Designation: C 1309 – 97 (Reapproved 2003)

Standard Practice for Performance Evaluation of In-Plant Walk-Through Metal Detectors[1]

This standard is issued under the fixed designation C 1309; 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.

INTRODUCTION

Nuclear regulatory authorities require personnel entering designated security areas to be screened for concealed weapons and personnel exiting areas containing specified quantities of special nuclear material to be screened for metallic nuclear shielding materials. Portal-type walk-through metal detectors are widely used to implement these requirements. This practice provides guidelines for evaluating the in-plant performance of walk-through metal detectors.

1. Scope

1.1 This practice is one of several (see Appendix X1) developed to assist operators of nuclear facilities with meeting the metal detection performance requirements set by regulatory authorities.

1.2 This practice consists of four procedures useful for evaluating the in-plant performance of walk-through metal detectors (see Fig. 1).

1.2.1 Two of the procedures provide data for evaluating probability of detection. These procedures use binomial data (alarm/not alarm).

1.2.1.1 The detection sensitivity test (DST)[2] is the initial procedure in the detection probability evaluation series. It is used to establish the probability of detection immediately after the detector has been adjusted to its operational sensitivity setting.

1.2.1.2 The detection sensitivity verification test (DSVT)[2] procedure periodically provides data for evaluation of continuing detection performance.

1.2.2 The third procedure is a "functional test." It is used routinely to verify that a metal detector is operating and responds with the correct audio and visual signals when subjected to a condition that should cause an alarm.

1.2.3 The fourth procedure is used to verify that alarms generated during detection sensitivity testing were likely the result of the detection of metal and not caused by outside interferences or the perturbation of the detection field by the tester's body mass.

1.2.3.1 This procedure also can be used to establish a probability of occurrence for false alarms, for example, 20 test passes by a clean-tester resulting in no alarms indicates a false alarm probability of less than 0.15 at 95 % confidence. This procedure is optional unless required by the regulatory authority.

1.3 This practice does not set test object specifications. The specifications should be issued by the regulatory authority.

1.4 This practice is intended neither to set performance levels nor to limit or constrain technologies.

1.5 This practice does not address safety or operational issues associated with the use of walk-through metal detectors.

2. Referenced Documents

2.1 *ASTM Standards:*

C 1238 Guide for Installation of Walk-Through Metal Detectors[3]

C 1269 Practice for Adjusting the Operational Sensitivity Setting of In-Plant Walk-Through Metal Detectors[3]

C 1270 Practice for Detection Sensitivity Mapping of In-Plant Walk-Through Metal Detectors[3]

F 1468 Practice for Evaluation of Metallic Weapons Detectors for Controlled Access Search and Screening[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *clean-tester*, *n*—a person who does not carry any extraneous metallic objects that would significantly alter the signal produced when the person carries a test object.

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

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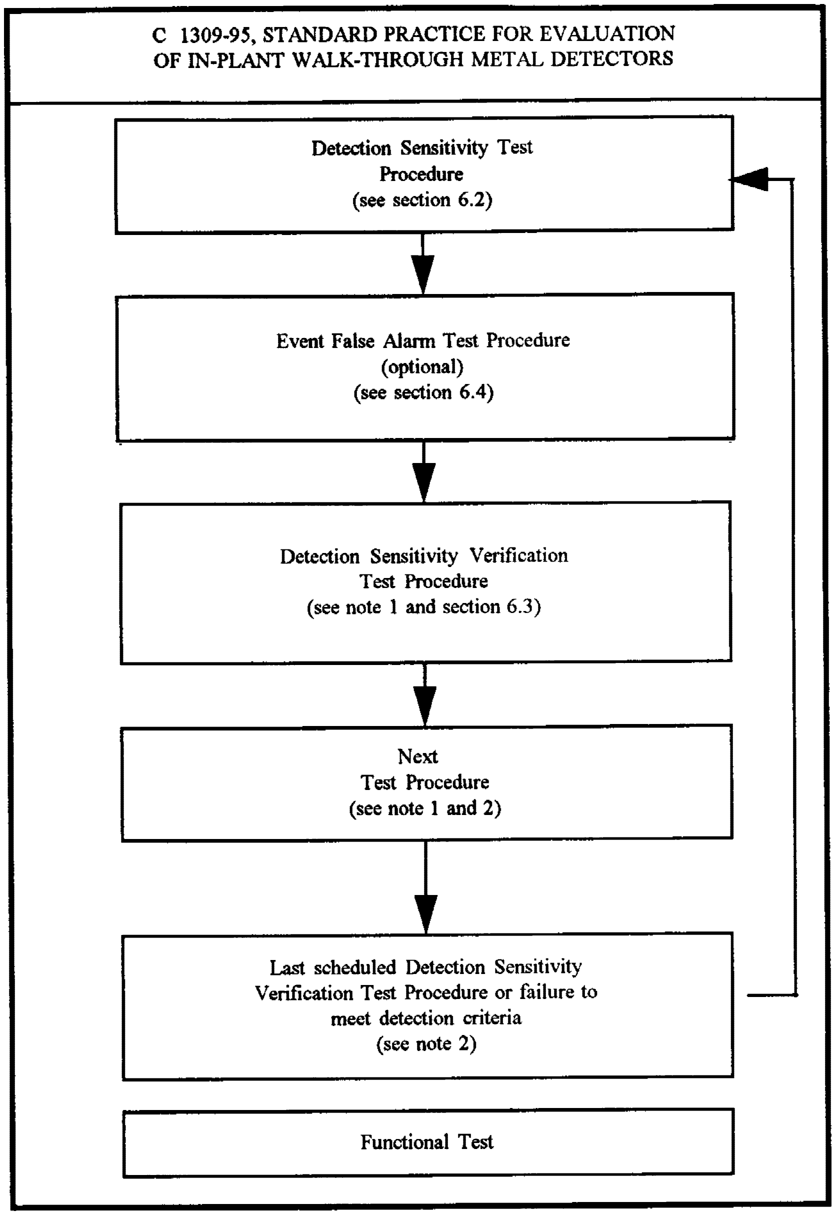
[2] The DST is one of two procedures used to evaluate detection rate. The Detection Sensitivity Verification Test (DSVT) is the other. In the evaluation test strategy, the DST is used to initially determine and document the detection rate and then the DSVT is used to periodically check that the detection rate continues to meet the requirements.

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

[4] *Annual Book of ASTM Standards*, Vol 15.07.



NOTE 1—The number of detection sensitivity verification tests in a series, the number of passes per test, the acceptance criteria, and the frequency may be established by regulatory authority or set by the security organization based on threat scenarios or vulnerability assessments; the numbers should be sufficient to provide a degree of assurance commensurate with the detector application.

NOTE 2—If the detector fails to meet the acceptance criteria, the verification series is terminated. The detector then must be tested to reestablish the probability of detection. If the probability of detection requirement cannot be met (repairs may be necessary), the detector must be mapped and the operational sensitivity setting reestablished. Performance testing can then be resumed starting with a new detection sensitivity test.

NOTE 3—If the detector fails the functional test, the detector must be immediately removed from service (see Appendix X1).

FIG. 1 Walk-Through Metal Detector Evaluation Testing Program

3.1.1.1 *Discussion*—By example but not limitation, such extraneous metallic objects may include: metallic belt buckles, metal buttons, cardiac pacemakers, coins, metal frame eyeglasses, hearing aids, jewelry, keys, mechanical pens and pencils, shoes with metal shanks or arch supports, metallic surgical implants, undergarment support metal, metal zippers, etc. In the absence of other criteria, a clean-tester passing through a metal detector shall not cause a disturbance signal greater than 10 % of that produced when carrying the critical test object through the detector. Test objects requiring very high sensitivity settings for detection require more complete elimination of extraneous metal to obtain less than 10 % signal disturbance. The tester shall have a weight between 50–104 kg and a height between 1.44–1.93 m. Should a given detector be sensitive to body size because of design or desired sensitivity, the physical size of testers should be smaller and within a narrower range. It is recommended that the clean-tester be surveyed with a high sensitivity hand-held metal detector to ensure that no metal is present.

3.1.2 *critical orientation*, *n*—the orthogonal orientation of a test object that produces the smallest detection signal or weakest detection anywhere in the detection zone; the orthogonal orientation of a test object that requires a higher sensitivity setting to be detected compared to the sensitivity settings required to detect the object in all other orthogonal orientations. See Fig. 2 for handgun orientations.

3.1.2.1 *Discussion*—Critical orientations are determined by testing using a mapping procedure such as described in Practice C 1270 (see 3.1.21 and Fig. 3).

3.1.2.2 *Discussion*—The term critical orientation can be applied in two ways. Critical orientation can refer to the worst case orthogonal orientation in a single test path or the worst case orthogonal orientation for all the test paths (the entire detection zone). The two are coincident in the critical test path.

3.1.3 *critical sensitivity setting*, *n*—the lowest sensitivity setting of a detector at which the critical test object in its critical orientation is consistently detected (10 alarms out of 10 passages) when passed through the detection zone on the critical test path.

3.1.4 *critical test element*, *n*—see **test element**.

3.1.5 *critical test object*, *n*—the one test object out of any given group of test objects that, in its critical orientation, produces the weakest detection signal anywhere in the detection zone.

3.1.5.1 *Discussion*—The group referred to consists of one or more objects that are to be detected at the same detector setting.

3.1.5.2 *Discussion*—Depending on the particular detector, some orientation-sensitive test objects may have different critical orientations through different test paths in the detection zone. Hence, care must be taken in determining the critical test object, its critical orientation, and the critical test path.

3.1.6 *critical test path*, *n*—the straight-line shortest-course path through the portal aperture, as defined by an element on the detection sensitivity map, that produces the smallest detection signal or weakest detection for a test object in its critical orientation (see Fig. 4 and Fig. 2).

3.1.7 *detection sensitivity map* (see Fig. 3 and Appendix X2), *n*—a depiction of the grid used to define test paths

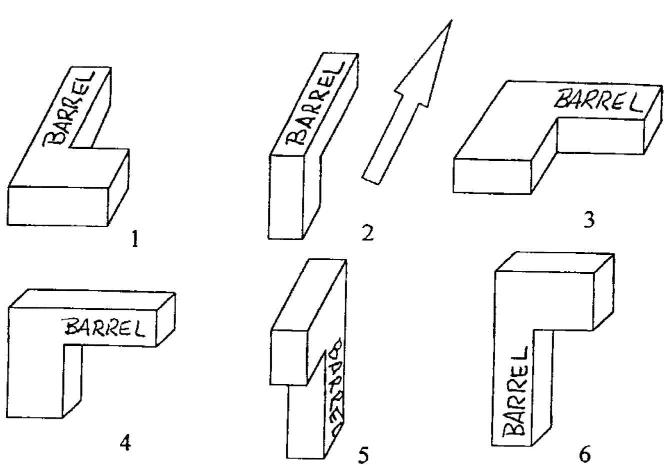


FIG. 2 Six Standard Orthogonal Orientations for a Handgun

52	68	52	52
49	55	75	71
50	52	75	73
48	58	74	70
35	63	81	72
47	62	89	74
47	69	79	75
57	71	81	79
62	74	74	69

critical test element

NOTE 1—Numbers are sensitivity setting values for a hypothetical detector. The numbers represent the lowest sensitivity setting at which the object was detected ten out of ten consecutive test passes through the indicated test path.

FIG. 3 Example of Detection Sensitivity Map

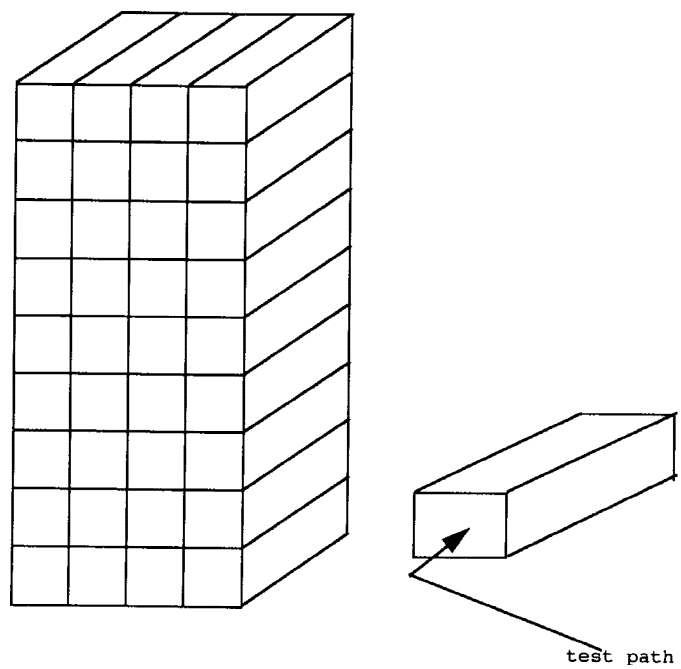


FIG. 4 3-D View of Detection Zones and Test Grid

through the detection zone, with each element of the grid containing a value, usually the sensitivity setting of the detector, that is indicative of the detectability of the test object.

3.1.7.1 *Discussion*—These values are relative and describe the detection sensitivity pattern within the detection zone for the specific test object. The values are derived by identically testing each defined test path using a specific test object in a single orthogonal orientation. The value is usually the minimum sensitivity setting of the detector that will cause a consistent alarm (10 out of 10 test passes when the test object