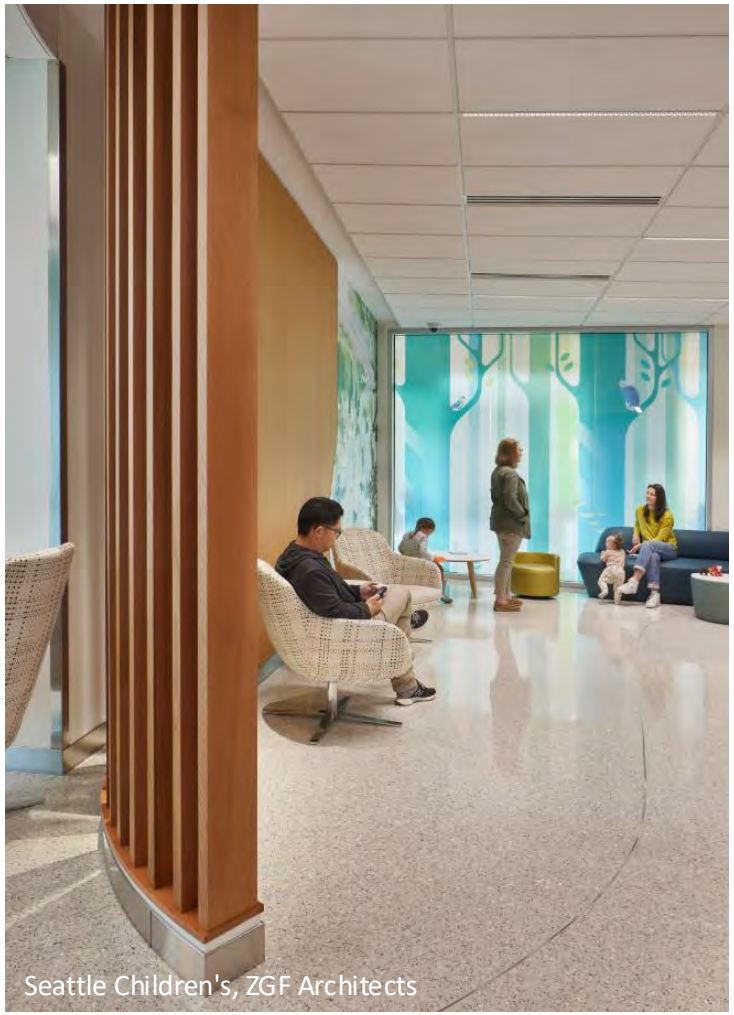
Practical Acoustics and Prefabricated Systems in Healthcare

Basel Jurdy

Principal, Acoustics and Vibration

Stantec

Content


Seattle Children's, ZGF Architects

Sound Masking Systems ROI?

- Exam Rooms FGI Acoustical Separation Requirements
- Objectives
- Speech Privacy
- Systems' Configurations
- Performance Specification
- Your ROI

Prefabricated Walls

- Patient Rooms FGI Acoustical Separation Requirements
- Mockup #1
- Mockup #2
- Findings
- Next Steps

Acoustical Walls Carbon Footprints

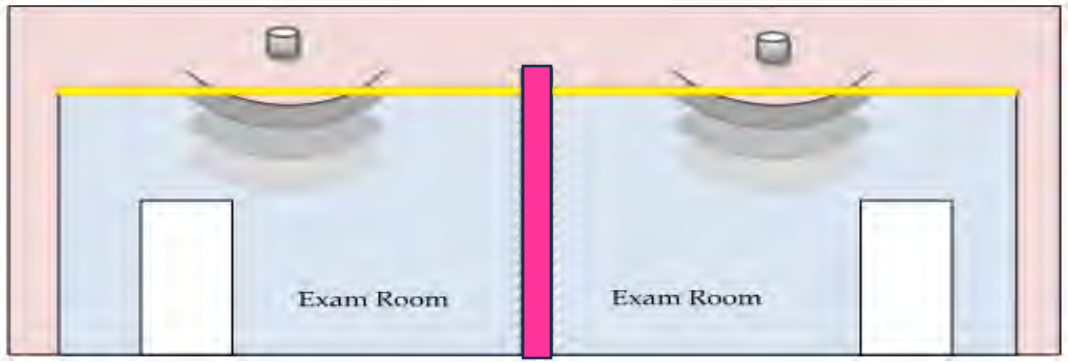
- Light Weight Sheetrock

Electronic Sound Masking System

Return on Investment

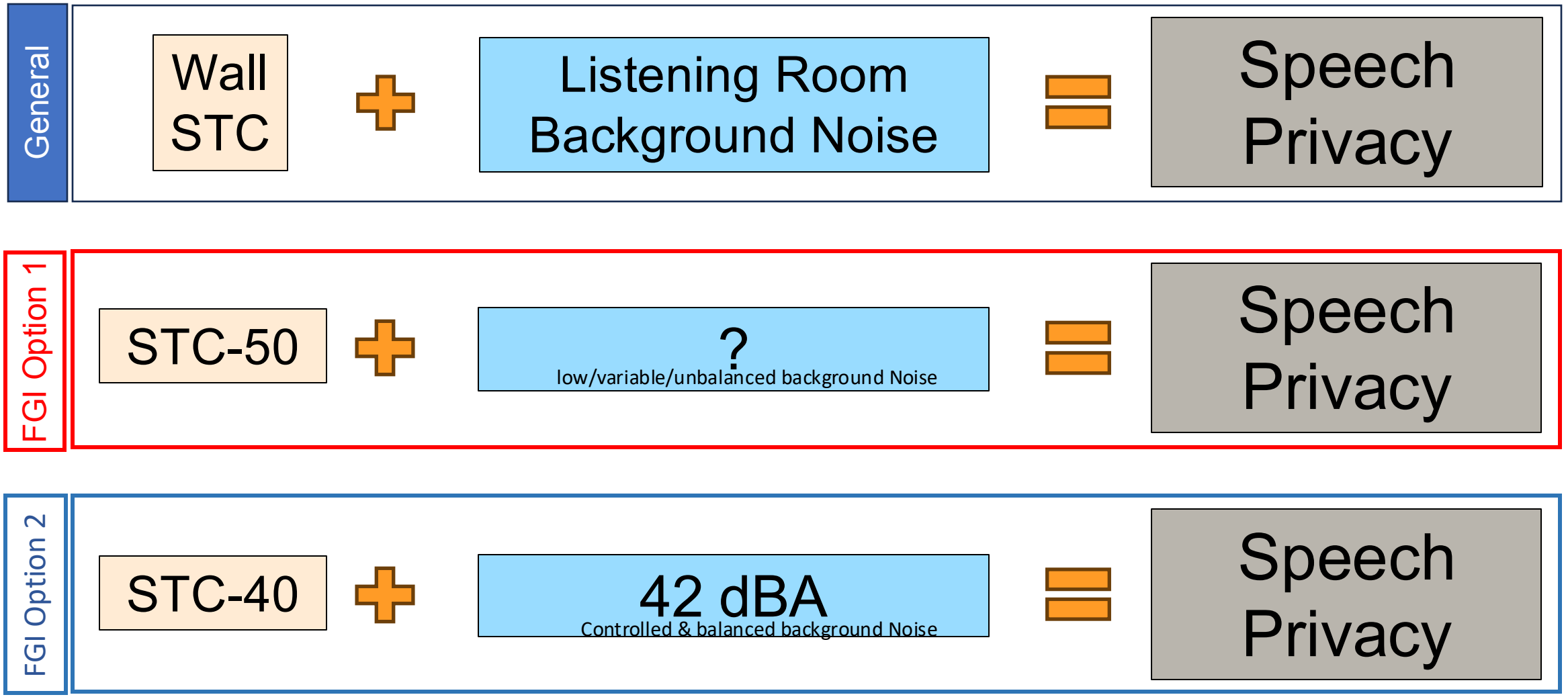
FGI - Exam Room to Exam Room Acoustical Separation Requirements

- STC-50 Wall (full height wall)
- CAC-35 Ceiling

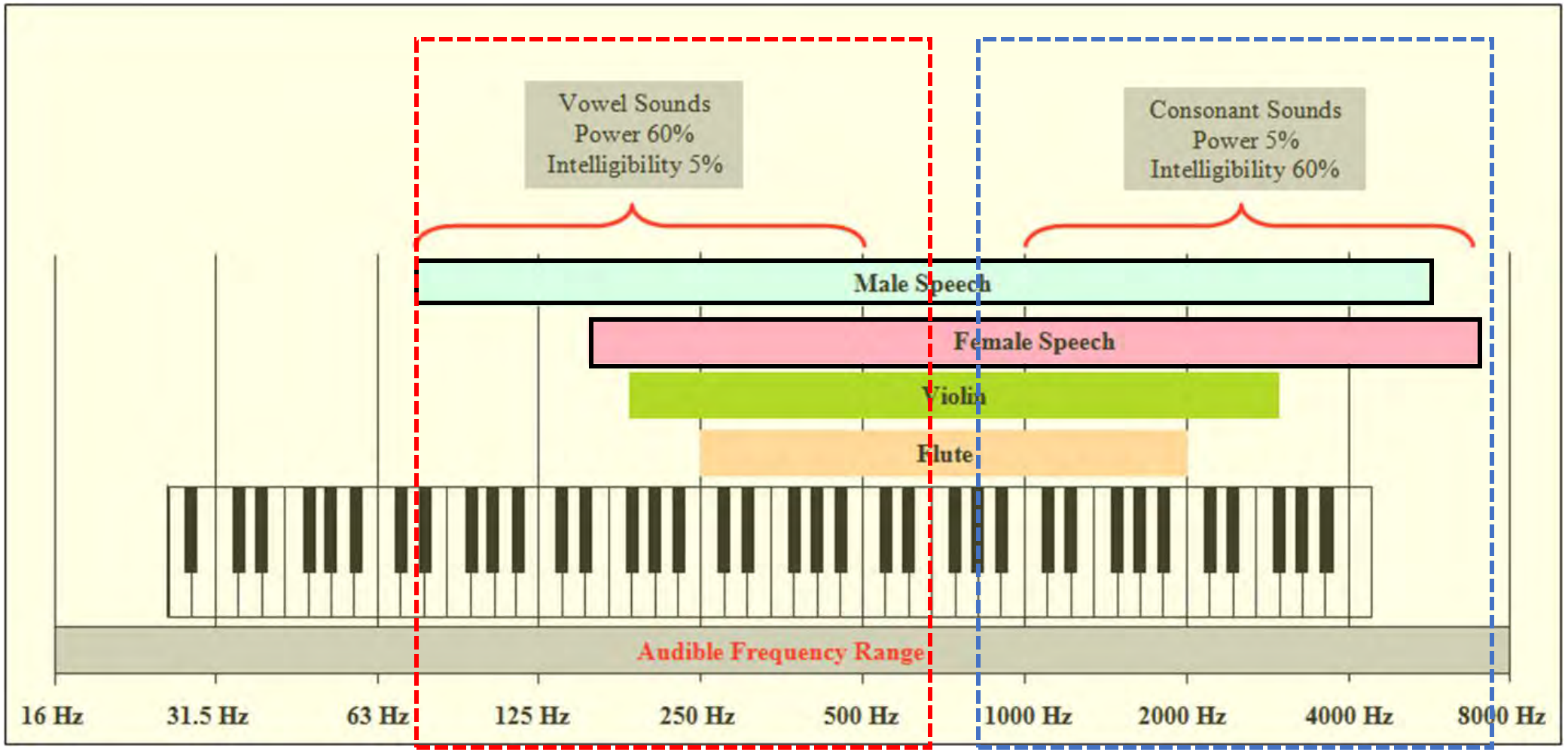


- STC-40 Wall (wall Stops 6” above ceiling)
- CAC-40 Ceiling
- Sound Masking System

Objective is to Achieve Speech Privacy



Speech First?

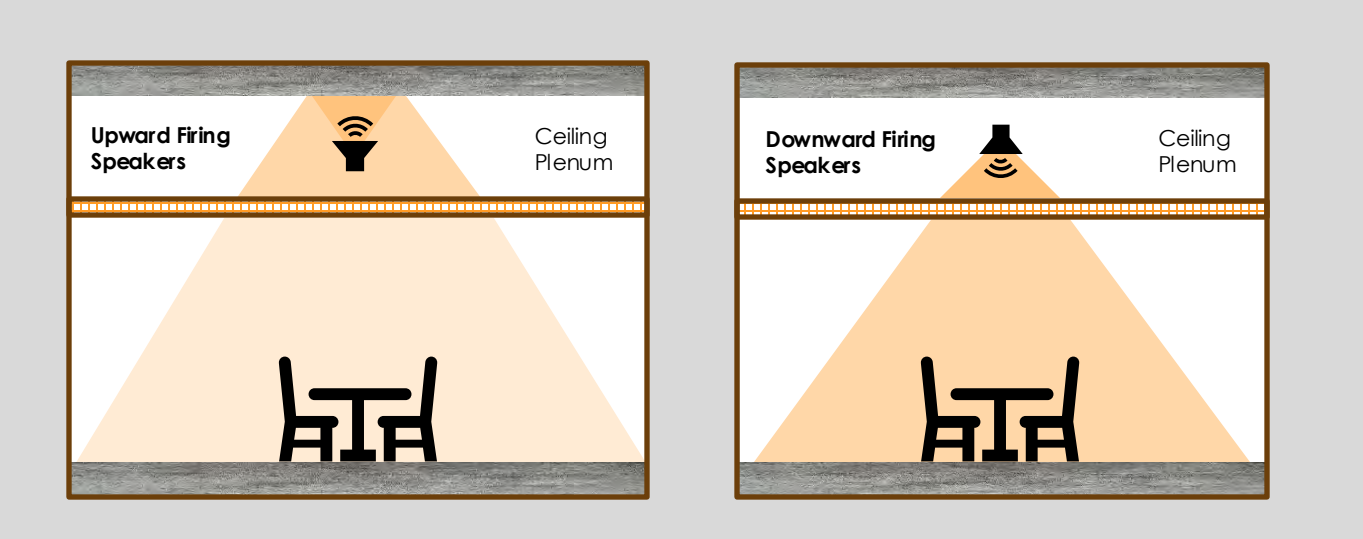


Speech Privacy

- Speech privacy describes the extent to which conversation can be understood by non-participants in the receiver space.
- Privacy means that speech from another area cannot be fully understood, although it may be heard.
- Privacy doesn't mean inaudibility
- To improve speech privacy, speech intelligibility should be reduced.
- Speech consists of vowels and consonants sounds.
- Consonants are extremely important for speech intelligibility.
- Speech intelligibility goes down if the consonants are masked.
- For example, the words "law" and "paw" would sound the same if the consonants "L" and "P" are not audible.
- The consonants are high frequency sounds, and the vowels are low frequency sounds.

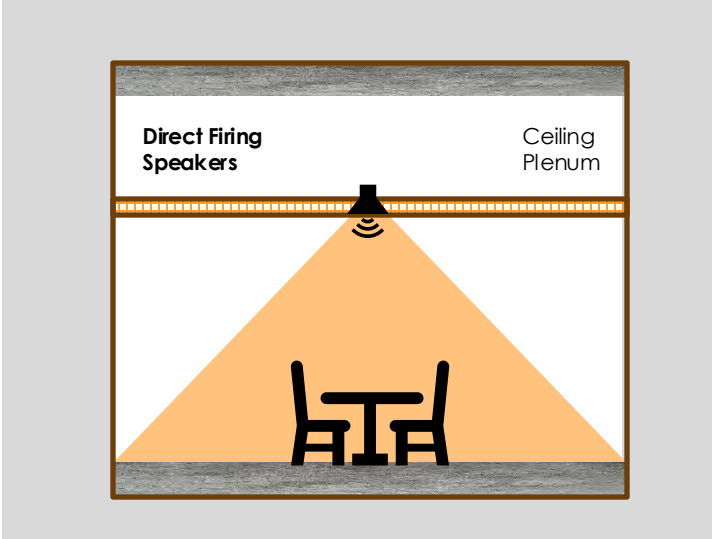
Sound Masking Systems Types

Indirect Field Masking System

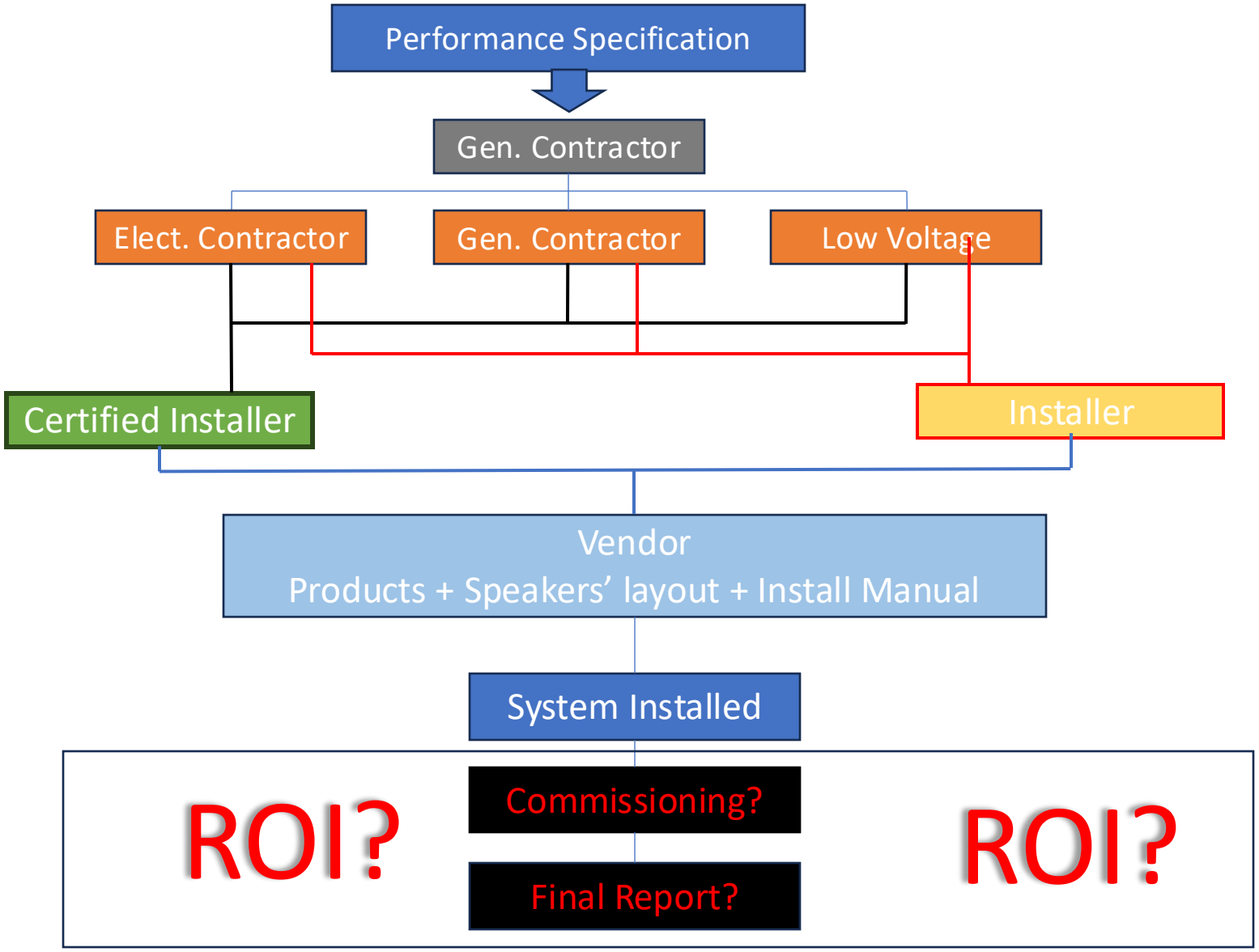


A masking system consists of speakers that emit masking noise into a space above the masking environment and permeate into the masking environment through an obstruction such as a ceiling

Direct Field Masking System

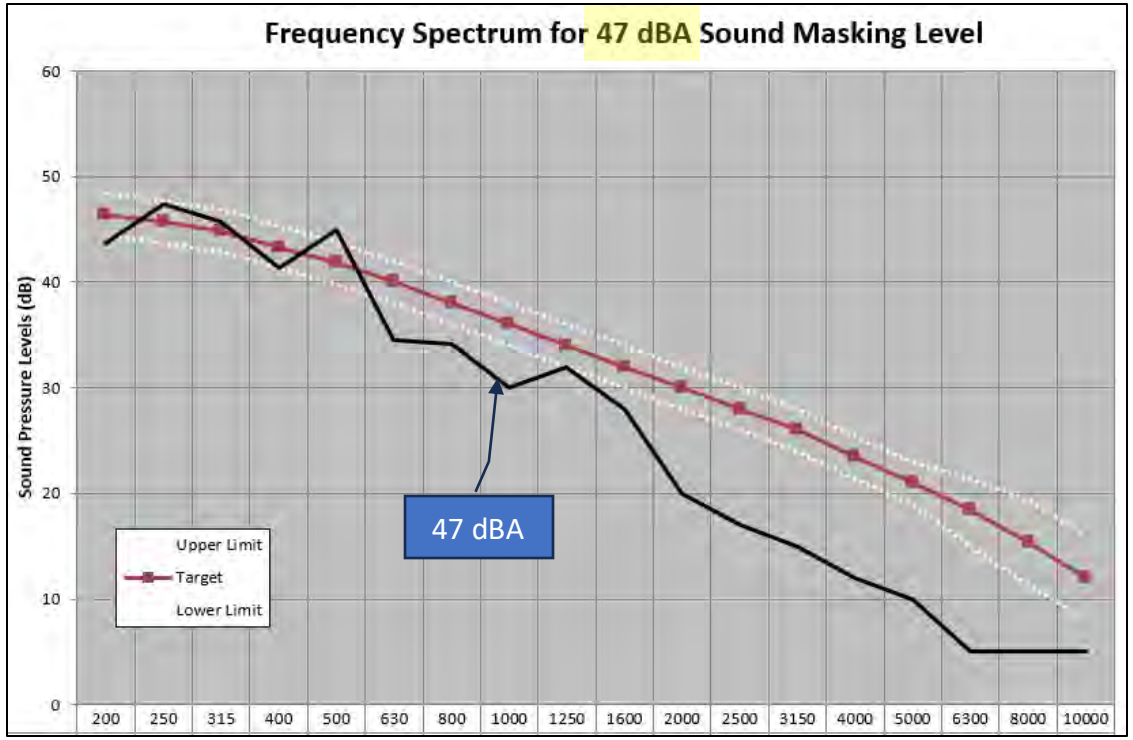


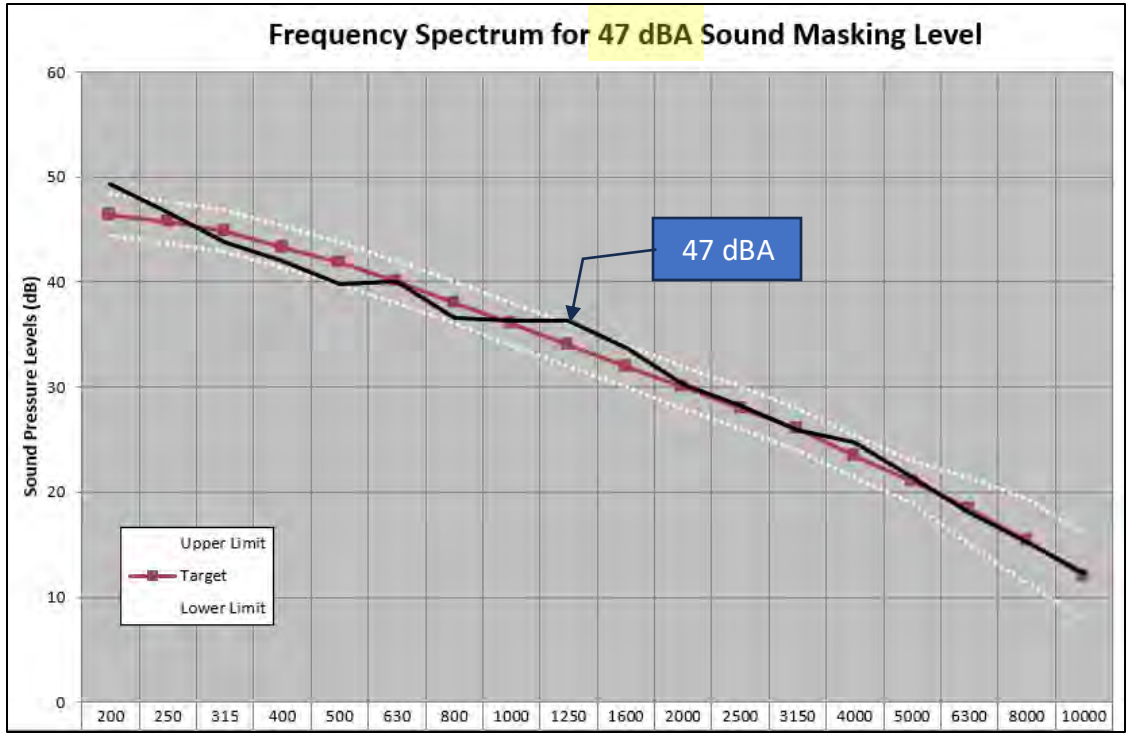
A masking system consists of speakers that emit masking noise directly into a masking environment without permeating through an obstruction such as a ceiling or other above ceiling accessories.

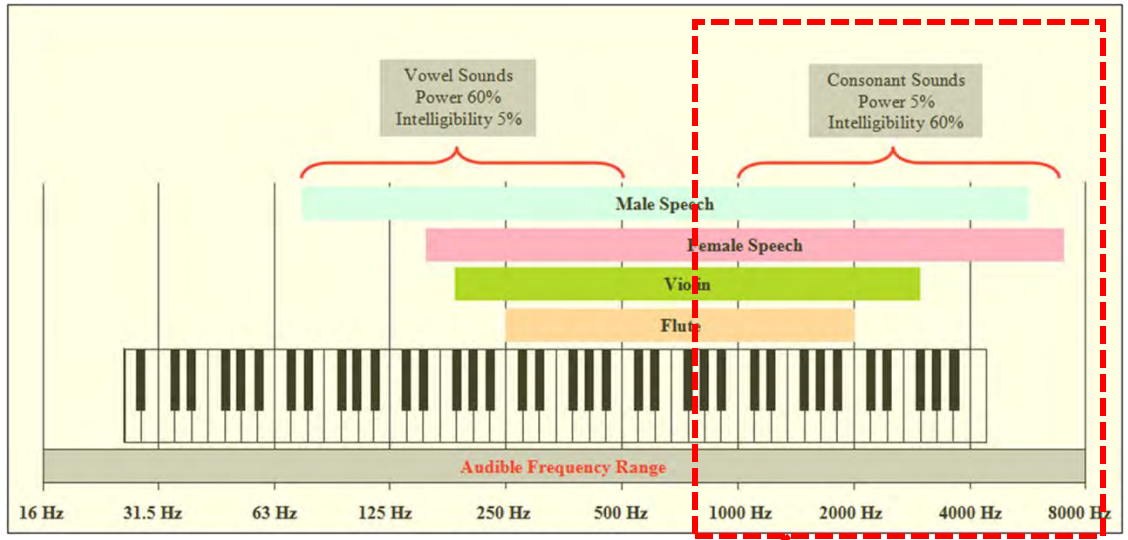

Performance Specification
Gen. Contractor
Elect. Contractor
Gen. Contractor
Low Voltage
Certified Installer
Installer
Vendor
Products + Speakers' layout + Install Manual
System Installed
ROI?
Commissioning?
Final Report?
ROI?

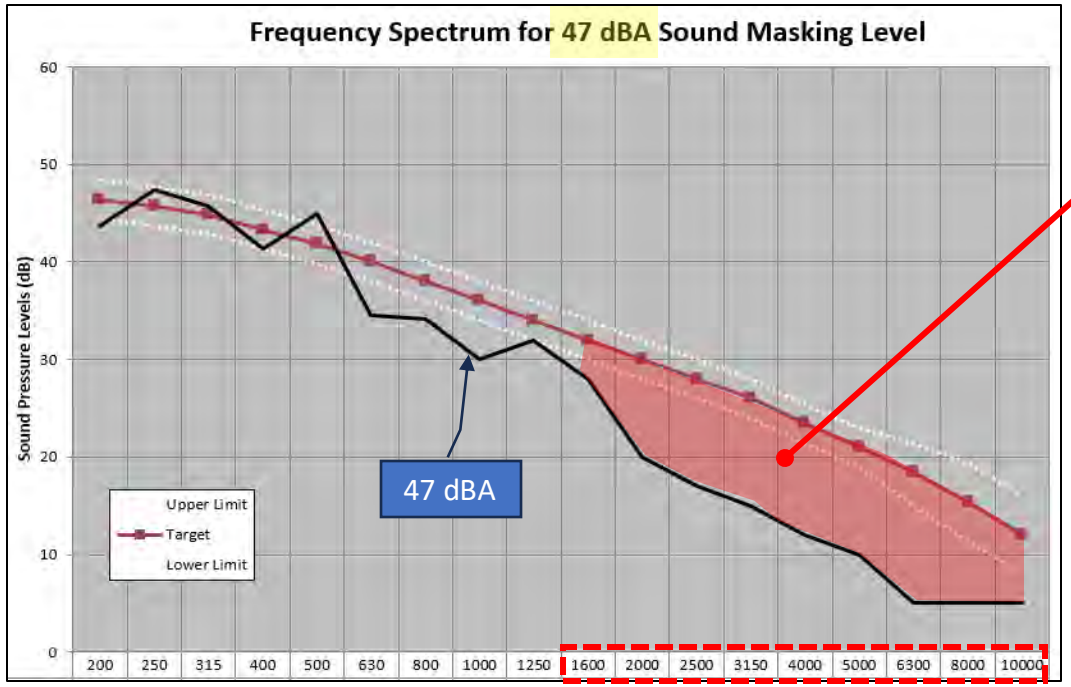
Sound Masking System Commissioning

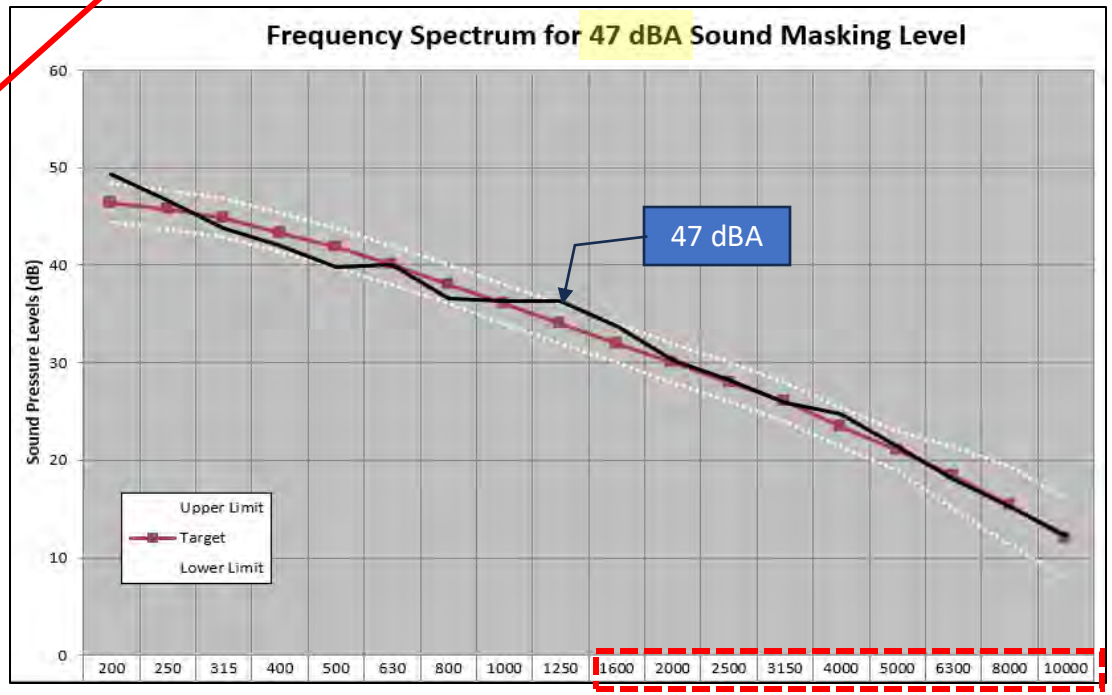
- Turn system on
- Adjust system to meet specification requirements
  - dBA **and** frequency distribution
- Confirm specified masking noise levels are met
  - Use **Proper** sound level meter (Type 1 or 2): dBA **and** frequency distribution
- Confirm at representative locations per zone






Vowel Sounds
Power 60%
Intelligibility 5%
Consonant Sounds
Power 5%
Intelligibility 60%
Male Speech
Female Speech
Violin
Flute
Audible Frequency Range
16 Hz
31.5 Hz
63 Hz
125 Hz
250 Hz
500 Hz
1000 Hz
2000 Hz
4000 Hz
8000 Hz

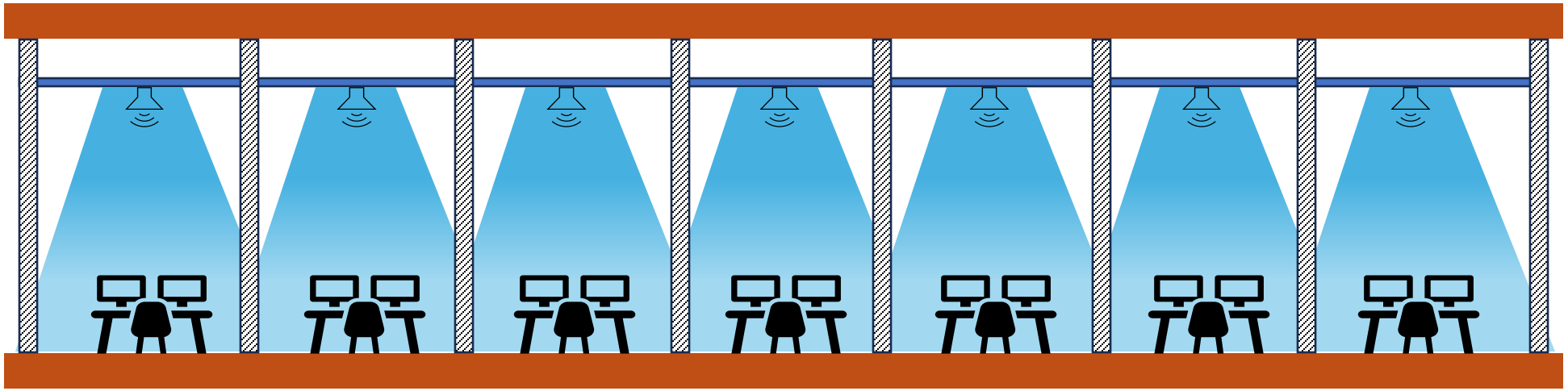

Frequency Spectrum for 47 dBA Sound Masking Level
Sound Pressure Levels (dB)
60
50
40
30
20
10
0
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
Upper Limit
Target
Lower Limit
47 dBA


Frequency Spectrum for 47 dBA Sound Masking Level
Sound Pressure Levels (dB)
60
50
40
30
20
10
0
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
Upper Limit
Target
Lower Limit
47 dBA

Commissioning Report

- Project Name
- Name of installer/adjustor/tuner/commissioner
- Brief description of installed system
- Plans showing speakers' layout (submittal suffices)
- Sound level meter used (Type 1 or Type2)
  - (Model, Type, Serial#, dated calibration certificate, and onsite calibration)
- Plan identifying spot check's locations
- **Show dBA and chart identifying the frequency spectrum of the measured sound relative to the specified masking curve per location**
- Comments per location (met spec, didn't meet spec and why)
- Reviewed by the Project acoustical consultant

Your Return on Investment



To Achieve Privacy
the sound masking system
shall be
Tuned to the sound level (dBA) **AND** balanced to the frequency Spectrum
as per Performance Specification.

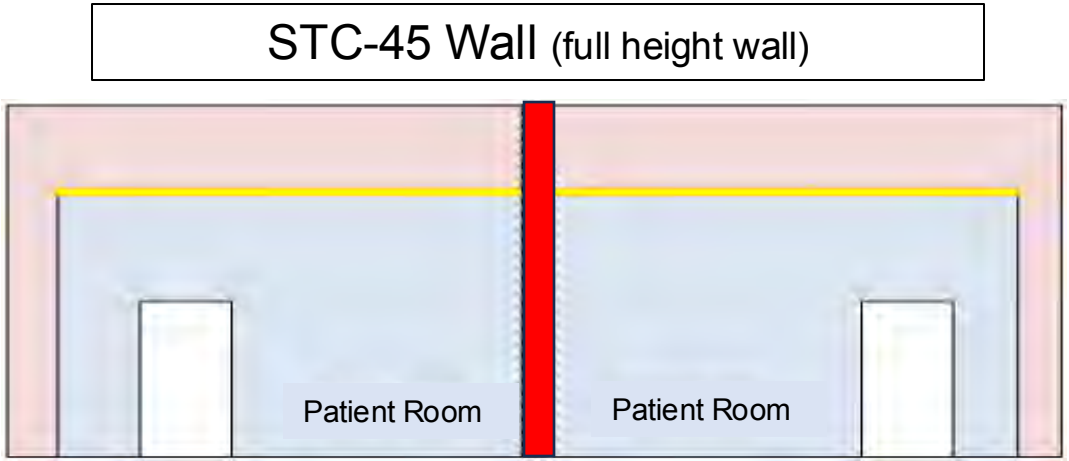
Prefabricated Partitions

Patient Rooms

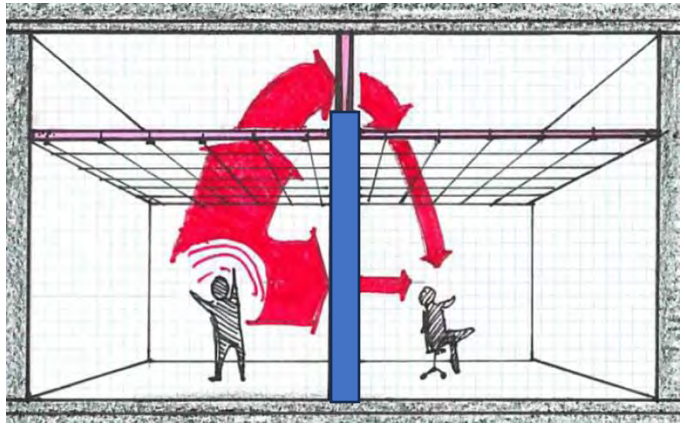
Flexibility to Adapt, Expand and Convert

Evergreen Health MC, Salus Architects

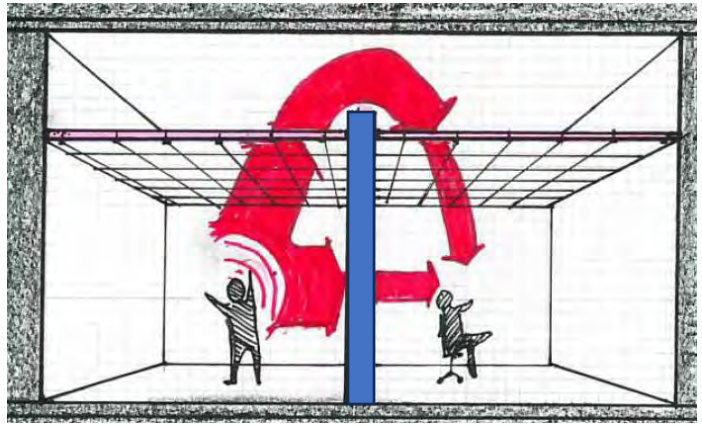
FGI – Patient Room to Patient Room Acoustical Separation Requirements



Full Height Wall vs 6” Above the Ceiling



To meet the FGI Separation Requirements Wall GWB is Full Height



Can we meet STC-45 without taking the gwb to structure?

Benefits

- Reduce cost of building full height walls?
- Reduce cost of penetration isolation?
- Future flexibility
- Reduce or eliminate sheetrock dust

Mockup #1

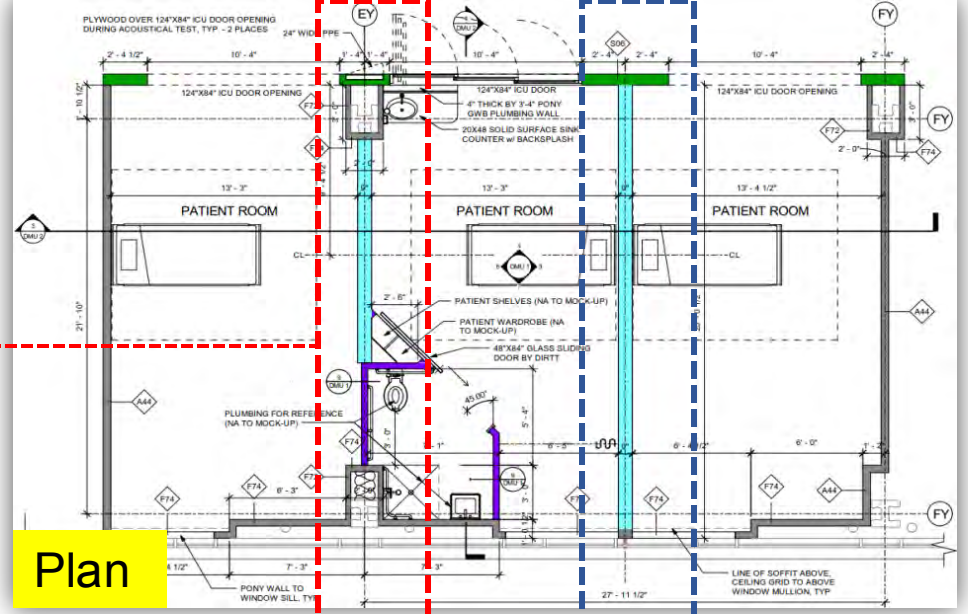
Acoustical Objectives

- Meet STC-45
- Above ceiling Condition
- Open Area
- Ceiling Tile CAC
- DOH

Mockup #1

Bulkhead above footwall, made up of 2x5 removable sheets of mass loaded vinyl.

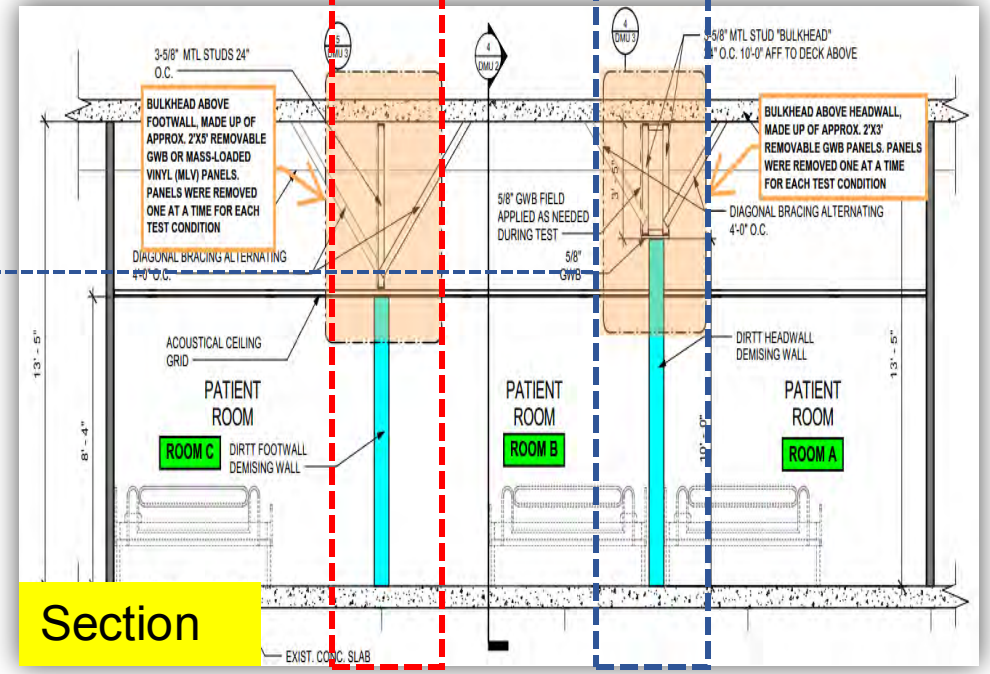
Prefabricated wall stopped at the ceiling plane.



Plan

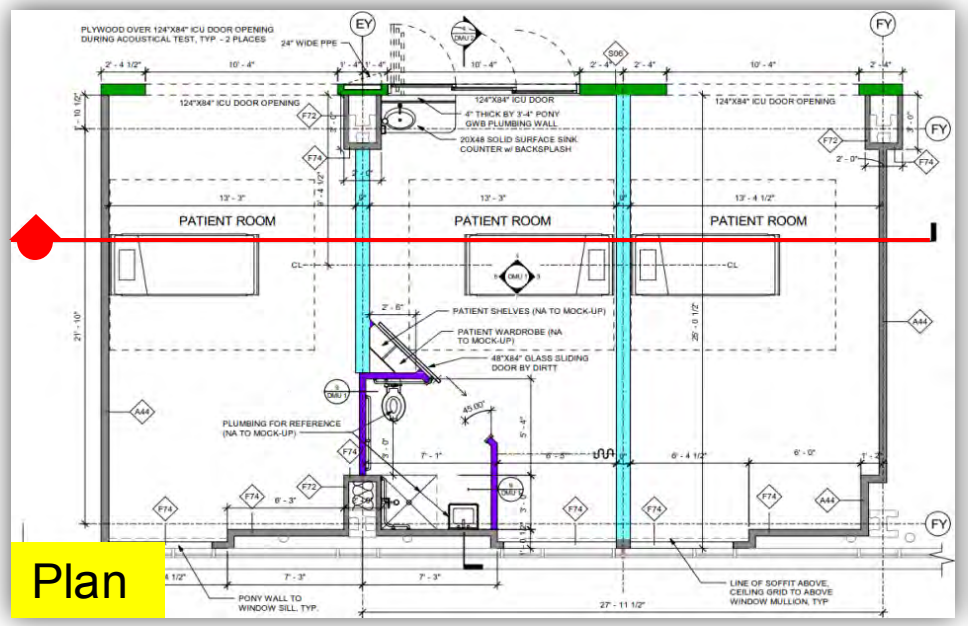
Bulkhead above footwall, made up of approximately 2x3 removable sheetrock panels.

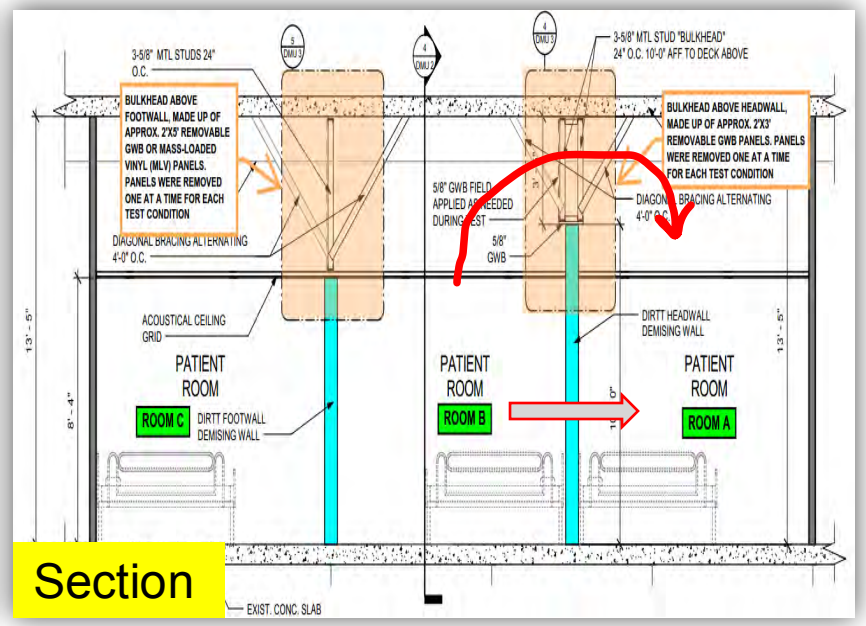
Prefabricated wall stopped above the ceiling plane.

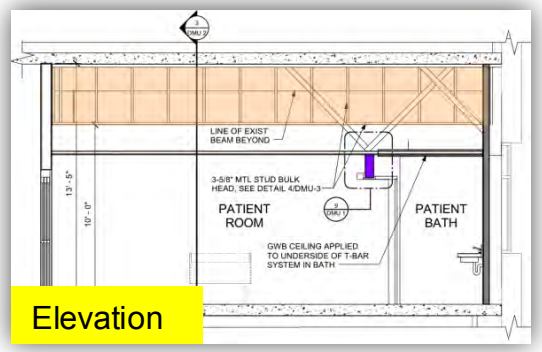


Section

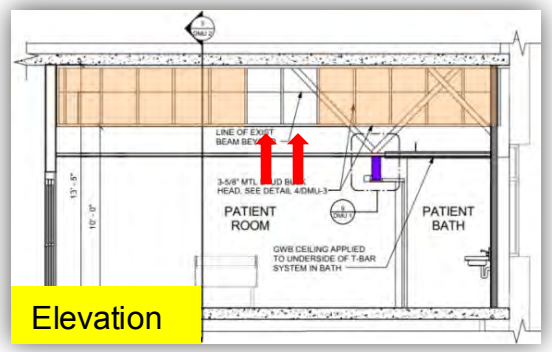
Mockup #1



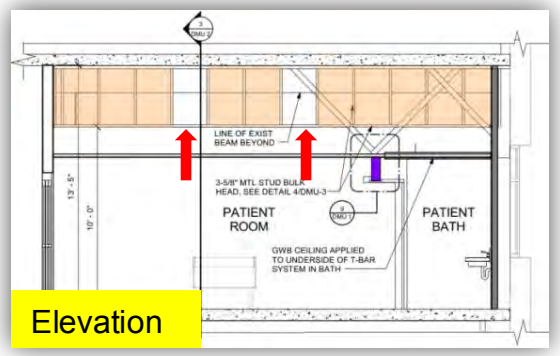




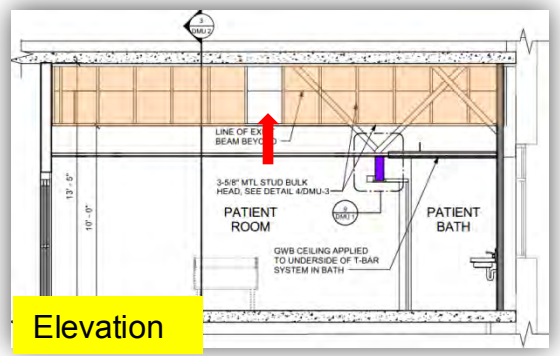
wall above ceiling
100% Closed



Two adjacent panels
removed



Two separate panels
removed

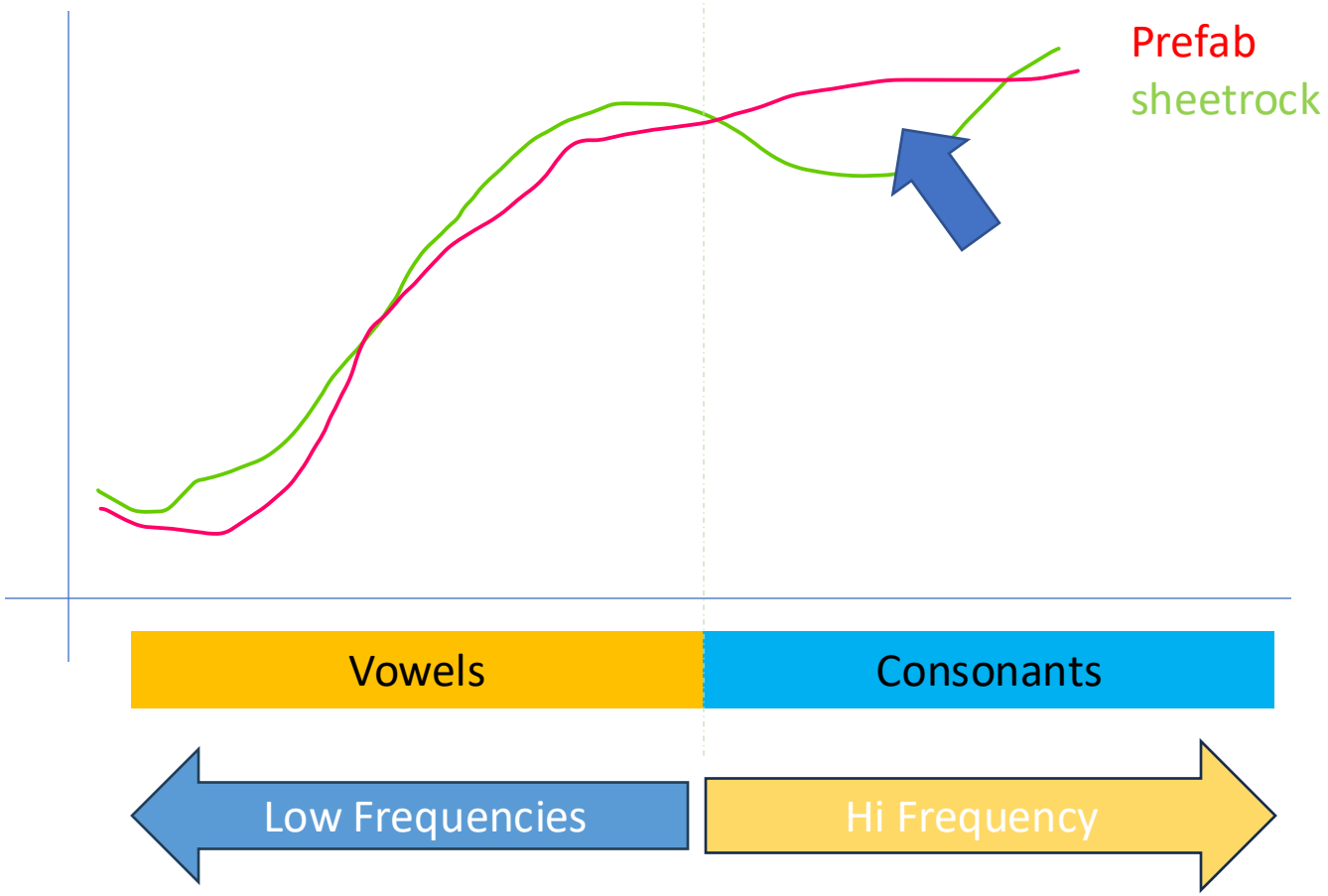


One panel removed

Mockup #1 Findings

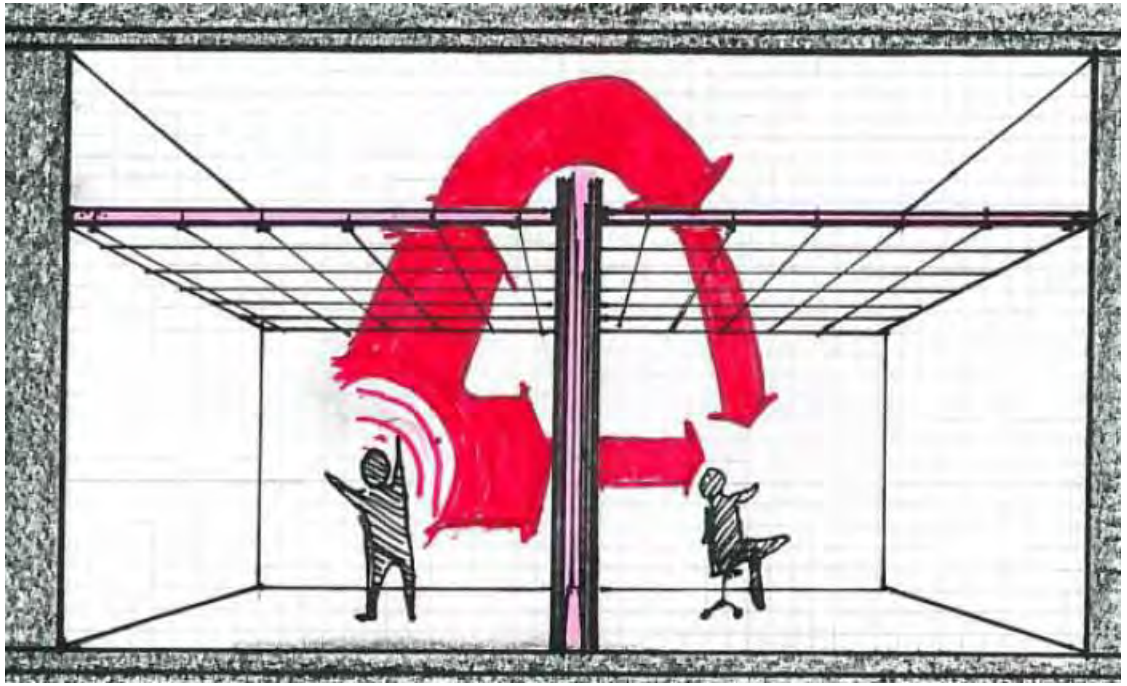
- It is possible to meet STC-45 without full closure above the ceiling
- 12 square feet can be left open
- Absorption in the plenum above the ceiling is important
- ACT Ceiling was CAC-40
- Subjective experience prefabricated wall sounded better than sheetrock construction

Mockup #1 Subjective Listening



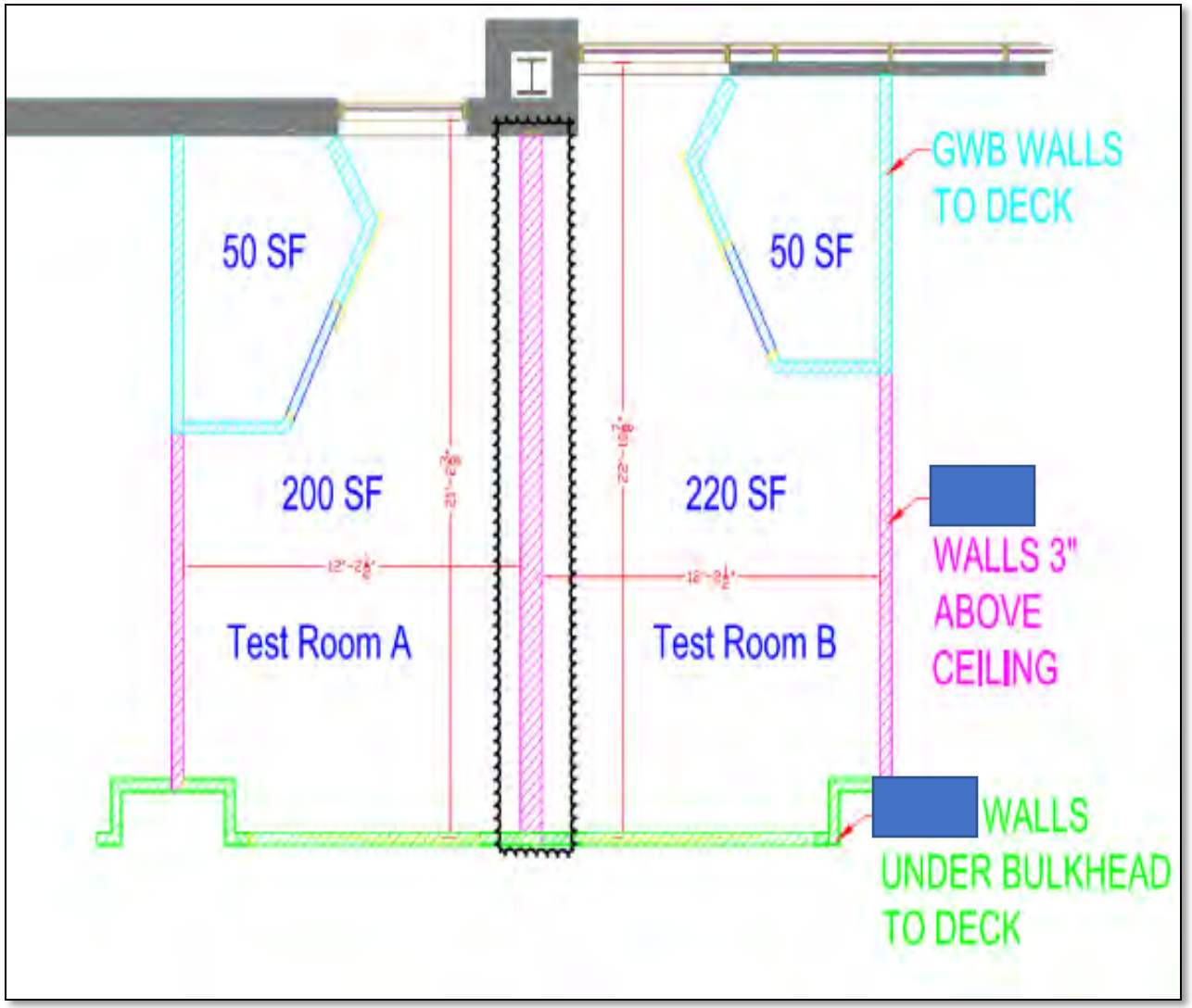
Mockup #2 Objectives

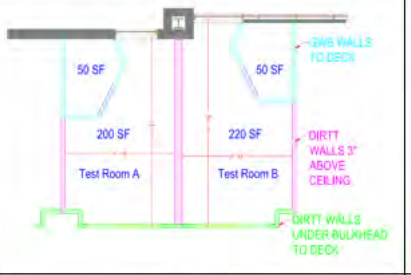
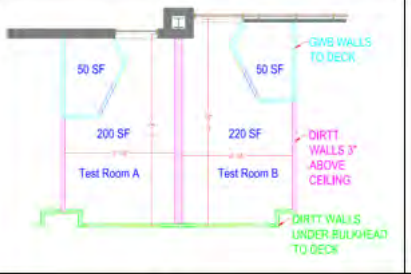
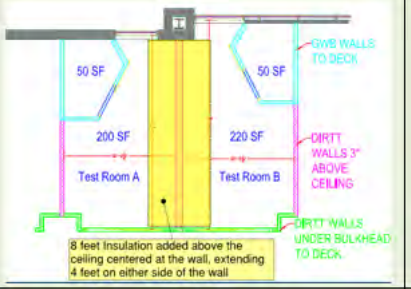
- Can the wall bulkhead above the ceiling be eliminated and still meet STC-45 separation?
- If yes, what is ceiling composition? And do we still need absorption in above the ceiling?

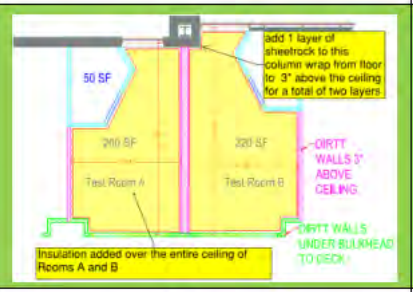
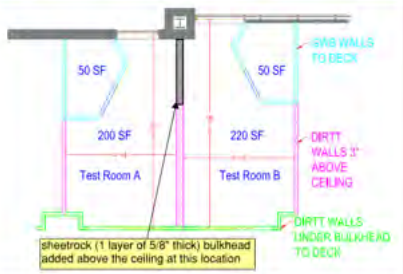
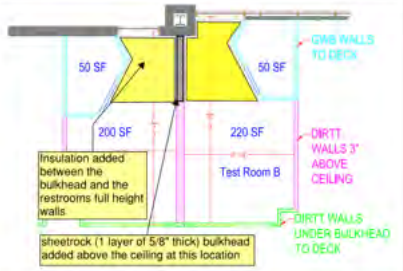
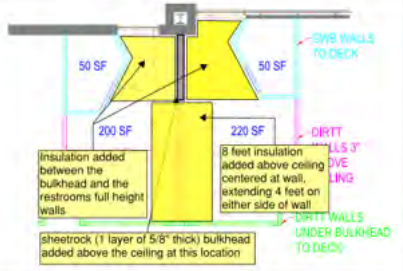


Mockup #2


EXIT


50 SF
50 SF
GWB WALLS TO DECK
200 SF
220 SF
Test Room A
Test Room B
WALLS 3" ABOVE CEILING
WALLS UNDER BULKHEAD TO DECK

Test	Condition	Plan	ASTC	ASTC Chart
1	Base Installation		37	1
2	Test 1 Condition + Entry Walls Blocking		36	2
3	Test 2 Condition + 8' Insulation Centered at Wall		43	3
4	Test 2 Condition + Insulation Over Full Ceiling Area		44	4

Test	Condition	Plan	ASTC	ASTC Chart
5	Test 4 Condition + adding 1 layer to sheetrock to column wrap		45	5
6	Test 2 Condition + 1/3 of over Ceiling Bulkhead Closed		33	6
7	Test 6 Condition + Insulation between bulkhead and bathroom walls		36	7
8	Test 6 Condition + 8' insulation Centered at wall		41	8

Mockup #2 Ceiling Materials

- Acoustical tile ceiling rated at CAC-40 or better backed with 1 layer of 5/8” sheetrock.
- Sound absorptive material in the form of 6.5” thick insulation laid on top of the entire ceiling.

Replace Sheetrock with MGO (Magnesium Oxide Board)
Replace Insulation with 3” thick K-13

Mockup #2 Findings and Questions

Findings

- It is possible to meet STC-45 without closure above the ceiling
- Absorption in the plenum above the ceiling is important
- ACT Ceiling was CAC-40 + 2.2 psf (gwb)

Questions

1. Can the ceiling CAC performance be improved to eliminate the need for GWB or MGO?
2. Can we eliminate the reliance on sound absorptive material in the plenum?

Questions and Next Steps

Q1 - Can the ceiling CAC performance be improved to eliminate the need for GWB or MGO?

A1 - Yes,

- 2x2x1/2” at CAC-44
- 2x4x1/2” at CAC-46

Q2 - Can we eliminate the reliance on sound absorptive material in the plenum?

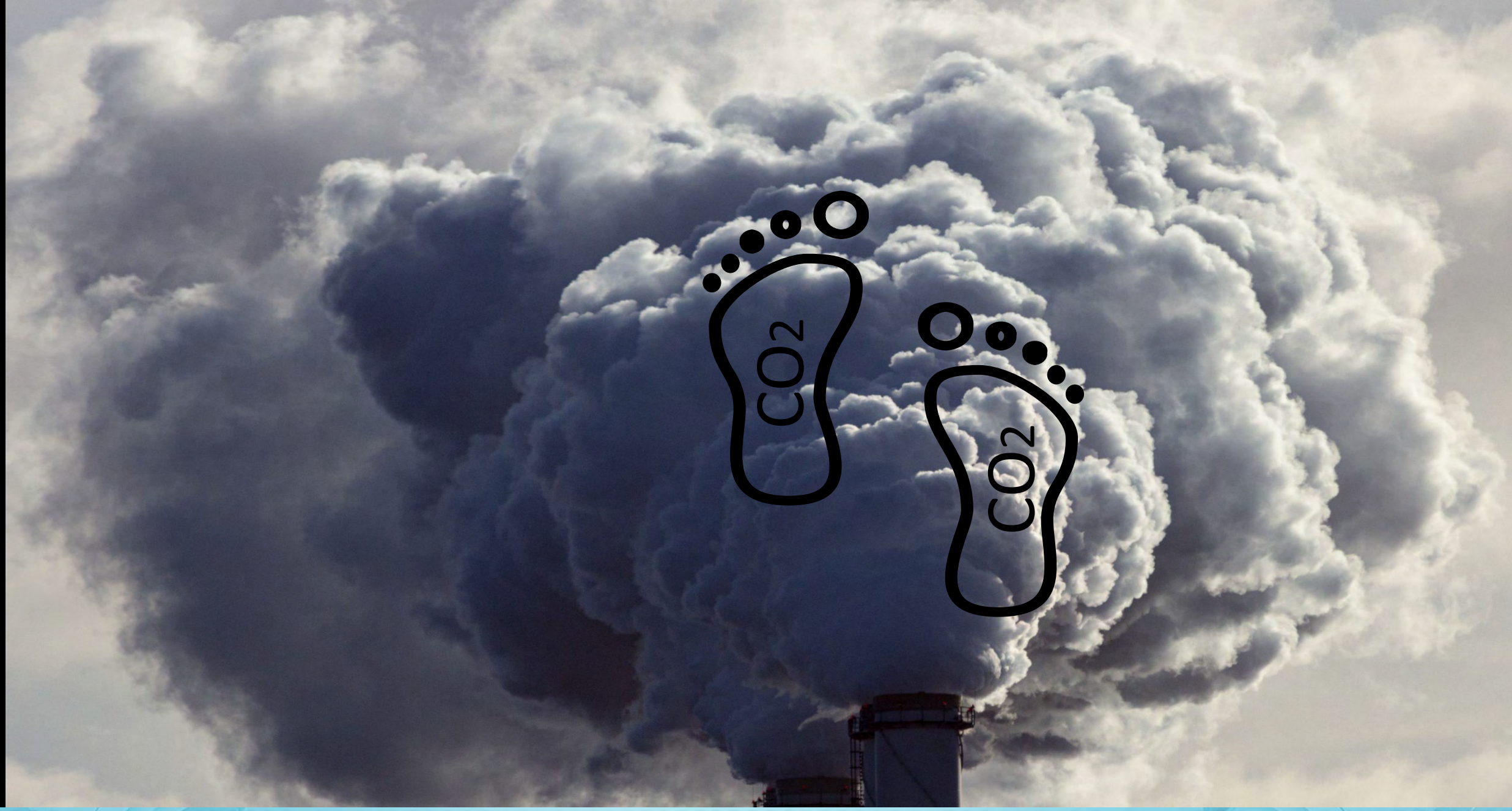
A2 - Yes,

- 2x2x1/2” at CAC-44
- 2x4x1/2” at CAC-46

Notes:

- Not vetted in a mockup
- Might require acoustical panels on the walls of the patient room

Acoustical Walls Carbon Footprint



Studs and Sheetrock Properties

Stud Variations

Manufacturer	Stud Name	Mils	Design Thickness (inch)	Standard Steel Stud Reference
Standard Steel	25 Gauge Steel	18	0.0188	25 Ga
	22 Gauge Steel	27	0.0283	22 Ga
	20 Gauge Steel	30	0.0312	20 Ga Drywall, Non-Structural
	20 Gauge Steel	33	0.0346	20 Ga Structural
Scafco Supreme Studs	D25	15	0.0155	25 Ga
	D20	20	0.0188	20 Ga
	30EQD	30	0.0235	20 Ga Drywall, Non-Structural
	33EQD	33	0.0235	20 Ga Drywall, Non-Structural
	33EQS	33	0.0295	20 Ga Structural
Clark Dietrich ProStuds	PS25	15	0.0158	25 Ga
	PS20	20	0.0190	20 Ga Drywall, Non-Structural
	PS30	30	0.0312	20 Ga Drywall, Non-Structural
	PS33	33	0.0346	20 Ga Structural
Cemco Viper Studs	X-18	18	0.0188	25 Ga
	X-22	22	0.0235	20 Ga Drywall, Non-Structural
	X-28	28	0.0295	20 Ga Structural

5/8” GWB Variations

Manufacturer	GWB Type	Weight (psf)
USG	Firecode Type X	2.2
	Ultralight Firecode X	1.9
	EcoSmart Firecode X	1.8
	EcoSmart Firecode30	1.7
CertainTeed	Type X	2.2
	Easi-Lite 30	1.7

Walls Assemblies

Acoustical Walls Carbon Footprint

WALL NUMBER	5/8" GWB	5/8" GWB	STUD			INSULATION	5/8" GWB	5/8" GWB	STC-RATING	TEST REPORT
			GAUGE	WIDTH	SPACING					
1		Std Type X	25	3-5/8"	16"	R-13	Std Type X		41	TL-93-338
2		Std Type X	PS-20	3-5/8"	16"	R-13	Std Type X		45	RAL-TL12-194
3		Ecosmart ULIX	PS-20	3-5/8"	16"	R-13	Ecosmart ULIX		44	WALL-150919
4		Std Type X	25	3-5/8"	24"	R-13	Std Type X		48	TL-92-348
5		Std Type X	PS-20	3-5/8"	24"	R-13	Std Type X		48	WALL-180602
6		Std Type X	V-X-18	3-5/8"	24"	R-13	Std Type X		44	TL17-358
7		Ecosmart ULIX	PS-20	3-5/8"	24"	R-13	Ecosmart ULIX		48	WALL-150923
8	Std Type X	Std Type X	25	3-5/8"	16"	R-13	Std Type X		52	TL-93-350
9	Std Type X	Std Type X	PS-20	3-5/8"	16"	R-13	Std Type X		47	RAL-TL12-195
10	Ecosmart ULIX	Ecosmart ULIX	PS-20	3-5/8"	16"	R-13	Ecosmart ULIX		46	WALL-150807
11	Std Type X	Std Type X	25	3-5/8"	24"	R-13	Std Type X		54	TL-92-368
12	Std Type X	Std Type X	PS-20	3-5/8"	24"	R-13	Std Type X		50	WALL-180603
13	Std Type X	Std Type X	V-X-18	3-5/8"	24"	R-13	Std Type X		50	TL17-359
14	Ecosmart ULIX	Ecosmart ULIX	PS-20	3-5/8"	24"	R-13	Ecosmart ULIX		50	WALL-160727
15	Std Type X	Std Type X	25	3-5/8"	16"	R-13	Std Type X	Std Type X	56	TL-92-421
16	Std Type X	Std Type X	PS-20	3-5/8"	16"	R-13	Std Type X	Std Type X	53	WALL-170104
17	Ecosmart ULIX	Ecosmart ULIX	PS-20	3-5/8"	16"	R-13	Ecosmart ULIX	Ecosmart ULIX	51	WALL-161222
18	Std Type X	Std Type X	25	3-5/8"	24"	R-13	Std Type X	Std Type X	58	TL-92-369
19	Std Type X	Std Type X	PS-20	3-5/8"	24"	R-13	Std Type X	Std Type X	53	WALL-180604
20	Std Type X	Std Type X	V-X-18	3-5/8"	24"	R-13	Std Type X	Std Type X	54	TL17-360
21	Ecosmart ULIX	Ecosmart ULIX	PS-20	3-5/8"	24"	R-13	Ecosmart ULIX	Ecosmart ULIX	52	WALL-160730

Walls Assemblies

WALL NUMBER	5/8" GWB	5/8" GWB	STUD			INSULATION	5/8" GWB	5/8" GWB	STC-RATING	TEST REPORT
			GAUGE	WIDTH	SPACING					
1		Std Type X	25	3-5/8"	16"	R-13	Std Type X		41	TL-93-338
2		Std Type X	PS-20	3-5/8"	16"	R-13	Std Type X		45	RAL-TL12-194
3		Ecosmart ULIX	PS-20	3-5/8"	16"	R-13	Ecosmart ULIX		44	WALL-150919
4		Std Type X	25	3-5/8"	24"	R-13	Std Type X		48	TL-92-348
5		Std Type X	PS-20	3-5/8"	24"	R-13	Std Type X		48	WALL-180602
6		Std Type X	V-X-18	3-5/8"	24"	R-13	Std Type X		44	TL17-358
7		Ecosmart ULIX	PS-20	3-5/8"	24"	R-13	Ecosmart ULIX		48	WALL-150923
8	Std Type X	Std Type X	25	3-5/8"	16"	R-13	Std Type X		52	TL-93-350
9	Std Type X	Std Type X	PS-20	3-5/8"	16"	R-13	Std Type X		47	RAL-TL12-195
10	Ecosmart ULIX	Ecosmart ULIX	PS-20	3-5/8"	16"	R-13	Ecosmart ULIX		46	WALL-150807
11	Std Type X	Std Type X	25	3-5/8"	24"	R-13	Std Type X		54	TL-92-368
12	Std Type X	Std Type X	PS-20	3-5/8"	24"	R-13	Std Type X		50	WALL-180603
13	Std Type X	Std Type X	V-X-18	3-5/8"	24"	R-13	Std Type X		50	TL17-359
14	Ecosmart ULIX	Ecosmart ULIX	PS-20	3-5/8"	24"	R-13	Ecosmart ULIX		50	WALL-160727
15	Std Type X	Std Type X	25	3-5/8"	16"	R-13	Std Type X	Std Type X	56	TL-92-421
16	Std Type X	Std Type X	PS-20	3-5/8"	16"	R-13	Std Type X	Std Type X	53	WALL-170104
17	Ecosmart ULIX	Ecosmart ULIX	PS-20	3-5/8"	16"	R-13	Ecosmart ULIX	Ecosmart ULIX	51	WALL-161222
18	Std Type X	Std Type X	25	3-5/8"	24"	R-13	Std Type X	Std Type X	58	TL-92-369
19	Std Type X	Std Type X	PS-20	3-5/8"	24"	R-13	Std Type X	Std Type X	53	WALL-180604
20	Std Type X	Std Type X	V-X-18	3-5/8"	24"	R-13	Std Type X	Std Type X	54	TL17-360
21	Ecosmart ULIX	Ecosmart ULIX	PS-20	3-5/8"	24"	R-13	Ecosmart ULIX	Ecosmart ULIX	52	WALL-160730

Red wall assemblies meet STC-45
Blue wall assemblies meet STC-50
All walls with 4 total layers meet STC-50


The End
Questions?
SIEMENS