Noise Barriers

Outdoor Noise Barriers: Design and Applications

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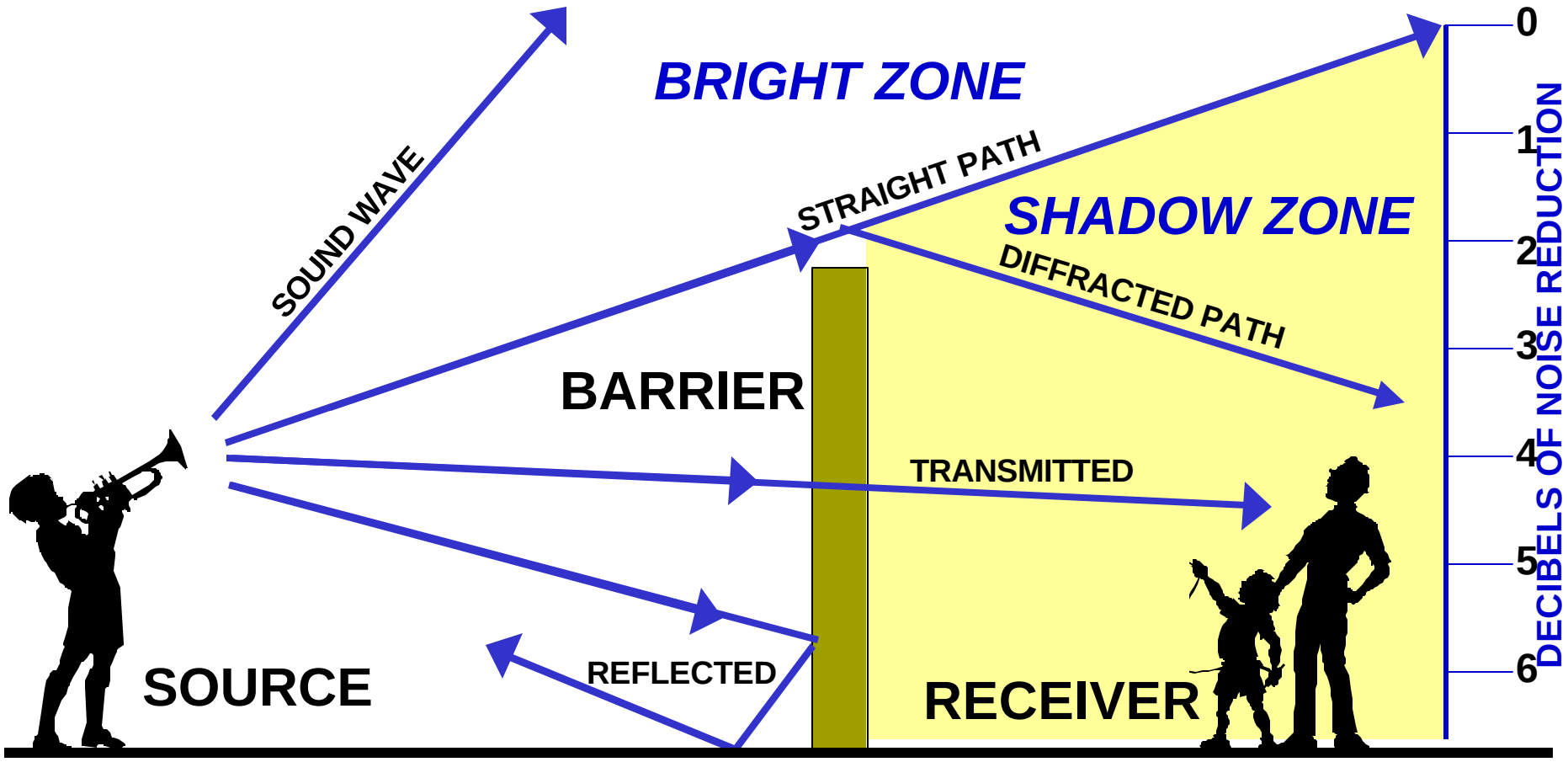
Topics

- **Barrier Fundamentals**
- **Attenuation Calculations**
- **Practical Limitations**
- **Design Considerations**
- **Structural Issues**
- **Case Studies**

Barrier Fundamentals

- **A sound barrier is a solid structure that intercepts the direct sound path from a sound source to a receiver.**
- **It reduces the sound pressure level within its shadow zone.**

Barrier Fundamentals



THE EFFECT OF A BARRIER ON SOUND WAVES

Typical Noise Barrier Wall

Fundamental Issues

- **How high does the barrier have to be?**
- **How close should the barrier be to the equipment?**
- **How much sound attenuation will we get from the barrier?**

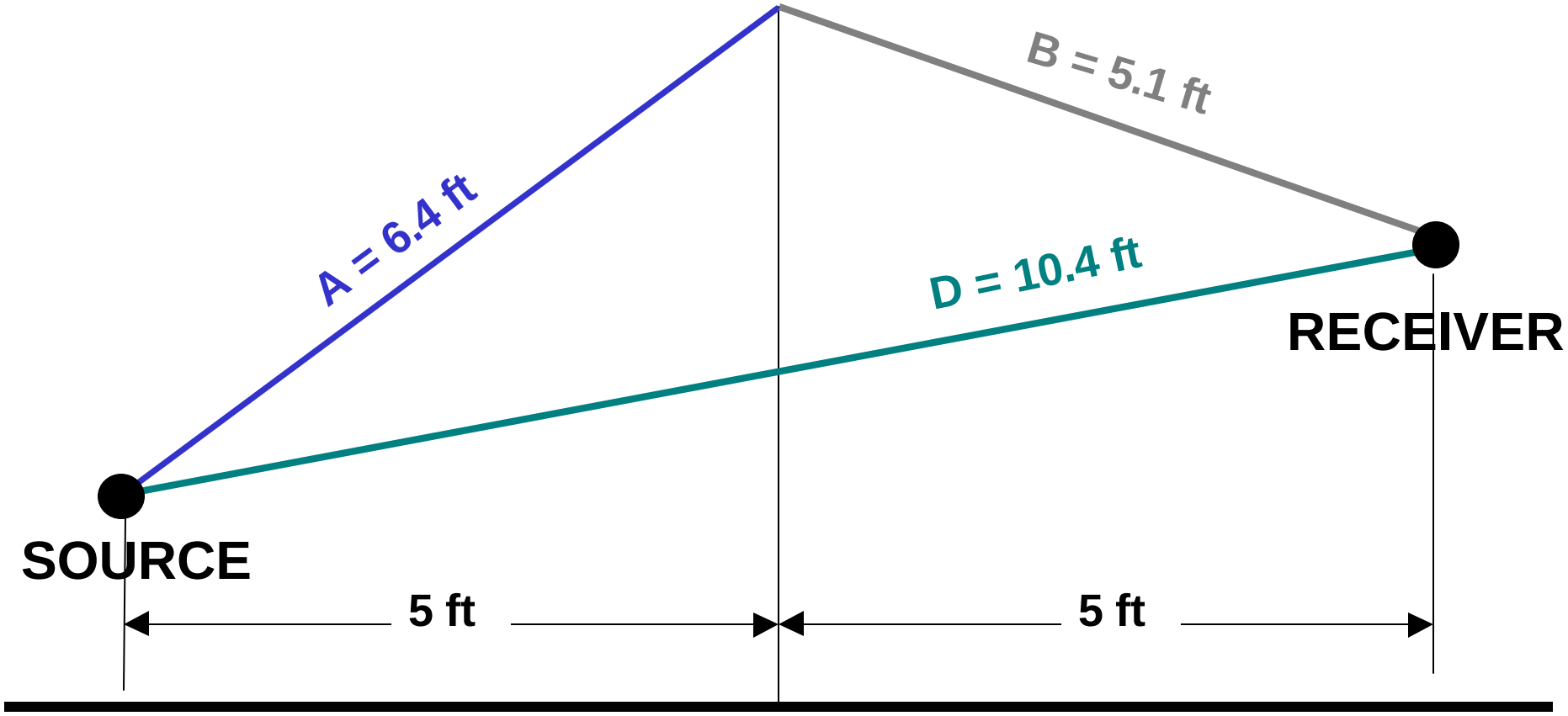
Barrier Attenuation

- **Based on mathematics involving Fresnel integrals (borrowed from optical diffraction theory).**
- **The theory agrees well with measurements.**
- **Tables and graphs are available for practical use.**

Path Length Difference

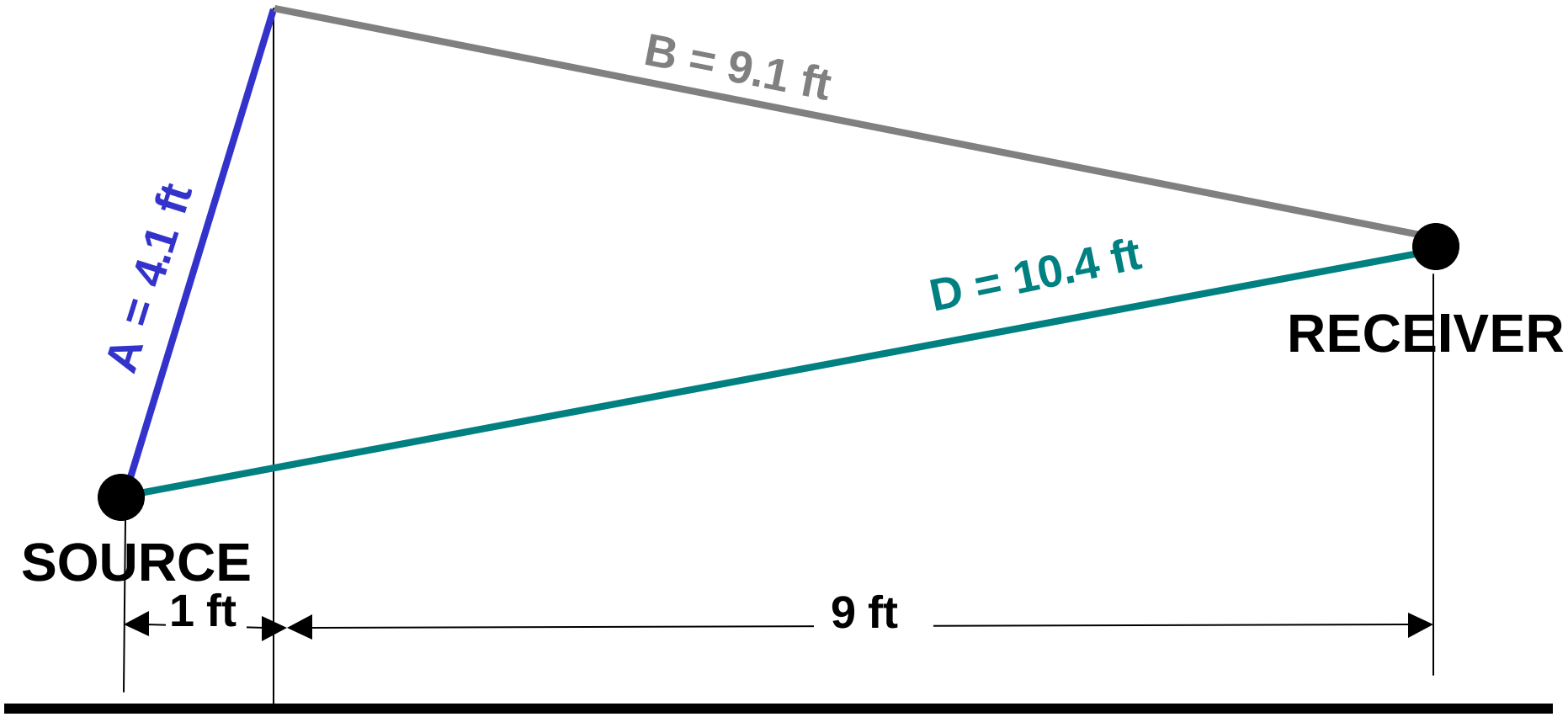
- **PLD is determined from basic geometry.**
- **Affected by barrier height and location.**
- **Also affected by source and receiver heights.**
- **A larger PLD will result in higher attenuation.**

Path Length Difference



POSITION 1: **PLD = A + B - D = 1.1 ft**

Path Length Difference



POSITION 2: **PLD = A + B - D = 2.8 ft**

INSERTION LOSS VALUES FOR AN IDEAL SOLID BARRIER

Path-Length Difference, ft	Insertion Loss, dB Octave Band Center Frequency, Hz							
	31	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**
0.01	5	5	5	5	5	6	7	8
0.02	5	5	5	5	5	6	8	9
0.05	5	5	5	5	6	7	9	10
0.1	5	5	5	6	7	9	11	13
0.2	5	5	6	8	9	11	13	16
0.5	6	7	9	10	12	15	18	20
1.0	7	8	10	12	14	17	20	22
2.0	8	10	12	14	17	20	22	23
5.0	10	12	14	17	20	22	23	24
10.0	12	15	17	20	22	23	24	24
20.0	15	18	20	22	23	24	24	24
50.0	18	20	23	24	24	24	24	24

Barrier Attenuation

- **High frequencies are attenuated more effectively than low frequencies.**
- **The maximum theoretical limit for barrier attenuation is 24 dB.**
- **The actual attenuation will always be less due to practical limitations.**

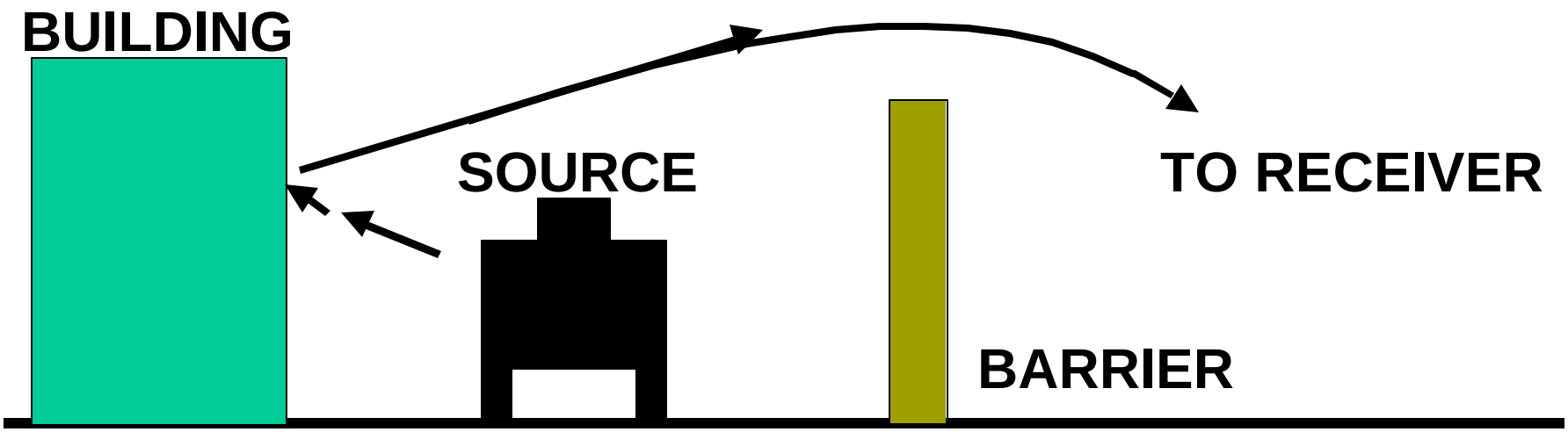
Attenuation Worksheet

Sound Barrier Attenuation Worksheet									
Source: Return air intake louvre									
Receiver: Second floor bedroom window at 100 feet distance (30 m)									
S/R distance - d (m)	106								
S/B distance - Dsb (m)	6								
B/R distance - Dbr (m)	100								
Source height - Hs (m)	33								
Receiver height - Hr (m)	15								
Barrier height - h (m)	36								
PLD (m)	2.9								
Octave-Band Centre Frequency (Hz)	63	125	250	500	1000	2000	4000	8000	dBA
Return fan discharge PWL (dB)	94	94	92	92	94	94	90	86	99
Adjustment for 2 similar fans (dB)	3	3	3	3	3	3	3	3	
Plenum attenuation (dB)	3	3	3	3	3	3	3	3	
Directivity index on axis (dB)	8	8	8	8	8	8	8	8	
Distance attenuation (dB)	41	41	41	41	41	41	41	41	
Receiver noise level - no barrier (dB)	61	61	59	59	61	61	57	53	66
Fresnel Number - N	1.058	2.100	4.200	8.399	16.799	33.598	67.196	134.391	
Barrier attenuation (dB)	8	10	12	15	18	20	22	23	
Receiver noise level - with barrier (dB)	53	51	47	44	43	41	35	30	48

Practical Limitations

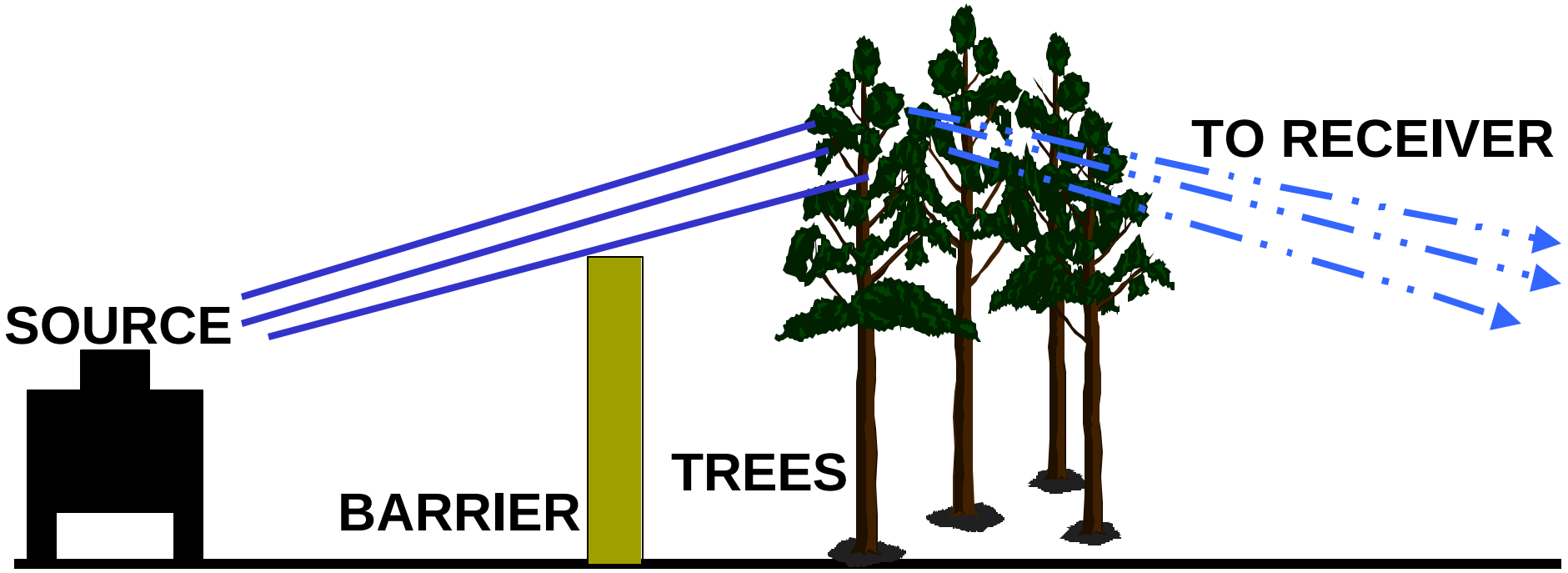
- **Barrier attenuation is generally limited to 10 to 15 dBA.**
- **There are usually practical limits on barrier height and width.**
- **Sound flanking around barrier edges.**
- **Reflections from near-by objects.**

Reflecting Surfaces



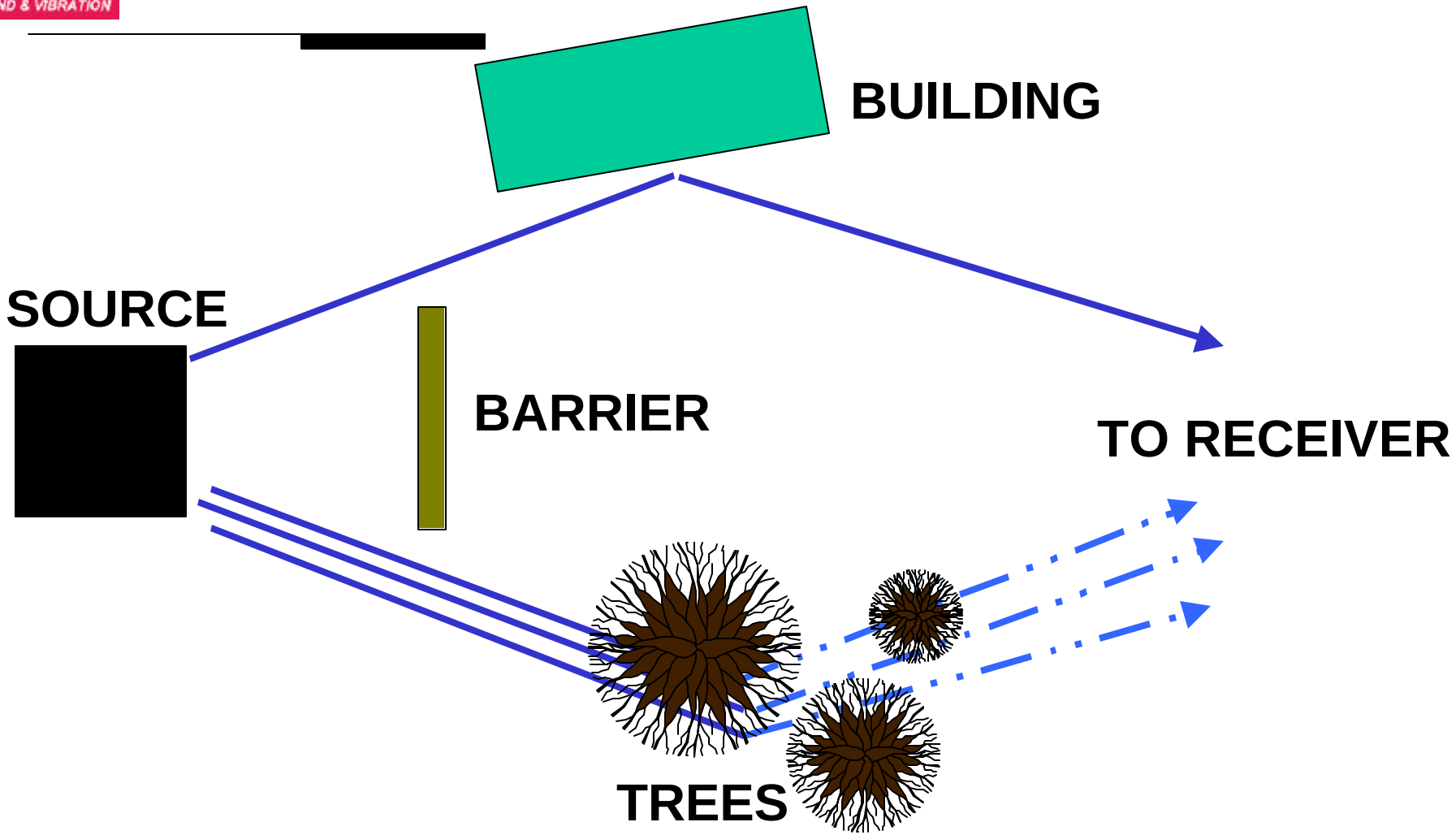
REFLECTION FROM WALL BEHIND BARRIER

Reflecting Surfaces



REFLECTION FROM TREES OVER TOP OF BARRIER

Reflecting Surfaces



REFLECTIONS AROUND ENDS OF BARRIER

Design Issues

- **Materials to be Used**
- **Sound Absorption**
- **Equipment Accessibility**
- **Equipment Ventilation**
- **Structural Issues**
- **General Design Guidelines**

Materials

- **Barriers should be constructed of solid, non-porous material.**
- **Minimum density of material should be 20 kg/m^2 (4 lb/ft^2).**
- **Sound transmission loss of barrier material must be at least 10 dB higher than the barrier attenuation.**

Materials

- **Useful materials include steel, pre-cast concrete, wood and composition boards.**
- **Steel panels are particularly suitable for mechanical equipment noise barriers (easy to cut holes and openings for pipes and duct penetrations).**

Sound Absorption

- **Sound absorbing material is often used on the source side of the barrier to reduce the buildup of sound pressure level.**
- **Prevents sound reflection from barrier surface.**
- **Improves overall acoustic performance of barrier system.**

Equipment Access

- **Doors and access panels can be provided in barrier walls.**
- **Adequate clearance must be maintained between barrier and equipment.**
- **Follow mechanical equipment supplier's recommendations.**

Equipment Ventilation

- **Follow mechanical equipment supplier's recommendations for ventilation requirements.**
- **Acoustic louvers or silencers can be provided on ventilation openings in barrier walls.**
- **It may be necessary to provide openings at the base of the barrier.**

General Design Guidelines

- **The “line of sight” between the source and receiver must be cut off completely by the barrier.**
- **A barrier should be at least 5 times wider than it is high.**
- **The barrier should be built as close as possible to either the source or receiver.**

Structural Issues

- **Wind Loading**
- **Seismic Restraint**
- **Concrete Footings**
- **Tie-in to Existing Walls**
- **Drainage**

Case Studies

Rooftop Condensing Unit

Dust Collector Fan

Ventilation and Access

Steel Structure

Base Anchor Bolts

Structural Bracing

3-Sided Barrier

Barrier/Enclosure

Rooftop Exhaust Fans

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