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SOURCE REFERENCES

Information compiled from publicly available standards and references:

ASTM C578 · ASTM C591 · ASTM C1029 · ASTM D1621 · ASTM E84 · ASTM C423 · ASCE 7-22 · IBC 2021 · IRC 2021 · NFPA 101 · FM 4474 · FM 4450 · ICC-ES AC71 · ICC-ES AC377 · ASHRAE 90.1

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ACOUSTIC PERFORMANCE MATERIAL SUBMITTAL

Expanded Polystyrene (EPS) & Polyurethane (PU) Foam Insulation Prepared for Acoustic Review / Building Permit

DATA COVERS:

- Sound Transmission Class (STC)
- Impact Insulation Class (IIC)
- Noise Reduction Coefficient (NRC)
- Sound Absorption Coefficient (SAC)

Standards:
ASTM E90 · ASTM E413 · ASTM E492 · ASTM C423 · ISO 354 · IBC 2021

SCOPE

This document provides acoustic performance data for Expanded Polystyrene (EPS, ASTM C578) and Spray/Rigid Polyurethane (PU/PIR, ASTM C591/C1029) foam insulation materials.

Values are presented by density and thickness.

permit applications acoustic consultant review design specification

Assembly-level performance, code references (IBC, IRC, OSHA, FHA), and a comparative summary are included to support:

ACOUSTIC METRICS — DEFINITIONS & APPLICABLE STANDARDS

Metric	Full Name	Standard	What It Measures	Typical Range (Insulation)
STC	Sound Transmission Class	ASTM E413 / E90	Airborne sound isolation between rooms (speech, music, TV). Higher = better isolation.	25–65 (assemblies)
IIC	Impact Insulation Class	ASTM E413 / E492	Structure-borne impact noise (footsteps, dropped objects). Higher = better isolation.	25–70 (assemblies)
NRC	Noise Reduction Coefficient	ASTM C423 / ISO 354	Average sound absorption across 250–2000 Hz (four-bandaverage). 0 = fully reflective, 1.0 = fully absorptive.	0.05–0.95
SAC	Sound Absorption Coefficient	ASTM C423	Absorption at each 1/3-octave frequency band. Used for room acoustics design.	0.01–1.00 per band
OITC	Outdoor-Indoor Transmission Class	ASTM E1332	Similar to STC but weighted for low-frequency exterior noise (traffic, aircraft).	20–55 (assemblies)
Delta IIC	Impact Isolation Improvement	ISO 140-8	Improvement in IIC provided by floor underlayment over bare concrete or wood sub-floor.	+3 to +30 dB

CODE MINIMUM ACOUSTIC REQUIREMENTS

Code / Standard	Section	Requirement	Applies To
IBC 2021	Section 1207	STC ≥ 50 (field-tested FIIC/FSTC) between dwelling units	Multi-family residential, hotels, motels, dormitories
IRC 2021	Section R302.13	STC ≥ 45 (lab) / FSTC ≥ 45 (field) for walls/floors between units	Two-family dwellings, townhouses
IRC 2021	Section R302.13	IIC ≥ 50 (lab) / FIIC ≥ 45 (field) for floor/ceiling assemblies	Two-family dwellings, townhouses
FHA / HUD	Noise Guidebook	Interior DNL ≤ 45 dB; STC ≥ 25 for units near highways/airports	Federally-assisted housing
OSHA 29 CFR 1910.95	—	Max 85 dBA 8-hr TWA; engineering controls required before PPE	Occupational / industrial noise
ASHRAE 2019 HVAC Apps	Chapter 49	NC 25–35 (bedrooms), NC 30–40 (offices), NC 40–50 (open offices)	HVAC system background noise — foam used as duct liner
IEC 61672 / ISO 1996	—	Environmental noise measurement — foam used in measurement rooms	Acoustic testing facilities

SECTION 1 — EXPANDED POLYSTYRENE (EPS) ACOUSTIC PERFORMANCE | ASTM C578

EPS is primarily a thermal insulation material. Its acoustic performance varies significantly by density and thickness. EPS is NOT a high-performance acoustic material in isolation — it must be used in composite assemblies to meet IBC STC/IIC minimums. EPS provides moderate sound absorption (NRC 0.10–0.35) and limited transmission loss.

TABLE 1A — EPS SOUND ABSORPTION COEFFICIENT (SAC) BY DENSITY & THICKNESS (ASTM C423 / ISO 354)

ASTM Type	Density (lb/ft³)	Thic-kness	125 Hz SAC	250 Hz SAC	500 Hz SAC	1000 Hz SAC	2000 Hz SAC	4000 Hz SAC	NRC (avg)	Performance Rating
Type I	0.90–1.14	1"	0.02	0.03	0.05	0.06	0.07	0.07	0.05	Poor
Type I	0.90–1.14	2"	0.03	0.05	0.08	0.10	0.11	0.09	0.09	Poor
Type I	0.90–1.14	3"	0.05	0.07	0.10	0.13	0.13	0.10	0.11	Poor
Type I	0.90–1.14	4"	0.06	0.09	0.12	0.15	0.14	0.11	0.13	Poor
Type VIII	1.15–1.34	1"	0.02	0.04	0.06	0.07	0.08	0.08	0.06	Poor
Type VIII	1.15–1.34	2"	0.03	0.06	0.09	0.11	0.12	0.10	0.10	Poor
Type VIII	1.15–1.34	3"	0.05	0.08	0.11	0.14	0.14	0.11	0.12	Poor
Type VIII	1.15–1.34	4"	0.07	0.10	0.14	0.17	0.16	0.12	0.15	Poor–Fair
Type II	1.35–1.79	1"	0.03	0.04	0.07	0.08	0.09	0.08	0.07	Poor
Type II	1.35–1.79	2"	0.04	0.07	0.10	0.12	0.13	0.11	0.11	Poor
Type II	1.35–1.79	3"	0.06	0.09	0.13	0.16	0.15	0.12	0.13	Poor
Type II	1.35–1.79	4"	0.08	0.11	0.15	0.19	0.17	0.13	0.16	Poor–Fair
Type II	1.35–1.79	6"	0.10	0.14	0.19	0.23	0.20	0.15	0.19	Fair
Type IX	1.80–2.20	1"	0.03	0.05	0.08	0.09	0.10	0.09	0.08	Poor
Type IX	1.80–2.20	2"	0.05	0.08	0.12	0.14	0.14	0.12	0.12	Poor
Type IX	1.80–2.20	3"	0.07	0.11	0.15	0.18	0.17	0.13	0.15	Poor–Fair
Type IX	1.80–2.20	4"	0.09	0.13	0.18	0.22	0.20	0.15	0.18	Fair
Type IX	1.80–2.20	6"	0.12	0.17	0.23	0.28	0.25	0.18	0.23	Fair

SAC values are representative averages based on published EPS acoustic literature (ISO 354 / ASTM C423). EPS has low absorption (NRC 0.05–0.23) due to its rigid closed-cell structure. Best absorption occurs at mid-to-high frequencies. For reference: acoustic foam NRC 0.70–0.95; fiberglass batt NRC 0.90–0.95.

CODE MINIMUM ACOUSTIC REQUIREMENTS

ASTM Type	Density (lb/ft³)	EPS Thick	TL 500 Hz (dB, board only)	TL 1000 Hz (dB, board only)	TL 2000 Hz (dB, board only)	STC (board only)	STC — Wall Assembly (EPS+2x4+5/8" GWB ea. side)	Notes
Type I	0.90–1.14	1"	14	18	23	12	STC 38–40	EPS contributes mass + decoupling
Type I	0.90–1.14	2"	16	21	26	14	STC 40–42	Increased TL vs 1"
Type I	0.90–1.14	4"	19	25	30	17	STC 42–44	Diminishing returns above 2"
Type VIII	1.15–1.34	1"	14	19	24	13	STC 38–41	
Type VIII	1.15–1.34	2"	17	22	27	15	STC 40–43	
Type VIII	1.15–1.34	4"	20	26	31	18	STC 43–45	

CODE MINIMUM ACOUSTIC REQUIREMENTS

ASTM Type	Density (lb/ft³)	EPS Thick	TL 500 Hz (dB, board only)	TL 1000 Hz (dB, board only)	TL 2000 Hz (dB, board only)	STC (board only)	STC — Wall Assembly (EPS+2x4+5/8" GWB ea. side)	Notes
Type II	1.35–1.79	1"	15	20	25	13	STC 39–42	—
Type II	1.35–1.79	2"	18	23	28	16	STC 41–44	—
Type II	1.35–1.79	4"	21	27	33	19	STC 43–46	—
Type II	1.35–1.79	6"	23	30	36	21	STC 44–47	Best single-material EPS
Type IX	1.80–2.20	2"	19	24	29	17	STC 42–45	—
Type IX	1.80–2.20	4"	22	28	34	20	STC 44–47	—
Type IX	1.80–2.20	6"	25	32	38	23	STC 45–48	Highest EPS density best TL

TL values for EPS board alone are illustrative — EPS as a standalone panel has very low STC. Assembly STC values include the contribution of structural framing and gypsum wallboard. To achieve IBC 2021 minimum STC 50 between dwelling units, EPS alone is insufficient; use in composite assemblies with resilient channels, double stud walls, or mass-loaded vinyl (MLV). ACOUSTIC

SECTION 2 — POLYURETHANE (PU/SPF) FOAM ACOUSTIC PERFORMANCE | ASTM C591 / C1029

Polyurethane foam — particularly open-cell SPF — is significantly superior to EPS in acoustic performance. Open-cell PU foam achieves NRC 0.70–0.90, comparable to premium acoustic products. Closed-cell PU foam is denser and less absorptive (NRC 0.15–0.40) but provides better transmission loss. PU foam spray-applied to cavities provides excellent air sealing which further improves assembly STC by +3–5 dB.

TABLE 2A — PU FOAM SOUND ABSORPTION COEFFICIENT (SAC) BY TYPE, DENSITY & THICKNESS (ASTM C423 / ISO 354)

PU Type	Cell Structure	Density (lb/ft³)	Thickness	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC (avg)	Rating
Open-cell SPF(Type I, C1029)	Open	0.5	1"	0.10	0.25	0.60	0.80	0.82	0.78	0.62	Good
Open-cell SPF (TypeI, C1029)	Open	0.5	2"	0.18	0.45	0.82	0.92	0.90	0.85	0.77	Very Good
Open-cell SPF(Type I, C1029)	Open	0.5	3"	0.28	0.65	0.90	0.95	0.93	0.88	0.86	Excellent
Open-cell SPF (Type I, C1029)	Open	0.5	4"	0.38	0.78	0.93	0.97	0.95	0.90	0.91	Excellent
Open-cell SPF (Type I, C1029)	Open	0.5	6"	0.52	0.88	0.96	0.99	0.97	0.92	0.95	Excellent
Closed-cell SPF (Type II, C1029)	Closed	2.0	1"	0.03	0.06	0.12	0.18	0.20	0.18	0.14	Poor
Closed-cell SPF (Type II, C1029)	Closed	2.0	2"	0.05	0.10	0.18	0.25	0.28	0.24	0.20	Poor–Fair
Closed-cell SPF (Type II, C1029)	Closed	2.0	3"	0.07	0.14	0.23	0.32	0.35	0.29	0.26	Fair
Closed-cell SPF (Type II, C1029)	Closed	2.0	4"	0.09	0.17	0.28	0.38	0.41	0.34	0.31	Fair
Closed-cell SPF (Type II, C1029)	Closed	2.0	6"	0.12	0.22	0.35	0.46	0.50	0.40	0.38	Fair
Rigid PU/PIR (C591 Type III)	Closed	3.0	1"	0.02	0.05	0.10	0.15	0.17	0.15	0.12	Poor
Rigid PU/PIR (C591 Type III)	Closed	3.0	2"	0.04	0.08	0.15	0.22	0.25	0.21	0.18	Poor
Rigid PU/PIR (C591 Type III)	Closed	3.0	4"	0.07	0.13	0.22	0.30	0.33	0.27	0.25	Fair
Rigid PU/PIR (C591 Type III)	Closed	3.0	6"	0.10	0.17	0.28	0.37	0.40	0.32	0.31	Fair
High-density PU (C591 Type VI)	Closed	6.0	1"	0.02	0.04	0.08	0.12	0.14	0.12	0.10	Poor
High-density PU (C591 Type VI)	Closed	6.0	2"	0.03	0.06	0.12	0.18	0.20	0.17	0.14	Poor
High-density PU (C591 Type VI)	Closed	6.0	4"	0.05	0.10	0.17	0.25	0.27	0.23	0.20	Poor–Fair

Open-cell SPF NRC values based on published SPFA data, ASTM C423 test reports, and acoustic literature. Closed-cell and rigid PU values derived from manufacturer test data and ISO 354 reference studies. NRC = average of SAC at 250, 500, 1000, 2000 Hz rounded to nearest 0.05.

Table 2B — PU Foam Transmission Loss (TL) & Assembly STC by Density & Thickness

PU Type	Density (lb/ft³)	Thick ness	TL 500 Hz	TL 1000 Hz	TL 2000 Hz	STC (ma- terial)	Delta IIC (floor underlay)	STC—Assembly (SPF-filled 2x4 + 5/8" GWB)	Notes
Open-cell SPF	0.5	2"	9	13	18	10	+8 to +12	STC 46–49	Air sealing adds +3–5 dB
Open-cell SPF	0.5	3.5"	11	16	21	12	+10 to +15	STC 48–52	Full 2x4 cavity fill
Open-cell SPF	0.5	5.5"	12	18	23	13	+12 to +18	STC 50–54	Full 2x6 cavity; good isolation
Closed-cell SPF	2.0	1"	14	20	26	15	+3 to +6	STC 40–43	Higher TL per inch
Closed-cell SPF	2.0	2"	19	26	32	18	+5 to +8	STC 43–47	Better mass-law performance
Closed-cell SPF	2.0	3"	23	30	37	22	+6 to +10	STC 46–50	Partial wall fill; strong performance
Closed-cell SPF	2.0	4"	26	33	40	25	+6 to +10	STC 48–52	Excellent TL for closed-cell
Rigid PU/PIR	3.0	2"	21	28	34	20	+4 to +7	STC 44–48	Board-stock installation
Rigid PU/PIR	3.0	4"	27	34	41	26	+5 to +8	STC 48–52	Continuous insulation
High-density PU	6.0	2"	25	32	39	24	+3 to +5	STC 46–50	High mass = good TL
High-density PU	6.0	4"	30	38	46	29	+4 to +6	STC 50–54	Best single-layer TL for PU

Assembly STC values include 2x4 or 2x6 wood framing + 5/8" Type X GWB each side (standard party wall). Green cells indicate assemblies meeting or exceeding IBC 2021 Section 1207 minimum STC 50. Delta IIC values apply when PU foam is used as floor underlayment under finish flooring. Air sealing benefit (+3–5 dB) is specific to spray-applied PU foam filling all framing cavities.

SECTION 3 — COMPARATIVE SUMMARY, APPLICATION GUIDE & PERMIT CHECKLIST

Table 3A — EPS vs. PU Foam Acoustic Property Comparison

Property	Test Method	EPS Type I 0.9 pcf	EPS TypeIX 2.0 pcf	PU Open-cell 0.5 lb/ft³	PU Open-cell 2.0 lb/ft³	PU Open-cell 3.0 lb/ft³	PU HD 6.0 lb/ft³
NRC 2" thick	ASTM C423	0.09	0.12	0.77	0.20	0.18	0.14
NRC 4" thick	ASTM C423	0.13	0.18	0.91	0.31	0.25	0.20
SAC 500 Hz, 2"	ASTM C423	0.08	0.12	0.82	0.18	0.15	0.12
SAC 1000 Hz, 2"	ASTM C423	0.10	0.14	0.92	0.25	0.22	0.18
STC — material, 2"	ASTM E90	14	17	10	18	20	25
STC — assembly, 2"	ASTM E90	40–42	42–45	46–49	43–47	44–48	46–50
Delta IIC 2"	ASTM E492	+2 to +4	+3 to +5	+8 to +12	+5 to +8	+4 to +7	+3 to +5
R-value/ inch	ASTM C518	3.85	4.35	3.70	6.20	6.30	5.80
Density (lb/ft³)	ASTM D1622	0.9	2.0	0.5	2.0	3.0	6.0
Meets IBC STC 50 (assembly)	IBC 1207	NO (alone)	NO (alone)	YES (3.5" + cavity)	YES (4"+ cavity)	YES (4"+ ci)	YES (4"+ ci)
Best acoustic use	—	Thermal/ struc- tural; not acoustic	Thermal/ struc- tural; not acoustic	Wall cavity fill; sound absorption	Wall/roof ci; transmission loss	Ci panels; transmission loss	Industrial; high mass TL

Table 3B — Application Guide: Which Foam for Which Acoustic Goal Acoustic Goal

Acoustic Goal	Recommended Material	Thickness	Expected Performance	Code Met
Sound absorption in studio/ music room	Open-cell PU SPF (0.5 lb/ft³)	2"–4"	NRC 0.77–0.91 (broadband)	ASHRAE NC goals met
Wall STC ≥ 50 — multi-family party wall	Open-cell SPF in 2x4/2x6 cavity	3.5"–5.5"	Assembly STC 48–54 (with GWB)	IBC 2021 §1207 — YES
Floor IIC ≥ 50 — apartment over apartment	Open-cell SPF or Closed-cell SPF underayment	2" underlayment	Delta IIC +8 to +15; assembly IIC 50–60	IBC 2021 §1207 — YES
Exterior wall thermal + acoustic (city location)	Closed-cell SPF or Rigid PU/PIR (2.0–3.0 lb/ft³)	2"–4"	Assembly STC 43–52; R-12 to R-25	IBC 2603.5 / STC req.
HVAC duct liner — ASHRAE NC compliance	Open-cell PU foam liner	1"–2" duct liner	NRC 0.62–0.77; NC reduction 5–10 dB	ASHRAE 90.1 — YES
Industrial noise control (OSHA compliance)	High-density PU (6.0 lb/ft³) panels	4"–6"	STC 50–54 (panel assembly); TL 30–40 dB	OSHA 1910.95 — YES
Below-grade foundation (thermal + minor acoustic)	EPS Type II/X (1.35–2.20 lb/ft³)	2"–4"	NRC 0.11–0.18; minor TL contribution	Thermal primary; acoustic incidental
Budget wall insulation — residential retrofit	EPS Type I/X in composite assembly	4"–6" + resilient channel + GWB	Assembly STC 45–50	IRC R302.13 — marginal

Acoustic Permit Review Checklist — AHJ / Building Department

	Verification Item	EPS	PU Open-cell	PU Closed-cell	Code Reference
1	ASTM C423 or ISO 354 test report provided for specific product/thickness	Req'd	Req'd	Req'd	ASTM C423
2	STC ≥ 50 (lab) verified for party wall / floor-ceiling assembly	Assembly req'd	Spray-filled cavity	With ci	IBC 2021 §1207
3	IIC ≥ 50 (lab) / FIIC ≥ 45 (field) for floor-ceiling (multi-family)	Assembly req'd	SPF underlayment	SPF underlayment	IBC 2021 §1207
4	Field-verified FSTC ≥ 45 / FIIC ≥ 45 test report (post-construction)	Req'd	Req'd	Req'd	IBC 2021 §1207.5
5	Assembly listing or ICC-ES evaluation report provided	Req'd	Req'd	Req'd	IBC 1703
6	Air sealing at penetrations and perimeter confirmed (flanking control)	Detail req'd	SPF self-sealing	Detail req'd	IBC 1207 / IRC R302
7	Resilient channel or isolation clips specified (if STC < 45 without)	Verify	May not need	Verify	Acoustic engineer
8	Floor underlayment product listing / Delta IIC value documented	N/A (poor IIC)	Req'd if used	Req'd if used	ASTM E492
9	OSHA 1910.95 noise survey (if industrial application)	If applicable	If applicable	If applicable	OSHA 29 CFR 1910.95
10	ASHRAE NC target confirmed (if HVAC duct liner application)	N/A	Req'd	N/A	ASHRAE 90.1 Ch.49

Important Notes

Values represent typical performance for the material type. Actual performance may vary depending on:

- *product formulation*
- *installation quality*
- *substrate conditions*
- *assembly design*
- *field conditions*

DISCLAIMER — ACOUSTIC PERFORMANCE

Acoustic performance values in this document are representative typical values compiled from:

- *ASTM C423*
- *ASTM E90*
- *ISO 354 test data*
- *Manufacturer technical literature*
- *SPFA guides*
- *Acoustic engineering references*

STC & IIC Ratings

STC and IIC ratings are assembly-level properties.
Foam material alone does not achieve minimum code-required acoustic ratings.

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