SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL

OFF-HIGHWAY MACHINERY PRACTICE

an American National Standard

SAE J994

Issued July 1967
Reaffirmed March 1985

ALARM - BACKUP - ELECTRIC - PERFORMANCE, TEST, AND APPLICATION

1. SCOPE:

This SAE Recommended Practice establishes the following criteria for electrically operated backup alarm devices on mobile construction and industrial machinery:

a. Backup alarm device performance requirements.
b. Measurement technique for alarm performance requirements.
c. Laboratory environmental tests.
d. Alarm activation on the vehicle.

2. BACKUP ALARM SYSTEM:

The backup alarm system (complete system) for purposes of this recommended practice, consists of an alarm, alarm control circuitry, and an actuating switch (refer to Figure 1).

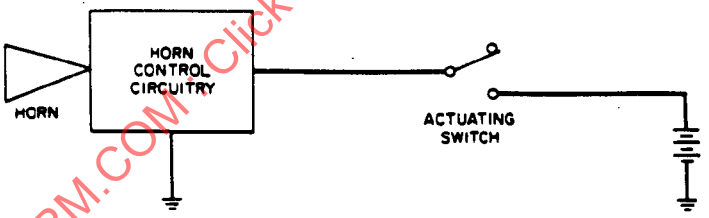


FIGURE 1 - Backup Alarm System Schematic

3. BACKUP ALARM PERFORMANCE REQUIREMENTS:

The performance requirements apply at ambient temperature of 77°F ± 20 (25°C ± 11) and at normal operating voltage of a 14 or 28 V battery system unless otherwise stated and measured as in 4.2 through 4.3.27.

SAENORM.COM : Click to view the full PDF of j994_198503

SAE Technical Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright 1990 Society of Automotive Engineers, Inc.
All rights reserved.

Printed in U.S.A.

S.A.E. LIBRARY

3.1 The predominant sound frequency of the alarm shall fall within the frequency range of 700 to 2800 Hz.

3.2 The cycles of sound level pulsations from the alarm shall be of the order of 1-2/s. The duration of the "on" and "off" intervals shall be approximately equal in length.

3.3 The sound level of the alarm shall be measured according to 4.2 and shall be any of the following with tolerances as stated in 3.4, 3.5, and 3.6.

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)

3.4 The sound level shall meet the design type or types specified and not vary from the values in 3.3 by more than ±4 dB with a normal system voltage of 14 or 28 V.

3.5 The sound level shall not vary more than ±8 dB from the values given in 3.3 for both extremes of the operating voltage range of 9.8 to 18.2 V and 19.6 to 36.4 V for 14 and 28 V systems, respectively.

3.6 The sound level shall not vary more than ±8 dB from a baseline measurement (determined as specified in 4.3) at -40°F ± 5 (-40°C ± 3) and 165°F ± 5 (74°C ± 3) when the alarm is in the appropriate environment chamber.

4. LABORATORY MEASUREMENT TECHNIQUE:

4.1 Instrumentation and Test Facilities:

4.1.1 A sound level meter which meets the Type 1 requirements of ANSI S1.4-1971, Specification for Sound Level Meters.

4.1.2 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 indicating meter, providing the system meets the requirements of SAE J184.

4.1.3 A filter set which meets the Class II octave band requirements of ANSI S1.11-1966 (R1971), Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets.

4.1.4 A sound level calibrator.

4.1.5 A temperature measuring system.

4.1.6 A voltage measuring system.

4.1.7 Vibration apparatus.

4.1.8 Environmental chamber.

SAENORM.COM : Click to view the full PDF of j994_198503

4.1.9 Dust chamber.

4.1.10 Rain, steam, and corrosion chamber.

4.2 Measurements:

4.2.1 The alarm device and a microphone shall be located in a free field 4 ft (1.2 m) above a horizontal reflecting plane or laboratory equivalent, with the microphone 4 ft (1.2 m) from the alarm's horn along its 0 deg axis. For determination of the sound levels in the appropriate environmental chamber for the extreme temperature tests, see 4.2.5. (A free field is defined as an area with no vertical reflecting surface within 50 ft (15.2 m). A horizontal reflecting plane is defined as the finished concrete in a laboratory or the equivalent when conducting testing in the field.)

4.2.2 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.

4.2.3 The sound level meter shall be set for fast response or equivalent and A-weighting network to check sound level.

4.2.4 The predominant sound level output shall be checked with an octave band filter set to determine that the frequency is within acceptable limits.

4.2.5 The sound level shall be determined and recorded for the backup alarm (type A, B, C, D, or E) when it is actuated in the environmental test chamber at 77°F ± 20 (25°C ± 11) and at extreme temperature as specified in 3.6.

4.3 Data Acquisition: All data measurements will be taken during a minimum test period of 1 min operation at ambient temperature of 77°F ± 20 (25°C ± 11) and normal battery system voltage of 14 or 28 V, unless either temperature or voltage is stated otherwise. The data must be correlated with performance requirements where specified. If requirements are not met at any step in testing, a decision will be necessary to determine if testing should be continued.

4.3.1 Measure and record the predominant sound frequency of the alarm. Correlate data with performance requirements in 3.1.

4.3.2 Measure and record the rate of cyclic sound level pulsations from the alarm. Correlate data with performance requirements in 3.2.

4.3.3 Measure and record the sound level of the alarm. Correlate the data with performance requirements and tolerance from 3.4.

4.3.4 Measure and record the sound level change between extremes of the operating voltage range between 9.8 to 18.2 V and 19.6 to 36.4 V for 14 or 28 V systems, respectively. Correlate the data with performance requirements and tolerance specified in 3.5.

SAENORM.COM : Click to view the full PDF of j994_196503

4.3.5 Perform the vibration tests as specified in 5.1 through 5.1.3.

4.3.6 Repeat 4.3.3 and 4.3.4.

4.3.7 Perform rain tests as specified in 5.2.

4.3.8 Repeat 4.3.3 and 4.3.4.

4.3.9 Perform corrosion test as specified in 5.3.

4.3.10 Repeat 4.3.3 and 4.3.4.

4.3.11 Perform steam test as specified in 5.4.

4.3.12 Repeat 4.3.3 and 4.3.4.

4.3.13 Perform dust test as specified in 5.5.

4.3.14 Repeat 4.3.3 and 4.3.4.

4.3.15 Measure and record the sound level of the alarm in the environmental chamber to obtain the baseline data as specified in 4.3.

4.3.16 Measure and record the sound level of the alarm in the environmental chamber at -40°F ± 5 (-40°C ± 3) after the complete system has been at this temperature for at least 1 h immediately prior to this test. The sound level should be within ±8 dB of the baseline data measured in 4.3.15.

4.3.17 Measure and record the sound level of the alarm in the environmental chamber at -40°F ± 5 (-40°C ± 3) for both extremes of the operating voltage range between 9.8 to 18.2 V and 19.6 to 36.4 V for 14 or 28 V systems, respectively, after the complete system has been at the above temperature for at least 1 h immediately prior to the test. No specified sound level is required, but the alarm is to be operational and register a reading on the meter above the existing ambient sound level.

4.3.18 Operate the complete system at -40°F ± 5 (-40°C ± 3) in the environmental chamber for 15 000 sound pulsation cycles as specified in 5.6 and 5.6.1.

4.3.19 Repeat 4.3.16 and 4.3.17.

4.3.20 Repeat 4.3.15 for the environmental chamber to be used for the high temperature evaluation.

4.3.21 Measure and record the sound level of the alarm in the environmental chamber at 165°F ± 5 (74°C ± 3) after the complete system has been at this temperature for 1 h immediately prior to this test. The sound level should be within ±8 dB of that measured in 4.3.20.

SAENORM.COM : Click to view the full PDF of j994_198503

4.3.22 Measure and record the sound level of the alarm in the environmental chamber at 165°F ± 5 (74°C ± 3) at both extremes of the operating range between 9.8 to 18.2 V and 19.6 to 36.4 V for 14 or 28 V systems, respectively, after the complete system has been at the above temperature for 1 h immediately prior to the test. No specified sound level is required, but the alarm is to be operational and register a reading on the meter above the existing ambient sound level.

4.3.23 Operate the complete system at 165°F ± 5 (74°C ± 3) in the environmental chamber for 15 000 sound pulsation cycles as specified in 5.6 and 5.6.2.

4.3.24 Repeat 4.3.21 and 4.3.22.

4.3.25 Repeat 4.3.3 and 4.3.4.

4.3.26 Operate the complete system for 470 000 sound pulsation cycles as specified in 5.6 and 5.6.3.

4.3.27 Repeat 4.3.1, 4.3.2, 4.3.3, and 4.3.4.

5. LABORATORY ENVIRONMENTAL TESTS:

Sound level output shall be measured during a minimum test period of 1 min according to the requirements of 3.4, 3.5, and 3.6 in the sequence under 4.3. The unit shall then be examined. Any unit showing evidence of material physical weakness, displacement, or ruptured parts shall be considered to have failed. The environmental tests are listed in the recommended test sequence.

5.1 Vibration Test: A sample unit (complete system), 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:

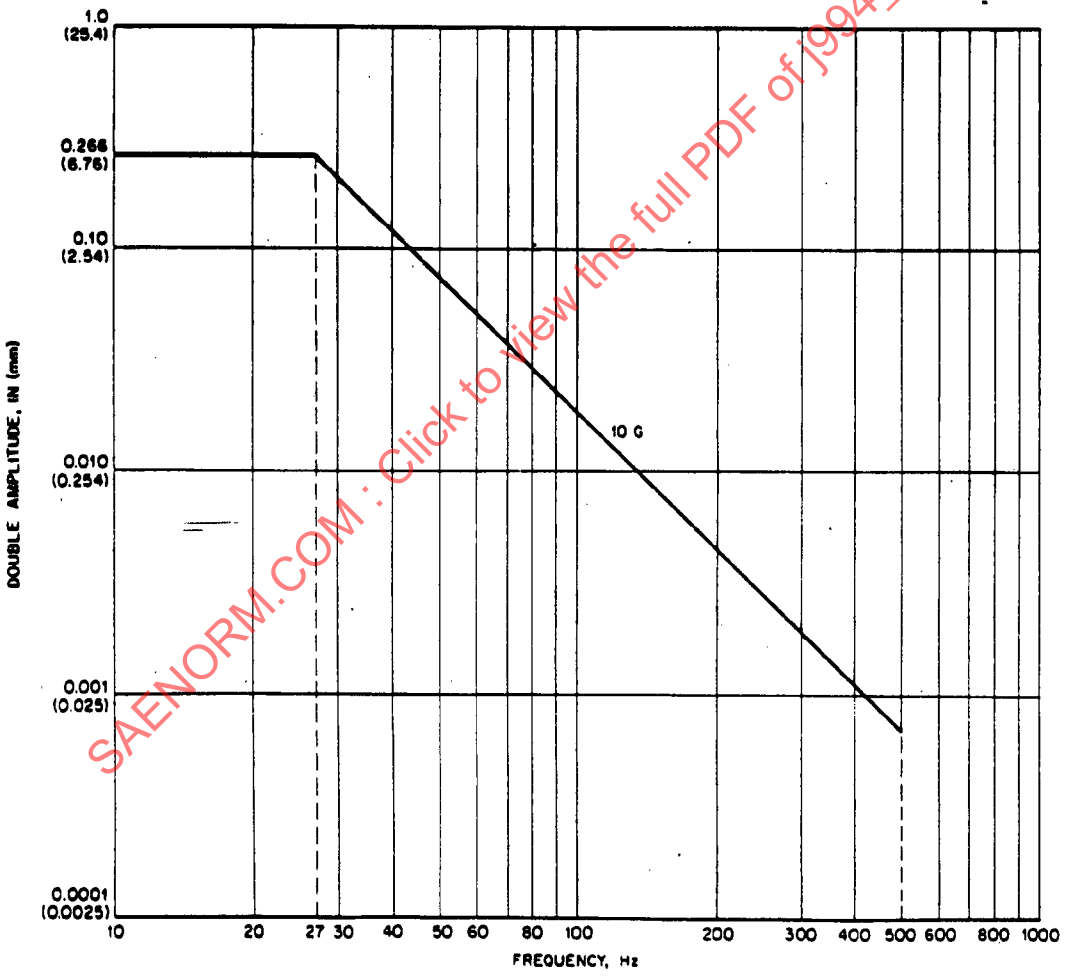
5.1.1 Resonance Search: Determine and record the resonant frequencies of the test item for each position (x-y-z axis) by slowly varying the frequency of applied vibration through 10 to 500 Hz with sufficient amplitude to excite the item. Resonance of components is determined by visual observation, strain-gaging of components, observing signal interruptions of the electronic circuit, or a combination of these. See Figure 2.

5.1.2 Resonance Dwell: Vibrate the test item for 30 min at a 10g (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 (x-y-z) as determined in 5.1.1. For resonance frequencies below 27 Hz, the 10g (peak to peak) level may be allowed to decrease to a minimum of 2g (peak to peak) at 10 Hz to facilitate testing with equipment with inadequate capacity to maintain 10g (peak to peak) down to 10 Hz. If resonance frequency changes during this test, immediately record its time of occurrence and adjust the frequency to maintain peak resonance. Record final resonance frequency.

SAENORM.COM : Click to view the full PDF of j994_198503

TEST SCHEDULE

EQUIPMENT	APPLICABLE TESTS: RESONANCE SEARCH	RESONANCE DWELL	SINUSOIDAL CYCLING	TEST TIME SCHEDULE (PER AXIS): DWELL TIME AT EACH RESONANCE	SINUSOIDAL CYCLING TIME	SWEEP TIME 10-500-10 H_2
BACKUP ALARM SYSTEM	X	X	X	30 MIN	3 H-LESS DWELL TIME	15 MIN



SAENORM.COM : Click to view the full PDF of j994_198303

FIGURE 2 - Vibration Test

5.1.3 Vibration Cycling: Use a cycle time of 15 min to ascend to 500 Hz and descend to 10 Hz (refer to Figure 2). Vibration cycling will be along each axis (x-y-z) at 10g (peak to peak) above 27 Hz. Below 27 Hz, the g level may be allowed to decrease to a minimum of 2g (peak to peak) at 10 Hz to facilitate testing with equipment with inadequate capacity to maintain 10g (peak to peak) down to 10 Hz. The total cycling time for each axis is 3 h minus the time spent on that axis for the resonant dwell test in 5.1.2. (Reference MIL-STD-810B, Method 514.1.) During the final 15 min cycle (on the axis checked last), connect the power to the alarm to check that it functions continuously throughout the cycle.

5.2 Rain Test: Mount a sample unit (complete system), not in operation, in its normal operating position with all drain holes open. Subject all exposed sides of the test item to simulated blown rain for at least 2 h with a precipitation rate of 0.1 in (2.5 mm) water per minute delivered at an angle of 45 deg from a nozzle with a solid cone spray. Allow alarm to drain for 1 h and immediately test the complete system.

5.3 Corrosion Test: Subject a sample unit (complete system), not in operation, to a salt spray (fog) test in accordance with ASTM B 117. Duration of test is to be 50 h consisting of two periods of 24 h exposure followed with 1 h drying time.

Immediately following the second 1 h drying period, operate the complete system.

5.4 Steam Test: Direct a spray of steam-cleaning detergent compound (trisodium phosphate) at the horn bell or alarm box louvers (whichever is applicable) from a nozzle located at 12 in (300 mm) for a time period of 10 s, followed by a 30 s drain period. After 50 continuous cycles of steam application and draining, operate the complete system.

5.5 Dust Test: Mount a sample unit (complete system) in its normal operating position, at least 6 in (150 mm) from the wall in a cubical box with inside measurements of 3 ft (0.90 m) on each side. The box shall contain 10 lb (4.5 kg) of AC dust of 50% fine and 50% coarse particles. For 5 h, agitate the dust every 15 min for a 2 s period with compressed air or fan blower blasts in a downward direction to diffuse the dust uniformly throughout the cube. After completion of the dust test, operate the complete system. An alternate method of testing a sample unit is in accordance with MIL-STD-810B, Method 510.

5.6 Life Cycle Test: Operate the backup alarm for 500 000 sound pulsation cycles (1 to 2 pulsations/s as per 3.2) at 30 s on and 30 s off intervals of the shift lever actuation switch at a normal battery voltage of either 14 or 28 V:

5.6.1 15 000 sound pulsation cycles at -40°F ± 5 (-40°C ± 3).

5.6.2 15 000 sound pulsation cycles at 165°F ± 5 (74°C ± 3).

5.6.3 470 000 sound pulsation cycles at 77°F ± 20 (25°C ± 11). Refer to Figure 2.

SAENORM.COM : Click to view the full PDF of j994_198503

6. VEHICLE APPLICATION:

6.1 The job requirements, along with local, state, or national codes, should dictate whether a backup alarm device shall be used on mobile construction and industrial machinery. The use of a backup alarm device may not be applicable on certain machines such as compactors, loaders, dozers, and fully revolving cranes and excavators which do not distinguish in direction of working travel and where the operator can face the direction of travel and have good visibility to the ground close to the machine in each direction of travel.

6.2 The backup alarm shall be activated immediately when the transmission control mechanism is shifted into a reverse position, and shall remain activated until the mechanism is shifted out of the reverse position.

6.3 In order to prevent inadvertently having the alarm sound when the vehicle is parked, the electrical circuit for the transmission control portion of the alarm may be connected through the vehicle manually operated disconnect switch.

7. GENERAL REQUIREMENTS:

7.1 The backup alarm shall be mounted on the equipment and be so protected or constructed as to withstand severe wear and tear, adverse weather, and unfavorable environmental conditions.

7.2 The sound of the backup alarm shall be distinctive when compared to the sound of the normal manually operated forward motion vehicle warning horn.

8. GENERAL COMMENTS:

8.1 It is recommended that persons technically trained and experienced in current techniques of sound measurements select the equipment and conduct the tests.

8.2 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 include:

8.2.1 The type of microphone, its directional response characteristics, and its orientation relative to the ground plane and source of noise.

8.2.2 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.

8.2.3 Proper signal levels, terminating impedances, and cable lengths on multi-instrument measurement systems.

SAENORM.COM : Click to view the full PDF of j994_198503