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LAND SEA AIR SPACE

TECHNICAL REPORT J247

INSTRUMENTATION FOR MEASURING ACOUSTIC IMPULSES — SAE J247

SAE Recommended Practice

Report of Automotive Safety Committee approved May 1971.

1. Scope—The purpose of this SAE Recommended Practice is to provide guidelines for selection and application of instrumentation for measuring sound pressure and body cavity over-pressure inside a passenger car, as typified by that generated during the deployment of a passive passenger restraint system(s). The objective is to achieve uniformity in instrumentation practice and reporting of test measurements. Use of this recommended practice will provide a basis for meaningful comparisons of test results from different sources.

2. Definitions

2.1 Data Channel—All of the instrumentation from and including a single transducer up to and including any display or analysis device or procedure that may alter the frequency content of the data.

2.2 Full-Scale—The maximum usable range of an instrument, based on linearity and/or signal distortion.

2.3 Data Channel Full-Scale—That value of a data channel, in terms of the input variable, determined by the component in the channel with the lowest full-scale level.

3. General Data Channel Requirements—The accuracy of a data channel is dependent upon many factors, such as linearity, zero drift, hysteresis, frequency response, and the interaction of components. For this reason, regular calibration shall be made for all instrumentation, using test methods and equipment traceable to known standards. A record of the instrumentation being used, listing function, manufacturer, model and serial number, and date of last calibration shall be maintained.

Proper usage of all 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.

3.1 Calibration Guidelines—The following are suggested when performing laboratory calibration of a data channel:

(a) Checks for amplitude linearity should cover the dynamic range expected during test measurements and should include any preamplifier used. (High-impedance transducers should be simulated during these checks.)

(b) The system's amplitude response, with frequency exclusive of transducer, should be made at an amplitude of 80% of maximum data channel output.

(c) Calibration shall include checks for the effects of all test site conditions (for example, temperature, barometric pressure, cable length, mechanical shock, etc.).

(d) Transducers and other instruments may be calibrated individually and the results factored into a total data channel accuracy.

3.2 Test Guidelines—The following are suggested when performing pretest calibration of a data channel:

(a) Proper signal levels, terminating impedances, etc., should be ensured for all components of the data channel(s).

(b) Calibration at a level greater than 50% of maximum data channel output should be employed at the time of test.

(c) Data channels should be scaled such that anticipated test values are 10-50% of full-scale. (Gain or attenuation used to meet paragraph 3.2(b) should be included in the calibration checks specified in paragraph 3.1(a).)

(d) Open-window tests should preferably be conducted under free-field conditions, or with a minimum of 30 ft lateral distance from walls or other hard (acoustically reflective) vertical surfaces.

4. Instrumentation Specifications

4.1 Transducer—Microphones or other devices used for pressure transduction shall meet the following specifications:

(a) Amplitude response—±1 dB over the frequency range of 20 Hz-20 kHz; +1, −3 dB over the frequency range of 5-20 Hz.

(b) Overshoot—Not more than 10% overshoot at test pressure.

(c) Harmonic distortion—Not more than 5% at the test pressure.

4.2 Amplifiers—Amplifiers, preamplifiers, or other signal-conditioning devices used in any data channel shall not degrade the output of the transducer in that data channel such that the specifications of paragraph 4.1 are not met. Attenuators or other signal-scaling devices must be accurate to 2%.

4.3 Tape Recorder—If used, a magnetic tape recorder must provide record/reproduce performance such that the transducer output is not degraded, except as provided by the following:

(a) Amplitude response—Overall (record/reproduce) response within ±0.5 dB over the frequency range desired for the data channel.

(b) Amplitude linearity—Deviation no more than 1% of full-scale from best straight line through zero.

(c) Phase response—Not more than 45 deg phase shift over the frequency range of 5 Hz-20 kHz for the microphone data channel(s).

(NOTE: The above specifications are best met with an instrumentation grade frequency-modulation magnetic tape recorder/reproducer.)

4.4 Graphic Display—The device used for graphic presentation of the pressure waveforms shall provide faithful amplitude and frequency reproduction of the transducer (or tape reproducer) output signal.

(NOTE: Because of the frequency limitations with typical oscillographic recorders, a tape recorder with appropriate reproduce/record tape speed ratio to maintain the data channel frequency response must be used. Direct display on a storage or camera-equipped oscilloscope is permissible.)

4.5 Calibrator—A closed-coupler acoustic calibrator shall be used to calibrate the data channel(s) containing a microphone. Static pressure or voltage-substitution (based on laboratory calibration) techniques may be used for the data channel(s) containing a pressure transducer if the use of a closed-coupler calibrator is not feasible.

4.6 Time Reference—To provide a timing reference, the voltage or other means used to initiate the restraint system deployment shall be monitored. "Time zero" shall be that instant in time when the initiation signal is applied to the system.

5. Transducer Locations—Location and orientation of the transducers within the vehicle passenger compartment are quite important; these must be uniform to provide for repeatability of measurements and correlation between various test setups. Locations specified in the SAE J941 are used as a base point for transducer locations, as specified below. A mean ear location (MEL) for this purpose is defined as a point 10 in. inboard from the X-Z plane, as shown in Fig. 2 of SAE J941, 3.5 in. rearward of line Z-Z, and 0.5 in. below line X-X.

5.1 Locations—At least two transducers shall be used, to be located at the mean ear location for the driver position and the right-front passenger position. The transducer diaphragm for the driver position is to be located at the MEL point defined above; that for the passenger position, at a MEL point symmetrical about the vehicle centerline to that defined above.

Other transducers may be used, if desired; their locations should be representative of expected noise exposure and described in detail.

5.2 Orientation—The transducer diaphragm should be grazed by the pressure wave(s); that is, the pressure wavefront should travel across the face of the transducer and be essentially normal to it.

5.3 Shock Isolation—To prevent spurious signals caused by microphonics or mechanical shock, all transducers (and associated signal preamplifiers) should be mounted in such a way as to be shock-isolated from the vehicle or component structure. Consideration must be given to the acceleration or shock sensitivity of the transducer and/or preamplifier used so that sufficient mechanical isolation is provided.

6. Data Presentation—The statement of test results shall contain at