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Frequently Asked Question:

## Why can't I have an NRC rating for a test on spaced objects (Type J mounting)?

First, let's review the relevant terminology: Source: ASTM C423-17 & ASTM C634-11

**reverberation** — the persistence of sound in an enclosed or partially enclosed space after the source of sound has stopped; by extension, in some contexts, the sound that so persists.

**reverberation time ( $T_{60}$ )** — for airborne sound, the time it takes a reverberant sound field to decay 60 dB after the source is interrupted.

**sound absorption** — (1) the process of dissipating sound energy [in this case it is a process that converts incident sound energy into heat via friction, thus reducing the reverberation time in a room.] (2) the property possessed by materials, objects and structures such as rooms of absorbing sound energy.

**Sabin** — the unit of measure of sound absorption in the inch-pound system, previously defined by ASTM C423. Originally described as "one square foot of open window".

**Wallace Sabine Equation** — (IP Units)  $T_{60} = .049 \frac{V}{a}$  Reverberation Time ( $T_{60}$ ) at a given frequency is a function of the Volume in ft<sup>3</sup> (V) and the total Sabins (a) present in the room. (Assumes even distribution of sound and absorption; more accurate for large rooms).

**absorptive area ( $m^2$ )** — the unit of measure of sound absorption in SI units, tested in accordance with the current version of ASTM C423. The observed/measured area of sound absorption provided by the specimen according to Sabine's reverberation time equation.

**sound absorption coefficient,  $\alpha$** ; [dimensionless]; Measured absorptive area ( $m^2$ ) of the test specimen divided by the test surface area covered by the specimen (in square meters) in a specified frequency band. Ideally, the fraction of the randomly incident sound power absorbed or otherwise not reflected.

**noise reduction coefficient (NRC)** — a single-number rating derived from measured values of sound absorption coefficients historically defined by previous versions of Test Method C423. Although NRC has been formally retired by ASTM, the rating continues to be cited by the architecture industry. It provides an overall estimate of the sound absorptive effectiveness for a continuous acoustical material. It is the average of the sound absorption coefficients for the 250, 500, 1000, and 2000 Hz one-third octave bands rounded to the nearest multiple of 0.05.

**sound absorption average (SAA)** — a single-number rating derived from measured values of sound absorption coefficients in accordance with the current version of ASTM C423. It provides an overall estimate of the sound absorptive property of an acoustical material. It is the average, rounded off to the nearest 0.01, of the sound absorption coefficients of a material for the twelve one-third octave bands from 200 Hz through 2500 Hz



One Sabin of absorption is *approximately* equal to one square foot of perfect absorption (e.g. an open window where all sound leaves and none reflects back, or “perfect black” for light). Sophisticated acousticians will exuberantly correct this and state that this is not 100% accurate from a physics perspective. They are correct, but it is actually a “good enough” understanding for general use by non-expert people. This is similar to other physics analogies (e.g. “fabric” of space time, or Ohms law as a “water pipe”), which break down upon deeper understanding.

Sound absorption **coefficients** are defined as Sabins (ft<sup>2</sup> of absorption) per square foot of material (truly, square foot area covered by the sample). NRC is essentially an average of four mid-range coefficients (see full definition above).

A relevant analogy is that sound absorption coefficients (and therefore NRC) are like “cost per square foot” where the “cost” is sound absorption (Sabins). One can easily calculate “cost per square foot” for wall coverings, floor coverings, ceiling treatments, etc. However, we can’t truly calculate “cost per square foot” for discrete objects such as chairs, light fixtures, lampshades, etc.

Let’s say that the you sell chairs and an architect demands to know the “cost per square foot” of your chairs. You politely try to explain that the chairs are sold individually, or as a quantity of objects (with a slight discount). The architect informs you that they have been “doing this for 30 years” and they would like to know the “cost per square foot” for your chairs, *thank you very much*. They remind you that your *competitor* has already provided “cost per square foot” for their chairs. *WHAT?!*

So, you step back and try to think of how you can calculate this, to give the architect what they need to make an informed decision. We know the “cost,” but what is the “square foot” for chairs? There are three possible ways to calculate “cost per square foot” for chairs:

- A. Based on the total exposed surface area of the chair, as determined by the sum of all surface areas of all exposed parts, possibly exported from a CAD model. This is the most literal interpretation of the request, but how useful is the resulting number, really? Your chairs would look less expensive if you just gave them more surface area!
- B. Since only the seat cushion is actually used, one could use the surface area of just the seat cushions in the calculation. However, this would give a wildly high number that may be misleading to the architect.
- C. Lay out the array of chairs within the room, according to the pattern that will be used in the actual space, then determine the square foot area of FLOOR covered by the array of chairs. In this scenario the “cost per square foot” is the total cost of all chairs divided by the total floor surface covered by the array of chairs. This might just be what they want to know!



Coming back to our acoustical test results. ASTM C423 allows the presentation of results for spaced object tests in Sabins (ft<sup>2</sup>) and m<sup>2</sup> absorptive area, but not absorption coefficient (Sabins per square foot). Without sound absorption coefficients, we can't calculate NRC (see definition of NRC above). There are three possible ways one could calculate sound absorption coefficients for spaced objects:

- A. Based on the total exposed surface area of the set of objects. For complex shapes, this could be exported from a CAD model. This is the most literal interpretation of the request, based on the minimum area requirement defined in ASTM E795 for spaced object arrays, but how useful is the resulting number, really? This is Method 2 on RAL's calculation worksheet for J-mount test reports.
- B. Since an incident sound wave may only have opportunity to pass through one face of the sample, one could use the surface area of just one of the larger faces in the calculation. However, this would give a wildly high number that is terribly misleading. RAL does not recommend this approach since it is not useful in comparison to other ceiling treatments. Also, it is more correct to think of the source as a sound "field" and not an individual incident "wave." The sound "field" encounters all exposed faces of the sample. This is Method 3 on RAL's calculation worksheet for J-mount test reports.
- C. Define an imaginary horizontal plane that extends through the entire array of test samples as installed in the chamber, then measure the length & width to determine the square foot area of this plane. This represents the area of CEILING covered by the array of objects/baffles. This method provides an accurate comparison to other ceiling treatment options such as acoustical ceiling tile. This might just be what the architect wants to know when they ask for NRC! Acousticians could also use the resulting apparent absorption coefficients in their acoustical modeling applications by assigning these values to larger horizontal single-sided planes. Since this is the preferred calculation, this is Method 1 on RAL's calculation worksheet for J-mount test reports.

There is currently a movement at ASTM to solidify method C above as an optional "Apparent Absorption Coefficient" and "Apparent NRC" under ASTM C423. At this time, the standard prohibits all three approaches. There are persons who argue for each of the three options above, so it may be some time before the ASTM E33 committee settles the debate.

Respectfully submitted,

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