REFERENCE FILE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TOP 1-2-608	2. GOVT ACCESSION NO. A103819	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* US ARMY TEST AND EVALUATION COMMAND TEST OPERATIONS PROCEDURE "SOUND LEVEL MEASUREMENTS"		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR*(s)*		8. CONTRACT OR GRANT NUMBER*(s)*
9. PERFORMING ORGANIZATION NAME AND ADDRESS US ARMY ABERDEEN PROVING GROUND (STEAP-MT-M) ABERDEEN PROVING GROUND, MARYLAND 21005		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS DARCOM-R 310-6
11. CONTROLLING OFFICE NAME AND ADDRESS US ARMY TEST AND EVALUATION COMMAND (DRSTE-AD-M) ABERDEEN PROVING GROUND, MARYLAND 21005		12. REPORT DATE 17 July 1981 13. NUMBER OF PAGES 38
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Acoustics	Measurement	Test methods
Detector	Noise	
Exposure	Pressure	
Impulse noise	Sound	

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Describes procedures for measuring the sound levels of developmental and production materiel as a means of evaluating personnel safety, recognition and community annoyance (by a drive-by test). It covers tests for steady-state noise from military vehicles and general equipment, and impulse noise from weapon systems and explosive ordnance materiel.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-102
*Test Operations Procedure 1-2-608 17 July 1981
AD No. A103819

SOUND LEVEL MEASUREMENTS

			Page
Paragraph	1.	SCOPE	1
	2.	FACILITIES AND INSTRUMENTATION	2
	3.	REQUIRED TEST CONDITIONS	5
	4.	TEST PROCEDURES	7
	4.1	Steady-State Noise Tests	7
	4.1.1	Methods	8
	4.1.1.1	Noise Tests of Stationary Equipment	8
	4.1.1.2	Interior-Noise Tests of Moving Equipment	11
	4.1.1.3	Exterior-Noise Tests of Moving Equipment (Drive-By)	12
	4.1.1.4	Aural-Nondetectability Tests	15
	4.1.1.5	Speech-Intelligibility Tests	17
	4.1.1.6	Typical-Duty-Cycle Tests	20
	4.1.2	Data Required	20
	4.2	Impulse-Noise Tests	20
	4.2.1	Methods	21
	4.2.1.1	Weapon-Firing Tests	23
	4.2.1.2	Explosive-Ordnance Tests	27
	4.2.1.3	Materiel Other Than Weapons and Explosive Ordnance	27
	4.2.2	Data Required	28
	5.	PRESENTATION OF DATA	29
Appendix	A	BACKGROUND	A-1
	B	DATA COLLECTION SHEET	B-1
	C	REFERENCES	C-1

1. SCOPE. This TOP describes procedures for measuring the sound levels transmitted through air of developmental and production materiel as a means of evaluating personnel safety, speech intelligibility, security from acoustic detection and recognition, and community annoyance (by a drive-by test). It covers tests for steady-state noise from military vehicles and general equipment, and impulse noise from weapon systems and explosive-ordnance materiel. For materiel that produce sound-pressure levels 171 db (6.89 kPa or 1.0 psi) and above, the procedures and instrumentation described in TOP 4-2-822,1/ for measuring blast overpressure, apply. This TOP does not include procedures for measuring the noise from aircraft.

1/ Footnote numbers match those in References, Appendix C.

*This TOP supersedes TOP 1-2-608, 3 June 1977.

Approved for public release; distribution unlimited.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

2.1.1 Stationary Operation Tests.

a. For movable test items, select an open area of uniform grade that is free of all sound-reflecting surfaces (such as buildings, trees, hillsides, or signboards) and interfering sound sources within 30 m (100 ft) of the test item and sound-measuring instrumentation. The terrain surface must be paved, stone, hard dirt, or other material having similar acoustic characteristics. State the test conditions in the test report.

b. For test items permanently mounted, test the item on-site, and state the conditions in the test report.

NOTE: Where no references are given, the test conditions and procedures listed have evolved over a number of years at Aberdeen Proving Ground, and they are still used for these tests.

c. For a test item that produces sound levels within 10 db of the average, ambient, sound-pressure level of the test site, use an anechoic chamber that has an ambient, sound-pressure level at least 10 db below that of the item being tested, and always at least 10 db below the criteria. (NOTE: See TOP 4-2-822 for converting db, psi, and kPa.) Where applicable use a windscreen when testing in wind velocities of 9 km/hr (6 mph) or more, but measurements shall not be made at velocities of 19 km/hr (12 mph) or more. (Exception: For aural-nondetectability measurements the use of conventional background-noise corrections is permitted. See ANSI S1.13.)[2/]

2.1.2 Interior-Noise Tests. The following courses are required:

a. Vehicle course: A smooth, straight, paved road, that is level (1% grade) and free of all loose gravel or other foreign matter; long enough to allow the vehicle to accelerate by 10 km/hr increments to the maximum speed tolerated by the vehicle, operator, or track in all forward gears and to maintain that speed for at least 30 seconds; and free of all sound-reflecting surfaces for a distance of 30 m on each side. For tracked vehicles without rubber pads, a similar course of compact earth having a cone index in the range of 100 to 150 is required unless otherwise specified.

b. Watercraft course: A body of water of sufficient area and smoothness to permit normal operation and maneuvering of the craft at maximum operational speeds. For pass-by tests, the area must be free of large obstructions (large piers, breakers, etc.) for a minimum of 30 m from the course the craft is to follow. Place three marker buoys in a straight line 15 m (50 ft) apart to mark the course.

2.1.3 Exterior-Noise Tests of Moving Equipment. These tests require a smooth, straight, paved road that is level (1% grade) and free of all loose gravel or other foreign matter; at least 60 m (200 ft) in length; and free of all sound-reflecting surfaces for 30 m on each side. For tracked vehicles without rubber pads, a similar course of compact earth having a cone index in the range of 100 to 150 is required unless otherwise specified. Measurements are not made when either the road surface or measurement surface is wet, covered with snow or ice, or during precipitation, unless requested by the test sponsor.

2.1.4 Aural-Nondetectability Tests for Steady-State Noise. For these tests select an open area of uniform grade; with a uniform, flat, grass surface free of tall vegetation, snow, or other sound-absorbing materials; and free of sound-reflecting surfaces for a radius of at least 80 m (260 ft) from the center of the area. For stationary tests of extremely low-noise-level items, use an anechoic chamber.

2.1.5 Speech-Intelligibility Tests. When possible, use the natural environment of the test item (i.e., its normal position of intended use) when testing against speech-intelligibility criteria. One of the following will usually be required:

a. Open-field facility: An open field, free of all large buildings or high hills that would reflect or block sound energy, and having an ambient-sound level equal to or below 50 db(A).

b. Closed-room facility: A room or chamber similar in acoustic characteristics to the location in which the test item is used. Vehicle-communication sets are tested in the vehicle(s) in which they are intended to be used. The ambient noise will vary with respect to the facility, and if no facility is specified, use 50 db(A) as the maximum allowable, ambient-pressure level.

2.1.6 Air-Conditioner Tests. These tests require a chamber with an acoustical tile ceiling and a movable wall to provide a room of the size for which the air conditioner was designed. The room should be empty except for sound-measuring instrumentation and electrical heater banks.

2.1.7 Firing Tests. Select a range to suit the type of weapon and firing or detonation requirements.

2.2 Instrumentation.

ITEM	MAXIMUM PERMISSIBLE ERROR OF MEASUREMENT*
Steady-state noise-measuring system (2.2.1 below)	±2 db from 20 Hz to 18 kHz

*Values may be assumed to represent ±2 standard deviations; thus, the stated tolerances should not be exceeded in more than 1 measurement of 20.

ITEM (CONT'D)	MAXIMUM PERMISSIBLE ERROR OF MEASUREMENT (CONT'D)
Impulse-noise-measuring system (2.2.2 below)	Peak pressure level to ±1 db, A-duration, B-duration to ±10%
Sound-level calibrator	Calibration signals to ±0.3 db
Tachometer (engine speed)	0 to 5000 rpm, ±2% full-scale range
Meteorological equipment:	
Wind speed	0 to 9 m/s, ±0.8 m/s (0 to 20 mph, ±1-3/4 mph)
Wind direction	±3°
Ambient temperature	-35° to +50° C, ±0.2° C (-31° to 122° F, ±3° F)
Relative humidity	5% to 100% RH, ±3%

2.2.1 Steady-State Noise System.

a. Microphones: Microphones shielded against wind effects, having an essentially flat response at grazing incidence (90°) should be used. Microphones having an essentially flat response at normal incidence (0°) can be used only with the addition of a random-incidence corrector. They must have a flat frequency response between 20 Hz and 18 kHz.

b. Sound-level meters: Conforming to the requirements for type 1 as specified by ANSI S1.4.3/

c. Octave-band filter sets: Conforming to the requirements for type E, class II as specified by ANSI S1.11.4/

d. Magnetic tape recorder: Having a flat frequency response from 20 Hz to 18 kHz (2 db).

2.2.2 Impulse-Noise System.

a. Microphones must have a flat dynamic response of ±2 db over the frequency range of 20 Hz to 70 kHz. Microphones having the appropriate dynamic range, rise-time characteristics and suitable conditioning electronics, should be used for measurements up to approximately 170 db. Procedures for measuring 171 db and above (such as muzzle blast from weapons) are described in TOP 4-2-822.

b. Air-pressure transducers (i.e., pressure gages), such as those described in TOP 4-2-822, are required for peak-pressure measurements 171 db and above.

c. A frequency-modulated (FM), magnetic-tape recorder, having a frequency response up to 80 kHz (±0.5 db) is required.

d. An oscilloscope with means to record the display output is required.

2.2.3 Alternate-Noise Instrumentation. Any sound-recording devices, components, or combinations of instrumentation used as part of or in lieu of the above items shall conform to ANSI S6.1[5/] and applicable provisions of ANSI S1.4.

3. REQUIRED TEST CONDITONS.

3.1 Safety.

a. All personnel exposed to hazardous noise or blast levels must wear hearing protection as required by Chapter 4, Section IV of AR 40-5[6/] or equivalent as prescribed by the pertinent SOP. Personnel who will be occupationally exposed to steady-state noise levels of 85 db(A) or greater or peak-pressure levels of impulse noise above 140 db shall also be entered in a hearing-conservation program as outlined in TB Med 501.[7/]

b. During tests neither the operator nor crew members shall occupy the location(s) where the noise is being measured unless they are essential to the operation of the test item and the hearing protection provided is capable of reducing the expected noise to nonhazardous levels. (See Paragraph 5.4.1.1, Table 5 and Figure 5 of MIL-STD-1474B (MI).[8/]

3.2 Facilities.

a. Facilities shall meet the requirements specified in Paragraph 2.1.

b. There shall be a sketch made showing location and orientation of test item and microphone or transducers with respect to the test site.

c. Tests will be conducted with the test item configured and operated as expected during field training or combat conditions.

d. If equipment requires an external power generator or other similar aids, the test will be conducted with all appropriate subsystems operating.

3.3 Instrumentation.

a. Appropriate instrumentation will be selected from that listed in Paragraph 2.2.

b. All instrumentation used shall have a valid calibration certification. Make an instrumentation-alignment check at the test site before, during, and immediately after the test by measuring a sound of known frequency and sound-pressure level using the microphone and recording system installed.

c. When the presence of one or more operators is required, the sensing transducer will be mounted 150 mm (6 in.) from the ear of each person: for impulse-noise measurements - 150 mm from the ear closest to the noise source and on a straight line between the ear and the noise source; for measurements of steady-state noise - 150 mm to the right of the right ear. If a wall or other reflecting surface is less than 300 mm (12 in.) from the ear, the microphone will be positioned equidistant from the ear and that surface.

With no operator present, measurements shall be made at the center of expected head positions. For standard test purposes, this position will be 1.5 m (60 in.) above the ground plane for standing personnel and 800 mm (31.5 in.) above the seat for seated personnel.

3.4 Test Item.

3.4.1 Vehicles.

a. Equip all vehicles with a calibrated tachometer.

b. When possible select new vehicles for the test--vehicles that have completed the prescribed break-in time. Inspect for normal operation in accordance with the appropriate specification and to insure that all auxiliary equipment, in continuous use when the vehicle is in motion, is installed and operating normally.

c. Load all load-carrying vehicles (trucks, trailers, forklifts, etc.) with two-thirds of their usual rated payloads.

d. Install all panels, canvas, louvers, and equipment used on the vehicle.

e. Check and adjust tire pressure or track tension to that prescribed for the load.

3.4.2 Stationary Equipment.

a. All safety equipment such as guards, mufflers, and warning devices shall be installed.

b. All noise-producing, auxiliary equipment, normally used with the test item, shall be installed.

3.5 Environment.

a. Ambient noise level for steady-state noise tests shall be at least 10 db below the noise being measured; for impulse-noise tests, 25 db below the noise being measured.

b. Tests shall not be conducted when wind exceeds 5.4 m/s (12 mph), or during precipitation. Microphones shall be shielded from wind effects under all conditions.

c. When the ambient temperature changes more than 3° C (5° F) during the conduct of the test, an instrumentation-alignment check (step 3.3b) shall be made after each series of measurements.

3.6 Data Requirements.

a. Prepare an acoustical test-data form similar to the sample data sheet presented in Appendix B and appropriate for the specific test planned.

b. Record information on the test item, the time and place of test trials, and the conditions under which the test is to be conducted. (See upper section of data sheet in Appendix B.)

4. TEST PROCEDURES.

4.1 Steady-State Noise Tests. For test purposes, steady-state noise is defined as a periodic or random variation in atmospheric pressure at audible frequencies. It may be continuous, intermittent, or fluctuating, with the sound-pressure level varying over a wide range, provided such variations have a duration exceeding one second. This definition is taken from MIL-STD-1474B(MI), Paragraph 3.16.

4.1.1 Methods.

4.1.1.1 Noise Tests of Stationary Equipment.

a. Generators, pumps, heaters, and other power equipment.

(1) Place microphones at the approximate centers of the probable head positions of all operating personnel and at positions 1.5 m from each side and each end of the test item, 1.5 m above the ground plane.

(2) Operate equipment in a manner most descriptive of its normal operating condition and record db(A), db(C), and octave-band pressure levels at all microphone locations. When the noise generated by operating conditions varies due to load, speed, or other reasons, conduct the test under that condition which produces the highest noise level.

(3) When the operating noise level is 85 db(A) or greater at a distance of 1.5 m, determine the distances and directions from the noise source at which the noise level is equal to 85 db(A). Make as many readings as necessary to accurately plot an 85-db(A) contour curve (Paragraph 5.1).

b. Vehicles.

(1) Place microphones 150 mm to the right of the driver's right ear and at the center of the probable head locations of the assistant driver, crew members, and passengers.

NOTE: When the occupants consist of a group of five or more persons in vehicles such as personnel carriers and buses, a noise survey will be made of all occupied spaces, and five positions covering the range from the highest to the lowest noise levels will be selected to represent the noise level for the entire crew.

(2) If an 85-db(A) contour curve around the exterior of the vehicle is required, place microphones on 30° radials around the vehicle, using at least 3 microphones per line with at least 1 microphone located at a higher than 85-db(A) location, and at least one at a lower than 85-db(A) location. (See also Paragraph 4.1.1.1a(3) above.)

(3) Operate the vehicle at idle and at two-thirds of the maximum-rated engine rpm. Operate vehicles having torque converters at their maximum, attainable, governed speed at torque-converter stall conditions. Observe appropriate limitations on idle and stall operations to prevent overheating or damage.

(4) Record db(A), db(C), and octave-band pressure levels at all interior microphone locations with windows open and again with windows closed.

(5) Make additional noise measurements as necessary at all crew positions in the vicinity of any auxiliary equipment, such as heaters, blowers, and hydraulic pumps, with engine idling.

c. Air Conditioners.

(1) Mount the air conditioner so that the grille is 1.22 m (48 in.) from the floor and centered in one end of the wall of the air-conditioner test facility, with the evaporator side protruding at least 102 mm (4 in.) inside the wall (Figure 1).

(2) Record the sound-pressure level at three locations inside, and three locations outside the test chamber as follows:

Inside: On a centerline perpendicular to the evaporator grille, 30° to the left, and 30° to the right of that centerline. All positions are 1.22 m from the center of the grille and 1.22 m above the floor.

Outside: On a centerline perpendicular to the condenser grille, 45° to the left, and 45° to the right of that centerline. All positions are 1.22 m from the center of the grille and at a height on line with the center of the grille.

(3) Operate the air conditioner at its maximum cooling capacity (coldest temperature setting and maximum blower speed) and record db(A), db(C), and octave-band pressure levels at each microphone location.

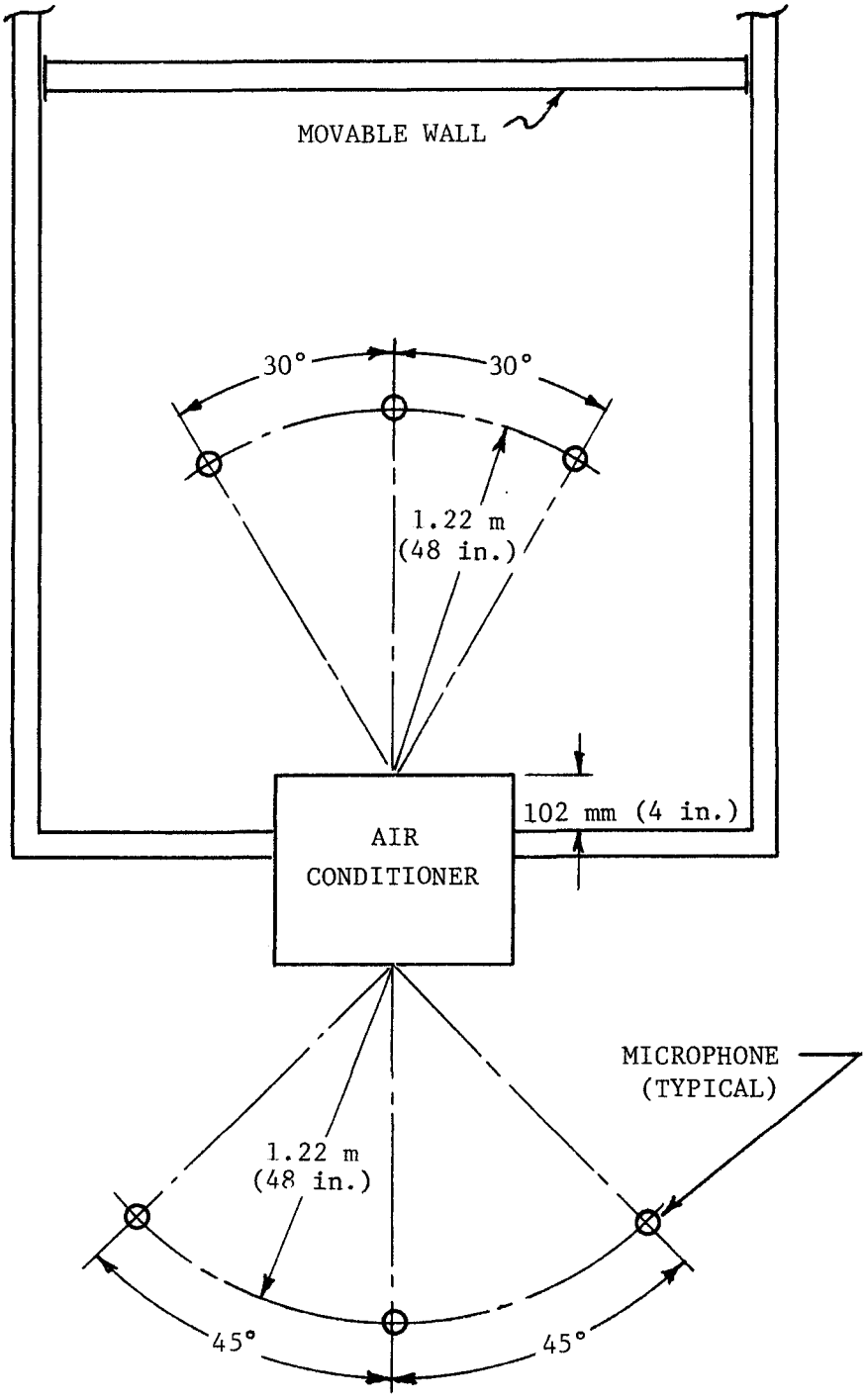


Figure 1. Air-Conditioner Test Setup.

4.1.1.2 Interior-Noise Tests of Moving Equipment.

a. Wheeled vehicles.

(1) Place microphones 150 mm to the right of the driver's right ear and at the center of the probable head position of the assistant driver, and at all positions normally occupied during field use. For vehicles expected to carry more than five persons, place microphones at five representative positions selected as a result of a noise survey conducted as described in Paragraph 4.1.1.1b(1) NOTE, but with the vehicle moving over a paved test course.

(2) Operate the vehicle in 10 km/hr increments to the maximum speed tolerated by the vehicle, operator, or track in the highest gear, over a paved test course (Paragraph 2.1) with any auxiliary equipment that adds to the overall noise level (e.g., heaters, blowers, air conditioners) in operation. Additional measurements may be made in all other gears at two-thirds of maximum or posted vehicle speed for that gear.

(3) Record db(A), db(C), and octave-band pressure levels at each microphone location for each gear range with the windows or hatches both open and closed.

b. Tracked vehicles. Conduct the test as in Paragraph 4.1.1.2 above except that when the tracks are without rubber pads, operate the vehicles on compact earth (Paragraph 2.1.2a).

c. Small watercraft. (Applies to craft having fixed positions for crew and passengers and sound generated only by the propulsion unit.)

(1) Place a microphone at the approximate ear positions of the operator, each crew member, and each passenger.

(2) Operate the craft in calm water - 150 mm waves or less - at five evenly spaced speed increments from slow to maximum.

(3) Record db(A), db(C), and an octave-band analysis at each microphone location for each speed.

d. Large watercraft. (Applies to vessels with multiple sources of noise.)

(1) Operate the vessel in waters not to exceed moderate seas - 1-m (3-ft) waves or less - at varying speeds up to and including top speed (flank).

(2) Conduct a noise survey of the pilothouse, crew compartment, engine rooms, and work areas under all conditions of vessel

operation, using a sound-level meter. With all special equipment normally used in that compartment operating, determine positions of maximum noise.

(3) Place a microphone in the area of maximum noise of each compartment and record the db(A), db(C), and octave-band analysis for the condition-of-vessel operation that produces the most noise.

(4) When cargo-handling, vehicle-movement, or pumping operations are part of the normal working operation of the vessel, conduct a separate test of each of these operations while the vessel is moored.

4.1.1.3 Exterior-Noise Tests of Moving Equipment (Drive-By).

a. Motor vehicles.[9/]

(1) Place a marker on the centerline of the vehicle path. At a point farther down the path and 15.2 m to one side of the centerline, place a microphone. For vehicles wider than 2.75 m (9 ft) measure the 15.2-m distance from the side of the vehicle closest to the microphone.

(2) Set the sound-level meter for fast response on the A-weighted network.

(3) In a gear that will allow the vehicle to reach maximum engine speed, operate the vehicle in 10 km/hr increments to the maximum speed tolerated by the vehicle, operator, or track by the time it reaches the marker. At the marker start accelerating so as to reach maximum engine speed 18.3 to 30.5 m farther down the path.

(4) Observe the sound-level meter during the period that the vehicle is accelerating and record maximum db(A) values as the vehicle is driven past the microphone. The applicable reading is the highest sound level obtained for the run (ignoring peaks caused by extraneous ambient noises).

(5) Make at least three measurements on each side of the vehicle unless it becomes obvious after the first run that one side is definitely higher in sound level. Report the sound level for the side of the vehicle with the highest readings.

(6) Report the sound level as the average of the two highest readings that are within 2 db of each other.

b. Powered mobile-construction equipment. (From SAE Procedure J-366b; for further details see SAE J88a.)[10/] Conduct this test using the same procedure as in Paragraph 4.1.1.3a above except:

(1) Place the microphone 15.2 m from, and perpendicular to, the longest side surface of the equipment being tested (Figure 3),

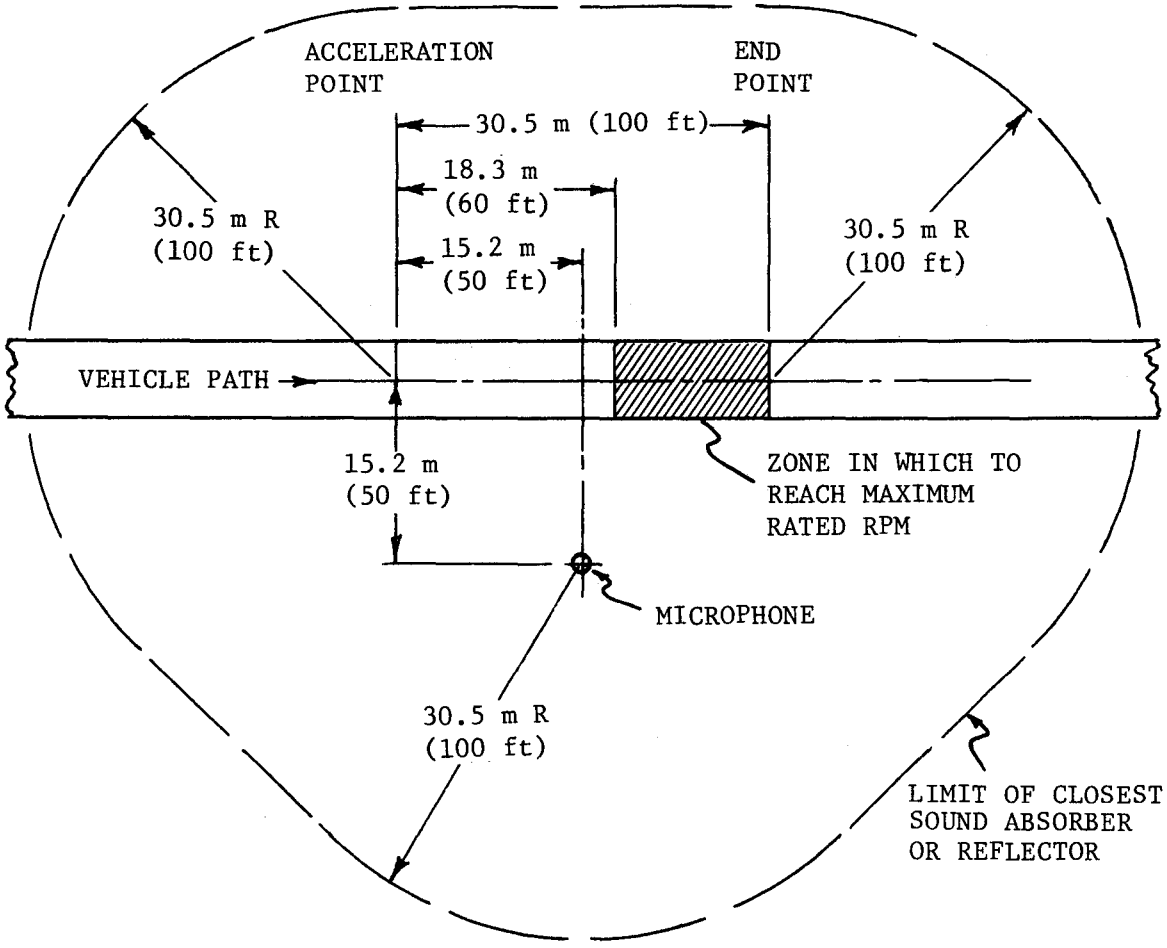


Figure 2. Motor Vehicle Drive-by Noise Test.

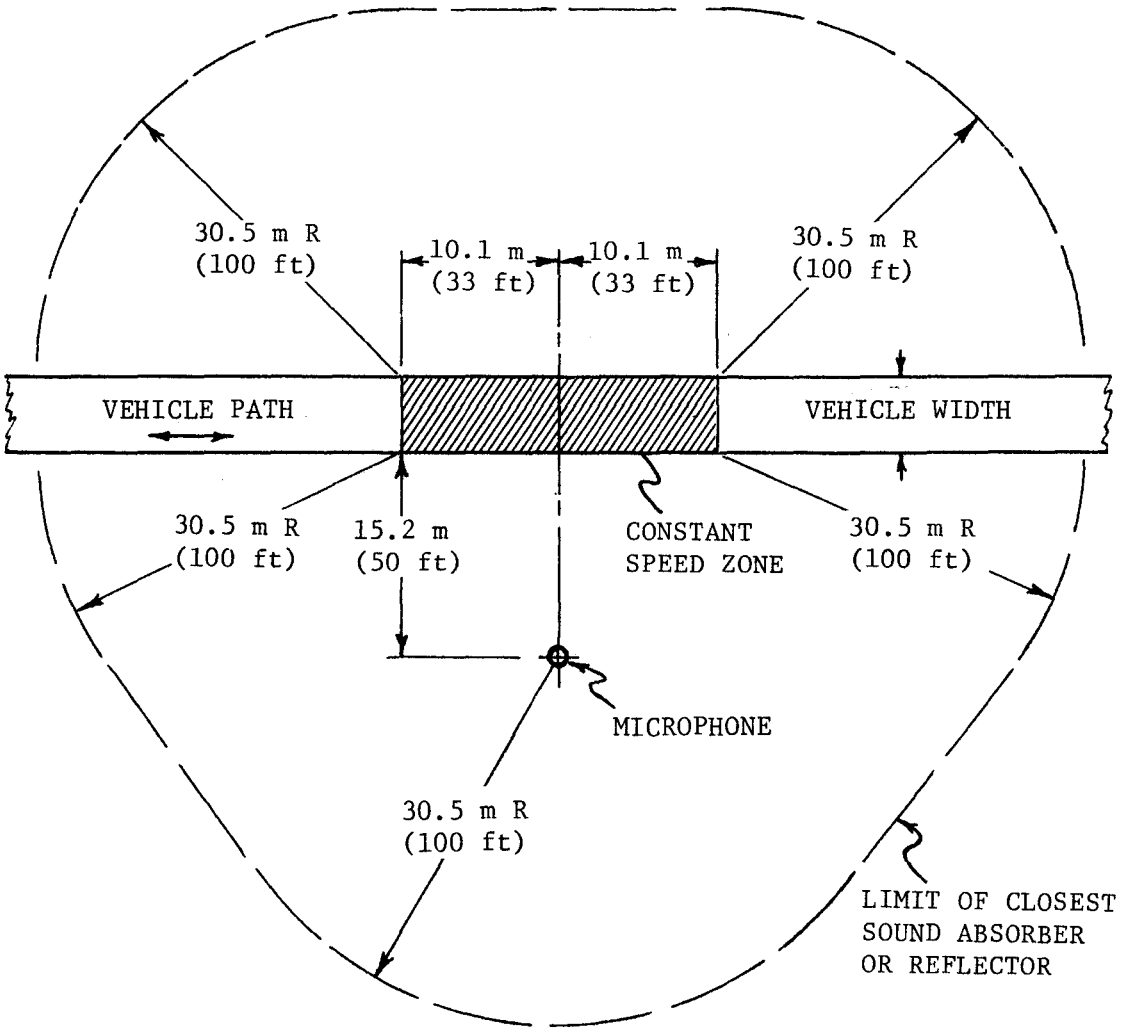


Figure 3. Powered Mobile-Construction-Equipment, Drive-by Noise Test. (From SAE J88a.)

1.2 m above the ground plane.

(2) Operate self-propelled equipment in a forward, intermediate gear over the prescribed course (Figure 3) at full-governed-engine speed. Operate hydrostatic or electrically driven equipment as nearly as possible to one-half its maximum ground speed.

(3) Test scrapers, spreaders, water distributors, and other equipment having major noise-generating machinery with that machinery in operation.

c. Watercraft. (From SAE Procedure J34a.)[11/]

(1) Place a microphone 25 m (82 ft) from the line described by three course markers (Paragraph 2.1.2b) on a dock, a floating platform, or another boat. Position the microphone so that it is perpendicular to the line of markers, opposite the center marker at 1.2 to 1.5 m (4 to 5 ft) above the water surface, and not closer than 0.6 m (2 ft) to the surface of the dock or platform on which the microphone stands.

(2) Set the sound-level meter for fast response on the A-weighting network.

(3) Operate the craft so that it passes within approximately 0.5 to 1 m of the far side of all three markers with the engine operating at the midpoint of the full-throttle rpm range recommended by the manufacturer.

(4) Observe the sound-level meter while the craft is passing the markers and record the maximum db(A) reading.

(5) Make at least three measurements for each side of the craft.

(6) Report the sound level for each side of the craft using the average of the two highest readings.

4.1.1.4 Aural-Nondetectability Tests. Select from Table 1 a measurement distance that corresponds to the nominal-nondetectability range desired or requested by the requirements document. Unless otherwise specified, the octave-band-pressure levels measured at the "measurement distances" must not exceed those values listed in the table for any band if nondetectability is to be achieved at the corresponding distances. If the ambient noise is less than 10 db below the level of the test item, the use of conventional, background-noise corrections is permissible (ANSI S1.13). If the test item is small and meets the safety requirements, the test may be conducted in an anechoic chamber. When measuring the noise of a large item at close distances, the measurement distance must be more than three times the major dimension of the item.

Table 1 - Limiting Octave-Band Levels (db) for Aural Nondetectability*

Nominal Nondetectability Distance (meters)	Measurement Distance** (meters)	Center Frequency (Hz)							
		63	125	250	500	1K	2K	4K	8K
5	1-1/4	48	34	32	32	32	32	32	32
10	2	50	36	34	34	34	34	34	34
20	2	56	42	40	40	40	40	40	41
30	2	60	46	44	44	44	44	44	45
100	6	60	46	44	45	45	45	47	48
200	10	62	48	46	46	47	48	51	53
300	10	66	52	50	50	51	53	57	61
400	15	65	51	49	49	50	53	58	64
500	20	64	50	48	49	50	53	60	67
750	25	66	52	50	51	53	58	68	78
1000	25	68	54	52	54	57	63	77	90
1250	25	70	56	54	56	60	67	85	102
1500	25	72	58	56	59	63	72	93	113
2000	25	74	60	58	62	68	80	108	135
4000	25	80	66	64	72	84	108	NA	NA
1000	50	62	48	46	48	51	56	70	83
2000	50	68	54	52	56	62	73	102	128
3000	50	72	58	56	61	70	88	131	NA
4000	50	74	60	58	66	78	102	NA	NA
5000	50	76	62	60	70	85	114	NA	NA
6000	50	78	64	62	73	91	127	NA	NA

*From MIL-STD-1474B(MI).

**Slant range from noise source to microphone.

a. Vehicle stationary - silent watch.

(1) Place a microphone 1.2 m above the ground plane at a measurement distance selected from Table 1.

(2) Record the ambient, sound-pressure levels in each octave band with the vehicle completely silent.

(3) Place the vehicle in a silent-watch condition; i.e., radio, rangefinder, and other electronic euqipment turned on and all other noise-producing devices or equipment turned off.

(4) Make a noise survey around the vehicle using a portable sound-level meter to determine that side which produces the maximum noise. Orient the vehicle so that the noisiest side faces the microphone, and record the sound-pressure levels in each octave band.

b. Vehicle stationary - combat readiness. Repeat the procedure described in a above with the vehicle engine at idle and all heaters, weapon systems, and electronic instruments operating.

c. Vehicle moving.

(1) Place the microphone in the center of a 50-m (164-ft) radius circle and record the ambient, sound-pressure level in each octave band.

(2) Operate the vehicle in both clockwise and counterclockwise directions at speeds of 5, 10, 15, 20, 25, 30 km/hr, and record the sound-pressure level in each octave band.

NOTE: If there are variations in the sound-pressure level with respect to vehicle position on the course, use only those positions producing the highest readings to determine the nondetectable distance.

d. Equipment at idle (standby condition).

(1) Place the microphone at the selected distance from the test item. While the item is completely silent, record the ambient sound-pressure level in each octave band.

(2) Turn the equipment to its lowest operable condition (idle) and again record the sound-pressure level in each octave band.

NOTE: Orient the test item so that the side of the test item generating the highest noise level is facing the microphone. Make an octave-band analysis at this point.

e. Equipment at maximum working condition. Use the procedure described in d above except operate the test equipment at its normal maximum-load condition. EXCEPTION: If, by reducing or increasing the speed or working condition of the test item, the noise level increases, conduct the test at that speed or condition that produces higher noise levels unless detrimental to the test item to do so.

4.1.1.5 Speech-Intelligibility Tests. For equipment that requires effective oral communication among crew or passengers for field employment, a speech-intelligibility test may be necessary. Such a test is particularly important if the sound-pressure levels recorded at each significant crew or passenger position (as determined in accordance with Paragraphs 4.1.1.1 through 4.1.1.4 above) approach or exceed the noise limits stated in Section 5.1.1 of MIL-STD-1474B(MI) as reproduced in Tables 2 and 3.

When required, conduct the speech-intelligibility test as described in TOP 1-2-610.[12/]

TABLE 2

STEADY-STATE NOISE CATEGORIES

System Requirement	Category
No direct person-to-person voice communication required. Maximum design limit. Hearing protection required.	A
System requirement for electrically aided communication via attenuating helmet or headset. Noise levels are hazardous to unprotected ears.	B
No frequent direct person-to-person voice communication required. Occasional shouted communication may be possible at a distance of one foot. Hearing protection required.	C
No frequent direct person-to-person voice communication required. Occasional shouted communication may be possible at a distance of two feet. Levels in excess of Category D require hearing protection.	D
Occasional telephone or radio use or occasional communication at distances up to 1.5 m (5 ft) required. (Equivalent to NC-70.)	E*
Frequent telephone or radio use or frequent direct communication at distances up to 1.5 m (5 ft) required. (Equivalent to NC-60.)	F*

*For design of mobile or transportable systems. For fixed plant facilities, see MIL-STD-1472.

NOTE: Categories A, B, C, and D are based primarily on hearing conservation priorities, while the remaining categories are based primarily on communication requirements.

TABLE 3

STEADY-STATE NOISE LIMITS FOR CATEGORIES OF PERSONNEL-OCCUPIED AREAS *

Octave Band Center Frequency	A**	B**	C**	D**	E***	F***
63 Hz	130 db	121 db	111 db	106 db		
125	119	111	101	96		
250	110	103	94	89		
500	106	102	88	83		
1000	105	100	85	80		
2000	112	100	84	79		
4000	110	100	84	79		
8000	110	100	86	81		
db(A) Criteria	108	100	90	Less Than 85	75	65
Alternate PSIL-4 Criteria					67	57

NOTE: For conversion of preferred frequencies to commercial frequencies, see ANSI S1.11.

*From MIL-STD-1474B(MI)

**In those cases where the mission profile for the equipment being developed exceeds eight hours of operation in each 24 hours, the limits specified in Categories A, B, C, and D shall be reduced sufficiently to allow for an exposure for longer than eight hours, as approved by the procuring activity in conjunction with the Surgeon General's Office, HQDA, DASG-PSP, Washington, DC 20314.

***Criteria in Categories E and F are defined by either the sound level in db(A) or the preferred speech interference level (PSIL-4). The db(A) sound level is the desired requirement. Where it is not possible to meet the specified db(A) level, the corresponding PSIL-4 level requirements shall be met.

4.1.1.6 Typical-Duty-Cycle Tests. When the typical-duty-cycle noise level is specified by the requirements document, determine the equivalent continuous noise level (L_{eq}) (sic) of the test item as described in MIL-STD-1474B(MI).

4.1.2 Data Required. Record the following data for each test, completing the form prepared earlier (Paragraph 3.6).

a. Test-item nomenclature and identification data.

b. Test-item condition (e.g., hatch position, with or without muffler, percent load, speed, etc.).

c. Test site (surface, terrain, etc.).

d. Type of test (stationary, highway, drive-by, etc.).

e. Meteorological data (temperature, humidity, barometric pressure, sky cover, wind direction, and velocity).

f. Nomenclature, model and serial numbers, and manufacturer of all instruments used.

g. Name of test conducter and equipment operator.

h. Microphone locations.

i. Sound levels in db(A), db(C), and in each octave band.

j. Noise-contour data (distances and directions from the equipment at which the specified noise limit is measured).

4.2 Impulse-Noise Tests. For test purposes, impulse noise is defined as a short burst of acoustic energy consisting of either a single impulse or a series of impulses. The pressure-time history of a single impulse includes a rapid rise to a peak pressure, followed by a somewhat slower decay of the pressure envelope to ambient pressure, both occurring within 1 second. A series of impulses may last longer than 1 second. The following data are required for the evaluation of impulse noises:

a. Peak pressure level in db or psi.

b. A-duration (Pressure-Wave Duration) - The time required for the pressure to rise to its principal positive peak and return momentarily to ambient pressure. (See MIL-STD-1474B(MI) for additional information.)

c. B-Duration (Pressure-Envelope Duration) - The duration of the primary portion of an impulse noise plus the duration of significant subsequent fluctuations. These durations are considered to be the time interval during which the envelope of pressure fluctuations (positive and negative) is within 20 db of the peak-pressure level. Significant subsequent pressure fluctuations are those whose summed duration is greater than 10% of the duration of the primary portion. The primary portion of an impulse noise is that period of time which is followed by a level which remains 20 db below the peak-pressure level for a significant duration. (See Paragraph 50 in the appendix of MIL-STD-1474B(MI) for a more detailed explanation.)

4.2.1 Methods. The procedures below apply to all impulse-noise tests that follow:

a. Select appropriate instrumentation in accordance with Paragraph 2.2. When the expected pressure levels are 170 db and below, use fast-response microphones. When the expected pressure levels are 171 db and above, follow procedures of TOP 4-2-822.

b. Record impulse noises using one of the following techniques:

(1) Photograph the trace obtained on a cathode-ray oscilloscope connected to the transducer system.

(2) Record the impulse noise with an FM tape recorder having a flat (0.5 db) frequency response up to at least 40 kHz. (If speed-reduction techniques and direct-readout devices are used in the analysis of the recorded noise data, the frequency-response characteristics of the devices must be at least proportionally equivalent to the characteristics of the recording device.)

c. Measure peak-pressure level and B-duration from data recorded during firing of at least 3 rounds. If the extreme spread of peak-pressure level exceeds 3 db, then additional rounds will be fired until the number of rounds equals or exceeds the extreme spread in db. Use the mean peak pressure and B-duration.

d. Use procedures below to map a 140-db noise-contour curve:

(1) Encircle the test item with transducers placed 1.5 m above the ground as close to the test item as is considered safe (in accordance with associated guidance documents, with one transducer on each 30° radial centered at the test item (Figure 4). If the weapon can be considered symmetrical, measurements may be made on one side only.

(2) Place a second series of transducers twice the distance away from the noise source as the first transducers, a third series of transducers twice the distance as the second, and finally a fourth series of transducers twice the distance as the third. From this configuration of transducers, a 140-db noise-contour curve around the test item can be predicted by interpolation.

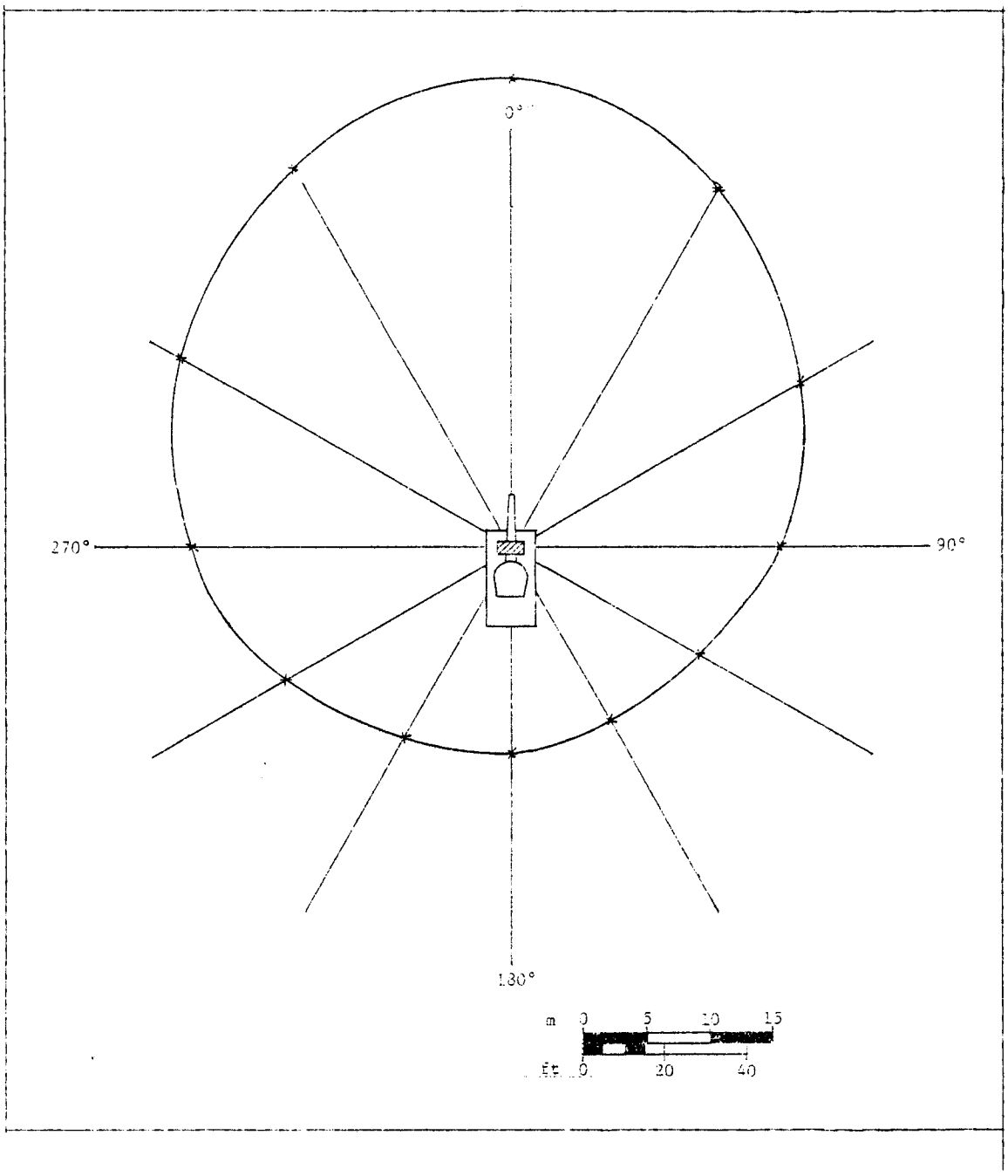


Figure 4. Typical 140-db Contour Curve for a Cannon-Fire Simulator Mounted on a Tank Gun Tube.

4.2.1.1 Weapon-Firing Tests. The following tests are conducted on an appropriate firing range (Paragraph 2.1.7). Unless otherwise stipulated, all weapons are positioned under realistic conditions comparable to those employed in combat or training missions. For weapons with various charges (e.g., separately loaded artillery ammunition), the charge that produces the highest peak-pressure level will be measured, in addition to those charges producing lower levels. Where impulse noise emanates from the rapid burning of a propellant, measurements should also be taken with the round at the upper and lower operating-temperature conditions specified by system requirements.

a. Hand-held and shoulder weapons.

(1) Mount hand-held and shoulder weapons in a test-firing fixture with their barrels or tubes 1.5 m above and parallel to the ground plane when practical.

(2) Mount one sensing transducer at the center of the probable head position of the operator and another sensing transducer 2 m (6 ft) to the left or right of the major noise source of the weapon (e.g., perpendicular to the muzzle for closed-breech systems, and perpendicular to the rear for rocket launchers) at the same height as the major noise source.

(3) Remotely fire 3 rounds, allowing enough time between rounds for the noise pulses from the preceding round to decay to ambient before the next round is fired. When automatic weapons are tested, it may be necessary to load the weapon one round at a time.

(4) Record peak pressure, A-duration, and B-duration for each round as outlined in Paragraph 4.2.1c.

b. Rifle with grenade launcher.

(1) Mount the rifle in a test-firing fixture with the rifle butt resting on the ground and the barrel elevated to its maximum safe position for launching grenades.

(2) Mount one sensing transducer at the center of the probable head position of the operator and another transducer 2 m to the left or right of the muzzle at the same height as the muzzle.

(3) Launch at least 3 grenades and record the peak pressure, A-duration, and B-duration of each launching as outlined in Paragraph 4.2.1c.

c. Machine guns (tripod-mounted).

(1) Mount the machine gun in a test-firing fixture representative of its normal tripod-mounting condition.

(2) Mount a sensing transducer at the center of the probable head position of each crew member, and mount another sensing transducer 2 m to the left or right of the muzzle at the same height as the muzzle.

(3) Fire at least 3 separate rounds with enough time between rounds for the pulse envelope to decay to ambient before the next round is fired. Record peak pressure, A-duration, and B-duration in accordance with Paragraph 4.2.1c.

d. Recoilless rifles.

(1) Mount the recoilless rifle in a firing fixture so that the tube is 1.5 m above and parallel to the ground plane, or in its tactical firing position (usually on a jeep).

(2) Mount a sensing transducer at the center of the probable head position of each crew member (gunner and assistant gunner), and another transducer 2 m to the left or right of the muzzle at the same height as the muzzle. Mount additional sensing transducers at as many positions around the weapon as necessary to describe the 140-db noise-contour curve (Paragraph 4.2.1d).

(3) Fire at least 3 rounds and record peak-pressure level, A-duration, and B-duration at the crew positions and the peak pressures around the test item to establish the 140-db noise-contour curve.

e. Mortars. (See TOP 4-2-822.)

(1) Position the weapon for remote firing so that the mortar tube is facing down range.

(2) Mount a sensing transducer at the center of the probable head position of each crew member; mount another sensing transducer 2 m to the left or right of the muzzle at the same height as the muzzle; and mount additional sensing transducers at as many locations as necessary to accurately describe the 140-db noise-contour curve (Paragraph 4.2.1d).

(3) Conduct tests with the weapon positioned at both the minimum and maximum safe-tube elevations.

(4) Fire at least 3 rounds, and record the peak-pressure level, A-duration, and B-duration at the crew positions and the peak pressures around the test item to establish the 140-db noise-contour curve.

f. Small arms mounted in vehicles.

(1) Mount the weapon in or on the vehicle as it would be under normal combat or training conditions.

(2) Position the vehicle to create the most severe noise conditions with respect to the crew members (e.g., gun firing directly over the hatch of a crew member) when firing the weapon down range.

(3) Mount a transducer at the center of the probable head position of each crew member while in a seated position.

With the vehicle hatches closed, fire the weapon and record sound-pressure level, A-duration, and B-duration at each crew position.

Repeat the above test with the hatches open.

(4) Mount a transducer at the center of the probable head positions of all crew members, simulating their heads protruding from an open hatch. Fire the weapon and record the sound-pressure level, A-duration, and B-duration at each crew position.

g. Towed Artillery.

(1) Position the weapon on an appropriate range in the same manner as it would be used for the training of personnel. (See TOP 4-2-822 also.) The weapon will be tested at minimum QE, at medium QE, and at the maximum QE (within range safety limits) of the weapon.

(2) Mount a sensing transducer at the center of the probable head position of each crew member and instructor, and mount additional sensing transducers at as many locations around the weapon as necessary (See TOP 4-2-822 also) to accurately construct a 140-db noise-contour curve (Paragraph 4.2.1d).

(3) Fire the weapon as many times as necessary (See TOP 4-2-822.), but at least 3 for each elevation to establish the peak pressure, A-duration, and B-duration for each transducer location in accordance with Paragraph 4.2.1c.

h. Self-propelled artillery (open mount).

(1) See TOP 4-2-822.

(2) Position the vehicle on an appropriate range so that the gun is facing forward with respect to the vehicle and down range. The weapon will be tested at minimum QE, at medium QE, and at the maximum QE within range safety limits of the weapon.

(3) Proceed with the test as in g above.

i. Self-propelled artillery (closed mount or turret).

(1) Position the vehicle on an appropriate range so that the gun is facing forward with respect to the vehicle and down range. Raise the muzzle to the elevation (within the range safety limits) that produces the highest noise level.

(2) Mount a sensing transducer at the center of the probable head position of each crew member while seated in the vehicle. Close all hatches during firing.

(3) Mount a sensing transducer 15.2 m to the left or right of the muzzle and 1.5 m above the ground plane (to represent an adjacent vehicle).

(4) Fire the weapon as many times as necessary, but at least 3, to establish the peak pressure, A-duration, and B-duration for each transducer location in accordance with Paragraph 4.2.1c.

j. Air defense weapons.

(1) Position the weapon on an appropriate firing range so that it is facing down range. Elevate the gun muzzle to the position (within the range safety limits) that produces the highest noise level achieved in normal firing.

(2) Mount sensing transducers at the center of the probable head positions of all crew members and operating personnel, and mount as many sensing transducers around the weapon as necessary to accurately map a 140-db noise-contour curve (Paragraph 4.2.1d) around the weapon.

(3) Fire the weapon as many times as necessary, but at least 3, to establish the peak pressure, A-duration, and B-duration for each transducer location in accordance with Paragraph 4.2.1c.

k. Tank Main Gun.

(1) Position the vehicle on an appropriate range so that the gun is facing forward with respect to the vehicle and down range. Raise the muzzle to the elevation (within the range safety limits) that produces the highest noise level.

(2) Mount a sensing transducer at the center of the probable head position of each member while seated in the vehicle. Close all hatches during firing.

(3) Mount a sensing transducer 15.2 m to the left or right of the muzzle and 1.5 m above the ground plane (to represent an adjacent vehicle).

(4) Fire the weapon as many times as necessary, but at least 3, to establish the peak pressure, A-duration, and B-duration for each transducer location in accordance with Paragraph 4.2.1c.

4.2.1.2 Explosive-Ordnance Tests. For these tests, noise-measuring efforts are concerned primarily with determining the area of noise hazard around the ordnance item rather than at an operator position.

a. Prepare explosive ordnance for tests as follows:

(1) Bury mines, or place mines on surface of an open field, in conformance with normal deployment.

(2) Support grenades in an open field 1.5 m above the ground plane.

(3) Place bombs nose down, on the surface of a field.

(4) Place or mount demolition charges in or on a simulated fixture for which the charges are designed, and 1.5 m above the ground plane.

b. Set the explosive ordnance for remote detonation.

c. Mount as many sensing transducers around the ordnance item as necessary to map a 140-db noise-contour curve (Paragraph 4.2.1d). Record the peak-pressure level, A-duration, and B-duration at each transducer location for as many detonations as considered feasible. The arithmetic averages of the peak-pressure level and B-duration for as many devices as were detonated will constitute the final results (see TOP 4-2-822 also).

4.2.1.3 Materiel Other Than Weapons and Explosive Ordnance. Items such as machinery (drophammers, jackhammers, etc.) and impact tools that produce impulse noises are tested not only against impulse-noise criteria, but also against steady-state criteria when appropriate. For impulse-noise tests, a minimum of five separate impulses is required to establish the arithmetic means of peak-pressure level and B-duration as described in Paragraph 4.2.1c.

a. Stationary machinery (e.g., drophammers). Since these test items are not portable, they may be tested within an enclosure, the most suitable of which is the room or area of intended use.

(1) Place sensing transducers at the center of the probable head positions of all operators, helpers, and maintenance and observer personnel.

(2) Mount as many transducers around the test item as necessary to accurately record and map a 140-db noise-contour curve of an item (Paragraph 4.2.1d).

(3) Operate the machine using the operation and material that cause the highest noise level.

(4) Make as many machine operations as necessary to assure completeness of noise data for the determination of peak-pressure level, B-duration, and the 140-db noise-contour curve.

b. Portable machinery (e.g., pneumatic hammers). Conduct these tests in an open area free of all reflecting surfaces and where the ambient sound-pressure level is at least 25 db below the values expected during the tests.

(1) Mount sensing transducers at the center of the probable head positions of the operator and all other personnel required in the area during the operation.

(2) Mount as many transducers around the setup as necessary to accurately record and map a 140-db noise-contour curve of the item (Paragraph 4.2.1d). Since noise levels would normally be expected to be about the same in all directions, transducers normally need to be located on only two radials.

(3) Operate the equipment using the operation and material causing the highest noise level and for as many operations as necessary to determine peak-pressure level, B-duration, and the 140-db noise-contour curve.

(4) If the portable machinery requires other equipment in support of its operation (such as generators or air compressors), test the supporting equipment also for its steady-state noise level as indicated in Paragraph 4.2.1.3 above.

4.2.2 Data Required. Record the following data (as applicable) for each test conducted (see also Paragraph 3.6):

a. Test item nomenclature and identification data.

b. Type of ammunition or explosive charge.

c. Test item condition (type mount, hatch-position mounting method, etc.).

d. Components and on-board equipment included.

e. Meteorological data (temperature, humidity, barometric pressure, sky cover, wind direction and velocity).

f. Nomenclature, model and serial numbers, and manufacturer of all instruments used.

g. Names of test conducter and equipment operator.

h. Microphone locations.

i. Peak-pressure level, A-duration, and B-duration measurements of impulse noise for each microphone location.

j. Noise-contour data (distance and directions from the test item at which 140-db peak is recorded).

5. PRESENTATION OF DATA.

5.1 Steady-State Noise.

a. Tabulate all direct-measurement data, using the data-collection sheet in Appendix B as applicable.

b. When data are recorded on magnetic tape, analyze the data in the laboratory for each specified requirement. If a requirement is not specified:

(1) Analyze the data for db(A), db(C), and octave-band sound levels in each of eight octave bands.

(2) Extract a portion of each test segment from the magnetic tape and plot a spectral analysis.

c. Present data taken for 85-db(A) contour curves as shown in Figure 5.

d. When required, compute the equivalent continuous noise level (L_{eq}) (sic) as described in MIL-STD-1474B(MI).

e. Compare the steady-state noise data with the limits for categories of personnel-occupied areas specified in MIL-STD-1474B(MI) or with any special noise criteria established for the system under test.

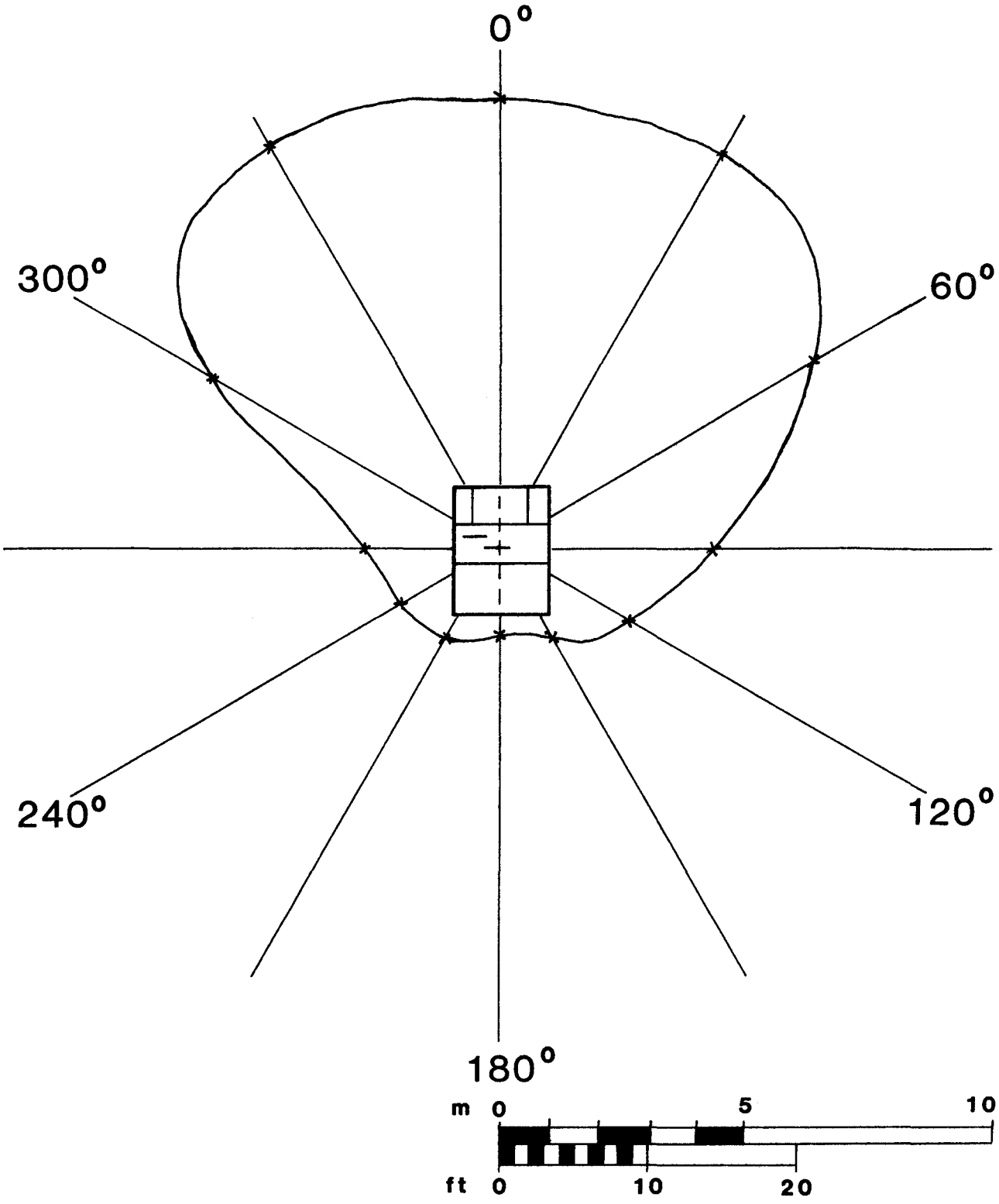


Figure 5. Typical 85-db(A) Noise-Contour Curve for a Military Vehicle.

f. Evaluate the noise condition for the following, as applicable:

(1) Minimum distance personnel may approach without hearing protection.

(2) Type of hearing protection required.

(3) Type of communication possible.

(4) Distance of probable communication.

(5) Speech intelligibility.

(6) Maximum detectable distance.

(7) Primary sources of noise (i.e., exhaust, tracks, etc.).

5.2 Impulse Noise.

a. Analyze copies of the oscilloscopic traces or the magnetic-tape record to determine peak-pressure level, A-duration, and B-duration. When speed-reduction techniques with direct-readout devices are used, the frequency-response characteristics of the devices must be at least proportionally equivalent to the characteristics of the recording device.

b. For systems that produce repetitive impulse, determine the number of impulses produced within the first 200 milliseconds. This number of impulses is multiplied by the average B-duration of single impulses to determine an effective B-duration, which is used to establish the maximum allowable peak-pressure level for the repetitive system.

c. Tabulate the data taken to determine safety conditions for personnel as shown in Figure 6. When making comparison noise tests between two types of weapons or ammunition, or determining whether a simulator is loud enough to represent the actual device, only peak-pressure levels are required and reported by round number.

d. Present data taken for 140-db contour curves as shown in Figure 4.

e. Compare the impulse-noise data with the limits for peak-pressure level and B-duration specified in MIL-STD-1474B(MI) with special requirements established for the system under test.

f. Evaluate the noise condition for the following, as applicable:

(1) Minimum distance personnel may approach the area without hearing protection.

Impulse-Noise Levels 20-mm Gun XM236

Crew Position No. 1				Crew Position No. 2			
Round	Peak Pressure Level (db)	"A" Duration* (ms)	"B" Duration* (ms)	Round	Peak Pressure Level (db)	"A" Duration (ms)	"B" Duration (ms)
1	152	0.7	111	1	146	1.0	141
2	153	0.8	106	2	145	1.2	137
3	151	0.9	101	3	146	0.9	135
4	152	0.7	107	4	145	1.1	131

Crew Position No. 3				Crew Position No. 4			
Round	Peak Pressure Level (db)	"A" Duration (ms)	"B" Duration (ms)	Round	Peak Pressure Level (db)	"A" Duration (ms)	"B" Duration (ms)
1	149	1.2	150	1	136	3.6	129
2	148	1.4	145	2	136	3.2	135
3	150	1.6	155	3	134	3.0	120
4	149	1.2	160	4	136	3.8	132

*"A" and "B" pulse duration as explained in MIL-STD-1474B(MI).

NOTES: Driver's and commander's hatches were in the umbrella position - all other hatches were closed.
For explosive-ordnance test reporting (Paragraph 5.2), substitute microphone position for crew position.

Figure 6. Typical Impulse-Noise Presentation.

(2) Type of hearing protection required.

(3) Maximum of detectable distance.

Recommended changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, MD 21005. Technical information may be obtained from the preparing activity: Commander, US Army Aberdeen Proving Ground, ATTN: STEAP-MT-M, Aberdeen Proving Ground, MD 21005. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22314. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX A
BACKGROUND

CHARACTERISTICS OF NOISE

A-1 General.

a. Sound - Sound is the sensation produced through the ear resulting from rapid fluctuations in atmospheric pressure. These fluctuations are expressed in decibels (db) using 0.0002 microbar (which is the same as 0.0002 dynes/cm^2) as the reference pressure (often abbreviated to "re 0.0002 μbar"). This reference is the smallest change in pressure at 1000 Hz that young men with good hearing can detect. The relative amplitude of these pressure fluctuations is termed the "sound pressure level (SPL)," and its value is given by

$$\text{SPL (in db)} = 20 \log \frac{P_1}{P_o},$$

where P_1 is the overpressure and P_o is the reference overpressure of 0.0002 microbar. For steady state noises, P_1 is the root-mean-square (rms) overpressure value, whereas for impulse noises, it is the instantaneous peak overpressure value. Figure A-1 shows the relationship between overpressure expressed in psi and decibels. (One microbar = 1.450×10^{-5} psi.) Sound may be produced by a vibrating object that regularly compresses the air near its surface causing a wave to propagate from the object, or by pulses in the air generated by a shock wave and its reflections. For a simple, pure tone (i.e., a sine wave) the number of times per second the pressure changes through a complete cycle is the frequency of the sound. The audible frequency range for men with acute hearing is about 20 to 20,000 Hz. Normal speech involves the frequencies from about 100 to 7000 Hz, with the most important frequency centered about 1200 Hz.

b. Noise - Noise is unwanted sound. Noises may be divided in two ways: (1) steady state (or continuous), such as that produced by a tank or jet engine, and (2) impulse (or impact or transient), such as that produced by gunfire.

A-2 Steady State Noises.

Steady state noises are continuous noises that maintain essentially the same amplitude and spectral distribution over a period of time. There are two principal types of steady state noises: (1) steady state wide band noise which covers a wide range of frequencies (examples - noises from tanks, reciprocating engines, and ambient noise) and (2) steady state narrow band noise covering noises that range from pure tones to those that are concentrated in a frequency band of less than one-third octave (examples - noises produced by turbines, transformers, and sirens operating under constant

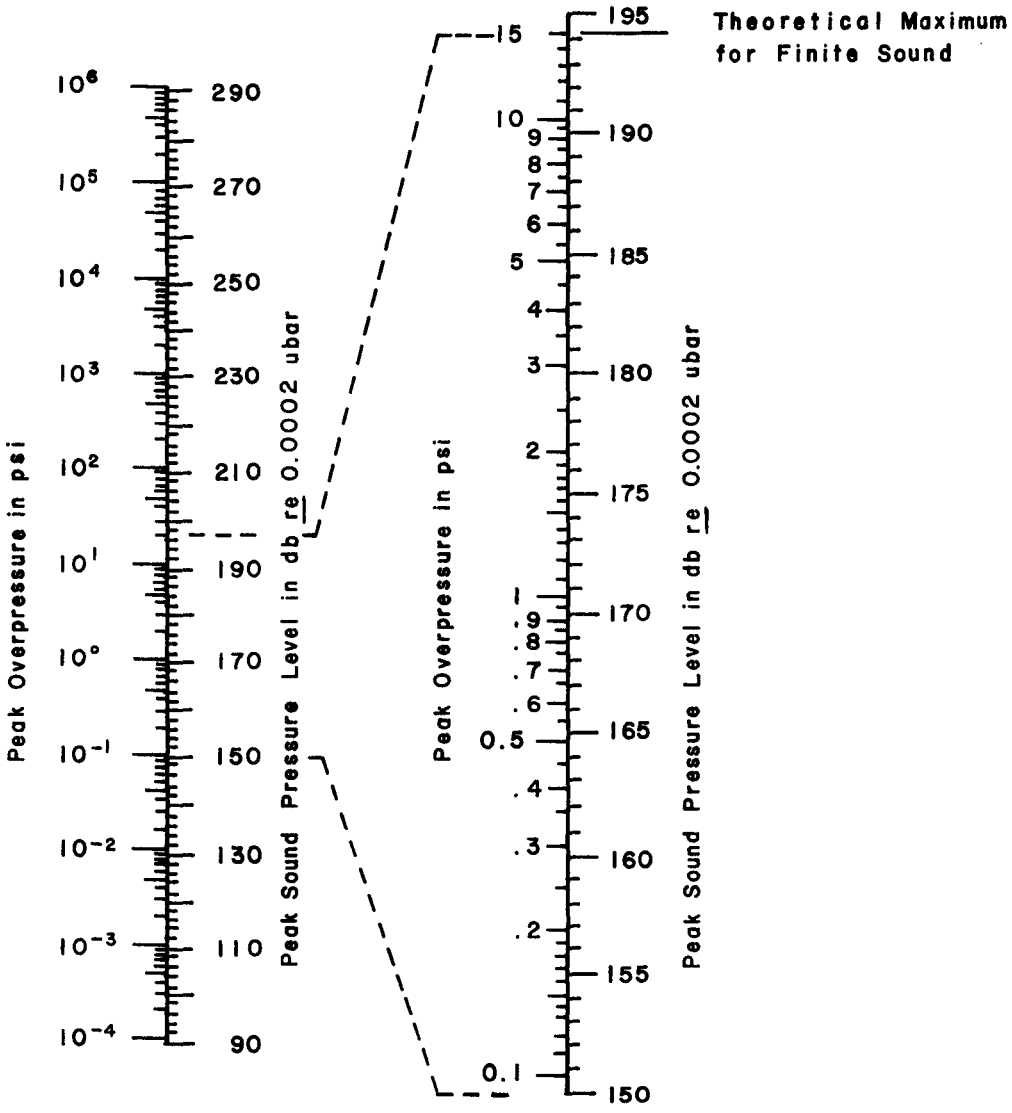


Figure A-1. Relationship of Overpressure Measurements to Noise Levels

(To convert from psi to kPa multiply by 6.89.)

conditions). Steady state noise levels are given as rms values expressed in decibels. Oscillograph traces of steady state noises are shown in Figure A-2.

A-3 Impulse Noises and Blast Waves.

An idealized impulse noise produces the same physical phenomenon as a blast wave. A shock front is created which is characterized by a discontinuity in pressure. The pressure rise from ambient to peak occurs in less than a microsecond. In practice, there may be precursors in the form of advance elements of the gun-firing process which arrive before the main muzzle blast. Reverberations and reflections also increase the complexity of the wave form creating a number of nodes. The duration of an impulse noise is generally in the millisecond range for large weapons and in microseconds for small arms. Impulse noises that are repeated rapidly, such as machine gun fire, are called "repeated impulse noises." In some cases, such as with gun noises heard from within a closed tank, the impulse has no apparent shock front. Peak sound pressure levels in decibels can be directly converted to blast overpressures in psi by the use of Figure A-1. Blast overpressure and impulse noises are discussed in greater detail in TOP 4-2-822.

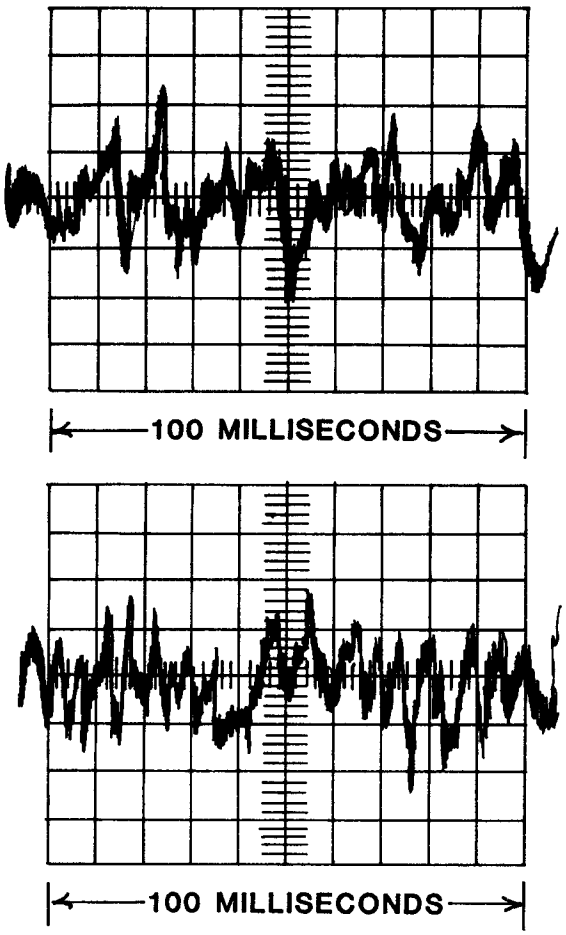


Figure A-2. Oscillographs of Typical Steady State Noises.

ACOUSTICAL TEST DATA

TIME: 1400				DATE: 7 MAY 1976	
TEST ITEM: TRUCK: CARGO, 1¼ TON, 6×6, M561			TEST CONDUCTED BY: WM. H. DIEGEL	TEST ITEM OPERATOR: TONY MILLER	
REG./MODEL NO: 05A 476 70	SERIAL NO: 7252 511C	ODOMETER: 13,500 / HOUR METER	TEST ITEM CONDITION: STANDARD CANVAS TOP - DOORS OPEN		
TEMPERATURE: 24.7°C	HUMIDITY: 63%	TEST SITE: PERRYMAN	SURFACE: PAVED	TERRAIN: LEVEL	
BAROMETRIC PRESSURE: 1012.2	SKY COVER: SCATTERED	STATIONARY OPERATION ☐	HIWAY DRIVING ☒	DRIVE-BY ☐	
WIND DIRECTION: S.S.W	WIND VELOCITY: 4.5 - 5.0 m/s	MICROPHONE: GR-1551-P1	SOUND LEVEL METER: GR-1551-C	OCTAVE ANALYZER: GR-1558AP	
INTERIOR ☒	EXTERIOR ☐	MICROPHONE LOCATION: AS DESCRIBED BELOW		TAPE RECORDER: —	TAPE NO.: —

GEAR	RPM	APPROX SPEED	dbA	dbB	dbC	ALL PASS	31.5	63	125	250	500	1,000	2,000	4,000	8,000	REMARKS
								DRIVER'S EAR POSITION								
1	1900	4	91	94	95	96		87	89	91	90	86	82	76	69	
2	1900	9	92	95	96	97		87	89	91	89	86	82	76	69	
3	1900	21	92	95	97	97		88	89	91	90	87	82	75	69	
4	1900	38	93	96	99	100		90	91	95	90	88	82	76	70	
								PASSENGER'S EAR POSITION								
1	1900	4	89	92	94	95		86	88	92	88	84	81	75	68	
2	1900	9	90	92	94	95		86	87	92	87	85	81	75	68	
3	1900	21	90	93	95	97		86	88	93	90	86	82	75	68	
4	1900	38	92	95	97	98		87	90	95	90	87	82	77	69	
			85					106	96	89	83	80	79	79	81	MAXIMUM ALLOWABLE LIMITS FOR UNPROTECTED HEARING (MIL-STD-1474 CATEGORY 'D')

Sample Form Showing Acoustical Test Data for M561 Cargo Truck.

APPENDIX C
REFERENCES

1. TOP 4-2-822, Airblast Pressure Measurement - Electronic, 15 January 1981.

2. ANSI S1.13, Sound Pressure Levels, Method for Measurement of.

3. ANSI S1.4, Sound Level Meters, Specification for, American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

4. ANSI S1.11, Octave, Half-Octave, and Third-Octave Filter Sets, Specifications for.

5. ANSI S6.1, Qualifying a Sound Data Acquisition System.

6. AR 40-R, Health and Environment, 25 September 1974.

7. TB MED 501, Noise and Conservation of Hearing, March 1980.

8. MIL-STD-1474B(MI), Noise Limits for Army Materiel, 18 June 1979.

9. Based partially on procedures in SAE J366b, Exterior Sound Level for Heavy Trucks and Buses, SAE Standard, Society of Automotive Engineers, Inc., 2 Pennsylvania Plaza, New York, NY 10001.

10. SAE J88a, Exterior Sound Level Measurement Procedure for Powered Mobile Construction Equipment, Recommended Practice.

11. SAE J34a, Exterior Sound Level Measurement Procedure for Pleasure Motorboats, Recommended Practice.

12. TOP 1-2-610, Human Factors Engineering, 20 December 1977.