THE INSTITUTE OF RADIO ENGINEERS, Inc.
1 East 79th Street, New York 21, N.Y.

60 IRE 27.C
Re: 60 IRE 27 PS2

12/19/60

TO: Members of the Standards Committee and
Chairmen of all Measurements Subcommittees

FROM: J. G. Kreer, Jr., Measurements Coordinator

SUBJECT: IRE Standards on Radio Interference: Measurement of Vehicular - Generated Radio Noise Affecting Mobile Communications Receivers in the Frequency Range 25 to 1000 MC.

The enclosed Proposed Standards on Radio Interference: Measurement of Vehicular - Generated Radio Noise Affecting Mobile Communications Receivers in the Frequency Range 25 to 1000 MC is forwarded to you for comment. Additional copies are available for Committee and Subcommittee members, upon request to the Technical Secretary, IRE, L. G. Cumming, 1 East 79th Street, New York 21, New York.

It is urgently requested that this Proposed Standard be given careful consideration by the Measurements Subcommittees and that written comments be forwarded not later than January 20, 1961.

Comments should be sent to the following:

Mr. R. J. Farber
147 Robby Lane
New Hyde Park, L. I.
New York.

with a copy to:

Mr. J. G. Kreer, Jr.
Bell Telephone Laboratories, Inc.
Whippany, New Jersey.

If no comments are received by January 20, 1961, it will be assumed that the Proposed Standard is satisfactory and it will be submitted for approval by the IRE Standards Committee.

J. G. Kreer, Jr.
Measurement Coordinator

Enclosure

cc: Radio Frequency Interference Committee

THE INSTITUTE OF RADIO ENGINEERS, INC.
1 East 79th Street, New York 21, New York

60 IRE 27. PS2
October, 1960

PROPOSED IRE STANDARDS ON RADIO INTERFERENCE: MEASUREMENT OF VEHICULAR-GENERATED RADIO NOISE AFFECTING MOBILE COMMUNICATIONS RECEIVERS IN THE FREQUENCY RANGE 25 TO 1000 MC

1. INTRODUCTION

The purpose of this standard is to provide a uniform method of measurement of vehicular-generated radio noise which may affect the performance of mobile communications receivers.

2. NATURE OF VEHICULAR RADIO INTERFERENCE

The spurious radio frequency energy generated by vehicular electrical systems is characterized by a broad frequency spectrum, components of which may be of sufficient amplitude to degrade received signal intelligibility. Vehicular radio noise has been shown, experimentally, to be essentially impulsive in nature. The repetition rate of these impulses may vary depending upon the nature of the design of the ignition system. The interference effect noted in mobile communications equipment for a given indicated radio noise level will vary depending upon the ignition system design. However, a measure of the radio noise level can be obtained by a substitution method using a standard impulse noise source. The user of this standard is cautioned that the interpretation of the measured results in terms of interference effect must consider the nature of the ignition system involved.

2.1 Definitions

For the purposes of this standard, the following definitions will apply:

2.1.1 Spectrum Density The spectrum density of a voltage impulse is defined as twice the magnitude of the Fourier transform of the impulse. It is a function of frequency and is given in units of volts-seconds, volts per cycle, etc.

For example, the spectrum density of a rectangular voltage pulse of width and height A is given by:

$$F(f) = 2\int_{-\tau/2}^{\tau/2} A \exp(-j2\pi ft)dt = 2A\tau \frac{\sin \pi f\tau}{\pi f \tau}$$

At frequencies, f, small compared to $1/\tau$, the quantity $\sin \pi f\tau/\pi f\tau \approx 1$ and the spectral intensity is closely equal to two times the height times width of the pulse.

2.1.1.1 dbmc Decibels above one microvolt per megacycle bandwidth.

2.1.1.2 dbkc Decibels above one microvolt per kilocycle bandwidth.

2.1.2 Frequency Selective Voltmeter A selective radio receiver, with provisions for output indication. For the purpose of this standard, it must provide peak output indication and meet the performance characteristics described in paragraph 3.1.4.

2.1.3 Impulse Generator A standard reference source of broadband impulse energy. For the purpose of this standard, characteristics described in paragraph 3.1.3 must be met.

2.1.4 Impulse Bandwidth The ratio of the peak sine wave response of the measuring instrument in terms of microvolts referred to its input terminals, to the known spectrum density of the impulse generator in terms of microvolts per unit bandwidth necessary to effect the same peak response.

2.2 Sources of Vehicular Radio Noise

Impulsive type radio noise arises principally from the ignition circuits of gasoline engine-driven vehicular equipment in which steep wave-front electrical transients are generated by the high tension distributor gap, and the discharge across the spark plugs. A secondary, but nonetheless troublesome, source of

interference is the battery charging circuit, in which electrical transients are generated as a result of commutation by the charging generator and as a result of the action of the regulator. Other lesser sources of interference which occasionally are troublesome are belt static, gauge or instrument static, and generator shaft static.

2.3 Vehicular Radio Noise Field

Mobile communications receivers have, in general, the same order of sensitivity as the best available measurement equipment. Therefore, the measurement antenna must be in close proximity to the vehicle being tested. Under these circumstances, the antenna is immersed in a very complex field exhibiting high field strength gradients. At low frequencies, the induction field predominates while at higher frequencies the radiation field predominates. Therefore, the method of measurement relies on the specification of measurement antenna type together with antenna placement and orientation with respect to the vehicle under test.

3. METHOD OF MEASUREMENT

This standard describes a method of measurement of the radio noise in terms of the spectrum density output of the calibrated impulse generator. Figure 1 illustrates the measurement principle. The radio noise at each desired frequency is measured as the open circuit antenna terminal voltage, in terms of microvolts per megacycle bandwidth. The measurement is accomplished by a substitution method using a calibrated impulse generator which is series-injected into the antenna circuit of the receiving antenna in such a manner as to make the absolute value of the measurement independent of antenna and instrument input impedances. When the radio noise and the calibrated impulse generator inputs, applies consecutively, produce the same peak response from the frequency selective voltmeter, the measured

value of the radio noise is equal to the impulse generator output corrected for the attenuation of the calibrated injection network and the loss occurring in the cable connecting the impulse generator to the injection network.

3.1 Test Equipment

The frequency selective voltmeter when used with a calibrated impulse generator and an appropriate series injection network shall be capable of measuring open circuit antenna voltage in terms of microvolts per megacycle bandwidth or in terms of dbmc.

3.1.1 The standard antenna shall be of the type shown in Fig. 2[1].

3.1.2 All measurements shall be performed using a standard injection network meeting the performance requirements detailed in Fig. 3. A typical injection network device which meets the specified performance requirements is shown in Fig. 4.

3.1.3 The calibrated impulse generator,[2] when applied to a 50 ohm resistive load, shall provide an output which is flat within ± 1.0 db over the frequency range of interest with maximum output sufficient to measure the desired range of spectrum density. The impulse generator shall provide for output adjustment to within 1.0 db. At other than maximum output, the impulse generator output shall be within ± 2 db of indicated output. A pulse repetition frequency between 30 and 400 impulses per second shall be available.

3.1.4 The frequency selective voltmeter shall possess the following electrical characteristics as a minimum performance requirement.

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1 Detail and assembly drawing for the Standard Antenna may be purchased from IRE at 1 East 79th Street, New York 21, New York at a cost of

2 Impulse generators are generally calibrated by the use of a sine wave signal generator. Therefore, the calibrated reading of the impulse generator is 0.707 of the true spectrum density value.

3.1.4.1 An impulse signal of 30 dbmc applied across the input terminals must produce at least a 2 db rise in peak meter indication. For instruments with aural-slide-back peak detectors, a 30 dbmc signal shall produce a usable audio response.

3.1.4.2 The spurious response rejection shall be at least 35 db.

3.1.4.3 The pulse turn-over effect shall produce no more than ± 0.5 db change in peak meter indication. This test is performed by reversing the polarity of an applied impulse generator signal of 80 dbmc at the input terminals with minimum input attenuation required to keep the meter on scale. The frequency spectrum of the impulse generator used to perform this test shall be at least as great as that of the impulse generator used in performing the measurements described in 3.2.

3.1.4.4 If a meter indicator is used, the peak meter indication shall not change more than 0.5 db when a constant level impulse generator signal is varied from 50 to 400 impulses per second.

3.1.4.5 The input impedance shall be nominally 50 Ω.

3.1.4.6 The impulse bandwidth shall not exceed one percent of the frequency to which the voltmeter is tuned.

3.2 Test Procedure

Radio noise shall be measured at the front and rear of the vehicle over the frequency range of interest. In the event radio noise from sources other than the vehicle is encountered at the frequency of interest, measurement shall be made at the nearest unoccupied frequency. The vehicle and test equipment antenna shall be arranged as shown in Fig. 5 with the antenna configuration as shown in Fig. 2. The measurement equipment shall be located at least 20' from the

measurement antenna and the vehicle under test. For each measurement the level recorded shall be the maximum value observed, when the vehicular engine speed is varied smoothly from idle to race.

3.3 Test Conditions

3.3.1 Test Area The measurement site shall be open flat terrain at a considerable distance (100 ft. or more) from reflecting or conducting objects such as large buildings, electrical lines, metallic fences, and trees. The ambient interference at the test area shall be at least 6 db below the test limit at any frequency of interest.

3.3.2 Vehicle Condition The vehicle under test shall be dry and the engine compartment closed.

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