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SURFACE VEHICLE RECOMMENDED PRACTICE

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(R) Emergency Vehicle Sirens

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1. ***Scope—***This SAE Recommended Practice provides laboratory test procedures, requirements and guidelines for electronic siren systems with a single loudspeaker, and electromechanical sirens for use on authorized emergency vehicles, which call for the right-of-way. This document is applicable only to such sirens that have all dimensions across the sound-emitting opening equal to or less than 0.5 m. Test procedures and performance requirements for individual system components are not included in this version.

Data obtained from measurements of siren performance depend not only on the characteristics of the siren tested, but additionally on the test procedures and the characteristics of the measurement instrumentation and test environment. These additional factors must be well defined and controlled to obtain reliable data. Detailed test methods are described here, which include specifications for a laboratory environment, to minimize the measurement uncertainty and obtain accurate and reproducible measurement results. Such results are necessary to qualify the performance of all sirens as equally as practicable. Requirements have been established based on the laboratory-measured performance of sirens that have been effective in emergency service.

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: http://www.sae.org

Whether a person will hear, recognize, and react quickly enough to the warning sounds produced by a siren during an emergency depends on many factors in addition to the sound pressure level (SPL) it produces in a controlled test environment. Reflection, scattering and attenuation caused by objects such as buildings, trees, road surfaces and vehicles contribute to sound propagation losses. Absorption of sound by the atmosphere itself also results in losses. Windows, soundproofing and other materials that are part of a vehicle further decrease sound levels. Background noises also interfere with the audibility of acoustical signals, an effect called masking. Siren sounds are masked by traffic and community noise, and noise produced by car stereos, air conditioning, wind and rain. There are also variations in how well different people can detect, identify and localize sounds, which are partly due to their ability to hear as a function of frequency. Finally, how effectively someone can react to a detected sound depends on the proximity and speed of the emergency vehicle, the speed of their vehicle, and their reflexes.

Emergency vehicle sirens do not produce sounds that are loud enough to warn effectively in all circumstances. A report prepared for the U.S. Department of Transportation by Bolt, Beranek, and Newman Inc. concluded that the sound levels produced by sirens would have to be increased greatly, to the point where these levels would be intolerable to the community, to be loud enough to warn effectively in all ordinary circumstances. There is no assurance that all other motorists will always hear, recognize, or react quickly enough to the warning sounds produced by a siren to take appropriate action. It is necessary for emergency vehicle operators to watch for the reaction of other motorists to the siren and be prepared to maneuver accordingly. Sirens have been effective in calling for the right-of-way by an emergency vehicle, but must always be used in conjunction with effective visual warning devices and operated only by properly trained personnel who are aware of the limitations noted here.

There is an additional concern for emergency vehicle operators and others exposed to siren noise. Sounds produced by emergency vehicle sirens are loud enough to increase the risk of temporary or permanent hearing loss. Appendix A contains information regarding occupational hearing loss and exposure to siren noise.

Appendix B is a data sheet that includes Tables B1 through B5C and descriptive statements for use when documenting test results. It outlines the data that must be recorded when performing the measurements specified in this document.

2. References

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

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

SAE J336—Sound Level for Truck Cab Interior
SAE J575—Test Methods and Equipment for Lighting Devices and Components for Use on Vehicles Less Than 2032 mm in Overall Width
SAE J759—Lighting Identification Code
SAE J994—Alarm—Backup—Electric Laboratory Performance Testing
SAE J1113-21—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 21: Immunity to Electromagnetic Fields, 10 kHz to 18 GHz, Absorber-Lined Chamber
SAE J1113-41—Limits and Methods of Measurement of Radio Disturbance Characteristics of Components and Modules for the Protection of Receivers Used On-Board Vehicles

2.1.2 ANSI PUBLICATIONS—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ANSI S1.1-1994 (R 1999)—Acoustical Terminology
ANSI S1.4-1983 (R 1997)—Specification for Sound Level Meters
ANSI S1.15-1997/Part 1—Measurement Microphones—Part 1: Specifications for Laboratory Standard Microphones
ANSI S1.40-1984 (R1997)—Specification for Acoustical Calibrators
ANSI S1.42-1986 (R 1998)—Design Response of Weighting Networks for Acoustical Instruments

2.1.3 IEC PUBLICATIONS—Available from IEC, Geneva Switzerland.

IEC 61094-1 (2000-07)—Measurement Microphones—Part 1: Specifications for Laboratory Standard Microphones
IEC 61094-4 (1995-11)—Measurement Microphones—Part 4: Specifications for Working Standard Microphones

2.1.4 DOT PUBLICATIONS—Available from the National Technical Information Service, Springfield, VA 22161.

Effectiveness of Audible Warning Devices on Emergency Vehicles. Report No. DOT-TSC-OST- 77-38. R.C. Potter, S.A. Fidell, M.M. Myles and D.N. Keast. Work performed by Bolt, Beranek and Newman Inc. for the U.S. Department of Transportation, Washington, DC 20590; August 1977

2.1.5 OTHER PUBLICATIONS—NIOSH publications available from NIOSH, Cincinnati Ohio 45226.

Criteria for a Recommended Standard: Occupational Noise Exposure Revised Criteria 1998. DHHS (NIOSH) Publication No. 98-126. National Institute for Occupational Safety and Health, Cincinnati, OH 45226-1998; June 1998
Preventing Occupational Hearing Loss - A Practical Guide. DHHS (NIOSH) Publication No. 96-110. National Institute for Occupational Safety and Health, Cincinnati, OH 45226-1998; October 1996
The NIOSH Compendium of Hearing Protection Devices. DHHS (NIOSH) Publication No. 95-105. National Institute for Occupational Safety and Health, Cincinnati, OH 45226-1998; October 1994
Health Hazard Evaluation Report HETA 81-059-1045, Newburgh Fire Department, Newburgh, New York, Tubbs, R.A., Flesch, J.P., National Institute for Occupational Safety and Health, Cincinnati, OH 45226-1998; February 1982
Health Hazard Evaluation Report HETA 84-493-1583, General Services Administration, Washington, DC., Flesch, J.P., Tubbs, R.A., National Institute for Occupational Safety and Health, Cincinnati, OH 45226-1998; April 1985

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

2.2.1 CALIFORNIA CODE OF REGULATIONS—Available from Barclays Law Publishers, South San Francisco, CA 94111.

California Code of Regulations Title 13, Article 8

3. *Definitions*

3.1 Siren—A device or system for producing acoustical signals that continuously vary in frequency and call for the right-of-way of an emergency vehicle. These signals, and the electrical signals that produce them, are generally referred to as siren signals.

3.2 Electronic Siren Amplifier—A device that is powered by the electrical system of the vehicle and produces an electrical signal that drives an electronic siren speaker. The amplifier also includes any controls for siren operation.

3.3 Electronic Siren Speaker—A transducer that converts the electrical signal from an electronic siren amplifier into acoustical energy. An electronic siren speaker includes the electroacoustical transducer and all mechanisms or housings required to couple and control the transducer acoustical output.

3.4 Electronic Siren System—A siren that is the combination of an electronic siren amplifier and an electronic siren speaker or speakers.

3.5 Electromechanical Siren—A siren that converts electrical energy into acoustical energy without the use of an electronic power amplifier. An example of such a siren is a motor-driven rotor spinning inside a fixed stator.

3.6 Cycling Period—The time required for the siren signal to sweep from the lowest to the highest fundamental frequency and back to the lowest fundamental frequency.

3.7 Sound Pressure Level (SPL)—Defined in ANSI S1.1-1994 as ten times the logarithm to the base ten of the ratio of the time-mean-square pressure of a sound, in a stated frequency band, to the square of the reference sound pressure in gases of 20 μPa.

3.8 A-Weighted Sound Pressure Level—A sound pressure level that has been measured with an A-weighting filter that meets the requirements of ANSI S1.42-1986.

3.9 Fast Time Setting—A setting available on sound level meters and other acoustical measurement instruments that provides the exponential-time averaging constant specified in ANSI S1.4-1983 for the fast exponential-time averaging characteristic.

3.10 Long-Term Time Setting—Any setting on a sound level meter or other acoustical measurement instrument that provides an exponential-time averaging constant of at least 20 s.

3.11 Device Axis—The axis that passes through the center of the sound emitting opening of the siren speaker, and is parallel to the forward facing direction of the siren speaker as installed on a vehicle according to the instructions provided by the manufacturer.

3.12 Wail Mode—Siren mode of operation that produces the wail signal, which is specified in 6.1.2.1.

3.13 Yelp Mode—Siren mode of operation that produces the yelp signal, which is specified in 6.1.2.2.

3.14 Maximum rms Level Hold Function—A detector output function of the acoustical measurement system that holds the maximum true rms level measured and outputs this level to the meter (e.g., “max hold” or “hold” functions in rms mode).

3.15 Normal rms Level Function—A detector output function of the acoustical measurement system that outputs the true rms level measured to the meter.

4. Identification Code and Markings

4.1 Identification Code—Emergency vehicle sirens or siren system components shall be marked with the code that indicates the function or functions for which the device was originally designed in accordance with SAE J759. This code also indicates the general location on/in a vehicle where the siren or siren system component should be permanently mounted. The code “EVS1” is for such devices that mount in the interior of the vehicle, including the trunk or any other dry compartment, code “EVS2” is for such devices that mount outside the vehicle, except under the hood, and code “EVS3” is for such devices that mount under hood.

4.2 Markings—All devices shall be marked using characters that are 3.0 mm or greater in height. After all of the appropriate environmental testing has been performed and the marking areas have been cleaned using a mild soap solution and towel, markings on labels must be clearly visible and legible, and the label shall remain reliably affixed to the device. All electronic siren system components shall be marked to indicate that they meet the requirements specified in SAE J1849 only when used with each other, and shall not be interchanged with components of other systems.

4.2.1 ELECTROMECHANICAL SIRENS—The name of the manufacturer, the model number, the input voltage, operating current, mounting orientation, and the identification code shall be marked.

4.2.2 ELECTRONIC SIREN SPEAKERS—The name of the manufacturer, the model number, mounting orientation, and the identification code shall be marked.

4.2.3 ELECTRONIC SIREN AMPLIFIERS AND ASSOCIATED CONTROLS—The name of the manufacturer, the model number, the operating (power supply) voltage and current, and the identification code shall be marked. If the amplifier and controls are separate components, each component shall be labeled as a part of a system and the identification code shall be marked on each component.

5. Tests—Personnel should be required to wear hearing protectors when exposure to acoustical noise equals or exceeds the NIOSH recommended exposure limit (see Appendix A). Hearing protectors should attenuate noise sufficiently to keep exposure at the ear below this recommended limit. During testing, personnel should wear hearing protection any time the siren is activated in their general vicinity. For all of the tests described as follows, the sirens tested shall be new, undamaged and randomly drawn from the production population. Five sirens, which will be referred to as siren #1 through siren #5, shall be used for the tests. Each siren shall be physically marked with its designated number. Siren #1 shall be subjected to the entire acoustical test. The other four sirens shall be subjected to the SPL measurement only at the measurement angle of 0 degree. After all four of these sirens have been subjected to this SPL measurement:

Siren #2 shall be subjected to the electromagnetic compatibility tests, which are described in 5.6, 5.7, and 5.8.

Siren #3 shall be subjected to the vibration, corrosion, dust and moisture tests, in the order written. Only those tests that are applicable based on the intended mounting location, which is indicated by the identification code, of the siren are required.

Siren #4 shall be subjected to the durability test.

Siren #5 shall be subjected to the extreme temperature tests. Only those tests that are applicable based on the intended mounting location, which is indicated by the identification code, of the siren are required.

After the tests mentioned above are complete, all four of these sirens shall again be subjected to the SPL measurement only at the measurement angle of 0 degrees. For all tests, the ambient laboratory temperature shall be in the range 18 °C to 30 °C except where noted otherwise.

Multiple variations of electronic siren amplifiers may be grouped into product families. Representative models may be tested to obtain family wide approval as long as model numbers or other codes are arranged to define such families, the amplification and signal generation circuitry are identical in the family, and the test report lists each specific model variation. The manufacturer shall have on record the details of each variation, and state why the performance of the untested model(s) should not be significantly affected by the variation. Untested electronic siren systems that include an electronic siren amplifier from a different electronic siren system that has met the requirements of SAE J1849 do not need to be subjected to the electromagnetic compatibility tests, which are described in 5.6, 5.7, and 5.8. In addition, these amplifiers are exempt from the temperature soaks, and the signal frequency and AC voltage measurements are not required, during the extreme temperature tests of such systems. However, the electronic siren loudspeakers shall be operated and temperature soaked according to the procedures specified for these tests.

5.1 Acoustical Test—This test is required for all devices.

5.1.1 ACOUSTICAL TEST EQUIPMENT AND FACILITIES

5.1.1.1 Acoustical Measurement System—The system shall meet the Type I requirements for a sound level meter specified in ANSI S1.4-1983. It shall have fast and long-term time settings, and maximum rms level hold and normal rms level functions. The microphone shall meet the Type WS2F, or Type WS3F specifications of IEC 61094-4, or the Type LS2F specifications of IEC 61094-1 or ANSI S1.15-1997/Part 1.

All of these microphone types are nominal one-half-inch diameter or smaller microphones with a free-field sensitivity that is approximately independent of frequency in the widest possible frequency range.

5.1.1.2 Sound Level Calibrator—The acoustical calibrator or pistonphone shall meet the requirements of ANSI S1.40-1984. The SPL the sound level calibrator is stated to produce shall be accurate within a tolerance of ±0.35 dB.

5.1.1.3 Test Speaker—Audio speaker that shall be used to qualify the anechoic room. This speaker shall have a closed-back design (non-dipole) and an operational transducer with a diameter between 0.14 m and 0.21m that shall be used for the room qualification.

5.1.1.4 Anechoic Room—Test room with surfaces that absorb essentially all of the incident sound energy over the frequency range of interest, thereby affording nearly free-field conditions over the measurement surface. The anechoic room shall maintain nearly free-field conditions from 500 Hz to 6300 Hz. Nearly free-field conditions are considered established when the SPL at positions –0.30 m, –0.15 m, 0.15 m, and 0.30 m ± 0.02 m relative to the fixed microphone location used for siren measurements, on the device axis of the test speaker aligned for a measurement angle of 0 degree (see 5.1.2.2), do not deviate by more than ±1.0 dB from the inverse distance law for SPL. This criteria must be met with a one-third-octave bandwidth noise stimulus at the following one-third-octave center frequencies: 500 Hz, 630 Hz, 800 Hz, 1000 Hz, 1250 Hz, 1600 Hz, 2000 Hz, 2500 Hz, 3150 Hz, 4000 Hz, 5000 Hz, and 6300 Hz. The room shall meet these requirements initially with the test speaker aligned for a measurement angle of 0 degree, and also with the speaker rotated horizontally 50 degrees from the initial orientation (i.e., measurement angle of 50 degrees). An angle of 50 degrees is used to decrease the level of the sound radiated directly to the microphone, and increase the level of the sound directed toward the chamber side walls. When qualifying the anechoic room, the front most part of the speaker shall be aligned with the front edge of the speaker mount. All deviations in the measured SPL from the inverse distance law for a given orientation shall be calculated relative to the SPL measured at the fixed microphone location used for siren measurements.

5.1.1.5 Speaker Mount—A test base that is 30.0 cm x 30.0 cm x 1.5 cm ± 1.0 cm shall be used to mount the siren speaker and test speaker.

5.1.1.6 *Direct Current Power Supply*—The power supply shall be regulated to ±1% with a maximum ripple of 75 mV peak-to-peak.

For electromechanical sirens, the power supply shall not allow the voltage to fall more than 10% below the initial supply voltage while the siren is energized and held at its highest operating frequency.

5.1.1.7 *DC Current Measurement System*—The system shall be able to perform DC current measurements that are accurate within a tolerance of ±5%.

5.1.1.8 *DC Voltmeter*—The voltmeter shall be able to perform DC voltage measurements that are accurate within a tolerance of ±1%.

5.1.1.9 *Oscilloscope for Signal Frequency Measurement*—A digital-sampling oscilloscope with adjustable time cursors, a minimum sampling bandwidth of 1 MHz, and storage capability for at least three cycles of the yelp signal shall be used.

5.1.2 ACOUSTICAL TEST PROCEDURES

5.1.2.1 *Laboratory Environmental Requirements*—The temperature, barometric pressure, and relative humidity of the anechoic room shall be recorded and held to as nearly constant values as practicable during the SPL measurements. These ambient environmental conditions shall not be outside of the ranges recommended by the manufacturer of the acoustical measurement equipment. In addition, the relative humidity shall be less than 80% and the barometric pressure shall be in the range 950 mbar to 1050 mbar.

5.1.2.2 *Microphone and Siren Speaker Setup*—Place the speaker mount in the anechoic room so that the siren speaker shall be at least 1 m from any surface, including the absorptive surfaces of the room. Secure the siren speaker on the speaker mount so that the front-most part of the speaker is aligned with the front edge of the mount and the speaker device axis is in the horizontal plane. Neither the speaker mount nor the securing equipment should interfere with the acoustical output or operation of the siren. Set up the microphone facing the speaker, 3.00 m ± 0.02 m from the front-most part of the speaker on its device axis. The device axis shall pass through the center of, and be perpendicular to, the diaphragm of the microphone. This relative orientation between the microphone and speaker constitutes a measurement angle of 0 degree. The microphone shall be at least 1 m from any surface, including the absorptive surfaces of the room.

The siren speaker shall be connected to the siren amplifier in such a way that the voltage difference between the output terminals of the amplifier and the terminals of the speaker shall not exceed ±1%.

5.1.2.3 *Acoustical Measurement System Calibration*—Calibrate the acoustical measurement system with the acoustical calibrator or pistonphone set at a design-center frequency in the range from 200 Hz to 1000 Hz. The A-weighting filter shall not be used during the calibration. The system shall be calibrated on the same range setting that will be used during the measurement. Correct the applied sound level for the ambient barometric pressure and the equivalent load volume. For calibrations performed above 300 Hz, also apply the correction necessary to compensate for the difference between the free-field response and pressure response of the microphone.

Set the level indicated on the measurement system to be within ±0.1 dB of the corrected level.

5.1.2.4 *Power Supply Voltage*—Set the DC power supply voltage to 13.6 V ± 0.2 V for devices that are designed to operate on nominal 12-V electrical systems (sometimes referred to as 14-V systems), 27.2 V ± 0.3 V for devices that are designed to operate on nominal 24-V systems, and 40.8 V ± 0.5 V on devices that are designed to operate on nominal 42-V systems. When setting the power supply voltage, measure this voltage at the junction between the power cables supplied by the manufacturer for the amplifier and the terminals of the power supply.

5.1.2.5 *SPL Measurements*—Operate the siren continuously in the yelp mode for a ten-minute warm-up period. Immediately following this period, SPL measurements shall be performed at the following angles (±2 degrees) relative to the device axis in the order written: 0 degree, 10 degrees, 20 degrees, 30 degrees, 40 degrees, 50 degrees, –50 degrees, –40 degrees, –30 degrees, –20 degrees, –10 degrees. These angles shall be realized by rotating the speaker mount. The axis of rotation shall be the vertical axis that passes through the center of this mount. A negative sign is used to denote angles measured with the device axis rotated clockwise from its initial 0 degree orientation.

In the yelp mode, measure the A-weighted SPL with the fast time setting and the maximum rms level hold function of the acoustical measurement system. Record the SPL reading to the nearest tenth of a decibel.

At each angle, repeat this measurement in the wail mode before rotating the speaker to the next angle.

The maximum rms level hold function shall be reset immediately before each such SPL measurement is performed after all other equipment adjustments have been done.

After all of the measurements done with the fast time setting in both the yelp and wail modes have been completed, change to the long-term time setting and the normal rms level function of the acoustical measurement system. Measure the A-weighted SPL with the long-term time setting in the wail and yelp modes at the same measurement angles, and in the same order specified for the fast time setting measurements. Each time a new measurement is started, wait for a period equal to the exponential-time averaging constant of the measurement. Then observe the fluctuations of the meter for at least one complete siren signal cycle. If the range of the fluctuations is greater than 1.0 dB, a longer time setting shall be used. Once the fluctuations have stabilized within this range, record the SPL reading estimated from the arithmetic mean of the maximum and minimum values observed to the nearest tenth of a decibel.

If it is necessary to adjust the measurement angle by entering the anechoic chamber, the siren may be turned off each time a new angle is set. However, the siren shall not be off any longer than 1 min, and shall have been on for at least 30 s immediately prior to performing a measurement. After the tests of the yelp and wail signals have been completed and the loudspeaker temperature has returned to the ambient laboratory temperature, other signals may be measured by repeating the described procedure.

5.1.2.6 *Signal Frequency Measurement*—Determine the lowest and highest fundamental frequencies of the wail and yelp signals. Connect the oscilloscope input to the AC output of the acoustical measurement system. For wail, adjust the time base of the oscilloscope so that one complete cycle of the fundamental frequency (lowest or highest) being measured occupies no less than one half of the display. Measure the half-period of this frequency by adjusting the cursors to be aligned with the zero-crossing of the initial rising and falling edges. Calculate the lowest and highest fundamental frequencies and the frequency range of the siren signal. When measuring the yelp signal, sample and store at least three cycles of the signal in the oscilloscope. Using the method described above for wail, calculate the lowest and highest fundamental frequencies and the frequency range of the yelp signal that has been stored.

5.1.2.7 *Signal Cycling Period Measurement*—Measure the cycling period of both the wail and yelp signals.

5.1.2.8 *DC Current Measurement*—This test is for informational purposes only. There are no performance requirements.

With the siren in the yelp mode, measure the DC current in the power cable of the siren amplifier. For electromechanical sirens, measure the DC current in the power cable connected to the siren while the siren is energized and held at its highest operating frequency.

5.1.2.9 *Stability Check*—After the SPL measurements are done, check the calibration of the acoustical measurement system by repeating the procedure specified in 5.1.2.3. If the sensitivity of the measurement system has changed by more than ±0.3 dB, the measurements shall be re-done. If necessary, the stability check may be done at more frequent intervals.

5.1.2.10 *Electromechanical Sirens*—All tests of electromechanical sirens, except when noted, shall be made while operating the siren in the wail mode.

5.2 Vibration Test—This test is required for all devices.

The siren shall be subjected to the vibration test specified in SAE J575 with the following exceptions. The test shall be done on three orthogonal axes consecutively with a two-hour duration for each axis. One excursion shall be in the vertical axis of the device with respect to its intended mounting position as identified in its mounting instructions. Mount the siren in accordance with its mounting instructions by using its intended mounting hardware and brackets fastened securely to the table of the vibration test machine.

5.3 Moisture Tests—This test is required only for devices that mount outside the vehicle, including under the hood (devices with identification code EVS2 or EVS3).

The siren shall be subjected to the high-pressure water test specified in SAE J994.

5.4 Corrosion Test—This test is required only for devices that mount outside the vehicle, including under the hood (devices with identification code EVS2 or EVS3).

The siren shall be subjected to the salt exposure test specified in SAE J575 with the following change regarding exposure. The exposure shall consist of two 24-hour periods each followed by a one-hour drying time.

5.5 Dust Test—This test is required only for devices that mount outside the vehicle, including under the hood (devices with identification code EVS2 or EVS3).

The siren shall be subjected to the dust test specified in SAE J575.

5.6 Radiated Emissions Test—This test is required for all electronic siren amplifiers.

The siren in the wail mode shall be subjected to the radiated emissions test specified in SAE J1113-41.

Measure and record the narrowband (with a peak detector) and broadband (with a quasi-peak detector) radiated disturbances for all of the frequency bands specified in SAE J1113-41. A passive resistive load, which is a non-inductive resistor with a resistance within ±1% of the nominal impedance of the speaker used in the siren system, may be substituted for the siren loudspeaker. Amplifiers that are an integral part of a speaker shall also be tested.

5.7 Conducted Emissions Test—This test is required for all electronic siren amplifiers.

All input power lead terminals (include both the positive and negative terminals) of the siren in the wail mode shall be subjected to the conducted emissions test specified in SAE J1113-41. Measure and record the narrowband (with a peak detector) and broadband (with a quasi-peak detector) conducted disturbances for all of the frequency bands specified in SAE J1113-41. The passive resistive load specified in 5.6 may be substituted for the siren loudspeaker. Amplifiers that are an integral part of a speaker shall also be tested.

5.8 Radiated Electromagnetic Immunity Test—This test is required for all electronic siren amplifiers.

In the wail mode, the siren shall be subjected to the radiated electromagnetic immunity test specified in SAE J1113-21. Sweep the field in frequency from 26 MHz to 1000 MHz at an amplitude of 10 V/m.

Continue to perform sweeps over this frequency range, but increment the field amplitude by 10 V/m each time before a new sweep is started until a change in the wail signal is observed. Record the field amplitude and frequency at which the change is observed and describe the change. The passive resistive load specified in 5.6 may be substituted for the siren loudspeaker. In this case, there shall be an alternative means to monitor the amplifier output for failure (e.g., monitor speaker or current probe).

Amplifiers that are an integral part of a speaker shall also be tested.

5.9 Durability Test—This test is required for all devices.

The siren shall be tested for 100 on-off cycles with a DC power supply voltage as specified in 5.1.2.4. For each cycle, the siren shall be operated continuously in the wail mode for 30 min, then turned off for a period of 30 min. For the duration of the test, the ambient laboratory temperature shall not fall below 18 °C.

5.10 Extreme Temperature Tests—These tests are required only for those devices specified with each particular temperature test.

5.10.1 EQUIPMENT FOR EXTREME TEMPERATURE TESTS

5.10.1.1 Environmental chamber—The environmental chamber(s) shall be capable of maintaining temperatures from –30 °C ± 3 °C to 90 ° ± 3 °C with the siren mounted and operating in the chamber. If necessary, more than one chamber may be used to satisfy the temperature range requirements.

5.10.1.2 AC Voltmeter—The voltmeter shall be able to perform true rms voltage measurements that are accurate within a tolerance of ± 1% from 500 Hz to 6300 Hz.

5.10.2 PROCEDURES FOR EXTREME TEMPERATURE TESTS—Equipment not under test shall remain outside the chamber during all extreme temperature testing.

5.10.2.1 High Temperature Test For Devices with Identification Code EVS1 or EVS2—This test is required only for devices that mount anywhere except under the hood.

At ambient laboratory temperature, use the voltmeter to measure the AC voltage at the speaker terminals with the siren in the yelp mode. The siren shall then be placed in the environmental chamber that has been pre-warmed to 65 °C ± 3 °C. The siren shall be off and allowed to soak at that temperature for a period of one hour. Then activate the siren for a period of five hours and maintain the temperature inside the chamber at 65 °C ± 3 °C. At the end of this period, use the voltmeter to re-measure the AC voltage at the speaker terminals with the siren in the yelp mode. Also measure the signal frequency of the wail in accordance with 5.1.2.6, but with an oscilloscope connected to the speaker terminals. Signal frequency and AC voltage measurements are not required for electromechanical sirens, which shall be temperature soaked and activated as described, but operated in the wail mode.

5.10.2.2 *High Temperature Test For Devices with Identification Code EVS3*—This test is required only for devices that mount under the hood.

Sirens comprised entirely of devices with code EVS3 shall be tested in accordance with 5.10.2.1, but with the environmental chamber pre-warmed and maintained at a temperature of 90 °C ± 3 °C. If at least one device does not have code EVS3, the siren shall first be tested in accordance with 5.10.2.1. All devices except those with identification code EVS3 shall then be removed from the chamber, and the EVS3 devices shall be tested in accordance with 5.10.2.1, but the environmental chamber shall be pre-warmed and maintained at a temperature of 90 °C ± 3 °C. The voltage and frequency measurements need not be re-done if the only device with code EVS3 is an electronic siren speaker. Signal frequency and AC voltage measurements are not required for electromechanical sirens, which shall be temperature soaked and activated as described, but operated in the wail mode.

5.10.2.3 *Low Temperature Test*—This test is required for all devices.

At ambient laboratory temperature, use the voltmeter to measure the AC voltage at the speaker terminals with the siren in the yelp mode. The siren shall then be placed in the environmental chamber that has been pre-cooled to –30 °C ± 3 °C. The siren shall be off and allowed to soak at that temperature for a period of five hours. Activate the siren at the end of the five-hour period. Within five minutes of activation, re-measure the AC voltage at the speaker terminals with the siren amplifier in the yelp mode. Also measure the signal frequency of the wail in accordance with 5.1.2.6, except with an oscilloscope connected to the speaker terminals. Signal frequency and AC voltage measurements are not required for electromechanical sirens, which shall be temperature soaked and activated as described, but operated in the wail mode.

6. Requirements

6.1 Acoustical Performance Requirements

6.1.1 SPL REQUIREMENTS—When measured in accordance with 5.1, the SPL produced by the siren subjected to the entire acoustical test shall meet all of the minimum requirements listed in Table 1. The SPL produced by the other sirens, which are tested only at the measurement angle of 0 degrees, shall meet the corresponding SPL requirement before any other tests (e.g., vibration) are performed, and shall not be reduced by more than 3 dB after these other tests are complete. When comparing the measured SPL values to the SPL requirements, the measured values shall be rounded to the nearest integer decibel value. For the purpose of this comparison, measured SPL values that contain a five in the first place to the right of the decimal shall be rounded up.

TABLE 1—SPL REQUIREMENTS

Measurement angle (degrees from device axis)	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for siren signals with cycling periods > 0.40 s	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for siren signals with cycling periods ≤0.40 s	A-weighted SPL (dB re 20 µPa) measured with a long-term time setting
0	118	117	115
±10	117	116	114
±20	116	115	113
±30	115	114	112
±40	113	112	110
±50	111	110	108

6.1.2 SIGNAL CYCLING PERIOD AND FREQUENCY REQUIREMENTS

6.1.2.1 *Wail*—The cycling period of the wail signal shall be between 2.0 s and 6.0 s. The fundamental frequency of this signal shall not fall below 500 Hz nor rise above 2000 Hz. Its range shall be at least one octave, and it shall be perceived as being continuous in frequency with no clearly audible discrete steps between frequencies.

6.1.2.2 *Yelp*—The cycling period of the yelp signal shall be between 0.24 s and 0.40 s. The fundamental frequency of this signal shall not fall below 500 Hz nor rise above 2000 Hz. Its range shall be at least one octave, and it shall be perceived as being continuous in frequency with no clearly audible discrete steps between frequencies.

6.2 Vibration Test Requirements—Cracking or rupture of parts of the device affecting its mounting shall constitute a failure.

6.3 Radiated Emissions Test Requirements—Document the narrowband and broadband radiated disturbances measured for all of the frequency bands specified in SAE J1113-41.

6.4 Conducted Emissions Test Requirements—Document the narrowband and broadband conducted disturbances measured on all input power lead terminals (include both the positive and negative terminals) of the siren for all of the frequency bands specified in SAE J1113-41.

6.5 Radiated Electromagnetic Immunity Test Requirements—Document the frequency and field strength at which a change occurred in the wail signal of the siren.

Include a description of the change in the documentation.

6.6 Extreme Temperature Tests Requirements—Wail and yelp signals must meet the signal frequency requirements specified in 6.1.2 when tested in extreme temperature conditions. The amplifier output voltage measured in these conditions must be within ±15% of the voltage measured at the ambient laboratory temperature. Electromechanical sirens shall operate as designed during and after exposure to the applicable extreme temperature soaks specified in the subsections of 5.10.

7. Guidelines

7.1 Installation—Devices should be mounted only in locations designated by the identification code. The manufacturer should provide the necessary mounting brackets and mechanical fasteners to properly secure the siren, and include a detailed installation guide that describes proper mechanical mounting and wiring of the siren. This guide should specify how to install the siren, provide warnings concerning the potential for hearing damage due to exposure to siren noise, and recommend that exposure to acoustical noise in the passenger compartment of the vehicle not equal or exceed the NIOSH recommended exposure limit (see Appendix A). The guide should also describe the proper use of external fuses, circuit breakers or other circuit protective devices, and other proper vehicle wiring techniques and practices. A wiring diagram and a list of the minimum wire gauges necessary for the safe operation of the siren should also be provided.

Siren amplifier controls should be placed within the convenient reach of the driver or, if intended for two man operation, the driver and passenger. In some vehicles, multiple control switches may be necessary for convenient operation from two positions. The driver should be able to manipulate the amplifier controls with minimal movement from his normal driving position and without loss of eye contact from the roadway.

Do not install the siren amplifier in the airbag deployment zone, since the amplifier can become a dangerous projectile during deployment.

The speaker or electromechanical siren should be positioned with the sound projecting opening pointing forward, parallel to the ground, and not obstructed by structural components of the vehicle such as the radiator. Mounting the siren under the hood and behind the radiator will result in a reduction of sound pressure levels at locations away from the vehicle and is not recommended.

In order to minimize the potential for hearing loss, exposure to acoustical noise in the passenger compartment of a moving vehicle with an operating siren should not equal or exceed the NIOSH recommended exposure limit (see Appendix A). To help achieve this goal, the speaker should be mounted as far from the vehicle occupants as possible, preferably in the front grille area. Acoustically insulated compartments, isolation mounts, or other methods of minimizing the noise level in the vehicle passenger area should be used. It is also recommended that the siren shall be operated with the windows closed. After the siren is installed, the SPL should be measured per SAE J336 at each riding position.

Operators should be warned about the potential for hearing damage that can be caused by exposure to siren noise.

Approaches used to minimize the potential for hearing loss may lead to the increased likelihood of loudspeaker damage during minor collisions, exposure of loudspeakers to snow, slush, mud, etc., and the inability to hear sirens on other emergency vehicles. Appropriate training of vehicle operators is recommended to alert them to these issues.

7.2 **Siren Signals—**The only requirements specified in SAE J1849 common to all siren signals are the SPL requirements. The wail and yelp signals, which are conventional siren signals recognized as such by the general public, also have cycling period and frequency requirements so that they may be recognized when heard. Other signals may be tested to meet the SPL requirements, but might not be recognized as siren signals when heard. Manufacturers shall note in the siren manual those signals that meet the SPL requirements.

8. Notes

8.1 **Marginal Indicia—**The change bar (l) located in the left margin is for the convenience of the user in locating areas where revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE EMERGENCY WARNING LIGHTS STANDARDS COMMITTEE
AND THE SAE LIGHTING COORDINATING COMMITTEE

APPENDIX A

OCCUPATIONAL HEARING LOSS AND EXPOSURE TO SIREN NOISE

A.1 Occupational exposure to noise can increase the risk of temporary or permanent hearing loss. Hearing loss often occurs cumulatively over time, and can eventually affect the understanding of speech. In general, the extent of hearing damage incurred over time depends primarily on the noise SPLs and the duration of exposure. A great deal of information regarding noise in the workplace and its effects is provided by the National Institute for Occupational Safety and Health (NIOSH), a federal agency that examines workplace hazards, in the *Criteria for a Recommended Standard: Occupational Noise Exposure Revised Criteria 1998*. Time-weighted average (TWA) noise SPL limits are given as a function of exposure duration. The higher the noise SPL, the shorter the duration of exposure allowed. The NIOSH recommended exposure limit, which should not be equaled or exceeded, is 85 dB (A-weighted) as an eight-hour TWA. Exposure to a particular noise SPL for a given duration is considered by NIOSH to be equivalent to a SPL that is 3 dB higher for half that duration. Table A1 summarizes the TWA A-weighted noise SPL limits as a function of exposure duration that produce exposures equivalent to the NIOSH recommended exposure limit. This limit is only meant to significantly minimize the excess risk due to occupational noise exposure of developing a maximum acceptable hearing impairment that still allows for speech discrimination. Exposure to noise in the workplace lower than the recommended limit does not entirely eliminate the risk of hearing loss resulting from occupational noise exposure, or other factors such as aging, exposure to noise encountered outside of the workplace, and hazards such as ototoxic chemicals.

TABLE A1—SOUND PRESSURE LEVEL LIMITS

A-weighted noise sound pressure level (SPL, in dB re 20 μPa) limits as a function of exposure duration that produce exposures equivalent to the NIOSH recommended exposure limit of 85 dB (A-weighted) as an 8 hour TWA, which should not be equaled or exceeded.

Duration of exposure per day (h)	TWA A-weighted SPL (dB)
8	85
4	88
2	91
1	94
1/2	97
1/4	100
1/8 (7 min and 30 s)	103
1/16 (3 min and 45 s)	106
1/32 (1 min and 53 s)	109

This NIOSH publication also includes information regarding hearing loss prevention programs and the use of personal hearing protection devices such as earplugs, earmuffs, and ear-canal caps. Hearing loss prevention programs are designed to quantify the nature and extent of hazardous noise exposure, monitor the effects of this exposure on hearing, and implement engineering or administrative controls to reduce noise exposure. *Preventing Occupational Hearing Loss - A Practical Guide* discusses hearing loss prevention programs in detail. It contains names, addresses, and phone numbers of associations that can provide assistance in contacting professionals who can be hired to administer or participate in a hearing loss prevention program, or perform noise measurements. Additional information concerning personal hearing protection devices is provided in *The NIOSH Compendium of Hearing Protection Devices*, which includes data for 241 different hearing protectors sold in the United States.

Sirens produce noise that is loud enough to significantly increase the risk of temporary or permanent hearing loss. Health Hazard Evaluation Report HETA 81-059-1045 recommends that siren loudspeakers be located in the front of the vehicle so that the vehicle itself isolates personnel from the noise. *Health Hazard Evaluation Report HETA 84-493-1583* states that locating the siren speakers in the front grille area minimizes driver noise exposure in an ambulance. With the siren loudspeaker installed in the grille area, A-weighted SPLs in the driver cab were measured to be 16.3 dB to 22.0 dB lower than levels measured with the loudspeaker installed on the cab roof. This study also demonstrated that closing vehicle windows attenuates siren noise SPLs measured with an A-weighting in the ambulance driver cab by 7.1 dB to 12.8 dB.

APPENDIX B

DATA SHEET

B.1 Information regarding test lab(s); include name of test lab(s), date(s) of tests, and name(s) of person(s) performing tests:

Description of siren under test; include manufacturer(s), model(s), and identification code(s) of siren or siren system components:

a. Siren #1 (entire acoustical test)
Serial number(s) of siren or siren system components:

TABLE B1—SPL MEASUREMENTS-SIREN #1

Measurement angle (degrees from device axis)	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for wail	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for yelp	A-weighted SPL (dB re 20 µPa) measured with a long-term time setting	
			wail	yelp
0				
10				
20				
30				
40				
50				
–50				
–40				
–30				
–20				
–10				

Cycling period (s) of wail:
Minimum fundamental frequency (Hz) of wail:
Maximum fundamental frequency (Hz) of wail:
Cycling period (s) of yelp:
Minimum fundamental frequency (Hz) of yelp:
Maximum fundamental frequency (Hz) of yelp:
Was the wail perceived as continuous in frequency with no clearly audible discrete steps between frequencies Y / N
Was the yelp perceived as continuous in frequency with no clearly audible discrete steps between frequencies Y / N
DC current (amps) measured in the power cable (for informational purposes only, no performance requirements):

b. Siren #2 (electromagnetic compatibility tests)
Serial number(s) of siren or siren system components:

TABLE B2A—SPL MEASUREMENTS-SIREN #2

Measurement angle (degrees from device axis)	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for wail	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for yelp	A-weighted SPL (dB re 20 µPa) measured with a long-term time setting	
			wail	yelp
0 (before electromagnetic compatibility tests)				
0 (after electromagnetic compatibility tests)				

TABLE B2B—RADIATED EMISSIONS/DISTURBANCES

Frequency Band (MHz)	Narrowband Electric Field Level Measured with Peak Detector (dB re µV/m)	Broadband Electric Field Level Measured with Quasi-Peak Detector (dB re µV/m)
0.15-0.3		
0.53-2.0		
5.9-6.2		
30-54		
70-108		

TABLE B2C—CONDUCTED EMISSIONS/DISTURBANCES ON POWER INPUT LEADS

Frequency Band (MHz)	Narrowband Electric Field Level Measured with Peak Detector on Positive Terminal (dB re µV/m)	Broadband Electric Field Level Measured with Quasi-Peak Detector on Positive Terminal (dB re µV/m)	Narrowband Electric Field Level Measured with Peak Detector on Negative Terminal (dB re µV/m)	Broadband Electric Field Level Measured with Quasi-Peak Detector on Negative Terminal (db re µV/m)
0.15-0.3				
0.53-2.0				
5.9-6.2				
30-54				
70-108				

Radiated Electromagnetic Immunity Test Results
Amplitude (V/m) of the test field at which a change in the wail signal is observed:
Frequency (MHz) of the test field at which a change in the wail signal is observed:
Describe the change observed in the wail signal:

c. Siren #3 (vibration, corrosion, dust, and moisture tests)
Serial number(s) of siren or siren system components:

TABLE B3—SPL MEASUREMENTS-SIREN #3

Measurement angle (degrees from device axis)	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for wail	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for yelp	A-weighted SPL (dB re 20 µPa) measured with a long-term time setting	
			wail	yelp
0 (before vibration, corrosion, dust, and moisture tests)				
0 (after vibration, corrosion, dust, and moisture tests)				

Did the vibration test cause any cracking or rupture of parts that would affect the mounting of the siren on a vehicle? Y / N

d. Siren #4 (durability test)
Serial number(s) of siren or siren system components:

TABLE B4—SPL MEASUREMENTS-SIREN #4

Measurement angle (degrees from device axis)	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for wail	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for yelp	A-weighted SPL (dB re 20 µPa) measured with a long-term time setting	
			wail	yelp
0 (before durability test)				
0 (after durability test)				

e. Siren #5 (extreme temperature tests)
Serial number(s) of siren or siren system components:

TABLE B5A—SPL MEASUREMENTS-SIREN #5

Measurement angle (degrees from device axis)	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for wail	A-weighted SPL (dB re 20 µPa) measured with the fast time setting for yelp	A-weighted SPL (dB re 20 µPa) measured with a long-term time setting	
			wail	yelp
0 (before extreme temperature tests)				
0 (after extreme temperature tests)				