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Standard Guide for Interpretation of Existing Field Instrumentation to Influence Emergency Response Decisions[1]

This standard is issued under the fixed designation D7316; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The objective of this guide is to provide useful information for the interpretation of radiological instrument responses in the event of a radiological incident or emergency.

1.2 For the purposes of this guide, a radiological incident or emergency is defined as those events that follow the indication of the presence of radioactive material outside of a Department of Energy (DOE) or Nuclear Regulatory Commission (NRC) defined radiological area. The event may be triggered by a law enforcement officer wearing a radiation pager during the course of his routine duties, a first responder at the scene of an accident wearing a radiation pager, a HAZMAT team responding to the scene of an accident known to involve radioactive material surveying the area, etc.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C859 Terminology Relating to Nuclear Materials

C1112 Guide for Application of Radiation Monitors to the Control and Physical Security of Special Nuclear Material (Withdrawn 2014)[3]

D1129 Terminology Relating to Water

D3648 Practices for the Measurement of Radioactivity

D4962 Practice for NaI(Tl) Gamma-Ray Spectrometry of Water

D7282 Practice for Set-up, Calibration, and Quality Control of Instruments Used for Radioactivity Measurements

E170 Terminology Relating to Radiation Measurements and Dosimetry

E181 Test Methods for Detector Calibration and Analysis of Radionuclides

2.2 *Other Documents:*

U.S. Department of Homeland Security National Response Plan, Nuclear/Radiological Incident Annex

3. Terminology

3.1 *Definitions*—See Terminology C859 for terms related to nuclear materials, Terminology E170 for terms related to radiation measurements and dosimetry, and Terminology D1129 for terms related to water.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *alpha particle (α), n*—particle consisting of two protons and two neutrons emitted from the nucleus of an atom during radioactive decay.

3.2.2 *beta particle (β), n*—electron or positron emitted from the nucleus of an atom during radioactive decay.

3.2.3 *gamma ray (γ), n*—photon emitted from the nucleus of an atom during radioactive decay.

3.2.4 *Geiger-Mueller (GM), n*—a type of radiation detector with sensitivity to γ–rays and α and β particles.

3.2.5 *national response plan (NRP), n*—a publication by the US Department of Homeland Security which details actions to be taken, with appropriate responsibilities and authorities, in the event of a national-scale emergency.

3.2.6 *naturally occurring radioactive materials (NORM), n*—radioactive materials which occur in nature, often concentrated by an industrial or chemical process.

3.2.6.1 *Discussion*—NORM includes uranium (U) and thorium (Th) and their decay products as well as potassium-40 (^{40}K). U and Th are often found in earthen products and ^{40}K is often found in agricultural products.

3.2.7 *neutron, n*—uncharged particle emitted during fission of an atomic nucleus.

[1] This guide is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.04 on Methods of Radiochemical Analysis.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

3.2.8 *radiological emergency, n*—an event which represents a significant threat to workers and the public due to the release or potential release of significant quantities of radioactive material.

3.2.9 *radiological incident, n*—an unplanned event involving radiation or radioactive materials.

3.2.10 *special nuclear material (SNM), n*—plutonium, uranium-233, or uranium enriched in the isotopes uranium-233 or uranium-235 (USA definition).

3.2.11 *turn-back limit, n*—a condition or set of conditions, which if met, require that the investigation cease and personnel involved in the investigation withdraw from the area to a predetermined "safe" location.

3.2.11.1 *Discussion*—It is the responsibility of the users of this guide to establish both the turn-back limit and withdrawal location, if appropriate.

3.3 *Abbreviations:*

3.3.1 *CsI*—cesium iodide, a scintillation detector material used to detect gamma and X-ray radiation.

3.3.2 ^{3}He—helium-3, used as a pressurized gas in neutron detection systems.

3.3.3 *HPGe*—high purity germanium, a semiconductor material used in high resolution γ–ray spectrometry.

3.3.3.1 *Discussion*—A detection system using high purity germanium may be necessary for positive nuclide identification.

3.3.4 *LiI*—lithium iodide, scintillation detector material used to detect neutron radiation.

3.3.5 *NaI*—sodium iodide, a scintillation detector material used to detect gamma and X-ray radiation.

3.4 *Acronyms:*

3.4.1 *HHRID or RID, n*—[hand-held] radio-isotope identifier.

4. Summary of Guide

4.1 The primary purpose of the guide is to enable first response organizations to properly implement protective actions for themselves and the public. This guide offers a decision-tree approach to the interpretation of radiological instrument responses, plus actions which may be taken with various instrument types, to evaluate the presence of certain types of radioactive materials before, during, or after a radiological incident or emergency. This information may be useful in further emergency or incident response activities. This guide is believed to be most effective when combined with specific training for each emergency response organization, as equipment availability and response scenarios have a significant impact on the decision process.

5. Significance and Use

5.1 This guide is intended for use by field personnel for the rapid evaluation of the presence of and type of radioactive materials, based on information obtained from available field instrumentation. Guidance is offered for actions which may be taken to better understand the instrument indications for various scenarios, and guidance is offered for personnel protection and consultation with additional appropriate authorities.

5.2 This guide does not include policy or procedures for radiation health protection. Such policy and procedures are determined locally by the organization(s) involved (site, city, county, state, federal). The policies and procedures may vary between organizations and may be dependent on the type of radiological incident. Users of this guide should be familiar with the policies of their local organizations.

6. Hazards

6.1 Turn-back limits and actions should be established prior to any type of investigation. These limits should be strictly adhered to by all personnel.

6.2 The vendor supplied safety instructions and organizational safety regulations should be consulted before using electronic and electrical equipment.

7. Equipment

7.1 There are many portable radiation instrument types that can passively or actively be used to evaluate the presence of radioactive materials. For the purposes of this guide they are loosely defined as:

7.1.1 *Radiation Pagers*—Typically worn on the person to act as a personal warning device, giving the wearer an indication of relative or actual dose rate as compared to established background levels. All known radiation pagers provide information about the level of γ-radiation, and many also provide information about the level of neutron radiation. They are typically used in a passive mode and worn on the outer layer of clothing.

7.1.2 *Count Rate Meters (Survey Meters)*—Typically hand-held, which provides the user an indication of counts per second or counts per minute of radiation being measured by the device. Instruments may be sensitive to α, β, γ, or neutron radiation, or a combination thereof.

7.1.3 *RID*—A device typically containing a CsI or NaI scintillation detector and associated software to make a preliminary identification of the source of gamma radiation. Some units use an HPGe detector for high resolution spectrometric analysis.

7.1.4 Fig. 1 describes the radiation-type detection capability of some radiation pagers based on the materials used for detection.

7.1.5 Fig. 2 describes the radiation-type detection capability of some hand-held radiation instruments based on the materials used for detection.

7.2 For a more complete discussion of radiation detection equipment, its operation and calibration, refer to Practices D3648, Test Methods E181, Practice D4962, Guide C1112, Practice D7282, or a combination thereof.

8. Calibration and Response Checks

8.1 Calibration is performed by qualified individuals, usually on an annual basis. This may require instruments to be returned to the manufacturer or other qualified service unit. Operating procedures for the instruments should indicate the

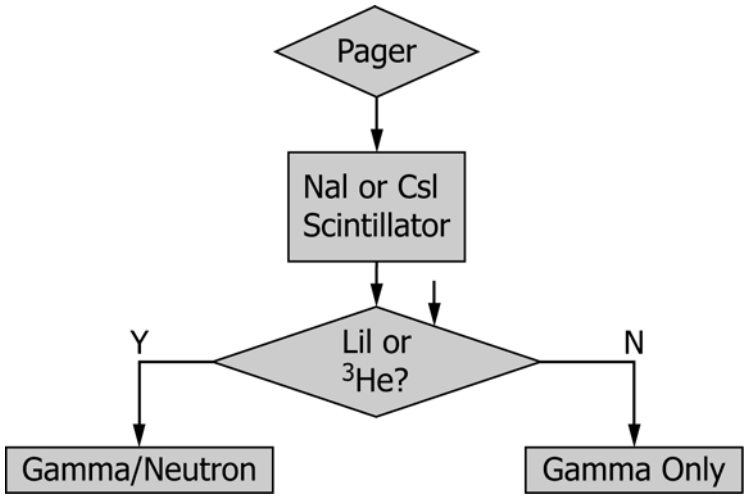

FIG. 1 Simple Chart of Pager Detection Capabilities

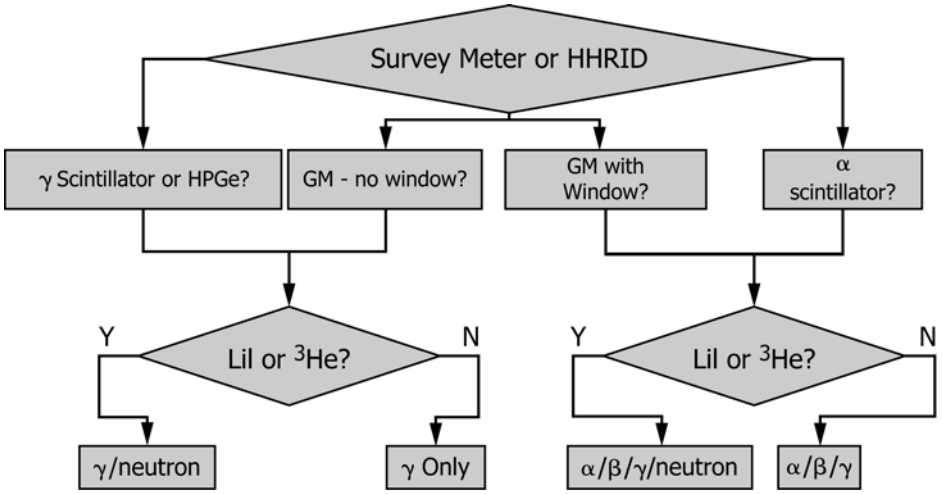

FIG. 2 Simple Chart of Radiation Instrument Detection Capabilities

calibration frequency and a method for users to confirm that an instrument is in calibration prior to use.

8.2 Response checks should be performed by the user prior to deployment of the instrument. The two checks which should be performed are a background check and a source check. RIDs may also be subjected to an identification confirmation check.

8.2.1 *Background Check*—Once the instrument has been turned on and has completed any start up processes, the dose or count rate reading should be compared to normal background. Standard operating procedures should state where this check is performed and what the expected background for this location is. Instruments found to read significantly above or below the normal values should not be used and should be submitted for diagnostic testing and repair.

8.2.2 *Source Check*—Once the background check is completed, a radioactive source should be used to verify the response. Radioactive sources may be commercial sealed sources or NORM. Standard operating procedures should indicate the source material to be used, the distance from the detector and the count rate or dose rate expected for that source, as well as an acceptance range for the instrument response. Instruments found to read outside the acceptance range should not be used and should be submitted for diagnostic testing and repair.

8.2.3 *RID Identification Check*—Once the background and source check are completed, a source of known radioactive material may be used to confirm the RID identification software is calibrated and functioning properly. The check source must include an isotope or isotopes which are included in the identifier library. Standard operating procedures should indicate what material to use for this check, and what the expected identification should be. If the RID does not correctly identify the known material, perform the calibration steps again (if applicable) and retry the identification. If the instrument still will not correctly identify the known material it should be not be used and should be submitted for diagnostic testing and repair.