

# AEROSPACE RECOMMENDED PRACTICE

**SAE** ARP1173

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## Test Procedure to Measure the R.F. Shielding Characteristics of E.M.I. Gaskets

### 1. PURPOSE

- 1.1 The purpose of this procedure is to establish a testing technique for measuring the R. F. shielding characteristics of EMI gasket materials with reliability and repeatability.
- 1.2 To establish standard terminology and fixed references.

### 2. DEFINITIONS

- 2.1 **Shielding Increase:** Is the difference of an electromagnetic field amplitude emanating from a seam (as measured under fixed test conditions) with and without a gasket in the seam, with the force joining the seam remaining constant. The difference is expressed in decibels based on voltage measurements.  
 $(A \text{ without gasket} - A \text{ with gasket}) = \text{Shielding Increase}$   
 $(\text{Emission value \#3} - \text{Emission value \#1}) = \text{Shielding Increase.}$
- 2.2 **Total Shielding Effectiveness:** Is the difference of an electromagnetic amplitude emanating from a source measured internal to an enclosure, and that from the same source measured in free space. The difference is expressed in decibels based on voltage measurements.  
 $(A \text{ free space} - A \text{ within enclosure}) = \text{Total shielding effectiveness.}$  This is approximated by the following relationship based on measurements made using this test procedure.  $(\text{Emission value \#2} - \text{Emission value \#1}) = \text{Total Shielding Effectiveness.}$
- 2.3 **Force:** The force used in testing during the use of a gasket should be expressed in kg/cm of length or kg/cm<sup>2</sup> of gasket or seam. (The kg/cm units are useful in cases where the width of gaskets are highly variable and cannot be defined or where comparison of the effectiveness of gaskets with different widths is desired).

### 3. TEST METHOD PREREQUISITES

- 3.1 It will be assumed that the gasket to be tested at the joint of an R. F. shielding enclosure is the weakest barrier against R. F. energy. Penetration of the enclosure will not be considered a factor due to the proper choice of material thickness for the test enclosure.
- 3.2 The electromagnetic energy can be encountered in three distinct forms (fields) depending upon the purpose of the gasket:
  - 3.2.1 Low impedance or magnetic field
  - 3.2.2 High impedance or electric field
  - 3.2.3 Planewave
- 3.3 The emission level measurements (4.1) should be at least 6 dB above the ambient electromagnetic level. The ambient electromagnetic level is measured with the generators energized but dummy loaded.

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#### 4. TEST METHOD (See Figure #1)

The method consists of an enclosure with the gasket to be tested placed between the body of the enclosure and the cover closing the opening of the enclosure. The leakage or emission of electromagnetic energy is measured internal to the test enclosure. The equipment utilized to measure this emission is a field intensity meter. It must be tunable to specific frequencies and have antennas to measure the different fields. Three electromagnetic emission values will be measured. Two are reference values. These values can be measured once at each frequency and utilized for all testing of gaskets between calibration dates only if the magnitude of the transmitted electromagnetic energy can be maintained at a constant output level. This reduces the amount of measurements to one emission value for the testing of gaskets.

##### 4.1 Emission Value #1 (Performance Measure):

4.1.1 This is emission into the test enclosure with the gasket to be tested placed between the cover and the enclosure's body. This procedure is repeated at different gasket pressures (force(s) on the cover). There shall be no less than three gasket pressures (forces) at which measurements are made, of which one measurement shall be at either 0.9, 3.6, 5.4, 17.9 kilograms per centimeter (5, 20, 30, or 100 pounds per linear inch). +/-5% of the value.

4.1.2 The magnetic field intensity used to measure the magnetic shielding capability shall be measured in amperes into the loop. This quantity shall be reported whenever magnetic measurements are made.

4.2 Emission Value #2 (Reference Level): This emission into the enclosure with the R. F. shielding gasket replaced by four 13 mm (1/2 in.) diameter, low carbon (1010) steel, electroless nickel plated (per MIL-STD-171) spacers. The thickness of these spacers shall be equal to the compressed height of the gasket for which the shielding characteristics are to be determined. In other words, for every pressure (compression) a possible different reference value is used.

It is therefore advisable to make a number of measurements of emission value #2 so that data for various spacings is available. The four metal spacers are used to provide a DC ground for the cover and to increase the repeatability of the measurement.

4.3 Emission Value #3 (Reference Level): This is the emission into the enclosure with the R. F. shielding gasket removed and the cover mounted directly onto the flange. This value will be dependent on surface finish, surface flatness, oxides, etc. These conditions also exist for the gasket measurement. Therefore, the difference between emission value #3 and emission value #1 reflects the change a designer would experience with and without a gasket being installed.

4.4 Dynamic Range: The dynamic range of the test facility will be determined as follows:

$$\text{Dynamic range} = \text{Reference Level (Para. 4.2)} \\ (\text{Ambient Level} + 6 \text{ dB}) \text{ (Quantities in decibels).}$$

4.5 The radiation of electromagnetic energy shall be measured utilizing the antennas specified on Fig. 1.

##### 4.5.1 The Loop Antenna:

4.5.1.1 The loop shall have a 203 mm (8 in.) ID and less than 230 mm (9 in.) OD.

4.5.1.2 The loop shall be constructed of 30 turns of #20 solid copper wire.

4.5.1.3 The loop shall be used for all magnetic field measurements.

#### 4.5.2 The Rod Antenna:

4.5.2.1 The rod shall be 203 mm (8 in.) long  $\pm$  .10 and 3.2 mm (1/8 in.) diameter.

4.5.2.2 The rod will be used for all electric field measurements.

4.6 The electromagnetic field radiating antenna shall be fed by generators having a source impedance between 50 and 600 ohms.

4.7 The emission of electromagnetic energy into the enclosure shall be radiated utilizing antennas specified for the field intensity-meter used.

The placement and orientation relative to the test enclosure shall be in accordance with Fig. 2 and 3.

4.8 The set-up of the test enclosure shall conform to the following specifications.

4.8.1 There shall be no possibility that E. M. energy can be emitted into the enclosure or cables, other than through the seam with the gasket under test.

4.8.2 The rear (bottom) of the test enclosure shall be mounted to a shield room wall or in the center of a ground plane with the minimum dimensions of 92 cm X 92 cm (3 X 3 ft) if used external to a shield room.

4.8.3 The test enclosure shall be bonded to this ground plane at least at all four corners of the test enclosure.

4.8.4 The test enclosure shall not be grounded at any place other than the points on the rear (bottom) panel.

4.8.5 The placement of the test enclosure shall be such that the emitting antennas will not be closer than 1 meter to any metal objects (including walls, if used in a shield room).

#### 4.9 Test Frequencies are:

400 Hz, 1 kHz, 14 kHz, 50 kHz, and 200 kHz - Magnetic field.

1 MHz, 18 MHz, and 100 MHz - Electric field.

400 MHz, 1 GHz, 3 GHz, and 10 GHz - Plane wave.

Test frequencies in addition to the ones specified are allowed and encouraged. Utilization of automated scanning equipment is desirable, however, not specified as a procedure.

### 5. TEST ENCLOSURE SPECIFICATIONS

5.1 Dimensions: 305 x 305 x 305 mm (12 x 12 x 12 in.) (inside dimensions).

5.2 Material: 1010 Steel 6.35 mm (1/4 in.) thick.

5.3 Construction: See Fig. 4.

5.4 Cover Dimensions: 380 x 380 x 9.5 mm (15 x 15 x 3/8 in.). The cover and the flange shall mate to within 0.025 mm (.001 in.) (maximum gap between cover and flanges).

5.5 Surface Finish: 63 micro inch and electroless nickel plated per MIL-STD-171.

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5.6 The pressure on the gasket shall be applied in such a manner that leakage or radiation of electromagnetic energy from the enclosure is not influenced. For instance, the method cannot impart electrical continuity between cover and the test enclosures, other than the gasket under test. Nylon bolts or other materials used shall be non-conductive and have a permeability of less than 1.10.

**6. NOTES**

6.1 **Special Calibration:** Uniformity of pressure ( $\pm 5\%$ ) - This may be determined by placing a calibration gasket between the cover and the enclosure. Apply the force for a given pressure and measure the deflection around the periphery of the enclosure. The calibration gasket is a gasket of relative large height and has one precise deflection characteristic.

Material for the calibration can be:

- a. Highly uniform sponge or low durometer rubber.
- b. Metal springs put together into a gasket shape.

6.2 **Deviations:** Deviations from this specification can only be tolerated if there is no doubt that the deviations will not alter the measured values of the test.

**7. CONCLUDING STATEMENT**

This procedure was chosen to evaluate gaskets and gasket materials because of its similarity to the practical conditions (electromagnetic environments and packaging configuration). However, it must be realized that the number values obtained from this procedure are, in part, a function of the test configuration chosen and other such factors. Therefore, the test results cannot be assumed to represent the absolute attenuation values. The qualitative data obtained, however, indicate the actual shielding characteristics of the gasket(s), in the specified condition.

**8. DATA COLLECTION**

The report of the data obtained from this procedure shall contain the following information.

- 8.1 Emission(s) Value #1
- 8.2 Emission(s) Value #2
- 8.3 Emission(s) Value #3
- 8.4 Shielding Increase (8.3-8.1)
- 8.5 Total Shielding Effectiveness (8.2-8.1)
- 8.6 The dynamic range of the test facility (emission value #2 - ambient level 6 dB).
- 8.7 Force(s) (p.l.i, kg/cm, psi., kg/cm<sup>2</sup>) at which the gasket was tested.
- 8.8 All test frequencies
- 8.9 Types of fields (magnetic, electric or far field) (planewave).
- 8.10 The level of current into the loop in milliamps.
- 8.11 Manufacturer of the gasket and the proper identification of this gasket (part number, composition, etc.).

8.12 Test laboratory and location

8.13 Date of test(s)

8.14 Names of those people who were witnesses to the test.

8.15 Test engineer, technician and the affiliated organization.

9. ILLUSTRATIONS

Figure 1 Isometric of test layout

Figure 2 Positions of antennas

Figure 3 Positions of antennas

Figure 4 Test Enclosure

Figure 5 Mounting of Enclosure

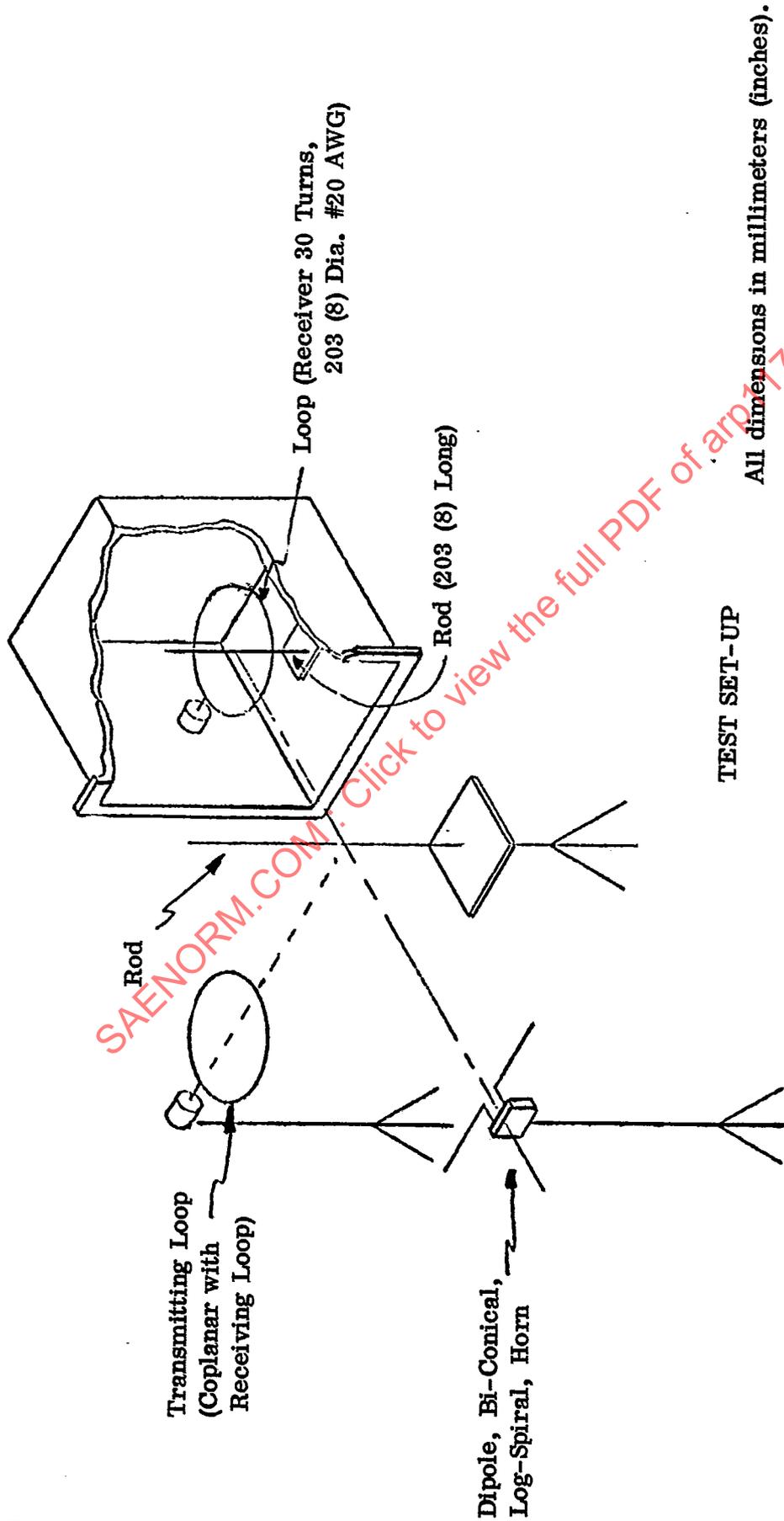
Figure 6 Reference Value Spacers and location of them

Figure 7 Test gasket dimensions

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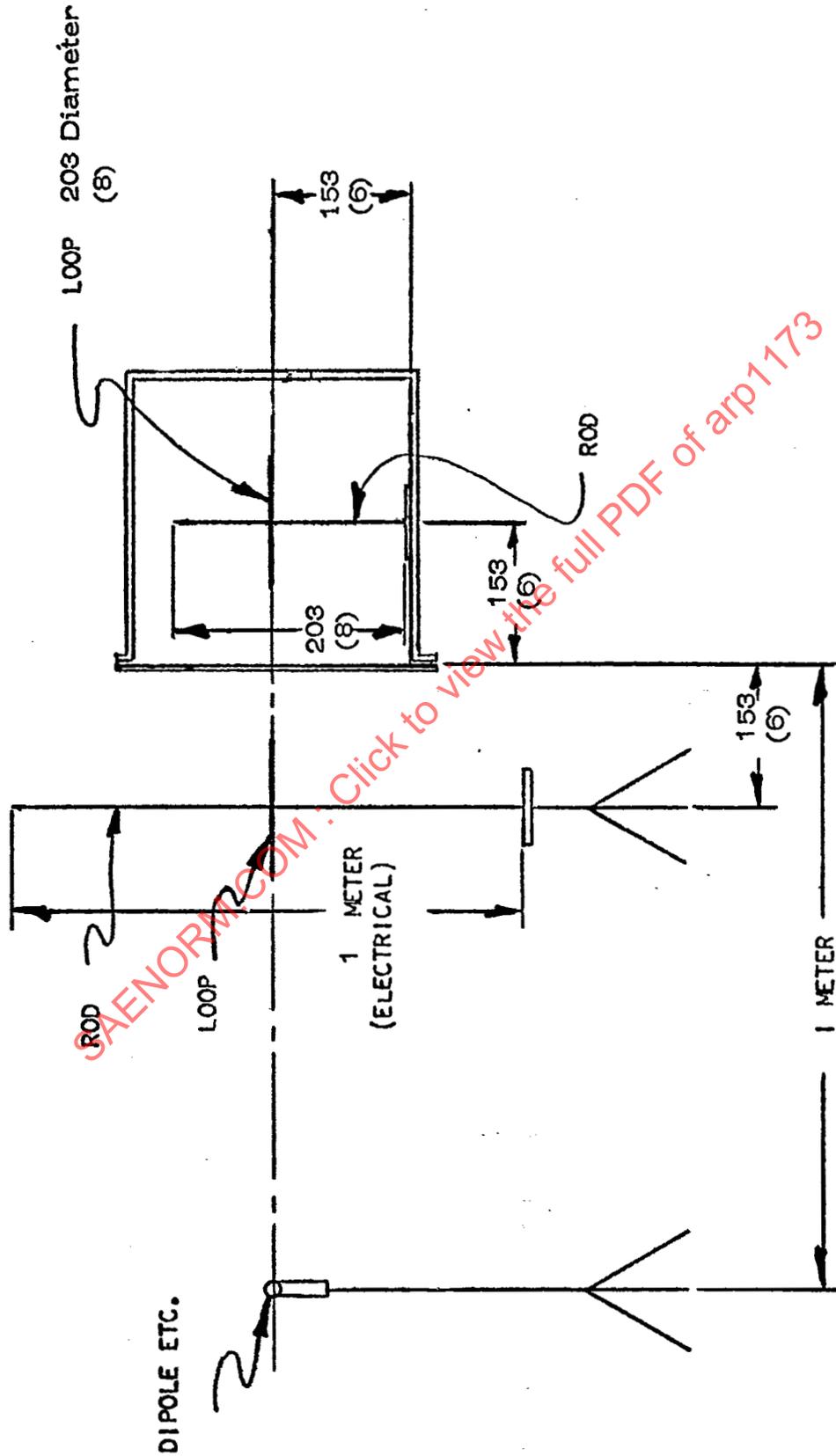
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TEST SET-UP

All dimensions in millimeters (inches).

FIGURE 1



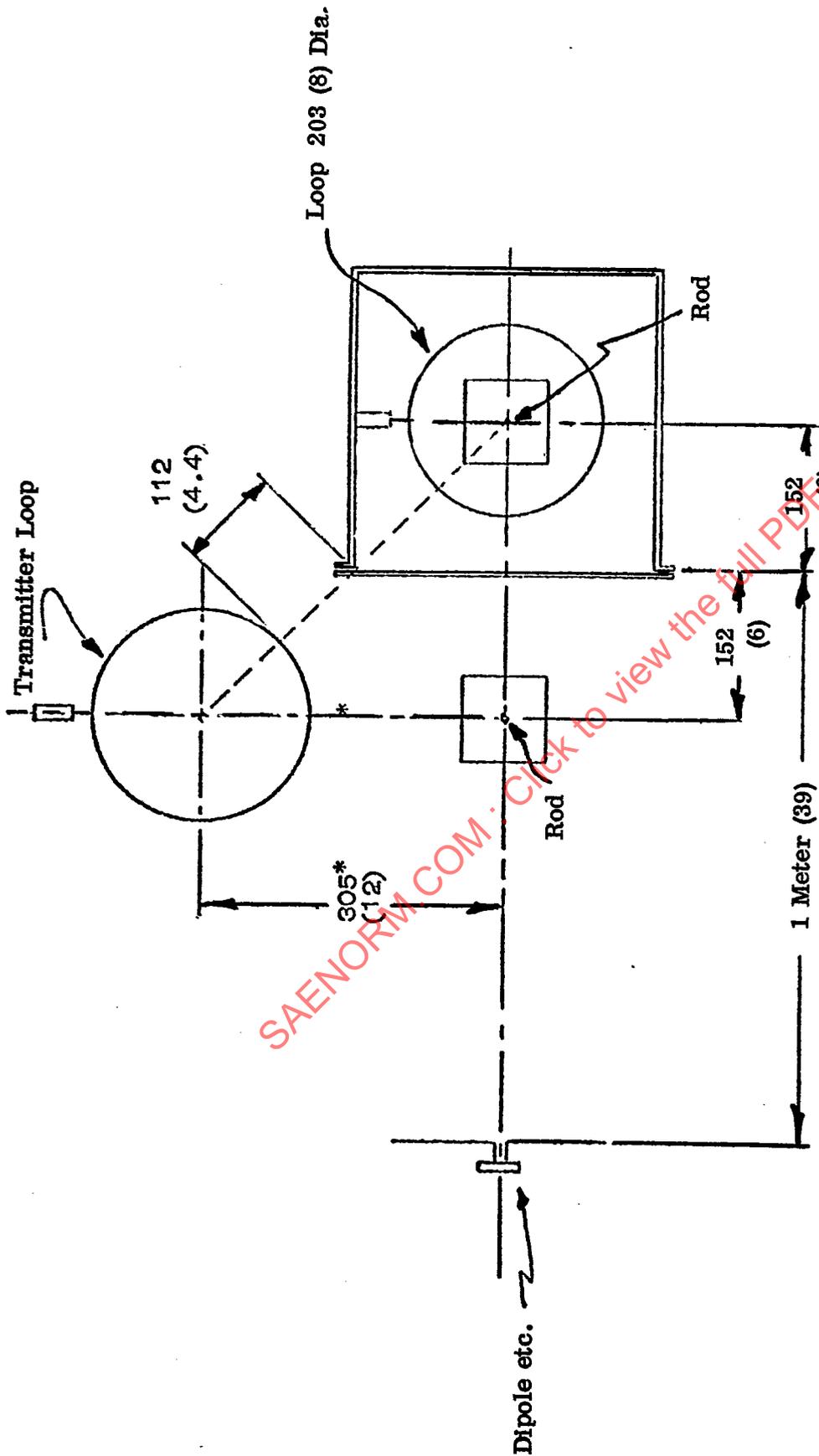
All dimensions in millimeters (inches).

ANTENNAE POSITIONS

FIGURE 2

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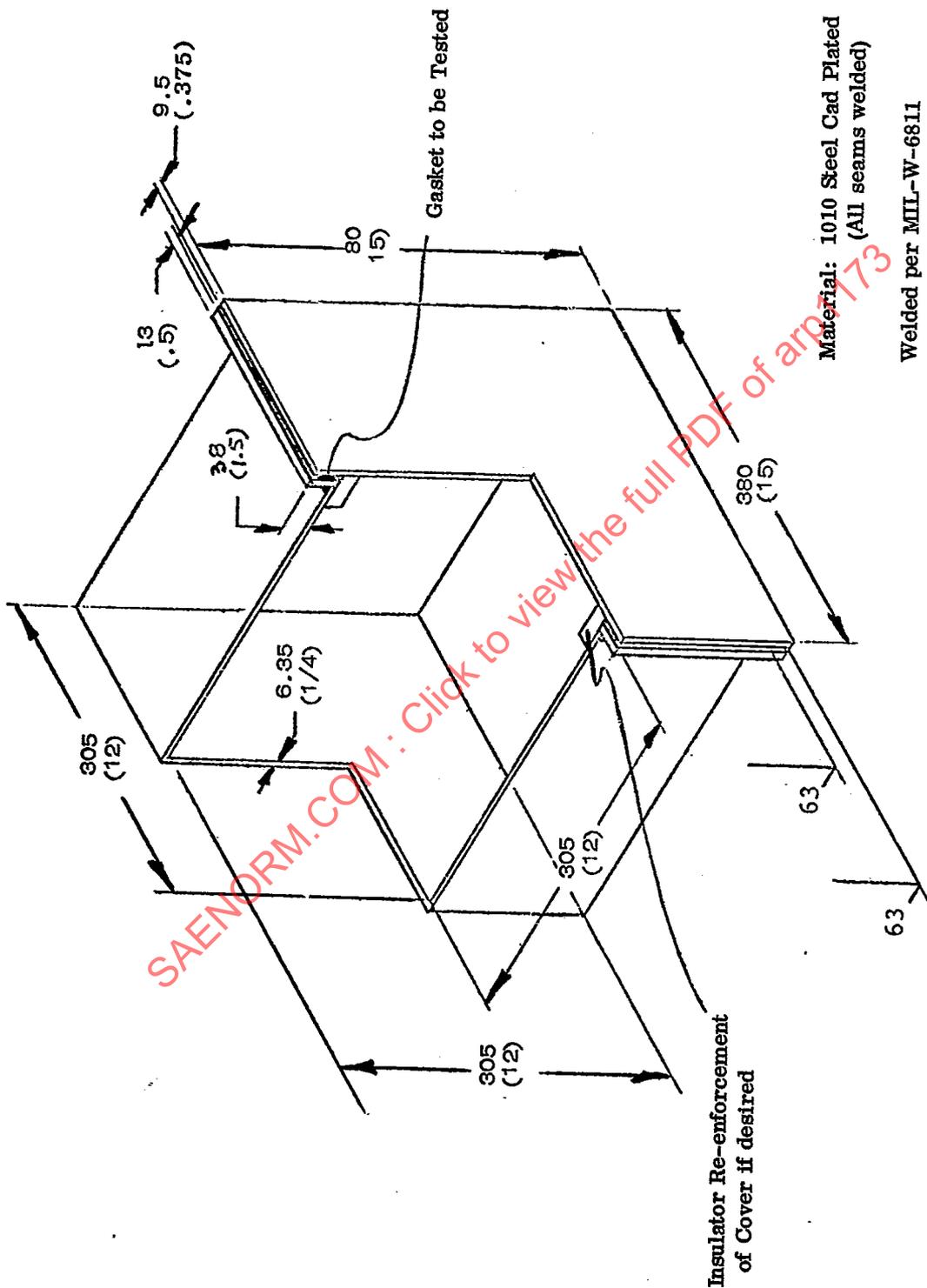


All dimensions in millimeters (inches).

\* If Transmitter Loop is 203 (8) in diameter.

ANTENNAE POSITIONS

FIGURE 3



TEST ENCLOSURE

All dimensions in millimeters (inches).

FIGURE 4