NIOSH

TECHNICAL REPORT

COMPENDIUM OF MATERIALS FOR NOISE CONTROL

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

COMPENDIUM OF MATERIALS FOR NOISE CONTROL

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Contract 210-77-00-63

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
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NIOSH Project Officer: William McKinnery
Principal Investigator: Robert Hedeen

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PREFACE

The publication of the first edition of the Compendium of Materials for Noise Control (No. 75-165) in 1975 was greeted with enthusiasm by noise control engineers and others interested in aural tranquility. For the first time, a comprehensive listing of noise control materials, with associated technical data, was available in a single source. In the ensuing years, as manufacturers dropped old product lines and added new products, the Compendium began to become obsolete. This second edition has been revised in many ways, but its aim is the same. It is designed for use by those selecting materials and systems for noise control. It will be found useful in determining availability, acoustical performance, and sources of noise control materials and systems, especially those with industrial applications. Data on specific products as well as general information on the uses and limitations of these products are included.

The primary sources of contact with the manufacturers of the products were the list of contributors to the first edition of the Compendium, the "Buyer's Guide" in S/V Sound and Vibration for July and August 1977, and the Riverbank Acoustical Laboratory client list. A total of 627 companies (as well as 21 testing laboratories and manufacturer's associations) derived from these sources were sent letters and questionnaires soliciting descriptions and technical data on their products. Responses generally took the form of product data literature and laboratory test reports, which had to be transcribed into a form suitable for typing in a tabular format. While the greatest pains were taken to ensure the accuracy of the tables, Murphy's Law virtually requires the inclusion of a few minor typographical errors, and for these the authors apologize. The final count of positive responses (those providing usable product information) was 146, providing a response to contact ratio of 23.3 percent. Remarkably, the ratio for the first edition of the Compendium was an almost identical 23.5 percent, although the contact lists, methods of contact, and numbers contacted were markedly different.

The data tables in this edition of the Compendium are entirely new. Contributors to the previous edition were asked to resubmit their products with the most recent data, and many companies not appearing before are represented. The organization of the data tables and the technical discussion has been revised with the hope of simplifying the use of the volume. The inclusion of eight tables of mufflers, silencers, and ducts is a major improvement to this edition. Data are presented as received from the manufacturers, and have not been verified by IITRI or NIOSH. Some products have been listed with little or no technical data. They have been included to make the user aware that the products exist, and the manufacturer should be contacted for any further required information.

The data tables comprise the principal content of the Compendium. The technical narrative provides highlights of the basic techniques of noise control.

While not intended as a substitute for the more advanced and detailed books on noise control, it is hoped that it will provide basic reference material for those not already familiar with the subject. This compendium is the authors' contribution to an ultimate goal of a quieter environment.

ACKNOWLEDGEMENTS

The preparation of data tables in this document would have been an impossible task without the diligence and patience of John Kopec of IITRI. The assistance of Carol Sessions and Mary Sims, also of IITRI, in preparing the manuscript is appreciated. Pat Wagner, Jill Reed, and Virginia Martin were typists who struggled to interpret the handwritten draft. Special thanks are extended to Dr. Renny S. Norman, IITRI Program Manager, for his understanding of the many problems involved.

Also, NIOSH is grateful to Bruel and Kjaer Instruments for permission to reprint their microphone curves, to EDN Magazine for Figure 1, and to the Acoustical and Insulating Materials Association for providing the absorption data on common building materials in Table 5. The illustrations in the data tables are from the manufacturers' literature and are reprinted with their kind permission.

ABSTRACT

This compendium of commercial noise-reduction materials and systems was developed for use by plant engineers, industrial hygenists, acoustical consultants, and others engaged in noise control. It can be used to determine the availability of noise control products, their characteristics and specifications, and their supply sources. Also included is a technical discussion of operating principals, uses, and limitations of the products listed.

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FIGURES

FIGURES (concl)

TABLES

COMPANY CODE NUMBERS AND ADDRESSES

Code	Company	Address	Pertinent Data Table
1	Accessible Products	1350 E. 8th St. Tempe, AZ 85281 (602) 967-8888	27
2	Acoustex of Canada Ltd.	83 Sunrise Ave. Toronto, Ontario M4A1B1 (416) 751-2380	16,28,29
3	Acoustics Development	1810 Holste Rd. Northbrook, IL 60062 (312) 272-8880	38
4	Acoustiflex Corporation	811 Center St. Plainfield, IL 60544 (815) 436-4640	2,10,14,16,18,25,26
5	Aeroacoustic Corporation	4876 Victor St. Jacksonville, FL 32207 (904) 731-3577	11,14,16,19,28,29,30,32,34
6	Air Filter Corporation	4554 W. Woolworth Ave. Milwaukee, WI 53218 (414) 353-5800	31,32
7	Alcoa (Aluminum Company of America)	1501 Alcoa Bldg. Pittsburgh, PA 15219 (412) 553-3770	16
8	Allied Steel Products	7800 N.W. 37th Ave. Miami, FL 33147 (305) 691-0615	20
9	Allied Witan Company	13805 Progress Pkwy. Cleveland, OH 44133 (216) 237-9630	29
10	Alpha Associates, Inc.	Two Amboy Ave. Woodbridge, NJ 07095 (201) 634-5700	7,16

Code	Company	Address	Pertinent Data Table
11	Alphadyne, Incorporated	2119 Grand Ave. St. Paul, MN 55105 (612) 698-5561	16,26
12	Alpro Structural Systems Corporation (Acoustics Division)	P.O. Box 50070 New Orleans, LA 70150 (504) 522-8656	5,16
13	American Acoustical Products	9 Cochituate St. Natick, MA 01760 (617) 237-4223	2,4,7,8,11,13,37
14	Amweld Building Products	100 Plant St. Niles, OH 44446 (216) 652-9971	20
15	Armstrong Cork Company	W. Liberty St. Lancaster, PA 17604 (717) 397-0611	14,18,26
16	Arrow Sintered Products Company	7650 Industrial Dr. Forest Park, IL 60130 (312) 921-7054	29
17	Atlas Minerals and Chemicals	Farmington Rd. Mertztown, PA 19539 (215) 682-7171	29
18	Babcock and Wilcox	P.O. Box 1260 Lynchburg Research Center Lynchburg, VA 24505 (804) 384-5111	5,27
19	Barry Wright Corporation (Vlier Division)	2333 Valley St. Burbank CA 91505 (213) 843-1922	29
20	BLI Corporation	33 Parker Ave. Stamford, CT 06906 (203) 325-3883	4,10,14,16,18,25,26,38
21	Bodyguard Inc.	P.O. Box 8338 Columbus, OH 43201 (614) 291-7601	16
22	Bostik	Boston St. Middleton, MA 01949 (617) 777-0100	37

Code	Company	Address	Pertinent Data Table
23	Breton Industries Inc.	10 Leonard St. Amsterdam, NY 12010 (518) 842-3030	15
24	Brunswick Corporation (Technetics Division)	2000 Brunswick Ln. Deland, FL 32720 (904) 736-1700	35
25	Builders Brass Works Corporation	3447 Union Pacific Ave. Los Angeles, CA 90023 (213) 269-8111	36
26	The Canada Metal Company Ltd. (Noise Control Division)	721 Eastern Ave. Toronto, Ontario, Canada M4M-1E6 (416) 465-4684	7,8
27	L. E. Carpenter and Company	170 N. Main St. Wharton, NJ 08885 (201) 366-2020	4
28	The Celotex Corporation	P.O. Box 22602 Tampa, FL 33622 (813) 871-4811	3,5,9,14
29	Certainteed Corporation (Insulation Group)	3000 Chrysler Rd. P.O. Box 15080 Kansas City, KS 66115 (913) 342-6624	4,35
30	Chemprene Division (The Richardson Company)	570 Fishkill Ave. Beacon, NY 12508 (914) 831-2800	11,13
31	Chemical Fabrics Corporation	P.O. Box 367 108 Northside Dr. Bennington, VT 05201 (802) 442-3122	4
32	Childers Products Corporation	P.O. Box 22228 23350 Mercantile Rd. Beachwood, OH 44122 (216) 464-8020	19,27,37
33	Controlled Acoustics Corporation	221 E. Hartsdale Ave. Hartsdale, NY 10530 (914) 725-1700	2,7,8,11, 37

Code	Company	Address	Pertinent Data Table
34	Conwed Corporation (Ceiling Products Division)	332 Minnesota St. St. Paul, MN 55101 (612) 221-1184	14
35	Curries Manufacturing	251 9th St. S.E. Mason City, IA 50401 (515) 423-1334	20
36	Daubert Chemical Company	1200 Jorie Blvd. Oakbrook, IL 60521 (312) 582-1000	37
37	DeVac Inc.	10130 State Highway 55 Minneapolis, MN 55441 (612) 542-3400	23
38	Dixie Manufacturing Company Inc.	110 Colley Ave. P.O. Box 59 Norfolk, VA 23501 (804) 625-8251	37
39	Donaldson Company Inc.	1400 W. 94th St. P.O. Box 1299 Minneapolis, MN 55440 (612) 887-3131	33
40	Doug Biron Associates Inc.	P.O. Box 413 Buford, GA 30518 (404) 945-2929	2,4,7,8, 9,11,15, 16,18,27, 28,29,37, 38
41	H. E. Douglass Engineering Sales Company	10861 Sherman Way Sun Valley, CA 91352 (213) 875-3144	38
42	E. I. DuPont DeNemours and Company Inc.	1007 Market St. Rm. B1216 Wilmington, DE 19899 (302) 774-1000	11
43	Duracote Corporation	350 N. Diamond St. Ravenna, OH 44266 (216) 296-3486	8,11
44	Duwe Precast Concrete Products Inc.	P.O. Box 2068 Oshkosh, WI 54901 (414) 231-3980	17
45	Eagle-Picher Industries, Inc. (Chemicals and Fibers Division)	P.O. Box 1328 Joplin, MO 64801 (417) 623-8000	5,27

Code	Company	Address	Pertinent Data Table
46	Eastman Chemical Products, Inc. (Plastics Products Division)	P.O. Box 431 Kingsport, TN 37662 (800) 251-0351	12
47	Eckel Industries Inc. (Eckoustic® Division)	155 Fawcett St. Cambridge, MA 02138 (617) 491-3221	2,4,8,11, 15,16,19, 37
48	Ecology Controls Inc.	223 Crescent St. Waltham, MA 02154 (617) 893-1020	38
49	Elwin G. Smith Company	100 Walls St. Pittsburgh, PA 15202 (412) 761-7474	16
50	Environmental Elements Corp. (Sound Control Systems Group)	P.O. Box 1318 Baltimore, MD 21203 (301) 368-7060	16,30,31, 32,34
51	Epic Metals Corporation	11 Talbot Ave. Rankin, PA 15104 (412) 351-3913	17
52	Federated Metals Corporation	P.O. Box 2600 270 Foothill Rd. Somerville, NJ 08876 (201) 356-2600	16,20,22
53	Feeder Corporation of America	4429 James Pl. Melrose Park, IL 60160 (312) 343-4900	38
54	Fenestra Company	4040 W. 20th St. P.O. Box 8189 Eric, PA 16505 (814) 838-2001	20
55	Fibron Corporation	P.O. Box 03061 Portland, OR 97203 (503) 286-8315	6,21,22
56	Fluid Kinetics Corporation	P.O. Box C.E. Ventura, CA 93001 (805) 644-5587	29
57	Foamade Industries	1220 Morse St. Royal Oak, MI 48068 (313) 548-5555	2

Code	Company	Address	Pertinent Data Table
58	Foam Design Inc.	Box 983 735 Westland Dr. Lexington, KY 40501 (606) 252-5671	11,15
59	Forty-Eight Insulations Inc.	P.O. Box 1148 Aurora, IL 60504 (312) 896-4800	22
60	Frommelt Industries Inc.	465 Huff St. Dubuque, IA 52001 (319) 556-2020	11
61	Gallagher-Kaiser Corporation	13710 Mt. Elliott Ave. Detroit, MI 48212 (313) 368-3100	16
62	General Acoustics Corporation	12248 Santa Monica Blvd. Los Angeles, CA 90025 (213) 820-1531	31
63	Glasrock® Products Inc.	7380 Bohannon Rd. Fairburn, GA 30213 (404) 964-1421	29
64	Globe-Amerada Glass Company	2001 Greenleaf Ave. Elk Grove Village, IL 60007 (312) 439-5200	12,23
65	Globe Industries Inc.	2638 E. 126th St. Chicago, IL 60633 (312) 646-1300	7,9
66	Goodyear Tire and Rubber Company	1144 E. Market St. Akron, OH 44316 (216) 794-2616	2,8,13,27
67	Haworth Inc.	545 E. 32nd Holland, MI 49423 (616) 392-5961	25
68	Holcomb and Hoke Manufacturing Company Inc.	1545 Van Buren St. P.O. Box A-33900 Indianapolis, IN 46203 (317) 784-2444	24
69	Hubert Fiberboard Inc.	P.O. Box 167, E. Morgan St. Boonville, MO 65233 (816) 882-2704	22

Code	Company	Address	Pertinent Data Table
70	I.D.E. Processes Corporation (Noise Control Division)	106 81st Ave. Kew Gardens, NY 11415 (212) 544-1177	16,19,28
71	Inryco Inc.	Box 393 4101 W. Burnham St. Milwaukee, WI 53201 (414) 383-4030	16,17
72	Insulation Contracting, Inc.	P.O. Box 1883 Mobile, AL 36601 (205) 456-4561	19
73	Insul-Coustic Corporation	Jernee Mill Road Sayreville, NJ 08872 (201) 257-6674	4,9,10, 11,18,26, 27,35
74	Johns-Manville Corporation	Ken-Caryl Ranch Denver, CO 80217 (303) 979-1000	3,4,14, 27,35
75	Kaiser Cement and Gypsum Corporation	Kaiser Center 300 Lakeside Dr. Oakland, CA 94666 (415) 271-2211	21,22
76	Kelley Company, Inc.	6720 N. Teutonia Ave. Milwaukee, WI 53209 (414) 352-1000	15
77	George Koch Sons Inc. (Thermal-Acoustics Division)	10 S. 11th Ave. Evansville, IN 47744 (812) 425-1321	16,19,25
78	Korfund Dynamics Corporation	P.O. Box 235 Cantiague Rd. Westbury, NY 11590 (516) 333-7580	2,8,11, 16,19,34, 37
79	Laminated Glass Corporation	355 W. Lancaster Ave. Haverford, PA 19041 (215) 642-2344	12
80	Lehigh Fluid Power Inc.	York Rd., Rt. 179 Lambertville, NJ 08530 (609) 397-3487	29
81	The Logan-Long Company Inc.	Rt. 73 and 25 Franklin, OH 45005 (513) 746-4561	9,37

Code	Company	Address	Pertinent Data Table
82	Lord/All Force Acoustics	2001 Peninsula Dr. P.O. Box 1067 Erie, PA 16512 (814) 838-7691	2,15,16 18,19,37, 38
83	Maher Engineering Company	1251 Rand Rd. Des Plaines, IL 60016 (312) 824-2124	2,7,8, 11,13,37
84	Martin Fireproofing Georgia Inc.	P.O. Box 768 Elberton, GA 30635 (404) 283-6942	17
85	Metal Building Interior Products Company	Kane Building 1640 E. 40th St. Cleveland, OH 44103 (216) 431-6040	4,14,18, 26
86	W. B. McGuire Company Inc.	1 Hudson Ave. Hudson, NY 12534 (518) 828-7652	15
87	Merco Manufacturing Inc.	P.O. Box 4110 Dallas, TX 75208 (214) 741-1538	17
88	Modu-Line Window Inc.	930 Single Ave. P.O. Box 128 Wausau, WI 54401 (715) 845-9666	23
89	Monsanto Plastics and Resins Company	800 N. Lindbergh Blvd. St. Louis, MO 63166 (314) 694-1000	12
90	National Cellulose Corporation	12315 Robin Blvd. Houston, TX 77045 (713) 433-6761	6,13,18, 22,27
91	National Concrete Masonry Association	6845 Elm St. P.O. Box 135 McLean, VA 22101 (703) 790-8650	22
92	National Gypsum Company Gold Bond Building Products	325 Delaware Ave. Buffalo, NY 14202 (716) 852-5880	14,26
93	Noise Control Associates Inc.	32 Park St. Montclair, NJ 07042 (201) 746-5181	10

Code	Company	Address	Pertinent Data Table
94	Noise Reduction Corporation	Rt. 1 Box 3 N. Redwood, MN 56275 (507) 637-3067	38
95	Overly Manufacturing Company	P.O. Box 70 574 W. Otterman St. Greensburg, PA 15601 (412) 834-7300	20
96	Owens Corning Fiberglass Corporation	Sound Laboratory Bldg. 300 Grandville, OH 43023 (614) 587-0610	4,11,14, 18,25,26, 27,35
97	Owens Illinois Inc.	P.O. Box 1035 Toledo, OH 43666 (419) 247-5000	13
98	Pittsburgh Corning Corporation	800 Presque Isle Dr. Pittsburgh, PA 15239 (412) 327-6100	4,18,35
99	Plicoflex Inc.	1430 E. Davis St. Arlington Heights, IL 60005 (312) 392-5700	24
100	Presray Inc.	159 Maple Blvd. Pawling, NY 12564 (914) 855-1220	36
101	The Proud Foot Company Inc.	P.O. Box 9 Greenwich, CT 06830 (203) 869-9031	1,18
102	Quietflo	137 S. Middletown Rd. Nanuet, NY 10954 (914) 352-8877	28
103	The R.C.A. Rubber Company	1833 E. Market St. Akron, OH 44305 (216) 784-1291	21
104	Reeves Brothers Inc. (Noise Control Materials Division)	222 Rampart St. Charlotte, NC 28203 (704) 333-1131	2,15
105	Richards-Wilcox Manufacturing Company	174 3rd St. Aurora, IL 60507 (312) 897-6951	20,24

Code	Company	Address	Pertinent Data Table
106	Robinson Acoustics Ltd.	313 Enford Rd. Richmond Hill, Ontario L4C3E9 (416) 889-0218	26
107	Rohm and Haas Company	Independence Mall West Philadelphia, PA 19105 (215) 592-3000	12
108	Rollform Products, Inc.	220 Seegers Elk Grove Village, IL 60007 (312) 640-7760	17
109	Scientific Applications Inc.	P.O. Box 615 Highway 34 W. Mt. Pleasant, IA 52641 (319) 385-9021	2,21,22
110	Shatterproof Glass Corporation	4815 Cabot Ave. Detroit, MI 48210 (313) 582-6200	12
111	Shielding, Inc.	3295 S. Highway 97 Redmond, OR 97756 (503) 548-4032	11
112	Singer Safety Products Inc.	444 N. Lake Shore Dr. Chicago, IL 60611 (312) 222-1860	2,11,15, 19
113	Span-Deck Incorporated	Box 99 Franklin, TN 37064 (615) 794-4556	17,21
114	Sonic Barrier Sound Products Ltd.	3400 Lysander Ln. Richmond, British Columbia V7B1C3 (604) 273-5722	19
115	Sonotrol Systems Ltd.	486 Evans Ave., Unit #8 Toronto, Ontario, Canada M8W2T7 (416) 252-5979	18,26
116	Sorber Sound Proofing Company	8 Aaron St. Framingham, MA 01701 (617) 879-2140	15

Code	Company	Address	Pertinent Data Table
117	The Soundcoat Company, Inc.	175 Pearl St. Brooklyn, NY 11201 (212) 858-4100	2,7,8,11, 13,37
118	Sound Control Design	215½ S. County St. Waukegan, IL 60085 (312) 623-1317	25
119	Sound Fold Inc.	P.O. Box 2125 Dayton, OH 45429 (513) 228-3773	15
120	Sound-Metal Engineering Inc.	P.O. Box 58 Lawrenceville, IL 62439 (618) 943-2396	16,19
121	The Spencer Turbine Company	600 Dayhill Rd. Windsor, CT 06095 (203) 688-8361	31
122	Stanley Door Systems	2400 E. Lincoln Rd. Birmingham, MI 48012 (313) 646-1100	20
123	Stark Ceramics, Inc.	P.O. Box 8880 Canton, OH 44711 (216) 488-1211	1
124	Sunnex Corporation	87 Crescent Rd. Needham, MA 02194 (617) 444-4730	29
125	Tempmaster Corporation	1222 Ozark St. N. Kansas City, MO 64116 (816) 421-0723	16,19
126	Tex-Steel Corporation	467 Industrial Air Park P.O. Box 992 Harlingen, TX 78550 (512) 423-0912	20
127	Tracoustics Inc.	415 E. St. Elmo Rd. P.O. Box 3610 Austin, TX 78764 (512) 444-1961	19
128	Transco Inc.	55 E. Jackson Blvd. Chicago, IL 60604 (312) 427-2818	16

Code	Company	Address	Pertinent Data Table
129	Trus Joist Corporation	9777 W. Chinden Blvd. Boise, ID 83702 (208) 375-4450	21
130	Tube-Lok Products	4644 S.E. 17th Ave. Portland, OR 97202 (503) 234-9731	2,8
131	United Sheet Metal Division (McGill Corporation)	200 E. Broadway Westerville, OH 43081 (614) 882-7401	16,35
132	United States Department of Agriculture, Forest Products Lab	P.O. Box 5130 Madison, WI 53705 (608) 257-2211	22
133	United States Gypsum Company	101 S. Wacker Dr. Chicago, IL 60606 (312) 321-3865	18,25,26
134	United Steel Deck, Inc.	475 Springfield Ave. P.O. Box 662 Summit, NJ 07901 (201) 277-1617	17
135	Universal Silencer Division Nelson Industries Inc.	P.O. Box 411 Stoughton, WI 53589 (608) 873-4272	28
136	Upstate Precision Manufacturing Inc.	Franklyn Building Rt. 9 Plattsburgh, NY 12901 (518) 563-7440	25
137	Velcro USA Inc.	681 5th Ave. New York City, NY 10022 (212) 751-2144	38
138	Verco Manufacturing Inc.	4340 N. 42nd Ave. Phoenix, AZ 85019 (602) 272-1347	17
139	Vibration and Noise Engineering Corporation	Metro Square 2655 Villa Creek Dr. Dallas, TX 75234 (214) 243-1951	19,28
140	Viracon Inc.	800 Park Dr. Owatonna, MN 55060 (507) 451-9551	12

Code	Company	Address	Pertinent Data Table
141	Vogel Peterson	Rt. 83 and Madison St. Elmhurst, IL 60126 (312) 279-7123	25
142	VSM Corporation Environmental Systems Group	7515 Northfield Rd. Cleveland, OH 44146 (216) 439-5400	16
143	Warren Sales Corporation	Box 11849 Knoxville, TN 37919 (615) 588-6459	1
144	Western Conference of Lathing and Plastering Institutes, Inc.	P.O. Box 6468 Santa Anna, CA 92706 (714) 531-1278	21,22
145	Weyerhaeuser Company	P.O. Box 188 Longview, WA 98632 (206) 425-2150	20,21,22
146	Zero, Weather Stripping Company Inc.	415 Concord Ave. Bronx, NY 10455 (212) 583-3230	36

OTHER ORGANIZATIONS SUPPLYING TECHNICAL MATERIAL

Association of Home Appliance Manufacturers (AHAM)	20 N. Wacker Dr. Chicago, IL 60606 (312) 236-2921
Brick Institute of America (BIA)	1750 Old Meadow Rd. McLean, VA 22101 (703) 893-4010
Hardwood Plywood Manufacturing Association (HPMA)	P.O. Box 6246 Arlington, VA 22206 (703) 671-6262
National Concrete Masonry Association (NCMA)	6845 Elm St. P.O. Box 135 McLean, VA 22101 (703) 790-8650
Portland Cement Association (PCA)	5420 Old Orchard Rd. Skokie, IL 60076 (312) 966-6200

Company	
Prestressed Concrete Institute (PCI)	20 N. Wacker Dr. Chicago, IL 60606 (312) 346-4071
Expanded Shale, Clay, and Slate Institute	7401 Wisconsin Ave. Suite 414 Bethesda, MD 20014 (301) 654-0140
United States Department of Agriculture, Forest Products Lab	P.O. Box 5130 Madison, WI 53705 (608) 257-2211
Western Conference of Lathing and Plastering Institutes, Inc.	P.O. Box 6468 Santa Anna, CA 92706 (714) 531-1278

CATEGORICAL LISTINGS OF COMPANIES CONTRIBUTING DATA

Table	Title	Organization Code Numbers
	Group A: Noise Control Materials	
1	Absorptive Block	101, 123, 143
2	Foams	4, 13, 33, 40, 47, 57, 66, 78, 82, 104, 109, 112, 117, 130
3	Felt	28, 74
4	Glass Fiber Material	13, 20, 27, 29, 31, 40, 47, 73, 74, 85, 96, 98
5	Mineral Fiber	12, 18, 28, 45
6	Spray On	55, 90
7	Barrier/Fiberglass	10, 13, 26, 33, 40, 65, 117
8	Barrier/Foam	13, 26, 33, 40, 43, 47, 66, 78, 117, 130
9	Mastic	28, 40, 65, 73, 81
10	Quilted	4, 20, 73, 93
11	Plain and Mass Loaded Plastics	5, 13, 30, 33, 40, 42, 43, 47, 58, 60, 73, 78, 96, 111, 112, 117
12	Glass/Plastic Sheets	46, 64, 79, 89, 107, 110, 140
13	Other Barrier Materials	13, 30, 66, 90, 97, 117
	Group B: Noise Control Systems	
14	Ceiling Tile	4, 5, 15, 28, 34, 74, 85, 92, 96
15	Curtains	23, 40, 47, 58, 76, 82, 86, 104, 112, 116, 119
16	Panels	2, 4, 5, 7, 11, 12, 21, 40, 47, 49, 50, 52, 61, 70, 71, 77, 78, 82, 120, 125, 128, 131, 142
17	Roof Decks	44, 51, 71, 84, 87, 108, 113, 134, 138
18	Unit Absorbers	4, 15, 20, 40, 73, 82, 85, 90, 96, 98, 101, 115, 133
19	Enclosures	5, 32, 47, 70, 72, 77, 78, 82, 112, 114, 120, 125, 127, 139
20	Doors	8, 14, 35, 52, 54, 95, 105, 122, 126, 145

Table	Title	Organization Code Numbers
21	Floors	55, 75, 103, 109, 113, 129, 144, 145
22	Walls	52, 55, 59, 69, 75, 90, 91, 109, 132, 144, 145
23	Windows	37, 64, 88
24	Operable Partitions	68, 99, 105
25	Open Plan	4, 67, 77, 96, 118, 133, 136, 141
26	Wall Treatment	4, 11, 15, 73, 85, 92, 96, 106, 115, 133
27	Pipe Lagging	1, 18, 32, 40, 45, 66, 73, 74, 90, 96
	Group C: Muffler, Silencer, and Duct Systems	
28	General Industrial Silencers	2, 5, 40, 70, 102, 135, 139
29	High Pressure Discharge	2, 5, 9, 16, 17, 19, 40, 56, 63, 80, 124
30	Fan Silencers	5, 50
31	Inlet and Exhaust Silencers	6, 50, 62, 121
32	Splitter/Louvers	5, 6, 50
33	Vehicular Mufflers	39
34	Duct Silencers	5, 50, 78
35	Ducting	24, 29, 73, 74, 96, 98, 131
	Group D: Miscellaneous	
36	Seals	25, 100, 146
37	Damping, Deadeners, Padding	13, 22, 32, 33, 36, 38, 40, 47, 78, 81, 82, 117
38	Special Applications	3, 20, 40, 41, 48, 53, 82, 94, 137

TESTING LABORATORIES WITH ACRONYMS AND ADDRESSES

Armstrong Acoustical Laboratories.................................... AAL
West Liberty St.
Lancaster, PA 17604
(717) 397-0611

Bolt Beranek & Newman.. BBN
50 Moulten St.
Cambridge, MA 02138
(617) 491-1850

Cedar Knolls Acoustical Laboratory.................................. CKAL
9 Saddle Rd.
Cedar Knolls, NJ 07927
(201) 539-6261

Cominco Product Research Center..................................... CLC
Sheridan Park
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Company Reference.. CR

Company Test... CT

Detroit Testing Laboratory Inc...................................... DTL
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Geiger & Hamme Labs.. G&H
Box 1345
Ann Arbor, MI 48106
(313) 971-3033

International Acoustics Testing Laboratory Inc. (INTEST)................INTEST
P.O. Box 8049
St. Paul, MN 55113
(612) 645-6699

Jim Walters Testing Laboratories.................................... JW
Jim Walters Research Corp.
10301 9th St. N.
St. Petersburg, FL 33702
(813) 576-4171

Electrical Testing Labs
Kodaras Acoustical Laboratory Division.............................. KAL
Industrial Park
Cortland, NY 13045
(607) 753-6711

National Bureau of Standards.................................... NBS
Sound Section
Room B106, Bldg. 233
Washington, D.C. 20234
(301) 921-3607

National Gypsum Company... NGC
1650 Military Rd.
Buffalo, NY 14217
(716) 873-9750

Owens Corning Reverberation Lab................................. OCRL
Product Testing Laboratory
Technical Center, Owens Corning Fiberglass Corporation
P.O. Box 415
Granville, OH 43023
(614) 587-0610

Riverbank Acoustical Laboratories............................... RAL
IIT Research Institute
1512 Batavia Ave.
Geneva, IL 60134
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Simpson Timber Company Research Center.......................... SRC
3330 Overlake Pkwy.
Redmond, WA 98052
(206) 885-4181

Wingerter Laboratories Incorporated............................. WLI
1820 N.E. 144th St.
N. Miami, FL 33161
(305) 944-3401

These organizations are the sources of the technical data presented in the tables. Their acronyms appear in the reference column of all tables. When the data provided by a manufacturer was not associated with a specific test laboratory, the letters CR indicate that the data was derived from a company reference. Following CR, when available, is the identification of the particular company brochure in which the data is published.

CKAL, CLC, G&H, INTEST, KAL, and RAL are independent acoustical testing laboratories specializing in the testing of noise control materials to the appropriate standards. AAL, JW, NGC, OCRL, and SRC are laboratories owned and operated by the manufacturer for the purpose of testing their own products. They occasionally perform tests for other companies. NBS no longer performs tests of this sort on a routine basis as in the past. BBN is an acoustical consulting firm. DTL and WLI perform a variety of testing services in addition to acoustical tests.

INTRODUCTION

The sounds of industry, growing in volume over the years, have heralded not only technical and economic progress but also the threat of an everincreasing incidence of hearing loss and other noise related health hazards to exposed employees. Noise is not a new hazard. Indeed, noise-induced hearing loss was observed centuries ago. Ramazzini in "De Morbis Artificium Distriba" in 1700 described how those hammering copper "have their ears so injured by that perpetual din...that workers of this class became hard of hearing and, if they grow old at this work, completely deaf." Before the Industrial Revolution, however, comparatively few people were exposed to high level workplace noise. It was the advent of steam power in connection with the Industrial Revolution that first brought general attention to noise as an occupational hazard. Workers who fabricated steam boilers were found to develop hearing loss in such numbers that such a malady was dubbed "boilermakers disease". Increasing mechanization in all industries and most trades has since proliferated the noise problem.

Exposures to noise levels found at the workplace, particularly in mechanized industries, are likely to be the most intense and sustained of any experience in daily living. As such, they represent the severest form of acoustic insult to man and therein pose the greatest harm to human function. The effects of occupational noise exposures include:

Temporary and permanent losses in hearing sensitivity

Physical and psychological disorders

Interference with speech communications or the reception of other wanted sounds

Decremental job performance

Engineering controls for the abatement of environmental noise reduce the intensity of the noise either at the source or in the immediate exposure environment. A number of these procedures require considerable expertise, and it is recommended that employers avail themselves of the services of a competent acoustical engineer in development of a noise abatement program. However, many noise control techniques may be implemented directly by company personnel at relatively little expense. (NOTE: The foregoing discussion was excerpted from "Criteria for a Recommended Standard...Occupational Exposure to Noise", DHEW (NIOSH) 1972).

SOME BASIC CONCEPTS

TERMINOLOGY AND DEFINITIONS

Sound consists of pressure waves traveling in an elastic medium, such as air, with propagation occurring in the direction of the wave motion. Noise is a subclass of sound: that sound which is undesirable to its receiver.

A pure tone of sound originates from simple harmonic motion, e.g., the reciprocating motion of a piston in air. The sound wave produced by this motion is a sinusoidal pressure wave whose fluctuation is governed by the displacement and rate at which the piston moves back and forth. Frequency is defined as the number of times this pressure fluctuation passes through a complete cycle in 1 sec. The unit of frequency is the hertz (1 Hz = 1 cycle per sec). The sound frequencies of some common items in air are shown in Figure 1.

The small changes above and below atmospheric pressure resulting from this compression and rarefaction of the air molecules are called "sound pressure". Since sound pressure is a periodic phenomenon, it is invariably expressed in terms of its root mean square (rms) value. Physiologically, the sensation of hearing is produced by this pressure variation. Broadband noise may be defined as a combination of sound waves with differing frequencies and amplitudes as distinct from a pure tone which has a single frequency and amplitude. Thus, broadband noise is a sound wave composed of a number of components combining to yield a resultant complex wave. In noise control work, broadband noise is the most common type of sound. The techniques available for analyzing the components of broadband noise into distinct frequency ranges is referred to as "spectral analysis".

If one were to freeze an oscillating, traveling, pressure fluctuation in time its resultant would be a wavelength defined as the measured distance between the maximum pressure points or any other analogous points on two successive parts of the wave. The Greek letter lambda (λ) is the symbol for wavelength, and it is measured in units of feet or meters.

The velocity with which the corresponding pressure points on successive parts of the wave pass a given point is the speed of sound, and the speed of sound is always equal to the product of the wavelength and the frequency, i.e., $c = \lambda f$. This speed is dependent on the equilibrium pressure, p_s, of the gas through which the sound wave is traveling and on the equilibrium gas density, ρ. The speed of sound (c) is given by the expression

$$c = \sqrt{\gamma p_s / \rho} \qquad \text{m/sec or ft/sec} \qquad (1)$$

where the constant γ is the ratio of the specific heat of a gas at constant pressure to its specific heat at constant volume. For air, at most normally

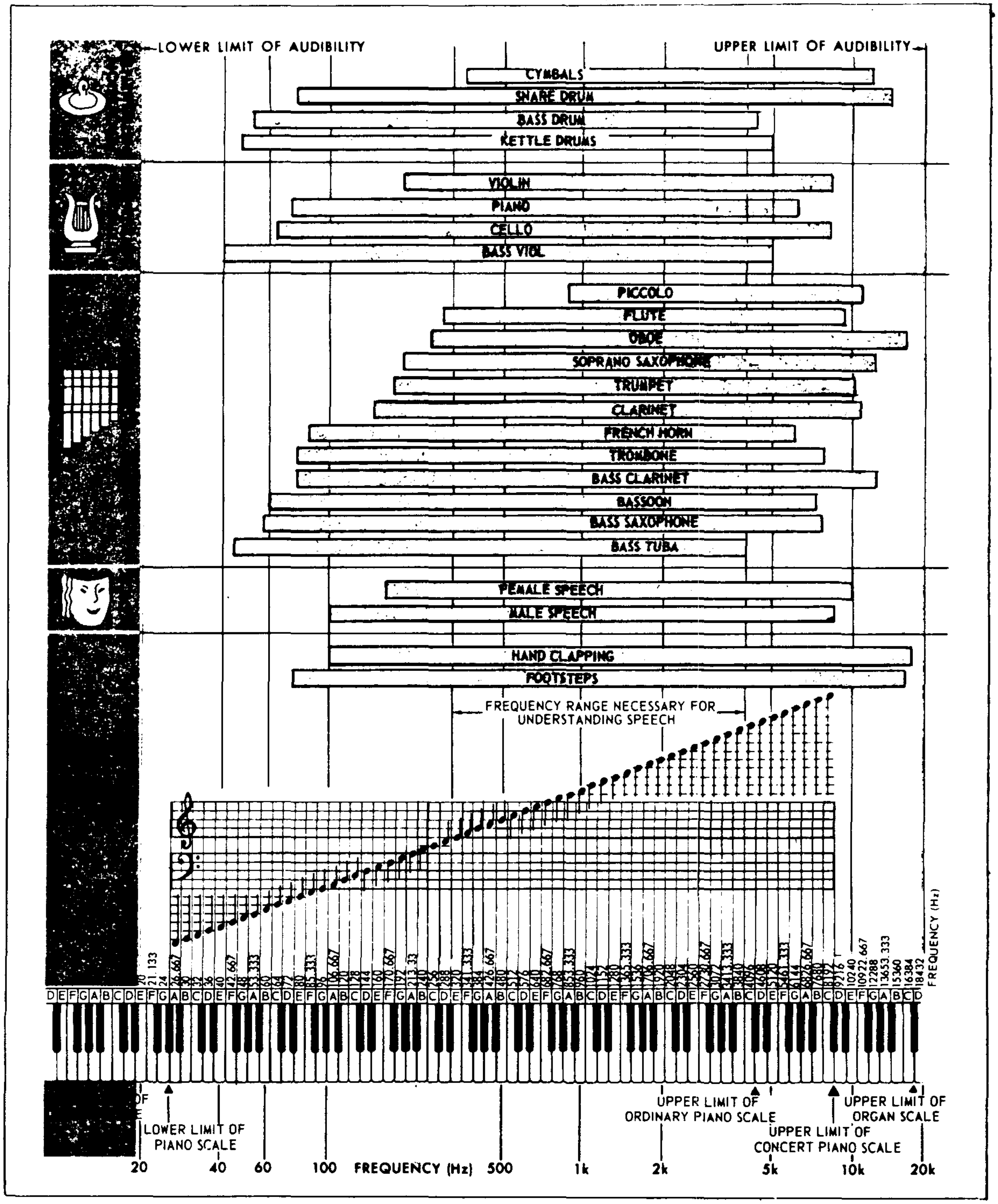


Figure 1. Audible sound frequencies of some musical instruments, voices, and other noises (approximate). (Courtesy of Sonotone Corp., Elmsford, NY. Reprinted by permission of EDN Magazine, April 1967.)

encountered temperatures, γ is equal to 1.4. If the medium may be considered a perfect gas (e.g., air), the speed of sound may also be expressed as

$$c = \sqrt{\gamma RT} \qquad (2)$$

where T is the absolute temperature and R is the ideal gas constant for the appropriate units. Substituting the values of the constants in equation (2), the speed of sound in air at a temperature t of 22°C (72°F) is

$$c = 20.05 \sqrt{(t+273)} = 344 \text{ m/sec} \qquad (t \text{ in } ^\circ\text{C}) \qquad (3a)$$

or

$$c = 49.05 \sqrt{(t+460)} = 1131 \text{ ft/sec} \qquad (t \text{ in } ^\circ\text{F}) \qquad (3b)$$

The simplest model of acoustic wave propagation is the free field. A free field is a region of space where the medium of wave propagation is considered to be homogeneous and free of obstructions. In a free field the sound from a point source radiates equally in all directions in the form of a spherical wave. As such, the intensity of the wave follows the same inverse square law as light, and the intensity drops to one-fourth its value each time the distance is doubled. The sound pressure drops by one-half when the distance from the source is doubled, since pressure can be shown to be proportional to the square root of intensity. The decrease in intensity or pressure does not hold everywhere within the free field. Near to the sound source (within about two or three wavelengths) the waves behave in a complicated manner requiring special mathematical description; this region is known as the near field. Further out, the inverse square relationship begins to hold; this region, theoretically extending indefinitely, is the far field. The intensity of a spherical wave in a free field at a distance r from the source is represented mathematically by

$$I = \frac{W}{4\pi r^2} = \frac{p^2}{\rho c} \qquad (4)$$

where I is the intensity in watts/m^2, W is the total acoustic power radiated by the source in watts, p is the root mean square sound pressure, and ρc is the product of the density of the medium and the speed of sound. This product is called the "characteristic impedance" of the medium through which the sound wave is traveling and is the constant of proportionality that relates the squared sound pressure to the sound intensity.

SOUND INTENSITY

The range of intensity which the human ear can perceive, from the barely discernible to the threshold of pain, is approximately seven orders of magnitude (10^7). The level of sensation is usually measured or reported in a smaller range of numbers by use of the logarithm of the ratio of the measured level to some reference level. For this purpose the unit of the Bel has been borrowed from telephone technology. The loudness of a sound is defined in Bels as

$$\text{number of Bels} = \log_{10} (I/I_o) \qquad (5)$$

where I is the intensity of sound and I_0 is the reference intensity, which has an agreed upon value of 1 picowatt/per square meter (pW/m^2). Therefore if $I = I_0$, the number of Bels is 0, and if $I = 10\ I_0$, the number of Bels is 1. The preferred unit for measuring sound has become the minimum difference in loudness that is usually perceptible, one-tenth of a Bel, or 1 decibel (dB); thus

$$\text{number of dB} = 10 \log_{10} (I/I_o) \tag{6}$$

When any acoustical quantity is expressed in terms of decibels relative to a reference quantity, it is known as a level. Thus the sound intensity level (L_I) is

$$L_I = 10 \log \frac{I}{I_o} \text{ dB re } I_o \tag{7}$$

It is clear from this expression that for each change in the intensity by one order of magnitude (factor of 10), the number of decibels is changed by 10; or, for each change in the intensity of a factor of 2, the number of decibels is changed by 3. Some decibel values for selected intensity ratios are shown in Table 1.

SOUND PRESSURE

Sound pressure is expressed in decibels for the same reason as intensity; the large range of values commonly encountered. As with sound intensity, there is a reference sound pressure, p_o, equal to 20 micropascals (μPa).

The sound pressure level in decibels is defined as the logarithm of the ratio of the mean squared pressure to the reference pressure squared:

$$L_p = 10 \log \frac{p^2}{p_o^2} = 20 \log \frac{p}{p_o} \text{ dB re } p_o \tag{8}$$

Note in the expression that the logarithm of the pressure ratio is multiplied by 20 instead of 10 as for sound intensity level. This is due to the fact that the pressure ratio is squared. Thus there is a 20 dB change in sound pressure level for an order of magnitude change in the sound pressure, and 40 dB change for an increase of 100 times; and instead of a 3 dB change for doubling as in sound intensity, there is a 6 dB change for doubling of sound pressure.

SOUND POWER

The amount of energy per unit time that radiates from a source in the form of an acoustic wave is sound power. If the source is enclosed by an imaginary surface, then all energy leaving the source must pass through this surface. This relationship can be written as

$$W = IS \tag{9}$$

where W is the sound power, S is the area of the surface enclosing the source, and I is the average intensity per unit area of the surface.

Table 1. Sound intensity level ratios and number of decibels for each.

Sound intensity ratio I/I_o	Number of decibels ($dB=10 \log (I/I_o)$)
1000.0	30.0
100.0	20.0
10.0	10.0
9.0	9.5
8.0	9.0
7.0	8.5
6.0	7.8
5.0	7.0
4.0	6.0
3.0	4.8
2.0	3.0
1.0	0.0
0.9	-0.5
0.8	-1.0
0.7	-1.5
0.6	-2.2
0.5	-3.0
0.4	-4.0
0.3	-5.2
0.2	-7.0
0.1	-10.0
0.01	-20.0
0.001	-30.0

If the source is in a free field, and radiates power equally, in all directions, then the sound power can be written from equation (4) as

$$W = I(4\pi r^2) \qquad (10)$$

where the enclosing surface is a sphere of radius r chosen for convenience. The expression for sound power level is given by

$$L_w = 10 \log_{10} \frac{W}{W_o} \text{ dB re } W_o \qquad (11)$$

where W is the sound power in watts, and W_o is the reference sound power of 10^{-12} watt or 1 pW. (NOTE: Some earlier texts use 10^{-13} watt as the reference value so whenever the power level is reported the reference used must also be stated.)

RELATIONSHIP BETWEEN SOUND INTENSITY, PRESSURE, AND POWER

For a young person with good hearing, the threshold of hearing at 1000 Hz (the quietest sound audible) corresponds to approximately a 20 μPa rms pressure. The Pascal (Pa) is the unit of pressure used throughout this volume, and is equal to one Newton per square meter. This value was thus chosen as the reference value for decibels of sound pressure P_o; a sound pressure of 20 μPa is 0 dB.

The reference sound intensity I_o was chosen to be 1 pW/m^2 so that the intensity level and the corresponding sound pressure level would be nearly numerically equal for spherical or plane sound waves in air at room temperature and sea level pressure.

Recalling equation (4), the relationship between L_p and L_I may be derived as

$$L_I = 10 \log \frac{I}{I_o} = 10 \log \frac{p^2}{\rho c\ I_o} = 10 \log \frac{p^2}{p_o^2} \frac{p_o^2}{\rho c\ I_o}$$

$$= L_p + 10 \log \frac{p_o^2}{\rho c\ I_o} \qquad (12)$$

Substituting the numerical values of the reference quantities, the density of air, and the speed of sound, equation (12) may be simplified to

$$L_I = L_p + 10 \log \frac{(20x10^{-6})^2}{(1.20)(344)(10^{-12})}$$

$$= L_p - 0.14 \approx L_p \qquad (12a)$$

Equation (4) may also be developed into a relationship between sound power and sound pressure

$$I = \frac{W}{S} = \frac{p^2}{\rho c} \qquad (4)$$

$$L_w = 10 \log \frac{W}{W_o} = 10 \log \frac{p^2 S}{\rho c\ W_o}$$

$$= 10 \log \left[\frac{p^2}{p_o^2} \frac{p_o^2}{\rho c\ W_o} S \right]$$

$$= L_p + 10 \log S + 10 \log \frac{p_o^2}{\rho c\ W_o} \qquad (13)$$

If spherical radiation into a free field is assumed, the power is radiated into a sphere of area $S = 4\pi r^2$ where r is the distance from the source to the measuring point.

Therefore

$$10 \log S = 10 \log 4\pi + 10 \log r^2 = 11 + 20 \log r$$

The values of the constants in the third term to the right in equation (13) are the same as in equation (12a) since W_o was chosen to equal I_o. Therefore, the third term is approximately zero and

$$L_w = L_p + 10 \log S = L_p + 20 \log r + 11 \text{ dB re 1 pW} \tag{14}$$

where r is measured in meters. If radiation occurs outdoors over the ground, the power is radiated into a hemisphere. The area S becomes equal to $2\pi r^2$ with the result that

$$L_w = L_p + 20 \log r + 8 \text{ dB re 1 pW} \tag{15}$$

with r again measured in meters. If the distance r is to be measured in feet, equations (14) and (15) become respectively

$$L_w = L_p + 20 \log r + 0.7 \text{ dB re 1 pW (spherical)} \tag{14a}$$

$$L_w = L_p + 20 \log r - 2.3 \text{ dB re 1 pW (hemispherical)} \tag{15a}$$

Equations (14) and (15) may be inverted to determine the sound pressure level if the sound power level is known. Generally, it is the sound pressure which is measured with microphones or other sensors and the sound power is then calculated. It is often desirable to know the sound power emitted by a source, since the sound power level remains almost constant regardless of the acoustic environment (free field, echos, etc.) the source is placed in. The sound pressure level developed by the same source will vary widely depending on the acoustic environment.

EXAMPLE 1: (a) Determine the sound pressure level at 10 m for a sound source radiating 116 dB re 1 pW uniformly into a free field. (b) Also determine the sound pressure level of this source at the same distance over a flat open plane.

SOLUTION: (a) Reversing equation (14) we have

$$\begin{aligned} L_p &= 116 - 20 \log 10 - 11 \\ &= 116 - 20 - 11 \\ &= 85 \text{ dB re } 20\ \mu\text{Pa} \end{aligned}$$

(b) Using equation (15) for hemispherical radiation

$$\begin{aligned} L_p &= 116 - 20 \log 10 - 8 \\ &= 116 - 20 - 8 \\ &= 88 \text{ dB re } 20\ \mu\text{Pa} \end{aligned}$$

For hemispherical radiation the result is just 3 dB greater than for spherical or free field radiation. This is borne out by the fact that radiation over a hard plane is like the radiation of a light bulb in front of a mirror. All light radiated into the hemisphere which contains the mirror is reflected into the hemisphere with which we are concerned. Or one may consider optically that there is a true source and an imaginary mirrow image that is also radiating which in effect gives us two identical sources and a 3 dB increase in sound pressure level.

To relate some of these values to how the human ear responds to sound is a complex process. Generally a change in sound pressure level of 1 dB can be just barely distinguished under proper conditions. A change of 3 dB in sound pressure level is readily discernable, and a change of 10 dB would give the psychological impression of doubling or halving the sound. Some common sounds, their sound pressure levels at a few feet, and sound power levels are listed in Table 2.

Table 2. Levels of some common sounds.

Sound power watts	Sound power level dB re 10^{-12} watt	Sound pressure Pa	Sound pressure level dB re 20μPa	Sound source
3000000.0	200	1 atmosphere	194	Saturn rocket
	185	20000.0	180	
	175		170	
30000.0	165	2000.0	160	Ram jet
	155		150	Turbot jet
300.0	145	200.0	140	Propeller aircraft
			135	Threshold of pain
	135		130	Pipe organ
3.0	125	20.0	120	Riveter, chipper
	115		110	Punch press
0.03	105	2.0	100	Passing truck
	95		90	Factory
0.0003	85	0.2	80	Noisy office
	75		70	
0.000003	65	0.02	60	Conversational speech
	55		50	Private office
0.00000003	45	0.002	40	Average residence
	35		30	Recording studio
0.0000000003	25	0.0002	20	Rustle of leaves
	15		10	Threshold of good hearing
0.000000000003	5	0.00002	0	Threshold of excellent youthful hearing

COMBINING DECIBELS

Since decibels represent the logarithm of the ratio of two quantities, they cannot be added directly. The antilogarithm must first be taken before the quantities can be combined arithmetically. This process is included automatically in decibel addition charts such as the one appearing in Figure 2.

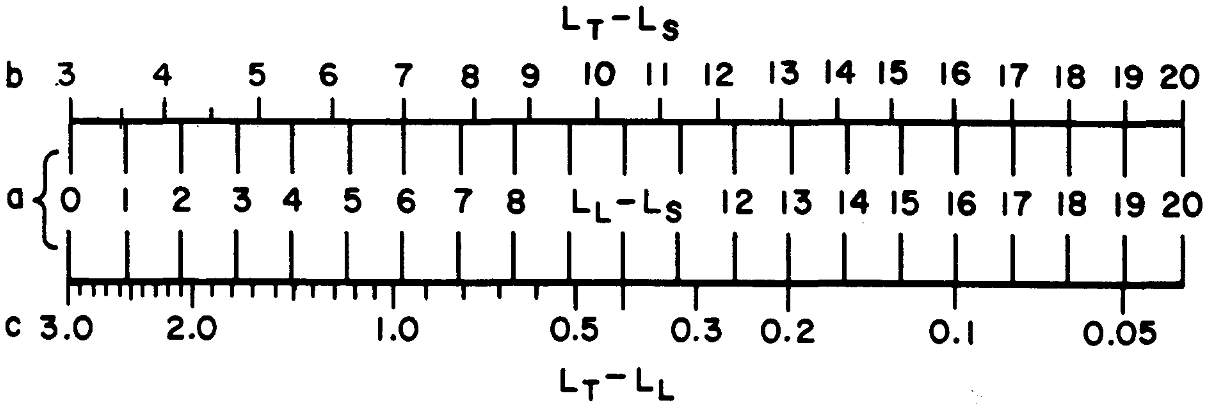


Figure 2. Chart for adding or subtracting decibels. Upper row b shows the difference between the total and smaller values. Bottom row c shows the difference between the total and larger values, and center row a shows the difference between the large and small values. (Chart good for any decibels--pressure, power, or intensity.) Use of this chart is shown in examples 7 and 8.

EXAMPLE 2: Two sources are radiating noise into a free field. One source has a sound power level of 123 dB and the other source has a sound power level of 117 dB re 1 pW. What is the combined sound power level of the two sources?

SOLUTION:

$$L_w = 10 \log \frac{W}{W_o}$$

or

$$W = W_o \text{ antilog } L_w/10$$

Source 1: $W_1 = 10^{-12}$ antilog 123/10

$= 10^{-12} \times 1.996 \times 10^{12} = 1.996$ watt

Source 2: $W_2 = 10^{-12}$ antilog 117/10

$= 10^{-12} \times 5.012 \times 10^{11} = 0.5012$ watt

$$W_T = W_1 + W_2 = 2.4972 \text{ watt}$$

$$L_w = 10 \log \frac{W_T}{W_o} = 10 \log \frac{2.4972}{10^{-12}}$$

$$L_w = 124 \text{ dB re } 1 \text{ pW}$$

The same process can be used for sound intensity level or sound pressure level. The solution is given to the nearest whole decibel since that was the accuracy implied by the problem statement.

EXAMPLE 3: Suppose the sound pressure level of each of the three individual noise sources is measured at a point such that with only the first source running, the sound pressure level is 86 dB re 20 μPa, with only the second source running it is 84 dB re 20 μPa, and with only the third source it is 89 dB re 20 μPa. What will be the sound pressure level at this point with all three sources running?

SOLUTION:

$$p_T^2 = p_o^2 \left[\text{antilog } \frac{L_{p1}}{10} + \text{antilog } \frac{L_{p2}}{10} + \text{antilog } \frac{L_{p3}}{10}\right]$$

$$= p_o^2 \; [\text{antilog } 8.6 + \text{antilog } 8.4 + \text{antilog } 8.9]$$

$$p_T^2 = p_o^2 \; [3.982 + 2.512 + 7.944] \times 10^8$$

$$= p_o^2 \times 14.438 \times 10^8$$

$$L_{pT} = 10 \log \frac{p^2{}_T}{p^2{}_o} = 10 \log [14.438 \times 10^8]$$

$$= 91.6 \text{ dB} \approx 92 \text{ dB}$$

Note that it was only necessary to add the pressure-squared values of the decibels, and the constant reference p_o^2 was carried through the calculations and not evaluated.

EXAMPLE 4: Add 85 dB and 88 dB using Figure 2.

SOLUTION: $L_L - L_S = 88 - 85 = 3$ dB. Enter row a at 3 and read row b to get 4.8 to be added to smaller level:

$$L_T = 85 + 4.8 = 89.8 \text{ dB} \approx 90 \text{ dB}$$

Or, enter row a to 3 and read value of row c to get 1.8 dB to be added to larger level:

$$L_T = 88 + 1.8 = 89.8 \text{ dB} \approx 90 \text{ dB}$$

To substract levels enter row b or c, whichever corresponds to the difference between the levels, then read value in row a which must be added (subtracted) to (from) the smaller (larger) value to obtain the unknown value.

EXAMPLE 5: Subtract 83 dB from 87 dB (see Figure 2).

SOLUTION: $L_T = L_s = 87 - 83 = 4$ dB. Enter row b to 4 and read value in row a of 1.7 which must be subtracted from the larger value of 87 dB to obtain the unknown value of 85.3 = 85.

EXAMPLE 6: Add the three sound pressure levels of Example 3 using the chart in Figure 2.

SOLUTION:

84 dB ⎤
⎥ 88.15 dB
86 dB ⎦ ⎤
⎥ 91.6 dB ≈ 92 dB
89 dB - - - - - ⎦

which is the same result obtained with the more lengthy procedure shown in Example 3.

DIRECTIONALITY

Now consider another aspect of the noise source; does the sound radiate equally in all directions in a spherical space? Until now it has been assumed that it does. If it does not, then one must be concerned with the directionality of the sound. The directionality of a sound source in a free field is given by the directivity factor Q_θ which will vary with the angle θ about the source. Q_θ is defined as the ratio between the squared sound pressure measured at an angle θ and a distance r from the source and the space-average squared sound pressure at the same distance r; that is

$$Q_\theta = \frac{p_\theta^2}{\bar{p}^2} = \text{antilog}\ \frac{L_{p\theta} - \bar{L}_p}{10} \qquad (16)$$

$L_{p\theta}$ = the sound pressure level measured at a distance r and an angle θ from the source

$\bar{L}_p$ = the average sound pressure level over the surface of an imaginary sphere with a radius of r

It is usually more convenient to express the directivity factor in its logarithmic form, the directivity index (DI_θ).

$$DI_\theta = 10 \log Q_\theta = L_{p\theta} - \bar{L}_p \qquad (17)$$

with directivity in mind, equation (14) should be modified accordingly:

$$L_w = L_{p\theta} + 20 \log r + 11 - DI_\theta \qquad (18)$$

If the source is placed on a hard reflective surface with a free field above, the power directed downward is reflected back up with the result that the intensity increases 3 dB (double) above that of the same source in a full free field. Equation (17) becomes

$$DI_\theta = L_{p\theta} - \overline{L}_p + 3 \qquad (17a)$$

while equation (18) remains the same. The 3 dB difference between equations (14) and (15) is now accounted for by the 3 dB in the DI_θ for hemispherical radiation. Note that if a source radiates uniformly into hemispherical free space, the DI_θ is equal to 3 and equation (18) reduces to equation (15).

EXAMPLE 7: What is the sound pressure level at 10 m in the direction of position 1 for a noise source when the free hemispherical field sound pressure levels measured at 3 m are

Position	L_p	Position	L_p	Position	L_p
1	100	5	89	9	101
2	94	6	90	10	100
3	97	7	93	11	97
4	93	8	96	12	95

SOLUTION: We must obtain $\overline{L}_p$ by averaging the pressures. Thus,

$$p_1^2 = p_o^2 \times \text{antilog } L_{p1}/10 = p_o^2 \times 10 \times 10^9 \text{ (Pa)}^2$$

$$p_2^2 = \qquad = p_o^2 \times 2.512 \times 10^9$$

$$p_3^2 = \qquad = p_o^2 \times 5.012 \times 10^9$$

$$p_4^2 = \qquad = p_o^2 \times 1.995 \times 10^9$$

$$p_5^2 = \qquad = p_o^2 \times 0.794 \times 10^9$$

$$p_6^2 = \qquad = p_o^2 \times 1.0 \times 10^9$$

$$p_7^2 = \qquad = p_o^2 \times 1.995 \times 10^9$$

$$p_8^2 = \qquad = p_o^2 \times 3.981 \times 10^9$$

$$p_9^2 = \qquad = p_o^2 \times 12.589 \times 10^9$$

$$p_{10}^2 = \qquad = p_o^2 \times 10 \times 10^9$$

$$p_{11}^2 = \qquad = p_o^2 \times 5.012 \times 10^9$$

$$p_{12}^2 = \qquad = p_o^2 \times 3.162 \times 10^9$$

$$\text{Total} = p_o^2 \times 58.052 \times 10^9$$

$$\text{Average} = p_o^2 \times 4.838 \times 10^9 \text{ (Pa)}$$

$$\overline{L}_p = 10 \log p^2_{avg} = 10 \log 4.838 \times 10^9$$

$$p^2_o = 96.9 \text{ dB re } 20\ \mu\text{Pa}$$

The average sound power level L_w is now determined from equation (15) since this radiation is hemispherical.

$$\begin{aligned} L_w &= \overline{L}_p + 20 \log r + 8 \\ &= 96.9 + 9.5 + 8 \\ &= 11.4 \text{ dB re } 1 \text{ pW} \end{aligned}$$

Now determine DI for position 1 from equation (17a).

$$DI_1 = 100 - 96.9 + 3 = 6.1 \text{ dB}$$

The sound pressure level at 10 m in the direction of position 1 can be found by inverting equation (18)

$$\begin{aligned} L_{p\theta} &= L_w - 20 \log r - 11 + DI_\theta \\ &= 114.4 - 20 \log 10 - 11 + 6.1 \\ &= 80.5 \text{ dB} \approx 81 \text{ dB re } 20\ \mu\text{Pa} \end{aligned}$$

To compare the results of averaging mean pressures with averaging sound pressure levels in this case $\overline{p^2}$ gives a value for $\overline{L}_p$ of 96.9 dB. By simply averaging the decibel values we would have obtained L_p = 95.4 which is about 1.5 dB low. This example points out the difference in the values obtained between arithmetic averaging of the decibel levels and averaging of the true values. Whenever a set of decibel levels of any sort must be averaged a simple arithmetic averaging process will yield a result that is lower than the true average of the measured value. This holds true for decibel sound power, decibel sound intensity, decibel sound pressure, or any other decibel numbers. However, if the spread of data to be averaged is less than 3 dB, a simple arithmetic average will yield reasonably accurate results.

NOISE WEIGHTING AND FILTERING

Thus far only the magnitude of sound has been discussed. Sound is generally not composed of a single frequency oscillating wave--sound can be made up of many frequencies, all existing simultaneously. A young, healthy ear is sensitive to the sound frequency range from about 20 to 20,000 Hz. This range narrows with age of the listener plus any possible hearing loss that may have occurred, so that for a normal adult the upper frequency limit may be approximately 14,000 Hz. Also the ear response varies with different frequencies; the least sensitivity in the lower frequency range and the greatest sensitivity in the range 2000 to 4000 Hz. This difference in sensitivity with frequency tends to become less as the intensity of the sound increases. Consequently, to build an instrument that responds to sound in a manner similar to the human ear, acousticians have developed four frequency weighting networks for measuring sound. These correspond to the A-, B-, C-, and D-weighting curves, and are electronic filters which attenuate the signal at different frequencies as shown in Figure 3. The specific attenuation versus frequency is shown in Table 3. At most common sound levels, the A-weighting curve corresponds most clearly to the response of the human ear; and consequently the A-weighting network is normally used in noise control work.

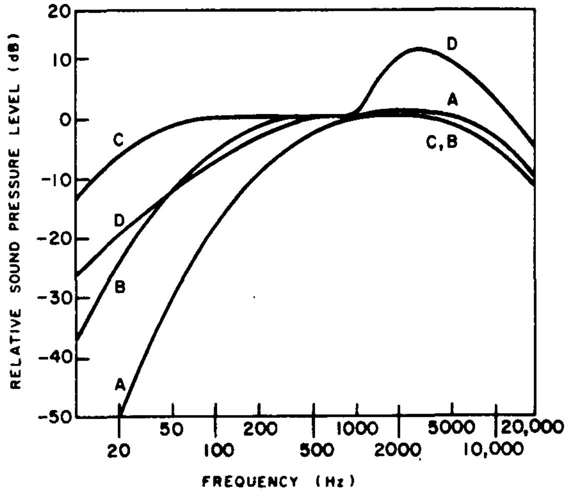


Figure 3. Standard A-, B-, and C-weighting curves for sound level meters; also proposed D-weighting curve for monitoring jet aircraft noise.

Other filters used to analyze acoustic energy pass a narrower range of frequencies than the A-, B-, C-, or D-curves. These filters are of two types--the first a constant bandwidth filter. This type of filter generally has a narrow bandwidth of a few hertz which does not change as the operating frequency changes. The second type of filter is more commonly used in acoustics and is a constant percentage bandwidth filter. The width of the band being utilized is a fixed percent of the frequency at which the instrument is operating.

For example, a 6 percent bandwidth filter would have a bandwidth of 60 Hz when it is set to operate at 1000 Hz, and a bandwidth of 120 Hz when operating at 2000 Hz.

The constant percentage filters most often used in acoustics are octave band filters or some submultiple of an octave such as one-half octave, one-third octave, or one-tenth octave. The logarithmic difference between each upper frequency limit, f_2, and the corresponding lower frequency limit, f_1, for constant perentage filters is also a constant. For octave band filters, this difference by definition is

$$\log f_2 - \log f_1 = \log \frac{f_2}{f_1} = \log 2 \qquad (19)$$

Table 3. A-, B-, and C-weighting networks for sound level meters as specified by ANSI SI.4-1971

Frequency Hz	A-weighting relative response dB	B-weighting relative response dB	C-weighting relative response dB
10	-70.4	-38.2	-14.3
12.5	-63.4	-33.2	-11.2
16	-56.7	-28.5	- 8.5
20	-50.5	-24.2	- 6.2
25	-44.7	-20.4	- 4.4
31.5	-39.4*	-17.1	- 3.0
40	-34.6	-14.2	- 2.0
50	-30.2	-11.6	- 1.3
63	-26.2*	- 9.3	- 0.8
80	-22.5	- 7.4	- 0.5
100	-19.1	- 5.6	- 0.3
125	-16.1*	- 4.2	- 0.2
160	-13.4	- 3.0	- 0.1
200	-10.9	- 2.0	0
250	- 8.6*	- 1.3	0
315	- 6.6	- 0.8	0
400	- 4.8	- 0.5	0
500	- 3.2*	- 0.3	0
630	- 1.9	- 0.1	0
800	- 0.8	0	0
1000	0 *	0	0
1250	+ 0.6	0	0
1600	+ 1.0	0	- 0.1
2000	+ 1.2*	- 0.1	- 0.2
2500	+ 1.3	- 0.2	- 0.3
3150	+ 1.2	- 0.4	- 0.5
4000	+ 1.0*	- 0.7	- 0.8
5000	+ 0.5	- 1.2	- 1.3
6300	- 0.1	- 1.9	- 2.0
8000	- 1.1*	- 2.9	- 3.0
10000	- 2.5	- 4.3	- 4.4
12500	- 4.3	- 6.1	- 6.2
16000	- 6.6	- 8.4	- 8.5
20000	- 9.3	-11.1	-11.2

*Values used for converting octave band readings into A-weighted sound levels.

and

$$f_2 = 2f_1 \tag{20}$$

If each filter has a frequency range equal to a submultiple, k, of an octave, then the constant difference is

$$\log f_2 - \log f_1 = \frac{\log 2}{k} = \log 2^{1/k} \tag{21}$$

and

$$f_2 = 2^{1/k} f_1 \tag{22}$$

NOTE: In the special case of one-third octave bands ($k = 3$), since $2^{1/3} = 1.25992$ and $10^{1/10} = 1.25893$, $f_2 = 10^{1/10} f_1$ is used in practice for computational convenience.

The center frequency, f_c, of a constant percentage filter is the logarithmic or geometric mean of f_1 and f_2

$$f_c = \text{antilog} \frac{\log f_1 + \log f_2}{2} = (f_1 \; f_2)^{1/2} \tag{23}$$

$$f_c = (2^{1/k} f_1 \; f_1)^{1/2} = 2^{1/2k} f_1 = 2^{-1/2k} f_2 \tag{24}$$

and

$$f_1 = 2^{-1/2k} f_c \tag{25}$$

$$f_2 = 2^{1/2k} f_c \tag{26}$$

The constant percentage, P_k, for a set of filters is thus

$$P_k = 100 \frac{(f_2 - f_1)}{f_c} = 100 \; (2^{1/2k} - 2^{-1/2k})$$

$$k = 1,2,3 \ldots \tag{27}$$

The most common constant percentages used are 70.7 percent of the center frequency for octave band filters and 23.2 percent for one-third octave bands.

For a broadband sound the octave band sound pressure level will be just the sum of the three one-third octaves that make up the octave band. Similarly, if measurements are made in one-tenth octaves then 10 of these will add up to the sound pressure level in the octave band. This addition must be made of the mean sound pressures squared and then converted to decibels or the decibels can be added using Figure 2. For example, if the three one-third octave levels are 65, 68, and 70 dB we get 72.9 dB for the octave band. The preferred series of octave band and one-third octave band center frequencies, as specified by ANSI S1.6, along with upper and lower frequency limits are shown in Table 4.

Table 4. Center and cutoff frequencies for preferred series of contiguous octave and one-third octave bands as specified by ANSI S1.6

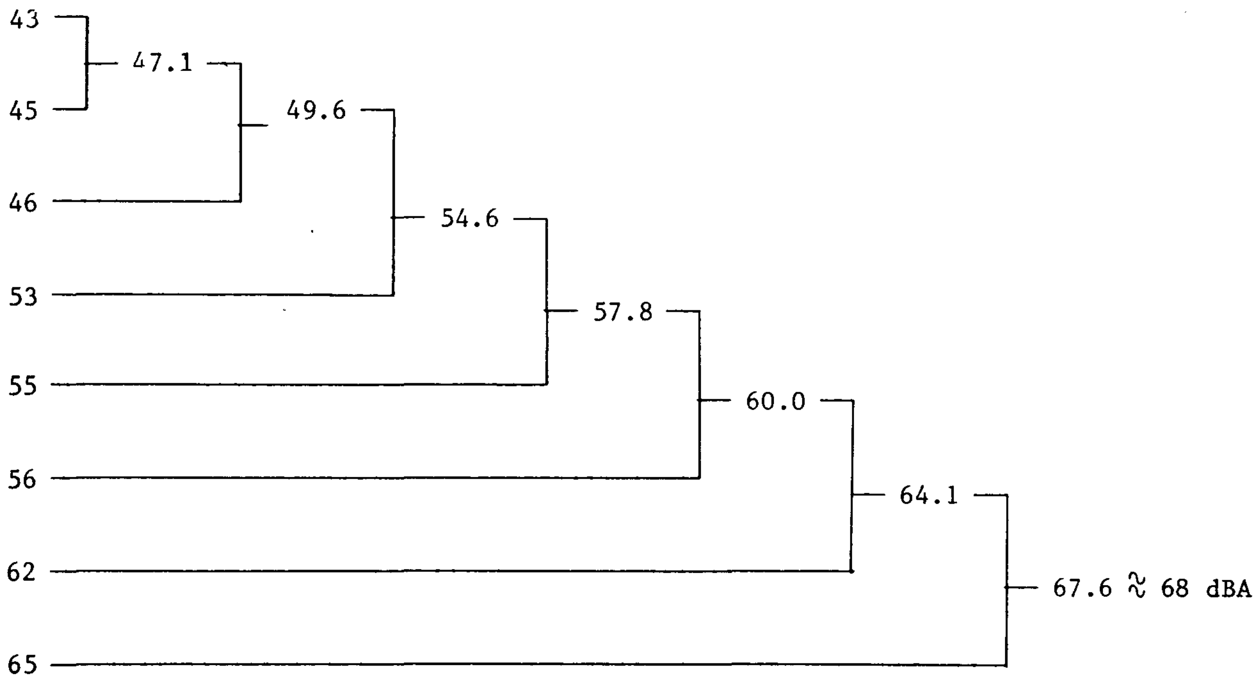
Frequency, Hz					
Octave			One-third octave		
Lower band limit	Center	Upper band limit	Lower band limit	Center	Upper band limit
11	16	22	11.2	12.5	14.1
			14.1	16	17.8
			17.8	20	22.4
22	31.5	44	22.4	25	28.2
			28.2	31.5	35.5
			35.5	40	44.7
44	63	88	44.7	50	56.2
			56.2	63	70.8
			70.8	80	89.1
88	125	177	89.1	100	112
			112	125	141
			141	160	178
177	250	354	178	200	224
			224	250	282
			282	315	354
354	500	707	354	400	447
			447	500	562
			562	630	707
707	1000	1414	707	800	891
			891	1000	1122
			1122	1250	1414
1414	2000	2828	1414	1600	1778
			1778	2000	2239
			2239	2500	2828
2828	4000	5656	2828	3150	3548
			3548	4000	4467
			4467	5000	5656
5656	8000	11312	5656	6300	7079
			7079	8000	8913
			8913	10000	11220
11312	16000	22624	11220	12500	14130
			14130	16000	17780
			17780	20000	22390

EXAMPLE 8: The unweighted octave band sound pressure levels for a particular noise source are as shown below. Determine the A-weighted level of this source.

SOLUTION: The A-weighted correction factors (rounded to the nearest decibel) from Table 3 corresponding to each octave band center frequency are added to the sound pressure levels as shown in the table below.

Octave band frequency, Hz	63	125	250	500	1000	2000	4000	8000
SPL, dB	71	62	64	68	62	55	52	44
A-weighted correction, dB	-26	-16	-9	-3	0	+1	+1	-1
SPL, dBA	45	46	55	65	62	56	53	43

The corrected octave band levels in the bottom row are then summed, either mathematically or with the aid of Figure 2.



INSTRUMENTS FOR NOISE MEASUREMENTS

MICROPHONES

The basic sensing instrument for measuring sound pressure in air is the microphone. These sensors come in a variety of sizes and types but they all have one thing in common. The basic sensor is a diaphragm which is forced to vibrate as the sound wave impinges upon it. This vibratory motion is then converted into an electrical signal in any one of a number of ways.

One of the ways to sense sound is to use the diaphragm as one side of a capacitor to which a large polarizing voltage is applied. Any movement in the diaphragm results in a change in the capacitance and an electrical signal is generated.

A second type of microphone is one in which the diaphragm is attached directly to a piezoceramic material. Motion of the diaphragm causes strain in the ceramic which results in the generation of an electronic signal. These microphones are generally less sensitive than the capacitor types since the diaphragm is mounted directly to the ceramic, although a polarization voltage is not required.

A third type is the dynamic (moving coil) microphone. In this type the diaphragm is attached to a coil which is forced to move through a magnetic field as the diaphragm moves. The movement of the coil through the magnetic field causes a current to flow in the coil. These microphones have a lower electrical impedance than condenser or ceramic microphones. Because of the mass of the coil, however, these microphones are more sensitive to vibration. Additionally, their magnetic operating principle makes them susceptible to external magnetic fields, and their low frequency response is limited due to the large excursions of the coil needed as the frequency is lowered.

A newcomer to the microphone arena is the electret microphone. These are capacitor microphones but the air gap between the capacitor plates is replaced with a prepolarized dielectric. This construction offers the quality of the capacitor microphone but elminates the need for the direct current bias voltage. These microphones are of more simple and rugged construction, and have a higher capacitance which simplifies some of the electrical problems associated with the very small capacitance of the capacitor type microphones.

The sensitivity of a microphone is generally dependent on the frequency and direction of the incident sound wave, and size of the diaphragm. The sensitivity at a given frequency is defined as the ratio of the root mean square output voltage to the root mean square sound pressure and is given in units of volts per pascal or other similar units.

If the sensitivity is measured by applying the sound pressure uniformly over the surface of the diaphragm with an electrostatic actuator the response is called pressure response.

The free field response at a given frequency is defined as the ratio of the root mean square output voltage to the root mean square sound pressure that existed at the microphone location prior to the insertion of the microphone.

These two definitions are identical for a microphone with negligible dimensions. However, when the wavelength of the sound wave becomes comparable to the dimensions of the diaphragm, the microphone acts as a reflector which causes an increase in pressure on the diaphragm and a corresponding increase in output voltage. This reflection effect also depends on the angle of incidence of the sound wave on the diaphragm.

Since it is impossible to make a microphone with zero dimensions there will always be some effect on the sound field when the microphone is inserted. Therefore, to obtain the pressure that exists at that point before the microphone is inserted one must apply correction to the sensitivity of the microphone. In Figure 4 some corrections are shown that must be applied to the microphone sensitivity as a function of frequency in kilohertz (kHz) and angle of incidence on the diaphragm.

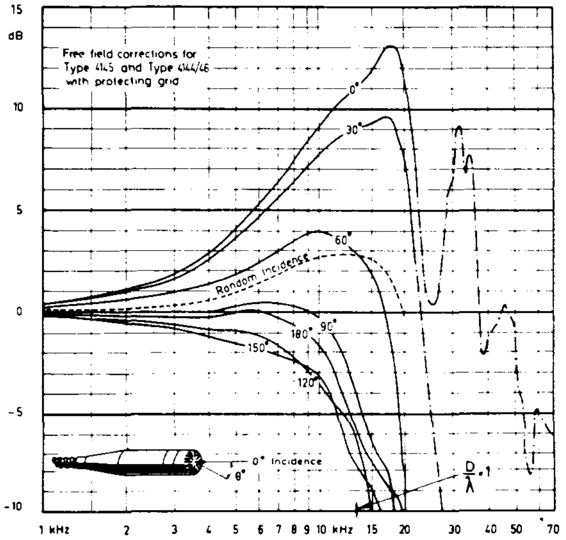


Figure 4. Free field correction for microphone with protecting grid (electrostatic actuator method of pressure calibration). (Courtesy Bruel & Kjaer Instruments Inc.)

As previously mentioned the increase in pressure at the diaphragm for wavelengths comparable to the dimensions of the diaphragm shows up very clearly in the sensitivity correction that must be applied when the sound wave is incident normally on the diaphragm. Note how close the peak in the zero incidence correction curve comes to the frequency where the wavelength equals the diameter of the diaphragm (shown in this figure as D/λ = 1).

Another view of the dependence of sensitivity on frequency and angle of incidence is shown in Figure 5. In this figure the relative response for five frequencies through the full 360 deg of possible incidence are shown. For the microphone shown, the circular symmetry makes the response symmetric about the axis of the diaphragm.

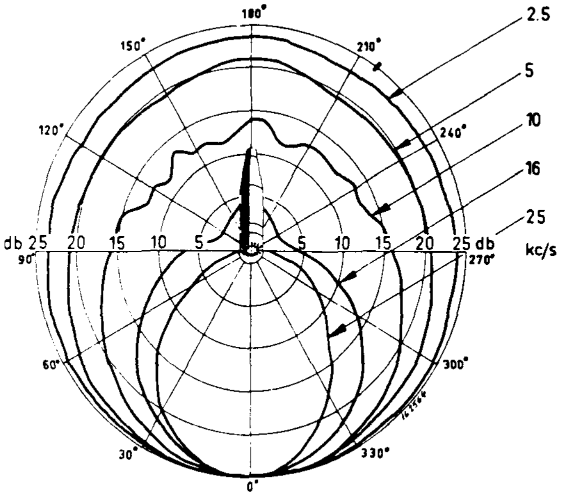


Figure 5. Typical directional characteristics for 1-inch microphone with protecting grid. (Courtesy Bruel & Kjaer Instruments Inc.)

To reduce the complexity of applying these corrections when using a microphone the manufacturers have designed microphones with proper tension and damping on the diaphragm so that either a free field response may be obtained directly or a pressure response will result. Figure 6 shows the response of a typical "pressure" microphone (Bruel & Kjaer 2.54 cm (1-inch) microphone). This type of microphone should be pointed at 90 deg to the source of the sound to obtain the proper flat frequency response. A flat frequency response is one in which the microphone sensitivity is independent of frequency.

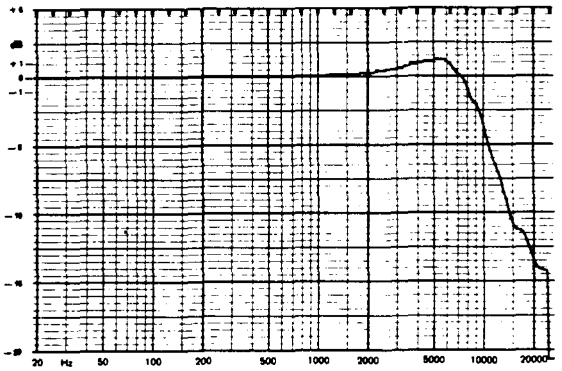


Figure 6. Frequency response curve supplied by B&K Instruments with 1-inch pressure microphone type 4144. (Courtesy Bruel & Kjaer Instruments Inc.)

To produce a so-called free field microphone, this manufacturer has constructed the diaphragm so that the pressure response is as shown in the lower curve in Figure 7. If the microphone is pointed at the sound source (0 deg incidence) the correction factor for 0 deg shown in Figure 4 must be applied. As an example, observe that the lower response curve in Figure 7 is -9 dB at 10,000 Hz. The 0 deg incidence correction curve at 10,000 Hz in Figure 4 is +9 dB. Adding the two curves at this frequency brings the free field response up to 0 dB-- the frequency response becomes flat.

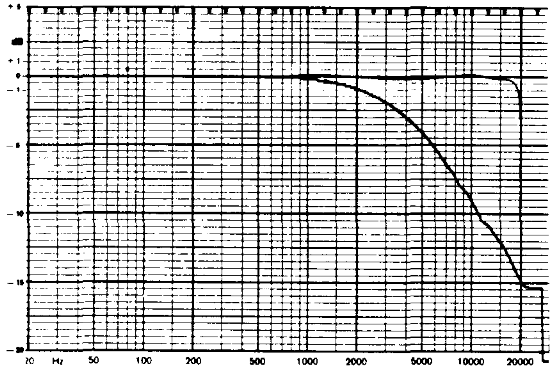


Figure 7. Frequency response curve supplied by B&K Instruments with 1-inch free field microphone type 4145. (Courtesy Bruel & Kjaer Instruments Inc.) Lower curve: microphone pressure response. Upper curve: microphone pressure response with correction added for zero angle of incidence giving the free field response.

These general characteristics hold for most microphones. If one desired to use a microphone which qualifies as a precision instrument he can take assurance in the fact that standards for the performance of such microphones are published by the American National Standards Institute (ANSI), for example, ANSI S1.12-1967, "Specifications for Laboratory Standard Microphones." When purchasing such a microphone the manufacturer will supply the buyer with a calibration curve, stating to which appropriate standard the microphone complies and this calibration will be traceable to the National Bureau of Standards (refer to standard ANSI S1.10-1966, "Method for the Calibration of Microphones").

SOUND LEVEL METERS

In its basic form a sound level meter (SLM) is simply a microphone mounted on an amplifier with a meter to indicate the level of the sound pressure at the microphone. While construction details may vary, all SLM should read the same value when exposed to the same sound pressure. Consequently, ANSI has another standard for sound level meters - ANSI S1.4-1971, "Specification for Sound Level Meters". This standard clearly points out the tolerances within which the meter must be able to measure sound pressure levels. NIOSH maintains a certification program for industrial sound level meter sets. The certified meters are essentially those meeting the ANSI S1.4-1971 standard for a type 2 sound level meter set to A-weighting and slow response. A list of certified meters is available in the NIOSH Certified Equipment List.

As previously discussed, sound is composed of both amplitude and frequency, and the A-, B-, C-, and D-weighting curves were introduced along with band pass filters. A typical SLM may incorporate some or all of these filters such as shown in the block diagram of Figure 8. The "typical" SLM has the microphone mounted on the front and the output is amplified and fed to one of the filter circuits as selected by a switch. Band pass filters are usually of the constant percentage or fractional octave type. Constant bandwidth filters are not usually provided on portable meters.

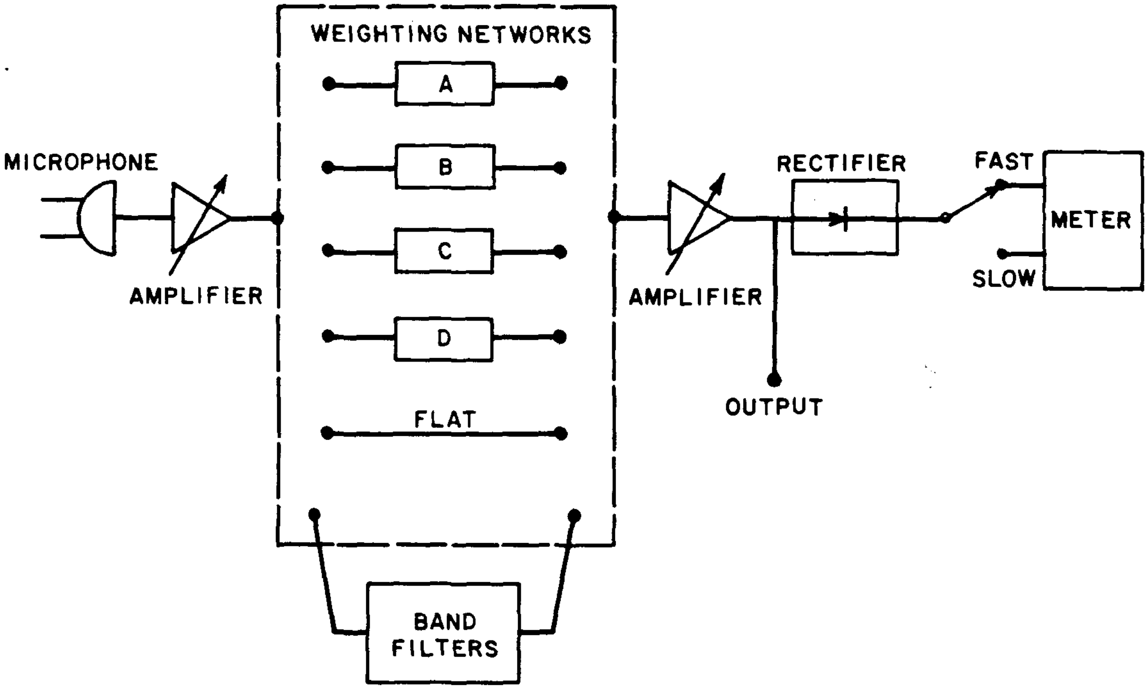


Figure 8. Block diagram of a sound level meter.

After passing through the selected filter network the signal is again amplified. At this point an output jack is provided so that the signal may be recorded on tape or fed to some other signal analyzing device. After being amplified the signal goes to a mean square rectifier and the value is displayed on a meter in decibel units. Note here that the meter may have either a fast or slow response which is switch selectable. The fast response provides an averaging time of 200 to 250 ms. The slow response position averages the signal for a greater period of time.

Each of the blocks shown in Figure 8 is covered in the specifications of ANSI S1.4-1971, including the response time of the meter. While this standard does not specify which of the filter circuits a SLM must have it does specify how accurately the weighting curves must correspond to the attenuations shown in Table 3. The accuracy requirements are divided into four groups:

Type 0 - Laboratory standard SLM (proposed)

Type 1 - Precision SLM (most stringent)

Type 2 - General purpose SLM

Type 3 - Survey SLM (least stringent)

A fifth type called special purpose SLM includes those which have only a portion of the variations possible. These special purpose meters must meet the standard for those features they do incorporate.

Only sound levels that are reasonably steady in time have been considered thus far. Another noise type which must be considered is the so-called "impulse" noise. This is a sound of short duration such as a gunshot or the noise produced by a hammer striking an object. To measure such sounds the SLM described is not very well equipped because the meter simply cannot respond fast enough. These sounds can best be measured by connecting the SLM output to a storage oscilloscope and reading the peak amplitude from the display. However, there are some instruments available which incorporate a "peak hold" feature. This is an instrument that has a very fast response electrical circuit which measures the peak of the sound pressure pulse and holds the value long enough for the meter to display the value that is held. The meter then holds this value until the operator resets the instrument.

Currently being considered by international standards groups is another meter response time called "impulse" response. This impulse measurement is between the meter fast response time and the true peak measurement (see S/V Sound and Vibration, March 1974).

CALIBRATION OF SOUND LEVEL METERS

Although a SLM comes from the factory calibrated and is provided with the appropriate traceability to the National Bureau of Standards, its performance must be checked on a regular basis. Several devices are available for this purpose. The most common of these is a calibrator which fits directly over the microphone and generates a known pressure level within the closed volume by the motion of a piston back and forth or with a small loudspeaker. It is recommended that a sound level meter be calibrated with a compatible acoustical calibrator before and after a measurement period. The manufacturer's instructions should be followed for procedures and corrections for environmental conditions such as temperature and atmospheric pressure. A complete recalibration of the sound level meter and acoustical calibrator is recommended on a periodic basis.

FREQUENCY ANALYZERS

Since a SLM is a small portable device it cannot incorporate all of the capabilities to analyze sounds which an engineer may desire. For this reason an output jack is often provided. With this output the engineer can either record the sounds on tape or he may connect the SLM directly to some other signal analysis device.

Some of the devices which find particular use in acoustics are frequency analyzers which can produce frequency spectra in real time in almost any desired bandwidth or type. These "real time analyzers" are generally of two types. The first is the multiple filter in which the electronic signal is fed to many filters simultaneously and the output of each is displayed in suitable fashion. The second type uses a time compression technique and feeds the signal through a single variable filter at such a speed that the signal appears to have been run through many filters at once. Of increasing importance in recent years have been analyzers which employ the same techniques in a digital manner. These analyzers are rather large expensive devices and are therefore not on the equipment list of the average individual or small company. The types of analysis that can be performed with these or other even more sophisticated instruments are many and varied.

METHODS OF NOISE CONTROL

The basic idea behind the techniques for limiting a person's exposure to noise is very simple and straightforward. The reference frame dealt with in noise reduction is composed of a sound source, the sound wave path, and a sound wave receiver which, in common circumstances, is an ear or a microphone that is used for measurement.

The best and most satisfying means of reducing noise levels is to reduce the source sound output. This approach may require major modifications, including better quality control, closer tolerances on moving parts, better balancing of rotating parts, and sometimes even a complete redesign of the technique utilized to perform the job for which this machine is intended. Since something vibrating causes compression and rarefaction of the air which is observed as sound, the above mentioned and many other modifications to a sound source are all aimed toward reducing the vibration of any part to the lowest possible level. Normally these modifications are not within the capability of the user and therefore must be left to the equipment manufacturers. Fortunately for those directly affected, manufacturers are beginning to make these changes.

At the other end of the noise control path is the receiver. The method of controlling noise exposure at the receiving end usually means removing the affected person from the sound field. When this cannot be done the alternative is to have the person wear ear muffs or ear plugs. This procedure is actually a control on the path of the noise but since it is incorporated directly with the receiver it is considered a receiver application.

The middle course of action is modification to the path the sound takes from the source to the receiver. It is with controls on the sound path that most of the items listed in this document are concerned.

Sound can reach a listener's ears by several different routes. The most obvious for internal noise sources is the direct path, a straight line through the air from source to receiver. In a given room, reflections from walls, ceiling, floor, or any solid objects may contribute as much or more to the sound pressure level than the direct path. As sound travels through solids and air, it may travel an indirect route through floors and walls and arrive at the receiver after reradiation.

Paths for external sound include penetration through and/or around open or closed doors, partitions, walls, windows, roofs, ceilings and floors. The effectiveness of a well-designed acoustical wall can be largely destroyed by relatively small openings.

Basically the two different acoustic environments that are employed in evaluating noise sources or the effectiveness of acoustic insulation are the free field and diffuse field. As previously mentioned a free field is defined as a homogenous, isotropic medium, free from boundaries.

A reverberant field exists when sound from the source bounces back and forth from the hard surfaces of the room such that the sound pressure level at any point is composed of many such reflected waves. In an ideal reverberant field the sound waves are perfectly reflected with no loss in intensity and a diffuse condition exists where the sound pressure level is equal everywhere. In real life, a perfect free or reverberant field is rarely found. Sound almost always propagates in an environment between these two extremes. Only in laboratories may approximations to these ideal fields be found. An anechoic (echo free) room has its walls, floors, and ceilings lined with material which absorbs the sound waves which reach it. The absence of reflections produces a sound field which is essentially free at most frequencies. A reverberation room on the other hand has walls, floor, and ceiling constructed of hard, solid materials to reflect as much of the sound waves as possible. The reflections in the sound field, along with the presence of irregularities in the surfaces and large rotating vanes produce a reverberant field. Most test procedures for acoustic materials have evolved around the use of a reverberation room.

In actual conditions when a sound wave strikes a surface it is partially reflected, partially transmitted through the surface, and partially absorbed. These interactions of sound waves and surfaces will be examined in turn.

The practical approach to noise control takes into account the noise sources, paths, and receivers. The following items must be determined successively to accomplish noise control:

1. Noise criteria for each occupied space.
2. Sound power level of the noise produced by each source.
3. Noise levels at typical employee positions in that space.
4. Attenuation of the noise by walls, ducts, etc., between each source and the space in question.
5. Required additional attenuation (item 3 minus item 1).
6. Identify major noise sources and select noise control treatment.
7. Any special mountings of the devices necessary to control flanking noise.
8. Any vibrating elements whose vibrations may be transmitted to some other member causing it to become a noise radiator.

Criteria: The first of these items, criteria for the space, is not part of the scope of this compendium. In a factory the criteria are determined by some federal agency such as the Occupational Safety and Health Administration (OSHA). In an office environment or concert hall the factors determining acoustic criteria are more numerous and complex than just a requirement for reduction of the sound pressure level to conserve hearing.

Sound Power: The second item is more straightforward. If at all possible one should obtain from the manufacturer of a noisy device the sound power levels that have been measured in the laboratory. Fortunately, more and more manufacturers are taking such measurements and data are becoming available. Barring this course one must make his own measurements of sound power, which can be very difficult if not completely impossible on a large piece of machinery in a factory environment. One usually is forced to make sound pressure level measurements at many locations around the noise source and attempt to estimate the sound power. The effects of other machinery, the room itself, background noises, etc., can preclude a very accurate determination.

The procedure for determining sound power is basically simple. Make enough measurements on a hemisphere around the source in a quiet anechoic space above a hard floor. If one is careful to choose his points on this hemisphere such that each measurement represents an equal area of the surface, then the sound power is computed with the aid of equations (14) or (18). It is important to realize that this procedure only produces accurate results if the measurements are made in a free field environment. When performed in a factory the results are far from accurate but provide an estimate of the sound power.

Noise Levels: The sound pressure levels must be measured at all locations where it is desirable to reduce the noise. These measurements must include an A-weighted sound pressure level, dBA, and they should also include measurements in each of the octave bands. For engineering analysis of machine noise sources a narrow band analysis of the noise can also be of value if the presence of pure tones is observed. This frequency analysis is an aid in determining the source of the noise as well as being necessary to make a proper selection of the noise control item. The best choice of noise control item is made by obtaining the closest fit possible between the noise spectrum and the noise reduction spectrum of the noise control device.

Noise Attenuation: Having measured the sound pressure levels and knowing the criteria that must be met, the noise level now must be reduced by the required amount. The fourth and fifth items can best be handled at the same time. When attempting to reduce the noise levels one is faced with the fact that the presently existing attenuation is not sufficient and more must be done. If the attenuation is sufficient this will be evident when the noise levels are measured at the desired locations.

Noise Control Devices: This item concerns the selection and use of noise reducing devices, and because this is the subject that occupies most of the latter portion of the compendium, it is only defined at this point.

Mountings: When the goal is to keep noise from traveling, any possible path should not be overlooked. Normally one thinks of sound traveling through the air but this certainly is not the only medium that will support sound waves. In fact, sound travels very well in most solids.

Therefore when one deals with flanking and transmission problems it must be remembered that the hard materials are very good conductors of sound. An aid in reducing sound transmitted through these objects is the mismatch of mechanical impedances at boundary surfaces such as from air to steel, or steel to wood. Just as with electrical power transmission, the greater the mismatch of impedances the more reflection of energy and loss in power transfer results. As in electronics, the optimum power is transferred when the impedances of the two items are equal. The same holds true for acoustics. Therefore, flanking paths can be greatly reduced by introducing materials in the path of the sound which have poorly matching mechanical impedance. For example, place pieces of rubber or cork between structural steel members, mount items on a material different from the main support, etc.

The most commonly occurring flanking path is an actual opening in the partition. A direct leak such as this can completely destroy the effectiveness of any sound barrier.

Vibration: Noise from vibrating elements may be considered as another aspect of the flanking problem. Vibrations in a solid structure may be radiated as sound. The use of vibration isolation devices causes a mechanical impedance mismatch between a vibrating machine and the surrounding structures, preventing vibrational energy from reaching any elements which may prove to be good sound radiators.

SOUND ABSORPTION

The sound absorbing quality of a material is described by an absorption coefficient, α, which is defined as the ratio of the total energy incident on a surface minus the energy reflected from the surface, to the energy incident upon the surface. As such the absorption coefficient can vary between zero and one. When the energy is perfectly reflected the ratio is zero and when the energy is completely absorbed this ratio is one. The absorption coefficient of a surface depends on the frequency of the sound impinging on it. To completely specify the absorption properties of a material, a table or curve of α versus frequency must be obtained.

The mechanism of sound absorption is that the acoustic energy of the wave is converted to some other form of energy, usually heat. Three major means of converting the acoustic energy are by using porous absorptive materials, diaphragmatic absorbers, and resonant or reactive absorbers.

Porous absorptive materials are the best known of the acoustical absorbers. These are usually fuzzy, fibrous materials, perforated board, foams, fabrics, carpets, and cushions, etc. In these materials the sound wave causes motion of the air in the spaces surrounding the fibers or granules, the frictional energy losses occur as heat, and the acoustic energy is reduced. Because this is the mechanism by which these materials absorb sound, it is easy to see that a "too loose" material will not cause enough frictional energy loss and will be a poor absorber. On the other hand, a material which is too dense will not permit enough air motion to generate sufficient friction and will also be a poor absorber. The latter type of material is more of a reflector than an absorber.

In a diaphragmatic absorber the panel oscillates at the same frequency as the sound wave impinging upon it (or at some harmonic). Since no material is perfectly elastic, the natural damping will absorb some of the incident energy. This type of absorber is usually more effective at lower frequencies since the higher frequencies tend to be reflected. Since the absorption coefficient of this absorber type is very dependent on mass, rigidity, size, shape, and mounting methods, it is difficult to forecast how any particular panel will operate in practice. Usually it is necessary to test prototypes for each specific application.

Resonant or reactive absorbers (often called Helmholtz resonators) are cavities which confine a volume of air which is connected to the atmosphere by a small hole or channel in the cavity. If the cavity is very small compared with the wavelength of the incident sound wave, the air in the connecting channel is forced to oscillate into and out of the cavity. The air inside the cavity acts as a spring and the kinetic energy of the vibration is essentially that of the air in the channel moving as an incompressible and frictionless fluid. This type of absorber has a very narrow frequency band where absorption takes place and as such its use is somewhat limited. This narrow band of absorption can be broadened by insertion of a porous type of absorber into the cavity. Also, the absorption peak is usually in the lower frequencies and as such this principle is useful for increasing the low frequency performance of common porous type absorbers.

Commercial panels are available which have many small holes in the face and the appropriate dimensions of absorber and air gap behind the faces to increase the low frequency absorption. This principle requires that the face plate have an opening of approximately 5 percent or less to effect any tuning. Common perforated absorption panels usually have a much higher open area, since the large closed surface acts to reflect the higher frequencies.

SOUND ABSORPTION MEASUREMENTS (PER ASTM C423-77)

The absorption coefficient of a material may be observed to vary with the frequency of the incident sound and with the angle of incidence between the sound waves and the materials. By testing the absorption properties of the material in a reverberation room, the dependence of absorption on direction may be averaged since in the diffuse sound field produced in a reverberation room the sound waves arrive from all directions with equal probability. Absorption coefficients measured in a reverberation room are called random incidence absorption coefficients. The presence of absorption removes energy from a sound field, and this energy loss can be measured by the rate at which the sound intensity in a room decays after the sound source is removed. The rate of decay of a sound field in a reverberation room is expressed as the "reverberation time" which is the time required for the sound pressure level to drop 60 dB after the source is removed.

The test procedure for the measurement of random incidence absorption coefficients is specified by and described in ASTM Standard C423-77, "Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms."

Often, instead of the absorption coefficient of a material, which is a nondimentional quantity, the total absorption of an area is considered. One sabin is 1 sq ft of perfect absorption; similarly, 2 sq ft of material with an absorption coefficient of 0.5 is also 1 sabin of total absorption. The total absorption of a patch of material is the product of the absorption coefficient and the surface area of the material. The units of total absorption are square feet. A metric sabin is used when dealing with metric quantities. Its definition is the same but the basic unit is a square meter. One metric sabin is equal to 10.76 English sabins.

The total absorption in the room is first measured without the specimen by turning on a sound source long enough to come to a steady state level and then measuring the rate of decay of the sound pressure level when the sound source is suddenly turned off. The total absorption of the room is then given by the Sabine equation

$$A = 0.9210 \frac{Vd}{c} \qquad (28)$$

where

V is the volume of the room; cu ft

d is the rate of decay of the sound field; dB/sec

c is the speed of sound; ft/sec

A is the total absorption in sabins; sq ft

If the volume used is expressed in cubic meters and the speed of sound is in meters per second, then the absorption will be given in metric sabins. After measuring the total absorption in the room the specimen is brought into the room and the total absorption is again measured in the same manner. The absorption added to the room by the test specimen is then determined by taking the difference, thus

$$A_{\text{specimen only}} = A_{\text{with specimen}} - A_{\text{without specimen}}$$

$$= 0.9210\ V\ (d_{\text{with}} - d_{\text{without}})/c \qquad (29)$$

The absorption coefficient is then determined by dividing the total absorption by the area of the specimen

$$\alpha = A/S \qquad (30)$$

where α is the absorption coefficient and S is the area of the specimen in either square meters or square feet as required.

There are several important factors to note about this standard laboratory procedure. First, the room must be very hard and be able to support a reverberant (diffuse) sound field very close to the ideal. Also, the room must be sufficiently large so that the introduction of a highly absorbing specimen will not destroy this diffuse field. Because of the second limitation the specimen must be small enough to not interfere with the diffuseness of the sound field but it must also be large enough so that accurate data may be obtained. The size of the specimen also introduces other effects such as the fact that smaller specimens will generally measure higher values of absorption coefficient than a larger area of the same material. To avoid variations from different laboratories the standard specifies that the specimen size is to be at least 21.95 sq m (72 sq ft), which is the customary size.

Absorption Coefficients Exceeding Unity

In this method of testing the diffuse sound field measures absorption for all angles of incidence and not just for normal incidence. The method of measuring absorption coefficients using the decay rate of the sound field can yield absorption coefficients as high as 1.2 to 1.3 (the absorption coefficient by definition must be between zero and 1). These higher values do not cause problems in practice.

The principal reasons that the measured values of absorption coefficients sometimes exceed unity are diffraction effects and the size of the specimen. Diffraction probably accounts for most of the difference in the lower frequencies while specimen size is more responsible for the effects at higher frequencies, since the theory which relates absorption to the decay rate of the sound field is based on an infinite size sample in a diffuse field.

An additional factor affecting the absorption in a reverberation room is that the air is also an absorber, the extent of which is dependent on temperature and relative humidity, especially at the higher frequencies. To control this dependency, the laboratory measurement of absorption is usually made in a room where these values are maintained within narrow limits. (Temperature and humidity values should be included in the laboratory report of a test.)

Mountings for Absorption Tests

Another item that affects the absorption properties of a material is the method of mounting. For a porous type absorber the space between it and the wall will increase the absorption somewhat as the space is increased. Consequently, to maintain standard mountings for testing, the Acoustical and Insulating Materials Association (AIMA) specifies seven standard mountings which should be used for testing sound absorbing materials. These mountings are shown in Figure 9. Laboratories making absorpiton tests will always include in their report which of these mountings were used for the test.

Since the standard mountings are based on actual methods of installing absorbing material, the mountings reported in tests made in recent years are predominantly numbers four and seven as these represent the most popular methods of mounting modern acoustical material. While no standard mounting exists for landscape screens or absorbent partitions, they are commonly tested in pairs in an upright position, arranged nonparallel to each other, and separated by approximately 1.52 m (5 ft).

Dependence of Absorption Coefficient on Frequency

Only the magnitude of sound absorption has been discussed but as with the other properties of sound the absorption also depends on frequency. Some typical sound absorption coefficients versus frequency are shown in Figure 10. Notice the increase in absorption coefficient with increasing frequency and increasing thickness.

The frequency dependence of the absorption coefficient is obtained by measuring the absorption as described above in six one-third octave bands centered at 125, 250, 500, 1000, 2000 and 4000 Hz. The laboratory report will therefore show six absorption coefficients and the frequencies at which they were measured. Note that these numbers are rounded to the nearest integral multiple of 0.01 as specified in the standard. Table 5 lists the average absorption coefficients of some typical building materials.

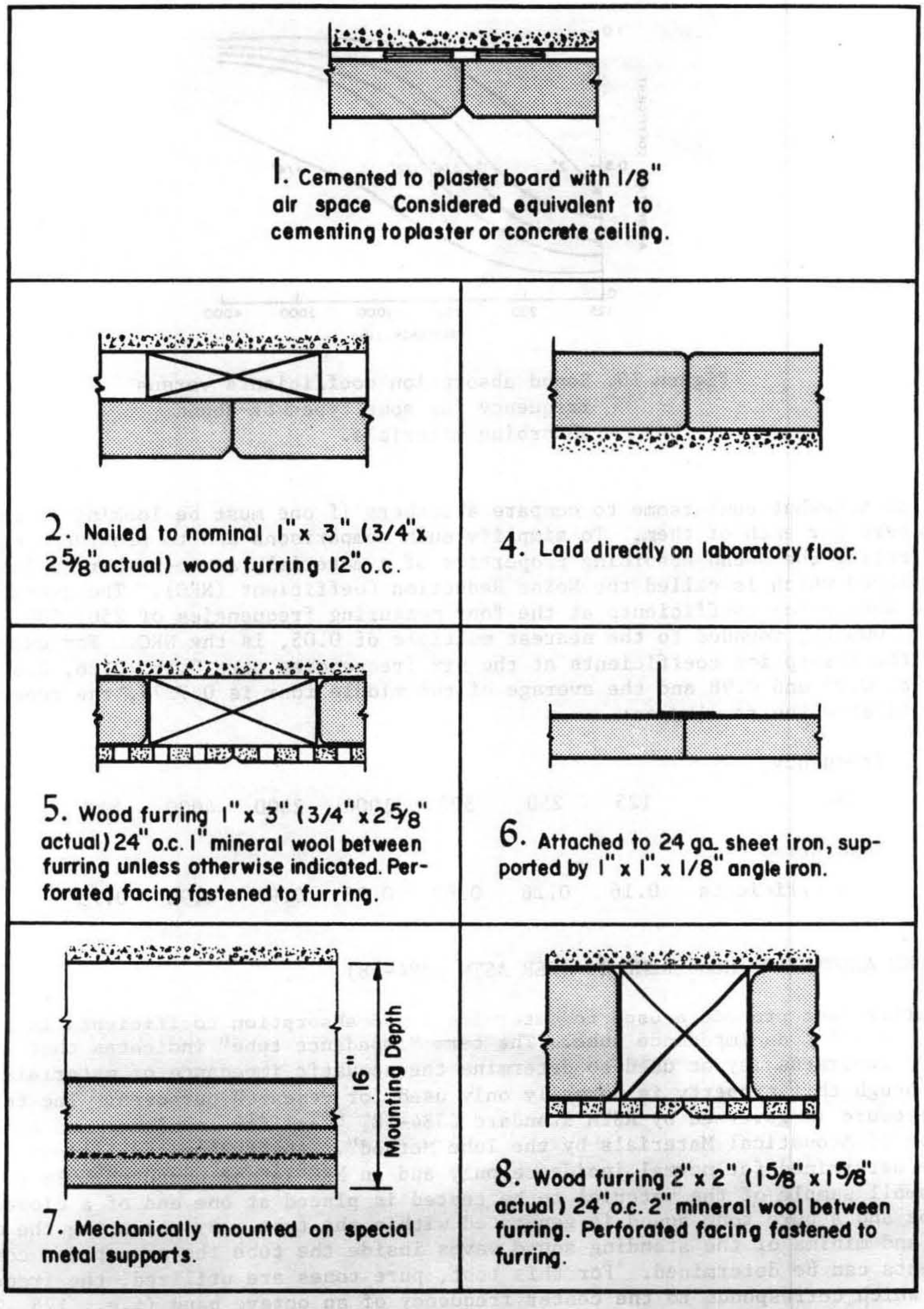


Figure 9. Mountings used in sound absorption tests. (from AIMA Bulletin, "Performance Data, Architectural Acoustical Material")

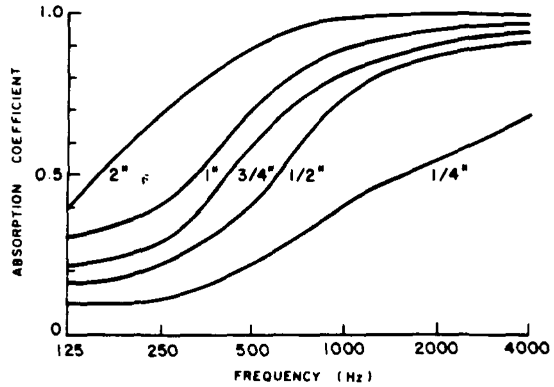


Figure 10. Sound absorption coefficients versus frequency for some types of sound absorbing materials.

It is somewhat cumbersome to compare absorbers if one must be looking at six numbers for each of them. To simplify such comparisons and to provide a means of rating the sound absorbing properties of a material, a one-number rating is employed which is called the Noise Reduction Coefficient (NRC). The average of the absorption coefficients at the four measuring frequencies of 250, 500, 1000, and 2000 Hz, rounded to the nearest multiple of 0.05, is the NRC. For example, if the absorption coefficients at the six frequencies were 0.16, 0.26, 0.68, 0.98, 0.99 and 0.98 and the average of the middle four is 0.7275, the report would show the results as:

Frequency, Hz	125	250	500	1000	2000	4000	NRC
Absorption Coefficients	0.16	0.26	0.69	0.98	0.99	0.98	0.75

SOUND ABSORPTION MEASUREMENTS (PER ASTM C384-58)

Another test procedure used to determine sound absorption coefficients is performed using an impedance tube. The term "impedance tube" indicates that the same apparatus may be used to determine the acoustic impedance of materials, although this property is normally only used for research purposes. The test procedure is governed by ASTM standard C384-58, "Test for Impedance and Absorption of Acoustical Materials by the Tube Method". Absorption coefficients (α_n) are determined for normal incidence only and an NRC is not computed. In effect, a small sample of the material to be tested is placed at one end of a closed tube and a pure tone sound is generated within the tube. By measuring the maxima and minima of the standing sound waves inside the tube the absorption coefficients can be determined. For this test, pure tones are utilized, the frequency of which corresponds to the center frequency of an octave band (i.e., 125, 250, 500, 1000, 2000 or 4000 Hz).

Table 5. Absorption Coefficients of general building materials and furnishings.

Complete tables of coefficients of the various materials that normally constitute the interior finish of rooms may be found in the various books on architectural acoustics. The following short list will be useful in making simple calculations of the reverberation in rooms.

MATERIALS	COEFFICIENTS, Hz					
	125	250	500	1,000	2,000	4,000
Brick, unglazed	0.03	0.03	0.03	0.04	0.05	0.07
Brick, unglazed, painted	.01	.01	.02	.02	.02	.03
Carpet, heavy, on concrete	.02	.06	.14	.37	.60	.65
Same, on 40 oz hairfelt or foam rubber	.08	.24	.57	.69	.71	.73
Same, with impermeable latex backing on 40 oz hairfelt or foam rubber	.08	.27	.39	.34	.48	.63
Concrete Block, coarse	.36	.44	.31	.29	.39	.25
Concrete Block, painted	.10	.05	.06	.07	.09	.08
Fabrics:						
Light velour, 10 oz per sq yd, hung straight, in contact with wall	.03	.04	.11	.17	.24	.35
Medium velour, 14 oz per sq yd, draped to half area	.07	.31	.49	.75	.70	.60
Heavy velour, 18 oz per sq yd, draped to half area	.14	.35	.55	.72	.70	.65
Floors:						
Concrete or terrazzo	.01	.01	.015	.02	.02	.02
Linoleum, asphalt, rubber or cork tile on concrete	.02	.03	.03	.03	.03	.02
Wood	.15	.11	.10	.07	.06	.07
Wood parquet in asphalt on concrete	.04	.04	.07	.06	.06	.07
Glass:						
Large panes of heavy plate glass	.18	.06	.04	.03	.02	.02
Ordinary window glass	.35	.25	.18	.12	.07	.04
Gypsum Board, ½″ nailed to 2 x 4's 16″ o.c.	.29	.10	.05	.04	.07	.09
Marble or Glazed Tile	.01	.01	.01	.01	.02	.02
Openings:						
Stage, depending on furnishings			.25 — .75			
Deep balcony, upholstered seats			.50 — 1.00			
Grills, ventilating			.15 — .50			
Plaster, gypsum or lime, smooth finish on tile or brick	.013	.015	.02	.03	.04	.05
Plaster, gypsum or lime, rough finish on lath	.14	.10	.06	.05	.04	.03
Same, with smooth finish	.14	.10	.06	.04	.04	.03
Plywood Paneling, ⅜″ thick	.28	.22	.17	.09	.10	.11
Water Surface, as in a swimming pool	.008	.008	.013	.015	.020	.025
Air, Sabins per 1000 cubic feet @ 50% RH				.9	2.3	7.2
ABSORPTION OF SEATS AND AUDIENCE, *sabins per square foot of seating area or per unit*						
Audience, seated in upholstered seats, per sq ft of floor area	0.60	0.74	0.88	0.96	0.93	0.85
Unoccupied cloth-covered upholstered seats, per sq ft of floor area	.49	.66	.80	.88	.82	.70
Unoccupied leather-covered upholstered seats, per sq ft of floor area	.44	.54	.60	.62	.58	.50
Wooden Pews, occupied, per sq ft of floor area	.57	.61	.75	.86	.91	.86
Chairs, metal or wood seats, each, unoccupied	.15	.19	.22	.39	.38	.30

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Often a laboratory or the manufacturer will measure the normal incidence absorption coefficients in an impedance tube and then estimate a value for the NRC.

Relationship between Random and Normal Incidence Coefficients

It is important to realize that a concrete theoretical relationship has not yet been developed to relate α_n to α, and that any estimate made is based on empirical relationships. A rule of thumb for relating α_n to α (Section V-1, ASTM C384) is that α_n is about one-half of α for small values of α and as α becomes large α_n becomes almost equal to α. The maximum difference occurs for intermediate values and can be as large as 0.25 to 0.35. In general α_n is always smaller than α (see Figure 11).

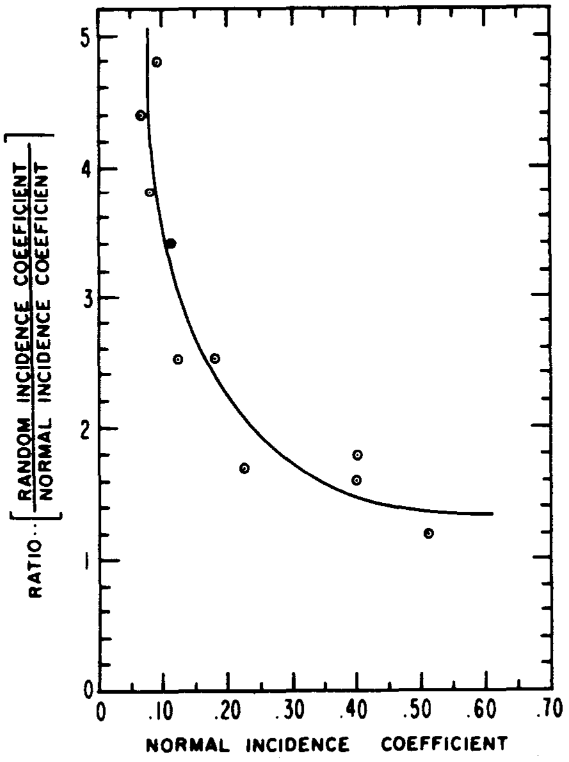

Figure 11. Relationship of random to normal incidence absorption coefficients at a test frequency of 500 Hz. (A. London, JASA, 1950)

NOISE CONTROL BY ABSORPTION

If different surfaces of a room are comprised of different materials (the usual case), the average absorption coefficient is determined by the sum of the coefficients of each area:

$$\bar{\alpha} = \frac{\Sigma S_i \alpha_i}{\Sigma S_i} \qquad (31)$$

where

α_i = random incidence coefficient of the ith surface

S_i = area of that surface

Another method which can be used to determine the average absorption coefficient of a room is due to Fitzroy (JASA, 1959)

$$\bar{\alpha} = S \left[\frac{x}{\bar{\alpha}_x} + \frac{y}{\bar{\alpha}_y} + \frac{z}{\bar{\alpha}_z}\right]^{-1} \qquad (32)$$

where

x = total floor-ceiling areas with average absorption coefficient $\bar{\alpha}_x$

y = total side wall areas with average absorption coefficient $\bar{\alpha}_y$

z = total end wall areas with average absorption coefficient $\bar{\alpha}_z$

This equation is especially useful for areas where the absorption material is not evently distributed.

When large extended areas of the same absorption material are used, the absorption coefficients may not be the same as observed in laboratory-sized samples. Table 6 presents suggested correction factors from Faulkner, Handbook of Industrial Noise Control (Industrial Press, NY 1976).

Table 6. Suggested correction factors for large extended areas of the same absorption material. Multiply the laboratory absorption coefficients by the factors given for each octave band.

	Frequency, Hz					
Common sample sizes, ft	125	250	500	1000	2000	4000
	Absorption Coefficient Multipliers					
8 by 9	0.49	0.66	0.79	0.88	0.94	0.97
6 by 8	0.43	0.60	0.75	0.86	0.92	0.96

At higher frequencies, the air within a room will absorb a fraction of the acoustic energy. An accurate determination of the absorption of the room requires the addition of this air absorption to the average absorption coefficient of the materials. This additional absorption is listed in Table 7.

Table 7. Air absorption at 20°C to be added to average absorption coefficient $\overline{\alpha}$ of room materials. V = volume of room in cu ft. S = surface area of room in sq ft.

Relative Humidity	2000 Hz	4000 Hz	6300 Hz	8000 Hz
30%	0.0144 V/S	0.0464 V/S	0.1024 V/S	0.1640 V/S
50%	0.0116 V/S	0.0296 V/S	0.0612 V/S	0.1040 V/S
70%	0.0104 V/S	0.0260 V/S	0.0488 V/S	0.0736 V/S

When the average absorption coefficients are known, the total room absorption in sabins is given by

$$A = \overline{\alpha}S \tag{33}$$

where

S = total area of the room.

Another useful quantity is the room constant

$$R = S(e^{\overline{\alpha}} - 1) \tag{34}$$

Frequently it is impractical or even impossible to determine the room constant by directly calculating $\overline{\alpha}$. In this case the room constant can be determined by first measuring the reverberation time of the room. This is a rather complicated procedure best left to a professional acoustician or noise consultant. The average absorption coefficient can then be derived from equation (28) such that

$$\overline{\alpha} = \frac{0.049\ V}{TS} \tag{35}$$

Here, T is the reverberation time in seconds. Note that the numerical value of the speed of sound in English units and the 60 dB decay (i.e., decay rate, d = 60/T) appearing in equation (28) have been incorporated into equation (35).

The effect of the room absorption and distance from the noise source on the sound pressure level can be seen in Figure 12 where the relative sound pressure level in decibels is plotted versus distance from a noise source of sound power level L_w for several values of the room constant. If the room constant is near zero (perfectly reflecting surfaces) the sound pressure level differs very little throughout the room and a reverberating field exists. On the other hand as the room constant becomes very large the sound pressure field approaches that of a free field. This information can be very important when considering sound treatment for a room.

In many cases, the operator of a piece of machinery is probably affected more by the direct field of the noise source rather than the reverberant field. Consequently, absorption treatment on the walls and ceiling will not reduce the noise of this machine at the operator's position. It can be seen in Figure 12 that the sound pressure level can never be below the straight line corresponding to the free field $1/r^2$ decrease.

Employees a little further from the machine will probably be in a region that can be called a semireverberant field, i.e., where the sound pressure level is made up of some combination of the direct and reflected sound. Figure 12 can be used as a quick guide to determine if sound absorption treatment reduces the noise level at a given location.

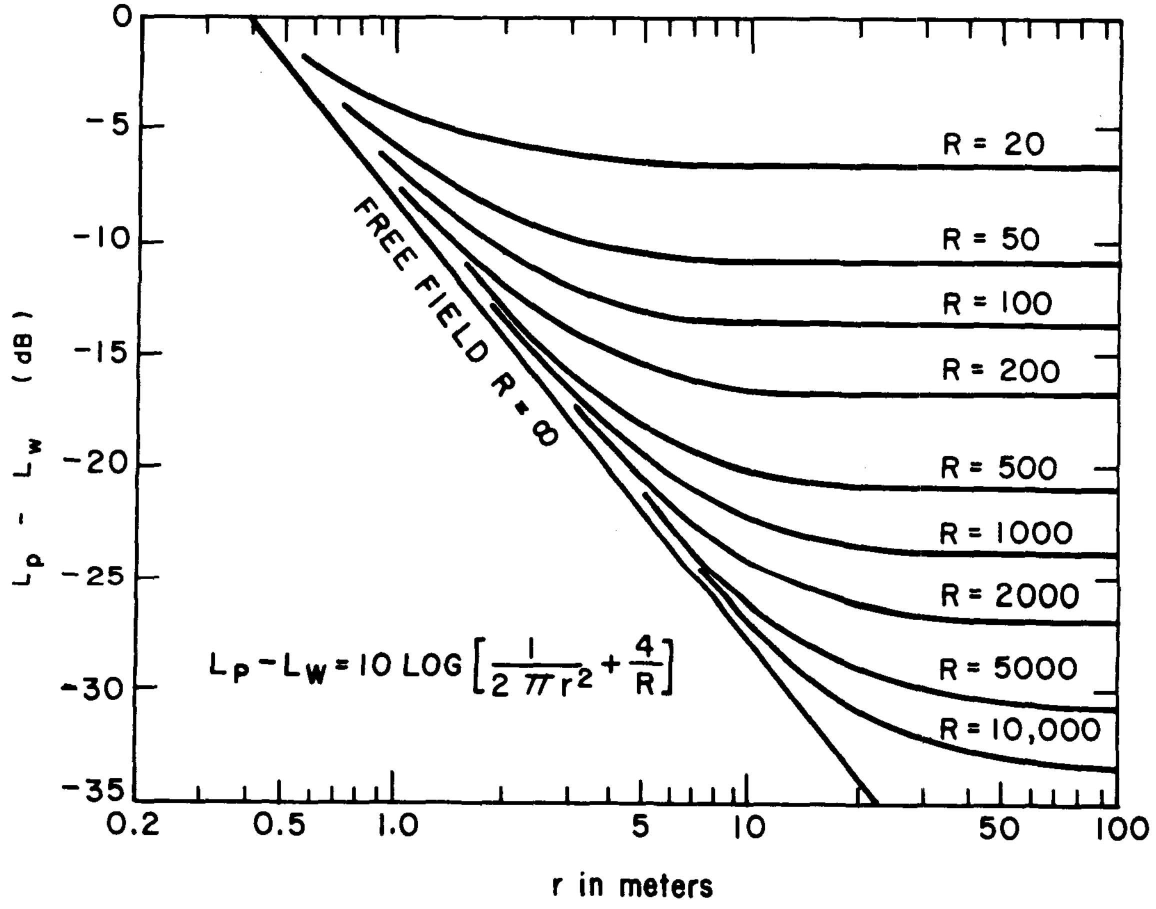

Figure 12. Relative sound pressure level versus distance from the source for semireverberant fields. r = distance from acoustic center; R = room constant.

Suppose it is desired to reduce the sound pressure level at a particular operator's position which is 8 m from the sound source with a sound power level of L_w. If the room constant is determined to be about 1000, any absorbent material on the walls will have a negligible effect on the sound pressure level at this position.

If however, the room constant is significantly below 1000, an absorption treatment of the surfaces of the room (e.g., R = 1000 after treatment) can have an appreciable effect which would be equal to

$$[(L_p - L_w)_{R<1000}] - [(L_p - L_w)_{R=1000}]$$

Thus in practice, one must first determine when absorption treatment will be useful. Figure 12 is based on the relationship

$$L_p = L_w + 10 \log \left(\frac{1}{2\pi r^2} + \frac{4}{R}\right) \qquad (36a)$$

for the usual case of a noise source resting on a hard surface. If the source were suspended above the floor of a large room, equation (36a) would become

$$L_p = L_w + 10 \log \left(\frac{1}{4\pi r^2} + \frac{4}{R}\right) \qquad (36b)$$

The more general form of this expression includes the directivity factor Q such that

$$L_p = L_w + 10 \log \left(\frac{Q}{4\pi r^2} + \frac{4}{R}\right) \qquad (36c)$$

Note that equations (36a, 36b, and 36c) are identical except for the first term in the argument of the logarithm. Equations (36a) and (36b) can be obtained readily from (36c) if one notes that for a nondirectional source in a free field $Q = 1$ and for the same nondirectional source in a free field over a reflecting plane $Q = 2$. (See Beranek, "Acoustics", pp 311-322, 1957, for the development and discussion of equation (36).)

Clearly the larger R becomes, the lower the sound pressure level at a given distance from the source. To determine the decrease in sound pressure level when absorption is added to a room, which increases the room constant R, one could calculate the value of L_p from equation (36) for R_1 before treatment and again for R_2, the room constant after treatment, or by the equivalent relation

$$\text{Reduction in dB} = (L_{p1} - L_w) - (L_{p2} - L_w) \qquad (37)$$

$$L_{p1} - L_{p2} = 10 \log \left[\left(\frac{Q}{4\pi r^2} + \frac{4}{R_1}\right) \Big/ \left(\frac{Q}{4\pi r^2} + \frac{4}{R_2}\right)\right]$$

where L_{p1} is the sound pressure level before acoustic treatment and L_{p2} is the sound pressure level after treatment, both levels measured at the same point in the room. The use of this equation is illustrated by the following example.

EXAMPLE 9: The dimensions of a room are 15.24 m (50 ft)(length), 7.62 m (25 ft) (width), and 3.66 m (12 ft)(height). The absorption in the room is shown below using absorption coefficients provided by AIMA in Table 5.

Room component	S_i (sq ft)	a_i (@ 500 Hz)
Floor; linoleum	1150	0.03
10 occupants seated at desks	100	0.55
Ceiling; plaster	1250	0.06
Side walls; gypsum board	1000	0.05
windows	100	0.10
End walls; gypsum board	450	0.05
doors	150	0.18
Total	4200	

Given these initial room conditions:

1. Can absorption treatment be effective in reducing the 500 Hz octave band sound level of a newly installed machine at a position 8 m from an observer?
2. How much reduction of the sound level from this source will be achieved using absorption treatment?

SOLUTION: Since the absorption present in the room is fairly evenly distributed, the average absorption coefficient may be calculated from equation (31).

$$\bar{\alpha} = \frac{\Sigma S_i \alpha_i}{\Sigma S_i} =$$

$$= \frac{(1150)(.03)+(100)(.55)+(1250)(.06)+(1000)(.05)+(100)(.10)+(450)(.05)+(150)(.18)}{4200}$$

$$= 0.065$$

and thus, the room constant from equation (33) before treatment

$$R_1 = S(e^{\bar{\alpha}} - 1) = 4200\ (e^{0.065} - 1) = 283 \text{ sq ft}$$

$$= 26.3 \text{ sq m}$$

Observing Figure 12, a room constant corresponding to about 26 sq m is well above the free field curve at r = 8 m. Absorption can thus be effective for this position. However, for a given room constant, absorption treatment will have less of an effect as the distance from the machine, or r, decreases. Also the use of absorber materials can never reduce the sound to a level below that of the free field radiation. At best, a sound absorber can reduce the reflections to zero which is the same as removing the surface entirely (i.e., no surface = no reflection = perfect absorber).

From the data tables, an acoustical wall treatment with an absorption coefficient of 0.95 at 500 Hz is selected to cover all four walls, and a type of mineral fiber ceiling panel with an absorption coefficient of 0.90 at 500 Hz is selected to cover the ceiling. With these treatments in place, the new absorption characteristics of the room are as shown:

Room component	S_i (sq ft)	a_i (@ 500 Hz)
Floor; linoleum	1150	0.03
10 occupants seated at desks	100	0.55
Ceiling; mineral fiber panels	1250	0.90
Side walls; wall treatment	1000	0.95
windows	100	0.10
End walls; wall treatment	450	0.95
doors	150	0.18

$$\bar{\alpha} = \frac{(1150)(.03)+(100)(.55)+(1250)(.90)+(1000)(.95)+(100)(.10)+(450)(.95)+(150)(.18)}{4200}$$

$$= 0.626$$

$$R_2 = 4200\ (e^{0.626)} - 1) = 3654 \text{ sq ft}$$

$$= 339.8 \text{ sq m}$$

The reduction in sound level at a distance $r = 8$ m from the source for application of the absorption material is calculated for the 500 Hz band using equation (37) with $Q = 2$ which assumes the noise source in the room will be sitting on the floor (hemispherical radiation)

$$\Delta L_p = 10 \log\left[\left(\frac{Q}{4\pi r^2} + \frac{4}{R_1}\right) \Big/ \left(\frac{Q}{4\pi r^2} + \frac{R}{R_2}\right)\right]$$

$$= 10 \log\left[\left(0.0025 + \frac{4}{26.3}\right) \Big/ \left(0.0025 + \frac{4}{339.8}\right)\right]$$

$$= 10.3 \text{ dB}$$

A drop of about 10 dB in the 500 Hz octave band at a point 8 m from the source would be expected after the described treatment had been applied to this room.

For the complete noise reduction expected, a similar analysis of absorption coefficients and room constants before and after treatment must be carried out for the remaining octave bands. The decibel sum of noise reduction in all bands is then calculated to arrive at the total noise reduction expected from the treatment. The appropriate A-weighting corrections (see Table 3) must be included in each octave band before decibel addition if the total noise reduction in dBA is desired.

Absorption of Ceilings

The main purpose of acoustical ceilings is for the absorption of sound. In the previous example, it was shown how the absorption added to a room can reduce the sound pressure level in the reverberant sound field region of a room.

There are many types of acoustical ceilings, ranging from the attractive tiles seen in homes and offices to the thicker sturdier panels that can be used in an industrial atmosphere. The range of absorption ability of modern acoustical ceilings extends from an NRC of about 0.30 to over 0.90. The ceiling used in the example had an NRC of 0.90. From a sampling of the tests performed at one acoustical testing laboratory the most common value for NRC is about 0.55 to 0.70 as can be seen in Figure 13. This sampling includes ceilings made of wood fiber, glass fiber, and other mineral fibers. It also includes the full range of densities and thicknesses that are common to ceilings. This figure shows the relative number of ceiling materials whose NRC lies in the indicated range. Since a mean value is about NRC = 0.60 one can say that typical noise reduction effects will be obtained with NRC = 0.60 items, not with NRC = 0.90 items.

Note that ceilings are usually tested with the number 7 mounting (40.64 cm (16 inch) plenum behind material). The effect of this mounting is to increase the absorption in the lower frequency range over what would be obtained if the material were mounted directly to the surface. The typical shape of the curve of sound absorption coefficient versus frequency can be seen in Figure 14. In this figure, three "typical" absorption coefficient versus frequency curves are shown. Note the increase in low frequency absorption, and reduction in high requency absorption for the absorbing material covered with a perforated metal facing tested using mounting number 7. Note also that while the thicker material will usually have a better low frequency absorption the two shown here for mounting number 4 appear to contradict this. However the thicker one does have an overall higher absorption level and this further points out that there is no such thing as "typical". These data once again reemphasize that the NRC should not be used as the basis for selecting any acoustical treatment. The full set of frequency data should be utilized and the chosen product matched to the noise spectrum in the space where it is to be used.

One note of caution on ceilings should be heeded. Since acoustic absorption takes place when the sound penetrates into the pores or openings in the material, care should be taken when the ceiling is painted. If the paint is not applied properly, it can plug the openings so that sound cannot enter into the material. The result is that sound is reflected from the surface, and the absorbent capability is completely destroyed. If it becomes necessary to paint an acoustical ceiling the manufacturer should be contacted for his recommended method which will preserve the acoustical qualities. If it is known before purchasing a ceiling that painting will be required in the future, the "paintability" of the ceiling should be considered, as some ceiling materials are better able to withstand painting than others. Again, check with the manufacturer for his recommendations.

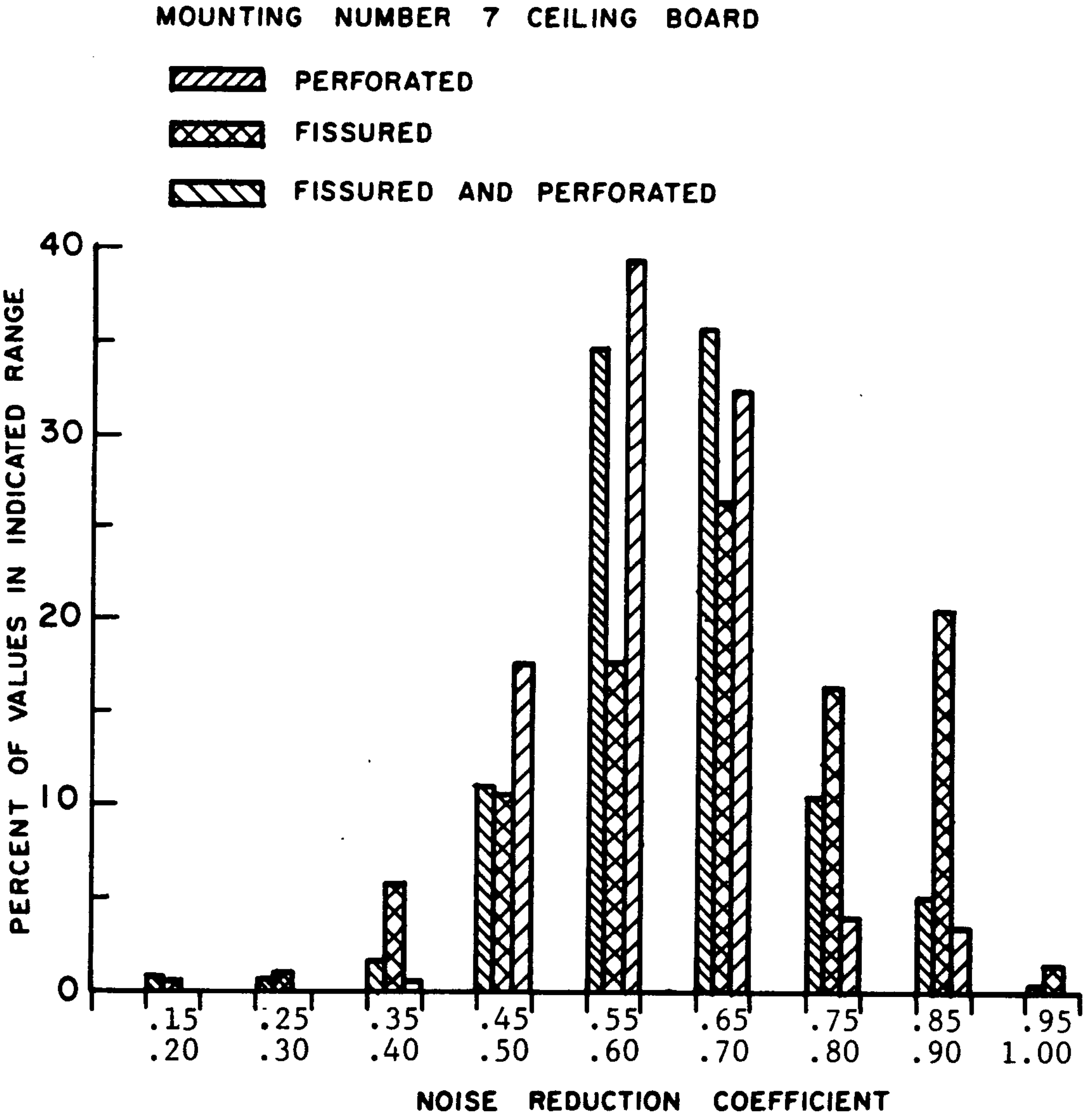

Figure 13. Relative distribution of absorption qualities of acoustical ceiling materials.

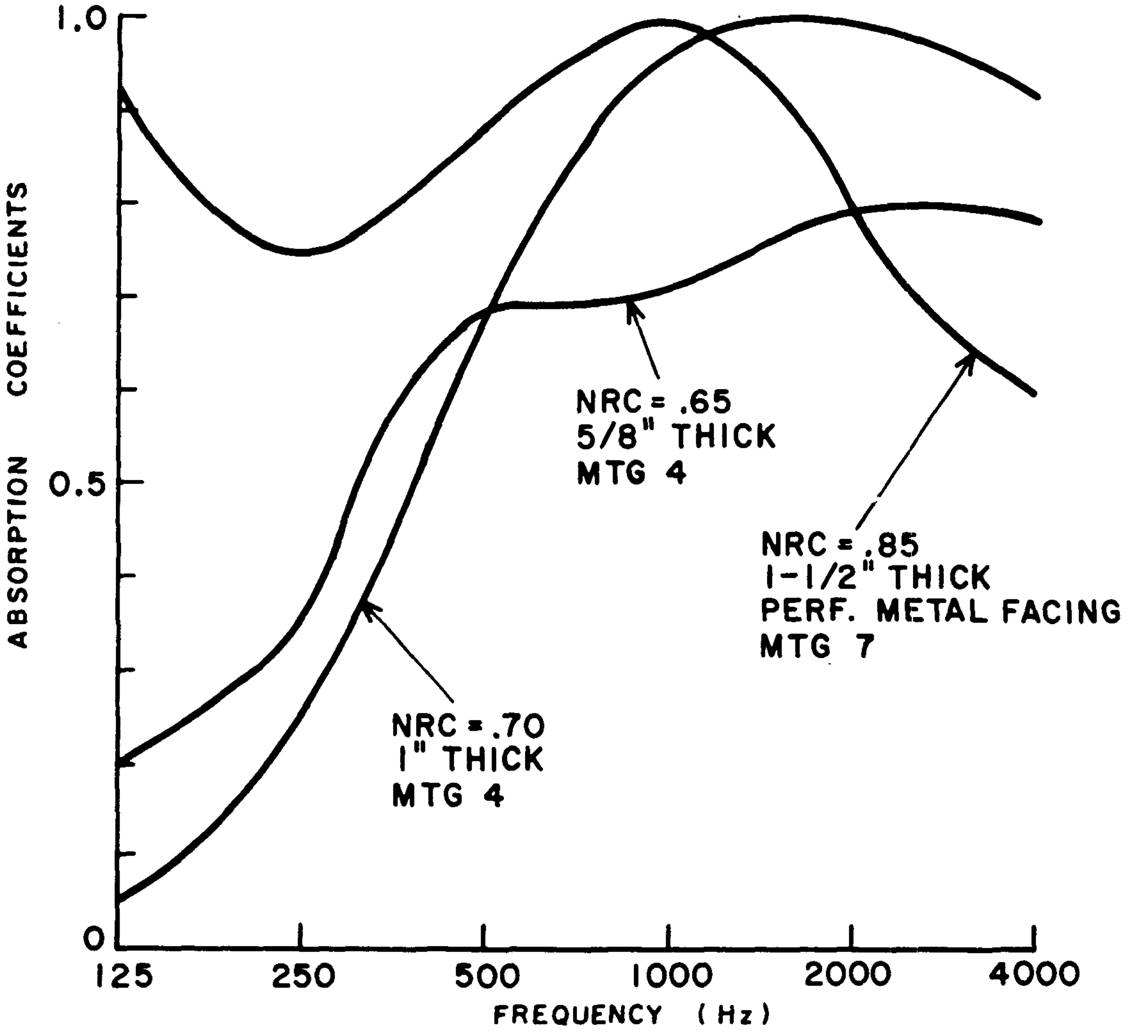

Figure 14. Typical absorption data for acoustical ceilings.

Absorption of Walls

Normally walls are considered to be sound barriers, but as seen in the example, the applications of absorbent materials to the walls of a room aid in the reduction of noise levels in a noisy space. While almost any absorption material may be used with success on walls, there is a certain class of material called wall facing or treatment specifically designed for this purpose. These generally have a fiberglass or mineral fiber core covered with fabric. They may be attached directly to the wall or attached by a system of furring strips to create an air gap between the treatment and the wall. As in the case of ceilings, this air gap would serve to decrease the low frequency absorption of the treatment.

Standard unpainted concrete block can also exhibit reasonable absorption characteristics, especially if they have a coarse texture. Noise reduction coefficients for concrete block are shown in Table 8.

Table 8. Noise reduction coefficients for concrete.

Material, medium texture, unpainted	Approximate NRC	Adjustment, percent	
		Coarse texture	Fine texture
Expanded shale block	0.45	Add 10	Deduct 10
Heavy aggregate block	0.27	Add 5	Deduct 5

Deductions from NRC for painted block, percent

Paint type	Application	One coat	Two coats	Three coats
Any	Spray	10	20	70
Oil base	Brushed	20	55	75
Latex or resin base	Brushed	30	55	90
Cement base	Brushed	60	90	--

(Courtesy Expanded Shale and Slate Institute)

A particular kind of block is constructed with internal cavities with slots or openings in the surface connecting the cavities to the outside. This configuration makes each block a Helmholtz resonator tuned to a particular frequency. Such blocks are generally most effective as absorbers at low frequencies and near the frequency for which they are tuned.

Absorption of Carpets

Carpets serve the dual purposes of floor covering and noise reduction. Noise reduction is achieved in two ways; carpets absorb the incident sound energy; and sliding and shuffling movements on carpets produce less noise than on bare floors. The Carpet and Rug Institute has published a report on "Sound Conditioning with Carpet" and some of their findings are:

1. NRC of carpets laid directly on bare concrete floor ranged from 0.25 to 0.55;
2. fiber type has virtually no influence on sound absorption;
3. cut pile provides greater noise reduction than loop pile;
4. the NRC increased as pile weight and/or pile heights were increased;
5. carpet pads have considerable effects on sound absorption as shown in Table 9;

6. permeability of backing results in higher NRC. In one test a carpet with a coated backing had an NRC of 0.40 and the same carpet with an uncoated backing had an NRC of 0.60; and

7. carpets and pads provide significant improvements in impact noise ratings of floors. Table 10 shows the results of tests made on a concrete slab using a woven, 44 oz wool carpet with various pads.

Table 9. Effects of padding on carpet noise reduction coefficient.

Pad weight oz	Pad material	NRC
--	None	0.35
32	Hair	0.50
40	Hair	0.55
86	Hair	0.60
32	Hair jute	0.55
40	Hair jute	0.60
86	Hair jute	0.65
31	Foam rubber, 3/8 inch	0.60
44	Sponge rubber	0.45

Table 10. Effects of carpets and pads on impact noise.

Floor covering	INR	IIC
None	-17	34
Carpet only	+14	65
Carpet with 40 oz hairfelt pad	+21	72
Carpet with urethane foam pad	+24	75
Carpet with 44 oz sponge rubber	+25	76
Carpet with 31 oz 3/8 inch form rubber	+28	79
Carpet with 80 oz sponge rubber	+29	80

Absorption of Furnishings

The use of general furnishings, such as chairs, draperies, carpets, etc., can provide absorption of the sound in the room. For offices, homes, schools, etc., the noise control should also be attractive. Modern sound absorption wall and ceiling treatments are available in many colors and patterns. But just using these is not quite enough. If the wall and ceiling treatment is selected for good sound absorption and the effect of general furnishings is overlooked, the finished area may be too dead and unpleasant. Some absorption data on these items are given in Table 5. The absorption of curtains and draperies depends on spacing from the wall, how close and deep the pleats are, size, and the material used. Some coefficients for these items can be found in the data tables.

SOUND BARRIERS

The portion of the sound wave that is not absorbed or reflected when the sound wave strikes a surface is transmitted through to the other side. The fraction of the incident energy that is transmitted through the partition is defined to be the transmission coefficient (τ). That portion of the energy which is "lost" upon transmission through a material is the difference between the incident energy and the transmitted energy. Expressed in decibel terms, the sound transmission loss is

$$TL = 10 \log \frac{W_i}{W_o} - 10 \log \frac{W_t}{W_o} = 10 \log \frac{W_i}{W_t} = 10 \log \frac{1}{\tau} \qquad (38)$$

Just as with the absorption coefficient the transmission coefficient depends on frequency and equation (38) indicates the transmission loss is also frequency dependent.

The mechanism of transmission loss is similar to that of a diaphragmatic absorber. The incident sound wave causes the partition to vibrate. This vibration in turn causes the air on the other side of the partition to be set into motion and sound is radiated as though this partition were now a sound source. However, this new sound field will be much lower in energy since much of the energy of the incident wave was spent in forcing the partition to vibrate.

It can be shown that for a "limp" panel, (a limp panel is an idealized panel without flexural stiffness), the transmission loss should theoretically increase by 6 dB each time the mass of the panel is doubled. This, however, does not hold strictly true in practice. In the real world a doubling of the mass of the wall will increase the transmission loss only by about 4 or 5 dB. The real world mass law, which is obtained from empirical results can be stated as

$$TL = 23 + 14.5 \log m \text{ dB} \qquad (39a)$$

where m is expressed in lb/sq ft or

$$TL = 13 + 14.5 \log m \text{ dB} \qquad (39b)$$

where m is expressed in kg/sq m. The increase predicted from this expression for a doubling of the mass is about 4.4 dB. Generally the transmission loss increases more slowly than 4.4 dB per octave of frequency below 1000 Hz, and approximately at the rate of 4.4 dB per octave above this frequency. Some notable exceptions to this are due to stiffness, resonances, and coincidence effects.

Resonance occurs when the frequency of the incident sound wave corresponds to a natural frequency of the partition. At this frequency very little energy is required to force the panel to vibrate, and the high amplitude of this vibration produces a correspondingly high sound pressure level on the opposite side of the panel. In some instances the sound wave passes through the panel almost as if it were not there. To avoid the effects of resonance it is desirable to have the lowest natural frequency possible. This condition can best be met by using panels which are as limp and as massive as possible.

A condition similar to resonance can occur when sound waves are incident on a panel at an oblique angle. At certain frequencies the phases of the incident wave will coincide with the phase of the panel's flexural waves. Under these conditions the intensity of the transmitted wave may nearly equal that of the incident wave. Wave coincidence can only occur when the wavelength of the sound in air is less than the wavelength of sound in the panel. Thus, coincidence can only occur at a frequency above a certain critical frequency which is determined by the material and thickness of the panel. For a single homogeneous panel, this frequency is given by

$$f_c = \frac{C^2}{1.8t} \sqrt{\frac{P}{E}} \qquad (40)$$

where C = speed of sound

t = thickness of panel

p = mass density of panel

E = modulus of elasticity of panel material

In practice the sound wave is usually not incident from a single direction but is more omnidirectional. A typical panel will have studs, braces, discontinuities, etc., and the effect of coincidence can usually be neglected. If, however, this effect is encountered it can usually be reduced by using very stiff and thick walls or by heavy walls with small stiffness. In general, the transmission properties of a wall behave more like the typical performance shown in Figure 15.

It should be emphasized that sound absorbent materials; due to their soft, porous structure, offer only low resistance to a sound wave and permit the passage of the wave through to the other side relatively unattenuated. Only when these materials are very dense or very thick will they appreciably reduce the amplitide of a sound wave as it passes through. Thus, a sound absorbing material is a poor sound barrier. Remember that if air can pass through the material, so can sound.

On the other hand, typical sound barrier materials are hard, heavy, and very reflective. These materials generally follow the mass law and as such offer a high resistance to the passage of a sound wave. A sound barrier material is a poor absorber and an absorbent material is a poor barrier.

SOUND TRANSMISSION LOSS MEASUREMENTS (per ASTM E90-77)

The test procedure for measurement of transmission loss of materials is specified by, and described in, ASTM Standard E90-77, "Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions". Unlike the absorption coefficient, the transmission coefficient is rarely measured in practice. Instead the transmission loss is calculated in a more roundabout manner from sound pressure levels. To measure the transmission loss of a specimen it is simply mounted in the connecting opening between two reverberation rooms. Care is taken to assure that the only sound path between the two rooms is through the specimen. A sound source is operated in the source room and sound pressure levels in the source room and the receiving room are then measured in each of 16 contiguous one-third octave bands from 125 through 4000 Hz. The transmission loss is then computed from the relationship

$$TL = NR + 10 \log S - 10 \log A \tag{41}$$

where TL is the transmission loss in decibels, S is the total area of the sound transmitting surface of the test specimen, A is the total absorption in the receiving room (expressed in units consistent with S), and

$$NR = L_{p_s} - L_{p_r} \tag{42}$$

is the noise reduction between the two reverberation rooms. Average sound pressure level in the source room is L_{p_s}. Average sound pressure level in the receiving room is L_{p_r}.

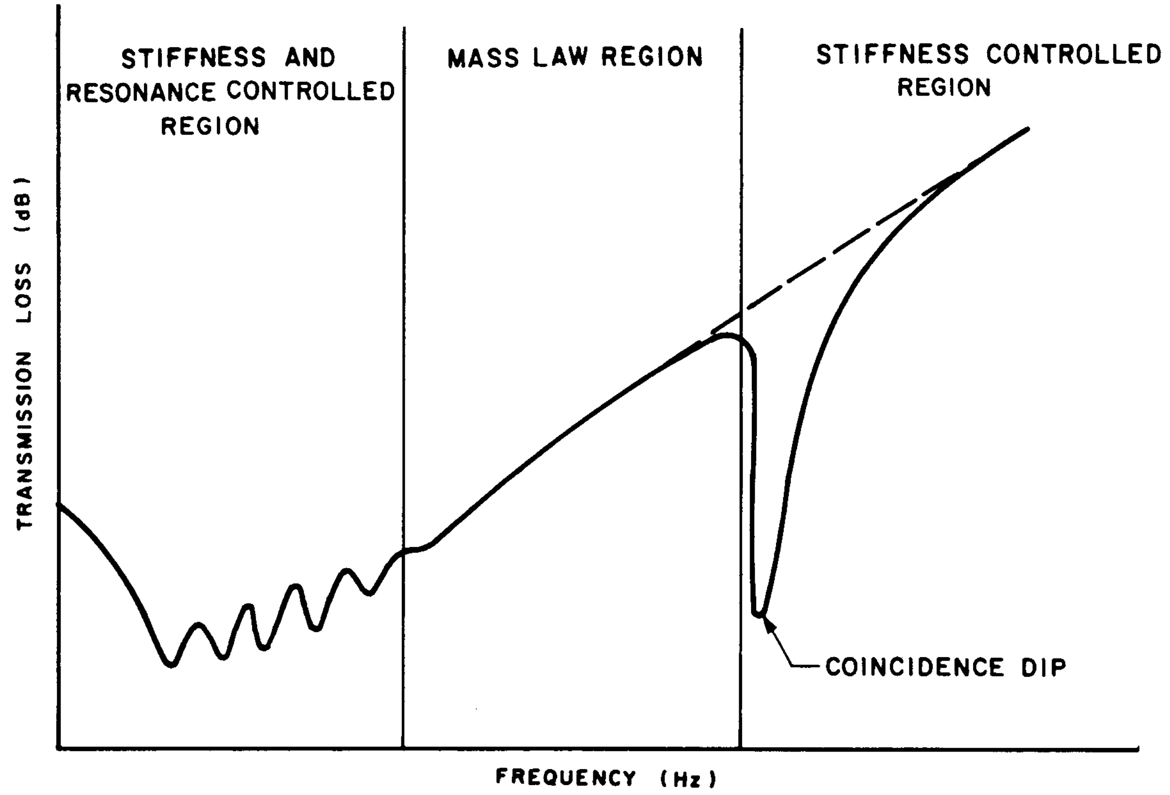

Figure 15. Typical practical performance of a wall relating to the transmission of sound showing the three separate regions.

The variation in sound pressure level over a large portion of each room must be carefully measured to ensure accuracy in determining the average level. The term for the absorption of the receiving room is necessary to account for the fact that the sound pressure level developed in the receiving room will depend upon the amount of absorption in the room. Equation (41) may be derived from the basic principles of equation (38) by noting that the power incident on a panel is equal to intensity times the area of the panel, and that decibels of intensity are approximately equal to decibels of pressure.

Dependence of Transmission Loss on Frequency

Since once again there is a situation where the acoustical properties of an item are frequency dependent and there are 16 numbers to describe these properties it is desirable to reduce this amount of data to a single number. In the case of TL properties this single-number rating is called Sound Transmission Class (STC). The STC is determined by comparing the set of transmission losses at all 16 frequencies to a set of standard STC contours as described in ASTM Standard E413-70T, "Tentative Classification for Determination of Sound Transmission Class". Briefly stated, the STC contour must be chosen which fits the TL curve in such a way that in no event is the TL curve more than 8 dB below the STC contour at any frequency, and the sum of the deviations of the TL values which are below the contour shall not exceed 32 dB. The highest contour to which the specimen TL curve can satisfy these requirements is used as the STC curve. The value of this curve at 500 Hz is then chosen as the STC of the specimen.

The STC values of some common materials are shown in Table 11. The values shown in Table 11 are representative because the weights and densities of these materials vary and some of the items are porous even though they are heavy.

Table 11. Sound transmission class of some common building materials.

Material	STC
24-gauge steel	26
1/8-inch plate glass	28
1/4-inch plate glass	30
3/16-inch steel plate	35
4-inch two-cell concrete block	41
4-inch two-cell concrete block (filled with sand)	43
Two layers of 5/8-inch gypsum board on 2x4-inch studs 16 inches on center	43
8-inch lightweight hollow concrete block	46
8-inch hollow core concrete block	50
4-inch brick wall with 1/2-inch plaster	50
8-inch brick wall	52
6-inch dense concrete	54
12-inch brick wall	59

In general these curves provide a good comparison between specimens, but due to the way deviations from the standard curve are handled poor comparisons can be made as shown in Figure 16. The partition shown by the solid line has TL values that are higher than those for the dashed curve except between about 600 to 2000 Hz and yet has a STC 5 dB lower than for the dashed curve. This only points out that STC is a convenience and should be used with care in selection of any particular item.

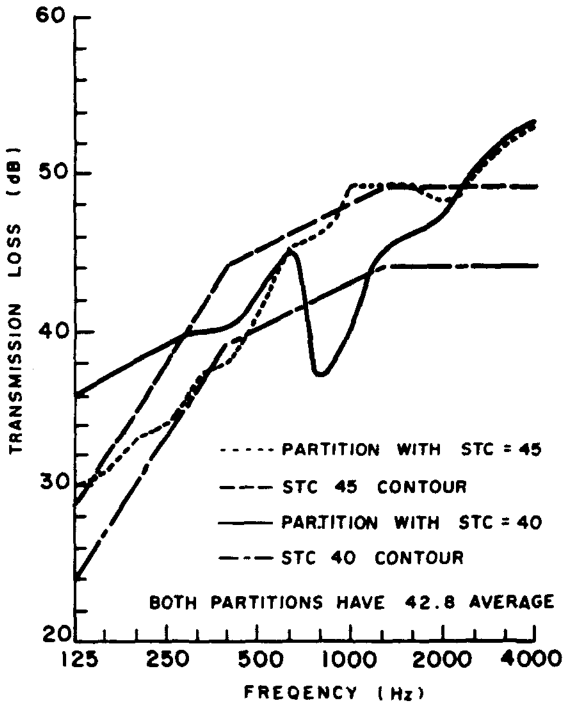

Figure 16. Determination of sound transmission class.

Test Facility Requirements

A few comments are in order at this point about the characteristics of the reverberation rooms used for testing partitions for transmission loss. One of these is that the rooms should be large enough to support a diffuse field in the lower frequencies. The size should be such that

$$V = 4\lambda^3 \qquad (43)$$

where V is the room volume and λ is the wavelength of the lowest frequency of interest in units consistent with V. For example if a room has a volume 178.3958 cu m (6300 cu ft) it should not be used for measurements below about 97 Hz.

A second requirement is that the sound field in the two reverberation rooms be sufficiently diffuse so that measurements can be made such as to ensure that the mean value of the noise reduction can be known to within 1 dB with 90 percent confidence. To accomplish this, laboratories use special, very hard rooms, with both fixed and rotating panels (vanes) to increase the diffuseness of the sound field.

A further requirement on the laboratory is the reduction of flanking path transmission to the point where it no longer interferes with the measurements. Flanking transmission occurs when the sound travels from the source room to the receiving room by some route other than through the test specimen. Some of these paths are through cracks or gaps around the specimen, into the floor or wall in the source room, through the connecting floor and wall, or any other route the sound may take as shown in Figure 17. Flanking path transmission is considered to have negligible effect on measurements when the sound pressure level transmitted by flanking is more than 10 dB below the level transmitted by the specimen.

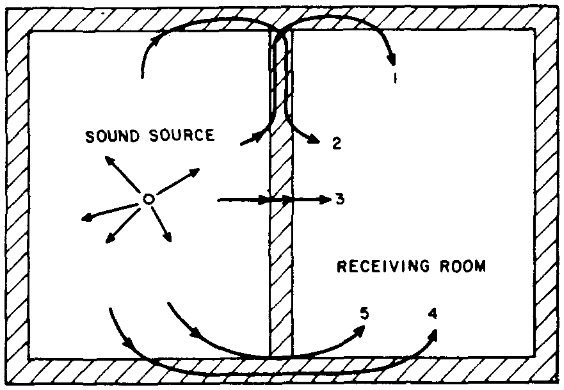

Figure 17. Possible routes for sound travel from one room to another. For paths 1 through 4 the sound travels some portion of the path in solid material. Path 5 represents transmission through any crack, gap, or other opening in the wall.

Finally, the ASTM standard for measuring transmission loss recommends that the minimum dimensions of the test specimen be at least 2.44 by 3.66 m (8 by 12 ft), with the exception that doors, windows, and other smaller items should be their normal size. This is because the full effects of stiffness, resonances, etc., will be different if the specimen is different from what will be constructed in actual use.

NOISE CONTROL BY BARRIER

Controlling noise by barrier is simply a matter of providing some form of wall or other heavy dense object between the source of the sound and the receiver, i.e., its path is blocked.

One of the most inexpensive and easiest to accomplish methods providing a barrier is to locate a source or a receiver behind an already existing barrier. For example, if a new apartment is to be constructed near an expressway and the landscape is hilly, the hill between the apartment and expressway can be used as a barrier. When this is not possible, bedrooms or other spaces where quiet is desired should be on the far side of the building. Hallways, elevators, etc., should be on the side facing the noise. In this way a great deal of special acoustical treatment can be eliminated.

In a factory the noisy machinery should not be in the same room with quieter objects. If noisy equipment is to be located outdoors, it should be placed on the side away from the area where quiet is desired. If the plant is located near a residential neighborhood the noisy activities such as loading docks should be on the side away from the homes. A little thought before the installation of some noise source can save a lot of time and money later.

To determine what the sound level in a room would be after a barrier wall has been erected, equation (41) can be reversed to obtain

$$NR = TL - 10 \log S/A \tag{44}$$

and it can then be seen that the noise reduction is dependent on the total absorption in the receiving room. This is understandable if one remembers what reverberation does to the sound field. The noise that comes through the wall bounces around in the receiving room so the level is not what it would be if a free field existed on the receiving side.

EXAMPLE 10: The sound pressure level on one side of a 3.05 by 4.27 m (10 by 14 ft) wall is measured 95 dB in the 500 Hz octave band. If the transmission loss of the wall is 47 dB in this band and the absorption in the receiving room is 1000 sabins, what will the sound pressure level be in the receiving room?

SOLUTION:

$$NR = L_{p_s} - L_{p_r} = TL - 10 \log S/A$$

or

$$\begin{aligned} L_{p_r} &= L_{p_s} - TL + 10 \log S/A \\ &= 95 - 47 + 10 \log \frac{10 \times 14}{1000} \\ &= 39.5 \text{ dB re } 20\ \mu\text{Pa} \end{aligned}$$

and the absorption in the receiving room has reduced the sound level by 8.5 dB more than what is predicted by simply subtracting the TL value from the sound level in the source room. Note that if the receiving room is very hard such that S > A, then the opposite is true.

In the general case of using a partition as a sound barrier, the partition may be a wall with a door and windows and may even be built in several sections each with a different transmission loss. It is necessary to know the average transmission loss of the entire assembly. This is found by first determining an average transmission coefficient $\overline{\tau}$ in a manner similar to finding the average absorption coefficient.

$$\overline{\tau} = \frac{\sum_i \tau_i S_i}{\sum_i S_i} \tag{45}$$

and

$$\overline{TL} = 10 \log 1/\overline{\tau} \tag{46}$$

where S_i and T_i are the area and transmission coefficient of the ith section of the partition. τ_i for each section may be determined by inverting equation (38):

$$\tau_i = \text{antilog}\left(-\frac{TL_i}{10}\right) \tag{47}$$

Now the noise reduction of this partition can be determined by combining equation (46) with equation (41) as

$$NR = \overline{TL} - 10 \log S/A \tag{48}$$

EXAMPLE 11: A partition consists of a concrete wall (TL=50) 3.66 m (12 ft) high by 30.5 m (100 ft) long with a window (TL=25), a door (TL=30), and an open area (leak) under the door. Determine the noise reduction through this wall in the 500 Hz band. The total absorption of the room on the receiving side of the wall is 300 sabins. The areas and transmission coefficients of each element of the partition are

ITEM	DIMENSION	AREA (sq ft)	TL (dB)	τ
wall	12 x 100	1151.4	50	0.00001
window	4 x 6	24.0	25	0.00316
door	7 x 3.5	24.5	30	0.00100
leak	0.5 inch x 3.5 ft	0.15	0	1.00000

SOLUTION: Note that the area of the concrete wall is 1200 sq ft minus the area of the window, door, and leak, and that the TL of an open area such as a leak is zero. The noise reduction of the wall is determined using equations (46), (47), and (48)

$$\bar{\tau} = \frac{(0.00001)(1151.4) + (0.00316)(24) + (0.001)(24.5) + (1)(0.15)}{1200} = 0.0002$$

$$\overline{TL} = 10 \log \frac{1}{0.0002} = 37 \text{ dB}$$

$$NR = 37 - 10 \log \frac{1200}{300} = 31 \text{ dB}$$

Due to the sections with lower TL values (especially the leak) and the hardness of the receiving room, the 50 dB wall results in a noise reduction of only 31 dB.

If absorption treatment is added to bring the absorption of the receiving room up to 2000 sabins, we will have a noise reduction of

$$NR = 37 - 10 \log \frac{1200}{2000} = 39 \text{ dB}$$

Observe that the increased absorption in the receiving room works together with the wall to produce a noise reduction greater than predicted from the wall alone.

If the leak is blocked with a seal that provides a transmission loss of 50 dB, the transmission coefficient τ of the leak drops from 1 to 0.00001. Considering the leak blocked while retaining the original receiving room absorption of 300 sabins, the noise reduction across the wall becomes

$$\bar{\tau} = \frac{(0.00001)(1151.4) + (0.00316)(24) + (0.001)(24.5) + (0.00001)(0.15)}{1200} = 0.00009$$

$$\overline{TL} = 10 \log \frac{1}{0.00009} = 40 \text{ dB}$$

$$NR = 40 - 10 \log \frac{1200}{300} = 34 \text{ dB}$$

The whole job, sealing the leak and providing 2000 sabins of absorption in the receiving room, results in a noise reduction of

$$NR = 40 - 10 \log \frac{1200}{2000} = 42 \text{ dB}$$

which represents an improvement of 11 dB over the original case. To improve this even more, it can be seen from the calculated transmittances that the door and the window are still the weakest links. This example also shows how a barrier and an absorbing material work together to improve the transmission loss. For this reason, many noise control materials are a composite of barrier with absorber bonded to it. Lead-loaded vinyl with absorbing plastic foam on one side is a popular combination. The example only considered the noise reduction at one frequency band, 500 Hz. A complete analysis would include similar computations for all significant frequency bands.

Walls As Barriers

In general, walls can be classified as nonload-bearing partition type walls, load-bearing, and masonry type walls. Masonry walls are made up of bricks, or various types of concrete and may be plastered or painted.

Plasterboard walls are relatively light, inexpensive, and easy to erect. A typical plasterboard wall consists of two plasterboard leaves, separated by an air space and a system of studs or framing members. The sound transmission loss of such a wall depends on the transmission losses of the individual leaves and on the degree of coupling introduced by the intervening air space and stud system. The studs can sometimes act as vibration conductors and thus may degrade the performance of a wall assembly. If the studs have low torsional rigidity (e.g., steel channels) transmission via the studs appears to be negligible. If proper construction techniques are used, it is possible to get a transmission loss greater than that predicted by the mass law. The main factor in achieving this enhanced performance is to construct what is referred to as a "double wall". In a double wall arrangement the two sides of the wall are independent of each other (there are no connecting braces, and each side uses its own set of studs).

Figure 18 shows the transmission losses of three wall assemblies as functions of frequencies. Wall assembly number 1 has the lowest STC even though its density is slightly higher than the other two assemblies. It can be seen from the figure that a significant increase (14 dB in this case) in transmission loss can be achieved by separating the two leaves of a wall and putting a sound absorbent batt in the wall cavity.

Load-bearing walls made from concrete or bricks are heavier than the plasterboard wall and consequently they can provide increased sound attenuation. For instance, the Brick Institute reports STC from 39 to 59 for specific walls made from structural clay tiles or bricks, with their weights ranging from 107.41 to 566.36 kg/sq m (22 to 116 lb/sq ft). Concrete walls also provide similar attenuation and in general the dense, heavyweight concrete walls perform better than the lightweight concrete walls - particularly at low frequencies.

In addition to plasterboard and masonry many other types of wall materials are used and the wall construction also ranges from a simple brick wall to walls with a complex stud system combined with acoustical and thermal batts. Plywood, hardboard, steel, etc., are other commonly used wall materials. In all cases it can be said that increased mass and decreased coupling between different components along the path of sound result in high transmission loss.

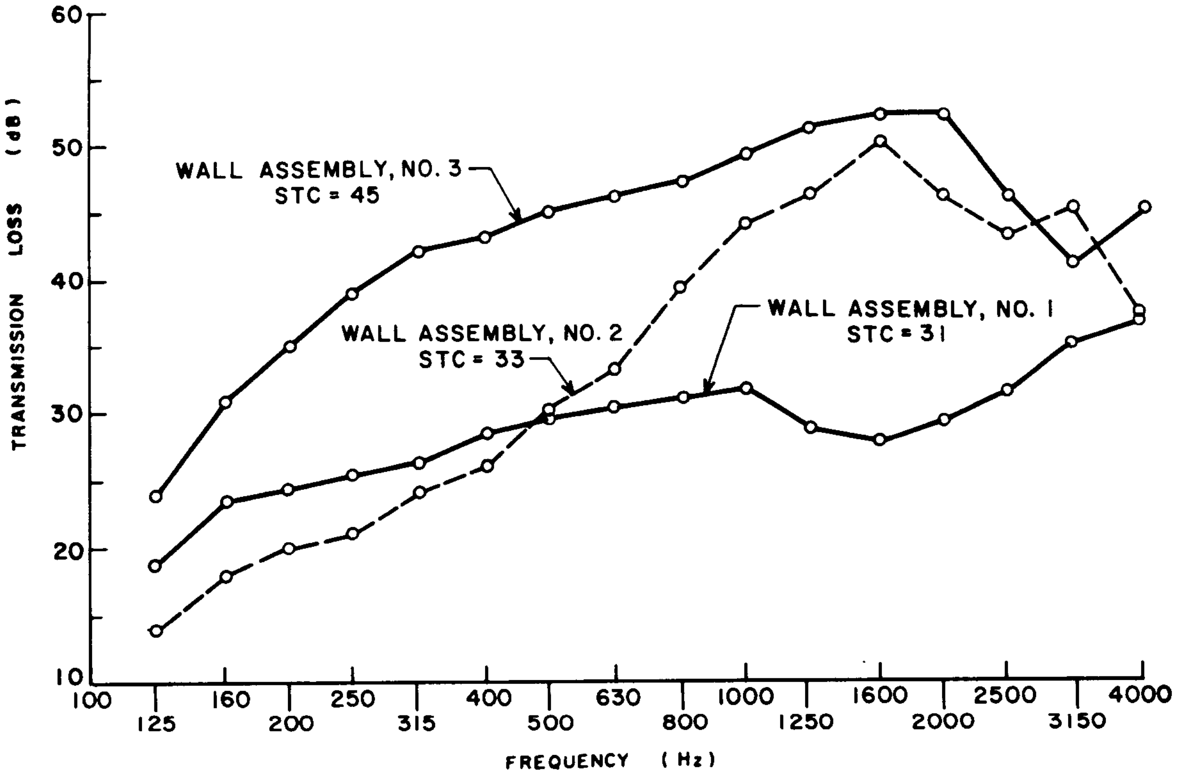

Figure 18. Improvement in wall transmission loss by spacing sides, and by adding absorbing material in the cavity. (Data courtesy National Research Council of Canada)
Wall Assembly No. 1: Two layers of 1/2-inch plasterboard with joint compound. Weight — 4.6 lb/sq ft.
Wall Assembly No. 2: Two 1/2-inch plasterboard leaves with 3-5/8-inch space, no studs. Weight — 4.2 lb/sq ft.
Wall Assembly No. 3: Two 1/2-inch plasterboard leaves with 3-5/8-inch space, 2-inch thick absorption. Weight — 4.2 lb/sq ft.

Glass as a Barrier

Glass windows are often the weak link in an otherwise good sound barrier. Acceptable sound transmission loss can be achieved in most cases by a proper selection of glass. Mounting of the glass in its frame should be done with care to eliminate noise leaks and to reduce the glass plate vibrations.

Acoustical performance of glass is often improved by a plastic inner layer or an air gap. Table 12 shows the comparison of STC values for glass and laminated glass of various thicknesses. Table 13 compares the monolithic glass plate with air-spaced glass of equal thicknesses.

Table 12. Sound transmission class of monolithic and laminated glass.

Overall Thickness inch	Monolithic Glass STC	Two equally thick layers glass with 0.030-inch plastic inner layer STC
0.125	23	—
0.25	28	34
0.5	31	37
0.75	36	41
1.00	37	—

Table 13. Sound transmission class of air-spaced glass and monolithic glass of comparable thickness.

Overall Thickness inch	Air-spaced Glass Construction	STC	Comparably Thick Glass without Air Space STC
1.0	Two 0.25-inch plates with 0.50-inch air space	32	31
1.5	Two 0.25-inch plates with 1-inch air space	35	31
2.75	0.25- and 0.5-8 inch with 2-inch air space	39	36
4.75	0.25- and 0.5-inch plates with 4-inch air space	40	36
6.75	0.25- and 0.5-inch plates with 6-inch air space	42	36

Doors As Barriers

Sound transmission loss of a door depends upon its material and construction, and the sealing between the door and the frame. Most doors are of wood or steel construction with various stiffnesses and barrier batts added to the hollow cavity inside the door if one exists. It is usually difficult to specify the STC of a door because the sealing between the door and the frame is not a precisely controlled variable. The variations in STC of two doors as the sealing was improved by increasing the deflection of gaskets, by adding extra gaskets, and by changing the gasket materials, are shown in Figure 19. In each case the improved sealing improves the performance such that the STC approaches its maximum possible value shown by the completely sealed case.

This figure points out improvements that can be made by attacking the weakest link. If better sealing does not offer sufficient improvement selecting

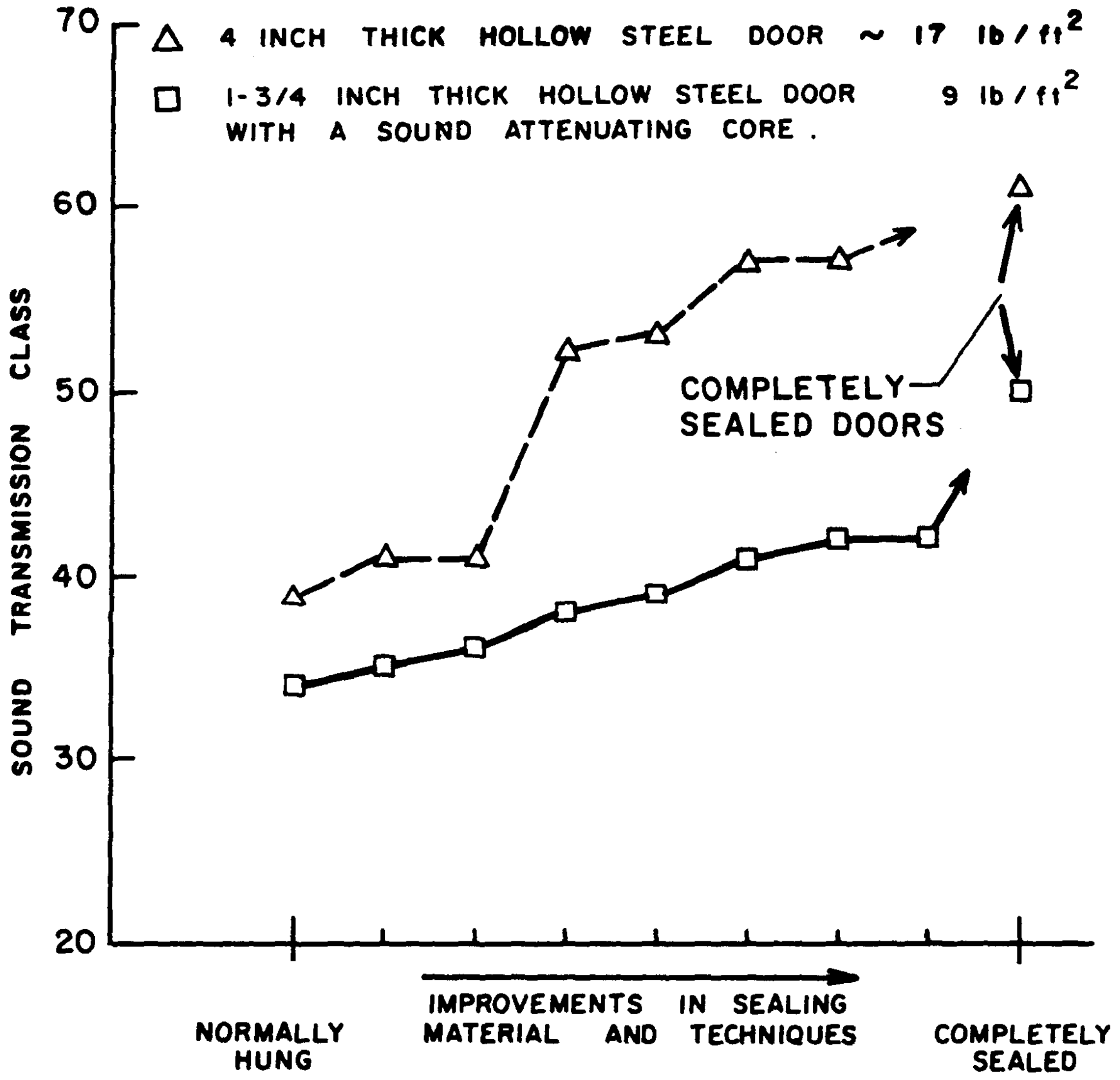

Figure 19. Effects of improved sealing of doors on sound transmission class. (Based on a series of tests on two different types of door.)

a better door design becomes necessary. Generally the heavier doors provide increased attenuation. Wood and steel doors behave essentially in a similar manner as shown in Figure 20 which shows a form of the mass law dependence of STC on weight (in lb/sq ft) for wood and steel doors. These data which are based on many tests conducted in an acoustical laboratory, indicate an increase of 8 to 9 dB in STC for a doubling of the weight. NOTE: That effects of better design, better sealing, etc., are also reflected in this figure. The approximate relationships are

$$\text{For steel doors:} \quad STC = 15 + 27 \log W \qquad (49a)$$

$$\text{For wood doors:} \quad STC = 12 + 32 \log W \qquad (49b)$$

where W = weight of the door in lb/sq ft. It should be emphasized that these relationships are purely empirical and that large deviations may be possible for any given door.

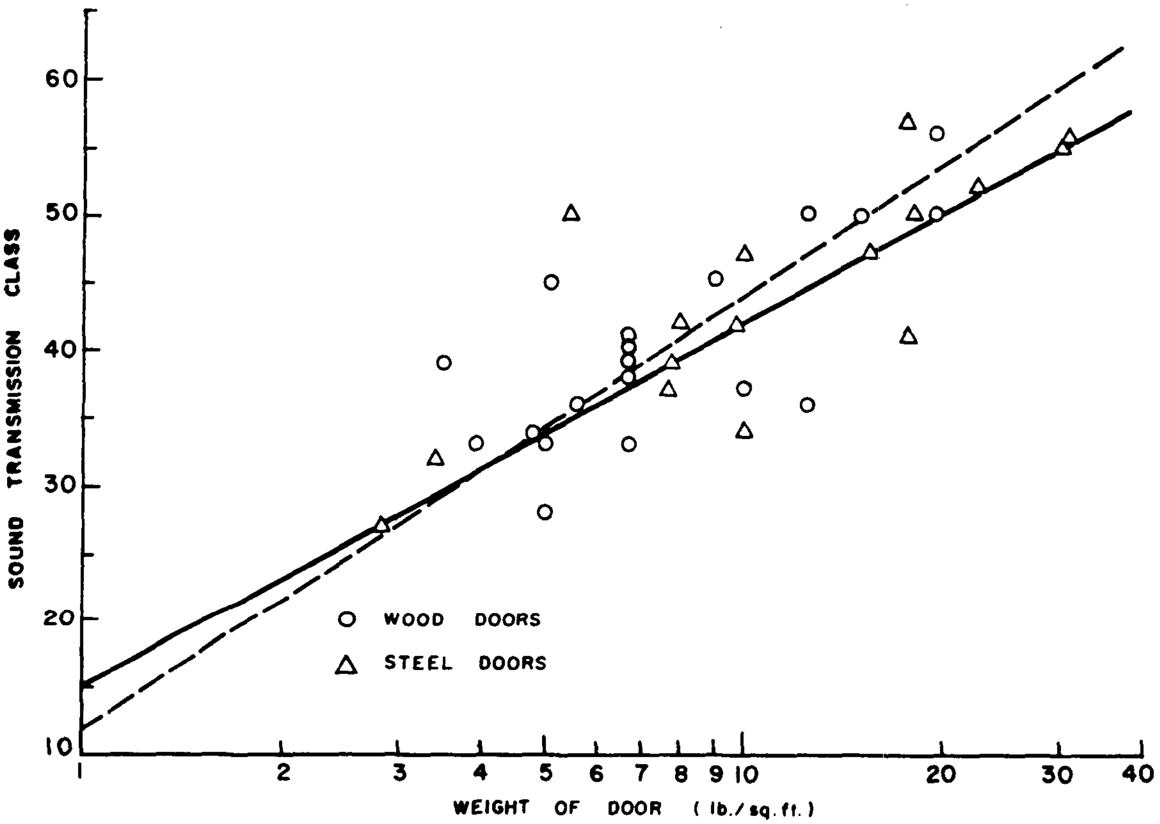

Figure 20. Dependence of sound transmission loss for doors on weight. Approximate STC for wood door, STC=12+32 log W; approximate STC for steel door, STC=15+27 log W; where W=weight of the door in lb/sq ft.

Ceilings As Barriers

The use of ceilings as sound barriers is not a normal application. Yet it is frequently through the ceiling and the open plenum above into the next room and down through the ceiling of the adjoining room that sound travels. This is just one flanking path that can seriously degrade the sound isolation between rooms.

There are several alternatives for reducing the noise transmitted in this way. One method is to place a barrier in the ceiling plenum between the two rooms. This may be difficult sometimes due to the piping, wiring, ductwork, etc., that is probably in this space.

A second way is to place some barrier material such as gypsum board on top of the ceilings. However, one must be careful because enclosing the space above the ceiling may decrease the absorption coefficient of the ceiling and reduce the absorption of the room below.

The third method is to use a ceiling that has both the proper absorption and sound transmission loss properties. For this reason ceilings are tested for their transmission from one room to another as well as for sound absorption. This test provides a sound attenuation factor for the ceiling. A two-room test procedure has been developed for this purpose. Basically, the procedure involves the construction within a room of a partition which does not quite reach the ceiling. The suspended panel ceiling to be tested is installed in the room on both sides of the partition so as to simulate a plenum above the suspended ceiling extending between both halves of the test room. The transmission loss of sound passing up through the suspended ceiling, through the plenum, and back down through the ceiling into the other half of the room is then measured. The transmission loss of the partition should be considerably greater than that of the test ceiling. A drawing illustrating this procedure appears in the text before data table 14.

Freestanding Walls As Barriers

A freestanding wall is defined here as a solid fence, with no bounding surface above the wall so that sound waves can pass freely over the wall.

As with all sound control systems the amount of attenuation provided by a freestanding wall depends on the frequency as well as many other factors. For low frequencies where the sound wavelength is of the same order of magnitude as the wall dimensions, the sound diffracts around the edges and over the top of the wall with very little attenuation (zero to 5 dB) on the other side. The higher frequencies can be very effectively attenuated with reductions of 20 dB being quite possible.

The attenuation of an infinitely long, freestanding wall can be determined from Figure 21 and the relationship

$$\text{Attenuation (dB)} = 20 \log (2.5\ N) + 5\ \text{dB} \qquad (50)$$

N = 1, for where

$$N = \left[\frac{2}{\lambda}(A + B - d)\right]^{\frac{1}{2}} \qquad (51)$$

λ = wavelength of sound, meters

d = straight line distance from source to receiver in meters,

A+B = shortest path length of wave travel over the wall between source and receiver.

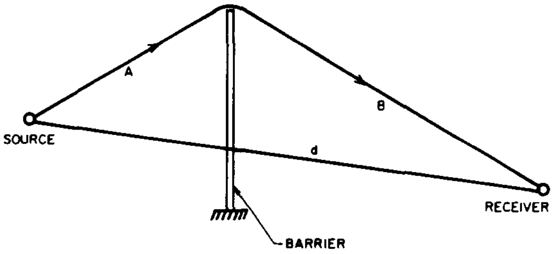

Figure 21. Geometry for determining sound attenuation by a freestanding wall.

Attenuations range from a low of about 5 dB to a maximum of about 24 dB. This attenuation can then be subtracted from the sound pressure level that would exist at the point of the receiver if the wall were not there.

The maximum attenuation occurs when A + B >> d and/or when λ is very small (high frequency).

EXAMPLE 12: Determine the attenuation at 1000 Hz for a freestanding wall 4 m high.

SOLUTION: The wavelength of sound at 1000 Hz is 0.344 m. Assume that the wall is long enough so that the sound diffracting around the ends can be neglected. Also assume the point noise source is 1.7 m from the ground and the receiver is a human ear also 1.7 m from the ground. Locate the wall such that the source is 3 m from the wall and the receiver 6 m from the wall. Then

$$N = \left[\frac{2}{.344}(3.78 + 6.43 - 9)\right]^{\frac{1}{2}} = 2.65$$

$$\text{Attenuation} = 20 \log \left[(2.5)(2.65)\right] + 5 = 21.4 \text{ dB}$$

On the other hand, how high must the wall be built to obtain a specified attenuation? For example, for the same case as above, how high must the wall be to obtain 15 dB attenuation at 125 Hz, where the wavelength is 2.75 m?

By rearranging equation (50),

$$N = 0.4 \text{ antilog } \frac{dB-5}{20}.$$

The value of A + B can be derived from equation (51) as

$$A + B = N^2 \lambda/2 + d.$$

The wall height can then be determined on a trial and error basis or graphically; in this case, A + B is 11.2 m, which corresponds to a wall height of 5 m. (Further discussion of the attenuation of sound by freestanding walls can be found in the Journal of the Acoustical Society of America, 55(3), pp 504-518, March 1974).

The wall should be constructed of such a material that transmission of sound through the wall does not degrade its performance since the above equations assume no transmission through the wall. This can be readily accomplished if the surface density of the wall is at least about 9.76 kg/sq m (2 lb/sq ft).

One final note on the use of a freestanding wall is that the noise from the source will reflect off the wall so that to an observer on the same side of the wall, the sound pressure level will be higher than if the wall were not there.

Noise Reduction And Enclosures

A barrier may be characterized by its noise reduction (NR) alone. For example, the sound pressure level inside an enclosure, L_1, and the sound pressure level outside the enclosure, L_2, may be measured simultaneously. The difference in these two levels is the NR value. If the noise source is inside the enclosure the NR is given by L_1-L_2, or NR is L_2-L_1 if the noise source is outside the enclosure.

The NR can differ significantly from the transmission loss for a specimen since the absorption in the two regions where the measurements are made is not included in the calculation. Whenever this value is presented in the data tables it is pointed out so the user will be aware of the difference.

The measurement of NR is not only used for enclosures, but for any case where the difference in two sound pressure levels is determined. One should also be aware that the NR of a specimen bears no relation to the noise reduction class (NRC) of an absorber material. The NR relates to the ability of a specimen to block sound whereas the NRC is a sound absorption property.

In many cases the purpose of an acoustic enclosure is to keep the noise from getting inside. Examples are soundproof booths for machine operators and audiometric test booths for testing the hearing of employees. It is relatively straightforward to calculate the noise reduction by employing the principles of transmission loss, since the enclosure may simply be regarded as a small room, and its walls as partitions. More often, however, an enclosure, or box, is placed around a noise source to keep the noise from getting outside. Several common designs of enclosures and barriers are illustrated in Figure 22.

In predicting the noise reduction for this case there are some subtleties which warrant further discussion.

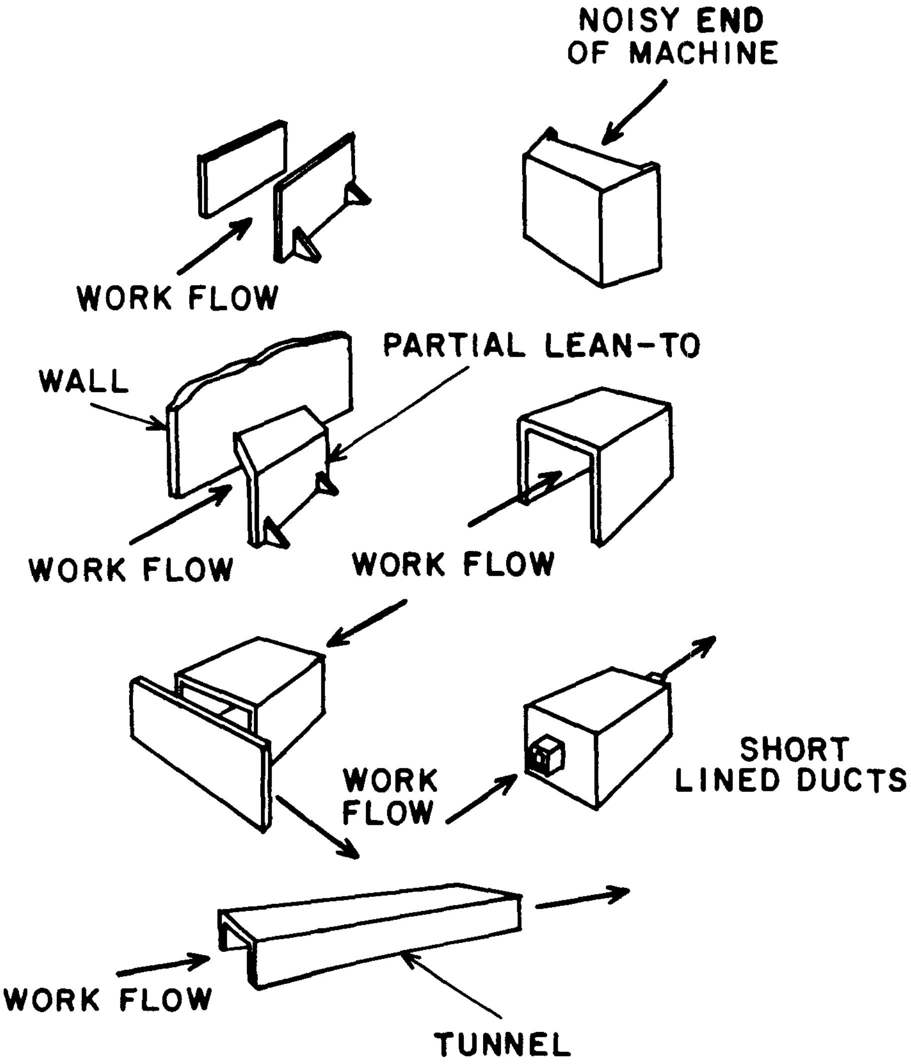

Figure 22. Typical barriers for partial noise control in work areas.

To predict the NR of an enclosure the procedure is the same as with a barrier wall. One first determines the transmittance of the total surface area and then, including the absorption of the space outside the enclosure, determines the noise reduction of the box.

EXAMPLE: A noisy machine sits in a room in a factory. The room has been found to have a total absorption of 3000 sabins at 250 Hz. It is desired to build a 3.05 m by 3.05 m by 3.05 m (10 ft by 10 ft by 10 ft) enclosure about the machine, made of partitions with a TL in the 250 Hz band of 50 dB. There will be a 1.07 m by 2.13 m (3.5 ft by 7 ft) door in the enclosure. The TL of the door at 250 Hz is 25 dB. What noise reduction can we expect to achieve from the use of the enclosure?

SOLUTION: As in example 11, we must calculate the average transmission loss, this time for four walls and a ceiling.

ITEM	AREA (sq ft)	TL (dB)	τ
Four walls (less door)	375.5	50	0.00001
Ceiling	100	50	0.00001
Door	24.5	25	0.00316

$$\bar{\tau} = \frac{(475.5)(0.00001) + (24.5)(0.00316)}{500} = 0.00016$$

$$\overline{TL} = 10 \log \frac{1}{0.00016} = 38 \text{ dB}$$

$$NR = 38 - 10 \log \frac{500}{3000} = 46 \text{ dB}$$

The NR computed above is the difference between noise levels inside and outside the box, and represent what one would most likely be concerned with in practice. However, what is the noise level inside the box? An interesting phenomenon occurs in a complete enclosure. If there is some source of sound power and a box is built around it, the sound energy density, or the intensity, will increase until the amount of power absorbed by the walls is equal to the power emitted by the source. This phenomenon is referred to as "sound build-up". To illustrate, suppose that the machine being enclosed has been found by prior testing, to produce 105 dB of sound power at 250 Hz. If the room constant R is 350 sq m, the sound pressure level of the machine at a distance of 1.5 m (5 ft) is

$$L_p = L_w + 10 \log \left[\frac{1}{2\pi r^2} + \frac{4}{R}\right]$$

$$= 105 - 11 = 94 \text{ dB re } 20\ \mu\text{Pa}$$

The enclosure is now placed around the machine. It is made of steel with an absorption coefficient of 0.2. The concrete floor it rests on also has an absorption coefficient of 0.2.

The room constant in the enclosure is

$$R = S(e^{\overline{\alpha}}-1) = 600(e^{.02}-1) = 12 \text{ sq ft}$$

$$= 1.1 \text{ sq m}$$

(Note that the surface area inside the enclosure used in determining R includes the area of the floor). The sound pressure level at 1.5 m (5 ft), (now just inside the enclosure wall) is

$$L_p = 105 + 10 \log \left[\frac{1}{2\Pi(1.5)^2} + \frac{4}{1.1} \right] = 111 \text{ dB re } 20\ \mu\text{Pa}$$

Recalling that the NR of the enclosure was found to be 46 dB, the sound pressure level just outside the enclosure will be 111 - 46 = 65 dB, compared with 94 dB at the same location before construction of the enclosure. The effect of building the enclosure has been a reduction of the noise by 29 dB. While this is a good improvement, it is a long way from the 46 dB predicted by the barrier properties of the enclosure alone.

This problem is not insurmountable. The solution is to add absorption to the lining of the walls of the enclosure. If the job is good enough, the level at the inside of the wall can be very nearly what it would be in a free field. In the above example, the external room constant was so large that the sound pressure at 1.5 m (5 ft) from the source was essentially that of a free field. As can be seen from Figure 12. Note that not in any case can the use of acoustical treatment inside a room reduce the sound pressure level at a point below that of the direct path transmitted wave. This wave is the free field wave which represents the minimum achievable sound pressure level that can be obtained without using a sound barrier between the source and the receiver.

Another factor that must be considered is resonance. If the dimensions of the box result in resonance due to one of the modes of the sound, the box can be driven to high levels of vibration and become a new radiator of these components of the sound. When this occurs the sound pressure level outside the box can be higher than it was even before the box was installed. This effect is significantly reduced when the noise source occupies a sufficient fraction of the room volume, by the use of absorbent lining on the interior surfaces of the enclosure, damping treatment on the panels, and stiffening of the panels.

IMPACT SOUND

The term impact sound as used here should not be confused with hazardous impact noise as defined by OSHA regulations. The tests described herein are used to measure transmission of footsteps and similar sounds and have little relevance to control of industrial impact noise.

A knowledge of sound transmission loss is useful for many objects such as walls, floors, doors, windows, specialized panels, or any other item that may be used to block a sound path. In the case of floors, however, not all noise in the space below the floor is due to airborne sound transmission through the floor. Some of the noise below the floor is due to sliding objects across the floor, footsteps, dropping objects, etc. These occurrences induce structural vibrations in the floor assembly which are reradiated as sound waves into the rooms above and below the floor.

IMPACT SOUND TRANSMISSION MEASUREMENTS (PER ASTM E497-77)

The recommended method for this test procedure has been published by ASTM as E492-77 "Method of Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".

This test utilizes a standard impact source which is known as a tapping machine. With this machine making fixed amplitude impacts on the floor the sound pressure level produced in the room below is measured in 16 contiguous one-third octave bands from 100 Hz through 3150 Hz. The sound pressure levels thus measured are affected by the absorption in the receiving room. In order to compare results from different receiving rooms, these values are normalized to a reference room which has an absorption of 108 sabins or 10 metric sabins. This normalization is obtained through the relationship

$$L_N = L_p - 10 \log (A_o/A_2) \quad \text{dB re } 20\ \mu\text{Pa} \qquad (52)$$

where

L_N is the normalized sound pressure level,

L_p is the mean square measured sound pressure level,

A_2 is the measured absorption in the receiving room measured as described for absorption tests, and

A_o is the reference absorption in the same units as A_2.

There is still much debate over the use of the tapping machine as an impact source. Many feel that this excitation is not representative of footsteps, sliding furniture, etc.

Just as with absorption and transmission data the impact data make comparisons between products difficult. There is another one-number rating called the Impact Insulation Class (IIC), which is obtained by comparing the normalized sound pressure levels at each of the 16 one-third octave bands to a set of standard contours as in the case of the STC for transmission loss. These contours however have a different shape from the STC contours. The normalized sound pressure level curve in this case must fit the standard contour in such a way that in no event is the L_N curve more then 8 dB above the IIC contour at any frequency, and the sum of the deviations of the L_N values which are above the IIC contour shall not exceed 32 dB. The lowest contour to which the specimen L_N curve can satisfy these requirements is the proper IIC contour and the value of this curve at 500 Hz is then chosen as the IIC number of the specimen. The standard contour is shown in Figure 23.

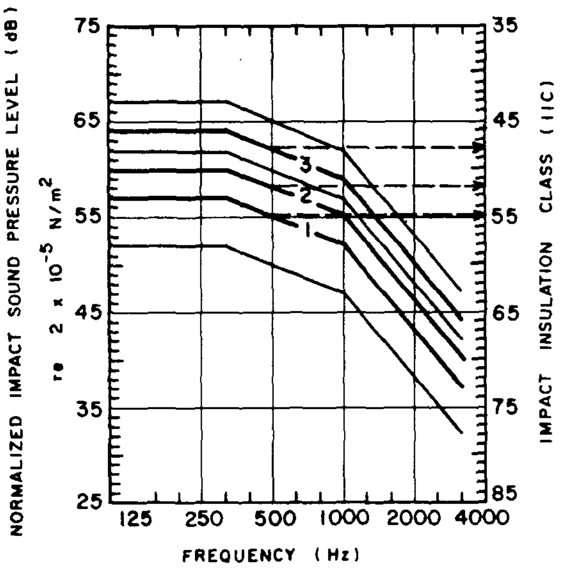

Figure 23. Impact insulation class contours. Contour 1, IIC = 55; Contour 2, IIC = 52; Contour 3, IIC = 48.

An older single-number rating for impact insulation which was used by the Federal Housing Administration is known as the Impact Noise Rating (INR). This rating is based on the same contours, but a standardized floor was given an INR = 0. Thus, the first contour above this had a rating of -1 (higher sound pressure level = poorer floor) and the first contour below had a rating of +1. Consequently the INR can take on positive and negative values. This standard floor compares to the IIC contour which has a value of 51 at 500 Hz; thus, any value of IIC can be obtained from the INR by adding 51. That is

$$\text{IIC} = \text{INR} + 51 \tag{53}$$

IMPACT NOISE CONTROL

The use of floors as barriers of sound in the path between two rooms is exactly as with walls plus a few additional considerations. First consider the STC of the floor. Generally, floors have good STC since their structural requirements are such that the floors are sufficient mass. However, this is not always true, especially in some of the modern apartment constructions.

One of the main problems with floors is that they are located in the direction of gravity for footsteps, falling objects, support of furniture and equipment of all sorts, etc. These falling objects produce impact noises both in the spaces above and below the floor. Because of these impacts, many floors are now tested for impact insulation.

Sound transmission of a floor can be decreased by increasing the weight of the floor or by designing a more complex floor system using acoustical batts, cavities, etc. The goal of these complexities is to decouple the bottom of the floor assembly from structural vibrations set up in the top part of the assembly.

The IIC of a floor cannot be significantly increased by increasing its weight, but a carpet on the floor, or even better, a carpet placed on a pad, can greatly increase the IIC. The effects of various floor treatments on STC and IIC are shown in Tables 10 and 14.

Table 14. Typical improvements with floor and ceiling treatments.

Type of treatment	Change in ratings	
	Airborne, STC	Impact, INR or IIC
2-inch concrete topping, 24 psf	3	0
Standard 44 oz carpet and 40 oz pad	0	48
Other carpets and pads	0	44 to 56
Vinyl tile	0	3
0.5 inch wood block adhered to concrete	0	20
0.5 inch wood block and resilient fiber underlay adhered to concrete	4	26
Floating concrete floor on fiberboard	7	15
Wood floor, sleepers on concrete	5	15
Wood floor on fiberboard	10	20
Acoustical ceiling resiliently mounted	5	27
Acoustical ceiling added to floor with carpet	5	10
Plaster or gypsum board ceiling resiliently mounted	10	8
Plaster or gypsum board ceiling with insulation in space above ceiling	13	13
Plaster direct to concrete	0	0

Consideration must be given to what happens when a piece of vibrating machinery is mounted on the floor. At the moment no particular test procedure exists to predict what noise this type of installation will have. What can be said is that if the floor is driven to a sufficiently high level of vibration it will become an acoustic radiator of noise into the spaces both above and below. To prevent such problems one must mount machinery on proper vibration isolation mounts.

It cannot be said that the real noises produced by objects hitting the floor above will resemble the noises of the tapping machine. Since the machine is portable, it cannot simulate the shifting of weight distributions that occur as a human walks across the floor, nor does it produce the sort of structural vibrations set up as furniture slides on the floor. These actions produce creaking and squeaking noises, especially in wood construction floors, which are not accounted for by the IIC values and the ASTM test method. The use of a tapping machine is only of value as a standard in comparing the performance of a floor to other floors similarly tested.

There is no definite way one can predict the sound pressure levels in the room below any particular floor without first measuring the noise of the specific impact of interest. The only handle that is available is that the higher the IIC the lower the sound level in the space below for most, but not all, types of impact noises. Of course, just as with STC, the true shape of the sound spectrum must be considered in its entirety.

With regard to airborne sound transmission, it was shown earlier that a good IIC floor probably has a good STC as well. It should not be overlooked, however, that flanking paths such as into the walls of the upper room, down through the wall, and out into the space of the room below, can contribute a good portion of the noise in the space below. Also, any impact on the floor will send vibrations into the walls which can become airborne sound in the room below.

Laboratories that measure impact insulation provide a good test floor in terms of isolation. Any good installation of a floor that must have a high insulation against impact noises should be equal to the laboratory setup. There are numerous ways and materials that can be used to increase the isolation of the floor from the wall and even from the subfloor. The interested reader should consult the relevant data tables of this volume as well as one of the many good books on architectural acoustics for the many designs presently used.

Of additional benefit to the sound barrier properties of a floor is the fact that if there is a space below there is probably some kind of ceiling also. Consequently, a floor should not be considered alone but as a floor-ceiling system. Well designed floor-ceiling systems can significantly improve the acoustic environment by reducing impact sound generation, increasing the sound absorption, and attenuating the airborne sound that passes through the floor.

OPEN PLAN OFFICE TREATMENT

In response to the growing popularity of open plan office architecture, a growing number of manufacturers are producing a variety of decorative wall treatments and freestanding landscape screens to divide a large office area into smaller work areas. Speech privacy bewteen work areas is a major concern of such treatments. The landscape screens provide sound absorption and act as a freestanding barrier to noise.

Such screens are generally constructed of an absorbent core held in a wood or metal frame and covered with fabric. The units may be attached together at their ends to enclose or delineate areas. They may have an open area at the bottom or they may extend to the floor, although the units which extend to the floor are more effective barriers. Since the screens are obviously sold as a preformed unit and the size of the specimen will affect the absorption, the measured absorption is reported directly in sabins per unit and is usually not reduced to a coefficient. Transmission of sound through the screens is described by normal transmission loss values. To reduce transmission, some screens contain an impermeable septum in the core.

Sound may still diffract over the tops of the screens as discussed in the section of freestanding barriers, and reflections off the ceiling may travel from one side of a screen to the other. For this reason, most open plan office designs incorporate a combination of landscape screens and sound absorbent ceilings. Electronic noise masking systems may also be employed to diminish the intelligibility of speech diffracting over the tops of the screens.

The Public Buildings Service of the Government Services Administration has published a test method to quantify the acoustic privacy of open plan office systems (PBS-C.2 "Test Method for the Sufficient Verification of Speech Privacy Potential Based on Objective Measurements"). This method defines interzone attenuation as the difference in decibels, at a given frequency, between the sound pressure level on one side of a screen and the level on the other side. Measurements are taken 0.914 m (3 ft) from a sound source on one side and at specified points on the other side. The distance between the source and the measuring point is called the interzone distance. Functional Interzone Attenuation at each frequency is defined as the average of individual interzone attenuation values over a specified range of interzone distances, typically 2.743 to 3.657 m (9 to 12 ft) from the source (the screen is usually 1.828 m (6 ft) from the source). The averages are "functional" because they represent interzone distances typical of actual office layouts.

The functional interzone attenuation in each one-third octave band between 400 Hz and 2000 Hz (representative of speech frequencies) are compared to the STC contours within the same frequency range and a single number descriptor is derived in a manner similar to the STC except that the allowable deficiencies are cut in half (4 at any one frequency and 16 total). This descriptor is called the NIC'. An open-plan office layout with an NIC' equal to or exceeding 20 is considered to provide adequate privacy between areas. Both screens and ceilings may be evaluated by this method by using them in conjunction with a standardized ceiling or screen, respectively.

PIPING, DUCTS, MUFFLERS AND SILENCERS

INSERTION LOSS

The tests previously described do not apply to such items as ducts, mufflers, pipe lagging, etc. The measurement procedure for these is simply to measure the noise radiating from some pipe or duct work, and then apply (insert) the specimen and measure the sound pressure levels again. The difference in sound pressure levels is due to the insertion of the device under test and is called the "insertion loss". This is a before-and-after type measurement as opposed to the simultaneous measurement on two sides of a partition for noise reduction and transmission loss. The concept of insertion loss may also apply to enclosures as was illustrated in example 13.

PIPE LAGGING

The covering of a pipe or duct with some sound barrier material is normally referred to as "lagging". Lagging amounts to wrapping the pipe with a flexible sound barrier material in such a way that no seams exist to permit an acoustic leak. This is accomplished by overlapping the barrier material at the places where one piece ends and another begins, also overlapping the two ends of each piece at the point where they wrap back on each other. These seams should then be secured with duct tape so that the barrier remains properly in place.

To realize the full benefit of the lagging, the barrier must not touch the pipe it is covering. Any direct connection between the lagging and the pipe will cause the lagging to vibrate as well, and reduce its effectiveness as a sound barrier. This incidently also holds for any enclosure around a noise source. The lagging can be effectively "floated" away from the pipe wall by first wrapping the pipe with a layer of foam, fiberglass, or other porous material that acts both as a vibration isolator, and sound absorber, and even increases the transmission loss in the higher frequencies. The outer layer of barrier material can be made of any limp impermeable membrane such as thin sheet metal, asphalted paper, rubber, lead loaded vinyl, lead sheet, etc. The heavier and limper the better, just as with any barrier application.

The means of determining how much reduction in sound level can be achieved by such treatment is a little more difficult to determine than for a wall or enclosure because of the different types of acoustical data that are encountered. Some items that are useful as lagging materials such as leaded vinyl may also be useful as a hanging curtain or as a plug to close some opening. Consequently, the manufacturer of these items may have them tested for transmission loss in the usual way between two reverberation rooms. This provides a good measure of the sound barrier capability of the material, but requires that one knows the sound pressure level very close to the pipe along its length and the absorption in the surrounding space. Some manufacturers actually mount their material on a piece of test pipe and determine the noise reduction of the covering by measuring the sound pressure level inside the pipe and in the space outside the lagging. To use these data requires that the sound pressure level inside the pipe, the sound pressure level produced by the pipe vibrations, and the absorption in the surrounding space be known.

Insertion loss measurements are made with a test pipe in a reverberation room with a noise source of some kind inside the pipe. Measurements are made in the room with only the bare pipe and again after the pipe is lagged. Insertion loss data are the most meaningful and easiest to use.

DUCTING

Sound may propagate through the ductwork which often connects spaces which would otherwise be sound isolated from each other. In particular, the noise of a fan or blower can travel great distances along the duct work and be heard in many areas of a building.

Figure 24 illustrates interconnection through ducts. The fan in room A produces vibrations which enter room B through the floor and it produces noise which may enter room B through the air diffuser or by vibration of the duct walls. The noise may travel to all other rooms through the duct. The men talking in room C produce noise in room B. Noise from the shop D may travel through the ducts to rooms B, C and E.

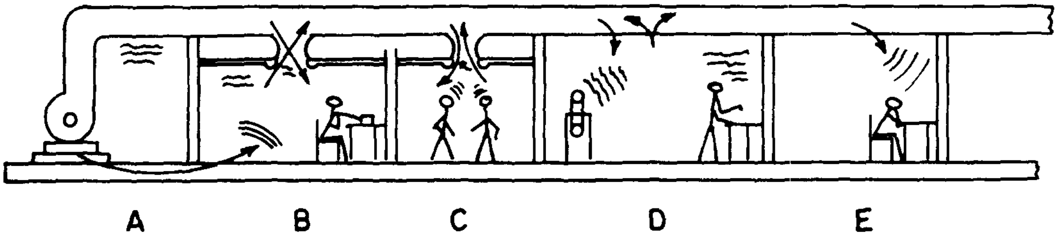

Figure 24. Interconnections between noise sources, paths, and receivers.

Figure 25 shows the use of flexible couplings between ducts and blower and between ducts and a noise attenuation package, as well as the use of vibration-isolating hangers. Figure 26 shows the noise sources in a simple duct system with the spectra of the sources and the attenuation of a lined duct, an attenuation package, a bend, and the end reflection losses.

A very good description of the propagation of sound as related to ductwork can be found in the "ASHRAE 1973 Systems Handbook". The following discussion presents some of the pertinent information taken from Chapter 35 of the book.

Normally occurring features of a duct system such as bends and abrupt changes in cross section can provide sound attenuations without the need for special silencing components. Elbows and bends, because they block the line-of-sight transmission of the waves, produce attenuations at the higher frequencies as shown in Table 15.

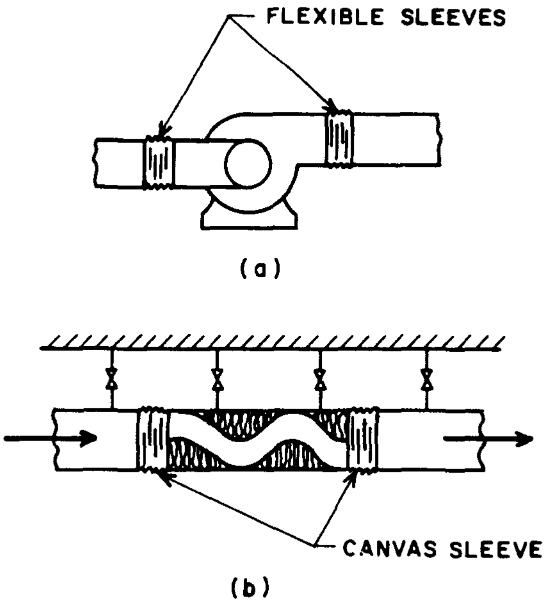

Figure 25. Uses of flexible couplings in ducts. (a) Canvas or flexible molded rubber and fabric sleeves serve as vibration breaks between fan and connecting ductwork. (b) Canvas or molded rubber connectors between ductwork and high-attenuation devices such as aircoustat package sound attenuators prevent short-circuiting of noise through duct walls. Vibration-isolating hangers should be used where objectionable amounts of noise may short-circuit through supports and building structure.

Table 15. Approximate attenuation in dB of round elbows.

Diameter or dimensions, (inch)	Octave band center frequency, Hz							
	63	125	250	500	1000	2000	4000	8000
5-10	0	0	0	0	1	2	3	3
11-20	0	0	0	1	2	3	3	3
21-40	0	0	1	2	3	3	3	3
41-80	0	1	2	3	3	3	3	3

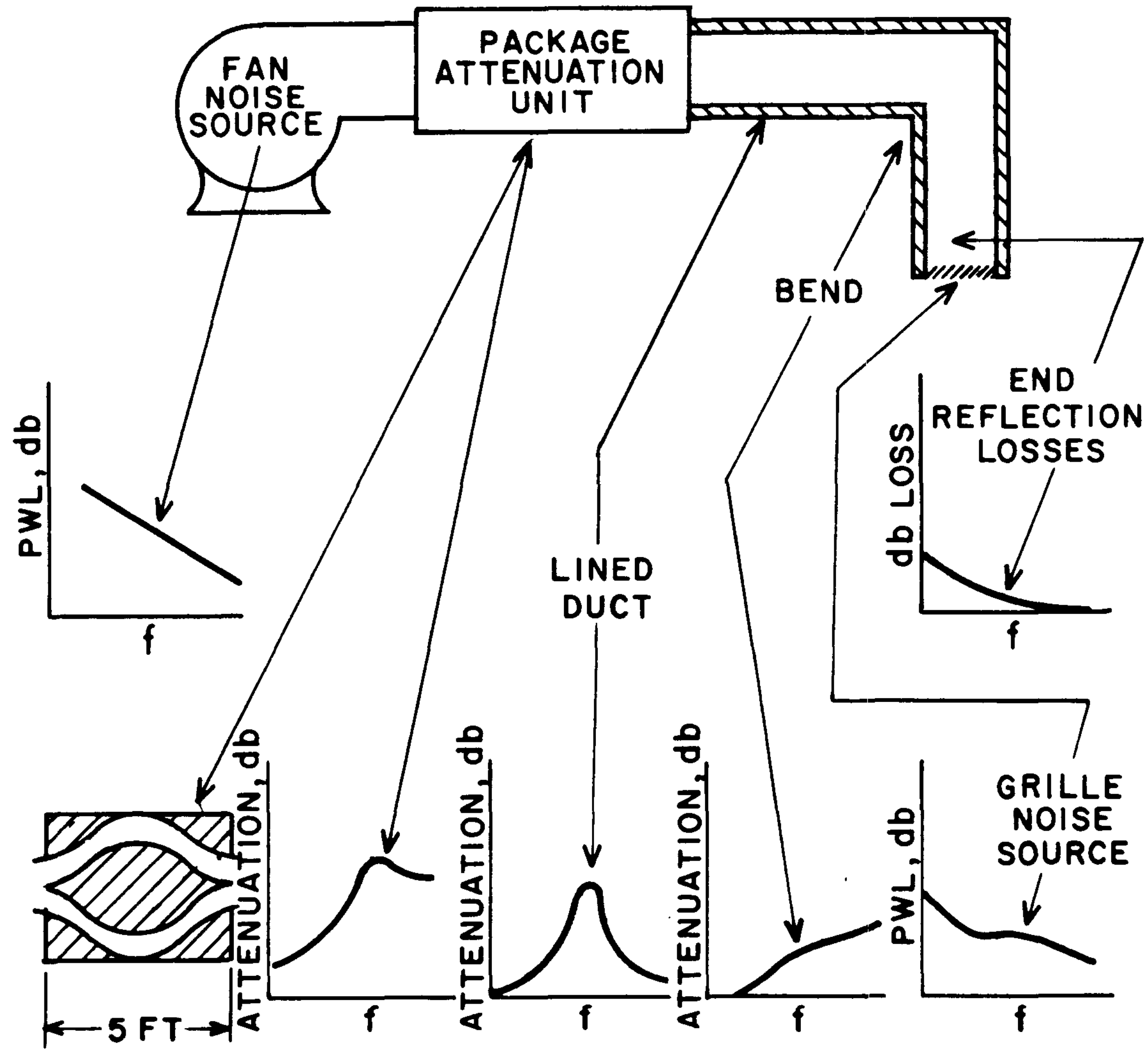

Figure 26. Noise sources and attenuation in a simple duct system. The sources are the fan and the grille. Attenuation is provided by a package attenuation unit, a lined duct, a bend, and by reflection of low-frequency waves backward at the end of the duct.

When a duct abruptly changes its cross section, as when it empties into a room, a portion of the wave will be reflected back down the duct because of a mismatch of acoustic impedance at the boundary of the two regions. Table 16 illustrates this. Note that the attenuation is best at the frequencies where the wavelength is much larger than the lateral dimension of the duct.

Table 16. Duct end reflection loss in dB.*

Duct diameter, (inch)	Octave band center frequency, Hz					
	63	125	250	500	1000	2000
5	17	12	8	4	1	0
10	12	8	4	1	0	0
20	8	4	1	0	0	0
40	4	1	0	0	0	0
80	1	0	0	0	0	0

*Applies to ducts terminating flush with wall or ceiling and several duct diameters from other room surfaces. If closer to other surfaces, use entry for next larger duct. No loss for frequencies above 2000 Hz.

The following points should be considered when lining a duct with absorptive material.

1. For absorption of frequencies below 500 Hz, the material should be at least 5.08 cm (2 inches) thick. Thin materials, particularly when mounted on hard surfaces, will absorb only the high frequencies.
2. Increased absorption at frequencies below 700 Hz may be obtained by using a perforated facing in which the area of the perforation is from 3 to 10 percent of the surface area. Such facings, however, decrease the absorption at high frequencies.
3. Any air space behind the material has considerable effect. Absorption coefficients should be based on the particular mounting method intended.

The dependence of absorption NRC on thickness is shown in Figure 27. This figure shows the range of typical NRC for any given thickness. The frequency dependence varies as with any absorbing material on the type and spacing of the pores, any covering such as mylar, perforated metal, etc. Again the specific product and thickness should be selected on the basis of the full range of frequency data and not just on NRC. If the entire duct cannot be lined, some improvement may be gained by lining two duct widths before and after bends and the last five duct widths before an outlet.

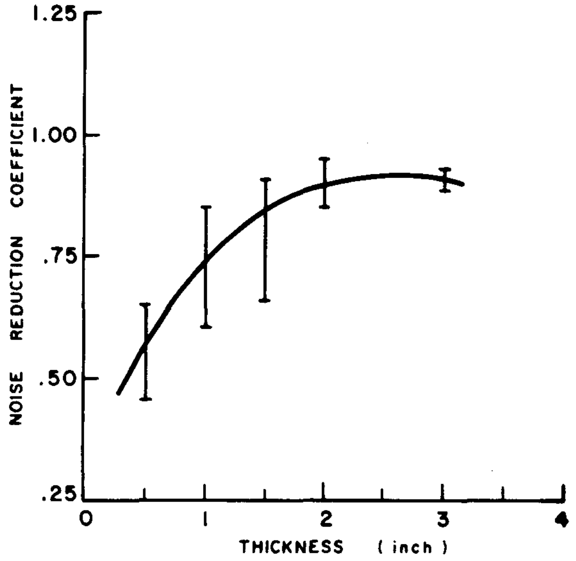

Figure 27. Dependence of noise reduction coefficient of duct lines on thickness.

Although the exact mathematics of sound attenuations in a lined duct is rather complicated, theoretically the following empirical relation can be used to estimate the sound attenuation if the proper limitations on its use are observed.

$$\text{Attenuation (dB)} = 12.6\ l\ \frac{P}{S}\ \alpha^{1.4} \qquad (54)$$

where l = length of lined duct in feet; p = perimeter of the duct inside the lining, inches; S = cross-sectional area of the duct inside the lining, square inches; and α = absorption coefficient of the lining (frequency dependent). Some limitations on the use of equation (54) are:

1. smallest side of the duct should be between 15.24 and 45.72 cm (6 and 18 inches);
2. duct width to height ratio should be less than 2;
3. the equation should not be used where airflow velocities are greater than 1219 m/min (4000 ft/min); and
4. line of sight propagation of the higher frequencies is not accounted for by this equation. (In a straight 3.048 cm (12 inch) duct the attenuation in the 8000 Hz octave band will be only about 10 dB for any lining length over 0.914 m (3 ft). The attenuation in the next lower octave band, 4000 Hz, will be about midway between 10 dB and the value calculated from equation (54). The frequency above which the 10 dB limit applies is inversely proportional to the shortest dimension of the duct.)

Some actual measurements have indicated that the sound level drops much faster than predicted by equation (54) for the first 1.524 m (5 ft) of the duct. After that the rate of sound level dropoff is much slower than predicted by equation (54). This is mainly due to flanking transmissions where the sound enters the duct wall and is transmitted along the wall itself. This flanking appears to be the limiting factor in any instance where the predicted sound attenuation exceeds 2 dB/ft. To reduce this flanking it is therefore recommended that flexible vibration couplings be inserted in the ductwork for every 25 dB of lining attenuation required in any frequency band.

If additional attenuation is still required then the attenuation can be increased by increasing the absorbing surface in the lined duct as shown, for example, in Figure 28. Another means of reducing the noise in a duct is by using a sound absorption plenum, shown in Figure 29, which is sometimes the most economical arrangement.

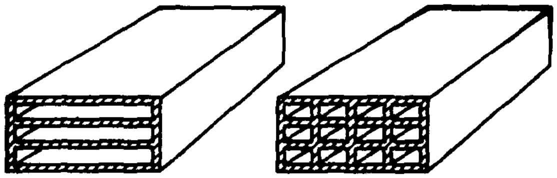

Figure 28. Increase of absorbing surface in lined ducts.

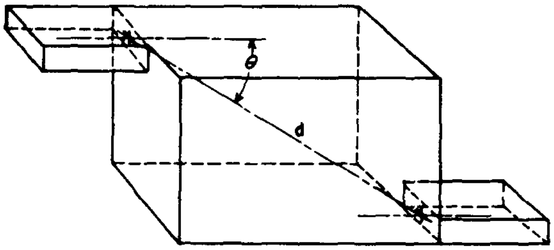

Figure 29. Sound absorbing plenum.

The attenuation provided by such a plenum can be determined by the empirical expression

$$\text{Attenuation (dB)} = 10 \log \left[\frac{1}{S_e \left(\frac{\cos\theta}{2\pi d^2} + \frac{1-\alpha}{\alpha S_w} \right)} \right] \tag{55}$$

where

α = absorption coefficient of the lining (frequency dependent)

S_e = plenum exit area

S_w = plenum wall area

d = distance between entrance and exit

θ = the angle of incidence at the exit, i.e., the angle d makes with the normal to the exit opening (deg)

English or metric units may be used, as long as they are consistent.

EXAMPLE 14: As an example of the attenuation a plenum can provide, suppose we build a box 3048 m (10 ft) on a side which attaches to a 0.6096 m (2 ft) square duct in the manner shown in Figure 29. Now line the plenum with a sound absorbing liner such as foam or fiberglass, which has an absorption coefficient in the 1000 Hz octave band of 0.6. What attenuation may we expect in the 1000 Hz band from this plenum?

SOLUTION: For the 1000 Hz band,

$$\alpha = 0.6$$

$$S_e = 4 \text{ ft}^2$$

$$S_w = 6 \times (10^2) - 4 = 596 \text{ sq ft}$$

$$d = \sqrt{8^2 + 10^2} = 12.8 \text{ ft}$$

$$\theta = \tan^{-1}(8/10) = 38.7 \text{ deg}$$

$$\text{Attenuation (dB)} = 10 \log \left[\frac{1}{4\left(\frac{\cos 38.7}{2\pi(12.8)^2} + \frac{1 - 0.6}{0.6 \times 596}\right)} \right] = 21.2 \text{ dB}$$

This result is fairly accurate as the predictions obtained with equation (55) normally are within a few decibels for frequencies where the wavelength is less than the plenum dimensions (in this case the wavelength is just over a foot). For the lower frequencies this equation can be conservative by 5 to 10 dB since the abrupt change in the duct dimensions acts to reflect these longer wavelengths.

It may be necessary to purchase a prepackaged silencer, which can be installed as part of the ductwork, and acoustically treated grills where the ducts terminate in rooms. The attenuation of these devices as with airflow silencing application is dependent on the flow rate, the pressure drop, and the noise frequency content, etc. Specific data for each application should be obtained directly from the manufacturer of these items.

Another concern in duct noise is with sound that propagates through the duct wall, into and out of the duct. As the primary concern in this case is keeping the sound from getting out of the duct, it should be remembered that ducts make good acoustical connections between rooms. One does not want to have sound enter the duct where it passes through a noisy room to be transmitted to another room, especially if a great deal of time, money, and effort have been expended to reduce the noise (e.g., from fans, blowers, etc.) by installing plenums or silencers. In either case if barrier treatment is applied on the outside of the ductwork or the piping it should reduce the transmission of sound through the walls.

MUFFLERS AND SILENCERS

A muffler or silencer is a section of pipe or duct which has been designed to reduce the transmission of sound along its length while allowing free flow of gas. Noisy gas flow through a duct consists of alternating pressure waves superimposed on a steady flow, analogous to an alternating current superimposed on a direct current in an electrical transmission line. Continuing this analogy, a muffler serves as a low-pass filter, removing or attenuating the alternating component while passing the steady component.

The performance of mufflers may be described in several ways. Insertion loss is defined as the difference in decibels between the sound pressure measured at a point before and after the muffler is placed between the source and the measurement point. Transmission loss is defined as 10 times the logarithm of the ratio of the sound power entering the muffler to the sound power transmitted through the muffler. Noise reduction is the difference between sound levels measured at the input of a muffler and its output. Attenuation is the decrease in sound power between two points in a system. It is usually determined by measuring the decrease in sound pressure per unit length of a duct or pipe. In practical terms, insertion loss is generally regarded as the most useful descriptor of performance and the most convenient to measure.

Mufflers are generally classified into three types: reactive, dissipative, and dispersive. Reactive mufflers consist of chambers, resonators, and finite sections of pipe which work to create a mismatch of acoustic impedance between the inlet and outlet of the muffler. Upon meeting a change in acoustic impedance, a portion of the energy in the sound wave is reflected, either to travel back to the source or to be reflected back and forth within the muffler. If the impedance relationships are correct- there will also be some amount of destructive interference with the oncoming wave, canceling out the pressure variations. The simplest kind of reactive muffler is the expansion chamber, where the duct opens into a large volume, creating an abrupt change in cross-sectional area at each end of the volume (Figure 30).

A mathematical analysis of the reflection and expansion of sound waves as they pass through the chamber leads to a theoretical expression for the transmission loss through such a muffler:

$$TL = 10 \log \left[1+\frac{1}{4}\left(m-\frac{1}{m}\right)^2 \sin^2 k\ell\right] \qquad (56)$$

where

$$m = \frac{\text{cross-sectional area of chamber}}{\text{cross-sectional area of duct}}$$

k = wave number = $2\pi/\lambda$

λ = wavelength of the sound

ℓ = length of expansion chamber

It can be seen from this theoretical relationship that the transmission loss of a muffler is a maximum at those frequencies where the length of the muffler is an odd multiple of a quarter-wavelength; $\lambda/4$, $3\lambda/4$, etc.

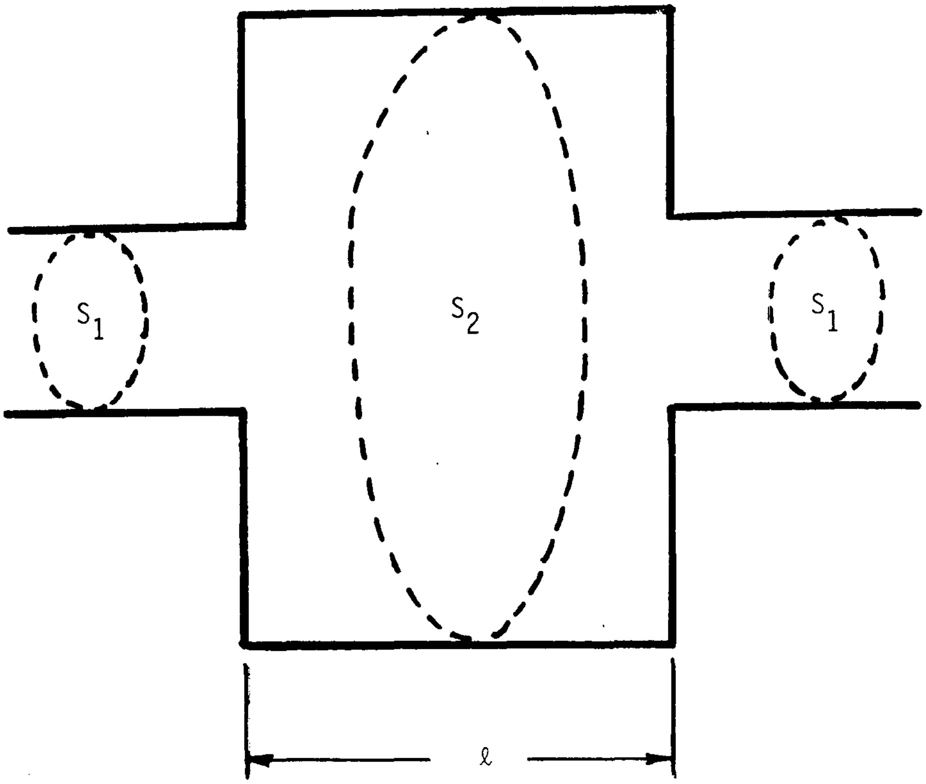

Figure 30. Schematic diagram of an expansion chamber

Figure 31 illustrates curves of TL versus the parameter $k\ell$ for various values of the area ratio m. The performance of expansion chamber mufflers is not affected by steady flow through it, at least for reasonable gas velocities. At very high speeds, noise from turbulence in the flow itself may make the muffler ineffective. Side-branch resonators work in a manner similar to expansion chambers. Openings in a through pipe lead to a chamber to the side of the main flow. The chamber and the openings form a Helmholtz resonator which attenuates noise at the frequency the resonator is tuned to.

EXAMPLE 15: It is desired to reduce the sound power output of a compressor by 10 dB. Design an expansion chamber for the exhaust which will accomplish this. The predominate frequency of the exhaust noise is 250 Hz, the exhaust port has a diameter of 7.62 cm (3 inches), and the temperature of the exhaust is 175°F.

SOLUTION: At this elevated temperature, the speed of sound and hence the wavelength at 250 Hz is significantly different from its value at room temperature: from equation (36)

$$c = 49.05 \sqrt{175 + 460} = 1236 \text{ ft/sec}$$

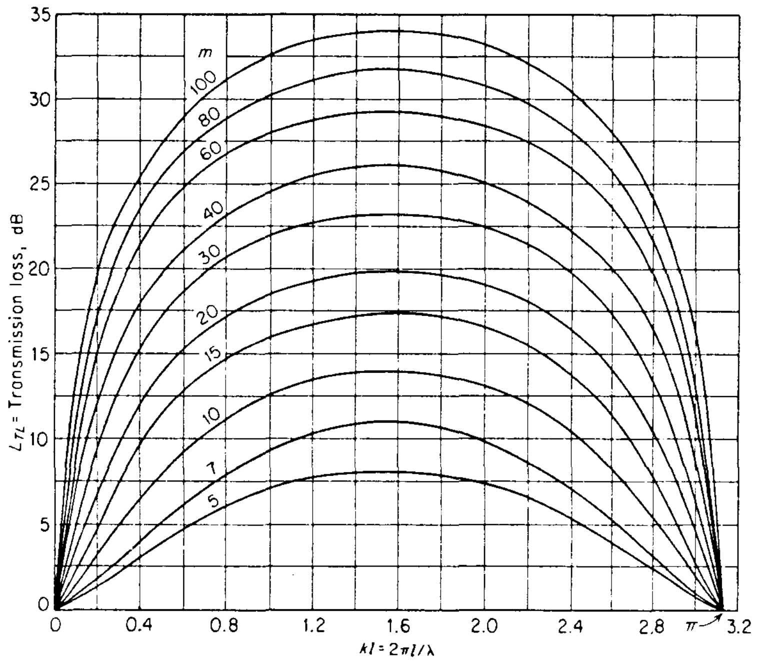

Figure 31. Transmission loss of expansion chamber of length ℓ and S_2/S_1 = m.

$$\lambda = \frac{c}{f} = \frac{1236}{250} = 4.94 \text{ ft}$$

$$k = \frac{2\pi}{\lambda} = 1.27$$

Figure 31 indicates that a chamber area to pipe area of m = 7 will be sufficient to produce a transmission loss of 10 dB. Substituting these values into equation (56) allows us to solve for the length of the expansion chamber (note that the argument of the sine is in radians).

$$10 = 10 \log \left[1 + \frac{1}{4}(7 - \frac{1}{7})^2 \sin^2 1.27\ell\right]$$

$$\ell = 0.839 \text{ ft}$$

About 25.4 cm (10 inches). Assuming the expansion chamber is to be cylindrical the ratio of the areas of chamber to pipe is equal to the ratio of the diameters squared.

$$m = D^2/d^2$$

$$7 = D^2/9$$

$$D = 7.9 \text{ inches}$$

A cylindrical expansion chamber 20.06 cm (7.9 inches) in diameter and 25.4 cm (10 inches) long will provide a TL of 10 dB in this case.

By observing that the abscissa of Figure 31 is proportional to frequency, one may see the major drawback to reactive mufflers--the attenuation they provide is only effective over a narrow frequency range. Since exhaust noise is often broadband, simple expansion chambers of the type illustrated in Figure 30 are rarely used. Most manufacturers of reactive mufflers produce units which contain a combination of differently tuned expansion chambers in series or parallel, with and without side-branch resonators. Some common examples are shown in Figure 32.

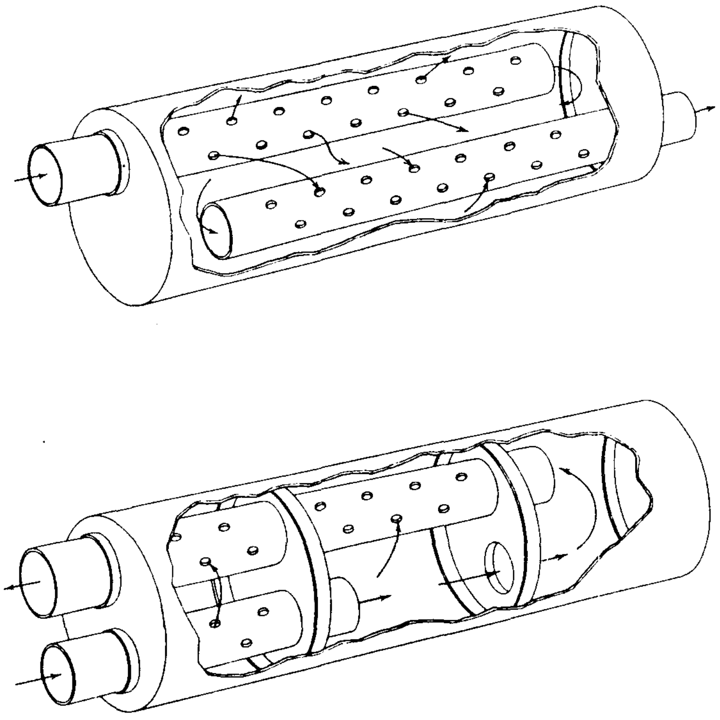

Figure 32. Expansion chamber mufflers.

Dissipative silencers employ a sound absorbing material to attenuate the sound waves. Fiberglass and stranded metal are common materials for this purpose. The incident sound energy is partially converted to heat by causing motion in the fibers during its passage through the material. The simplest form of dissipative silencers incorporate parallel baffles running lengthwise of a fibrous material often covered with plastic or perforated sheet metal to protect the fibers and prevent them from entering the airstream. The acoustical performance depends on the thickness, spacing, and length of the baffles as well as the absorption coefficients of the material.

Decreasing the thickness of each baffle and the parallel spacing between them, and increasing the length of the baffles will increase the performance of the system, particularly at frequencies above 500 Hz. Additional noise attenuation may be achieved by staggering sets of parallel baffles, thereby blocking line-of-sight transmission of the sound waves down the duct. Commercially manufactured parallel baffle units are often produced in modular form enabling them to be stacked and combined by the user to fit any size or performance requirements.

A commonly encountered form of parallel baffle is the tubular silencer. In this configuration, the baffle has the form of a slug or cylinder of absorbing material, often protected by plastic or perforated metal, suspended along the axis of a circular outer shell. The inner surface of the shell may also be lined with acoustic material. The performance of these units is similar to rectangular parallel baffle silencers--good high frequency attenuation with somewhat lesser performance at lower frequencies. Figures 33 and 34 illustrate some typical parallel and tubular baffle silencers.

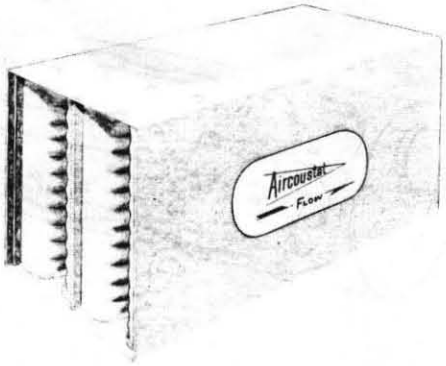

Figure 33. Parallel baffle silencer.

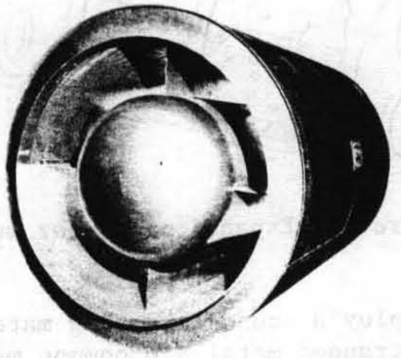

Figure 34. Tubular baffle silencer.

Dispersive mufflers are pressure reducing devices that fit downstream of an orifice or a constriction in a piping system. They act to drop the gas pressure, hence reducing the velocity, and to straighten the flow, reducing the turbulence. Gas velocity and turbulence are prime causes of aerodynamically induced noise. They may be used to reduce noise from control valves, outlet nozzles, blow-off lines, and in ducting.

Aerodynamic noise tends to be relatively broad band in nature, the spectrum rolling off slightly on either side of a frequency peak. This peak may be approximated by the relationship

$$f_{max} = SV/d \qquad (57)$$

where

S = Strouhal number (= 0.2, approximately constant)

V = flow velocity

d = exit diameter

It can be shown that the sound power radiated by a gas jet is proportional to the eighth power of the jet speed. Such a strong dependence means that even a small reduction in velocity can effect substantial reductions in noise levels.

Dispersive silencers usually have the form of a slotted or perforated metal cage or a covering of porous material around the exit of an air line. The velocity of the jet is reduced by these devices by making the path of jet to the ambient atmosphere more complicated.

The muffler designs most effective over a broad range of frequencies are generally the combination designs. Designs employing a combination of elements enable use of the advantages of each type. Since reactive silencers are usually most effective over a narrow range of frequencies, such a device will often be lined with acoustical materials to broaden the absorption characteristics as well as flow straighteners to reduce turbulence. Likewise, since a parallel baffle silencer is most effective at higher frequencies, it might be combined with a series of reactive elements tuned to lower frequencies to provide broad band attenuation. Commercial silencers are readily available in a wide variety of types and sizes. Although applications can vary, reactive silencers are considered best for reciprocating exhausts or other pulsing gas flows; dissipative silencers are useful in large air handling ducts and flues; and dispersive silencers find most use in high speed, high pressure systems.

The pressure drop through a silencer can often be a critical factor in the selection process. All silencers create a line pressure drop to some degree. Care must be taken to choose a unit which will not materially affect the performance of the system it is attached to. Many manufacturers produce silencers with standard, medium, and low pressure drop characteristics. Also several silencers may often be installed in parallel to reduce pressure drop while retaining silencing performance. Dispersive-type silencers tend to introduce the most extreme pressure drop while straight-through dissipative units cause little pressure drop.

The performance of many silencers is proportional to the gas flow rate through them and to the size of the piping in the system. A thorough understanding of the operational characteristics of the problem system is necessary before a wise choice of silencer can be made. Most important is knowledge of the frequency spectrum of the noise. The goal is to choose a silencer whose attenuation curve most nearly matches the spectrum of the noise source while meeting other design parameters such as pressure drop, construction adequate for the operating climate, mountability, and cost.

VIBRATION

An understanding of mechanical vibration is essential to noise control since all sound begins as a vibration of something. Noise radiating from vibrating machines can reach excessive levels, especially if the machine has large, thin panels. A more common problem is the coupling of vibration to structural elements of the building such as floors, walls, and piping. This kind of vibration problem can be effectively reduced by the proper use of isolation or damping treatment. While the emphasis of this document is on noise control through modification of the sound path, a short discussion of basic vibration control will aid in a better understanding of noise control modifications to the source.

The simplest vibrating system is the undamped single degree of freedom system. In its most elementary form, it consists of a mass which is displaced and a spring which restores the displacement, such as a vibrating machine on a single isolator mount. The term single degree of freedom indicates that the system can only move along one dimension, i.e., up and down. While consideration of such a simple system moves us quite some distance from real world vibrating systems, the basic principles behind its behavior also govern the much more complicated systems normally encountered.

When the system is given an initial motion, it will vibrate at its natural frequency, that frequency which causes the change of the kinetic energy of mass into potential energy in the spring at the most efficient rate. The natural frequency is strictly a function of the mass and stiffness of the system. Also a function of mass and stiffness is the static deflection, the amount the spring deforms when the mass is applied. The natural frequency may most easily be predicted by the relationship

$$f_n = \frac{3.13}{\sqrt{d}} \text{ Hz} \qquad (57a)$$

where d = static deflection in inches, or

$$f_n = \frac{4.98}{\sqrt{d}} \text{ Hz} \qquad (57b)$$

where d = static deflection in centimeters.

Figure 35 shows a chart of natural frequency versus static deflection. When the system is excited by a time-varying force (as in an out-of-balance machine), it will vibrate at the frequency of the force.

The effectiveness of the isolation provided by the spring can be characterized by the transmissibility (TR); the ratio of the force transmitted through the spring to the exciting force due to the mass. The transmissibility of a simple spring-mass system is given theoretically by

$$\mathrm{TR} = \frac{1}{(f/f_n)^2 - 1} \tag{58}$$

where f = forcing frequency

f_n= natural frequency

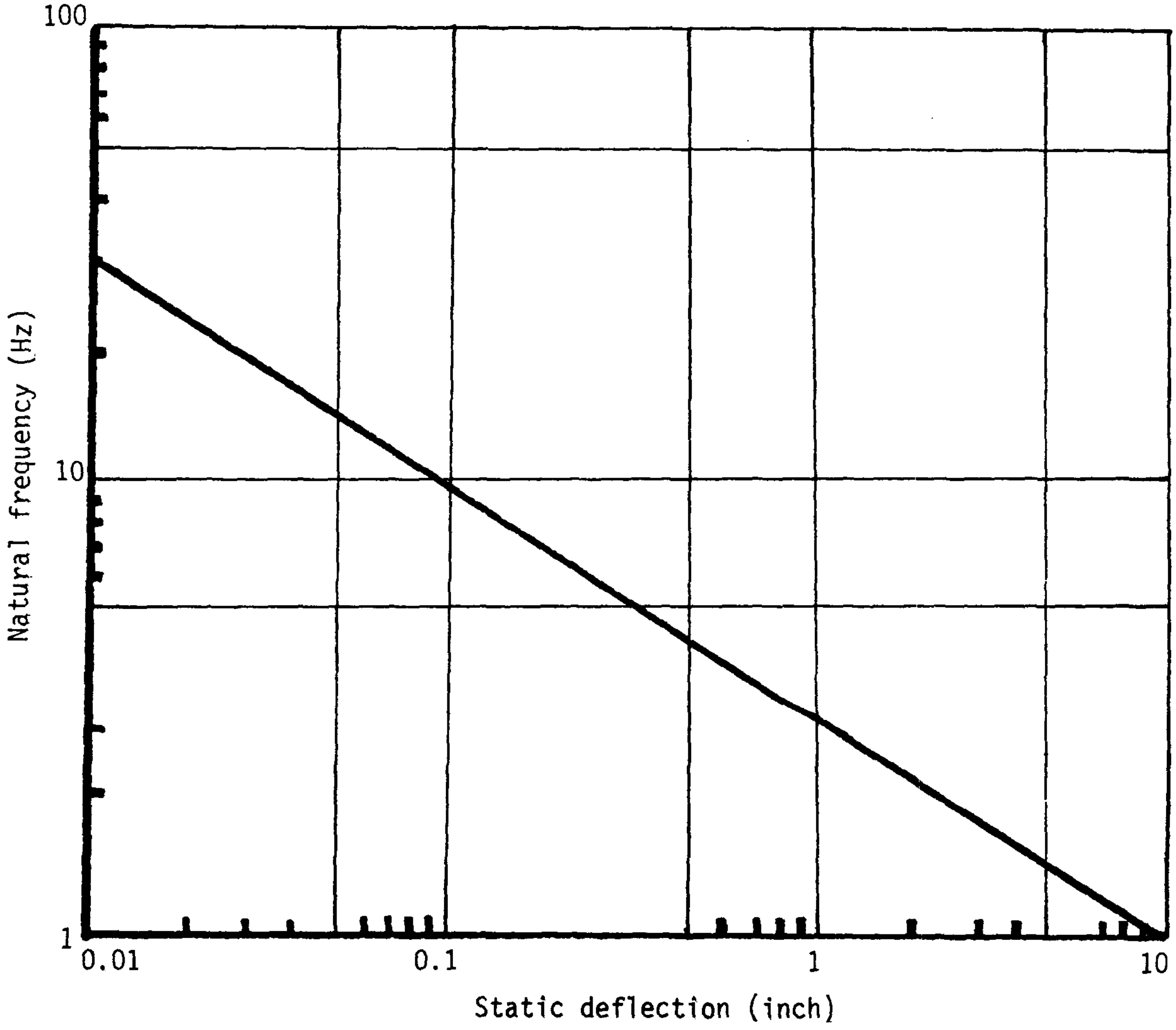

Figure 35. Natural frequency of a single degree of freedom vibrating system as a function of static deflection.

This relationship is illustrated by the solid curve in Figure 36. Note that the curve goes, theoretically at least, to infinity when the forcing frequency is equal to the natural frequency of the system. This indicates that the transmitted force becomes infinite at this point. In actual use, the presence of a property called damping limits the response of the natural frequency, but it is still an operating frequency to be avoided.

Damping is an element of vibrating systems analogous to absorption in noise control — it dissipates the energy of the system. All materials have some amount of internal damping, and specific damping elements may be added to a vibrating system. Damping produces the broken lines in Figure 36, lowering the response at resonance.

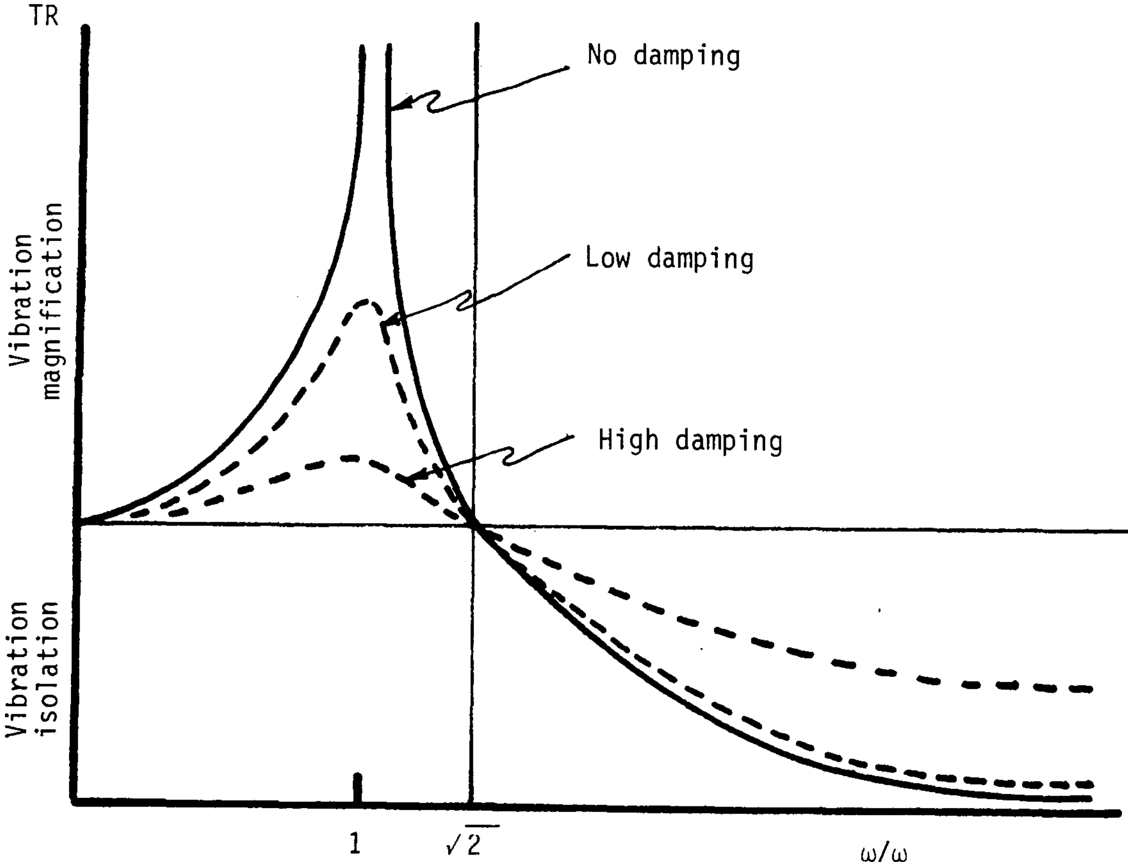

Figure 36. Response of a single degree of freedom vibration system with various damping factors.

From the definition of transmissibility, it is apparent that when TR is greater than one, the forces transmitted will be magnified. A glance at Figure 36 will show that no isolation is possible unless the ratio of forcing frequency to natural frequency is greater than the square root of two. Consequently, the basic approach to vibration isolation is to lower the natural frequency of the system as much as possible. The lower the natural frequency is relative to the forcing frequency, the more isolation is theoretically realizable. The natural frequency is lowered by increasing the static deflection, i.e., by making the springs softer or by increasing the mass, or both.

It is interesting to note from Figure 36 that the addition of damping to a system actually decreases the isolation at a given frequency ratio. Damping tends to stiffen the system and allow easier transmission of forces. In a vibration isolation scheme, damping is primarily useful in smoothing out the peak at resonance. Since an isolated machine operates above its natural frequency, it must pass through resonance as it is turned on or off. The presence of damping in the isolators prevents excessive vibration levels at this point.

A more common use of damping is on vibrating machines or structures which have large thin panels. These panels can shake like a drumhead, radiating considerable acoustic energy. Viscoelastic materials with high internal damping may be applied to panels to substantially reduce the vibration levels and hence reduce the radiated noise. The damping properties of materials may be characterized in many ways. Two of the more common are the material loss factor (η) and the decay rate.

The loss factor is a dimensionless ratio of the amount of energy lost in each vibratory cycle to total energy stored in the material. It may be considered analogous to the absorption coefficient of acoustical materials. The loss factor generally varies with both frequency and temperature, and can range from 1×10^{-4} in a material such as steel, with poor damping, to as high as 0.5 in especially formulated viscoelastic materials.

The decay rate is analogous to a reverberation time measurement. The damping material is applied to a loosely supported steel plate. The plate is made to vibrate by a magnetic exciter and the vibration level is monitored by a microphone in the near field. When the excitation is removed, the damping rate is measured in decibels per second. The more effective damping materials cause the vibration to decay at a faster rate.

VIBRATION ISOLATORS

Anything which has resiliency may be used for vibration isolation. Steel springs are perhaps most common, especially for large heavy machinery. Rubber and other elastomeric materials with metal support housings are commercially available in a wide range of models and applications. Care must be taken that the deflection of the vibrating source on its isolators does not become so great that the stability of the source is affected. For small sources or less serious vibrations where small static deflections are indicated, pads of flexible material such as neoprene, cork, felt, etc., which fit under the entire base of the source present the most economical solutions. When large deflections are needed, pneumatic mounts resembling innertubes are available which lower the natural frequency without requiring excessive deflection.

In piping and ducting in which there is some fluid flowing, vibrations from the pump, blower, or fan may transmit far from the source. It is recommended that flexible pipe connections be inserted every so often in the pipe to prevent the passage of the pipe wall vibration to the next section of pipe. Prevention of such vibration paths, or short circuits, can be very helpful in reducing the amount of attenuation required in the succeeding section of piping.

Piping connected to vibrating machinery such as a compressor should be isolated by flexible couplings, or isolation hangers as shown in Figure 37. The use of additional mass to further reduce vibrations is also shown. The compressor itself is mounted on vibration isolators. Where this is insufficient, the floor itself should be isolated from adjacent building structures as shown in Figure 38. Other isolation may also be used for offices adjacent to production areas.

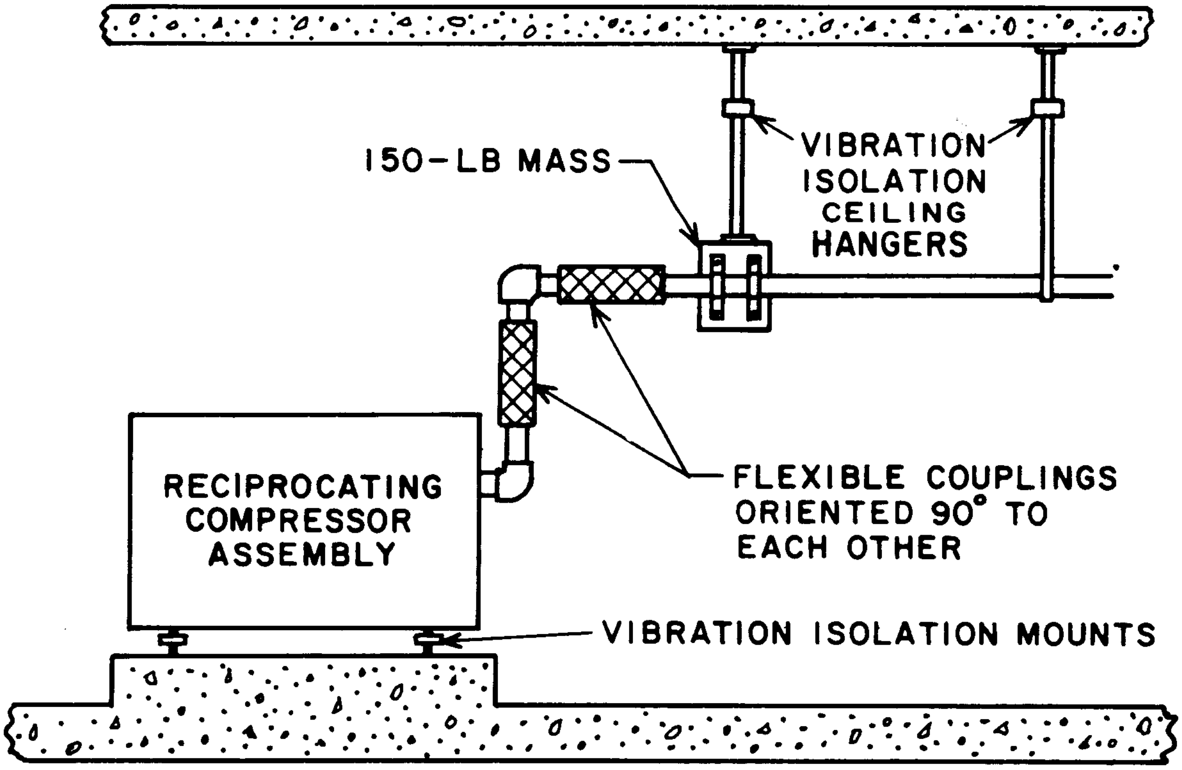

Figure 37. Vibration isolation of compressor piping

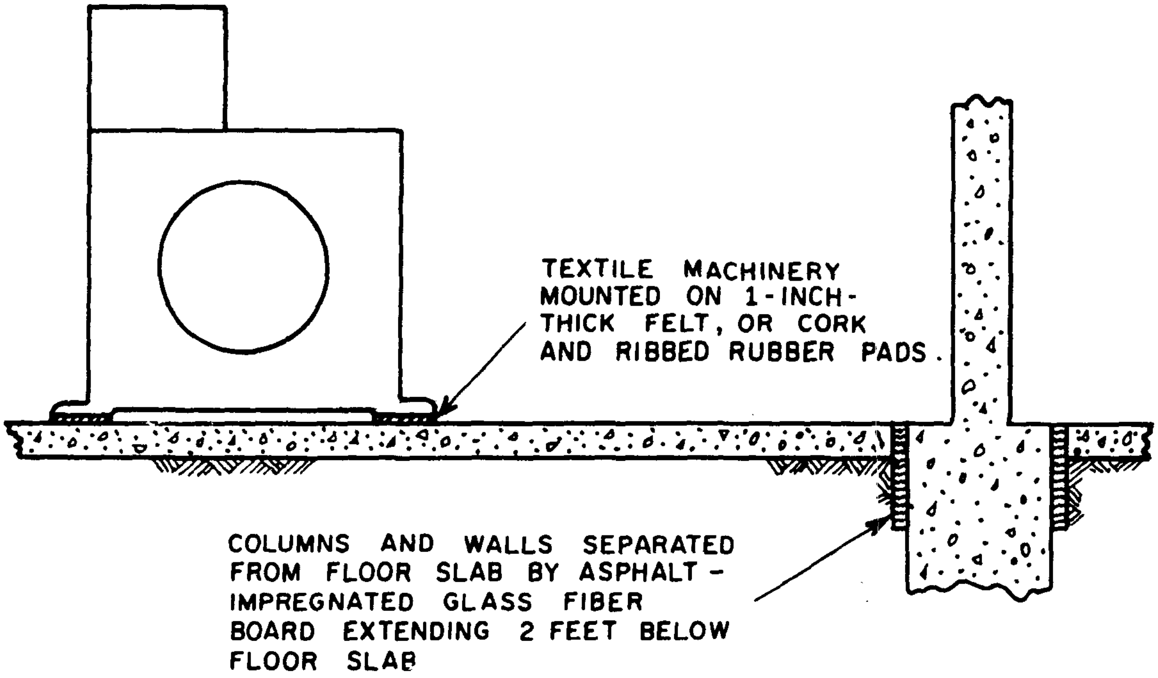

Figure 38. Vibration break in building structure to reduce transmission of vibrations.

VIBRATION DAMPING

The application of damping material to large panels can substantially reduce vibration-induced radiated noise. Polymer plastic materials are widely used today, although the older asphalt-based mastic materials are also common. The materials are typically available either as sheets which may be applied to panels with adhesive (some have adhesive backing) or as compounds intended for trowel or spray application. The thicknesses required are usually about 1.5240 mm (0.0625 inch) and rarely over 3.048 mm (0.125 inch). It is rarely necessary to cover the entire surface of a panel with damping material. Usually, a few strategically placed sheets on a panel will reduce the vibration levels sufficiently. The proper location of the sheets may be determined by trial-and-error or by extensive modal analysis. Modal analysis, the determination of the vibration geometry of a unit, is a complicated procedure best left to experts. Since the viscoelastic materials commonly appearing in dampers may change their characteristics radically at different frequencies and temperatures, it is essential to obtain knowledge of the frequency and temperature conditions associated with a specific problem before choosing a damping material. The choice boils down to selecting the material which provides the maximum loss factor or decay rate at the frequency and temperature of interest. The predominant vibration frequency of a panel may best be measured with accelerometers feeding through an octave or one-third octave filter, but useful data can be obtained by placing a microphone or sound level meter near to the surface of the panel while it is vibrating.

Constrained-layer damping materials can be very useful. These are typically sandwich panels consisting of a layer of damping material between two sheets of metal. Constraining the damping material in this manner places different and more efficient strain patterns in the material than simply affixing it to the outside of panel. These constructions form and work much like normal sheet metal, and may be considered as replacements for more common sheet material in particularly severe problems. Alternately, an existing panel may be made into a constrained-layer type by applying a layer of damping compound and adhering or bolting an outer layer of sheet metal over it.

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NOISE CONTROL

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DESCRIPTION OF PERTINENT STANDARDS

The published standards that pertain to the many types of noise measurements are too numerous to be included here. While ASTM is by no means the only organization publishing standards, it is these standards which cover almost all of the tests reported in the data tables. It is therefore pointed out that since through the years standards have been changed, data obtained using older standards are somewhat different than they are today.

A user knows the year of the standard because the ASTM designation shows the year as the last digits of the code number. For example, for the present absorption test the code designation is C423-66 indicating standard number C423 first appeared as a standard in 1966. This does not necessarily mean that 1966 is the first year ASTM had a standard for absorption testing but that this form of the standard was published in 1966.

It should also be noted here that there are standards covering the measurement of these values under field rather than laboratory conditions. The procedures are basically the same in principle, but generally, tests performed in the field will yield poorer results than tests performed under controlled laboratory conditions. However if careful attention is given to detail during construction and good measurement practice is maintained, the field test can give values approaching the laboratory values.

ABSORPTION

The absorption standards are given, followed by a brief description of each.

ANSI/ASTM C423-77: American Society for Testing and Materials, plus American National Standards Institute Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

This method covers the measurement of sound absorption in a diffuse reverberant sound field by measuring the decay rate. Included in the specifications are the test methods, room and specimen requirements, sound source and detection limits. See text page 49.

There are primarily two methodologies of reporting data. If the specimen is an extended flat surface, then the data are usually reported as random incidence absorption coefficients (i.e., absorption per unit area). This is found by measuring the difference of the time decay of the empty room (without specimen) and of the room with the specimen. The absorption coefficients are given in sabins per square foot and/or metric sabins per square meter. This method sometimes requires a one-number rating called the noise reduction coefficient (NRC). The NRC is an average of the values of the absorption coefficients at 250, 500, 1000, and 2000 Hz. These are the center frequencies of octave bands

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having equal power per constant proportional bandwidth, called pink noise. Also, the 125 and 4000 Hz octave bands are recorded. The second technique is used when the specimen is a specific size or shape (unit absorbers, chairs, landscape screens). Then, the results are reported as sabins per object or metric sabins per object. The size, shape, number, and spacing of the objects used during the test must be stated exactly.

This test method allows the NRC to be reported above 1.0 but is still rounded off to the nearest 0.05. Techniques for calculating 95 percent confidence limits and percent of uncertainty are slightly revised from previous test methods. Also a proposed change in filtering techniques is pending as a requirement for this standard.

ASTM C423-66: American Society for Testing and Materials Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms.

This method follows the same procedures as ASTM C423-77 except that the maximum NRC value is limited to 0.95. This was the recommended procedure even in cases where the NRC exceeded unity. However, the exact data were also reported.

ASTM C423-65T: American Society for Testing and Materials Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms.

This test method and ASTM C423-66 are exactly alike. The number is different because the method was accepted tentatively in 1965, and then adopted officially in 1966.

ASTM C423-60T: American Society for Testing and Materials Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms.

This standard covers the same tests as ASTM C423-66 but allows a choice of three different sound sources. The other portions of the test procedure are essentially the same and results obtained in accordance with either form are equivalent.

The current standard states that the test signals shall be one-third octave bands of random noise with a continuous frequency spectrum and with either equal energy per constant bandwidth, called white noise, or equal energy per constant proportional bandwidth, called pink noise.

This earlier version of the standard permitted swept frequency tones or "warble" tones. The tone was warbled at a rate of 5 to 10 times per second through a range of +11 percent to -11 percent of the center frequency giving a bandwidth of approximately one-third octave. In lieu of warbling the tone signal this standard also permitted the use of suitable multitones centered on the standard test frequencies with a bandwidth of one-third octave. Finally, it also permitted the use of white noise of one-third octave bands centered on the standard test frequencies.

One of the main reasons for rewriting the absorption standard was to eliminate the differences in test signals between testing laboratories. The newer standard specifies only the one type of test signal that may be used. While the test signals are quite different in these two test procedures, no problems are encountered when using the earlier data since the values obtained according to each standard compare well with each other.

ASTM C423-58: American Society for Testing and Materials Standard Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms.

This standard preceded and is similar to C423-60T. It was one of the first modern standards dealing with the properties of absorption as measured in the reverberation room.

ASTM C384-58: American Society for Testing and Materials Standard Method of Test for Impedance and Absorption of Acoustical Materials by the Tube Method.

The methodology for computing normal incidence absorption coefficients is specified. The method uses a closed tube with the specimen mounted in one end. A pure tone of sound is generated within the tube and the maxima and minima of the sound pressure inside the tube are measured.

Normal incidence absorption coefficients, which this method determines are always lower than random incidence coefficients determined in a reverberation room. There is no simple way of relating these two values, especially since the relationship depends on the material itself.

TRANSMISSION LOSS, SOUND TRANSMISSION CLASS, AND IMPACT ISOLATION

The standards of transmission loss, determination of sound transmission class, and impact isolation are given, followed by a brief description of each.

ASTM E90-75: Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

This method covers the laboratory measurement of airborne sound transmission loss of building partitions such as walls, floor-ceiling assemblies, doors, windows, and other space dividing elements. Refer to text (page 69). Basically, the procedure calls for mounting the specimen between two reverberation rooms. One room contains a calibrated noise source (source room) where its sound pressure level is measured at 16 frequencies. Then similar sound pressure levels are measured in the receiving room. The noise reduction qualities of the barrier are determined by the differences in sound levels. Special care in laboratory preparation is required, such as elimination of gaps and flanking paths.

Specific room qualifications are required. Sizing, conditioning, mounting and construction of the specimens are considered in the standard. Measurement precision requires a 95 percent confidence limit.

ASTM E90-70: American Society for Testing and Materials Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

The same procedures as mentioned in E90-75 except fewer limits on room qualifications and a 90 percent confidence limit on measurements.

ASTM E90-66T: American Society for Testing and Materials Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

This standard which covers testing of sound barrier properties is the same as E90-70. It was in this standard that the test frequencies were fixed at one-third octave of either pink or white noise. Prior to this the transmission loss standard permitted the testing laboratory a choice of one of three different sound source signals.

ASTM E90-61T: American Society for Testing and Materials Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

The same testing as in E90-66T and E90-70 is covered by this standard. However, the sound source is not as completely specified in this standard. Because of the different sound sources used, the data obtained under this standard sometimes showed values a few decibels higher in the lower frequencies. Also, this standard had provision for determining two different one-number ratings of the specimen.

One of these ratings is called the "Nine-Frequency Average". This number is simply the average decibel value of the transmission losses at the nine test frequencies of 125, 175, 250, 350, 500, 700, 1000, 2000, and 4000 Hz. It should be noted that the test frequencies, while they are approximately one-third octave wide, they are centered on the one-half octaves and are not the series used in today's test standards.

The other one-number rating was called the Sound Transmission Class (STC). STC obtained by this method are equivalent to STC computed by E413-70T to within the accuracy of the measurements, however the methods of computation are different.

The change made in 1966 for transmission loss testing was the same as the change made in the absorption standard. The choice of one-third octave wide warble tone bands, or multitone bands, as in absorption testing, were replaced with a continuous spectrum source, either white or pink noise in shape, and filtered with a one-third octave band filter. Whereas this change produced little effect in absorption coefficients, the values of transmission loss tested with the newer sound source showed values 2 to 3 dB lower in the first few bands leaving the higher frequency bands relatively unchanged. Normally, a 2 to 3 dB change would not be a matter of major concern, although this 2 or 3 dB could result in a lower value of STC for a particular product.

ASTM E90-55: American Society for Testing and Materials Standard Recommended Practice for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

This standard preceded and is similar to E90-61T. It was one of the first modern standards dealing with the properties of transmission loss of industrial materials.

ASTM E336-71: American Society for Testing and Materials Standard Method of Test for the Measurement of Airborne Sound Insulation in Buildings.

This standard establishes uniform procedures for the determination of field transmission loss, i.e., the airborne sound insulation provided by a partition already installed in a building. It also establishes a standard method for the measurement of the noise reduction between two rooms in a building. If the test structure is a complete enclosure out-of-doors, neither the field transmission loss nor the noise reduction is appropriate; instead, a method for determining the insertion loss is established.

Results from this method may then be reported in three ways: Field Sound Transmission Class (FSTC), which provides an evaluation of the performance of a partition in certain common sound insulation problems; Noise Isolation Class (NIC), which provides an evaluation of the sound isolation between two enclosed spaces which are acoustically connected by one or more paths; or Field Insertion Loss (FIL), which is a measure of the sound isolation between two locations, one of which is not enclosed.

ASTM E336-67T: American Society for Testing and Materials Standard Method of Test for the Measurement of Airborne Sound Insulation in Buildings.

This test method and ASTM E336-71 are exactly alike. The numbers are different because it was accepted as a tentative method in 1967 before the offical adoption in 1971.

AMA-I-II-1967: Acoustical Materials Association Ceiling Sound Transmission Test by the Two-Room Method for Measurement of Normalized Attenuation Factors.

The method of test is intended for the direct measurement of sound transmission through a suspended ceiling. This is a performance test for a configurational property of ceiling construction, without explicit reference to the sound absorption coefficients or sound transmission loss (TL) of ceiling materials. Performance is rendered independent of the total in situ absorption contribution of the receiving-room ceiling under test conditions by normalizing results with respect to separate measurements and thereby focusing attention upon the relative energy transmission of the ceiling configuration. The method of test is designed to reflect field conditions of ceiling erection under laboratory conditions of measurement control.

ASTM E413-70T: American Society for Testing and Materials Tentative Classification for Determination of Sound Transmission Class.

The purpose of this classification is to provide a standard method for determining the one-number rating of sound barrier items. The original intention of STC was to correlate measured sound reduction properties with subjective impressions of the specimen performance when used as a barrier against such sounds as speech, music, radio, television, etc., because these are the types of sounds that exist in most homes, apartments, offices, and schools. Consequently, the sounds of a factory, or of jet aircraft, or other transportation systems, whose noise spectrum is quite different from music or speech are not well treated by the STC value. It is therefore necessary to use the complete set of TL values to determine the performance of a partition against such noises.

Prior to the publication of E413 in 1970 the procedure for determining STC was published by ASTM as a recommended method (RM14-2) in 1966. This procedure is the same as E413 and first appeared in 1966 when E90 was revised. The procedure for determining STC before 1966 was a part of E90-61T and was different from the present method (see discussion of E90-61T).

This standard specifies the technique for comparing the TL values at each of the 16 one-third octave bands to the STC contours and the determination of the STC. The highest contour to which the specimen TL curve meets the requirements (see page 71) is the STC curve. The value of this curve at 500 Hz is the STC rating of the specimen. The numerical values for this set of standard contours are shown in Table 16.

ASTM E492-77: American Society for Testing and Materials Tentative Method of Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine.

ASTM E492-73T (RM14-4): American Society for Testing and Materials Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine.

These procedures were originally published in 1971 as a recommended method only (RM14-4). The method uses a standard tapping machine to produce impacts on a floor-ceiling assembly and the sound pressure levels produced by these impacts are measured in the room below the assembly. There is still much debate over the use of the tapping machine as to impact source because many feel that these impacts are not representative of noises produced by such occurrences as dropping objects on the floor, sliding objects across the floor, and in particular, the noises due to footfalls. Prior to the publication in 1971 of RM14-4 there was no American standard to cover impact testing. There is, however, an international standard which is very much the same which is published by the International Standards Organization (ISO) as R140. This standard does not provide for an IIC value but did specify normalization to 10 metric sabins (meter^2) absorption.

FHA 750: Federal Housing Administration Guide to Impact Noise Control in Multifamily Dwellings.

This authority establishes a method of testing which makes it possible to evaluate the ability of different floors to impede the transmission of impact noise to the space below.

A tapping machine, which generates the impact noise, is set into operation on the floor. Sound pressure levels are then taken in the space below. These levels are normalized to a receiving room with a reverberation time of 0.5 second. The normalized levels are then compared to the standard FHA impact noise curve, allowing a single number, the Impact Noise Rating (INR), to be determined. INR numbers which are zero or greater meet the recommended FHA specifications; those less than zero do not. The higher the INR the better the impact isolation.

AMERICAN NATIONAL STANDARDS INSTITUTE

For the many other types of acoustic test data there is probably some type of standard which governs the procedure. While the above test standards and the many other standards that relate to specific types of items provide for the measurement of particular items, there is another series of standards that specifies general acoustic measurement methods, values for references, etc. These are the standards published by the American National Standards Institute (ANSI).

This institute was originally known as the American Standards Association and the published standards have the prefix ASA. In 1966 the name was changed to United States of America Standards Institute (USASI) and standards published by this group are prefixed with USAS. Again in 1969 the name of this organization was changed. Since American National Standards Institute is the current name, the following standards are shown with the prefix ANSI regardless of the year of publication. While some copies of earlier standards may bear the title of ASA standard or USAS standard, all of these have been adopted as ANSI standards. These standards specify how to make acoustic measurements, the characteristics of laboratory microphones, how calibrations shall be performed on these, test room characteristics, etc. This organization does not concern itself with the special procedures which must be followed when making these measurements on any special class of items.

ASA Z24.19-1957: Laboratory Measurement of Airborne Sound Transmission Loss of Building Floors and Walls

This recommended practice is intended to cover the random incidence or reverberant sound method for the laboratory measurement of airborne sound transmission loss of floors, walls, windows, doors, etc. It gives specifications for the test facility and testing equipment including the signal requirements of random noise or warble tone, sound sources, position of microphones, and format for the report. It also gives minimum conditions of the sample.

ANSI S1.1-1960: American National Standard Acoustical Terminology (Including Mechanical Shock and Vibration).

The purpose of this standard is to establish and define standard acoustical terminology.

ANSI S1.2-1962: American National Standard Method for the Physical Measurement of Sound.

Methods for measuring and reporting the sound pressure levels and sound power generated by a source of sound are established. This standard applies primarily to airborne sound produced by apparatus which normally operates in air. These sounds must not be impulsive and must be of sufficient duration to be within the dynamic measuring capabilities of the instruments used.

ANSI S1.4-1971: American National Standard Specification for Sound Level Meters

The purpose of this standard is to maintain maximum possible accuracy of sound level measuring instruments and to maintain uniformity between instrument measured quantities.

Characteristics of sound level meters starting with the amplitude, frequency response, and directional properties of the microphone are specified. The frequency weighting filters are standardized both to shape of the weighting function and tolerances on these shapes. The tolerances are divided into three groups with Type I (Precision) the most stringent, then Type II (General Purpose) and Type III (Survey) the least stringent. Meter response time and output requirements are also covered.

ANSI S1.6-1967: American National Standard Preferred Frequencies for Acoustical Measurements.

To maintain uniformity and comparability among measurements this standard specifies which series of frequencies shall be used as the preferred octave, one-half octave, and one-third octave bandwidths. It is in this standard that the one-third octave series is modified so that they are actually one-tenth decade. This modification changes the bandwidths less than 0.1 percent and provides a series of frequencies where 10 successive one-third octave bands are in the ratio of 10:1 in center frequency.

ANSI S1.8-1969: American National Standard Preferred Reference Quantities for Acoustical Levels.

Values to be used as reference when acoustic quantities such as power, pressure, intensity, etc., are stated in the form of levels are specified. This standard does not specify that level shall be used but provides the reference to a convenient magnitude for any physical quantity that may be used in acoustics.

ANSI S1.10-1966: American National Standard Method for the Calibration of Microphones.

Techniques and principles involved for performing absolute calibration of microphones are described. Experimental procedures for determining pressure, free field, and diffuse field calibrations are standardized. These procedures provide for either absolute calibration based on the reciprocity principle or calibration by comparison with another microphone.

ANSI S1.11-1966: American National Standard Specification for Octave, Half-Octave, and One-Third Octave Band Filter Sets.

Just as ANSI S1.4 specifies the characteristics and tolerances on sound level meters, this standard specifies the characteristics of band pass filters for acoustical measurements. Some of the items specified are the features of the pass band and the slope and width of the skirts of the band. This standard assures the user of acoustic band pass filter sets that measurements made with one filter set will agree with those made with any other filter set providing each set conforms to the standard.

ANSI S1.12-1967: American National Standard Specification for Laboratory Standard Microphones.

The physical, electrical, and acoustical properties of microphones that are suitable for calibration by an absolute method, such as the reciprocity technique described in ANSI S1.10, are described. These microphones are intended to be used for acoustical standards or as comparison microphones for calibrating other microphones by the comparison technique.

ANSI S1.13-1971: American National Standard Method for the Measurement of Sound Pressure Levels.

This standard is a partial revision of ANSI S1.12-1962 and contains recommendations pertaining to the techniques of the physical measurement of sound. These techniques are applicable to a variety of environment conditions but are not intended to include measurements made for the purpose of determining the sound power level radiated from a source. This standard is applicable to the many different types of sound pressure level measurements that may be encountered in practice and is intended to provide assistance to those persons responsible for the preparation of test codes, ordinances, acoustical criteria, and effects of noise on people, etc.

ANSI S1.21-1972: American National Standard Method for the Determination of Sound Power Levels of Small Sources in Reverberation Rooms.

While the main purpose of this standard is to describe in detail the procedures for the measurement of sound power levels, its pertinence here is due to the lengthy and complete discussion of the quality and characteristics of the reverberation room for making the measurements. This standard describes both a direct method for determining sound power level and a comparison method which uses a calibrated reference sound source.

GUIDE TO THE DATA TABLES

While almost any porous material will absorb some sound energy, and any dense impermeable material will block sound transmission, the products listed in the following tables have been designed specifically to perform these functions efficiently and economically. While it is probably impossible to organize a listing such as this without categories, categorization implies a certain rigidity of purpose for a product which may be misleading. Within most of the tables, there are products with other potential uses which would place them in another category. Each product has been placed in the table corresponding to its prime function, and on occasion the same product is listed in more than one table. For each entry in the tables, contact with the manufacturer is recommended for information on other uses of the products, as well as for additional required data which are not included in this document.

The tables are divided into four broad groups: materials, systems, silencers, and miscellaneous. Materials are defined as single component products which may be composites of different substances. Systems are more complicated products of many components which often must be assembled by the end user.

- Within the first two broad groups, the tables are arranged in a progression from strictly absorbing products, through products with both absorptive and barrier properties, to strictly barrier products. Where materials or systems have several types of properties, the appropriate table is divided into subtables.

- Products are arranged within a table in order of increasing single number descriptor (NRC, STC, NIC'). When no descriptor was provided, it was calculated from the data where possible. Such calculated descriptors are identified by (c). The most recent ASTM standard allows values of NRC equal to 1.0 whereas previously the highest allowed NRC was 0.95. The NRC of materials tested under older standards was not recalculated. This points out the necessity of examining the frequency band absorption coefficients and not choosing a material on the basis of NRC alone.

- Many products were tested for properties such as noise reduction, where there is no standard single number descriptor. In these cases, the data values were arithmetically averaged and arranged in order of increasing average value. This was done solely to provide a logical scheme for arranging the entries in the table. A product position in such a table says very little about the product acoustical properties. Again, refer to the frequency-dependent data.

- The weight or density of a product may be in terms of lb/ft^3, lb/ft^2, or lb/unit. The column headings show the units used in each table.

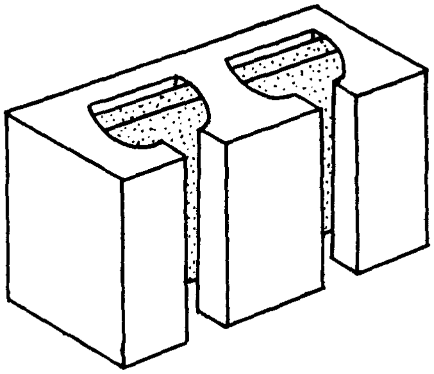
- Due to space limitations, the manufacturer of each product is denoted by a code number. The code numbers are identified in a list at the beginning of the book.

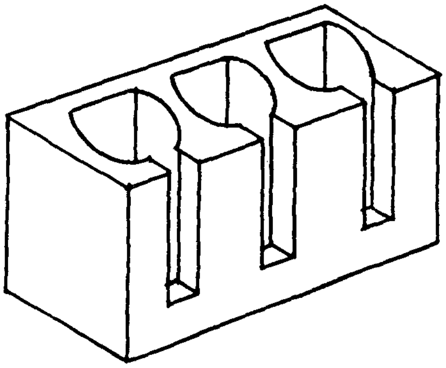
- The reference column identifies the laboratory where the acoustic test was performed and the test report number. The laboratory acronyms are explained in a list at the beginning of this book. Where no laboratory data were provided, the letters CR (company reference) appear, followed by the identifying number of the company publication from which the data were derived.

- Some products did not fit well into the format of the tables. The descriptive paragraph associated with each entry indicates any deviations from the table format.

DATA TABLES

CATEGORY 1. ABSORPTIVE BLOCK





CATEGORY 1. ABSORPTIVE BLOCK

The sound absorption of concrete blocks with built-in cavities are listed. The absorption techniques of plain and damped Helmholtz resonators are used.

A block can be tuned for high absorption around a given frequency by the proper sizing of cavities and openings (slots, cuts, holes), as shown in the illustrations. The addition of absorptive material (fiberglass, mineral wool, foam, etc.) to the interior of the cavity, can provide a wider frequency range of absorption. The block also acts as a sound barrier. Additional provisions to enhance barrier performance are available. A properly balanced block offers a composite absorptive-barrier system. Organizations contributing data to this table are: 101, 123, and 143.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED ON PAGE 53.

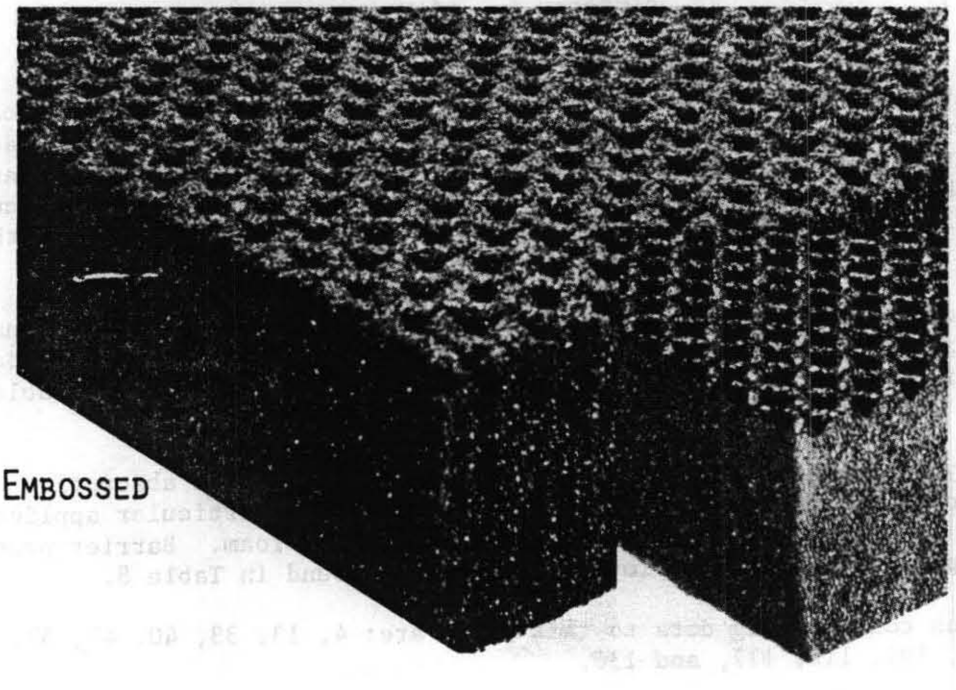
Table 1. Absorptive block.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft³)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.40	8 x 16 inch block with three 3/8-inch horizontal slots, 33/66 ratio core spaces. Temperature range 0-400°F, 0-100% humidity											
	.08	.41	.44	.32	.50	47	8	--	4	143	Sound Control Bloc Type D1	RAL
.45	8 x 16 inch block with two 3/4-inch vertical slots, 50/50 ratio core spaces. Temperature range 0-400°F, 0-100% humidity											
	.08	.27	.94	.39	.28	.38	4	--	4	143	Sound Control Bloc Type G1A	RAL
.45	Two cavity blocks, standard expanded-shale mixture, one coat paint, two slots											
	.97	.44	.38	.39	.50	.60	8	28 lb	4	101	Soundblox Type A-1	G&H
.45	Two cavity blocks within combustible fibrous filler, 8 inch, painted two slots.											
	.74	.57	.45	.35	.36	.34	8	--	4	101	Soundblox Type B	G&H 9.1 PR
.45	8 x 16 inch face with four 3/8-inch horizontal slots, 33/66 ratio core spaces. Temperature range 0-400°F, 0-100% humitidy.											
	.17	.41	.56	.26	.51	.48	8	--	4	143	Sound Control Bloc Type E1	RAL
.45	8 x 16 inch block with six 1-1/2-inch and three 2-inch diameter holes, 33/66 ratio core spaces. Temperature range 0-400°F, 0-100% humidity.											
	.14	.59	.49	.27	.39	.37	8	--	4	143	Sound Control Bloc Type C1	RAL
.50	Narrow slots, unfilled cavities, unpainted surface											
	.19	.83	.41	.38	.42	.40	4	19 lb	4	101	Soundblox Type A	G&H 9.1 PR
.50	6 inch narrow slots, unfilled cavities, painted											
	.62	.84	.36	.43	.27	.50	6	23.4 lb	4	101	Soundblox Type A	G&H 9.1 PR
.50	8 x 16 inch block with eighteen 1-1/2-inch diameter holes, 50/50 ratio core spaces, with acoustical insert. Temperature range 0-400°F, 0-100% humidity.											
	.23	.88	.25	.35	.45	.52	8	--	4	143	Insulation and Sound Control Bloc Type B1	RAL
.55	Glazed tile with horizontal cores filled with fiberglass pads, random perforations in faces, 8 x 16 inch brick shaped tiles											
	.19	.64	.73	.62	.20	.14	4	48.2	4	123	Starkoustic Acoustile Random Pattern	RAL A66-19
.55	8 inch, narrow slots, metal septa (without fibrous filler) in cavities											
	1.07	.57	.61	.37	.56	.55	8	34 lb	4	101	Soundblox Type Q	G&H 9.1 PR
.55	8 inch, wide slots, incombustible fibrous fillers with metal septa in cavities, painted.											
	.70	.77	.61	.48	.44	.41	8	36 lb	4	101	Soundblox Type R	G&H 9.1 PR
.60	Glazed tile with horizontal cores filled with fiberglass pads, random perforation in faces, 5 x 12-inch brick shaped tiles.											
	.06	.66	.79	.62	.29	.16	4	48.2	4	123	Starkoustic Acoustile Random Pattern	RAL A64-128
.60	8 x 16 inch block with two 3/4-inch vertical slots, 33/66 ratio core spaces. Temperature range 0-400°F, 0-100% humidity.											
	.33	.97	.56	.40	.51	.54	8	--	4	143	Sound Control Bloc Type F1A	RAL
.65	8 x 16 inch block with two 3/4 inch vertical slots, 50/50 ratio core spaces with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.27	.75	.83	.58	.49	.45	4	--	4	143	Sound Control Bloc Type G2A	RAL
.65	Wide slots flaring inward, incombustible fibrous fillers with metal septa in cavities, painted.											
	.39	.99	.65	.58	.43	.45	6	27 lb	4	101	Soundblox Type R	G&H 9.1 PR
.65	8 x 16 inch blocks with two 1-1/2-inch vertical slots, 33/66 ratio core spaces. Temperature range 0-400°F, 0-100% humidity.											
	.30	.89	.69	.42	.54	.45	8	--	4	143	Sound Control Bloc Type F1B	RAL

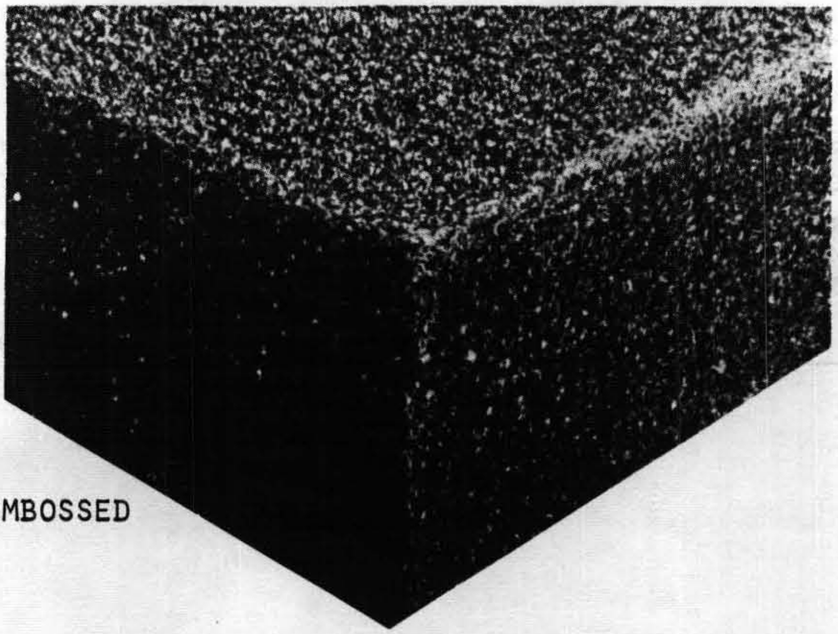
Table 1. Absorptive block concluded.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft³)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.65	8 x 16 inch block with two 3/4-inch vertical slots. 33/66 ratio core space, with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.62	1.02	.63	.47	.45	.48	8	--	4	143	Sound Control Bloc Type F2A	RAL
.65	8 inch, three cavities filled with incombustible fibrous fillers and metal septa, painted, wide slots											
	.61	.91	.65	.65	.42	.49	8	39 lb	4	101	Soundblox Type RR	G&H 9.1 PR
.65	8 x 16 inch block with three 3/8-inch horizontal slots, 1-1/2 inch fibrous filler in cavity. Temperature range 0-400°F, 0-100% humidity.											
	.44	1.10	.68	.48	.42	.56	8	--	4	143	Insulation and Sound Control Bloc Type A1	RAL
.65	8 x 16 inch block with eighteen 1-1/2-inch diameter holes, 50/50 ratio core spaces with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.33	1.02	.51	.61	.52	.63	8	--	4	143	Sound Control Bloc Type B5	RAL
.70	Two cavity blocks with incombustible fibrous filler, painted two slots.											
	.20	.95	.85	.49	.53	.50	4	17 lb	4	101	Soundblox Type B	G&H 9.1 PR
.70	8 x 16 inch block with two 3/4-inch vertical slots, 33/66 ratio core spaces with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.79	.95	.79	.54	.49	.55	8	--	4	143	Sound Control Bloc Type F4A	RAL
.70	8 x 16 inch block with two 3/4-inch vertical slots, 33/66 ratio core space with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.73	.99	.69	.53	.49	.54	8	--	4	143	Sound Control Bloc Type F3A	RAL
.70	8 x 16 inch block with eighteen 1-1/2-inch diameter holes, 50/50 ratio core spaces, with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.29	1.05	.52	.59	.54	.66	8	--	4	143	Sound Control Bloc Type B3	RAL
.75	8 x 16 inch block with two 1-1/2-inch vertical slots, 33/66 ratio core spaces with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.53	1.11	.85	.59	.54	.51	8	--	4	143	Sound Control Bloc Type F4B	RAL
.75	8 x 16 inch block with eighteen 1-1/2-inch diameter holes, 50/50 ratio core spaces with acoustic insulation. Temperature range 0-400°F, 0-100% humidity.											
	.49	1.16	.82	.58	.53	.64	8	--	4	143	Sound Control Bloc Type B4	RAL
.75	8 x 16 inch block with eighteen 1-1/2-inch diameter holes, 50/50 ratio core spaces with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.49	1.14	.76	.64	.55	.58	8	--	4	143	Sound Control Bloc Type B2	RAL
.80	8 x 16 inch block with two 1-1/2-inch vertical slots, 33/66 ratio core spaces with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.66	1.07	.86	.66	.58	.52	8	--	4	143	Sound Control Bloc Type F3B	RAL
.80	8 x 16 inch block with two 1-1/2-inch vertical slots, 33/66 ratio core spaces with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.72	1.03	.93	.70	.58	.51	8	--	4	143	Sound Control Bloc Type F2B	RAL
.85	8 x 16 inch block with six 1-1/2-inch and three 2-1/2-inch diameter holes, 33/66 ratio core spaces with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.62	1.15	1.01	.68	.49	.51	8	--	4	143	Sound Control Bloc Type C2	RAL
.85	8 x 16 inch block with three 3/8-inch slots, 33/66 ratio core spaces with acoustical inserts. Temperature range 0-400°F, 0-100% humidity.											
	.57	1.17	1.01	.72	.58	.69	8	--	4	143	Sound Control Bloc Type D2	RAL
.95	8 x 16 inch block with four 3/8-inch thick horizontal slots, 33/66 ratio core spaces with acoustical inserts. Temperature 0-400°F, 0-100% humidity.											
	.56	1.12	1.10	.86	.65	.72	8	--	4	143	Sound Control Bloc Type E2	RAL

CATEGORY 2. FOAM



EMBOSSED



UNEMBOSSED

CATEGORY 2. FOAM

The sound absorption properties of various types of foams are listed. Foam has excellent absorption, provides a fair amount of vibration isolation and damping, but is a poor sound barrier material. Ester types of polyurethane foams are the most commonly used for noise reduction. These flexible foams are available in reticulated open-pore construction or nonreticulated with a microporous integral skin left intact.

Foams with convoluted surfaces and compressed feltlike foams are also manufactured to maximize absorption in specific frequency regions. Flame retardants and protective films for dirty or oily environments are commonly available options.

The porosity, thickness, and surface of a foam as well as its absorption coefficients should be considered in selecting a foam for a particular application. The data in this section are absorption coefficents of foam. Barrier properties of composite materials employing foam may be found in Table 8.

Organizations contributing data to this table are: 4, 13, 33, 40, 47, 57, 66, 78, 82, 104, 109, 112, 117, and 130.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.
2. ABSORPTION COEFFICIENTS ARE SHOWN EITHER AS PERCENTAGES (NORMAL INCIDENCE DATA) OR AS DECIMAL FRACTIONS (RANDOM INCIDENCE DATA). THE DIFFERENCES BETWEEN THESE TWO DATA ARE DISCUSSED ON PAGE 56.

Table 2. Foam.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft³)	Mounting	Company	Product	Reference
.20 (c)	Acoustical foam. Temperature range -45 to 250°F.											
	.05	.07	.10	.20	.43	.88	1/4	--	--	13	Hush Cloth	CR
.20 (c)	Cellular, nonfibrous foam, 24 x 48 inch. Temperature range -45 to 275°F.											
	.05	.06	.11	.21	.44	.81	1/4	--	--	33	Quietfoam	CR QF-TDS-200R2
.25	Acoustical foam											
	.05	.08	.14	.24	.61	.96	1/4	2	--	40	dba sorb-"AF"	CR L-AM-1-76
.25 (c)	Not an open pore foam, the membranes connecting the skeletal strands have not been removed, 80 pores/inch.											
	.30	.10	.12	.22	.60	.91	1/4	2	--	57	Scott Fine-pore Acoustical Foam	CR 3655
.35 (c)	Flexible polyurethane foam											
	.08	.10	.20	.30	.70	1.00	1/4	2	--	4	Coustifoam	CR
.35 (c)	Embossed, cellular, nonfibrous foam 24 x 48 inch. Temperature range -45 to 275°F.											
		.16	.25	.46	.60	.68	1/4	--	--	33	Quietfoam Embossed	CR QF-TDS-200R2
.40 (c)	Type CF formulated polyurethanes with deep texture embossing and tough urethane film facing. Temperature range -45 to 275°F.											
		.16	.28	.52	.72	.76	1/4	--	--	13	Hushcloth Densified Embossed	CR
.40 (c)	Compressed foam (a reticulated fully open pore foam).											
	.60	.10	.20	.45	.80	.10	1/2	--	--	57	Scottfelt 3-900	CR 3655
.45	Flexible polyurethane foam											
	.09	.11	.22	.60	.88	.94	1/2	2	--	4	Coustifoam	CR
.45	Acoustical foam											
	.06	.14	.25	.60	.93	.97	1/2	2	--	40	dba sorb-"AF"	CR L-AM-1-76
.45 (c)	Acoustical foam. Temperature range -45 to 250°F.											
	.70	.10	.25	.60	.91	.99	1/2	--	--	13	Hushcloth	CR
.45 (c)	Flexible polyester polyurethane foam. Measurement made with material in contact with backing plate.											
	.15	.12	.25	.57	.85	.90	1/2	2	--	57	Scott Pyrell Foam	CR 3665 R2
.45 (c)	Cellular, nonfibrous foam 24 x 48 inch. Temperature range -45 to 275°F.											
	.06	.12	.25	.57	.89	.98	1/2	--	--	33	Quietfoam	CR QF-TDS-200R2
.50 (c)	Not an open pore foam, the membranes connecting the skeletal strands have not been removed, 80 pores/inch											
	.70	.12	.30	.62	.95	.95	1/2	2	--	57	Scott fine-pore Acoustical Foam	CR 3655
.60 (c)	Type CF formulated polyurethanes with deep texture embossing with tough urethane. Temperature range -45 to 275°F.											
		.26	.43	.75	.93	.95	1/2	--	--	13	Hushcloth Densified Embossed	CR
.60 (c)	Embossed, cellular, nonfibrous foam 24 x 48 inch. Temperature range -45 to 275°F.											
		.25	.44	.77	.90	.93	1/2	--	--	33	Quietfoam (Embossed)	CR QF-TDS-200R2
.60 (c)	Formulated foam with a tough polymer film. Temperature range -45 to 275°F.											
		.25	.42	.78	.90	.93	1/2	--	--	33	Quietfoam - CAB	CR QF-C(TENT)
.60	Acoustical foam											
	.08	.20	.38	.78	.95	.97	3/4	2	--	40	dba sorb-"AF"	CR L-AM-1-76

Table 2. Foam continued.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.60	Polyurethane foam, aluminized polyester film face. Temperature range -60 to 275°F.											
	.14	.37	.69	.61	.79	.48	1	1.8	4	104	#2210 Film/Foam Material	RAL A76-211
.60	Polyurethane foam, aluminized polyester film face, pressure sensitive adhesive back. Temperature -60 to 275°F.											
	.10	.18	.46	.81	.88	.55	1	2.3	4	104	#2211 Film/Foam Material	RAL A76-212
.60 (c)	Compressed foam (a reticulated fully open pore film)											
	.10	.22	.39	.72	.10	.10	1	--	--	57	Scottfelt 2-900	CR3655
.60 (c)	Acoustical foam. Temperature range -40 to 250°F											
	.08	.23	.45	.80	.95	1.00	1	2	--	82	Soundscreen Composites	CR
.60	Foam with aluminized Mylar cover											
	.09	.26	.67	.70	.67	.41	1	--	--	82	Soundscreen Absorbing Foam FOA-5	CR
.65 (c)	Foam with polymer film surface. Temperature range -40 to 250°F.											
		.25	.44	.78	.90	.95	1/2	--	--	117	Cabfoam	CR714C
.65 (c)	Acoustical foam. Temperature range -45 to 250°F.											
	.10	.25	.53	.81	.98	.96	3/4	--	--	13	Hush Cloth	CR
.65 (c)	Flexible polyester polyurethane foam. Measurements made with material in contact with backing plate.											
	.12	.25	.47	.90	.95	.88	1	2	--	57	Scott Pyrell Foam	CR 3665-R2
.65 (c)	Compressed foam (a reticulated fully open pore foam)											
	.90	.20	.47	.85	.10	.10	1	4.5 to 6.0	--	57	Scottfelt 3-900	CR 3655
.65	Acoustical foam											
	.10	.25	.47	.93	.97	.97	1	2	--	40	dba sorb-"AF"	CR L-AM-1-76
.70 (c)	Foam with polymer film surface. Temperature range -40 to 250°F											
		.32	.59	.89	.95	.96	3/4	--	--	117	Cabfoam	CR 7143
.70 (c)	Type CF formulated polyrethanes with deep texture embossing. Temperature range -45 to 275°F.											
		.36	.56	.89	.95	.95	3/4	--	--	13	Hushcloth Densified Embossed	CR
.70 (c)	Formulated foam with a tough polymer film. Temperature range -45 to 275°F.											
		.32	.60	.89	.95	.96	3/4	--	--	33	Quietfoam - CAB	CR QF-C
.70 (c)	Embossed, cellular, nonfibrous foam 24 x 48 inch. Temperature range -45 to 275°F.											
		.32	.59	.89	.95	.96	3/4	--	--	33	Quietfoam Embossed	CR QF-TDS-200R2
.70	Polyurethane foam.											
	.14	.25	.55	1.00	.87	.94	1	1.8	--	78	Noiseguard Foam	CR K60B
.70	Flexible polyurethane foam.											
	.22	.35	.60	.98	.94	.99	1	2	--	4	Coustifoam	CR
.70 (c)	Noise absorbing liner. Temperature to 180°F. 54 x 96 inch.											
		.30	.67	.91	.98	.94	1	0.9	--	47	Eckousta Foam Type 1000B	CR SES 76081
.70 (c)	Noise absorbing liner. Temperature to 180F. Size 36 x 54 inch.											
		.30	.67	.91	.98	.94	1	2	--	47	Eckousta Foam Plain	CR SES 76081
.70	Plastic acoustical foam. Temperature range -45 to 250°F.											
								2 & 4	--	13	Hushcloth UL-94 Foam	CR

Table 2. Foam continued.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.70 (c)	Not an open pore foam, the membranes connecting the skeletal strands have not been removed, 80 pores/inch.											
	.10	.28	.50	.95	.10	.95	1	2	--	57	Scott Fine-Pore Acoustical Foam	CR 3655
.70	Polyurethane foam. Temperature range -60 to 275°F.											
	.11	.22	.72	1.09	.85	.88	1	2.6	4	104	#1200 Acoustic Foam	RAL A76-208
.70	Acoustic foam (MAF) bonded. 1 mil clear mylar to flame resistant, urethane foam.											
	.21	.56	.62	.79	.76	.54	1	3.5	--	112	Sound Stopper Mylar	RAL A73-171
.70 (c)	Cellular, nonfibrous foam 24 x 48 inch. Temperature range -45 to 275°F.											
	.13	.30	.62	.91	.98		1	--	--	33	Quietfoam	CR QF-TDS-200R2
.70 (c)	Compressed foam (a reticulated fully open pore foam)											
	.20	.40	.73	.86	.86	.93	1	--	--	57	Scottfelt 7-900	CR 3655
.70	Foam with aluminized Mylar cover.											
	.10	.24	.77	.80	.91	.51	2	--	--	82	Soundscreen Absorbing Foam FOA-3	CR
.75	Polyurethane foam, perforated vinyl film face. Temperature range -30 to 225°F.											
	.14	.30	.68	1.09	.88	.37	1	3.8	4	104	#3220 Upholstery Mat	RAL A76-209
.75	Polyurethane foam, perforated vinyl film face, pressure sensitive adhesive back. Temperature range -30 to 125°F.											
	.13	.36	.70	1.05	.80	.38	1	4.2	4	104	#3221 Upholstery Mat	RAL A76-210
.75 (c)	Foam with polymer film surface. Temperature range -40 to 250°F.											
		.46	.70	.92	.97	.98	1	--	--	117	Cabfoam	CR 714C
.75 (c)	Acoustical foam. Temperature range -45 to 250°F.											
	.12	.32	.70	.92	.99	.94	1	--	--	13	Hushcloth	CR
.75 (c)	Type CF formulated polyurethanes with deep texture embossing with tough urethane. Temperature range -45 to 275°F.											
		.43	.66	.93	.98	.96	1	--	--	13	Hushcloth Densified Embossed	CR
.75 (c)	Cellular, nonfibrous foam 24 x 48 inch (with film). Temperature range -45 to 275°F.											
	.08	.41	.77	.95	.85		1	--	--	33	Quietfoam	CR QF-TDS-200R2
.75 (c)	Foam with a tough polymer film. Temperature range -45 to 250°F.											
		.46	.70	.92	.97	.98	1	--	--	33	Quietfoam - CAB	CR QF-C
.75 (c)	Embossed, cellular, nonfibrous foam 24 x 48 inch. Temperature range -45to 275°F.											
		.46	.70	.92	.97	.97	1	--	--	33	Quietfoam Embossed	CR QF-TDS-200R2
.75	Acoustical foam											
	.15	.36	.74	.97	.97	.97	2	2	--	40	dba sorb-"AF"	CR L-AM-1-76
.80	Absorbing foam											
	.06	.44	.80	.99	.99	.99	1	--	--	82	Soundscreen Absorbing Foam FOA-1	CR
.80 (c)	Foam with impervious facing.											
	.25	.50	.81	.95	.85	.81	1	--	--	13	Hushcloth	CR
.80 (c)	Reticulated, fully open pore, flexible, ester type of polyurethane foam. 90 pores/linear inch. Temperature range -40to 250°F.											
	.20	.44	.77	.10	.10	.10	2	1.8	--	57	Scott Industrial Foam	CR 3655

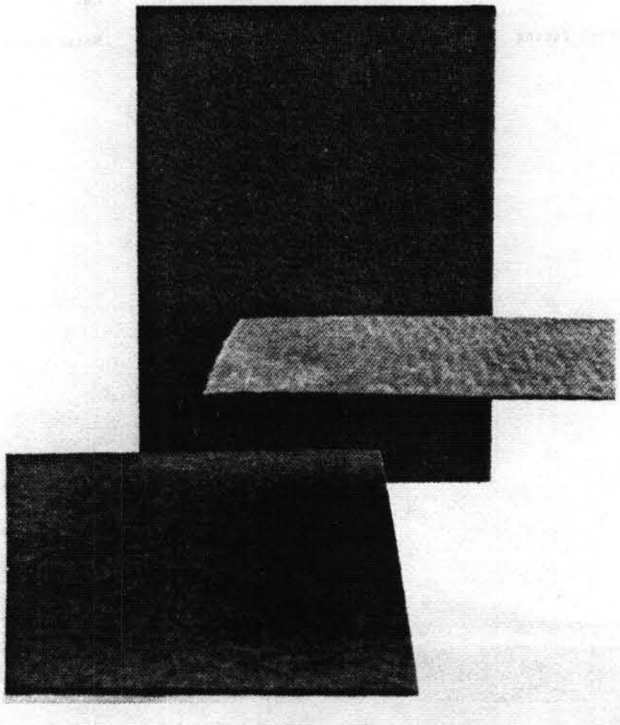
Table 2. Foam continued.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.80	Flexible polyurethane foam											
	.28	.40	.86	.95	.98	.97	2	2	--	4	Coustifoam	CR QF-TDS-200R2
.80 (c)	Cellular, nonfibrous foam 24 x 48 inch. Temperature range -45 to 275°F.											
	.25	.51	.82	.98	.97		2	--	--	33	Quietfoam	CR QF-TDS-200R2
.80	Flexible polyurethane foam											
	.36	.54	.91	.86	.97	.99	3	2	--	4	Coustifoam	CR
.85	Standard porous acoustic foam.											
	.11	.48	1.04	.90	.89	.97	1	1.8	--	112	Sound Stopper SAF	RAL A69-65
.85 (c)	Compressed foam (a reticulated fully open pore foam)											
	.26	.61	.90	.98	.10	.10	2	4.5 to 6.0	--	57	Scottfelt 3-900	CR 3655
.90	Flexible polyurethane foam											
	.67	.80	.90	.92	.94	.97	4	2	--	4	Coustifoam	CR
.90	Flexible polyurethane foam											
	.72	.83	.88	.93	.95	.98	5	2	--	4	Coustifoam	CR
.90	Flexible polyurethane foam											
	.72	.83	.88	.94	.97	1.00	6	2	--	4	Coustifoam	CR
.95 (c)	Reticulated, fully open pore, flexible ester type of polyurethane foam, 90 pores/linear inch. Temperature range -40 to 250°F.											
	.41	.83	.10	.10	.10	.10	4	1.8	--	57	Scott Industrial Foam	CR 3655
1.00	Absorbing foam											
	.36	.99	.99	.99	.99	.99	2	--	--	82	Soundscreen Absorbing Foam FOA-2	CR
1.00 (c)	Reticulated, fully open pore, flexible ester type of polyurethane foam, 90 pores/linear inch. Temperature range -40 to 250°F.											
	.80	.10	.10	.10	.10	.10	6	1.8	--	57	Scott Industrial Foam	CR 3655
	Plastic foam. Tested by ASTM C384-58 (normal incidence). Temperature range -45 to 225°F.											
	.05	.07	.11	.21	.44	.81	1/4	2	--	117	Sound Foam	CR 707D
	Plastic foam. Tested by ASTM C384-58 (normal incidence). Temperature range -45 to 225°F.											
	.05	.12	.26	.58	.89	.98	1/2	2	--	117	Sound Foam	CR 707D
	Plastic foam. Tested by ASTM C384-58 (normal incidence). Temperature range -45 to 225°F.											
	.13	.30	.63	.91	.98		1	2	--	117	Sound Foam	CR 707D
	Plastic foam. Tested by ASTM C384-58 (normal incidence). Temperature range -45 to 225°F.											
	.25	.52	.83	.98	.97		2	2	--	117	Sound Foam	CR 707D
	Urethane foam flexible. ASTM 384-58 (normal incidence). Temperature range -40 to 325°F.											
	.07	.13	.33	.87	.64	.73	--	2	--	104	#1100 Acoustic Foam	CR 7-11
	Polyester urethane foam. aluminized polyester film face. ASTM 384-59 (normal incidence). Temperature range -30 to 325°F.											
	.04	.09	.74	.32	.18	.16	--	2	--	104	#2110 Film/Foam Mat	CR
	A urea formaldehyde foam. Nonstandard test. Frequencies at 100, 200, 400, 800, 1600, 3200 Hz											
	.90	.23	.58	.70	.89	.78	1-1/4	0.7	--	109	Rapco-foam	CR 7.14 RA

Table 2. Foam concluded.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
A urea formaldehyde foam. Nonstandard test. Frequencies at 100, 200, 400, 800, 1600, and 3200 Hz.												
	.10	.34	.78	.85	.93	.86	1-1/2	0.7	--	109	Rapco-foam	CR 7.14 RA
A urea formaldehyde foam. Nonstandard test. Frequencies at 100, 200, 400, 800, 1600, and 3200 Hz.												
	.12	.44	.83	.92	.95	.92	2	0.7	--	109	Rapco-foam	CR 7.14 RA
Polyester urethane foam, Tedlar film face. Temperature range -40 to 325°F. Random incidence coefficients from normal incidence by graphical conversion (ASTM C384-58).												
	.06	.20	.68	.41	.28	.16	--	2	--	104	#2140 Film/Foam Mat	CR
Polyester urethane foam with perforated vinyl film. Temperature range -30 to 225°F. Random incidence coefficients from normal incidence by graphical conversion (ASTM C384 58).												
	.16	.31	.67	.99	.75	.80	--	2	--	104	#3120 Upholstery Mat	CR
Urethane foam with perforated vinyl facing.							--	--	--	130	Noise Control Material	

CATEGORY 3. FELT



CATEGORY 3. FELT

Felt is made of various fibers formulated together by pressure, heat, chemical action, etc., without weaving or knitting. In some cases felt is saturated with a massive substance such as asphalt, alumina, or silica. This offers a more moisture resistant product, with better thermo characteristics and some barrier properties.

Table 3 is divided into two parts:
- 3A Absorption Properties of Felt
- 3B Barrier Properties of Felt

Organizations contributing data to this table are: 28 and 74.

CAUTION

THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED ON PAGE 53.

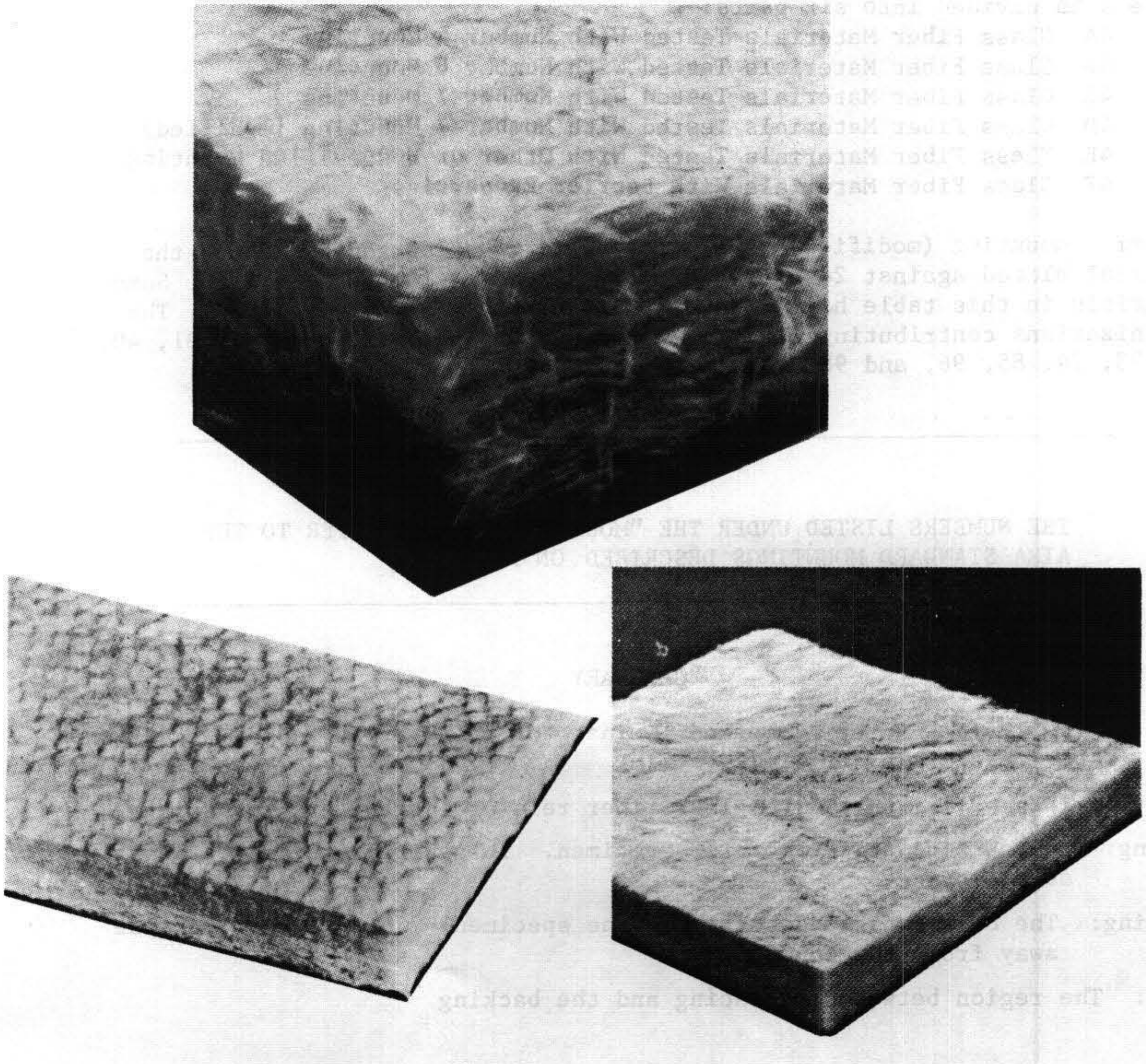
Table 3A. Absorption properties of felt.

NRC	Absorption Coefficients											
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.15	Asphalt saturated rag fibers in a felt formulation.											
(c)	.02	.02	.10	.21	.28	.16	--	--	--	28	Saturated felt	CR 6011
.30	(Resinated cotton). High-loft felt composed of cotton and synthetic fibers.											
(c)	.02	.06	.17	.37	.57	.63	--	--	--	28	Noise Control Batting	CR 6011
.80	Aluminum/silica insulation; heat resistance to 2400°F.											CR IND-3075
	.34	.70	.79	.84	.79	.90	1	8	--	74	Cerafelt	10-77
.80	Aluminum/silica insulation; heat resistance to 2400°F.											CR IND-3075
	.61	.70	.77	.90	.90	.90	2	8	--	74	Cerafelt	10-77
.85	Aluminum/silica insulation; heat resistance to 2400°F.											CR IND-3075
	.52	.69	.78	.92	.93	.90	3	8	--	74	Cerafelt	10-77
.85	Aluminum/silica insulation; heat resistance to 2400°F.											CR IND-3075
	.63	.76	.81	.90	.89	.90	4	8	--	74	Cerafelt	10-77
.85	Aluminum/silica insulation; heat resistance to 2400°F.											CR IND-3075
	.65	.79	.80	.94	.91	.90	5	8	--	74	Cerafelt	10-77
.90	Aluminum/silica insulation; heat resistance to 2400°F.											CR IND-3075
	.70	.84	.83	.94	.89	.90	6	8	--	74	Cerafelt	10-77

Table 3B. Barrier properties of felt.

STC	Transmission Loss, dB																				
	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
3	A resinated cotton high loft felt composed of cotton and synthetic fibers.																				
(c)	4	3	2	2	3	2	2	3	2	2	3	3	4	4	5	5	--	--	28	Noise Control Batting	CR 6011
21	Asphalt saturated rag fibers in a felt formulation.																				
(c)	12	12	12	11	13	15	16	18	19	21	23	24	25	27	30	31	--	--	28	Saturated felt	CR 6011

CATEGORY 4. GLASS FIBER MATERIALS



CATEGORY 4. GLASS FIBER MATERIALS

Long glass fibers when bonded with resins or other bonding materials convert acoustic energy into heat through air friction within the porous body of the material. However, glass fiber products are rather poor sound barrier materials.

Table 4 is divided into six parts:

- 4A Glass Fiber Materials Tested With Number 4 Mounting
- 4B Glass Fiber Materials Tested With Number 6 Mounting
- 4C Glass Fiber Materials Tested With Number 7 Mounting
- 4D Glass Fiber Materials Tested With Number 7 Mounting (modified)
- 4E Glass Fiber Materials Tested With Other or Unspecified Mounting
- 4F Glass Fiber Materials With Barrier Properties

Number 7 mounting (modified) is a nonstandard mounting consisting of the material placed against 24 gauge sheet metal over a 16 inch air gap. Some materials in this table have data associated with several mountings. The organizations contributing data to this table are: 13, 20, 27, 29, 31, 40, 47, 73, 74, 85, 96, and 98.

CAUTION

THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED ON PAGE 53.

GLOSSARY

ASJ: (All-Service Jacket) Embossed laminate of white kraft facing with glass fiber reinforcing and foil backing

FRK: Foil-faced laminate with glass fiber reinforcing and kraft backing

Facing: The outside surface of the specimen. In general, the side facing the sound source

Backing: The other outside surface of the specimen. In general, the side away from the sound source.

Core: The region between the facing and the backing

Table 4A. Glass fiber materials tested with number 4 mounting.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.40	Temperature to 450°F											
	.61	.45	.35	.32	.48	.31	2	6	4	96	705, ASJ Faced	OCRL
.45	Temperature to 450°F											
	.66	.46	.47	.40	.52	.31	3	6	4	96	705, ASJ Faced	OCRL
.45	Temperature to 450°F											
	.65	.52	.42	.36	.49	.31	4	6	4	96	705. ASJ Faced	OCRL
.50	Composed of glass fiber, high temperature insulation											
	.12	.27	.43	.66	.73	.84	1	8	4	73	Birfelt Insulation	KAL 1724.74
.55	Flexible, bonded, unfaced fiberglass blanket. Temperature to 450°F											
	.12	.28	.51	.67	.76	.70	1	.75	4	74	Microlite	CT
.55	.06	.24	.47	.71	.85	.97	1	--	4	96	Aeroflex type 150	OCRL
.55	Temperature to 450°F											
	.18	.73	.43	.58	.39	.30	1	6	4	96	705, ASJ Faced	OCRL
.60	Fiberglass material, temperature to 1000°F.											
	.15	.23	.49	.78	.94	.85	3/4	2.5	4	73	Studio Blanket	KAL 439529
.60	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.11	.29	.53	.77	.87	.85	1	1	4	74	Microlite	CT
.60	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 850°F.											
	.15	.22	.56	.71	.83	.94	1	3	4	74	Springlass 1000 Board	CT
.65 (c)	Fiberglass thermal and acoustical insulation consisting of borosilicate glass bonded with a phenolic resin type 1001. Temperature to 450°F.											
	.10	.26	.62	.85	.78	.75	1	1	4	29	Universal Blanket	CR 30-31 09U
.65	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.11	.23	.60	.82	.91	.94	1	1.50	4	74	Microlite	CT
.65	Temperature to 450°F											
	.12	.74	.72	.68	.53	.24	1	3	4	96	703, FRK Faced	OCRL
.65	.21	.63	.99	.74	.33	.17	2	--	4	96	Preengineered Bldg. Insulation	OCRL
.70	Temperature to 450°F											
	.12	.28	.73	.89	.92	.93	1	1.58	4	96	701 Fiberglas	OCRL
.70	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.10	.23	.63	.86	.99	.92	1	2	4	74	Microlite	CT
.70	Temperature to 450°F											
	.03	.22	.69	.91	.96	.99	1	3	4	96	703 Fiberglas	OCRL
.70	.08	.28	.65	.89	.99	.99	1	--	4	96	Aeroflex type 300	OCRL
.70	Temperature to 450°F											
	.51	.65	.86	.71	.49	.26	2	3	4	96	703, FRK Faced	OCRL
.70	Fiberglass faced with asphalt and kraft paper, 16, 20, and 24 inch wide, paper side exposed to sound											
	.71	.99	.85	.61	.41	.26	6	--	4	96	Fiberglas Bldg Insulation	OCRL

Table 4A. Glass fiber materials tested with number 4 mounting continued.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.75	Temperature to 450°F											
	.08	.25	.74	.95	.97	.99	1	6	4	96	705 Fiberglas	OCRL
.75	Plain, performated metal panel											
	.29	.54	.71	.95	.93	.83	1	--	4	96	Fiberglas Roof Form Board	OCRL
.75	Plain											
	.18	.34	.79	.99	.93	.90	1	--	4	96	Fiberglas Roof Form Board	OCRL
.75	Mat faced											
	.13	.32	.81	.99	.97	.90	1	--	4	96	Fiberglas Roof Form Board	OCRL
.75	Temperature to 450°F											
	.84	.88	.86	.71	.52	.25	3	3	4	96	703, FRK Faced	OCRL
.75	.38	.98	.99	.62	.42	.24	3	--	4	96	Preengineered Bldg Insulation	OCRL
.75	Fiberglass faced with asphalt and kraft paper, 16, 20, and 24 inch wide, paper side exposed to sound											
	.38	.98	.99	.62	.36	.24	3-1/2	--	4	96	Fiberglas Bldg Insulation	OCRL
.75	Temperature to 450°F											
	.88	.90	.84	.71	.49	.23	4	3	4	96	703, FRK Faced	OCRL
.80	Fiberglass core with 1/8 inch glass fiber substrate facing on one or two sides.											
	.24	.59	.91	.85	.79	.75	1	--	4	27	Vicracoustic	CKAL
.80	Fiberglass material, temperature to 1000°F											
	.29	.40	.86	.98	1.01	1.02	1-1/2	2.5	4	73	Studio Blanket	KAL 439528
.80	Fiberglass thermal and acoustical insulation (borosilicate glass bonded phenolic resin) type 501, temperature to 450°F.											
	.23	.52	.88	.98	.90	.87	2	.6	4	29	Universal Blanket	CR 30-31 09U
.80	Flexible, bonded, unfaced fiberglass blanket Temperature to 350°F.											
	.25	.53	.85	.91	.90	.91	2	.75	4	74	Microlite	CT
.80	.56	.99	.99	.64	.48	.23	4	--	4	96	Preengineered Bldg Insulation	OCRL
.85	.14	.57	.99	.99	.89	.65	1/8	--	4	96	Glastrate	OCRL
.85	.18	.53	.89	.92	.96	.99	1	--	4	96	HT-26	OCRL
.85	.16	.49	.99	.99	.99	.99	1-1/4	--	4	96	HT-23	OCRL
.85	Adhered to gypsum slab											
	.25	.49	.98	.99	.91	.85	1-1/2	--	4	96	Fiberglas Roof Form Board	OCRL
.85	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.28	.55	.90	.97	.94	.97	2	1	4	74	Microlite	CT
.85	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 850°F											
	.50	.76	.91	.88	.94	.88	2	3	4	74	Spin-glas 1000 Board	CT
.85	.20	.51	.88	.99	.99	.99	2	--	4	96	Aeroflex Type 150	OCRL
.85	Fiberglass core with 1/8 inch glass fiber substrate facing on one or two sides.											
	.47	.95	.89	.77	.75	.76	2	--	4	27	Vicracoustic	OCRL
.85	.21	.62	.93	.92	.91	.99	2-1/2	--	4	96	Fiberglas Noise Barrier Batts	OCRL

Table 4A. Glass fiber materials tested with number 4 mounting concluded.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft³)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.90	.30	.66	.99	.99	.99	.95	2	1.6	4	74	Hull Insulation	CT
.90	Adhered to gypsum slab											
	.33	.67	.99	.99	.94	.90	2	--	4	96	Fiberglas Roof Form Board	OCRL
.90	Temperature to 850°F											
	.21	.66	.99	.99	.99	.99	2	--	4	96	Intermediate Service Board	OCRL
.95	.36	.85	1.09	.97	1.01	1.02	2	2.9	4	74	Incombustible Hull Board	CT
.95	Temperature to 450°F											
	.24	.77	.99	.99	.99	.99	2	1.58	4	96	701 Fiberglas	OCRL
.95	Temperature to 450°F											
	.22	.82	.99	.99	.99	.99	2	3	4	96	703 Fiberglas	OCRL
.95	Glass fiber molded via thermo-setting binder method											
	.31	.87	1.14	1.17	1.09	1.04	2	6	4	73	I-C Pres-Glas	CKAL 7701.33
.95	Temperature to 450°F											
	.19	.74	.99	.99	.99	.99	2	6	4	96	705 Fiberglas	OCRL
.95	.41	.99	.99	.99	.99	.99	2-1/2	--	4	96	HT-23	OCRL
.95	Flexible fiberglass											
	.43	.91	.99	.98	.95	.93	3	1.25	4	29	Ultracoustic Blanket	CR 30-31-01U
.95	Temperature to 450°F											
	.43	.99	.99	.99	.99	.99	3	1.58	4	96	701 Fiberglas	OCRL
.95	Temperature to 450°F											
	.53	.99	.99	.99	.99	.99	3	3	4	96	703 Fiberglas	OCRL
.95	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 850°F											
	.68	.99	.99	.94	.98	.99	3	3	4	74	Spin-glas 1000 Board	CT
.95	Temperature to 450°F											
	.54	.99	.99	.99	.99	.99	3	6	4	96	705 Fiberglas	OCRL
.95	Fiberglass faced with asphalt and kraft paper, 16, 20, and 24 inch wide, insulation side exposed to sound											
	.34	.85	.99	.97	.97	.99	3-1/2	--	4	96	Fiberglas Bldg Insulation	OCRL
.95	.38	.88	.99	.99	.97	.99	3-1/2	--	4	96	Fiberglas Noise Barrier Batts	OCRL
.95	Temperature to 450°F											
	.73	.99	.99	.99	.99	.99	4	1.58	4	96	701 Fiberglas	OCRL
.95	Temperature to 450°F											
	.84	.99	.99	.99	.99	.97	4	3	4	96	703 Fiberglas	OCRL
.95	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 850°F											
	.98	.99	.99	.95	.92	.99	4	3	4	74	Spin-glas 1000 Board	CT
.95	Temperature to 450°F											
	.75	.99	.99	.99	.97	.98	4	6	4	96	705 Fiberglas	OCRL
.95	.56	.99	.99	.98	.97	.99	4	--	4	96	HT-26	OCRL
.95	Fiberglass faced with asphalt and paper, 16, 20, and 24 inch wide, insulation side exposed to sound											
	.64	.99	.99	.99	.99	.99	6	--	4	96	Fiberglas Bldg Insulation	OCRL

Table 4B. Glass fiber materials tested with number 6 mounting.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.20	Temperature to 350°F											
	.15	.32	.13	.13	.29	.51	1/8	6	6	74	Exact-O-Board	CT
.35	Temperature to 250°F											
	.16	.37	.25	.34	.51	.73	1/4	3	6	74	Exact-O-Mat	CT
.40	Temperature to 350°F											
	.16	.37	.27	.40	.54	.59	1/4	3	6	74	Exact-O-Board	CT
.45	Temperature to 250°F											
	.14	.37	.30	.45	.61	.74	3/8	2	6	74	Exact-O-Mat	CT
.45	Temperature to 350°F											
	.17	.40	.32	.49	.59	.68	3/8	2	6	74	Exact-O-Board	CT
.45	Temperature to 250°F											
	.17	.39	.36	.50	.64	.78	1/2	1.5	6	74	Exact-O-Mat	CT
.50	Temperature to 350°F											
	.18	.43	.40	.53	.67	.78	1/2	1	6	74	Microlite B	CT
.55	Temperature to 450°F											
	.16	.36	.23	.57	.96	.90	3/8	1.5	6	74	Microlite AA	CT
.55	Temperature to 250°F											
	.23	.41	.41	.58	.72	.85	1/2	1.9	6	74	Tuf-Skin Microlite	CT
.60	Temperature to 450°F											
	.18	.39	.37	.72	.95	.99	1	42	6	74	Microlite AA	CT
.60	Temperature to 350°F											
	.22	.46	.51	.64	.74	.78	1	.5	6	74	Microlite B	CT
.65	Temperature to 350 °F											
	.26	.50	.55	.69	.79	.86	1	.6	6	74	Microlite B	CT
.65	Temperature to 250°F											
	.26	.51	.56	.67	.77	.79	1	.75	6	74	Exact-O-Mat	CT
.65	Temperature to 350°F											
	.32	.56	.58	.67	.73	.76	1	.8	6	74	Spin-Glass SG-28	CT
.65	Temperature to 250°F											
	.24	.53	.59	.71	.81	.86	1	1	6	74	Exact-O-Mat	CT
.70	Temperature to 250°F											
	.26	.51	.63	.83	.91	.94	1	1.75	6	74	Tuf-Skin Microlite	CT
.70	Temperature to 450°F											
	.18	.41	.50	.92	.99	.96	1	.60	6	74	Microlite AA	CT
.70	Temperature to 350°F											
	.31	.52	.59	.79	.81	.92	1	1	6	74	Spin-Glass SG-26	CT
.70	Temperature to 350°F											
	.26	.51	.59	.77	.88	.94	1	1	6	74	Microlite B	CT
.70	Temperature to 350°F											
	.26	.53	.60	.77	.84	.87	1	1.2	6	74	Spin-Glas SG-25	CT
.70	Temperature to 350°F											
	.23	.54	.64	.81	.89	.91	1	1.5	6	74	Spin-Glas SG-24	CT

Table 4B. Glass fiber materials tested with number 6 mounting continued.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft³)	Mounting	Company	Product	Reference
.70	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.24	.53	.65	.81	.89	.95	1	1.5	6	74	Microlite	CT
.70	Temperature to 250°F											
	.28	.51	.63	.80	.89	.91	1	1.5	6	74	Exact-O-Mat	CT
.70	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 450°F											
	.25	.55	.63	.78	.84	.93	1	1.6	6	74	Spin-Glas 812 Board	CT
.70	Temperature to 350°F											
	.27	.51	.62	.83	.91	.91	1	1.9	6	74	Spin-Glas SG-23	CT
.70	Fiberglass type IB-420. Temperature range -20 to 450°F											
	.21	.48	.59	.82	.96	.99	1	4.20	6	29	Industrial Insulation Board	CR 30-31-12U
.75	Glassfibers bonded with an inert resin. Temperature to 450°F											
	.17	.61	.67	.91	.87	.82	1	1	6	29	MG Superfine Insulation	CR 30-31-59U
.75	Temperature to 450°F											
	.20	.42	.52	.99	.98	.95	1	1	6	74	Microlite AA	CT
.75	Fiberglass thermal and acoustical insulation. Temperature to 425°F											
	.32	.51	.60	.83	.98	.86	1	1.5	6	29	MG Ultralite	CR 30-31-58U
.75	Fiberglass thermal and acoustical insulation. Temperature to 250°F											
	.32	.51	.60	.83	.98	.86	1	1.5	6	29	Ultralite 150	CR 30-31-05U
.75	Fiberglass thermal and acoustical insulation. Temperature to 250°F											
	.41	.58	.65	.89	.90	.86	1	2	6	29	Ultralite 200	CR 30-31-05U
.75	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.25	.48	.66	.87	.94	.94	1	2	6	74	Microlite	CT
.75	Laminate with limp, flexible septum inside layers of glass fibers firmly bonded											
	.41	.58	.65	.89	.90	.90	1	2	6	33	Quietfibre LGF	CR QF-LGF-302/2C/7/77
.75	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 450°F											
	.25	.49	.63	.99	.99	.99	1	3	6	74	Spin-Glass 814 Board	CT
.75	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 850°F											
	.29	.50	.65	.93	.97	.99	1	3	6	74	Spin-Glass 1000 Board	CT
.75	Fiberglass type IB-300. Temperature range -20 to 450°F											
	.23	.51	.64	.91	.98	.99	1	3	6	29	Industrial Insulation Board	CR 30-31-12U
.75	Fiberglass type IB-600. Temperature range -20 to 450°F											
	.23	.51	.64	.90	.99	.95	1	6	6	29	Industrial Insulation Board	CR 30-31-12U
.75	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.33	.61	.72	.82	.88	.85	1-1/2	.60	6	74	Microlite	CT
.75	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.33	.60	.70	.82	.87	.86	1-1/2	.75	6	74	Microlite	CT
.75	Semi-rigid, bonded, unfaced fiberglass board											
	.64	.43	.81	.80	.90	.97	2	6	6	74	Spin-Glass 860 PL Board	CT

Table 4B. Glass fiber materials tested with number 6 mounting continued.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft³)	Mounting	Company	Product	Reference
.80	Glass fibers bonded with an inert resin. Temperature to 450°F											
	.16	.63	.70	.95	.89	.84	1	1.5	6	29	MG Superfine Insulation	CR 30-31-59U
.80	Fiberglass thermal and acoustical insulation consisting of borosilicate glass bonded with a phenolic resin type 1501. Temperature to 450°F											
	.34	.56	.76	.96	.92	.81	1	1.5	6	29	Universal Blanket	CR 30-31-09U
.80	Glass fibers bonded with an inert resin. Temperature to 450°F											
	.17	.63	.74	.97	.90	.86	1	2	6	29	MG Superfine Insulation	CR 30-31-59U
.80	Temperature to 350°F											
	.29	.53	.75	.97	.99	.99	1	2.4	6	74	Spin-Glass SG-22	CT
.80	Fiberglass thermal and acoustical insulation. Temperature to 250°F											
	.38	.53	.71	.97	.95	.90	1	3	6	29	Ultralite 300	CR 30-31-05U
.80	Temperature to 450°F											
	.20	.50	.76	.99	.99	.99	1-1/2	.60	6	74	Microlite AA	CT
.80	Semi-rigid, bonded, unfaced fiberglass board											
	.56	.50	.85	.91	.92	.93	2	3	6	74	Spin-Glass 830 PL Board	CT
.80	Semi-rigid, bonded, unfaced fiberglass board											
	.58	.49	.90	.89	.91	1.06	2	4.2	6	74	Spin-Glass 840 PL Board	CT
.85	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.31	63	80	.94	.97	.97	1-1/2	1	6	74	Microlite	CT
.85	Temperature to 350°F											
	.33	.66	.81	.91	.96	.94	2	.5	6	74	Microlite B	CT
.85	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.40	.75	.85	.89	.94	.96	2	.60	6	74	Microlite	CT
.85	Temperature to 350°F											
	.39	.74	.83	.93	.87	.91	2	.8	6	74	Spin-Glass SG-28	CT
.85	Wall and panel envelope insulations, WP-11											
	.32	.68	.94	.94	.84	.80	2	1.10	6	29	WP WP-EES	CR 30-40-28
.85	Wall and panel envelope insulations, WP-16											
	.34	.70	.96	.97	.86	.83	2	1.58	6	29	WP WP-EES	CR 30-40-28
.90	Flexible, bonded, unfaced fiberglass blanket. Temperature to 350°F											
	.38	.72	.86	.96	.96	.95	2	.75	6	74	Microlite	CT
.90	Temperature to 350°F											
	.39	.74	.88	.99	.95	.99	2	1	6	74	Spin-Glas SG-26	CT
.90	Temperature to 350°F											
	.43	.74	.92	.99	.97	.97	2	1.2	6	74	Spin-Glas SG-25	CT
.90	Wall and panel envelope insulations, WP-30											
	.32	.74	.97	.98	.87	.85	2	3	6	29	WP WP-EES	CR 30-40-28
.90	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 450°F											
	.45	.72	.99	.99	.99	.99	2	3	6	74	Spin-Glas 814 Board	CT

Table 4B. Glass fiber materials tested with number 6 mounting concluded.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.90	Wall and panel envelope insulations, WP-40											
	.27	.79	.98	.99	.88	.86	2	4	6	29	WP WP-EES	CR 30-40-22
.90	Wall and panel envelope insulations, WP-60											
	.48	.82	.97	.99	.90	.86	2	6	6	29	WP WP-EES	CR 30-40-28
.95	Temperature to 250°F											
	.48	.85	.99	.99	.99	.99	2	1.5	6	74	Tuf-Skin Microlite	CT
.95	Temperature to 350°F											
	.48	.75	.97	.99	.99	.99	2	1.5	6	74	Spin-Glas SG-24	CT
.95	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 450°F											
	.47	.77	.96	.99	.99	.99	2	1.6	6	74	Spin-Glas 812 Board	CT
.95	Temperature to 350°F											
	.43	.76	.99	.99	.99	.99	2	1.9	6	74	Spin-Glas SG-23	CT
.95	Temperature to 350°F											
	.59	.87	.99	.99	.99	.99	2	2-4	6	74	Spin-Glas SG-22	CT
.95	Temperature to 350°F											
	.53	.92	.99	.99	.99	.99	3	.8	6	74	Spin-Glas SG-28	CT
.95	Temperature to 350°F											
	.57	.91	.99	.99	.99	.99	3	1	6	74	Spin-Glas SG-26	CT
.95	Temperature to 350°F											
	.63	.94	.99	.99	.99	.99	3	1-2	6	74	Spin-Glas SG-25	CT
.95	Temperature to 350°F											
	.56	.94	.99	.99	.99	.99	3	1.5	6	74	Spin-Glas SG-24	CT
.95	Temperature to 350°F											
	.72	.99	.99	.99	.99	.99	3	1.9	6	74	Spin-Glas SG-23	CT
.95	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 850°F											
	.71	.99	.99	.99	.99	.99	3	3	6	74	Spin-Glas 1000 Board	CT
.95	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 850°F											
	.48	.74	.99	.99	.99	.99	2	3	6	74	Spin-Glas 1000 Board	CT
.95	Temperature to 350°F											
	.72	.99	.99	.99	.99	.99	4	.8	6	74	Spin-Glas SG-28	CT
.95	Temperature to 350°F											
	.74	.99	.99	.99	.99	.99	4	1	6	74	Spin-Glas SG-26	CT
.95	Semi-rigid, bonded, unfaced fiberglass board. Temperature to 850°F											
	.89	.99	.99	.99	.99	.99	4	3	6	74	Spin-Glas 1000 Board	CT

Table 4C. Glass fiber materials tested with number 7 mounting.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft³)	Mounting	Company	Product	Reference
.35	Temperature to 450°F											
	.45	.30	.23	.50	.34	.51	1	6	7	96	705, ASJ Faced	OCRL
.40	Temperature to 450°F											
	.53	.40	.31	.54	.33	.51	2	6	7	96	705, ASJ Faced	OCRL
.45	Temperature to 450°F											
	.54	.43	.33	.58	.37	.54	3	6	7	96	705, ASJ Faced	OCRL
.45	Temperature to 450°F											
	.62	.49	.33	.54	.35	.50	4	6	7	96	705, ASJ Faced	OCRL
.65	Teflon coated glass fabric											
	.60	.69	.54	.70	.72	.75	--	11 oz/ sq yd	7	31	Fabrasorb	CR CFC-1002-76
.70	Temperature to 450°F											
	.48	.60	.80	.82	.52	.35	1	3	7	96	703, FRK Faced	OCRL
.70	Fiberglass faced with asphalt and kraft paper, 16, 20, and 24 inch wide, paper side exposed to sound											
	.78	.87	.90	.71	.40	.32	3-1/2	--	7	96	Fiberglas Bldg Insulation	OCRL
.75	Fiberglass with PVC wrap											
	.72	.66	.69	.86	.79	.49	1	.75	7	85	Poly Pad	CR
.75	Equipment insulation C-8; CL-8 glass fiber with thermosetting binding formulation											
	.73	.66	.69	.86	.79	.49	1	.8	7	29	C-series	CR 30-40-25U
.75	Equipment insulation C-11, CL-11 glass fiber with thermosetting binding formulation											
	.74	.68	.71	.86	.80	.52	1	1.1	7	29	C-series	CR-30-40-25U
.75	Fabric reinforced vinyl faced											
	.38	.55	.99	.94	.50	39	1-1/2	.6	7	85	Decorative Faced Acoustical Insulation	CR
.75	Fabric reinforced vinyl faced rigid board											
	.38	.55	.99	.94	.50	.39	1-1/2	.6	7	85	Decorative Faced Rigid Board Acoustical Insulation	CR
.75	Temperature to 450 F											
	.50	.61	.99	.83	[illegible]	.35	[illegible]	3	7	96	703, FRK Faced	OCRL
.75	Temperature to 450°F											
	.59	.64	.99	.81	.50	.33	3	3	7	96	703, FRK Faced	OCRL
.75	Temperature to 450°F											
	.61	.69	.99	.81	.48	.34	4	3	7	96	703, FRK Faced	OCRL
.75	Fiberglass faced with asphalt and kraft paper, 16, 20, and 24 inch wide, paper side exposed to sound											
	.84	.92	.94	.64	.45	.34	6	--	7	96	Fiberglas Bldg Insulation	OCRL
.85	Temperature to 450°F											
	.56	.85	.70	.89	.93	.99	1	1.58	7	96	701 Fiberglas	OCRL
.85	Fiberglass with PVC wrap											
	.72	.86	.80	.86	.84	.57	1-1/2	.75	7	85	Poly Pad	CR
.85	Equipment insulation C-8, CL-8 glass fiber with thermosetting bonding formulation											
	.72	.86	.80	.86	.84	.57	1-1/2	.8	7	29	C-series	CR 30-40-25U
.85	Equipment insulation C-11, CL-11 glass fiber with thermosetting binding formulation											
	.74	.87	.80	.86	.84	.59	1-1/2	1.1	7	29	C-series	CR 30-40-25U
.90	.69	.77	.80	.99	.96	.72	1/8	--	7	96	Glastrate	OCRL

Table 4C. Glass fiber materials tested with number 7 mounting continued.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.90	Fiberglass with PVC wrap											
	.80	.90	.92	.89	.82	.54	1	1.5	7	85	Poly Pad	CR
.90	Temperature to 450°F											
	.65	.94	.76	.98	.99	.99	1	3	7	96	703 Fiberglas	OCRL
.90	Temperature to 450°F											
	.68	.91	.78	.97	.99	.99	1	6	7	96	705 Fiberglas	OCRL
.90	Equipment insulation C-8, CL-8 glass fiber with thermosetting binding formulation											
	.80	.90	.92	.89	.82	.54	2	.8	7	29	C-series	CR 30-40-25U
.90	Equipment insulation C-11, CL-11 glass fiber with thermosetting binding formulation											
	.83	.92	.93	.90	.83	.57	2	1.1	7	29	C-series	CR 30-40-25U
.90	Equipment insulation C-8, CL-8 glass fiber with thermosetting binding formulation											
	.98	.89	.97	.94	.82	.53	2-1/2	.8	7	29	C-series	CR 30-40-25U
.90	Equipment insulation C-11, CL-11 glass fiber with thermosetting binding formulation											
	.98	.89	.97	.95	.83	.54	2-1/2	1.1	7	29	C-series	CR 30-40-25U
.90	.59	.84	.79	.94	.96	.99	2-1/2	--	7	96	Fiberglas Noise Barrier Batts	OCRL
.95	Temperature to 450°F											
	.76	.99	.98	.99	.99	.99	2	1.58	7	96	701 Fiberglas	OCRL
.95	Temperature to 450°F											
	.66	.95	.99	.99	.99	.99	2	3	7	96	703 Fiberglas	OCRL
.95	Temperature to 450°F											
	.62	.95	.98	.99	.99	.99	2	6	7	96	705 Fiberglas	OCRL
.95	Temperature to 850°F											
	.79	.99	.99	.99	.99	.99	2	--	7	96	Intermediate Service Board	OCRL
.95	Equipment insulation C-8, CL-8 glass fiber with thermosetting binding formulation											
	.99	.95	.99	.94	.83	.54	3	.8	7	29	C-series	CR 30-40-25U
.95	Equipment insulation C-11, CL-11 glass fiber with thermosetting binding formulation											
	.99	.95	.99	.95	.84	.55	3	1.1	7	29	C-series	CR 30-40-25U
.95	Temperature to 450°F											
	.77	.99	.99	.99	.99	.99	3	1.58	7	96	701 Fiberglas	OCRL
.95	Temperature to 450°F											
	.66	.93	.99	.99	.99	.99	3	3	7	96	703 Fiberglas	OCRL
.95	Temperature to 450°F											
	.66	.92	.99	.99	.99	.99	3	6	7	96	705 Fiberglas	OCRL
.95	.73	.98	.98	.99	.99	.99	3-1/2	--	7	96	Fiberglas Noise Barrier Batts	OCRL
.95	Fiberglass faced with asphalt and kraft paper, 16, 20, and 24 inch wide, insulation side exposed to sound											
	.80	.98	.99	.99	.98	.99	3-1/2	--	7	96	Fiberglas Bldg. Insulation	OCRL
.95	Temperature to 450°F											
	.87	.99	.99	.99	.99	.99	4	1.58	7	96	701 Fiberglas	OCRL

Table 4C. Glass fiber materials tested with number 7 mounting concluded.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.95	Temperature to 450°F											
	.65	.99	.99	.99	.99	.99	4	3	7	96	703 Fiberglas	OCRL
.95	Temperature to 450°F											
	.59	.91	.99	.99	.99	.99	4	6	7	96	705 Fiberglas	OCRL
.95	Temperature to 450°F											
	.61	.99	.99	.99	.99	.99	4	1.58	7	96	701 Fiberglas	OCRL
.95	Temperature to 450°F											
	.62	.99	.99	.99	.99	.99	4	3	7	96	703 Fiberglas	OCRL
.95	Temperature to 450°F											
	.57	.99	.99	.99	.99	.99	4	6	7	96	705 Fiberglas	OCRL
.95	Fiberglass faced with asphalt and kraft paper, 16, 20, and 24 inch wide, insulation side exposed to sound											
	.86	.99	.99	.99	.99	.99	6	--	7	96	Fiberglas Bldg Insulation	OCRL

Table 4D. Glass fiber materials tested with number 7 mounting (modified).

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.35	Temperature to 450°F											
	.60	.39	.34	.29	.47	.30	4	6	7 mod	96	705, ASJ Faced	OCRL
.40	Temperature to 450°F											
	.38	.36	.39	.37	.56	.38	2	6	7 mod	96	705, ASJ Faced	OCRL
.40	Temperature to 450°F											
	.48	.44	.40	.31	.52	.29	3	6	7 mod	96	705, ASJ Faced	OCRL
.45	Temperature to 450°F											
	.25	.48	.28	.57	.39	.30	1	6	7 mod	96	705, ASJ Faced	OCRL
.55	Temperature to 450°F											
	.31	.45	.62	.65	.51	.28	1	3	7 mod	96	703, FRK Faced	OCRL
.65	Temperature to 450°F											
	.38	.51	.83	.73	.53	.37	2	3	7 mod	96	703, FRK Faced	OCRL
.65	Temperature to 450°F											
	.56	.74	.74	.67	.48	.23	3	3	7 mod	96	703, FRK Faced	OCRL
.65	Temperature to 450°F											
	.70	.78	.73	.67	.46	.24	4	3	7 mod	96	703, FRK Faced	OCRL
.70	Temperature to 450°F											
	.38	.34	.68	.82	.87	.96	1	1.58	7 mod	96	701 Fiberglas	OCRL
.70	Temperature to 450°F											
	.33	.28	.62	.88	.96	.99	1	3	7 mod	96	703 Fiberglas	OCRL
.70	Temperature to 450°F											
	.32	.30	.66	.90	.95	.99	1	6	7 mod	96	705 Fiberglas	OCRL
.90	Temperature to 450°F											
	.38	.63	.99	.99	.99	.99	2	3	7 mod	96	703 Fiberglas	OCRL
.90	Temperature to 450°F											
	.39	.59	.99	.99	.99	.99	2	6	7 mod	96	705 Fiberglas	OCRL
.90	Temperature to 850°F											
	.33	.57	.99	.99	.99	.99	2	--	7 mod	96	Intermediate Service Board	OCRL
.90	Temperature to 450°F											
	.44	.66	.99	.99	.99	.99	2	1.58	7 mod	96	701 Fiberglas	OCRL
.95	Temperature to 450°F											
	.53	.96	.99	.99	.99	.99	3	1.58	7 mod	96	701 Fiberglas	OCRL
.95	Temperature to 450°F											
	.45	.98	.99	.99	.99	.99	3	3	7 mod	96	703 Fiberglas	OCRL
.95	Temperature to 450°F											
	.49	.93	.99	.99	.99	.99	3	6	7 mod	96	705 Fiberglas	OCRL

Table 4E. Glass fiber materials tested with other or unspecified mounting.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft³)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.35 (c)	Temperature to 1200°F											
	.07	.10	.18	.39	.81	.98	1/4	--	-	13	Hushcloth HT-NM	CR
.50 (c)	Temperature to 1200°F											
	.09	.13	.23	.66	.91	.99	1/2	--	-	13	Hushcloth HT-NM	CR
.55	High density glass fiber blanket faced both sides with glass fiber fabric and stitched together with nylon thread, 24 x 48 inch stand											
	.09	.15	.41	.78	.90	.90	1	2.4	2	20	Studio Blanket	CR
.60	Cloud-lite 12 x 48 x 1 inch with 1-1/2 lb fiberglass core. Fabric covered decorative type											
	.11	.30	.53	.74	.81	.79	1	--	-	85	Cloud-Lite Acoustic Baffles	CR 9.1 ME
.60	Smooth surface acoustical pad unperforated											
	.69	.72	.59	.68	.36	.31	-	2	-	85	Shadow-Coustic	CR 9.1 ME
.65	Textile type fiberglass blanket, temperature to 350°F											
	.16	.50	.44	.77	.95	.89	1/2	2.5	-	13	Fibracoustic SK	CR
.65	Type 100 Eckousta-Glas, high temperature, long fibered fibrous glass. Temperature to 350°F. Sizes 24 x 48 inch sheets											
	--	.22	.62	.95	.90	.82	1	3	-	47	Eckoustic Noise Absorbing Liner	CR SES 76081
.65 (c)	Temperature to 350°F, 24 x 48 inch sheets											
	--	.22	.62	.95	.90	.82	1	3	-	47	Eckousta-Glas Type 100	CR SES 76081
.65	12 x 48 x 1 inch											
	.39	.52	.59	.75	.77	.71	1	--	-	85	Cloud-Lite Acoustic Baffles	CR 9.1 ME
.65	Acoustical fiberglass											
	.06	.20	.64	.90	.95	.97	1	--	-	40	dba Sorb-"AG"	CR
.65	Smooth surface acoustical pad, unperforated											
	.67	.83	.68	.77	.35	.24	-	3	-	85	Shadow-Coustic	CR 9.1 ME
.70	High density glass fiber faced both sides with glass fiber fabric and stitched together with nylon thread, 24 x 48 inch stand											
	.02	.21	.60	.99	.95	.95	2	2.4	2	20	Studio Blanket	CR
.75	Smooth surface acoustical pad, perforated											
	.61	.83	.59	.79	.86	.80	-	2	-	85	Shadow-Coustic	CR 9.1 ME
.75	Acoustical fiberglass											
	.16	.34	.72	.97	.97	.97	2	--	-	40	dba Sorb-"AG"	CR
.75 (c)	Temperature to 1200°F											
	.25	.46	.68	.85	.95	.99	1	--	-	13	Hushcloth HT-NM	CR
.80	Fiberglass thermal and acoustical insulation consisting of borosilicate glass bonded with a phenolic resin type 2001. Temperature to 450°F											
	.33	.56	.68	.95	.93	.88	1	2	-	29	Universal Blanket	CR 30-31-09U
.80	Textile type fiberglass blanket, temperature to 350°F											
	.40	.55	.70	.95	.95	.90	1	2.5	-	13	Fibracoustic SK	CR
.80	Fiberglass core with 1/8 inch molded glass fiber substrate facing on one or two sides											
	.33	.74	.90	.83	.73	.72	1	--	8	27	Vicracoustic	CKAL

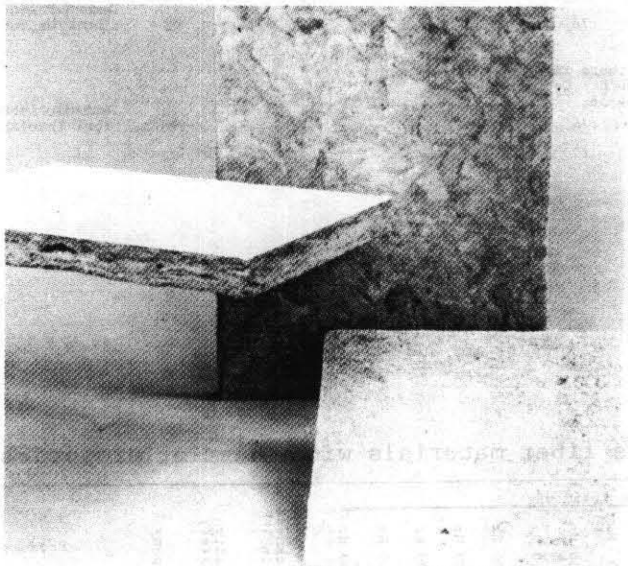
Table 4E. Glass fiber materials tested with other or unspecified mounting concluded.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.80	Fiberglass core with 1/8 inch molded glass fiber substrate facing on one or two sides											
	.27	.72	.87	.82	.74	.70	1	--	2	27	Vicracoustic	CKAL
.85	Fiberglass core with 1/8 inch molded glass fiber substrate facing on one or two sides											
	.57	.98	.92	.76	.71	.78	2	--	2	27	Vicracoustic	OCRL
.95	Acoustical fiberglass											
	.76	.97	.97	.97	.97	.97	4	--	-	40	dba Sorb-"AG"	CR
	Three pieces 1 inch thick fabricated glass fiber mat. Temperature to 1200°F. Coefficients are normal incidence by ASTM C384-58											
	.33	.40	.46	.64	.84	.82	3	.94	-	98	Temp-Mat Acoustical Insulation	--
	Two layers of 1 inch thick fabricated glass fiber mat. Temperature to 1200°F. Coefficients are normal incidence by ASTM C384-58											
	.32	.44	.47	.65	.76	.89	2	.94	-	98	Temp-Mat Acoustical Insulation	--
	100% select grade type E glass fibers fabricated on mat form. Temperature to 1200°F. Coefficients are normal incidence by ASTM C384-58											
	.09	.23	.46	.70	.74	.99	1	.94	-	98	Temp-Mat Acoustical Insulation	--

Table 4F. Glass fiber materials with barrier properties.

STC	Transmission Loss, dB																Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz					
17	Glass fiber molded via thermosetting method																				
	7	12	11	10	10	9	10	13	16	17	19	22	24	27	28	31	1	18	73	IC Pres-Glas	KAL 439294
20	Glass fiber molded via thermosetting binder method																				
	14	13	11	12	13	13	13	13	19	22	24	27	29	32	34	36	1	.35	73	IC Pres-Glas	KAL 439293

CATEGORY 5. MINERAL FIBER MATERIALS



CATEGORY 5. MINERAL FIBER MATERIALS

Open-cell absorptive materials can be divided into three classes: methane foams, glass fibers, and mineral fibers. Materials in the latter class are generally low density, flexible products which are available in sheet or roll geometries. Mineral fiber products are used as absorptive fillers for acoustic panels, enclosures, or partition walls.

Organizations contributing data to this category are: 12, 18, 28, and 45.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED ON PAGE 53.

Table 5A. Absorption properties of mineral fiber.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.45 (c)	Mineral wool fibers and thermosetting resins formed into panels.											
	.02	.11	.38	.67	.70	.65	1/4	--	--	28	Mineral Fiber Boards	CR 6011
.75	Homogenous, mineral fiber insulating board for thermal and acoustical insulation 24 x 48 inch. Temperature range below ambient to 1050°F, relative humidity 0 to 99%. Test method ASTM C423-66.											
	.10	.29	.73	.97	.97	1.00	1	6 to 8	4	45	MT Board	RAL A 72-110
.85 (c)	Mineral wool fibers and thermosetting resins formed into panels.											
	.11	.47	.87	.98	.99		1	--	--	28	Mineral Fiber Board	CR 6011
.85	Homogenous mineral fiber insulating board for thermal and acoustical insulation 24 x 48 inch. Temperature range below ambient to 1050°F, relative humidity 0 to 99%. Test method ASTM C423-66.											
	.29	.58	.88	1.01	1.01	1.00	2	6 to 8	4	45	MT Board	RAL A 72-111
.95	Homogenous mineral fiber insulating board for thermal and acoustical insulation 24 x 48 inch. Temperature range below ambient to 1050°F, relative humidity 0 to 99%. Test Method ASTM C423-66.											
	.47	.85	1.03	1.04	1.03	1.00	3	6 to 8	4	45	MT Board	RAL A 72-112
.95	Homogenous mineral fiber insulating board for thermal and acoustical insulation 24 x 48 inch. Temperature range below ambient to 1050°F, relative humidity 0 to 99%. Test Method ASTM C423-66.											
	.63	1.10	1.17	1.06	1.04	.99	4	6 to 8	4	45	MT Board	RAL A 72-113

Table 5B. Barrier properties of mineral fiber.

STC	Transmission Loss, dB 125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Company	Product	Reference
13(c)	Mineral wool fibers and thermosetting resins formed into panels 2 x 4 ft																				
	12	12	8	8	9	9	10	11	12	12	13	14	16	17	20	23	1	--	28	Mineral Fiber Boards	CR 6011
15	2 inch thick rock mineral wool																				
	12	9	11	9	9	10	11	12	14	15	16	18	19	20	21	23	2	9	12	Alpro Rock Mineral Wool	RAL TL 73-20
15	Mineral wool, rigid boards of 24 x 48 x 2 inch thick, a 1200°F. mineral fiber board																				
	10	8	8	8	6	8	11	13	14	15	16	18	19	21	23	24	2	7.2	18	1080 Hilboard	RAL TL 75-79
	Mineral wool insulation, a 1200°F. mineral fiber batt, test method ASTM E336-71. Data listed are noise reduction																				
	0.0	2.2	2.2	2.8	4.0	7.5	11.8	16.0	14.8	14.5	19.5	16.0	20.5	18.0	19.5	19.5	2	8	18	Flexwhite Insulation	RAL NR 75-14

CATEGORY 6. SPRAY-ON MATERIALS

Sound absorption provided by spray-on coatings depends on the type of material used, thickness, and the substrate material. Different spraying techniques are usually centered around a nozzle-type delivery system. The data presented in this category relate to different spray-on materials applied to different base materials. Thus, direct comparisons are limited by base material corrections.

When a spray-on material is appropriately applied to a good barrier material, a composite absorptive/barrier system can be created. For related barrier data, see walls. Organizations contributing data are: 55, 90, and 91.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED ON PAGE 53.

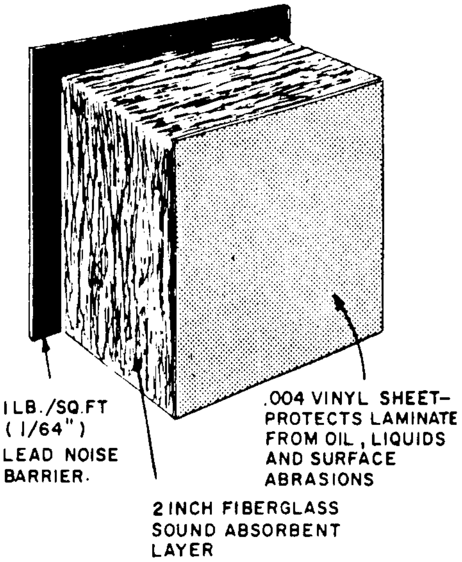
GLOSSARY

Lath: Thin, lightweight structure used as groundwork for plastering, tiles, etc. It may be in a form of perforated metal, wire cloth, thin wood strips, etc.

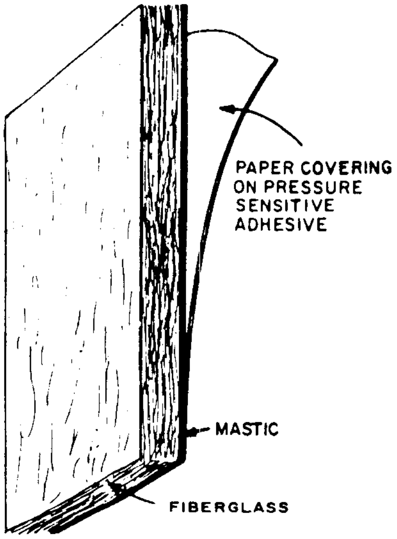
Table 6. Spray-on materials.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft²)	Mounting	Company	Product	Reference
.55	Spray-on cellulose insulation for exposed interior applications, fire resistant, nonwashable, a chemically treated cellulose fiber that offers a durable surface and bonds to all common construction materials. Applied to solid base. Temperature limits - prolonged exposure above 150°F.											
	.05	.16	.44	.79	.90	.91	5/8	--	4	90	K-13	RAL
.75	A chemically treated cellulose fiber, bondable, durable surface, fire resistant spray-on. Temperature limits - prolonged exposure above 150°F.											
	.08	.29	.75	.98	.93	.76	1	--	4	90	K-13	RAL
.75	A chemically treated cellulose fiber, bondable, durable surface, fire resistant spray-on, applied to 1/2 inch plywood base. Temperature limits - prolonged exposure above 150°F.											
	.10	.30	.73	.92	.98	.98	1-1/4	--	4	90	K-13	RAL
.95	A chemically treated cellulose fiber, bondable, durable surface, fire resistant spray-on, applied to metal lath base. Temperature limits - prolonged exposure above 150°F.											
	.47	.90	1.10	1.03	1.05	1.03	1	--	4	90	K-13	RAL
.60	Cellulose fiber insulation applied to 3/4 inch thick plywood. Temperature range 0-180°F.											
	.05	.19	.58	.80	.89	.94	1	0.78 -	4	55	Energy Guard	RAL
	Spray-on insulation tested under ASTM C384-58 and corrected to random incidence; upper line is normal incidence; lower line is random incidence.											
		.16	.36	.89	.97		1-1/2	--	--	55	Fibron #1 Grey	CR 7/6/76
		.29	.60	.99	.99							
	Spray-on insulation tested under ASTM C384-58 and corrected to random incidence. Upper line is normal incidence; lower line is random incidence.											
		.15	.27	.71	.97		1-1/4 to 1-1/2	--	--	55	Fibron #2 Grey	CR 7/6/76
		.27	.47	.94	.99							
	Spray-on insulation tested under ASTM C384-58 and corrected to random incidence. Upper line is normal incidence; lower line is random incidence.											
		.16	.33	.79	.99		1-1/2	--	--	55	Fibron #3 Grey	CR 7/6/76
		.30	.55	.98	.99							
	Spray-on insulation tested under ASTM C384-58 and corrected to random incidence. Upper line is normal incidence; lower line is random incidence.											
		.18	.40	.95	.99		1-1/2	--	--	55	Fibron #1 White	CR 7/6/76
		.33	.64	.99	.99							
	Spray-on insulation tested under ASTM C384-58 and corrected to random incidence. Upper line is normal incidence; lower line is random incidence.											
		.17	.40	.92	.99		1-1/2	--	--	55	Fibron #2 White	CR 7/6/76
		.32	.64	.99	.99							
	Spray-on insulation tested under ASTM C384-58 and corrected to random incidence. Upper line is normal incidence; lower line is random incidence.											
		.15	.36	.89	.99		1-1/2	--	--	55	Fibron #3 White	CR 7/6/76
		.27	.60	.99	.99							
	Spray-on insulation tested under ASTM C384-58 and corrected to random incidence. Upper line is normal incidence; lower line is random incidence.											
		.33	.85	.99	.96		2-1/2	--	--	55	Fibron #1 Tan	CR 7/6/76
		.55	.99	.99	.96							
	Spray-on insulation tested under ASTM C384-58 and corrected to random incidence. Upper line is normal incidence; lower line is random incidence.											
		.26	.77	1.00	.98		2	--	--	55	Fibron #2 Tan	CR 7/6/76
		.45	.97	.99	.99							

CATEGORY 7. BARRIER/FIBERGLASS COMPOSITES



Composite Lead/Fiberglass With a Protective Facing



Composite Mastic/Fiberglass With Pressure Sensitive Adhesive

CATEGORY 7. BARRIER/FIBERGLASS COMPOSITES

Composite products consisting of fiberglass (absorption) and a dense backing material (barrier) mostly lead, asbestos, felt, mastic, etc, are listed. The absorption parameters are dependent upon the type, thickness, density, and surface characteristics of the fiberglass. The transmission loss is dependent upon the mass and rigidity of the barrier material. The absorptive barrier can also offer good thermal properties. Precautionary measures to control problems of moisture and soiling are also available in various forms (wraps, coatings, encapsulations, chemical treatments, etc).

The composite absorptive barrier can be adapted for a variety of uses such as machine and room enclosures, vehicle and heavy equipment quieting, pipe and duct wrapping, or as space absorbers. Organizations contributing data are: 10, 13, 26, 33, 40, 55, and 117.

CAUTION

NOISE REDUCTION AND TRANSMISSION LOSS VALUES MAY HAVE BEEN SUBSTANTIALLY INCREASED DUE TO THE MATERIAL ON WHICH THE PRODUCT WAS MOUNTED.

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Mastic: Any of various quick-drying pasting cements. For sound barrier application this is usually a dense flexible asphalted product.

Scrim: A light, loosely woven cotton or woolen cloth.

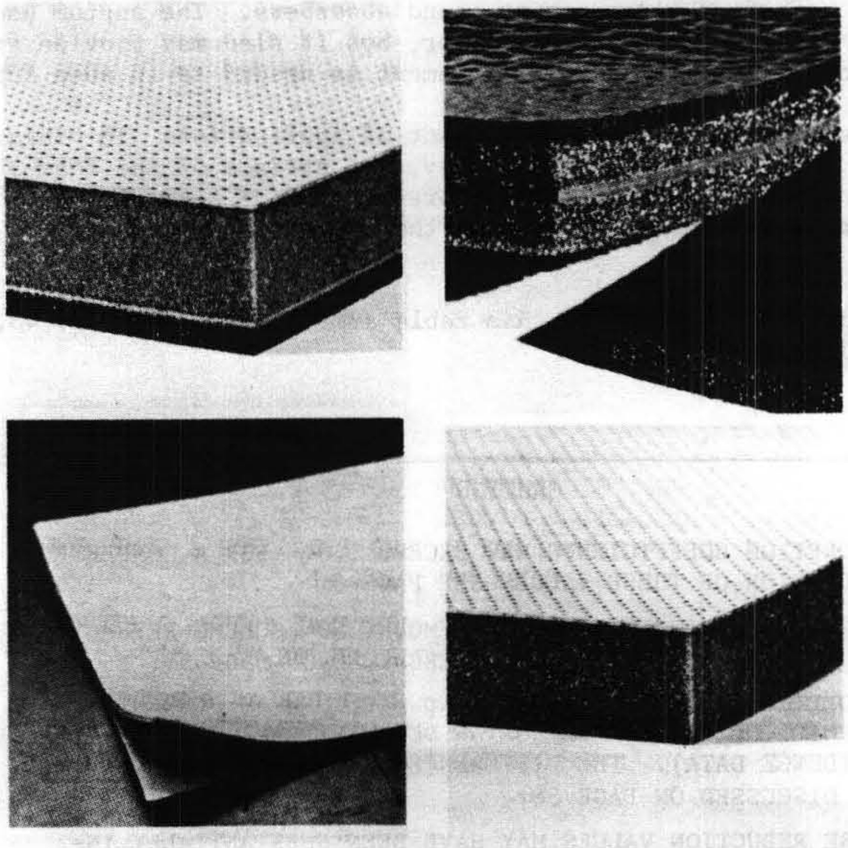
Table 7A. Absorption properties of barrier/fiberglass composites.

NRC	Absorption Coefficients						Thickness (in.)	Density (1b/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.40 (c)	Three ply; paper facing on pressure sensitive adhesive, 1 lb/ft^2 mastic, fiberglass 1.5 lb density 1/2 inch thick.											
	.03	.09	.26	.57	.75	.75	--	--	--	65	Acoustigard L 24-49(100)	G&H
.40 (c)	G-49P mastic core mastic with a 1/2 inch thick and 1.5 lb density fiberglass.											
	.03	.10	.14	.60	.75	.75	--	--	--	40	dba damp-'G'	CR D-G-1-76 Test 3
.50 (c)	Acoustical thermal wrap of solid lead barrier and fiberglass. Temperature to 350°F.											
	.03	.17	.42	.63	.73	.89	1/2	--	--	13	Hushcloth V1	CR
.55 (c)	Acoustical Marine mat, solid lead barrier coupled with a dual density fiberglass. Temperature to 350°F											
	.48	.48	.47	.55	.75	.79	1/2	--	--	13	Hushcloth V	CR
.60 (c)	Three plv; paper facing on pressure sensitive adhesive, on mastic (1 lb/ft^2) and 1 lb density, 1 inch thick, fiberglass.											
	.08	.23	.55	.80	.86	.80	--	--	--	65	Acoustigard L 24-48(100)	G&H
.60 (c)	G-48P mastic core with a 1 inch thick 1 lb density, fiberglass											
	.07	.24	.58	.82	.86	.80	--	1	--	40	dba damp-'G'	CR D-G-1-76
.75 (c)	Acoustical thermal wrap of solid lead barrier and fiberglass. Temperature to 350°F.											
	.08	.36	.78	.92	.95	.95	1	--	--	13	Hushcloth V1	CR
.75 (c)	Acoustical Marine mat, solid lead barrier coupled with a dual density fiberglass. Temperature to 350°F.											
	.50	.55	.69	.85	.89	.89	1	--	--	13	Hushcloth V	CR
.75 (c)	Septum sandwiched by inert glass fiber. Temperature to 400°F. Density shown is lb/ft^2											
	.41	.58	.65	.89	.90	.90	1	1	6	117	Soundmat LGF	CR 716
.95 (c)	Acoustical thermal wrap of solid lead barrier and fiberglass. Temperature to 350°F.											
	.82	.92	.96	.98	.99		4	--	--	13	Hushcloth V1	CR
.95 (c)	Acoustical thermal wrap of solid lead barrier and fiberglass. Temperature to 350°F.											
	.28	.82	.97	.98	.99		2	--	--	13	Hushcloth V1	CR

Table 7B. Barrier properties of barrier/fiberglass composites.

STC	Transmission Loss, dB																Thickness (in.)	Density (lb/ft2)	Company	Product	Reference
	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz					
23	Woven texture, leaded vinyl with a fiberglass cloth.																				
	12	14	11	14	15	16	19	20	22	24	25	28	30	32	32	33	.075	.75	10	Alpha-Sonic #75	RAL TL78-9
28	Woven texture leaded vinyl, fiberglass cloth.																				
	15	16	16	19	20	22	24	26	28	29	31	33	35	37	38	39	.15	1.56	10	Alpha-Sonic #150	RAL TL78-8
	Noise control product 111 composite for double wall and cavity construction. 1 lb/sq ft (1/64 inch) thick sheald laminated to 2 inch fiberglass. A .004 vinyl sheet is then applied. Test method: NCP 111 was applied to the inside of a steel (24 gauge) machine enclosure 24 x 24 x 30 inch. 30 dB (lin) 34 dBA. Data cited are noise reduction.																				
	18			23			24			28			43			43	2-1/64		26	Sheald NCP 111	CR
	G-49P mastic core mastic with a 1/2 inch thick and 1.5 lb density fiberglass. Data cited are insertion loss.																				
	10			15			21			28			35			41	--	--	40	dba damp-"G"	CR D-G-1-76
	G-48P mastic core with a 1 inch thick 1 lb density fiberglass. Data cited are insertion loss.																				
	12			15			23			32			39			45	--	--	40	dba damp-"G"	CR D-G-1-76 Test G-L-97
	Laminate with limp, flexible septum, inside layer is of glass fibers, firmly bonded.																				
	22			21			27			30			36			39	1	1	33	Quietfibre LGF	CR QF-LGF-302/ 20/7/77

CATEGORY 8. BARRIER/FOAM COMPOSITES



CATEGORY 8. BARRIER/FOAM COMPOSITES

Composite materials utilizing an acoustical foam (absorption) combined with a barrier (septum) material such as lead, vinyl, barium, steel, wood, etc., are listed. These materials may be formulated into a sandwich type array (foam/barrier-septum/foam) with the septum position varying. Usually in this type of array, one side of the foam acts as a sound absorber and the other side acts as a vibration damping material. However, in some freestanding acoustical barriers, both foam sides act as sound absorbers. The septum usually acts as a sound (transmission loss) barrier, but it also may provide strength. In some cases, only a barrier/foam arrangement is needed as in some enclosures.

Variations in design offer a wide assortment of applications in vibration and sound control. The type thickness, density, and surface of the foam should be considered for specific purposes of vibration and/or absorption. The thickness, rigidity and mass qualities of the septum influence barrier performance.

Organizations contributing data to this table are: 13, 26, 33, 40, 43, 47, 66, 73, 117, and 130.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED ON PAGE 53.
3. ABSORPTION COEFFICIENTS ARE SHOWN EITHER AS PERCENTAGES (NORMAL INCIDENCE DATA) OR AS DECIMAL FRACTIONS (RANDOM INCIDENCE DATA). THE DIFFERENCES BETWEEN THESE TWO DATA ARE DISCUSSED ON PAGE 56.
4. NOISE REDUCTION VALUES MAY HAVE BEEN SUBSTANTIALLY INCREASED DUE TO THE MATERIAL ON WHICH THE PRODUCT WAS MOUNTED.
5. VALUES PRESENTED ON PAGE 199 ARE NOISE REDUCTIONS; ON PAGE 200, INSERTION LOSSES; ON PAGE 201, NOISE REDUCTIONS. SEE PAGES 70 AND 94 FOR EXPLANATION OF DIFFERENCES.

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Loaded: A foreign substance added to the base material. In noise control materials this usually means addition of a dense material to a fabric type material to increase sound transmission loss.

Lead loaded: Lead added to a base material such as vinyl to increase sound transmission loss.

Table 8A. Absorption properties of barrier/foam composites.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
.20 (c)	Combination of Quietdamp sheet and Quietfoam bonded together. Temperature range 32° to 175°F.											
	.05	.06	.10	.20	.45	.82	1/4	.37	--	33	Quietfoam Damping Sheet 102	CR QD-TDS-102-R2
.25 (c)	Pigskin pattern vinyl faced, nonlead-filled barrier laminated to 1/4 inch foam.											
	.05	.08	.14	.24	.61	.96	.375	1.04	--	40	dba spec-"FM"	CR S-FM-1-76
.25 (c)	Foam and mass material. 1/4 inch foam, 1/2 lb/ft^2 lead sheet/1/4 inch foam. 3 x 4 ft panel. Data for 1/4 inch foam only.											
	.05	.08	.14	.24	.61	.96	.52	.625	--	40	dba Lam-"AM"	CR L-AM-1-76
.30	Rubber, foam 1/2 inch. Temperature range 0 to 200°F.											
	.05	.10	.22	.36	.60	.72	.606	1.03	4	66	Acousta Sheet 500	RAL 77-159
.50 (c)	Foam and mass material, 1/4 inch foam/1/2 lb/ft^2 lead sheet/1/2 inch foam. Data for 1/2 inch foam only.											
	.06	.14	.25	.60	.93	.97	.77	.67	--	40	dba Lam-"AM"	CR L-AM-1-76
.60	1 inch thick foam, rubber, Temperature range 0 to 200°F.											
	.10	.24	.54	.79	.95	.78	1.106	1.17	4	66	Acousta Sheet 1000	RAL A-77-158
.65 (c)	Acoustical foam and mass material (lead). 1/4 inch foam/ 1 lb/ft^2 lead/1 inch foam, 3 x 4 ft panel. Data for 1 inch foam only.											
	.10	.25	.47	.93	.97	.97	1.276	1.25	--	40	dba Lam-"AM"	CR L-AM-1-76
.70	Fabricated from high strength, high performance acoustical foam, fused to a noise attenuating barrier layer, 54 x 96 inch sheets. Temperature to 180°F. Data read from graph.											
		.30	.67	.91	.98	.94	1	.9	--	47	Eckoustic Noise Absorbing Liners Type 1000B	CR SES 76081
.80	Tedlar covered.											
	.60	.54	.95	.85	.91	.51	1	--	--	82	Absorbing Foam FOA-4	CT
	Polyurethane foam on outside, thin layer of lead in middle. Temperature range -45° to 225°F. Normal incidence coefficients by ASTM C384-58.											
		.16	.26	.47	.60	.68	1/4	.04	--	117	Soundfoam Embossed	CR 702D
	Polyurethane foam, thin layer lead in middle. Temperature range -45° to 225°F. Normal incidence coefficients by ASTM C384-58.											
		.25	.44	.77	.90	.95	1/2	.08	--	117	Soundfoam Embossed	CR 702D
	Polyurethane foam, thin layer of lead in middle. Temperature range -45° to 225°F. Normal incidence coefficients tested by ASTM C384-58.											
		.32	.58	.89	.95	.96	3/4	.06	--	117	Soundfoam Embossed	CR 702D
	Polyurethane foam, lead layer in middle. Temperature range -45° to 225°F. Normal incidence coefficients by ASTM C384-58.											
		.46	.70	.93	.97	.98	1	.08	--	117	Soundfoam Embossed	CR 702D

Table 8B. Barrier properties of barrier/foam composites (transmission loss).

	Transmission Loss, dB																						
STC	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
20	Reinforced lead vinyl on filled fiberglass fabric with 1/4 inch urethane foam.																						
	7	5	6	7	12	12	14	15	18	19	22	24	25	28	30	32	32	30	.28	.46	43	Dura-Sonic 4729	RAL TL73-203
21	Reinforced lead vinyl on filled fiberglass fabric with 1/4 inch urethane foam.																						
	8	8	7	9	12	12	14	15	17	20	22	24	25	28	31	34	34	32	.27	.25	43	Dura-Sonic 4840	RAL TL73-201
26	Reinforced lead vinyl with 1/4 inch foam.																						
	15	12	12	13	17	18	20	22	23	25	27	29	31	33	36	37	37	37	.3	.875	43	Dura-Sonic 4848	RAL TL73-49
26	Nonreinforced filled vinyl with 1/4 inch foam.																						
	11	11	12	14	17	18	20	21	23	25	27	29	31	34	36	39	40	40	.34	1	43	Dura-Sonic 5332	RAL TL73-211
26 (c)	1 lb limp mass barrier bonded to 1/4 inch layer foam. Temperature range 0 to 200°F.																						
		12			18			22			29			35			41		3/8	1	117	Soundmat FV	CR 713C
27	Pigskin pattern vinyl faced, nonlead filled barrier laminated to 1/4 inch foam.																						
		16			17			23			27			33			39		.375	1.04	40	dba spec -"FM"	CR FM-144
28	Foam .5 inch, rubber .106 inch. Temperature range 0 to 200°F.																						
	17	18	14	16	20	20	23	25	26	27	29	30	31	33	36	38	41	43	.606	1.03	66	Acoust Sheet 500	RAL A-77-159
	Mass material for composite usage (lead sheet), foam faced.																						
		9			9			12			17			26			30		.02	.5	40	dba Lam -"AM"	CR
	Mass material for composite usage (lead sheet), foam faced.																						
		16			17			18			21			35			35		.021	1	40	dba Lam-"AM"	CR
	Mass material for composite usage (M-filled vinyl, gold colored), foam faced.																						
		12			13			16			21			27			32		.067	.5	40	dba Lam -"AM"	CR
	Mass material for composite usage (C-filled vinyl, black) foam faced.																						
		12			13			16			21			27			32		.067	.5	40	dba Lam -"AM"	CR
	Mass material for composite usage (M-filled vinyl, gold colored), foam faced																						
		12			18			20			27			35			40		.13	1	40	dba Lam -"AM"	CR
	Mass material for composite usage (C-filled vinyl, black) foam faced.																						
		13			19			24			31			36			41		.13	1	40	dba Lam -"AM"	CR
	Limp mass 1 lb barrier layer bonded to a 1/4 inch foam layer. Foam temperature range -45° to 225°F.																						
		12			18			22			29			35			41		3/8	1	33	Quietfoam MAT-FV	CR QF/FV-TDS-202
	Flexible, open cell polyurethane foam sandwiched between a 1/8 inch thick layer of black vinyl and a 1/8 inch thick layer of volara. (A lead septum is also available.) Foam temperature range -45° to 225°F.																						
		11			15			18			24			28			28		1/2	13	33	Quietfoam MAT FVP	CR QF-FVP-203/26/7/77
	Type 1000B fabricated from high strength, high performance acoustical foam, fused to a noise attenuating barrier layer, 54 x 96 inch sheet. Temperature to 180°F.																						
					15			20			26			32			36		1	.9	47	Eckoustic Noise Absorbing Liners	CR SES 76081
	Isolation foam, lead barrier, acoustical foam. Weight is given for lead only.																						
		15			18			21			23			31			36		--	1	13	Hushcloth	CR
	Isolation foam, lead barrier, acoustical foam. Weight is given for lead only.																						
		16			21			25			32			36			40		--	2	13	Hushcloth	CR
	Dense plastic barrier sandwiched between two layers of urethane foam, perforated vinyl facing.																		--	--	130	Noise Control Material	CR
	Dense plastic barrier sandwiched between two layers of urethane foam, tough, skid-resistant floor mat material one side.																		--	--	130	Noise Control Material	CR

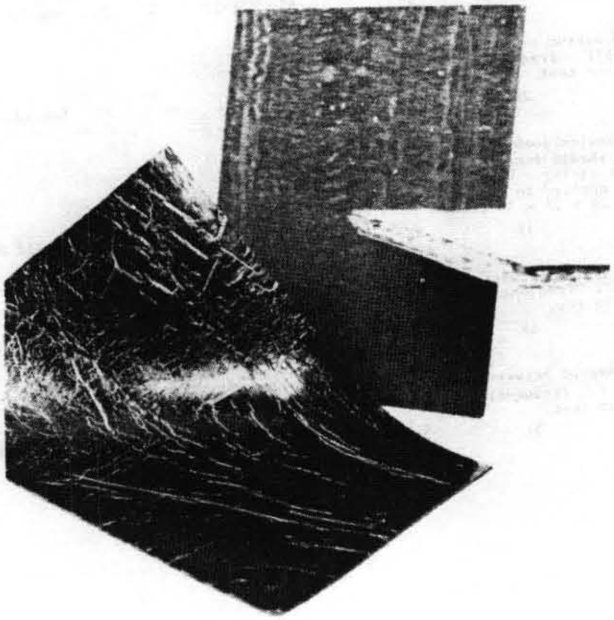
Table 8C. Barrier properties of barrier/foam composites (insertion loss).

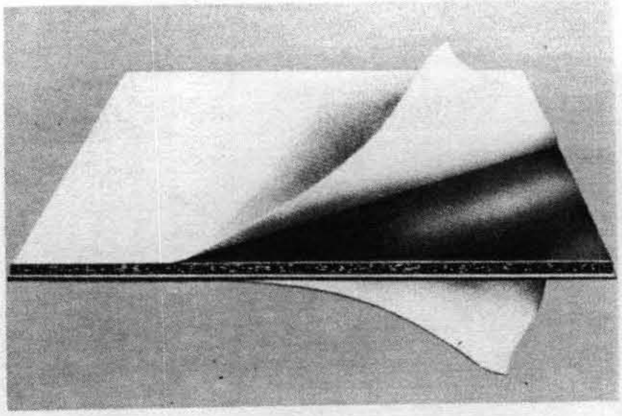
	Insertion Loss, dB																				
STC	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	Thickness (in.)	Density (lb/Ft2)	Company	Product	Reference
Flexible, barium-loaded vinyls on 1/4 inch plywood enclosure. Temperature range (foam) -40° to 300°F.																					
	15			12			17			18			22			25	--	1	78	Noiseguard Laminates	CR K60B
Flexible, barium-loaded vinyls on 18 gauge steel enclosure.																					
	20			12			19			22			26			31	--	1	78	Noiseguard Laminates	CR K60B
Flexible, tedlar film with acoustical foam on 1/4 inch plywood enclosure. Foam temperature range -40° to 300°F. Weight is foam only.																					
	29			21			24			23			25			26	1-1/4	.18 to .23	78	Noiseguard Laminates	CR K60B
Flexible, acoustical foam on 1/4 inch plywood enclosure. Foam temperature range 40° to 300°F. Weight given is foam only.																					
	28			20			25			26			29			31	1-1/4	.18 to .23	78	Noiseguard Laminates	CR K60B
Flexible, acoustical foam with tedlar film on 18 gauge steel enclosure. Temperature range -40° to 300°F. Weight is foam only.																					
	16			18			28			31			34			42	1	.18 to.23	78	Noiseguard Laminates	CR K60B
Flexible, acoustical foam on 18 gauge steel enclosure. Foam temperature range -40° to 300°F. Weight is foam only																					
	15			16			28			33			38			45	1	.18 to.23	78	Noiseguard Laminates	CR K60B
Flexible, barium-loaded vinyls with acoustical foam. Foam temperature range -40° to 300°F. Weight is foam only.																					
	29			25			29			33			31			41	1	.18 to .23	78	Noiseguard Laminates	CR K60B
Flexible, barium-loaded vinyls with acoustical foam on 18 gauge steel enclosure. Foam temperature range -40° to 300°F. Weight is foam only.																					
	18			20			32			38			36			45	1	.18 to.23	78	Noiseguard Laminates	CR K60B
Flexible, barium-loaded vinyls with acoustical foams (1 inch foam-vinyl-1/4 inch foam) on 1/4 inch plywood enclosure. Foam temperature range -40° to 300°F. Weight is foam only.																					
	30			26			29			28			36			45	--	.18 to.23	78	Noiseguard Laminates	CR K60B
Flexible, barium-loaded vinyls with acoustical foam (1 inch foam-vinyl-1/2 inch foam) on 1/4 inch plywood enclosure. Temperature range foam -40° to 300°F. Weight is foam only.																					
	30			27			28			27			41			49	--	.18 to.23	78	Noiseguard Laminates	CR K60B
Flexible, barium-loaded vinyls with acoustical foams (1 inch foam-vinyl-1/4 inch foam) on 18 gauge steel enclosure. Temperature range -40° to 300°F. Weight is foam only.																					
	18			21			32			31			47			54	1-1/4	.18 to.23	78	Noiseguard Laminates	CR K60B
Flexible, barium-loaded vinyls with acoustical foams (1 inch foam-vinyl-1/2 inch foam) on 18 gauge steel enclosure. Temperature range -40° to 300°F. Weight is foam only.																					
	18			22			28			38			50			56	1-1/2	.18 to.23	78	Noiseguard Laminates	CR K60B

Table 8D. Barrier properties of barrier/foam composites (noise reduction).

STC	Noise Reduction, dB																Thickness (in.)	Density (lb/ft2)	Company	Product	Reference
	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz					
	Continuously cast thin lead sheet used in conjunction with various ceiling assemblies.																				
	14			12			16			25			30			25	--	2 to 3	26	Sheald (HTL Ceilings)	CR 13-300
	Double septum isolated by 1/4 inch acoustical foam and 1 inch absorption foam.																				
	15			20			24			30			39			38	1-1/2	--	13	Hushcloth DS	CR
	Noise control product 1, 1 lb/sq ft, 1/64 inch thick sheald laminated to 1 inch of polyurethane foam. Weight given is for lead only. Test method NCP1 was applied to the inside of a steel (24 gauge) machine enclosure 24 x 24 x 36 inch.																				
	19			22			24			27			36			41	1-1/64	1	26	Sheald NCP1	CR
	High mass, limp treated lead septum between two surfaces of foam. Temperature range -45° to 275°F. Frequencies are approximate centers of octave bands used in test.																				
	17			18			25			26			33			38	--	.83 to 1	33	Quietfoam Mat	CR MF-TDS- 300R2
	Noise control product 11, sandwich combination, 1 inch foam damping 1 lb/sq ft, 1/64 inch thick, sheald septum, 1 inch foam noise absorption layer with plastic facing. Weight given is for lead only. Test method NCP11 was applied to the inside of a steel (24 gauge) machine enclosure 24 x 24 x 30 inch.																				
	17			22			26			37			45			47	2-1/64	1	26	Sheald NCP11	CR
	High mass, limp treated lead septum between two surfaces of foam. Temperature range -45° to 275°F. Frequencies are approximate centers of octave bands used in test.																				
	18			24			38			48			53			59	--	.83 to 1	33	Quietfoam Mat	CR MF-TDS- 300R2
	High mass, limp treated lead septum between two surfaces of foam. Temperature range -45° to 275°F. Frequencies are approximate centers of octave bands used in test.																				
	21			28			43			52			55			59	--	.83 to 1	33	Quietfoam Mat	CR MF-TDS- 300R2

CATEGORY 9. MASTICS





CATEGORY 9. MASTICS

Mastics are normally quick-drying cements which are used for sound barrier applications. They are usually dense, flexible, asphaltic products with reliability varying from elastic to semirigid. Mastics are applicable as barrier, deadening, or damping materials used in vehicles, doors, appliances, metal enclosures, etc.

The following data include absorption, insertion loss and transmission loss qualities of different mastics. Organizations contributing data to this table are: 28, 40, 65, 73, and 81.

CAUTION

NOTE THAT BARRIER VALUES SHOWN ON PAGE 204 ARE TRANSMISSION LOSSES AND THOSE SHOWN ON PAGE 205 ARE INSERTION LOSSES. REFER TO PAGES 70 AND 94 FOR DISCUSSION.

GLOSSARY

Facing:	The outside surface of the specimen. In general the side facing the sound source
Backing:	The other outside surface of the specimen. In general the side not facing the sound source
Core:	The region between the facing and the backing
Creped Kraft:	Crinkled, strong paper
Mastic:	Any of various quick-drying pasting cements. For sound barrier application this is usually a dense flexible asphalted product.

Table 9A. Absorption properties of mastic.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.05 (c)	Formulated asphalt with inert fillers between selected skin covering layers.											
	.02	.02	.02	.10	.12	.02	--	--	--	28	Mastic (asphalt)	CR 6011
.30 (c)	G-60P mastic core with 28 gram cotton padding.											
	.04	.06	.20	.42	.60	.68	--	--	--	40	dba damp-"G"	CR D-G-1-76 Test 1
.30 (c)	Three ply; paper facing on pressure sensitive adhesive, 1 lb/ft^2 mastic, and 28 gram resinated cotton padding 1/4 inch thick. Refer to insertion loss data.											
	.04	.07	.20	.41	.61	.68	--	--	--	65	Acoustigard L24-60(100)	G&H CR 25-6-75
.60 (c)	G-75P mastic core with 85 gram cotton padding.											
	.06	.20	.55	.83	.85	.82	--	--	--	40	dba damp-"G"	CR D-G-1-76
.60 (c)	Three ply; paper facing on pressure sensitive adhesive, 1 lb/ft^2 mastic, 85 gram resinated cotton padding 3/4 inch thick. Refer to insertion loss data.											
	.07	.20	.55	.83	.85	.82	--	--	--	65	Acoustigard L24-75(100)	G&H CR 25-6-75

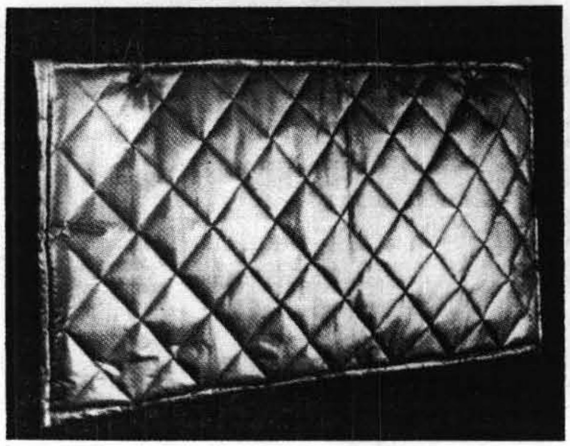
Table 9B. Barrier properties of mastic (transmission loss).

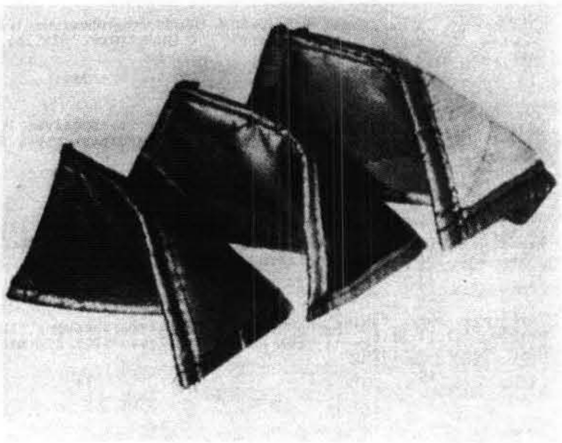
STC	Transmission Loss, dB 125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
24	Gray, lead free, elastomer based																				
	15	14	14	15	16	20	16	18	20	27	30	33	36	38	40	43	--	1	73	575 NCS Mastic	CKAL 7604.36
25	Creped kraft, mastic tissue, KW-003-100 sheet with amberlite.																				
	10	11	13	17	18	19	20	22	23	26	28	31	33	35	36	38	.125	1	81	KW Series	RAL TL73-195
27(c)	Formulated asphalt with inert fillers between selected skin covering layers																				
	16	17	17	17	19	21	22	24	26	27	30	32	32	34	37	38	--	--	28	Mastic (asphalt)	CR 6011
27	Creped kraft, mastic tissue KW-003-100 sheet with amberlite.																				
	13	14	15	17	17	19	21	24	28	30	32	35	38	41	45	46	.625	1.3	81	KW Series	RAL TL73-196
47	Consists of 1 lb/ft^2 mastic core backed with 40 lb creped kraft, faced with 12 lb tissue, and a 1/4 inch thick 28 gram resinated cotton. Data read from graph.																				
	26			35			47			54			54			58	--	--	65	Acoustigard L02-60(100)	G&H GL-115T CR 25-6-75
	Mastic core with 40 lb creped kraft backing and 12 lb tissue facing.																				
	23			32			45			50			50			52	--	1	65	Acoustigard L02-30(100)	CR 25-6-75
	Mastic core, data read from graph.																				
	29			45			50			53			53			60	--	1	65	Acoustigard L02-30(100)	CR 25-6-75

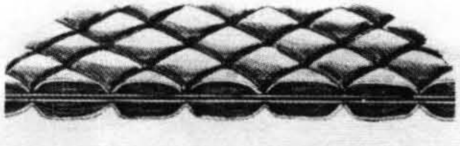
Table 9C. Barrier properties of mastic (insertion loss).

STC	Insertion Loss, dB 125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Company	Product	Reference
	Three ply; paper facing on pressure sensitive adhesive, 1 lb/ft^2 of mastic, and .00075 inch polyethylene film. STC 26. Data read from graph.																				
	11			15			22			27			34			36	--	--	66	Acoustigard L24-80 (100)	G&H GL-1T
	G-80P asphalt mastic core faced with paper, adhesive on .00075 inch polyethylene film.																				
	10			15			22			28			34			37	--	--	40	dba damp-"G"	CR D-G-1-76
	G-75P mastic core with 85 gram weight cotton padding.																				
	14			17			24			30			35			43	--	--	40	dba damp-"G"	GL-5T CR D-G-1-76
	G-60P mastic core with 28 gram cotton padding.																				
	10			15			24			30			37			44	--	--	40	dba damp-"G"	GL-4T CR D-G-1-76
	Three ply; paper facing on pressure sensitive adhesive, 1 lb/ft^2 mastic, fiberglass 1.5 lb density, 1/2 inch thick, STC 26, NRC .45. Data read from graph.																				
	10			14			22			28			35			40	--	--	65	Acoustigard L24-49(100)	G&H GL-8T
	Three ply; paper facing on pressure sensitive adhesive, 1 lb/ft^2 mastic, 85 gram resinated cotton padding, 3/4 inch thick, STC 26, NRC .60. Data read from graph.																				
	10			15			23			27			37			44	--	--	65	Acoustigard L24-75(100)	G&H GL-5T
	Three ply; paper facing on pressure sensitive adhesive, 1 lb/ft^2 mastic, 28 gram resinated cotton padding, 1/4 inch thick, STC 25, NRC .30. Data read from graph.																				
	13			17			23			30			35			43	--	--	65	Acoustigard L24-60(100)	CR 25-6-75 G&H GL-4T
	Three ply; paper facing on pressure sensitive adhesive, 1 lb/ft^2 mastic, 1 lb density, 1 inch thick fiberglass, STC 27, NRC .65. Data read from graph.																				
	11			14			23			32			38			44	--	--	65	Acoustigard L24-48(100)	G&H GL-9T

CATEGORY 10. QUILTED MATERIALS







CATEGORY 10. QUILTED MATERIALS

With the availability of various sandwich type configurations, quilted materials are very versatile for sound control. They have good thermal properties and are resistant to moisture, many chemicals, and abrasion.

The facing material may be aluminized glass cloth, a fiberglass scrim type cloth, or other impervious facing materials. The absorption material can be foam but usually consists of a glass fiber material to achieve higher fire ratings. The quilt composite may be simply a facing material encapsulating an absorption material. It may include a barrier septum (usually lead) or a barrier-type backing (lead vinyl) for improved transmission loss properties.

This pliable composite can be used for barriers or enclosures, equipment or wall liners, duct or pipe covering, machinery quieting, or source isolation. Both absorption and sound transmission data are supplied. Organizations contributing data to this table are: 4, 20, 73, and 93. For related sections, see curtains and unit absorbers.

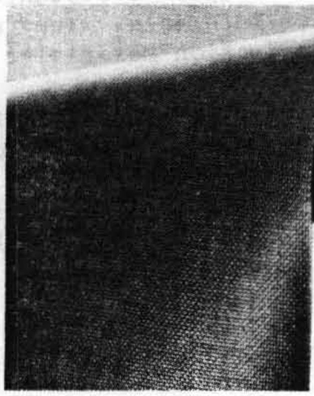
Table 10A. Absorption properties of quilted materials.

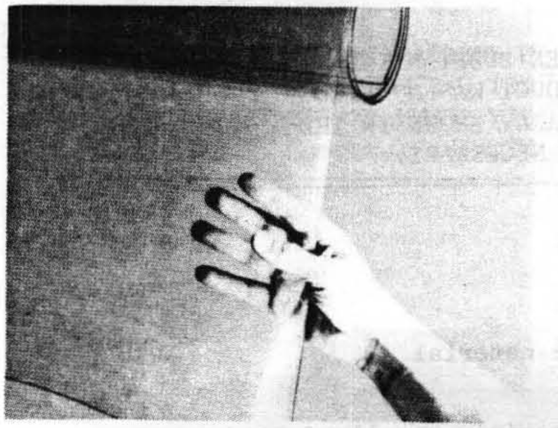
NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft2)	Mounting	Company	Product	Reference
.55	Fiberglass scrim cloth, 3/4 inch fiberglass insulation, and aluminum glass cloth. Temperature range -65° to 450°F.											
	.23	.41	.43	.63	.68	.58	3/4	2.5	4	73	Insul-Quilt	KAL 439127
.65	Fiberglass cloth, 1-1/2 inch fiberglass insulation and aluminized glass cloth. Temperature range -65° to 450°F.											
	.32	.60	.65	.68	.58	.35	1-1/2	2.5	4	73	Insul-Quilt AGS	CKAL 7701.37
.65	Fiberglass scrim cloth, 1-1/2 inch fiberglass insulation, and aluminum glass cloth. Temperature range -65° to 450°F.											
	.32	.60	.65	.68	.58	.35	1-1/2	2.5	4	73	Insul-Quilt ASG	CKAL 7701.37
.70	Quilted blanket. Temperature range -30° to 250°F.											
	.05	.46	.92	.83	.58	.27	3/4	.28	4	5	Sorba Glas AK-1F/1	RAL A 76-142
.70	Laminate, medium density fiberglass. Glass cloth, aluminum fiberglass fabric. Temperature range -65° to 450°F.											
	.26	.43	.84	.79	.70	.56	3/4	1.5	4	93	Quilt/Teez	KAL 428457
.70	Fiberglass scrim cloth on underside, 3/4 inch fiberglass insulation and a covering of aluminized glass cloth. Temperature range -65° to 450°F.											
	.22	.43	.89	.74	.69	.66	3/4	2.5	4	73	Insul-Quilt AGC	KAL 439128

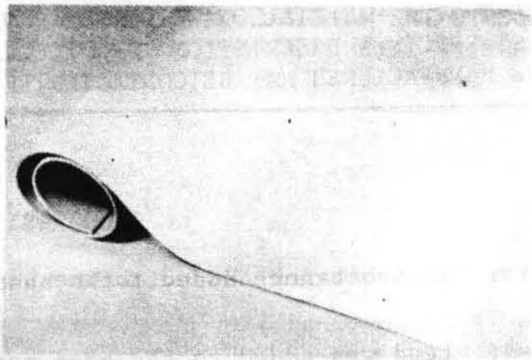
Table 10B. Barrier properties of quilted materials.

STC	Transmission Loss, dB 125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	Thickness (in.)	Density (lb/ft2)	Company	Product	Reference
18	Fiberglass cloth with 1-1/2 inch fiberglass insulation and aluminized glasscloth																				
	2	4	7	14	12	13	15	12	17	19	20	21	24	26	29	34	1-1/2	2.5	73	Insu-Quilt AGS	KAL 428460
26	Fiberglass scrim cloth with 1-1/2 inch fiberglass insulation, aluminized glasscloth and 1 lb/ft^2 lead septum, temperature range -65^o to 450^{o}F.																				
	10	12	17	22	22	22	23	19	21	27	33	34	39	44	51	58	1-1/2	--	73	Insu-Quilt AGS	KAL 428459
26	Quilt/Teez containing a 1 lb/ft^2 lead septum. Laminate: medium density fiberglass; 1 lb/ft^2 lead septum. Glass cloth: aluminum fiberglass fabric																				
	10	12	17	22	22	22	23	19	21	27	33	34	39	44	51	58	1-1/2	1.5	93	Quilt/Teez	KAL 1703-74
27	Quilted blanket, temperature range -30^o to 250^{o}F.																				
	15			19			21			28			33			37	3/4	.28	4	Sorba-Glas AK-1F/1	CR
27	Flexible blanket of mineral wool filler and asbestos -- aluminum skin																				
	10			15			26			41			53			56	2	1	20	Plenum Sound Barrier I	CR

CATEGORY 11. PLAIN AND MASS LOADED PLASTICS







CATEGORY 11. PLAIN AND MASS-LOADED PLASTICS

Mass-loaded plastics are formulated from lead or nonlead fillers and vinyl in order to increase noise reduction capabilities. The composition may include a reinforcing material such as fiberglass to increase toughness. Such materials offer flame, oil, chemical, and moisture resistance. These plastics are used primarily as thin pliable barrier materials. They may be draped, wrapped, or framed into versatile noise reduction materials.

These plastics may be combined with absorptive materials to form effective absorptive barriers. Data in this section relate to acoustical barrier properties only. These properties are noise reduction (NR), sound transmission loss (TL), and insertion loss (IL). Organizations contributing data to this table are: 5, 13, 30, 33, 40, 42, 43, 48, 53, 60, 78, 96, 111, 112, and 117.

CAUTION

TRANSMISSION LOSS VALUES MAY HAVE BEEN SUBSTANTIALLY INCREASED DUE TO THE MATERIAL ON WHICH THE PRODUCT WAS MOUNTED. WHEN THE TEST SPECIMEN DESCRIPTION IS NOT CLEARLY SHOWN IN THE TABLE, THE MANUFACTURER MAY BE CONTACTED IF NECESSARY.

GLOSSARY

Loaded: Foreign substance added to the base material

Leaded or
Lead Loaded: Lead was added to the base material--usually fabric type materials--to increase the sound transmission loss

Table 11. Plain and mass-loaded plastics.

STC	Transmission Loss, dB																		Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz					
14	Flexible reinforced lead vinyl on filled fiberglass fabric																						
	3	1	1	3	5	6	8	10	12	13	16	17	19	20	22	23	24	25	.02	.21	43	Dura-Sonic Style 2304	RAL TL 73-200
15	Noise barriers/enclosures clear strip curtain barrier																						
	8	8	6	9	11	12	14	14	16	15	15	14	14	16	16	17	17	18	2	1/2	47	Eckousta-Clear 2mm Strip	CKAL SES 77095
17	Two sheets of lead vinyl material with 1/4 inch air between them																						
	14	14	13	15	15	14	13	12	11	13	16	19	22	26	31	35	38	42	1/4	.33	111	Lead Vinyl with Air Space	RAL TL 73-45
18	Leaded vinyl material																						
	12	7	9	10	10	11	12	13	14	16	18	19	21	23	23	25	26	27	.035	.33	111	Lead Vinyl Acoustic Barrier	RAL TL 73-45
19	Flexible reinforced lead vinyl with filled fiberglass fabric																						
	6	5	5	7	10	11	13	14	16	18	20	22	23	26	27	30	32	33	.03	.42	43	Dura-Sonic Style 4758	RAL TL 73-202
19	Fabric reinforced, mass-filled vinyl, temperature range -40 to 180°F.																						
		6			10			15			23			27			30		.045	.40	4	Sound-gard SG-400	CR
19	Noise barrier clear strips																						
	12	13	12	15	15	16	18	17	16	15	17	17	20	21	21	22	24	25	.12	--	47	Eckousta-Clear 3mm Strip	CKAL SES 77095
20	Limp dense sound barrier, fiberglass material coated both sides with lead filled vinyl																						
	12	9	8	10	12	12	14	15	17	19	20	22	24	26	27	28	30	32	.04	1/2	112	Sound Stopper Lead Vinyl	RAL TL 72-232
20	Nonreinforced filled vinyl																						
	8	5	6	7	11	12	14	15	17	19	21	23	24	26	28	30	32	34	.05	.5	43	Dura-Sonic Style 5345	RAL TL 73-206
20	Flexible, limp, dense nonlead loaded vinyl reinforced with fiberglass																						
		9			10			16			20			26			32		.06	0.48	40	dba bar-"FM" SM Series	CR B-FM-1-76
20	Noise Barrier clear sheet barrier																						
	10	8	8	11	9	12	13	16	17	18	21	21	24	25	26	28	30	32	.08	1/2	47	Eckousta-Clear 2mm Sheet	CKAL SES 77095
20	Vinyl sheets available in barium sulfate loaded, lead filled, nontoxic, unsupported, supported																						
		9			10			16			20			26			32		.120	1/2	78	Noiseguard Flexible Vinyls	CR K60B
20	Clear vinyl																						
	10	9	9	9	11	12	14	16	18	19	22	23	25	27	27	30	32	33	--	1/2	73	1-C Clear Vinyl	CKAL 7604.40
20	100 series, a flexible limp mass, available with lead and nonlead fillers																						
		9			10			16			20			26			32		--	.5	78	Noise Guard Flexible Vinyls	CR K60B
21	Limp flexible PVC sheet visible acoustical curtain																						
		12			13			16			21			27			33		.08	0.6	40	dba bar-"FM" CP-60	CR B-FM-1-76
22	Acoustical curtain, limp, tough, vinyl, loaded with nonlead filler, reinforced with a high strength fabric																						
		11			12			18			22			29			34		.082	0.75	40	dba bar-"FM" BS-Series	CR B-FM-1-76
23	Nonreinforced filled vinyl (embossed vinyl face)																						
	9	8	9	10	13	14	17	18	20	22	24	26	27	30	32	34	35	36	.06	.60	43	Dura-Sonic Style 5129	RAL TL 73-204
23	Noise barrier clear sheets																						
	12	10	11	14	13	17	16	19	21	22	24	26	27	29	30	32	33	34	.16	1	47	Eckousta-Clear 4mm Sheet	CKAL SES 77095
24	Nonreinforced filled vinyl embossed vinyl faced with 1/4 inch urethane foam																						
	10	9	9	11	15	15	17	19	21	23	25	28	30	33	34	34	34	35	.31	.65	43	Dura-Sonic Style 5225	RAL TL 73-205
25	Fabric reinforced, mass-filled vinyl, temperature range -40° to 180°F.																						
		10			16			23			28			31			37		.095	.75	4	Sound-gard SG-750	CR

Table 11. Plain and mass-loaded plastics continued.

STC	Transmission Loss, dB																						
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
25	Limp, dense sound barrier, fiberglass material coated both sides with lead filled vinyl																						
	18	13	14	15	16	17	18	20	22	24	26	27	29	31	33	34	35	36	.06	.75	112	Sound Stopper Lead Vinyl	RAL TL 73-67
25	Flexible reinforced lead vinyl and filled fiberglass fabric																						
	16	12	12	13	18	18	20	21	22	25	27	27	29	32	34	35	36	38	.06	.83	43	Dura-Sonic Style 4825	RAL TL 73-48
25	Nonreinforced filled vinyl																						
	11	11	11	13	17	18	19	20	22	25	27	29	30	32	35	36	38	39	.09	1	43	Dura-Sonic Style 5216	RAL TL 73-210
25	Mass (nonlead) loaded neoprene, reinforced with polyester fabric, smooth surface, reinforced flexible noise barrier matterial. Temperature range -20° to 180°F.																						
	13	10	12	10	16	18	21	22	23	24	27	29	31	33	35	36	37	39	.12	.94	42	Fairprene ND-0004	RAL TL 75-111
25	Clear vinyl																						
	13	14	13	14	14	16	18	20	23	23	26	27	29	30	32	34	36	37	--	1	73	1-C Clear Vinyl	CKAL 7604.42
26	Flexible limp, dense, nonlead loaded vinyl unsupported, hanging acoustical curtain																						
		12			17			19			28			36			40		.125	1.0	40	dba bar-"FM" DK Series	CR B-FM-1-76
26	Limp, dense, nonlead loaded vinyl cast onto an aluminum scrim fire resistant surface, high temperature curtain																						
		12			17			19			28			36			40		.125	1.0	40	dba bar-"FM" DK-FR Series	CR B-FM-1-76
26	Flexible, limp, dense nonlead loaded vinyl reinforced with fiberglass																						
		12			18			20			27			35			40		.125	1.0	40	dba bar-"FM" SM Series	CR B-FM-1-76
26	Fabricated lead free sheet material. A limp, dense, mastic material with pressure sensitive adhesive. Temperature range -20° to 180°F.																						
	13	13	13	14	19	18	21	21	23	25	27	29	31	32	34	35	35	36	1/8	1	112	Sound Stopper Damp Sheet	RAL TL 72-213
26	Nonreinforced filled vinyl, embossed vinyl face																						
	12	12	12	14	18	19	20	22	24	26	29	31	32	35	37	39	41	42	36	1.15	43	Dura-Sonic Style 5155	RAL TL 73-209
26	Flexible high mass loaded sheet with a tough skin laminated to a fire-retardant foam with vinyl facing, temperature range 0° to 200°F.																						
	12	12	12	14	18	19	20	22	24	26	29	31	32	35	37	39	41	42	3/8	1	112	Sound Stopper VBF	RAL TL 73-249
27	Fabric reinforced, mass-filled vinyl, temperature range -40° to 180°F.																						
		15			17			21			28			33			37		.094	1.01	4	Sound-gard SG 1000	CR
27	Acoustical curtain, limp, tough, vinyl loaded with nonlead filler reinforced with a high strength fabric																						
		16			17			23			27			33			39		.110	1.0	40	dba bar-"FM" BS Series	CR B-FM-1-76
27	Nonreinforced filled vinyl, embossed vinyl face																						
	13	12	13	14	19	18	21	22	24	26	28	30	32	34	35	37	38	38	.11	1.10	43	Dura-Sonic Style 5517	RAL TL 73-208
27	Vinyl sheets available in barium sulfate loaded, lead filled, nontoxic, unsupported, supported. Temperature range -40° to 180°F.																						
	14	17	15	18	17	20	19	23	25	26	27	29	32	33	36	38	39	41	.120	1	78	Noiseguard Flexible Vinyl	CKAL
27	100 series, a flexible limp mass, available with lead and nonlead fillers																						
		17			17			23			27			33			39		--	1	78	Noiseguard Flexible Vinyls	CR K60B
31	Sound control blanket using a formulated plastic barrier																						
	20	18	18	19	20	22	23	24	27	30	32	34	34	33	32	32	35	38	1	--	13	Whispermat	CR
19-27	Nonleaded, limp, flexible, formable, versatile, weather resistant, polyester reinforced vinyl, or woven glass roving or Beta glass fabric																		--	--	58	Flexible Noise Barrier Material	CR
12-29	Mass loaded, fiberglass reinforced, vinyl coated fabric																		--	.5 to 1.0	58	Loaded Vinyl Fabric	CR

Table 11. Plain and mass-loaded plastics concluded.

STC	Transmission Loss, dB																						
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
15-21	Tough, tear resistant PVC, lightweight, resistant to yellowing, fading, clouding																						
																			--	--	58	Transparent Noise Barrier Material	CR
	Flexible reinforced lead vinyl and filled fiberglass fabric																						
	14	16	13	14	18	18	21	23	24	26	28	29	31	33	35				.077	1	43	Dura-Sonic Style 5144	RAL TL 77-105
	Chlorosulfonated polyethylene (hypalon) filled with powdered lead applied to a base fabric of nylon (plain weave) and 1/4 inch polyurethane foam																						
																			--	.45	30	Hypalon/Foam/ Fabric Specification 21828	CR CRP 21789
	Loaded vinyl fabrics for curtains and enclosures																						
																			--	--	60	Attenu-Son	
	Clear or yellow PVC flexible strip curtains, for noise isolation in industrial plants. Resistant to most acids, temperature range 0° to 200°F.																						
																			--	--	60	Saf-T-Strip	
	Enclosure construction 1/4 inch plywood, composite liner is 1 lb/ft^2 vinyl. Temperature range -40° to 300°F. Data are insertion loss																						
		15			12			17			18			22			25		--	--	78	Composite Enclosure	CR 60B
	Glass fiber reinforced lead weighted plastic sheet, temperature range 0° to 200°F. Data are noise reduction																						
		12			13			16			23			26			31		.025	.42	33	Quietfab	CR QM-TDS-300-R1
	Lead/vinyl barrier with glass fiber, temperature range 0° to 200°F. Data are noise reduction																						
		12			13			17			23			26			32		.025	.42	117	Sound Fab	CR 708D
	Enclosure construction 18 gauge steel, composite liner is 1 lb/ft^2 vinyl. Temperature range -40° to 300°F. Data are insertion loss																						
		20			12			19			22			26			31		--	--	78	Composite Enclosure	CR K60B
	Glass fiber reinforced lead weighted plastic sheet, temperature range 0° to 200°F. Data are noise reduction																						
		11			14			17			22			39			40		1.025	.42	33	Quietfab and Quietfoam	CR QM-TDS-300-R1
	Data are insertion loss																						
		15			18			25			26			29			36		1/8	--	96	Fiberglass Reinforced Plastic	OCRL
	Lead/vinyl barrier and glass fiber, temperature range 0° to 200°F. Data are noise reduction																						
		15			18			20			29			33			37		.050	.83	117	Sound Fab	CR 708D
	Glass fiber reinforced lead weighted plastic sheet, temperature range 0° to 200°F. Data are noise reduction																						
		15			17			20			29			34			37		.050	.83	33	Quietfab	CR QM-TDS-300-R1
	Data are insertion loss																						
		19			22			28			31			32			25		1/4	--	96	Fiberglass Reinforced Plastic	CT
	Data are insertion loss																						
		21			27			29			34			27			36		1/2	--	96	Fiberglass Reinforced Plastic	CT

CATEGORY 12. GLASS AND PLASTIC SHEETS

A broad category of materials which are linked because they are available as transparent sheet materials. They can exist as independent or as composite barrier systems. Their usefulness is augmented whenever visibility plus noise control is desired. Structurally, they can be rigid or flexible. Glass or plastic barriers are usually mounted in a fixed location.

Composite panels of glass separated by a plastic type layer, such as polyvinyl butyral are frequently used. In some cases, an air space is also provided. This total combination offers increased thermal and acoustical isolation.

Other related sections are curtains, panels, operable partitions, windows and enclosures. Organizations contributing data to this table are: 46, 64, 79, 89, 107, 110, and 140.

Table 12. Glass and plastic sheets.

STC	Transmission Loss, dB																						
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
18	Extruded sheet of cellulose acetate butyrate plastic																						
	11	7	8	7	10	12	13	14	15	16	17	19	21	23	25	26	28	29	1/16	0.38	46	Uvex	RAL TL 76-110
26	Extruded sheet of cellulose acetate butyrate plastic																						
	16	14	15	16	18	20	22	22	23	24	26	27	29	31	33	33	35	36	3/16	1.16	46	Uvex	RAL TL 76-109
27	Plexiglass, temperature range up to 190°F.																						
		16	18	18	17	20	21	22	24	25	28	30	31	33	33	35	35		1/4	1.45	107	Plexiglass Acrylic Sheet	KAL 1481-1-73
30	Extruded sheet of cellulose acetate butyrate plastic																						
	17	18	15	17	23	22	24	25	28	29	30	31	33	35	38	39	41	42	.220	1.4	46	Uvex	RAL TL 77-161
30	Extruded sheet of cellulose acetate butyrate plastic																						
	17	19	15	16	23	23	25	26	28	29	31	33	35	37	39	41	41	42	1/4	1.5	46	Uvex	RAL TL 77-162
30	Plexiglass, temperature range up to 190°F.																						
		21	21	24	23	25	27	26	28	31	32	33	34	32	26	31	37		1/2	2.9	107	Plexiglass Acrylic Sheet	KAL 1481-2-73
32	Plexiglass, temperature range up to 190°F.																						
		25	26	27	28	29	32	32	33	34	32	38	31	34	36	40	46		1	5.82	107	Plexiglass Acrylic Sheet	KAL 1481-3-73
34	Plasticized polyvinyl butyral interlayer between glass plies, 1/8 inch glass - 0.30 inch, Saflex - 1/8 inch glass, temperature range -20° to 120°F.																						
		30	26	26	28	30	30	31	33	34	35	36	36	33	33	37	41		1/4	3.3	89	Saflex Laminated Glass	RAL TL 77-150
34	Plasticized polyvinyl butyral interlayer between glass plies, 1/8 inch glass - 0.60 inch Saflex - 1/8 inch glass, temperature range -20° to 120°F.																						
		27	28	23	30	29	30	32	33	34	35	36	36	36	35	36	39		5/16	3.38	89	Saflex Laminated Glass	RAL TL 68-202
35	Plasticized polyvinyl butyral interlayer between glass plies, single strength glass - 0.03 inch Saflex - single strength glass, temperature range -20° to 120°F.																						
		29	29	25	27	29	29	31	32	34	34	34	34	35	33	36	39		.235	2.8	89	Saflex Laminated Glass	RAL TL 77-194
36	Laminated glass, 2 ply glass with plastic layer, starred data are at 175, 350, 700, 1400, and 2800 Hz																						
		25	28*		28	30*		33	35*		36	36*		35	35*		39		9/32	3.4	64	Acousta Pane 36	RAL TL 65-27
36	Two layers of 1/8 inch glass with 0.060 inch plastic core																						
		27	25	27	28	29	30	31	33	35	37	38	39	41	41	41	38		9/32	3.7	110	Shatterproof Sound Control Glass	RAL TL 72-9
36	Plasticized polyvinyl butyral interlayer between glass plies, 1/8 inch glass - 0.03 inch Saflex - 1/4 inch glass, temperature range -20° to 120°F.																						
		29	30	31	34	32	33	35	35	35	35	34	35	34	38	42	45		3/8	4.63	89	Saflex Laminated Glass	RAL TL 68-206
36	Plasticized polyvinyl butyral interlayer between glass plies, 1/4 inch glass - 1/2 inch airspace - 1/8 inch, glass - 0.30 inch Saflex - 1/8 inch glass, temperature range -20° to 120°F.																						
		28	26	22	27	31	33	35	36	37	39	40	39	36	36	41	46		1	6.4	89	Saflex Laminated Glass	RAL TL 78-2
37	Plasticized polyvinyl butyral interlayer between glass plies, 1/4 inch glass - 0.30 inch Saflex - 1/4 inch glass, temperature range -20° to 120°F.																						
		29	30	31	34	33	34	35	35	35	35	33	35	39	42	45	46		1/2	5.95	89	Saflex Laminated Glass	RAL TL 77-192
37	1/4 inch glass - 0.030 inch Laminate, 1/4 inch glass																						
		33	30	30	32	34	34	35	36	36	35	35	37	40	43	46	49		.51	6.1	140	Sound Control Glass	RAL TL 77-174
37	Plasticized polyvinyl butyral interlayer between glass plies, 1/4 inch glass - 0.045 inch Saflex - 1/4 inch glass, temperature range -20° to 120°F.																						
		31	26	31	33	36	35	36	36	37	35	34	36	38	42	45	50		9/16	6.3	89	Saflex Laminated Glass	RAL TL 77-153
38	2 ply 1/4 inch float/0.045 vinyl Laminate																						
		29	29	31	33	34	35	36	37	37	36	34	36	39	41	44	47		1/2	6.1	79	Hushlite	RAL TL 76-133

Table 12. Glass and plastic sheets concluded.

<table>
<tr><th rowspan="2">STC</th><th colspan="18">Transmission Loss, dB</th><th rowspan="2">Thickness (in.)</th><th rowspan="2">Density (lb/ft^2)</th><th rowspan="2">Company</th><th rowspan="2">Product</th><th rowspan="2">Reference</th></tr>
<tr><th>100 Hz</th><th>125 Hz</th><th>160 Hz</th><th>200 Hz</th><th>250 Hz</th><th>315 Hz</th><th>400 Hz</th><th>500 Hz</th><th>630 Hz</th><th>800 Hz</th><th>1000 Hz</th><th>1250 Hz</th><th>1600 Hz</th><th>2000 Hz</th><th>2500 Hz</th><th>3150 Hz</th><th>4000 Hz</th><th>5000 Hz</th></tr>
<tr><td>38</td><td colspan="18">Plasticized polyvinyl butyral interlayer between glass plies, 1/4 inch glass - 0.06 inch Saflex - 1/4 inch glass, temperature range -20° to 120°F.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>32</td><td>26</td><td>31</td><td>33</td><td>36</td><td>34</td><td>36</td><td>37</td><td>36</td><td>36</td><td>35</td><td>36</td><td>39</td><td>43</td><td>46</td><td>50</td><td></td><td>9/16</td><td>6.4</td><td>89</td><td>Saflex
Laminated
Glass</td><td>RAL
TL 77-154</td></tr>
<tr><td>38</td><td colspan="18">Plasticized polyvinyl butyral interlayer between glass plies, 1/4 inch glass - 0.30 inch Saflex - 3/8 inch glass, temperature range -20° to 120°F.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>29</td><td>30</td><td>31</td><td>36</td><td>35</td><td>36</td><td>35</td><td>35</td><td>35</td><td>35</td><td>37</td><td>40</td><td>43</td><td>45</td><td>47</td><td>49</td><td></td><td>5/8</td><td>7.55</td><td>89</td><td>Saflex
Laminated
Glass</td><td>RAL
TL 68-210</td></tr>
<tr><td>39</td><td colspan="18">Laminated glass, 2 ply 1/4 inch glass, 0.045 inch plastic core</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>34</td><td>33</td><td>34</td><td>36</td><td>36</td><td>36</td><td>37</td><td>36</td><td>37</td><td>37</td><td>37</td><td>38</td><td>41</td><td>45</td><td>49</td><td>52</td><td></td><td>1/2</td><td>6.3</td><td>64</td><td>Plate Glass</td><td>RAL
TL 76-15</td></tr>
<tr><td>39</td><td colspan="18">Two layers of 1/4 inch glass with 0.045 inch plastic core</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>31</td><td>29</td><td>31</td><td>32</td><td>34</td><td>35</td><td>35</td><td>36</td><td>38</td><td>38</td><td>39</td><td>39</td><td>40</td><td>43</td><td>45</td><td>47</td><td></td><td>1/2</td><td>6.8</td><td>110</td><td>Shatterproof
Sound Control
Glass</td><td>RAL
TL 72-105</td></tr>
<tr><td>39</td><td colspan="18">Plasticized polyvinyl butyral interlayer between glass plies, 1/4 inch glass - 0.30 inch Saflex - 1/2 inch glass, temperature range -20° to 120°F.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>35</td><td>33</td><td>33</td><td>34</td><td>36</td><td>36</td><td>37</td><td>36</td><td>35</td><td>34</td><td>39</td><td>41</td><td>46</td><td>48</td><td>50</td><td></td><td></td><td>3/4</td><td>9.6</td><td>89</td><td>Saflex
Laminated
Glass</td><td>RAL
TL 77-193</td></tr>
<tr><td>40</td><td colspan="18">Laminated glass, 2 ply 1/4 inch glass, with plastic core. Starred data are at 175, 350, 700, 1400, and 2800 Hz</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>31</td><td>32*</td><td></td><td>34</td><td>36*</td><td></td><td>38</td><td>40*</td><td></td><td>40</td><td>40*</td><td></td><td>37</td><td>41*</td><td></td><td>46</td><td></td><td>1/2</td><td>6.7</td><td>64</td><td>Acousta
Pane 40</td><td>RAL
TL 66-293</td></tr>
<tr><td>40</td><td colspan="18">Plasticized polyvinyl butyral interlayer between glass plies, 1/4 inch glass - 0.30 inch Saflex - 1/4 inch glass - 0.30 inch Saflex - 1/4 inch glass, temperature range -20° to 120°F.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>34</td><td>30</td><td>32</td><td>35</td><td>37</td><td>37</td><td>37</td><td>37</td><td>36</td><td>35</td><td>38</td><td>42</td><td>45</td><td>48</td><td>50</td><td>53</td><td></td><td>13/16</td><td>9.1</td><td>89</td><td>Saflex
Laminated
Glass</td><td>RAL
TL 77-151</td></tr>
<tr><td>41</td><td colspan="18">Plasticized polyvinyl butyral interlayer between glass plies. 1/4 inch glass - 0.06 inch Saflex - 1/4 inch glass - 0.06 inch Saflex - 1/4 inch glass, temperature range -20° to 120°F.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>33</td><td>30</td><td>33</td><td>36</td><td>38</td><td>37</td><td>39</td><td>38</td><td>37</td><td>37</td><td>39</td><td>42</td><td>44</td><td>47</td><td>49</td><td>53</td><td></td><td>13/16</td><td>9.6</td><td>89</td><td>Saflex
Laminated
Glass</td><td>RAL
TL 77-155</td></tr>
<tr><td>42</td><td colspan="18">Two layers of 3/8 inch glass with 0.045 inch plastic core</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>33</td><td>32</td><td>35</td><td>35</td><td>36</td><td>38</td><td>38</td><td>39</td><td>40</td><td>42</td><td>42</td><td>43</td><td>45</td><td>47</td><td>49</td><td>50</td><td></td><td>3/4</td><td>10.2</td><td>110</td><td>Shatterproof
Sound Control
Glass</td><td>RAL
TL 72-104</td></tr>
<tr><td>43</td><td colspan="18">Laminated glass, 3 ply 1/4 inch glass, plastic core. Starred data are at 175, 350, 700, 1400, and 280 Hz</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>34</td><td>35*</td><td></td><td>36</td><td>39*</td><td></td><td>41</td><td>43*</td><td></td><td>43</td><td>43*</td><td></td><td>41</td><td>45*</td><td></td><td>50</td><td></td><td>3/4</td><td>10.1</td><td>64</td><td>Acousta
Pane 43</td><td>RAL
TL 66-294</td></tr>
<tr><td>35</td><td colspan="18">2 ply 1/8 inch float/.045 vinyl Laminate</td><td>9/32</td><td>3.4</td><td>79</td><td>Hushlite</td><td>CR</td></tr>
<tr><td>36</td><td colspan="18">2 ply 3/16 inch float/0.045 vinyl Laminate</td><td>7.16</td><td>5.2</td><td>79</td><td>Hushlite</td><td>CR</td></tr>
<tr><td>40</td><td colspan="18">3 ply 1/4 inch float/2 ply .045 vinyl</td><td>3/4</td><td>9.4</td><td>79</td><td>Hushlite</td><td>CR</td></tr>
<tr><td></td><td colspan="18">Extruded acrylic/PVC sheet in thicknesses from .028 to .250 inch</td><td>--</td><td>--</td><td>107</td><td>Kydex 100</td><td>CR</td></tr>
<tr><td></td><td colspan="18">Extruded polycarbonate sheet in thicknesses from .005 to .500 inch</td><td>--</td><td>--</td><td>107</td><td>Tuffak</td><td>CR</td></tr>
</table>

CATEGORY 13. OTHER BARRIER MATERIALS

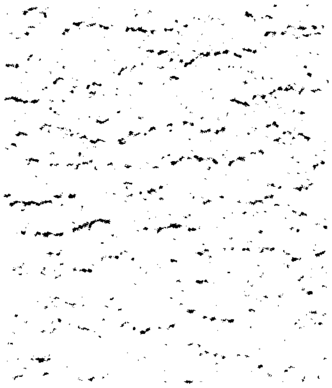
Items listed in this category are separated from specific categories because of designated purpose, special application, or slight fabrication changes. These items as well as all items listed in other categories should be considered with respect to particular acoustical performance and not limited to the designated use.

Organizations contributing data to this table are: 13, 30, 66, 90, 97, and 117.

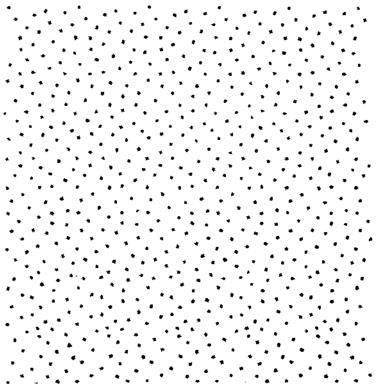
Table 13. Other barrier materials.

STC	Transmission Loss, dB 100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
22 (c)	Floor covering: 1/8 inch vinyl face, 1/4 inch foam layer, lead septum, volara base 1/8 inch. Temperature range -45° to 225°F.																						
	13	11	13	15	15	17	18	19	21	23	24	26	28	28	29	28	28	33	1/2	14	117	Soundmat -FVP	CR 702D
26	Rubber																						
	13	11	12	12	17	19	21	22	25	26	28	29	31	34	36	38	39	41	.106	.89	66	Acousta Sheet 200 and 300	RAL TL-75-118
30 (c)	Flexible septum sandwiched by layers of inert glass fiber.																						
		22			21			27			29			36			39		--	1	117	Soundmat - LGF	CT
	Sound barrier floor mats for trucks, buses, etc.																		7/16	1	13	Hushcloth	CR
	A hypalon special compound made of oil resistant synthetic rubber with ozone and age resistance.																		.033	--	30	Chem-Tone CRP 21789	CR
	Interlacing of cellulose fibers laminated to polyethylene 4 x 8 ft sheet, lead or felt paper backing.																		--	.25	90	K-13 Acoustical Blanket	
	Glass ceramic material in honeycomb or matrix geometry. Nonflammable for use in high temperatures or adverse environments. Temperature to 2000°F, humidity to 100%. Data are normal incidence absorption coefficients by ASTM C384-58 at frequencies of 1400, 1495, 1606, 1614, 1619, 1745, 2005 Hz.																						
		83			84			98			99			99			92		1	1.7 to 3.3	97	CER-VIT ^{R}	CR

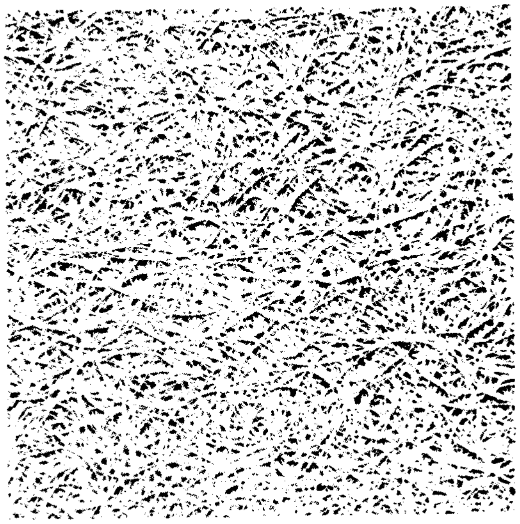
CATEGORY 14. CEILING TILES



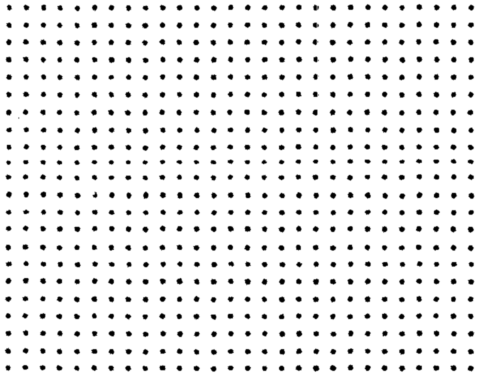
FISSURED



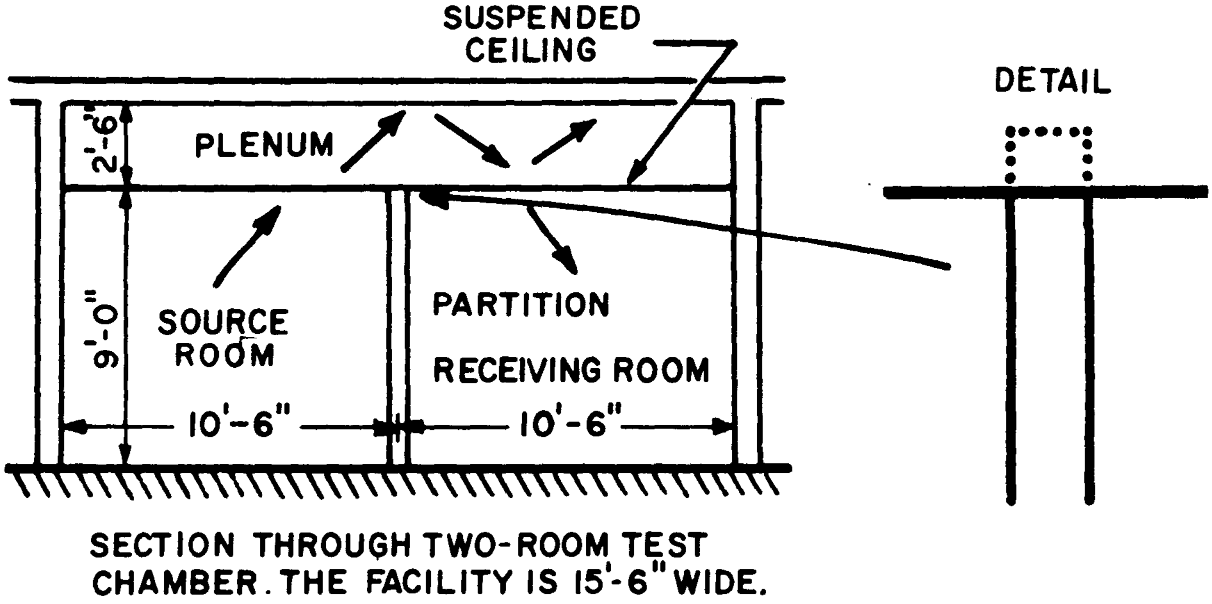
RANDOM PERFORATED



STANDARD PANELS



UNIFORM PERFORATED



Test Configuration for AMA-1-II

CATEGORY 14. CEILING TILES

Ceiling tiles vary acoustically from highly reflective to very absorbent and can have from poor to good barrier properties. Typical tile parameters include texture, type of perforation, pattern, structural integrity, and appearance. Descripters such as embossed, fissured, plain, facing type, backing material, edge type (beveled, rabbeted, square, etc.), light reflectance, fire rating, moisture resistance, and asthetic value are usually included with the overall acoustical performance. The well-designed acoustical ceiling is an essential part of sound control.

Organizations contributing data to this table are: 4, 5, 15, 28, 34, 74, 85, 92, 96, and 113. Related categories are panels, unit absorbers, and open plan systems.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED ON PAGE 53.

GLOSSARY

Facing:	The outside surface of the specimen. In general the side facing the sound source
Backing:	The other outside surface of the specimen. In general the side not facing the sound source
Core:	The region between the facing and the backing

Table 14A. Absorption properties of ceiling tile.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft²)	Mounting	Company	Product	Reference
.40 to .44	Acoustical tile, fire rated.											
	.37	.34	.42	.65	.75	.78	5/8	--	--	34	Conwed Fissura Tile and Panels	CR A-4
.40 to .44	Protectone panels, natural fissured, foil-back, reveal edge 2 x 2 ft.						3/4	1.4	7	28	Celotone Tile	CR 5033
.45	Acoustical grid panels composed of long wood fibers and inorganic cement binder exhibiting coarse fiber surface, painted or unpainted, edges are square.											
	.45	.43	.31	.42	.56	.79	1	1.8	7	92	Gold Bond Tectum Grid Panels	RAL A75-87
.50	A substantially rigid tile of mineral composition, scrubable finish, surface edges are beveled, kerfed, and rabbeted; 12 x 12 inch.											
	.39	.32	.45	.59	.63	.73	5/8	.9	7	92	Gold Bond Solitude Tile Fissured	NGC 8458
.50	Substantially rigid grid panel of basic mineral composition 2 x 4 ft.											
	.30	.34	.53	.64	.52	.38	5/8	.91	7	92	Gold Bond Solitude Grid Panel (TXMP)	RAL A71-91
.50	Rigid tile of basic mineral composition with beveled, kerfed and rabbetted edges, 12 x 12 inch.											
	.43	.32	.46	.58	.68	.66	5/8	.94	7	92	Gold Bond Solitude Tile Nondirectional	NGC 7457
.50	Texture micro-perforated substantially rigid grid panel of basic mineral composition used for fire rated assemblies, fine perforated, spatter effect surfaces, edges are square 2 x 4 ft.											
	.28	.36	.65	.62	.44	.33	5/8	1.21	7	92	Gold Bond Fire Shield Solitude Grid Panel (TXMP)	RAL A73-133
.55 (c)	Acoustical tile, fire rated.											
	.37	.34	.42	.65	.75	.78	5/8	--	--	34	Conwed Fissura Tile and Panels	CR A-4
.55	Substantially rigid grid panel of basic mineral composition, surface contains small random perforations, edges are square 2 x 4 ft.											
	.20	.29	.49	.68	.74	.58	5/8	.81	7	92	Gold Bond Solitude Grid Panel Needle Perforated	NGC 7472
.55	Substantially rigid grid panel of mineral composition nondirectional fissures, edges are square, 2 x 4 ft.											
	.29	.28	.57	.72	.67	.67	5/8	.86	7	92	Gold Bond Solitude Grid Panel Nondirectional	RAL A75-180
.55	Substantially rigid grid panel of basic mineral composition, surface has linear fissured pattern, edges are square, 2 x 4 ft.											
	.23	.28	.50	.63	.75	.71	5/8	.87	7	92	Gold Bond Solitude Grid Panel Fissured	NGC 7468
.55	12 x 12 inch metal clad mineral fiber acoustical ceiling tile.											
	.34	.34	.47	.69	.73	.59	5/8	1.16	7	4	Acousti-Clad "S"	RAL A74-64
.55	12 x 12 inch metal clad mineral fiber acoustical ceiling tile.											
	35	.31	.49	.75	.74	.56	5/8	1.2	7	4	Acousti Clad	RAL A74-62
.55 (c)	Acoustical tile, standard, vinyl acrylic coating.											
	.35	.31	.42	.63	.75	.75	5/8	--	7	34	Conwed Fissura Tile and Panels	CR Form A-4
.55 (c)	Lightweight acoustical panel.											
	.31	.37	.51	.68	.55	.37	5/8	--	7	34	Conwed Pebbled Panels	CR Form A-7
.50 to .60	Safetone N-D perforated stippled 2 x 4 ft.						5/8	1	7	28	High Density Lay-In Panel	CR 5033
.50 to .60	Safetone Strata 2 x 2 ft.						5/8	1	7	28	High Density Lay-In Panel	CR 5033
.50 to .60	Protectone N-D perforated stippled.						5/8	1.1	7	28	High Density Lay-In Panel	CR 5033

Table 14A. Absorption properties of ceiling tile continued.

		Absorption Coefficients											
NRC		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft2)	Mounting	Company	Product	Reference
.50 to .60	Fire rated lay-in panel square edge. Available sizes 24 x 48 inch, 24 x 24 inch, 30 x 60 inch.							5/8	--	--	34	Rockface	CR 902-47
.50 to .60	Standard lay-in panel, square edge 24 x 24 inch							5/8	--	--	34	Rockface	CR 902-47
.50 to .60	Standard concealed tile, butted, kerfed and rabbeted, beveled edge 12 x 12 inch.							3/4	--	--	34	Rockface	CR 902-47
.50 to .60	Standard accent system tile, square rabbeted accent edge 24 x 24 inch							3/4	--	--	34	Rockface	CR 902-47
.50 to .60	Standard reveal tile, square reveal edge, available sizes 24 x 24 inch, 24 x 48 inch.							3/4	--	--	34	Rockface	CR 902-47
.50 to .60	Fire rated reveal tile square reveal edge, 24 x 24 inch.							3/4	--	--	34	Rockface	CR 902-47
.50 to .60	Fire rated concealed tile, butted, kerfed, and rabbeted, beveled edge, 12 x 12 inch.							3/4	--	--	34	Rockface	CR 902-47
.60	Absorptive mineral fiberboard panels, with vinyl film finish 4 x 6 ft and 4 x 4 ft.	.12	.19	.63	.94	.73	.58	5/8	1.1	4	15	Armstrong Armashield Acoustical Wall Panel	AAL T56181
.60	12 x 12 inch metal clad mineral fiber acoustical ceiling tile.	.33	.32	.52	.85	.80	.59	5/8	1.1	7	4	Acousti-Clad "S"	RAL A-74-63 C 423-66
.60	Substantially rigid grid panel of basic mineral composition. Used as fire protective ceiling in fire rated assemblies, needle perforated surface edges are square 2 x 4 ft.	.25	.29	.60	.83	.71	.53	5/8	1.2	7	92	Gold Bond Fire Shield Solitude Grid Panel Needlepoint	RAL A-73-134
.60	Substantially rigid grid panel of basic mineral composition. Use as fire protective ceilings in fire rated assemblies, nondirectional fissured surface edges are square, 2 x 4 ft.	.23	.31	.54	.68	.78	.82	5/8	1.2	7	92	Gold Bond Fire Shield Solitude Grid Panel Nondirectional	NGC 7441
.60	Substantially rigid grid panel of mineral composition. Used in fire rated assemblies, lined fissured surface edges are square.	.28	.32	.65	.73	.73	.75	5/8	1.21	7	92	Gold Bond Fire Shield Solitude Grid Panel Fissured	RAL A-73-132
.60	For use behind unperforated ceilings. Density is lb/ft^3	.69	.72	.59	.68	.36	.31	--	2	--	85	Shadow-Coustic	CR 9.1 Me
.55 to .65	Grande, textured. 2 x 4 ft.							1/4	.50	7	28	Acoustiform Lay-in Panels	CR 5033
.55 to .65	Vinyl coated embossed aluminum bonded to a mineral fiber substrate 2 x 4 ft.							5/8	--	--	34	Conwed Metal Face Panels	CR 866R-977
.55 to .65	Safetone Fissuretone 2 x 4 ft.							5/8	.9	7	28	High Density Lay-in Panel	CR 5033
.55 to .65	Safetone fissuretone reveal edge 2 x 2 ft.							5/8	.9	7	28	High Density Lay-in Panel	CR 5033
.55 to .65	Safetone N-D fissuretone 2 x 4 ft.							5/8	.9	7	28	High Density Lay-in Panel	CR 5033
.55 to .65	Fissuretone 2 x 4 ft.							5/8	1	7	28	High Density Lay-in Panel	CR 5033
.55 to .65	Protectone N-D fissuretone 2 x 4 ft.							5/8	1	7	28	High Density Lay-in Panel	CR 5033

Table 14A. Absorption properties of ceiling tile continued.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
.55 to .65	Protectone N-D Perforated 2 x 4 ft						5/8	1.1	7	28	High Density Lay-in Panel	CR 5033
.55 to .65	Safetone N-D perforated 2 x 4 ft						5/8	1.1	7	28	High Density Lay-in Panel	CR 5033
.65	Rigid grid panel composed of asbestos fibers and cement binder, perforated and backed with factory applied thin membrane, 2 x 2 ft.											
	.67	.85	.57	.65	.58	.41	3/16	1.5	7	92	Gold Bond Asbestibel Grid Panel Random Perforation	RAL A-74-98
.65	Duratone 2 x 4 ft lay-in panel, glass fiber reinforced aluminum facing for use in areas where a rugged, durable, stain resistant panel is needed.											
	.32	.32	.59	.94	.71	.52	5/8	1.1	7	4	Alumiclad	RAL A-74-65 C423-66
.65	1 inch thick fiberglass faced with 3/16 inch perforated marine veneer; moisture resistant.											
	.22	.35	.77	.94	.60	.41	1-3/16	1.7	2	74	Marine Acoustical Unit	CR IND-3089 7/76
.65	For use behind unperforated ceilings. Density is lb/ft^3.											
	.67	.83	.69	.77	.35	.24	--	3	--	85	Shadow-Coustic	CR 9.1 Me
.60 to .70	Fissured Grande, painted face, 2 x 4 ft.						1/4	.5	7	28	Acoustiform Lay-in Panels	CR 5033
.60 to .70	Safetone N-D texturetone reveal edge 2 x 2 ft.						3/4	1.1	7	28	Celotone Tile	CR 5033
.60 to .70	Natural fissured protectone tile 12 x 12 inch.						3/4	1.4	7	28	Celotone Tile	CR 5033
.60 to .70	Safetone texture-tone reveal edge, 2 x 2 ft.						3/4	1.4	7	28	Celotone Tile	CR 5033
.60 to .70	Safetone tile chase 12 x 12 inch.						3/4	1.5	7	28	Celotone Tile	CR 5033
.70	Rigid grid panel composed of asbestos fibers and cement binder, perforated through and backed with a factory applied thin membrane.											
	.75	.90	.61	.66	.67	.55	3/16	1.28	7	92	Gold Bond Asbestibel Grid Panel Uniform Perforation	RAL A-73-196
.70	Shasta pattern. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.76	.77	.59	.70	.74	.77	5/8	--	7	96	Fiberglas Film Faced Ceiling Board	OCRL
.70	Textured pattern. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.66	.72	.59	.62	.82	.83	5/8	--	7	96	Fiberglas Film Faced Ceiling Board	OCRL
.70	1 inch thick fiberglass faced with 3/16 inch perforated marine veneer; moisture resistant.											
	.67	.72	.64	.75	.63	.45	1-3/16	1.7	7	74	Marine Acoustical Unit	CR IND-3089 7/76
.65 to .75	Design (plaid, riviera, striated) tile 12 x 12 inch						3/4	1.1	--	28	Safetone Tile	CR 5033
.65 to .75	Safetone marquis reveal edge panel 2 x 2 ft.						3/4	1.2	7	28	Celotone Tile	CR 5033
.65 to .75	Safetone N-D texture-tone 12 x 12 inch.						3/4	1.3	7	28	Celotone Tile	CR 5033
.65 to .75	Safetone, texture-tone, foil-back, 12 x 12 inch.						3/4	1.3	7	28	Celotone Tile	CR 5033
.65 to .75	Safetone texture-tone, 12 x 12 inch.						3/4	1.3	7	28	Celotone Tile	CR 5033
.65 to .75	Le Baron, 2 x 2 ft.						3/4	1.3	--	28	Safetone Panels	CR 5033

Table 14A. Absorption properties of ceiling tile continued.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.65 to .75	Safetone tile natural fissured, 12 x 12 inch.						3/4	1.4	7	28	Celotone Tile	CR 5033
.65 to .75	Safetone natural fissured foil-back 12 x 12 inch.						3/4	1.4	7	28	Celotone Tile	CR 5033
.65 to .75	Safetone natural fissured, foil-back, reveal edge, 2 x 2 ft.						3/4	1.4	7	28	Celotone Tile	CR 5033
.65 to .75	Safetone, texture-tone, foil-back, reveal edge, 2 x 2 ft.						3/4	1.4	7	28	Celotone Tile	CR 5033
.65 to .75	Protectone tile, natural fissured, foil-back, 12 x 12 inch.						3/4	1.5	7	28	Celotone Tile	CR 5033
.75	Ranier pattern. Aizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.76	.78	.60	.71	.86	.79	5/8	--	7	96	Fiberglas Film Faced Ceiling Board	OCRL
.75	For use behind perforated ceilings. Density is lb/ft^3.											
	.61	.83	.59	.79	.86	.80	--	2	--	85	Shadow-Coustic	CR 9.1 Me
.80	Fissured, painted finish. Sizes 2 x 2 ft, 2 x 4 ft.											
	.64	.82	.68	.86	.83	.57	5/8	--	7	96	Painted Ceiling Board	OCRL
.80	Random fissured. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.70	.83	.62	.78	.91	.92	5/8	--	7	96	Fiberglas Film Faced Ceiling Board	OCRL
.80	Frescor, painted finish. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.62	.76	.67	.84	.84	.71	3/4	--	7	96	Painted Ceiling Board	OCRL
.80	Monterey or carmel pattern. 2 x 4 ft, 2 x 2 ft.											
	.71	.82	.77	.75	.87	.93	1	--	7	96	Archi Texture Ceiling Board	OCRL
.75 to .85	Protectone, mat faced, 2 x 4 ft.						1	.75	7	28	Acoustiform Lay-in Panels	CR 5033
.85	Alpha pattern, 2 x 4 ft, 2 x 2 ft.											
	.64	.79	.69	.85	.99	1.03	3/4	--	7	96	Archi Texture Ceiling Board	OCRL
.85	Fissured and random fissured, painted finish. Sizes 2 x 2 ft, 2 x 4 ft.											
	.62	.78	.72	.93	.94	.74	3/4	--	7	96	Painted Ceiling Board	OCRL
.85	Textured, painted finish. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.76	.73	.78	.92	.92	.83	3/4	--	7	96	Painted Ceiling Board	OCRL
.85	Fissured and random fissured, vinyl coated. Sizes 2 x 2 ft, 2 x 4 ft.											
	.61	.88	.69	.90	.96	.82	5/8	--	7	96	Painted Ceiling Board	OCRL
.85	Fissured and random fissured, painted finish. Sizes 2 x 2 ft, 2 x 4 ft.											
	.66	.85	.68	.93	.87	.69	5/8	--	7	96	Painted Ceiling Board	OCRL
.85	Frescor, painted finish. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.69	.86	.68	.87	.90	.81	5/8	--	7	96	Painted Ceiling Board	OCRL
.85	Frescor finish, vinyl coated. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.60	.85	.68	.88	.92	.79	5/8	--	7	96	Painted Ceiling Board	OCRL
.85	Textured finish, vinyl coating. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.65	.88	.72	.86	.93	.98	5/8	--	7	96	Painted Ceiling Board	OCRL

Table 14A. Absorption properties of ceiling tile concluded.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft2)	Mounting	Company	Product	Reference
.85	Textured, painted finish. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.63	.90	.68	.90	.96	.91	5/8	--	7	96	Painted Ceiling Board	OCRL
.85	Textured, painted finish. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft, 4 x 4 ft.											
	.72	.70	.82	.98	.94	.84	1	--	7	96	Painted Ceiling Board	OCRL
.85	Frescor, painted finish. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft, 4 x 4 ft.											
	.69	.80	.73	.96	.93	.79	1	--	7	96	Painted Ceiling Board	OCRL
.85	Sculptured. Sizes 2 x 2 ft, 2 x 4 ft, 2 x 5 ft.											
	.65	.86	.95	.88	.72	.61	3	--	7	96	Fiberglas Film Faced Ceiling Panel	OCRL
.90	Alpha pattern. 2 x 4 ft, 2 x 2 ft.											
	.63	.82	.75	.95	1.01	1.11	1	--	7	96	Archi Texture Ceiling Board	OCRL
.95	Alpha II											
	.68	.87	.87	.99	.99	.99	--	--	7	96	Glass Cloth Ceiling Board	OCRL
.95	Nubby II											
	.78	.97	.88	.99	.99	.99	--	--	7	96	Glass Cloth Ceiling Board	OCRL
.95	Omega II											
	.67	.89	.89	.99	.99	.99	--	--	7	96	Glass Cloth Ceiling Board	OCRL
.95	Textured											
	.74	.90	.85	.99	.99	.99	--	--	7	96	Glass Cloth Ceiling Board	OCRL

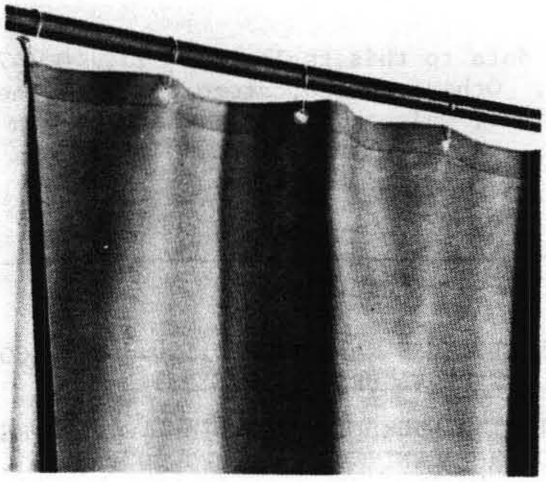
Table 14B. Barrier properties of ceiling tile.

STC	Attenuation Factor, dB																Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz					
38	Texture micro-perforated substantially rigid of basic mineral composition. Used for fire rated assemblies. Fine perforated, spatter effect surface; edges are square. 2 x 4 ft. Test method: AMA-1-11.																				
	28	36	35	28	28	31	32	35	39	41	44	48	50	50	50	51	5/8	1.23	92	Gold Bond Fire Shield Solitude Grid Panel	G&H NG-358FT
39	Substantially rigid grid panel of basic mineral composition. 2 x 4 ft. Test method: AMA-1-11.																				
	24	27	32	29	29	32	34	36	39	42	44	43	42	43	45	47	5/8	.86	92	Gold Bond Solitude Grid Panel (TXMP) Texture Micro-Perf.	NGC 6143
35 to 39	Acoustical tile, standard and reveal. Test method: AMA-1-11.																				
	28	34	36	27	27	30	29	31	33	36	39	46	54	56	58	59	5/8	--	34	Conwed Fissura Tile and Panels	CR Form A-4
35 to 39	Lightweight acoustical panel. Test method: AMA-1-11.																				
	26	33	34	26	24	28	29	33	34	35	40	46	50	49	48	47	5/8	--	34	Conwed Pebbled Panels	CR A-7
35 to 39	Fire rated lay-in panel, square edge. Test method: AMA-1-11.																5/8	--	34	Rockface	CR 902-47
35 to 39	Fire rated concealed tile. Butted, kerfed and rabbeted edge. 12 x 12 inch. Test method: AMA-1-11.																3/4	--	34	Rockface	CR 902-47
35 to 39	Fire rated reveal tile, square reveal edge, 2 x 2 ft. Test method: AMA-1-11.																3/4	--	34	Rockface	CR 902-47
35 to 39	Standard reveal tile, square reveal edge, 2 x 2 ft and 2 x 4 ft. Test method: AMA-1-11.																3/4	--	34	Rockface	CR 902-47
35 to 39	Standard concealed tile, butted, kerfed and rabbeted beveled edge. 12 x 12 inch. Test method: AMA-1-11.																3/4	--	34	Rockface	CR 902-47
35 to 39	Vinyl coated embossed aluminum bonded to a mineral fiber substrate constellation or fire rated style, 2 x 4 ft. Test method: AMA-1-11.																5/8	--	34	Conwed Metal Face Panels	CR 866R- 977
35 to 39	Standard lay-in panel, square edge, 2 x 2 ft. Test method: AMA-1-11.																5/8	--	34	Rockface	CR 902-47
40	Substantially rigid grid panel of basic mineral composition. Surface contains small random perforations, edges are square, 2 x 4 ft. Test method: AMA-1-11.																				
	24	28	33	30	30	32	35	37	38	40	46	44	46	49	52	54	5/8	081	92	Gold Panel Solitude Grid Panel Needle Perforated	NGC 6145
40	Duratone 2 x 4 ft lay-in panel, glass fiber reinforced aluminized facing for use in areas where a rugged, durable, stain resistance panel is needed.																				
	30	37	37	31	31	34	35	37	38	42	45	50	54	52	52	53	5/8	1.2	8	Alumiclad	CR JM-77-FT
41	Substantially rigid grid panel of basic mineral composition. Surface has linear fissured pattern; edges are square. 2 x 4 ft. Test method: AMA-1-11.																				
	25	29	32	31	31	34	36	38	41	43	44	44	44	47	49	51	5/8	.87	92	Gold Bond Solitude Grid Panel Fissured	NGC AMAI-II
41	Substantially rigid grid panel of mineral composition. Nondirectional fissures, edges are square, 2 x 4 ft. Test method: AMA-1-11.																				
	27	29	34	31	32	35	37	39	41	42	45	45	45	50	52	54	5/8	89	92	Gold Bond Solitude Grid Panel Nondirectional	NGC 7477
41	Substantially rigid grid panel of basic mineral composition. Use as fire protective ceiling in fire rated assemblies; needle perforated surface edges are square, 2 x 4 ft. Test method: AMA-1-11.																				
	31	38	36	30	30	33	36	38	40	43	46	49	51	52	50	53	5/8	1.22	92	Gold Bond Fire- Shield Solitude Grid Panel Needlepoint	G&H NG-360FT
42	Substantially rigid grid panel of mineral composition. Use in fire rated assemblies. Linear fissured; surface edges are square. Test method: AMA-1-11.																				
	32	39	38	32	31	36	37	39	42	44	48	50	52	53	53	51	5/8	1.2	92	Gold Bond Fire- Shield Solitude Grid Panel Fissured	G&H NG-359FT
44	Substantially rigid tile of mineral composition, scrubable finish, surface edges are beveled, kerfed, and rabbeted, 12 x 12 inch. Test method: AMA-1-11.																				
	26	29	37	35	35	39	41	42	43	46	49	51	53	55	56	57	5/8	.93	92	Gold Bond Solitude Tile Fissured	NGC 6139

Table 14B. Barrier properties of ceiling tile concluded.

<table>
<tr><th rowspan="2">STC</th><th colspan="16">Attenuation Factor, dB</th><th rowspan="2">Thickness (in.)</th><th rowspan="2">Density (lb/ft^2)</th><th rowspan="2">Company</th><th rowspan="2">Product</th><th rowspan="2">Reference</th></tr>
<tr><th>125 Hz</th><th>160 Hz</th><th>200 Hz</th><th>250 Hz</th><th>315 Hz</th><th>400 Hz</th><th>500 Hz</th><th>630 Hz</th><th>800 Hz</th><th>1000 Hz</th><th>1250 Hz</th><th>1600 Hz</th><th>2000 Hz</th><th>2500 Hz</th><th>3150 Hz</th><th>4000 Hz</th></tr>
<tr><td>44</td><td colspan="16">Substantially rigid grid panel of basic mineral composition. Use as fire protective ceilings in fire rated assemblies; nondirectional fissured surface edges are square; 2 x 4 ft. Test method: AMA-1-11.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>33</td><td>36</td><td>38</td><td>34</td><td>35</td><td>37</td><td>41</td><td>43</td><td>44</td><td>46</td><td>49</td><td>48</td><td>50</td><td>53</td><td>50</td><td>44</td><td>5/8</td><td>1.2</td><td>92</td><td>Gold Bond Fire-Shield Solitude Grid Panel Nondirectional</td><td>NGC 6131</td></tr>
<tr><td>44</td><td colspan="16">Diagonal perforated pattern 12 x 12 inch. Felted mineral core tile.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>33</td><td>38</td><td>39</td><td>33</td><td>34</td><td>38</td><td>38</td><td>41</td><td>42</td><td>45</td><td>47</td><td>51</td><td>54</td><td>54</td><td>54</td><td>56</td><td>5/8</td><td>1.2</td><td>5</td><td>Acousti-Clad</td><td>CR JM-74-FT</td></tr>
<tr><td>40 to 44</td><td colspan="16">Acoustical tile, semiconcealed. Test method: AMA-1-11.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>31</td><td>41</td><td>41</td><td>32</td><td>32</td><td>36</td><td>38</td><td>40</td><td>42</td><td>47</td><td>55</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>5/8</td><td>--</td><td>34</td><td>Conwed Fissura Tile and Panels</td><td>CR Form A-4</td></tr>
<tr><td>40 to 44</td><td colspan="16">Vinyl coated embossed aluminum bonded to a mineral fiber substrate. Plain square edge or fire rated styles, 2 x 4 ft. Test method: AMA-1-11.</td><td>5/8</td><td>--</td><td>34</td><td>Conwed Metal Face Panels</td><td>CR 866R-977</td></tr>
<tr><td>40 to 44</td><td colspan="16">Fire rated Acousti Clad 12 x 12 inch diagonal pattern.</td><td>5/8</td><td>1.2</td><td>5</td><td>Acousti Clad</td><td>CR JM-75-FT</td></tr>
<tr><td>45</td><td colspan="16">Rigid tile of basic mineral composition with beveled, kerfed and rabbeted edges, 12 x 12 inch. Test method: AMA-1-11.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>28</td><td>29</td><td>37</td><td>35</td><td>35</td><td>39</td><td>40</td><td>43</td><td>43</td><td>47</td><td>49</td><td>51</td><td>53</td><td>56</td><td>58</td><td>60</td><td>5/8</td><td>0.94</td><td>92</td><td>Gold Bond Solitude Tile Nondirectional</td><td>NGC 6138</td></tr>
<tr><td>45</td><td colspan="16">Delta pattern mineral core tile</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>32</td><td>35</td><td>39</td><td>36</td><td>35</td><td>37</td><td>40</td><td>41</td><td>43</td><td>46</td><td>48</td><td>51</td><td>54</td><td>53</td><td>54</td><td>54</td><td>5/8</td><td>1.2</td><td>5</td><td>Acousti Clad</td><td>CR JM-76-FT</td></tr>
<tr><td>45 to 49</td><td colspan="16">Standard accent system tile, square rabbeted accent edge, 2 x 4 ft. Test method: AMA-1-11.</td><td>3/4</td><td>--</td><td>34</td><td>Rockface</td><td>CR 902-47</td></tr>
</table>

CATEGORY 15. CURTAINS



CATEGORY 15. CURTAINS

The acoustical properties of curtains are dependent upon the curtain material, surface texture, backing material and placement. All these factors produce variation in curtain acoustical performance. Curtains may contain a thick absorptive material for added absorption or simply be mass-loaded for barrier use only. Curtains may overlap and rely only on surface contact for scaling or may use mastic sealing agents. They may be hung as combined overlapping units or as a single acoustical curtain. Guide rails for variable placement are also used.

Organizations contributing data to this table are: 23, 40, 47, 58, 76, 82, 86, 104, 112, 116, and 119. Other related categories are panels, quilted materials, operable partitions, unit absorbers, and open plan systems.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED ON PAGE 53.

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Lead Loaded: Lead was added to the fabric type material to increase its sound transmission loss.

Table 15A. Absorption properties of curtain systems.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.20 (c)	Flexible curtain barrier 54 inch wide x 20 inch long of acoustical polyurethane foam fused to high density polyvinyl. Data read from graph.											
		.05	.10	.22	.48	.85	5/16	1.1	--	47	Eckoustic Noise Barrier Type 250	CR SES 72091
.20 (c)	Chemically treated fabric, pleat width 30 inch. May be mounted over acoustical batts											
	.03	.07	.15	.23	.33	.41	.55	.11	2	119	Pleated Wall System	IATL
.45 (c)	Flexible curtain barrier 54 ft wide x 20 ft long of acoustical polyurethane foam fused to high density polyvinyl. Data read from graph.											
		.10	.28	.50	.85	.95	9/16	1.1	--	47	Eckoustic Noise Barrier Type 500	CR SES 72091
.45	High density polyester foam sandwiched between two layers of heavy duty vinyl. One vinyl layer perforated.											
	.59	.39	.29	.42	.74	.62	19/32	.33	--	86	Soft-R Sound	RAL
.80	Sound absorbing draperies, hung 2 inch from wall.											
	.11	.48	1.04	.90	.89	.97	1	.15	--	112	Foam Curtain	RAL

Table 15B. Barrier properties of curtain systems.

STC	Transmission Loss, dB																						
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
12	Clear, overlapping plastic strips, each 12 inch wide																						
		8	7	7	7	7	8	10	11	11	12	12	13	13	13	13	14		1/8	1.23	86	Model DF-300 Pendador	RAL
15	High-density polyester foam sandwiched between two layers of heavy-duty vinyl. One vinyl layer perforated																						
		8	3	4	7	9	11	11	12	13	14	15	16	19	22	25	29		19/32	.33	86	Soft-R Sound	RAL
19	Woven fiberglass, coated both sides vinyl																						
	8	11	8	6	12	12	15	15	16	17	20	22	24	26	28	29	30	31	.040	.469	104	Style 23096	RAL TL 76-153
19	Woven fiberglass, coated both sides vinyl																						
	8	9	6	7	12	11	14	15	16	18	19	21	24	26	27	28	30	31	.050	.469	104	Style 23082	RAL TL 76-151
19 .	Woven fiberglass, coated both sides vinyl																						
	8	10	5	6	12	11	15	15	16	17	19	21	24	26	27	28	30	32	.042	.469	104	Style 23071	RAL TL 76-149
19	Style #8205 fiberglass reinforced leaded vinyl Velcro joints 8, 10, or 12 ft length x 49 inch																						
		5			10			14			20			26			32		--	1/2	23	Sound Coated Curtains and Enclosures	CR 8205
19-25	Cousti-curtain noise barrier 4 ft wide 8 or 12 ft long. Transparent style available																						
																			--	--	58	Flexible Noise Barrier Curtains	CR
20	Leaded vinyl																						
		9	8	10	12	12	14	15	17	19	20	22	24	26	27	28	30		.037	.44	112	Sound Stopper lead vinyl curtain	RAL
20	SL series acoustical curtain, fiberglass reinforced modified lead-loaded vinyl 54 inch wide																						
		9			10			16			20			26			32		.055	.48	40	dba bar-"FM"	CR SL 70
20	1/2 lb/ft^2 loaded vinyl with 1/2 inch foam																						
		11			12			15			20			26			32		.5	.53	82	SSC-4	RAL
21	Clear vinyl																						
		12			13			16			21			27			33		.08	.60	82	SSC-5	RAL
21	Extruded, tough, clear PVC designed to be vertically suspended, used for traffic doors controlling dust, noise, temperature, and fumes, strip 12 inch wide, temperature range -40^{o}F to 120^{o}F.																						
	13	15	15	16	17	18	18	19	17	17	18	22	27	24	25	28	29	30	.25	1.4	76	Kelflex 303	RAL TL 78-106
23	Woven fiberglass, coated both sides vinyl																						
	11	14	12	12	16	16	18	19	20	21	22	24	24	25	27	28	29	29	.064	.797	104	Style 23097	RAL TL 76-154
23	Woven fiberglass, coated both sides vinyl																						
	11	13	12	11	16	15	18	19	20	21	23	25	28	29	30	32	33	36	.066	.781	104	Style 23072	RAL TL 76-150
23	Extruded, tough, clear PVC designed to be vertically suspended in overlapping strips facilitating 2 way traffic. Temperature range -40^{o}F. to 120^{o}F.																						
	14	17	16	17	17	18	16	16	19	22	25	24	27	29	30	32	33	33	.30	2.0	76	Kelflex 404	RAL TL 78-107
24	Woven fiberglass, coated both sides vinyl																						
	11	13	11	12	16	16	19	19	20	22	24	26	28	30	31	33	35	37	.086	.813	104	Style 23086	RAL TL 76-152
24	SL series acoustical curtain, fiberglass reinforced modified lead-loaded vinyl 54 inch wide																						
		12			14			19			25			31			36		.090	.83	40	dba bar-"FM"	CR SL-120
25	Leaded vinyl																						
		13	14	15	16	17	18	20	22	24	26	27	29	31	33	34	35		.064	.76	112	Lead vinyl curtain	RAL
25	Style #8208 fiberglass reinforced leaded vinyl, Velcro joints 8, 10, or 12 ft lengths x 49 inch wide																						
		12			18			21			27			32			36		--	.75	23	Sound Control Curtains and Enclosures	CR 8208

CATEGORY 16. PANELS

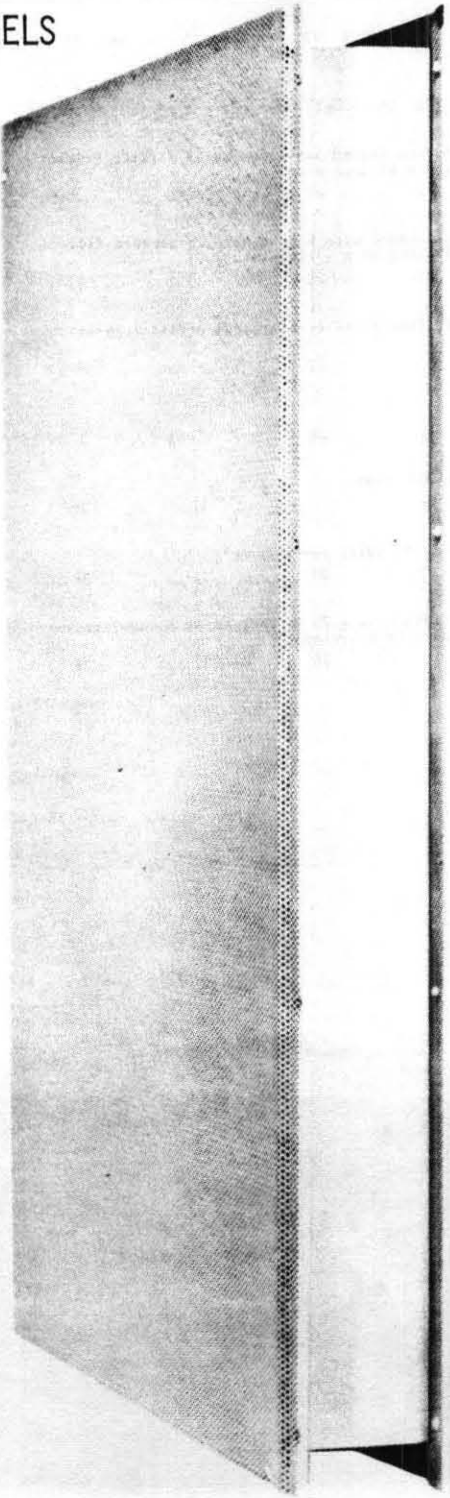


Table 15B. Barrier properties of curtain systems concluded.

STC	Transmission Loss, dB																		Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz					
26	Clear curtains																						
	14	13	13	14	19	18	20	21	25	26	27	28	30	33	34	36	37	39	.120	0.9	116	Reinforced Hush-view	CT
26	Clear curtains																						
	14	13	13	15	18	17	19	20	24	26	27	28	31	32	34	35	37	38	.120	0.9	116	Superclear Hush-view	CT
26	Style #8210 fiberglass reinforced leaded vinyl-nominal 1 lb/ft^2, Velcro joints 8, 10, or 12 ft lengths x 49 inch wide																						
		11			17			21			27			34			40		--	1	23	Sound Control Curtains and Enclosures	CR 8210
27	Style #8410 unsupported vinyl loaded with high density nonlead filler Velcro joints 8, 10, or 12 ft lengths x 49 inch wide																						
		15			19			21			28			33			37		--	1	23	Sound Control Curtains and Enclosures	CR 8410
27	SL series acoustical curtain, fiberglass reinforced modified lead-loaded vinyl 54 inch wide																						
		17			17			23			27			33			39		.110	1.0	40	dba bar-"FM"	CR SL-144
27	Vinyl curtain 1 lb/ft^2																						
		15			19			21			28			33			37		.125	1.18	82	Soundscreen Curtains SSC-1	RAL
27	1 lb/ft^2 loaded vinyl with 1 inch foam																						
		15			16			19			25			31			36		1.0	1.18	82	Soundscreen Curtains SSC-2	RAL
27	1 lb/ft^2 loaded vinyl with 1 inch Tedlar cover foam																						
		15			16			19			25			31			36		1.0	1.18	82	SSC-3	RAL
	Flexible curtain barriers 54 inch wide x 20 ft long of acoustical polyurethane foam fused to high density polyvinyl																						
					15			20			26			32			36		5.16 to 9.16	1.1	47	Eckoustic Noise Barrier Type 250 & Type 500	CR SES72091

CATEGORY 16. PANELS

Prefabricated sound barrier panels can be used in machinery enclosures, walls, facings, etc. They are usually composite products using sound barrier materials for facing and backing and a sound absorbent material in the core. The exposed surfaces of the panels are available in different colors, textures, and materials to suit the requirements of a specific application.

The organizations contributing data to this table are: 2, 4, 5, 7, 11, 12, 21, 40, 47, 49, 50, 52, 61, 70, 71, 77, 78, 82, 120, 125, 128, 131, and 142. Other related categories are walls, barrier materials, and enclosures.

GLOSSARY

Facing:	The outside surface of the specimen. In general the side facing the sound source
Backing:	The other outside surface of the specimen. In general the side not facing the sound source
Core:	The region between the facing and the backing
Septum:	A layer that separates two surfaces

Table 16A. Absorption properties of panels.

<table>
<tr><th rowspan="2">NRC</th><th colspan="6">Absorption Coefficients</th><th rowspan="2">Thickness (in.)</th><th rowspan="2">Density (lb/ft^3)</th><th rowspan="2">Mounting</th><th rowspan="2">Company</th><th rowspan="2">Product</th><th rowspan="2">Reference</th></tr>
<tr><th>125 Hz</th><th>250 Hz</th><th>500 Hz</th><th>1000 Hz</th><th>2000 Hz</th><th>4000 Hz</th></tr>
<tr><td>.65</td><td colspan="12">12 x 108 inch panels, 1-1/2 inch of 1-1/2 lb/ft^3 fiberglass, foil faced insulation, faced with 20 gauge steel.</td></tr>
<tr><td></td><td>.27</td><td>.56</td><td>1.03</td><td>.77</td><td>.29</td><td>.18</td><td>1-1/2</td><td>1.5</td><td>7</td><td>125</td><td>Acousti-Panel</td><td>RAL
A74-225</td></tr>
<tr><td>.75</td><td colspan="12">Transparent acoustical panels, 3/16 inch thick Uvex with 1 inch acoustical foam.</td></tr>
<tr><td></td><td>.32</td><td>.39</td><td>.64</td><td>1.10</td><td>.92</td><td>.92</td><td>5</td><td>2.03</td><td>--</td><td>21</td><td>Clear & Quiet</td><td>RAL</td></tr>
<tr><td>.85</td><td colspan="12">22 gauge perforated steel face, 16 gauge cold rolled steel back. Coated with Korfund Vibradamp compound. Insulating and absorbing core.</td></tr>
<tr><td></td><td>.29</td><td>.60</td><td>.95</td><td>.99</td><td>.87</td><td>.80</td><td>2</td><td>--</td><td>--</td><td>78</td><td>Korfund Noiseguard Panel</td><td>RAL</td></tr>
<tr><td>.85</td><td colspan="12">Two ply steel, outside surface 16 gauge, with glass or mineral wool acoustical filler, inside surface 22 gauge perforated steel.</td></tr>
<tr><td></td><td>.29</td><td>.60</td><td>.95</td><td>.99</td><td>.87</td><td>.80</td><td>2</td><td>--</td><td>--</td><td>78</td><td>Noiseguard Metal Panel</td><td>CR</td></tr>
<tr><td>.85</td><td colspan="12">26 gauge exterior panel, 24 gauge liner, 1-1/2 inch fiberglass insulation.</td></tr>
<tr><td></td><td>.63</td><td>.94</td><td>.96</td><td>.78</td><td>.65</td><td>.62</td><td>10</td><td>3.88</td><td>4</td><td>71</td><td>RW9-36 Acoustical Panel</td><td>RAL
A73-228</td></tr>
<tr><td>.90</td><td colspan="12">22 gauge perforated steel face, wire grid, 1 mil PVC, 4-1/2 lb/ft^3 insulation divided by 16 gauge steel septum, 16 gauge steel back, 2 ft 4 inch wide by various heights.</td></tr>
<tr><td></td><td>.33</td><td>.69</td><td>.99</td><td>1.05</td><td>.90</td><td>.76</td><td>4</td><td>--</td><td>4</td><td>61</td><td>Gyro-Kleen PGS Panel</td><td>RAL</td></tr>
<tr><td>.95</td><td colspan="12">Layered outer face 8 gauge galvanized steel, inner face 22 gauge perforated galvanized steel, filled with 4 lb/ft^3 mineral wool.</td></tr>
<tr><td></td><td>.68</td><td>1.13</td><td>1.23</td><td>1.06</td><td>1.00</td><td>.93</td><td>2</td><td>6.1</td><td>4</td><td>142</td><td>Sonoshield Std-216</td><td>RAL
A73-121</td></tr>
<tr><td>.95</td><td colspan="12">22 gauge zinc-coated perforated steel face, 16 gauge zinc-coated steel back, fiberglass or mineral wool core.</td></tr>
<tr><td></td><td>.15</td><td>.66</td><td>1.07</td><td>1.06</td><td>.97</td><td>.86</td><td>2</td><td>6.5</td><td>--</td><td>47</td><td>TEC Noise Barrier Panels</td><td>CKAL</td></tr>
<tr><td>.95</td><td colspan="12">Modular metal acoustical panels, 16 gauge galvanized steel back, 22 gauge perforated galvanized steel face, insulating and absorbing material in core.</td></tr>
<tr><td></td><td>.40</td><td>.80</td><td>.99</td><td>.99</td><td>.99</td><td>.99</td><td>2</td><td>--</td><td>--</td><td>40</td><td>dba bar-"RE"</td><td>CR</td></tr>
<tr><td>.95</td><td colspan="6">16 gauge galvanized steel back, 22 gauge perforated galvanized steel face, 4 lb/ft^3 mineral wool core.</td><td>2</td><td>--</td><td>--</td><td>142</td><td>Sonoshield Std-216</td><td>RAL</td></tr>
<tr><td>.95</td><td colspan="6">16 gauge galvanized steel back, 22 gauge perforated galvanized steel face, 4 lb/ft^3 mineral wool core.</td><td>2</td><td>--</td><td>--</td><td>142</td><td>Sonoshield Std-416</td><td>RAL</td></tr>
<tr><td>.95</td><td colspan="12">12 x 108 inch 20 gauge steel panel, containing 1-1/2 inch of 1-1/2 lb/ft^3 foil faced fiberglass insulation, with 1-1/2 inch perforated face panel containing fiberglass insulation of 1 lb/ft^2 density.</td></tr>
<tr><td></td><td>.49</td><td>.88</td><td>1.12</td><td>1.07</td><td>.96</td><td>.93</td><td>3</td><td>3.7</td><td>7</td><td>125</td><td>Acousti-Panel</td><td>RAL
A74-226</td></tr>
<tr><td>.95</td><td colspan="12">L-21 acoustical liner with 1W21A exterior panels.</td></tr>
<tr><td></td><td>.58</td><td>.90</td><td>1.11</td><td>1.01</td><td>.83</td><td>.64</td><td>3</td><td>--</td><td>4</td><td>71</td><td>L-21 Acousti-wall</td><td>RAL
A76-53</td></tr>
<tr><td>.95</td><td colspan="12">L21 liner, M7-35 exterior, 1-1/2 inch fiberglass insulation.</td></tr>
<tr><td></td><td>.44</td><td>.79</td><td>1.08</td><td>1.01</td><td>.88</td><td>.74</td><td>3-1/2</td><td>--</td><td>4</td><td>71</td><td>L21 Acoustical Liner with M7-35 Exterior Panel</td><td>RAL
A73-83</td></tr>
<tr><td>.95</td><td colspan="12">2 x 9 ft perforated face 22 gauge steel, fiberglass core, 22 gauge back.</td></tr>
<tr><td></td><td>.76</td><td>1.19</td><td>1.17</td><td>1.02</td><td>.90</td><td>.89</td><td>4</td><td>5.33</td><td>4</td><td>77</td><td>Noise Control Panel</td><td>RAL</td></tr>
<tr><td>.95</td><td colspan="12">Standard panel, 16 gauge zinc-coated solid sheet, 22 gauge perforated sheet zinc-coated, 3/32 inch diameter holes spaced 3/16 inch staggered center, framing 16 gauge. Acoustical fill not less than 4 lb/ft^3.</td></tr>
<tr><td></td><td>.75</td><td>1.01</td><td>1.11</td><td>1.06</td><td>1.02</td><td>.95</td><td>4</td><td>6</td><td>4</td><td>139</td><td>Vanec Acoustical Systems</td><td>RAL
A73-74</td></tr>
</table>

Table 16A. Absorption properties of panels continued.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.95	22 gauge galvanized steel face, 16 gauge back, fiberglass or mineral wool core, 10 x 4 ft. Temperature range to 800°F.											
	.77	.99	.99	.99	.93	.77	4	7	--	78	Noiseguard Metal Panels	CKAL 704-21
.95	22 gauge perforated steel face, 16 gauge steel back, 4-1/4 lb/ft^3 mineral wool core. 18, 30 and 42 inch widths with 7, 8, 10 and 12 ft heights.											
	.71	1.14	1.16	1.06	1.04	1.13	4	--	--	47	Eckoustic Modular Panels	CR SES 77051
.95	20 gauge zinc-coated perforated steel face, 16 gauge zinc-coated steel back, core of fibrous glass or mineral wool not less than 4-1/4 lb/ft^3.											
	.51	1.10	1.12	1.06	1.05	.93	4	--	--	47	Eckoustic Modular Panels Type HD	CKAL SES 69102
.95	22 gauge perforated steel face, wire grid, 1 mil PVC 4-1/2 lb/ft^3 insulation, 16 gauge steel back, 2 ft 4 inch wide by various heights.											
	.63	.95	1.06	1.05	.93	.74	4	--	4	61	Gyro-Kleen WPG Panel	RAL
.95	16 gauge cold rolled steel back, 22 gauge perforated steel face, coated with Korfund Vibradamp compound, insulating and absorbing core.											
	.77	.99	.99	.99	.93	.77	4	--	--	78	Korfund Noiseguard Panel	RAL
.95	Industrial sandwich wall, Bold Rib II aluminum siding, 3/4 inch subgirts, 1-1/2 inch thick 1.65 lb density, glass fiber insulation with 1 mil thick foam saran plastic film. .032 inch finish sheet, 12 inch perforated liner sheet. Temperature range 40° to 200°F. Used on interior and exterior walls.											
	.51	1.04	1.12	.96	.82	.64	4-1/8	1.3	4	7	Bold Rib II with Rib Liner Panel (Curtain Wall)	RAL A75-57
.95	Perforated steel face, 4-1/2 inch thick 1 lb/ft^3 fiberglass, 1-1/2 inch thick 1-1/2 lb/ft^3 foil-faced fiberglass, 20 gauge steel back, 1 x 9 ft.											
	.78	1.11	1.12	1.14	1.06	1.05	6	4.1	7	125	Acousti-Panel	RAL A74-227
.95	22 gauge perforated steel face, fiberglass core, 22 gauge steel back, 2 x 9 ft.											
	1.05	1.20	1.16	1.04	1.00	1.01	6	6.28	4	77	Noise Control Panel	RAL A62-243
.95	L13 liner, M9-36 exterior, 1-1/2 inch fiberglass insulation.											
	.46	.82	1.11	.93	.84	.81	--	4.04	7	71	L13 Acoustical Liner with M9-36 Exterior Panel	RAL A77-176
.95	L21 liner, M9-36 exterior, 1-1/2 inch fiberglass insulation.											
	.58	.81	1.05	.97	.86	.82	--	--	4	71	L21 Acoustical Liner with M9-36 Exterior Panel	RAL A76-233
1.00	Acoustic modular panels, sandwich type construction, filled with acoustical material.											
	.74	.88	1.11	1.01	1.02	1.06	4	--	--	71	Type 22-HT-4	CR NCD-7559
1.00 (c)	22 gauge galvanized perforated face (3/32 inch diameter holes on 3/16 inch centers), 3 lb density fiberglass core, 2 x 9 ft. Tested to ASTM C423-60T.											
	.79	1.19	1.17	1.02	.90	.89	4	5.33	4	4	Modular Acoustical Panels	RAL A62-242
1.00 (c)	Minimum 20 gauge galvanized, perforated steel facing, 16 gauge galvanized steel face, nonhygroscopic, verminproof, incombustible-acoustical-thermal core.											
	.70	1.10	1.11	1.04	1.02	.96	4	6.5	--	2	Sound Soaker Panels	CR
1.00 (c)	22 gauge galvanized, perforated steel facing (3/32 inch diameter holes on 3/16 inch staggered centers), 16 gauge galvanized steel back, insulating-absorbing core.											
	.76	.99	.99	.99	.99	.99	4	--	--	40	dba bar-"RE"	CR

Table 16A. Absorption properties of panels concluded.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
1.00 (c)	Acoustical panel, 22 gauge galvanized, perforated steel face, 18 gauge galvanized steel back, 16 gauge galvanized channel form, 16 gauge channel separators, bonded mineral wool core. Also available with inset window.											
	.69	1.08	1.11	1.06	1.01	.98	4-1/4	6.1	--	50	Enelco Sound Metal	CR 7014
1.00 (c)	22 gauge perforated steel facing, 18 gauge galvanized steel back, 3-1/2 lb/ft^2 mineral wool core.											
	.69	1.08	1.11	1.06	1.01	.98	4-1/2	6.86	4	50	Enelco Panel TP-4, TP-6, TP-7	RAL A76-224
1.00 (c)	22 gauge galvanized perforated steel facing (3/32 inch diameter holes on 3/16 inch staggered centers), 22 gauge galvanized steel back, 3 lb density fiberglass core, 2 x 9 ft. Tested to ASTM C423-60T.											
	1.05	1.20	1.16	1.04	1.00	1.01	6	6.28	4	4	Modular Acoustical Panel	RAL A62-243-60T
1.00 (c)	Fabricated with facings and stiffeners of 22 gauge zinc-coated paintable steel. Facings are perforated with 3/32 inch holes on 5/32 inch staggered centers, with 2 inch thick fine fibered fibrous glass core, 30 inch widths and 4, 5, 6, 8 or 10 ft lengths.											
	.23	.88	1.55	1.35	1.25	1.08	--	--	--	47	Eckoustic Functional Panels (EFPS)	CKAL SES 76001
1.00 (c)	16 gauge galvanized steel back, 22 gauge galvanized steel face, .093 inch diameter holes, located on .156 inch staggered centers, 4 inch thick absorptive material, 6 lb/ft^3, protected by 2 mil polyethylene.											
	.94	.96	.98	1.01	1.02	1.07	--	--	--	82	Modular Panel and Enclosure	CR DS 4200
	Noise control for industrial equipment.						--	--	--	72	I C Panel	

Table 16B. Barrier properties of panels.

STC	Transmission Loss, dB																		Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz					
9	Perforated aluminum face type F with 1/8 inch holes on 9/32 inch staggered centers. 1 inch of light density fiberglass weighing 0.18 lb/ft^2 and a layer of aluminum foil.																						
	9	5	3	5	4	4	5	4	7	7	9	10	10	12	13	14	16	17	1-3/8	.52	12	Alpro	RAL TL73-19
10	Perforated aluminum face type F, foam center, aluminum foil back. Perforated 1/8 inch holes on 9/32 inch staggered centers. 1/8 inch polyurethane foam, aluminum foil .001 inch thick.																						
	7	5	1	5	5	5	5	6	7	8	10	11	11	14	15	17	18	19	1/2	.45	12	Alpro	RAL TL73-16
18	Perforated aluminum face, 1/8 inch foam center, lead foil back, type F aluminum face, perforated with 1/8 inch holes on 9/32 inch staggered centers, 1/8 inch thick polyurethane foam and lead foil 1/64 inch thick.																						
	13	15	12	15	15	15	15	14	15	16	17	20	20	22	21	22	24	25	33/64	1.41	12	Alpro	RAL TL73-18
22	Perforated aluminum face, fiberglass center, lead foil back, type F aluminum face, 1/8 inch holes on 9/32 inch staggered centers. 1 inch layer of light density fiberglass and 1/64 inch thick lead foil.																						
	13	15	11	14	15	15	16	17	20	22	23	23	24	25	25	26	27	28	1-25/64	1.48	12	Alpro	RAL TL73-17
25	18 gauge L-10; 20 gauge 1W21A; 1-1/2 inch fiberglass insulation.																						
	10	8	12	14	14	15	17	20	22	27	27	28	28	31	34	37	39	39	3.5	3.2	71	L-10 Steel Liner with 1W21A Aluminum Panel	RAL TL72-122
26	Transparent convoluted panels of 3/16 inch thick Uvex with 1 inch acoustical foam. Convolutions 5 inch thick overall.																						
	21	22	21	19	16	14	17	20	23	26	31	34	35	35	35	35	36	37	.5	2.03	21	Clear & Quiet	RAL TL76-163
27	2 x 4 ft transparent parabolic/sinusoidal acoustical panel. Butyrate base with foam wedges.																						
	22	23	12	15	16	17	18	21	27	31	35	37	38	38	40	44	45	47	4.25	--	11	Alphasonic	CR 11771-I
31	Industrial sandwich wall 0.032 inch thick Bold Rib I aluminum siding; 3/4 inch subgirts, 1-1/2 inch thick, 1.65 lb density glass fiber with 1 mil thick foam saran plastic film facing; finish sheet of 0.032 inch thick 12 inch solid liner sheet. Temperature range -50° to 200°F.																						
	16	13	12	15	20	25	27	28	32	34	36	36	37	39	43	44	44	45	4-1/8	2.1	7	Curtain wall Bold Rib I exterior with 12 inch Rib Liner	RAL TL75-28
31	Industrial sandwich wall construction. .032 inch aluminum siding, 3/4 inch subgirts, 1-1/2 inch, 1.65 lb density glass fiber, 1 mil thick foam Saran plastic film facing, finish sheet of 0.32 and 12 inch solid liner sheets. Temperature range -50° to 200°F.																						
	16	14	13	17	22	24	25	27	31	33	37	36	38	40	41	42	44	45	4-1/8	2.1	7	Curtain Wall Bold Rib II with 12 inch Rib Liner	RAL TL75-27
33	Gauge metal C-liner, 12 inch wide with standing interlocking side joint, 1/4 inch thick subgirt. Gauge metal 12 inch wide fluted channel with concealed joints and 1-1/2 inch thick fiberglass core. Single units up to 30 ft long. Temperature range -30° to 200°F.																						
	18	18	16	18	20	23	26	29	33	36	38	41	42	40	40	43	45	48	3-1/4	4.6	49	C-Liner with Channelwall VI Exterior	RAL TL72-66
34	20 gauge liner panels with 18 gauge exterior.																						
		18	19	22	22	23	27	30	34	37	38	38	39	41	44	47	51		3	5.27	71	L-21 Acoustiwall	RAL
34	Industrial sandwich wall. 12 inch perforated rib panel facing and liner backed by 1-1/2 on center fiberglass with foam saran facing. 20 gauge steel septum with 1/2 x 1 inch 18 gauge subgirts. Temperature range -50° to 200°F.																						
	17	15	15	20	25	28	29	31	34	36	40	43	46	48	50	52	53	54	3	3.45	7	Type II Acoustical Draft Curtain Panel	RAL TL74-244
35	2 x 4 ft panel, slotted 1.5 inch on center, 1.5 inch deep and .25 inch wide, rear surface sealed with 0.46 lb/ft^2 damping compound. Low density cellular glass.																						
		24	18	22	25	27	29	33	33	38	37	40	42	44	46	49	50		3.5	2.76	98	Geocoustics Panel	CR
35	Industrial sandwich wall, .032 inch perforaced face and liner, 1-1/2 inch thick fiberglass with foam saran facing. Temperature range -50° to 200°F.																						
	18	16	17	22	27	29	30	32	34	36	39	41	44	47	48	49	51	51	3	3.45	7	Type I Acoustical Draft Curtain Panel	RAL TL74-245
35	Gauge metal C-liner 12 inch wide, with standing interlocking side joint, 1/4 inch thick subgirt. Gauge metal 12 inch fluted profile with standing interlocking side joints with 1-1/2 inch thick fiberglass core. Single units up to 30 ft long. Temperature range -30° to 200°F.																						
	19	17	17	20	24	27	30	33	36	39	42	44	45	45	45	43	45	48	3-1/4	4.9	49	C-Liner with Shadewall Exterior	RAL TL75-5

Table 16B. Barrier properties of panels continued.

STC	Transmission Loss, dB																		Thickness (in.)	Density (lb/ft^3)	Company	Product	Reference
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz					
36	18 gauge 2L41, 20 gauge M9-36, 1-1/2 inch fiberglass insulation.																						
	17	19	19	20	22	27	31	33	35	38	42	44	47	49	47	51	54	55	4.1	5.5	71	2L41 Acoustical Liner with M9-36 Exterior Panel	RAL TL76-148
37	22 gauge zinc-coated steel face perforated with 3/32 inch diameter holes on 5/32 inch staggered centers; 16 gauge zinc-coated steel back; fiberglass or mineral wool core.																						
	19	17	24	23	23	27	30	34	38	42	47	48	51	55	56	55	57	58	2	6.5	47	TEC Noise Barrier Panel	CKAL 7604.26
37	Double wall sheet metal panel, perforated metal facing, 20 gauge backing, 4 inch fiberglass core.																						
	15	16	17	21	25	29	33	35	39	42	47	49	51	54	55	57	58	59	4	5.1	131	Uni-Housing	RAL TL71-39
37	0.032 inch Bold Rib II aluminum siding, 5/8 inch thick gypsum board, 3/4 inch subgirts, 1-1/2 inch thick, 1.65 lb density glass fiber insulation with 1 mil thick foam saran plastic facing, finish sheet of 0.032 inch thick 12 inch perforated liner. Temperature range -50° to 200°F.																						
	21	19	17	22	26	30	34	35	37	40	42	45	48	48	46	49	53	54	[illegible]-5/8	4.5	7	Bold Rib II	RAL TL75-29
38	Layered back 8 gauge galvanized steel, 22 gauge perforated galvanized steel facing. 4 lb/ft^3 mineral wool core.																						
	18	16	18	24	27	31	33	36	40	43	45	48	50	52	53	53	54	54	2	6.1	142	Sonoshield	RAL TL73-127
39 (c)	Aluminum or steel exterior, lead treatment core, wire mesh retainer, aluminum reflector layer, 3 x 3 inch diamond washers.																						
	24	23	19	21	23	23	27	31	37	41	42	43	44	46	48	49	50	52	2	3.1	128	Noisecon-12 Panel	RAL TL72-74
40	Layered back 16 gauge galvanized steel, 22 gauge perforated steel facing. 4 lb/ft^3 mineral wool core.																						
		24			30			37			46			54			56		2	--	142	Sonoshield Std-216	RAL
40	20 gauge perforated steel face, 4 inch fiberglass core, 18 gauge sheet steel back.																						
	21	18	19	24	29	33	37	42	46	50	54	56	57	59	60	62	64	65	4	5.6	131	Uni-Housing	RAL TL71-327
40 (c)	Standard 4 inch thick panel, 16 gauge sheet steel back, 22 gauge perforated sheet steel face, inorganic filler (6 lb/ft^3) core. Varying sizes available																						
		22	25	28	30	33	38	40	43	48	52	[illegible]	53	54	56	57	58		4	--	8[illegible]	Soundscreen Modular Panels	CR
40 to 44	22 gauge galvanized perforated steel face (3/32 inch diameter holes on 3/16 inch staggered centers), 22 gauge galvanized steel back, 3 lb density fiberglass core.																						
		23			32			40			50			57			63		4	5.33	5	Modular Acoustical Panel	CR
41	Layered back 16 gauge galvanized steel, 22 gauge perforated galvanized steel facing, 4 lb/ft^3 mineral wool core.																						
		23			32			40			50			57			63		2	--	142	Sonoshield Std-416	RAL
41	22 gauge perforated steel facing (3/32 inch diameter holes on 3/16 inch staggered centers), 16 gauge cold-rolled steel facing. Vibradamp compound and absorbing material core. Temperature range to 800°F.																						
		24			31			40			49			53			58		2	--	78	Korfund Noiseguard Panel	CR K16G
41	Layered face 16 gauge galvanized steel, 22 gauge perforated galvanized steel facing, 4 lb/ft^3 mineral wool core with optional 4 mil plastic sheet, 1/2 inch wire mesh and 1/4 inch sound board.																						
	21	26	23	25	30	33	37	39	39	41	43	46	49	52	55	56	57	58	2	6.2	142	Sonoshield	RAL TL77-47
41	Standard panel, 16 gauge zinc-coated solid sheet, 22 gauge perforated sheer zinc-coated 3/32 inch diameter holes spaced 3/16 inch staggered centers, framing 16 gauge, acoustical fill not less than 4 lb/ft^3.																						
	23	22	21	25	29	34	37	40	44	47	50	52	54	55	58	59	57	58	4	6	139	Vanec Acoustical Systems	RAL TL73-81
41	22 gauge perforated steel facing, 16 gauge steel backing, fiberglass or mineral wool core. 10 x 4 ft.																						
		24			31			42			52			59			62		4	7	78	Noiseguard Metal Panels	CKAL 704-21
41	22 gauge perforated steel facing, wire grid, 1 mil PVC, 4-1/2 lb/ft^3 insulation, 16 gauge steel back, 2 ft 4 inch wide by various heights.																						
		20			30			37			49			55			60		4	--	61	Gvro-Kleen WPG Panel	RAL

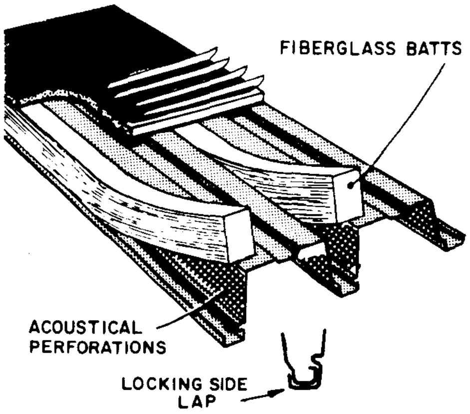
Table 16B. Barrier properties of panels continued.

STC	Transmission Loss, dB 100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
41	22 gauge perforated steel face (1/16 inch holes on 3/16 inch staggered centers), 16 gauge steel back, 4.25 lb/ft^3 mineral wool core. 18, 30 and 42 inch widths by 7, 8, 19 and 12 ft heights.																						
		19			30			39			50			58			60		4	--	47	Eckoustic Modular Panels Series C	CR SES 77051
42	Panel 18 gauge galvanized steel back, perforated 22 gauge steel face. 3.5 lb/ft^3 mineral wool core.																						
	21	25	22	24	29	34	38	41	45	48	52	54	56	58	61	64	66	67	4	6.3	50	Enelco TP-3 Panel	RAL TL77-21
42	22 gauge galvanized perforated steel facing, 18 gauge galvanized steel back, 16 gauge galvanized steel channel forms, 16 gauge steel channel separators, mineral wool core.																						
		22			27			41			51			58			66		4-1/4	6.1	50	Enelco Soundmetal	CR 7014
42	Minimum 20 gauge galvanized perforated steel facing, minimum 16 gauge galvanized steel back, nonhygroscopic, verminproof, incombustible absorbing core.																						
		22			32			40			50			60			62		4	6.5	2	Sound Soaker Panels	CR
42	16 gauge galvanized steel back, 22 gauge galvanized perforated steel face (.093 inch diameter holes on .156 inch staggered centers), 4 inch thick absorptive material. 6 lb/ft^3 protected by 2 mil polyethylene in core.																						
		22			30			40			52			52			58		--	--	82	Modular Panel and Enclosure	CR DS 4200
43	Acoustic modular panels, sandwich type construction, filled with acoustical material.																						
		26			32			38			47			49			57		4	--	70	Type 22-HT-4	CR NCD 7559
44	16 gauge steel back, 22 gauge perforated steel face, 4.25 lb/ft^3 mineral wool core. Available with 3-5/8 inch double glaze windows.																						
		26			33			39			48			57			61		--	--	47	Eckoustic Modular Panels Series CD	CR SES 77051
44	Gauge metal C-liner 12 inch wide with standing interlocking joint, 4 inch thick subgirt, trimwall 12 inch wide with flush surface and interlocking joints. Gauge metal with glass fiber insulation 1 ft wide to any width and up to 30 ft long as single lengths any height with laps. Temperature range -30° to 200°F.																						
	22	22	23	28	35	37	39	41	45	49	52	54	54	52	52	52	55	55	3-1/4	4.9	49	C-Liner Trimwall Exterior	RAL TL75-8
44	Gauge metal C-liner 12 inch wide, with standing interlocking side joint, 1/4 inch thick subgirt, gauge metal 12 inch wide fluted profile with standing interlocking side joints with mineral fiber insulation. Single units 1 ft wide by 30 ft long to any height with Lap. Temperature -30° to 200°F.																						
	21	20	23	30	35	39	44	48	50	53	54	55	54	52	51	51	53	55	3-1/4	6.1	49	C-Liner Shadowall Exterior	RAL TL70-231
44	Gauge metal C-liner 12 inch wide with standing interlocking side joint, 1/4 inch thick subgirt, gauge metal 12 inch wide fluted channel wall with concealed joints and mineral fiber core. Single units up to 30 ft long. Temperature range -30° to 200°F.																						
	22	20	25	31	36	39	42	45	49	51	52	54	56	57	59	59	60	61	3-1/4	--	49	C-Liner Channelwall VI Exterior	RAL TL72-83
44	Standard panel of 20 gauge zinc-coated perforated steel face, 16 gauge zinc-coated steel back, 4.25 lb/ft^3 mineral wool core.																						
		25			32			38			49			56			62		4	--	47	Eckoustic Modular Panels Type HD	CKAL SES 69102
44	20 gauge L21, 1-1/2 inch fiberglass core, firewall rated.																						
	19	22	25	27	32	37	43	48	54	57	60	61	60	60	63	66	68	70	5-1/8	9.2	71	L21 Acoustical Liner with 1W11A Exterior Panel	RAL TL77-19
45 to 49	22 gauge galvanized steel face (3/32 inch diameter holes on 3/16 inch staggered centers), 22 gauge galvanized steel back, 3 lb/ft^3 fiberglass core.																						
		28			47			55			58			59			66		6	6.28	5	Modular Acoustical Panel	G&H
46	Gauge metal C-liner 12 inch wide, with standing interlocking joint, 1/4 inch thick subgirt. Gauge metal 12 inch fluted profile with standing interlocking side joints with 1-1/2 inch thick fiberglass core and two layers of 5/8 inch gypsum board. Temperature range -30° to 200°F.																						
	22	24	25	31	36	39	44	49	53	54	55	55	56	57	57	57	58	58	4-3/4	11	49	C-Liner Shadowall Exterior 1 hr Firewall	RAL TL70-230
47	22 gauge perforated steel face, wire grid, 1 mil PVC, 4-1/2 lb/ft^3 insulation divided by 16 gauge steel septum, 16 gauge steel back; 2 ft 4 inch wide by various heights.																						
		23			41			49			56			60			50		4	--	61	Gyro-Kleen PGS Panel	RAL

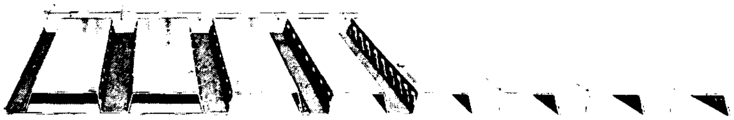
Table 16B. Barrier properties of panels concluded.

STC	Transmission Loss, dB																		Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz					
60	Paneling applied to 3/16 inch steel plate, 2 x 6 inch channel stiffeness on 42 inch centers. Paneling: aluminum or steel exterior, lead treatment core, wire mesh retainer, aluminum reflector layer. Weight given includes backing plate.																						
	40	42	44	46	51	53	54	56	58	61	64	68	69	68	68	68	70	72	--	15.6	128	Noisecon-12 on duct	RAL TL72-205
	2 x 4 ft transparent convoluted butyrate panels with mylar sealed foam wedges attached along convolutions. Temperature to 150°F, humidity to 100%. Tested in place, covering 57% of machine. Data cited are noise reduction.																						
		10			14			15			17			18			19		--	--	11	Alphasonic	CR
	22 gauge galvanized perforated steel face (3/32 inch diameter holes on 3/16 inch staggered centers), 16 gauge galvanized steel back, absorbing core.																						
		13			23			32			44			52			53		2	--	40	dba bar-"RE"	CR
	22 gauge galvanized perforated steel face (3/32 inch diameter holes on 3/16 inch staggered centers), 16 gauge galvanized steel back, absorbing core.																						
		25			30			41			51			58			61		4	--	40	dba bar-"RE"	CR
	Steel back, perforated galvanized face, sound absorbing core is moisture, vermin, and fireproof, chemically inert.																		--	--	70		CR NCD 7554
	Galvanized steel, primed or finish-painted. 4 to 30 ft lengths. Density range 2 to 4 lb/ft^2. Application: sound barrier for wall construction.																		--	--	71	L21 Acoustiwall	CR

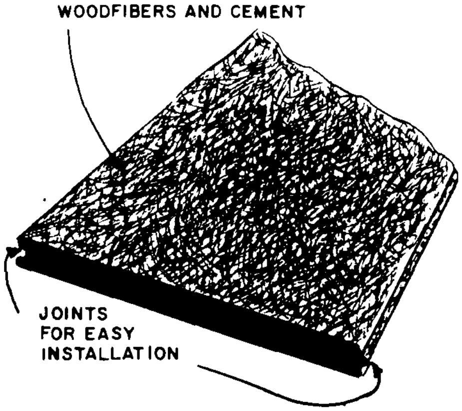
CATEGORY 17. ROOF DECKS



PERFORATED FACING AND FIBERGLASS CORE



ROOF DECK AND CONCRETE



ROOF DECK PANEL FOR ABSORPTION

CATEGORY 17. ROOF DECKS

A roof deck is structurally designed to support dynamic loads and to provide the base for a roof system. Acoustically, roof decks act as a sound barrier or as an absorptive barrier system. Roof decks are usually arranged in an interlocking sandwich array consisting of prefinished, prefabricated, modular type panels. Basically, these panels include a backing layer (solid), a facing material (perforated metal) and a core area. The core area incorporates an integral channeling network which enhances overall structural rigidity, and eliminates self-excitation (vibrating panel). The geometry permits addition of an absorptive insulation material (fillers, batts, etc) for improved sound absorption.

Thickness may vary but usually range from 1 to 10 inches. Large offices, schools, churches, factories, etc, typically use a primary roof deck system. Modified roof decking can also be used in existing areas where improved thermal and acoustical properties are needed. Organizations contributing data to this table are: 45, 51, 71, 84, 87, 108, 113, 134, and 138.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED ON PAGE 53.

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Roof Deck: A platform or a surface covering the structural framework to form a roof

Reverberation Time: Defined as the time required for the sound pressure level of a room to decay 60 decibels, this quantity is an indirect measure of the total sound absorption provided by the room.

Table 17A. Absorption properties of roof deck.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.55	8 inch section, 4 feet wide, prestressed concrete plank, no topping, acoustical soffit, and zonolite core fill											
	.59	.48	.51	.55	.61	.77	8	47	4	113	Concrete Plank	RAL A 62-188
.65	24 inch wide perforated steel deck with 1-1/2 inch deep ribs 6 inches o.c., filled with 2-1/2 inch wide fiberglass, bagged in 1/2 mil PVC. Tested with 1-7/8 inch fiberglass insulation											
	.55	.81	.80	.59	.31	.20	1-1/2	1.74	4	51	B30 Acoustic Deck	RAL A 77-71
.65	Structural cement-wood fiber. Also available with urethane facing											
	.18	.30	.67	1.00	.66	.82	2	6.92	4	84	Fibroplank	RAL A 75-208
.70	16-16 to 20-20 ga perforated steel deck; four 1-1/2 inch deep cells fiberglass filled, 24 inches wide, thickness shown is of glass fiber filler											
	.14	.35	.77	.99	.75	.47	1	3.7 to 6.1	4	108	Type RFC1-1/2 Acoustical Deck	CR 5.5/ROL
.70	Perforated steel, 6 inches o.c., ribs filled with insulation, 6 to 30 foot span											
	.19	.76	1.02	.73	.37	.21	1-1/2	2.5	-	71	B Acoustideck	RAL
.70	Perforated steel, 6 inches o.c., ribs filled with insulation, 6 to 45 foot span											
	.37	.49	.68	.98	.58	.39	1-5/8	5 to 9	-	71	NF Acoustideck	CR 24:120M
.75	Perforated steel, 12 inches o.c., ribs filled with insulation, 6 to 45 foot span											
	.60	.90	.95	.78	.34	.22	3	6.33	-	71	H Acoustideck	RAL
.75	Acoustical roof slab systems. Weight shown is lb/ft^3											
	.21	.43	.97	.82	.83	.80	--	40	4	44	DuLite	RAL
.80	18 to 22 ga perforated steel; 1-1/2 inch deep ribs 6 inches o.c. fiberglass filled, 30 inches wide. Tested with 1 inch rigid fiberglass roof insulation backing, thickness shown is thickness of glass fiber filler											
	.25	59	1.07	.91	.56	.20	1	1.7 to 2.7	4	108	Type B Acoustical Deck	CR 5.5/ROL
.80	16 to 22 ga perforated steel deck; 3 inch deep ribs 8 inches o.c. fiberglass filled, 24 inches wide. Tested with 1 inch thick fiberglass roof insulation backing, thickness shown is of glass fiber											
	.31	.75	1.01	.92	.55	.33	1	2.2 to 4.3	4	108	BP3 Acoustical Deck	CR 5.5/ROL
.80	16-16 to 20-20 ga perforated steel deck, three 3-inch deep cells, fiberglass filled, 24 inches wide, thickness shown is of fiberglass filler											
	.19	.47	.96	.92	.75	.53	1	4.1 to 6.8	4	108	Type RFC3 Acoustical Deck	CR 5.5/ROL
.80	24 inch wide perforated steel deck with 1-1/2 inch deep ribs 6 inches o.c. filled with 1-1/2 inch wide fiberglass insulation. Tested with 1-7/8 inch fiberglass backing											
	.44	.99	1.00	.84	.43	.21	1-1/2	1.74	4	51	B30 Acoustic Deck	RAL A 77-72
.80	24 inch wide perforated steel deck with 1-1/2 inch deep ribs 6 inches o.c. filled with fiberglass insulation. Tested with 1-7/8 inch fiberglass backing											
	.51	.90	.93	.81	.52	.28	1-1/2	1.9	4	51	IB Acoustic Deck	RAL A 75-45
.80	Perforated steel, 6 inch o.c. ribs filled with insulation, 1 inch rigid insulation 6 to 30 foot span											
	.19	.69	1.12	.88	.52	.27	1-1/2	2.5	-	71	S Acoustideck	CR 24:120M
.80	2 inch wide flutes filled with fiberglass with block mat face, flutes perforated with six holes per square inch											
	.61	1.02	.91	.78	.42	.23	1-1/2	4.36	-	138	Type B Metal Deck 1.5 pcf Batts	RAL A 77-162

Table 17A. Absorption properties of roof deck continued.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
.80	2 inch wide flutes filled with fiberglass, flutes perforated with six holes per square inch											
	.66	.99	.92	.79	.43	.23	1-1/2	4.36	-	138	Type B Metal Deck 0.75 pcf Fiberglass	RAL A 77-163
.80	Structural cement-wood fiber. Also available with urethane facing											
	.29	.48	1.01	.92	.88	.91	3	9.25	4	84	Fibroplank	RAL A 75-206
.80	Perforated steel, 12 inch o.c. ribs filled with insulation batt, backed with 1-7/8 inch thick Owens-Corning fiberglass, 6 to 45 foot span											
	.69	.97	1.00	.73	.40	.32	4-1/2	5.9	4	71	4-1/2 inch H Panel	CR 24:120M
.80	Perforated steel, 12 inch o.c. ribs filled with insulation, 6 to 45 foot span											
	.79	1.02	.82	.66	.61	.61	7-1/2	6.33	4	71	H Acoustideck	RAL
.85	16 to 22 ga perforated steel deck; 1-1/2 inch ribs 6 inches o.c. fiberglass filled, 24 inches wide. Tested with 1 inch rigid fiberglass roof insulation backing, thickness shown is of glass fiber filler											
	.19	.58	1.14	1.00	.59	.25	1	1.8 to 3.6	4	108	Type BP1-1/2 Acoustical Deck	CR 5.5/ROL
.85	24 inch wide perforated steel deck with 1-1/2 inch deep ribs 6 inches o.c. filled with 2-1/2 inch wide fiberglass insulation. Tested with 1-7/8 inch fiberglass backing											
	.50	1.01	1.00	.84	.46	.26	1-1/2	1.74	4	51	B30 Acoustic Deck	RAL A 77-70
.85	Perforated steel, 6 inch o.c. ribs filled with insulation, 1-7/8 inch rigid insulation, 6 to 30 foot span											
	.47	1.01	1.01	.90	.53	.24	1-1/2	2.5	-	71	S Acoustideck	CR 24:120M
.85	16 to 22 ga perforated steel deck; 3 inch deep ribs 8 inches o.c. fiberglass filled; 24 inches wide. Tested with 2 inch thick fiberglass roof insulation backing, thickness shown is of glass fiber											
	.54	.97	1.04	.91	.55	.31	2	2.2 to 4.3	4	108	BP3 Acoustical Deck	CR 5.5/ROL
.85	2-1/2 inch wide flutes filled with fiberglass with block mat facing, perforated flutes eight holes per square inch											
	.69	1.01	1.02	.86	.56	.32	3	4.31	-	138	Type N Metal Deck	RAL A 77-161
.85	Perforated steel, 12 inches o.c. ribs filled with insulation batt 2 inches thick											
	.83	1.16	1.06	.68	.49	.46	8	6.17	4	71	H Acoustideck	RAL A 70-22
.90	2-ply 20 ga steel, perforated ribs spaced 6 inches o.c., ribs 2 inches wide, fiberglass laid in rib channels											
	.47	.93	1.06	.96	.56	.23	1-1/2	2.05	4	134	Type B Acoustical Deck	RAL A 76-125
.90	Steel roof deck with perforated ribs and insulations batts which are placed from the top side											
	.53	1.01	1.06	.94	.58	.30	1-1/2	3.5	-	87	Type B1 Acoustical Roof Deck	RAL A 76-57
.90	18 to 22 ga perforated steel deck; 1-1/2 inch ribs 6 inches o.c. fiberglass filled, 30 inches wide. Tested with 2 inch rigid fiberglass roof insulation backing, thickness shown is thickness of glass fiber											
	.52	.96	1.05	.91	.61	.30	2	1.7 to 2.7	4	108	Type B Acoustical Deck	CR 5.5/ROL
.90	24 inch wide perforated steel deck with 3 inch deep ribs 8 inches o.c. filled with fiberglass insulation. Tested with 1-7/8 inch fiberglass backing											
	.58	1.00	1.05	.93	.57	.33	3	2.2	4	51	E300 Acoustic Deck	RAL A 75-44
.90	2-ply 20 ga steel, perforated ribs space 8 inches o.c., ribs 2 inches wide with strips of fiberglass insulation laid in channel, 8 x 9 foot											
	.59	1.00	1.05	.95	.60	.34	3	2.65	4	134	Type N Acoustical Deck	RAL A 76-124

Table 17A. Absorption properties of roof deck concluded.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.90	3 inch deep steel roof deck with perforated ribs and insulation batts (1.5 lb/ft^2) which are placed from the top side											
	.65	1.02	1.02	.90	.56	.29	3	3.91	4	87	Type N Acoustical Roof Deck	RAL A 76-322
.90	Perforated steel, 12 inch o.c. ribs filled with insulation, 6 to 45 foot span											
	.73	1.13	1.06	.89	.52	.31	3	3.97	4	71	N Acoustideck	CR 24 120M
.95	16-16 to 20-20 ga perforated steel deck; three 3 inch deep cells, fiberglass filled; 24 inches wide, thickness shown is of fiberglass filler											
	.34	.80	1.15	1.00	.84	.61	2	4.1 to 6.8	4	108	Type RFC3 Acoustical Deck	CR 5.5/ROL
.95	Perforated steel; 12 inch o.c. ribs filled with insulation, 6 to 45 foot span											
	.65	1.08	1.14	.99	.79	.61	4-1/2	6.5	4	71	HF Acoustideck	CR 24:120M
.95	Perforated steel, 12 inch o.c. ribs filled with insulation, 6 to 45 foot span											
	.68	1.13	1.11	.95	.78	.58	6	7.38	4	71	HF Accustideck	CR 24:120M
.95	Perforated steel, 12 inch o.c. ribs filled with insulation, 6 to 45 foot span											
	.91	1.23	1.07	1.00	.79	.64	7-1/2	7.55	4	71	HF Accustideck	CR 24:120M

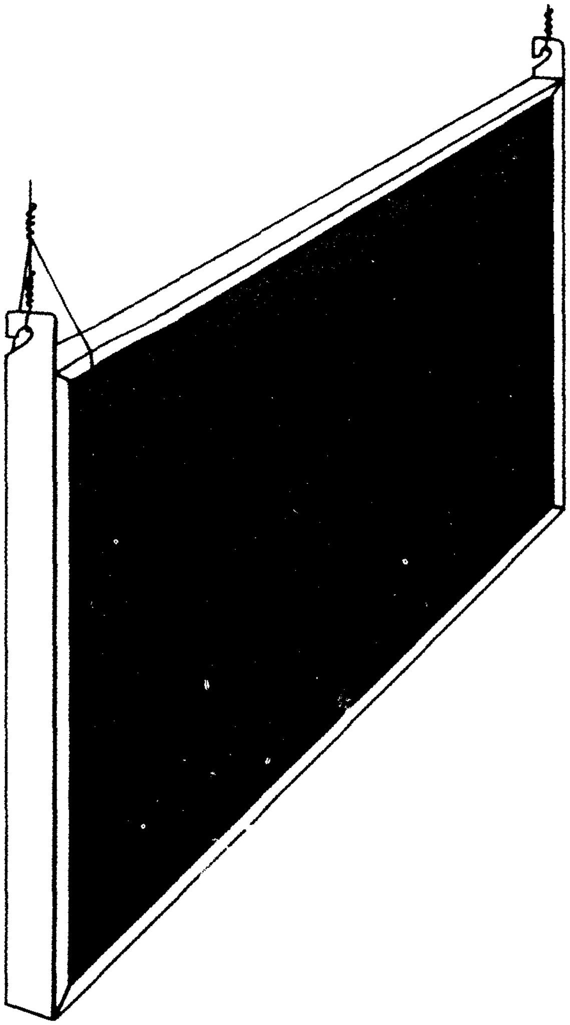
Table 17B. Barrier properties of roof deck.

	Transmission Loss, dB																				
STC	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
45	Steel roof decking, 22 gauge.																				
	29			38			45			48			49			49	1-1/2	1.71	71	S Acoustideck	CR 24-1 20M
45	Steel roof decking, 22 gauge																				
	29			38			45			48			49			49	1-1/2	1.82	71	B Acoustideck	CR 24-1 20M
46	Steel roof decking, 20 gauge.																				
	30			39			46			49			50			50	1-1/2	2.06	71	S Acoustideck	CR 24-1 20M
46	Steel roof decking, 20 gauge																				
	30			39			46			49			50			50	1-1/2	2.18	71	B Acoustideck	CR 24-1 20M
46	Steel roof decking. 20 gauge																				
	30			39			46			49			50			50	3	2.57	71	N Acoustideck	CR 24-1 20M
47	Steel roof decking, 18 gauge																				
	31			40			47			50			51			51	1-1/2	2.75	71	S Acoustideck	CR 24-1 20M
47	Steel roof decking, 18 gauge																				
	31			40			47			50			51			51	1-1/2	2.91	71	B Acoustideck	CR 24-1 20M
47	Steel roof decking, 20 gauge																				
	31			40			47			50			51			51	4-1/2	3.06	71	H Acoustideck	CR 24-1 20M
48	Steel roof decking, 18 gauge																				
	30			39			46			49			50			50	3	3.43	71	N Acoustideck	CR 24-1 20M
49	Steel roof decking, 20-18 gauge																				
	33			42			49			52			53			53	1-5/8	4.16	71	NF Acoustideck	CR 24-1 20M
49	Steel roof decking, 18 gauge																				
	33			42			49			52			53			53	4-1/2	4.08	71	H Acoustideck	CR 24-1 20M
50	Steel roof decking, 18-18 gauge																				
	34			43			50			53			54			54	1-5/8	4.80	71	NF Acoustideck	CR 24-1 20M
50	Steel roof decking, 20-18 gauge																				
	34			43			50			53			54			54	3	4.66	71	NF Acoustideck	CR 24-1 20M
50	Steel roof decking, 20-18 gauge																				
	34			43			50			53			54			54	4-1/2	4.74	71	HF Acoustideck	CR 24-1 20M
50	Steel roof decking, 18 gauge																				
	34			43			50			53			54			54	6	4.57	71	H Acoustideck	CR 24-1 20M
51	Steel roof decking, 16 gauge																				
	35			44			51			54			55			55	4-1/2	5.12	71	H Acoustideck	CR 24-1 20M
51	Steel roof decking, 18 gauge																				
	35			44			51			54			55			55	7-1/2	5.05	71	H Acoustideck	CR 24-1 20M
52	Steel roof decking, 18-18 gauge																				
	36			45			52			55			56			56	4-1/2	5.58	71	HF Acoustideck	CR 24-1 20M
52	Steel roof decking, 16-18 gauge																				
	36			45			52			55			56			56	1-5/8	5.44	71	NF Acoustideck	CR 24-1 20M
52	Steel roof decking, 18-18 gauge																				
	36			45			52			55			56			56	3	5.47	71	NF Acoustideck	CR 24-1 20M

Table 17B. Barrier properties of roof deck concluded.

	Transmission Loss, dB																				
STC	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
52	Steel roof decking. 16 gauge																				CR 24-1 20M
	36			45			52			55			56			56	6	5.72	71	H Acoustideck	
53	Steel roof decking, 16 gauge																				CR 24-1 20M
	37			46			53			56			57			57	7-1/2	6.32	71	H Acoustideck	
53	Steel roof decking, 18-18 gauge																				CR 24-1 20M
	37			46			53			56			57			57	7-1/2	6.57	71	HF Acoustideck	
53	Steel roof decking, 16-18 gauge																				CR 24-1 20M
	37			46			53			56			57			57	4-1/2	6.41	71	HF Acoustideck	
53	Steel roof decking, 18-18 gauge																				CR 24-1 20M
	37			46			53			56			57			57	6	6.08	71	HF Acoustideck	
53	Steel roof decking, 16-18 gauge																				CR 24-1 20M
	37			46			53			56			57			57	3	6.27	71	NF Acoustideck	
54	Steel roof decking, 16-18 gauge																				CR 24-1 20M
	38			47			54			57			58			58	7-1/2	7.66	71	HF Acoustideck	
54	Steel roof decking, 16-16 gauge																				CR 24-1 20M
	38			47			54			57			58			58	7-1/2	8.21	71	HF Acoustideck	
54	Steel roof decking, 16-16 gauge																				CR 24-1 20M
	38			47			54			57			58			58	6	7.60	71	HF Acoustideck	

CATEGORY 18. UNIT ABSORBERS



CATEGORY 18. UNIT ABSORBERS

Sound absorption in a room can be increased by adding unit absorbers. They are easy to install and available in various shapes and sizes. The amount of absorption that can be obtained depends on the unit absorber spacing. The amount of sound energy absorbed by a particular unit absorber is proportional to the area exposed to the incident sound energy. For this reason, many absorbers are suspended from ceilings using wires to expose all surfaces to the sound. For efficient usage unit absorbers should be placed as close to the noise source as practical.

Organizations contributing data to this table are: 4, 15, 20, 40, 73, 82, 85, 90, 96, 98, 101, 115, and 133.

CAUTION

ABSORPTION DATA PRESENTED ARE TOTAL ABSORPTION FOR EACH ITEM (SABINS/UNIT). THE TERM UNIT REFERS TO THE MANUFACTURER'S STANDARD SIZE UNIT AS DESCRIBED IN THE TABLE. FOR EXPLANATION OF SABINS SEE PAGE 50.

Table 18. Unit absorbers.

	Absorption, sabins/unit											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
Perforated 12 x 18 inch low density cellular glass block												
	.83	1.18	1.09	1.01	.98	1.20	2	8	4	98	Geocoustic Blocks	KAL 2141-77
Tedlar covered 12 x 18 inch low density cellular blocks with 1/8 inch diameter holes side by side. Testing strung on cables												
	.94	1.00	1.15	.96	1.01	1.35	2	--	-	98	Geocoustic Blocks	KAL 2088-77
Perforated 12 x 18 inch low density cellular glass blocks												
	1.07	1.18	1.26	1.23	1.21	1.37	4	8	4	98	Geocoustic Blocks	KAL 2141-77
12 x 18 inch low density cellular glass block, spaced 1/2 inch apart in both directions on cables												
	.95	1.18	1.12	1.28	1.36	1.14	2	8	-	98	Geocoustic Blocks	KAL 2000-76
12 x 18 inch low density cellular glass block, spaced 6 inches apart in both directions on cables												
	1.03	1.16	1.20	1.31	1.45	1.59	2	8	-	98	Geocoustic Blocks	KAL 2000-76
Perforated 12 x 18 inch low density cellular glass blocks, spaced 2 inches apart												
	.93	1.39	1.33	1.47	1.28	1.33	2	8	4	98	Geocoustic Blocks	KAL 2141-77
12 x 18 inch low density cellular glass blocks, spaced 2 feet o.c. both directions on cables												
	1.15	1.16	1.22	1.31	1.56	1.66	2	8	-	98	Geocoustic Blocks	KAL 2000-76
16 inch o.c., 11-1/2 x 16 x 1/8 inch resonant cavity in back. Low density cellular glass												
	.2	.8	2.0	2.2	1.8	1.2	2	9.42	-	98	Geocoustic II Unit	RAL
12 x 18 inch low density cellular glass blocks, spaced 3 feet o.c. in both directions on cables												
	1.17	1.34	1.28	1.51	1.71	1.68	2	8	-	98	Geocoustic Blocks	KAL 2000-76
Low density cellular glass block, 11-1/2 x 16 inch with 1/8 inch resonant cavity in back, spaced 24 inches o.c. apart												
	.2	.7	2.0	2.2	2.0	1.7	2	9.42	-	98	Geocoustic II Unit	RAL
Perforated 12 x 18 inch low density cellular glass blocks spaced 6 inches apart												
	1.14	1.53	1.53	1.40	1.63	1.71	2	8	4	98	Geocoustic Blocks	KAL 2141-77
Tedlar covered 12 x 18 inch low density cellular glass blocks with 1/8 inch diameter holes. Spaced 2 feet o.c. one direction and 3 feet o.c. the other, on cables												
	1.07	1.45	1.55	1.43	1.69	1.87	2	--	-	98	Geocoustic Blocks	KAL 2088-77
Slotted 12 x 18 inch low density cellular glass blocks												
	1.23	1.50	1.59	1.70	1.65	1.70	4	8	4	98	Geocoustic Blocks	KAL 2141-77
12 x 18 inch low density cellular glass, Tedlar covered, spaced 2 feet o.c. both directions on cables												
	1.24	1.30	1.63	1.63	1.72	1.91	4	8.75	-	98	Geocoustic Blocks	KAL 2000-76
12 x 18 inch low density cellular glass blocks, spaced 2 feet o.c. both directions on cables												
	1.27	1.38	1.55	1.56	1.77	2.02	4	8		98	Geocoustic Blocks	KAL 2000-76
Perforated 12 x 18 inch low density cellular glass blocks spaced 2 inches apart												
	1.24	1.59	1.82	1.61	1.60	1.74	4	8	4	98	Geocoustic Blocks	KAL 2141-77

Table 18. Unit absorbers continued.

NRC	Absorption, sabins/unit						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
	32 inch o.c., 11-1/2 x 16 inch with 1/8 inch resonant cavity in back. Low density cellular glass blocks											
	.2	.6	2.6	2.4	2.2	1.8	2	9.42	-	98	Geocoustic II Unit	RAL
	Perforated 12 x 18 inch low density cellular glass spaced 6 inches apart											
	1.31	1.59	1.78	1.74	1.81	2.00	4	8	4	98	Geocoustic Blocks	KAL 2141-77
	12 x 18 inch low density cellular block, thick slotted, spaced 2 feet o.c. both directions on cables											
	1.09	1.42	1.73	1.73	2.02	2.49	2	8	-	98	Geocoustic Blocks	KAL 2000-76
	Slotted 12 x 18 inch low density cellular glass blocks spaced 2 inches apart											
	1.27	1.69	1.99	1.91	1.95	1.99	4	8	4	98	Geocoustic Blocks	KAL 2141-77
	Slotted 12 x 18 inch low density cellular glass blocks spaced 6 inches apart											
	1.21	1.79	1.99	2.36	2.26	2.32	4	8	4	98	Geocoustic Blocks	KAL 2141-77
	11-1/2 x 16 inch low density cellular glass, 3 feet o.c.											
	.2	.9	2.4	3.6	2.8	2.5	4	9.4	-	98	Geocoustic Unit	RAL 74-197
	12 x 18 inch low density cellular glass block, thick slotted, spaced 2 feet o.c. both directions on cables											
	1.27	1.82	2.29	2.50	2.63	2.64	4	8	-	98	Geocoustic Blocks	KAL 2000-76
	12 x 18 inch low density cellular glass block, slotted on both sides, suspended 24 inches o.c. in one direction and 16 inches o.c. in the other											
	.93	1.43	1.86	2.87	3.14	3.22	4	8	-	98	Geocoustic Hanging Absorbers	KAL 2152-77
	12 x 18 inch absorber, slotted on both sides, suspended 24 inches o.c. in one direction and 52 inches o.c. in other. Low density cellular glass											
	.92	1.38	2.25	3.44	3.72	3.80	4	8	-	98	Geocoustic Hanging Absorbers	KAL 2152-77
	2 x 2 foot mineral fiber blanket encased in white plastic film, spaced 1 foot apart in rows 3 feet o.c.											
	1.5	2.7	5.7	6.7	5.4	3.8	2	7.5	-	133	Acoustisorber Space Units	RAL
	Pipe insulation, 1 inch I.D. x 3 inch O.D., 9 feet long hung vertically in a single row 6 inch o.c. spacing. May be used as unit absorbers											
	0.3	1.2	3.5	5.9	7.4	8.9	-	--	-	96		OCRL
	18 x 24 inch low density cellular glass block, slotted both sides, spaced 3 feet o.c. both ways on cables											
	1.61	3.64	5.00	6.62	7.65	7.28	4	8	-	98	Geocoustic Hanging Block	KAL 2000-76
	Pipe insulation, 1 inch I.D. x 3 inch O.D., 9 feet long, hung vertically in single row 12 inches o.c. spacing. May be used as unit absorbers											
	0.2	1.1	3.7	7.8	9.5	10.3	-	--	-	96		OCRL
	T-egg crate array; fiberglass board, painted											
	4.5	5.5	5.4	6.5	6.0	5.2	1-5/8	--	-	115	Series 100 Ceiling Baffles	CKAL 7701.42
	T-egg crate array; fiberglass, fabric cover											
	4.8	5.7	5.8	6.8	5.6	4.6	2	--	-	115	Series 400 Ceiling Baffles	CKAL 7701.44
	Plastic Industrial types cloud-lite 24 x 28 inch with 1-1/2 inch fiberglass											
	1.8	3.4	5.3	7.0	8.8	8.4	1	--	-	85	Cloud-Lite Acoustic Baffles	CR 9.1 ME

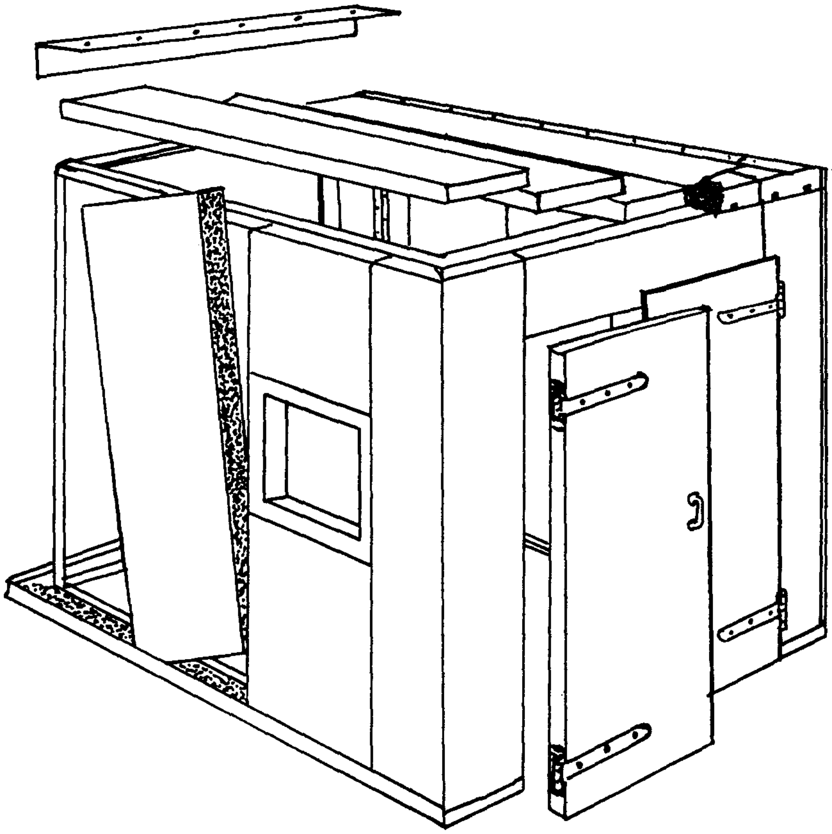
Table 18. Unit absorbers continued.

NRC	Absorption, sabins/unit 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft³)	Mounting	Company	Product	Reference
Fiberglass and mineral wool cylinder, 12 inch diam x 24 inch long, density shown is weight of unit in lb												
	2.9	5.2	6.5	8.4	8.5	8.2	--	4.5	-	20	Sonosorber	CR
24 x 48 inch baffle strung on 3 foot centers. Noise control for halls, arenas, auditoriums												
		3.35	7.59	8.80	9.50		1-1/2	12.8	-	4	Type A Baffles	G&H
Plastic industrial type. Cloud-lite 24 x 48 inch with 1-1/2 inch fiberglass												
	2.4	4.4	6.9	9.1	11.5	10.9	1-1/2	--	-	85	Cloud-Lite Acoustic Baffles	CR 9.1 ME
Molded fiberglass cylinders, 12 x 24 inch												
	4.35	6.40	7.50	8.62	9.58	9.43	--	2.75	-	73	I-C Drum Sound Absorber	KAL 428458
Noise baffles 2 x 4 foot for factories, gymnasiums, swimming pools, areas of high humidity or vapor concentrations, glass fiber core, thin film facing and durable reinforced coated fabric frame on 4 foot centers												
	2.18	4.65	9.23	10.35	10.63	9.68	3	1.24	-	4	Echo-Sorb	G&H
12 x 24 inch sound absorbing cylindrical fiberglass units enclose two tuned metal resonators to attenuate low or frequent sound												
	3.65	5.84	8.48	9.51	9.98	9.90	--	3	-	101	Noisemaster Resonator Sound Absorbers	KAL 438552
23 x 48 x 1-1/2 inch fiberglass wrapped in plastic film, hung vertically in rows 4 feet o.c. spacing. May be used as unit absorbers												
	2.1	5.9	9.8	13.3	11.6	7.6	--	4.7	-	96		OCRL
Noise baffles 2 x 4 foot for factories, gymnasiums, swimming pools, areas of high humidity or vapor concentrations, glass fiber core, thin film facing, and durable reinforced coated fabric frame, 6 foot centers												
	2.17	5.43	9.30	11.13	11.75	10.55	3	1.24	-	4	Echo-Sorb	G&H
24 x 48 inch type A baffles, noise control for halls, arenas, auditoriums, strung on 4 foot centers												
		3.85	8.82	10.87	11.58		1-1/2	12.8	-	4	Type A Baffles	G&H
24 x 48 x 1-1/2 inch thick fiberglass												
	1.5	7.0	11.5	16.0	12.0	7.8	1-1/2	--	-	82	UNA-1 Unit Absorber	CR
Absorptive panel, mineral-fiber core encased in opaque white film 2 x 4 foot												
	3.2	5.2	10.4	14.3	13.3	10.1	1-1/2	8	-	15	Armstrong Shrink-Wrapped Vertical Baffle Absorbers	AAL T52552 T56965
Fiberglass boards encased in plastic												
	4.30	6.55	9.75	13.30	13.60	13.30	1-1/2	4.2	-	73	I-C Noise Stop Baffles	KAL 1376-2-72
24 x 48 inch type A baffles, noise control for halls, arenas, auditoriums, strung on 6 foot centers												
		4.43	9.97	13.37	13.55		1-1/2	12.8	-	4	Type A Baffles	G&H
24 x 48 inch type A baffles, noise control for halls, arenas, auditoriums, strung on 8 foot centers												
		5.80	10.41	15.22	14.82		1-1/2	12.8	-	4	Type A Baffles	G&H
4 x 6 foot panel of cellulose fiber material on lightweight metal lath												
	8.4	17.1	30.0	39.7	41.6	41.6	--	--	-	90	K-13 Panel System	CR
Absorbing space unit enclosed in mylar with grommets 2 x 4 foot												
							1	2.25	-	40	dBA Spec-SA	CR

Table 18. Unit absorbers concluded.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	32 inch o.c. (patch), 11-1/2 x 16 inch, with 1/8 inch cavity in back. Data given are absorption coefficients											
	.03	.08	.37	.34	.31	.25	2	9.42	-	98	Geocoustic II Unit	CR
	24 inch o.c. (patch), low density cellular glass block. Data given are absorption coefficients											
	.05	.17	.50	.55	.50	.42	2	9.42	-	98	Geocoustic II Unit	CR
	16 inch o.c. (rectangle), 11-1/2 x 16 inch, with 1/8 inch cavity in back. Data given are absorption coefficients											
	.11	.44	1.00	1.00	1.00	.66	2	9.42	-	98	Geocoustic II Unit	CR
	22 ga galvanized perforated steel face mineral wool insulation, varying sizes, 2 x 4 foot through 3 x 10 foot. Data given are absorption coefficients											
	.8	.7	.9	.7	.8	.6	3	--	-	82	Functional Absorber	CR
	2 x 4 foot absorptive panel, mineral-fiber core encased in opaque white film. Data given are absorption coefficients. Density given is weight of unit in lb											
	.34	.55	.89	.99	.98	.72	1-1/2	8	7	15	Armstrong Shrink-Wrapped Vertical Baffle Absorbers	AAL T52584
	12 x 18 inch, seven slots per unit, 1/4 x 1-1/2 x 18 inch, spaced 1-1/2 inch o.c., low density cellular glass, can be used for unit absorbers. Data given are absorption coefficients											
	.41	.67	.98	1.04	.97	.76	3-1/2	9.94	4	88	Geocoustic	RAL A 75-19

CATEGORY 19. ENCLOSURES



CATEGORY 19. ENCLOSURES/QUIET ROOMS

Quiet rooms are either constructed as complete units or prefabricated modular sections. Uses for Quiet rooms include viewing stations, study areas, audiometric testing rooms, music practice areas, recording studios, supervisory control centers, etc. Quiet room data are related to the finished product or a prefabricated section.

Enclosures are usually configured for a particular piece of equipment or machinery. Designs for enclosures are influenced by operator accessibility, thermal environment, chemical and moisture resistance, and overall maintenance. Data are presented for fabricated materials which can be used for enclosures. Since many installations are unique, a detailed analysis is required in determining the effectiveness of a proposed enclosure system.

Organizations contributing data to this table are: 5, 32, 47, 70, 72, 77, 78, 82, 112, 114, 120, 125, 127, and 139. Other related categories are: panels, unit absorbers, walls, and operable partitions.

CAUTION

1. NOISE REDUCTION DATA ARE SOMETIMES OBTAINED BY COMPUTATIONS BASED ON DATA FOR INDIVIDUAL PANELS WHICH ARE USED TO CONSTRUCT THE ROOM. ALSO, SPECIAL CUSTOMER OPTIONS (WINDOWS, VENTS, ETC.) MAY AFFECT THE PERFORMANCE OF A ROOM.
2. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.
3. **VALUES PRESENTED ON PAGE 260 ARE TRANSMISSION LOSSES AND THOSE PRESENTED ON PAGE 262 ARE NOISE REDUCTIONS. SEE PAGE 70 FOR EXPLANATION OF DIFFERENCES.**

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Anechoic: Echo free

Anechoic Wedges: Wedge-shaped sound absorbing units commonly used to create a free field type environment

Table 19A. Absorption properties of enclosure systems.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
.85 (c)	Standard panel model 2P											
	.50	.70	.95	.95	.90	.82	2	--	--	5	Silent Room Model OBCF	CR B-135
.90 (c)	Standard panel models 4P, 4PH, 4PHT.											
	.69	.99	.96	.89	.83	.81	4	--	--	5	Silent Room Model OBCF	CR B-135
.95	Four metal wall panels: two were 85-1/2 x 30 inch and two were 85-1/2 by 15 inch. One layer perforated metal approximately 4 inch absorbent material, layer of unperforated metal. For use in music rooms.											
	.57	.97	1.09	1.10	1.08	1.02	4	10.25	4	120	Acoustical Panels	RAL A 72-167
.95	Type 1 prefabricated panels, widths of 16 to 48 inch and lengths of 48 to 144 inch, 16 gauge back, 22 gauge perforated face with 4 inch thick acoustical filler in core.											
	.62	1.08	1.12	1.06	1.03	.97	4	--	--	127	Acoustic Modular Enclosure System	CR ME 400C
.95	Type II prefabricated panels width 16 to 48 inch, lengths 48 to 144 inch, gypsum board barrier, 16 gauge back, 22 gauge perforated face with 4 inch thick acoustical filler in core.											
	.62	1.08	1.12	1.06	1.03	.97	4	--	--	127	Acoustical Modular Enclosure System	CR ME 400C
.95 (c)	Panel 6PHT, heavy duty, high temperature.											
	.85	.99	.97	.92	.85	.83	6	--	--	5	Silent Room Model OBCF	CR B-135
.95	Portable enclosure, prefabricated Type 1 acoustical modular panels, with full view windows, sealed doors, heavy duty floors, quiet ventilation, and electrically intact. 16 standard sizes.											
	.62	1.08	1.12	1.06	1.03	.97	--	--	--	127	Personnel Enclosures	CR ME 401B-1978
.95	Prefabricated panels of single wall configuration, 4 inch thick, 16 gauge steel back, 22 gauge perforated face. Floor panels 4-3/16 inch thick, 11 and 16 gauge steel. Sizes from 4 ft x 3 ft 8 inches x 7 ft 8 inch to 21 ft 8 inch x 10 ft 4 inch x 8 ft 1 inch, panel weight 8.5 lb/sq ft.											
	.48	1.01	1.11	1.05	.97	.83	--	--	--	127	RE & RS Series Audiometric Rooms	RAL
.95	**Enclosure modular panels and systems**. Panel 16 gauge zinc-coated steel backing, 22 gauge zinc-coated steel perforated facing with 3/32 inch holes on 3/16 inch staggered centers. Acoustical fill 4 lb/cu ft windows, doors, floor, connecting components and ventilating systems.											
	.75	1.01	1.11	1.06	1.02	.95	4	--	--	139	Vanec Acoustical Systems	CR B-900-1-0
1.00	Two panels connected by special battens, 7 ft high by 10 ft 10 inch wide.											
	.58	.73	1.10	1.09	1.00	1.00	4	454	4	47	88-5 Audiometric Room Panels	CKAL 7501.76

Table 19B. Barrier properties of enclosure systems (transmission loss).

STC	Transmission Loss, dB																		Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz					
23(c)	Sliding or bi-fold door, covered with 26 gauge steel, urethane core, 14 x 17 inch double paned window. For use in Soundscreen modular systems																						
	15	17	22	21	22	23	24	25	25	25	24	19	22	30	34	36	37	38	2	--	82	Soundscreen Doors	CR GP-4200
23(c)	Air opening 6 x 14 inch, duct lined with fiberglass, 4 ft long vent panel																						
	9	10	11	12	13	14	17	19	21	23	24	29	35	48	46	44	43	40	4	--	82	Soundscreen Ventilation Panels	CR GP-4200
30	12 x 108 inch 20 gauge steel containing 1-1/2 inch of 1-1/2 lb/ft^3 fiberglass foil faced																						
	17	15	18	20	22	22	21	25	28	32	36	39	40	41	41	40	43		1-1/2	1.5	125	Acousti Panel	RAL TL 74-238
30(c)	6 ft long vent panel																						
	12	13	14	15	16	20	25	30	32	34	36	40	44	50	54	56	57	53	4	--	82	Soundscreen Ventilation Panel	CR GP-4200
31(c)	Swinging single door, 34 x 76 inch, 16 gauge steel exterior, 22 gauge perforated steel, with 18 x 18 inch double panel window																						
	19	21	20	23	25	27	30	30	28	29	31	33	32	32	33	35	38	41	4	--	82	Soundscreen Doors	CR GP-4200
31(c)	Standard urethane panels, varying sizes																						
	22	27	25	24	24	24	23	23	28	38	43	45	47	49	50	53	56	57	4	--	82	Soundscreen Modular Panels	CR GP-4200
33	Acoustical enclosure and wall system providing transmission loss qualities with airflow capabilities. Constructed out of .028 inch aluminized steel and acoustical material 30 inch wide x 96 inch long. So arranged to be designated as "the Breathing Panel"																						
		12			22			32			47			58			59		2	--	32	Muffl-wall	CKAL 7804.19
34(c)	8 ft long vent panel																						
	13	15	17	19	21	23	31	40	43	46	47	48	50	52	55	56	58	56	4	--	82	Soundscreen Ventilation Panel	CR GP-4200
36	12 x 108 inch 20 gauge steel, containing 1-1/2 inch of 1-1/2 lb/ft^3 fiberglass and 1/2 inch gypsum board																						
	21	22	23	24	25	28	28	29	32	35	39	42	44	44	43	44	46	48	1-1/2	3.5	125	Acousti Panel	RAL TL 74-239
36	12 x 100 inch 20 gauge steel, containing 1/2 inch gypsum board 1-1/2 inch of 1-1/2 lb/cu ft fiberglass and another 1/2 inch gypsum board																						
	23	22	21	20	21	29	35	38	39	40	42	44	43	43	42	41	43	45	1-1/2	5.5	125	Acousti Panel	RAL TL 74-240
36(c)	2 x 4 ft panel, two 18 x 30 inch acrylic windows 1/4 inch thick																						
	19	21	23	25	27	28	30	32	34	36	38	39	40	41	41	41	41	42	4	--	82	Soundscreen Modular Panels	CR GP-4200
38(c)	10 ft long vent panel																						
	15	16	18	22	25	30	38	40	43	48	51	52	52	53	54	55	58	58	4	--	82	Soundscreen Ventilation Panel	CR GP-4200
42	Type I prefabricated panels, widths of 16 to 48 inch with lengths of 48 to 144 inch. 16 gauge back, 22 gauge perforated face with 4 inch thick acoustical filler in core																						
		22			28			40			49			54			57		4	--	127	Acoustic Modular Enclosure System	CR 1974 ME-400C
44	Type II prefabricated panels, width 16 to 48 inch, lengths 48 to 144 inch gypsum board barrier, 16 gauge back, 22 gauge perforated face with 4 inch thick acoustical filler in core																						
		24			31			41			50			56			57		4	--	127	Acoustic Modular Enclosure System	CR ME-400C
	Standard panels made of steel and fiberglass (Model 2P), 4 x 6 ft up in 1 ft increments - all 78 inch high inside, 100 inch outside																						
		20			25			31			37			43			46		2	--	5	Silent Room Model OBCF	CR B-135
	11 ft 6 inch long x 8 ft 2 inch wide x 8 ft 11 inch high enclosure with four double-wing doors 3 ft wide																						
		26			36			40			44			50			50		3	--	70	1 DE-100-21	CR NCD-7560.2
	Heavy duty panel Model 4PH, and high temperature panel Model 4PHT, temperature to 1000°F. 4 x 6 ft up in 1 ft increments - all 78 inch high inside, 100 inch outside																						
		26			33			41			46			52			55		4	--	5	Silent Room Model OBCF	CR B-135

Table 19B. Barrier properties of enclosure systems (transmission loss) concluded.

STC	Transmission Loss, dB																		Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz					
	Standard panels made of steel fiberglass Model 4P, 4 x 6 ft up in 1 ft increments - all 78 inch high inside, 100 inch outside																						
		23			29			37			42			48			54		4	--	5	Silent Room Model OBCF	CR B-135
	Heavy duty panel high temperature Model 6PHT, temperature to 1000°F. 4 x 6 ft up in 1 ft increments - all 78 inch high inside, 100 inch outside																						
		31			37			44			49			55			58		6	--	5	Silent Room Model OBCF	CR B-135
	Enclosure modular panels and systems, panels 16 gauge zinc-coated steel backing, 22 gauge zinc-coated steel perforated facing with 3/32 inch holes on 3/16 inch staggered centers, acoustical fill 4 lb/cu ft windows, doors, floor connecting components and ventilation system																						
		22			29			40			50			55			57		4	20	139	Vanec Acoustical Systems	CR B-900-1-0

Table 19C. Barrier properties of enclosure systems (noise reduction).

	Noise Reduction, dB																						
STC	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
Free standing enclosure 72 x 96 x 84 inch high. Leaded vinyl supported by metal frame																							
		9	6	6	7	9	11	13	16	19	21	21	19	21	23	26	26		--	--	112	Sound Stopper free standing enclosure	RAL
Free standing enclosure 72 x 96 x 84 inch high. Leaded vinyl supported by metal frame																							
		11	8	7	10	10	14	16	19	19	20	20	21	22	22	22	23		--	--	112	Sound Stopper free standing enclosure	RAL
Enclosure with inside dimensions of 80 x 80 x 84 inch high, outside dimensions 84 x 84 x 89 inch high. 16 gauge steel back, 22 gauge perforated steel face with a core of 4-3/4, lb density absorption material. Door, window, ventilation, and electrical supplied																							
		16			24			25			29			34			37		2	--	78	Noise Guard Portable Office Enclosure	CR K44
22 gauge galvanized steel back, 22 gauge galvanized perforated face, 6 lb/cu ft absorption material core, 1/8 inch structural steel floor. S.V.R. -1: outside dimensions 6 ft 4 inch x 6 ft 4 inch x 7 ft 6 inch (1350 lb). S.V.R. -2: outside dimensions 6 ft 6 inch x 10 ft 4 inch x 8 ft 0 inch (2300 lb)																							
		19			21			26			32			36			38		2	--	82	Versacoustic Rooms	CR DS4202
OCBF labyrinth models, 4 x 6 ft up in 1 ft increments, all 78 inch high inside, 100 inch outside																							
		16			21			28			36			36			35		--	--	5	Silent Room Portable	CR B-135
OCBF door model 4 x 6 ft up in 1 ft increments, all 78 inch high inside, 100 inch outside																							
		20			23			28			36			36			35		--	--	5	Silent Room Portable	CR B-135
Prefabricated, acoustically treated room designed for maximum visibility and personnel safety. Constructed from tracoustics 1, 2 inch panels, 16 gauge galvanized steel outer and 22 gauge perforated steel interiors. Solid steel floor with rubber mat																							
		25			17			30			39			42			45		--	--	127	RC 200 Series Control Rooms	CR ME-402
Portable prefabricated type 1 acoustical module panels with full view windows, sealed doors, heavy duty floors, quiet ventilation. 16 standard sizes																							
		25			17			30			39			42			45		--	--	127	Personnel Enclosures	CR ME-401B-1978
53 x 38 x 88 inch outside, 45 x 30 x 80 inch inside, one 30 x 24 inch window, three perforated walls, carpeted floor																							
	21	23	22	29	32	36	36	36	36	37	39	41	41	41	39	39	41	42	8	--	120	25M Hearing Test Booth	RAL NR 76-8
Outside is 83 x 113 x 91 inch, inside is 75 x 105 x 86 inch, with one 30 x 86 inch window																							
	24	23	24	26	29	34	36	38	39	37	37	40	42	40	38	42	45	46	8	--	120	Model 802 Practice Module	RAL NR 76-7
4 inch thick panels, outer surface 16 gauge CRS, CRS perforated 3/22 inch on 3/16 inch staggered centers, 10 gauge inner surface; floor is one piece with top surface and 16 gauge lower, booth dimensions 38 x 53 x 90 inch outside, 30 x 45 x 80 inch inside. Data are insertion loss																							
	21	23	22	29	32	36	36	36	36	37	39	41	41	41	41	41	42	44	4	--	77	Hearing Test Booth	RAL
Audiometric booth 6 ft 10 inch high x 3 ft 4 inch wide x 3 ft 6 inch deep with isolators on casters, windows, jack panel, ventilator. 2 inch thick panel construction, 22 gauge perforated zinc coated steel face, mineral wool filler, 16 gauge steel back																							
	27	24	16	27	31	30	32	34	39	40	43	46	49	52	52	53	54	53	--	--	47	Model 442	CKAL 738-02
All steel construction, outside dimensions 32 x 42 x 71 inch, inside 28 x 38 x 60 inch. Available in several variations and models																							
		20			32			38			44			52			53		2	--	114	Mini Booth	CR V7B IC3
Portable audiometric booth 29-1/2 inch wide x 40 inch deep and 62 inch high with isolators or casters. Also window, jack panel, ventilation. 2 inch thick panel construction, perforated inside of 22 gauge zinc coated steel, outside of 16 gauge steel, mineral wool core																							
	13	15	24	24	35	35	38	40	43	44	44	47	52	52	53	52	53	51	--	--	47	AB200HD Type 1	CKAL 77-08.01
Prefabricated panels of single wall configurations 4 inch thick. 16 gauge outer surface and 22 gauge perforated inner surface. Floor panels, 4-3/16 inch thick of 11 and 16 gauge steel. Sizes from 4 ft x 3 ft 8 inch x 7 ft 8 inch to 21 ft 8 inch x 10 ft 4 inch x 8 ft 1 inch. Panel weight 8.5 lb/ft^2																							
	24	24	23	28	31	34	39	44	46	48	52	55	57	58	60	59	59	59	--	--	127	RE & RS Series Audiometric Room	RAL

Table 19C. Barrier properties of enclosure systems (noise reduction) concluded.

	Noise Reduction, dB																						
STC	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
Model 88S prefabricated panels, final assembly at location																							
	20	20	15	28	31	36	42	46	50	52	54	55	55	58	58	59	59		--	--	47	Single Wall Examination Room	CKAL 75-01.76
Enclosure with inside dimensions of 76 x 76 x 84 inch high and 84 x 84 x 91 inch high. 16 gauge steel back, 22 gauge perforated steel face with a core of 4-3/4 lb. density. Door, window, ventilation, and electrical supplied																							
		27			36			45			50			55			59		4	--	78	Noise Guard Portable Office Enclosure	CR K44
16 gauge steel back, 22 gauge steel perforated face, nonflammable mineral wool core, dimensions 29 x 39 x 74 inch																							
								40			47			52			56		2	--	82	Model AR-18 Audiometric Rooms	CR DS4203
Inside 72 x 76 x 78 inch, vent sealed, 16 gauge CR steel outside, 22 gauge CR steel inside, one wall contained a double glazed window 24 x 30 inch																							
		32			36			46			58			64			66		4	--	120	Single Walled Audiometric Rooms	RAL NR 71-56
Two model 802 practice modules. The measurement was made from module to module																							
	38	42	45	51	51	56	56	57	61	68	74	81	84	78	85	90	92	95	8	--	120	Model 802 Practice Modules	RAL NR 76-6
Model 88D, inner room was a model 88-S audiometric room, the outer was assembled from 4 inch thick panels connected together by special battens, 4 inch air space																							
	36	34	39	50	62	71	80	85	89	90	90	88	90	92	89	87	84	79	--	--	47	Double Wall Audiometric Room	CKAL 75-08-03
Prefabricated panels of double wall configuration, 4 inch thick, 16 gauge back and 22 gauge perforated face. Floor panels 4-3/16 inch thick 11 and 16 gauge steel. Sizes from 4 ft x 3 ft 8 inch x 7 ft 8 inch to 21 ft 8 inch x 10 ft 4 inch x 8 ft 1 inch. Panel weight 8.5 lb/sq ft.																							
	41	49	46	55	61	71	73	74	82	84	87	90	90	92	92	98	98	98	--	--	127	RE & RS Series Audiometric Rooms	RAL
Inside is 72 x 76 x 78 inch and outside is 96 x 100 x 94 inch																							
		49			56			76			100			>107			>108		--	--	120	Double Walled Audiometric Room	RAL NR71-58
																			--	--	77	Portable Shop Office	--

CATEGORY 20. DOORS

CATEGORY 20. DOORS

A door is basically an operable partition used for privacy and security purposes. Acoustically, it is primarily a noise barrier. There may be instances where a door has a perforated side and has absorptive qualities. Absorption materials may also be applied to a surface. The data presented are primarily sound transmission values.

The acoustical performance of a door is dependent upon surface material, filler material in the cavity area, and the sealing capability. The cavity area may be hollow, but for improved barrier results different mass related configurations are used. The seal design is the critical parameter for doors. Various seals and sealing techniques are available which can be pressure sensitive, magnetic, spring loaded, or contact type. Organizations contributing data to this table are: 4, 8, 35, 52, 54, 95, 105, 122, 126, and 145.

GLOSSARY

Facing:	The outside surface of the specimen. In general, the sound source side
Backing:	The surface of the specimen opposite the facing. In general, the side opposite the sound source
Core:	The region between the facing and the backing.

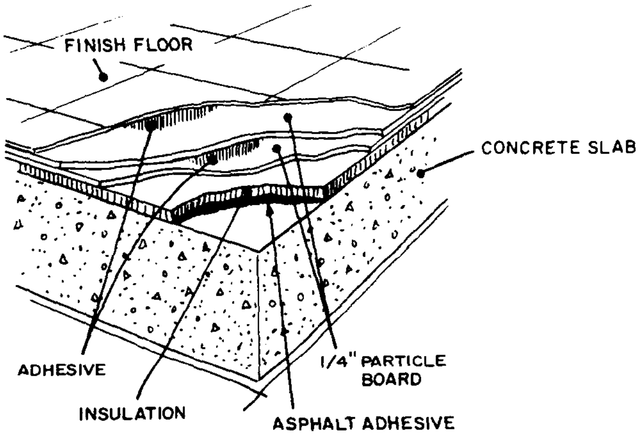
Table 20. Doors.

STC	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft²)	Company	Product	Reference
	Transmission Loss, dB																						
26	35-3/4 x 83 5/8 inch metal door, with foam core. Door was operable and contained gaskets that contacted the face at the top and sides																						
	22	25	27	26	27	27	28	29	29	29	27	22	24	35	35	31	28	30	1-3/4	7.5	126	Door	RAL TL 76-119
28	Metal door; 2 ft 4 inch to 3 ft 6 inch x 6 ft 8 inch																						
	20	24	21	23	23	26	28	29	30	31	31	29	24	24	32	37	40		1-3/4	2.7	122	STA-TRU Door	RAL TL 77-46
32	Flush metal door 35-3/4 x 79-1/8 inch, maximum temperature 150°F.																						
	24	26	24	27	26	27	27	28	30	31	32	32	31	32	35	38	40	37	1-3/8	3.4	14	Standard 1400 Series Door	RAL TL 69-299
33	Flush metal door 35-3/4 x 79-1/8 inch, temperature range -67° to 165°F.																						
	29	28	28	29	30	30	30	29	30	31	33	33	31	34	37	38	38	37	1-3/4	4.6	14	Standard 1500 Series 18 Gauge Door	RAL TL 69-290
35	Retains appearance of conventional hollow metal door. Maximum area of glazing 720 square inch																						
		32	32	30	29	29	33	40	41	42	43	43	42	41	42	45	48		1-3/4	6.8	95	Single Glazed Acoustical Door	RAL TL 73-160
35	35-3/4 x 83-5/8 inch metal door, foam core																						
	25	27	29	30	32	33	37	40	41	38	36	33	32	33	34	37	39	41	1-3/4	7.5	126	Fully Operable Door	RAL 76-117
35	Metal door, frame has adjustable gasket stops at top and sides with a single automatic threshold closer																						
	27	24	28	31	33	34	34	35	36	36	36	36	34	33	34	36	37	36	1-3/4	11.7	8	Allied Sound Retardant Doors and Frames	RAL TL 73-166
36	18 gauge skins, steel grid, sound deadened, gasketed frame, in sizes to 5 ft 0 inch x 10 ft 0 inch																						
		27	24	25	26	30	32	34	36	35	34	35	36	39	40	41	41		1-3/4	5.3	54	Presidential Door	RAL TL 77-135
36	Flush metal door 35-3/4 x 79-1/8 inch, temperature range -67° to 165°F.																						
	29	29	29	30	32	32	34	34	35	36	37	36	33	35	37	39	39	39	1-3/4	6.7	14	UL 1500 Series 18 Gauge Door	RAL TL 69-293
36	Timeblend high density core with hardwood surfaces 35-7/8 x 83-3/4 inch																						
		34			34			35			36			38			40		1-3/4	6.7	145	Sound Retardant Door	RAL TL 64-182
38	18 gauge skins, steel grid, sound deadened, heavy density insulation, gasketed frame, in sizes to 5 ft 0 inch x 10 ft 0 inch																						
		28	25	29	31	31	37	36	37	35	35	36	37	40	42	43	43		1-3/4	6.0	54	Presidential Door	RAL TL 77-134
38	Fully insulated door equipped with automatic drop closers, frame has aluminum gasketed stops																						
	22	30	29	33	31	33	33	32	33	35	37	40	42	41	42	43	41	41	1-3/4	8	35	#747 Door	RAL TL 78-76
39	Metal door, frame equipped with adjustable gaskets at the top and sides, bottom fitted with a single automatic threshold closer																						
	30	30	29	31	34	36	38	36	35	37	40	41	41	41	41	40	40	41	1-3/4	10.8	8	Allied Sound Retardant Doors and Frames	RAL TL 73-188
39	Metal door, frame equipped with adjustable gaskets at the top and sides, bottom fitted with a single automatic threshold closer																						
	30	29	30	32	33	32	32	35	38	41	42	41	40	40	41	40	40	41	1-3/4	12.0	8	Allied Sound Retardant Doors and Frames	RAL TL 73-227
40	Core of concrete block 6 ft 10 inch x 9 ft 5 inch																						
		28	28	32	32	33	34	35	36	39	42	43	43	44	43	42	44		2-5/8	--	105	#873 Acoustical Door	RAL
41	Metal door, frame equipped with adjustable gaskets at the top and sides, bottom fitted with two automatic threshold closers																						
	29	30	30	31	34	36	37	37	37	39	42	42	41	44	46	47	49	49	1-3/4	10.8	8	Allied Sound Retardant Doors and Frames	RAL TL 73-189
42	Retains appearance of conventional hollow metal door																						
		26	26	29	32	38	42	41	42	43	41	41	41	43	45	46	47		1-3/4	7.7	95	Flush Acoustical Door	KAL 704-7
42	Metal door, adjustable gaskets at top, bottom, and sides																						
	25	24	29	32	33	37	38	39	41	41	42	43	43	46	51	54	55	56	1-3/4	11.7	8	Allied Sound Retardant Doors and Frames	RAL TL 73-168
42	Timeblend high density core with hardwood surfaces 36 x 84 inch																						
		37			39			39			41			45			40		2-1/4	--	145	Sound Retardant Door	RAL TL 61-194

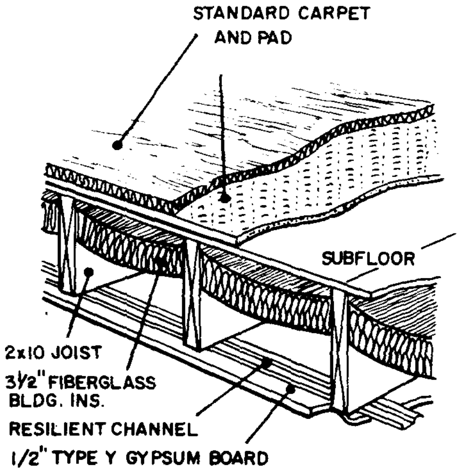
Table 20. Doors concluded.

	Transmission Loss, dB																						
STC	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft²)	Company	Product	Reference
42	Standard plywood door. Core: 1 lb sheet lead, glass fiber in cavity 1/8 inch plywood finish face. Data read from graph																						
		19	22	29	35	39	39	39	40	42	44	45	46	48	50	53	56		--	--	52	Acoustilead	CR L771-2-5M
43	Metal door, frame equipped with adjustable gaskets at the top, bottom, and sides																						
	28	26	28	32	34	37	39	40	43	46	48	46	42	44	47	51	52	52	1-3/4	11.7	8	Allied Sound Retardant Doors and Frames	RAL TL 73-175
43	Double, full-perimeter neoprene seals at jambs, head, and sill																						
		35	36	36	36	36	38	38	41	43	44	44	45	47	45	45	45		4-1/2	34	95	7.2 PSI Blast Door	RAL TL 65-181
45	35-3/4 x 83-5/8 inch metal door with foam core																						
	31	27	28	34	37	41	45	47	47	46	46	45	43	44	46	51	52	53	1-3/4	7.5	126	Door	RAL TL 76-115
45	Retains appearance of conventional hollow metal door																						
		35	39	39	42	45	42	45	46	48	47	46	46	45	48	49	50		1-3/4	9.5	95	Flush Acoustical Door	RAL TL 63-188
45	Metal door, frame equipped with adjustable gaskets at the top, bottom, and sides																						
	29	30	29	31	35	38	40	42	45	47	49	49	46	48	50	50	53	53	1-3/4	10.8	8	Allied Sound Retardant Doors and Frames	RAL TL 73-186
45	Retains appearance of conventional hollow metal door																						
		25	27	35	38	40	40	41	43	44	45	47	48	49	50	50	53		1-3/4	11.3	95	Single Glazed Acoustical Door	RAL TL 66-285
46	Retains appearance of conventional hollow metal door, 300 square inch glazed area																						
		25	26	34	38	40	41	41	43	45	47	49	51	53	54	55	58		1-3/4	11.3	95	Double Glazed Acoustical Door	RAL TL 66-284
47	Steel plate door with insulation between the plates																						
	39	42	44	40	43	42	44	43	42	45	48	49	49	50	50	52	53		4-1/8	11.3	105	#1850 Single Slide Door	RAL TL 76-126
51	Retains appearance of conventional hollow metal door																						
		35	38	35	39	44	46	50	50	52	52	50	52	56	57	56	56		1-3/4	8.6	95	Flush Acoustical Door	RAL TL 63-183
51	Timeblend high density core with hardwood surfaces 35-7/8 x 83-3/4 inch																						
		36			44			49			51			55			62		1-3/4	--	145	Sound Retardant Door	RAL TL 64-183
51	Double, full-perimeter composite seals at jambs, head, and sill																						
		43	45	45	49	51	51	48	50	51	55	55	57	57	56	53	49		2-1/2	21.9	95	Flush Acoustical Door	RAL TL 63-312
53	Double, full-perimeter neoprene seals at jambs, head, and sill																						
		32	40	44	46	47	47	48	50	51	53	55	58	61	62	62	63		4	23	95	Flush Acoustical Door	RAL TL 67-3
60	Metal door																						
		40	38	43	48	50	54	56	56	58	60	61	64	68	68	71	71	74	8	45	95	Flush Acoustical Door	RAL 704-4
62	Two 1-3/4 inch metal doors with frames separated by 7 inch air space																						
		50	55	50	56	57	56	59	60	65	67	65	61	60	65	67	70		10-1/2	8.6	95	Tandem Flush Acoustical Door	RAL TL 63-182
	20 gauge skins, steel grid, sound deadened. Sizes to 3 ft 6 inch x 7 ft 2 inch																						
		22			21			36			38			32			33		1-3/8	4.5	54	Presidential Door	G&H DSP-25T

CATEGORY 21. FLOORS



Concrete Subfloor
with a Finish Floor Cover



A Floor with Wood Support Structure
and a Carpet Cover

CATEGORY 21. FLOORS

Materials used for basic floor structures are concrete, wood and metal. Floor coverings include tile, wood, or carpet. Acoustic measurements on floors are either sound transmission (STC or NR) or sound impact (INR or IIC) tests. The latter procedure is performed with a calibrated tapping machine.

Concrete floors are typically heavy and provide a good transmission barrier, but they are efficient transmitters of tapping sounds. The tapping sound transmission can be reduced significantly by using carpets, pads, and insulation filled cavities.

Organizations contributing data to this table are: 55, 75, 103, 109, 113, 129, 144, and 145.

CAUTION

1. THE PRODUCT LISTED IN THE TABLE MAY ONLY BE A FLOOR ACCESSORY BUT IT WAS TESTED IN A FLOOR SYSTEM AND, HENCE IS LISTED IN THIS TABLE.
2. FOR IMPACT DATA, THE VALUES SHOWN ARE SOUND PRESSURE LEVELS GENERATED IN A ROOM BELOW WHEN THE STANDARD TAPPING MACHINE WAS OPERATED ON THE FLOOR COVERING. SEE PAGE 88 FOR FURTHER EXPLANATION.

GLOSSARY

Wood Joists:	Parallel timbers that support the planks of a floor
Standard Carpet and Pad:	44 oz per square yard Gro-Point carpet with 40 oz per square yard hair felt pad (see page 66).
Floor Deck:	A platform or a surface covering the structural framework to form a floor.

Table 21A. Floors (transmission and impact).

Transmission Loss, dB (upper line); Impact Noise Level, dB (lower line)

STC IIC		100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^3)	Company	Product	Reference
46	Carpet and pad, 1/2 inch Fir-Tex carpet board, 5/8 inch plywood, on 2 x 10 inch wood joists 16 inch on center. 1/2 inch Null-A-Fire gypsum board on resilient channels underneath.		26	25	31	38	38	44	47	51	55	62	69	70	72	73	76	76						
78		42	42	41	42	34	34	28	24	22	16	12	11							--	--	75	Wood Joist Floor	KAL
46	18 inch Trus joist cavity with 5/8 inch plywood, 1-5/8 inch concrete, and standard carpet and pad on top. 5/8 inch gypsum board on bottom.		--			--			--			--			--									
62			63			48			39			33			25					20-1/2	--	129	Trus Joist	KAL 224-38-65 224-37-65
47	14 inch Trus Joist cavity with 3/4 inch plywood, 1/4 inch underlayment and 1/8 inch vinyl tile on top. Resilient channel with 5/8 inch gypsum board.		30	32	35	36	39	42	45	47	50	52	52	51	47	50	59	65						
45			74	75	73	71	69	63	57	52	47	45	45	48	52	49	44	40		16-1/4	--	129	Trus Joist	CKAL 7212-04
47	1/16 inch vinyl asbestos tile, 5/8 inch plywood underlayment, 1/3 inch plywood subfloor, R-11 insulation batt on 2 x 10 inch wood joists 16 inch on center. 1/2 inch Null-A-Fire gypsum board on resilient channels beneath.		27	33	36	35	38	41	44	47	51	51	54	57	59	61	57	60						
44		70	71	71	70	72	72	72	69	67	64	58	53	50	46	45	47			--	--	75	Wood Joist Floor	CKAL
48	14 inch Trus Joist cavity with 3/4 inch plywood, resin paper, and 3/8 inch plywood on top. Resilient channel with 5/8 inch gypsum board on bottom.		26	31	34	37	41	45	49	51	52	53	53	52	48	47	52	56						
62			50	42	36	34	30	26	24	18	17	14	11	12						16-1/4	7.5	129	Trus Joist	RAL TL70-48 IN70-7
48	14 inch Trus Joist cavity with 1-3/4 inch floor decking and standard carpet and pad on top. Resilient channel with 1/2 inch gypsum board on bottom.		26	28	36	38	40	41	47	51	55	60	63	66	72	71	71	72						
65			45	39	35	31	32	26	26	22	15	15								16-1/2	8.9	129	Trus Joist	KAL 858-3-70
48	14 inch Trus Joist cavity with 3/4 inch plywood, 1/4 inch sound board, and 1/2 inch parquet flooring on top. Resilient channel and 5/8 inch gypsum board on bottom.		30	34	34	37	39	43	45	47	50	51	52	52	49	51	57	64						
41			77	74	73	72	72	68	66	62	58	57	56	58	62	61	52	45		16-5/8	--	129	Trus Joist	CKAL 7212-01
48	Ceiling 1/8 inch veneer plaster on 1/2 inch gypsum lath plus 1/2 inch glass fiber strips on joists. Floor 1-1/2 inch cellular concrete on 1/2 inch plywood subfloor or 2 x 12 inch wood joists spanning 11 ft 6 inch with 3-1/2 inch insulation. Field tested.	28	25	28	37	37	42	44	46	49	51	53	57	60	60	60	62	67	68					
39		70	70	72	69	72	74	73	72	71	68	65	65	64	64	63	61			--	--	144	"F" Floor	BBN P.N. 166338
49	14 inch Trus Joist cavity with 3/4 inch plywood, resin paper, and 3/8 inch plywood on top. Resilient channel with 1/2 inch gypsum board on bottom.		28	28	30	33	36	41	45	48	52	55	57	58	58	54	56	62						
66			49	45	42	44	39	33	29	22	16	11								16-5/8	9	129	Trus Joist	RAL TL70-53 IN70-8
49	Carpet and pad, 1/2 inch Fir-Tex carpet board, 5/8 inch plywood, R-11 insulation batt on 2 x 10 inch wood joists 16 inch on center. 1/2 inch Null-A-Fire gypsum board on resilient channels underneath.		33	29	38	37	37	45	51	57	61	65	71	75	77	77	74	75						
78		42	37	36	32	31	30	22	19	17	12	11								--	--	75	Wood Joist Floor	KAL
49	1/16 inch vinyl asbestos tile, 3/8 inch particle board, 1/2 inch gypsum board, 1/2 inch plywood subfloor, R-11 insulation batt on 2 x 10 inch wood joists 16 inch on center. 1/2 inch Null-A-Fire gypsum board on resilient channels underneath.		31	34	35	38	40	43	46	47	48	51	55	59	62	62	62	65						
46		70	70	70	67	71	71	69	66	63	59	54	49	45	42	44	44			--	--	75	Wood Joist Floor	CKAL
50	14 inch Trus Joist with rockwool batts. 1-3/4 inch floor decking with standard carpet and pad on top. Resilient channel with 5/8 inch gypsum board on bottom.		32	30	38	42	38	43	48	51	55	61	65	68	72	75	75	75						
65			45	38	33	27	28	15	19	18	15									16-1/2	9.7	129	Trus Joist	KAL 858-5-70

Table 21A. Floors (transmission and impact) continued.

STC IIC	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft²)	Company	Product	Reference
	Transmission Loss, dB (upper line); Impact Noise Level, dB (lower line)																						
49 50	1/16 inch vinyl asbestos tile, 3/8 inch particle board, 1/2 inch gypsum board, 1/2 inch plywood subfloor, R-11 insulation batt on 2 x 10 inch wood joists 16 inch on center. Two layers 1/2 inch Null-A-Fire gypsum board on resilient channels underneath.																						
		32	36	39	40	41	43	45	45	49	52	54	58	61	60	61	63						
	64	63	65	63	66	66	65	63	61	59	55	49	46	41	41	41			--	--	75	Wood Joist Floor	CKAL
50 44	2-1/2 inch thick cellular concrete in waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath.																						
	31	33	33	37	37	43	45	44	49	55	59	63	61	61	62	66	70	71					
	74	69	72	71	69	69	69	71	67	62	58	57	57	55	50	45			--	--	144	"B" Floor	BBN P.N. 166338
50 44	1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists, 3-1/2 inch insulation. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	26	28	31	37	40	43	45	47	52	53	56	60	60	61	63	67	71	70					
	69	64	68	66	67	67	68	68	64	64	62	62	63	62	59	53			--	--	144	"C" Floor	BBN P.N. 166338
51 44	2-1/2 inch thick asphaltic gypsum concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists, 3-1/2 inch insulation. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	25	31	33	38	40	44	44	46	51	58	60	62	63	61	62	64	69	72					
	70	68	69	68	69	68	67	69	65	63	59	58	59	60	56	49			--	--	144	"A" Floor	BBN P.N. 166338
51 53	1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch subfloor on 2 x 12 inch wood joists, 3-1/2 inch insulation. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath. Field tested.																						
	27	31	31	39	39	42	47	48	51	53	56	60	59	59	60	64	66	68					
	67	65	67	66	67	66	68	67	63	60	57	57	56	53	48	44			--	--	144	"D" Floor	BBN P.N. 166338
51 63	Carpet and pad, 1/2 inch Fir-Tex carpet board, 1/2 inch gypsum board, 1/2 inch plywood subfloor, R-11 insulation batt on 2 x 10 inch wood joists 16 inch on center, 1/2 inch Null-A-Fire gypsum board on resilient channels underneath.																						
		30	35	39	39	39	45	49	55	55	57	59	65	68	70	70	70						
	57	53	45	38	34	29	26	24	20										--	--	75	Wood Joist Floor	CKAL
52 51	14 inch Trus Joint cavity with two layers of 1-1/2 inch sound attenuation blankets. 3/4 inch plywood with mastic layers, 1/4 inch underlayment and 1/8 inch vinyl tile on top. Resilient channels with 5/8 inch gypsum board on bottom.																						
		24	38	38	42	43	46	49	50	53	56	58	62	61	63	67	68						
		68	67	68	65	63	58	51	44	39	37	35	33	37	37	39	28		16-1/4	--	129	Trus Joist	CKAL 7212-03
52 51	14 inch Trus Joist cavity with two layers of 1-1/2 inch sound attenuation blankets. 3/4 inch plywood with mastic layers, 1/4 inch underlayment and 1/2 inch parquet flooring on top. Resilient channels and 5/8 inch gypsum board on bottom.																						
		34	37	39	40	44	45	48	50	53	56	59	63	62	65	67	69						
		68	67	68	65	64	60	58	52	47	45	42	41	45	42	41	33		16-5/8	--	129	Trus Joist	CKAL 7212-02
53 69	14 inch Trus Joist cavity with 3/4 inch plywood, 15 lb asphalted felt and 5/8 inch mastical gypsum concrete on top. Resilient channel and 5/8 inch gypsum board bottom.																						
		33	37	37	43	46	50	54	57	59	60	60	58	52	52	59	65						
		70	69	67	66	67	65	62	62	61	62	61	64	69	70	63	56		16-1/2	11.9	129	Trus Joist	RAL TL 70-1 IN 70-2
55 42	1-1/2 inch thick cellular concrete on 1/2 inch plywood subfloor, 2 x 12 inch wood joists spanning 11 ft 6 inch with 3-1/2 inch insulation. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath connected to joists with resilient clips. Field tested.																						
	41	45	43	42	43	47	49	50	52	55	58	59	60	60	60	65	68	68					
	56	54	61	61	61	65	66	67	67	64	63	63	63	64	61	57			--	--	144	"E" Floor	BBN P.N. 166338
58 55	2 x 10 inch wood floor joists with glass fiber insulation. 3/8 inch plywood 1/2 inch sound deadening board, 1/2 inch plywood underlayment, and vinyl floor covering on top. Resilient channel with 5/8 inch gypsum board bottom.																						
		36	42	43	47	49	52	55	58	61	66	70	71	71	70	74	75						
		61	59	62	61	59	58	55	50	47	44	39	36	37	37	32	25		12-1/4	10.8	145	Vinyl Finish Floor	RAL TL70-72 IN70-11

Table 21A. Floors (transmission and impact) concluded.

STC IIC	Transmission Loss, dB (upper line); Impact Noise Level, dB (lower line)																						
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft²)	Company	Product	Reference
58 42	14 inch Trus Joist cavity with 1-3/4 inch floor decking and standard carpet and pad on top. 1/2 inch gypsum board on bottom.																						
		22	21	30	35	35	38	45	47	52	56	61	65	66	69	70	71						KAL
		56	51	48	40	40	39	32	32	27	23	19	18	16	15	15			16-1/2	8.8	129	Trus Joist	858-1-70
58 80	14 inch Trus Joist with 3/4 inch plywood and 1-5/8 inch lightweight concrete on top. Resilient channel with 5/8 inch gypsum board on bottom.																						
		39	40	43	47	51	54	57	57	57	59	64	66	65	64	69	74						RAL TL70-44
		40	33	27	25	22	19	17	12	12	12	11	9						17-1/2	--	129	Trus Joist	IN70-6
60 72	14 inch Trus Joist with 2 inch thermafiber insulation, 3/4 inch plywood 15 lb asphalted felt, and 5/7 inch mastical gypsum concrete on top. Resilient channel and 5/8 inch gypsum board on bottom.																						
		39	45	45	49	52	54	57	60	63	67	70	70	65	63	69	77						RAL TL70-9
		41	34	27	23	22	18	14	10	7	7								16-1/2	12.3	129	Trus Joist	IN70-4

Table 21B. Floors (transmission loss).

STC	Transmission Loss, dB																						
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft²)	Company	Product	Reference
44	2 x 10 inch wood joists, 5/8 inch plywood, 40 oz hair felt pad, 44 oz wool loop carpet. Ceiling, 4 mil polyethylene sheet, burlap to wood stripping, 1-5/8 inch Iso Schaum foam, 5/8 inch gypsum board.																						
		27	24	26	31	34	39	46	51	56	61	76	70	72	71	71	66		--	--	109	Iso Schaum Foam	KAL 610-1-68
46	8 inch section, 4 ft wide concrete plank, three cavities, no topping, acoustical soffit, cores not filled.																						
	32	32	33	33	34	38	39	44	47	45	44	46	51	57	58	60	64	67	8	45	113	Concrete plank	RAL TL68-249
46	8 inch section, 4 ft wide concrete plank, no topping, acoustical soffit, 1/2 inch insulation board, 1/2 inch wood parquet floor, cores not filled.																						
	33	32	32	36	34	38	41	45	47	45	43	46	55	62	66	68	72	74	9	45	113	Concrete plank	RAL TL68-292
50	4 x 8 ft by 8 inch concrete slab (hollow core) with wet bottom layer of 2 inch slump concrete.																						
		32	35	39	38	41	43	47	49	52	52	53	52	57	60	62	63		8	50	113	Concrete plank	INTEST 5-346-1
55	3 inch 20 gauge steel deck with 2-1/2 inch concrete. Ceiling, 5/8 inch gypsum board on resilient channels.																						
	35	35	37	39	44	48	50	53	55	58	60	63	62	59	61	65	67		6-7/8	51.2	71	3"H Hi-Bond Floor Deck	RAL TL74-122
56	3V-32 20 gauge steel deck with 3 inch lightweight concrete. Ceiling, 1/2 inch gypsum board on resilient channels.																						
	35	36	38	41	44	49	51	53	55	57	59	62	63	65	62	60	66	68	3-1/2	51	71	3V-32 Hi-Bond Floor Deck	RAL TL73-216
59	6 inch 20 gauge steel deck with 4 inch lightweight concrete. Ceiling, 5/8 inch gypsum board on resilient hangers.																						
	40	41	44	43	47	50	53	56	59	63	65	68	68	68	67	68	69	69	11-1/2	60.5	71	6"H Hi-Bond Floor Deck	RAL TL74-66

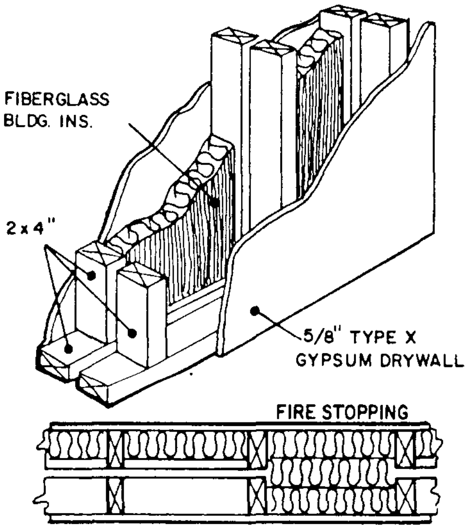
Table 21C. Floors (impact level).

	Impact Noise Level, dB																					
IIC	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
33	2 x 10 inch joists, 5/8 inch plywood. Ceiling, 5/8 inch gypsum, insulation in cavity, impact on 3/32 inch Flexi-Floor both sides.																						
	79	76	85	86	82	82	83	80	77	74	68	65	62	61	62	55			10-3/4	7.1	103	Flexi-Floor	RAL IN76-1
42	8 inch section, 4 ft wide prestressed concrete plant, no topping, acoustical soffit, 1/2 inch insulation board, 1/2 inch wood parquet floor, cores not filled, bottom painted.																						
	71	70	72	75	76	75	74	71	68	65	64	62	52	44	42	37	32	30	9	45	113	Concrete plank	RAL IN68-4
48	1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation and covering of .07 inch thick vinyl/foam/felt, 2 lb/yd^2. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	71	65	68	65	67	66	67	67	63	61	58	55	53	48	38	28			--	--	144	"C" Floor	BBN 166338
48	1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch subfloor on 2 x 10 inch wood joists with 3-1/2 inch insulation, with covering .07 inch thick vinyl/foam/felt 2.4 lb/yd^2. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath. Field tested.																						
	62	62	69	68	68	68	67	68	65	60	56	53	48	41	33	26			--	--	144	"D" Floor	BBN P.N. 166338
49	2-1/2 inch thick asphaltic gypsum concrete on a waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation and covered with .07 inch thick vinyl/foam/felt 2.4 lb/yd^2. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	68	66	67	66	67	66	65	65	61	59	54	50	48	44	37	25			--	--	144	"A" Floor	BBN P.N. 166338
49	1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation, covering of vinyl/foam/felt .105 inch thick at 2.8 lb/yd^2. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	68	64	67	66	66	65	65	65	58	56	51	45	40	30	23	16			--	--	144	"C" Floor	BBN P.N. 166338
49	1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation and covering of vinyl/foam/felt .140 inch thick at 4.25 lb/yd^2. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	67	65	68	66	66	65	65	65	60	56	51	45	40	32	25	18			--	--	144	"C" Floor	BBN P.N. 166338
50	1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation, semishag nylon cut pile 1 inch on jute backing. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	70	67	69	68	64	60	56	54	47	40	34	26	24	21	19	17			--	--	144	"C" Floor	BBN P.N. 166338
50	1/1-2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation, vinyl covering of vinyl/foam .25 inch thick at 3.5 lb/yd^2. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	70	65	67	62	59	54	45	38	33	27	22	16	16	13	8	6			--	--	144	"C" Floor	BBN P.N. 166338
50	1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch subfloor on 2 x 12 inch joists with 3/1-2 inch insulation and with covering of .105 inch thick vinyl/foam/felt at 2.8 lb/yd^2. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath. Field tested.																						
	62	63	67	66	66	66	65	64	59	53	47	39	33	27	21	17			--	--	144	"D" Floor	BBN P.N. 166338
50	1-1/2 inch cellular concrete on 1/2 inch plywood subfloor, 2 x 12 inch wood joists spanning 11 ft 6 inch with 3-1/2 inch insulation between joists and with a covering of .07 inch thick vinyl/foam/felt at 2.4 lb/yd^2. Ceiling, 1/2 inch plaster on gypsum lath connected to joists via resilient clips. Field tested.																						
	53	53	60	60	62	63	63	64	64	61	59	56	54	51	44	38			--	--	144	"E" Floor	BBN P.N. 166338
53	.14 inch foam-backed vinyl sheet, 3/8 inch particle board, 1/2 inch gypsum board, 1/2 inch plywood subfloor, R-11 insulation batt on 2 x 10 inch wood joists 16 inch on center. Two layers 1/2 inch Null-A-Fire gypsum board on resilient channels underneath.																						
	63	64	65	62	64	63	60	52	44	39	32	27	25	19	19	18			--	--	75	Wood Joist Floor	CKAL

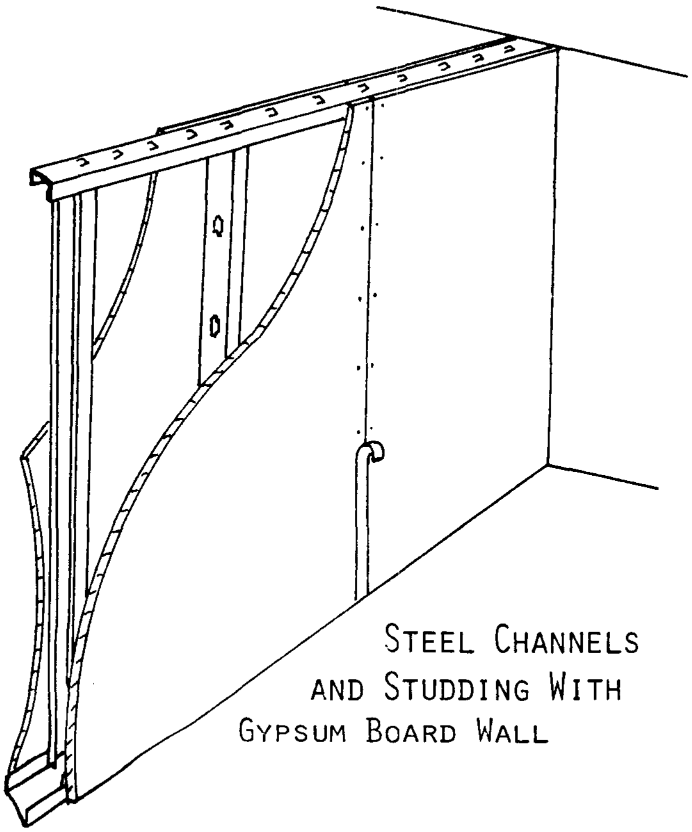
Table 21C. Floors (impact level) concluded.

	Impact Noise Level, dB																					
IIC	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
53	Carpet of semishag nylon cut pile on a jute back 62 oz/yd^2. 1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath. Field tested.																						
	64	63	66	64	63	60	57	54	46	38	30	24	18	15	11	8			--	--	144	"D" Floor	BBN P.N. 166338
55	Carpet of tightly woven nylon loop pile on 3/16 inch thick foam rubber backing overall surface weight of 69 oz/yd^2, pile height 7/64 inch. 1-1/2 cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	65	59	56	53	47	41	34	29	24	21	18	16	12	10	9	9			--	--	144	"C" Floor	BBN P.N. 166338
55	1-1/2 inch cellular concrete on 1/2 inch plywood subfloor on 2 x 12 inch wood joists spanning 11 ft 6 inch with 3-1/2 inch insulation between joists and with a covering of .105 inch thick vinyl/foam/felt at 2.8 lb/yd^2. Ceiling, 1/2 inch plaster on gypsum lath connected to joists via resilient clips. Field tested.																						
	52	54	61	60	62	61	60	61	59	52	48	41	36	32	29	24			--	--	144	"E" Floor	BBN P.N. 166338
57	Carpet of tightly-woven nylon loop pile on a unitong backing and an overall surface weight of 64 oz/yd^2, pile height is 3/16 inch. 1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation. Ceiling, 1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	63	61	60	57	52	48	42	38	32	25	18	16	12	10	9	8			--	--	144	"C" Floor	BBN P.N. 166338
57	40 oz hair and jute pad on a floor of 1-1/2 inch cellular concrete on waterproof membrane, 1/2 inch resilient underlayment, 1/2 inch plywood subfloor on 2 x 12 inch wood joists with 3-1/2 inch insulation. Ceiling, 1-1/2 inch plaster on 3/8 inch gypsum lath stapled to joists. Field tested.																						
	63	55	51	46	40	33	28	24	18	16	13	12	9	8	6	5			--	--	144	"C" Floor	BBN P.N. 166338
58	5/8 inch thick plywood, 40 oz hair/felt pad, 44 oz wool loop pile 1/4 inch carpet. Ceiling, 4 mil polysheet, wood stripping, burlap strips, 1-5/8 inch cavity filled with Iso Schaum foam, 5/8 inch gypsum board. Tested to ISO R140-1960.																		--	--	109	Iso Schaum Foam	KAL 610-2-68
59	Carpet and pad, 5/8 inch plywood underlayment, 1/2 inch plywood subfloor, R-11 insulation batt, on 2 x 10 inch wood joists 16 inch on center. 1/2 inch Null-A-Fire gypsum board on resilient channels underneath.																						
	61	57	53	47	43	39	34	32	24	24	19	20							--	--	75	Wood Joist Floor	CKAL
60	Carpet of semishag nylon cut pile on a jute back 62 oz/yd^2. 1/2 inch cellular concrete on 1/2 inch plywood subfloor on 2 x 12 inch wood joists spanning 11 ft 6 inch with 3-1/2 inch insulation between joists. Ceiling, 1/2 inch plaster on gypsum lath connected to joists via resilient clips. Field tested.																						
	54	54	60	57	57	55	50	48	43	36	28	20	16	13	11	7			--	--	144	"E" Floor	BBN P.N. 166338.
70	8 inch section, 4 ft wide concrete plank, no topping, acoustical soffit, standard carpet and pad, cores not filled, painted bottom.																						
	49	50	44	41	42	39	40	36	25	33	29	23	19	10	8	9			--	45	113	Concrete Plank	RAL IN68-5
	Carpet pad and sound control 1/8 inch mastic core faced on one side with closed cell expanded polyethylene and on the other side with creped kraft paper, 3/8 inch thick. IIC = 60.																		--	--	40	dba spec Carpet Pad	CR GL-12MT
	Carpet pad and sound control unit, 1/8 inch mastic core faced on one side with closed cell expanded polyethylene and on the other side with creped kraft paper, 3/8 inch thick, 1 lb/ft^2. IIC = 66.																		--	--	40	dba spec Carpet Pad	CR
	Needle-punched fiber felt of various weights and thicknesses(1/4 to 5/8 inch), coated and waffled latex rubber.																		--	--	38	Villa Hair & Jute Cushion	CR
	Needle-punched fiber felt of various weights and thicknesses (1/4 to 5/8 inch), coated with waffled latex rubber.																		--	--	38	Cheveux Coated Hair Cushion	CR

CATEGORY 22. WALLS



Gypsum Board Wall with Twin Stud Support and Insulation



STEEL CHANNELS AND STUDDING WITH GYPSUM BOARD WALL

CATEGORY 22. WALLS

Walls are primarily gypsum board, masonry, wood, aluminum, or steel. Walls can be used as load carrying structures or area separation barriers. The many variations of construction offer a wide range of acoustical barrier performance.

Gypsum is the most commonly used wall material; however, walls using gypsum boards of approximately the same thicknesses (say 1/2 inch) can be erected in a variety of ways with each wall construction providing a different sound transmission loss. Most common variables in such wall construction are the number of gypsum boards, thickness of the insulation added in the cavity, additional sound deadening boards, and different stud materials and construction. Organizations contributing data to this table are: 52, 55, 59, 69, 75, 90, 91, 109, 132, 144, and 145. Related categories are panels, enclosures, operable partitions, and open plan systems.

GLOSSARY

Facing: The outside surface of the specimen. In general the side facing the sound source

Backing: The other outside surface of the specimen. In general the side not facing the sound source

Core: The region between the facing and the backing

Batt: Fiber wadded in sheets

Fiberglass bolt: Fiberglass roll of a given length

Furring: The creating of air spaces with thin strips of wood or metal before adding wall bonds or plaster

Gypsum: A hydrated sulfate of calcium. $CaSO_4 \cdot 2H_2O$. Used for making wallboards, plaster of Paris, etc.

Lath: Thin, lightweight structure used as groundwork for plastering, mounting tiles, etc. It may be in a form of gypsum board, perforated metal wire cloth, thin wood strips, etc.

Screw Stud: Studs on which the wall boards are attached by screws

Stud: An upright piece in a frame to which boards or laths are applied

Table 22A. Gypsum board walls (ASTM E90-70 or equivalent).

<table>
<tr><th rowspan="2">STC</th><th colspan="18">Transmission Loss, dB</th><th rowspan="2">Thickness (in.)</th><th rowspan="2">Density (lb/Ft²)</th><th rowspan="2">Company</th><th rowspan="2">Product</th><th rowspan="2">Reference</th></tr>
<tr><th>100 Hz</th><th>125 Hz</th><th>160 Hz</th><th>200 Hz</th><th>250 Hz</th><th>315 Hz</th><th>400 Hz</th><th>500 Hz</th><th>630 Hz</th><th>800 Hz</th><th>1000 Hz</th><th>1250 Hz</th><th>1600 Hz</th><th>2000 Hz</th><th>2500 Hz</th><th>3150 Hz</th><th>4000 Hz</th><th>5000 Hz</th></tr>
<tr><td rowspan="2">36</td><td colspan="18">2 x 4 studs at 16 inch o.c., 1/2 inch fiberboard each side 1/2 inch gypsum wallboard each side</td><td rowspan="2">4-5/8</td><td rowspan="2">5.3</td><td rowspan="2">69</td><td rowspan="2">Standard Stud Dry Wall with Fiberboard</td><td rowspan="2">RAL TL65-186</td></tr>
<tr><td></td><td>17</td><td></td><td></td><td>29</td><td></td><td></td><td>37</td><td></td><td></td><td>42</td><td></td><td></td><td>45</td><td></td><td></td><td>38</td><td></td></tr>
<tr><td rowspan="2">38</td><td colspan="18">22 gauge steel facings, glass fiber core; data read from graph</td><td rowspan="2">2-1/4</td><td rowspan="2">--</td><td rowspan="2">52</td><td rowspan="2">Acoustilead</td><td rowspan="2">CR L7710-1-43M</td></tr>
<tr><td></td><td>15</td><td>18</td><td>26</td><td>29</td><td>34</td><td>37</td><td>41</td><td>42</td><td>45</td><td>48</td><td>51</td><td>52</td><td>53</td><td>55</td><td>56</td><td>57</td><td></td></tr>
<tr><td rowspan="2">39</td><td colspan="18">Standard steel stud and gypsum board construction partition with 2 x 2 inch furring, 1 inch glass fiber, 1 pound sheet lead, 5/8 inch gypsum board; data read from graph</td><td rowspan="2">1-1/2</td><td rowspan="2">--</td><td rowspan="2">52</td><td rowspan="2">Acoustilead</td><td rowspan="2">CR L7710-1-43M</td></tr>
<tr><td>12</td><td>17</td><td>23</td><td>29</td><td>40</td><td>41</td><td>42</td><td>43</td><td>47</td><td>50</td><td>52</td><td>53</td><td>52</td><td>47</td><td>46</td><td>48</td><td>53</td><td>54</td></tr>
<tr><td rowspan="2">39</td><td colspan="18">2 x 4 studs at 24 o.c., 1/2 inch gypsum board both sides</td><td rowspan="2">6-5/8</td><td rowspan="2">6.3</td><td rowspan="2">69</td><td rowspan="2">Staggered Stud Dry Wall</td><td rowspan="2">RAL TL65-185</td></tr>
<tr><td></td><td>19</td><td></td><td></td><td>30</td><td></td><td></td><td>41</td><td></td><td></td><td>48</td><td></td><td></td><td>47</td><td></td><td></td><td>42</td><td></td></tr>
<tr><td rowspan="2">40</td><td colspan="18">Staggered wood studs, 24 inch o.c. faces with 1/2 inch gypsum</td><td rowspan="2">6-1/2</td><td rowspan="2">6.2</td><td rowspan="2">109</td><td rowspan="2">Test Wall</td><td rowspan="2">RAL TL77-111</td></tr>
<tr><td>15</td><td>22</td><td>23</td><td>26</td><td>29</td><td>30</td><td>34</td><td>40</td><td>44</td><td>46</td><td>49</td><td>51</td><td>53</td><td>53</td><td>49</td><td>39</td><td>43</td><td>48</td></tr>
<tr><td rowspan="2">40</td><td colspan="18">Wall of 5/8 inch gypsum board, both sides on 2 x 4 studs, 16 inch o.c. filled with Iso Schaum foam</td><td rowspan="2">--</td><td rowspan="2">6.4</td><td rowspan="2">109</td><td rowspan="2">Iso Schaum Foam</td><td rowspan="2">CR NCI 68-7</td></tr>
<tr><td></td><td>21</td><td>23</td><td>28</td><td>34</td><td>35</td><td>34</td><td>36</td><td>40</td><td>41</td><td>46</td><td>48</td><td>49</td><td>45</td><td>41</td><td>44</td><td>49</td><td></td></tr>
<tr><td rowspan="2">40</td><td colspan="18">Cellulose fibers sprayed between 5/8 inch layer gypsum board and 1/2 inch plywood with 5/8 inch gypsum board other side</td><td rowspan="2">--</td><td rowspan="2">--</td><td rowspan="2">90</td><td rowspan="2">K-13</td><td rowspan="2">RAL TL70-118</td></tr>
<tr><td></td><td>23</td><td>23</td><td>22</td><td>29</td><td>38</td><td>34</td><td>35</td><td>40</td><td>44</td><td>46</td><td>49</td><td>49</td><td>42</td><td>43</td><td>48</td><td>51</td><td></td></tr>
<tr><td rowspan="2">41</td><td colspan="18">Standard steel stud and gypsum board construction partition with 1 x 2 inch furring, 1 inch glass fiber, 1 pound sheet lead, 5/8 inch gypsum board; data read from graph</td><td rowspan="2">1/4</td><td rowspan="2">--</td><td rowspan="2">52</td><td rowspan="2">Acoustilead</td><td rowspan="2">CR L7710-1-43M</td></tr>
<tr><td>13</td><td>20</td><td>29</td><td>36</td><td>39</td><td>38</td><td>42</td><td>41</td><td>44</td><td>48</td><td>49</td><td>52</td><td>50</td><td>44</td><td>43</td><td>45</td><td>48</td><td>51</td></tr>
<tr><td rowspan="2">41</td><td colspan="18">Cellulose fibers sprayed between layers of 1/2 inch gypsum board</td><td rowspan="2">--</td><td rowspan="2">6.3</td><td rowspan="2">90</td><td rowspan="2">K-13</td><td rowspan="2">RAL TL69-131</td></tr>
<tr><td></td><td>21</td><td>20</td><td>26</td><td>33</td><td>37</td><td>38</td><td>40</td><td>44</td><td>45</td><td>49</td><td>52</td><td>54</td><td>53</td><td>51</td><td>52</td><td>54</td><td></td></tr>
<tr><td rowspan="2">44</td><td colspan="18">3-5/8 inch metal stud with 5/8 inch gypsum board each side and urea formaldehyde foam in cavity</td><td rowspan="2">--</td><td rowspan="2">5.1</td><td rowspan="2">109</td><td rowspan="2"></td><td rowspan="2">RAL</td></tr>
<tr><td></td><td>23</td><td>24</td><td>30</td><td>32</td><td>39</td><td>40</td><td>46</td><td>49</td><td>54</td><td>58</td><td>60</td><td>59</td><td>49</td><td>46</td><td>50</td><td>56</td><td></td></tr>
<tr><td rowspan="2">44</td><td colspan="18">5/8 inch type x gypsum wallboard - vertical joints, .3-5/8 inch metal studs, with Iso Schaum foam</td><td rowspan="2">--</td><td rowspan="2">5.4</td><td rowspan="2">109</td><td rowspan="2">Test Wall with Foam</td><td rowspan="2">CR NCI 68-8</td></tr>
<tr><td></td><td>20</td><td>28</td><td>33</td><td>35</td><td>39</td><td>43</td><td>44</td><td>48</td><td>48</td><td>50</td><td>50</td><td>51</td><td>47</td><td>42</td><td>43</td><td>48</td><td></td></tr>
<tr><td rowspan="2">46</td><td colspan="18">Facing of two layers of 1/2 inch gypsum board, core of 3-5/8 inch screw studs and backing of two layers of 1/2 inch gypsum board</td><td rowspan="2">5-5/8</td><td rowspan="2">9</td><td rowspan="2">145</td><td rowspan="2">Gypsum Wallboard</td><td rowspan="2">CR</td></tr>
<tr><td></td><td>28</td><td>31</td><td>33</td><td>35</td><td>4</td><td>43</td><td>44</td><td>49</td><td>52</td><td>55</td><td>55</td><td>56</td><td>53</td><td>44</td><td>45</td><td>50</td><td></td></tr>
<tr><td rowspan="2">46</td><td colspan="18">Staggered wood studs, 24 inch o.c. faced with 1/2 inch gypsum with Rapco® foam</td><td rowspan="2">6-1/2</td><td rowspan="2">6.5</td><td rowspan="2">109</td><td rowspan="2">Test Wall</td><td rowspan="2">RAL TL77-145</td></tr>
<tr><td>23</td><td>23</td><td>28</td><td>30</td><td>34</td><td>38</td><td>42</td><td>45</td><td>49</td><td>51</td><td>54</td><td>56</td><td>57</td><td>57</td><td>54</td><td>52</td><td>56</td><td>59</td></tr>
<tr><td rowspan="2">46</td><td colspan="18">Staggered stud, wood frame partition, 2 x 4 inch studs 16 inch o.c. on 2 x 6 plate, one layer of 5/8 inch gypsum board each side, spray-in insulation</td><td rowspan="2">--</td><td rowspan="2">--</td><td rowspan="2">55</td><td rowspan="2">Fibron A-100 Spray-in Wall Insulation</td><td rowspan="2">CR SRC 75-120-1A</td></tr>
<tr><td></td><td>30</td><td>32</td><td>36</td><td>40</td><td>41</td><td>42</td><td>45</td><td>47</td><td>47</td><td>47</td><td>48</td><td>48</td><td>45</td><td>42</td><td>47</td><td>53</td><td></td></tr>
<tr><td rowspan="2">47</td><td colspan="18">2 inch thick mineral fiber tested as batts inside wall: 5/8 inch gypsum board, both sides of 2-1/2 inch staggered metal studs 24 inch o.c.</td><td rowspan="2">3-3/4</td><td rowspan="2">5.9</td><td rowspan="2">59</td><td rowspan="2">Acoustifiber</td><td rowspan="2">RAL TL73-107</td></tr>
<tr><td></td><td>23</td><td>33</td><td>38</td><td>42</td><td>47</td><td>50</td><td>53</td><td>55</td><td>56</td><td>57</td><td>57</td><td>56</td><td>51</td><td>48</td><td>50</td><td>53</td><td></td></tr>
<tr><td rowspan="2">47</td><td colspan="18">Single row wood stud, cavity insulation, gypsum board with resilient channels facing 5/8 inch gypsum board, direct attached core, 2 x 4 wood studs 16 inch o.c. with 2-1/4 inch glass fiber absorption, backing 5/8 inch gypsum board mounted on RC-1 resilient channels</td><td rowspan="2">5-9/32</td><td rowspan="2">6.36</td><td rowspan="2">132</td><td rowspan="2">USDA Wall (B)FPL 242</td><td rowspan="2">RAL TL73-72</td></tr>
<tr><td>24</td><td>25</td><td>29</td><td>34</td><td>40</td><td>43</td><td>45</td><td>47</td><td>50</td><td>51</td><td>52</td><td>54</td><td>52</td><td>46</td><td>44</td><td>48</td><td>53</td><td>53</td></tr>
<tr><td rowspan="2">47</td><td colspan="18">2 x 8 inch wood joists on 16 inch centers; Upper side: 1-1/2 inch concrete over 1/2 inch plywood sheathing; Lower side: 5/8 inch gypsum wallboard 1-1/2 inch Energy Guard cellulose spray insulation in joist cavity</td><td rowspan="2">--</td><td rowspan="2">--</td><td rowspan="2">55</td><td rowspan="2">Energy Guard</td><td rowspan="2">CR</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Table 22A. Gypsum board walls (ASTM E90-70 or equivalent) continued.

STC	Transmission Loss, dB 100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^3)	Company	Product	Reference
48	Cellulose fibers sprayed on interior of gypsum board partition, 1-5/8 inch metal studs, faced both sides with 5/8 inch gypsum board																						
		24	31	35	36	39	43	47	50	52	53	55	55	52	51	53	55		3	6.3	90	K-13	RAL TL69-171
48	5/8 gypsum board, 1 pound sheet lead, 2 inch glass fiber, 5/8 inch gypsum board on 2-1/2 inch steel studs; data read from graph																						
		24	29	38	40	43	45	48	52	53	54	55	55	52	50	52	60		3-3/4	--	52	Acoustilead	CR
48	Facing of 5/8 inch gypsum board with 1/2 inch sound deadening board lining, core of wood studs and backing of 5/8 inch gypsum board with 1/2 inch sound deadening board lining																						
		24	28	34	37	42	47	51	55	58	61	62	64	63	60	61	64		5-7/8	7.7	145	Partition Wall System	RAL TL70-3
49	Cellulose fibers sprayed between layers of 5/8 inch gypsum board on 3-5/8 inch metal studs																						
		29	35	38	41	41	44	45	49	52	52	53	53	51	50	53	55		5	6.6	90	K-13	RAL TL69-173
49	2 x 4 studs 16 inch o.c., 1/2 inch fiber board each side, outer facing was 1/2 inch gypsum wall board																						
		27			38			48			57			59			55		5-3/4	7.3	69	Standard Stud Dry Wall	RAL TL65-233
49	Staggered stud, wood frame partition, 2 x 4 inch studs 16 inch o.c. on 2 x 6 plate, two layers of 5/8 inch gypsum board one side only																						
		34	38	41	43	45	44	48	49	50	49	50	51	48	46	50	55		--	--	55	Fibron A-100 Spray-In Wall Insulation	CR SRC 75-120-1A
49	5/8 inch gypsum board, 3-5/8 inch steel stubes with cavities filled with 2 inch fiberglass and 5/8 inch gypsum board																						
		30	37	28	41	53	51	56	50	41	52	58	58	55	59	58	59		--	--	109	Rapco-Foam	WLI 22100
50	2 x 4 studs 24 inch o.c., 1/2 inch fiber board each side, 1/2 inch gypsum board each side																						
		29			40			47			58			62			57		7-3/4	8.0	69	Staggered Stud Dry Wall	RAL TL65-200
50	Facing of 5/8 inch gypsum board with 1/2 inch sound deadening board, core of wood studs and backing of 5/8 inch gypsum board with 1/2 inch sound deadening board																						
		27	30	34	39	42	47	52	56	59	59	60	60	61	61	60	60		7-7/8	8.5	145	Wall with Sound Deadening Boards	RAL TL70-4
50	2 x 4 wood studs - 16 inch o.c. with separate stud plates on concrete floor, gypsum board - two 5/8 inch layers each side, one layer sound deadening board, 1/2 inch Firtex																						
																			--	--	55	Energy Guard	CR
51	Staggered stud, wood frame partition, 2 x 4 inch studs, 16 inch o.c. on 2 x 6 plate, two layers of 5/8 inch gypsum board																						
		38	41	44	46	46	47	49	51	50	50	51	52	50	50	54	59		--	--	55	Fibron A-100 Spray-on Wall	CR SRC 75-120-1C
52	Facing of 5/8 inch gypsum board with 1/2 inch Homosole sound deadening board, core of wood studs and backing of 5/8 inch gypsum board with 1/2 inch sound deadening board																						
		28	32	39	43	46	56	55	57	59	62	63	65	64	61	62	63		5-7/8	7.8	145	Partition Wall System	RAL TL70-2
52	Cellulose fibers sprayed into interior of gypsum board wall																						
		32	36	37	42	47	48	51	52	55	57	58	57	54	54	56	59		--	--	90	K-13	RAL TL69-130
52	2 x 4 wood studs, 16 inch o.c. with separate stud plates on concrete floor, gypsum board, two layers 5/8 inch each side, 1/2 inch Firtex layer sound deadening board and 1-1/2 inch Fibron Grey spray-on insulation																						
																			--	--	55	Fibron Grey Spray-on	CR
54	Cellulose fiber sprayed between wood frame wall: two layers 5/8 inch gypsum board, staggered wood studs, single layer 5/8 inch gypsum board																						
		34	38	41	45	48	51	52	53	55	56	58	58	57	57	58	60		8	12.2	90	K-13	RAL TL70-120
54	5/8 inch gypsum board, 3-5/8 inch steel studs with the cavity filled with U.F.C. foam, and 5/8 inch gypsum board																						
		53	50	51	48	52	52	48	55	54	56	52	53	60	53	61	61		--	--	109	Rapco-Foam	WLI 22100
55	Double row wood stud, cavity insulation, gypsum board; Facing: 1/2 inch gypsum board, core double row 2 x 3 studs, 16 inch o.c., 2-1/2 inch plate separation, two layers 2-1/4 inch glass fiber absorption backing 1/2 inch gypsum board																						
	28	31	35	40	46	49	52	54	57	59	61	63	64	64	62	59	61	63	8.5	6.4	132	USDA Wall (A)FPL 309	RAL TL75-84

Table 22A. Gypsum board walls (ASTM E90-70 or equivalent) concluded.

STC	Transmission Loss, dB 100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft²)	Company	Product	Reference
56	Single row wood stud, cavity insulation, multiple layers gypsum board with resilient channels, Facing: two layers, 5/8 inch gypsum board mounted on RC-1 resilient channels, core 2 x 4 wood studs, 16 inch o.c. with 2-1/4 inch glass fiber absorption. Backing: three layers, 5/8 inch gypsum board mounted on RC-1 resilient channels																						
	34	36	42	46	49	51	52	53	53	56	59	62	63	63	58	57	58	59	6-11/16	11.6	132	USDA Wall (A)FPL 341	RAL TL73-75
57	Double row wood stud, cavity insulation, gypsum board, Facing 5/8 inch gypsum board, Core: double row 2 x 4 wood stud, 16 inch o.c., 1 inch plate separation, two layers, 3-1/2 inch glass fiber absorption, Backing: 5/8 inch gypsum board																						
	30	35	39	42	49	52	53	55	56	59	62	64	65	62	59	62	66	70	9.25	7.6	132	USDA Wall (B)FPL 309	RAL TL75-83
58	2 x 4 wood stud, 16 inch o.c. with separate stud plate on concrete floor gypsum board, 2 layers 5/8 inch each side; one layer 1/2 inch Firtex sound deadening board, one stud cavity filled with Energy Guard loose fill																						
																			--	--	55	Energy Guard	CR
63	Double row wood stud, cavity insulation, multiple layers gypsum board, Facing: two layers, 5/8 inch gypsum board; Core: double row 2 x 4 wood stud, 16 inch o.c., 1 inch plate separation, two layers, 3-1/2 inch glass fiber absorption, Backing: two layers 5/8 inch gypsum board																						
	39	41	46	50	55	58	59	61	62	64	67	69	70	67	66	68	69	70	10.5	12.2	132	USDA Wall (C)FPL 309	RAL TL75-82

Table 22B. Gypsum board walls (AMA-1-11).

STC	Transmission Loss, dB											Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
	125 Hz	175 Hz	250 Hz	350 Hz	500 Hz	700 Hz	1000 Hz	1400 Hz	2000 Hz	2800 Hz	4000 Hz						
35	Facing of 1/2 inch gypsum board, core of 2 x 4 inch wood studs 16 inch on center, and backing of 1/2 inch gypsum board.																
	19	17	28	30	35	38	45	48	42	37	44	4-5/8	5.90	--	75	Wood Frame Partition	CR 470-1
36	Facing of 5/8 inch Null-A-Fire gypsum board, core of 2 x 4 inch wood studs 16 inch on center and backing of 5/8 inch Null-A-Fire gypsum board.																
	30	22	31	30	37	39	44	43	39	45	52	4-7/8	7.10	--	75	Wood Frame Partition	NBS 240
37	Facing of 5/8 inch Null-a-Fire gypsum board, core of KWS-158 speed studs 24 inch on center and backing of same as facing.																
	17	20	30	35	43	46	49	47	37	37	46	2-7/8	5.6	--	75	Metal Frame Partition	CR 476
39	Facing of 5/8 inch Null-A-Fire gypsum board, core of KWS-250 speed studs 24 inch on center and backing of same as facing.																
	23	27	33	35	42	45	50	49	39	36	41	3-1/4	5.2	--	75	Metal Frame Partition	CR 476
40	Facing of 5/8 inch Null-A-Fire gypsum board, core of KWS-358 speed studs 24 inch on center and backing of same as facing.																
	20	29	35	38	44	48	51	50	39	39	44	4-7/8	5.4	--	75	Metal Frame Partition	CR 476
41	Facing of 5/8 inch Null-A-Fire gypsum board, core of KWS-358 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.																
	27	34	39	41	45	48	51	51	34	38	43	4-7/8	5.4	--	75	Metal Frame Partition	CR 476
42	Facing of 5/8 inch Null-A-Fire gypsum board, core of KWS-250 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.																
	25	32	38	43	48	50	51	51	43	39	44	3-1/4	5.2	--	75	Metal Frame Partition	CR 476
43	Facing of two layers 3/8 inch and 1/2 inch gypsum board core of KWS-158 speed studs 24 inch on center and backing of same as facing.																
	23	25	34	39	44	47	49	50	51	49	50	3-3/8	7.1	--	75	Metal Frame Partition	CR 476
44	Facing of two layers 3/8 and 5/8 inch gypsum board, core of KWS-158 speed studs 24 inch on center and backing of same as facing.																
	24	26	39	42	49	49	52	52	35	52	57	3-5/8	8.4	--	75	Metal Frame Partition	CR 476
44	Facing of 1/2 inch gypsum board, core of 2 x 3 inch wood studs staggered at 8 inch on center and backing of 1/2 inch gypsum board.																
	36	31	36	40	40	46	47	50	52	41	45	6-5/8	6.2	--	75	Wood Frame Partition	NBS 242
44	Facing of two layers 5/8 inch gypsum board, core of 2 x 4 inch wood studs 16 inch on center and backing of same as facing.																
	23	29	38	38	40	44	48	51	51	46	53	6-1/8	10.93	--	75	Wood Frame Partition	CR 470
44	Facing of 5/8 inch gypsum board, core of 2 x 3 inch wood studs staggered at 8 inch on center and backing of 5/8 inch gypsum board.																
	43	44	37	38	40	46	48	47	41	44	50	6-7/8	7.7	--	75	Wood Frame Partition	NBS 243
45	Facing of two layers 1/2 inch gypsum board, core of KWS-158 speed studs 24 inch on center and backing of same as facing.																
	24	29	34	39	46	47	52	53	53	45	48	3-5/8	7.8	--	75	Metal Frame Partition	CR 476
45	Facing of two layers 1/2 inch Null-A-Fire gypsum board, core of KWS-250 speed studs 24 inch on center, and backing of same as facing.																
	23	34	34	41	47	51	53	58	59	49	47	4-1/2	8.7	--	75	Metal Frame Partition	CR 476
45	Facing of two layers 1/2 inch gypsum board, core of 2 x 4 inch wood studs 16 inch on center and backing of same as facing.																
	23	31	37	41	41	46	49	51	53	48	49	5-5/8	8.68	--	75	Wood Frame Partition	CR 470

Table 22B. Gypsum board walls (AMA-1-11) continued.

STC		Transmission Loss, dB																
		125 Hz	175 Hz	250 Hz	350 Hz	500 Hz	700 Hz	1000 Hz	1400 Hz	2000 Hz	2800 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
45	Facing of two layers 3/8 and 1/2 inch gypsum board, core of 2 x 4 inch wood studs 16 inch on center, and backing of same as facing.	25	33	39	39	41	47	49	52	51	51	50	5-3/8	8.10	--	75	Wood Frame Partition	CR 470
45	Facing of two layers 1/2 and 5/8 inch gypsum board, core of 2 x 4 inch wood studs 16 inch on center, and backing of same as facing.	22	31	39	41	42	47	49	52	53	50	55	5-7/8	9.88	--	75	Wood Frame Partition	CR 470
46	Facing of two layers 1/2 and 5/8 inch gypsum board, core of KWS-158 speed studs 24 inch on center and backing of same as facing.	24	32	37	40	45	49	51	51	50	48	51	3-7/8	8.8	--	75	Metal Frame Partition	CR 476
46	Facing of two layers 5/8 inch gypsum board, core of KWS-158 speed studs 24 inch on center and backing of same as facing.	24	31	39	42	46	48	49	50	45	46	51	4-1/8	10.2	--	75	Metal Frame Partition	CR 476
46	Facing of two layers 3/8 and 1/2 inch gypsum board, core of KWS-250 speed studs 24 inch on center and backing of same as facing.	23	31	37	42	47	49	52	52	53	51	55	4-1/4	7.2	--	75	Metal Frame Partition	CR 476
46	Facing of two layers 3/8 and 5/8 inch gypsum board, core of KWS-250 speed studs 24 inch on center and backing of same as facing.	24	31	37	41	45	49	50	53	52	53	53	4-1/2	8.5	--	75	Metal Frame Partition	CR 476
46	Facing of two layers 3/8 and 1/2 inch gypsum board, core of 2 x 4 inch wood studs 16 inch on center with insulation blanket in space and backing of same as facing.	26	36	38	40	44	48	51	53	53	55	52	5-3/8	8.26	--	75	Wood Frame Partition	CR 470
46	Facing of 1/2 inch gypsum board, 1/2 inch Fir Tex sound deadening board, 6 inch strip of laminating compound 24 inch on center between layers, core of 2 x 4 inch wood studs 24 inch on center and backing of same as facing.	31	34	36	40	46	48	51	53	55	55	53	5-5/8	6.68	--	75	Wood Frame Partition	G&H 1B1-12FT-(2)
46	Facing of 1/2 inch gypsum board, 1/2 inch Fir-Tex rated sound deadening board,. 6 inch strip of laminating compound 24 inch on center between layers, core of 2 x 4 inch wood studs 16 inch on center and backing of same as facing.	23	31	37	43	49	54	55	55	55	56	55	5-5/8	7.04	--	75	Wood Frame Partition	G&H 1B1-6FT-(1)
46	Facing of two layers 1/2 inch gypsum board, core of 2 x 4 inch wood studs 16 inch on center with insulation blanket in space and backing of same as facing.	24	31	38	42	43	46	49	51	52	48	50	5-5/8	8.82	--	75	Wood Frame Partition	CR 470
46	Facing of two layers 1/2 and 5/8 inch gypsum board, core of 2 x 4 inch wood studs 16 inch on center with insulation blanket in space and backing of same as facing.	23	32	39	42	43	46	49	52	54	52	56	5-7/8	10	--	75	Wood Frame Partition	CR 470
47	Facing of two layers 1/2 inch gypsum board, core of KWS-250 speed studs 24 inch on center and backing of same as facing.	24	33	38	43	45	49	52	54	53	47	50	4-1/2	7.9	--	75	Metal Frame Partition	CR 476
47	Facing of two layers 5/8 and 3/8 inch gypsum board, core of 2 x 4 inch wood studs 16 inch on center with insulation blanket in space and backing of same as facing.	24	35	39	41	44	48	50	51	48	48	45	5-1/2	9.28	--	75	Wood Frame Partition	CR 470

Table 22B. Gypsum board walls (AMA-1-11) continued.

STC		Transmission Loss, dB 125 Hz	175 Hz	250 Hz	350 Hz	500 Hz	700 Hz	1000 Hz	1400 Hz	2000 Hz	2800 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
47	Facing of 1/2 inch gypsum board, 1/2 inch Fir-Tex sound deadening board, core of 2 x 3 inch wood studs staggered at 8 inch on center and backing of same as facing.	34	35	37	41	44	48	50	52	54	53	52	5-5/8	7.72	--	75	Wood Frame Partition	G&H 1B1-19FT-(1)
48	Facing of two layers 3/8 and 1/2 inch gypsum board, core of KWS-158 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.	30	30	40	48	50	50	52	52	52	55	53	3-3/8	7.1	--	75	Metal Frame Partition	CR 476
48	Facing of two layers 1/2 and 5/8 inch gypsum board, core of KWS-250 speed studs 24 inch on center and backing of same as facing.	26	32	39	42	46	47	50	52	52	51	54	4-3/4	8.9	--	75	Metal Frame Partition	CR 476
48	Facing of two layers 5/8 inch gypsum board, core of KWS-250 speed studs 24 inch on center and backing of same as facing.	26	34	40	42	46	50	52	52	48	45	51	5	10.3	--	75	Metal Frame Partition	CR 476
48	Facing of two layers 3/8 and 1/2 inch gypsum board, core of KWS-358 speed studs 24 inch on center and backing of same as facing.	29	35	42	42	46	48	52	58	55	53	55	5-3/8	7.3	--	75	Metal Frame Partition	CR 476
48	Facing of two layers 5/8 and 3/8 inch gypsum board, core of 2 x 4 inch wood studs 16 inch on center and backing of same as facing.	25	33	40	42	45	48	52	55	54	54	56	5-1/2	9.16	--	75	Wood Frame Partition	CR 470
48	Facing of two layers 5/8 inch gypsum board, core of KWS-358 speed studs 24 inch on center and backing of same as facing.	27	37	41	43	47	51	52	53	49	45	49	6-1/8	10.4	--	75	Metal Frame Partition	CR 476
49	Facing of two layers 1/2 and 5/8 inch gypsum board, core of KWS-158 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.	28	39	44	47	49	48	48	50	50	49	49	3-7/8	8.8	--	75	Metal Frame Partition	CR 476
49	Facing of two layers 5/8 inch gypsum board, core of KWS-158 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.	27	38	43	46	47	48	50	51	48	47	52	4-1/8	10.2	--	75	Metal Frame Partition	CR 476
49	Facing of two layers 3/8 and 5/8 inch gypsum board, core of KWS-358 speed studs 24 inch on center and backing of same as facing.	27	36	39	43	47	50	53	53	52	52	52	5-5/8	8.6	--	75	Metal Frame Partition	CR 476
49	Facing of 5/8 inch gypsum board, 1/2 inch Fir-Tex sound deadening board, 6 inch strip of laminating compound 24 inch on center between layers, core of 2 x 4 inch wood studs 24 inch on center and backing of same as facing.	36	38	42	43	49	52	53	54	54	55	57	5-7/8	7.58	--	75	Wood Frame Partition	G&H 1B1-10FT-(2)
49	Facing of two layers 1/2 and 5/8 inch gypsum board, core of KWS-358 speed studs 24 inch on center and backing of same as facing.	28	37	41	43	46	50	52	54	53	52	56	5-7/8	9	--	75	Metal Frame Partition	CR 476
50	Facing of two layers 1/2 inch Null-A-Fire gypsum board, core of KWS-250 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.	27	36	42	47	48	50	53	55	54	50	51	4-1/2	8.7	--	75	Metal Frame Partition	CR 476
50	Facing of two layers 5/8 inch gypsum board, core of KWS-250 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.	31	41	46	48	50	52	54	53	50	47	53	5	10.3	--	75	Metal Frame Partition	CR 476

Table 22B. Gypsum board walls (AMA-1-11) continued.

<table>
<tr><th rowspan="2">STC</th><th colspan="11">Transmission Loss, dB</th><th rowspan="2">Thickness (in.)</th><th rowspan="2">Density (lb/ft²)</th><th rowspan="2">Mounting</th><th rowspan="2">Company</th><th rowspan="2">Product</th><th rowspan="2">Reference</th></tr>
<tr><th>125 Hz</th><th>175 Hz</th><th>250 Hz</th><th>350 Hz</th><th>500 Hz</th><th>700 Hz</th><th>1000 Hz</th><th>1400 Hz</th><th>2000 Hz</th><th>2800 Hz</th><th>4000 Hz</th></tr>
<tr><td>50</td><td colspan="11">Facing of 5/8 inch gypsum board, 1/2 inch Fir-Tex sound deadening board, 6 inch strip of laminating compound 24 inch on center between layers, core of 2 x 4 inch wood studs 16 inch on center and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>29</td><td>34</td><td>41</td><td>46</td><td>50</td><td>54</td><td>56</td><td>61</td><td>58</td><td>59</td><td>60</td><td>5-7/8</td><td>8.42</td><td>--</td><td>75</td><td>Wood Frame Partition</td><td>G&H 1B1-28FT-(1)</td></tr>
<tr><td>50</td><td colspan="11">Facing of two layers 5/8 inch gypsum board, core of KWS-358 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>32</td><td>40</td><td>45</td><td>49</td><td>51</td><td>51</td><td>52</td><td>52</td><td>49</td><td>48</td><td>50</td><td>6-1/8</td><td>10.4</td><td>--</td><td>75</td><td>Metal Frame Partition</td><td>CR 476</td></tr>
<tr><td>50</td><td colspan="11">Facing of two layers 5/8 and 3/8 inch gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>30</td><td>36</td><td>42</td><td>44</td><td>48</td><td>51</td><td>51</td><td>54</td><td>52</td><td>53</td><td>50</td><td>7-1/4</td><td>10.53</td><td>--</td><td>75</td><td>Wood Frame Partition</td><td>CR 470</td></tr>
<tr><td>50</td><td colspan="11">Facing of two layers 3/8 and 1/2 inch gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>32</td><td>35</td><td>42</td><td>44</td><td>47</td><td>51</td><td>52</td><td>54</td><td>54</td><td>53</td><td>55</td><td>7-3/8</td><td>9.30</td><td>--</td><td>75</td><td>Wood Frame Partition</td><td>CR 470</td></tr>
<tr><td>50</td><td colspan="11">Facing of 1/2 inch gypsum board, 1/2 inch Fir-Tex sound deadening board, core of 2 x 4 inch wood studs, staggered 12 inch on center and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>30</td><td>36</td><td>38</td><td>44</td><td>48</td><td>51</td><td>51</td><td>52</td><td>55</td><td>56</td><td>56</td><td>7-5/8</td><td>7.40</td><td>--</td><td>75</td><td>Wood Frame Partition</td><td>G&H 1B1-11FT-(2)</td></tr>
<tr><td>50</td><td colspan="11">Facing of two layers 1/2 inch gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>30</td><td>35</td><td>42</td><td>44</td><td>48</td><td>51</td><td>51</td><td>52</td><td>52</td><td>49</td><td>49</td><td>7-5/8</td><td>10.20</td><td>--</td><td>75</td><td>Wood Frame Partition</td><td>CR 470</td></tr>
<tr><td>50</td><td colspan="11">Facing of two layers 1/2 and 5/8 inch gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>30</td><td>37</td><td>43</td><td>44</td><td>47</td><td>51</td><td>52</td><td>53</td><td>41</td><td>50</td><td>50</td><td>7-7/8</td><td>11.25</td><td>--</td><td>75</td><td>Wood Frame Partition</td><td>CR 470</td></tr>
<tr><td>50</td><td colspan="11">Facing of two layers 5/8 inch Null-A-Fire gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>33</td><td>38</td><td>41</td><td>44</td><td>45</td><td>49</td><td>52</td><td>54</td><td>48</td><td>49</td><td>55</td><td>8</td><td>10.6</td><td>--</td><td>75</td><td>Wood Frame Partition</td><td>CR 470</td></tr>
<tr><td>50</td><td colspan="11">Facing of two layers 5/8 inch gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>31</td><td>37</td><td>42</td><td>44</td><td>48</td><td>51</td><td>52</td><td>54</td><td>49</td><td>49</td><td>50</td><td>8-1/8</td><td>12.5</td><td>--</td><td>75</td><td>Wood Frame Partition</td><td>CR 470</td></tr>
<tr><td>50</td><td colspan="11">Facing of 5/8 inch Null-A-Fire gypsum board, 1/2 inch Fir-Tex sound deadening board, core of two rows 2 x 4 inch wood studs 16 inch on center separated by 1 inch airspace and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>32</td><td>41</td><td>41</td><td>44</td><td>47</td><td>52</td><td>56</td><td>57</td><td>58</td><td>58</td><td>60</td><td>11-1/2</td><td>9.96</td><td>--</td><td>75</td><td>Wood Frame Partition</td><td>G&H 1B1-25FT-(2)</td></tr>
<tr><td>51</td><td colspan="11">Facing of two layers 3/8 and 5/8 inch gypsum board, core of KWS-158 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>28</td><td>37</td><td>43</td><td>48</td><td>50</td><td>50</td><td>51</td><td>52</td><td>52</td><td>53</td><td>52</td><td>3-5/8</td><td>8.4</td><td>--</td><td>75</td><td>Metal Frame Partition</td><td>CR 476</td></tr>
<tr><td>51</td><td colspan="11">Facing of two layers 3/8 and 1/2 inch gypsum board, core of KWS-250 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>32</td><td>33</td><td>43</td><td>47</td><td>47</td><td>50</td><td>51</td><td>54</td><td>54</td><td>54</td><td>53</td><td>4-1/4</td><td>7.2</td><td>--</td><td>75</td><td>Metal Frame Partition</td><td>CR 476</td></tr>
<tr><td>51</td><td colspan="11">Facing of two layers 1/2 inch gypsum board, core of KWS-250 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>30</td><td>36</td><td>44</td><td>48</td><td>49</td><td>50</td><td>52</td><td>52</td><td>52</td><td>49</td><td>50</td><td>4-1/2</td><td>7.9</td><td>--</td><td>75</td><td>Metal Frame Partition</td><td>CR 476</td></tr>
<tr><td>51</td><td colspan="11">Facing of two layers 1/2 inch gypsum board, core of KWS-358 speed studs 24 inch on center and backing of same as facing.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>34</td><td>38</td><td>42</td><td>47</td><td>50</td><td>52</td><td>52</td><td>53</td><td>51</td><td>48</td><td>51</td><td>5-5/8</td><td>8.1</td><td>--</td><td>75</td><td>Metal Frame Partition</td><td>CR 476</td></tr>
</table>

Table 22B. Gypsum board walls (AMA-1-11) continued.

STC		Transmission Loss, dB															
		125 Hz	175 Hz	250 Hz	350 Hz	500 Hz	700 Hz	1000 Hz	1400 Hz	2000 Hz	2800 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
51	Facing of two layers 1/2 and 5/8 inch gypsum board, core of KWS-358 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.	28	38	43	45	48	48	51	53	53	51	53	5-7/8	9	--	75	Metal Frame Partition	CR 476
51	Facing of two layers 1/2 inch gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center, with insulation blanket in space and backing of same as facing.	35	39	45	45	49	50	53	54	53	50	50	7-5/8	10.4	--	75	Wood Frame Partition	CR 470
51	Facing of 5/8 inch gypsum board, 1/2 inch Fir-Tex sound deadening board, 6 inch strip laminating compound 24 inch on center between layers, core of 2 x 4 inch wood stud staggered 8 inch on center and backing of same as facing.	38	39	43	45	48	55	58	57	58	58	59	7-5/8	9.72	--	75	Wood Frame Partition	G&H 1B1-22FT CR 470-8
51	Facing of two layers 1/2 and 5/8 inch gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center with insulation blanket in space and backing of same as facing.	35	40	45	46	49	51	53	54	52	50	50	7-7/8	11.53	--	75	Wood Frame Partition	CR 470
51	Facing of two layers 5/8 inch Null-A-Fire gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center with insulation blanket in space and backing of same as facing.	38	44	44	47	46	49	52	54	49	50	54	8	10.7	--	75	Wood Frame Partition	CR 470
52	Facing of two layers 1/2 and 5/8 inch gypsum board, core of KWS-250 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.	35	38	44	48	48	49	51	54	54	54	56	4-3/4	8.9	--	75	Metal Frame Partition	CR 476
52	Facing of two layers 3/8 and 1/2 inch gypsum board, core of KWS-358 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.	32	37	42	46	51	51	54	53	53	52	51	5-3/8	7.3	--	75	Metal Frame Partition	CR 476
52	Facing of two layers 5/8 and 3/8 inch gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center with insulation blanket in space and backing of same as facing.	35	40	43	46	50	52	54	55	53	54	51	7-1/4	10.72	--	75	Wood Frame Partition	CR 470
53	Facing of two layers 3/8 and 5/8 inch gypsum board, core of KWS-250 speed wood studs staggered 8 inch on center insulation blanket in space and backing of same as facing.	34	37	44	48	49	50	52	53	54	54	55	4-1/2	8.5	--	75	Metal Frame Partition	CR 476
53	Facing of 5/8 inch Null-A-Fire gypsum board, 1/2 inch Fir-Tex sound deadening board, core of two rows 2 x 3 inch wood studs separated by 1 inch air space and backing of same as facing.	38	44	42	48	52	58	59	56	50	53	60	8-1/2	9.4	--	75	Wood Frame Partition	G&H KG-8FT-(1) CR 470-9
54	Facing of two layers 3/8 and 5/8 inch gypsum board, core of KWS-358 speed studs 24 inch on center with insulation blanket in space and backing of same as facing.	35	38	47	49	52	51	53	55	58	55	57	5-5/8	8.6	--	75	Metal Frame Partition	CR 476
54	Facing of two layers 3/8 and 1/2 inch gypsum board, core of 2 x 4 inch wood studs staggered 8 inch on center with insulation blanket in space and backing of same as facing.	31	41	46	48	49	51	53	55	56	55	56	7-3/8	9.42	--	75	Wood Frame Partition	CR 470
54	Facing of two layers 1/2 inch gypsum board, core of two rows 2 x 4 inch wood studs 16 inch on center with 1/2 inch sound deadening board in 1 inch air space and backing of same as facing.	36	40	45	48	52	54	55	57	56	57	57	11	13.6	--	75	Wood Frame Partition	CR 470

Table 22B. Gypsum board walls (AMA-1-11) concluded.

	Transmission Loss, dB																
STC	125 Hz	175 Hz	250 Hz	350 Hz	500 Hz	700 Hz	1000 Hz	1400 Hz	2000 Hz	2800 Hz	4000 Hz	Thickness (in.)	Density (lb/ft²)	Mounting	Company	Product	Reference
54	Facing of two layers 5/8 inch gypsum board, core of two rows 2 x 4 inch wood studs 16 inch on center and backing of same as facing.																
	35	41	45	49	52	56	54	56	53	53	55	11-1/2	15.2	--	75	Wood Frame Partition	CR 470
56	Facing of two layers 5/8 inch gypsum board, core of two rows 2 x 4 inch wood studs 16 inch on center with sound deadening board in 1 inch air space and backing of same as facing.																
	37	44	47	50	53	55	56	56	56	57	57	11-1/2	16	--	75	Wood Frame Partition	CR 470

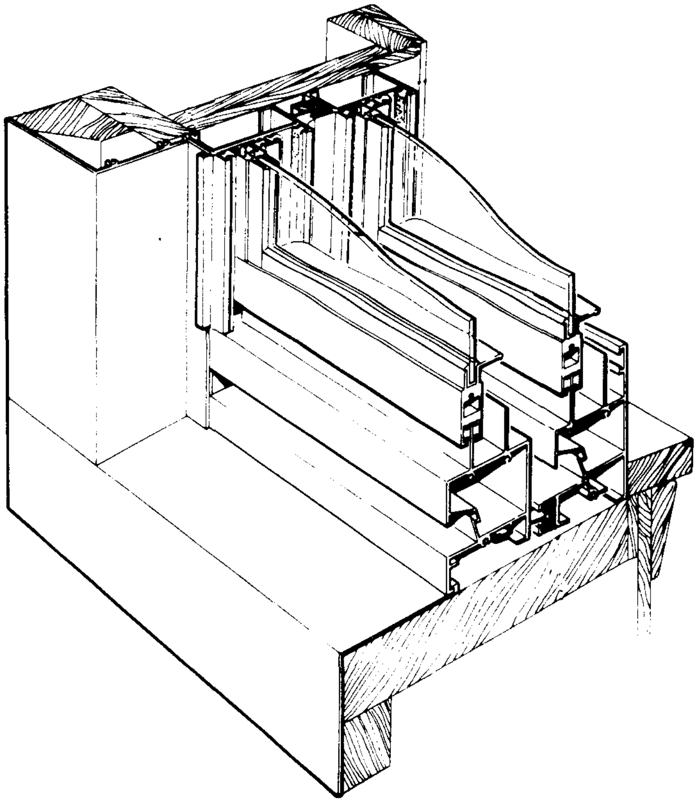
Table 22C. Plaster, concrete, steel, and other walls.

STC	Transmission Loss, dB																		Thickness (in.)	Density (lb/ft²)	Company	Product	Reference
	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz					
40	Ext. wall: outdoor side, 7/8 inch portland cement plaster on 17 gauge wire lath, rockwool insulation with vapor barrier, 1/2 inch veneer base and veneer finish 1/16 inch																						
	29	28	28	32	38	35	35	38	39	39	39	41	41	41	43	45	47	48	5-1/4	13.7	144		RAL TL77-41
41	Typical block configuration two or three core concrete, temperature range -20 to 1500°F. Data read from graph																						
		25	26	27	31	33	35	37	39	42	45	45	46	47	47	47	47		4	20	91	4 inch Hollow Concrete	CR
41	Ext. wall, outdoor side 7/8 inch, portland cement plaster on 17 gauge wire lath, paper base, rockwool insulation, 3/8 inch gypsum lath, 1/2 inch sanded gypsum plaster, a lime putty coat																						
	30	29	26	29	38	38	38	39	40	40	40	41	41	43	44	45	46	47	5-1/2	17.7	144		RAL TL77-43
42	Standard steel office partition with 1 x 2 inch furring, 1 inch glass fiber, 1 pound sheet lead, 1/4 inch plywood; data read from graph																						
		17	22	26	32	36	42	45	46	48	51	52	57	60	62	65	66		1-1/8	--	52	Acoustilead	CR L7110-1-43M
43	22 gauge steel facings, glass fiber core, 1 pound sheet lead; data read from graph																						
		18	23	28	34	40	40	44	45	47	49	52	53	55	56	57	58		2-1/4	--	52	Acoustilead	CR L7110-1-43M
43	Ext. wall: outdoor side: 7/8 inch portland cement plaster on 1/2 inch gypsum sheeting, steel studs; indoor side: rockwool insulation, 1/2 inch veneer base and veneer finish																						
	25	30	40	41	39	40	40	41	42	41	41	42	43	43	45	46	48	49	3	14.4	144		RAL TL77-44
43	Ext. wall: outdoor side 7/8 inch portland cement plaster on 17 inch wire lath, on 1 inch polystyrene sheeting 2 x 4 studs (16 inch o.c.); indoor side 3/8 inch gypsum lath and 1/2 inch sanded plaster and putty finish, single 2 x 4 sole plate and a double cap plate, fire stop																						
	25	27	23	26	37	35	41	45	50	49	43	45	43	49	54	58	60	59	6-1/4	17.7	144		RAL TL78-93
44	Partition steel stud metal lath and plaster with urea-formaldehyde foam fill																						
		26	24	27	35	40	42	46	50	52	52	51	58	45	46	47	48		3	18	109		KAL
44	Exterior wall: outdoor side: 7/8 inch portland cement plaster on wire lath, 17 gauge, 1/2 inch gypsum sheathing, 2 x 4 wood studs; indoor side: rockwool insulation, 1/2 inch veneer base and finish, 2 x 4 inch single sole plate, double cap plate																						
	23	24	23	30	38	37	43	46	49	51	50	50	44	44	49	56	60	63	5-3/4	12.9	144		RAL TL78-91
45	4 inch cinder block, with 1 x 2 inch furring, 1 inch glass fiber, 1 pound sheet lead, 1/4 inch plywood; data read from graph																						
		33	28	29	32	35	39	42	46	50	52	55	58	59	60	60	60		1	--	52	Acoustilead	CR L7710-1-43M
46	22 gauge steel facings, glass fiber core, 2 pound sheet lead; data read from graph																						
		25	27	30	37	41	42	45	47	48	51	53	54	56	57	58			2-1/4	--	52	Acoustilead	CR L7710-1-43M
47	Standard steel office partition with 1 x 2 inch furring, 1 inch glass fiber, 1 pound sheet lead, 1/2 inch gypsum board; data read from graph																						
		23	29	32	39	43	45	47	49	51	53	54	56	58	60	62	64		1-1/4	--	52	Acoustilead	CR L7710-1-43M
47	1/4 inch plywood, 1 pound sheet lead, 1-1/2 inch glass fiber, 1 pound sheet lead, 1/4 inch plywood; data read from graph																						
	21	24	25	30	36	40	47	48	50	52	52	53	54	56	58	58	60	57	2	--	52	Acoustilead	CR L7710-1-43M
47	Ext wall: outdoor side - 7/8 inch portland cement plaster on 17 gauge wire lath, paper base, 2 x 4 wood studs; indoor side of rockwool insulation, vapor barrier, resilient clips, 3/8 inch thick gypsum lath, 1/2 inch thick sanded gypsum plaster and putty finish																						
	37	39	41	44	47	47	46	47	47	46	47	45	44	47	48	50	51	52	6	21.1	144		RAL TL77-40
47	Exterior wall: outdoor side - 7/8 inch portland cement plaster on 17 gauge wire lath, paper backed, 25/32 inch insulated sheeting, 2 x 4 studs on 16 inch centers, single sole plate, double cap plate, fire strip, 3/8 inch gypsum lath, 1/2 inch sanded and plaster finish																						
	25	31	26	33	43	45	46	49	52	51	49	51	51	52	56	62	64	66	7	19.1	144		RAL TL78-90

Table 22C. Plaster, concrete, steel, and other walls concluded.

<table>
<tr><th rowspan="2">STC</th><th colspan="18">Transmission Loss, dB</th><th rowspan="2">Thickness (in.)</th><th rowspan="2">Density (lb/ft²)</th><th rowspan="2">Company</th><th rowspan="2">Product</th><th rowspan="2">Reference</th></tr>
<tr><th>100 Hz</th><th>125 Hz</th><th>160 Hz</th><th>200 Hz</th><th>250 Hz</th><th>315 Hz</th><th>400 Hz</th><th>500 Hz</th><th>630 Hz</th><th>800 Hz</th><th>1000 Hz</th><th>1250 Hz</th><th>1600 Hz</th><th>2000 Hz</th><th>2500 Hz</th><th>3150 Hz</th><th>4000 Hz</th><th>5000 Hz</th></tr>
<tr><td rowspan="2">48</td><td colspan="18">Exterior wall: outdoor side 7/8 inch portland cement plaster on 17 gauge wire lath, 1/2 inch gypsum sheathing, 2 x 4 wood studs; indoor side rockwool insulation, 1/2 inch veneer base and veneer finish</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>27</td><td>29</td><td>28</td><td>39</td><td>41</td><td>40</td><td>45</td><td>48</td><td>49</td><td>50</td><td>47</td><td>50</td><td>50</td><td>50</td><td>51</td><td>55</td><td>56</td><td>60</td><td>5-3/4</td><td>17.1</td><td>144</td><td></td><td>RAL
TL78-92</td></tr>
<tr><td rowspan="2">48</td><td colspan="18">Exterior wall: outdoor side 7/8 inch portland cement plaster, 25/32 inch sheeting, 17 gauge wire lath, paper backed, rockwool insulation with vapor barrier, 1/2 inch thick veneer base and 1/16 inch finish of veneer plastic, 2 x 4 studs, 16 inch o.c., single sole plate, double cap plate</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>24</td><td>26</td><td>27</td><td>36</td><td>42</td><td>42</td><td>45</td><td>46</td><td>47</td><td>49</td><td>49</td><td>50</td><td>50</td><td>51</td><td>52</td><td>55</td><td>57</td><td>59</td><td>6-3/8</td><td>16.0</td><td>144</td><td></td><td>RAL
TL78-89</td></tr>
<tr><td rowspan="2">49</td><td colspan="18">4 inch cinder block, with 2 x 2 inch furring, 1 inch glass fiber, 1 pound sheet lead, 1/4 inch plywood; data read from graph</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>33</td><td>35</td><td>36</td><td>37</td><td>40</td><td>45</td><td>47</td><td>51</td><td>53</td><td>55</td><td>58</td><td>59</td><td>60</td><td>61</td><td>61</td><td>61</td><td></td><td>1</td><td>--</td><td>52</td><td>Acousitlead</td><td>CR L7710-
1-43M</td></tr>
<tr><td rowspan="2">50</td><td colspan="18">Standard steel office partition with 2 x 2 inch furring, 1 inch glass fiber, 1 pound sheet lead, 1/2 inch gypsum board; data read from graph</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>26</td><td>32</td><td>37</td><td>41</td><td>44</td><td>46</td><td>49</td><td>51</td><td>52</td><td>54</td><td>55</td><td>56</td><td>58</td><td>60</td><td>62</td><td>64</td><td></td><td>1-1/4</td><td>--</td><td>52</td><td>Acoustilead</td><td>CR L7710-
1-43M</td></tr>
<tr><td rowspan="2">50</td><td colspan="18">Exterior wall: outdoor side 7/8 inch portland cement plaster, 17 gauge wire lath and paper base, rockwool insulation with vapor barrier, horizontal resilient channels on 24 inch o.c., 1/2 inch thick veneer base gypsum board, veneer plaster finish</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>34</td><td>39</td><td>43</td><td>45</td><td>48</td><td>51</td><td>52</td><td>52</td><td>51</td><td>48</td><td>49</td><td>52</td><td>51</td><td>49</td><td>48</td><td>50</td><td>52</td><td>53</td><td>6-1/4</td><td>--</td><td>144</td><td></td><td>RAL
TL77-38</td></tr>
<tr><td rowspan="2">52</td><td colspan="18">22 gauge steel facings, glass fiber core, 3 pound sheet lead; data read from graph</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>34</td><td>33</td><td>39</td><td>43</td><td>46</td><td>47</td><td>49</td><td>51</td><td>52</td><td>53</td><td>54</td><td>56</td><td>57</td><td>58</td><td></td><td></td><td></td><td>2-1/4</td><td>--</td><td>52</td><td>Acoustilead</td><td>CR L7710-
1-43M</td></tr>
<tr><td rowspan="2">53</td><td colspan="18">Exterior wall: outdoor side 7/8 inch portland cement plaster on 17 gauge wire lath, rockwool insulation, vapor barrier, resilient clips, 1/2 inch thick sanded gypsum plaster and putty finish</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>41</td><td>44</td><td>43</td><td>46</td><td>49</td><td>51</td><td>54</td><td>55</td><td>56</td><td>55</td><td>52</td><td>49</td><td>49</td><td>52</td><td>55</td><td>57</td><td>60</td><td>59</td><td>6</td><td>--</td><td>144</td><td></td><td>RAL
TL77-45</td></tr>
<tr><td rowspan="2">54</td><td colspan="18">Exterior wall: outdoor side 7/8 inch portland cement plaster on 1/2 inch gypsum sheeting, 3-5/8 inch steel studs; indoor side: insulation, 1/2 inch veneer base, veneer finish</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>26</td><td>31</td><td>41</td><td>47</td><td>51</td><td>54</td><td>55</td><td>55</td><td>55</td><td>56</td><td>55</td><td>54</td><td>54</td><td>53</td><td>51</td><td>56</td><td>58</td><td>60</td><td>6</td><td>1.4</td><td>144</td><td></td><td>RAL
TL77-66</td></tr>
<tr><td rowspan="2">56</td><td colspan="18">Exterior wall: outdoor side 7/8 inch portland cement plaster on 17 gauge wire lath, 2 x 4 wood studs; indoor side, rockwool insulation with vapor barrier, resilient channels were located horizontally, 1/2 inch veneer base and veneer finish</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>35</td><td>39</td><td>46</td><td>49</td><td>52</td><td>55</td><td>56</td><td>57</td><td>57</td><td>55</td><td>54</td><td>56</td><td>57</td><td>54</td><td>56</td><td>58</td><td>61</td><td>62</td><td>6-1/4</td><td>13.5</td><td>144</td><td></td><td>RAL
TL77-67</td></tr>
</table>

CATEGORY 23. WINDOWS



CATEGORY 23. WINDOWS

Sound transmission losses of window assemblies are listed. Various types of windows, e.g., pivoted, dual glazed, laminated glass, venetian blind, and plastic windows, etc, are presented. Simple windows are usually the "weak links" in the sound isolation of rooms and buildings, but it is possible to select windows with high sound transmission losses to make the interiors of the buildings reasonably quiet. In the buildings at airports the selection of windows will determine to a large extent the interior noise levels. In such instances entirely sealed, dual glazed windows with a large airspace between the plates provide acceptable sound attenuation. Thickness, sealing, transparent barrier material and spacing are all important in the acoustic performance of a window.

Organizations contributing data to this table are: 37, 64, 73, and 88.

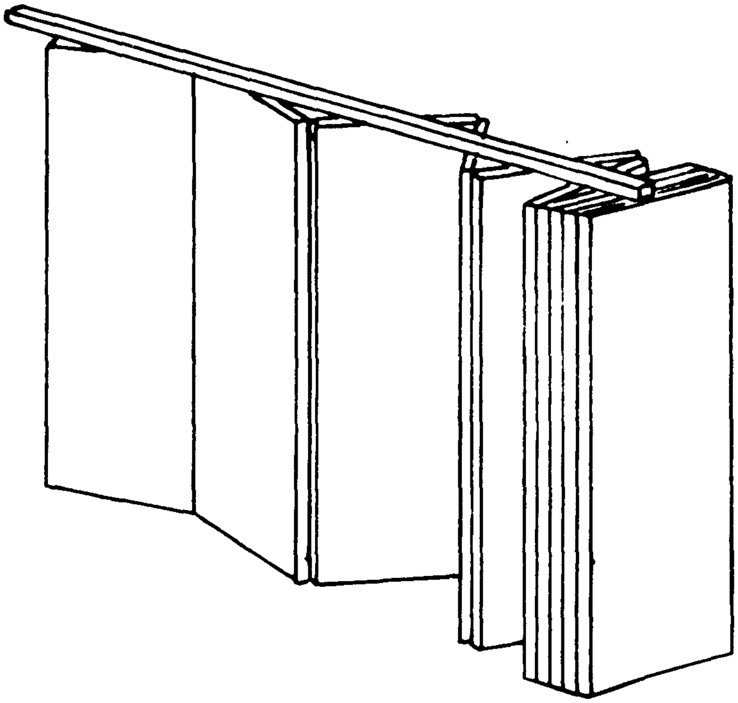
GLOSSARY

Facing:	The outside surface of the specimen. In general the side facing the sound source
Backing:	The other outside surface of the specimen. In general the side not facing the sound source
Core:	The region between the facing and the backing
Glazed Window:	A window furnished with glass
Dual Glazed Window:	A window furnished with two glass panes

Table 23. Windows.

STC	Transmission Loss, dB 100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
37	Two panes of 1/8 inch glass on both sides of a 2-1/4 inch air space																						
		13	20	24	25	29	33	35	37	40	44	47	49	49	50	51	43		2-3/4	5.0	37	Model 650	RAL TL69-244
40	Two panes 1/4 inch glass on both sides of 2-1/4 inch air space																						
	30	27	27	27	32	34	31	36	40	42	43	42	42	38	41	47	51	52	3-1/4	7.1	37	Model 660	RAL TL69-236
43	3/16 inch glass, 1-1/8 inch airspace, 1/4 inch insulated glass, 1/2 inch airspace, 1/4 inch glass all glazed to 43-1/2 x 57-3/4 inch aluminum window frame																						
	26	28	29	31	31	36	35	40	42	44	45	47	48	45	42	49	48	48	2-13/16	9.5	88	Series 325 vertical pivoting windows	RAL TL78-116
44	1/4 inch polished plate, 2 inch air space, 3/8 inch polished plate, 36 x 84 inch nominal perimeter																						
	30	32	34	34	35	38	42	44	46	45	43	44	44	42	43	49	53	57	2-5/8	8.4	64	Amerada Insulated Sound Control Unit	RAL TL71-254
44	Two panes of 1/4 inch glass on both sides of a 2-1/4 inch air space																						
	22	20	30	32	35	37	40	42	45	47	47	49	47	44	45	52	53	57	3-1/4	7.6	37	Model 650	RAL TL69-24[illegible]
45	Two panes 3/16 inch glass, 2-1/4 inch air space, two panes 1/4 inch glass																						
	30	26	29	30	34	36	39	43	46	48	50	52	51	48	48	52	57	60	3-1/8	6.8	37	Model 660 Double Hung	RAL TL74-19
48	Two panes 1/4 inch glass, 4 inch air space, two panes 3/16 inch glass																						
		27	32	34	37	40	41	45	49	52	56	58	59	56	53	51	60		4-7/8	7.0	37	Model 720	RAL TL71-242
48	Two panes 3/16 inch glass, 4-1/2 inch air space, two panes 1/4 inch glass																						
	32	30	29	34	40	42	43	46	49	51	54	55	55	52	51	52	56	59	5-3/8	7.4	37	Model 660 DB	RAL TL74-16
48	3/16 inch and 1/4 inch glass on both sides of 4-3/4 inch air gap																						
	31	27	33	36	39	41	42	44	48	50	52	53	54	54	54	55	59	62	5-5/8	9.0	37	Model 650 DB	RAL TL72-156
49	1/2 inch Acousta-Pane, 2 inch air gap, 3/8 inch Acousta-Pane, 36 x 84 inch nominal perimeter																						
	40	40	39	39	39	43	44	46	48	49	50	50	50	51	54	55	57	58	3-1/8	12.1	64	Amerada Insulated Sound Control Unit	RAL TL71-253

CATEGORY 24. OPERABLE PARTITIONS



CATEGORY 24. OPERABLE PARTITIONS

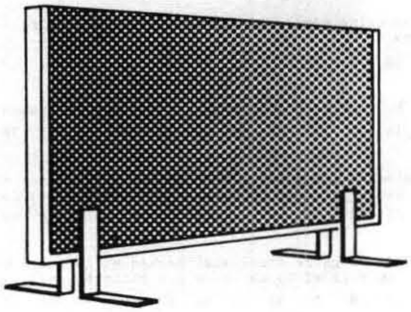
Operable partitions are used as room dividers which are more rigid than flexible curtains. They are usually suspended from the ceiling on an overhead track. These partitions are often mounted on rollers for ease of operation and are opened in an accordianlike fashion. For individual access, smaller exit doors may be included; especially where the partitions are used for large areas such as gymnasiums, shops, hangers, auditoriums, etc.

Sealing is one of the main design parameters for acoustical performance. Various techniques are used in maintaining an acoustical seal at each fold and around the perimeter when the partition is closed. Organizations contributing data to this table are: 68, 99, and 105.

Table 24. Operable partitions.

STC	Transmission Loss, dB 100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft²)	Company	Product	Reference
34	Fabric cover, vinyl lead liners, fiber glass liner																						
	13	13	16	19	23	26	29	32	35	36	39	43	44	46	48	51	53	54	--	4.8	99	Curtition	RAL
37	3-1/4 inch 26 gauge steel slats backed by 18 ounce per 54 inch vinyl impregnated liner faced by 48 ounce per 54 inch vinyl fabric																						
	16	15	19	23	24	29	33	36	36	39	42	45	46	48	49	50	51	50	--	4 8	68	Soundguard X-8	RAL TL 71-316
38	#240 vinyl covering panels hinged to operate as a single-unit. Standard aluminum base																						
		14	19	28	32	33	35	37	37	40	41	41	43	43	43	44	40		3	--	105	#380 Folding Wall with #240 Panels	RAL
38	Center-hung bi-fold wall with #2540V vinyl covered panels																						
	15	21	26	36	35	37	37	37	39	39	40	40	39	36	34	37	38	39	3	5.9	105	#2500 Series Folding Wall	RAL OT 76-10
39	5-1/4 inch wide 22 gauge steel slat backed by 18 ounce per 54 inch vinyl impregnated liner faced by 48 ounce per 54 inch vinyl fabric																						
	15	18	21	25	28	31	34	37	42	43	43	45	48	49	52	53	53	55	--	5.9	68	Foldoor Super Soundguard X24	RAL TL71-38
39	3-1/4 inch wide 22 gauge steel slat backed by 18 ounce per 54 inch vinyl impregnated liner faced by 48 ounce per 54 inch vinyl fabric																						
	19	19	24	27	28	30	31	35	41	47	49	50	48	49	50	51	51	51	--	6.1	68	Super Soundguard X16 Fully Operable	RAL TL71-256
40	Facing 3/8 inch particle board, 2-1/2 lb/ft^3 mineral wool, with laminated fabrics																						
	16	17	26	29	32	34	36	37	40	41	39	42	43	45	46	46	47	46	2-1/4	4.9	68	Foldoor Series 1	RAL TL70-225
40	5-1/4 inch wide 24 gauge steel slat backed by 18 ounce per 54 inch vinyl impregnated liner faced by 48 ounce per 54 inch vinyl fabric																						
	17	20	23	26	28	30	34	38	44	48	48	48	50	51	53	53	54	53	--	5.8	68	Foldoor Super Soundguard X12	RAL TL72-23
41	5-1/4 inch wide 22 gauge steel slat backed by 18 ounce per 54 inch vinyl impregnated liner faced by 48 ounce per 54 inch vinyl fabric																						
	23	22	24	26	29	32	34	37	42	45	46	48	49	51	52	54	55	56	--	6.24	68	Super Soundguard X24 Folding Door	RAL TL71-210
42	Facing 1/4 inch particle board fabric covered filled with 2-1/2 lb/ft^3 rockwool three 11-gauge strips 5 inch wide laminated to back of particle board																						
	21	22	27	31	34	34	36	40	41	42	42	44	47	49	50	48	49	50	3	5.3	68	Foldoor Series 2	RAL TL72-210
42	Center-hung bi-fold wall with #2540 V vinyl covered panels																						
		21	27	36	38	38	38	39	41	41	42	43	45	47	46	46	44		3	5.9	105	#2500 Series Folding Wall with Compression Unit	RAL OT76-9
43	3/8 inch particle board faces (fabric covered), 2-1/2 lb/ft^3 rockwool and steel dampers																						
	20	24	30	32	36	37	39	41	41	42	43	44	46	47	47	46	45	44	3	5.6	68	Foldoor Series 3	RAL TL76-103
43	#245 vinyl covered panels, hinged to operate as a single unit. Standard aluminum base, automatic bottom pressure seal gasket																						
		25	30	36	41	39	40	40	41	44	44	44	45	46	46	45	41		3	--	105	#380 Folding Wall with #245 panels	RAL
45	#245 vinyl covered panels, standard aluminum base, automatic bottom pressure seal gasket																						
		22	31	36	40	41	43	45	46	47	45	44	44	45	47	49	50		3	--	105	#380 Folding Wall with #245 panels	RAL
48	3/8 inch flakeboard faces (fabric covered), 6 lb/ft^3 rockwool, steel dampers																						
	28	32	38	38	41	40	43	45	47	48	49	51	53	52	52	49	50	52	3-3/4	8.7	68	Foldoor Series 4	RAL TL77-69
	Steel panels bonded to fabric, with perforated Tuftex-360 fabric. Partition has an NRC value of 0.75																						
																			12	--	68	Foldoor X12	RAL A71-37

CATEGORY 25. OPEN PLAN SYSTEMS



OFFICE LANDSCAPE SCREEN

CATEGORY 25. OPEN PLAN SYSTEMS

Open plan systems refer to products and materials which are used in open plan offices, buildings, or educational areas. The room configuration for open plan areas has no interior floor to ceiling partitions. Basically, there is one, large open area which is subdivided into working modules using movable partitions. These movable partitions are generally free standing, partial height barriers. They are often called landscape screens and are typically 5 to 6 ft high. These screens have absorptive and barrier properties so that speech privacy can be obtained between modules. Acoustically, these screens may be rated according to absorptive (NRC), transmission loss (STC), or noise isolation class (NIC') properties. The two other major elements of open plan systems are in absorptive ceiling and a sound masking system. In order to achieve adequate speech privacy, all three elements must have good acoustic performance.

Organizations contributing data to this table are: 4, 67, 77, 96, 118, 133, 136, and 141.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.

GLOSSARY

Landscape screen:	A partial height, movable partition with absorptive and barrier properties.
NIC':	Noise isolation class referred to open plan system performance. Higher numbers indicate better acoustic isolation.

Table 25A. Absorption properties of open plan office systems.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^2)	Mounting	Company	Product	Reference
.80	Fabric cover, fiberglass, full face.											
	.33	.53	.81	.90	.87	.90	2	1.04	--	136	Formfac Landscape Screen	RAL A 76-284
.80	Glass fiber insulation covered with fabric. Density is lb/ft^3.											
	.25	.47	.71	.79	.81	.78	2	1.9	--	67	Unigroup Standard Fabric Panel	RAL TL-77-62
.80	2 x 8 ft or 8 x 12 ft 4 pcf mineral fiber blankets encased in white polyvinyl chloride film, surrounded by 20 gauge galvanized steel frame, front is of galvanized expanded and flattened metal mesh and back is covered with 1/8 inch Duron hardboard.											
	.28	.70	.95	.89	.71	.61	2	2.5	4	133	Acoustisorber Screens	CR SC-852/ USG/10-77
.85	1/2 inch urethane foam and nylon velvet facing containing 1/10 inch perforated hardboard and filled with 6 lb/ft^3 fiberglass.											
	.32	.57	.86	.94	.93	.86	2-1/4	--	--	141	Planscape AR CR-6AR	RAL A 75-49
.90	Center core 3/16 inch septum with aluminum foil, 1/2 inch layer of 6 lb/ft^3 fiberglass, 1/8 inch of 12 lb/ft^3 fiberglass, outer layer of .6 lb/ft^3 fiberglass covered with polyester fabric.											
	.32	.55	.88	1.07	1.09	1.05	1-1/4	--	--	141	Planscape 2 SM 60P	CKAL 7601.65
.90	Fabric cover, fiberglass, absorbing area.											
	.37	.60	.93	1.03	1.00	1.02	2	1.2	--	136	Formfac Landscape Screen	RAL A 76-284
.90	Two layers fiberglass, one layer polyester fabric. Density is lb/ft^3.											
	.23	.40	.85	.96	.95	.97	2	1.7	--	67	ERA-1 Acoustical Panel	RAL TL-77-64
.90	Acoustical panel perforated side with 1/8 inch diameter holes on 1/4 inch staggered centers. 2.5 pcf sound attenuation blanket.											
	.22	.57	1.02	1.04	.96	.90	2	1.89	4	118	Multi-Use Panel	RAL 478-24
.90	5 ft high, two layer fiberglass core 3 inch thick with double aluminum foil septum. Fabric covered.											
	.09	.54	1.06	1.04	.99	1.04	--	--	--	96	Sound Screen II	CR 1-AC-7815
1.00	4 x 4 ft glass fiber nubby texture, high performance ceiling panel.											
	.79	.96	.88	1.06	1.06	1.05	1-1/2	.44	7	4	Nubby Open Plan	RAL A 78-51
	Septum faced on either side with 1 inch thick glass fiber and facing of open weave, seamless, nondirectional fabric. All enclosed in a frame.						2-1/4	1.8	--	136	Acoustical Screen	RAL TL 77-126
	Nylon velvet over 3/8 inch foam, 1/8 inch perforated hardboard, air core. Data shown are sabins/unit.											
	12.4	17.1	21.6	26.6	33.4	32.7	1-3/4	--	--	141	Planscape Std. CR-6	RAL A 72-15

Table 25B. Barrier properties of open plan office systems.

STC	Description	Transmission Loss, dB																		Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
		100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz					
13	Fabric cover, glass fiber (7 lb/ft^3), aluminum frame	9	10	7	6	6	6	8	10	10	11	12	14	15	15	15	16	17	19	2	2.09	136	Formfac Landscape Screen	RAL TL 76-192
18	Glass fiber insulation covered with fabric 80 x 48 inch. Density is lb/ft^3	10	13	12	9	13	12	13	14	15	16	17	18	21	23	28	32	34	37	2	1.9	67	Unigroup Standard Fabric Panel	RAL TL 77-62
24	Center core 3/16 inch septum with aluminum foil, 1/2 inch layer of 6 lb/ft^3 fiberglass, 1/8 inch of 12 lb/ft^3 fiberglass, outer layer of .6 lb/ft^3 fiberglass covered with polyester fabric	12	11	11	12	11	13	16	19	22	24	28	30	33	36	39	41	43	45	1-1/4	--	141	Planscape 2 SM 60 P	CKAL 7604.33
26	2 x 8 ft or 8 x 12 ft 4 pcf mineral fiber blankets encased in white poly vinyl chloride film with galvanized expanded and flattened metal mesh front with 1/8 inch Duron Hardboard back		13	11	13	15	15	18	22	27	31	34	34	36	38	37	28	28		2	2.5	133	Acoustisorber Screens	CR SC-852/ USG/10-77
29	Two layers fiberglass, one layer polyester fabric 80 x 48 inch. Density is lb/ft^3.	17	18	15	15	18	19	22	25	28	30	31	31	33	38	45	47	49	51	2	1.7	67	ERA-1 Acoustical Panel	RAL TL 77-64
42	Ceiling panel 2 x 4 ft, tested to AMA-I-II																			1/2	1.9	4	Vinyl rock F-123	CR A111

Table 25C. Speech privacy potential of open plan office systems.

NIC'	Description	Functional Interzone Attenuation, dB								Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
		400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz					
19	Alpha II. Test method PBS-C.2	22	17	20	19	20	20	21	20	1-1/2	--	96	Glass Cloth Ceiling Board	CR 1-AC-8150
20	4 x 4 ft glass fiber nubby texture, high performance acoustical panel, test in accordance with PBS-C.2	18	19	20	21	21	22	23	22	1-1/2	.44	4	Nubby Open Plan	G & H AFX IL2
20	Nubby II. Test method PBS-C.2	21	18	19	20	20	21	21	23	1-1/2	--	96	Glass Cloth Ceiling Board	CR 1-AC-8150
20	Omega II. Test method PBS-C.2	21	17	20	20	21	22	23	24	1-1/2	--	96	Glass Cloth Ceiling Board	CR 1-AC-8150
20	Textured II. Test method PBS-C.2	21	17	19	20	21	21	21	23	1-1/2	--	96	Glass Cloth Ceiling Board	CR 1-AC-8150
21	5 ft high. Two layers fiberglass core 3 inch thick with double aluminum foil septum. Fabric covered. Test method PBS-C.2									--	--	96	Sound Screen II	CR 1-AC-7815

CATEGORY 26. WALL TREATMENTS

CATEGORY 26. WALL TREATMENTS

Facings in the form of panels, boards, and coverings which can be mounted on walls are used to improve acoustic performance. Wall treatments are made from a variety of materials and are available in various designs, colors, and surface textures. Aesthetic value plus sound control are major criteria for selection of wall treatments.

Organizations contributing data to this table are: 4, 11, 15, 73, 85, 92, 96, 106, 115, and 133. Related categories are walls, unit absorbers, panels, ceiling tile, and open plan systems.

CAUTION

1. ABSORPTION COEFFICIENTS MAY EXCEED 1.0. FOR A COMPLETE DISCUSSION OF THESE VALUES SEE PAGE 51.
2. THE NUMBERS LISTED UNDER THE "MOUNTING" COLUMN REFER TO THE AIMA STANDARD MOUNTINGS DESCRIBED ON PAGE 54.

GLOSSARY

Facing:	The outside surface of the specimen. In general the side facing the sound source
Backing:	The other outside surface of the specimen. In general the side not facing the sound source
Core:	The region between the facing and the backing
Lath:	Thin lightweight structure used as groundwork for plastering, mounting tiles, etc. It may be in a form of gypsum board, perforated metal wire cloth, thin wood strips, etc.

Table 26. Wall treatment.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.40	Acoustical interior wall panels composed of long wood fibers and inorganic cement binder, coarse fiber surface, painted or unpainted, edges are square. Temperature range -50 to 150°F.											
	.08	.14	.27	.57	.59	.63	1	18.9	2	92	Gold Bond Tectum Interior Wall Panels	NGC 7309
.50	Fiberglass, fabric cover											
	.01	.09	.31	.62	.88	1.04	7/16	9.75	4	115	Noise Stop Wall Panel	CKAL 7601.63
.55	1 inch 703 with 1/8 inch pegboard facing.											
	.09	.35	.99	.58	.24	.10	1	--	--	96	OCWT	OCRL
.60	1 inch 703 with 1/4 inch pegboard facing.											
	.08	.32	.99	.76	.34	.12	1	--	--	96	OCWT	OCRL
.60	1 inch TIW Type 1 with 1/4 inch pegboard facing.											
	.08	.41	.99	.82	.26	.32	1	--	--	96	OCWT	OCRL
.60	Paper-faced 3-1/2 inch fiberglass with 1/4 inch pegboard facing on 2x4 wood studs 16 inches O.C.											
	.50	.99	.70	.41	.38	.27	--	--	--	96	OCWT	OCRL
.65	1 inch painted linear glass cloth board.											
	.03	.17	.63	.87	.96	.96	1	--	--	96	OCWT	OCRL
.65	1 inch TIW Type 1											
	.11	.33	.70	.80	.86	.85	1	--	--	96	OCWT	OCRL
.70	Absorptive mineral fiberboard panels with vinyl film finish 4 x 6 ft.											
	.16	.52	.64	.81	.73	.49	5/8	26	2	96	Armstrong Armashield Acoustical Wall Panels	AAL T56181
.70	1 inch 703											
	.06	.20	.65	.90	.95	.98	1	1.58	--	96	OCWT	OCRL
.70	1 inch textured glass cloth board.											
	.05	.22	.67	.93	.99	.95	1	--	--	96	OCWT	OCRL
.70	2 inch TIW Type 1 with 1/4 inch pegboard facing.											
	.26	.89	.99	.58	.26	.17	2	--	--	96	OCWT	OCRL
.70	3 inch TIW Type 1 core with 1/4 inch pegboard facing.											
	.53	.99	.97	.51	.32	.16	3	--	--	96	OCWT	OCRL
.70	4 inch TIW Type 1 core with 1/4 inch pegboard facing.											
	.70	.99	.94	.58	.37	.19	4	--	--	96	OCWT	OCRL
.70	5 inch TIW Type 1 with 1/4 inch pegboard facing.											
	.78	.99	.89	.63	.34	.14	5	--	--	96	OCWT	OCRL
.70	6 inch TIW Type 1 with 1/4 inch pegboard facing.											
	.95	.99	.88	.64	.36	.17.	6	--	--	96	OCWT	OCRL
.70	3-1/2 inch fiberglass with 1/4 inch pegboard facing on 2x4 wood studs 16 inch O.C.											
	.45	.99	.87	.41	.30	.18	--	--	--	96	OCWT	OCRL
.75	1 inch nubby glass cloth board											
	.04	.21	.73	.99	.99	.90	1	--	--	96	OCWT	OCRL
.75	2 inch 703 with 1/4 inch pegboard facing.											
	.26	.97	.99	.66	.34	.14	2	--	--	96	OCWT	OCRL
.75	1 inch linear glass cloth board facing backed with 1 inch air space.											
	.04	.26	.78	.99	.99	.98	2	--	--	96	OCWT	OCRL

Table 26. Wall treatment continued.

NRC	Absorption Coefficients 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.75	3 inch 703 core with 1/4 inch pegboard facing.											
	.49	.99	.99	.69	.37	.15	3	--	--	96	OCWT	OCRL
.75	4 inch 703 core with 1/4 inch pegboard facing.											
	.80	.99	.99	.71	.38	.13	4	--	--	96	OCWT	OCRL
.75	5 inch 703 core with 1/4 inch pegboard facing.											
	.98	.99	.99	.71	.40	.20	5	--	--	96	OCWT	OCRL
.75	6 inch 703 core with 1/4 inch pegboard facing.											
	.95	.99	.98	.69	.36	.18	6	--	--	96	OCWT	OCRL
.75	Anechoic wedge panels 12 x 12 inch											
	.09	.40	.79	.90	.93	.83	--	6.5	4	106	Robac	CPRC SA-75-126
.80	Fiberglass panel, fabric.											
	.10	.29	.81	.99	1.04	.99	1	7.5	4	115	AF570 Wall Panel	CKAL 7601.59
.80	Paper-faced 3-1/2 inch fiberglass on 2x4 wood studs 16 inch O.C.											
	.38	.96	.99	.68	.47	.35	--	--	--	96	OCWT	OCRL
.85	Premolded fiberglass boards incased in class I flame rated fabric, decorative.											
	.31	.48	.89	1.01	1.01	1.02	1	6	4	73	Noise Control Panels	KAL 434350
.85	1 inch fiberglass, fabric covered. Sizes 2 x 4 ft, 4 x 4 ft, 4 x 8 ft.											
	.26	.31	.86	1.08	1.13	1.03	1	--	--	96	Wall Panel 700 Series	OCRL
.85	1 inch painted linear glass cloth board facing with 2 inch air space.											
	.17	.40	.94	.99	.97	.99	3	--	--	96	OCWT	OCRL
.85	1 inch painted linear glass cloth board facing with 3 inch air space.											
	.19	.53	.99	.99	.92	.99	4	--	--	96	OCWT	OCRL
.85	2-1/4 inch fiberglass on 2x2 wood studs 16 inch O.C.											
	.30	.69	.94	.92	.92	.98	--	--	--	96	OCWT	OCRL
.90	Glass fabric faced panel 4 x 4 ft.											
	.72	.93	.72	.97	1.02	1.01	1	4.1	7	4	Nubby 90	RAL A76-32
.90	1 inch AF545; 1 inch thick 4.5 lb/ft^3 fiberglass; 7/16 inch noise stop, 9.75 lb/ft^3; fiberglass with fabric 0.11 lb/ft^2											
	.13	.47	1.02	1.12	1.06	1.01	1-7/16	4.38	4	115	AF545 Noise Stop Wall Panel	CKAL 7601.61
.90	2 x 4 ft mineral fiber blanket encased in white plastic film, flush.											
	.29	.69	.99	.99	.86	.72	2	9	--	133	Acoustisorber Wall Panel	CR SC-851/ USG/10-77
.90	2 x 4 ft mineral fiber blanket encased in plastic film with flattened expanded metal one face, flush.											
	.35	.74	.99	.96	.85	.65	2	9	--	133	Geocoustisorber Wall Panel	CR SC-851/ USG/10-77
.90	1 inch 703 core with 1 inch painted linear glass cloth board facing.											
	.18	.71	.99	.99	.99	.99	2	--	--	96	OCWT	OCRL
.90	2 inch TIW Type 1 with 24 gauge perforated metal facing.											
	.25	.64	.99	.97	.88	.92	2	--	--	96	OCWT	OCRL
.90	1 inch TIW Type 1 core with 1 inch linear glass cloth board facing.											
	.23	.72	.99	.99	.99	.99	2	--	--	96	OCWT	OCRL

Table 26. Wall treatment continued.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.90	1 inch painted linear glass cloth board facing with 5 inch air space.											
	.41	.73	.99	.98	.94	.97	6	--	--	96	OCWT	OCRL
.95	Fiberglass boards, decorative.											
	.48	.76	.89	1.02	1.07	1.05	1-1/2	--	4	73	Noise Control Panels	KAL 438442
.95	2 inch 703											
	.18	.76	.99	.99	.99	.99	2	1.58	--	96	OCWT	OCRL
.95	2 x 4 ft mineral fiber blanket encased in white plastic film. Tested with 2 inch air space behind panel.											
	.35	.76	.99	.99	.99	.72	2	9	--	133	Acoustisorber Wall Panels	CR SC-851/ USG/10-77
.95	2 x 4 ft mineral blanket encased in plastic film with flattened expanded metal one face. 2 inch air space behind panel.											
	.37	.85	.99	.99	.93	.68	2	9	--	133	Geocoustisorber Wall Panel	CR SC-851/ USG/10-77
.95	2 inch 703 with 24 gauge perforated metal facing.											
	.18	.73	.99	.99	.97	.93	2	--	--	96	OCWT	OCRL
.95	1 inch 703 core with 1 inch nubby glass cloth board facing.											
	.25	.76	.99	.99	.99	.97	2	--	--	96	OCWT	OCRL
.95	2 inch TIW Type 1											
	.25	.75	.99	.99	.99	.99	2	--	--	96	OCWT	OCRL
.95	1 inch TIW Type 1 core with 1 inch nubby glass cloth board facing.											
	.26	.75	.99	.99	.99	.99	2	--	--	96	OCWT	OCRL
.95	3 inch 703											
	.53	.99	.99	.99	.99	.99	3	--	--	96	OCWT	OCRL
.95	2 inch 703 core with 1 inch painted linear glass cloth board facing.											
	.59	.99	.99	.99	.99	.99	3	--	--	96	OCWT	OCRL
.95	2 inch 703 core with 1 inch nubby glass cloth board facing.											
	.50	.99	.99	.99	.99	.97	3	--	--	96	OCWT	OCRL
.95	3 inch TIW Type 1											
	.46	.99	.99	.99	.99	.99	3	--	--	96	OCWT	OCRL
.95	2 inch TIW Type 1 with 1 inch painted linear glass cloth board facing.											
	.48	.99	.99	.99	.99	.99	3	--	--	96	OCWT	OCRL
.95	2 inch TIW Type 1 with 1 inch nubby glass cloth board facing.											
	.51	.99	.99	.99	.97	.95	3	--	--	96	OCWT	OCRL
.95	4 inch 703											
	.99	.99	.99	.99	.98	.98	4	--	--	96	OCWT	OCRL
.95	3 inch 703 core with 1 inch painted linear glass board facing.											
	.88	.99	.99	.99	.93	.98	4	--	--	96	OCWT	OCRL
.95	3 inch 703 core with 1 inch nubby glass cloth board facing.											
	.75	.99	.99	.99	.99	.97	4	--	--	96	OCWT	OCRL

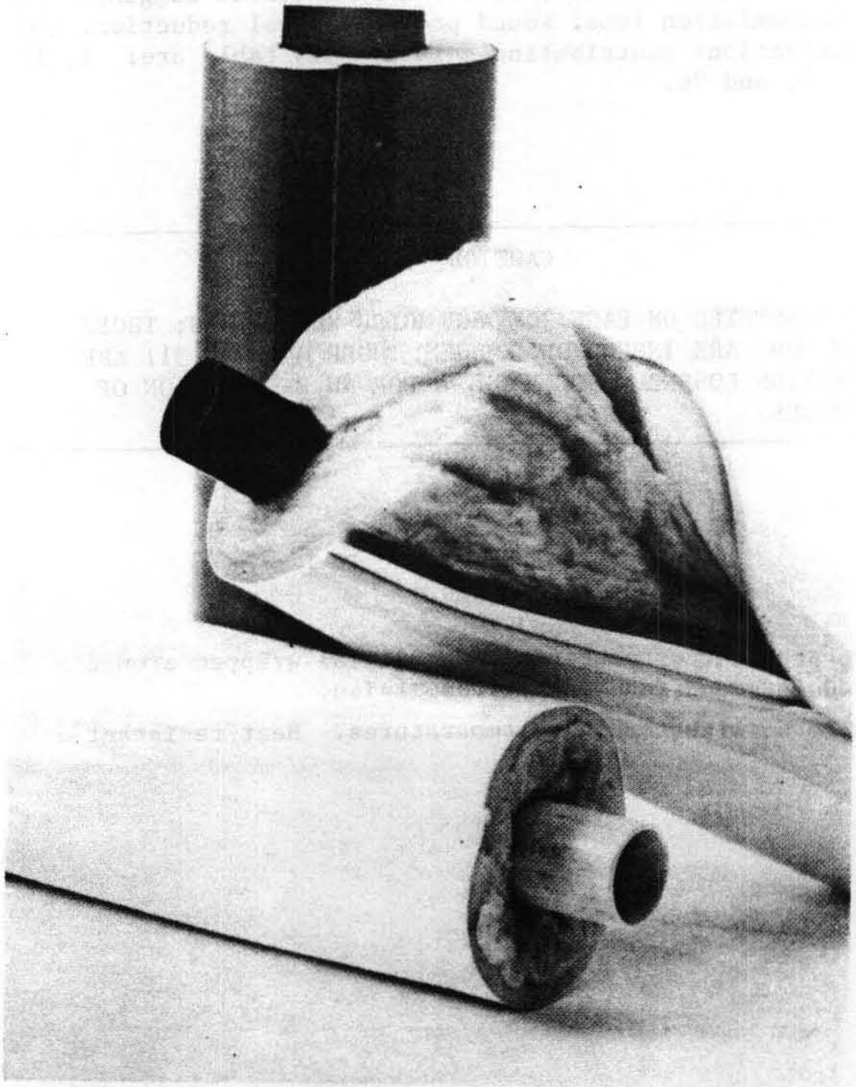
Table 26. Wall treatment continued.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.95	4 inch TIW Type 1											
	.57	.99	.99	.99	.99	.99	4	--	--	96	OCWT	OCRL
.95	3 inch TIW Type 1 with 1 inch painted linear glass cloth board facing.											
	.77	.99	.99	.99	.99	.99	4	--	--	96	OCWT	OCRL
.95	3 inch TIW Type 1 with 1 inch nubby glass cloth board facing.											
	.71	.99	.99	.99	.99	.92	4	--	--	96	OCWT	OCRL
.95	5 inch 703											
	.95	.99	.99	.99	.99	.99	5	--	--	96	OCWT	OCRL
.95	4 inch 703 core with 1 inch painted linear glass cloth facing.											
	.87	.99	.99	.99	.99	.99	5	--	--	96	OCWT	OCRL
.95	4 inch 703 core with 1 inch nubby glass cloth board facing.											
	.88	.99	.99	.99	.99	.96	5	--	--	96	OCWT	OCRL
.95	5 inch TIW Type 1											
	.83	.99	.99	.99	.99	.99	5	--	--	96	OCWT	OCRL
.95	4 inch TIW with 1 inch painted linear glass cloth board facing.											
	.77	.99	.99	.99	.99	.99	5	--	--	96	OCWT	OCRL
.95	4 inch TIW Type 1 with 1 inch nubby glass cloth board facing.											
	.79	.99	.99	.99	.99	.98	5	--	--	96	OCWT	OCRL
.95	6 inch 703											
	.99	.99	.99	.99	.99	.99	6	--	--	96	OCWT	OCRL
.95	5 inch 703 core with 1 inch painted linear glass cloth board facing.											
	.99	.99	.99	.99	.99	.99	6	--	--	96	OCWT	OCRL
.95	5 inch 703 core with 1 inch nubby glass cloth board facing.											
	.92	.99	.99	.99	.99	.99	6	--	--	96	OCWT	OCRL
.95	6 inch TIW Type 1											
	.93	.99	.99	.99	.99	.99	6	--	--	96	OCWT	OCRL
.95	5 inch TIW Type 1 with 1 inch painted linear glass cloth board facing.											
	.87	.99	.99	.99	.99	.99	6	--	--	96	OCWT	OCRL
.95	5 inch TIW Type 1 with 1 inch nubby glass cloth board facing.											
	.92	.99	.99	.99	.99	.93	6	--	--	96	OCWT	OCRL
.95	6 inch 703 core with 1 inch painted linear glass cloth board facing.											
	.86	.99	.99	.99	.99	.99	7	--	--	96	OCWT	OCRL
.95	6 inch 703 core with 1 inch nubby glass cloth board facing.											
	.85	.99	.99	.99	.99	.99	7	--	--	96	OCWT	OCRL
.95	6 inch TIW Type 1 with 1 inch painted linear glass cloth board facing.											
	.95	.99	.99	.99	.99	.99	7	--	--	96	OCWT	OCRL

Table 26. Wall treatment concluded.

NRC	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.95	6 inch TIW Type 1 with 1 inch nubby glass cloth board facing.											
	.95	.99	.99	.99	.99	.94	7	--	--	96	OCWT	OCRL
.95	3-1/2 inch fiberglass on 2x4 wood studs 16 inch O.C.											
	.34	.80	.99	.97	.97	.92	3-1/2	--	--	96	OCWT	OCRL
.95	3-1/2 inch fiberglass with 1 inch painted linear glass cloth board facing on 2x4 wood study 16 inch O.C.											
	.66	.99	.99	.99	.99	.97	4-1/2	--	--	96	OCWT	OCRL
.95	3-1/2 inch fiberglass with 1 inch nubby glass cloth board on 2x4 wood studs 16 inch O.C.											
	.67	.99	.99	.99	.99	.90	4-1/2	--	--	96	OCWT	OCRL
.95	Paper-faced 3-1/2 inch fiberglass with 1 inch painted linear glass cloth board facing on 2x4 wood studs 16 inch O.C.											
	.66	.99	.99	.99	.99	.99	4-1/2	--	--	96	OCWT	OCRL
.95	Paper-faced 3-1/2 inch fiberglass with 1 inch nubby glass cloth board facing on 2x4 wood studs 16 inch O.C.											
	.66	.99	.99	.98	.99	.95	4-1/2	--	--	96	OCWT	OCRL
.95	6 inch fiberglass on 2x6 wood studs 16 inch O.C.											
	.67	.99	.99	.99	.99	.98	6	--	--	96	OCWT	OCRL
.95	6 inch fiberglass with 1 inch painted linear glass cloth board facing on 2x6 wood studs 16 inch O.C.											
	.89	.99	.99	.99	.99	.99	7	--	--	96	OCWT	OCRL
1.00	Fiberglass, decorative.											
	.63	.83	.96	1.06	1.07	1.07	2-1/2	--	4	73	Noise Reduction Panels	KAL 438443
	Decor panels 3 to 6 lb rigid fiberglass, core faced with decor fabric, reinforced fabric, vinyl vapor barrier. 2 x 4 through 4 x 10 ft in thicknesses from 1 to 8 inches.						--	--	--	85	MBI Thermal Acoustic Insulation	CR 7.14 ME
.95 (c)	Fiberglass 2 inch thick with fabric.											
	.20	.79	1.17	1.17	1.05	1.04	2	7	4	115	AF570 Wall Panel	CKAL 7601.62

CATEGORY 27. PIPE LAGGINGS



CATEGORY 27. PIPE LAGGINGS

Pipe laggings can effectively reduce the ambient noise levels if the pipe and fluid generated noise is of high amplitude compared to other ambient noise. Pipe laggings consist essentially of a decoupling element and a "floating" barrier where the decoupling element stops the pipe vibrations from driving the barrier material. Thermal properties and ease of application are the important criteria in the selection of the most suitable lagging. Data shown may consist of transmission loss, sound pressure level reduction, and noise reduction. Organizations contributing data to this table are: 1, 18, 32, 40, 45, 66, 73, 74, 90, and 96.

CAUTION

VALUES PRESENTED ON PAGE 307 ARE NOISE REDUCTIONS; THOSE ON PAGE 309, ARE INSERTION LOSSES; THOSE ON PAGE 311 ARE TRANSMISSION LOSSES. SEE PAGE 94 FOR AN EXPLANATION OF DIFFERENCES.

GLOSSARY

Lagging: Strip or sheet of nonconducting material wrapped around a pipe to reduce sound (and heat) transmission.

Refractory: Able to withstand high temperatures. Heat resistant.

Table 27A. Pipe lagging (noise reduction).

Noise Reduction, dB																						
100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft²)	Company	Product	Reference
Corrugated aluminum and lead laminate.																						
				14			16			26			37			41		5/16	1.2	73	Acousti-Jac N-C-S	RAL 7604.222
0.5 inch foam; .106 inch rubber.																						
			1	6	5	4	9	11	14	15	21	22	20	17	24	21	24	.606	1.03	66	Acousta Sheet 500	RAL
Standard convoluted foam. A .040 inch vinyl jacket laminated to flexible polyurethane foam. Used for thermal and acoustical insulation on pipes and tanks. Temperature limits -60° to 220°F foam, -20° to 150°F jacket. Density given is linear weight in lb/ft.																						
0	0	0	0	0	0	3	5.1	8.4	9.9	13.8	18.6	20.4	23.9	25.1	26.9	28.5	29.5	1	1.47	1	Acoustazip	RAL NR 78-11
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	1	0	0	1.8	0	0	1	4.3	9	8	11.5	13.8	17.5	17	19.5	18	23	1	.33	18	Kaowool Blanket	RAL NR 73-13
Barium-filled vinyl, 1 inch convoluted foam. Temperature range 0 to 150°F barium-filled vinyl, -60° to 220°F foam. Used as thermal and acoustical insulation on pipes. Density given is linear weight in lb/ft.																						
0	0	.9	.8	2.2	6.6	7.6	10.3	15.3	13.4	20.8	23.7	24.7	25.3	30.7	31.2	33	33	1	4.9	1	Acoustazip	RAL NR 78-13
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	1	1	1.8	3	.5	1	4	6	9.8	11	13.5	17.3	21.8	22	25	23	29.3	1	.5	18	Kaowool Blanket	RAL NR 73-10
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
1	0	0	0	1.2	2.7	6	14.3	18.5	19	22	26	26	31	26	28.5	26.5	29	1	.5	18	Kaowool Blanket	RAL NR 73-8
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	1	2	0	2.8	7.5	10	14.5	18.5	19	22	27	26	31	27	29	26	29	1	.5	18	Kaowool Blanket	RAL NR 73-9
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls.																						
0	1.5	0	1.8	2.5	3.5	5.5	13.5	17.8	18.8	23.5	26	27	32.3	27.8	29	29.5	33	1	.66	18	Kaowool Blanket	RAL NR-73-3
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	0	0	0	.5	0	0	5.5	6.5	10	13	20	21	27	24	27	27	29.5	1	66	18	Kaowool Blanket	RAL NR-73-5
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	1	1	.8	3.5	7.5	9.8	16.5	19.5	16	23	25	27	32.5	26	28	28.5	32	1	.66	18	Kaowool Blanket	RAL NR 73-4
Cellulose fiber blanket in two layers, 1 inch total thickness, 4 x 8 ft sheets.																						
				5			8			8			12			15		1	--	90	K-13 Acoustical Blanket	CR 5-BMG 8277
Mineral wool, a 1200°F mineral fiber batt.																						
0	0	0	0	0	0	0	0	2.2	3.1	5.5	7.8	8	10	8.6	10	10	10.3	1.5	.38	18	Flexwhite Mineral Wool	RAL NR 75-9
Barium-filled vinyl, 1/2 inch foam, 1 inch fiberglass. Temperature range barium-filled vinyl 0 to 150°F; fiberglass 0 to 450°F; foam -60° to 220°F. Used as thermal and acoustical insulation on pipes. Density given is linear weight in lb/ft.																						
.5	2	2.5	3.3	5.2	6.9	9.7	11.6	18.1	14.2	22.4	26	24.7	28.3	33	33	32.8	34.5	1.5	5.7	1	Acoustazip	RAL NR 78-12
Mineral wool insulation, a 1200°F mineral fiber batt.																						
0	0	0	0	0	.5	1.6	1.2	2.5	4.2	6.2	9.1	9.1	11.5	10.5	12	12	12	1.5	.75	18	Flexwhite Mineral Wool	RAL NR 75-11

Table 27A. Pipe lagging (noise reduction) concluded.

Noise Reduction, dB																						
100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	Thickness (in.)	Density (lb/ft^2)	Company	Product	Reference
Mineral wool insulation, a 1200°F mineral fiber batt.																						
.8	1	0	0	0	0	1	2.5	5.5	5.8	7.2	10.5	8.2	14	12.1	15	14	15	1.5	1	18	Flexwhite Mineral Wool	RAL NR 75-13
Mineral wool, a 1200°F mineral fiber batt.																						
2	.5	1	.5	3	4	7	9	13	14	14.3	18.5	14.5	19	16	19	18.2	19.5	2	.5	18	Flexwhite Mineral Wool	RAL NR 75-10
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	1	1	.8	3.5	7.5	9.8	16.5	19.5	16	23	25	27	32.5	26	28	28.5	32	2	.66	18	Kaowool Blanket	RAL NR 73-4
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	1.5	0	1.8	2.5	3.5	5.5	13.5	17.8	18.8	23.5	26	27	32.3	27.8	29	29.5	33	2	.66	18	Kaowool Blanket	RAL NR 73-3
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
1	0	0	0	1.2	2.7	6	14.3	18.5	19	22	26	26	31	26	28.5	26.5	29	2	.66	18	Kaowool Blanket	RAL NR 73-8
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	1	2	0	2.8	7.5	10	14.5	18.5	19	22	27	26	31	27	29	26	29	2	.66	18	Kaowool Blanket	RAL NR 73-9
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	.3	0	0	1.3	0	3	7.8	12	18.3	17	24	26	32	28	31.8	26	34	2	.66	18	Kaowool Blanket	RAL NR 73-14
Mineral wool insulation, a 1200°F mineral fiber batt.																						
2	0	1.5	2	2.5	5	7	9.8	12.8	14	13.5	18.8	14	19.8	16.8	19.5	18.5	21.2	2	1	18	Flexwhite Mineral Wool	RAL NR 75-12
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
1.5	0	1	.3	3.8	3.5	6	13.3	14	19.8	21.5	25.5	28	35.5	29	30.8	25	34	2	1	18	Kaowool Blanket	RAL NR 73-11
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	0	0	0	0	1.2	4.3	11	15.5	15.5	22.5	26	27	32	25	27	26.5	30	2	1.33	18	Kaowool Blanket	RAL NR 73-6
Cellulose fiber blanket in two layers, 2-1/2 inch total thickness, 4 x 4 ft sheets.																						
				5			10			15			22			30		2.5	--	90	K-13 Acoustical Blanket	CR
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	0	0	0	2.6	1.8	7.5	13.5	18.5	26	26	30	32	38	30.5	33	26.3	34	3	1	18	Kaowool Blanket	RAL NR 73-15
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
1.8	3	2	1	5	5	10	16.5	22.8	27.5	26	29.5	33	38	30	33	26.5	34	3	1.5	18	Kaowool Blanket	RAL NR 73-12
High temperature insulation (up to 2300°F). Flow velocity 30 ft/sec. Available in 2 x 45 and 4 x 25 ft rolls. Available in 1/4, 1/2, 1, 1-1/2 and 2 inch thicknesses and 3, 4, 6 and 8 lb densities.																						
0	0	0	1.8	1	4.3	7	15.5	21.5	17.5	24.5	27.5	28	33.8	26.5	27.5	27.5	30	3	2	18	Kaowool Blanket	RAL NR 73-7
Cellulose fibers laminated to polyethylene combined with lead felt, available in 4 x 8 ft sheets.																						
				6			20			23			39			42		--	--	90	K-13 Acoustical Blanket	CR
Cellulose fibers laminated to polyethylene combined with lead, felt, etc. Available in 4 x 8 ft sheets. Desntiy given is volume density in lb/ft^3.																						
				7			16			19			32			36		--	2.5	90	K-13 Acoustical Blanket	CR
Cellulose fiber blanket in two layers, 1-1/2 inch total thickness, 4 x 8 ft sheets.																						
				5			10			12			19			21		1.5	--	90	K-13 Acoustical Blanket	CR

Table 27B. Pipe lagging (insertion loss).

	Insertion Loss, dB											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
1 inch urethane with WFRJ (vapor barrier) jacket (.06 lb/sq ft)												
	-	0	0	0	1	9	1	--	--	96		OCRL
Fiberglass pipe with WFRJ jacket (Glasclad - .06 lb/sq ft)												
	-	0	5	9	14	20	1	--	--	96		OCRL
Kaylo pipe with aluminum jacket (Glasclad - .25 lb/sq ft)												
	-	1	4	8	12	20	1-1/2	--	--	96		OCRL
Fiberglass pipe with aluminum jacket (Glasclad - .25 lb/sq ft)												
	-	1	6	14	19	26	1	--	--	96		OCRL
Three layers thermal insulating wool (TIW) Type I (1 inch thick FRK faced)												
	-	2	10	17	19	25	1	--	--	96		OCRL
Two layers thermal insulating wool (TIW) Type I (1 inch FRK faced)												
	-	0	6	12	16	23	1	--	--	96		OCRL
One layer thermal insulating wool (TIW) Type I (1 inch thick FRK faced)												
	-	0	2	7	12	18	1	--	--	96		OCRL
Three layers ED-100 duct wrap (1 inch thick, FRK faced)												
	-	0	12	19	23	31	1	--	--	96		OCRL
Two layers ED-100 duct wrap (1 inch thick, FRK faced)												
	-	0	8	13	20	30	1	--	--	96		OCRL
One layer ED-100 duct wrap (1 inch thick, FRK faced)												
	-	0	4	7	13	18	1	--	--	96		OCRL
Fiberglass pipe with 1.40 lb/sq ft jacket.												
	-	2	9	18	22	29	1	--	--	96		OCRL
1200 molded pipe covering. Homogenous, mineral fiber pipe insulation in preformed half sections for use as thermal or acoustical insulations. Temperatures up to 1200°F; relative humidity to 99%.												
	-	3	10	15	25	31	1-1/2	10	--	45	Epitherm Pipe Covering	RAL NR 72-30
Kaylo pipe, no covering.												
	-	0	2	6	9	12	1-1/2	--	--	96		OCRL
1200 molded pipe covering. Homogenous mineral fiber pipe insulation is preformed half sections for use as thermal or acoustical insulations. Temperature up to 1200°F; relative humitidy to 99%.												
	4	5	15.5	18	29.5	30.5	2	10	--	45	Epitherm Pipe Covering	RAL NR 72-31
Rigid, hydrous calcium silicate insulation in sectional pipe form. Temperature to 1500°F.												
			6	11	11	14	2	13	--	74	Thermo-12 Plain Facing	CT
Rigid, hydrous calcium silicate insulation in sectional pipe form; canvas jacket.												
			9	13	12	16	2	13	--	74	Thermo-12 Canvas Jacket	CT
Rigid, hydrous calcium silicate insulation in sectional pipe form; aluminum jacket.												
			13	16	16	18	2	13	--	74	Thermo-12 Aluminum Jacket	CT

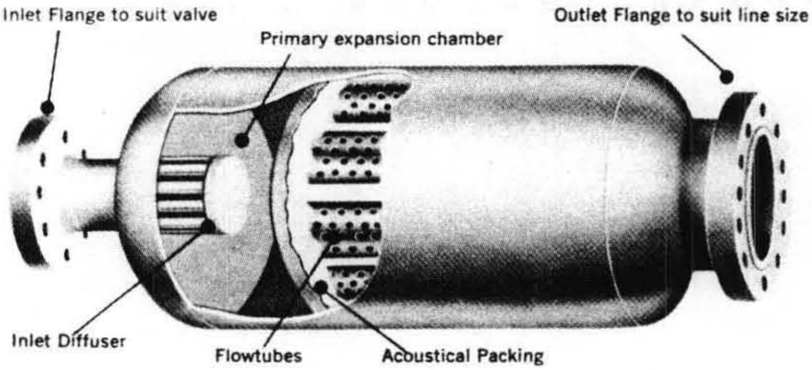
Table 27B. Pipe lagging (insertion loss) concluded.

NRC	Insertion Loss, dB 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft³)	Mounting	Company	Product	Reference
Rigid, bonded fiberglass pipe insulation with aluminum or stainless steel jacket.												
			17	18	24	29	2	--	--	74	Micro-Lok 650; ML Jacket	CT
Rigid, bonded fiberglass pipe insulation with kraft-fiberglass-aluminum jacket.												
			12	14	21	27	2	--	--	74	Micro-Lok 650; AP Jacket	CT
Rigid, bonded fiberglass pipe insulation.												
			8	9	15	18	2	--	--	74	Micro-Lok 650; Plain Facing	CT
Fiberglass pipe with aluminum jacket (Glasclad - .25 lb/sq ft)												
		1	6	15	21	28	2	--	--	96		OCRL
Fiberglass pipe with 1.40 lb/sq ft jacket.												
		4	11	18	23	29	2	--	--	96		OCRL
Fiberglass pipe with WFRJ jacket (Glasclad - .06 lb/sq ft)												
		0	6	13	20	27	2	--	--	96		OCRL
Urethane (outer layer 1 inch thick) plus Fiberglass pipe (inner layer 1 inch thick), no covering.												
		0	3	11	15	21	2	--	--	96		OCRL
2 inch urethane with WFRJ (vapor barrier) jacket (.06 lb/sq ft).												
		0	0	0	2	10	2	--	--	96		OCRL
Fiberglass pipe with aluminum jacket (Glasclad - .25 lb/sq ft).												
		2	8	18	23	30	3	--	--	96		OCRL
Fiberglass pipe with WFRJ jacket (Glasclad - .06 lb/sq ft).												
		2	8	15	22	29	3	--	--	96		OCRL
3 inch urethane with WFRJ (vapor barrier) jacket (.06 lb/sq ft).												
		0	0	1	3	10	3	--	--	96		OCRL
Fiberglass pipe with 1.4 lb/sq ft jacket.												
		4	13	20	24	30	3	--	--	96		OCRL
Kaylo pipe (inner layer 1-1/2 inch thick) plus fiberglass pipe (outer layer 1-1/2 inch thick) with aluminum jacket (Glasclad - .25 lb/sq ft)												
		1	8	20	21	28	3	--	--	96		OCRL
Kaylo pipe with aluminum jacket (Glasclad - .25 lb/sq ft).												
		0	3	6	10	17	3	--	--	96		OCRL
Kaylo pipe, no covering.												
		0	3	7	10	11	3	--	--	96		OCRL
Urethane (outer layer 1 inch thick) plus fiberglass pipe (inner layer 2 inch thick), no covering.												
		0	5	13	16	24	3	--	--	96		OCRL
Urethane (outer layer 1 inch thick) plus fiberglass pipe (inner layer 3 inch thick), no covering.												
		1	5	14	16	23	4	--	--	96		OCRL

Table 27C. Pipe lagging (transmission loss).

<table>
<tr><th rowspan="2">STC</th><th colspan="16">Transmission Loss, dB</th><th rowspan="2">Thickness (in.)</th><th rowspan="2">Density (lb/ft^2)</th><th rowspan="2">Company</th><th rowspan="2">Product</th><th rowspan="2">Reference</th></tr>
<tr><th>125 Hz</th><th>160 Hz</th><th>200 Hz</th><th>250 Hz</th><th>315 Hz</th><th>400 Hz</th><th>500 Hz</th><th>630 Hz</th><th>800 Hz</th><th>1000 Hz</th><th>1250 Hz</th><th>1600 Hz</th><th>2000 Hz</th><th>2500 Hz</th><th>3150 Hz</th><th>4000 Hz</th></tr>
<tr><td>24</td><td colspan="16">Flexible, limp, dense nonlead-loaded vinyl laminated to 1/4 inch acoustical foam.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>12</td><td></td><td></td><td>14</td><td></td><td></td><td>18</td><td></td><td></td><td>26</td><td></td><td></td><td>31</td><td></td><td></td><td>36</td><td>0.34</td><td>0.83</td><td>40</td><td>dba Aircon-"DW"</td><td>CR DW-120</td></tr>
<tr><td>26</td><td colspan="16">Corrugated aluminum and lead laminate.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>15</td><td>14</td><td>15</td><td>16</td><td>18</td><td>19</td><td>21</td><td>24</td><td>24</td><td>26</td><td>28</td><td>30</td><td>32</td><td>34</td><td>35</td><td>37</td><td>5/16</td><td>1.2</td><td>73</td><td>Acousti-Jac N-C-S</td><td>CKAL 7604.22</td></tr>
<tr><td>26</td><td colspan="16">Flexible, limp, dense nonlead-loaded vinyl laminated to 1/4 inch acoustical foam.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>12</td><td></td><td></td><td>17</td><td></td><td></td><td>19</td><td></td><td></td><td>28</td><td></td><td></td><td>36</td><td></td><td></td><td>40</td><td>0.375</td><td>1</td><td>40</td><td>dba Aircon "DW"</td><td>CR DW-144</td></tr>
<tr><td>26</td><td colspan="16">Flexible, limp, dense nonlead-loaded vinyl laminated to 1/4 inch acoustical foam.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>12</td><td></td><td></td><td>17</td><td></td><td></td><td>19</td><td></td><td></td><td>28</td><td></td><td></td><td>36</td><td></td><td></td><td>40</td><td>0.385</td><td>1</td><td>40</td><td>dba Aircon-"DW"</td><td>CR DW (FR)-144</td></tr>
<tr><td>28</td><td colspan="16">Liquid catalytically cured barrier mastic: temperature range -10 to 350°F, relative humidity to 100%. Transmission loss barrier applied to any shape and contour such as compressors, turbines, fans, gearboxes, piping and ducting.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>16</td><td>16</td><td>18</td><td>18</td><td>30</td><td>22</td><td>20</td><td>21</td><td>27</td><td>31</td><td>35</td><td>39</td><td>42</td><td>45</td><td>47</td><td>50</td><td>--</td><td>1.75</td><td>32</td><td>Muffl-Lag</td><td>CKAL 734-14</td></tr>
</table>

CATEGORY 28. GENERAL INDUSTRIAL SILENCERS



CATEGORY 28. GENERAL INDUSTRIAL SILENCERS

Information in this category is limited to products used in industrial rather than vehicle applications. These silencers are used to quiet gas flows in a variety of applications from high volume airflow to high temperature steam outlets. These units may have reactive or absorptive components or a combination of both. Materials are specified for heavy duty, industrial applications. Organizations contributing data to this table are: 2, 5, 40, 70, 102, 135, and 139.

CAUTION

1. SILENCER PERFORMANCE FIGURES OFTEN DO NOT CONFORM TO STANDARD REFERENCE MEASUREMENTS. FOR SPECIFIC APPLICATIONS, SEE MANUFACTURER'S PRODUCT LITERATURE.
2. IN MANY CASES, ONLY REPRESENTATIVE INFORMATION IS PRESENTED FOR A GIVEN PRODUCT LINE. SEE MANUFACTURER'S LITERATURE FOR COMPLETE LISTINGS OF SIZES AND PERFORMANCE DATA.

Table 28A. General industrial silencers (attenuation).

	Attenuation, dB								Company	Product	Reference
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz			
Standard panel filters, fabricated steel sheet and plate, welded. Nominal capacity 1750 to 63,000 cfm.	2	3	4	5	8	13	14	13	135	FSH Series Filter Silencer	CR 241
Two stage filters, fabricated steel sheet and plate welded. Nominal capacity 1750 to 35,500 cfm.	2	3	4	5	8	13	14	13	135	FCRH Series Filter Silencer	CR 241
Unit constructed of heavy duty steel sheet and plate welded throughout. Nominal capacity 1750 to 35,500 cfm. Used on centrifugal compressors, blowers and gas turbines.	2	3	4	5	8	13	14	13	135	FASH Series Absolute Filter Silencer	CR 241
Heavy duty, compact unit, dry pleated paper element, used on engines, compressors and blowers. Sizes vary from 7-1/2 inch diameter to 6-1/2 inch long with pipe size 1/2 to 20 inch diameter x 28-1/2 inch long with 6 inch pipe size.	5	8	10.5	12.5	14	14	14	13	135	CCS Series Intake Filter	CR 34-3002
Absorption silencer, straight through design, all welded construction. Pipe size 5 to 30 inch, sizes range from 11 inch diameter to 36 inch long to 36 inch diameter x 189 inch long.	2	3	5	8	15	22	23	20	135	Model U6H and U6G	CR 214A
Heavy duty, all welded, explosion resistant, flange type, straight through design, and exterior surfaces prime coated. Pipe size 4 to 36 inch, various sizes from 10 inch diameter x 33 inch long to 54 inch diameter x 227 inch long. Vertical or horizontal mounting.	17	18	17	16	13	11	8	7	135	Turbo-Charged Engine Silencer Model UT	CR 223A
Air intake silencer, pipe sizes from 22 to 36 inch, and size varies from 26 inch diameter x 57 inch long to 40 inch diameter x 93 inch long.	4	5	7	11	17	22	22	19	135	SU3H Series	CR 12-3003
Heavy duty assembly with a weather hood, employs an oil wetted polyurethane foam filter element for use on small blowers, compressors, and engines. Rated capacity 15 to 1050 cfm.	14	17	19	18	15	14	13	12	135	FS Series Filter Silencer	CR 242
Exhaust silencers for turbo charged engines, welded steel, exterior surfaces prime coated, gas flows through a ported tube and attenuating chambers.	12	23.5	24	16.5	11	10.5	10.5	10.5	2	Model A4	CR A4/9/74
Intake filter/silencer for reciprocating engines, compressors, blowers, for low and midfrequency noise reduction. Welded steel, exterior surfaces are prime coated. Internal surfaces are cleaned and coated with a rust inhibitor. Temperature to 200°F. Vertical mounting.	14	19	22.5	19	15	12	10.5	10.5	2	Model A10	CR A10/9/74
Intake and exhaust silencers for reciprocating engine blowers, compressors. Welded steel, exterior faces prime coated, gas flows through ported tubes and attenuating chambers.	17	21	21	17.5	15	14	13	12	2	Model A1	CR A1/9/74
Spark arrester/exhaust silencer for reciprocating engines, welded steel, exterior surfaces are prime coated. The spark collector box is provided with a plugged outlet which can be led to any convenient point. Gas flow through ported tubes and attenuating chambers. Vertical mounting.	17.5	21	20.5	18	15.5	14.5	13.5	13	2	Model A7	CR A7/9/74
Heavy duty all welded construction with spark traps, explosion resistant, exterior surface prime coated, standard silencing. Pipe sizes 4 to 30 inch Various sizes 14 inch diameter x 35 inch long to 66 inch diameter x 146 inch long. Vertical or horizontal mounting.	17	19	20	18	17	16	15	14	135	Spark Arrester Silencer Model UCC UCCH	CR 216A
Noncritical silencer, industrial usages, pipe size 1 to 30 inch. Various sizes from 5 inch diameter x 21 inch long to 72 inch diameter x 229 inch long.	17	19	20	18	17	16	15	14	135	Type UC Silencer	CR 224B

Table 28A. General industrial silencers (attenuation) continued.

Attenuation, dB										
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Company	Product	Reference
Heavy duty, all welded explosion resistant, flange type, straight through design, exterior surfaces prime coated. Pipe size 8 x 36 inch various sizes from 14 inch diameter x 80 inch long to 54 inch diameter x 335 inch long. Vertical or horizontal mounting.										
21	22	20	18	17	15	14	13	135	Turbocharged Engine Silencer Model UTM	CR 223A
Heavy duty, welded unit construction of carbon steel sheet and plate used for subcritical PLV applications, pipe size 8 to 30 inch, size range 22 inch diameter x 61 inch long to 66 inch diameter x 206 inch long.										
18	21	21	19	17	15	14	13	135	UCI Series Inlet Silencer	CR 244
A heavy duty, welded unit constructed of carbon steel sheet and plate used for subcritical PLV applications, pipe size 1 to 30 inch, size range 22 inch diameter x 61 inch long to 66 inch diameter x 206 inch long.										
17	20	21	19	17	16	14	13	135	UCD Group Chamber Type Discharge Silencer	CR 244
Exhaust silencers for turbocharger engines, welded steel, exterior surfaces prime coated, gas flows through a ported tube and attenuating chambers.										
14	26	27.5	19	14	13	13	13	2	Model A5	CR A5/9/74
Heavy duty, all welded explosion resistant, flange type, straight through design, exterior surfaces prime coated, pipe size 4 to 36 inch. Various sizes from 10 inch diameter x 47 inch long to 78 inch diameter x 345 inch long. Vertical or horizontal mounting.										
23	24	23	21	17	15	14	13	135	Turbocharged Engine Silencer Model UTR	CR 223A
Air discharge silencer, pipe sizes 8 to 84 inch, size varies from 14 inch diameter x 31 inch long to 90 inch diameter x 265 inch long.										
4	6	10	19	28	30	26	21	135	SUGD Series	CR 12-3002
Intake silencer, pipe size 8 to 84 inch, size varies from 14 inch diameter x 31 inch long to 90 inch diameter x 265 inch long.										
4	6	10	20	28	30	26	21	135	SUHI Series	CR 12-3021
Spark arrester/exhaust silencer for reciprocating engines, welded steel, and prime coated surfaces, gas flows through ported tubes, spinning section and attenuating chambers. Vertical mounting.										
22	26	27	24	20.5	19	18	18	2	Model A8	CR A8/9/74
Intake and exhaust silencer for reciprocating engines, blowers, compressors, welded steel, prime coated exterior faces, gas flows through ported tubes and attenuating chambers.										
22	26	26.5	24	21	19	18	18	2	Model A2	CR A2/9/74
Average dampening silencer, pipe sizes from 1 to 30 inch. Various sizes from 5 inch diameter x 21 inch long to 72 inch diameter x 229 inch long.										
23	24	25	24	22	21	20	18	135	Type US Silencer	CR 224B
Heavy duty all welded construction with spark traps, explosion resistant, exterior surface prime coated, standard silencing, pipe sizes from 4 to 30 inch. Various sizes 14 inch diameter x 47 inch long to 66 inch diameter x 230 inch long. Vertical or horizontal mounting.										
23	24	25	24	23	21	20	20	135	Spark Arrester Silencer Model USC USCH	CR 216A
Intake and exhaust silencers for reciprocating engines, compressors, blowers, exhausters, pumps, high frequency noise reduction with minimal pressure loss. All welded steel, exterior surfaces prime coated. Temperature up to 950°F.										
5	8	12	19	28.5	38	34.5	24.5	2	Model A11	CR A11/9/74
Intake filter/silencer for reciprocating engines, compressors, blowers, mid or high frequency noise reduction. Welded steel, exterior surfaces prime coated internal surfaces cleaned and coated with rust inhibitor, filter element washable. Temperature up to 200°F. Vertical mounting.										
11	14	19	25	29	29	26	18	2	Model A9	CR A9/9/74
Absorption silencer, straight through design, continuous welded shell seams, double seal crimped end construction, pipe sizes 1/2 to 4 inch, size varies from 3-1/4 inch diameter x 8 inch long to 8-1/2 inch diameter x 48-3/4 inch long.										
3	5	10	17	30	42	44	40	135	Model UH and UG	CR 214A
Absorption silencer straight through with annular design, all welded construction sizes range from 9-3/4 inch diameter x 22 inch long to 73-1/2 inch diameter x 204 inch long.										
3	5	10	17	30	42	44	40	135	Model SUH and SUG	CR 214A

Table 28A. General industrial silencers (attenuation) concluded.

Attenuation, dB										
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Company	Product	Reference
A heavy duty, welded unit constructed of carbon steel sheet plate used for critical PLV applications. Pipe size from 1 to 30 inch, diameter versus length from 8 x 27 inch to 66 x 206 inch.										
17	21	24	26	27	26	25	21	135	RIS Group, Chamber Absorptive Type Inlet Silencer	CR 244
Intake and exhaust silencers for reciprocating engines, blowers, compressors. Welded steel, exterior surfaces prime coated, gas flows through a series of ported tubes, and attenuating chambers.										
25	29	29	26	24	22.5	22	20.5	2	Model A3	CR A3/9/74
Reactive chamber type silencer, for large slow speed reciprocating or positive displacement machinery. Nominal capacity 1875 to 26,000 cfm.										
28	29	29	28	26	25	24	28	135	RF Series Filter Silencer	CR 241
Maximum silencing, nontuned, multichambered; pipe size 1 to 30 inch various sizes from 5 inch diameter x 21 inch long to 72 inch diameter x 265 inch long.										
27	29	30	28	27	26	25	22	135	Type UR Silencer	CR 224B
Heavy duty, welded unit, constructed of carbon steel sheet and plate. Used for subcritical PLV applications. Pipe size 1 to 30 inch, size range 5 inch diameter x 21 inch long to 72 inch diameter x 304 inch long.										
28	31	31	30	27	26	25	24	135	UR AND URD Chamber Type Discharge Silencer	CR 244
Heavy duty, welded unit, constructed of carbon steel sheet and plate. Used for companion silencer with UCD series, pipe size 10 to 30 inch, size ranges 30 inch diameter x 54-1/2 inch long to 72 inch diameter x 133 inch long.										
21	26	29	32	32	30	26	21	135	WBM Series Blower Mounted Discharge Silencer	CR
Heavy duty, welded unit, constructed of carbon steel sheet and plate. Used for critical PLV applications, pipe size 1 to 30 inch, size ranges 6 inch diameter x 29 inch long to 60 inch diameter x 276 inch long.										
22	26	30	32	32	30	27	21	135	SD Group, Combination Chamber Absorptive Type Discharge Silencer	CR 244
Application intake and exhaust silencers for blowers, compressors, noise reduction ovar a wide frequency range, welded steel, exterior surfaces prime coated. Temperature up to 950°F. Gas flows through a series of attenuating chambers and a circular airway lined with sound absorbent material which is retained by perforated sheet steel and woven fabric.										
16	23	27	31	35	35	29.5	24	2	Model A13	CR A13/9/74
Intake and exhaust silencers for reciprocating engines, compressors, blowers, exhausters, pumps. Welded steel, exterior surface prime coated. Temperature up to 950°F. Gas flows through a circular airway lined with sound absorbent material which is retained by perforated sheet steel and layers of woven fabric.										
6.5	11	20.5	31	42	46	41	24	2	Model A12	CR A12/9/74
Aluminum exhaust silencer, pipe sizes 2-1/2 to 54 inch. Varied sizes range from 10 inch diameter x 41 inch long to 114 inch diameter x 403 inch long.										
33	34	35.5	34	32	31.5	30.5	29	135	SUR Series Exhaust Silencer	CR
Heavy duty, welded unit, constructed of carbon steel sheet and plate, used for critical PLV applications. Pipe size 1 to 30 inch, size ranges 8 inch diameter x 33 inch long to 72 inch diameter x 304 inch long.										
28	32	35	36	37	36 .	27	26	135	RD Group, Combination Chamber Absorptive Type Discharge Silencer	CR 244
Engine exhaust muffler for reciprocating engines, various sizes, carbon steel.										
34	36	37	36	34	32	30	28	40	dba aircon-"M"	CR
Intake and exhaust silencers for blowers, compressors; high noise reduction over a wide frequency range. All welded steel, exterior surfaces prime coated. Temperature up to 950°F. Gas flow through a series of attenuating chambers and a circular airway lined with sound absorbent material which is retained by a perforated sheet steel and woven fabric.										
22	27.5	32.5	37.5	43	43.5	38.5	29.5	2	Model A14	CR A14/9/74
Absorptive-type silencer, heavy duty, welded steel construction with acoustical packing. Pipe size 1/2 to 48 inch, with 3-1/2 inch diameter x 10 inch long to 54 inch diameter x 310 inch long.								102	Quietflo Silencer CIS-DCS	
Carbon steel, one coat primer, sizes 4 to 24 inch diameter inlet. Broadband silencing for specific flow. Model P (intake/exhaust silencer) pulsating flow resonator design; Model PB suitable for high-pressure, high velocity flow, continuous or intermittent; Model PE, for high velocity flow with low pressure drop requirements.								70	Models P, PB, PE Silencers	CR NCD-7553

Table 28B. General industrial silencers (insertion loss).

Insertion Loss, dB 63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Company	Product	Reference
4 inch diameter pipe. Temperature range -20° to 200°F.										
	0.5	1.5	3	8	14	13	11	5	Model 4TB 2.5 Industrial Silencer	CR B-136
Carbon steel sheet 1/4 inch, zinc or epoxy resin surfaces. Data are noise reduction at 3 ft.										
2	4	13	13	13	7	2	2	102	Quietflow Silencer	CR
12 inch diameter pipe. Temperature range -20° to 200°F.										
1	2.5	6	11	15	12	8	7	5	Model 12TB 2.5 Industrial Silencer	CR B-136
30 inch diameter pipe. Temperature range -20° to 200°F.										
3	8	12	14	10	9	6	4	5	Model 30TB 2.5 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
2	5	10	14	12	10	8	6	5	Model 20TB 2.5 Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
0.5	1.5	4	9	14	17	15	12	5	Model 4TA 2.5 Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
0.5	1	2	5	13	21	22	18	5	Model 4TB 4 Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
1	2	6	11	16	18	16	13	5	Model 4T 2.5 Industrial Silencer	CR B-136
30 inch diameter pipe. Temperature range -20° to 200°F.										
8	12	16	16	12	10	7	5	5	Model 30TA 2.5 Industrial Silencer	CR B-136
12 inch diameter pipe. Temperature range -20° to 200°F.										
2.5	6	11	15	18	14	10	8	5	Model 12TA 2.5 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
5	10	15	17	14	11	9	7	5	Model 2CTA 2.5 Industrial Silencer	CR B-136
Fabricated of mild steel; shell, 10 gauge carbon steel; splitters 22 gauge perforated galvanized, backed up with noise absorptive material encased in fiberglass cloth, high flow, low pressure drop. Sizes 4 to 64 ft^2 from 4000 to 128,000 acfm. Temperature to 400°F.										
4	6	10	14	18	18	12	8	70	AV Series Industrial Silencers	CR NCD-7447
30 inch diameter pipe. Temperature range -20° to 200°F.										
11	15	18	17	13	11	8	6	5	Model 30T 2.5 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
8	12	17	18	15	12	10	8	5	Model 20T 2.5 Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
0.5	1	3	7	17	27	29	24	5	Model 4TB 6 Industrial Silencer	CR B-136
12 inch diameter pipe. Temperature range -20° to 200°F.										
4	10	13	18	18	15	11	9	5	Model 12T 2.5 Industrial Silencer	CR B-136
Carbon steel, coated steel, galvanized or stainless steel, acoustical absorption material is chemically inert. Flow from 300 to 15,000 cfm. Temperature range -40° to 350°F and special to 800°F, Model AB36-20-11.										
4	6	10	18	20	20	14	12	70	AB Series Industrial Silencers for Contaminated Flow	CR NCD-7556
12 inch diameter pipe. Temperature range -20° to 200°F.										
1.5	3	11	18	24	19	15	12	5	Model 12TB 4 Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
1	2	5	13	21	25	24	19	5	Model 4TA 4 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
3	7	15	22	20	16	13	10	5	Model 20TB 4 Industrial Silencer	CR B-136

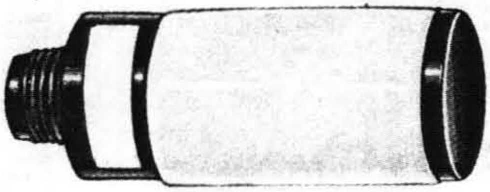
Table 28B. General industrial silencers (insertion loss) continued.

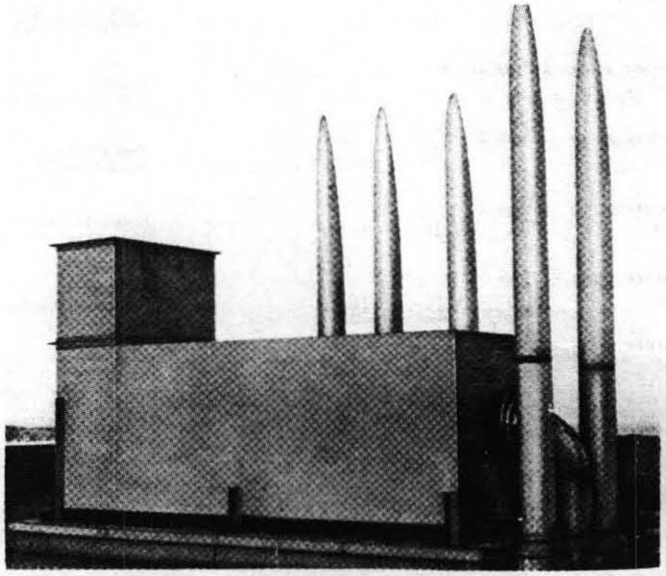
Insertion Loss, dB										
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Company	Product	Reference
30 inch diameter pipe. Temperature range -20° to 200°F.										
5	12	18	22	18	14	11	8	5	Model 30TB 4 Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
0.5	1	3	8	20	31	34	26	5	Model 4TBA Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
1.5	3.5	9	17	23	27	25	20	5	Model 4T 4 Industrial Silencer	CR B-136
Carbon steel sheet 1/4 inch, zinc or epoxy resin surfaces for reciprocating compressor. Data are noise reduction at 10 ft.										
21	29	22	15	20	14	9	2	102	Quietflow Silencer	CR
Carbon steel or corten steel for corrosion and erosion resistance; acoustical packing 18 inch diameter, 55 inch long; other types available LAS 30(c), 30 inch diameter x 110 inch long; type LAS 42(c) 42 inch diameter x 175 inch long. Data are noise reduction at 3 ft.										
10	5	8	22	18	30	30	33	102	Quietflow Line Silencers and Type LAS 18 c	CR LS-5M
12 inch diameter pipe. Temperature range -20° to 200°F.										
4	9	17	23	27	21	16	13	5	Model 12TA 4 Industrial Silencer	CR B-136
12 inch diameter pipe. Temperature range -20° to 200°F.										
2	5	11	22	30	25	20	16	5	Model 12TB 6 Industrial Silencer	CR B-136
30 inch diameter pipe. Temperature range -20° to 200°F.										
12	19	25	24	19	15	12	9	5	Model 30TA 4 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
7	15	22	26	22	17	14	11	5	Model 20TA 4 Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
1	3	7	17	27	33	31	25	5	Model 4TA 6 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
4	9	19	29	27	20	17	13	5	Model 20TB 6 Industrial Silencer	CR B-136
Carbon steel sheet 1/4 inch, zinc or epoxy resin surface. Data are noise reduction at 2 ft.										
21	32	24	27	12	18	10	10	102	Quietflow Silencer	CR
30 inch diameter pipe. Temperature range -20° to 200°F.										
6	15	24	30	23	18	14	11	5	Model 30TB 6 Industrial Silencer	CR B-136
30 inch diameter pipe. Temperature range -20° to 200°F.										
16	23	28	25	20	16	13	10	5	Model 30T 4 Industrial Silencer	CR B-136
12 inch diameter pipe. Temperature range -20° to 200°F.										
6	14	20	26	28	22	17	14	5	Model 12T 4 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
12	19	25	28	23	18	15	12	5	Model 20T 4 Industrial Silencer	CR B-136
12 inch diameter pipe. Temperature range -20° to 200°F.										
2	5	13	26	35	30	21	19	5	Model 12TB 8 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
5	11	22	33	30	23	18	15	5	Model 20TB 8 Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
2	5	11	23	30	35	32	26	5	Model 4T 6 Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
1	3	8	20	32	38	36	28	5	Model 4TA 8 Industrial Silencer	CR B-136

Table 28B. General industrial silencers (insertion loss) concluded.

Insertion Loss, dB								Company	Product	Reference
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz			
Flow tubes, acoustic packing, explosion chamber, construction includes corten steel for flow tubes, heavy wall carbon steel for the shell, all welded construction. Data are noise reduction.										
7	7	20	22	26	33	36	36	102	Quietflo Vent Silencers Type VS.108	CR
12 inch diameter pipe. Temperature range -20° to 200°F.										
5	11	22	30	35	27	21	17	5	Model 12TA 6 Industrial Silencer	CR B-136
30 inch diameter pipe. Temperature range -20° to 200°F.										
15	24	32	32	25	19	15	12	5	Model 30TA 6 Industrial Silencer	CR B-136
30 inch diameter pipe. Temperature range -20° to 200°F.										
7	18	28	35	28	22	18	13	5	Model 30TB 8 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
9	20	29	34	29	22	18	14	5	Model 20TA 6 Industrial Silencer	CR B-136
4 inch diameter pipe. Temperature range -20° to 200°F.										
2	5	16	26	35	40	37	30	5	Model 4T 8 Industrial Silencer	CR B-136
30 inch diameter pipe. Temperature range -20° to 200°F.										
21	30	36	33	26	20	16	13	5	Model 30T 6 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
15	24	32	36	30	23	19	15	5	Model 20T 6 Industrial Silencer	CR B-136
12 inch diameter pipe. Temperature range -20° to 200°F.										
8	18	26	34	36	28	22	18	5	Model 12T 6 Industrial Silencer	CR B-136
12 inch diameter pipe. Temperature range -20° to 200°F.										
5	13	26	35	40	32	23	20	5	Model 12TA 8 Industrial Silencer	CR B-136
30 inch diameter pipe. Temperature range -20° to 200°F.										
18	28	38	37	29	23	19	14	5	Model 30TA 8 Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
11	23	33	40	33	25	20	16	5	Model 20TA 8 Industrial Silencer	CR B-136
30 inch diameter pipe. Temperature range -20° to 200°F.										
24	35	42	38	30	24	19	15	5	Model 30T 8 Industrial Silencer	CR B-136
12 inch diameter pipe. Temperature range -20° to 200°F.										
9	22	30	40	41	33	25	21	5	Model 12TA Industrial Silencer	CR B-136
20 inch diameter pipe. Temperature range -20° to 200°F.										
18	28	38	42	35	27	22	17	5	Model 20T 8 Industrial Silencer	CR B-136
Intake or discharge silencer, carbon steel, fiberglass padding, stainless steel screen and fiberglass cloth.										
11	18	32	42	48	50	49	37	40	dba aircon-"S"	CR
Industrial silencers for various needs.								139	Vanec Silencers	CR

CATEGORY 29. HIGH PRESSURE DISCHARGE SILENCERS





CATEGORY 29. HIGH PRESSURE DISCHARGE SILENCERS

These silencers range in size from less than 1 inch in diameter to several feet in diameter. They are used to quiet high pressure gas or steam discharges. The simplest application is for noise reduction of shop air discharge lines. Large geometries are used in exhaust or industrial discharge stack applications. Organizations contributing data to this table are: 2, 5, 9, 16, 17, 19, 40, 56, 63, 80, and 124.

CAUTION

1. SILENCER PERFORMANCE FIGURES OFTEN DO NOT CONFORM TO STANDARD REFERENCE MEASUREMENTS. FOR SPECIFIC APPLICATIONS, SEE MANUFACTURER'S PRODUCT LITERATURE.
2. IN MANY CASES, ONLY REPRESENTATIVE INFORMATION IS PRESENTED FOR A GIVEN PRODUCT LINE. SEE MANUFACTURER'S LITERATURE FOR COMPLETE LISTINGS OF SIZES AND PERFORMANCE DATA.

Table 29. High pressure discharge silencers.

Attenuation, dB										
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Company	Product	Reference
Code V-500-363987. Porous permeable plastic material made from high density polyethylene. NPT 1/2. Data are noise reduction.										
	8.5	7	4.5	5	6.5	19	20	17	Vyon Silencers	CR 6-2
Code V-375-363985. Porous permeable plastic material made from high density polyethylene. NPT 3/8. Data are noise reduction.										
	11	9	6.5	2	8.5	21	23	17	Vyon Silencers	CR 6-2
Code V-125-363981. Porous permeable plastic material made from high density polyethylene. NPT 1/8. Data are noise reduction.										
	10	12.5	10.5	8	15.5	24.5	31	17	Vyon Silencers	CR 6-2
Code V-250-363983. Porous permeable plastic material made from high density polyethylene. NPT 1/4. Data are noise reduction.										
	9.5	8	8	9.5	18	29	31	17	Vyon Silencers	CR 6-2
Steam and gas vent blowdown silencers, high pressure, high velocity.										
17	18	23	32	38	40	36	30	2	Model VSI	CR
Steam and gas vent blowdown silencers, high velocity, low pressure (below 28 psig) and all welded steel, exterior surfaces prime coated. The gas flows through a circular airway lined with sound absorber material, which is retained by woven cloth (woven steel and perforated steel sheet).										
22	26	31	36	38	36	30	22	2	Model VAS	CR
CS Type, speed control muffler, atomuffler design for eliminating air exhaust noise. NPT 1/8 to 3/8. Provides the added feature of speed for air operated devices. Data are insertion loss.										
18	24	30	36	38	42	45	42	9	Speed Control Muffler	CR 612
VP type, vacuum pump muffler. NPT 1/8 to 2 inch. Recommended for simulation chambers, transfer and control devices. Data are insertion loss.										
18	24	30	36	38	42	45	42	9	Vacuum Pump Muffler	CR 612
Single chamber, air motor muffler, EP Type 4-44 series. NPT 1/8 to 2. Applicable for silencing the objectionable whine created by air motor exhaust. Data are insertion loss.										
18	24	30	36	38	42	45	42	9	Air Starter Muffler	CR 612
EP Type, single chamber, multichamber, air exhaust muffler. NPT 3 to 6. Control of air exhaust noise from air cylinders, valves, tools, hoist, clutches, and other air operated devices. Data are insertion loss.										
18	24	30	36	38	42	45	42	9	Air Exhaust Atomuffler	CR 612
Steam and gas vent blowdown silencers, high velocity, low pressure (below 28 psig), all welded steel, exterior surfaces prime coated. The gas flows straight through a circular airway lined with sound absorbent material which is retained by woven cloth (woven steel and perforated steel sheet).										
26	30	36	42	45	42	35	27	2	Model VAR	CR
Steam and gas vent blowdown silencers, high pressure, high velocity, welded steel, exterior surfaces prime coated.										
18	21	29	40	47	50	46	40	2	Model VSS	CR
Steam and gas vent blowdown silencers, high pressure, high velocity, all welded steel, exterior surfaces prime coated. The gas flows initially through inlet diffusers and annular airway lined with sound absorbent material which is retained by woven fabric (woven steel mesh and perforated steel sheet).										
21	25	37	50	57	60	56	51	2	Model VSR	CR
Oil coalescing, noncorroding, sintered polyethylene structure, operating pressure to 100 psi. NPT 1/8. Attenuation: 18 dB at 20 psi; 20 dB at 30 psi; 22 dB at 40 psi; 24 dB at 50 psi; 24 dB at 60 psi; 24 dB at 70 psi; 24 dB at 80 psi. Data read from graph.								80	Pneumatic Silencers S Series	CR 1277
Oil coalescing, noncorroding, sintered polyethylene structure, operating pressure to 100 psi. NPT 1/4. Attenuation: 26 dB at 40 psi; 29 dB at 50 psi; 29 dB at 60 psi; 29 dB at 70 psi; 29 dB at 80 psi. Data read from graph.								80	Pneumatic Silencers S Series	CR 1277

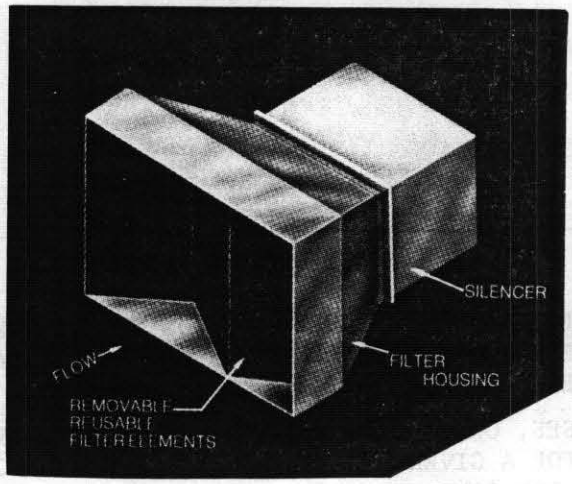
Table 29. High pressure discharge silencers continued.

Attenuation, dB								Company	Product	Reference
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz			
Oil coalescing, noncorroding, sintered polyethylene structure, operating pressure to 100 psi. NPT 1/2. Attenuation: 31 dB at 20 psi; 33 dB at 30 psi; 33 dB at 40 psi; 33 dB at 50 psi; 33 dB at 60 psi; 32 dB at 70 psi; 30 dB at 80 psi. Data read from graph.								80	Pneumatic Silencers S Series	CR 1277
Oil coalescing, noncorroding, sintered polyethylene structure, operating pressure to 100 psi. NPT 3/4. Attenuation: 24 dB at 20 psi; 24 dB at 30 psi; 26 dB at 40 psi; 26 dB at 50 psi; 28 dB at 60 psi; 29 dB at 70 psi; 29 dB at 80 psi. Data read from graph.								80	Pneumatic Silencers S Series	CR 1277
Oil coalescing, noncorroding, sintered polyethylene structure, operating pressure to 100 psi. NPT 1 inch. Attenuation: 24 dB at 20 psi; 28 dB at 30 psi; 28 dB at 40 psi; 30 dB at 50 psi; 30 dB at 60 psi; 27 dB at 70 psi; 26 dB at 80 psi. Data read from graph.								80	Pneumatic Silencers S Series	CR 1277
Focus-Flo silent nozzles, high thrust. Noise reduction versus thrust: 6 dBA at 4 oz; 9 dBA at 8 oz; 10 dBA at 12 oz; 10 dBA at 16 oz; 10 dBA at 20 oz. Data read from graph.								124	Sunnex 308	CR NB 766
Focus-Flo silent nozzle, medium thrust. Noise reduction versus thrust: 14 dBA at 4 oz; 14 dBA at 8 oz; 10 dBA at 12 oz; 9 dBA at 16 oz; 7 dBA at 20 oz; 6 dBA at 24 oz; 6 dBA at 28 oz; 6 dBA at 32 oz. Data read from graph.								124	Sunnex 309	CR NB 766
Focus-Flo, silent blowgun, pressure range 45 to 100 psi. from zero to full flow. Noise reduction 10 to 15 dB.								124	Sunnex 301 Variable	CR
Constructed of Porex (high density polyethylene), sizes from 1/8 to 3/4 inch NPT; .60 to 1.5 inch diameter and 1 to 4.5 inch porous length. Air valve exhaust ports, cylinder exhaust ports. Temperature range 180°F maximum. Noise reduction: 25 dBA (3/4 NPT); 26 dBA (1/2 NPT); 19 dBA (3/8 NPT); 18 dBA (1/4 NPT); 9 dBA (1/8 NPT).								63	Glasrock ® Pneumatic Silencer	CR 92RR 117725C
Mini hush 4-0-M, 1-7/8 length x 5/8 inch diameter. Noise reduction: 27 dBA.								40	dba Aircon-"PF"	CR 4-0-M
Mini hush 2-0-M, 1-1/4 length x 7/16 inch diameter. Noise reduction: 22 dBA.								40	dba Aircon-"PF"	CR 2-0-M
Mini hush 3-0-M, NPT 1/8. Noise reduction: 25 dBA.								40	dba Aircon-"PF"	CR 3-0-M
Permahush PH3, 1-7/8 length x 7/8 inch diameter. NPT 1/4. Noise reduction: 12 dBA at 3 scfm.								40	dba Aircon-"PF"	CR PH3
Minihush 1-0-T, 1 inch length x 7/16 inch diameter. 1/4 inch tube. Noise reduction: 18 dBA.								40	dba Aircon-"PF"	CR 1-0-T
Permahush PH6, 2-1/2 inch length x 1-1/4 inch diameter, NPT 3/8. Noise reduction: 16 dBA at 6 scfm.								40	dba Aircon-"PF"	CR PH6
Permahush, PH12, 3-1/2 inch length x 1-3/4 inch diameter, NPT 1/2. Noise reduction: 20 dBA.								40	dba Aircon-"PF"	CR PH12
Permahush, PH25, 4-1/4 inch length x 2-1/2 inch diameter, NPT 3/4. Noise reduction: 15 dBA.								40	dba Aircon-"PF"	CR PH25
SQF-2, sintered bronze muffler in protective plastic housing, NPT 1/4. Noise reduction: 23 dBA at 10 cfm; 23.5 dBA at 15 cfm; 25.5 dBA at 20 cfm; 25 dBA at 25 cfm.								16	"Super Quite Flow" Silencers/Muffler	CR
SQF-4, sintered bronze muffler in protective plastic housing, NPT 1/2. Noise reduction: 16.5 dBA at 10 cfm; 18 dBA at 15 cfm; 19 dBA at 20 cfm; 21.5 dBA at 25 cfm; 23 dBA at 30 cfm; 23.5 dBA at 35 cfm.								16	"Super Quite Flow" Silencer/Muffler	CR
SQF-3, sintered bronze muffler in protective plastic housing, NPT 3/8. Noise reduction: 16.5 dBA at 15 cfm; 18 dBA at 20 cfm; 19 dBA at 25 cfm; 20 dBA at 30 cfm; 20 dBA at 35 cfm.								16	"Super Quite Flow" Silencer/Muffler	CR
SQF-1, sintered bronze muffler in protective plastic housing, NPT 1/8. Noise reduction: 16 dBA at 10 cfm, 15 dBA at 17 cfm.								16	"Super Quite Flow" Silencer/Muffler	CR
Sintered Bronze muffler in plastic housing, NPT 1-1/4 and 1-1/2. Noise reduction: 13 dBA at 40 cfm.								16	"Super Quite Flow" Silencer/Muffler	CR 925

Table 29. High pressure discharge silencers concluded.

<table>
<tr><th colspan="8">Attenuation, dB</th><th rowspan="2">Company</th><th rowspan="2">Product</th><th rowspan="2">Reference</th></tr>
<tr><th>63 Hz</th><th>125 Hz</th><th>250 Hz</th><th>500 Hz</th><th>1000 Hz</th><th>2000 Hz</th><th>4000 Hz</th><th>8000 Hz</th></tr>
<tr><td colspan="8">Model SBL. 25 to 30 dBA reduction when used on 100 psi air.</td><td>5</td><td>Blowoff Silencers</td><td>CR B-32R3</td></tr>
<tr><td colspan="8">Water-resistant acoustic packing for use with steam. Noise reduction 37 dBA.</td><td>5</td><td>Model HBS Silencer</td><td></td></tr>
<tr><td colspan="8">Water-resistant acoustic packing for use with steam. Noise reduction 46 dBA.</td><td>5</td><td>Model RBS Silencer</td><td></td></tr>
<tr><td colspan="8">Model TSN-125, metal construction, can be used for stationary air cleaning applications, NPT 1/8. 78 dBA at 3 ft and 0.5 lbf.</td><td>19</td><td>ThrustR</td><td>CR PC-78</td></tr>
<tr><td colspan="8">Model QE-125, metal construction, NPT 1/8. dBA at 3 ft: 61.5 at 10 scfm; 63.5 at 20 scfm; 65.5 at 30 scfm.</td><td>19</td><td>Quiek</td><td>CR PC-78</td></tr>
<tr><td colspan="8">Model TSN-250, metal construction, can be used for stationary air cleaning applications, NPT 1/4. 80 dBA at 3 ft and 0.5 lbf; 85 dBA at 3 ft and 1 lbf.</td><td>19</td><td>ThrustR</td><td>CR PC-78</td></tr>
<tr><td colspan="8">Model QE-250, metal construction, NPT 1/4. dBA at 3 ft: 62.5 at 10 scfm; 65 at 20 scfm; 67 at 30 scfm; 68.5 at 40 scfm.</td><td>19</td><td>Quiek</td><td>CR PC-78</td></tr>
<tr><td colspan="8">Model QE-375, metal construction, NPT 3/8. dBA at 3 ft: 69 at 10 scfm; 72 at 20 scfm; 74 at 30 scfm; 75.5 at 40 scfm; 76.5 at 50 scfm.</td><td>19</td><td>Quiek</td><td>CR PC-78</td></tr>
<tr><td colspan="8">Model QE-500, metal construction, NPT 1/2. dBA at 3 ft: 74 at 20 scfm; 76.5 at 30 scfm; 78 at 40 scfm; 79 at 50 scfm; 79.5 at 60 scfm.</td><td>19</td><td>Quiek</td><td>CR PC-78</td></tr>
<tr><td colspan="8">Hush-Flo silencer nozzle, metal construction. Sizes up to NPT 1/2. dBA at 3 ft: 59 at 10 scfm; 63 at 20 scfm; 68 at 30 scfm; 73 at 40 scfm.</td><td>19</td><td>Hush-Flo Nozzle</td><td>CR PC-78</td></tr>
<tr><td colspan="8">MM Type micro-miniature muffler, compact, lightweight, radial flow discharge, variable flow control, self-cleaning, rust resistant, variable tone control. NPT 1/8 and 1/4 inch. Use on pneumatic circuit applications such as control, pilot, limit, zone, and relay valves.</td><td>9</td><td>Micro-Miniature Muffler</td><td>CR 612</td></tr>
<tr><td colspan="8">PM Type, model P, porous metal filter and muffler, compact, applicable limited space, intake filtering, cryogenic phase separation, pressure or vacuum equalization. MNPT 1/8 to 2 inch.</td><td>9</td><td>Porous Metal Filter & Muffler</td><td>CR 612</td></tr>
<tr><td colspan="8">PC Type, model C, porous metal adjustable flow filter and muffler, controls air cycle speeds, regulates airflow,adjustable flow. 1/8 to 1 inch MNPT.</td><td>9</td><td>Adjustable Flow Filter & Muffler</td><td>CR</td></tr>
<tr><td colspan="8">AE Type, air ejector muffler, adaptable to any compressed air ejector presently used for the ejection of parts. 1/8 to 1 inch NPT.</td><td>9</td><td>Air Ejector Muffler</td><td>CR 612</td></tr>
<tr><td colspan="8">BM Type, bantam muffler, compact, applicable limited space, corrosion-resistant metal, disperses exhaust air over a 360 deg pattern. 1/8 to 2 inch NPT.</td><td>9</td><td>Bantam Muffler</td><td>CR</td></tr>
<tr><td colspan="8">FS Type, filter silencer, dual-stage depth filtration, noise attenuation, perform at high or low velocities, NPT 1/8 to 2 inch and 3 to 6 inch.</td><td>9</td><td>Filter Silencer</td><td>CR 612</td></tr>
<tr><td colspan="8">TF Type, Thru-Flow muffler, constructed of corrosion-resistant material, for applications where compressed air is being used on heavy slurries.</td><td>9</td><td>Thru-Flow Muffler</td><td>CR</td></tr>
<tr><td colspan="8">AE Type, model T, tube type air ejector, pinpoints noise-free parts ejection size 1/4 and 3/4 inch diameter x 12 inch length.</td><td>9</td><td>Tube Type Air Ejector Muffler</td><td>CR</td></tr>
<tr><td colspan="8">DF Type, end flow muffler, lightweight, single direction exhaust airflow, small in size, 1/8 to 2 inch NPT.</td><td>9</td><td>End Flow Muffler</td><td>CR 612</td></tr>
<tr><td colspan="8">SM Type, steam exhaust muffler, compact, lightweight, corrosion resistant, has coating for resistance to alkalis, heavy duty metal cylinder wall dis-seminators, NPT 1 to 6 inch.</td><td>9</td><td>Steam Exhaust Muffler</td><td>CR 612</td></tr>
<tr><td colspan="8">Carbon steel, low alloy corrosion resistant material, glass fiber or scovia acoustic pack, heavy gauge sheet acoustic facing, steel bar supports, steel plate sheet material.</td><td>56</td><td>Blowoff Silencer</td><td>CR 701</td></tr>
</table>

CATEGORY 30. FAN SILENCERS



CATEGORY 30. FAN SILENCERS

Silencers in this group may be used on either fan inlet or discharge plenums. Characteristic dimensions are difficult to identify since length, width, and height are all variables. These silencers often include filters, transition sections, and plenum volumes. Interior splitter or baffle geometries are usually used as primary noise reduction methods. Organizations contributing data to this table are: 5 and 50.

CAUTION

1. SILENCER PERFORMANCE FIGURES OFTEN DO NOT CONFORM TO STANDARD REFERENCE MEASUREMENTS. FOR SPECIFIC APPLICATIONS, SEE MANUFACTURER'S PRODUCT LITERATURE.
2. IN MANY CASES, ONLY REPRESENTATIVE INFORMATION IS PRESENTED FOR A GIVEN PRODUCT LINE. SEE MANUFACTURER'S LITERATURE FOR COMPLETE LISTINGS OF SIZES AND PERFORMANCE DATA.

Table 30. Fan silencers (insertion loss).

Insertion Loss, dB								Company	Product	Reference
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz			
For use when fan inlet is connected to process, discharge to atmosphere. Dimensions, WxHxL:* 24 x 24 x 24 inch, 5000 rated cfm**										
2	4	8	16	28	30	22	10	5	Model DF-5-1, Fan Discharge Silencer	CR B-229
For use when fan inlet is connected to process, discharge to atmosphere. Dimensions, WxHxL:* 24 x 36 x 24 inch, 9000 rated cfm**										
2	4	8	16	28	30	22	10	5	Model DF-9-1, Fan Discharge Silencer	CR B-229
For use when fan inlet is connected to process, discharge to atmosphere. Dimensions, WxHxL* 48 x 30 x 24 inch, 18,000 rated cfm**										
2	4	8	16	28	30	22	10	5	Model DF-18-1, Fan Discharge Silencer	CR B-229
For use when fan inlet is connected to process, discharge to atmosphere. Dimensions, WxHxL* 48 x 42 x 24 inch, 24,000 rated cfm**										
2	4	8	16	28	30	22	10	5	Model DF-24-1, Fan Discharge Silencer	CR B-229
For use when fan inlet is connected to process, discharge to atmosphere. Dimensions, WxHxL* 54 x 48 x 24 inch, 32,000 rated cfm**								5		
2	4	8	16	28	30	22	10	5	Model DF-32-1, Fan Discharge Silencer	CR B-229
For use when fan inlet is connected to process, discharge to atmosphere. Dimensions, WxHxL:* 60 x 78 x 48 inch, 60,000 rated cfm**										
4	9	18	32	43	44	34	21	5	Model DF-60-1, Fan Discharge Silencer	CR B-229
For use when fan inlet is connected to process, discharge to atmosphere. Dimensions, WxHxL* 72 x 102 x 48, 110,000 rated cfm**										
6	13	23	30	31	28	23	18	5	Model DF-110-1, Fan Discharge Silencer	CR B-229
Designed to bolt directly onto the fan inlet flange. Silencer includes an inlet bell mouth and silencing element, followed by a plenum section with one or two removable plates to allow access to the bolts. Dimensions, WxHxL* 30 x 24 x 30 inch, 5000 rated cfm**										
8	9	10	12	13	13	13	11	5	Model C1-5-1, Aeracoustic Fan Silencers	CR B-229
Designed to bolt directly onto the fan inlet flange. Silencer includes an inlet bell mouth and silencing element, followed by a plenum section with one or two removable plates to allow access to the bolts. Dimensions, WxHxL* 44 x 44 x 34 inch, 18,000 rated cfm**										
6	7	9	10	10	10	9	7	5	Model C1-18-1, Aeracoustic Fan Silencers	CR B-229
Designed to bolt directly onto the fan inlet flange. Silencer includes an inlet bell mouth and silencing element, followed by a plenum section with one or two removable plates to allow access to the bolts. Dimensions, WxHxL* 52 x 52 x 42 inch, 32,000 rated cfm**										
7	8	11	16	17	17	15	12	5	Model C1-32-1, Aeracoustic Fan Silencers	CR B-229
Designed to bolt directly onto the fan inlet flange. Silencer includes an inlet bell mouth and silencing element, followed by a plenum section with one or two removable plates to allow access to the bolts. Dimensions, WxHxL* 72 x 66 x 50 inch, 60,000 rated cfm**										
8	10	14	19	20	20	15	12	5	Model C1-60-1, Aeracoustic Fan Silencers	CR B-229
Designed to bolt directly onto the fan inlet flange. Silencer includes an inlet bell mouth and silencing element, followed by a plenum section with one or two removable plates to allow access to the bolts. Dimensions, WxHxL* 96 x 78 x 60 inch, 110,000 rated cfm**										
9	12	18	26	27	22	16	13	5	Model C1-110-1, Aeracoustic Fan Silencers	CR B-229
For single inlet fans without inlet boxes, 90 deg inlet. Designed to bolt directly to the fan inlet flange. Dimensions, WxHxL* 15.5 x 36 x 49 inch, 5000 rated cfm**										
8	9	10	12	16	18	19	16	5	Model SS1-5-1, Fan Inlet Silencer	CR B-229
For single inlet fans without inlet boxes, 90 deg inlet. Designed to bolt directly to the fan inlet flange. Dimensions, WxHxL* 19 x 60 x 73 inch, 18,000 rated cfm**										
8	9	10	19	21	21	17	15	5	Model SS1-18-1, Fan Inlet Silencer	CR B-229
For single inlet fans without inlet boxes, 90 deg inlet. Designed to bolt directly to the fan inlet flange. Dimensions, WxHxL* 20 x 66 x 83 inch, 24,000 rated cfm**										
8	9	10	18	21	20	17	15	5	Model SS1-24-1A, Fan Inlet Silencer	CR B-229

*Dimensions without flanges. Add 4 to 6 inch to allow for flanges.

**Maximum allowable flow is 10% higher than rated flow.

Table 30. Fan silencers (insertion loss) continued.

	Insertion Loss, dB										
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Company	Product	Reference
For single inlet fans without inlet boxes, 90 deg inlet. Designed to bolt directly to the fan inlet flange. Dimensions, WxHxL* 38 x 88 x 106 inch, 60,000 rated cfm**	11	13	22	30	33	33	27	22	5	Model SS1-60-1, Fan Inlet Silencer	CR B-229
For single inlet fans without inlet boxes, 90 deg inlet. Designed to bolt directly to the fan inlet flange. Dimensions, WxHxL* 49 x 108 x 127 inch, 110,000 rated cfm**	9	13	23	30	30	26	22	18	5	Model SS1-110-1, Fan Inlet Silencer	CR B-229
Designed to bolt directly to the fan inlet flange. Silencer includes inlet bell mouth and the silencing section, followed by a plenum section large enough to accommodate the fan inlet opening. Dimensions, WxHxL* 15.5 x 36 x 49 inch, 5000 rated cfm**	8	9	10	12	13	13	13	11	5	Model S1-5-1, Fan Inlet Silencer	CR B-229
Designed to bolt directly to the fan inlet flange. Silencer includes inlet bell mouth and the silencing section, followed by a plenum section large enough to accommodate the fan inlet opening. Dimensions, WxHxL* 19 x 60 x 73 inch, 18,000 rated cfm**	8	9	10	15	16	16	12	10	5	Model S1-18-1, Fan Inlet Silencer	CR B-229
Designed to bolt directly to the fan inlet flange. Silencer includes inlet bell mouth and the silencing section, followed by a plenum section large enough to accommodate the fan inlet opening. Dimensions, WxHxL* 17 x 73 x 95 inch, 32,000 rated cfm**	10	8	9	13	18	16	12	10	5	Model S1-32-1, Fan Inlet Silencer	CR B-229
Designed to bolt directly to the fan inlet flange. Silencer includes inlet bell mouth and the silencing section, followed by a plenum section large enough to accommodate the fan inlet opening. Dimensions, WxHxL* 38 x 88 x 106 inch, 60,000 rated cfm**	11	12	17	25	28	26	22	17	5	Model S1-60-1, Fan Inlet Silencer	CR B-229
Designed to bolt directly to the fan inlet flange. Silencer includes inlet bell mouth and the silencing section, followed by a plenum section large enough to accommodate the fan inlet opening. Dimensions, WxHxL* 49 x 108 x 127 inch, 110,000 rated cfm**	9	11	18	25	25	21	17	13	5	Model S1-110-1, Fan Inlet Silencer	CR B-229
For fans with inlet boxes. Internal configuration of this model is designed so that the silencer exit matches the fan inlet box thereby eliminating the need for a separate transition piece. Dimensions, WxHxL* 15.5 x 36 x 22 inch, 5000 rated cfm**	8	9	10	12	13	13	13	11	5	Model 1B-5-1, Aeracoustic Fan Silencers	CR B-229
For fans with inlet boxes. Inernal configuration of this model is designed so that the silencer exit matches the fan inlet box thereby eliminating the need for a separate transition piece. Dimensions, WxHxL* 19 x 60 x 32 inch, 18,000 rated cfm**	8	9	10	15	15	16	12	10	5	Model 1B-18-1, Aeracoustic Fan Silencers	CR B-229
For fans with inlet boxes. Internal configuration of this model is designed so that the silencer exit matches the fan inlet box thereby eliminating the need for a separate transition piece. Dimensions, WxHxL* 17 x 73 x 38 inch, 32,000 rated cfm**	6	6	8	13	18	16	12	10	5	Model 1B-32-1, Aeracoustic Fan Silencers	CR B-229
For fans with inlet boxes. Internal configuration of this model is designed so that the silencer exit matches the fan inlet box thereby eliminating the need for a separate transition piece. Dimensions, WxHxL* 38 x 88 x 44 inch, 60,000 rated cfm**	9	11	17	25	27	27	20	17	5	Model 1B-60-1, Aeracoustic Fan Silencers	CR B-229
For fans with inlet boxes. Internal configuration of this model is designed so that the silencer exit matches the fan inlet box thereby eliminating the need for a separate transition piece. Dimensions, WxHxL* 49 x 108 x 54 inch, 110,000 rated cfm**	9	11	18	24	25	21	17	14	5	Model 1B-110-1 Aeracoustic Fan Silencers	CR B-229
For fans with inlet boxes Internal configuration of this model is designed so that the silencer exit matches the fan inlet box thereby eliminating the need for a separate transition piece. Dimensions, WxHxL* 49 x 118.5 x 57 inch, 140,000 rated cfm.**	8	9	13	20	22	18	14	11	5	Model 1B-140-1, Aeroacoustic Fan Silencers	CR B-229

*Dimensions without flanges. Add 4 to 6 inch to allow for flanges.

**Maximum allowable flow is 10% higher than rated flow.

Table 30. Fan silencers (insertion loss) concluded.

Insertion Loss, dB 63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Company	Product	Reference
For fans with inlet boxes. Internal configuration of this model is designed so that the silencer exit matches the fan inlet box thereby eliminating the need for a separate transition piece. Dimensions, WxHxL:* 47 x 173 x 58 inch, 180,000 rated cfm.**										
8	9	15	22	24	26	16	13	5	Model 1B-180-1, Aeroacoustic Fan Silencers	CR B-229
For fans with inlet boxes. Internal configuration of this model is designed so that the silencer exit matches the fan inlet box thereby eliminating the need for a separate transition piece. Dimensions, WxHxL:* 55 x 138 x 66 inch, 200,000 rated cfm.**										
6	7	13	19	20	16	13	10	5	Model 1B-200-1, Aeroacoustic Fan Silencers	CR B-229
Model SF (01 through 36). Straight through design with formed noses and tails, 3 ft unit.										
4	6	12	17	18	15	11	9	50	Enelco Fan Silencers	CR 3879 2/77
Model SF (01 through 36). Straight through design with formed noses and tails, 5 ft unit.										
6	9	17	26	28	23	17	14	50	Enelco Fan Silencers	CR 3879 2/77
Model FS (01, 02, 05, 06, 07). High volume flow silencer. Straight through design with formed noses and tails, 4 ft unit.										
5	8	13	17	20	15	13	12	50	Enelco Fan Silencers	CR 3877 5/76
Model FS (03, 04). High volume flow silencer, 4 ft unit.										
5	8	13	21	25	19	14	13	50	Enelco Fan Silencers	CR 3877 5/76
Model FS (08, 09, 10, 11) High volume flow silencer, 4 ft unit.										
5	8	12	13	12	9	8	8	50	Enelco Fan Silencers	CR 3877
Model FS (01, 02, 05, 06, 07). High volume flow silencer. Straight through design with formed noses and tails. 8 ft unit.										
9	14	24	28	28	21	15	15	50	Enelco Fan Silencers	CR 3877 5/76
Model FS (03, 04). High volume flow silencer, 8 ft unit.										
8	14	24	35	37	27	22	18	50	Enelco Fan Silencers	CR 3877
Model FS (08, 09, 10, 11). High volume flow silencer, 8 ft unit.										
9	15	22	26	22	18	13	11	50	Enelco Fan Silencers	CR 3877

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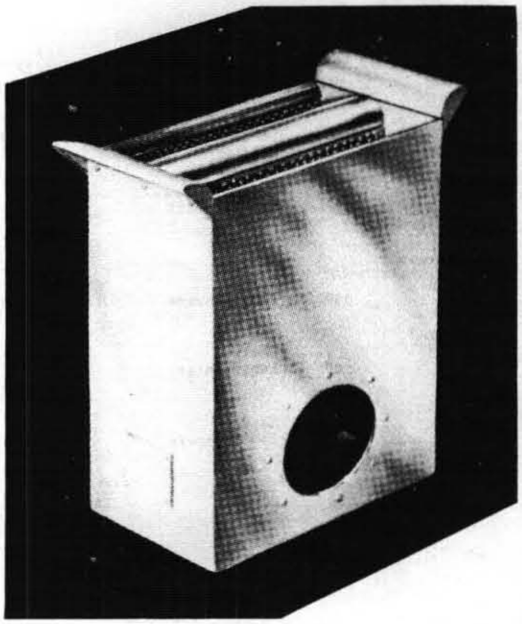
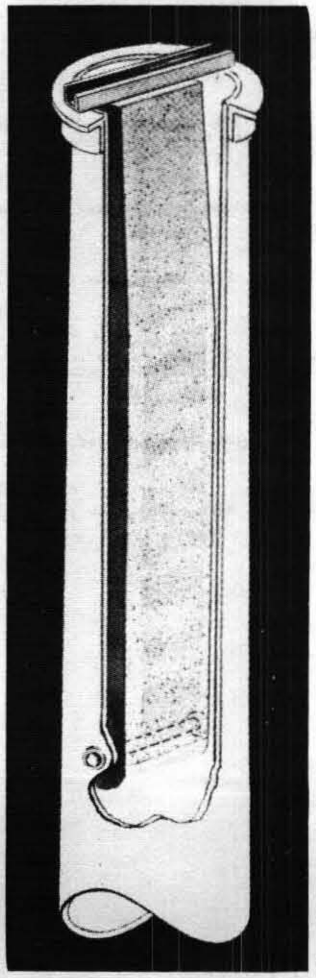
*Dimensions without flanges. Add 4 to 6 inch to allow for flanges

**Maximum allowable flow is 10% higher than rated flow.

CATEGORY 31. INLET AND EXHAUST SILENCERS





CATEGORY 31. INLET AND EXHAUST SILENCERS

This category includes a wide range of silencer geometries. These units are only used for industrial applications. Deformation is presented on silencers for large exhaust stacks and chimneys. Also, exhaust systems for large plenums are included. Materials vary for ambient to high temperature gas installations. For related infomation see general industrial silencers and high pressure discharge silencers. Organizations contributing data to this table are: 6, 50, 62, and 121.

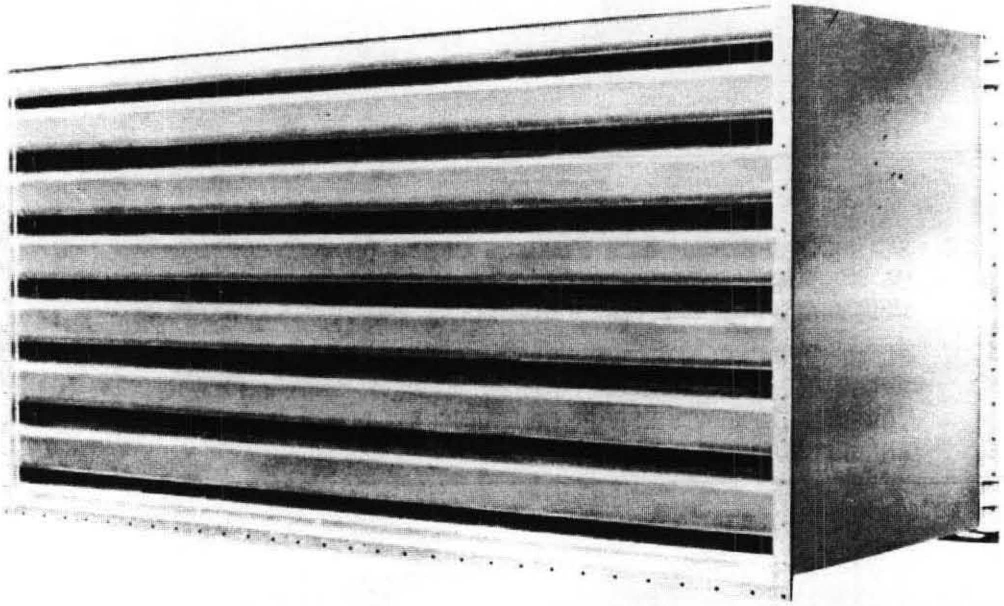
CAUTION

1. SILENCER PERFORMANCE FIGURES OFTEN DO NOT CONFORM TO STANDARD REFERENCE MEASUREMENTS. FOR SPECIFIC APPLICATIONS, SEE MANUFACTURER'S PRODUCT LITERATURE.
2. IN MANY CASES, ONLY REPRESENTATIVE INFORMATION IS PRESENTED FOR A GIVEN PRODUCT LINE. SEE MANUFACTURER'S LITERATURE FOR COMPLETE LISTINGS OF SIZES AND PERFORMANCE DATA.

Table 31. Inlet and exhaust silencers.

	Insertion Loss, dB										
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Company	Product	Reference
Silencers for up to 625 cfm. For intake or discharge of centrifugal compressors or blowers. Temperature range 0 to 1000°F. 5 inch size.			3.5	7	17	21.5	11.5	10.5	121	Filter/Silencers	CR 300D
Silencers for up to 1600 cfm. For intake or discharge of centrifugal compressors or blowers. Temperature range 0 to 1000°F. 8 inch size.			5	10.5	23	16	13.5	12	121	Filter/Silencers	CR 300D
Silencers for up to 400 cfm. For intake or discharge of centrifugal compressors or blowers. Temperature range 0 to 1000°F. 4 inch size.			5.5	10	22.5	27.5	16.5	11	121	Filter/Silencers	CR 300D
Silencers for up to 900 cfm. For intake or discharge of centrifugal compressors or blowers. Temperature range 0 to 1000°F. 6 inch size.			7	12.5	25	23	14	12	121	Filter/Silencers	CR 300D
Compact silencer for air conditioning equipment. Deep sound attenuator nondirectional for air and sound, and construction of .062 inch thick aluminum and fiberglass. Used in return air grilles and transfer grilles; 24 inch long x 24 inch wide. Other sizes available.	7	12	12	12	19	25	25	20	6	Compact Airsan Silencer	CR 6/4/65
Silencers for up to 2500 cfm. For intake or discharge of centrifugal compressors or blowers. Temperature range 0 to 1000°F. 10 inch size.			6.5	13.5	27	22.5	14	12	121	Filter/Silencers	CR 300D
Silencers for up to 6500 cfm. For intake or discharge of centrifugal compressors or blowers. Temperature range 0 to 1000°F. 16 inch size.			14.5	24	29.5	13.5	9	9.5	121	Filter/Silencer	CR 300D
Silencers for up to 4800 cfm. For intake or discharge of centrifugal compressors or blowers. Temperature range 0 to 1000°F. 14 inch size.			10.5	25.5	27.5	18	12	9	121	Filter/Silencer	CR 300D
Silencers for up to 3500 cfm. For intake or discharge of centrifugal compressors or blowers. Temperature range 0 to 1000°F. 12 inch size.			7	14	31.5	28	20	5.5	121	Filter/Silencer	CR 300D
Silencers for up to 230 cfm. For intake or discharge of centrifugal compressors or blowers. Temperature range 0 to 1000°F. 3 inch size.			9.5	10.5	22.5	21.5	28	18.5	121	Filter/Silencer	CR 300D
Model CV04, intermediate volume flow silencer. Constructed of carbon steel with acoustically lined shell and a center acoustic bubble.	13	15	19	34	33	36	33	26	50	Enelco Vent Silencer	CR 3884 5/76
Model CV06 through CV10, intermediate volume flow silencer. Constructed of carbon steel with acoustically lined shell and a center acoustic bubble.	14	18	22	36	36	34	33	25	50	Enelco Vent Silencer	CR 3884 5/76
Model CV12 through CV16, intermediate volume flow silencer. Constructed of carbon steel with acoustically lined shell and a center acoustic bubble.	16	21	28	36	38	35	33	25	50	Enelco Vent Silencer	CR 3884 5/76
Model HV08 silencer, 3/16 inch carbon steel shell, panel is of 16 gauge thick steel with fiberglass cloth and bonded mineral wool acoustical fill. Temperature up to 450°F.	16	22	32	40	40	34	28	23	50	Enelco Vent Silencer	CR 1889
Model HV12 silencer, 3/16 inch carbon steel shell, panel is of 16 gauge thick steel with fiberglass cloth and bonded mineral wool acoustical fill. Temperature up to 450°F.	20	26	39	49	50	40	33	29	50	Enelco Vent Silencer	CR 1889
Model CV27 through CV40 intermediate volume flow silencer. Constructed of carbon steel with acoustically lined shell and a center acoustic bubble.	20	27	36	37	38	33	31	26	50	Enelco Vent Silencer	CR 3884 5/76
Model CV18 through CV25 intermediate volume flow silencer. Constructed of carbon steel with acoustically lined shell and a center acoustic bubble.	19	25	33	39	38	34	33	27	50	Enelco Vent Silencer	CR 3884 5/76
Model C11905, shell material 14 gauge cold rolled steel, fire retardant acoustical material. Vent is painted with inorganic zinc-rich primer. Temperature range -15 to 140°F.	13	17	19	33	37	43	46	48	62	Weatherproof Inlet and Exhaust Air Silencer	CR 154-75 8-76

CATEGORY 32. SPLITTER/LOUVER SILENCERS



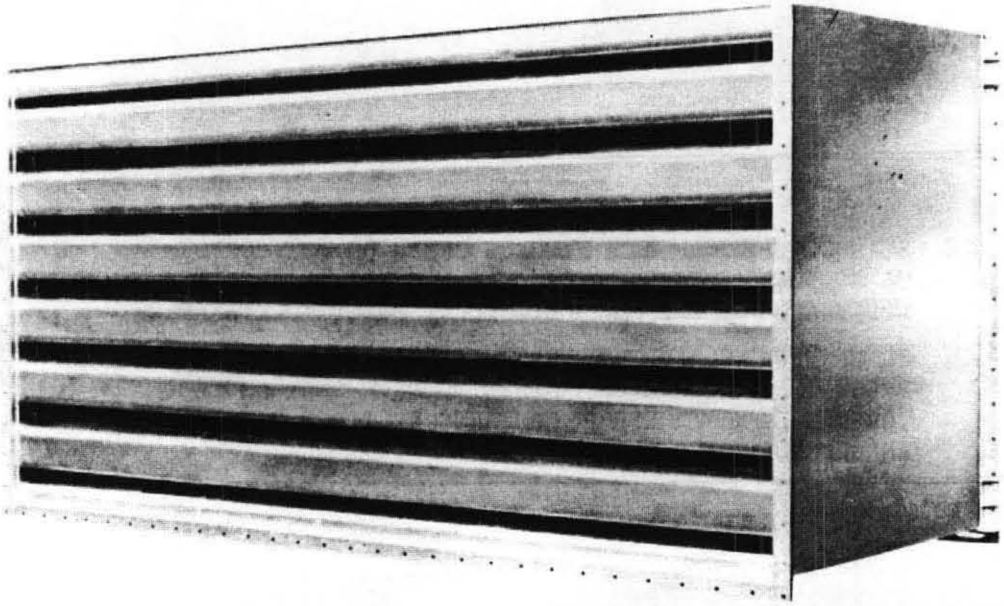
CATEGORY 32. SPLITTER/LOUVER SILENCERS

A splitter or louver geometry indicates that a large area of uniformly flowing gas is divided into smaller, narrower passages. Sometimes the main flow direction is altered by the splitter or louver. These geometries generally block direct line of sight noise transmission from an interior noise source to the ambient environment. Absorptive materials are often installed within a splitter or louver to improve sound absorption performance. Organizations contributing data to this table are: 5, 6, and 50.

CAUTION

1. SILENCER PERFORMANCE FIGURES OFTEN DO NOT CONFORM TO STANDARD REFERENCE MEASUREMENTS. FOR SPECIFIC APPLICATIONS, SEE MANUFACTURER'S PRODUCT LITERATURE.
2. IN MANY CASES, ONLY REPRESENTATIVE INFORMATION IS PRESENTED FOR A GIVEN PRODUCT LINE. SEE MANUFACTURER'S LITERATURE FOR COMPLETE LISTINGS OF SIZES AND PERFORMANCE DATA.

CATEGORY 32. SPLITTER/LOUVER SILENCERS



CATEGORY 32. SPLITTER/LOUVER SILENCERS

A splitter or louver geometry indicates that a large area of uniformly flowing gas is divided into smaller, narrower passages. Sometimes the main flow direction is altered by the splitter or louver. These geometries generally block direct line of sight noise transmission from an interior noise source to the ambient environment. Absorptive materials are often installed within a splitter or louver to improve sound absorption performance. Organizations contributing data to this table are: 5, 6, and 50.

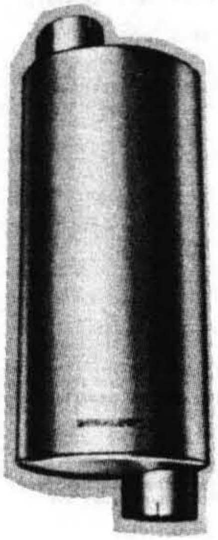
CAUTION

1. SILENCER PERFORMANCE FIGURES OFTEN DO NOT CONFORM TO STANDARD REFERENCE MEASUREMENTS. FOR SPECIFIC APPLICATIONS, SEE MANUFACTURER'S PRODUCT LITERATURE.
2. IN MANY CASES, ONLY REPRESENTATIVE INFORMATION IS PRESENTED FOR A GIVEN PRODUCT LINE. SEE MANUFACTURER'S LITERATURE FOR COMPLETE LISTINGS OF SIZES AND PERFORMANCE DATA.

Table 32. Splitter/louver silencers.

Insertion Loss, dB										
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Company	Product	Reference
SS Series, aluminum, stainless and galvanized available. 24 inch size.										
3	6	12	22	27	20	12	8	5	Stack-Stuffer Silencers, SSA3	CR Bull. B-38
SS Series, Aluminum, stainless and galvanized available. 48 inch size.										
6	12	22	27	20	12	8	4	5	Stack-Stuffer Silencers, SSA3	CR Bull. B-38
SS Series, aluminum, stainless and galvanized available. 96 inch size.										
12	22	27	20	12	8	4	2	5	Stack-Stuffer Silencers, SSA3	CR Bull. B-38
Acoustical louvers, top surfaces solid, bottom surface absorptive, water stops on upper surface, outer casings 16 gauge galvanized steel, internals 22 gage galvanized steel.										
	6	11	15	18	18	16	12	5	Aeroacoustic Silentflow Louvers	CR Bull. B-46
Splitter silencers, Model A8, 6 inch modules, available in several models.										
7	15	30	54	65	68	60	45	5	Aeroacoustic Splitter Silencers	CR Bull. B-133
Splitter silencers, Model F2, 12 inch modules.										
5	10	17	23	24	20	16	12	5	Aeroacoustic Splitter Silencer	CR Bull. B-133
Splitter silencers, Model Q10, 15 inch modules.										
9	17	29	41	43	27	22	17	5	Aeroacoustic Splitter Silencers	CR Bull. B-133
Splitter silencers, Model V3, 18 inch modules.										
5	8	13	18	15	12	9	7	5	Aeroacoustic Splitter Silencer	CR Bull. B-133
Airfoil shaped turning vane for noise and directional air control, 14 gauge aluminum extrusion, acoustically treated with fiberglass, which is protected by an open protective metal facing. Temperature range 290°F, humidity, no limit, maximum velocity 4000 fpm. Standard available length 10 ft.										
	8	8	11	18	25	28	20	6	Airsan Acoustiturn	CR
Sound absorption louver, available in 54 standard sizes, for use in controlling fan noises, air intakes, cooling tower inlets. (Reported values are transmission loss.)										
3	6	7	10	14	13	12	10	50	Acoustilouvre	
Sound absorption louver available in 54 standard sizes for use in controlling fan noises, air intakes, cooling tower inlets. (Reported values are transmission loss.)										
4	7	8	11	16	17	13	10	50	Enelco Acoustilouvre Model AL-1	CR Form 858 AL1

CATEGORY 33. VEHICULAR MUFFLERS



CATEGORY 33. VEHICULAR MUFFLERS

The muffler products listed in this category are only applicable to heavy equipment and trucks. No information is presented for automotive use. Single and dual muffler configurations are presented. The required exhaust noise level at 50 ft from the vehicle is often the determining factor in muffler selection. For low noise requirements, muffler shell noise becomes a major contributing factor so that double wrapping or high temperature insulation may be added to the basic muffler design. The organization contributing data to this table is company 39.

CAUTION

1. MUFFLER PERFORMANCE FIGURES OFTEN DO NOT CONFORM TO STANDARD REFERENCE MEASUREMENTS. FOR SPECIFIC APPLICATIONS, SEE MANUFACTURER'S PRODUCT LITERATURE.
2. IN MANY CASES, ONLY REPRESENTATIVE INFORMATION IS PRESENTED FOR A GIVEN PRODUCT LINE. SEE MANUFACTURER'S LITERATURE FOR COMPLETE LISTINGS OF SIZES AND PERFORMANCE DATA.
3. SEVERAL MANUFACTURERS WERE SOLICITED FOR VEHICULAR MUFFLER INFORMATION, BUT ONLY ONE COMPANY PROVIDED DATA FOR THIS TABLE.

Table 33. Vehicular mufflers.

Sound Measurement Criteria		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
76 72 70	1.2 2.0 1.6	NTC-230	Trucks, Cummins turbocharged engines cab side mount Single 4" systems	39	MUM09-0022 or MPM09-0141 or MKM10-0147	CR 1200-192
75 71 69	1.0 1.7 1.4	Formula 230			MUM09-0022 or MPM09-0141 or MKM10-0147	
77 73 71	1.5 2.4 1.9	NTC-250			MUM09-0022 or MPM09-0141 or MKM10-0147	
76 72 70	1.3 2.0 1.7	Formula 250			MUM09-0022 or MPM09-0141 or MKM10-0147	
78 74 72	1.3 2.1 1.7	NTC-270			MUM09-0022 or MPM09-0141 or MKM10-0147	
79 73	1.9 2.4	NTC-270CT			MUM09-0022 or MKM10-1047	
79 73	2.1 2.8	PT-270			MUM09-0022 or MKM10-0147	
77 71	2.2 2.9	NTC-290			MUM09-0022 or MKM10-0147	
78 74 72	1.4 2.3 1.8	NTC-290 (pre 1976)			MUM09-0022 or MPM09-0141 or MKM10-0147	
76 70	1.8 2.4	Formula 290			MUM09-0022 or MKM10-0147	
78 72	2.3 3.0	PT-330D			MUM09-0022 or MKM10-0147	
78 72	1.9 2.5	NTC-335			MUM09-0022 or MKM10-0147	
79	2.2	NTC-350			MUM09-0022	
78 72	1.8 2.4	Formula 335			MUM09-0022 or MKM10-0147	
78 72	1.8 2.4	NTC-350-Y			MUM09-0022 or MKM10-0147	
80	2.6	NTF-365			MUM09-0022	
78 74 72	1.1 1.8 1.5	VT-555			MUM09-0022 or MPM09-0141 or MKM10-0147	
78 74 72	1.2 1.9 1.5	VTF-555			MUM09-0022 or MPM09-0141 or MKM10-0147	
79 73	2.2 2.9	VT-903			MUM09-0022 or MKM10-0147	
78 72	1.9 2.5	Formula 903			MUM09-0022 or MKM10-0147	
75 73 71 69	0.5 0.9 0.9 1.5	NTC-230	Trucks, Cummins turbocharged engines cab side mount Single 5" systems		MPM09-0161 or MPM09-0197 or MPM10-0106 or MFM10-0165	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
74	0.4	Formula 230	Trucks, Cummins	39	MPM09-0161	CR
72	0.7		turbocharged engines		or MPM09-0197	1200-192
70	0.7		cab side mount		or MPM10-0106	
68	1.3		Single 5" systems		or MFM10-0165	
76	0.6	NTC-250			MPM09-0161	
74	1.0				or MPM09-0197	
72	1.0				or MPM10-0106	
70	1.8				or MFM10-0165	
75	0.5	Formula 250			MPM09-0161	
73	0.9				or MPM09-0197	
71	0.9				or MPM10-0106	
69	1.6				or MFM10-0165	
77	0.5	NTC-270			MPM09-0161	
75	1.0				or MPM09-0197	
73	0.9				or MPM10-0106	
71	1.6				or MFM10-0165	
78	0.8	NTC-270CT			MPM09-0161	
76	1.4				or MPM09-0197	
74	1.3				or MPM10-0106	
72	2.3				or MFM10-0165	
78	0.9	PT-270			MPM09-0161	
76	1.5				or MPM09-0197	
74	1.5				or MPM10-0106	
72	2.7				or MFM10-0165	
76	0.9	NTC-290			MPM09-0161	
74	1.5				or MPM09-0197	
72	1.5				or MPM10-0106	
70	2.7				or MFM10-0165	
77	0.6	NTC-290			MPM09-0161	
75	1.0	(Pre 1976)			or MPM09-0197	
73	0.9				or MPM10-0106	
71	1.7				or MFM10-0165	
75	0.8	Formula 290			MPM09-0161	
73	1.3				or MPM09-0197	
71	1.3				or MPM10-0106	
69	2.3				or MFM10-0165	
77	1.0	PT-330D			MPM09-0161	
75	1.6				or MPM09-0197	
73	1.6				or MPM10-0106	
71	2.9				or MFM10-0165	
77	0.9	NTC-335			MPM09-0161	
75	1.5				or MPM09-0197	
73	1.4				or MPM10-0106	
71	2.4				or MFM10-0165	
78	1.0	NTC-350			MPM09-0161	
76	1.8				or MPM09-0197	
74	1.6				or MPM10-0106	
72	2.8				or MFM10-0165	
77	0.8	Formula 335			MPM09-0161	
75	1.3				or MPM09-0197	
73	1.3				or MPM10-0106	
71	2.3				or MFM10-0165	
77	0.8	NTC-350-Y			MPM09-0161	
75	1.3				or MPM09-0197	
73	1.3				or MPM10-0106	
71	2.3				or MFM10-0165	
79	1.1	NTF-365			MPM09-0161	
77	1.8				or MPM09-0197	
75	1.8				or MPM10-0106	
73	1.1				or MPM10-0108	
79	1.4	NTA-400			MPM09-0161	
77	2.1				or MPM09-0197	
75	2.1				or MPM10-0106	
73	1.4				or MPM10-0108	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
80	1.7	NTA-420	Trucks, Cummins	39	MPM09-0161	CR
78	2.4		turbocharged engines		or MPM09-0197	1200-192
76	2.4		cab side mount		or MPM10-0106	
74	1.6		Single 5" systems		or MPM10-0102	
80	1.5	KT-450			MPM09-0161	
78	2.4				or MPM09-0197	
76	2.4				or MPM09-0106	
74	1.4				or MPM10-0108	
82	2.9	KTA-525			MPM09-0161	
74	2.8				or MPM10-0108	
82	2.5	KTA-600			MPM09-0161	
74	2.4				or MPM10-0108	
77	0.5	VT-555			MPM09-0161	
75	0.9				or MPM09-0197	
73	0.8				or MPM10-0106	
71	1.4				or MFM10-0165	
77	0.6	VTF-555			MPM09-0161	
75	1.1				or MPM09-0197	
73	0.9				or MPM10-0106	
71	1.5				or MFM10-0165	
78	1.0	VT-903			MPM09-0161	
76	1.8				or MPM09-0197	
74	1.8				or MPM10-0106	
72	2.9				or MFM10-0165	
77	0.9	Formula 903			MPM09-0161	
75	1.7				or MPM09-0197	
73	1.6				or MPM10-0106	
71	2.6				or MFM10-0165	
70	0.6	NTC-230	Trucks, Cummins		MPM09-0141	
69	0.5	Formula 230	turbocharged engines		MPM09-0141	
71	0.7	NTC-250	cab side mount		MPM09-0141	
70	0.6	Formula 250	Split systems 5x4x4		MPM09-0141	
72	0.6	NTC-270			MPM09-0141	
73	0.9	NTC-270CT			MPM09-0141	
73	1.1	PT-270			MPM09-0141	
71	1.1	NTC-290			MPM09-0141	
72	0.7	NTC-290(pre 1976)			MPM09-0141	
70	0.9	Formula 290			MPM09-0141	
72	1.2	PT-330D			MPM09-0141	
72	0.9	NTC-335			MPM09-0141	
73	1.1	NTC-350			MPM09-0141	
72	0.9	Formula 335			MPM09-0141	
72	0.9	NTC-350-Y			MPM09-0141	
74	1.3	NTF-365			MPM09-0141	
74	1.4	NTA-400			MPM09-0141	
75	1.7	NTA-420			MPM09-0141	
75	1.8	KT-450			MPM09-0141	
77	2.8	KTA-600			MPM09-0141	
72	0.6	VT-555			MPM09-0141	
72	0.7	VTF-555			MPM09-0141	
73	1.1	VT-903			MPM09-0141	
72	1.0	Formula 903			MPM09-0141	
70	0.4	NTC-270	Trucks, Cummins		MFM10-0172	
71	0.6	NTC-270CT	turbocharged engines		MFM10-0172	
71	0.7	PT-270	cab side mount		MFM10-0172	
69	0.7	NTC-290	Split systems 5x5x5		MFM10-0172	
70	0.5	NTC-290(pre 1976)			MFM10-0172	
68	0.6	Formula 290			MFM10-0172	
70	0.8	PT-330D			MFM10-0172	
70	0.6	NTC-335			MFM10-0172	
69	0.8	NTC-350			MFM10-0172	
70	0.7	Formula 335			MFM10-0172	
70	0.7	NTC-350-Y			MFM10-0172	
72	0.9	NTF-365			MFM10-0172	
71	1.0	NTC-400			MFM10-0172	
72	1.3	KT-450			MFM10-0172	
73	2.2	KTA-600			MFM10-0172	
73	2.6	KTA-525			MFM10-0172	
70	0.4	VT-555			MFM10-0172	
70	0.5	VTF-555			MFM10-0172	
71	0.7	VT-903			MFM10-0172	
70	0.7	Formula 903			MFM10-0172	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
75	1.8	NTC-230	Trucks, Cummins turbocharged engines chassis mount vertical tailpipe single 4" systems	39	MOM12-1000	CR 1200-192
74	2.9				or MBM10-0002	
73	1.6	Formula 230			MOM12-1000	
74	2.5				or MBM10-0002	
76	2.2	NTC-250			MOM12-1000	
75	1.9	Formula 250			MOM12-1000	
77	2.1	NTC-270			MOM12-1000	
78	2.8	NTC-270CT			MOM12-1000	
78	3.0	PT-270			MOM12-1000	
77	2.2	NTC-290(pre 1976)			MOM12-1000	
75	2.8	Formula 290			MOM12-1000	
77	2.8	NTC-335			MOM12-1000	
77	2.8	Formula 335			MOM12-1000	
77	2.8	NTC-350-Y			MOM12-1000	
77	1.9	VT-555			MOM12-1000	
76	2.6				or MBM10-0002	
77	2.0	VTF-555			MOM12-1000	
76	2.7				or MBM10-0002	
77	2.9	Formula 903			MOM12-1000	
76	0.8	NTC-230	Trucks, Cummins turbocharged engines chassis mount vertical tailpipe single 5" systems		MOM12-0131	
73	1.7				or MOM12-0176	
68	1.7				or MOM12-0189	
75	0.7	Formula 230			MOM12-0131	
72	1.4				or MOM12-0176	
67	1.4				or MOM12-0189	
77	0.9	NTC-250			MOM12-0131	
74	2.0				or MOM12-0176	
69	2.0				or MOM12-0189	
76	0.8	Formula 250			MOM12-0131	
73	1.7				or MOM12-0176	
68	1.7				or MOM12-0189	
78	0.8	NTC-270			MOM12-0131	
75	1.8				or MOM12-0176	
70	1.7				or MOM12-0189	
79	1.3	NTC-270CT			MOM12-0131	
76	2.6				or MOM12-0176	
71	2.5				or MOM12-0189	
79	1.4	PT-270			MOM12-0131	
76	3.0				or MOM12-0176	
71	2.9				or MOM12-0189	
77	1.4	NTC-290			MOM12-0131	
74	3.0				or MOM12-0176	
69	2.9				or MOM12-0189	
78	0.9	NTC-290 (pre 1976)			MOM12-0131	
75	1.9				or MOM12-0176	
70	1.8				or MOM12-0189	
76	1.2	Formula 290			MOM12-0131	
73	2.6				or MOM12-0176	
68	2.5				or MOM12-0189	
78	1.5	PT-330D			MOM12-0131	
79	1.4	NTC-335			MOM12-0131	
75	2.6				or MOM12-0176	
70	2.5				or MOM12-0189	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
79	1.6	NTC-350	Trucks, Cummins turbocharged engines chassis mount vertical tailpipe single 5" systems	39	MOM12-0131	CR 1200-192
71	3.0				or MOM12-0189	
78	1.2	Formula 335			MOM12-0131	
75	2.6				or MOM12-0176	
70	2.5				or MOM12-0189	
78	1.2	NTC-350-Y			MOM12-0131	
75	2.5				or MOM12-0176	
70	2.5				or MOM12-0189	
80	1.7	NTF-365			MOM12-0131	
80	2.2	NTA-400			MOM12-0131	
81	2.5	NTA-420			MOM12-0131	
81	2.6	KT-450			MOM12-0131	
78	0.8	VT-555			MOM12-0131	
75	1.6				or MOM12-0176	
70	1.6				or MOM12-0189	
78	0.9	VTF-555			MOM12-0131	
75	1.7				or MOM12-0176	
70	1.7				or MOM12-0189	
79	1.6	VT-903			MOM12-0131	
71	2.9				or MOM12-0189	
78	1.4	Formula 903			MOM12-0131	
75	2.7				or MOM12-0176	
70	2.6				or MOM12-0189	
75	1.8	NTC-230	Trucks, Cummins turbocharged engines chassis mount horizontal tailpipe single 4" systems		MOM12-0100	
73	2.5				or MTM10-0048	
70	2.4				or MTM10-0043	
74	1.5	Formula 230			MOM12-0100	
72	2.1				or MTM10-0048	
69	2.0				or MTM10-0043	
76	2.1	NTC-250			MOM12-0100	
74	3.0				or MTM10-0048	
71	2.8				or MTM10-0043	
75	1.8	Formula 250			MOM12-0100	
73	2.6				or MOM10-0048	
70	2.4				or MTM12-0043	
77	1.8	NTC-270			MOM12-0100	
75	2.6				or MTM10-0048	
72	2.5				or MTM10-0043	
78	2.7	NTC-270CT			MOM12-0100	
77	2.0	NTC-290 (pre 1976)			MOM12-0100	
75	2.8				or MTM10-0048	
72	2.6				or MTM10-0043	
75	2.7	Formula 290			MOM12-0100	
77	2.7	NTC-335			MOM12-0100	
77	2.7	Formula 335			MOM12-0100	
77	2.7	NTC-350-Y			MOM12-0100	
77	1.8	VT-555			MOM12-0100	
75	2.4				or MTM10-0048	
72	2.3				or MTM10-0043	
77	1.9	VTF-555			MOM12-0100	
75	2.5				or MTM10-0048	
72	2.3				or MTM10-0043	
77	2.8	Formula 903			MOM12-0100	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
77 72	1.2 1.1	NTC-230	Trucks, Cummins turbocharged engines chassis mount horizontal tailpipe single 5" systems	39	MOM12-0108 or MOM12-0186	CR 1200-192
76 71	1.0 1.0	Formula 230			MOM12-0108 or MOM12-0186	
78 73	1.4 1.4	NTC-250			MOM12-0108 or MOM12-0186	
77 72	1.2 1.2	Formula 250			MOM12-0108 or MOM12-0186	
79 74	1.2 1.2	NTC-270			MOM12-0108 or MOM12-0186	
80 75	1.8 1.7	NTC-270CT			MOM12-0108 or MOM12-0186	
80 75	2.0 2.0	PT-270			MOM12-0108 or MOM12-0186	
78 73	2.1 2.0	NTC-290			MOM12-0108 or MOM12-0186	
79 74	1.3 1.3	NTC-290 (pre 1976)			MOM12-0108 or MOM12-0186	
77 72	1.8 1.7	Formula 290			MOM12-0108 or MOM12-0186	
79 74	2.2 2.2	PT-330D			MOM12-0108 or MOM12-0186	
79 74	1.9 1.9	NTC-335			MOM12-0108 or MOM12-0186	
79 74	1.8 1.7	Formula 335			MOM12-0108 or MOM12-0186	
80 75	2.2 2.1	NTC-350			MOM12-0108 or MOM12-0186	
79 74	1.8 1.7	NTC-350-Y			MOM12-0108 or MOM12-0186	
81 76	2.5 2.4	NTF-365			MOM12-0108 or MOM12-0186	
81 76	2.8 2.7	NTA-400			MOM12-0108 or MOM12-0186	
81	1.9	NTA-420			MOM12-0225	
81	2.1	KT-450			MOM12-0225	
79 78 74	1.1 0.6 1.0	VT-555			MOM12-0108 or MOM12-0225 or MOM12-0186	
79 78 74	1.2 0.8 1.1	VTF-555			MOM12-0108 or MOM12-0225 or MOM12-0186	
80 79 75	2.3 1.3 2.2	VT-903			MOM12-0108 or MOM12-0225 or MOM12-0186	
79 78 74	1.8 1.1 1.8	Formula 903			MOM12-0108 or MOM12-0225 or MOM12-0186	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
72	1.1	1673T	Trucks, Caterpillar turbocharged engines cab side mount single 4" systems	39	MUM09-0022	CR 1200-255
75	1.2	1674T			MUM09-0022	
68	1.4	3306T			MKM10-0147	
73	1.1				or MUM09-0022	
70	1.6	3406T-E			MKM10-0147	
77	1.2				or MUM09-0022	
68	0.7	1673T	Trucks, Caterpillar turbocharged engines cab side mount single 5" systems		MPM10-0106	
71	0.5				or MPM09-0161	
69	0.8				or MPM09-0197	
70	0.8	1674TA			MPM10-0106	
72	0.9				or MPM09-0197	
74	0.5				or MPM09-0161	
72	1.4	1693T			MPM10-0106	
74	1.5				or MPM09-0197	
76	0.9				or MPM09-0161	
72	1.3	1693TA			MPM10-0108	
75	1.4				or MPM10-0127	
77	1.3				or MPM09-0161	
69	0.7	3306T			MPM10-0106	
71	0.8				or MPM09-0197	
73	0.5				or MPM09-0161	
70	1.8	3406T			MOM12-0251	
74	1.6				or MPM10-0106	
77	1.0				or MPM09-0161	
69	1.9	3406TA			MOM12-0251	
73	1.8				or MPM10-0106	
76	1.1				or MPM09-0161	
72	0.8	3406T-E			MPM10-0106	
74	0.6				or MPM10-0127	
76	0.6				or MPM09-0161	
72	1.8	3408T			MPM10-0106	
74	1.1				or MPM10-0127	
76	1.1				or MPM09-0161	
70	1.5	3408TA			MPM10-0108	
73	1.6				or MPM10-0127	
75	1.6				or MPM09-0161	
68	0.6	1673T	Trucks, Caterpillar turbocharged engines split systems 5x4x4		dual MPM09-0141	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
71	0.2		Trucks, Caterpillar turbocharged engines cab side mount split systems 5x5x5	39	dual MPM09-0161	CR 1200-255
70	0.7	1674TA	5x4x4		dual MPM09-0141	
71	0.4		5x5x5		dual MPM09-0197	
73	0.2				or dual MPM09-0161	
72	1.1	1693T	5x4x4		dual MPM09-0141	
76	0.7				or dual MUM09-0022	
71	0.5		5x5x5		dual MPM10-0106	
75	0.4				or dual MPM09-0161	
76	1.2	1693TA	5x4x4		dual MUM09-0022	
72	1.0		5x5x5		dual MPM10-0106	
75	0.9				or dual MPM09-0197	
69	0.6	3306T	5x4x4		dual MPM09-0141	
71	0.2		5x5x5		dual MPM09-0161	
72	1.3	3406T	5x4x4		dual MPM09-0141	
76	0.9				or dual MUM09-0022	
70	1.2		5x5x5		dual MFM10-0165	
73	0.7				or dual MPM09-0197	
71	1.4	3406TA	5x4x4		dual MPM09-0141	
75	0.9				or dual MUM09-0022	
69	1.3		5x5x5		dual MFM10-0165	
72	0.8				or dual MPM09-0197	
71	0.7	3406T-E	5x4x4		dual MPM09-0141	
69	0.7		5x5x5		dual MFM10-0165	
72	0.4				or dual MPM09-0197	
71	1.4	3408T	5x4x4		dual MPM09-0141	
75	0.9				or dual MUM09-0022	
69	1.2		5x5x5		dual MFM10-0165	
72	0.8				or dual MPM09-0197	
70	1.9	3408TA	5x4x4		dual MPM09-0141	
74	1.3				or dual MUM09-0022	
70	1.1		5x5x5		dual MPM10-0106	
71	1.2				or dual MPM09-0197	
72	0.8	1673T	Trucks, Caterpillar turbocharged engines chassis mount vertical tailpipe single 5" systems		MOM12-0131	
75	0.9	1674TA			MOM12-0131	
77	1.4	1693T			MOM12-0131	
73	0.8	3306T			MOM12-0131	
78	1.7	3406T			MOM12-0131	
77	1.8	3406TA			MOM12-0131	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
70	1.7	3406T-E	Trucks, Caterpillar turbocharged engines chassis mount vertical tailpipe single 5" systems	39	MOM12-0189	CR 1200-255
77	0.9				or MOM12-0131	
77	1.9	3408T			MOM12-0131	
69	1.1	1673T	Trucks, Caterpillar turbocharged engines chassis mount horizontal tailpipe single 5" systems		MOM12-0186	
73	1.1				or MOM12-0108	
71	1.2	1674TA			MOM12-0186	
76	1.3				or MOM12-0108	
77	1.3	1693T			MOM12-0225	
70	1.1	3306T			MOM12-0186	
74	1.1				or MOM12-0108	
78	1.4	3406T			MOM12-0225	
77	1.5	3406TA			MOM12-0225	
73	1.3	3406T-E			MOM12-0186	
77	1.3				or MOM12-0108	
77	1.5	3408T			MOM12-0225	
76	1.9	3408TA			MOM12-0225	
78	2.5	6-71T	Truck, Detroit Diesel turbocharged engine cab side mount single 4" systems	39	MUM09-0022	CR 1200-208
79	2.5	6V-71T			MUM09-0022	
74	1.8	6-71T	Truck, Detroit Diesel turbocharged engine cab side mount single 5" systems		MKM10-0149	
77	1.0				MPM09-0161	
75	1.8	6V-71T			MKM10-0149	
78	1.0				MPM09-0161	
72	1.5	8V-71T			MPM10-0108	
75	2.4				MKM10-0149	
78	1.6				MPM09-0161	
72	1.6	8V-71TA			MPM10-0108	
75	2.5				MKM10-0149	
78	1.7				MPM09-0161	
71	1.3	8V-71TT			MPM10-0108	
74	2.3				MKM10-0149	
77	1.4				MPM09-0161	
72	1.6	6V-92T			MPM10-0108	
77	1.7				MPM10-0127	
78	1.7				MPM09-0161	
72	1.7	6V-92TA			MPM10-0108	
78	1.8				MPM10-0127	
79	1.8				MPM09-0161	
71	1.1	6V-92TT			MPM10-0108	
76	1.2				MPM10-0127	
77	1.2				MPM09-0161	
73	2.0	8V-92T			MPM10-0108	
76	2.2				MPM10-0127	
78	2.2				MPM09-0161	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
73	2.1	8V-92TA	Truck, Detroit Diesel turbocharged engine cab side mount single 5" systems	39	MPM10-0108	CR 1200-208
76	2.3				MPM10-0127	
78	2.3				MPM09-0161	
72	1.7	8V-92TT			MPM10-0108	
75	1.8				MPM10-0127	
77	1.8				MPM09-0161	
80	2.5	12V-71T	Truck, Detroit Diesel turbocharged engine cab side mount dual 4" systems		dual MUM09-0022	
72	1.0	12V-71T	Truck, Detroit Diesel turbocharged engine cab side mount dual 5" systems		dual MPM10-0108	
76	1.8				or dual MKM10-0149	
79	1.0				or dual MPM09-0161	
69	2.1	6-71T	Truck, Detroit Diesel turbocharged engine cab side mount split systems 5x4x4		dual MSM09-0142	
73	1.4				or dual MPM09-0141	
69	1.2		5x5x5		dual MFM10-0165	
73	0.8				or dual MPM09-0197	
70	2.1	6V-71T	5x4x4		dual MSM09-0142	
74	1.3				or dual MPM09-0141	
70	1.2		5x5x5		dual MFM10-0165	
74	0.8				or dual MPM09-0197	
70	1.8	8V-71T	5x4x4		dual MKM10-0147	
74	2.1				or dual MPM09-0141	
70	1.8		5x5x5		dual MPM10-0165	
75	1.3				or dual MPM09-0197	
70	1.9	8V-71TA	5x4x4		dual MKM10-0147	
74	2.2				or dual MPM09-0141	
70	2.0		5x5x5		dual MFM10-0165	
75	1.4				or dual MPM09-0197	
69	1.6	8V-71TT	5x4x4		dual MKM10-0147	
73	1.8				or dual MPM09-0141	
69	1.6		5x5x5		dual MFM10-0165	
74	1.1				or dual MPM09-0197	
71	1.8	6V-92T	5x4x4		dual MKM10-0147	
74	2.1				or dual MPM09-0141	
71	1.9		5x5x5		dual MPM10-0165	
75	1.3				or dual MPM09-0197	
71	2.0	6V-92TA	5x4x4		dual MKM10-0147	
74	2.3				or dual MPM09-0141	
71	2.1		5x5x5		dual MFM10-0165	
75	1.4				or dual MPM09-0197	
70	1.3	6V-92TT	5x4x4		dual MKM10-0147	
73	1.5				or dual MPM09-0141	
70	1.3		5x5x5		dual MFM10-0165	
74	0.9				or dual MPM09-0197	
71	2.3	8V-92T	5x4x4		dual MKM10-0147	
78	2.0				or dual MUM09-0022	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria						
		Engine Model	Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)					
71 75	2.3 1.7	8V-92T	Truck, Detroit Diesel turbocharged engine cab side mount split systems 5x5x5	39	dual MFM10-0165 or dual MPM09-0197	CR 1200-208
71 78	2.4 2.0	8V-92TA	5x4x4		dual MKM10-0147 or dual MUM09-0022	
71 75	2.4 1.8		5x5x5		dual MFM10-0165 or dual MPM09-0197	
70 74	2.0 2.3	8V-92TT	5x4x4		dual MKM10-0147 or dual MPM09-0141	
70 74	2.0 1.4		5x5x5		dual MFM10-0165 or dual MPM09-0197	
77	1.7	6-71T	Truck, Detroit Diesel turbocharged engine chassis mount vertical tailpipe single 5" system		MOM12-0131	
78	1.7	6V-71T			MOM12-0131	
79	2.4	8V-71T			MOM12-0131	
79	2.5	8V-71TA			MOM12-0131	
78	2.2	8V-71TT			MOM12-0131	
81	2.5	6V-92T			MOM12-0131	
79	2.1	6V-92TT			MOM12-0131	
79	1.7	12V-71T	Truck, Detroit Diesel turbocharged engine chassis mount vertical tailpipe dual 5" systems		dual MOM12-0131	
74 79	2.4 2.4	6-71T	Truck, Detroit Diesel turbocharged engine chassis mount horizontal tailpipe single 5" systems		MOM12-0186 or MOM12-0108	
75 80	2.4 2.4	6V-71T			MOM12-0186 or MOM12-0108	
77 82	2.4 2.4	12V-71T	Truck, Detroit Diesel turbocharged engine chassis mount horizontal tailpipe dual 5" systems		dual MOM12-0186 or dual MOM12-0108	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)				
78	3.1	Truck, Detroit Diesel 8V-71N cab side mount duals 3-1/2" systems	39	MSM09-0146	CR 1200-166
74	3.4			or WSM09-0211	
81	2.7	Truck, Detroit Diesel 8V-71N cab side mount dual 4" systems		MSM09-0135	
76	2.9			or WSM09-0212	
75	1.3			or WTM10-0066	
72	3.7			or WZM10-0067	
72	3.6			or WTM10-0104	
		Truck, Detroit Diesel 8V-71N cab side mount single w/conventional wye			
84	3.5	4" systems w/conventional wye		MPM09-0141	
81	2.9			or WKM10-0064	
82	3.9	5" systems w/conventional wye		MTM10-0038	
80	3.9			or WTM10-0065	
79	3.6			or MFM10-0165	
		Truck, Detroit Diesel 8V-71N cab side mount singles w/wye connector			
77	3.2	4" systems w/wye connector 3-1/2x 3-1/2x4		MAM07-0093 Wye Conn. + MKM10-0064	
80	3.8			or MAM07-0093 Wye Conn. + MPM09-0141	
79	4.0	4x4x4 5" systems w/wye connector 3-1/2x3-1/2x5		MAM07-0094 Wye Conn. + MTM10-0038	
77	4.0			or MAM07-0094 Wye Conn. + MTM10-0065	
76	3.8			or MAM07-0094 Wye Conn. + MFM10-0165	
77	4.0			or MAM09-0104 Wye Conn. + MTM10-0038	
75	4.0			or MAM09-0104 Wye Conn. + MTM10-0065	
74	3.8			or MAM09-0104 Wye Conn. + MFM10-0165	
77	---	4x4x5		MAM07-0090 Wye Conn. + MTM10-0065	
74	---			or WAM09-0217 Wye Conn. + MTM10-0065	
75				or MAM09-0235 Wye Conn. + MTM10-0065	
76	---			or MAM07-0090 Wye Conn. + MFM10-0165	
73	---			or WAM09-0217 Wye Conn. + MFM10-0165	
74	---			or MAM09-0235 Wye Conn. + MFM10-0165	
83	1.8	Truck, Detroit Diesel 8V-71N chassis mount duals, vertical tailpipe 4" systems		MOM12-0154	
81	1.8			or WOM12-0183	
74	3.9			or WOM12-0006	
83	2.2	Truck, Detroit Diesel 8V-71N chassis mount duals, horizontal tailpipe 3-1/2" systems		MOM09-0158	
81	2.2			or WOM09-0210	
84	1.8	Truck, Detroit Diesel 8V-71N chassis mount duals, horizontal tailpipe 4" systems		MOM09-0168	
82	1.8			or WOM09-0213	
73	3.9			or WOM12-0230	
85	3.3	Truck, Detroit Diesel 8V-71N chassis mount singles, vertical tailpipe w/conventional wye 5" systems		MOM12-0176	
80	3.3			or MOM12-0189	
82	3.5	w/wye connector 5" systems w/wye connector 3-1/2x3-1/2x5		MAM07-0094 Wye Conn. + MOM12-0176	
77	3.4			or MAM07-0094 Wye Conn. + MOM12-0189	
80	3.5			or MAM09-0104 Wye Conn. + MOM12-0176	
75	3.4			or MAM09-0104 Wye Conn. + MOM12-0189	
82	---	4x4x5 3-1/2x3-1/2x5		MAM07-0090 Wye Conn. + MOM12-0176	
79	---			or WAM09-0217 Wye Conn. + MOM12-0176	
80	---			or MAM09-0235 Wye Conn. + MOM12-0176	
77	---			or MAM07-0090 Wye Conn. + MOM12-0189	
74	---			or WAM09-0217 Wye Conn. + MOM12-0189	
75	---			or MAM09-0235 Wye Conn. + MOM12-0189	

Table 33. Vehicular mufflers continued.

Sound Measurement Criteria		Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)				
83	2.5	Truck, Detroit Diesel 8V-71N chassis mount singles, horizontal tailpipe w/conventional wye 5" systems	39	MOM12-0186	CR 1200-166
85	2.6	5" systems w/wye connector 3-1/2x3-1/2x5		MAM07-0094 Wye Conn. + MOM12-0108	
81	2.5			or MAM07-0094 Wye Conn. + MOM12-0186	
84	2.6			or MAM09-0104 Wye Conn. + MOM12-0108	
79	2.6			or MAM09-0104 Wye Conn. + MOM12-0186	
85	---	4x4x5		MAM07-0090 Wye Conn. + MOM12-0108	
82	---			or WAM09-0217 Wye Conn. + MOM12-0108	
83	---			or MAM09-0235 Wye Conn. + MOM12-0108	
81	---			or MAM07-0090 Wye Conn. + MOM12-0186	
78	---			or WAM09-0217 Wye Conn. + MOM12-0186	
79	---			or MAM09-0235 Wye Conn. + MOM12-0186	
74	2.0	Truck, Cummins V8-185, V8-210, V-555 cab side mount dual 3" systems		MTM08-5078	CR 1200-218
83	1.5	Truck, Cummins V8-185, V8-210, V-555 cab side mount single w/conventional wye 4" systems		MPM09-0063	
80	1.5			or MPM09-0141	
78	2.4			or MSM09-0142	
66	2.1			or WTM10-0066	
68	2.5			or WZM10-0145	
81	1.5	Truck, Cummins V8-185, V8-210 V-555 cab side mount single w/wye connector 4" systems		MAM07-0045 Wye Conn. + MUM09-0022	
78	2.0			or MAM07-0045 Wye Conn. + MPM09-0063	
74	2.0			or MAM07-0045 Wye Conn. + MPM09-0141	
74	2.8			or MAM07-0045 Wye Conn. + MSM09-0142	
65	2.5			or MAM07-0045 Wye Conn. + WTM10-0066	
67	2.9			or MAM07-0045 Wye Conn. + WZM10-0145	
78	2.2	Truck, Cummins V8-185, V8-210 V-555 chassis mount dual, vertical tailpipe 3" systems		MBM08-5083	
80	1.9	Truck, Cummins V8-185, V8-210 V-555 chassis mount dual horizontal tailpipe 3" systems		MZM08-5023	
76	2.0			or MTM08-5078	
71	1.9			or WOM09-0159	
73	2.4			or MOM09-0170	
83	2.0	Truck, Cummins V8-185, V8-210 V-555 chassis mount single, vertical tailpipe w/conventional wye 4" systems		MBM10-0002	
80	2.3			or MBM10-0049	
76	2.5			or MOM12-0154	
74	2.5			or WOM12-0183	
83	1.4			or MOM12-1000	
78	2.5	Truck, Cummins V8-185, V8-210 V-555 chassis mount single, vertical tailpipe w/wye connector 4" systems		MAM07-0045 Wye Conn. + MBM10-0002	
77	2.7			or MAM07-0045 Wye Conn. + MBM10-0049	
73	2.8			or MAM07-0045 Wye Conn. + MOM12-0154	
71	2.7			or MAM07-0045 Wye Conn. + WOM12-0183	
78	1.6			or MAM07-0045 Wye Conn. + MOM12-1000	
82	1.8	Truck, Cummins V8-185, V8-210 V-555 chassis mount single, horizontal tailpipe w/conventional wye 4" systems		MOM09-0124	
74	2.9			or MOM09-0168	
72	2.9			or WOM09-0213	
82	1.6			or MTM10-0006	
77	1.6			or MTM10-0043	
79	2.1			or MTM10-0048	
80	1.4			or MOM12-0100	
76	2.2	Truck, Cummins V8-185, V8-210 V-555 chassis mount single, horizontal tailpipe w/wye connector 4" systems		MAM07-0045 Wye Conn. + MOM09-0124	
77	2.6			or MAM07-0045 Wye Conn. + MTM10-0006	
74	2.1			or MAM07-0045 Wye Conn. + MTM10-0043	
75	2.3			or MAM07-0045 Wye Conn. + MTM10-0048	
76	2.1			or MAM07-0045 Wye Conn. + MOM12-0100	

Table 33. Vehicular mufflers concluded.

Sound Measurement Criteria		Application	Company	Product Model Number	Reference
Exhaust Noise (dBA at 50 ft)	Back Pressure Full Load (in. Hg)				
75	1.3	Truck, Caterpillar 1140, 1145, 1150, 1160, and 3208NA cab side mount dual 3" systems	39	MTM08-5C78	CR 1200-237
75 71	1.0 1.1	Truck, Caterpillar 1140, 1145, 1150, 1160, and 3208NA cab side mount 3-1/2" systems		MSM09-0146 or WSM09-0211[w]	
81 79 76 75	1.5 1.4 2.3 1.2	Truck, Caterpillar 1140, 1145, 1150 1160, and 3208NA cab side mount single w/conventional wye 4" systems		MPM09-0063 or MPM09-0141 or MSM09-0142 or WKM10-0054[w]	
79 77 75 71 72	1.2 1.6 1.6 2.4 1.4	Truck, Caterpillar 1140, 1145, 1150 1160, and 3208NA cab side mount single w/wye connector 4" systems 3x3x4 3-1/2x3-1/2x4		MAM07-0045 Wye Conn. + MUM09-0022 or MAM07-0045 Wye Conn. + MPM09-0063 or MAM07-0045 Wye Conn. + MPM09-0141 or MAM07-0045 Wye Conn. + MSM09-0142 or MAM07-0045 Wye Conn. + WTM10-0066[w]	
76	1.7	Truck, Caterpillar 1140, 1145, 1150 1160, and 3208NA chassis mount dual, vertical tailpipe 3" systems		MBM08-5083	
79 76 72 74	1.0 1.2 1.2 1.2	Truck, Caterpillar 1140, 1145, 1150 1160, and 3208NA chassis mount dual, horizontal tailpipe 3" systems		MZM08-5023 or MTM08-5078 or WOM09-0159[w] or MOM09-0170	
81 79 73	2.0 2.4 2.3	Truck, Caterpillar 1140, 1145, 1150 1160, and 3208NA chassis mount single, vertical tailpipe w/conventional wye 4" systems		MBM10-0002 or MBM10-0049 or MOM12-0154	
77 75 69 78	2.1 2.5 2.5 1.6	Truck, Caterpillar 1140, 1145, 1150, 1160, and 3208NA chassis mount single, vertical tailpipe w/wye connector 4" systems 3x3x4		MAM07-0045 Wye Conn. + MBM10-0002 or MAM07-0045 Wye Conn. + MBM10-0049 or MAM07-0045 Wye Conn. + MOM12-0154 or MAM07-0045 Wye Conn. + MOM12-1000	
		3-1/2x3-1/2x4		MAM07-0093 Wye Conn. + MUM09-0022 or MAM07-0093 Wye Conn. + MPM09-0063 or MAM07-0093 Wye Conn. + MPM09-0141 or MAM07-0093 Wye Conn. + MSM09-0142 or MAM07-0093 Wye Conn. + WTM10-0066[w]	
82 75 77 80 82	1.8 2.5 1.7 1.8 1.4	Truck, Caterpillar 1140, 1145, 1150, 1160, and 3208NA chassis mount single, horizontal tailpipe w/conventional wye 4" systems		MOM09-0124 or MOM09-0168 or MTM10-0043 or MTM10-0048 or MOM12-0100	
78 78 73 76 78	1.9 1.8 1.8 1.9 1.5	Truck, Caterpillar 1140, 1145, 1150, 1160, and 3208NA chassis mount single, horizontal tailpipe w/wye connector 4" systems 3x3x4 3-1/2x3-1/2x4		MAM07-0045 Wye Conn. + MOM09-0124 or MAM07-0045 Wye Conn. + MTM10-0006 or MAM07-0045 Wye Conn. + MTM10-0043 or MAM07-0045 Wye Conn. + MTM10-0048 or MAM07-0045 Wye Conn. + MOM12-0100	

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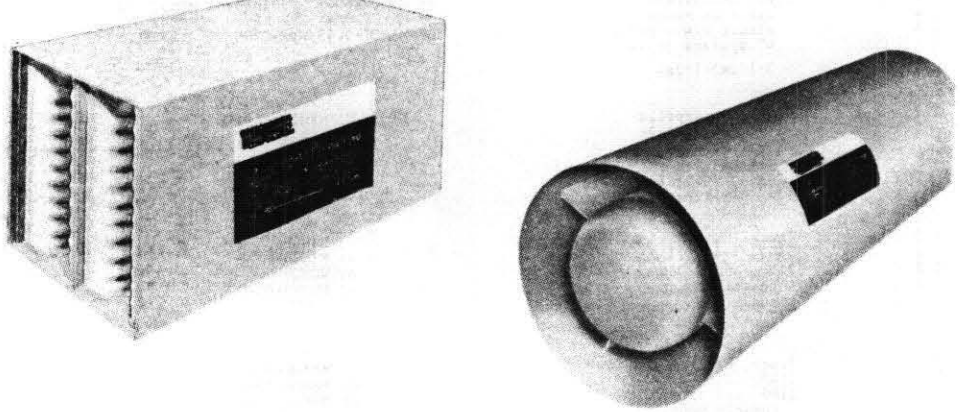
[w] Muffler has double-wrapped body to reduce "shell" noise.

CATEGORY 34. DUCT SILENCERS



CATEGORY 34. DUCT SILENCERS

Duct silencers are inserted into round or rectangular ducts to reduce external noise levels. These silencers include structural elements which conform to the duct size. Internal splitters, bullets, louvers, and turning vanes are often included in these designs. They are mainly used for lower gas velocities. Organizations contributing data to this table are: 5, 50, and 78.

CAUTION

1. SILENCER PERFORMANCE FIGURES OFTEN DO NOT CONFORM TO STANDARD REFERENCE MEASUREMENTS. FOR SPECIFIC APPLICATIONS, SEE MANUFACTURER'S PRODUCT LITERATURE.
2. IN MANY CASES, ONLY REPRESENTATIVE INFORMATION IS PRESENTED FOR A GIVEN PRODUCT LINE. SEE MANUFACTURER'S LITERATURE FOR COMPLETE LISTINGS OF SIZES AND PERFORMANCE DATA.

Table 34. Duct silencers.

Attenuation, dB												
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Size (in.)	Face Velocity (fpm)	Company	Product	Reference
Duct silencers available in several models and sizes.												
	9	14	18	18	14	11	8	--	0	5	Model Q3 Aeroacoustic Duct Silencer	CR B-42
Duct silencers available in several models and sizes.												
	8	13	17	18	14	11	8	--	2000	5	Model Q3 Aeroacoustic Duct Silencer	CR B-42
Duct silencers available in several models and sizes.												
	7	12	17	18	14	11	8	--	4000	5	Model Q3 Aeroacoustic Duct Silencer	CR B-42
Duct silencers, 12 x 6 inch to 24 x 48 inch.												
	9	18	31	46	52	31	20	--	0	5	Model T7 Aeroacoustic Duct Silencer	CR B-43
Duct silencers, 12 x 6 inch to 24 x 48 inch.												
	7	16	29	44	51	31	20	--	2000	5	Model T7 Aeroacoustic Duct Silencer	CR B-43
Duct silencers, 12 x 6 inch to 24 x 48 inch.												
	6	15	28	42	50	30	19	--	4000	5	Model T7 Aeroacoustic Duct Silencer	CR B-43
Duct silencers												
	11	20	31	36	32	23	17	24	0	5	Model HC, Circular Duct Silencer	CR B-44
Duct silencers												
	10	20	30	36	31	23	17	24	2000	5	Model HC Circular Duct Silencer	CR B-44
Duct silencers												
	9	19	29	31	31	23	17	24	4000	5	Model HC, Circular Duct Silencer	CR B-44
Duct silencers												
	11	20	26	25	19	14	10	36	0	5	Model HC Circular Duct Silencer	CR B-44
Duct silencers												
	10	20	25	25	19	14	10	36	2000	5	Model HC, Circular Duct Silencer	CR B-44
Duct silencers												
	9	19	25	25	19	14	10	36	4000	5	Model HC, Circular Duct Silencer	CR B-44
Duct silencers												
	13	20	23	20	15	10	8	48	0	5	Model HC, Circular Duct Silencer	CR B-44
Duct silencers												
	13	20	23	20	15	10	8	48	2000	5	Model HC, Circular Duct Silencer	CR B-44
Duct silencers												
	12	19	23	20	15	10	8	48	4000	5	Model HC, Circular Duct Silencer	CR B-44
Duct silencers												
	13	20	21	17	12	9	7	60	0	5	Model HC, Circular Duct Silencer	CR B-44
Duct silencers												
	13	19	21	17	12	9	7	60	2000	5	Model HC, Circular Duct Silencer	CR B-44
Duct silencers												
	13	19	21	17	12	9	7	60	4000	5	Model HC, Circular Duct Silencer	CR B-44
Intermediate volume flow silencer, splitter panels, perforated galvanized steel face sheet, 16 gauge. Acoustical material encased in glass cloth. Available in several sizes.												
5	7	16	29	38	34	26	19	--	--	50	Enelco Circular Silencers CS	CR 3878
Circular duct silencers												
5	8	19	26	25	13	12	11	--	6000	50	Enelco Aircoustat Model CA	CR 2365 DVIOM 9/77

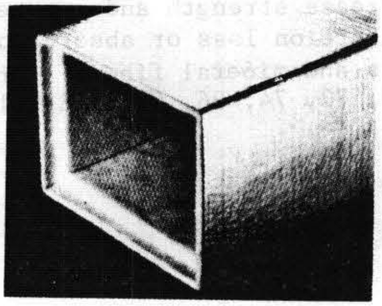
Table 34. Duct silencers continued.

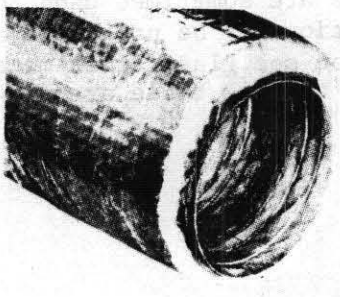
Attenuation, dB								Size (in.)	Face Velocity (fpm)	Company	Product	Reference
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz					
Circular duct silencers												
4	7	18	25	24	14	12	12	--	4000	50	Enelco Aircoustat Model CA	CR 2365 DVIOM 9/77
Circular duct silencers												
4	7	18	24	23	15	13	13	--	2000	50	Enelco Aircoustat Model CA	CR 2365 DVIOM 9/77
Circular duct silencers												
4	7	18	24	22	16	16	17	--	Static	50	Enelco Aircoustat Model CA	CR 2365 DVIOM 9/77
Circular duct silencers												
4	7	18	24	22	16	15	17	--	2000	50	Enelco Aircoustat Model CA	CR 2365 DVIOM 9/77
Circular duct silencers												
4	7	17	24	22	15	14	15	--	4000	50	Enelco Aircoustat Model CA	CR 2365 DVIOM 9/77
Circular duct silencers												
3	6	17	23	21	16	14	15	--	6000	50	Enelco Aircoustat Model CA	CR 2365 DVIOM 9/77
Duct silencer												
8	13	18	24	28	23	16	10	--	4000	50	Enelco Aircoustat Model 3SLR	CR 7554 6/77
Duct silencer												
7	12	17	21	26	24	17	11	--	2000	50	Enelco Aircoustat Model 3SLR	CR 7554 6/77
Duct silencer												
6	10	16	19	24	25	18	12	--	Static	50	Enelco Aircoustat Model 3SLR	CR 7554 6/77
Duct silencer												
6	9	15	18	22	25	20	13	--	2000	50	Enelco Aircoustat Model 3SLR	CR 7554 6/77
Duct silencer												
5	9	14	16	21	25	21	13	--	4000	50	Enelco Aircoustat Model 3SLR	CR 7554 6/77
Duct silencer												
8	13	16	20	26	19	13	8	--	4000	50	Enelco Aircoustat Model 3XLR	CR 7557 6/77
Duct silencer												
7	11	14	18	25	20	13	8	--	2000	50	Enelco Aircoustat Model 3XLR	CR 7557 6/77
Duct silencer												
6	9	10	15	24	22	13	10	--	Static	50	Enelco Aircoustat Model 3XLR	CR 7557 6/77
Duct silencer												
4	7	9	14	23	24	15	12	--	2000	50	Enelco Aircoustat Model 3XLR	CR 7557 6/77
Duct silencer												
3	6	7	12	21	25	17	14	--	4000	50	Enelco Aircoustat Model 3XLR	CR 7557 6/77
Tubular units, high pressures.												
4	10	22	33	37	34	21	14	--	Static	78	Hush A Tube Model RJ	CR K33E
Tubular units, high pressures.												
4	9	21	33	37	34	21	14	--	1000	78	Hush A Tube Model RJ	CR K33E
Tubular units, high pressures.												
4	9	20	31	36	33	21	14	--	2000	78	Hush A Tube Model RJ	CR K33E
Tubular units, high pressures.												
4	8	20	30	35	33	21	14	--	2500	78	Hush A Tube Model RJ	CR K33E
Tubular units, high pressures.												
4	5	16	20	19	13	9	7	--	Static	78	Hush A Tube Model RB	CR K33E

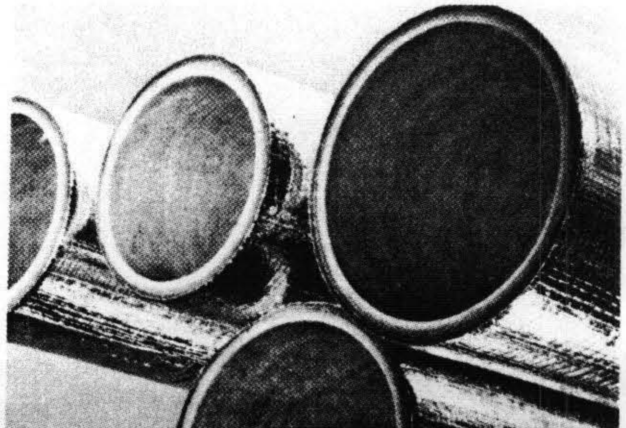
Table 34. Duct silencers concluded.

Attenuation, dB												
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Size (in.)	Face Velocity (fpm)	Company	Product	Reference
Tubular units, high pressures.												
3	5	16	20	18	13	8	7	--	1000	78	Hush A Tube Model RB	CR K33E
Tubular units, high pressures.												
3	5	16	20	18	13	8	7	--	2000	78	Hush A Tube Model RB	CR K33E
Tubular units, high pressures.												
3	5	16	20	18	13	8	7	--	2500	78	Hush A Tube Model RB	CR K33E
Rectangular duct silencers, low and medium pressures.												
9	18	36	46	50	50	53	29	--	Static	78	Hush A Duct Model 84SP	CR K33E
Rectangular duct silencers, low and medium pressures.												
7	15	32	43	49	49	51	29	--	1000	78	Hush A Duct Model 84SP	CR K33E
Rectangular duct silencers, low and medium pressures.												
5	14	30	39	46	43	33	24	--	2000	78	Hush A Duct Model 84SP	CR K33E
Rectangular duct silencers, low and medium pressures.												
5	11	27	34	42	40	23	17	--	2500	78	Hush A Duct Model 84SP	CR K33E
Rectangular duct silencers, low and medium pressures.												
7	11	23	38	44	42	34	22	--	Static	78	Hush A Duct Model 60SP	CR K33E
Rectangular duct silencers, low and medium pressures.												
7	11	22	36	43	42	35	22	--	1000	78	Hush A Duct Model 60SP	CR K33E
Rectangular duct silencers, low and medium pressures.												
6	9	20	32	40	39	30	20	--	2000	78	Hush A Duct Model 60SP	CR K33E
Rectangular duct silencers, low and medium pressures.												
5	6	18	27	36	36	26	16	--	2500	78	Hush A Duct Model 60SP	CR K33E
Rectangular duct silencers, low and medium pressures												
4	7	17	23	28	32	25	14	--	Static	78	Hush A Duct Model 36SP	CR K33E
Rectangular duct silencers, low and medium pressures.												
3	7	16	22	28	31	25	14	--	1000	78	Hush A Duct Model 36SP	CR K33E
Rectangular duct silencers, low and medium pressures.												
2	7	16	20	26	30	24	14	--	2000	78	Hush A Duct Model 36SP	CR K33E
Rectangular duct silencers, low and medium pressures												
1	7	16	20	26	30	24	14	--	2500	78	Hush A Duct Model 36SP	CR K33E

CATEGORY 35. DUCTING MATERIALS







CATEGORY 35. DUCTING MATERIALS

The materials listed in this category are generally used to form air conditioning and heating ducts. Common elements are formed fiberglass boards (in round or rectangular shapes) covered with an aluminized fabric or plastic skin. Circular wire rods are sometimes used to increase strength and yet retain flexibility. Information may be presented as insertion loss or absorption. For related information see glass fiber materials and mineral fibers. Organizations contributing data to this table are: 24, 29, 73, 74, 96, 98, and 131.

Table 35A. Absorption properties of ducting.

NRC	Absorption Coefficients						Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz						
.55	Bonded fiberglass faced with black coated mat											
	.18	.41	.39	.58	.72	.85	1/2	2	6	74	Linacoustic	CR IND-3319 4-77
.55	Bonded fiberglass with foil-scrim-kraft facing											
	.18	.35	.40	.62	.78	.87	5/8	--	6	74	Micro-Aire Type LP	CR IND-3319 4-77
.60	Fiberglass thermal and acoustical duct liner #200											
	.16	.53	.41	.60	.84	.87	1/2	2	6	29	Ultralite Duct Liner	CR 30-32-08U
.65	Fiberglass thermal and acoustical duct liner #300											
	.15	.51	.44	.77	.92	.87	1/2	3	6	29	Ultralite Duct Liner	CR 30-32-08U
70	Bonded fiberglass faced with black coated mat											
	.28	.51	.63	.80	.89	.91	1	1.5	6	74	Linacoustic	CR IND-3319 4-77
.70	Bonded fiberglass with foil-scrim-kraft facing											
	.24	.48	.60	.82	.94	.99	1	--	6	74	Micro-Aire M/F Type 475	CR IND-3319 4-77
.70	Bonded fiberglass with neoprene facing											
	.35	.45	.64	.89	.87	.84	1	1.5	6	74	Microlite	CR IND-3319 4-77
.70	Bonded fiberglass board with foil-scrim-kraft facing											
	.24	.48	.60	.82	.94	.99	1	--	6	74	Micro-Aire M/F Type 800	CR IND-3319 4-77
.75	Fiberglass thermal and acoustical duct liner											
	.32	.51	.60	.83	.98	.86	1	1.5	6	29	Ultralite Duct Liner	CR 30-32-08U
.75	Fiberglass thermal and acoustical duct liner #200											
	.41	.58	.65	.89	.90	.86	1	2	6	29	Ultralite Duct Liner	CR 30-32-08U
75	Inorganic glass fibers preformed into boards, one side coated NFPA-90A coating.											
	24	.49	.65	.93	99	99	1	3	6	29	Coated Duct Liner Board	CR 30-32-57U
.75	Inorganic glass fibers, preformed into boards with a thermosetting resin, one side coated, NFPA-90A coating											
	.24	.52	.66	.88	.97	.95	1	4.2	6	29	Coated Duct Liner Board	CR 30-32-57U
.75	Bonded fiberglass with black coated mat											
	.22	.45	.66	.93	.99	.99	1	--	6	74	Linacoustic R	CR IND-3319 4-77
.80	Fiberglass thermal and acoustical duct liner #300											
	.38	.53	.71	.97	.95	.90	1	3	6	29	Ultralite Duct Liner	CR 30-32-08U
.80	Inorganic glass fibers, preformed into boards using resins, one side coated with NFPA-90A coating											
	.26	.47	.66	.96	.99	.96	1	6	6	29	Coated Duct Liner Board	CR 30-32-570
.85	Bonded fiberglass with black coated mat											
	.33	.63	.79	.92	.98	.94	1-1/2	1.5	6	74	Linacoustic	CR IND-3319 4-77
.90	Bonded fiberglass board with foil-scrim-kraft facing											
	.39	.66	.87	.99	.99	.99	1-1/2	--	6	74	Micro-Aire M/F Type 800	CR IND-3319 4-77
.90	Slotted 1.5 inch o.c., 1.5 inch deep, 0.25 inch wide made of low density glass. Density shown is lb/ft^2											
	.41	.67	.98	1.04	.97	.76	3.5	2.9	4	98	Geocoustic Muffler Lining	RAL A 75-19

Table 35A. Absorption properties of ducting concluded.

	Absorption Coefficients											
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	Density (lb/ft^3)	Mounting	Company	Product	Reference
.95	Bonded fiberglass with black coated mat											
	.44	.77	.96	.99	.99	.99	2	1.5	6	74	Linacoustic	CR IND-3319 4-77
.95	Inorganic glass fibers resin formulated into preformed boards one side coated, NFPA-90A coating											
	.50	.78	.99	.99	.99	.99	2	3	6	29	Coated Duct Liner Board	CR 30-32-57U
.95	Inorganic glass fibers, preformed into boards using resins. One side coated with NFPA-90A coating											
	.42	.74	.99	.99	.99	.99	2	4.2	6	29	Coated Duct Liner Board	CR 30-32-57U
.95	Inorganic glass fibers, preformed into boards using resins, one side coated with NFPA-90A coating											
	.53	.76	.99	.99	.99	.97	2	6	6	29	Coated Duct Liner Board	CR 30-32-570
.95	Fibered fiberglass bond with a thermosetting binder pressure molded. Temperature up to 450°F.											
	.37	.88	1.05	1.02	.95	.92	--	8	--	73	High Density Tubes	CR

Table 35B. Barrier properties of ducting (insertion loss).

NRC	Insertion Loss, dB						Thickness (in.)	Density (lb/ft^3)	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz					
Flexible, bonded fiberglass blanket. Facing: plain											
				1	2	4	1	.6	74	Microlite, Plain Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: plain											
			1	2	4	5	1	1.6	74	Spin-glas #812 Boards, Plain Facing	CR IND-3319 4-77
Mechanically bonded unfaced fiberglass blanket											
				1	4	8	1/2	--	74	Glas-Mat	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: plain											
			1	3	4	5	1	1	74	Microlite, Plain Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing plain											
			1	3	5	6	1	2	74	Microlite, Plain Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: plain											
			3	6	7	6	2	1.6	74	Spin-glas #812 Boards, Plain Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: plain											
			3	6	8	9	2	1	74	Microlite, Plain Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: plain											
			2	6	10	11	1	6	74	Spin-glas #817 Boards, Plain Facing	CR IND-3319 4-77
Rigid, hydrous calcium silicate insulation - block form											
		7	4	3	6	12	1-1/2	13	74	Thermo-12	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: plain											
			4	8	10	11	2	2	74	Microlite, Plain Facing	CR IND-3319 4-77
Rigid, hydrous calcium silicate insulation - block form											
		8	5	5	7	11	2	13	74	Thermo-12	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: vinyl											
		1	3	6	11	18	1-1/2	.75	74	Microlite, Vinyl Facing	CR IND-3319 4-77
Mechanically bonded unfaced fiberglass blanket											
			4	9	13	16	1	--	74	Glas-Mat	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: vinyl											
		2	5	7	13	17	1-1/2	.6	74	Microlite, Vinyl Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: vinyl											
		2	4	6	13	19	1-1/2	1	74	Microlite, Vinyl Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: plain											
			1	4	5	5	2	.6	74	Microlite, Plain Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: foil-scrim-kraft											
		2	4	7	14	19	1-1/2	.6	74	Microlite, FSK Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: foil-scrim-kraft											
		2	4	7	14	20	1-1/2	.75	74	Microlite, FSK Facing	CR IND-3319 4-77

Table 35B. Barrier properties of ducting (insertion loss) continued.

NRC	Insertion Loss, dB						Thickness (in.)	Density (lb/ft^3)	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz					
Flexible, bonded fiberglass blanket. Facing: vinyl											
		3	5	8	13	18	2	.6	74	Microlite, Vinyl Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: foil-scrim-kraft											
		1	4	7	16	21	1	1.6	74	Spin-glas #812 Boards, FSK Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: foil-scrim-kraft											
		1	4	8	15	22	1	1.5	74	Microlite, FSK Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: plain											
			6	11	15	18	2	3	74	Spin-glas #1000 Boards, Plain Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: foil-scrim-kraft											
		2	6	9	15	20	2	.6	74	Microlite, FSK Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: vinyl											
		2	6	9	15	21	1	2	74	Microlite, Vinyl Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: foil-scrim-kraft											
		2	5	9	16	21	1	2	74	Microlite, FSK Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: foil-scrim-kraft											
		2	5	9	16	22	1-1/2	1	74	Microlite, FSK Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: foil-scrim-kraft											
		2	5	12	16	21	1	3	74	Spin-glas #814 Boards FSK Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: foil-scrim-kraft											
		3	5	12	16	21	1	4.25	74	Spin-glas #815 Boards, FSK Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: vinyl											
		3	6	10	16	22	2	1	74	Microlite, Vinyl Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: plain											
			8	14	17	19	2	6	74	Spin-glas #817 Boards, Plain Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: foil-scrim-kraft											
		2	7	11	18	23	1-1/2	1.5	74	Microlite, FSK Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: foil-scrim-kraft											
		3	7	11	17	23	2	1	74	Microlite, FSK Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: foil-scrim-kraft											
		3	6	12	19	22	1	6	74	Spin-glas #817 Boards, FSK Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: vinyl											
		4	8	11	17	22	3	.75	74	Microlite, Vinyl Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: plain											
			9	15	18	20	3	3	74	Spin-glas #1000 Boards, Plain Facing	CR IND-3319 4-77

Table 35B. Barrier properties of ducting (insertion loss) concluded.

NRC	Insertion Loss, dB						Thickness (in.)	Density (lb/ft^3)	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz					
Flexible, bonded fiberglass blanket. Facing: foil-scrim-kraft											
		3	8	12	18	23	1-1/2	2	74	Microlite, FSK Facing	CR IND-3319 4-77
Flexible, bonded fiberglass blanket. Facing: foil-scrim-kraft											
		5	9	13	18	23	3	.75	74	Microlite, FSK Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: foil-scrim-kraft											
		3	11	16	22	26	2	3	74	Spin-glas #814 Boards, FSK Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: foil-scrim-kraft											
		4	11	17	22	26	2	4.25	74	Spin-glas #815 Boards, FSK Facing	CR IND-3319 4-77
Semi-rigid, bonded fiberglass boards. Facing: foil-scrim-kraft											
		6	11	18	21	25	2	6	74	Spin-glas #817 Boards, FSK Facing	CR IND-3319 4-77

Table 35C. Attenuation properties of ducting.

	Noise Reduction, dB/ft										
NRC	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Thickness (in.)	P/A Ratio	Company	Product	Reference
Cylindrical muffler, lining I.D. 30 inch nominal and actual low density cellular glass											
	.4	.9	1	1	1	1	3.5	--	98	Geocoustic Muffler Lining	CR
Rectangular muffler lining 25 x 25 inch low density cellular glass											
	.4	1	1	2	1	1	3.5	--	98	Geocoustic Muffler Lining	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.5	.5	1.5	2.8	4	2.7	1	3	96	Aeroflex Duct Liner, Type 150	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.7	.6	1.7	2.9	4.1	2.8	1	3	96	Aeroflex Duct Liner, Type 200	CR
Rectangular muffler lining 16 x 16 inch low density cellular glass											
	.7	1	3	3	3	2	3.5	--	98	Geocoustic Muffler Lining	CR
Cylindrical muffler, lining I.D. 16 inch nominal, 16 inch actual. Low density cellular glass											
	.7	1	3	3	3	2	3.5	--	98	Geocoustic Muffler Lining	CR
Fiberglass board with scrim-reinforced foil vapor barrier facing											
	1.1	.9	2.3	3.3	3.8	2.1	1	3	96	Type 475 FR	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.4	.5	1.7	4.4	3.8	2.2	1	3	96	Duct Liner Board	CR
Fiberglass board with scrim-reinforced foil vapor barrier facing											
	1	.8	2.4	3.4	3.9	2.2	1	3	96	Type 800 FR	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.6	.8	2	3.4	3.9	3.6	1	4	96	Aeroflex Duct Liner, Type 150	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.6	.1	2	3.4	4.1	3.7	1	4	96	Aeroflex Duct Liner, Type 200	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.3	1	2.4	3.4	3.8	3.4	1	6	96	Aeroflex Duct Liner, Type 200	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.2	1.1	2.4	3.5	3.9	3.7	1	6	96	Aeroflex Duct Liner, Type 150	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.4	1.3	3.1	3.6	3.9	3.5	2	6	96	Aeroflex Duct Liner, Type 150	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.9	1.1	3.2	4.6	3.5	2.6	2	3	96	Aeroflex Duct Liner, Type 150	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.5	1.2	2.1	3.4	5.1	3.8	1	5	96	Aeroflex Duct Liner, Type 150	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.6	1	3.8	4.7	3.6	2.3	2	3	96	Duct Liner Board	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.2	1.1	2.1	3.5	5.3	3.8	1	5	96	Aeroflex Duct Liner, Type 200	CR

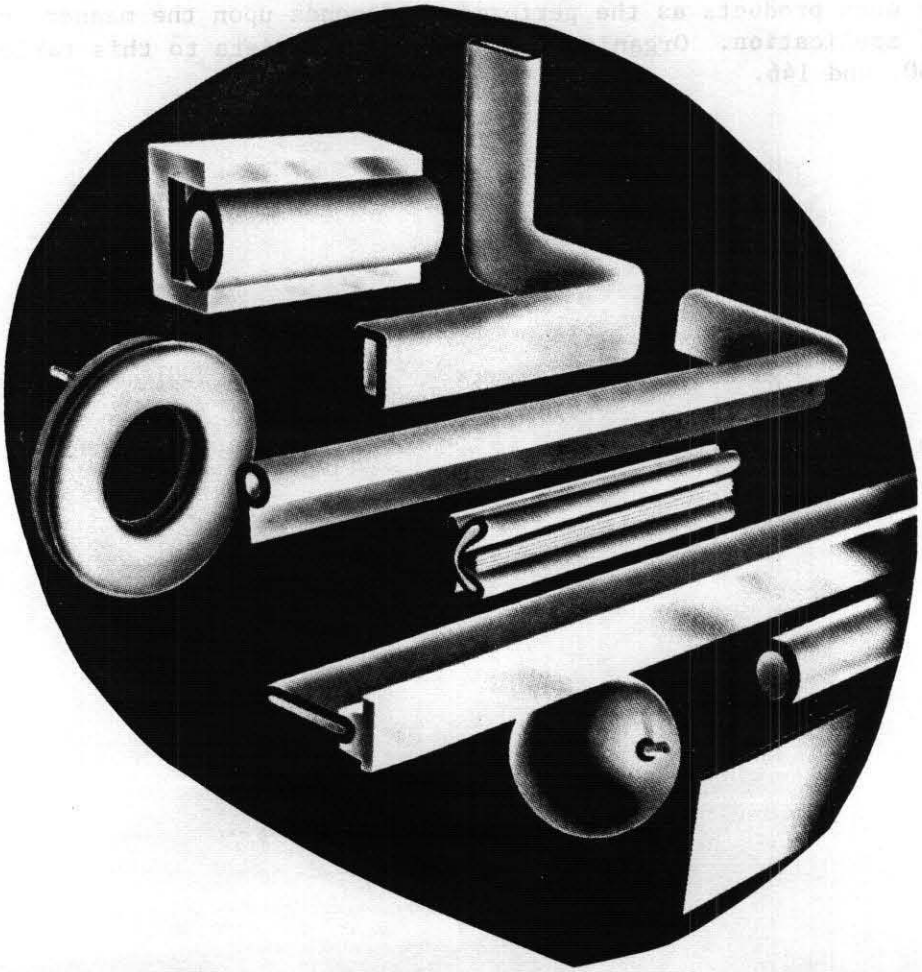
Table 35C. Attenuation properties of ducting continued.

NRC	Noise Reduction, dB/ft						Thickness (in.)	P/A Ratio	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz					
Fiberglass duct with foil/scrim jacket; high pressure											
	.1	.9	1.5	3.2	4.3	6.8	14	--	74	Micro-Aire HV-3 Rigid Round	CR IND-3319 4-77
Fiberglass board with scrim-reinforced foil vapor barrier facing											
	.4	1.4	3.3	3.9	5	3.7	1	6	96	Type 475 FR	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.9	1.5	3	4.1	3.9	3.8	2	4	96	Aeroflex Duct Liner, Type 150	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.3	.9	2.7	4.7	5.2	4.1	1	6	96	Duct Liner Board	CR
Fiberglass blanket insulation faced with a vinyl film. Temperature range 0° to 250°F. 18 inch diameter											
	2	4	5	4	2	1	--	--	29	Glass Flex Air Duct	CR 30-32-58U
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.4	1.7	2.9	3.9	4.8	4.4	1	8	96	Aeroflex Duct Liner, Type 200	CR
Fiberglass board with scrim-reinforced foil vapor barrier facing											
	.3	1.4	3.4	4.1	5.2	4	1	6	95	Type 800 FR	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.4	1.7	3.1	4	4.8	4.4	1	8	96	Aeroflex Duct Liner, Type 150	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.4	1.8	3.7	4.2	4.8	4.4	2	8	96	Aeroflex Duct Liner, Type 150	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.4	2	4.1	4.7	5.1	3.7	2	6	96	Duct Liner Board	CR
Glass fiber with fire-rated coating tested at air velocity of 2000 fpm											
	.5	1.8	3.4	4.7	5.3	4.1	2	5	96	Aeroflex Duct Liner, Type 150	CR
Fiberglass blanket insulation faced with a vinyl film. Temperature range 0° to 250°F. 16 inch diameter											
	2	5	5	5	3	2	--	--	29	Glass Flex Air Duct	CR 30-32-58U
Fiberglass blanket insulation faced with a vinyl film. Temperature range 0° to 250°F. 14 inch diameter											
	2	5	5	5	4	2	--	--	29	Glass Flex Air Duct	CR 30-32-58U
Cylindrical muffler, lining I.D. 8 inch nominal, 8.625 inch actual low density cellular glass											
	1	3	5	6	5	3	3.5	--	98	Geocoustic Muffler Lining	CR
Fiberglass blanket insulation faced with a vinyl film. Temperature range 0° to 250°F. 12 inch diameter											
	2	5	5	6	5	2	--	--	29	Glass Flex Air Duct	CR 30-32-58U
Rectangular muffler lining 8 x 8 inch low density cellular glass											
	1	3	6	6	6	4	3.5	--	98	Geocoustic Muffler Lining	CR
Fiberglass blanket insulation faced with a vinyl film. Temperature range 0° to 250°F. 10 inch diameter											
	2	5	6	6	6	4	--	--	29	Glass Flex Air Duct	CR 30-32-58U

Table 35C. Attenuation properties of ducting concluded.

	NRC	Noise Reduction, dB/ft						Thickness (in.)	P/A Ratio	Company	Product	Reference
		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz					
Fiberglass blanket insulation faced with a vinyl film. Temperature range 0° to 250°F. 8 inch diameter		2	5	7	7	7	5	--	--	29	Glass Flex Air Duct	CR 30-32-58U
Fiberglass duct with foil-scrim jacket; high pressure		.2	1.1	2.5	6	12.2	16	10	--	74	Micro-Aire HV-3 Rigid Round	CR IND-3319 4-77
Flexible round ducting of fiberglass helix wrapped with fiberglass insulation and covered with plastic skin		5.2	6.7	6.3	6	9.2	5.8	8	--	74	Micro-Aire FLX	CR IND-3319 4-77
Fiberglass blanket insulation faced with a vinyl film. Temperature range 0° to 250°F. 6 inch diameter		2	5	8	7	9	9	--	--	29	Glass Flex Air Duct	CR 30-32-58U
Fiberglass duct with foil-scrim jacket		.3	1.3	3.2	7.8	14.4	18.5	8	--	74	Micro-Aire Rigid Round	CR IND-3319 4-77
Cylindrical muffler lining of geocoustic material. Nominal 4 inch, actual 4.5 inch, muffler lining I.D. low density glass		2	6	10	11	10	7	3.5	--	98	Geocoustic Muffler Lining	CR
Flexible round ducting of fiberglass helix wrapped in fiberglass insulation and covered with plastic skin		6.5	7.7	7.7	8.2	10.5	6.3	10	--	74	Micro-Aire FLX	CR IND-3319 4-77
Fiberglass blanket insulation faced with a vinyl film. Temperature range 0° to 250°F. 4 inch diameter		3	7	8	9	11	10	--	--	29	Glass Flex Air Duct	CR 30-32-58U
Flexible round ducting of fiberglass helix wrapped with fiberglass insulation and covered with plastic skin		6.5	8.5	8.5	8	10.5	10.7	6	--	74	Micro-Aire FLX	CR IND-3319 4-77
Rectangular muffler lining 4 x 4 inch, low density cellular glass		3	7	12	13	12	8	3.5	--	98	Geocoustic Muffler Lining	CR
Fiberglass duct with foil-scrim jacket; high pressure		.5	2	5.3	11.4	18.6	29	5	--	74	Micro-Aire HV-3 Rigid Round	CR IND-3319 4-77
Rectangular muffler lining 2 x 2 inch, low density cellular glass		6	14	24	26	24	16	3.5	--	98	Geocoustic Muffler Lining	CR
Cylindrical muffler lining I.D., nominal 2 inch, actual 2.375 inch, low density glass		7	16	28	30	28	19	3.5	--	98	Geocoustic Muffler Lining	CR
Double wall duct, filled with insulation, inside wall perforated up to 150°F.		.82	1.15	1.88	2.21	2.17	2.02	4	--	131	Acousti K-27 Duct	CR
Porous sheet material of sintered metal fibers bonded to perforated sheet. Used as a viscous absorber lining separated from a duct wall by an air gap. Used in limited space silencers; high pressure, temperature, or velocity gas streams; chemically hostile environments								--	--	24	Brunscoustic Plate	CR
Porous sheet material made from sintered metal fibers in a variety of materials and a wide range of acoustic flow resistances. Used as a viscous absorber lining separated from a duct wall by an air space. Used in limited space silencers, high pressure, temperature, or velocity gas streams, chemically hostile environments								--	--	24	Feltmetal	CR

CATEGORY 36. SEALS



CATEGORY 36. SEALS

A very good sound barrier system would be rendered ineffective by a small noise leak. The products listed in the table can be used in a variety of ways to stop such noise leaks. Meaningful acoustic information cannot be provided for such products as the performance depends upon the manner and the place of application. Organizations contributing data to this table are: 25, 100, and 146.

Table 36. Transmission loss properties of seals.

	Transmission Loss, dB																		
STC	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	Company	Product	Reference
35	Weather stripping tested on 3 x 7 ft x 1-3/4 inch door.																		
	21	24	31	33	34	38	37	36	33	33	34	34	34	35	35	39	146	Type 170,770	KAL
39	Aluminum or anodized sections with closed cell foam neoprene seal tested with 1-3/4 inch hollow metal door (operable). Starred data are at 175, 350, 700, 1400, and 2800 Hz.																		
	28	33*		37	41*		37	36*		40	42*		43	41*		37	25	9603 Sur-Round Door Frame Seal	RAL TL 63-306
39	Weather stripping tested on 3 x 7 ft x 1-3/4 inch door.																		
	22	25	31	35	36	39	40	41	36	36	38	38	38	42	43	47	146	Type 170, 361, 663	KAL
40	Weather stripping tested on 3 x 7 ft x 1-3/4 inch door.																		
	22	23	31	34	37	39	41	43	42	41	41	41	42	41	39	42	146	Type 770, 361, 663	KAL
41	Weather stripping tested on 3 x 7 ft x 1-3/4 inch door.																		
	21	25	34	36	37	40	44	44	40	38	40	41	44	45	43	43	146	Type 326/328, 663, 328	KAL
41	Weather stripping tested on 3 x 7 ft x 1-3/4 inch door.																		
	20	26	34	35	37	40	45	44	40	39	42	42	43	43	43	42	146	Type 326/328, 351, 663	KAL
42	Weather stripping tested on 3 x 7 ft x 1-3/4 inch door.																		
	20	26	34	36	37	40	46	44	42	40	42	43	45	44	45	46	146	Type 326/328, 361, 663	KAL
	Various sizes for any particular sealing application. Available in neoprene, EPDM, silicone, various elastomers fabric reinforced, natural rubber, polyurethane, butyl, viton and epichlorohydrin.																100	Pneuma-Seal ®	CR S-76

CATEGORY 37. DAMPING, DEADENERS, AND PADDING MATERIALS

The materials in this category are primarily used for decreasing vibration. A material may do this by absorbing, restricting, or changing the frequency characteristics of the vibrating structure. The material performance is usually mass related. In most cases where an absorptive material is used, its function is that of a cushioning device or deadener to limit vibration rather than as a sound absorber.

The information presented is not consistent between companies as that comparative evaluation of materials is not possible. Therefore, products are listed in alphabetical order by organization.

Organizations contributing data to this table are: 13, 22, 32, 33, 36, 38, 40, 47, 78, 81, 82, and 117.

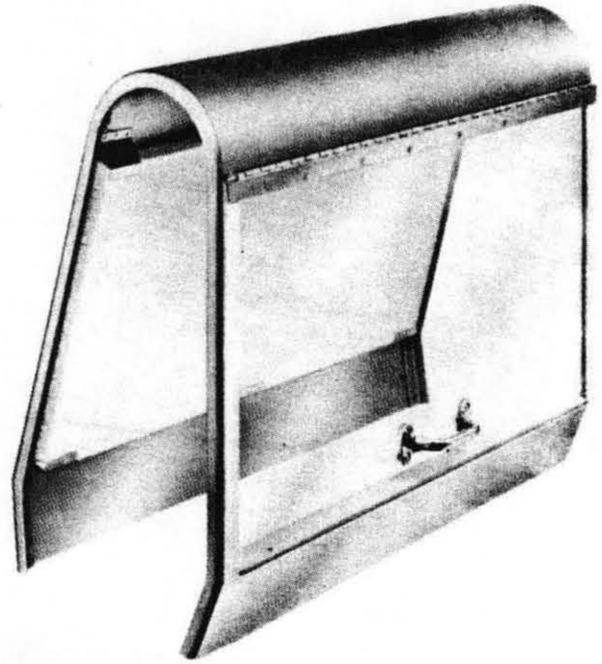
Table 37. Damping material.

31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Company	Product	Reference
Asphalt-based, pressure sensitive damping sheets; -30° to 400°F, .07 inch thick, .7 lb/ft^2.Loss factor data shown for material bonded to 20 gauge steel at 70°F. Data read from graph.										
.025	.037	.053	.066	.070	.065	.052	.039	22	Bostik 6211	CR
Damping from 125 to 4000 Hz. Temperature range -30° to 400°F. Asphalt based damping sheets, .070 inch thick, .7 lb/ft^2. Loss factor data shown for material bonded to 20 gauge sheet steel at 70°F.										
.025	.035	.052	.063	.070	.065	.051	.037	47	TEC Damping Sheet	CR SES 77072
.016 aluminum T3003-5005 H-14 laminated with a viscoelastic adhesive to .015 (1 lb/sq ft) lead. For use on noise radiating equipment or piping. Data shown are transmission loss, STC=26.										
		13	17	21	26	32	39	32	Muffl-Jac	CKAL 744-26
Sound deadener, creped kraft mastic with resinated cotton, 5/8 inch thick, 1.3 lb/ft^2. Data shown are transmission loss, STC=27.										
		13	17	21	30	38	46	81	KA Series	RAL TL 73-196
C-1002 E.A.R. energy absorbing sheet material on a 1/4 inch steel plate. Data shown are noise reduction.										
	15	13	19	20	23	22	27	40	dba damp-"V"	CR
Sprayable asphalt mastic, a vibration damping compound, .125 inch thick, 105 lb/ft^3. Decay rate, dB/sec: 12 at 0°F; 13 at 20°F; 19.2 at 40°F; 25.6 at 60°F; 26 at 80°F; 17.8 at 100°F.										
								36	Pioneer 216 Sound Deadener	G&H
Troweled or airless sprayed, viscoelastic, water-base damping compound. Loss factor: .13 at 77°F; .18 at 86°F; .21 at 95°F; .23 at 104°F; .235 at 113°F; .215 at 122°F. Temperature range 75° to 150°F.										
								82	Soundscreen T M. Sprayable Damping DPS-1	CR DS 4301
Damping layer between metal structure and constraining layer, .05 inch thick, 69 lb/ft^3. Loss factor: .22 at 100 Hz; .38 at 1000 Hz.										
								33	Quietdamp DD	CR QD-DD-121
Damping layer between metal structure and constraining layer, .01 inch thick, 69 lb/ft^3. Loss factor: .10 at 100 Hz; .22 at 1000 Hz.										
								33	Quietdamp DD	CR QD-DD-121
Thick plate vibration damping compound, .01 inch thick, 69 lb/ft^3. Loss factor for 1 to 4 thickness ratio .03 at 100 Hz; .07 at 1000 Hz Temperature range -20° to 350°F.										
								117	Dyad 606	CR 701C
Thick plate vibration damping compound, .05 inch thick, 69 lb/ft^3. Loss factor for 1 to 4 thickness ratio: .07 at 100 Hz; .14 at 1000 Hz. Temperature range -20° to 350°F.										
								117	Dyad 609	CR 701C
Quick curing epoxy compound combining compound 101 and epoxy. 12 lb/gallon. Loss factor for percent damping treatment: .005 at 5%; .022 at 10%; .051 at 15%; .10 at 20%; .14 at 30%; .17 at 40%; .20 at 50%.										
								33	Quietdamp Epoxy 110	CR QD-TDS-110
Viscoelastic damping compound, epoxy resin based, 11.5 lb/gallon. 22 dB/sec decay rate at 86°F. Loss factor for percent treatment by weight. .05 at 15%, .10 at 20%, .14 at 30%. Temperature range -65° to 375°F.										
								117	Epoxy -10 Vibration Damping Compound	CR 705D
Viscoelastic plastic, water soluable paste, 11.5 lb/gallon. Loss factor for percent damping treatment: .01 at 5%; .043 at 10%; .10 at 15%; .16 at 20%; .22 at 30%; .27 at 40%; .30 at 50%.										
								33	Quietdamp Compound 101	CR QD-TDS-101
Viscoelastic damping compound, spray or trowel-on, 45 dB/sec decay rate at 72°F. Loss factor for percent treatment by weight: .04 at 10%; .10 at 15%; .16 at 20%; .22 at 30%. Temperature range -40° to 375°F.										
								117	GP-1 Vibration Damping	CR 706D
Embossed foam bonded to damping compound, damping weight .33 lb/ft^2, foam density 2 lb/ft^3, 75 dB/sec decay rate at 72°F. Loss factor at 70°F when attached to steel sheet: .15 on 16 gauge; .18 on 18 gauge; .25 on 20 gauge; .35 on 22 gauge. Temperature range -45° to 225°F.										
								117	Foam Damping Sheet Embossed	CR 704D
Precured damping compound formed into 24 x 48 inch or 48 x 72 inch sheets. .05 inch thick, .33 lb/ft^2. Loss factor at 70°F when attached to steel sheet: .15 on 16 gauge; .18 on 18 gauge; .25 on 20 gauge; .35 on 22 gauge. Temperature range -45° to 375°F.										
								117	GP-2 Damping Sheet	CR 703D
1/16 inch sheet of compound 101, .33 lb/ft^2. Percent critical damping when attached to sheet steel: 16 gauge, 7.5%; 18 gauge, 9%; 20 gauge, 12.5%; 22 gauge, 17.5%.										
								33	Quietdamp Sheet-102	CR QD-TDS-102

Table 37. Damping material concluded.

	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Company	Product	Reference
Spray-on compound, 81 lb/ft^3. Loss factor .22 at 60°F.									82	DPS Damping Compound	
Vinyl/graphite composite in sheets, .062 inch and .188 inch thick, 95 lb/ft^3. Loss factor 0.30 at 60°F.									82	DAP Damping Sheet	
Type 80-2K-WR compound, self-extinguishing, vistagreen. Loss factor = 0.2 at 80°F for a damping material-to-metal thickness ratio of 2.									78	Korfund Epoxy Vibrodamper Compound	CR BL K17E
Type 80A, general purpose damping compound, green, 1.3 lb/ft^3, maximum thickness 3/16 inch, 45 dB/sec decay rate at 80°F.									78	Korfund Vibrodamper Compound	CR BL K17E
Reinforced viscoelastic damping sheet, .05 inch thick, .33 lb/ft^2. Loss factor 0.017. Decay rate 75 dB/sec.									13	Hushcloth VE-33	CR
Impact and structural damping sheet material, 16 gauge, loss factor 0.13.									13	HC-EAS-50	CR
Impact and structural damping sheet material, 18 gauge, loss factor 0.16.									13	HC-EAS-50	CR
Impact and structural damping sheet material, 22 gauge, loss factor 0.32.									13	HC-EAS-50	CR
3/16 inch C2003 energy absorbing sheet material on 1/16 inch steel. Typical noise reduction 24 dBA.									40	dba damp-"V"	CR
Sound deadener of chipboard, mastic, and resinated cotton, 0.5 to 2 lb/ft^2.									81	C A Series	CR
Viscoelastic copolymer, aluminum skin, self-adhesive, 1 lb/ft^2. Temperature range -40° to 250°F.									117	Sound Foil Vibration Damping Composite	CR 710
0.5 to 2 lb/sq ft mastic with 1/8 inch polyethylene foam.									81	KA & KFO Series	CR
.5 to 2 lb/sq ft mastic with 3/4 inch polyethylene foam.									81	CFJ Series Chipboard	CR
Mastic creped kraft, .5 to 2 lb/ft^2.									81	KW Series Plain Kraft	CR
Mastic jute, .5 to 2 lb/ft^2.									81	KJ Series Creped Kraft	CR

CATEGORY 38. SPECIAL APPLICATIONS



CATEGORY 38. SPECIAL APPLICATIONS

Several products are presented here which have unique acoustical features not included in other categories. Some examples are ear plugs and ear protectors, special covers or enclosures, and partial barriers. Many of these products do not have appropriate acoustic data so that specific information must be requested from the manufacturer or distributor. Organizations contributing data to this table are: 3, 20, 40, 41, 48, 53, 82, and 137.

Table 38. Special applications.

NRC	Center Frequency, Hz							Thickness (in.)	Density (lb/ft³)	Company	Product	Reference
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz					
	Enclosure Model 122, transparent dome, sportsorber cone on a metal side enclosure, with magnapatch ports of aluminized mylar film on foam. Designed to shield vibrating part feeders. Data are insertion loss											
	26	20	30	25	27	33	42	--	30	48	Sound Shield	CR VFE 100/200
	Foamed polymer ear plugs. Data are attenuation values											
	25	25	25	26	35	40	37	--	--	40	dba spec-"EP"	CR
	Ear plugs held in the ears by a head support. Data are attenuation values read from a graph											
	18	16	15	15	29	32	30	--	--	41	Sound Sentry 7500	CR
	Sound encapsulator, transparent sound curtain with 360 deg visual access for parts feeders and general purpose shielding. Data are noise reduction											
	3	8	8	13	16	21	23	--	--	53	Flexi-View NS-Series	RAL LP74-7
	22 gauge stainless steel with clear and tough Lexan viewing areas. Provides 10 dBA of noise reduction											
								--	--	82	Soundscreen Conveyor Covers	CR DS-4801
80 (c)	2 x 4 ft transparent parabolic/sinusoidal shaped acoustical panel on a butyrate base with foam wedges. Data are absorption coefficients read from a graph											
	.38	.43	.61	1.12	.95	.94		--	--	11	Alphasonic	CR 11771-I
	Perforated metal backed with absorptive material, fabricated into various designs for use as sound control booths around telephones, wall mounted, pedestal mounting, floor mounting, and directory shelf available.											
								--	--	3	Acousti-Booth	CR
	Electronic masking system consisting of a broadband continuous noise generating source with an optimized speech privacy contour. The contour has a rising spectrum below 250 Hz, a peak at 250 Hz, and a 6 to 12 dB per octave dropoff at higher frequencies.											
								--	--	20	Priva-Talk	CR
	Retrofit noise kits for installation in equipment operations cabs											
								--	--	94	Noise Insulation Kits	CR
	Molded plastic tape or buttons with tiny hooks designed to engage, retain, and disengage reticulated foams											
								--	--	137	Arrowhead Fasteners	CR
	Mating strips of material with tiny hooks on one strip and loop pile on the other. For many fastening and sealing applications											
								--	--	137	Hook & Loop Fastener	CR

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