

(R) ALARM—BACKUP—ELECTRIC LABORATORY PERFORMANCE TESTING

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. **Scope**—The scope of this SAE Standard is the definition of the functional, environmental, and life cycle test requirements for electrically operated backup alarm devices primarily intended for use on off-road, self-propelled work machines as defined by SAE J1116 JUN86 (limited to categories of 1) construction, and 2) general purpose industrial).

1.1 **Purpose**—The purpose of this document is to define a set of performance requirements for backup alarms, independent of machine usage. The laboratory tests defined in this document are intended to provide a uniform and repeatable means of verifying whether or not a test alarm meets the stated requirements. For on-machine requirements and test procedures, refer to SAE J1446.

2. **References**

2.1 **Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J184—Qualifying a Sound Data Acquisition System

SAE J1116—Categories of Off-Road Self-Propelled Work Machines

SAE J1446—On-Machine Alarm Test and Evaluation Procedure for Construction and General Purpose Industrial Machinery

2.1.2 ANSI PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI S1.4—Specification for Sound Level Meters

ANSI S1.11—Specification for Octave Band and Fractional Octave Band Analog and Digital Filter Sets

ANSI S1.40—Specification for Acoustical Calibrators

2.1.3 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117—Method of Salt Spray (Fog) Testing

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2.1.4 MIL SPECIFICATION—Available from Defense Printing Service, Detachment Office, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.

MIL-STD-810B—Environmental Test Methods 510 and 514.1

2.2 Related Publications—The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1105—Performance, Test and Application of Electric Forward Warning Horn

SAE J1211—Recommended Environmental Practices for Environmental Electronic Equipment

2.2.2 ANSI PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI S1.1 - 1960 (R1976)—Acoustical Terminology

ANSI S1.13 (R1986)—Methods for the Measurement of Sound Pressure Level

2.2.3 GENERAL MOTORS CORPORATION MATERIALS—Available from GM AC Rochester/GMC, P.O. 1360, Flint, MI 48501-8054.

AC fine and AC coarse dust

3. Definitions

3.1 Free Field—A free field, for the purposes of this document, is defined as a space with no reflecting surface within 15 m of the sound source in any direction.

3.2 Horizontal Reflecting Plane—A horizontal reflecting plane is defined as flat ground with a surface no rougher than an asphalt road. A paved parking lot with no reflecting surfaces within 15 m would be an acceptable horizontal reflecting plane for the tests outlined in this document.

3.3 Zero Degree Axis—A line known as the "zero degree axis" is defined to correspond to the centerline of the sound producer, perpendicular to and extending outward from the output face of the alarm.

4. Instrumentation—It is recommended that persons technically trained and experienced in current techniques of sound measurement select the equipment.

4.1 A sound level meter which meets the Type I requirements of ANSI S1.4.

4.2 As an alternative to making direct measurements using a sound level meter, a microphone or sound level meter may be used with a magnetic tape recorder and/or a graphic level recorder or indicator meter, provided the system meets the requirements of SAE J184.

4.3 A filter set which meets the Class II octave band requirements of ANSI S1.11.

4.4 A sound level calibrator meeting the requirement of ANSI S1.40.

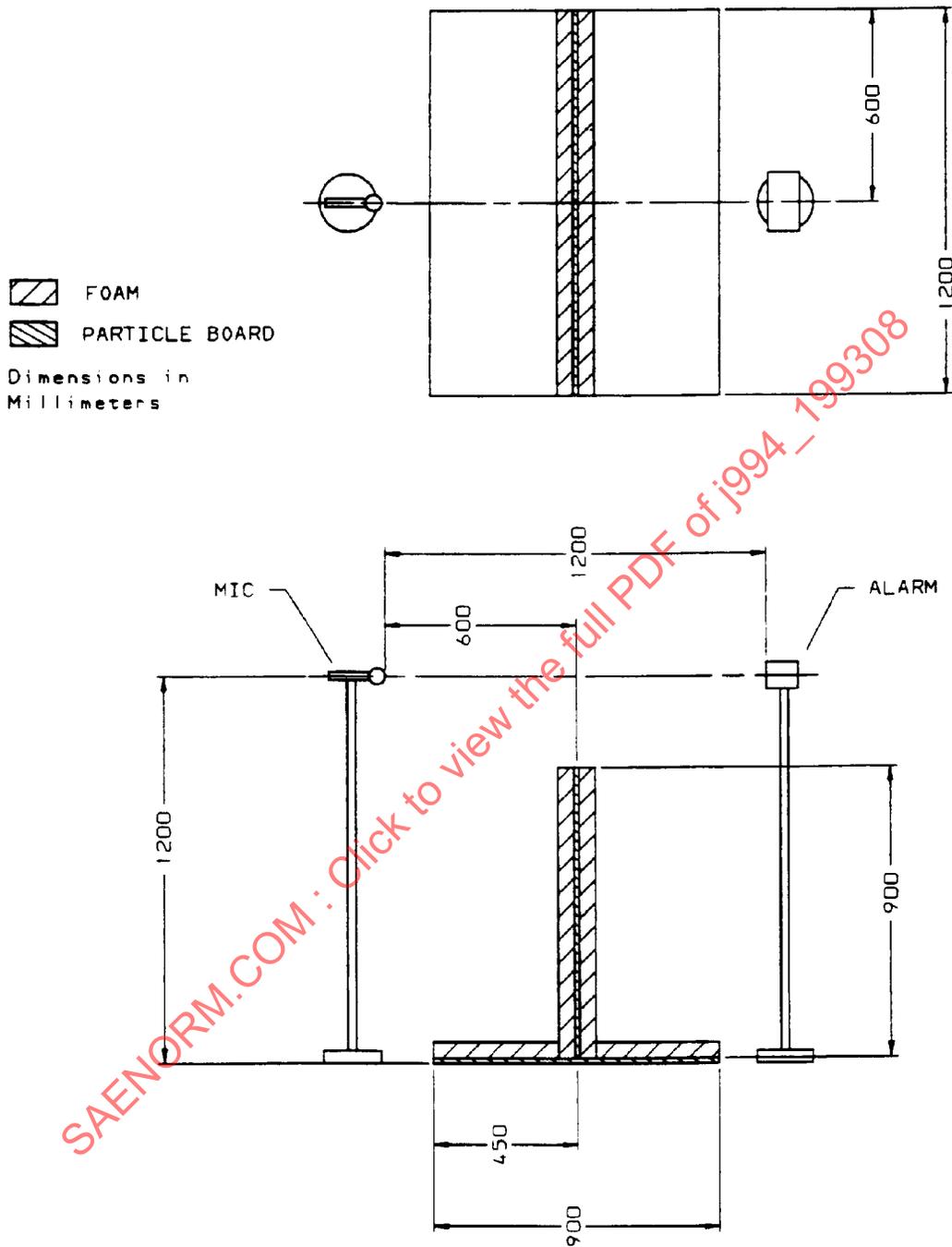
4.5 A temperature measuring system accurate to ± 0.5 °C over the range of -40 to $+85$ °C.

4.6 A voltage measuring system accurate to ± 100 mV over the range of 9 to 36 VDC.

4.7 Vibration apparatus.

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- 4.8 Environmental chamber.
- 4.9 Dust chamber.
- 4.10 Rain, steam, and corrosion chamber.
5. **Sound Level Test Setup**—Sound Level Test - Two acceptable test methods will be described for measuring alarm sound level.
- 5.1 **Test Method 1**—The alarm is located in a free field or an equivalent fully anechoic room. The microphone is directed toward the alarm sound output opening along the zero degree axis and at the distance specified by the test requirements.
- 5.2 **Test Method 2**—This is an alternative method for testing an alarm sound level without the aid of an anechoic room. The alarm is located in a free field except for a horizontal reflecting plane and an acoustical barrier partition. The acoustical barrier partition must be constructed.
- 5.2.1 **REQUIRED MATERIALS FOR ACOUSTICAL BARRIER**—Unless otherwise specified, all dimensional tolerances are ± 10 mm.
- Two pieces of particle board 900 mm x 1200 mm x 16 mm ± 2 mm thick
 - Two Tripods adjustable to 1200 mm high
 - Three each 200 mm x 200 mm x 90 degree sheet metal shelf brackets.
 - Two sections of sound absorbing foam of dimensions 1200 mm x 1350 mm and a thickness of 50 mm or greater. The sound absorbing foam should have an absorption efficiency of at least 50% at 50 Hz rising to at least 75% at 1000 Hz and greater.
- 5.2.2 **CONSTRUCTION OF ACOUSTICAL BARRIER**—Using the three 200 mm shelf brackets and screws, center and attach one of the 900 mm x 1200 mm particle boards perpendicular to the other 900 mm x 1200 mm base board to yield a 900 mm high wall as shown in Figure 1. Two brackets should be located 150 mm from the outside edge on one side of the upright board. The third bracket should be mounted in the center on the other side of the upright board. Cover the exposed particle board with the sound absorbing foam as shown in Figure 1.
- 5.2.3 **ALARM AND MICROPHONE LOCATIONS**—Secure the alarm and microphone to their tripods. Position the alarm and microphone on opposite sides of and equidistant from the sound barrier at a height of 1200 mm above the horizontal reflecting plane. The distance between the two devices is specified in 6.3 of the Functional Test Requirements.
- 5.3 **Allowable Background Noise Level**—While the sound level test is in progress, the sound level due to all sources other than the alarm device shall be at least 10 dB lower than the sound level of the alarm. This precaution reduces the effect of background noise on the sound level test results.
- 5.4 **Sound Level Meter Settings**—The sound level meter shall be set for fast response or equivalent and have the A-weighting network installed when checking sound levels.
- 5.5 **Instrumentation Precautions**—Proper usage of all test instrumentation is essential to obtain valid measurements. Operating manuals or other literature furnished by the instrument manufacturer should be referred to for both recommended operation of the instrument and precautions to be observed. Specific items to review include:



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FIGURE 1—ACOUSTICAL BARRIER DIMENSIONS FOR TEST METHOD 2

- 5.5.1 THE MICROPHONE—The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and source of noise.
- 5.5.2 MULTI-INSTRUMENT SYSTEMS—Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems should be observed.

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- 5.5.3 CALIBRATION—Proper acoustical calibration procedure, including the influence of extension cables, etc. Field calibration should be made immediately before and after each test sequence. Internal calibration means are acceptable for field use, provided that external calibration is accomplished immediately before or after field use.
- 5.5.4 THE WEATHER—The effects of ambient weather conditions on the performance of all instruments (for example, temperature, humidity, and barometric pressure). Instrumentation can be influenced by low temperatures and caution should be exercised.
- 5.5.5 WINDSCREENS—When using a windscreen, it should be calibrated for the type of noise source being measured and data corrected if necessary. It is recommended that measurements be made only when the wind speed is below 19 km/h.

6. **Functional Test Requirements**—Unless otherwise specified, data measurements will be taken during a minimum test period of 1 min operation at ambient temperature of $25\text{ }^{\circ}\text{C} \pm 11\text{ }^{\circ}\text{C}$ and supply voltage of 14 VDC $\pm 0.2\text{ VDC}$ for a nominal 12 V alarm and 28 VDC $\pm 0.2\text{ VDC}$ for a nominal 24 V alarm.

6.1 **Predominant Sound Frequency**—Measure and record the predominant sound frequency of the alarm. The predominant sound frequency shall be checked with a third octave passband filter set. The acceptable frequency range is 700 to 2800 Hz.

6.2 **Cyclic Pulsation Rate and Duty Cycle**—Measure and record the rate of cyclic sound level pulsations from the alarm and the duration of the "on" and "off" intervals. The cycles of sound level pulsations from the alarm shall be of the order of 1 to 2 per second. The duration of the "on" interval shall be equal to that of the "off" interval within $\pm 20\%$.

6.3 **Sound Level**—Measure and record the sound level of the alarm using the methods of 5.1 or 5.2. The microphone shall be placed on the zero axis of the alarm at a distance of 1.2 m from the front face of the alarm. The sound level shall be any of the following:

- Type A - 112 dB(A)
- Type B - 107 dB(A)
- Type C - 97 dB(A)
- Type D - 87 dB(A)
- Type E - 77 dB(A)
- Type F - Other

(Sound level rating in dBA must be imprinted on the alarm.)

Unless otherwise stated, the tolerance on sound level measurements is $\pm 4\text{ dB(A)}$.

6.4 **Sound Level Change With Voltage**—Measure and record the sound level at the extreme operating voltages of 9 and 16 VDC for a nominal 12 V system and 18 and 32 VDC for a nominal 24 V system. The sound level shall not vary more than $\pm 8\text{ dB}$ from the values given in 6.3.

6.5 **Off-Axis Sound Levels**

6.5.1 HORIZONTAL MOUNTING SURFACE—All sound level measurements are made at a radius of 1.2 m from the sound producer. The initial measurement is on the zero degree axis. Twelve additional measurements are taken at 15 degree intervals from -90 to $+90$ degrees through the horizontal plane as shown in Figure 2.

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For each location described previously, measure the sound level using either Test Method 1 or Test Method 2 of Section 5. Record the data in Column 2, the form shown in Figure 3. The values recorded in Column 3 of the form are obtained by subtracting the sound level at the zero degree axis from the sound level at each angular position. The data from Column 3 is plotted on the chart of Figure 4 to obtain the profile of sound variation as a function of direction from the alarm. Fill in the blanks and check the appropriate boxes at the tops of the form and the profile sheets.

- 6.5.2 VERTICAL MOUNTING SURFACE—The alarm is next rotated 90 degrees about the zero axis, as shown in Figure 5. Repeat the procedure of 6.5.1.

This document does not specify any limitations on sound variation as a function of direction from the alarm but does require that the sound variation profiles be made available upon request.

7. **Environmental Tests**—Unless otherwise specified, all data measurements will be taken during a minimum test period of 1 min operation at temperatures specified and supply voltage of 14 VDC \pm 0.2 VDC for a nominal 12 V system and 28 VDC \pm 0.2 VDC for a nominal 24 V system.

- 7.1 **Low Temperature Test**—Temperature soak the alarm in the environmental chamber at 40 °C \pm 3 °C for at least 2 h prior to the following tests. Remove the alarm from the environmental chamber to make measurements.

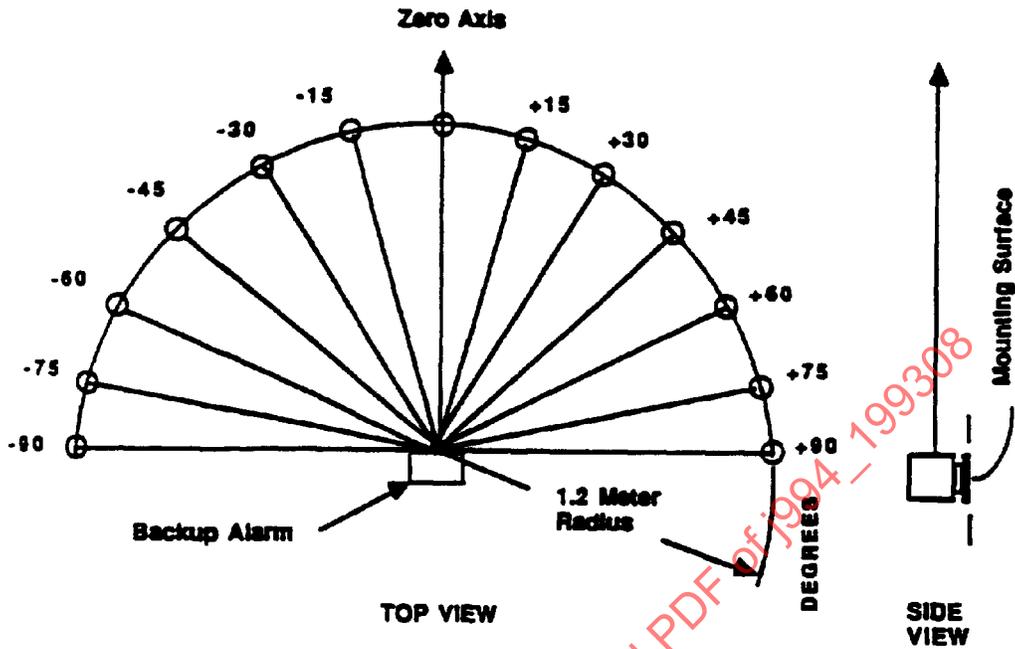
- 7.1.1 LOW TEMPERATURE, NOMINAL SYSTEM VOLTAGE—Within 1 min after removing the alarm from the environmental chamber, measure and record the sound level and predominate sound frequency of the alarm. The sound level must be within \pm 8 dBA of the baseline data measured in 6.3. The predominate sound frequency must be within the range specified in 6.1.

- 7.1.2 LOW TEMPERATURE, SYSTEM VOLTAGE EXTREMES—Repeat 7.1. Within 1 min after removing the alarm from the environmental chamber, measure and record the sound level and predominate sound frequency of the alarm for both extremes of operating voltage of 9 and 16 VDC for a 12 V alarm and 18 and 32 VDC for a 24 V alarm. The sound level shall be within \pm 8 dBA of the baseline data measured in 6.3 and within the frequency range specified in 6.1.

- 7.1.3 ROOM TEMPERATURE CHECK—Remove the alarm from the chamber and allow it to warm up to 25 °C \pm 11 °C for at least 1 h. Repeat 6.3. The alarm shall meet the sound level requirements of 6.3.

- 7.2 **High Temperature Test**—Temperature soak the alarm in the environmental chamber at 85 °C \pm 3 °C for at least 2 h prior to the following tests. Remove the alarm from the environmental chamber to make measurements.

- 7.2.1 HIGH TEMPERATURE, NOMINAL SYSTEM VOLTAGE—Within 1 min after removing the alarm from the environmental chamber, measure and record the sound level and predominate sound frequency of the alarm. The sound level shall be within \pm 8 dBA of the value measured in 6.3. The predominate sound frequency shall be within the range specified in 6.1.



Note: Measurement locations indicated by "O" symbols

FIGURE 2—BACKUP ALARM SOUND LEVEL MEASUREMENT LOCATIONS—
MOUNTING SURFACE HORIZONTAL

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Backup Alarm Sound Level Data Sheet		
Manufacturer: _____		Date _____
Alarm Name & Model No.: _____		Sample No. _____
Zero Axis Sound Level (dBA) at 1.2 Meters _____		
Test Method 1 <input type="checkbox"/>	Test Method 2 <input type="checkbox"/>	
Alarm Mounting Position: Vertical <input type="checkbox"/>		Horizontal: <input type="checkbox"/>
Angle (Degrees)	Recorded Sound Level (See Note A) (dBA)	Sound Level Deviation (See Note B) (dBA)
-90		
-75		
-60		
-45		
-30		
-15		
0		0
+15		
+30		
+45		
+60		
+75		
+90		

NOTE A—All sound level measurements made at 1.2 m radius from the sound producer, as shown on Figures 2 and 4.

NOTE B—Subtract sound level measured at 0 degree axis from sound level measured at angle.

FIGURE 3—BACKUP ALARM SOUND LEVEL DATA SHEET

Manufacturer: _____ Sample No.: _____
Alarm Name & Model No.: _____
Zero Axis Sound Level (dBA) at 1.2 Meters: _____
Alarm Mounting Position: Vertical Horizontal

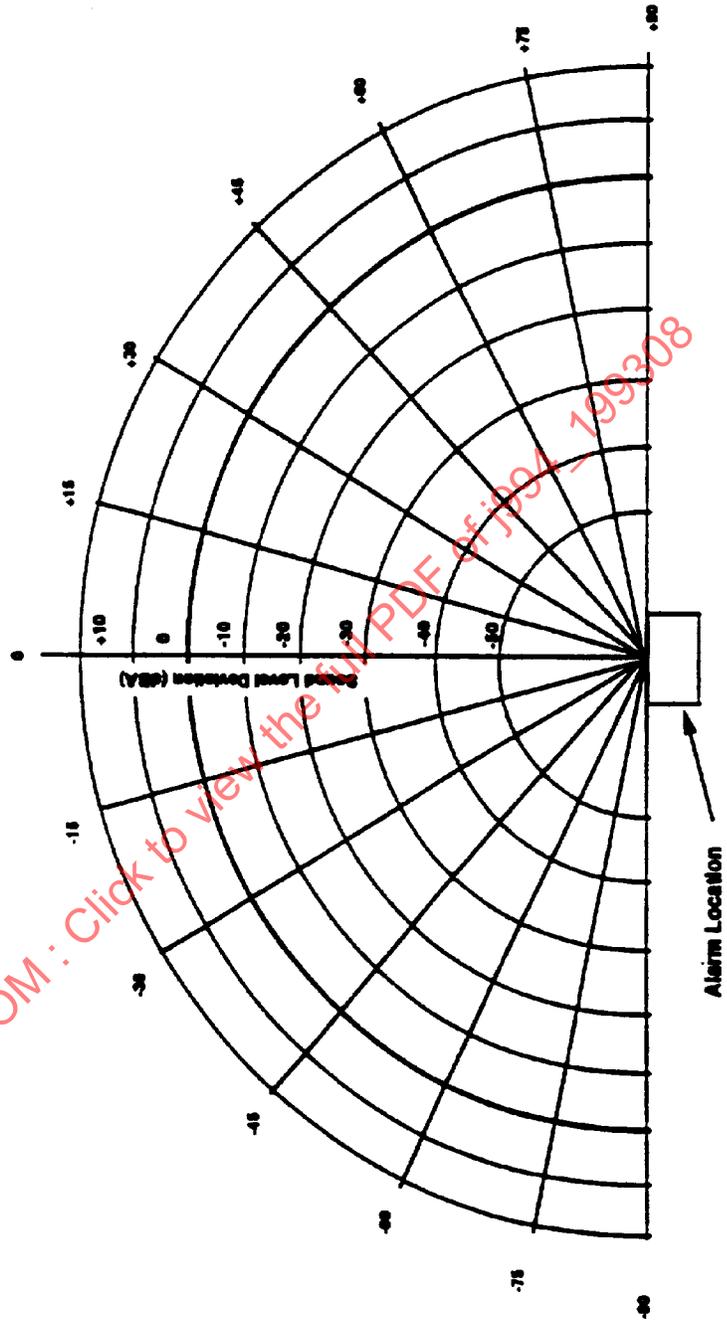


FIGURE 4—SOUND LEVEL DIRECTIONALITY CHART

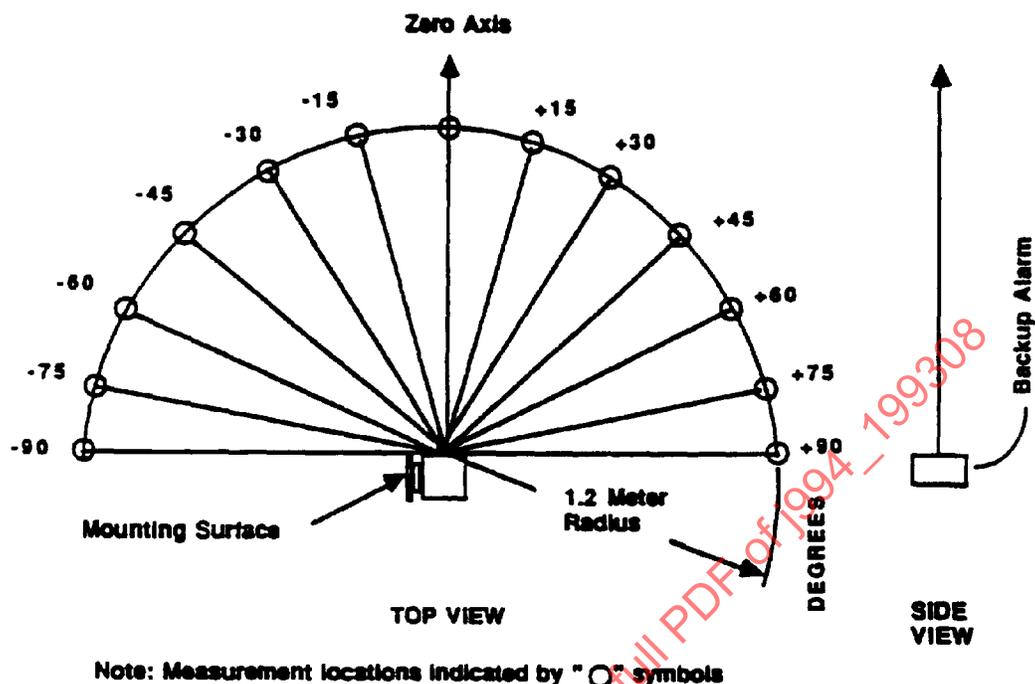


FIGURE 5—BACKUP ALARM SOUND LEVEL MEASUREMENT LOCATIONS—
MOUNTING SURFACE VERTICAL

- 7.2.2 **HIGH TEMPERATURE, SYSTEM VOLTAGE EXTREMES**—Repeat 7.2. Within 1 min after removing the alarm from the environmental chamber, measure and record the sound level and predominant sound frequency of the alarm for both extremes of operating voltage of 9 and 16 VDC for a 12 V alarm and 18 and 32 VDC for a 24 V alarm. The sound level shall be within ± 8 dBA for the value measured in 6.3 and within the frequency range specified in 6.1.
- 7.2.3 **ROOM TEMPERATURE CHECK**—Remove the alarm from the environmental chamber and allow it to cool to $25\text{ }^{\circ}\text{C} \pm 11\text{ }^{\circ}\text{C}$ for at least 1 h. Repeat 6.3.
- 7.3 **Rain Test**—Mount a sample alarm, not in operation, such that the zero axis of the alarm is horizontal. Subject all exposed sides of the alarm item to simulated blown rain for at least 2 h with a precipitation rate of 2.5 mm water per minute delivered at an angle of 45 degrees from a nozzle with a solid cone spray. Within 1 min after removal from the rain test, measure and record the sound level of the alarm. The sound level shall meet the requirements of 6.3.
- 7.4 **Vibration Test**—A sample alarm, as mounted on the supports supplied, shall be bolted to the table of the vibration test machine and the test conducted as follows with the alarm in operation.
- 7.4.1 **RESONANCE SEARCH**—Determine and record the resonant frequencies of the test item for each position (x-y-z axis) by slowly varying the frequency of applied vibration through 10 to 500 Hz with sufficient amplitude to excite the item. Resonance of components is determined by visual observation, strain-gaging of components, observing signal interruptions of the electronic circuit, or a combination of these. See Figure 6.

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7.4.2 RESONANCE DWELL—Vibrate the test item for 30 min at a 10 g (peak to peak) level at the most severe resonant frequency and at no more than three other significant resonant frequencies (if they were found) along each axis as determined in 7.4.1. For resonant frequencies below 27 Hz, vibrate at a constant amplitude of 6.76 mm as shown in Figure 6. If the resonance frequency changes during this test, immediately record its time of occurrence and adjust the frequency to maintain peak resonance. Record final resonance frequency.

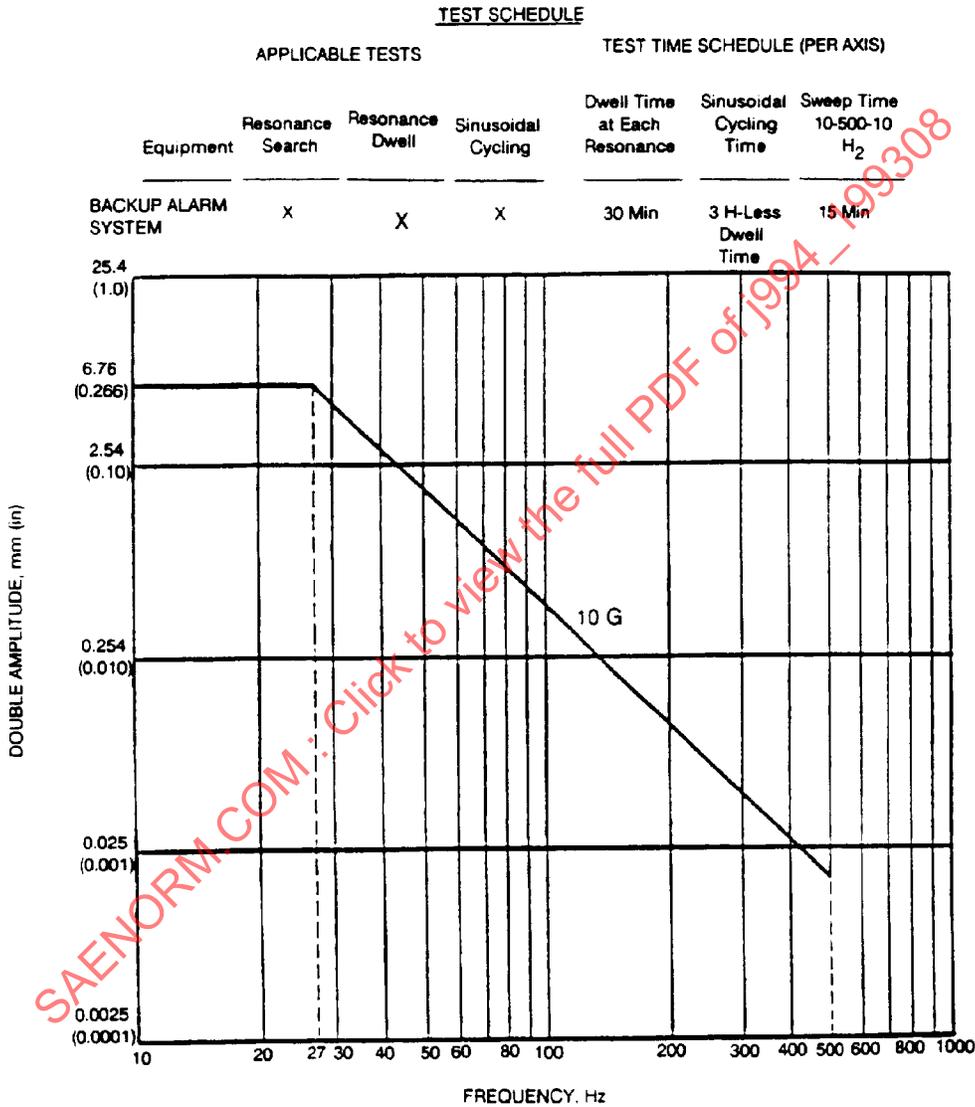


FIGURE 6—VIBRATION TEST

7.4.3 VIBRATION CYCLING—Use a cycle time of 15 min to ascend to 500 Hz and descend to 27 Hz (refer to Figure 6). Vibration cycling will be along each axis (x-y-z) at 10 g (peak to peak) above 27 Hz. The total cycling time for each axis is 3 h minus the time spent on the axis for the resonant dwell test in 7.4.2 (MIL-STD-810B Method 514.1). During the final 15 min cycle (on axis checked last), connect the power to the alarm to check that it functions continuously throughout the cycle. At the end of the vibration test, repeat 6.3.