June 16, 2021

Development of an Anechoic Termination

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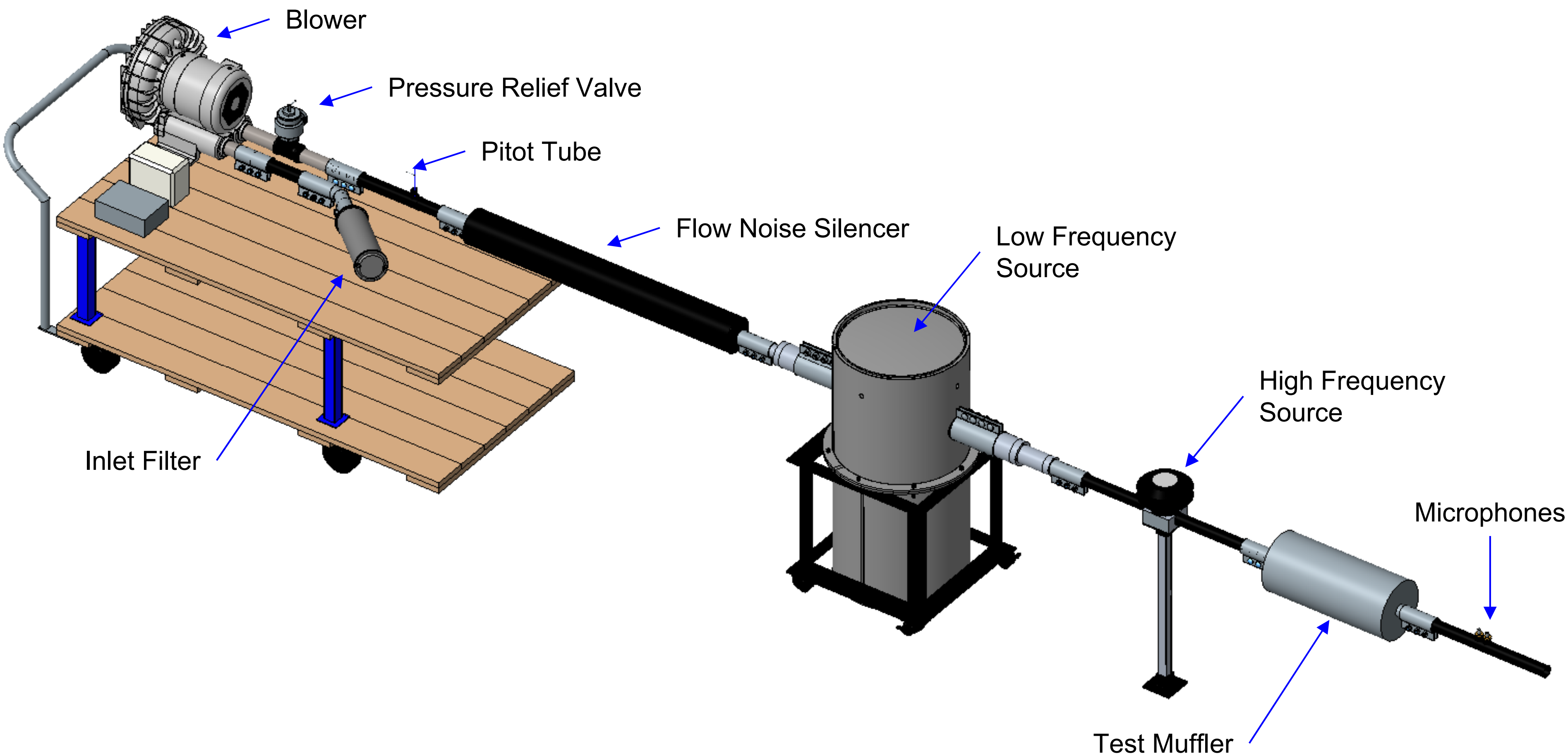
Schematic



Blower
Pressure Relief Valve
Pitot Tube
Flow Noise Silencer
Low Frequency Source
High Frequency Source
Microphones
Inlet Filter
Test Muffler

Flow Rig Pictures

Specification Summary

Pressure Range: $0 - 110\ \mathrm{H_2O}$

Flow Velocity Range: $0 - 0.17\ \mathrm{Ma}$

Plane Wave Cutoff Frequency

$$f_{cutoff} = \frac{1.84c}{\pi D_o}\sqrt{1 - M^2}$$

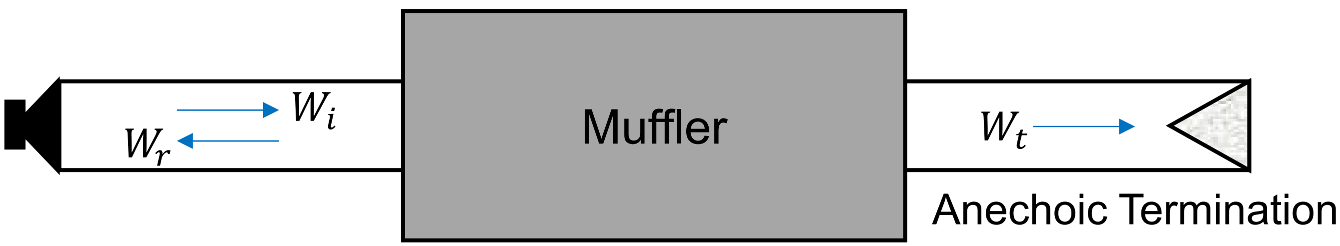
Mach Number [Ma]	Cutoff Frequency 2" OD - [Hz]
0	3957
0.05	3952
0.1	3936
0.15	3911

Current Qualifications

- The flow rig is currently qualified for:
  i. Pressure Drop
  ii. Transmission Loss (No Flow)
  iii. Noise Reduction (No Flow)
  iv. Insertion Low with Flow

Rational for an Anechoic Terminations

- An anechoic termination is necessary for the measurement of sound power independent of position
- Uses for anechoic terminations
  I. Measurement of the sound power of fans and other air-moving devices
  II. Measurement of transmission loss (TL)

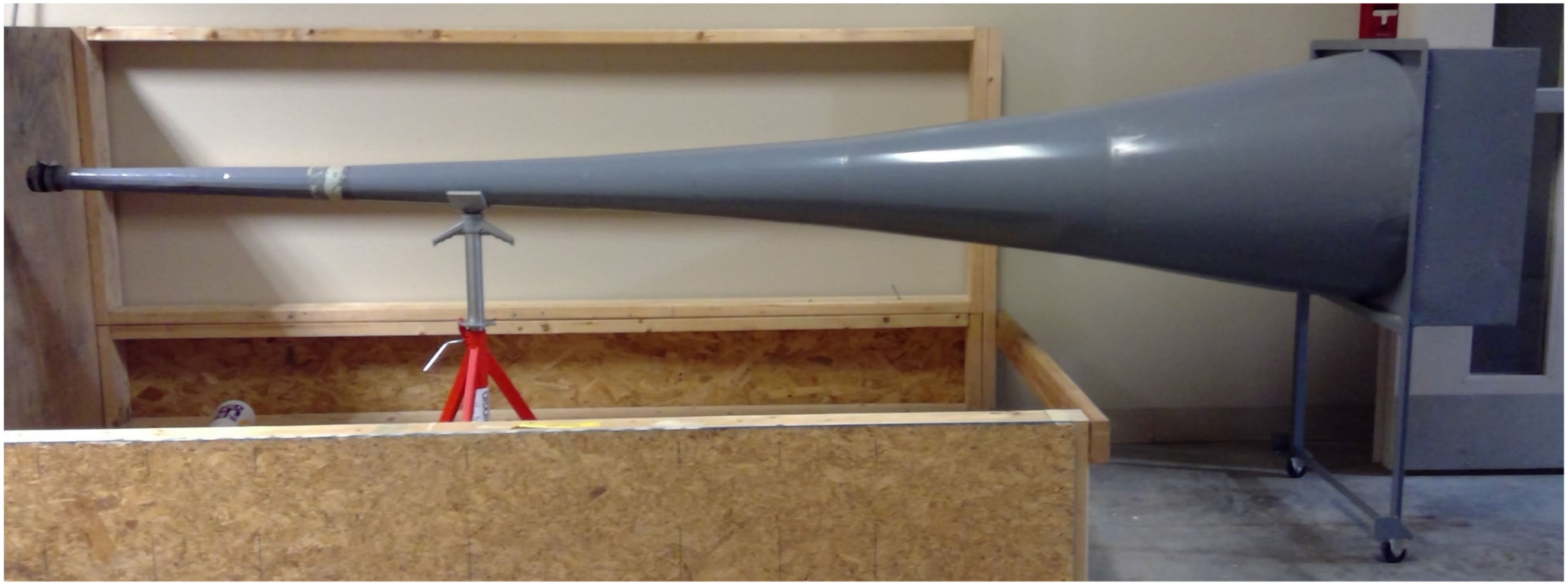


$$TL(dB) = 10\log_{10}\frac{W_i}{W_t}$$

Design of the Anechoic Termination

Donated by Hank Howell, Ph. D.

Total Length: $3.3\,m\ (\sim 11 ft)$



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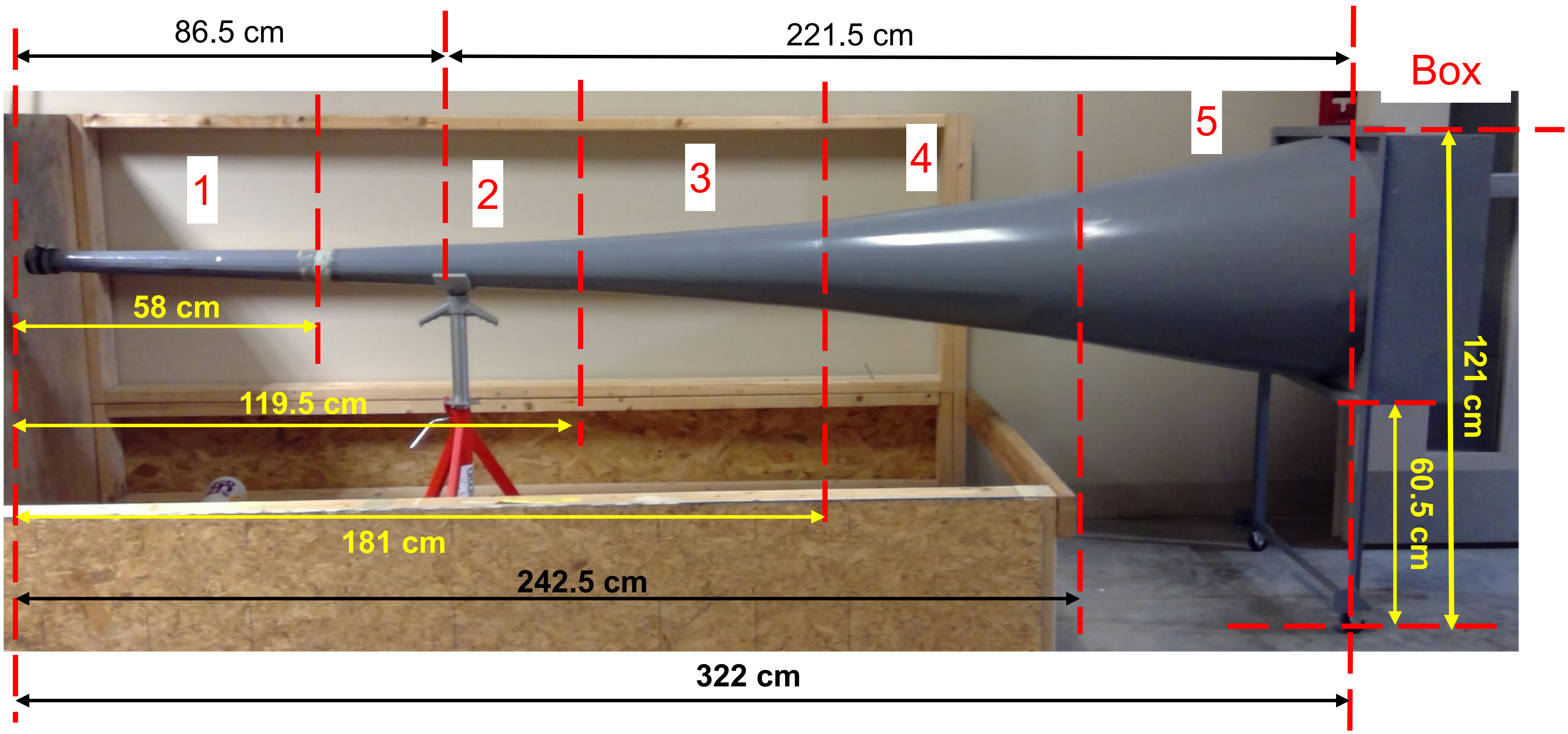

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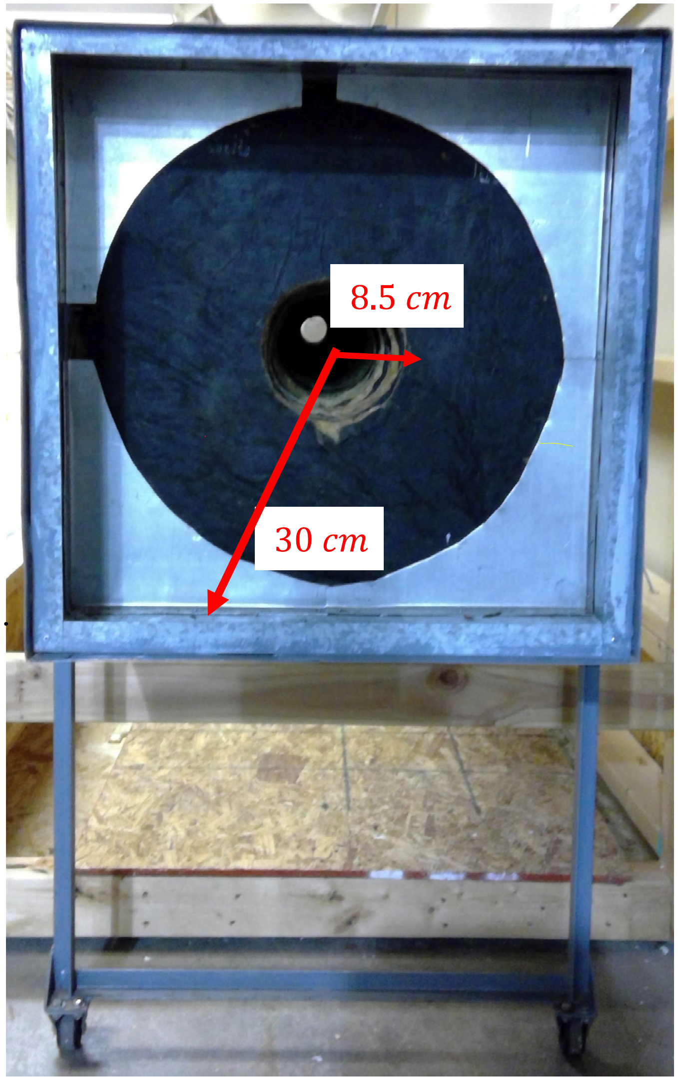
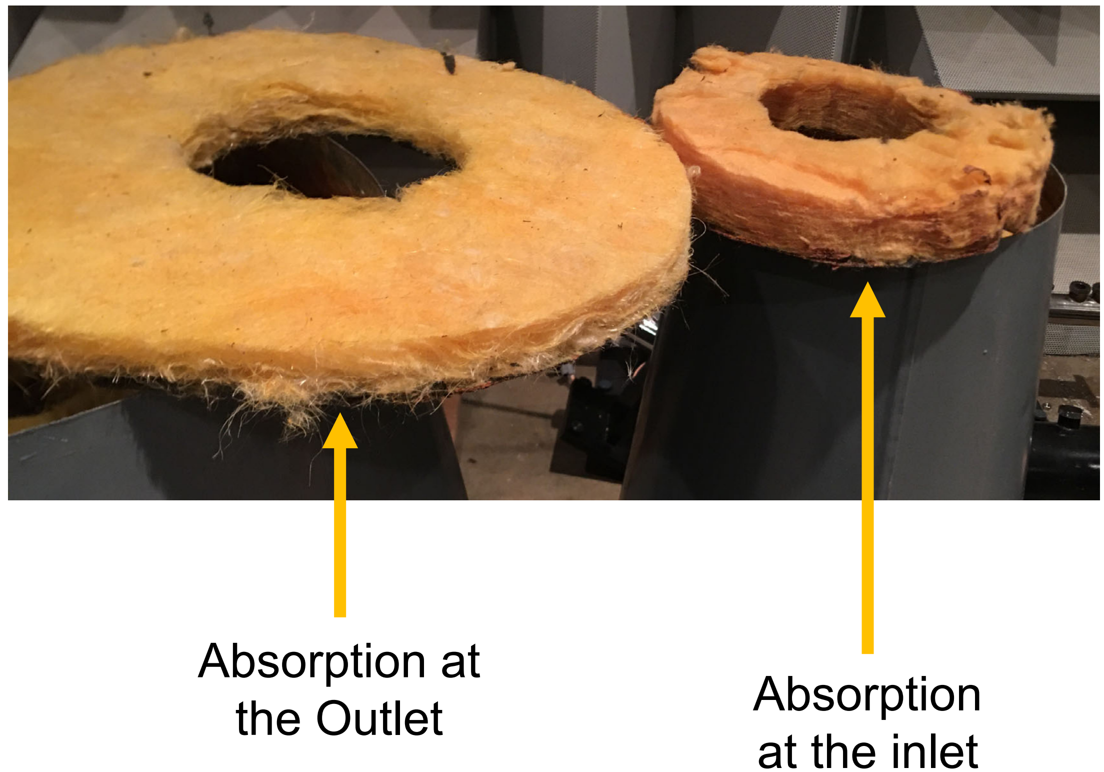




Measurement of the Absorption Coefficient

- Use two-microphone technique modified for flow
- Complex pressure reflection coefficient including effect of flow

$$R = \frac{H_{12}e^{-j\beta M s} - e^{-j\beta s}}{e^{-j\beta s} - H_{12}e^{-j\beta M s}}$$

$$\beta = \frac{k}{1-M^2} \quad H_{12} = \frac{p_2}{p_1}$$

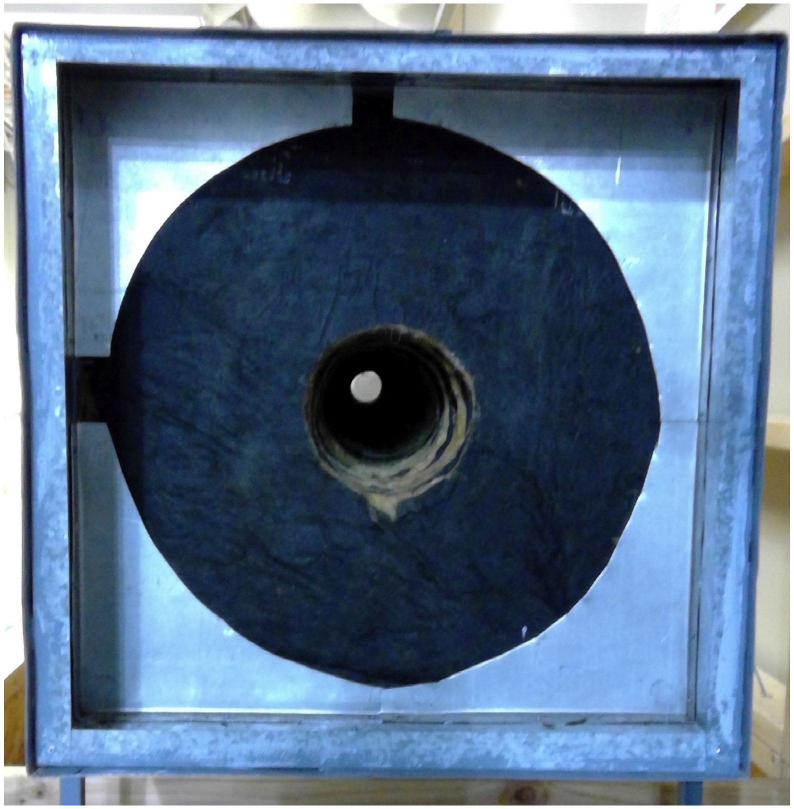
- Reflection and Absorption coefficient

$$r_a = \sqrt{Re(R)^2 + Im(R)^2}$$

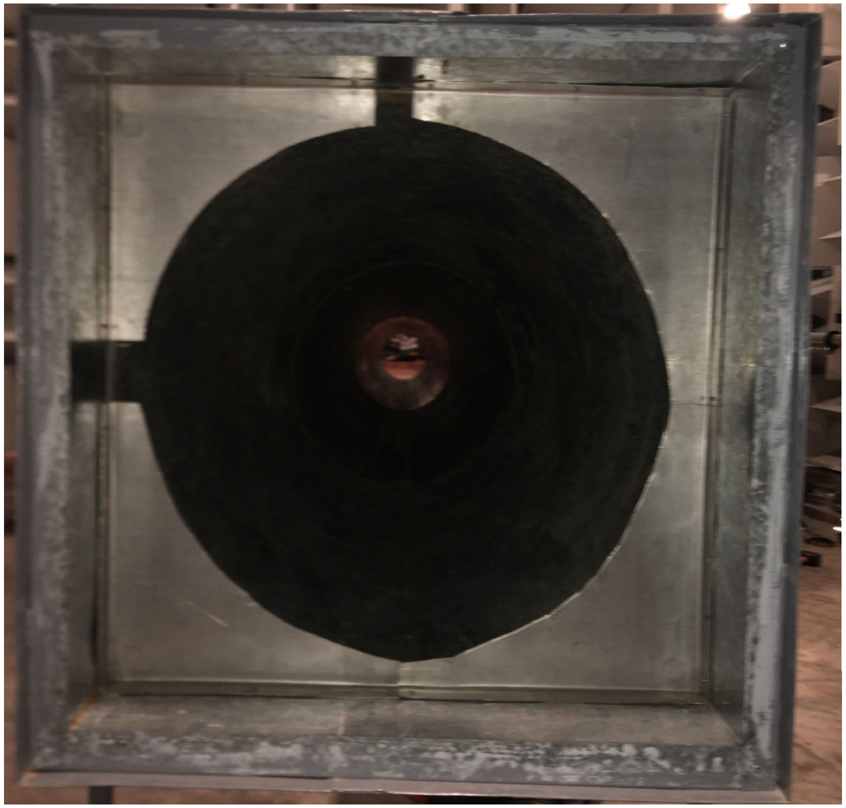
$$\alpha = 1 - r_a^2$$

Measurement Cases

Case 1: With Absorption



Case 2: Empty Horn

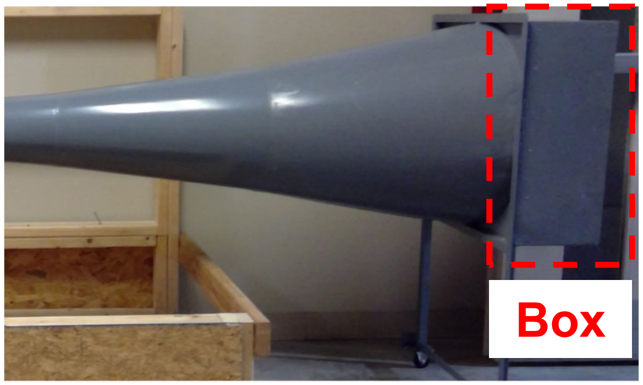


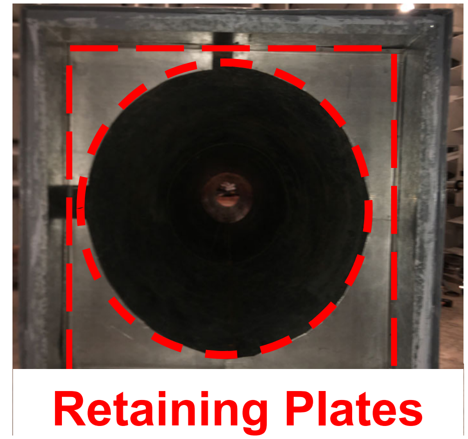
Measurement Cases

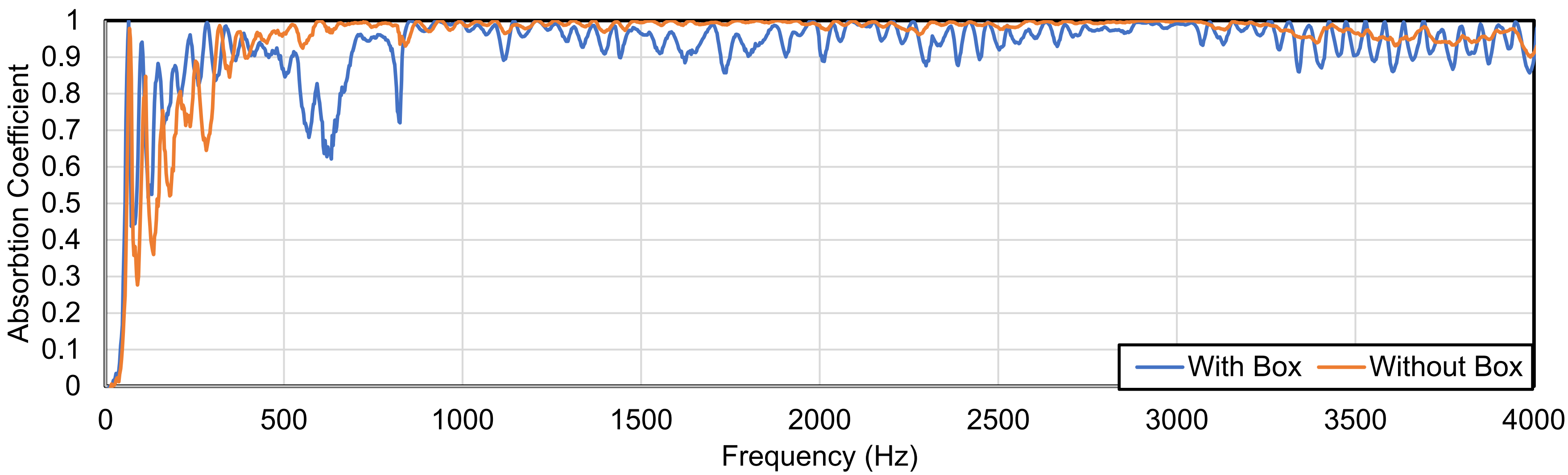
Case 1: With Absorption

Case 2: Empty

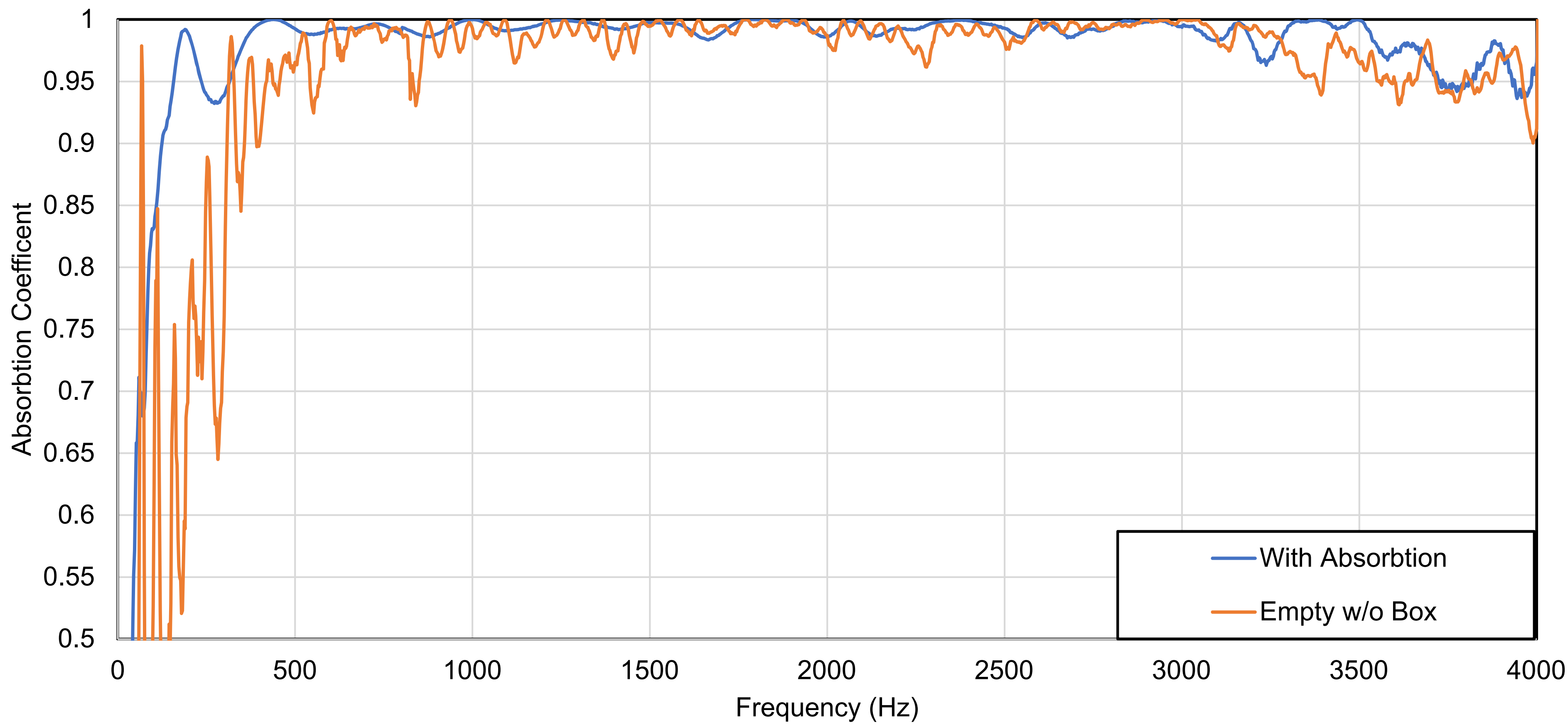
Affect of Box's Retaining Plates Sans Flow



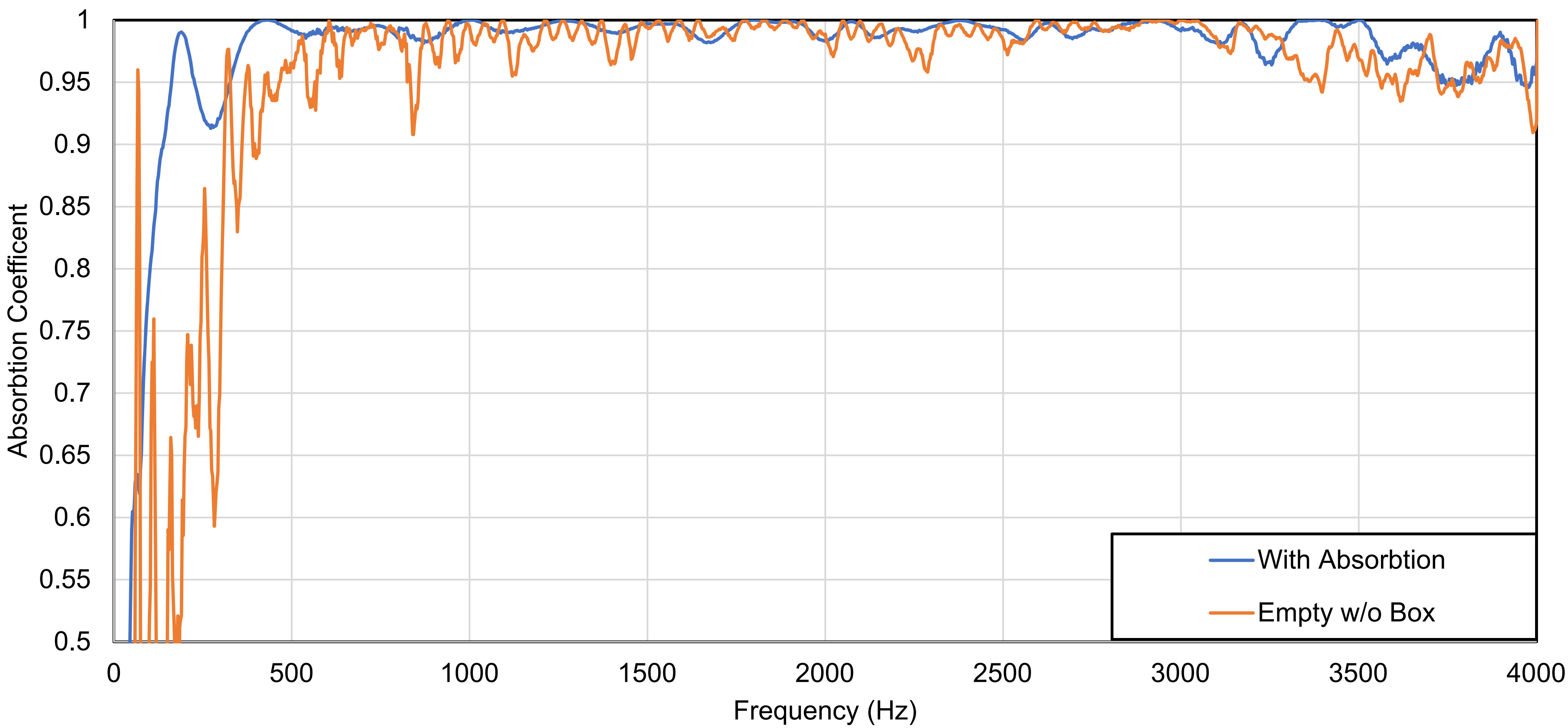




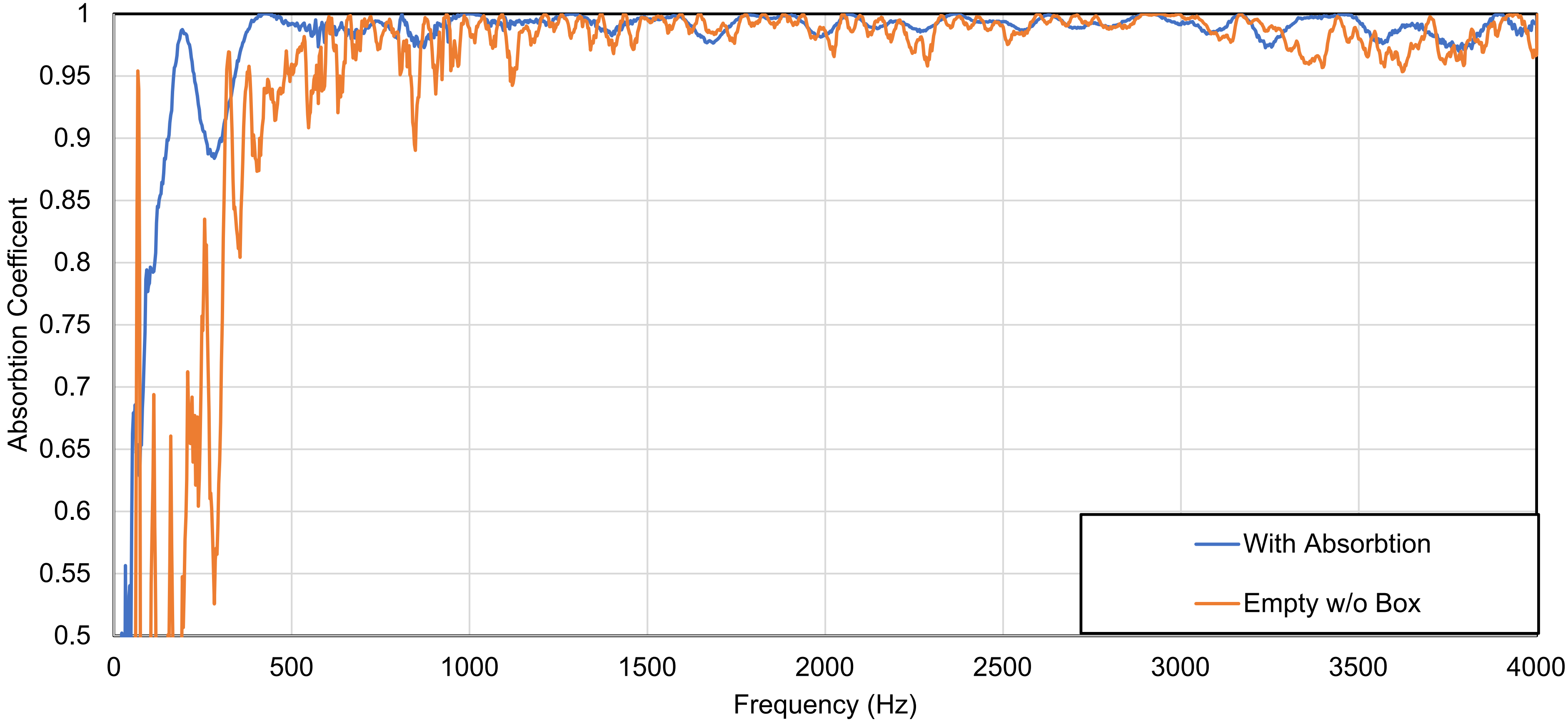
Affect of Glass Fiber Lining No Flow



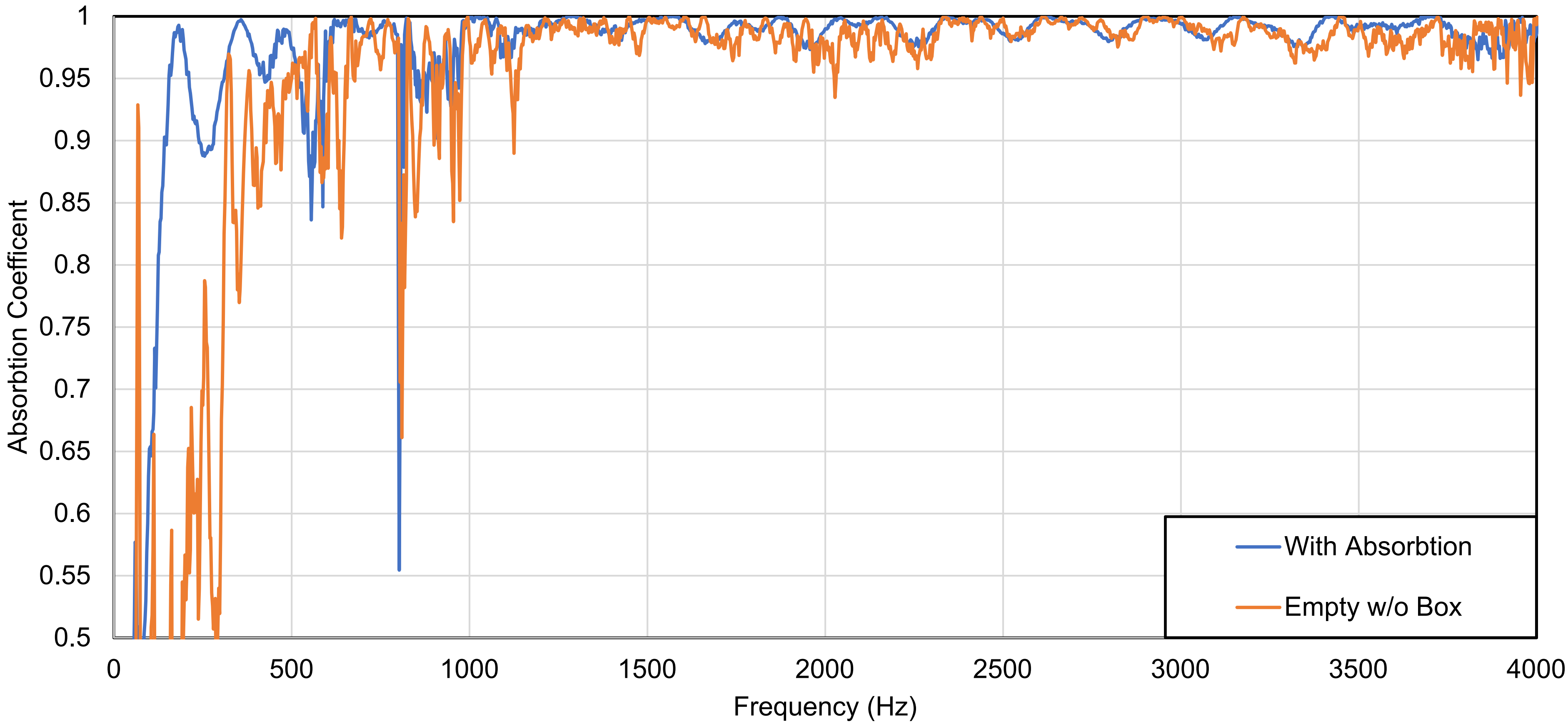
Affect of Glass Fiber Lining Mach 0.05



Affect of Glass Fiber Lining Mach 0.1



Affect of Glass Fiber Lining Mach 0.15



Summary of Results

	Average Absorption Coefficent							
	No Flow		Mach 0.05		Mach 0.1		Mach 0.15	
Freq. Range	With Absorpstion	Empty w/o Box	With Absorpstion	Empty w/o Box	With Absorpstion	Empty w/o Box	With Absorpstion	Empty w/o Box
>10 Hz	0.98	0.96	0.98	0.96	0.98	0.95	0.97	0.95
>100 Hz	0.99	0.97	0.99	0.97	0.99	0.97	0.99	0.96
>500 Hz	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98

- Under No flow and Mach Numbers less than 0.15 the absorption predominantly effects frequencies less than 100Hz
- Mach numbers greater than 0.1 the absorption predominantly influences frequencies up to and above 500 Hz

Conclusions and Next Steps

- The anechoic termination is very affective at frequencies above 500Hz under flow conditions less than Mach 0.15
- The performance below 1000Hz at Mach 0.15 needs to be improved
- Measure transmission loss with flow of simple easily validated muffler using the two-load and three-point method.