



An Educational  
White Paper

The Acoustical Issues  
and Benefits

of Raised

Access

Floors

*A collaborative project presented by*

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by

**DYNASOUND**<sup>®</sup>

*Leaders in soundmasking solutions*

# **\_the Acoustical Issues and Benefits of Raised-Access Floors**

## **section\_1**

### **Acoustical Issues in Office Buildings\_**

- **Open Plan – *speech noise distraction***
- **Private Offices – *lack of confidential speech privacy***
- **Raised-Access Floors – *sound transmission performance***

### **Open Plan Speech Distraction / Key Points\_**

- Several major studies show that employees rate speech noise distraction as the number one facility issue impacting their job satisfaction and productivity. Solving this ongoing problem involves integrating the combined acoustical performance of *ceilings, office furniture, and soundmasking systems*.
- Soundmasking can increase speech privacy by 50% — *providing the most effective acoustical solution at the lowest possible cost*. The addition of soundmasking slightly raises the building's background ambient sound level so that conversations are more difficult to understand. Soundmasking has been an “*industry best practices*” solution to speech noise distraction in office buildings since the mid-1960s.
- When employees are provided with acceptable speech privacy, financial models show a 300% - 500% return on investment for soundmasking solutions, with payback periods of less than three months. Properly designed and installed soundmasking solutions generally result in employees achieving significant improvements in productivity, concentration, accuracy, and work satisfaction.

- Soundmasking systems frequently provide *voice paging* within the same system — *eliminating the cost of redundant speakers and amplifiers and locating them above the ceiling line or underneath the floor, where they are invisible.*

## Private Offices & Conference Rooms / Key Points\_\_

In today's more flexible office construction, closed office speech privacy is generally poor. Confidential conversations are frequently *overheard* and *understood* by occupants located outside of these private offices. The loss of sensitive and confidential information is an *increasing corporate security issue*. The addition of soundmasking, combined with minor additional acoustical corrections, will solve the problem by increasing speech privacy to the *confidential* level per ASTM standards.

## Raised-access floors with regard to Sound Transmission Performance / Key Points\_\_

Acoustical tests were conducted at Geiger & Hamme laboratories with the Interface AR - 2'x 2' concrete raised-raised-access floor panels to determine the sound transmission performance. The results showed excellent performance with both the static and air handling raised-access floor systems. In fact, the raised-raised-access floor tests show that any loss of sound transmission in "as built" offices would typically come from ceilings or partitions - not from the concrete raised-raised-access floor system. (*See section "Sound Transmission tests of raised-access floors" - pg. 5*).

## section\_2

### Modern Raised-Access Floor Systems\_

- **Owner Benefits – “engineered” Raised-Access Floor Soundmasking**
- **Acoustical Issues of Raised-Access Floors**
- **How Soundmasking Passes through Raised-Access Floors**
- **Office Trends– *flexible space***
- **Soundmasking Designed for Raised-Access Floors**

### Owner Benefits of “Engineered” Soundmasking Systems Located In Raised-Access Floor Cavities\_

- High performance and very uniform soundmasking distribution, +/-2 decibels (see site test results)
- Significantly lower installed cost compared to typical ceiling plenum Soundmasking systems, while generally providing superior sound distribution performance.
- Compared to exposed structure soundmasking; under floor soundmasking can be *substantially less expensive*.
- Delivering soundmasking coverage closer to the sources of conversational distractions than overhead soundmasking, under floor soundmasking more effectively covers speech conversation that may pass through raised-access floor supply air openings.
- Soundmasking speakers are individually secured to the raised-access floor system without interfering with ongoing cabling management.
- Removes soundmasking components from crowded and often difficult to access ceiling plenums

### Acoustical Issues of Raised-Access Floors\_

- Air-handling raised-access floor systems operate at low sound levels (NC 25) compared to traditional overhead-ducted HVAC systems (NC 35). This means the building’s ambient background sound level is significantly lower (*more quiet*) with

- under-floor air distribution. This may *increase the possibilities of speech noise distraction problems*.
- The need for effective soundmasking has been well established for over 30 years as a *mandatory component* in an overall acoustical solutions program for open plan offices. In private offices, recent studies by Dynasound, Armstrong, & SMED International have proven the essential role of soundmasking in order to achieve *confidential speech privacy*.
  - In static or air-handling raised-access floors, careful design and engineering is essential in providing uniform distribution of soundmasking in the floor cavity.
  - Preventing *crosstalk* and losses of *confidential speech privacy* in private offices through supply air diffusers in raised-access floor cavities can be a concern. Raised-access floor soundmasking corrects the problem by “covering up” the conversation so that it cannot be understood.
  - As noted in the section below, “*How Sound Masking Works*”, the U.S. Department of Defense has insisted for over 20 years that raised-access floor soundmasking is installed in their top-secret government and military facilities in order to stop the “crosstalk” issue between private offices. The reason is obviously to prevent anyone from overhearing and understanding conversations in private offices - by either inadvertent or deliberate human eavesdropping of sensitive conversations.

## How Soundmasking Passes Through Raised-Access Floors\_

- The raised-access floor cavity consists of a concrete floor slab, and the raised-access floor panels consist of concrete, steel, or other hard surface components. These highly sound reflective surfaces provide a *direct and reverberant sound field* with all of the popular heights of raised-access floor systems. This means that soundmasking speakers can be spaced quite far apart and still provide a uniform level of soundmasking within the floor cavity.
- Extensive acoustical tests show that soundmasking evenly fills the raised-access floor cavity and passes through the raised-access floor panels primarily at the joint lines of each 2' x 2' floor panel. This occurs regardless of the location of raised-access floor carpeting. Quite literally, the joint lines of each raised-access floor panel transmit soundmasking from below the floor in a uniform manner that would be equivalent to having linear speakers on 24" centers in both directions.

As a result of Dynasound's 20 years of experience with various raised-access floor air grille manufacturers and models, we know that additional soundmasking passage occurs through these air diffusers. We have observed that typical spacing of raised-access floor air diffusers is one per 85 to 100 sq. ft.

- For over 20 years, The United States Department of Defense has designed top - secret government and military facilities incorporating Soundmasking under raised-access floors. Dynasound has installed over 25 secured facilities since 1982 with this concept.
- Quite literally, the defense and security of the United States is based on the fact that raised-access floor soundmasking works to provide totally confidential speech privacy for occupants of highly secure offices and conference rooms.
- For effective distribution of soundmasking through raised-access floor panels, it is critical that the appropriate soundmasking signal be shaped (*tuned*) in 1/3-octave bands. This allows the delivery of the correct amount of facility-specific soundmasking to cover each of the important human speech frequencies.

Lastly the size, shape, and design of *raised-access floor* soundmasking speakers perform a vital role in correctly delivering multi-directional soundmasking within the raised-access floor cavity. Dynasound currently has three different raised-access floor soundmasking speakers to respond to the various cavity heights of raised-access floor systems.

## Office Trends of Raised-Access Floors in Flexible Spaces\_\_

The average office “churn rate” for USA corporations is approximately 44% per year (IFMA, 2002). Many companies move workstations in excess of 100% per year.

- Higher churn rates drive the need for faster and more cost effective movement of power, data, and telecommunication cables to provide that increased flexibility.
- Raised-access floor systems have grown in popularity due to their ability to accommodate rapid cabling changes. In addition the new generations of raised-access floors provide the benefits of under floor air distribution.
- An increasing trend in high flexibility offices is the use of *open structure* without traditional suspended acoustical ceilings. This challenges the ability to provide acceptable degrees of speech privacy, due to increased overhead reflection of distracting speech conversation.
- The critical addition of soundmasking within the raised-access floor cavity, will successfully manage most of this distracting speech noise, while at the same time also solving the potential problem of crosstalk under the floor.

## Soundmasking for Raised-Access Floor Systems\_\_

- Dynasound's new low-profile high-performance raised-access floor soundmasking speakers are designed to provide uniform dispersion of soundmasking in shallow 2.5" raised-access floors as manufactured by SMED, Cable Floor, and Power Floor.
- One new shallow raised-access floor soundmasking speaker design provides engineered omni-directional sound dispersion — *creating the required sound distribution for optimum performance within low-profile raised-access floor cavities of non air-handling raised-access floors.*
- New mid-range soundmasking speakers are designed to provide high quality sound dispersion for 4" to 8" raised-access floors. These Dynasound speakers contain a high performance acoustic suspension speaker to generate exceptional soundmasking performance.
- New high efficiency soundmasking speakers are now available for air handling raised-access floor systems that are typically 10" or greater in height. These units contain a large driver, and are engineered for ease of installation and use in raised-access floors while providing superior soundmasking performance.
- New Dynasound soundmasking speaker deflectors are available for some specific air diffuser models used with raised-access floor air-supply systems. Our years of raised-access floor soundmasking and these speaker deflectors allow Dynasound to **guarantee** the project will *achieve established industry standards for soundmasking uniformity.*

## section\_3

### Acoustical Test Results\_

- **Sound transmission performance of Raised-Access Floors**
- **Soundmasking performance under shallow Raised-Access Floors**
- **Soundmasking performance under air-handling Raised-Access Floors**

### Sound Transmission Performance of Raised-Access Floors\_

At Geiger and Hamme acoustical laboratories, the Interface AR 1-1/16” concrete raised-access floor panel was installed *as a 12” deep air supply plenum* inside the test chamber, in conformance to ASTM test procedure E-413-73. This test is designed to measure the acoustical impact of room-to-room sound attenuation between offices. The purpose of the test was to measure the impact, if any, that raised-access floors would have on sound transmission loss between private offices.

Then a full height, test standard 54 STC rated drywall partition (5&1/2”) was installed on top of the raised-access floor system. York air diffusers were also positioned in the raised-access floor.

The test results show that the raised-access floor system achieved an NNIC (normalized noise isolation class) rating of 52 without air diffusers, and an NNIC rating of 51 when the York diffusers were installed.

*(The NNIC rating is similar to a traditional STC [sound transmission class] rating, except that NNIC measures the noise reduction between two rooms divided by a partition. This assembly includes both the raised-access floor system and open plenum within the raised-access floor. The STC rating only measures sound passage through a single building component. The value of the NNIC rating is that it more closely resembles as-built construction.)*

**These test results are very high sound transmission performance ratings. When considering sound transmission performance in as-built construction, we must also examine the performance of standard partitions and suspended acoustical ceilings.**

Typical ratings for ceilings are CAC 35 (ceiling attenuation class) while standard drywall partitions are STC 36 non-insulated and STC 41 insulated. **As a result, in “as-built” construction, the acoustical weakest link will generally be the ceiling or wall system, and the NNIC rated 51 or 52 raised-access floor *will not* be the conduit for sound transmission to occur. Speech sound waves will always follow the path of least resistance. Since standard walls and ceilings have far lower sound transmission performance than the raised-access floor, the weakest link is obvious.**

## Soundmasking Performance Under Shallow Raised-access floor System\_

### Site Test Information\_

- Dynasound soundmasking performance within a shallow raised-access floor
- Atlanta office facility – 2.5” low profile raised-access floor
- Field measurement of spatial (sound) uniformity
- Measurements are decibels of sound (dBA)
- Dynasound floor soundmasking speakers located at 14’x 16’o.c. - under the raised-access floor system
- Test data results (*see data that follows*)

### Soundmasking Performance in Shallow 2.5” Raised-Access Floor\_

*(Numbers reported are in decibels of soundmasking (dBA))*

	0 Ft	2 Ft	4 Ft	6 Ft	8 Ft	10 Ft	12 Ft	14 Ft	2 Ft	4 Ft	6 Ft
0 Ft	49.6	49.7	49.2	49.1	50.4	49.2	48.8	49.7			
2 Ft	48.9										
4 Ft	49.6										
6 Ft	49.3										
8 Ft	49.3	50.3	49.6	50.6	49.0	49.9	50.5	51.5	50.1	50.7	49.3
10 Ft	49.5										
12 Ft	49.4										
14 Ft	48.9										
16 Ft	49.7										

(Speaker spacing is on 16’x14’ centers)

Results show excellent sound soundmasking uniformity:

- Typical readings average less than 2 decibels (dBA) difference across the floor space as measured according to ASTM test standards.
- The worst-case situation – shows only 2.7 decibels (dBA) difference between test point readings.

# Dynasound Soundmasking Performance In Deep - Air Handling Raised-Access Floor Office Facility\_

(Owner: KSBA Architects, Pittsburgh, PA. – A leading call center architectural firm)

## Project Specifics\_

- 12” deep – Tate cement filled waffle steel floor panel with air delivery.
- Dynasound # DS 2493 plenum soundmasking speakers, located 16’o.c.
- Dynasound # DS 1012 soundmasking generator, 1/3-octave equalizer & amplifier.
- A prominent acoustical consulting firm – The Sextant Group, Pittsburgh, provided the following analysis and data from the project
- The study used the ASTM “Standard Guide for Measurement of Masking Sound in Open Plan Offices” (ASTM Designation E-1041) as reference
- The objectives of the measurements are to determine the soundmasking uniformity in relationship to the specified sound spectrum.
- The floor area was 2,000sq.ft. and involved ten workstations with dividers.
- There was an exposed wood ceiling, peaking at 22’-0”.

The chart below shows the standard deviations in sound uniformity from the specified sound spectrum. The standard deviations were within acceptable guidelines, which are the ASTM test standards for soundmasking uniformity. This acceptable range is a 2 decibels (dBA) range from minimum to maximum-recorded soundmasking energy levels.

The study covers the important frequencies involving human speech (500hz - 4,000hz.). The results show the sound uniformity was within industry recommended standards for acceptable soundmasking uniformity.

**Speech Range Frequencies**

500	630	800	1000	1250	1600	2000	2500	3150	4000
0.5	0.3	0.3	0.2	0.6	0.5	0.6	0.3	0.3	1.5
0.6	0.7	1.0	0.5	0.7	0.4	0.3	0.7	0.4	0.1
0.9	0.8	0.4	0.4	0.3	1.0	0.6	0.8	1.4	1.0
0.4	1.3	2.0	0.3	0.9	0.6	0.3	0.5	1.3	1.4
0.7	0.5	0.5	0.3	0.3	0.6	0.6	0.3	0.1	0.6
0.9	0.5	1.1	0.6	0.2	0.5	0.6	0.7	0.5	0.8
1.2	0.7	1.0	0.4	0.3	0.4	0.6	0.7	0.8	1.7
0.6	0.6	0.9	0.5	1.3	1.2	1.2	0.5	0.4	0.4
0.6	0.9	1.0	0.5	0.6	0.8	0.9	0.8	0.6	0.7

## Test Conclusion\_

The maximum reading was 48.4 dBA, and the minimum was 46.8 dBA. ***Most acoustical consultants and engineers would find this to be an excellent performance range for a soundmasking system.***

## section\_4

### Soundmasking Observations\_

- **Dynasound– leader in Raised-Access Floor Soundmasking**
- **Advantages of Acoustical Programming – computer modeling**
- **Assuring Even Soundmasking Distribution**
- **Assuring Even Soundmasking Distribution – with air handling**
- **Under floor Soundmasking costs less – yet performs better**
- **Under floor Soundmasking Speaker Placement**
- **How Under floor Soundmasking Affects the Private Office**

### Dynasound\_the Leader in Raised-Access Floor Soundmasking\_

Dynasound soundmasking expertise and experience with **raised-access floors** is extensive and unparalleled:

- In 1982, our Audio Security Division pioneered the concept of installing sound-soundmasking within raised-access floors. This enabled the U.S. Department of Defense to prevent loss of speech confidentiality through air-supply raised-access floors.
- Dynasound has installed over 750,000sq.ft. using this concept.
- Our on-site acoustical evaluations of installations, as well as independent site tests by prominent acoustical consultants, indicate excellent soundmasking performance. Soundmasking uniformity is within +/-2 decibels. This is the established standard of quality for acceptable soundmasking performance.
- Raised-access floor soundmasking requires proper location of speakers as well as sophisticated equipment design that can be adjusted in 1/3-octave band frequencies in order to achieve superior facility-specific soundmasking performance.

## Advantages of Acoustical Programming\_\_

Dynasound's exclusive *Acoustical Programming Software*, **APS**, is a *design lifesaver in office projects*. This software provides enormous value to the project team when used in the early planning stages. The program accurately predicts the level of speech privacy that will result from the preliminary selection of interiors components; i.e. *ceilings, walls, office furniture, & soundmasking*.

The **APS** program provides the following critical information:

- Evaluates the project to predict the speech privacy performance, both with and without soundmasking, while the project is still in the planning stage.
- The program contains a value-engineering module that will identify the acoustical contribution of each component mentioned above. The result will allow the client to receive the following performance benefits:
  - i Achieve the maximum amount of speech privacy.
  - ii Deliver soundmasking at the lowest possible volume of sound.
  - iii Provide Dynasound's soundmasking system at the lowest possible cost.
- In many cases, **APS** shows the project team how to re-allocate and *balance* the acoustical performance of ceilings and office furniture, achieve increased speech privacy, *and at the same time provide soundmasking at little or no additional cost to the project*.
- Determines the most effective type of speaker and location for soundmasking to be installed in each specific project. No other manufacturer can provide this depth of coverage. The options for Dynasound's soundmasking speaker locations include the following:
  - i In the ceiling plenum
  - ii Within the raised-access floor system cavity
  - iii Suspended from steel beams/joists in open structure offices
  - iv Within supply air ducts for private offices

## Assuring Even Soundmasking Distribution Under Raised-Access Floors\_\_

Properly designed and installed raised raised-access floor sound soundmasking can be tuned to a +/- 2 decibel (dBA) sound level, 48" above the floor, which is the accepted standard for proper soundmasking uniformity. Dynasound's experience has proven that this high degree of performance can be achieved. *Note that in order to adjust or "tune" the soundmasking correctly, the soundmasking system must provide the capability to adjust the sound curve in 1/3-octave band increments.*

With air-supply raised-access floor systems, our engineers have found that the positioning of under floor sound speakers relative to raised-access floor access panel intersections, air highways, and supply air grilles is a critical component of insuring satisfactory acoustical performance. However, correct placement of supply air grilles and soundmasking speaker controls and baffles will insure that proper performance will be maintained from future churn and reconfigurations.

The design and configuration of the HVAC supply air grilles is an important detail in maintaining speech privacy. The goal is to have air grilles that “break up” or block the direct passage of speech sound waves from the open raised-access floor plenum directly into private offices on top of the floor.

## Assuring Even Soundmasking Distribution with Raised-Access Floor Air Supply\_\_

For air-handling floors Dynasound soundmaskers are placed in the floor cavity as required to meet industry recommended standards for spatial uniformity. Speaker volume controls and baffling provide additional refinements to achieve these standards.

## Under Floor Soundmasking Less Expensive than Above Ceiling Plenum or Open Structure Soundmasking Often with Superior Performance\_\_

The cost of raised-access floor installations can be significantly less than ceiling mounted speakers because floor mounting has much easier access and does not require suspended drops (*shots, pins, hanger wire, etc.*) from structure above — *nor does it require the cost and time of using ladders or other mechanical lifts. The savings in labor and reduction in installation time will help speed up the overall construction process and deliver the project to the client quicker and at less cost.*

In open structure facilities, the need for additional pendant mounted soundmasking speakers, combined with more stringent speaker wire installation details, are required in order to provide acceptable soundmasking uniformity and installation. Both of these factors cause *significantly increased costs versus raised-access floor soundmasking.*

## Raised-Access Floor Soundmasking Speaker Placement\_\_

When using low profile static raised-access floors, speakers are typically placed 14' to 16' on center. Speaker spacing for deeper air-handling raised-access floors is also typically 14' to 16' on center (or more in some cases) and may differ slightly based on specific room dimensions.

## Closed Plan Areas - Private Offices\_\_

- Soundmasking works very well in private offices and *static non-air supply* raised raised-access floors do not present any difficulties.
- With air-supply raised-access floor systems, if soundmasking is not added (ideally through the raised-access floor system), sound leaks can become a potentially significant risk issue in transmitting confidential speech information - *through air diffusers via the open floor cavity*.
- Soundmasking installed under raised-access floors provides more effective “coverage” for speech conversation than ceiling plenum soundmasking. The soundmasking source under the floor is much closer to persons talking in either seated or standing positions than is the case with ceiling plenum speakers.

Dynasound experience confirms that when soundmasking is installed in air-supply raised raised-access floor cavities — *speech privacy can be maintained when supply air grille penetrations are managed properly*. Dynasound’s diffuser deflector will alleviate sound leakage occurring in problematic diffuser designs. If future churn results in supply air diffuser relocation, changes in sound soundmasking speaker deflectors can easily correct non-uniform sound distribution in the space.