The Engineering Society For Advancing Mobility Land Sea Air and Space®
400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

HIGHWAY VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

SAE J1849

Issued July 1989

EMERGENCY VEHICLE SIRENS

1. SCOPE:

This SAE document provides test procedures, requirements, and guidelines for electronic and electromechanical sirens for use on authorized emergency vehicles. It is based on the performance of state-of-the-art devices that have proven effective in emergency service. However, it is important for the user to understand that such devices will not necessarily be heard by the drivers of every vehicle under all conditions in time to permit all drivers to take appropriate action.

Sound levels high enough to be heard at reasonable distances in soundproofed automobiles with operating air-conditioners and stero sound systems are so high as to be environmentally unacceptable. The siren is a useful warning device for 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.

2. DEFINITIONS:

2.1 Siren: A device for producing standardized acoustical signals which have become recognized as the call for the right-of-way by an emergency vehicle.

2.1.1 Electromechanical Siren: A device consisting of a motor and a rotor within a stator. When electrically energized, air is pumped through the rotor. The discharge of air is modulated by a number of ports that open and close at varying rates thereby altering the pitch of the siren.

2.1.2 Electronic Siren Amplifier: A device intended to convert direct current into an alternating current of varying frequency but constant voltage for the purpose of supplying energy to the electronic siren speaker.

2.1.3 Electronic Siren Speaker: A transducer intended to radiate acoustical energy into the air with an acoustical waveform equivalent to the input electrical waveform. The electronic siren speaker shall include the electrical to mechanical transducer plus any and all mechanisms or housings required to couple and control transducer acoustical output.

2.1.4 Electronic Siren System: An assembly of matched devices including an electronic siren speaker, an electronic siren amplifier, and such controls as are necessary to operate the system.

The number, wattage, and nominal impedance of electronic siren speakers are determined by the design of the amplifier and so specified on the nameplate of the electronic siren amplifier.

2.2 Siren Signals:

2.2.1 Wail: A tonal pattern of slow automatic increases and decreases in frequency at the rate of 10 to 30 cpm. This signal can be produced by both electronic and electromechanical sirens. The frequency of this signal shall not fall below 650 Hz for electronic siren systems nor rise above 2000 Hz for either system and shall encompass a range from high to low of at least 850 Hz.

2.2.2 Yelp: A tonal pattern of rapid automatic increases and decreases in frequency at a rate of 150 to 250 cpm. This signal is usually produced only by electronic siren systems. The frequency of this signal shall not fall below 650 Hz for electronic siren systems nor rise above 2000 Hz for either system and shall encompass a range from high to low of at least 850 Hz.

2.2.3 Manual Wail: Intermittently operated wail by a push botton or other control means.

2.2.4 Auxiliary Signals: Any signal other than wail, yelp, or manual. While such signals may have legitimate uses in nonemergency situations and may be included as a part of an electronic siren system, it is recommended that only wail, yelp, or manual wail be used as a call for the right-of-way by an emergency vehicle.

2.3 Anechoic Chamber: An acoustical device testing room in which all six of the surfaces absorb at least 99% of the incident acoustic energy over the frequency range of interest. The chamber shall be in compliance with ANSI S1.13-1971 (3).

2.4 Sound Pressure Level: A quantity in decibels read from a sound level meter or oher acoustical instrumentation system that fulfills the requirements of ANSI S1.4-1971-Type 1 (1) that is switched to the "Flat" or "Unweighted" network. The sound pressure level (Lp) is defined by $Lp = 20 \log 10 (p/po)$, where "p" is the sound pressure and "po" is the reference sound pressure.

2.5 "A" Weighted Sound Level: The setting on an acoustical instrumentation system that adds a filter network to modify the reading of sound pressure level. The "A" weighting network discriminates against the lower frequencies according to a relationship approximately equivalent to the auditory sensitivity of the human ear at moderate sound levels.

2.6 Electronic Siren Output Voltage: A potential expressed in V AC rms that is required to produce the sound pressure levels as defined by this document when applied to an electronic siren speaker.

2.7 Nominal Impedance: The impedance expressed in Ohms of an electronic siren speaker over the range of frequencies of interest. This nominal impedance for the purposes of this document shall be that of the speaker at 1000 Hz.

3. IDENTIFICATION CODE AND MARKING:

3.1 Identification Code:

3.1.1 Devices conforming to this document which are intended to be mounted in the interior of the vehicle including the trunk or any other dry compartment designed for mounting equipment shall be identified with the code EVS1 in accordance with SAE J759.

3.1.2 Devices conforming to this document which are intended to be mounted outside the vehicle or in any other wet location (except under hood) shall be identified with the code EVS2 in accordance with SAE J759.

3.1.3 Devices conforming to this document which are intended to be mounted under hood shall be identified with the code EVS3 in accordance with SAE J759.

3.2 Markings: All markings shall be 3.0 mm or greater in height, permanently affixed to the device.

3.2.1 Electromechanical Sirens: The name of the manufacturer, the model number, the intended input voltage, operating amperage, mounting orientation, and the SAE identification code indicating mounting location shall be shown.

3.2.2 Electronic Siren Speakers: The name of the manufacturer, the model number, the nominal impedance, operating wattage, mounting orientation, and the SAE identification code indicating mounting location shall be shown.

If two or more speakers are used as an array, the exact geometry in which the array was tested must be specified. Approval of an array of speakers is valid only when mounted on a vehicle in exact conformance with the specified geometry.

3.2.3 Electronic Siren Amplifiers and Associated Controls: The name of the manufacturer, the model number, the nominal impedance, operating wattage and number of speaker(s) to which the device is intended to be connected, the intended input voltage, output voltage, and the SAE identification code indicating mounting location shall be shown.

3.2.3 (Continued):

If the amplifier and controls are separate components, each component shall be identified as to the system of which it was intended to be a part and the SAE identification code indicating mounting location shall be shown.

The controls for all functions shall be clearly identified and visible during operation both day and night.

3.2.4 Systems Which Have Been Tested as a Whole Without the Use of the Standard Signal Generator/Amplifier or Standard Resistive Load: The components of such a system shall be marked to indicate that they are approved only when used with each other and should not be interchanged with components or other systems.

4. TESTS:

4.1 General Information: Because siren systems can be composed of a single device or multiple, interconnected devices mounted in various locations inside or outside the vehicle, the tests required for any specific device or component are determined by its type, function and intended mounting location.

To permit assembly of electronic siren systems using devices manufactured by more than one manufacturer, electronic siren speakers and electronic siren amplifiers may be independently certified in accordance to the requirements of this document.

4.1.1 Electronic Siren Speakers: In conformance with the requirements and procedures of this document, all tests of electronic siren speakers may be made using a standard signal source. For typical electronic siren speakers having 11 ohms impedance referenced at 1000 Hz, the input test voltage "E" is defined as:

$$E = \sqrt{11 \text{ ohms} \times \text{rated wattage of the siren speaker}}$$

Thus, the input voltage for testing an 11 ohm/100 watt speaker shall be 33.0 V rms ± 0.5.

Alternatively, the input test voltage for speakers of any impedance or wattage may be determined by applying a constant frequency signal of 1000 Hz to the speaker through a wattmeter and increasing the voltage until the nameplate wattage of the speaker is reached. This voltage shall then be the test voltage.

When multiple siren speakers are tested connected in parallel, the input test voltage shall be 90% of voltage determined by either of the previously mentioned methods. This reduced voltage is necessary to approximate the internal losses within a typical electronic siren amplifier and the external wiring when additional electronic siren speakers are connected.

4.1.2 Electronic Siren Amplifiers: In conformance with the requirements and procedures of this document, all tests of electronic siren amplifiers may be made using a standard, noninductive resistive load per 4.2.6. This load shall have a resistance of 11.0 ohms ± 0.2 (equivalent to the impedance of the typical electronic siren speaker referenced at 1000 Hz).

To test the performance of the amplifier if two such speakers are connected in parallel, the resistance shall be 5.5 ohms ± 0.1.

Electronic siren amplifiers designed to operate with nontypical electronic siren speakers (other than 11 ohm nominal impedance) may be tested using a noninductive, resistive load of the size matching the nominal impedance of the speaker intended for use.

4.1.3 Family Approvals: Manufacturers of electronic siren amplifiers who market multiple variations of these amplifiers may elect to group such devices into product families. Representative models may be tested to obtain family wide approval as long as:

a. Model numbers or identification codes are arranged to define such families and,

b. The amplification and signal generation circuitry are identical in the family and,

c. The test report shall list each specific model variation and the manufacturer shall have on record the details of each variation, and state that the performance of the tested and untested members of the family are the same.

4.1.4 Electronic Siren Systems: While it is permissible to test an electronic siren system as a whole (siren amplifier connected to a siren speaker) without the use of the standard signal source and the standard resistive load, the devices comprising a system so tested, cannot be interchanged with any other devices or used as a part of any other system. The testing of a siren system as a whole shall be in conformance with the requirements and procedures of this document.

4.1.5 Electromechanical Sirens: In conformance with the requirements and procedures of this document, all tests of electromechanical sirens shall be made using a timer to automatically operate a relay of sufficient current carrying capacity to energize and de-energize the siren motor at a rate of 10 to 30 times per minute.

Electromechanical sirens whose acoustical performance substantially exceeds the requirements of this document (5.1.4) are exempted from this requirement and may be tested by automatic operation at any convenient rate.

4.2 Test Equipment and Instrumentation:

4.2.1 Test Voltage: Unless otherwise specified, the test voltage shall be 13.6 V DC ± 0.2 for devices intended for operation on 12 V systems and 27.2 V DC ± 0.2 for devices intended for operation on 24 V systems.

4.2.2 Acoustical Test Fixture: A test base approximately 30 x 30 x 2.5 cm shall be used to mount the device. The support shall be capable of being rotated by a turntable from 0 to ±50 deg and shall position the acoustic axis of the device(s) at a height of at least 1.5 m. The axial positions shall contain no reflective surfaces with dimensions greater than 2.5 cm within 1.5 m of the siren or speaker(s) unless the design of the system incorporates external surfaces for proper operation. Such requirements, if any, shall be fully defined in the reports.

4.2.3 Direct Current Power Supply: The power supply shall be regulated to ±0.1 V with a maximum ripple of 75 mV peak to peak. Output current capacity must be at least 1.5 times the rated current for the device under test. The output voltage shall be adjustable to provide the voltage required for specific tests.

Electromechanical sirens may be tested using an automotive battery of the correct nominal voltage for the siren provided the battery shall have a minimum cranking rate at -18°C of 450 amps for 30 s and a reserve capacity of 100 min at a discharge rate of 25 amps. A power supply as defined may be used during the test to maintain the battery charge.

4.2.4 Integrating Wattmeter: The integrating wattmeter used for measuring the electronic siren speaker input power shall be of adequate capacity to record peak wattage and have a range from 100 Hz to 20 kHz with ±1% accuracy.

4.2.5 Sound Metering System: The sound metering system shall meet the requirements of SAE J184.

4.2.6 Standard Noninductive, Resistive Load: The noninductive resistor shall be of adequate size to dissipate the heat produced during the test. The resistor shall have a value of 11 ohms ± 0.2 if being used in place of a typical electronic siren speaker or 5.5 ohms ± 0.1 if used in place of two typical speakers connected in parallel.

If the amplifier under test is designated by the manufacturer for use with nontypical siren speakers, the resistance values specified by the manufacturer shall be used.

4.2.7 Standard Signal Source: The signal generator/amplifier shall be capable of generating square wave signals at the required voltage from at least 500 to 2000 Hz into reactive loads with impedances as low as 4 ohms with rise and fall times of no more than 20 µs from 10 to 90% and 90 to 10% of the maximum waveform value. The amplifier shall remain stable regardless of the reactive nature of the load.

4.2.8 Voltmeter for Measuring Electronic Siren Amplifier Output: The voltmeter shall be capable of measuring the true AC rms value of nonsinusoidal waveforms with crest factors of up to 10 with a band width of at least 100 Hz to 20 kHz. Accuracy over this entire band width shall be ±1%.

4.3 Test Procedures:

4.3.1 Test Sequence: The sequence of tests shall be:

a. The tests under 4.3.2.1 in any order.

b. The tests under 4.3.2.2 in any order.

c. The test under 4.3.4 or 4.3.5 as required.

d. The test under 4.3.3.

To reduce the time to test, two identical devices may be used. One device may be used for performing the entire test sequence except 4.3.3. The second device may be used to simultaneously run test 4.3.3.

Note: To determine whether or not an electromechanical siren is exempt from compliance with the cyclic rate requirement, it shall be necessary to run test 4.3.5 before the start of the test sequence. Regardless of the outcome, this test shall be performed again in the required sequence.

4.3.2 Environmental Tests:

4.3.2.1 Tests from SAE J575 with modifications as indicated:

a. Vibration test

b. Moisture test

c. Dust test

d. Corrosion test

Devices intended only for interior mounting in the vehicle do not need to be tested per b, c, and d.

4.3.2.2 Additional Environmental Tests:

4.3.2.2.1 High Temperature Operating Test for All Devices Other Than Those Designed for Under Hood Mounting: The device shall be subjected to an ambient temperature of 50°C ± 3 for a period of 6 h. The device shall be connected to any other components necessary to form an operable system and shall be off during the first hour and shall then operate continuously for the next 5 h.

Other components may be mounted in the test chamber if they are to be tested or outside the chamber if they are not under test. The device shall operate before the start of the test in the normal fashion. If the siren produces more than one siren signal, the setting of the unit shall be changed periodically to reasonably test all siren signals.

4.3.2.2.1 (Continued):

The measurements shall be made before the test, not less than 3 min or more than 4 min after the beginning of the second hour of operation, and not less than 3 min or more than 4 min after the end of the test. At each required measurement:

a. Electromechanical sirens shall have the maximum input amperage measured using an ammeter per 4.3.6.1 and the cyclic rate recorded.

b. Electronic siren amplifiers shall have the output voltage determined per 4.3.6.2 and the cyclic rate (cpm) of wail and yelp (if present) shall be measured and recorded.

c. Electronic siren speakers shall have their input wattage measured in accordance with 4.3.6.3.

4.3.2.2.2 High Temperature Test for Devices Designated by the Manufacturer as Permissible for Under Hood Mounting, i.e., In the Engine Compartment: Such devices shall be tested in accordance with 4.3.2.2.1 except at a temperature of 90°C ± 3.

4.3.2.2.3 Low Temperature Operating Test: All devices shall be subject to an ambient temperature of -30°C ± 3 for 6 h. The device shall be connected to any other components necessary to form an operable system and shall be turned off (not operating) during the first 5 h of the test and then turned on and operated during the last hour of the 6 h test.

Other components may be mounted in the test chamber if they are to be tested or outside the chamber if they are not under test. The device shall operate before the start of the test in the normal fashion. If the siren produces more than one siren signal, the setting of the unit shall be changed periodically to reasonably test all siren signals. At each required measurement:

a. Electromechanical sirens shall have the maximum input amperage measured using an ammeter per 4.3.6.1 and the cyclic rate recorded.

b. Electronic siren amplifiers shall have the output voltage determined per 4.3.6.2 and the cyclic rate (cpm) of wail and yelp (if present) shall be measured and recorded.

c. Electrnoic siren speakers shall have their input wattage measured in accordance with 4.3.6.3.

The measurements shall be made before the test, not less than 3 min nor more than 4 min after the beginning of the last hour of operation, and not less than 3 min nor more than 4 min after the end of the test.

4.3.3 Durability Test: The device shall be connected to any other components necessary to form an operable system and the device shall be operated continuously for 200 h at an ambient temperature of 25°C ± 3 in cycles consisting of 30 min on and 30 min off. The device shall operate in the normal fashion before the start of the test. If the siren produces more than one siren signal, the setting of the unit shall be changed periodically to reasonably test all siren signals.

At each required measurement:

a. Electromechanical sirens shall have the maximum input amperage measured using an ammeter per 4.3.6.1 and the cyclic rate recorded.

b. Electronic siren amplifiers shall have the output voltage determined per 4.3.6.2 and the cyclic rate (cpm) of wail and yelp (if present) shall be measured and recorded.

c. Electronic siren speakers shall have their input wattage measured in accordance with 4.3.6.3.

The measurements shall be made before the test, and not less than 3 min nor more than 4 min after the end of the test.

4.3.4 Performance Test for Electronic Siren Amplifiers: The electronic siren amplifier shall be connected to a DC power supply per 4.2.3 and to a load with a voltmeter conforming to 4.2.8 connected between the amplifier and the load.

The amplifier shall be allowed to operate for 5 min and output voltage readings taken per 4.3.6.2 for all siren signals. The frequency range and cyclic rate will also be determined for the siren tones of wail and yelp (if present).

The input voltage shall then be increased to 15.0 V DC for devices intended to operate on 12 V systems or 30 V for devices intended to operate on 24 V systems, and the procedure mentioned repeated.

4.3.5 Acoustical Performance Test: Electromechanical sirens and electronic siren speakers shall be tested in conformance with the following procedures:

4.3.5.1 General: Acoustical tests shall be conducted at a temperature of 25°C ± 3.

With the device under test mounted on the acoustical test fixture per 4.2.2 in an anechoic chamber, the microphone shall be positioned in line with the device at a distance of 3.0 m ± 0.01 from the edge of the device. The microphone shall be mounted at normal incidence to the device axis, in line with the device axis and at the same height as the device axis.

4.3.5.1 (Continued):

The device shall be located as far away from the walls of the anechoic chamber as possible. There shall be no significant reflecting surfaces within 1.5 m of the microphone used to measure the generated signal or within 1.5 m of the path between the device and the microphone. Position the device at 0 deg and connect the microphone to the instrumentation system.

Without changing the setup, adjust the measuring instrumentation to measure the "A weighted" sound level. Adjust the response characteristic of the system to provide a time constant of 0.02 s. Operate the device for 1 min and record the maximum and minimum "A weighted" sound pressure level at the 0 deg point. At the 0 deg point, determine the minimum and maximum fundamental frequency of sound produced by the device. The cyclic rate of wail and yelp (if present) shall also be measured and recorded.

Repeat the procedure by indexing the turntable until readings are obtained from 50 deg left to 50 deg right at 10 deg ± 0.5 intervals. Sound pressure readings should be recorded to the nearest 0.5 dB. Frequency and cyclic rate readings need be taken only at the 0 deg point.

During the test, technicians and observers shall remain outside the chamber. The instrumentation shall be calibrated using a pistonphone or calibrator before and after each period of use and at intervals not exceeding 2 h when the measuring instrumentation is used for a period longer than 2 h. The air temperature and pressure in the chamber shall be recorded during the test.

A record shall be kept of the calibration during the test period and any changes in calibration noted. The test shall be considered invalid if changes in calibration exceed 1 dB. All calibration equipment used during the performance of the measurements shall be operating correctly and traceable to the National Bureau of Standards.

4.3.5.2 Electronic Siren Speaker(s): Siren speakers shall be securely mounted to the test fixture and connected to the signal generator/amplifier per 4.2.7. A signal of the appropriate test voltage varying in frequency from 650 to 2000 Hz at a rate of 10 to 30 cpm (approximating wail) shall be applied to the terminals of the device and the acoustical measurements made according to the general procedure.

The tests shall then be repeated using the same signal but increasing the rate to 150 to 250 cpm (approximating yelp).

If testing a complete system per 4.1.4, the electronic siren amplifier is used as the signal source and operated in the wail and yelp modes.

NOTE – If multiple siren speakers are tested, the exact geometry of the array must be reported and the test results applied only to mountings which conform to this geometry.

4.3.5.3 Electromechanical Sirens: The siren shall be securely mounted on the test fixture and the device connected to a power supply through a relay of adequate size. A timer shall be used to energize the relay to achieve a rate of 10 to 30 cpm. The periods of on and off need not be the same and can be set to maximize the performance of the siren.

Acoustical measurements are then made in accordance with the general procedure and the cyclic rate recorded.

4.3.6 Secondary Test Procedures Used in Performing the Environmental, Performance, and Durability Tests:

4.3.6.1 Input Amperage Test: An ammeter of appropriate size shall be connected to the electromechanical siren between the device and the power supply. The maximum input amperage of the device shall be determined at an operating voltage of 13.6 V ± 0.2 at the terminals of the siren (27.2 V ± 0.2 if intended for 24 V operation).

4.3.6.2 Output Voltage Test: Amplifiers for electronic sirens shall be connected to any other components necessary to form an operable system and a voltmeter per 4.7.8 installed between the output terminals of the amplifier and the load. The output voltage of the amplifier shall be determined at 13.6 V ± 0.2 input voltage to the amplifier (27.2 V ± 0.2 if intended for 24 V operation) or such other voltage as called for in the test.

4.3.6.3 Input Wattage Test: An integrating wattmeter per 4.2.4 shall be connected between the output terminals of the signal generator/amplifier and the input terminals of the electronic siren speaker.

5. REQUIREMENTS:

These requirements apply to new, undamaged production units selected at random. The device shall be tested in accordance with the test procedures in section 4.

5.1 Performance Requirements:

5.1.1 When tested in conformance with 4.3.2, the device shall meet the requirements of SAE J575, with modifications as indicated.

5.1.1.1 Vibration

5.1.1.2 Moisture

5.1.1.3 Dust

5.1.1.4 Corrosion

Any device which when tested fails the test or shows signs of change that would cause failure under any of the tests is to be considered a failure.

5.1.2 Additional Environmental and Durability Requirements: When tested according to 4.3.2.2 and 4.3.3, any device or component which fails to operate at any of the required measurements shall be considered a failure.

Also considered failures are:

a. Electromechanical sirens that require more than 125% of nameplate amperage at any required measurement or that were tested at a cyclic rate other than from 10 to 30 cpm. However, electromechanical sirens producing sound pressure levels 2 dB(A) or greater than the required values at all required measurements in 5.1.4, can be tested at any cyclic rate.

b. Electronic siren amplifiers that produce at any required measurement:

At 13.6 V (or 27.2 V) input, less than 92% or more than 108% of the nameplate voltage.

A wail signal at a cyclic rate other than from 10 to 30 cpm.

A yelp signal (if present) at a cyclic rate other than from 150 to 250 cpm.

c. Electronic siren speakers that when operated at the test voltage draw at any required measurement:

More than 108% of the nameplate wattage.

5.1.3 When tested in conformance to 4.3.4, an electronic siren amplifier shall be considered a failure if when operated at an input voltage of 13.6 V ± 0.2 (or 27.2 V ± 0.2), at any required measurement:

The output voltage is less than 92% or more than 108% of the nameplate output voltage.

A wail signal is measured at a cyclic rate other than from 10 to 30 cpm or at a frequency of less than 650 Hz or more than 2000 Hz or had a range of high to low of less than 850 Hz.

A yelp signal (if present) is measured at a cyclic rate other than from 150 to 250 cpm or at a frequency of less than 650 Hz or more than 2000 Hz or had a range of high to low of less than 850 Hz.

The amplifier is also considered a failure if when operated at an input voltage of 15.0 V (or 30 V), at a required measurement:

The output voltage is more than 125% of the nameplate voltage.

A wail signal is measured at a cyclic rate other than from 10 to 30 cpm or at a frequency of less than 650 Hz or more than 2000 Hz or had a range of high to low of less than 850 Hz.

A yelp signal (if present) is measured at a cyclic rate other than from 150 to 250 cpm or at a frequency of less than 650 Hz or more than 2000 Hz or had a range of high to low of less than 850 Hz.

5.1.4 Acoustical Performance: When measured in accordance with 4.3.5, the wail signal and the yelp signal (if present in the system) when operating within the required cycle rates shall produce at least the following sound pressure levels:

Location Degrees	0	±10	±20	±30	±40	±50
Line A dB(A) SPL	118	117	116	115	113	111
Line B dB(A) SPL	111	110	109	108	107	106

The sound pressure at each point must equal or exceed the value shown in Line A during some portion of each wail and yelp cycle (if yelp is present) except that up to three points may fall 1 dB(A) below the value shown so long as the total of all points exceeds 1262.

The sound pressure at each point must not fall below the value shown in Line B during any portion of each wail and yelp cycle (if yelp is present) except that up to three points may fall 1 dB(A) below the value shown so long as the total of all points exceeds 1191.

The exemption for electromechanical sirens applies only if the measured sound pressure level exceeds the table of values by 2 or more dB(A) at all points in both Line A and Line B.

5.2 Effect of Failure of a Given Test: The failure of any device or component at any point in the required test sequence shall constitute a failure of the entire sequence. The entire test sequence including the tests that were passed shall be considered void and the entire test sequence shall be repeated using a new device or component or the original device or component after repair.

Failure of a component which is included in order to have an operable system but which is not itself under test shall have no effect on the test sequence. Such a component may be replaced with a similar component and the test sequence continued.

5.3 Matching of Components in Electronic Siren Systems: In accordance with their respective nameplates, only properly matched electronic siren speaker(s) and electronic siren amplifiers shall be interconnected. The number, wattage, and nominal impedance of connected electronic siren speakers shall be in conformance with the requirements presented on the nameplate of the electronic siren amplifier.

6. GUIDELINES:

6.1 General: Proper installation is vital to the performance of the siren and the safe operation of the emergency vehicle. It is important to recognize that the operator of the emergency vehicle is under psychological and physiological stress caused by the emergency situation. The siren system should be installed in such a manner as to:

a. Not reduce the acoustical performance of the system.

b. Limit as much as practical the noise level in the passenger compartment of the vehicle.

c. Place the controls within convenient reach of the operator so that he can operate the system without losing eye contact with the roadway.

6.2 Mounting and Wiring: All devices should be mounted in accordance with the manufacturers instructions and securely fastened to vehicle elements of sufficient strength to withstand the forces applied to the device.

All wiring should conform to the minimum wire size and other recommendations of the manufacturer and be protected from moving parts and hot surfaces. Looms, grommets, cable ties, and similar installation hardware should be used to anchor and protect all wiring.

Fuses or circuit breakers should be located as close to the power takeoff points as possible and properly sized to protect the wiring and devices.

Particular attention should be paid to the location and method of making electrical connections and splices to protect these points from corrosion and loss of conductivity. Ground terminations should be only made to substantial chassis components.

6.3 Placement of Electromechanical Sirens and Electronic Siren Speakers: The sound projecting opening should be pointed forward, parallel to the ground, and not obstructed or muffled by structural components of the vehicle. Concealed or under hood mounting will result in a dramatic reduction in performance and is not recommended.

To minimize potential hearing loss, it is recommended that a maximum sound pressure level of 85 dB(A) be present in the passenger area when the vehicle is in motion with the siren operating. Manufacturers and users of emergency vehicles should measure the actual sound pressure levels per SAE J336 at each riding position.

Electromechanical sirens and electronic siren speakers should be mounted as far from the occupants as possible using acoustically insulated compartments and isolation mountings to minimize the transmission of sound into the vehicle. It may be helpful to mount the device on the front bumper, engine cowl or fender, heavily insulate the passenger compartment, and operate the siren only with the windows closed.