

A stone prayer hall, column loudspeakers on the piers. The room caps the STI before any document names one.

NLC ACADEMY · EPISODE 29

The standard sets no number.

IEC 60268-16 defines how to measure speech intelligibility, the Speech Transmission Index, and sets no pass mark. The number that counts comes from the code, the authority or the contract.

THE SENTENCE THE WHOLE FIELD GETS BACKWARDS

The metric is a method

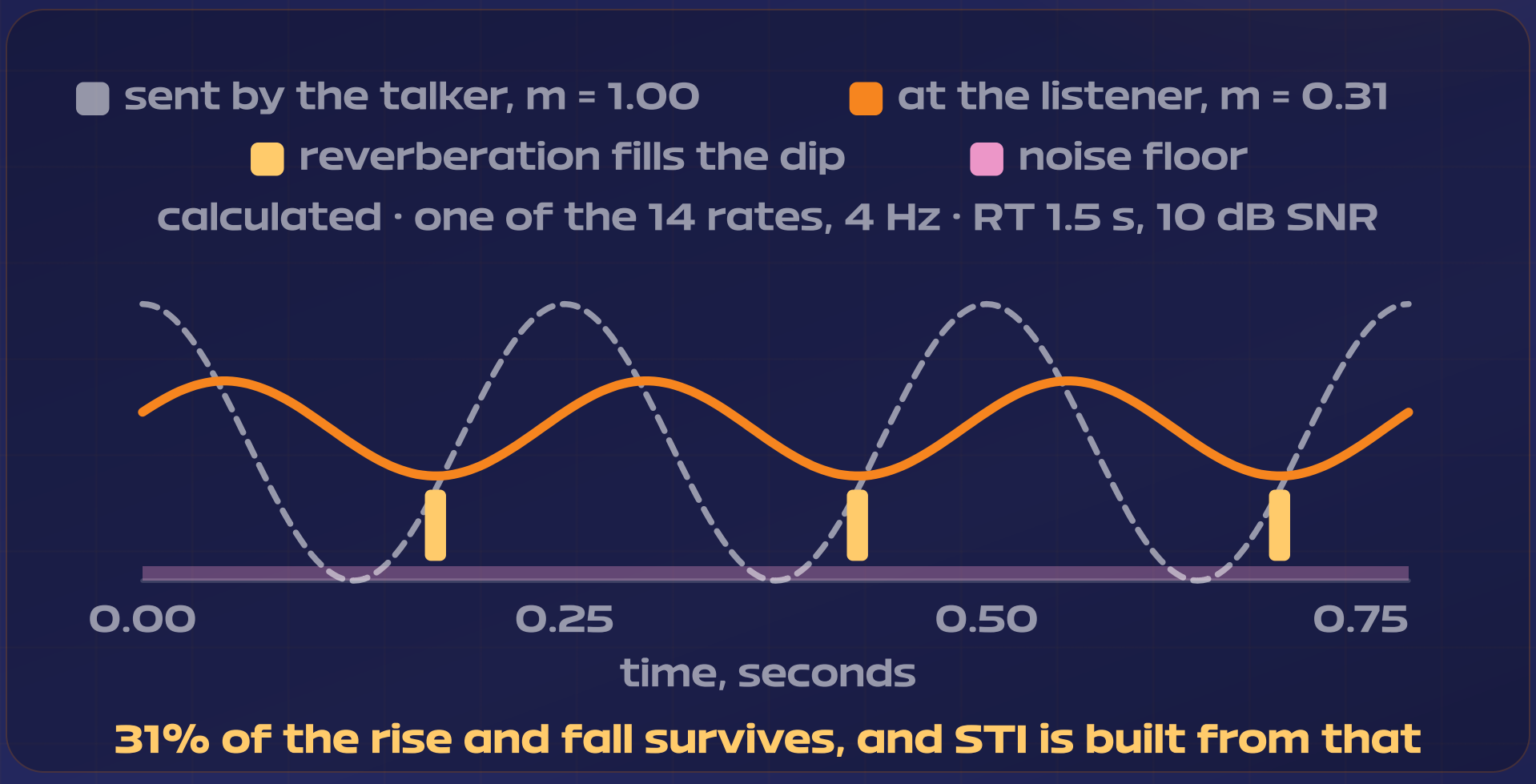


Clause 1 of **IEC 60268-16:2020+COR1:2025**: it "does not provide STI criteria for certification of transmission channels (e.g. criteria for a voice-alarm system), but some typical application values are provided in Annex G". The meter gives a number; a code or a contract decides whether it passes. [1]

And Annex G is informative. It offers 0.50 as a target value for voice-alarm systems and 0.46 as a normal lower limit, both of them band centres, and its own note calls them minimum target values. "IEC 60268-16 requires 0.50" quotes an example as a rule.

WHAT THE NUMBER ACTUALLY IS

STI measures the rhythm that survives



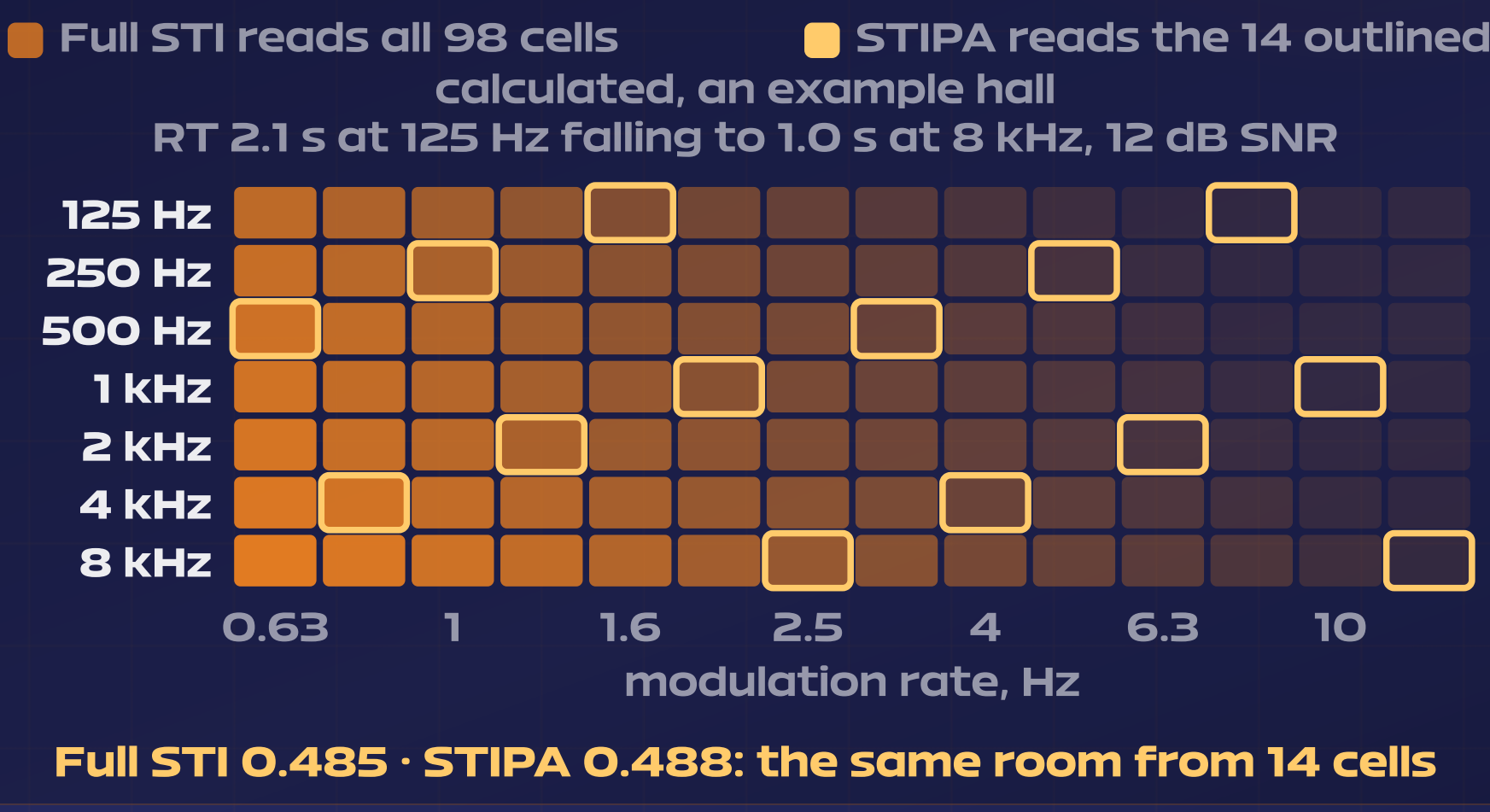
31% of the rise and fall survives, and STI is built from that

Speech is loudness rising and falling a few times a second. The test signal carries that rhythm and the meter measures how much of it arrives: reverberation fills the dips, noise lifts the floor. At 4 Hz, in a 1.5 s room at 10 dB signal-to-noise, **31% survives**. [1][7]

Each surviving depth becomes an apparent signal-to-noise ratio, clipped at 15 dB either way and scaled to 0 to 1. So the model gives no credit above +15 dB: past that point a louder system has nothing left to buy. [7]

FULL STI AGAINST STIPA

STIPA reads 14 of the 98 cells



Full STI 0.485 · STIPA 0.488: the same room from 14 cells

Full STI samples 14 modulation rates in each of 7 octave bands: 98 cells. STIPA samples two per band, **14 cells**. The standard times a measurement at 10 to 20 s; field meters run 15 to 25 s. In a smoothly decaying room the two agree: TNO's validation put most readings within **±0.02**. [1][10]

The shortcut fails where the decay stops being smooth: distinct echoes, loudspeakers far apart without delay lines, or reverberation past about 3 s through a band-limited system. Use Full STI there. A large mosque can be all three. [10]

TWO STANDARDS, ONE MASHED-UP TABLE

The word scale is ISO 9921, the letters are IEC

IEC letter bands: 0.04 wide from 0.36 to 0.76

U	J	I	H	G	F	E	D	C	B	A	A+

ISO 9921 words, a different standard

bad	poor	fair	good	excellent

0.30 0.45 0.60 0.75

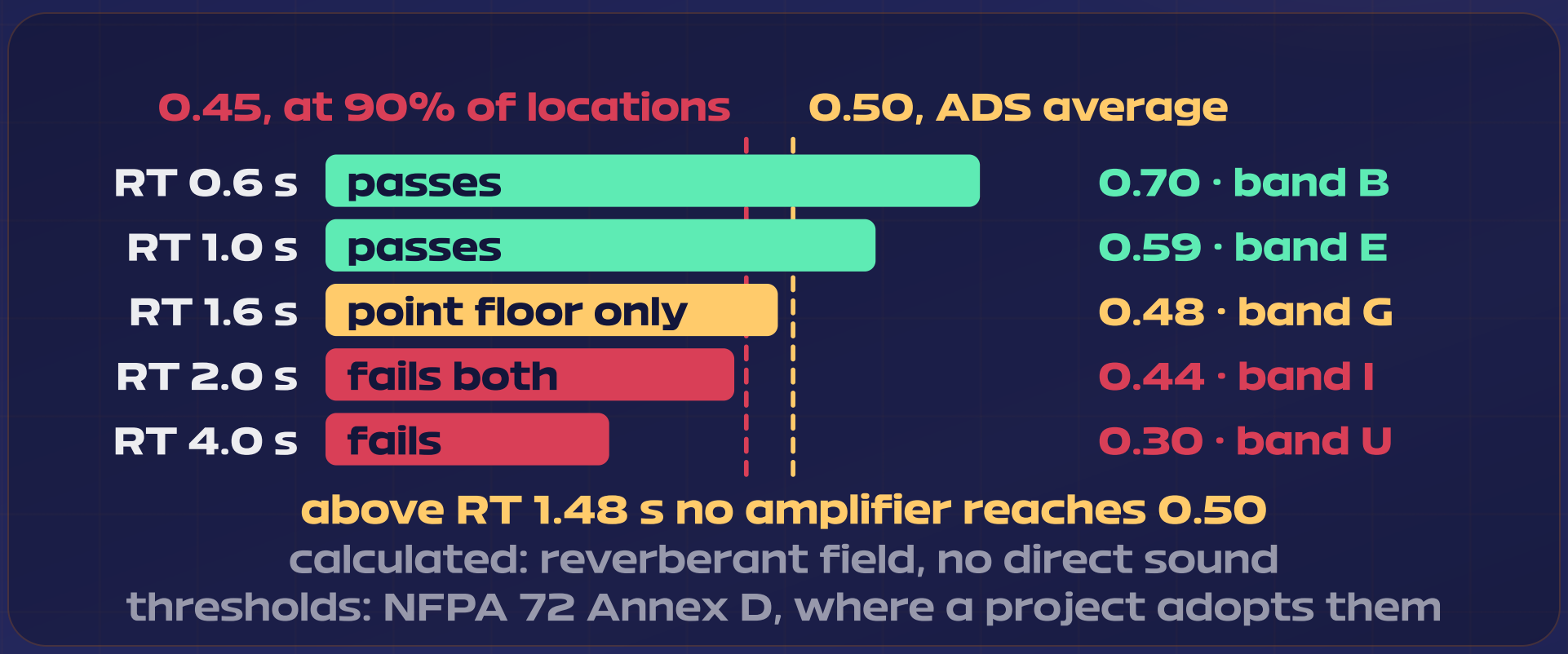
the bands are 0.04 wide because the reading repeats to 0.03

IEC 60268-16's own scale is twelve **letter** bands, U to A+: ten of them 0.04 wide between 0.36 and 0.76, U and A+ open-ended, each quoted value a band centre. Bad to excellent is **ISO 9921**'s scale; IEC's informative annexes borrow the words and point there. [1][2]

That step is the measurement's own scatter: at 15 s the standard puts the maximum deviation over repeats near **0.03**. So 0.02 between two readings may be scatter rather than a difference, and three decimals is theatre. Whether it passes is a contract question, not a physics one.

THE ROOM SETS A CEILING

In the reverberant field, the room sets the ceiling



Calculated, from the standard's own statistical model: a listener out in the reverberant field, no direct sound, one reverberation time (RT), no noise. STI 0.70 at RT 0.6 s, 0.59 at 1.0 s, 0.48 at 1.6 s and 0.30 at 4.0 s; 0.50 goes at **RT 1.48 s**, 0.45 at **RT 1.88 s**. [1][7]

Those are the limits of **that** listener, not of physics. Level alone cannot move them: as the Acoustical Society of America puts it, reinforcement makes speech louder, and if it was unclear before it stays unclear, only louder. Directivity, distance, coverage and delay alignment can, which is slide 9. The two lines drawn here are NFPA 72 Annex D's figures, where a project adopts them. [3][7][11]

QUANTIFY THE THESIS

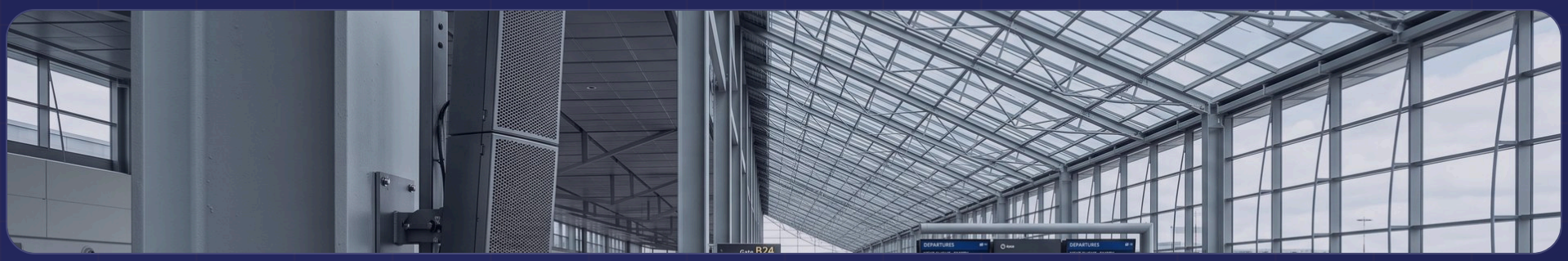
The room is nearly three times the lever

calculated from STI 0.50 at RT 1.2 s, 10 dB SNR

+10 dB of level — +0.042 STI

halve the reverberation — +0.115 STI

the room is 2.7 times the lever



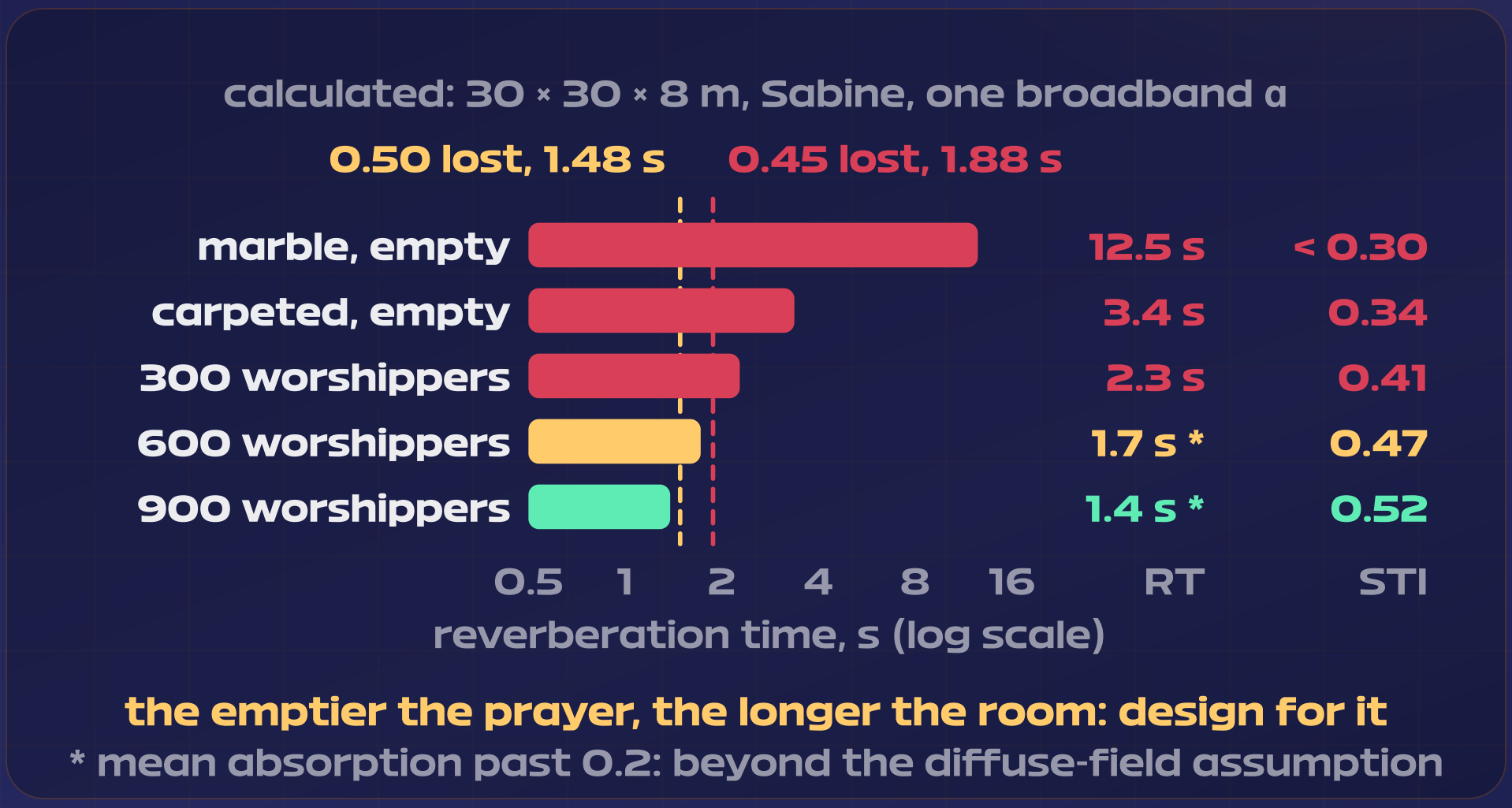
An airport concourse, the column array in the foreground. Turning that up is the small lever; the glass roof and the hard floor are the big one.

From RT 1.2 s at 10 dB signal-to-noise, STI 0.50: 10 dB more level buys +0.042, halving the reverberation time buys +0.115. 2.7 times the return, on the same room. [1]

And louder is not automatically better. The standard's level-dependent auditory masking lowers predicted STI as level rises, with no knee at any one value; measured word recognition in noise falls above about **69 dB SPL** at constant signal-to-noise, and meter makers cite a practical 80 dBA ceiling. NFPA 72 caps total sound pressure at 110 dBA at the minimum hearing distance. [1][3][12]

THE SAUDI DESIGN CASE

The emptiest prayer is the hardest room



the emptier the prayer, the longer the room: design for it

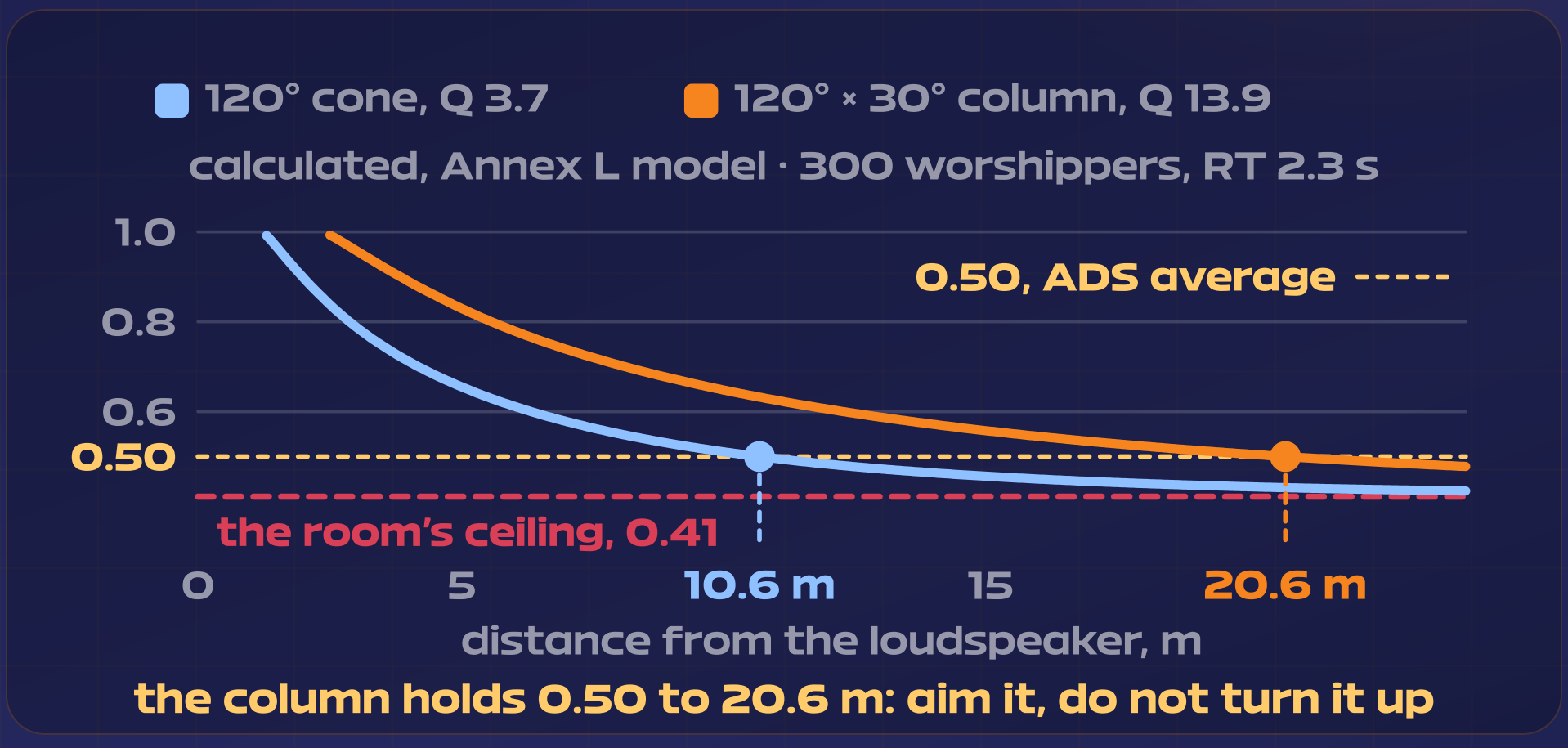
* mean absorption past 0.2: beyond the diffuse-field assumption

A 30 × 30 × 8 m hall in marble and plaster rings for **12.5 s**. Carpet takes it to 3.4 s. Each worshipper adds about 0.55 m² of absorption, so 300 bring it to 2.3 s, and 900, a full floor at the published prayer density, to 1.4 s. [9][11]

A worked illustration, not a survey: Sabine, one broadband coefficient per surface. On published 500 Hz carpet values the same hall runs about 1.7 times longer, and from about 380 worshippers its mean absorption clears 0.2, where a diffuse field stops existing. Abdou's 21-mosque study found quality worse unoccupied. [9][11]

THE THIRD LEVER

Aim the sound. Do not turn it up.

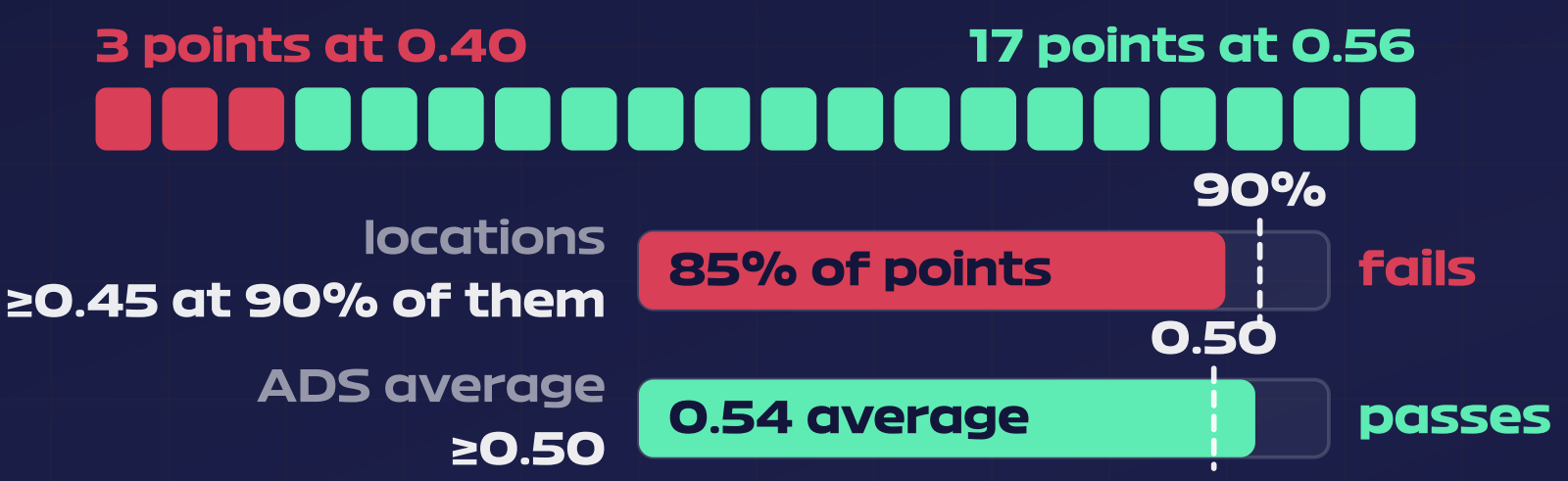


Direct sound falls 6 dB per doubling of distance; the reverberant field does not. Inside the critical distance $D_c = 0.141\sqrt{(Q\,R)}$ the listener beats that ceiling. By the standard's Annex L, in that sparse prayer: a 120° cone (directivity Q 3.7) holds 0.50 to **10.6 m**, a 120° × 30° column (Q 13.9) to **20.6 m**. [1][8]

Annex L assumes a diffuse field, exponential decay, a listener on axis and no echoes, and Q from coverage angles assumes a clean cut-off: design arithmetic, not measurement. Four times the Q doubles the critical distance, and so does four times the room constant. [1][8]

THE THRESHOLD IS TWO NUMBERS

≥0.45 at 90% of locations, ADS average ≥0.50



the average alone is not enough for acceptance

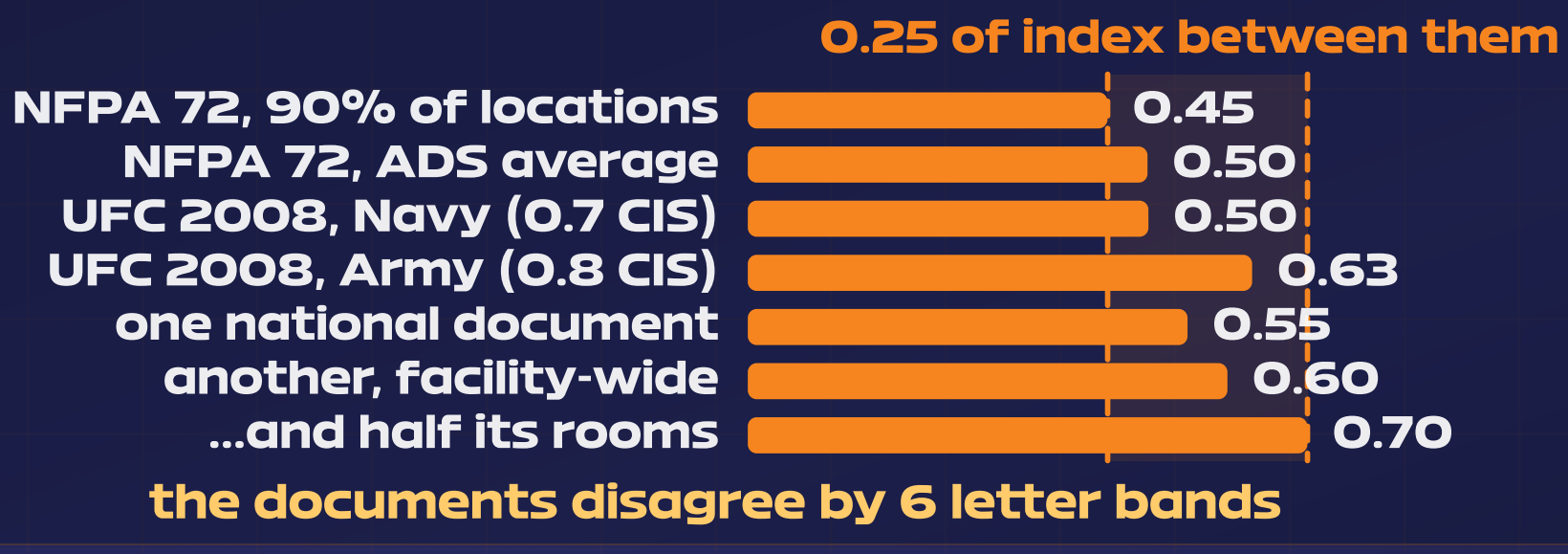
1. The two numbers live in NFPA 72 **Annex D**, which NFPA marks informational, not part of the requirements: at least 90% of locations in each acoustically distinguishable space (ADS) at STI 0.45, average at least 0.50. They bind when a project adopts them. [3]

2. The Common Intelligibility Scale converts exactly, $CIS = 1 + \log_{10}(STI)$, so STI 0.45 and 0.50 are CIS 0.65 and 0.70. Documents written in CIS may state their own pairings and rounding: use the scale your project's document cites. [3][4]

A room where every location reads 0.50 passes both parts. One averaging 0.54 with 15% of its locations at 0.40 passes the average and fails the 90% test. This example shows why the average alone is insufficient for acceptance.

ACCEPTANCE CRITERIA VARY BY APPLICATION AND JURISDICTION

There is no natural constant at 0.50



A 2008 US defence mass-notification document, inactive since September 2026, asks indoors for **0.7 CIS** for the Navy and Marine Corps and **0.8 CIS** for the Army and Air Force, each with its own rounding note. A peer-reviewed survey of six European countries finds Sweden's building regulation carrying 0.55, 0.60 and 0.70 in different clauses. [3][5]

And "EN 54-32" is not a standard anyone is certified to: it is CEN/TS 54-32, a Technical Specification that gives recommendations. EN 54-16, -4 and -24 certify products, EN 54-13 system compatibility. The STI number is in none of them. [4][5]

THE SAUDI ANSWER

No acceptance number, in the documents we reviewed

SBC 201 / 801	NFPA 72	IEC 60268-16	not identified
WHERE it is required	HOW to build and test	HOW to measure	in reviewed documents

the metric is a method; the threshold lives somewhere else

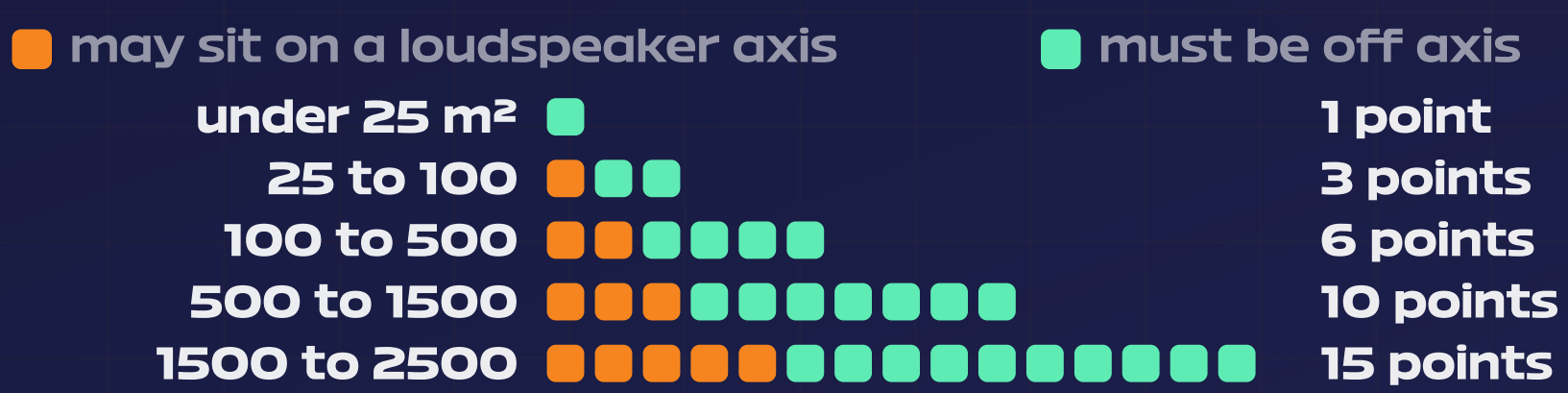
confirm the edition, the project requirements and the authority

SBC 201 and SBC 801 say **where** a voice alarm system is required and hand off to **NFPA 72** for how to build and test it, at clauses 907-6 and 907-7 of the 2024 Arabic issue. NFPA 72's mandatory text then says quantitative measurements **shall not be required**, and shall be permitted. IEC 60268-16 sets no criterion. [3][6]

We did not identify a universal numerical STI acceptance threshold in the documents reviewed. Confirm the applicable code edition, the project requirements and the requirements of the approving authority. What we read: SBC 801 of 2007 and 2018, the 2024 abridged Arabic SBC 201, the 2024 tables of contents, 32 Civil Defence regulations and both submission guides. The official English SBC we could not open. [6][13]

THE GULF-NATIVE ROUTE NOBODY INVOKES

GSO already adopted the design standard



below 25 m² the one point may not sit on an axis at all
then 15 per 2500 m², spacing not over 12 m

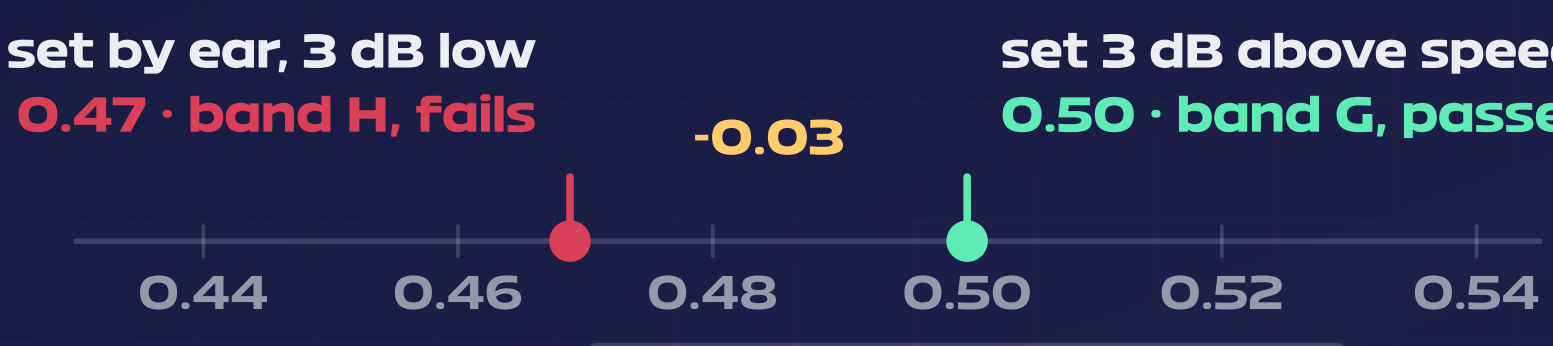
1 GSO adopted **ISO 7240-19** as a Gulf Standard in 2013, and adopted IEC 60268-16:2020 itself in September 2026. A Gulf Standard is non-mandatory by definition, so either governs a job once a technical regulation, an authority or the specification adopts it. [6][13]

2 It is where the **point count** lives: 1 below 25 m², 3 to 100, 6 to 500, 10 to 1500, 15 to 2500, then 15 per 2500 m², no more than 12 m apart. [6]

And the rule that is easiest to miss: **no more than one third of points on a loudspeaker axis**. Directly under a loudspeaker the direct sound flatters the reading, so a set of positions chosen for convenience records the best case rather than the space.

HOW A GOOD REPORT IS CHECKED

Three things that invalidate a STIPA result



One. Set the test signal from real speech: take the A-weighted equivalent level over at least 40 s of talker, or the whole recorded announcement, then add 3 dB, because the pauses pull that average below the speech itself. **Two.** Run the analyser with the signal off: above about 0.2 the background is too unsteady to trust. [1]

Three. Measure quiet and add the crowd in post-processing, but that adds the crowd's **noise**, not its absorption, which changes the reverberation and is a separate correction. Log the loop check, and state the edition. [1]

THINGS THAT ARE STALE IN 2026

Dead documents still turn up in public address specifications



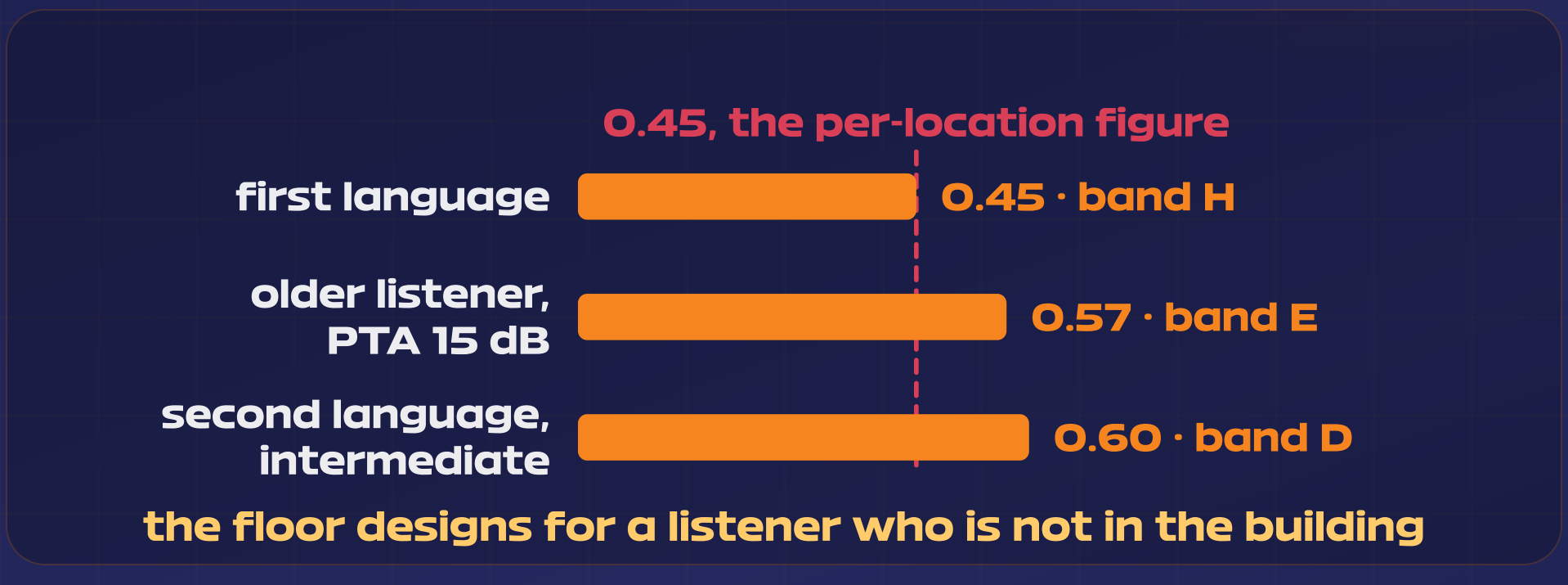
1. **IEC 60849 is withdrawn**, replaced in 2007 by ISO 7240-19 and -16. Its European successor, EN 50849:2017, **excludes fire evacuation** from its scope. RASTI was marked obsolete in 2011 and deleted in 2020. [1][4]

2. The 30 s everyone quotes was RASTI's measurement time, not STIPA's. Cite **IEC 60268-16:2020+COR1:2025**, and note that two shortcuts are banned in normative text for a *predicted* STI: RASTI as an indication of it, and **STI converted from %ALcons**. [1]

The %ALcons-to-STI equation built into major prediction software has, in the STI book editor's own words, no documented source in open literature. [7]

THE GULF DETAILS

Two languages, one crowd, thirty degrees of drift



The standard puts numbers on the bilingual problem. For an intermediate second-language listener to receive the equivalent of 0.45, the system must measure **0.60**; for an older listener with a 15 dB pure-tone average hearing loss, **0.57**. These are the standard's own worked examples. Designing to the floor designs for someone who is not in the building. [1]

A delay line set at 20 °C drifts: in dry air sound travels about 5% faster at 50 °C, so a 100 m run lands **14 ms** early in an unconditioned summer concourse. The heat also adds high-frequency air absorption, but only about 0.9 dB *more* at 4 kHz over 50 m than at 20 °C. Say which Gulf effects are large and which are not. [8]

WRITE THIS INSTEAD

The intelligibility clause that survives a handover

A PROJECT TEMPLATE, SIX TRACEABLE LINES, ADAPT BEFORE USE

a. STI per IEC 60268-16:2020+COR1:2025, measured by STIPA; STIPA(IR) declared where it is derived from an impulse response.
b. Acceptance criterion with its document and edition. If that is NFPA 72 Annex D: at least 90% of locations at STI 0.45 or better, average at least 0.50 in each ADS.
c. Assessed per acoustically distinguishable space, by its own RT and ambient noise, not per loudspeaker zone.
d. Point count and spacing per ISO 7240-19, no more than one third on a loudspeaker axis.
e. The design assumptions behind the number: RT at handover, ambient noise, loudspeaker Q and coverage, delay alignment.
f. Report on the Annex K sheet, plus the edition used and a closing loop check, which are ours rather than Annex K's.

Put the acoustic treatment and the loudspeaker directivity in the same package. They are the two levers no sound-level cap limits.

SOURCES

Where each number comes from

[1] IEC 60268-16 ed.5 2020 cl.1, 3.6, 3.8; ed.4 2011 annexes
[2] ISO 9921:2003 Table F.1, the word labels
[3] NFPA 72-2025 Annex D, D.2.4 (guidance); 2022 cl. 18.4.11
[4] IEC 60849:1998 withdrawn 2007; EN 50849:2017; CEN/TS 54-32
[5] Garlinska et al. 2021, Safety and Fire Technology 57(1)
[6] ISO 7240-19:2007 (GSO 2013); SBC 801-2018 cl. 907.2
[7] van Wijngaarden (ed.), Past, present and future of the STI
[8] JBL Sound System Design Reference Manual, ch. 3, 5 to 7
[9] Abdou, JASA 113(3) 2003; Su and Yilmazer 2008 for density
[10] TNO STIPA validation; Embedded Acoustics BA-WP-2020-199
[11] ASA, Classroom Acoustics for Architects (ANSI/ASA S12.60)
[12] Studebaker et al., JASA 105(4) 1999, pp. 2431 to 2444
[13] Saudi RD M/43 1438H; Standards and Quality Law 2024 art. 13

Every chart marked calculated is computed by sti_physics.py from the published models, and self-tested against the cited figures on every build. Editions, clauses and DOIs are listed in full in the Sources section of the article.

PRACTICAL SOUND SYSTEM ENGINEERING

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