Designation: C 1236 – 99 (Reapproved 2005)

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

This standard is issued under the fixed designation C 1236; 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 one of a series on special nuclear material (SNM) monitors and their performance evaluation. Others in the series provide information on SNM monitoring, monitor calibration, and methods of evaluation (see 1.3), but Guide C 993, in particular, provides much of the basis for this guide. The purpose for a guide to in-plant performance evaluation is to provide a comparatively rapid way to *verify* whether SNM monitors perform as expected for detecting SNM or an alternative test source.

1.2 Guide C 993 points out that in-plant evaluation is one part of a program to keep SNM monitors in proper operating condition and that in-plant evaluation can be used as a routine operational evaluation or can be used to verify performance after a monitor is calibrated.

1.3 This guide is based on ASTM standards that describe applying and evaluating SNM monitors.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 993 Guide for In-Plant Performance Evaluation of Automatic Pedestrian SNM Monitors

C 1112 Guide for Application of Radiation Monitors to the Control and Physical Security of Special Nuclear Material

C 1189 Guide to Procedures for Calibrating Automatic Pedestrian SNM Monitors

3. Terminology

3.1 *Definitions:*

3.1.1 *vehicle monitoring station*—a type of vehicle SNM monitor that monitors vehicles while they are stopped, awaiting clearance at an entry/exit station.

3.1.1.1 *Discussion*—These monitors are described in 5.3.2 of Guide C 1112.

3.1.2 *vehicle portal monitor*—an automatic vehicle SNM monitor that monitors moving vehicles as they pass through radiation detectors during their approach to an entry/exit station.

3.1.2.1 *Discussion*—These monitors are described in 5.3.1 of Guide C 1112.

3.2 Terminology for confidence coefficient, confidence interval, detection probability, evaluations, nuisance alarm, SNM, SNM monitor, and test sources is defined or described in Section 3 of Guide C 993.

4. Summary of Guide

4.1 The monitor to be evaluated is a vehicle SNM portal monitor (see 3.1.1) or a vehicle SNM monitoring station (see 3.1.2).

4.2 As a first step, the monitor's indicated background measurement value is recorded for possible future use in troubleshooting.

4.3 If the monitor is being evaluated in routine operation, the number of nuisance alarms since the last evaluation is examined for evidence of possible misoperation.

4.4 The detection probability for a test source is evaluated by repeatedly transporting a test source through the monitor.

4.5 The results of the evaluation are analyzed and recorded.

5. Significance and Use

5.1 SNM monitors are an effective and unobtrusive means to search for concealed SNM, and facility security plans use them to prevent SNM theft or unauthorized removal from SNM access areas. Functional testing of monitors on a daily basis with radioactive sources can assure that they are in good working order. The significant use of a less frequent, in-plant evaluation of an SNM monitor is to verify that the monitor

[1] This guide is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.05 on Methods of Tests.

Current edition approved June 1, 2005. Published October 2005. Originally approved in 1993. Last previous edition approved in 1999 as C 1236-99.

[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.

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States.

Copyright by ASTM Int'l (all rights reserved); Thu Apr 16 08:43:16 EDT 2009
Downloaded/printed by
Laurentian University pursuant to License Agreement. No further reproductions authorized.

achieves an expected probability of detection for an SNM or alternative test source.

NOTE 1—An SNM test source used for in-plant evaluation is normally shielded only by protective encapsulation and the parts of a vehicle that may lie between the source and the monitor's detectors. However, the evaluation procedure could just as well be used to verify an expected level of detection for SNM inside of containers or shields.

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(Tl) 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).

7. Test Materials

7.1 The required material is a test source that may be standard SNM, process SNM, or an alternative test source as described in Section 7 of Guide C 993.

8. Procedure

8.1 *Procedure for Nuisance Alarm Evaluation*:

8.1.1 Examine records of nuisance alarms when evaluating a monitor in routine service.

8.1.2 The record of alarms should be one generated at the monitoring point.

8.1.3 Depending on how the monitoring-point records are kept, the alarm record may or may not include an estimate of the number of vehicle passages. Hence, either the number of nuisance alarms since the last evaluation or, preferably, information for estimating the nuisance alarm rate per passage may be available.

8.1.4 Compare the number of nuisance alarms or the estimated nuisance alarm rate (nuisance alarms divided by passages) with the expected number derived from previous experience. A high number of nuisance alarms or a high-nuisance alarm rate may indicate a change in monitor performance or an unacceptable SNM monitoring environment. In any case, the problem must be investigated and corrected.

8.1.5 Refer to the manufacturer's recommended procedures for suggestions on investigating and correcting excessive nuisance alarms. Guide C 993 and Guide C 1189 also provide information that may be helpful in resolving monitoring problems.

8.2 *Procedure for Detection Probability Evaluation*:

8.2.1 At the start, a test source (see 7.1), vehicle, location for the source in the vehicle, vehicle passage speed and path through the monitor, and number of vehicle passages must be chosen (if they have not already been chosen).

NOTE 2—It is the responsibility of the users of this evaluation to coordinate its application with the appropriate regulatory authority so that mutually agreeable choices for the items listed and the evaluation frequency are used.

8.2.2 The vehicle used in the performance evaluation must be selected on some basis that assures that the vehicle by itself does not cause alarms. A possible choice for assurance during an evaluation is the following:

8.2.2.1 The individual who will drive the vehicle during the evaluation can first drive it into or through the monitor, as appropriate, without a source. The chosen manner of passage and the chosen number of passages should be used, and the results (alarm or not for each passage) should be recorded. Any alarms that occur disqualify the vehicle from further use; select another vehicle and restart the evaluation.

8.2.3 Next, the individual should drive the vehicle transporting the source into or through the monitor, as appropriate. After each passage, record the results (detection or miss), and move the vehicle well away from the monitor before making the next passage. Allow the monitor's background measurement to update after each passage, or after each 20 % of passages when 10 or more passages are used.

8.2.4 When the total number of passages with the source is complete, tally the results and analyze them by using Table 1. Record the analysis result, acceptance, or rejection.

8.2.5 The acceptance criteria in Table 1 provides at least 95 % confidence that the probability of detection for the test source used in the evaluation is greater than 0.50. Therefore, the hypothesis that the monitor is operating as expected is accepted. Rejection criteria does not provide 95 % confidence that the probability of detection is greater than 0.50, so the hypothesis is rejected. In that case, the monitor can be repaired, recalibrated, and evaluated again. See 8.2.5 through 8.2.7 of Guide C 993 for a discussion of the criteria.

8.2.6 Other criteria (for more passages, different detection probabilities, or accumulated results) could be used as well. Appendix X2 provides additional criteria for verifying a test source detection probability with 95 % confidence in an evaluation. The criteria can also be used for making a point estimate of detection probability from results accumulated from more than one evaluation.

9. Report

9.1 Written reports should be used to document the evaluation.

9.2 A report for a vehicle monitor evaluation may include the following: monitor switch settings or parameter values, measured background intensity (if available) and the monitor's

TABLE 1 Number of Detections for Acceptance and Rejection

NOTE 1—Complete the number of passages chosen in 8.2.1 and then use the criteria for that number of passages 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

Copyright by ASTM Int'l (all rights reserved); Thu Apr 16 08:43:16 EDT 2009
Downloaded/printed by
Laurentian University pursuant to License Agreement. No further reproductions authorized.

displayed count rate, nuisance alarm data and results, detection probability data, and results. See Appendix X1 for an example of an evaluation report form.

10. Errors and Bias

10.1 Section 10 of Guide C 993 gives examples of errors and bias that can occur in an SNM monitor evaluation. The discussion of the influence of the occupant (a person) in that guide usually applies as well to the occupying vehicle of an automatic vehicle monitor.

11. Keywords

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

APPENDIXES

(Nonmandatory Information)

X1. EVALUATION REPORT

X1.1 An example of a vehicle SNM monitor in-plant evaluation report is shown in Fig. X1.1.

VEHICLE SNM MONITOR IN-PLANT EVALUATION REPORT

Type of Evaluation—Post Calibration _____ Routine _____ Date _____

Monitor Information

Monitor identification _____
Location _____
Switch or parameter values _____
Calibration or Due Date _____
Criterion for Acceptance _____

Background Information

Background intensity (if measured) _____
Monitor displayed count rate _____

Nuisance Alarm Data and Result

Total number of alarms or _____
Total alarms and passages and _____
Calculated nuisance alarm rate _____
Result _____ Accept _____ Reject

Detection Probability Verification Data and Result

Test source identification _____
Vehicle identification _____
Source location and passage speed _____
Vehicle path through the monitor _____

Results of No-Source Passages

Passage 1.	Alarm _____	No Alarm _____
Passage 2.	Alarm _____	No Alarm _____
Passage 3.	Alarm _____	No Alarm _____
.	. .	. .
.	. .	. .
Passage 29.	Alarm _____	No Alarm _____
Passage 30.	Alarm _____	No Alarm _____
Result	Fail (alarms) _____	Pass (none) _____

Results of Source Passages

Passage 1.	Detect _____	Miss _____
Passage 2.	Detect _____	Miss _____
Passage 3.	Detect _____	Miss _____
.	. .	. .
.	. .	. .
Passage 29.	Detect _____	Miss _____
Passage 30.	Detect _____	Miss _____
TOTALS	_____	_____

Evaluation Result _____ Accept _____ Reject

Names and Signatures of Evaluators

_____ _____

_____ _____

FIG. X1.1 Vehicle SNM Monitor In-plant Evaluation Report

Copyright by ASTM Int'l (all rights reserved); Thu Apr 16 08:43:16 EDT 2009
Downloaded/printed by
Laurentian University pursuant to License Agreement. No further reproductions authorized.

X2. ADDITIONAL DETECTION CRITERIA

X2.1 Acceptance criteria for various detection probabilities and numbers of total passages are illustrated in Table X2.1. The total number of passages and number of detections can be the results of one evaluation, or they can be results accumulated over a period of time from a number of evaluations, as long as the same test object is used and the monitor has been in continuous operation during the period without recalibration, adjustment, or repair. When using accumulated results, all results obtained during the period must be included. If a monitor has required repair, adjustment, or recalibration, only results accumulated afterward can be used to evaluate the monitor's performance.

TABLE X2.1 Detection Criteria for Verifying Detection Probability

Total Number of Passages	Listed Number of Detections or More Required to Verify a Detection Probability[A] of:					
	0.50	0.75	0.80	0.85	0.90	0.95
20	15	19	20	20	...[B]	...
30	20	27	28	29	30	...
50	32	43	45	47	49	...
100	59	83	87	92	96	99
250	139	200	211	223	234	244
1000	527	774	822	869	916	962

[A]For total passages from a single evaluation, the detection probability is estimated to be greater than the column heading value with at least 95 % confidence. For accumulated passages from more than one evaluation, the column heading is a point estimate of the detection probability.

[B]An inadequate total number of passages to estimate the indicated detection probability with at least 95 % confidence in a single evaluation.

X2.2 *Example of Using Table X2.1*:

X2.2.1 Suppose a facility evaluates a monitor once a week using 10 passages with a particular test object and accumulates results for ten weeks. If the results total 94 detections and 6 misses for 100 passages, the 100 passages row in Table X2.1 gives a point estimate of greater than 0.85 for the detection probability over the 10-week period.

X2.2.2 Fifteen weeks later, assuming the monitor for some reason still has not been recalibrated, if the accumulated results are 235 detections and 15 misses out of 250 total passages, the 250-passage row gives a point estimate of greater than 0.90 for the detection probability over the 15-week period.

X2.2.3 At this point, suppose the monitor is recalibrated, and the initial 10 passages provided 9 detections. Table 2 then shows that the monitor's detection probability is verified to be greater than 0.50 with at least 95 % confidence. At this point, no accumulated data from previous evaluation can be included because of the recalibration.

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).

Copyright by ASTM Int'l (all rights reserved); Thu Apr 16 08:43:16 EDT 2009
Downloaded/printed by
Laurentian University pursuant to License Agreement. No further reproductions authorized.