NILECJ-STD-0212.00
SEPTEMBER 1975

LAW ENFORCEMENT STANDARDS PROGRAM

RF COAXIAL CABLE ASSEMBLIES FOR MOBILE TRANSCEIVERS

STANDARD

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 RF coaxial cable assemblies
for mobile transceivers.

At head of title: Law Enforcement Standards Program.
Cover title: RF coaxial cable assemblies for
mobile transceivers.
"NILECJ-STD-0212.00."
Bibliography: p. 5
Supt. of Docs. no.: J1.41/2: 0212.00
1. Coaxial cables—Standards—United States.
2. Radio lines—Standards—United States. I. Title.
II. Title: Law Enforcement Standards Program.
III. Title: RF coaxial cable assemblies for mobile
transceivers.
TK3351.N34 1976 621.38'028 75-619317

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 35 cents
Stock Number 027-000-00357-5

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NILECJ STANDARD
FOR

RF COAXIAL CABLE ASSEMBLIES FOR MOBILE TRANSCEIVERS

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

SEPTEMBER 1975

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

LAW ENFORCEMENT ASSISTANCE ADMINISTRATION

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NATIONAL INSTITUTE OF LAW ENFORCEMENT AND CRIMINAL JUSTICE

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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 Marshall J. Treado, Program Manager for Communications Systems, and Jacob J. Diamond, Chief of LESL. NBS Electromagnetics Division staff members responsible for the preparation of the standard were Harold E. Taggart and Robert M. Jickling.

NILECJ STANDARD
for
RF Coaxial Cable Assemblies for Mobile Transceivers

CONTENT

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-0212.00, RF Coaxial Cable Assemblies for Mobile Transceivers, is a law enforcement equipment standard developed by LESL and approved and issued by NILECJ. Additional standards as well as other documents are being 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 rf coaxial cable assemblies for mobile transceivers. The NILECJ Guideline Series is designed to fill that need. We plan to issue guidelines for 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 nontechnical 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

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

NILECJ STANDARD for RF COAXIAL CABLE ASSEMBLIES FOR MOBILE TRANSCEIVERS

1. PURPOSE AND SCOPE

The purpose of this document is to establish requirements and methods of test for rf coaxial cable assemblies used with mobile transceivers by law enforcement agencies. This standard addresses the transmission line and connectors between the mobile transceiver and the mobile antenna and complements the other NILECJ standards for mobile communications equipment [3, 4, 5].

2. CLASSIFICATION

For the purposes of this standard, rf coaxial cable assemblies for mobile transceivers are classified by their operating frequencies.

2.1. Type I

RF coaxial cable assemblies which operate in the 400-512 MHz band.

2.2. Type II

RF coaxial cable assemblies which operate in the 150-174 MHz band.

2.3. Type III

RF coaxial cable assemblies which operate in the 25-50 MHz band.

3. DEFINITIONS

The principal terms used in this document are defined in this section. Additional definitions relating to law enforcement communications are available [2].

3.1. Characteristic Impedance

The impedance a transmission line would have if it were of infinite length.

3.2. Coaxial Cable

A transmission line formed by two coaxial conductors separated by a dielectric.

3.3. Coaxial Cable Assembly

A section of coaxial cable terminated, for the purposes of this standard, in a coaxial connector at one end.

3.4. Directional Coupler

A transmission coupling device for separately sampling either the forward or reflected wave in a transmission line.

3.5. Insertion Loss

The ratio of the power delivered to an output load before the insertion of a transmission line to the power delivered after the insertion of the line, expressed in decibels.

3.6. Standing Wave Ratio (SWR)

The ratio of the maximum to the minimum voltage or current appearing along a transmission line.

4. REQUIREMENTS

4.1. Configuration

The rf coaxial cable assembly shall consist of a section of flexible coaxial cable of 50-ohm characteristic impedance with a noncontaminating jacket, terminated at one end with a coaxial connector conforming with 4.2. To conduct the SWR test, place a connector which is compatible with the input connector of the standard output load on the other end of the coaxial cable.

4.2. Connector

The coaxial connector shall consist of a general purpose, Series UHF plug, military number PL-259, with a reducing adapter, if necessary, in solder-type affixation, or the equivalent in solderless crimp-type. The male contact of 3.97 mm (0.156 inch) diameter shall be supported by an insulator with a dielectric constant of 5.0 or less. Mechanical mating shall be provided by a ⅝-24 threaded coupling sleeve. See figure 1.

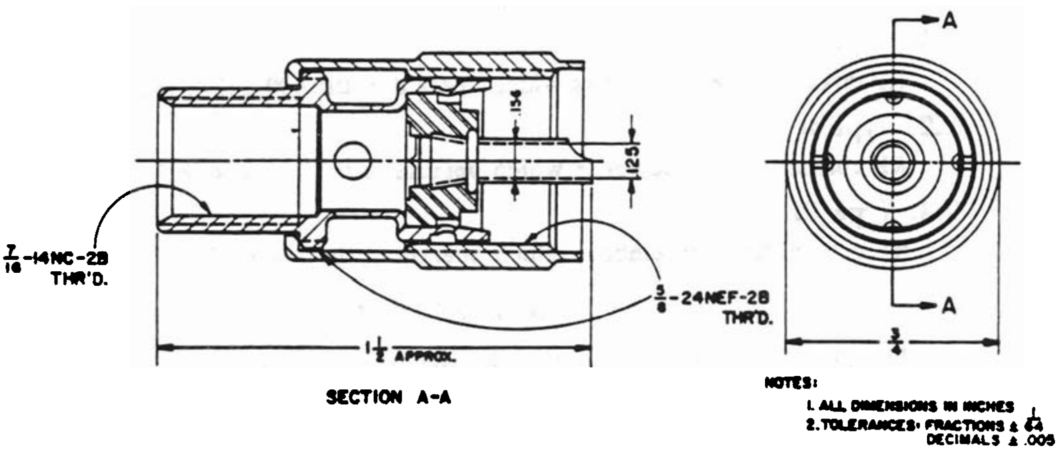

FIGURE 1. Connector plug.

4.3. User Information

The information supplied to the user by the manufacturer or distributor shall include the frequency range of operation and the maximum power rating of the assembly.

4.4. Test Sequence

The rf coaxial cable assembly shall be tested for compliance with the following requirements in the order given.

4.5. Mechanical Durability

After subjection to the mechanical durability test in accordance with 5.3, the assembly shall show no visible signs of mechanical failure and shall meet the requirements of 4.6.

4.6. Vibration Stability

The coaxial connector shall not loosen when the assembly is subjected to the vibration test in accordance with 5.4. During the test, the assembly shall meet the requirements of 4.8 and 4.9.

4.7. Temperature and Humidity Stability

While being operated at −30°C (−22° F), at 60°C (140° F), and at 50°C (122° F) and 90 percent relative humidity, in accordance with 5.5, the rf coaxial cable assembly shall meet the requirements of 4.8 and 4.9.

4.8. Standing Wave Ratio

When measured in accordance with 5.6, the standing wave ratio of the rf coaxial cable assembly shall not exceed 1.6 for Type I, 1.5 for Type II, and 1.4 for Type III operation.

4.9. Insertion Loss

When measured in accordance with 5.7, the insertion loss of the assembly, in decibels, shall not exceed 2.3 for Type I, 1.2 for Type II, and 0.6 for Type III operation.

5. TEST METHODS

5.1. Standard Test Conditions

Allow all measurement equipment to warm up until the system has achieved sufficient stability to perform the measurement. Unless otherwise specified, perform all measurements at standard temperature and humidity.

5.1.1. Standard Temperature

Standard ambient temperature shall be between 20° C (68° F) and 30° C (86° F).

5.1.2. Standard Relative Humidity

Standard ambient relative humidity shall be between 10 percent and 85 percent.

5.1.3. Standard Test Frequency

The standard test frequency shall be an operating frequency within the range specified in paragraph 4.3.

5.1.4. Standard Duty Cycle

The standard duty cycle shall be 2 minutes in the transmit mode followed by 3 minutes in the standby mode.

5.2. Test Equipment

The test equipment in this section is limited to that equipment which is the most critical in making the required measurements. All other test equipment shall be of comparable quality.

5.2.1. Standard Output Load

The standard output load shall be a 50-ohm resistive termination having a SWR of 1.10 or less at the standard test frequency.

5.2.2. Selective Voltmeter

The selective voltmeter shall have a resolution of at least 0.1 decibel over the frequency range of the cable assembly under test.

5.2.3. Power Meter

The power meter shall be capable of measuring up to 110 watts of forward power and 15 watts or less of reflected power with an uncertainty of less than 10 percent. It may be a through-line directional wattmeter, or directional couplers with power meters on the side arms.

5.2.4. Environmental Chamber

The environmental chamber shall produce air temperatures from −30° to 60° C (−22° to 140° F) and relative humidities in excess of 90 percent while shielding the test item from heating or cooling air currents blowing directly on it. The temperature of the test item shall be measured with a thermometer separate from the sensor used to control the chamber air temperature.

5.3. Mechanical Durability Tests

Connect and disconnect the connector pair 200 times. Then, using a mandrel with a radius of 20 times the diameter of the coaxial cable, flex the middle portion of the cable 200 times through an arc of at least 180 degrees.

5.4. Vibration Test

Secure the coaxial cable assembly to the vibration table. Perform a two-part test for a total of 30 minutes in each of two directions, namely the directions parallel to, and perpendicular to, the major axis of the assembly.

First subject the assembly to three 5-minute cycles of simple harmonic motion having an amplitude of 0.38 mm (0.015 inch) [total excursion of 0.76 mm (0.03 inch)] applied initially at a frequency of 10 Hz and increased at a uniform rate to 30 Hz in 2½ minutes, then decreased at a uniform rate to 10 Hz in 2½ minutes.

Then subject the assembly to three 5-minute cycles of simple harmonic motion having an amplitude of 0.19 mm (0.0075 inch) [total excursion 0.38 mm (0.015)] applied initially at a frequency or 30 Hz and increased at a uniform rate to 60 Hz in 2½ minutes, then decreased at a uniform rate to 30 Hz in 2½ minutes.

5.5. Temperature and Humidity Tests

Place the unenergized coaxial cable assembly in an environmental chamber whose temperature is maintained at −30°±2° C (−22°±3.6° F). After the assembly has reached temperature equilibrium, wait 30 minutes, then proceed in accordance with 5.6 and 5.7. Repeat the above procedure at 60°±2° C (140°±3.6° F).

Place the assembly in an environmental chamber at 50°±2° C (122°±3.6° F) and at least 90 percent relative humidity. Maintain these conditions for at least 8 hours, and then proceed in accordance with 5.6 and 5.7.

5.6. Standing Wave Ratio Test

Set up the test equipment as shown in figure 2. Using a transmitter output power of at least 30 watts and the standard test frequency, subject the assembly to 15 minutes of operation at the standard duty cycle. Measure the forward power and the reflected power. Calculate the SWR of the coaxial cable assembly from the following, where P_f is the forward power and P_r is the reflected power [6]:

$$\mathrm{SWR} = \frac{\sqrt{P_f} + \sqrt{P_r}}{\sqrt{P_f} - \sqrt{P_r}}$$

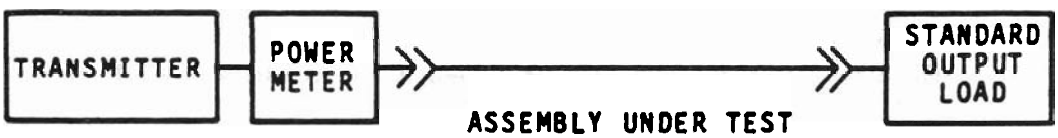

FIGURE 2. Block diagram for SWR measurement.

5.7. Insertion Loss Test

Set up the test equipment as shown in figure 3. Using a signal source of approximately 1 milliwatt and the standard test frequency, measure the signal level in decibels using the selective voltmeter, both with and without the coaxial cable assembly in place [1, 7].

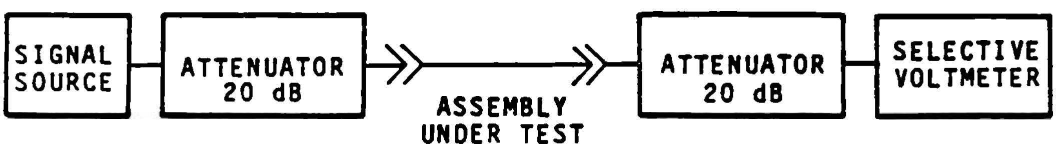

FIGURE 3. Block diagram for insertion loss measurement.

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U.S. GOVERNMENT PRINTING OFFICE : 1976 OL—597-110