

S6.4.1.2.6 Allow the tire to cool for between 15 minutes and 25 minutes. Measure its inflation pressure. Then, deflate the tire, remove it from the test rim, and inspect it for the conditions specified in S6.4.2(a).

S6.4.2 Performance requirements. When the tire is tested in accordance with S6.4.1:

(a) There shall be no visual evidence of tread, sidewall, ply, cord, innerliner, belt or bead separation, chunking, open splices, cracking, or broken cords, and

(b) The tire pressure, when measured at any time between 15 minutes and 25 minutes after the end of the test, shall not be less than 95% of the initial pressure specified in S6.4.1.1.1.

S6.5 *Tire strength.*

S6.5.1 *Tire strength for passenger car tires.* Each tire shall comply with the requirements of S5.3 of §571.109.

S6.5.2 *Tire strength for LT tires.* Each tire shall comply with the requirements of S7.3 of §571.119.

S6.6 *Tubeless tire bead unseating resistance.* Each tire shall comply with the requirements of S5.2 of §571.109. For light truck tires, the maximum permissible inflation pressure to be used for the bead unseating test is as follows:

Load Range C	260 kPa.
Load Range D	340 kPa.
Load Range E	410 kPa.

For light truck tires with a nominal cross section greater than 295 mm (11.5 inches), the maximum permissible inflation pressure to be used for the bead unseating test is as follows:

Load Range C	190 kPa.
Load Range D	260 kPa.
Load Range E	340 kPa.

S7. *Phase-in schedule for tire markings.*

S7.1 *Tires manufactured on or after September 1, 2005 and before September 1, 2006.* For tires manufactured on or after September 1, 2005 and before September 1, 2006, the number of tires complying with S4, S5.5, S5.5.1, S5.5.2, S5.5.3, S5.5.4, S5.5.5, and S5.5.6 of this standard must be equal to not less than 40% of the manufacturer's production during that period.

S7.2 *Tires manufactured on or after September 1, 2006 and before September 1, 2007.* For tires manufactured on or after September 1, 2006 and before Sep-

tember 1, 2007, the number of tires complying with S4, S5.5, S5.5.1, S5.5.2, S5.5.3, S5.5.4, S5.5.5, and S5.5.6 of this standard must be equal to not less than 70% of the manufacturer's production during that period.

S7.3 *Tires manufactured on or after September 1, 2007.* Each tire must comply with S4, S5.5, S5.5.1, S5.5.2, S5.5.3, S5.5.4, S5.5.5, and S5.5.6 of this standard.

[67 FR 69627, Nov. 18, 2002, as amended at 68 FR 38150, June 26, 2003; 69 FR 31319, June 3, 2004; 71 FR 886, Jan. 6, 2006; 72 FR 49211, Aug. 28, 2007; 73 FR 72358, Nov. 28, 2008; 77 FR 760, Jan. 6, 2012]

§571.141 Standard No. 141; Minimum Sound Requirements for Hybrid and Electric Vehicles.

S1. *Scope.* This standard establishes performance requirements for pedestrian alert sounds for motor vehicles.

S2. *Purpose.* The purpose of this standard is to reduce the number of injuries that result from electric and hybrid vehicle crashes with pedestrians by providing a sound level and sound characteristics necessary for these vehicles to be detected and recognized by pedestrians.

S3. *Application.* This standard applies to—

(a) Electric vehicles with a gross vehicle weight rating (GVWR) of 4,536 Kg or less that are passenger cars, multi-purpose passenger vehicles, trucks, or buses;

(b) Hybrid vehicles with a gross vehicle weight rating (GVWR) of 4,536 Kg or less that are passenger cars, multi-purpose passenger vehicles, trucks, or buses; and

(c) Electric vehicles and hybrid vehicles that are low speed vehicles.

S4. *Definitions.* *Band* or *one-third octave band* means one of thirteen one-third octave bands having nominal center frequencies ranging from 315 to 5000Hz. These are Bands 25 through 37 as defined in Table A1, Mid-band Frequencies for One-Third-Octave-Band and Octave-Band Filters in the Audio Range, of ANSI S1.11-2004: "Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters" (incorporated by reference, see §571.5).

Band sum means the combination of Sound Pressure Levels (SPLs) from selected bands that produce an SPL rep-

resenting the sound in all of these bands. Band sum is calculated with the following equation:

$$Band\ Sum = 10\ log_{10} \sum_{i=1}^2 10^{(SPL_i/10)}$$

where SPL_i is the sound pressure level in each selected band.

Electric vehicle means a motor vehicle with an electric motor as its sole means of propulsion.

Front plane of the vehicle means a vertical plane tangent to the leading edge of the vehicle during forward operation.

Hybrid vehicle means a motor vehicle which has more than one means of propulsion for which the vehicle’s propulsion system can propel the vehicle in the normal travel mode in at least one forward drive gear or reverse without the internal combustion engine operating.

Rear plane means a vertical plane tangent to the leading edge of the rear of the vehicle during operation in reverse.

Trim level is defined to mean a subset of vehicles within the same model designation with the same body type and which are alike in their general level of standard equipment, such as a “base” trim level of a vehicle model. Vehicles with only minor trim differences that are unlikely to affect vehicle-emitted sound are not considered different for the purposes of this safety standard.

S5. Requirements. Subject to the phase-in set forth in S9 of this standard, each hybrid and electric vehicle must meet the requirements specified in either S5.1 or S5.2. subject to the requirements in S5.3. Each vehicle must also meet the requirements in S5.4 and S5.5.

S5.1 Performance requirements for four-band alert sounds.

S5.1.1 Stationary. When stationary the vehicle must satisfy S5.1.1.1 and S5.1.1.2 whenever the vehicle’s propulsion system is activated and:

(i) In the case of a vehicle with an automatic transmission, the vehicle’s gear selector is in Neutral or any gear

position other than Park that provides forward vehicle propulsion;

(iii) in the case of a vehicle with a manual transmission, the vehicle’s parking brake is released and the gear selector is not in Reverse.

S5.1.1.1 For *detection*, the vehicle must emit a sound having at least the A-weighted sound pressure level according to Table 1 in each of four non-adjacent bands spanning no fewer than 9 of the 13 bands from 315 to 5000 Hz.

S5.1.1.2 For *directivity*, the vehicle must emit a sound measured at the microphone on the line CC’ having at least the A-weighted sound pressure level according to Table 1 in each of four non-adjacent bands spanning no fewer than 9 of the 13 bands from 315 to 5000Hz.

TABLE 1—ONE-THIRD OCTAVE BAND MIN. SPL REQUIREMENTS FOR SOUND WHEN STATIONARY AND CONSTANT SPEEDS LESS THAN 10KM/H

One-third octave band center frequency, Hz	Min SPL, A-weighted dB
315	39
400	39
500	40
630	40
800	41
1000	41
1250	42
1600	39
2000	39
2500	37
3150	34
4000	32
5000	31

S5.1.2 Reverse. For vehicles capable of rearward self-propulsion, whenever the vehicle’s gear selector is in the Reverse position, the vehicle must emit a sound having at least the A-weighted sound pressure level according to Table 2 in each of four non-adjacent bands spanning no fewer than 9 of the 13 bands from 315 to 5000Hz.

TABLE 2—ONE-THIRD OCTAVE BAND MIN. SPL REQUIREMENTS FOR SOUND WHILE IN REVERSE

One-third octave band center frequency, Hz	Min SPL, A-weighted dB
315	42
400	41
500	43
630	43
800	44
1000	44
1250	45
1600	41
2000	42
2500	40
3150	37
4000	35
5000	33

S5.1.3 *Constant pass-by speeds greater than 0 km/h but less than 20 km/h.* When at a constant speed greater than 0 km/h but less than 20 km/h the vehicle must emit a sound having at least the A-weighted sound pressure level according to Table 1 or Table 3 as applicable based upon vehicle test speed in each of four non-adjacent bands spanning no fewer than 9 of the 13 bands from 315 to 5000 Hz.

TABLE 3—ONE-THIRD OCTAVE BAND MIN. SPL REQUIREMENTS FOR CONSTANT PASS-BY SPEEDS GREATER THAN OR EQUAL TO 10 KM/H BUT LESS THAN 20 KM/H

One-third octave band center frequency, Hz	Min SPL, A-weighted dB
315	45
400	44
500	46
630	46
800	47
1000	47
1250	48
1600	44
2000	45
2500	43
3150	40
4000	38
5000	36

S5.1.4 *Constant pass-by speeds greater than or equal to 20km/h but less than 30 km/h.* When at a constant speed equal to or greater than 20 km/h but less than 30 km/h the vehicle must emit a sound having at least the A-weighted sound pressure level according to Table 4 in each of four non-adjacent bands spanning no fewer than 9 of the 13 bands from 315 to 5000 Hz.

TABLE 4—ONE-THIRD OCTAVE BAND MIN. SPL REQUIREMENTS FOR CONSTANT PASS-BY SPEEDS GREATER THAN OR EQUAL TO 20 KM/H BUT LESS THAN 30 KM/H

One-third octave band center frequency, Hz	Min SPL, A-weighted dB
315	52
400	51
500	52
630	53
800	53
1000	54
1250	54
1600	51
2000	51
2500	50
3150	47
4000	45
5000	43

S5.1.5 *Constant 30km/h pass-by.* When at a constant speed of 30–32 km/h the vehicle must emit a sound having at least the A-weighted sound pressure level according to Table 5 in each of four non-adjacent bands spanning no fewer than 9 of the 13 bands from 315 to 5000 Hz.

TABLE 5—ONE-THIRD OCTAVE BAND MIN. SPL REQUIREMENTS FOR 30–32 KM/H PASS-BY

One-third octave band center frequency, Hz	Min SPL, A-weighted dB
315	56
400	55
500	57
630	57
800	58
1000	58
1250	59
1600	55
2000	55
2500	54
3150	51
4000	49
5000	47

S5.2 *Performance requirements for two-band alert sounds.* When operating under the vehicle speed conditions specified in Table 6, the vehicle must emit sound having two non-adjacent one-third octave bands from 315 to 3150 Hz each having at least the A-weighted sound pressure level according to the minimum SPL requirements in Table 6 and spanning no fewer than three one-third octave bands from 315 to 3150 Hz. One of the two bands meeting the minimum requirements in Table 6 shall be the band that has the highest SPL of the 315 to 800 Hz bands and the second band shall be the band meeting the minimum requirements in Table 6 that

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has the highest SPL of the 1000 to 3150 Hz bands. The two bands used to meet the two-band minimum requirements

must also meet the band sum requirements as specified in Table 6.

TABLE 6—ONE-THIRD OCTAVE BAND MINIMUM REQUIREMENTS FOR TWO-BAND ALERT

Vehicle speed	A-weighted SPL, dB(A)	
	Minimum in each band	Band sum
Reverse	40	48
Stationary and up to but not including 10 km/h	40	44
10 km/h up to but not including 20 km/h	42	51
20 km/h up to but not including 30 km/h	47	57
30 km/h	52	62

S5.2.1 When tested according to the test procedure in S7.1 the vehicle must emit a sound measured at the microphone on the line CC' having at least two non-adjacent octave bands from 315 to 3150 Hz each having at least the A-weighted sound pressure level, indicated in the "Minimum in Each Band" column in Table 6 for the "Stationary up to but not including 10 km/h" condition. The two bands used to meet the two-band minimum requirements must also meet the Band Sum as specified in Table 6.

S5.3 If a hybrid vehicle to which this standard applies is evaluated for compliance with requirements in S5.1.1 through S5.1.5 or S5.2 (Stationary, Reverse, Pass-by at 10 km/h, 20 km/h, and 30 km/h, respectively), and during testing to any one of those requirements the vehicle is measured for ten consecutive times without recording a valid measurement, or for a total of 20 times without recording four valid measurements because the vehicle's ICE remains active for the entire duration of a measurement or the vehicle's ICE activates intermittently during every measurement, the vehicle is exempted from meeting the specific requirement that was under evaluation at the time the ICE interfered in the prescribed manner.

S5.4 *Relative volume change to signify acceleration and deceleration.* The sound produced by the vehicle in accordance with paragraph S5 shall change in volume, as calculated in S7.6, from one critical operating condition to the next in accordance with the requirements in Table 7.

TABLE 7—MINIMUM RELATIVE VOLUME CHANGE REQUIREMENTS

Critical operating speed intervals	Minimum relative volume change, dB
Between:	
Stationary and 10 km/h	3
10 km/h and 20 km/h	3
20 km/h and 30 km/h	3

S5.5 *Sameness requirement*

S5.5.1 Any two vehicles of the same make, model, model year, body type, and trim level (as those terms are defined in 49 CFR 565.12 or in section S4 of this safety standard) to which this safety standard applies shall be designed to have the same pedestrian alert sound when operating under the same test conditions and at the same speed including any test conditions and speeds for which an alert sound is required in Section S5 of this safety standard.

S5.5.2 For the purposes of this requirement, the pedestrian alert sound of vehicles which meet the applicable requirements in S5.1 through S5.4 of this standard are deemed to be the same if the digital source of the sound, if any, is the same and if the algorithms that either generate the sound directly or process the digital source to generate the sound are the same.

S6. *Test Conditions.*

S6.1 *Weather conditions.* The ambient conditions specified by this section will be met at all times during the tests described in S7. Conditions will be measured with the accuracy required in S6.3.3 at the microphone height specified in S6.4 ±0.02 m.

S6.1.1 The ambient temperature will be between 5 °C (41 °F) and 40 °C (104 °F).

S6.1.2 The maximum wind speed at the microphone height is no greater than 5 m/s (11 mph), including gusts.

S6.1.3 No precipitation and the test surface is dry.

S6.1.4 *Background noise level.* The background noise level will be measured and reported as specified in S6.7, *Ambient correction.*

S6.2 *Test surface.* Test surface will meet the requirements of ISO 10844:1994, ISO 10844:2011, or ISO 10844:2014 (incorporated by reference, see §571.5).

S6.3 *Instrumentation.*

S6.3.1 *Acoustical measurement.* Instruments for acoustical measurement will meet the requirements of S5.1 of SAE J2889-1 (incorporated by reference, see §571.5).

S6.3.2 *Vehicle speed measurement.* Instruments used to measure vehicle speed during the constant speed pass-by tests in S7 of this standard will be capable of either continuous measurement of speed within ± 0.5 km/h over the entire measurement zone specified in S6.4 or independent measurements of speed within ± 0.2 km/h at the beginning and end of the measurement zone specified in S6.4.

S6.3.3 *Meteorological instrumentation.* Instruments used to measure ambient conditions at the test site will meet the requirements of S5.3 of SAE J2889-1 (incorporated by reference, see §571.5).

S6.4 *Test site.* The test site will be established per the requirements of 6.1 of SAE J2889-1 (incorporated by reference, see §571.5), including Figure 1, "Test Site Dimensions" with the definitions of the abbreviations in Figure 1 as given in Table 1 of SAE J2889-1 (incorporated by reference, see §571.5). Microphone positions will meet the requirements of 7.1.1 of SAE J2889-1 (incorporated by reference, see §571.5).

S6.5 *Test set up for directivity measurement* will be as per S6.4 with the addition of one microphone meeting the requirements of S6.3.1 placed on the line CC', 2m forward of the line PP' at a height of 1.2m above ground level.

S6.6 *Vehicle condition*

(a) The vehicle's doors are shut and locked and windows are shut.

(b) All accessory equipment (air conditioner, wipers, heat, HVAC fan, audio/video systems, etc.) that can be shut down, will be off. Propulsion battery cooling fans and pumps and other components of the vehicle's propulsion battery thermal management system are not considered accessory equipment. During night time testing test vehicle headlights may be activated.

(c) Vehicle's electric propulsion batteries, if any, are charged according to the requirements of S7.1.2.2 of SAE J2889-1 (incorporated by reference, see §571.5). If propulsion batteries must be recharged during testing to ensure internal combustion engine does not activate, manufacturer instructions will be followed.

(d) Vehicle test weight, including the driver and instrumentation, will be evenly distributed between the left and right side of the vehicle and will not exceed the vehicle's GVWR or GAWR:

(1) For passenger cars, and MPVs, trucks, and buses with a GVWR of 4,536 kg (10,000 pounds) or less, the vehicle test weight is the unloaded vehicle weight plus 180 kg (396 pounds);

(2) For LSVs, the test weight is the unloaded vehicle weight plus 78 kg (170 pounds).

(e) Tires will be free of all debris and each tire's cold tire inflation pressure set to:

(1) For passenger cars, and MPVs, trucks, and buses with a GVWR of 4,536 kg (10,000 pounds) or less, the inflation pressure specified on the vehicle placard in FMVSS No. 110;

(2) For LSVs, the inflation pressure recommended by the manufacturer for GVWR; if none is specified, the maximum inflation pressure listed on the sidewall of the tires.

(f) Tires are conditioned by driving the test vehicle around a circle 30 meters (100 feet) in diameter at a speed that produces a lateral acceleration of 0.5 to 0.6 g for three clockwise laps followed by three counterclockwise laps;

S6.7 *Ambient correction.*

S6.7.1 Measure the ambient noise for at least 30 seconds immediately before and after each series of vehicle tests. A series is a test condition, *i.e.* stationary, reverse, 10 km/h pass-by test,

20 km/h pass-by test, or 30 km/h pass-by test. Ambient noise data files will be collected from each microphone required by the test procedures in S7.

S6.7.2 For each microphone, determine the minimum A-weighted overall ambient SPL during the 60 seconds (or more) of recorded ambient noise consisting of at least 30 seconds recorded immediately before and at least 30 seconds immediately after each test series.

S6.7.3 For each of the 13 one-third octave bands, the minimum A-weighted ambient noise level during the 60 seconds (or more) from the two 30 second periods of ambient noise recorded immediately before and after each test series will be determined for each microphone.

S6.7.4 To correct overall SPL values for ambient noise, calculate the difference, for each microphone, between the measured overall SPL values for a test vehicle obtained in sections S7.1.4(b) and S7.3.4(b) and the minimum overall ambient SPL values determined in S6.7.2, above. Using Table 8, determine a correction factor for each microphone. Subtract the correction factor from the overall SPL value

measured under sections S7.1.4(b) and S7.3.4(b) to calculate the corrected overall SPL value. Any test for which the minimum overall SPL of the ambient is within 3 dB of the uncorrected overall SPL of the vehicle is invalid and not analyzed further.

S6.7.5 To correct one-third octave band sound levels for ambient noise, calculate the difference, for each microphone, between the uncorrected level for a one-third octave band (obtained in sections S7.1.5(b), S7.1.6(b) and S7.3.5(b)) and the minimum ambient level in the same one-third octave band as determined in S6.7.3. Use Table 9 to determine if a correction is required for each microphone and one-third octave band. If a correction is required, subtract the appropriate correction factor in Table 9 from the uncorrected one-third octave band sound level to calculate the corrected level for each one-third octave band. If the level of any ambient one-third octave band is within 3 dB of the corresponding uncorrected one-third octave band level, then that one-third octave band is invalid and not analyzed further.

TABLE 8—OVERALL SPL CORRECTIONS FOR AMBIENT NOISE

Difference between vehicle measurement and ambient noise level	Correction
Greater than 10 dB	0 dB.
Greater than 8 dB but less than or equal to 10 dB	0.5 dB.
Greater than 6 dB but less than or equal to 8 dB	1.0 dB.
Greater than 4.5 dB but less than or equal to 6 dB	1.5 dB.
Greater than 3 dB but less than or equal to 4.5 dB	2.5 dB.
Less than or equal to 3 dB	Invalid test run.

TABLE 9—1/3 OCTAVE BAND CORRECTIONS FOR AMBIENT NOISE

Difference between vehicle 1/3 octave band sound pressure level and ambient noise level	Correction
Greater than 6 dB	0 dB.
Greater than 4.5 dB but less than or equal to 6 dB	1.5 dB.
Greater than 3 dB but less than or equal to 4.5 dB	2.5 dB.
Less than or equal to 3 dB	Specific 1/3 octave band is not useable.

S7. Test Procedure.

S7.1 Stationary vehicle in forward gear.

S7.1.1 Execute stationary tests and collect acoustic sound files.

(a) Position the vehicle with the front plane at the line PP', the vehicle centerline on the line CC' and the

starting system deactivated. For vehicle equipped with a Park position, place the vehicle's gear selector in "Park" and engage the parking brake. For vehicles not equipped with a Park

position, place the vehicle's gear selector in "Neutral" and engage the parking brake. Activate the starting system to energize the vehicle's propulsion system.

(b) For vehicles equipped with a Park position for the gear selector, after activating the starting system to energize the vehicle's propulsion system, apply and maintain a full application of the service brake, disengage the vehicle parking brake and then place the vehicle's gear selector in "Drive," or any forward gear. For vehicles not equipped with a Park position for the gear selector, after activating the starting system to energize the vehicle's propulsion system, apply and maintain a full application of the service brake, disengage the vehicle parking brake, disengage the manual clutch (fully depress and hold the clutch pedal), and place the vehicle's gear selector in any forward gear.

(c) Execute multiple tests to acquire at least four valid tests within 2 dBA overall SPL in accordance with S7.1.2 and S7.1.3. For each test, measure the sound emitted by the stationary test vehicle for a duration of 10 seconds.

(d) During each test a left (driver's side), a right (passenger side), and a front-center acoustic file will be recorded.

S7.1.2. Eliminate invalid tests.

(a) Determine validity of sound files collected during S7.1.1 tests. Measurements that contain any distinct, transient, loud sounds (*e.g.*, chirping birds, overhead planes, trains, car doors being slammed, etc.) are considered invalid. Measurements that contain sounds emitted by any vehicle system that is automatically activated and constantly engaged during the entire 10 second performance test are considered valid. Measurements that contain sound emitted by any vehicle system that is automatically activated and intermittently engaged at any time during the stationary performance test, are considered invalid. Additionally, when testing a hybrid vehicle with an internal combustion engine, measurements that include sound emitted by the ICE either intermittently or continuously are considered invalid. A valid test requires a valid

left side, a valid right side, and a valid front-center acoustic sound file.

(b) Sequentially number all tests which are deemed valid based upon the chronological order in which they were conducted. Acoustic files will be identified with a test sequence number and their association with the left side, right side, or front center microphone.

S7.1.3 Identify first four valid tests within 2dBA.

(a) For each valid test sound file identified in S7.1.2, determine a maximum overall SPL value, in decibels. Each SPL value will be reported to the nearest tenth of a decibel.

(b) Compare the first four left-side SPL values from S7.1.3(a) of this paragraph, and determine the range by taking the difference between the largest and smallest of the four values. In the same manner, determine the range of SPL values for the first four right-side and the first four front-center sound files. If the range for the left side, right side, and front-center are all less than or equal to 2.0 dB, then the twelve sound files associated with the first four valid tests will be used for the one-third octave band evaluations in S7.1.5. and S7.1.6. If the range of the SPL values for the left side are not within 2 dBA, or for the right side are not within 2 dBA, or for the front-center of the vehicle are not within 2 dBA, an iterative process will be used to consider sound files from additional sequential tests until the range for all three microphone locations are within 2 dBA for the same sequence number recordings for all three locations.

S7.1.4 Compare the average overall SPL for the left and right side of the test vehicle to determine which is lower.

(a) Document the maximum overall SPL values in each of the eight acoustic data files (four left side files and four right side files) identified in S7.1.3.

(b) Correct each of the eight SPL values from S7.1.4(a) according to S6.7 using the ambient sound level recorded during the test. The results will be reported to the nearest tenth of a decibel.

(c) Calculate a left-side average and a right-side average from the ambient-corrected overall SPL values from S7.1.4(b), and determine the lower of the

two sides. The result will be reported to the nearest tenth of a decibel.

(d) If the left-side value from S7.1.4(c) is the lower one, then the left side acoustic data will be further evaluated for compliance at the one-third octave band levels in accordance with S7.1.5. If the left-side value from S7.1.4(c) is not the lower one, the right-side acoustic data will be further evaluated for compliance at the one-third octave band level in accordance with S7.1.5.

S7.1.5 Select one-third octave bands to be used for evaluating compliance with detection requirements for a stationary vehicle.

(a) For each of the four left-side or right-side acoustic files, which ever was selected in S7.1.4, determine the sound pressure level in each one-third octave band from 315 Hz up to and including 5000 Hz.

(b) Correct the one-third octave band levels in all four sound files to adjust for the ambient sound level recorded during the test according to paragraph S6.7.

(c) For each one-third octave band, average the corrected levels from the four sound files. The results will be reported to the nearest tenth of a decibel.

(d) For alerts designed to meet the four-band requirements of S5.1 of this standard:

(i) Select any four one-third octave bands that are non-adjacent to each other and that span a range of at least nine one-third octave bands in the range of 315 Hz up to and including 5000 Hz to evaluate according to paragraph S7.1.5(d)(ii). This step will be repeated until compliance is established or it is determined that no combination meeting this selection criterion can satisfy paragraph S7.1.5(d)(ii).

(ii) Compare the average corrected sound pressure level from S7.1.5(c) in each of the four one-third octave bands selected in paragraph S7.1.5(d)(i) to the required minimum level of the corresponding one-third octave band specified in paragraph S5.1.1, Table 1, to determine compliance.

(e) For alerts designed to meet the two-band requirements of S5.2 of this standard:

(i) Select the two one-third octave bands, one below 1000 Hz and one at or

above 1000 Hz, having the largest A-weighted SPL values within the range of 315 Hz up to 3150 Hz and that are non-adjacent to each other to evaluate according to S7.1.5(e)(ii), below. In the event that the pair of bands with the largest SPL values are the 800 Hz and 1000 Hz bands, then select both of the following pairs to evaluate according to S7.1.5(e)(ii): The 800 Hz band along with the band having the second-largest A-weighted SPL value from the 1000 Hz and above bands; and, the 1000 Hz band along with the band having the second-largest A-weighted SPL value from the 800 Hz and below bands. At least one of the band pairs selected as specified in this paragraph shall meet the minimum requirements when evaluated according to S7.1.5(e)(ii).

(ii) Compare the average corrected sound pressure level from S7.1.5(c) in each of the two one-third octave bands selected in paragraph S7.1.5(e)(i) to the required minimum level of the corresponding one-third octave band specified in paragraph S5.2, Table 6. Also, compare the band sum of the two bands to the required minimum band sum in Table 6.

S7.1.6 Select one-third octave bands to be used for evaluating compliance with directivity requirements for a stationary vehicle.

(a) Determine the one-third octave band levels associated with the four front center sound files selected in S7.1.3.

(b) The identified one-third octave band levels in each of the four sound files will be corrected for the measured ambient levels as specified in paragraph S6.7.

(c) The four corrected sound pressure level values calculated from each of the four sound files in each one-third octave band will be averaged together to get the average corrected sound pressure level in each one-third octave band.

(d) For alerts designed to meet the four-band requirements of S5.1 of this standard:

(i) Select any four one-third octave bands that are non-adjacent to each other and that span a range of at least nine one-third octave bands in the range of 315 Hz up to and including 5000 Hz to evaluate according to paragraph

S7.1.6(d)(ii). This step will be repeated until compliance is established or it is determined that no combination meeting this selection criterion can satisfy paragraph S7.1.6(d)(ii).

(ii) Compare the average corrected sound pressure level from S7.1.6(c) in each of the four one-third octave bands selected in paragraph S7.1.6(d)(i) to the required minimum level of the corresponding one-third octave band specified in paragraph S5.1.1, Table 1, to determine compliance.

(e) For alerts designed to meet the two-band requirements of S5.2 of this standard:

(i) Select the two one-third octave bands, one below 1000 Hz and one at or above 1000 Hz, having the largest A-weighted SPL values within the range of 315 Hz up to 3150 Hz and that are non-adjacent to each other to evaluate according to S7.1.6(e)(ii), below. In the event that the pair of bands with the largest SPL values are the 800 Hz and 1000 Hz bands, then select both of the following pairs to evaluate according to S7.1.6(e)(ii): The 800 Hz band along with the band having the second-largest A-weighted SPL value from the 1000 Hz and above bands; and, the 1000 Hz band along with the band having the second-largest A-weighted SPL value from the 800 Hz and below bands. At least one of the band pairs selected as specified in this paragraph shall meet the minimum requirements when evaluated according to S7.1.6(e)(ii), below.

(ii) Compare the average corrected sound pressure level from S7.1.6(c) in each of the two one-third octave bands selected in paragraph S7.1.6(e)(i) to the required minimum level of the corresponding one-third octave band specified in paragraph S5.2, Table 6. Also, compare the band sum of the two bands to the required minimum band sum in Table 6.

S7.2 *Stationary vehicle in reverse gear.* Test the vehicle per S7.1.1 through S7.1.5 except that the rear plane of the vehicle is placed on the PP' line, no center microphone is used, and the vehicle's transmission gear selector is placed in the 'Reverse' position. The minimum sound level requirements for the Reverse test condition are contained in S5.1.2, Table 2, for four-band

compliance and in S5.2, Table 6, for two-band compliance.

S7.3 *Constant speed pass-by tests at speeds greater than 0 km/h but less than 20 km/h.*

S7.3.1 Execute pass-by tests at 11km/h (± 1 km/h) and collect acoustic sound files.

(a) For each test, measure the sound emitted by the test vehicle while at a constant speed of 11km/h (± 1 km/h) throughout the measurement zone specified in S6.4 between lines AA' and PP'. Execute multiple test runs at 11km/h (± 1 km/h) to acquire at least four valid tests within 2dBA in accordance with S7.3.2 and S7.3.3.

(b) During each test, record a left (driver's side) and a right (passenger side) acoustic sound file.

S7.3.2 Eliminate invalid tests and acoustic sound files

(a) Determine validity of sound files collected during S7.3.1 tests. Measurements that contain any distinct, transient, background sounds (*e.g.*, chirping birds, overhead planes, car doors being slammed, etc.) are considered invalid. Measurements that contain sounds emitted by any vehicle system that is automatically activated and constantly engaged during the entire performance test are considered valid. Measurements that contain sound emitted by any vehicle system that is automatically activated, and intermittently engaged at any time during the performance test, are considered invalid. Additionally, when testing a hybrid vehicle with an internal combustion engine that runs intermittently during a specific test, measurements that contain sound emitted by the ICE are considered invalid. A valid test requires both a valid left side and a valid right side acoustic sound file.

(b) Tests which are deemed valid will be numbered sequentially based upon the chronological order in which they were collected. Sound files will retain their test sequence number and their association with the left side or right side microphone.

S7.3.3 Identify "first four valid tests within 2 dBA".

(a) For each valid test sound file identified in S7.3.2, determine a maximum overall SPL value, in decibels.

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The SPL value will be reported to the nearest tenth of a decibel.

(b) Compare the first four left side maximum overall SPL values. Of the four SPL values calculate the difference between the largest and smallest maximum SPL values. The same process will be used to determine the difference between the largest and smallest maximum SPL values for the first four right side maximum SPL values. If the difference values on the left and right sides of the test vehicle are both less than or equal to 2.0 dB, then the eight sound files associated with the first four valid tests will be used for the final one-third octave band evaluation in accordance with S7.3.4 and S7.3.5. If the first four test sound files on each side of the vehicle are not within 2 dBA, an iterative process will be used to consider sound files from additional sequential tests until the range for both microphone locations are within 2 dBA for the same sequence number recordings for both locations.

S7.3.4 Determine average overall SPL value on each side (left and right) of test vehicle.

(a) Document the maximum overall SPL value in decibels for each of the eight acoustic sound data files (four left-side files and four right-side files) identified in S7.3.3.

(b) Each of the eight acoustic sound data file maximum overall SPL values will be corrected for the recorded ambient conditions as specified in paragraph S6.7. The test results will be reported to the nearest tenth of a decibel.

(c) Calculate the average of the four overall ambient-corrected SPL values on each side of the vehicle to derive one corrected maximum overall SPL value for each side of the vehicle. The result will be reported to the nearest tenth of a decibel.

(d) The side of the vehicle with the lowest average corrected maximum overall SPL value will be the side of the vehicle that is further evaluated for compliance at the one-third octave band levels in accordance with S7.3.5.

S7.3.5 Select one-third octave bands to be used for evaluating compliance with the constant speed pass-by requirements.

(a) The side of the vehicle selected in S7.3.4 will have four associated individual acoustic sound data files. Each sound file shall be broken down into its one-third octave band levels.

(b) The identified octave band levels in each of the four sound files will be corrected for the measured ambient levels as specified in paragraph S6.7.

(c) The four corrected sound pressure level values calculated from each of the four sound files in each one-third octave band will be averaged together to get the average corrected sound pressure level in each one-third octave band.

(d) For alerts designed to meet the four-band requirements of S5.1 of this standard:

(i) Select any four one-third octave bands that are non-adjacent to each other and that span a range of at least nine one-third octave bands in the range of 315 Hz up to and including 5000 Hz to evaluate according to paragraph S7.3.5(d)(ii). This step will be repeated until compliance is established or it is determined that no combination meeting this selection criterion can satisfy paragraph S7.3.5(d)(ii).

(ii) Compare the average corrected sound pressure level from S7.3.5(c) in each of the four one-third octave bands selected in paragraph S7.3.5(d)(i) to the required minimum level of the corresponding one-third octave band specified in paragraph S5.1.3, Table 3, to determine compliance.

(e) For alerts designed to meet the two-band requirements of S5.2 of this standard:

(i) Select the two one-third octave bands, one below 1000 Hz and one at or above 1000 Hz, having the largest A-weighted SPL values within the range of 315 Hz up to 3150 Hz and that are non-adjacent to each other to evaluate according to S7.3.5(e)(ii), below. In the event that the pair of bands with the largest SPL values are the 800 Hz and 1000 Hz bands, then select both of the following pairs to evaluate according to S7.3.5(e)(ii): The 800 Hz band along with the band having the second-largest A-weighted SPL value from the 1000 Hz and above bands; and, the 1000 Hz band along with the band having the second-largest A-weighted SPL value from the 800 Hz and below bands. At least one of

the band pairs selected as specified in this paragraph shall meet the minimum requirements when evaluated according to S7.3.5(e)(ii), below.

(ii) Compare the average corrected sound pressure level from S7.3.5(c) in each of the two one-third octave bands selected in paragraph S7.3.5(e)(i) to the required minimum level of the corresponding one-third octave band specified in paragraph S5.2, Table 6. Also, compare the band sum of the two bands to the required minimum band sum in Table 6.

S7.3.6 The procedures in S7.3.1 through S7.3.5 may be repeated for any pass-by test speed greater than 0 km/h and less than 20 km/h. For test speeds greater than 0 km/h and less than 10 km/h, the minimum sound level requirements are contained in S5.1.1, Table 1, for four-band compliance and in S5.2, Table 6, for two-band compliance. For test speeds greater than or equal to 10 km/h and less than 20 km/h, the minimum sound level requirements are contained in S5.1.3, Table 3, for 4-band compliance and in S5.2, Table 6, for 2-band compliance.

S7.4 *Pass-by tests at speeds greater than or equal to 20 km/h and less than 30 km/h.* Repeat the procedures of S7.3 at 21 km/h ± 1 km/h. The procedures in S7.3 also may be repeated for any pass-by test speed greater than 20 km/h and less than 30 km/h. For this range of test speeds, the minimum sound level requirements are contained in S5.1.4,

Table 4, for four-band compliance and in S5.2, Table 6, for two-band compliance.

S7.5 *Pass-by tests at 30 km/h.* Repeat the procedures of S7.3 at 31 km/h ± 1 km/h. For this test speed, the minimum sound level requirements are contained in S5.1.5, Table 5, for four-band compliance and in S5.2, Table 6, for two-band compliance.

S7.6 *Relative volume change.* The valid test run data selected for each critical operating scenario in S7.1 (S7.1.5(c)), S7.3 (S7.3.5(c)), S7.4 and S7.5 will be used to derive relative volume change as required in S5.4 as follows:

S7.6.1 Calculate the average sound pressure level for each of the 13 one-third octave bands (315 Hz to 5000 Hz) using the four valid test runs identified for each critical operating scenario from S7.1.3 and S7.3.3 (stationary, 10 km/h (11±1km/h), 20 km/h (21±1km/h), and 30 km/h (31±1km/h)).

S7.6.2 For each critical operating scenario, normalize the levels of the 13 one-third octave bands by subtracting the corresponding minimum SPL values specified in Table 1 for the stationary operating condition from each of the one-third octave band averages calculated in S7.6.1.

S7.6.3 Calculate the NORMALIZED BAND SUM for each critical operating scenario (stationary, 10 km/h (11±1km/h), 20 km/h (21±1km/h), and 30 km/h (31±1km/h)) as follows:

$$NORMALIZEDBANDSUM = 10 * \log_{10} \left(\sum_{13}^{i=1} 10^{\frac{Normalized\ Band\ Level_i}{10}} \right)$$

Where:

i represents the 13 one-third octave bands and *Normalized Band Level_i* is the normalized one-third octave band value derived in S7.6.2.

S7.6.4 Calculate the relative volume change between critical operating scenarios (stationary to 10km/h; 10km/h to 20 km/h; 20km/h to 30 km/h) by subtracting the NORMALIZED BAND SUM of the lower speed operating scenario from the NORMALIZED BAND SUM of the next higher speed operating

scenario. For example, the relative volume change between 10 km/h (11±1km/h) and 20 km/h (21±1km/h) would be the NORMALIZED BAND SUM level at 21±1km/h minus the NORMALIZED BAND SUM level at 11±1km/h.

S8 *Prohibition on altering the sound of a vehicle subject to this standard.* No entity subject to the authority of the National Highway Traffic Safety Administration may:

- (a) Disable, alter, replace, or modify any element of a vehicle installed as

original equipment for purposes of complying with this Standard, except in connection with a repair of a vehicle malfunction or to remedy a defect or non-compliance; or

(b) Provide any person with any mechanism, equipment, process, or device intended to disable, alter, replace, or modify the sound emitting capability of a vehicle subject to this standard, except in connection with a repair of vehicle malfunction or to remedy a defect or non-compliance.

S9 Phase-in schedule.

S9.1 Hybrid and Electric Vehicles manufactured on or after March 1, 2020, and before February 28, 2021. For hybrid and electric vehicles to which this standard applies manufactured on and after March 1, 2020, and before March 1, 2021, except vehicles produced by small volume manufacturers, the quantity of hybrid and electric vehicles complying with this safety standard shall be not less than 50 percent of one or both of the following:

(a) A manufacturer's average annual production of hybrid and electric vehicles on and after September 1, 2016, and before September 1, 2019;

(b) A manufacturer's total production of hybrid and electric vehicles on and after March 1, 2020, and before March 1, 2021.

S9.2 Hybrid and Electric Vehicles manufactured on or after March 1, 2021. All hybrid and electric vehicles to which this standard applies manufactured on or after March 1, 2021, shall comply with this safety standard.

[81 FR 90514, Dec. 14, 2016, as amended at 83 FR 8196, Feb. 26, 2018; 85 FR 54280, Sept. 1, 2020]

§571.201 Standard No. 201; Occupant protection in interior impact.

S1. Purpose and scope. This standard specifies requirements to afford impact protection for occupants.

S2. Application. This standard applies to passenger cars and to multipurpose passenger vehicles, trucks, and buses with a GVWR of 4,536 kilograms or less, except that the requirements of S6 do not apply to buses with a GVWR of more than 3,860 kilograms.

S3. Definitions.

A-pillar means any pillar that is entirely forward of a transverse vertical

plane passing through the seating reference point of the driver's seat.

Ambulance means a motor vehicle designed exclusively for the purpose of emergency medical care, as evidenced by the presence of a passenger compartment to accommodate emergency medical personnel, one or more patients on litters or cots, and equipment and supplies for emergency care at a location or during transport.

B-pillar means the forwardmost pillar on each side of the vehicle that is, in whole or in part, rearward of a transverse vertical plane passing through the seating reference point of the driver's seat, unless:

(1) There is only one pillar rearward of that plane and it is also a rearmost pillar; or

(2) There is a door frame rearward of the A-pillar and forward of any other pillar or rearmost pillar.

Brace means a fixed diagonal structural member in an open body vehicle that is used to brace the roll-bar and that connects the roll-bar to the main body of the vehicle structure.

Convertible means a vehicle whose A-pillars are not joined with the B-pillars (or rearmost pillars) by a fixed, rigid structural member.

Convertible roof frame means the frame of a convertible roof.

Convertible roof linkage mechanism means any anchorage, fastener, or device necessary to deploy a convertible roof frame.

Daylight opening means, for openings on the side of the vehicle, other than a door opening, the locus of all points where a horizontal line, perpendicular to the vehicle longitudinal centerline, is tangent to the periphery of the opening. For openings on the front and rear of the vehicle, other than a door opening, *daylight opening* means the locus of all points where a horizontal line, parallel to the vehicle longitudinal centerline, is tangent to the periphery of the opening. If the horizontal line is tangent to the periphery at more than one point at any location, the most inboard point is used to determine the daylight opening.

Door frame means the rearmost perimeter structure, including trim but excluding glass, of the forward door