions of this special permit in addition to the training required by §§ 172.700 through 172.704.

No person may use or apply this special permit, including display of its number, when this special permit has expired or is otherwise no longer in effect.

Under Title VII of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—"The Hazardous Materials Safety and Security Reauthorization Act of 2005" (Pub. L. 109-59), 119 Stat. 1144 (August 10, 2005), amended the Federal hazardous materials transportation law by changing the term "exemption" to "special permit" and authorizes a special permit to be granted up to two years for new special permits and up to four years for renewals.

12. REPORTING REQUIREMENTS: Shipments or operations conducted under this special permit are subject to the Hazardous Materials Incident Reporting requirements specified in 49 CFR §§ 171.15 - Immediate notice of certain hazardous materials incidents, and 171.16 - Detailed hazardous materials incident reports. In addition, the grantee(s) of this special permit must notify the Associate Administrator for Hazardous Materials Safety, in writing, of any incident involving a package, shipment or operation conducted under terms of this special permit.

Issued in Washington, D.C.:

for Dr. Magdy El-Sibaie
Associate Administrator for Hazardous Materials Safety

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Pipeline and Hazardous Material Safety Administration, U.S. Department of Transportation, East Building PHH-30, 1200 New Jersey Avenue, Southeast, Washington, D.C. 20590.

Copies of this special permit may be obtained by accessing the Hazardous Materials Safety Homepage at http://hazmat.dot.gov/sp_app/special_permits/spec_perm_index.htm Photo reproductions and legible reductions of this special permit are permitted. Any alteration of this special permit is prohibited.

PO: CHH/sln

(4) Each inner packaging is marked "1.4B Detonators" or "1.4S Detonators", as appropriate.

[Amdt. 173-224, 55 FR 52617, Dec. 21, 1990, as amended at 56 FR 66268, Dec. 20, 1991; Amdt. 173-236, 58 FR 50536, Sept. 24, 1993; Amdt. 173-253, 61 FR 27175, May 30, 1996]

Subpart D—Definitions Classification, Packing Group Assignments and Exceptions for Hazardous Materials Other Than Class 1 and Class 7

SOURCE: Amdt. 173-224, 55 FR 52634 Dec. 21, 1990, unless otherwise noted.

§ 173.115 Class 2, Divisions 2.1, 2.2, and 2.3—Definitions.

(a) *Division 2.1 (Flammable gas).* For the purpose of this subchapter, a *flammable gas* (Division 2.1) means any material which is a gas at 20 °C (68 °F) or less and 101.3 kPa (14.7 psia) of pressure (a material which has a boiling point of 20 °C (68 °F) or less at 101.3 kPa (14.7 psia)) which—

(1) Is ignitable at 101.3 kPa (14.7 psia) when in a mixture of 13 percent or less by volume with air; or

(2) Has a flammable range at 101.3 kPa (14.7 psia) with air of at least 12 percent regardless of the lower limit.

Except for aerosols, the limits specified in paragraphs (a)(1) and (a)(2) of this section shall be determined at 101.3 kPa (14.7 psi) of pressure and a temperature of 20 °C (68 °F) in accordance with ASTM E681-85, Standard Test Method for Concentration Limits of Flammability of Chemicals or other equivalent method approved by the Associate Administrator. The flammability of aerosols is determined by the tests specified in § 173.306(i) of this part.

(b) *Division 2.2 (non-flammable, nonpoisonous compressed gas—including compressed gas, liquefied gas, pressurized cryogenic gas, compressed gas in solution, asphyxiant gas and oxidizing gas).* For the purpose of this subchapter, a nonflammable, nonpoisonous compressed gas (Division 2.2) means any material (or mixture) which—

(1) Exerts in the packaging an absolute pressure of 280 kPa (40.6 psia) or greater at 20 °C (68 °F), and

(2) Does not meet the definition of Division 2.1 or 2.3.

(c) *Division 2.3 (Gas poisonous by inhalation).* For the purpose of this subchapter, a *gas poisonous by inhalation* (Division 2.3) means a material which is a gas at 20 °C (68 °F) or less and a pressure of 101.3 kPa (14.7 psia) (a material which has a boiling point of 20 °C (68 °F) or less at 101.3 kPa (14.7 psia)) and which—

(1) Is known to be so toxic to humans as to pose a hazard to health during transportation, or

(2) In the absence of adequate data on human toxicity, is presumed to be toxic to humans because when tested on laboratory animals it has an LC_{50} value of not more than 5000 mL/m^3 (see § 173.116(a) of this subpart for assignment of Hazard Zones A, B, C or D). LC_{50} values for mixtures may be determined using the formula in § 173.133(b)(1)(i) of this subpart.

(d) *Non-liquefied compressed gas.* A *non-liquefied compressed gas* means a gas, other than in solution, which in a packaging under the charged pressure is entirely gaseous at a temperature of 20 °C (68 °F).

(e) *Liquefied compressed gas.* A *liquefied compressed gas* means a gas which in a packaging under the charged pressure, is partially liquid at a temperature of 20 °C (68 °F).

(f) *Compressed gas in solution.* A *compressed gas in solution* is a non-liquefied compressed gas which is dissolved in a solvent.

(g) *Cryogenic liquid.* A *cryogenic liquid* means a refrigerated liquefied gas having a boiling point colder than −90 °C (−130 °F) at 101.3 kPa (14.7 psia) absolute. A material meeting this definition is subject to requirements of this subchapter without regard to whether it meets the definition of a non-flammable, non-poisonous compressed gas in paragraph (b) of this section.

(h) *Flammable range.* The term *flammable range* means the difference between the minimum and maximum volume percentages of the material in air that forms a flammable mixture.

(i) *Service pressure.* The term *service pressure* means the authorized pressure marking on the packaging. For example, for a cylinder marked "DOT

3A1800", the service pressure is 12410 kPa (1800 psig).

(j) *Refrigerant gas or Dispersant gas.* The terms *Refrigerant gas* or *Dispersant gas* apply to all non-poisonous refrigerant gases, dispersant gases (fluorocarbons) listed in §§172.101, 173.304(a)(2), 173.314(c), 173.315(a)(1) and 173.315(h), and mixtures thereof, or any other compressed gas having a vapor pressure not exceeding 1792 kPa (260 psia) at 54 °C (130 °F), and restricted for use as a refrigerant, dispersant or blowing agent.

[Amdt. 173–224, 55 FR 52634, Dec. 21, 1990, as amended at 56 FR 66268, Dec. 20, 1991; 57 FR 45461, Oct. 1, 1992; Amdt. 173–236, 58 FR 50236, Sept. 24, 1993; Amdt. 173–234, 58 FR 51532, Oct. 1, 1993; Amdt. 173–241, 59 FR 67506, Dec. 29, 1994; Amdt. 173–255, 61 FR 50625, Sept. 26, 1996; 66 FR 45379, 45380, 45382, Aug. 28, 2001]

§ 173.116 Class 2—Assignment of hazard zone.

(a) The hazard zone of a Class 2, Division 2.3 material is assigned in column 7 of the §172.101 table. There are no hazard zones for Divisions 2.1 and 2.2. When the §172.101 table provides more than one hazard zone for a Division 2.3 material, or indicates that the hazard zone be determined on the basis of the grouping criteria for Division 2.3, the hazard zone shall be determined by applying the following criteria:

Hazard zone	Inhalation toxicity
A	LC_{50} less than or equal to 200 ppm.
B	LC_{50} greater than 200 ppm and less than or equal to 1000 ppm.
C	LC_{50} greater than 1000 ppm and less than or equal to 3000 ppm.
D	LC_{50} greater than 3000 ppm or less than or equal to 5000 ppm.

(b) The criteria specified in paragraph (a) of this section are represented graphically in §173.133, Figure 1.

[Amdt. 173–224, 55 FR 52634, Dec. 21, 1990, as amended at 56 FR 66268, Dec. 20, 1991; Amdt. 173–138, 59 FR 49133, Sept. 26, 1994]

§§ 173.117–173.119 [Reserved]

§ 173.120 Class 3—Definitions.

(a) *Flammable liquid.* For the purpose of this subchapter, a *flammable liquid* (Class 3) means a liquid having a flash point of not more than 60.5 °C (141 °F), or any material in a liquid phase with a flash point at or above 37.8 °C (100 °F) that is intentionally heated and offered for transportation or transported at or above its flash point in a bulk packaging, with the following exceptions:

(1) Any liquid meeting one of the definitions specified in §173.115.

(2) Any mixture having one or more components with a flash point of 60.5 °C (141 °F) or higher, that make up at least 99 percent of the total volume of the mixture, if the mixture is not offered for transportation or transported at or above its flash point.

(3) Any liquid with a flash point greater than 35 °C (95 °F) which does not sustain combustion according to ASTM 4206 or the procedure in appendix H of this part.

(4) Any liquid with a flash point greater than 35 °C (95 °F) and with a fire point greater than 100 °C (212 °F) according to ISO 2592.

(5) Any liquid with a flash point greater than 35 °C (95 °F) which is in a water-miscible solution with a water content of more than 90 percent by mass.

(b) Combustible liquid. (1) For the purpose of this subchapter, a *combustible liquid* means any liquid that does not meet the definition of any other hazard class specified in this subchapter and has a flash point above 60.5 °C (141 °F) and below 93 °C (200 °F).

(2) A flammable liquid with a flash point at or above 38 °C (100 °F) that does not meet the definition of any other hazard class may be reclassed as a combustible liquid. This provision does not apply to transportation by vessel or aircraft, except where other means of transportation is impracticable. An elevated temperature material that meets the definition of a Class 3 material because it is intentionally heated and offered for transportation or transported at or above its flash point may not be reclassed as a combustible liquid.

(3) A combustible liquid which does not sustain combustion is not subject to the requirements of this subchapter as a combustible liquid. Either the test method specified in ASTM 4206 or the procedure in appendix H of this part may be used to determine if a material sustains combustion when heated

A58 (144) An aqueous solution containing 24% or less alcohol by volume is not subject to these Regulations.

A59 A tyre assembly unserviceable or damaged is not subject to these Regulations if the tyre is completely deflated. A tyre assembly with a serviceable tyre is not subject to these Regulations provided the tyre is not inflated to a gauge pressure exceeding the maximum rated pressure for that tyre. However, such tyres (including valve assemblies) must be protected from damage during transport, which may require the use of a protective cover.

A60 (215) This entry only applies to the technically pure substance or to formulations derived from it having an SADT higher than 75°C (167°F) and therefore does not apply to formulations which are self-reactive substances. For self-reactive substances, see Subsection 3.4 and Appendix C.1 of these Regulations. Homogeneous mixtures containing not more than 35 per cent by mass of azocarbonamide and at least 65 per cent of inert substance are not subject to these Regulations unless criteria of other classes or divisions are met.

A61 (168) Asbestos which is immersed or fixed in a natural or artificial binder (such as cement, plastic, asphalt, resins or mineral ore) in such a way that no escape of hazardous quantities of respirable asbestos fibres can occur during transport is not subject to these Regulations. Manufactured articles, containing asbestos and not meeting this requirement, are nevertheless not subject to these Regulations when packed so that no escape of hazardous quantities of respirable asbestos fibres can occur during transport.

A62 (178) This designation must only be used when no other appropriate designation exists and then only with the approval of the appropriate authority of the State of origin.

A63 Not used.

A64 (306) This entry may only be used for substances that do not exhibit explosive properties of Class 1 when tested in accordance to Test Series 1 and 2 of Class 1 (See *UN Manual of Tests and Criteria*, Part 1).

A65 (270) Aqueous solutions of Division 5.1 inorganic solid nitrate substances are considered as not meeting the criteria of Division 5.1 if the concentration of the substances in solution at the minimum temperature encountered in transport is 80% or less of the saturation limit.

△ **A66** Polyester resin kits consist of two components: a base material (Class 3, Packing Group II or III) and an activator (Division 5.2). The organic peroxide must be Type D, E or F, not requiring temperature control that are authorized for transport on passenger aircraft are permitted in the kits. Packing Group II or III is assigned according to the criteria for Class 3, applied to the base material.

△ **A67** Non-spillable batteries meeting the requirements of Packing Instruction 806 are not subject to these Regulations if, at a temperature of 55°C (131°F), the electrolyte will not flow from a ruptured or cracked case. The battery must not contain any free or unabsorbed liquid. Any electrical battery or battery powered device, equipment or vehicle having the potential of dangerous evolution of heat must be prepared for transport so as to prevent:

(a) a short circuit (e.g. in the case of batteries, by the effective insulation of exposed terminals; or in the case of equipment, by disconnection of the battery and protection of exposed terminals); and

(b) unintentional activation

Note:
Wheelchairs/mobility aids with gel type batteries do not require the battery to be disconnected provided the battery terminals are insulated to prevent accidental short circuits (see 2.3.2.3).

The words "Not Restricted" and the Special Provision number must be included in the description of the substance on the Air Waybill as required by 8.2.6, when an Air Waybill is issued.

A68 (272) This substance must not be transported under the provisions of Division 4.1 unless specifically authorized by the appropriate national authority (see UN 0143).

△ **A69** Articles, each containing not more than 100 mg of mercury, gallium or inert gas and packaged so that the quantity of mercury, gallium or inert gas per package is 1 g or less, are not subject to these Regulations when carried as cargo.

The words "Not Restricted" and the Special Provision number must be included in the description of the substance on the Air Waybill as required by 8.2.6, when an Air Waybill is issued.

△ **A70** Internal combustion engines, being shipped either separately or incorporated into a machine or other apparatus, the fuel tank of which has never contained any fuel and the fuel system of which is completely empty of fuel or that are powered by a fuel that does not meet the classification criteria for any class or division and without batteries or other dangerous goods, are not subject to these Regulations.

The words "Not Restricted" and the Special Provision number must be included in the description of the substance on the Air Waybill as required by 8.2.6, when an Air Waybill is issued. This does not apply to UN 3166 Vehicles, flammable liquid powered and Vehicles, flammable gas powered.

A71 (38) This substance is not subject to these Regulations when it contains 0.1% or less calcium carbide.

A72 (163) A substance specifically listed by name in the List of Dangerous Goods must not be transported under this entry. Materials transported under this entry may contain 20% or less nitrocellulose provided the nitrocellulose contains 12.6% or less nitrogen.

A73 (237) The membrane filters, including paper separators, coating, or backing materials, etc. that are present in transport, must not be liable to propagate a detonation as tested by one of the tests described in the *UN Manual of Tests and Criteria, Part I, Test Series 1(a)*.

In addition, the appropriate authority may determine, on the basis of the results of suitable burning rate tests taking account of the standard tests in the *UN Manual of Tests and Criteria, Part III, subsection 33.2.1*,