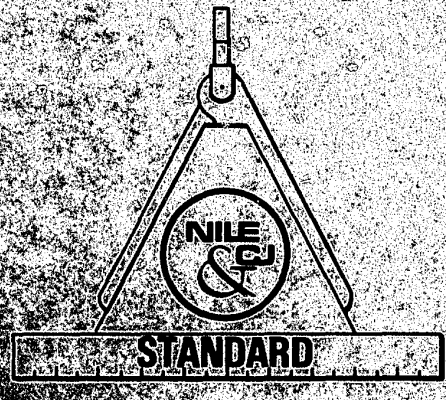
NILECJ-STD-0602.00
OCTOBER 1974

LAW ENFORCEMENT STANDARDS PROGRAM

HAND-HELD METAL DETECTORS FOR USE IN WEAPONS DETECTION



U.S. DEPARTMENT OF JUSTICE
Law Enforcement Assistance Administration
National Institute of Law Enforcement and Criminal Justice

Library of Congress Cataloging in Publication Data

National Institute of Law Enforcement and Criminal Justice.
NILECJ standard for hand-held metal detectors for use in weapons detection.

At head of title: Law Enforcement Standards Program. "NILECJ-STD-0602.00."
1. Metal detectors—Standards—United States. I. Title. II. Title: Hand-held metal detectors for use in weapons detection. III. Title: Law Enforcement Standards Program.
TK7882.M4N37 1975 363.3'3'028 74-28443

LAW ENFORCEMENT STANDARDS PROGRAM

NILECJ STANDARD
FOR
HAND-HELD METAL DETECTORS FOR USE IN WEAPONS DETECTION

A Voluntary National Standard Promulgated by the National Institute of Law Enforcement and Criminal Justice.

OCTOBER 1974

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For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 65 cents
Stock Number 2700-00285

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ACKNOWLEDGMENTS

This standard was formulated by the Law Enforcement Standards Laboratory of the National Bureau of Standards under the direction of Robert M. Mills, Manager, Investigative Aids Program, and Jacob J. Diamond, Chief of LESL.

NILECJ STANDARD FOR HAND-HELD METAL DETECTORS FOR USE IN WEAPONS DETECTION

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FOREWORD

Following a Congressional mandate[1] to develop new and improved techniques, systems, and equipment to strengthen law enforcement and criminal justice, the National Institute of Law Enforcement and Criminal Justice (NILECJ) has established the Law Enforcement Standards Laboratory (LESL) at the National Bureau of Standards. LESL's function is to conduct research that will assist law enforcement and criminal justice agencies in the selection and procurement of quality equipment.

In response to priorities established by NILECJ, LESL is (1) subjecting existing equipment to laboratory testing and evaluation and (2) conducting research leading to the development of several series of documents, including national voluntary equipment standards, user guidelines, state-of-the-art surveys and other reports.

This document, NILECJ-STD-0602.00, Hand-Held Metal Detectors for Use in Weapons Detection, is a law enforcement equipment standard developed by LESL and approved and issued by NILECJ. Additional standards as well as other documents will be issued under the LESL program in the areas of protective equipment, communications equipment, security systems, weapons, emergency equipment, investigative aids, vehicles and clothing.

This equipment standard is a technical document consisting of performance and other requirements together with a description of test methods. Equipment which can meet these requirements is of superior quality and is suited to the needs of law enforcement agencies. Purchasing agents can use the test methods described in this standard to determine firsthand whether a particular equipment item meets the requirements of the standard, or they may have the tests conducted on their behalf by a qualified testing laboratory. Law enforcement personnel may also reference this standard in purchase documents and require that any equipment offered for purchase meet its requirements and that this compliance be either guaranteed by the vendor or attested to by an independent testing laboratory.

The necessarily technical nature of this NILECJ standard, and its special focus as a procurement aid, make it of limited use to those who seek general guidance concerning hand-held metal detectors. The NILECJ Guideline Series is designed to fill that need. We plan to issue guidelines to this as well as other law enforcement equipment as soon as possible, within the constraints of available funding and the overall NILECJ program.

The guideline documents to be issued are highly readable and tutorial in nature, in contrast to the standards, which are highly technical and intended for laboratory use by technical personnel. The guidelines will provide, in non-technical language, information for purchasing agents and other interested persons concerning the capabilities of equipment currently available. They may then select equipment appropriate to the performance required by their agency. Recommendations for the development of particular guidelines should be sent to us.

NILECJ standards are subjected to continuing review. Technical comments and recommended revisions are invited from all interested parties. Suggestions should be addressed to the Program Manager for Standards, National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, U.S. Department of Justice, Washington, D.C. 20531.

LESTER D. SHUBIN, *Manager*,
Standards Program
National Institute of Law
Enforcement and Criminal Justice

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[1] Section 402(b) of the Omnibus Crime Control and Safe Streets Act of 1968, as amended.

NILECJ STANDARD FOR HAND-HELD METAL DETECTORS FOR USE IN WEAPONS DETECTION

1. PURPOSE AND SCOPE

The purpose of this document is to establish performance requirements and methods of test for hand-held metal detectors used for determining the location of metal weapons carried on a person. The standard also applies to detectors which can be hidden on the operator's body.

2. CLASSIFICATION

2.1 Security Applications

A detector may meet the requirements for one or more security applications, as defined below.

2.1.1 Application 1—Unobtrusive Search for Ferromagnetic Weapons

Unobtrusive scanning for ferromagnetic guns and large knives on persons carrying normal metal items including foil packages.

2.1.2 Application 2—Open Search for Ferromagnetic Weapons

Open scanning of persons for ferromagnetic guns and large knives.

2.1.3 Application 2NM—Open Search for Metal Weapons

Open scanning of persons for guns and large knives constructed of either ferromagnetic or nonferromagnetic metal.

2.1.4 Application 3—Open Search for Small Metal Weapons

Open scanning for either ferromagnetic or nonferromagnetic metal weapons as small as a razor blade on persons who have supposedly removed all metal items.

2.2 Alarm Indication Class

2.2.1 Class I—Simple Alarm Indication

An alarm indication having only two states, one for the absence and the other for the presence of significant metal.

2.2.2 Class II—Proportional Alarm Indication

An alarm indication which is proportional to the size, proximity, orientation, and material of a metal object. The operator must judge whether the magnitude of the indication constitutes an alarm.

2.3 Detector Type

2.3.1 Passive Detector

One which does not intentionally generate any external magnetic field. It usually responds only to ferromagnetic materials and magnets.

2.3.2 Active Detector

One which generates an external magnetic field. It usually responds to any metal.

3. DEFINITIONS

3.1 Detection

A positive alarm indication caused by a test object, test signal or weapon.

3.2 Positive Alarm Indication

The change in alarm indicator response which is considered to indicate metal.

3.3 Separation Distance

The shortest distance between the metal sensing area of the detector and a test object or the center of the test coil. If the metal sensing element has an open loop geometry, the surface of an imaginary membrane stretched over the metal sensing element shall be considered to be part of the sensing area.

4. REQUIREMENTS

4.1 Ambient Temperature

Detectors shall meet the requirements of this standard over the ambient temperature range of at least 15° C to 38° C (59° F to 100° F).

4.2 Controls

The manufacturer shall specify the settings or a calibration procedure for all controls for each applicable combination of security application and alarm indication class. The direction of movement of the final adjustment of a control shall be specified if significant. The setting of all external controls by an operator familiar with the procedure shall not require more than ten seconds.

4.3 Alarm Indication

For Class I detectors, any pilot indication which is on whenever the detector power is applied must be separate and distinct (not vary only in degree) from the alarm indication. For Class II detectors, the manufacturer shall specify the positive alarm indication to be used in determining detection for each required security application.

4.3.1 Audible Alarm Indicators

Any audible indicator other than an earphone shall produce an alarm-state sound pressure level at the ear of the operator of at least 63 decibels, measured in accordance with 5.2.2. The sound pressure level of a Class I indication measured in accordance with 5.2.2, shall be at least 9 decibels higher in the alarm state than in the non-alarm state.

Any Class II alarm indication consisting of a frequency change shall have a quiescent state frequency drift rate, measured in accordance with 5.2.3, of not more than 5 hertz per second. The non-alarm state frequency, if an operator option, shall include 440 hertz in the adjustment range. The positive alarm indication for security applications 1, 2, and 2 NM shall be a fundamental frequency change of at least 50 hertz. The positive alarm indication for security application 3 shall be a change in fundamental frequency of at least 20 hertz. For security application 1, if there is an audible indicator, there shall be provision for using an earphone which, when used, shall disable any other audible indicator.

4.3.2 Visible Alarm Indicators

Any visible alarm indication shall be readily perceptible when tested in accordance with 5.2.4. The positive alarm indication of a deflection type of alarm indicator shall be a deflection of at least one-half of end scale or 5 millimeters (0.2 inch), whichever is greater.

4.3.3 Other Indicators

Indicators with responses other than visible or audible shall have a positive alarm indication that is readily perceptible to the operator in normal operating environments.

4.4 Detection Performance

The detector shall meet the detection performance requirements for each security application in which it is required to operate. When tested in accordance with 5.3, each test object or test signal listed in table 1 under required detection for that security application shall be detected. Conversely, the test object listed under forbidden detection shall not be detected.

TABLE I. *Detection Performance Requirements*

The test objects listed below are described in 5.3.1.1, figure 2 and figure 3. The test coil for producing the test signal is described in 5.3.1.2.

Security Application	Required Detection		Forbidden Detection
	Active Detector	Passive Detector	
1	Object 1M	Test Signal	Foil Package
2	Object 1M	Test Signal	
2NM	Objects 1M and 1N		
3	Objects 1M, 1N and 2		

4.5 Time Varying Generated Magnetic Field

The carrier frequency of any magnetic field generated by the detector shall be between 1.00 kilohertz and 1.000 megahertz. The frequency of any amplitude modulation shall be greater than 400 hertz. When measured in accordance with 5.4, the maximum peak-to-peak voltage induced by the generated magnetic field shall not exceed $200(f/85)^{4/5}$ millivolts for detectors operating at frequencies, f, in kilohertz, less than or equal to 85 kilohertz, and shall not exceed 200 millivolts for those operating at frequencies greater than 85 kilohertz (see figure 1).

4.6 Operation Near Metal Walls

The detector shall not produce a positive alarm indication when tested in accordance with 5.5.

4.7 Batteries

4.7.1 Condition

The manufacturer shall provide a means of determining that the batteries require recharging or replacement before their degradation adversely affects the detection performance.

4.7.2 Minimum Battery Life

After the battery life test of 5.6, the detector shall meet the alarm indication requirements of 4.3 and the detection performance requirements of 4.4 for test object 1M or the test signal, whichever is applicable.

4.8 Interference

The detector shall comply with the Federal Communications Commission Code of Federal Regulations; Title 47—Telecommunications; Part 15, Radio Frequency Devices.

4.9 Electrical Safety

If the potential difference between any two parts of the detector exceeds 42.4 volts peak, the detector shall comply with Underwriters Laboratories Standard UL 114 for Office Appliances and Business Equipment (ANSI X4.12-1970).[1]

[1] Copies of this standard may be obtained from Underwriters Laboratories, Inc., 207 E. Ohio Street, Chicago, Illinois 60611.

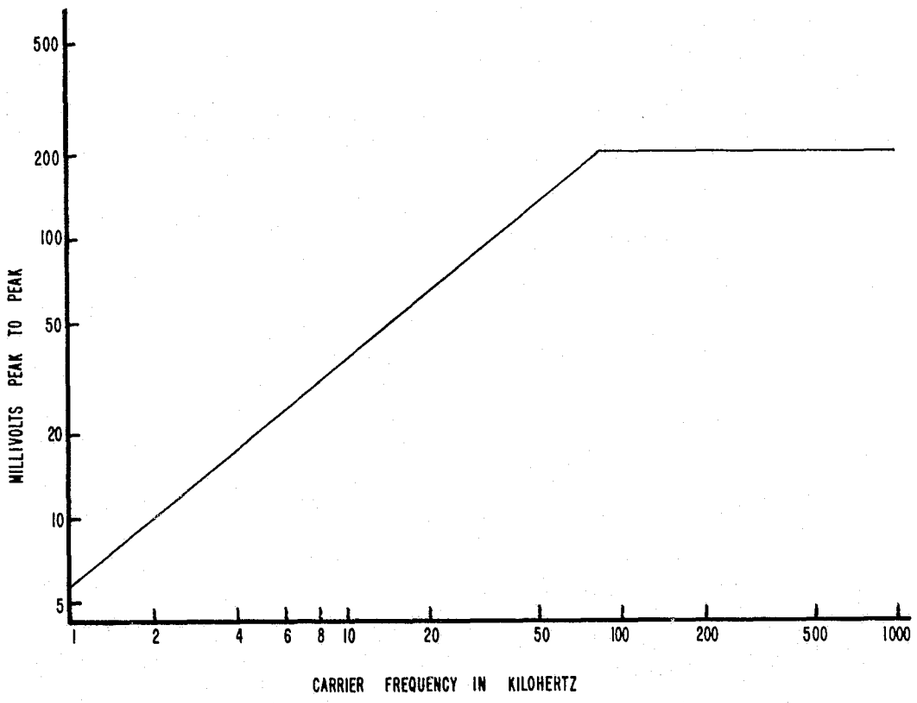

FIGURE 1. *Maximum Induced Voltage in 22.5cm Loop at 2.5cm Separation Distance*

4.10 Data Supplied by the Manufacturer

An operator's manual shall be supplied by the manufacturer or distributor with each detector. This manual shall clearly state the instructions for operation and maintenance of the device and shall include the following information:

A. Security Applications (as described in 2.1) and corresponding alarm indication class (as classified in 2.2) for which the detector can be adjusted to operate.

B. Recommended initial range of response for any class II indication.

C. Detector type (as classified in 2.3).

D. Overall dimensions of the detector.

E. Dimensions of the detector in the region normally gripped by the hand.

F. Weight of the detector.

G. Battery type and quantity.

H. Operating ambient temperature range.

5. TEST METHODS

5.1 General Test Conditions

5.1.1 Test Location

The distance between any metal object other than a test object and the closest part of the detector shall be greater than 0.90 meter (35 inches).

5.1.2 Environment

At the time of the tests, the ambient temperature shall be between 15°C and 38°C (59°F and 100°F); the relative humidity shall be between 10 percent and 80 percent.

5.1.3 Preparations

New batteries of the type listed in the operator's manual shall be installed at the beginning of the tests and as instructed in any test method. Any setup or calibration adjustments specified in the operator's manual shall be performed if required.

5.2 Alarm Indication Tests

5.2.1 Equipment

5.2.1.1 Sound Level Meter

The sound pressure level meter shall comply with ANSI S1.4, 1971 "Specifications for General Purpose Sound Level Meters"[2] for type 3, A-weighting, reference pressure 20 micropascals.

5.2.1.2 Audio Frequency Measurement System

The system for measuring the fundamental audio frequency of an audible alarm indication shall be capable of measuring a frequency difference with an accuracy of 1 hertz and be capable of providing a new measurement within 4 seconds after a change in frequency.

5.2.1.3 Illumination Meter

The illumination meter shall be capable of measuring light levels of 25 lux (2.3 foot-candles) and 10,000 lux (929 foot-candles) with an error of not more than 10 percent. The integrated spectral response shall be within 10 percent of the CIE photopic curve.

5.2.2 Sound Pressure Level Test

Perform the test in an anechoic chamber or at an outdoor location, at least 6 meters (20 feet) from any large object, where the ambient sound pressure level at the time of the test is not more than 53 decibels. Hold the detector in the normal manner in the right hand at waist level with that arm extended in front of the body. Direct the metal-sensing area of the detector to the left, with the detector's major axis horizontal. Position the sound pressure level meter microphone 0.80 meter (31 inches) from the center of the palm of the hand holding the detector. Place the microphone adjacent to the right ear of the tester approximately 15 centimeters (6 inches) from the head. For a detector with Class I alarm indication, measure the sound pressure level with the detector power applied and the alarm indicator in the non-alarm state. Then position test object 1M, described in figure 2, at a separation distance of 5 centimeters (2 inches) to produce an alarm, and again measure the sound pressure level. For a detector with Class II alarm indication, adjust the initial frequency, if adjustable, to about 440 hertz and measure the sound pressure level with the detector power applied. Then position test object 1M at a separation distance of 5 centimeters (2 inches) for maximum detector response and measure the sound pressure level.

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[2] Copies of this standard may be obtained from the American National Standards Institute, Inc., 1420 Broadway, New York, New York 10018.

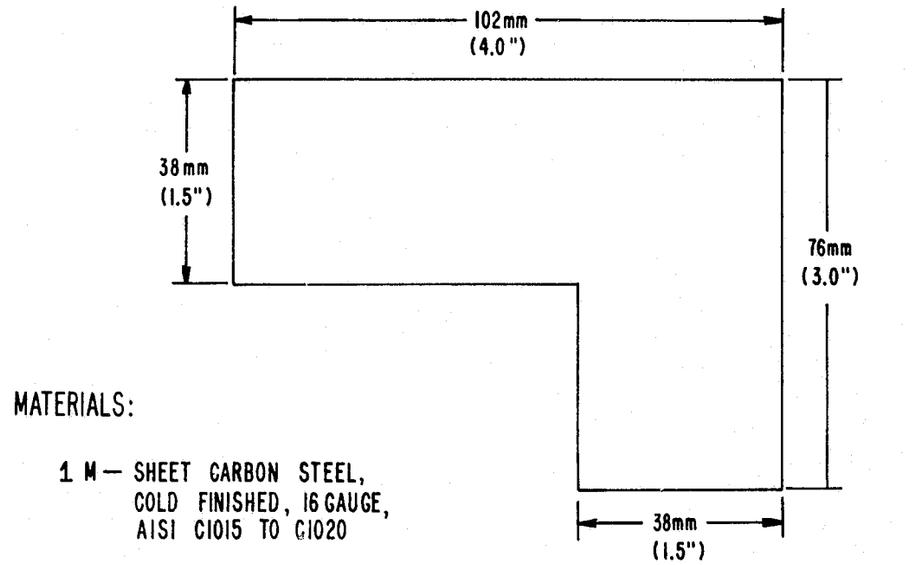

FIGURE 2. *Test Objects 1M and 1N Simulating .25 Semiautomatic Pistol*

5.2.3 Frequency Stability Test

After the detector has been off for at least 5 minutes, turn it on and adjust the initial frequency, if adjustable, to any convenient value. Complete any operator adjustments specified in the operator's manual within ten seconds. At 15 seconds and again at 45 seconds after the detector has been turned on, measure the frequency. Compute the average frequency drift rate by taking the difference between the measured frequencies and dividing by 30 seconds. Perform the procedure 3 more times and compute the mean of the average frequency drift rates.

5.2.4 Visible Alarm Indicator Test

Position the detector with its alarm indicator 0.80 meter (31 inches) from the eyes, at a test site where the ambient illumination is 10,000 lux (929 foot-candles) plus or minus 10 percent. After waiting at least three minutes to allow for eye accommodation, turn on the detector and move a metal object near the detector to cause an alarm. Observe the indication.

Repeat the test at a test site where the ambient illumination is 25 lux (2.3 foot-candles) plus or minus 10 percent.

5.3 Detection Performance Tests

If the detector can be adjusted for both alarm indication classes, the detection performance test shall be performed for each class. The detection performance shall be evaluated by bringing a test object to the detector or by applying a test signal to the detector using a test coil, each at a test separation distance specified in table 2. The

detector and any nearby metal shall be kept stationary to ensure that the change in the detector's response is due to a change in the test signal or the position of a test object.

TABLE 2. *Test Separation Distances*

	Separation Distance	
	Centimeters	*Inches*
Test Object 1M	7.6	3.0
Test Object 1N	7.6	3.0
Test Object 2	2.5	1.0
Test Coil	10.0	3.9
Foil Package	7.6	3.0

5.3.1 Equipment

5.3.1.1 Test Objects

Test objects 1M, 1N, and the foil package shall be of the sizes and materials shown in figures 2 and 3. Test object 2 shall be a stainless steel double edge razor blade with a nominal thickness of 0.1 millimeter (0.004 inch).

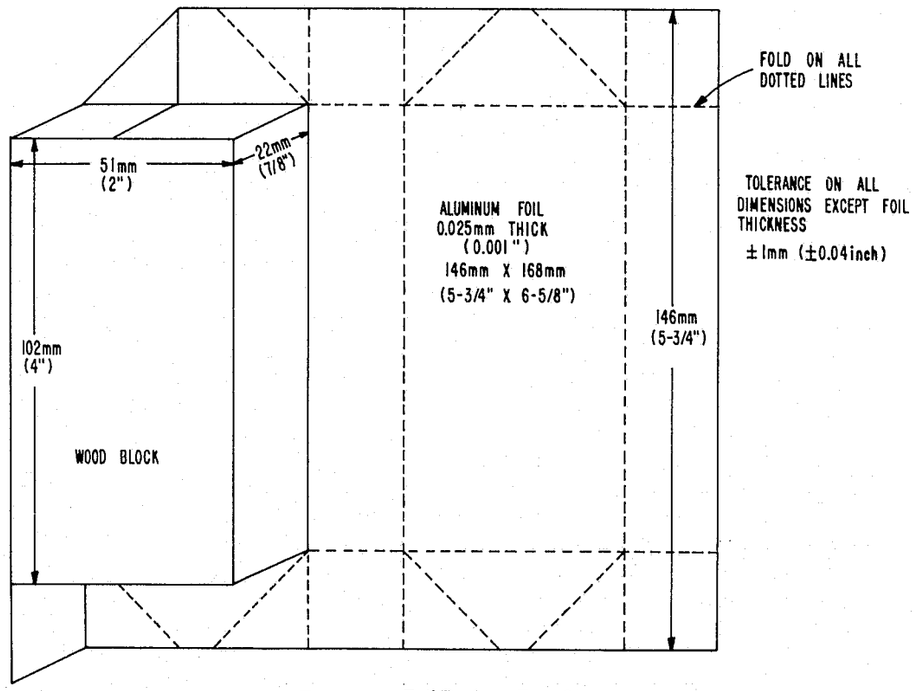

FIGURE 3. *Foil Package Test Object*

5.3.1.2 Test Coil

The test coil for generating the test signal shall consist of 25 turns of AWG 30 insulated copper magnet wire, close wound on a 2.54±0.13 centimeter (1.00±0.05 inch) diameter nonmetallic coil form. Separation distance measurements shall be made with respect to the center of the coil. The connecting wires shall be twisted pair or shielded cable.

5.3.1.3 Direct Current Source

The power source shall be capable of maintaining a direct current of 400 milliamperes ±3 percent in the test coil.

5.3.1.4 Detector, Test Object and Test Coil Supports

The detector and test object or test coil shall be firmly supported by nonmetallic materials such that the test separation distance between them is positively established. The position and orientation of the test object or test coil shall be adjustable for maximum detector response at the specified test separation distances. The test object shall be removable without changing the position of the detector.

5.3.2 Procedure

Set up the detector and test object or test coil supports at the test location and adjust them for the appropriate test separation distance listed in table 2. Remove the test object. Turn on the detector, permit it to warm up, and adjust its controls as specified in the operator's manual for the security application and alarm indication class. An alarm indicator with a Class I indication shall be in the non-alarm state. The response of an alarm indicator with a Class II indication shall be within the manufacturer's recommended initial range.

5.3.2.1 For Passive Detectors

Pass a direct current of 400 milliamperes ±3 percent through the test coil. Position and orient the coil for maximum detector response, or an alarm, at the test separation distance. Occasionally turn off the coil current and readjust the detector controls to maintain the initial detector setting or zeroing while positioning the test coil. Turn off the current in the test coil without moving the detector or coil. Turn off the detector for one minute. Then turn on the detector and readjust its controls (without moving the detector or coil) within 10 seconds. Do not make further adjustments to any controls. Reestablish the current in the test coil. Forty-five seconds after the detector is turned on, note the alarm indicator response and turn off the current in the test coil. Immediately note the new alarm indicator response. The test signal shall be considered to have been detected only if the alarm indicator with the current off is in the non-alarm state for a Class I indication or in the manufacturer's recommended initial range for a Class II indication, and the change in alarm indicator response corresponds to a positive alarm indication.

5.3.2.2 For Active Detectors

Position and orient the test object for maximum detector response, or an alarm, at the test separation distance. Occasionally remove the test object and readjust the detector controls to maintain the initial detector setting or zeroing while positioning the test object. After the position of maximum detector response has been located, remove the test object without moving the detector. Turn off the detector for one minute. Then turn on the detector and readjust any controls (without moving the detector) within 10 seconds. Do not make further adjustments to any controls. Reposition the test object for maximum detector response or an alarm. Forty-five seconds after the detector is turned on, note the alarm indicator response and then remove the test object. Immediately note the new alarm indicator response. The test object shall be considered to have been detected only if the alarm indicator with the test object removed is in the nonalarm state for a Class I indication or in the manufacturer's recommended initial range for a Class II indication, and the change in alarm indicator response corresponds to a positive alarm indication.

5.4 Time Varying Generated Magnetic Field Test

5.4.1. Equipment

A single turn circular wire loop 22.5 centimeters (8.9 inches) in diameter shall be connected to the input of an oscilloscope. The connecting wires shall be a twisted pair or shielded cable. The oscilloscope horizontal deflection shall have a calibrated range suitable for measuring the period of the carrier waveform of any magnetic field generated

by the detector under test with an error of not more than 5 percent. The oscilloscope shall have a vertical deflection range suitable for measuring peak-to-peak voltages of 5 to 200 millivolts for the carrier frequency with an error of not more than 5 percent.

5.4.2 Procedure

Set up the wire loop and the detector at the test location and support them in a manner that permits the position of the detector to be varied with respect to the loop while maintaining a separation distance of 2.50±.05 centimeters (0.98±0.02 inch). Turn on the detector and adjust its controls as specified in the operator's manual. Position the detector for maximum deflection of the oscilloscope. Determine the period of the carrier waveform and the peak-to-peak voltage induced in the loop.

5.5 Test for Operation Near a Metal Wall

5.5.1 Metal Test Panel

The metal test panel shall be cold-finished sheet carbon steel AISI C1015 to C1020, 0.914 meter (3.00 feet) by 0.914 meter (3.00 feet), 0.75±0.13 millimeters (0.030±0.005 inch) thick. The panel shall be mounted or supported in a manner which keeps the panel flat.

5.5.2 Procedure

Position the detector with its sensor plane parallel to, centered with respect to, and 0.90 meter (35 inches) from the plane of the test panel. Turn on the detector and adjust its controls as specified in the operator's manual. Note the alarm indicator response. Then rapidly (within 1 second) change the separation distance to 0.60 meter (24 inches) and immediately note the new alarm indicator response.

5.6 Battery Life Test

Install in the detector new or fully charged batteries of the type specified by the manufacturer. At the test location, turn on the detector and adjust its controls for operation at the security application and alarm indication class under test. Periodically adjust the controls as necessary for a period of 1 hour. Turn off the detector for 1 hour. Repeat the procedure for a total operating time of 3 hours. Twenty-four hours after the start of the test, again turn on the detector for 1 hour and off for 1 hour for three on cycles and a total operating time of 6 hours. After the last operating period, repeat the detection performance test of 5.3 for test object 1M or the test signal. If the detector has an audible alarm indicator other than an earphone, repeat the sound pressure level test of 5.2.2. If the requirements of 4.7.2 are not satisfied after performing the above test, repeat this test procedure once with another set of batteries obtained either from a different supplier or a different manufacturing lot.

A detector which can be adjusted for Class I or Class II alarm indication need not be tested when adjusted for Class I operation if the minimum battery life requirements are satisfied for Class II operation.

U. S. GOVERNMENT PRINTING OFFICE : 1975 O - 566-724

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