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Technical Basis Document (TBD) and User Guides

P. J. Chiaro, Jr. **RECEIVED**
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DEPARTMENT OF ENERGY

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Instrumentation and Controls Division

TECHNICAL BASIS DOCUMENT (TBD) AND USER GUIDES

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BACKGROUND

To ensure that radiation protection instruments are appropriate for (1) "the type(s), levels, and energies of the radiation(s) encountered, "and (2) "for existing environmental conditions," [10 CFR 835.401(c)(2) & (3)], some U. S. Department of Energy (DOE) facilities have developed Technical Basis Documents (TBDs) and Instrument User Guides. Most are paper-based and not easily updated or shared.

Due to the need to share information, the development of a standard TBD and a web-based User Guide format was needed. The combination of both documents should help those involved in the purchase, approval, and use of radiation instruments with ensuring that a specific instrument model is appropriate for use at their facility.

1. TECHNICAL BASIS DOCUMENT

1.1 BACKGROUND AND SCOPE

A Technical Basis Document (TBD) should provide the background information for establishment of an instrument's operational requirements. Due to the amount and location of DOE facilities, no one set of requirements is possible. Operational requirements will vary based on the local environments and missions at each facility. Environmental conditions that can affect an instrument's operations are ambient temperature, humidity, and radio frequency, and to a lesser extent, magnetic fields, and interfering ionizing radiations. Consideration should also be made regarding how an instrument is to be used. If an instrument will be transported around the facility, vibration and shock can cause problems if they are not addressed in the TBD.

This document provides guidance for the development of a TBD.

1.2 APPLICATION

This document applies to radiation instruments used for personnel and equipment contamination monitoring, dose rate monitoring, and air monitoring.

1.3 ESTABLISHING OPERATIONAL LIMITATIONS

Tests performed by instrument manufacturers and independent facilities have found that certain environmental conditions can cause detrimental effects on a radiation instrument's ability to operate correctly. Observable effects usually include reduced response, increased response, erratic response, or no response. Without prior knowledge of these operational limitations, instruments could be placed into service that are not appropriate for the expected environmental conditions.

The TBD should contain specific information about the expected environmental conditions and information about the radiation types and levels expected to be encountered at the facility. The following sections provide guidance in a format that can be used to establish a facility-specific TBD.

1.3.1 Radiation Types

This section should contain a statement regarding the types of radiation encountered at the facility, i.e., alpha, beta, gamma, and/or neutron. Information about expected energy levels or isotopes is also suggested.

Example

Expected radiation types: Beta, Gamma.

Common Isotopes: ¹³⁷Cs, ⁶⁰Co, ⁹⁰Sr/⁹⁰Y

Interfering Ionizing Radiations—An instrument's response to radiations other than those it was calibrated for should be known. Typically, radiation instrumentation users will be the personnel who are most aware of the various radiations at the facility.

Example

Instruments shall be capable of monitoring alpha radiation in the presence of beta-gamma and neutron radiation; beta-gamma radiation in the presence of alpha and neutron radiation; and neutron radiation in the presence of alpha and beta-gamma radiation.

1.3.2 Temperature and Humidity

Atmospheric conditions will obviously vary across the complex. Conditions within weather protected and non-weather protected locations should be used as a basis for establishing operating requirements. These can usually be obtained from local weather records or through an analysis of individual operations within each location. Climatic information is also available in existing Military Standards, such as MIL-STD 810.

Besides minimum and maximum conditions, exposure times should be considered. Instruments used for brief periods at elevated temperature and high humidity should not be required to meet the same requirements as instruments used for extended periods of times in those conditions.

Example

Outdoor Conditions

Expected temperature range: +10 °F to +110 °F.

Typical Relative Humidity Levels: 20 to 95% RH.

Barometric Pressure: 28 to 31 in Hg.

Indoor Conditions

Possible temperature range: +40 °F to +120 °F.

Expected temperature range: +65 °F to +80 °F.

Possible relative humidity range: 20 to 95% RH.

Expected relative humidity range: <75% RH.

Note: Most facilities are environmentally controlled. These conditions may be external to the facilities while the operating environment is stable and controlled inside most facilities.

1.3.3 Radio Frequency and Magnetic Fields

Radio frequencies (non-ionizing radiation) and magnetic fields must be considered when evaluating radiation instrumentation. The prevalence of radios and cellular communication, as well as the use of other non-communications equipment that generate RF fields have increased the amount of interfering non-ionizing radiation in the environment. Documented susceptibilities include response effects (increased and decreased), and other operational changes such as alarm activation, display effects, etc. Information about local RF emitting devices such as their output frequency is necessary to ensure that the instrument is properly evaluated prior to use. The local communications group could probably provide the necessary information for the establishment of operating criteria.

The use of a scan evaluation over a frequency range of 20 or 80 MHz to 1000 MHz at 20 Volts/meter will ensure that an instrument's susceptibility is known.

1.4 REQUIREMENT REFERENCE

Title 10, Code of Federal Regulations, Part 835; Occupational Radiation Protection

2. USER GUIDE

2.1 SCOPE

A User Guide is a consolidated source of information for an instrument model's operating limitations and susceptibilities. The information is based on controlled evaluations performed across the DOE complex, from field-use experience and manufacturer-supplied data. It can be used with a TBD to determine if a particular model meets the operational requirements of a specific facility, or as a means to share information about a particular model with other users.

The user guide is set up for use on the World Wide Web to enable easier updating and viewing. Access to the web site is uncontrolled, but registration is required when providing operational comments. A description of each user guide section follows.

2.2 SPECIFICS

A typical user guide is divided into the following sections:

1. **Description**—Describes the instrument model, probe/detector type, operating range(s), basic operating description, etc.
2. **Typical Uses**—Describes how the instrument is commonly used, i.e., dose rate measurement, contamination, etc.
3. **Operational Limitations (test-based)**—Provides a breakdown of the limitations on the instrument's use as determined by controlled testing performed either by the manufacturer or independent laboratory. The subsections are as follows:
 - 3.1 Temperature,
 - 3.2 Humidity,
 - 3.3 Radio Frequency,
 - 3.4 Magnetic Field,
 - 3.5 Vibration and Shock,
 - 3.6 Energy Response,
 - 3.7 Interfering Ionizing Radiations, and
 - 3.8 Other Limitations.
4. **Test Information**—Provides links to appropriate testing information available on the World Wide Web.
5. **User List**—Provides a listing of the instrument's current users. The list is updated as needed and used to notify interested people of new information regarding a specific instrument model automatically, as needed.
6. **User Comments**—Contains a list of field-use observations and experiences provided by other users. All comments are shown by date and user name. Each comment is reviewed before being added to the users guide.

2.3 EXAMPLES

Three example user guides are attached as Appendices 1 through 3.

Appendix 1, Eberline RO-20

Appendix 2, Bicron Surveyor with Pancake GM Probe

Appendix 3, Ludlum Model 12 with a 43-65 Probe

3. INSTRUMENT USER GUIDE

EBERLINE MODEL RO-20

3.1 DESCRIPTION

The Eberline Model RO-20 is a portable, battery powered air ionization chamber used to detect beta, gamma, and x-ray radiation. It has five linear ranges of 0 - 5, 0 - 50, and 0 - 500 mR/hr, and 0 - 5, and 0 - 50 R/hr. The ion chamber is vented to the atmosphere so that changes in atmospheric pressure will affect the response of the instrument.

3.2 TYPICAL USES

The Eberline RO-20 is typically used to perform dose rate surveys. It is commonly used to establish stay times or monitor areas to establish protection boundaries.

3.3 OPERATIONAL INFORMATION

Temperature

Operating Range

Manufacturer: -40°F to +140°F (-40°C to +60°C)

Available Testing: -10°C to 50°C (+14°F to +122°F)

Limitations

RO-20s can be susceptible to rapid changes in temperature especially when operated using the most sensitive range. The susceptibility is greater when exposed to changes that are lower than ambient (22°C to -10°C).

Precautions

When it is necessary to operate an RO-20 after a temperature change of >10°C, it is recommended that the instrument reach thermal equilibrium prior to use.

Humidity

Operating Range

Manufacturer: Operable from 0 to 95%, non-condensing

Available Testing: Exposed to 95% (non-condensing) for eight hours, and 40% for 4 hours at 22 ± 2°C.

Limitations

None for non-condensing atmospheres.

Precautions

None.

Radio Frequency

Operating Range

Manufacturer: None provided.

Available Testing: Tested at 20 Volts/meter over a frequency band from 100 kHz to 1000 MHz and at 2450 MHz.

Limitations

Some susceptibility may exist from 730 to 800 MHz when operated using the most sensitive range.

Precautions

The RO-20 should not be operated using the most sensitive range in RF fields from 730 to 800 MHz.

Magnetic Field

Operating Range

Manufacturer: None provided.

Available Testing: 10 Gauss (10 Oersted) DC, and 60 Hz (1.26 Gauss) AC in two orientations.

Limitations

None for field intensities up to those performed during testing.

Precautions

If field conditions are unknown, it is recommended that a response check be performed prior to use at the location of use. Some effect may be seen when operated in high magnetic fields.

Vibration and Shock

Operating Range

Manufacturer: None provided.

Available Testing: Exposure to 15 Hz and 28 Hz at 2 G in three orientations. No shock information available.

Limitations

Typical electronic equipment handling procedures.

Precautions

It is recommended that a response check be performed prior to use if it is suspected that the unit had been exposed to an extreme vibration condition or shock event.

Energy Response

Note: The following information is provided by the manufacturer.

Limitations

Information is normalized to a ^{137}Cs calibration, slide closed and facing the source.

Photon

$\pm 30\%$ from 8 keV to 1.3 MeV with open slide facing the source.

$\pm 15\%$ from 33 keV to 1.3 MeV with the slide closed.

$\pm 15\%$ from 55 keV to 1.3 MeV through the side of the case.

Beta

Uranium slab - 30% of the true mrad/hr field behind 7 mg/cm² window with RO-20 resting on the slab, slide open.

^{90}Sr - ^{90}Y - approximately 93% of true mrad/hr field at 30 cm with the slide open.

Fast Neutron Response (PuBe)

8% in mR/hr of true neutron field in mrem/hr.

Note - Available test results indicated a rate of 6%.

Interfering Ionizing Radiations

Operating Range

Manufacturer: N/A.

Available Testing: N/A.

Limitations

N/A.

Precautions

This instrument is designed to respond to x-ray, gamma, and beta. It also responds to neutrons. Information regarding its neutron response is available in the energy response section.

Other Limitations

The RO-20 has been revised since its inception. Revisions were made to address fundamental susceptibilities with changes in temperature. Questions regarding currently available units should be addressed to the manufacturer.

Questions not addressed directly in this document should be addressed to other users or the manufacturer.

3.4 TEST INFORMATION

PNNL - http://www.pnl.gov/health/health_prot/instrume.html

ORNL - <http://www.ic.ornl.gov/centers/ite/hpinfo.htm>

LANL - <http://esh-4.lanl.gov/ric1/result.htm>

3.5 USER LIST

This section provides a listing of the instrument's current users. The list is updated and used to notify people of new information regarding a specific instrument model, as needed.

3.6 USER COMMENTS

This section contains a list of field-use observations and experiences that have been provided by other users. All comments are shown by date and user name. Each comment is reviewed before being added to the TBD.

User Name	Date	Comment	Key Word (Main Issue of Comment)
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4. INSTRUMENT USER GUIDE

BICRON SURVEYOR M WITH PANCAKE GM PROBE

4.1 DESCRIPTION

The Surveyor M is a portable, battery operated count rate meter. The pancake GM tube is a Bicron Model PGM. The ranges are X 1 (0 - 500 cpm), X 10 (0 - 5000 cpm), X 100 (0 - 50000 cpm), and X 1000 (0 - 500000 cpm). The X 1000 range is not recommended for use with this instrument/detector combination.

4.2 TYPICAL USES

The Bicron Surveyor M/PGM is typically used for beta/gamma contamination surveys. It is commonly used to check for contamination on equipment or personnel.

4.3 OPERATIONAL INFORMATION

Temperature

Operating Range

Manufacturer: -20°C to +50°C (-29°C to +122°F)

Available Testing: -10°C to 50°C (+14°C to +122°F)

Limitations

None when operated within the stated temperature range.

Precautions

If operation is required outside the stated temperature range, a response check should be performed after the instrument reaches thermal equilibrium with the ambient conditions prior to use.

Humidity

Operating Range

Manufacturer: 5% change in reading from 10 to 95% relative humidity.

Available Testing: Exposed to 95% (non-condensing) for eight hours, and 40% for 4 hours at $22 \pm 2^\circ\text{C}$.

Limitations

None for non-condensing atmospheres.

Precautions

None.

Radio Frequency

Operating Range

Manufacturer: None provided.

Available Testing: Tested using a scan from 0.3 MHz to 35 MHz, and at 140 MHz at 50 volts/meter. Also tested at 915 MHz and 2.45 GHz at 0.4 watts/meter² and 2.0 watts/meter² respectively.

Limitations

None.

Precautions

None. If field conditions are unknown, it is recommended that a response check be performed prior to use at the location of use.

Magnetic Field

Operating Range

Manufacturer: None provided.

Available Testing: 10 Gauss DC.

Limitations

This instrument/probe combination shows a susceptibility to magnetic fields when operated using the X 1 range. Other, less sensitive ranges do not seem susceptible.

Precautions

The instrument/probe combination should not be operated using the X1 range in areas where magnetic fields may exist. If field conditions are unknown, it is recommended that a response check be performed prior to use at the location of use.

Vibration and Shock

Operating Range

Manufacturer: Up to 100g per lightweight machine of MIL-STD 202C, method 202B (shock). Up to 5 g in three mutually orthogonal axes at one or more frequencies from 10 to 33 Hz.

Available Testing: Exposure to 15 Hz and 28 Hz at 2 G in three orientations. No shock information available.

Limitations

Typical electronic equipment handling procedures.

Precautions

It is recommended that a response check be performed prior to use if it is suspected that the unit had been exposed to an extreme vibration condition or shock event.

Energy Response

No information available.

Interfering Ionizing Radiations

This instrument/probe combination responds to most all ionizing radiations.

Other Limitations

None.

4.4 TEST INFORMATION

ORNL - <http://www.ic.ornl.gov/centers/ite/hpinfo.htm>

4.5 USER LIST

This section provides a listing of the instrument's current users. The list is updated and used to notify people of new information regarding a specific instrument model, as needed.

4.6 User Comments

This section contains a list of field-use observations and experiences provided by other users. All comments are shown by date and user name. Each comment is reviewed before being added to the TBD.

User Name	Date	Comment	Key Word (Main Issue of Comment)
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5. INSTRUMENT USER GUIDE

LUDLUM MODEL 12 WITH A MODEL 43-65 PROBE

5.1 DESCRIPTION

The Ludlum Model 12 is a portable, battery operated count ratemeter. The Ludlum Model 43-65 detects alpha radiation. The Ludlum Model 12 has a scale of 0-500 counts per minute with four range multipliers; X1, X10, X100, and X1000.

5.2 TYPICAL USES

The Model 12/43-65 instrument combination is typically used to do alpha surface contamination surveys. It is commonly used to check for contamination on equipment or personnel.

5.3 OPERATIONAL INFORMATION

This section provides a breakdown of the limitations on the instrument's use as determined by controlled testing, or as stated by the manufacturer.

Temperature

Operating Range

Manufacturer: -40°C to 50°C (-40 to 122°F)

Available Testing: -10°C to 50°C (+14 to +122°F)

Limitations

The instrument is susceptible to rapid changes in temperature especially when operated using the X1 range. The X1 is also affected when ambient temperatures are less than +10°C (+50°F) or greater than +40°C (+104°F).

Precautions

If operation is required outside of the stated temperature range, a response check should be performed after the instrument reaches thermal equilibrium with the ambient conditions.

This instrument/probe combination should not be used on the X1 range when the ambient temperature is less than +10°C (+50°F) or greater than +40°C (+104°F).

When exposing this instrument/probe combination to a temperature change of greater than 10 °C is necessary, it is recommended that the instrument reach thermal equilibrium and then be successfully response checked before use.

Humidity

Operating Range

Manufacturer: No information available.

Available Testing: Exposed to 95% (non-condensing) for eight hours, and 40% for 4 hours at 22 ± 2°C.

Limitations

None for non-condensing atmospheres.

Precautions

None.

Radio Frequency

Operating Range

Manufacturer: None provided.

Available Testing: Tested using a scan from 0.3 MHz to 35 MHz, and at 140 MHz at 50 volts/meter. Also tested at 915 MHz and 2.45 GHz at 0.4 watts/meter² and 2.0 watts/meter² respectively.

Limitations

The instrument/probe combination is susceptible to RF fields. Susceptibilities were indicated at frequencies below 35 MHz, and at 140 and 915 MHz, primarily on the X1 range.

Precautions

The Ludlum Model 12 with a Ludlum Model 43-65 should not be operated in radio frequency fields on the X1 range. If field conditions are unknown, or when operated using other ranges, it is recommended that a response check be performed before use at the location of use.

Magnetic Field

Operating Range

Manufacturer: None provided.

Available Testing: 10 Gauss (10 Oersted) DC, and 60 Hz (1.26 Gauss) AC in two orientations.

Limitations

The instrument/probe combination is susceptible to magnetic fields.

Precautions

The Ludlum Model 12 with a Ludlum Model 43-65 should not be used in areas where magnetic fields exist.

Vibration and Shock

Operating Range

Manufacturer: None provided.

Available Testing: No test information available.

Limitations

Typical electronic equipment handling procedures.

Precautions

It is recommended that the instrument be response checked before use if it is suspected that the unit had been exposed to an extreme vibration condition or shock event.

Energy Response

N/A

Interfering Ionizing Radiations

Operating Range

Manufacturer: None.

Available Testing: Gamma - Exposed to 11.7 R/hr ¹³⁷Cs gamma field.

Neutron - Exposed to a 1 rem/hr unmoderated ²⁵²Cf neutron field.

Limitations

The response of the Ludlum Model 12 with a Ludlum Model 43-65 was 2000 to 4000 counts per minute when exposed to the neutron field. No response was observed when exposed to the gamma field.

Precautions

It is recommended that this instrument/probe combination not be used when neutrons are present.

Other Limitations

Questions not addressed directly in this document should be addressed to other users or the manufacturer.

5.4 TEST INFORMATION

This section provides links to national laboratory testing information available on the world wide web.

ORNL - <http://www.ic.ornl.gov/centers/ite/hpinfo.htm>

5.5 USER LIST

This section provides a listing of the instrument's current users. The list is updated and used to notify people of new information regarding a specific instrument model, as needed.

5.6 USER COMMENTS

This section contains a list of field-use observations and experiences provided by other users. All comments are shown by date and user name. Each comment is reviewed before being added to the TBD.

User Name	Date	Comment	Key Word (Main Issue of Comment)
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