

Mechanical Noise Generation, Duct Attenuators and Internal Duct Lining use in Noise Control

Presented By:
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1

ACMV SYSTEMS
Basic Fan's Sound Power Level

SWL = 77 + 10logkW + 10logP dB

SWL = 25 + 10logQ + 20logP dB

SWL = 130 + 20logkW - 10logQ dB

Where SWL = overall sound power level in the octave frequency bands from 31.5Hz to 8000Hz

kW = Rated motor power, kW

P = Static pressure developed by the fan, mm w.g.

Q = Volume flow delivered, m^3/h

As published in Woods Practical Guide to Noise Control

Correction To Obtain Band Spectra For Various Fan Blade Types

Example: Axial Fan; Q=13,000m^3/h, P=17mm w.g.

SWL = 25 + 10logQ + 20logP dB
= 25 + 10log (13000) + 20log (17) dB
= 90dB (basic noise data)

Octave Band Centre Frequency, Hz	Add to overall sound power level, dB							
	63	125	250	500	1000	2000	4000	8000
Centrifugal:								
Backward curved blades	-4	-6	-9	-11	-13	-16	-19	-22
Forward curved blades	-2	-6	-13	-18	-19	-22	-25	-30
Radial blades	-3	-5	-11	-12	-15	-20	-23	-26
Axial	-7	-9	-7	-7	-8	-11	-16	-18
Bifurcated	-3	-3	-4	-5	-7	-8	-11	-
Propeller Fan	-3	-4	-1	-8	-12	-13	-20	-

Octave Band Centre Frequency, Hz	Add to overall sound power level, dB							
	63	125	250	500	1000	2000	4000	8000
Overall SWL	90	90	90	90	90	90	90	90
Spectrum correction for Axial	-7	-9	-7	-7	-8	-11	-16	-18
Octave Band SWL	83	81	83	83	82	79	74	72

As published in Woods Practical Guide to Noise Control

AHU Data - Fan Inlet/Outlet Sound Power



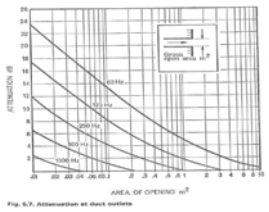
Fan SWL
= Measured L_{p1m}(free-field) + free field distance attn + Opening end reflection

Distance Attenuation Formula:
$A_{tt} = 10\log (1/4\pi r^2)$
r = 1m
A_{tt} = -11dB --------- (1)

So $L_{p1m} \rightarrow L_{p0m}$ + 11dB ≡ L_w

(2) -----

End reflection



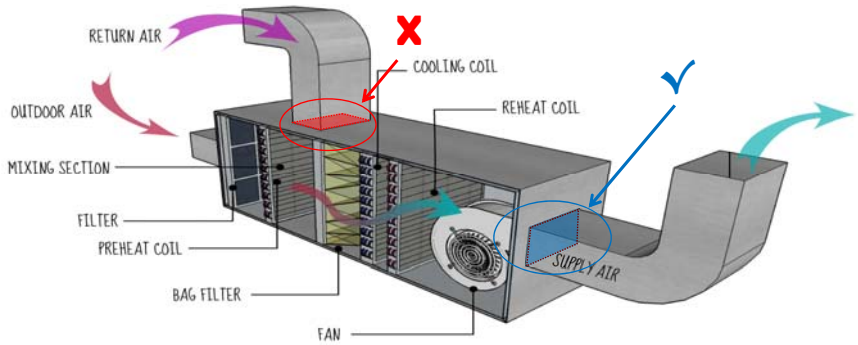
When sound exits an opening, the back pressure caused by the air impedance miss-match causes sound energy to be attenuated.

Example:
SA opening A = 600 x 400 = 0.24m^2
So, for fan SWL = Measured L_{p1m}(free-field) + 11dB + End reflection
@ each octave band

Octave Band	63	125	250	500	1k	2k	4k
Measured L_p Values	X	X	X	X	X	X	X
Attenuation at outlet	+9	+5	+2	-	-	-	-
Measured L_p to L_w	+11	+11	+11	+11	+11	+11	+11
SWL Value L_w	Y	Y	Y	Y	Y	Y	Y

Note: If fan data in dBA, do dBA to dBL spectrum correction first i.e. +26@63Hz, +16@125Hz, +9@250Hz, +3@500Hz, +0@1kHz, -1@2kHz, -1@4kHz

AHU Outlet and Inlet Sound Power Data



The RA measured $L_{p1m(free\text{-}field)}$ when corrected to SWL induct cannot be applicable for calculation usage because of losses from;

- Filters
- Coils
- Mixing boxes (semi-reverberant and exit condition)

have not been taken into account.

Insertion Loss For Unlined Ducts Type

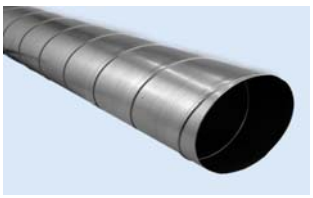
Rectangular Duct

Duct Size, mm	P/A, 1/mm	Attenuation, dB/m Octave Midband Frequency, Hz 63	125	250	>250
150 × 150	0.26	0.98	0.66	0.33	0.33
305 × 305	0.13	1.15	0.66	0.33	0.20
305 × 610	0.10	1.31	0.66	0.33	0.16
610 × 610	0.07	0.82	0.66	0.33	0.10
1220 × 1220	0.03	0.49	0.33	0.23	0.07
1830 × 1830	0.02	0.33	0.33	0.16	0.07



Round Duct

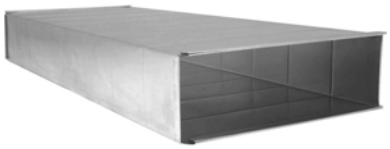
Diameter, mm	Attenuation, dB/m Octave Band Center Frequency, Hz 63	125	250	500	1000	2000	4000
$D \le 180$	0.10	0.10	0.16	0.16	0.33	0.33	0.33
$180 < D \le 380$	0.10	0.10	0.10	0.16	0.23	0.23	0.23
$380 < D \le 760$	0.07	0.07	0.07	0.10	0.16	0.16	0.16
$760 < D \le 1520$	0.03	0.03	0.03	0.07	0.07	0.07	0.07



As published in 2015 ASHRAE Handbook – HVAC Application SI

Insertion Loss For Acoustically Line Ducts

Example: Duct Dimension: 510mmW x 250mmH



25mm Lining Rectangular Duct

Dimensions, mm	Insertion Loss, dB/m Octave Band Center Frequency, Hz 125	250	500	1000	2000	4000
150 × 150	2.0	4.9	8.9	19.0	24.3	14.1
150 × 250	1.6	3.9	7.9	16.7	20.0	12.1
150 × 300	1.6	3.9	7.5	16.4	19.0	11.8
150 × 460	1.6	3.3	7.2	15.4	17.1	10.8
200 × 200	1.6	3.9	7.5	16.4	19.0	11.8
200 × 300	1.3	3.3	6.9	14.8	16.1	10.5
200 × 460	1.3	3.0	6.6	14.1	14.8	9.8
200 × 610	1.3	2.6	6.2	13.1	13.5	9.2
250 × 250	1.3	3.3	6.9	14.4	15.4	10.2
250 × 410	1.3	2.6	6.2	13.1	13.1	8.9
250 × 510	1.0	2.6	5.9	12.5	12.1	8.5
250 × 760	1.0	2.3	5.6	11.8	10.8	7.9

50mm Lining Rectangular Duct

Dimensions, mm	Insertion Loss, dB/m Octave Band Center Frequency, Hz 125	250	500	1000	2000	4000
150 × 150	2.6	9.5	16.1	23.6	24.3	14.1
150 × 250	2.3	7.9	14.4	21.0	20.0	12.1
150 × 300	2.0	7.5	13.8	20.3	19.0	11.8
150 × 460	2.0	6.9	13.1	19.0	17.1	10.8
200 × 200	2.0	7.5	13.8	20.3	19.0	11.8
200 × 300	2.0	6.2	12.8	18.4	16.1	10.5
200 × 460	1.6	5.9	12.1	17.7	14.8	9.8
200 × 610	1.6	5.2	11.5	16.4	13.5	9.2
250 × 250	2.0	6.2	12.5	18.0	15.4	10.2
250 × 410	1.6	5.2	11.2	16.4	13.1	8.9
250 × 510	1.3	4.9	10.8	15.7	12.1	8.5
250 × 760	1.3	4.3	10.2	14.8	10.8	7.9

As published in 2015 ASHRAE Handbook – HVAC Application SI

Insertion Loss For Acoustically Line Ducts

Example: Duct Dimension: 510mmW x 250mmH

Square Elbows With Turning Vanes

	Insertion Loss, dB Unlined Elbows	Lined Elbows
$fw < 48$	0	0
$48 \le fw < 96$	1	1
$96 \le fw < 190$	4	4
$190 \le fw < 380$	6	7
$fw > 380$	4	7

Note: f = center frequency, kHz, and w = width, mm

Square Elbows Without Turning Vanes

	Insertion Loss, dB Unlined Elbows	Lined Elbows
$fw < 48$	0	0
$48 \le fw < 96$	1	1
$96 \le fw < 190$	5	6
$190 \le fw < 380$	8	11
$380 \le fw < 760$	4	10
$fw > 760$	3	10

Note: f = center frequency, kHz, and w = width, mm

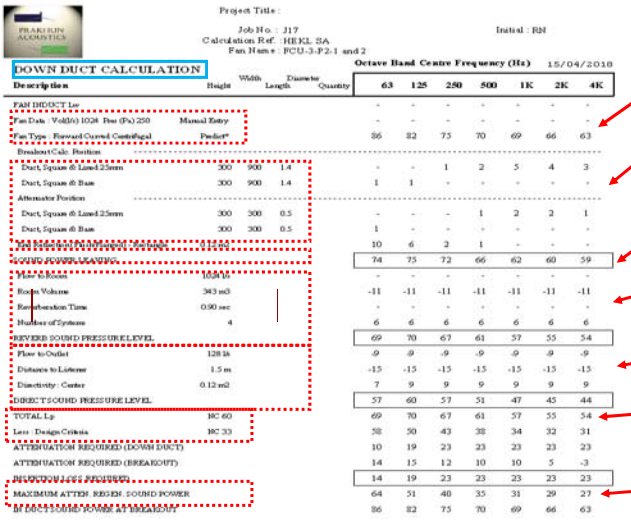
As published in 2015 ASHRAE Handbook – HVAC Application SI

Duct-borne Noise

4 main elements

1.	Downduct noise	• Noise travel from the fan/blower → duct → diffuser/grille
2.	Duct breakout	• In the air path down the duct, sound energy would come in contact (grazing) with the duct walls. • Energy is dissipated with the change of sound energy to kinetic /heat energy within the sheet metal ducting molecules. • This kinetic energy is then re-radiated as sound energy within the ceiling space, then into the condition space via the ceiling layer. • The spectrum of noise concentrates only at lower frequencies and its presence is noted in the form of a low frequency rumble, particularly areas adjacent to plantrooms and directly below the main duct
3.	Turbulent induced air noise	• Generated when in-duct velocity are high
4.	Volume control element	• To direct or channel air creates noise. Minimize the use of volume control elements and use a self-balancing duct system. e.g. There must not be any Oppose Blade Dampers for a room with a noise criteria less than NC 30.

Mechanical Noise Control
Down Duct Calculation Written Based on ASHRAE Application Handbook



Fan Data i.e. blade type, static pressure, total flow, etc.

All related duct elements i.e. rectangular duct, circular duct, straight duct, elbow, bend, internal lining of various thicknesses

L_w leaving grille

Path 1 - L_p rev.

Path 2 - L_p direct

Path 3 - Total L_p compared to the intended design Criteria

Attenuator self-noise/regenerated noise

Downduct calculation accounts for fan and re-gen noise propagated down the duct into the room via airborne

Mechanical Noise Control
Breakout Calculation Written Based on ASHRAE Application Handbook

Project Title :

Job No. : J17 Initial : RN
Calculation Ref : HEKL SA
Fan Name. : PCU-3-P2-1 and 2

BREAKOUT CALCULATION 15/04/2018

Description	Height	Width	Length	Diameter	Octave Band Centre Frequency (Hz) 63	125	250	500	1K	2K	4K
SOUND POWER Lw(in) (Down Duct)					86	82	75	70	69	66	63
Less : DUCT TL		300	900	5.0	-19	-22	-25	-28	-31	-35	-41
					16	16	16	16	16	16	16
SOUND POWER Lw(out)					83	76	66	58	54	47	38
Ceiling : Mineral Fiber (Low Density) 50kg/m3					-13	-15	-17	-19	-25	-30	-33
				Ref. 1.7	-4	-4	-4	-4	-4	-4	-4
RESULTANT SOUND PRESSURE LEVEL				NC 44	66	57	45	35	25	13	1
Less : Room Criteria				NC 35	58	50	43	38	34	32	31
ADDITIONAL ATTENUATION REQ. (BREAKOUT)					7	6	1	-3	-9	-19	-30
ADDITIONAL ATTENUATION REQ. (DOWN DUCT)					10	19	23	23	23	23	23
INSERTION LOSS REQUIRED					10	19	23	23	23	23	23

Duct Transmission Loss, proportionate to duct thickness, area of radiating surface, distance from receiver, etc.

Ceiling type as noise barrier, cater for various of ceiling product either solid or with penetration i.e. RA grille, linear slots, etc.

Total L_p compared to the intended design criteria

Compare Lp from Downduct and Breakout and choose highest for attenuator selection.

Breakout calculation accounts for the noise breaking out from the duct walls, as noise travels down the duct. Breakout noise is a predominant problem only for areas near (<10m) from plantroom or fan source.

Sample of Noise Criteria Reference

A Centre of Excellence, Bank Negara – Training Centre

2.0 DESIGN CRITERIA REQUIREMENTS FOR CONTINUOUS BACKGROUND NOISE

The contractor shall ensure the following design criteria shall be achieved within this project. The design criteria shall be applicable for the continuous noise resultant from all the ACMV (Air Conditioning and Mechanical Ventilation) Systems within this project.

Any spaces that have been relocated or newly introduced subsequent to the issuance of this document shall achieve the same noise criteria resultant from the ACMV systems for a similar space as detailed within the following noise criteria table;

Space	Project Design Noise Criteria	Australian/New Zealand Standard (AS/NZS 2107:2000)
Auditorium	NC30-NC35	35-40dBA (NC30-35)
Classroom (All seating capacities)	NC30-NC35	30-35dBA (NC25-30)
Recording	NC30-NC35	35-40dBA (NC30-35)
Maker Space	NC35-NC38	
Meeting (10) ASB and Misi	NC35-NC38	40-45dBA (NC35-40)
Study Room (All seating capacities)	NC35-NC38	40-45dBA (NC35-40)
Exec MBA Suite	NC35-NC38	40-45dBA (NC35-40)
Office – Private Office	NC35-NC38	35-40dBA (NC30-35)
Av. Control Room	NC35-NC40	40-45dBA (NC35-40)
Green Room	NC35-NC40	40-45dBA (NC35-40)
Secretary	NC35-NC40	
Prayer	NC35-NC40	
Office – Open Plan Room	NC35-NC40	40-45dBA (NC35-40)
Work space (ASB)	NC35-NC40	
PB Room	NC35-NC40	
Library (Reading)	NC35-NC40	40-45dBA (NC35-40)
Librarian Admin	NC35-NC40	40-45dBA (NC35-40)
Lounge	NC35-NC40	
Dining/Cafe	NC40-NC45	45-50dBA (NC40-45)
Data Control	NC45-NC50	
Electrical/IT	NC50-NC55	

Malaysia International Exhibition Centre, MiTEC

2.0 DESIGN CRITERIA FOR CONTINUOUS BACKGROUND NOISE

The contractor shall ensure the following design criteria shall be achieved within this project. The design criteria shall be applicable for the continuous noise resultant from all the ACMV (Air Conditioning and Mechanical Ventilation) Systems within this project.

Any spaces that have been relocated or newly introduced subsequent to the issuance of the Design and Build Architectural drawings shall have a noise control design against intrusive noise from external of space to achieve the following noise criteria.

Space	Noise Criteria
Exhibition Hall	NC35-40
Pre-function/Concourse Area/Display	NC40-45
Auditorium/ Multipurpose Hall	NC30-35
L1 Upper Lobby/L1 Lobby/Fire Lift Lobby	NC40-45
Organizer Office/VIP Meeting Rooms/Breakout Rooms/ICT Training	NC30-35
Media Centre Rooms	NC30-35
VIP Room/Business Centre	NC30-35
VIP Lounge	NC35-40
Open Plan/General Offices/Hall Management Office/Custom Office	NC35-40
Broadcasting Room	NC30-35
Lift Lobby	NC40-45
Speciality Restaurant	NC35-40
Male/Female Surau	NC35-40
Male/Female Locker Room	NC35-40
AVCR Room	NC35-40
Laundry Room	NC55-60
Fruit & Vege. Prep/Seafood prep/Butchery/Meat Prep/Flower Room/Bakery/Pastry	NC40-45
Staff Resting Area/Canteen/Food Court	NC40-45
Medical Assistance Room	NC35-40
Driver's Room	NC35-40
Convenience Store	NC40-45
Diaper/Nursing Room	NC35-40

Revision: 0
E/AC- 3 of 4/2

12

Duct-borne Noise

4 main elements

1.	Downduct noise	• Noise travel from the fan/blower → duct → diffuser/grille
2.	Duct breakout	• In the air path down the duct, sound energy would come in contact (grazing) with the duct walls. • Energy is dissipated with the change of sound energy to kinetic /heat energy within the sheet metal ducting molecules. • This kinetic energy is then re-radiated as sound energy within the ceiling space, then into the condition space via the ceiling layer. • The spectrum of noise concentrates only at lower frequencies and its presence is noted in the form of a low frequency rumble, particularly areas adjacent to plantrooms and directly below the main duct
3.	Turbulent induced air noise	• Generated when in-duct velocity are high
4.	Volume control element	• To direct or channel air creates noise. Minimize the use of volume control elements and use a self-balancing duct system. e.g. There must not be any Oppose Blade Dampers for a room with a noise criteria less than NC 30.

Maximum Recommended Duct Airflow Velocities Needed to Achieve Specified Acoustic Design Criteria

		Maximum Airflow Velocity, m/s	
Main Duct Location	**Design RC(N)**	**Rectangular Duct**	**Circular Duct**
In shaft or above drywall ceiling	45	17.8	25.4
	35	12.7	17.8
	25	8.6	12.7
Above suspended acoustic ceiling	45	12.7	22.9
	35	8.9	15.2
	25	6.1	10.2
Duct located within occupied space	45	10.2	19.8
	35	7.4	13.2
	25	4.8	8.6

Notes:
1. Branch ducts should have airflow velocities of about 80% of the values listed.
2. Velocities in final run-outs to outlets should be *50%* of the values or less.
3. Elbows and other fittings can increase airflow noise substantially, depending on the type. Thus, duct airflow velocities should be reduced accordingly.
4. Design criteria RC(N) is an extension from the RC criteria, whereby N further denotesXXX, as per International Standard XXX

Maximum Recommended "Free" Supply Outlet and Air Opening Velocities Needed to Achieve Specified Acoustic Design Criteria

Type of Opening	"Free" Opening Airflow Design RC(N)	Velocity, m/s
Supply air outlet	45	3.2
	40	2.8
	35	2.5
	30	2.2
	25	1.8
Return air opening	45	3.8
	40	3.4
	35	3.0
	30	2.5
	25	2.2

Note:

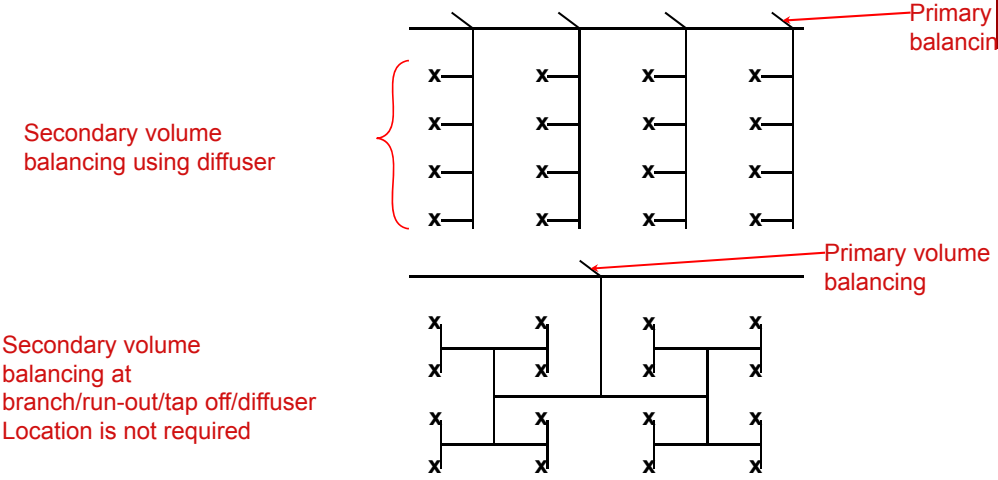
The Presence of diffusers or grilles can increase sound levels a little or a lot, depending on how many diffusers or grilles are installed and on their design, construction, installation, etc. Thus, allowable outlet or opening airflow velocities should be reduced accordingly.

Duct-borne Noise

4 main elements

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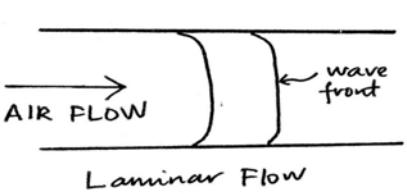
Primary and Secondary Volume Balancing



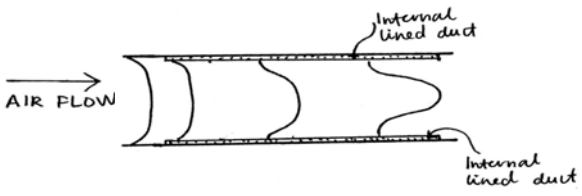
Efficiency of Duct Internal Lining

Duct Length	Effectiveness of Internal Lining
First ≤ 3m	100%
First 3 – 6m	60%(#)
First 6m ≥	35%(#)

Note (#): The efficiency value is not well documented/published. These values are in-house recommended values used after numerous on-site evaluation of as-built system. These values may not be used/reproduce for any specific purposes.



Duct without internal lining

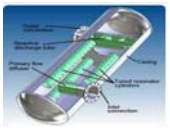


Duct with internal lining

Types of Attenuator

1. Absorptive – Dissipative type
2. Absorptive – Dissipative type with Mylanex covering (<20µg)
3. Cylindrical
4. Non-fibrous type
5. Packless/inductive type
6. Inductive and dissipative type





Attenuator – Theory of Sound Absorption

Dissipative Type

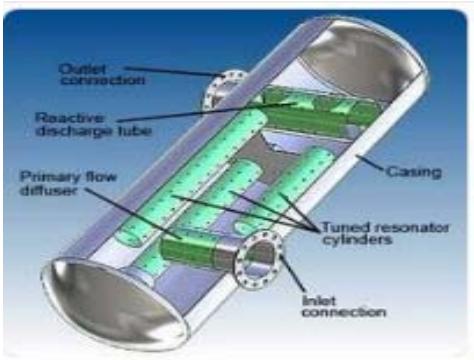




1) Airway – splitter wall surface resistance air molecule kinetic energy → heat

2) Splitter 'medium' – The stone/mineral wool consist of a porous material with millions of fine fibre allowing for kinetic to heat energy dissipation of energy. 'Low' frequencies have high energy content, thus require larger splitter width and higher medium density for energy absorption and conversion

Attenuation via Impedance and Acoustic Absorption



Inductive Type

- Air impedance mis-match (Vel.↑↓, Pa ↑↓), causes a backdraft of energy which 'cancel' off the on-coming energy wave.
- Energy loss through standing waves and wave cancellation within the resonance chamber.





Good Attenuator Design

Combination both Dissipative and Inductive

Attenuator – Splitter and Air-way

There are various shapes and dimensions for an attenuator's splitter module, depending on each manufacturer specialist design.

- Entry/exit Nosing (square, round, bellmouth, 'A' shape, etc) would all contribute to the 'Pressure Loss' across the attenuator and the self-noise/regenerated noise @ exit of attenuator.

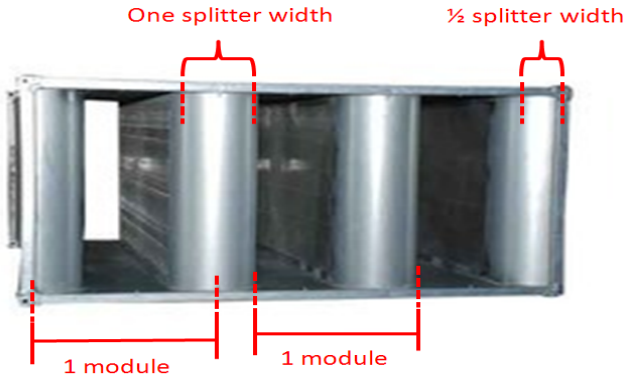
Major parameter that determine attenuator performance is its % of open area.

% of open area = $\frac{\text{Air way } (m^2)}{\text{1 module } (m^2)}$

50% → 25%

Low — Insertion Loss (dB) — High

Low — Pressure Loss (Pa) — High



Attenuator Pressure Loss

$\Delta p = 0.6kv^2$

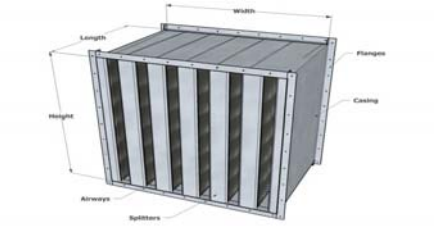
Where: Δp = pressure loss across attenuator

k = pressure loss factor with respect to attenuator face velocity

v = attenuator face velocity

$\Delta p \downarrow$ → width ↑ (by one-module width)

$\Delta p \downarrow$ → height ↑



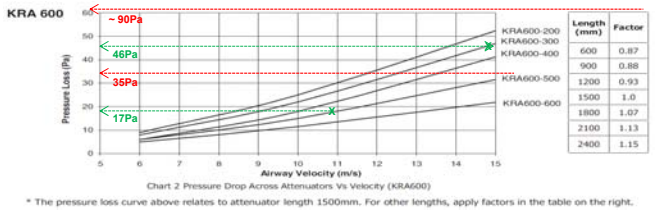


Chart 2 Pressure Drop Across Attenuators Vs Velocity (KRA600)

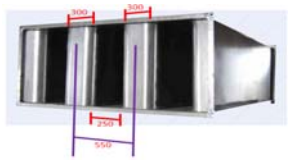
* The pressure loss curve above relates to attenuator length 1500mm. For other lengths, apply factors in the table on the right.

Example:

Main duct size ($100\%_{area}$) = 7m/s

Rule of Thumb

Attenuator face ($140\%_{area}$) = 5m/s



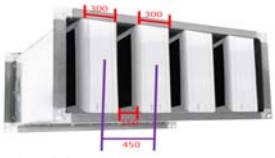
KRA600-500 (Module 550)

% open area = 250/(250+150+150) = 45%

→ Airway velocity = 11.1m/s

→ Attn. Pressure Loss = 17Pa

Say face velocity 5m/s



KRA600-300 (Module 450)

% open area = 150/(150+150+150) = 33%

→ Airway velocity = 15.2m/s

→ Attn. Pressure Loss = 46Pa

GOOD DESIGN

% open area = 250/(250+150+150) = 45%

→ Airway velocity = 15.5m/s

→ Attn. Pressure Loss = 35Pa

Common Mis-conception

Say face velocity 7m/s

(Attn. size = Duct size)

% open area = 150/(150+150+150) = 33%

→ Airway velocity = 21.2m/s

→ Attn. Pressure Loss = ~90Pa

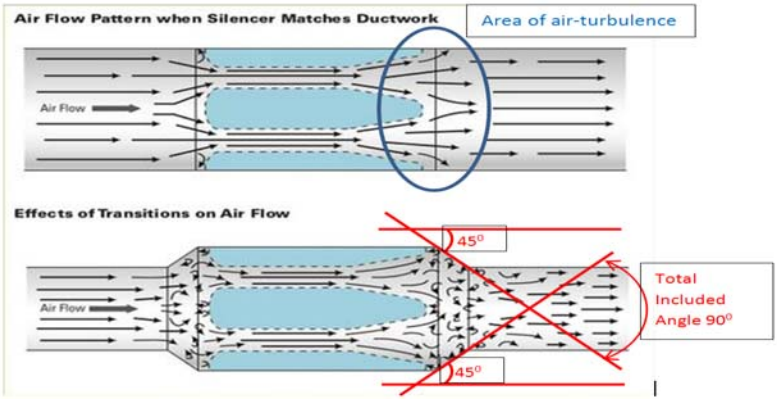
BAD DESIGN

No	Model	% Open Area	Length	63	125	250	500	1k	2k	4k	8k
1	KRA600-500 (M550)	45%	2100	10	14	21	25	37	31	17	13
2	KRA600-300 (M450)	33%	2100	13	19	30	36	48	46	34	23

Attenuator Regenerated Noise

$L_w = (60 \log V) + (10 \log H) + (10 \log m) - sp$

Where: V = Airway velocity (m/s)
H = Attenuator height
m= Number of modules
sp = V dependant spectrum corr. (eg: 63Hz (-4), 1kHz (-15), 4kHz (-17), etc. for V=20m/s)
and also dependant on attenuator splitter exit design



Duct Transition

- Total included angle as a guide shall not be greater than 30°
- Rectangular to round transitions, if used, should be sized according to the following formula.

Length = 0.9 x (diagonal-diameter)

Where:

Length	=	minimum transition length
Diagonal	=	diagonal cross sectional dimension of rectangular duct.
Diameter	=	diameter of circular duct.

- Rectangular duct transitions into attenuators should have the minimum length according to the following formula.

Length = 2.3 x [(X2+Y2)1/2 - D]

Where:

X, Y	=	cross-sectional dimension of rectangular attenuator
D	=	diagonal cross-sectional dimension of the connecting rectangular duct

OFFSETS 2 AND 3 AND TRANSITIONS MAY HAVE EQUAL OR UNEQUAL INLET AND OUTLET AREAS. TRANSITIONS MAY CONVERT DUCT PROFILES TO ANY COMBINATION FOR RECTANGULAR, ROUND OR FLAT OVAL SHAPES.

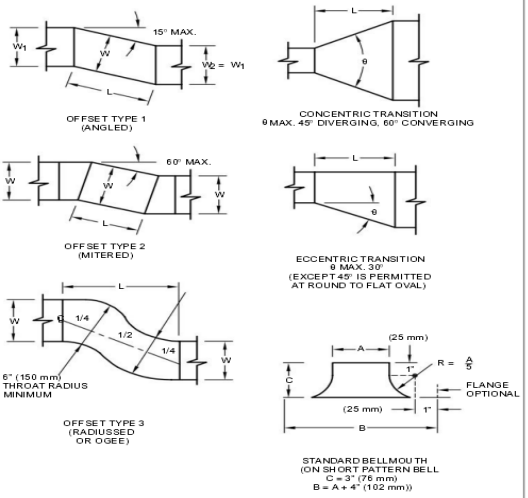
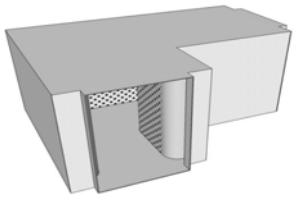
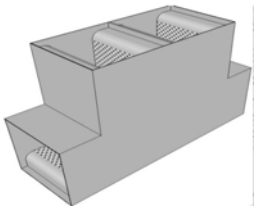


FIGURE 2-7 OFFSETS AND TRANSITIONS

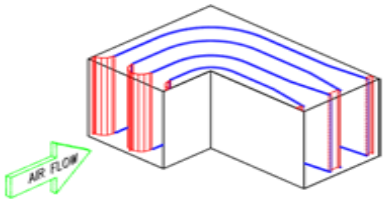
Elbow Attenuator



OK



OK

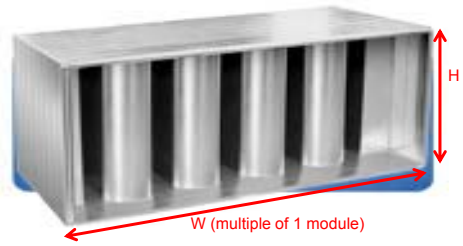


Due to centrifugal force, air distribution will not be even through out the individual airway.

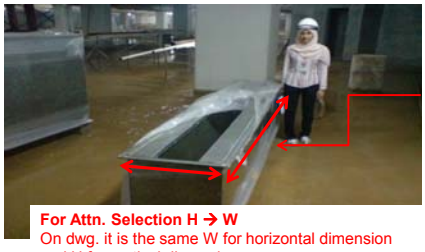
Airway velocity	V ↑↓
Pressure drop	Pa ↑↓
Regenerated Noise	dB ↑↓

Horizontal Attenuator

Conventional



Horizontal Type

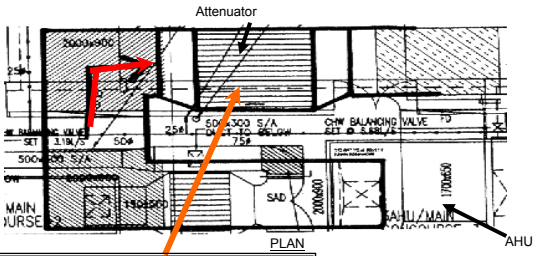


For Attn. Selection
W → H
On dwg. it is the same W for horizontal dimension and H for vertical dimension

For Attn. Selection H → W
On dwg. it is the same W for horizontal dimension and H for vertical dimension

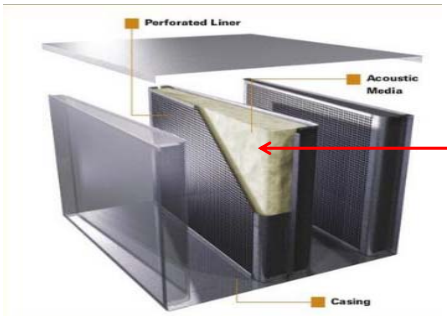
Rectangular Attenuator (Conventional)

Rectangular Attenuator (Horizontal Splitter)



• Horizontal turn from the AHU (SA) to the attenuator inlet.
• Attenuator shall be a HORIZONTAL Splitter attenuator.

Insulation Material



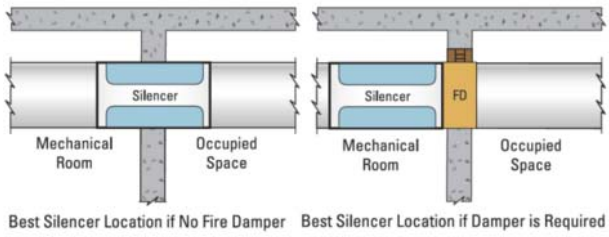
40-100kg/m^3 stone/mineral wool insulation

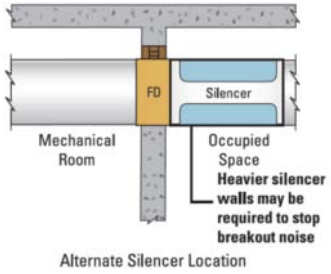
a)Insulation density, kg/m^3 ↑	IL_{Lf}(dB) ↑	IL_{Mf}(dB) ↑	IL_{Hf}(dB) ↑
b)Splitter width ↑	IL_{Lf}(dB) ↑	IL_{Mf}(dB) ↘	IL_{Hf}(dB) ↘
c)% open airway ↓	IL_{Lf}(dB) ↑	IL_{Mf}(dB) ↑	IL_{Hf}(dB) ↑

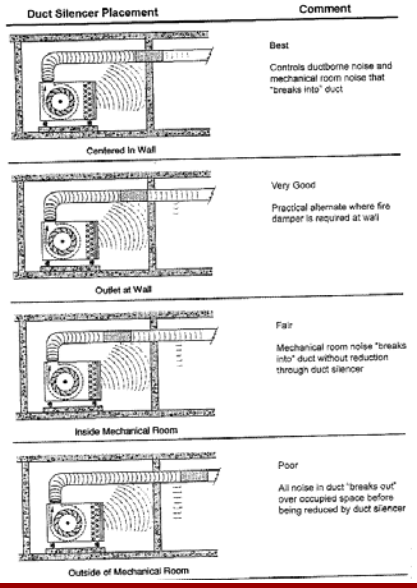
Note:

- The perforated steel (1.0mm or less thickness) is acoustically transparent for opening equal or more than 23.5% open area.
- Perforated foil not recommended as the open area is typically around 11-12% and thus will not achieve the values as stipulated in ASHRAE or SMACNA guidelines for insertion loss for duct internal lining

Guidelines For Duct Attenuator Placement

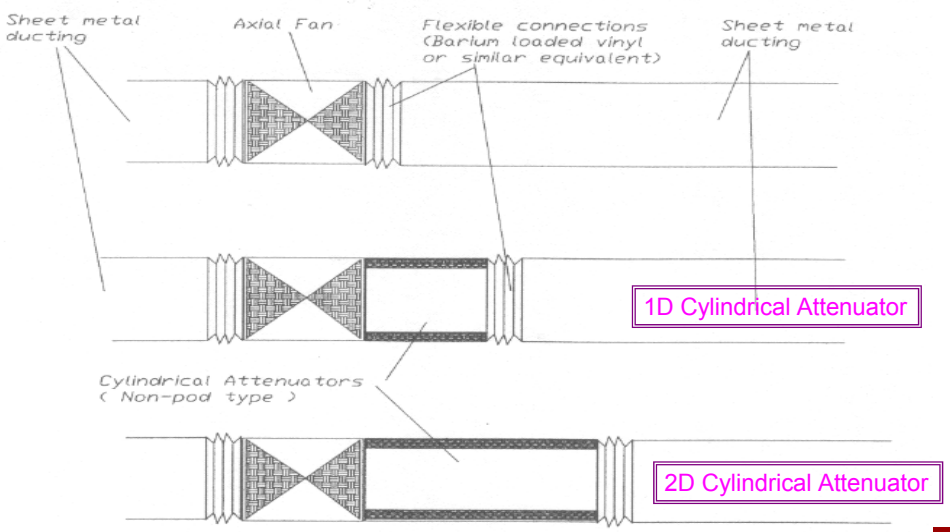




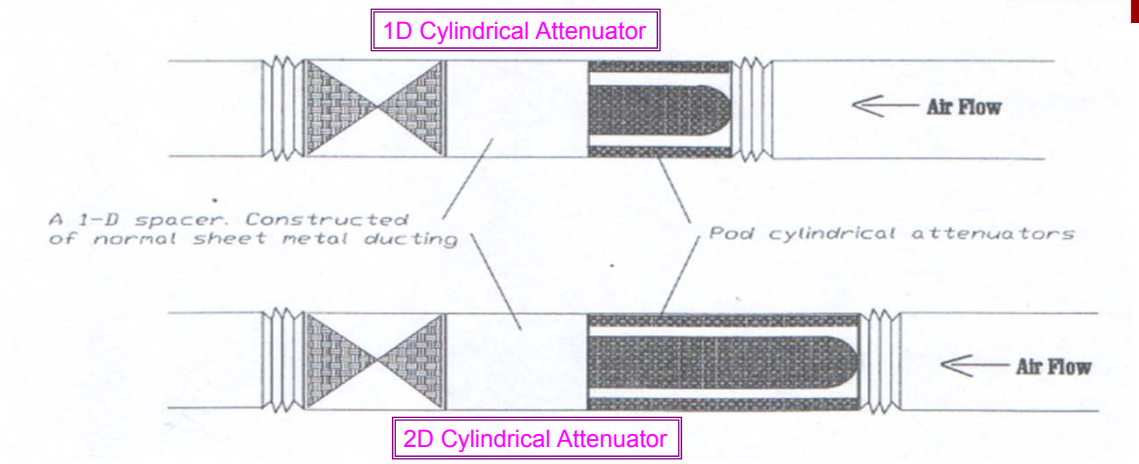


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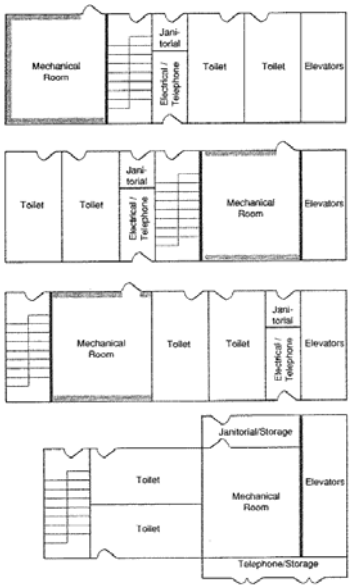
Cylindrical Duct Attenuator Mounting Details (Straight Through)



Cylindrical Attenuator Mounting Details (Pod)



Plantroom Orientation And Equipment Layout

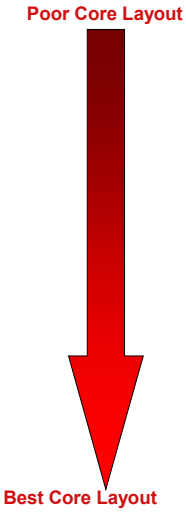


Poor Core Layout
Exposes 3 mechanical room walls to surrounding tenant space. Impenetrable partition between mechanical room and exit stairs results in supply and return air wall openings next to tenant space.

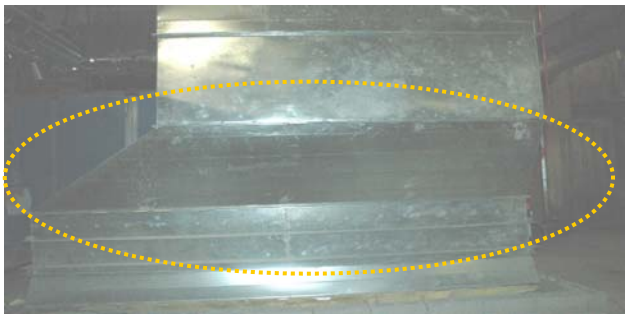
Fair Core Layout
Exposes 2 mechanical room walls to surrounding tenant space. Impenetrable mechanical room partition to elevators and exit stairs results in supply and return air wall openings next to tenant space.

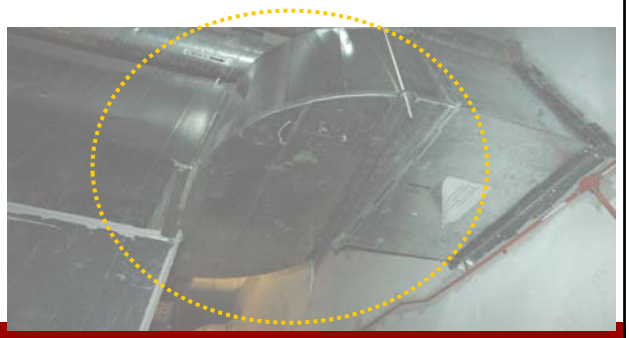
Better Core Layout
Exposes 2 mechanical room walls to tenant space. Ceiling over toilets can be used for either supply ducts or return air path.

Best Core Layout
No mechanical room walls exposed to tenant space. No supply or return air openings need be next to tenant space. Ceiling over toilets can be used for supply ducts or return air path.



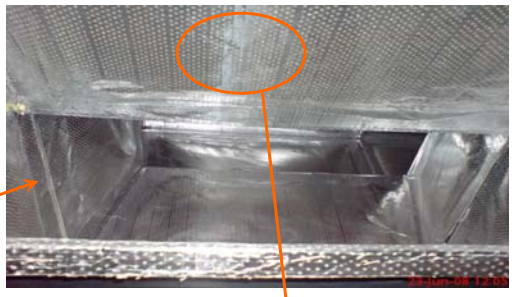
Duct Abrupt Transition





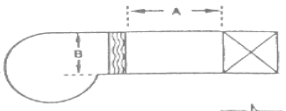
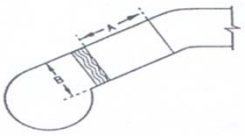
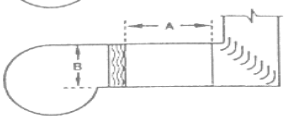
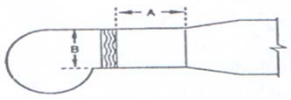
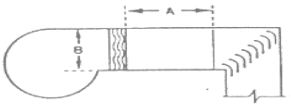
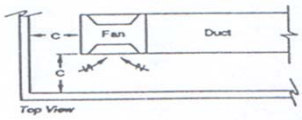
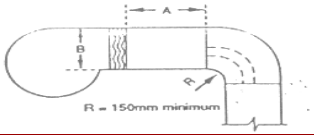
Internal Lining – Using Foil





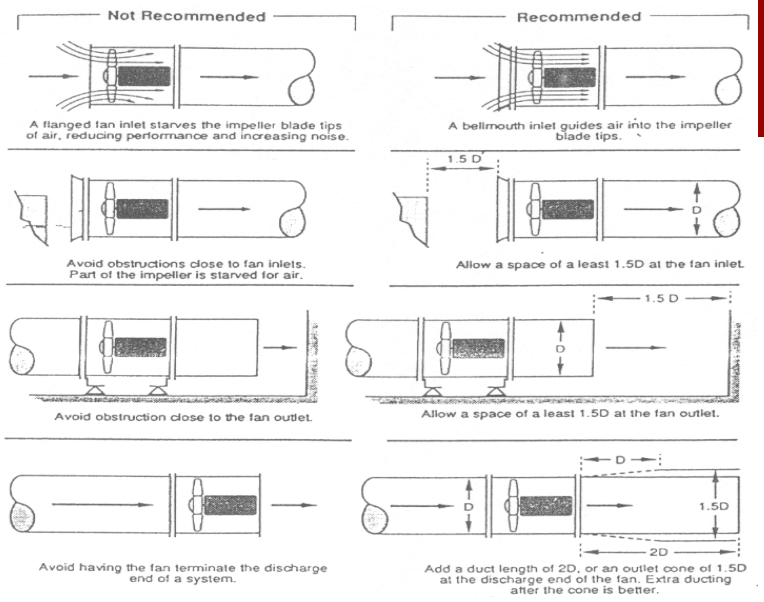


Other Design Guidelines To Ensure Noise Generation From The 'INVISIBLE ELEMENTS' Are Kept At A Minimum

Fan/Duct Layout	Comment	Fan/Duct Layout	Comment
	Bad if A < 3 • B		Very good if A > 3 • B Fair if A < 3 • B
	Bad if A < 3 • B Very Bad if turning vanes are deleted		Best if A > 1.5 • B Transition wall slopes of 1:7 preferred. Slopes of 1:4 permitted if inlet velocity less than 10 m/s.
	Fair if A < 3 • B Bad if A < 1.5 • B		Best if C > 1.5 • fan wheel diameter Good if C = fan wheel diameter Poor if C < fan wheel diameter
	Good if A > 3 • B Fair if A > 1.5 • B Bad if A < 1.5 • B		

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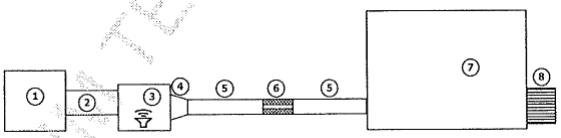
Guidelines For Un-ducted Axial Flow Fan Installations



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Testing Method of Attenuator Insertion Loss ASTM 477 – Different Type of Testing

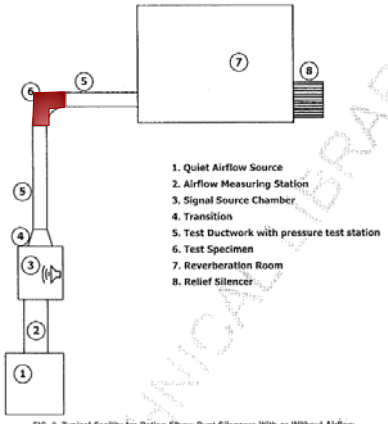
Example of a facility set-up to accommodate straight silencer testing



1. Quiet Airflow Source
2. Airflow Measuring Station
3. Signal Source Chamber
4. Transition
5. Test Ductwork with pressure test station
6. Test Specimen
7. Reverberation Room
8. Relief Silencer

FIG. 1 Typical Facility for Rating Straight Duct Silencers With or Without Airflow

Example of a facility set-up to accommodate elbow silencer testing



1. Quiet Airflow Source
2. Airflow Measuring Station
3. Signal Source Chamber
4. Transition
5. Test Ductwork with pressure test station
6. Test Specimen
7. Reverberation Room
8. Relief Silencer

FIG. 2 Typical Facility for Rating Elbow Duct Silencers With or Without Airflow

Note: In AMCA 1011-03, it is clearly stated that the acoustical dynamic insertion loss, airflow generated noise and pressure drop as a function of air flow obtained in accordance with ASTM E477-99

39

Testing Method of Attenuator Insertion Loss ASTM 477 – Duct length requirement based on air flow direction

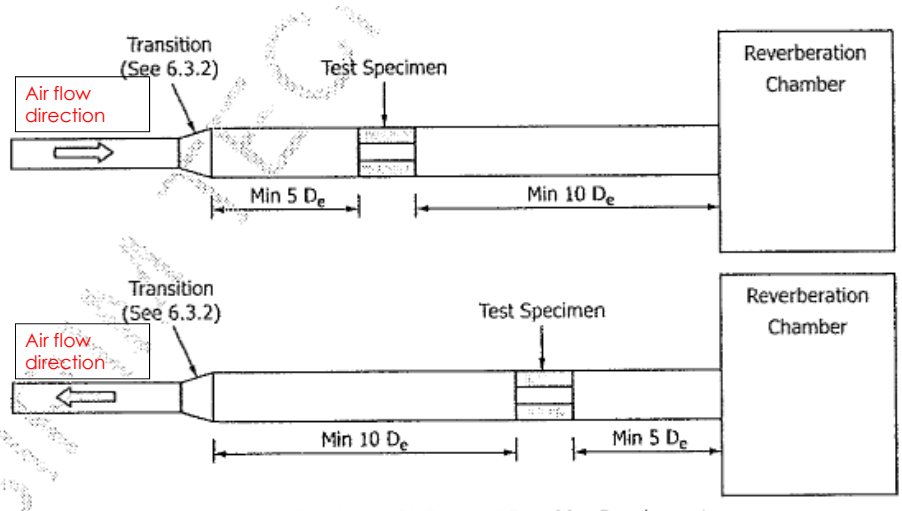


FIG. 4 Test Specimen with Duct and Transition Requirements

40

Thank You