Designation: C 993 – 97

Standard Guide for
In-Plant Performance Evaluation of Automatic Pedestrian SNM Monitors[1]

This standard is issued under the fixed designation C 993; 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 This guide is affiliated with Guide C 1112 on applying special nuclear material (SNM) monitors, Guide C 1169 on laboratory performance evaluation, Guide C 1189 on calibrating pedestrian SNM monitors, and Guides C 1236 and C 1237 on in-plant evaluation. This guide to in-plant performance evaluation is a comparatively rapid way to verify whether a pedestrian SNM monitor performs as expected for detecting SNM or SNM-like test sources.

1.1.1 In-plant performance evaluation should not be confused with the simple daily functional test recommended in Guide C 1112. In-plant performance evaluation takes place less often than daily tests, usually at intervals ranging from weekly to once every three months. In-plant evaluations are also more extensive than daily tests and may examine both a monitor's nuisance alarm record and its detection sensitivity for a particular SNM or alternative test source.

1.1.2 In-plant performance evaluation also should not be confused with laboratory performance evaluation. In-plant evaluation is comparatively rapid, takes place in the monitor's routine operating environment, and its results are limited to verifying that a monitor is operating as expected, or to disclosing that it is not and needs repair or recalibration.

1.2 In-plant evaluation is one part of a program to keep SNM monitors in proper operating condition. Every monitor in a facility is evaluated. There are two applications of the in-plant evaluation: one used during routine operation and another used after calibration.

1.2.1 *Routine Operational Evaluation*—In this form of the evaluation, nuisance alarm records for each monitor are examined, and each monitor's detection sensitivity is estimated during routine operation. The routine operational evaluation is intended to reassure the plant operator, and his regulatory agency, that the monitor is performing as expected during routine operation. This evaluation takes place without pretesting, recalibration, or other activity that might change the monitor's operation, and the evaluation simulates the normal use of the monitor.

1.2.2 *Post-Calibration Evaluation*—This form of the evaluation is part of a maintenance procedure; it should always follow scheduled monitor recalibration, or recalibration connected with repair or relocation of the monitor, to verify that an expected detection sensitivity is achieved. Nuisance alarm data do not apply in this case because the monitor has just been recalibrated. Also, having just been calibrated, the monitor is likely to be operating at its best, which may be somewhat better than its routine operation.

1.3 The values stated in SI units are to be regarded as standard.

1.4 *This standard does not purport to address the safety problems, 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 The guide is based on ASTM standards that describe application and evaluation of SNM monitors, as well as technical publications that describe aspects of SNM monitor design and use.

2.2 *ASTM Standards:*

C 859 Terminology Relating to Nuclear Materials[2]
C 1112 Guide for Application of Radiation Monitors to the Control and Physical Security of Special Nuclear Material[2]
C 1169 Guide for Laboratory Evaluation of Automatic Pedestrian SNM Monitor Performance[2]
C 1189 Guide to Procedures for Calibrating Automatic Pedestrian SNM Monitors[2]
C 1236 Guide for In–Plant Performance Evaluation of Automatic Vehicle SNM Monitors[2]
C 1237 Guide to In–Plant Performance Evaluation of Hand–Held SNM Monitors[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *alternative test source*—although no other radioactive materials individually or collectively duplicate the radioactive emissions of uranium or plutonium, some materials have

---

[1] This guide is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.12 on Safeguard Applications.

Current edition approved May 10, 1997. Published May 1998. Originally published as C 993 – 91. Last previous edition C 993 – 92.

[2] *Annual Book of ASTM Standards*, Vol 12.01.

somewhat similar attributes and are sometimes used as alternative test sources.

3.1.2 *alternative gamma-ray test sources*—examples of alternative gamma-ray sources are HEU or ^{133}Ba used in place of plutonium when a plutonium source is not readily available or is prohibited.

3.1.2.1 *Discussion*—Table 1 tabulates amounts of HEU mass, plutonium mass, and ^{133}Ba source activity that produce equal response in two different types of monitor.

3.1.3 *alternative neutron test source*—a common alternative neutron source used in place of plutonium is ^{252}Cf that emits neutrons from spontaneous fission as does plutonium.

3.1.3.1 *Discussion*—Alternative test sources may have short decay half-lives in comparison to SNM isotopes; for example, the half-life of ^{133}Ba is 10.7 years and ^{252}Cf 2.64 years. Larger source activities than initially needed are often purchased to obtain a longer working lifetime for the source.

3.1.4 *confidence coefficient*—the theoretical proportion of confidence intervals from an infinite number of repetitions of an evaluation that would contain the true result.

3.1.4.1 *Discussion*—In a demonstration, if the true result were known the theoretical confidence coefficient would be the approximate proportion of confidence intervals, from a large number of repetitions of an evaluation, that contain the true result. Typical confidence coefficients are 0.90, 0.95 and 0.99.

3.1.5 *Confidence Interval for a Detection Probability*—An interval, based on an actual evaluation situation, so constructed that it contains the (true) detection probability with a stated confidence.

3.1.5.1 *Discussion*—Confidence is often expressed as 100* the confidence coefficient. Thus, typical confidence levels are 90, 95 and 99 %.

3.1.6 *detection probability*—the proportion of passages for which the monitor is expected to alarm during passages of a particular test source.

3.1.6.1 *Discussion*—Although probabilities are properly expressed as proportions, performance requirements for detection probability in regulatory guidance have sometimes been expressed in percentage. In that case, the detection probability as a proportion can be obtained by dividing the percentage by 100.

3.1.7 *nuisance alarm*—a monitoring alarm not caused by SNM but by other causes, such as statistical variation in the measurement process, a background intensity variation, or an equipment malfunction.

TABLE 1 Alternative Test Source Equivalent Amounts[A]

Monitor Category	Monitor Description	Plutonium, g	Uranium, g	^{133}Ba (µCi) Required in NaI(T1) Scintillator Monitors	^{133}Ba (µCi) Required in Plastic Scintillator Monitors
I	Standard plutonium	1	64	2.5	3.2
II	Standard uranium	0.29	10	0.9	1.4
III	Improved sensitivity	0.08	3	0.4	0.6
IV	High sensitivity	0.03	1	0.2	0.3

[A] This table combines information from Tables II and V of the report referenced in Footnote 8. Note that the term "category" refers to an SNM monitor performance category used in that report and not to an SNM accountability category. Also note that the ^{133}Ba source strengths depend on individual differences in how the scintillators respond to radiation from the barium isotope and plutonium.

3.1.8 *process-SNM test source*—an SNM test source fabricated by a facility from process material that differs in physical or isotopic form from the material recommended in 3.1.11 for standard test sources.

3.1.8.1 *Discussion*—This type of source is used when it meets plant operator or regulatory agency performance requirements and a suitable standard source is not readily available. Encapsulation and filtering should follow that recommended in 3.1.11.

3.1.9 *SNM*—special nuclear material: plutonium of any isotopic composition, ^{233}U, or enriched uranium as defined in Terminology C 859.

3.1.9.1 *Discussion*—This term is used here to describe both SNM and strategic SNM, which includes plutonium, ^{233}U, and uranium enriched to 20 % or more in the ^{235}U isotope.

3.1.10 *SNM monitor*—radiation detection system that measures ambient radiation intensity, determines an alarm threshold from the result, and then, when it monitors, sounds an alarm if its measured radiation intensity exceeds the threshold.

3.1.11 *standard SNM test source*—a metallic sphere or cube of SNM having maximum self attenuation of its emitted radiation and an isotopic composition listed below that minimizes the intensity of its radiation emission. Encapsulation and filtering also affect radiation intensity, and particular details are listed for each source. This type of test source is used in laboratory evaluation but, if suitable and readily available, may be used for in-plant evaluation.

3.1.12 *standard plutonium test source*—a metallic sphere or cube of low-burnup plutonium containing at least 93 % ^{239}Pu, less than 6.5 % ^{240}Pu, and less than 0.5 % impurities.

3.1.12.1 *Discussion*—A cadmium filter can reduce the impact of ^{241}Am, a plutonium decay product that will slowly build up in time and emit increasing amounts of 60-keV radiation. Begin use of a 0.04-cm thick cadmium filter when three or more years have elapsed since separation of plutonium decay products. If ten or more years have elapsed since separation, use a cadmium filter 0.08 cm thick. The protective encapsulation should be in as many layers as local rules require. A nonradioactive encapsulation material, such as, aluminum ($\leq$0.32 cm-thick) or thin ($\leq$0.16 cm-thick) stainless steel or nickel, should be used to reduce unnecessary radiation absorption.

3.1.13 *standard uranium test source*—a metallic sphere or cube of highly enriched uranium (HEU) containing at least 93 % ^{235}U and less than 0.25 % impurities. Protective encapsulation should be thin plastic or thin aluminum ($\leq$0.32 cm thick) to reduce unnecessary radiation absorption in the encapsulation. No additional filter is needed.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *post-calibration evaluation*—verifies performance after repair, relocation, or recalibration. Monitor is prepared for best operation. Monitor is not yet in routine operation. Only sensitivity is evaluated.

3.2.2 *routine-operational evaluation*—verifies performance in routine operation. Simulates normal use of a monitor. Uses no monitor preparation procedures. Both sensitivity and nuisance alarm probability or rate are evaluated.

4. Summary of Guide

4.1 *Preliminary Steps Common to Both Forms of In-Plant Evaluation*:

4.1.1 The monitor being evaluated is an automatic walkthrough-portal or monitoring booth.

4.1.2 The monitor's indicated background measurement value is recorded for possible future use in troubleshooting.

4.1.3 *Nonmandatory Information*—If a gamma-ray survey meter (see 6.1) capable of quickly and precisely measuring environmental gamma-ray intensity is available, its use and recording its measurement value may provide additional beneficial information for future troubleshooting.[3] Independent knowledge of the ambient background intensity also can help to interpret performance differences at different monitor locations or at one location at different times.

4.2 *Steps for Routine Operational Evaluation*:

4.2.1 Determine nuisance alarm probability during the period since the monitor was last maintained, calibrated, or evaluated (see 8.1). Use recorded numbers of alarms and pedestrian passages from records kept during routine monitor use.

4.2.1.1 Handwritten alarm logs or records from the monitor's control unit can provide total alarms (see Section 6) from which alarms from daily or other performance testing and alarms explained by radioactive material presence in follow-up searches must be subtracted.

4.2.1.2 Total pedestrian passages can be estimated from operating logs or recorded information from the monitor's control unit.

4.2.2 Estimate detection probability by transporting a standard SNM, process-SNM, or alternative test source (see Section 7) through the monitor in a specific way adopted for evaluation beforehand (see 8.2).

4.2.2.1 Record the results, detect or miss for each passage.

4.2.2.2 End testing when a total number of passages, selected beforehand, is reached.

4.2.2.3 Analyze the results as a binomial experiment (see 8.2).

4.3 *Steps for Post-Calibration Evaluation*:

4.3.1 Calibrate the monitor according to procedures suggested by the manufacturer, Guide C 1189, or local practice.

4.3.2 Estimate detection probability by transporting a standard SNM, process-SNM, or alternative test source (see Section 7) through the monitor in a specific way adopted beforehand (see 8.2).

4.3.2.1 Record the results, detect or miss for each passage.

4.3.2.2 End testing when a total number of passages, selected beforehand, is reached.

4.3.2.3 Analyze the results as a binomial experiment (see 8.2).

5. Significance and Use

5.1 SNM monitors are an effective and unobtrusive means to search pedestrians for concealed SNM. Facility security plans use SNM monitors as one means to prevent theft or unauthorized removal of designated quantities of SNM from access areas. Daily testing of the monitors with radioactive sources guarantees only the continuity of alarm circuits. The in-plant evaluation is a way to estimate whether an acceptable level of performance for detecting chosen quantities of SNM is obtained from a monitor in routine service or after repair or calibration.

5.2 The evaluation verifies acceptable performance or discloses faults in hardware or calibration.

5.3 The evaluation uses test sources shielded only by normal source filters and encapsulation and, perhaps, by intervening portions of the transporting individual's body. The transporting individual also provides another form of shielding when the body intercepts environmental radiation that would otherwise reach the monitor's detectors. Hence, transporting individuals play an important role in the evaluation by reproducing an important condition of routine operation.

5.4 The evaluation, when applied as a routine-operational evaluation, provides evidence for continued compliance with the performance goals of security plans or regulatory guidance. It is the responsibility of the users of this evaluation to coordinate its application with the appropriate regulatory authority so that mutually agreeable evaluation frequency, test sources, way of transporting the test source, number of test-source passages, and nuisance-alarm-rate goals are used. Agreed written procedures should be used to document the coordination.

6. Apparatus

6.1 *Gamma Ray Survey Meter (Nonmandatory Information)*—Historical records of gamma-ray background intensity may provide useful information for troubleshooting future monitoring problems. An evaluation offers a good opportunity to record both the monitor's indicated background count and the gamma-ray background intensity. If desired, gamma-ray intensity can be measured with a survey meter and recorded during the evaluation. The gamma-ray survey meter should have a NaI(T1) or plastic scintillator capable of measuring environmental gamma radiation in the range from 60 keV to 3 MeV at background intensities that normally range between 5 and 25 μR/h (1.3 and 6.5 nC kg/h or 0.36 and 1.8 pA/kg).

6.2 *Recording Devices*—Written operator logs can provide records of alarms and passages needed for determining nuisance alarm rates. In some cases, monitor controllers can automatically accumulate these records and communicate them to operators or maintenance personnel by data terminal, printer, or other means. If so, operator logs are still essential for providing information on alarms that result from testing or detected passage of radioactive material.

6.3 *Written Records*— When written operator logs provide the only information on total alarms and passages, passages should be determined from an average number of passages per day or week and the elapsed time rather than logging passages on an individual basis.

7. Test Materials

7.1 The materials needed for detection sensitivity evaluation

---

[3] Fehlau, P. E., Sampson, T. E., Henry, C. N., Bieri, J. M., and Chambers, W. H., "On-Site Inspection Procedures for SNM Doorway Monitors," U.S. Nuclear Regulatory Commission Contractor Report NUREG/CR-0598 and Los Alamos Scientific Laboratory Report LA-7646, 1979.

are agreed upon (see 5.4) types and amounts of material. These may be standard SNM (see 3.1.11), process SNM (see 3.1.8), or alternative (see 3.1.1) test sources. Standard 10 and 3-g ^{235}U spherical test sources used in laboratory evaluations are available to Department of Energy (DOE) contractors from Los Alamos.[4]

7.2 A monitor's detection sensitivity for certain types of SNM can be estimated using alternative test sources.

7.2.1 *Alternatives for ^{233}U and ^{238}Pu*—A detection sensitivity estimated with standard HEU or low-burnup plutonium test sources demonstrates that a monitor has adequate gamma-ray sensitivity for detecting equal amounts of the more radioactive forms of SNM, ^{233}U, and ^{238}Pu.

7.2.2 *Alternatives for Low-Burnup Plutonium*—Detecting a standard HEU or substitute ^{133}Ba test source demonstrates that a monitor has adequate gamma-ray sensitivity for detecting low-burnup plutonium in the amounts listed in Table 1. The amounts were derived from source measurements in automatic pedestrian SNM monitors. When using ^{133}Ba, which has a 10.7-year half-life, purchasing approximately twice the activity listed in Table 1 will give the test source a useful lifetime of about 10 years. The reasoning is that a source with twice the activity is equivalent to the listed amount of low-burnup plutonium with 3-years accumulation of radioactive daughters. At the end of its 10-year useful lifetime, the source activity is reduced to the listed amount of plutonium freshly separated from its daughters. Hence, the equivalence is maintained over the period that standard plutonium sources may be used without filtering (see 3.1.9.1).

7.2.3 *Alternative Sources for SNM Neutron Emission*—A detection sensitivity estimated for neutron monitors using ^{252}Cf, a spontaneous-fission neutron source, can demonstrate adequate neutron sensitivity for detecting low-burnup plutonium in an amount corresponding to 1 g of ^{240}Pu for each 1000 neutrons per second from ^{252}Cf. For example, a 6000 neutron/s ^{252}Cf test source is equivalent to 6 g of ^{240}Pu. This, in turn, is equivalent to a 100-g quantity of plutonium containing 6 % ^{240}Pu.

7.3 The information on test source size in Table 1 applies to monitoring situations that require detecting small quantities of SNM that appear in the table. In other monitoring situations, test source amounts should be determined on an individual basis, and the table should not be used.

7.4 The performance of any SNM monitor will depend on its environmental background, hence one test source may not serve to evaluate all monitors in all circumstances. Different locations may require different test sources.

8. Procedures

8.1 *Procedure for Nuisance Alarm Evaluation (Not Used for Post-Calibration Evaluation)*:

8.1.1 Nuisance alarms can stem from counting statistics, background intensity variations, and equipment malfunction.

8.1.2 *Recording Data*— Nuisance alarms must be recorded along with the total number of passages through the monitor. Recording can be a continuous process when a monitor is attended and a written record of alarms and passages is kept in a log book, or when the monitor control unit automatically records alarms and passages. When automatic recording of passages is not possible, carefully estimating the number of passages per day may suffice.

8.1.3 *Analyzing Data*— During a routine-operational evaluation, the nuisance alarm probability or rate is calculated from the recorded total number of alarms and passages since the last evaluation. Alarms from daily tests or known passage of radioactive material are subtracted from the alarm total. The nuisance alarm probability per passage is the total number of alarms divided by the total number of passages. Monitors often have nuisance alarm probabilities in the range from 0.00025 to 0.001 per passage when properly operating and without interference from facility operation. The nuisance alarm rate is the number of passages divided by the number of alarms. The corresponding rate range to the probabilities mentioned above is 1 alarm per 4000 passages to 1 alarm per 1000 passages.

8.1.4 *Correcting Problems*—Consistent nuisance alarm rates high enough to cause a lack of credibility for a monitor's alarms must be investigated and corrected.

8.1.4.1 Begin investigating by checking the monitor's calibration. Refer to the manufacturer's recommended procedure, Guide C 1189, or local procedures.

8.1.4.2 If the problem persists, then recording the monitor's count rate on a strip chart or data logger may disclose interference from sources of radiation or, perhaps, intermittent misoperation of the portal. Radiation interference may be reduced by shielding its source. Causes of intermittent misoperation can usually be found and repaired once they are known to exist.

8.2 *Procedure for Detection Probability Evaluation*:

8.2.1 At the start of the evaluation, a test source must have been chosen that is agreeable (see 5.4) to the plant operator and his regulatory agency. Section 7 describes some different types of sources, but there are undoubtedly others that could be used.

8.2.2 A uniform, convenient, and agreeable (see 5.4) way for an individual to carry the source through the monitor also must have been chosen. The specified way should take into account the region of the portal that the source will pass through and the passage speed of the source, two factors that affect SNM monitor sensitivity. For example, a source passing through the waist region of a portal monitor may be more readily detected than one passing through the head or foot regions. In either case, a source is usually more readily detected when carried by an individual walking slowly than one walking rapidly. The specified way to carry the source must give final results after 5 to 30 passages. The chosen way should be refined during preliminary evaluation and initial experience with in-plant evaluation and then used consistently thereafter. Some examples of ways that have been used to carry a source are walking with the source held in a hand near the beltbuckle or behind the back, to walk with the source in a pocket or attached to a shoe or boot, and to walk with the source attached to other parts of the body.

8.2.3 The source may have to be attached to an individual to

---

[4] Group NIS-6, MS-J562, Los Alamos National Laboratory, Los Alamos, NM 87545.

make it move in a desired manner through the monitor. Convenient means for attachment, other than holding or in a pocket, are with adhesive tape, rubber bands, and butterfly clamp or binder paper clips.

8.2.4 During preliminary evaluation and initial experience with in-plant evaluation, the total number of passages must be chosen and agreed upon (see 5.4). See Table 2 for interpreting results for 5, 10, 15, 20, and 30 total passages. Once the chosen number is refined by experience, it should be used thereafter unless circumstances change. The number may be different for individual monitors or certain types of monitor in a plant. In general, monitors having high sensitivity for the test source and method of passage can be successfully evaluated with the fewest passages.

8.2.4.1 Once the number of passages is chosen, the individuals who will pass the test source through the monitor should first pass through without a source for the chosen number of times in the manner described in 8.2.4.2. This may disclose any radioactive items carried by the testing individuals or other unexpected circumstances that influence the evaluation results. Make a written record of results (passage number, detect or miss) as they are obtained.

8.2.4.2 The testing individual or individuals should next pass through the monitor transporting a test source. After each passage, the individual should move well away from the monitor before making the next passage. After each five passages, the monitor's background measurement should be allowed to update. Updating is often visible on the monitor's count display or, if not, the monitor's operating manual should give the background update time. Wait for at least one update period before continuing to test. Make a written record of results (passage number, detect or miss) as they are obtained.

8.2.5 The result of each passage is that the source is detected (alarm) or missed (no alarm). Evaluation results should be tallied as total passages and total detections. When the total number of passages has been completed and the results tallied, acceptance or rejection of the hypothesis that the monitor is operating properly can be determined.

8.2.6 The results of the evaluation are analyzed using the tables of confidence intervals published by Dixon and Massey.[5] Table 2 lists the number of detections required for acceptance and rejection for five different cases. The total number of passages used is a matter of choice that may have to change under different operating conditions or as substitute sources decay (any change should be agreeable as in 5.4).

TABLE 2 Number of Detections for Acceptance and Rejection

NOTE 1—The chosen number of trials must have been completed and the criteria for that number of trials must be used to determine acceptance or rejection of the monitor's performance.

Total Number of Passages	Number of Detections for Acceptance	Number of Detections for Rejection
5	5	4 or less
10	9 or more	8 or less
15	12 or more	11 or less
20	15 or more	14 or less
30	20 or more	19 or less

8.2.7 The above acceptance criteria were chosen to provide at least 95 % confidence that the probability of detection is greater than 0.50. Results falling at or below the rejection number do not provide 95 % confidence that the probability of detection is greater than 0.50. In this case, the monitor can be repaired, recalibrated, and evaluated again. In any case, record the results.

9. Report

9.1 Written reports of in-plant evaluation results serve as evidence for carrying out a scheduled maintenance and evaluation program. Written reports also document the performance of a particular monitor operating in a particular environment and, in the future, may provide information that helps to resolve operating problems at that location.

9.2 The content and form of the written report should be part of the agreement mentioned in 5.4. Written reports may include any of the following information.

9.2.1 Information on positions of any accessible switches and adjustments.

9.2.2 Measured background intensity (if available) and the monitor's displayed count rate.

9.2.3 Nuisance alarm data and calculated alarm probability or rate.

9.2.4 Sensitivity evaluation data and results.

9.3 Appendix X1 contains an example evaluation report.

10. Error and Bias

10.1 The outcome of sensitivity evaluation, using a particular test source and way of carrying it through the monitor, is acceptance or rejection of the monitor's performance. There is a possibility that the wrong outcome will be assigned.

10.1.1 *Rejection*—Should rejection be wrongfully assigned, then recalibration and reevaluation may lead to acceptance. If the monitor is rightfully rejected, then repair, recalibration, and evaluation may restore it to proper operation and acceptance.

10.1.2 *Acceptance*—Should the monitor be wrongly assigned acceptance, the next routine operational evaluation may reject it.

10.2 Consistently lower than expected performance in a monitor may result from operating it in an inappropriate environment or calibrating it in an inappropriate manner. Besides manufacturer's manuals, other information is available that may help.

10.2.1 *General Information*—Part 1 of Report LA10633-MS[6,7] discusses general factors that affect monitor operation.

10.2.2 *Calibration Information.*

10.2.2.1 Guide C 1189 on procedures for calibrating pedestrian SNM monitors discusses calibration factors that can affect monitor operation.

10.3 Biased procedures can influence sensitivity evaluation results.

---

[5] Dixon, W. J., and Massey, F. J., *Introduction to Statistical Analysis*, McGraw-Hill Book Co., New York, NY, 1969.

[6] Supporting data are available from ASTM Headquarters. Request RR: C26–1002.

[7] Fehlau, P. E., "An Applications Guide to Pedestrian SNM Monitoring," Los Alamos National Laboratory Report LA-10633-MS, February 1986, as corrected by Los Alamos errata document N2-91:1352:PEF, Oct. 28, 1991.

10.3.1 In a walkthrough SNM monitor, the individual's passage speed and gait can affect performance.

10.3.2 In a wait-in monitor, the direction that the individual faces can bias results; facing one of the detectors often lessens source shielding by the body over other positions and makes the monitor more sensitive.

10.3.3 In almost any monitor, an individual's body mass can influence performance. Whenever a different individual or group of individuals is used for operational evaluation, the results may change somewhat.

10.4 Seasonal attire can bias evaluation results when it provides different amounts of shielding for test-source radiation. Winter footwear, in particular, often is much heavier than summer footwear and provides greater shielding.

10.5 The way of carrying the test source during sensitivity evaluation may be an important source of bias when it involves an arm or leg that rapidly moves through a walkthrough monitor. This way of carrying a source may be inadvisable because it is subject to greater variability among different individuals than other ways, such as on top of the head or in a shirt pocket, that causes the source to move at a more uniform passage speed.

10.6 Test source shielding by the body can bias sensitivity evaluation results. For example, carrying the source in an armpit may be inadvisable because it provides shielding that depends on body mass and bone structure that could bias results for different testing individuals.

10.7 The monitor's environment can bias the evaluation outcome. Evaluation during unusual, short-term environmental circumstances, such as short-term unusually high background intensity, may change the outcome of the evaluation.

10.8 Routine-operational evaluation results could be biased by any pretesting that is not normally done before an individual passes through the monitor in its routine operation. An evaluating individual's attitude and manner of conducting the evaluation may change if he believes the monitor is or is not operating properly based on pre-testing. Similarly, the monitor itself may perform differently after recalibration than it had been performing before in routine operation. In either case, the pretest activity changes the procedure to a post-calibration evaluation.

10.9 Inattention to the outlined procedures in Section 8 and the sources of bias and error in this section can alter the evaluation outcome and reduce the value of in-plant evaluation. Failure to coordinate evaluation procedures beforehand with the plant operator or regulatory authority to reach an agreement (see 5.4) also decrease the value of an in-plant evaluation program.

11. Keywords

11.1 gamma radiation; material control and accountability; neutron radiation; nuclear materials management; radiation detectors; radiation monitors; safeguards; security

APPENDIX

(Nonmandatory Information)

X1.

X1.1 The example of a laboratory evaluation report shown in Fig. X1.1 contains the basic information that may be available in the two applications of in-plant evaluation.

Date ____________

Monitor Information
Monitor identification ____________
Location ____________
Visible switch settings ____________
Visible adjustable
Potentiometer positions ____________

Background Information
Background intensity (if measured) ____________
Monitor displayed count rate ____________

Nuisance Alarm Data and Result
Total number of alarms ____________
Total number of passages ____________
Calculated nuisance alarm probability ____________ rate ____________
Result
Accept ____________ Reject ____________

Detection Probability Evaluation Data and Result
Test source identification ____________
Way of carrying source ____________
Number of detections ____________ Number of passages ____________
Result
Accept ____________ Reject ____________

FIG. X1.1 SNM Monitor In-Plant Evaluation Report

NOTICE: This standard has either been superceded and replaced by a new version or discontinued. Contact ASTM International (www.astm.org) for the latest information.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).