Scary Noise?

District Cooling & CHP Infrastructure in Sensitive Campus Locations

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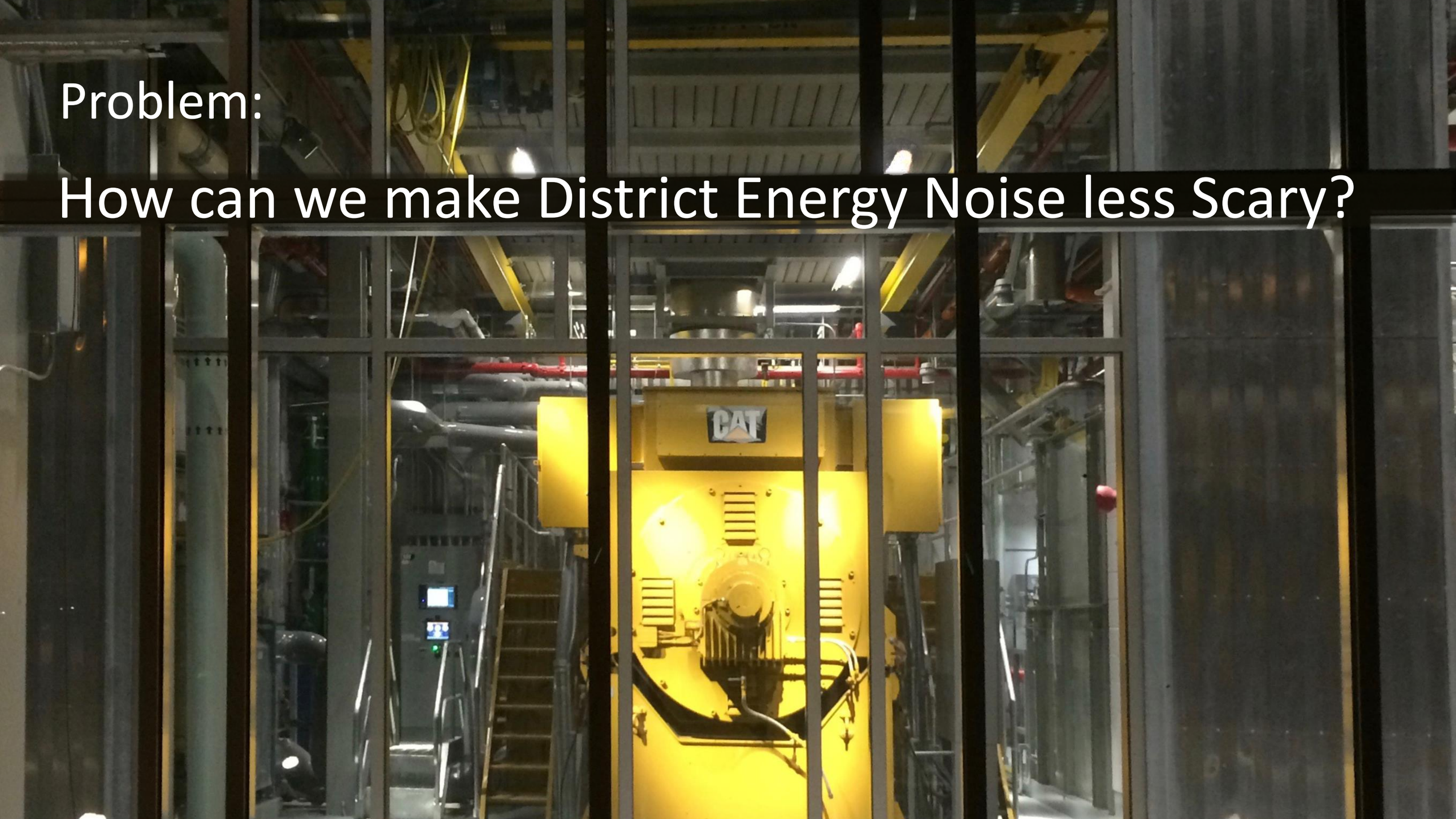
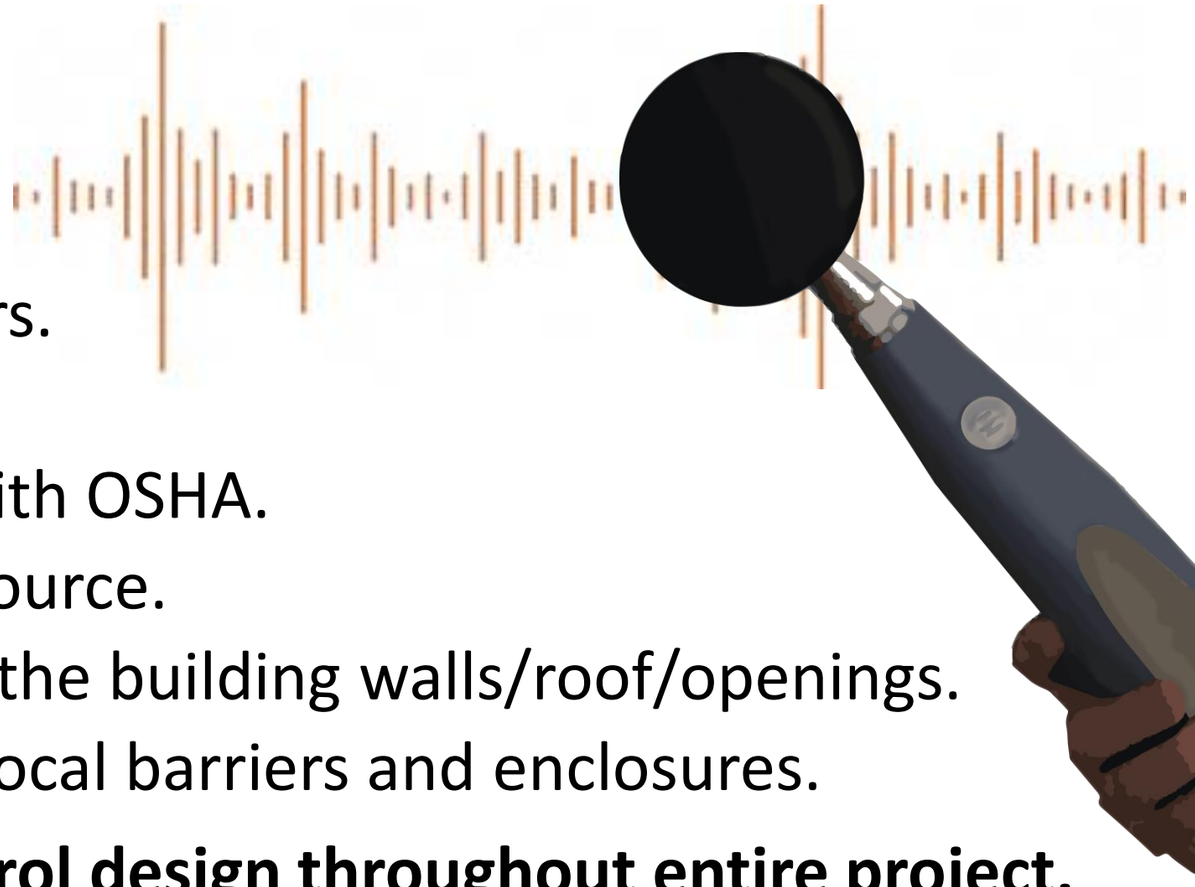


Problem:

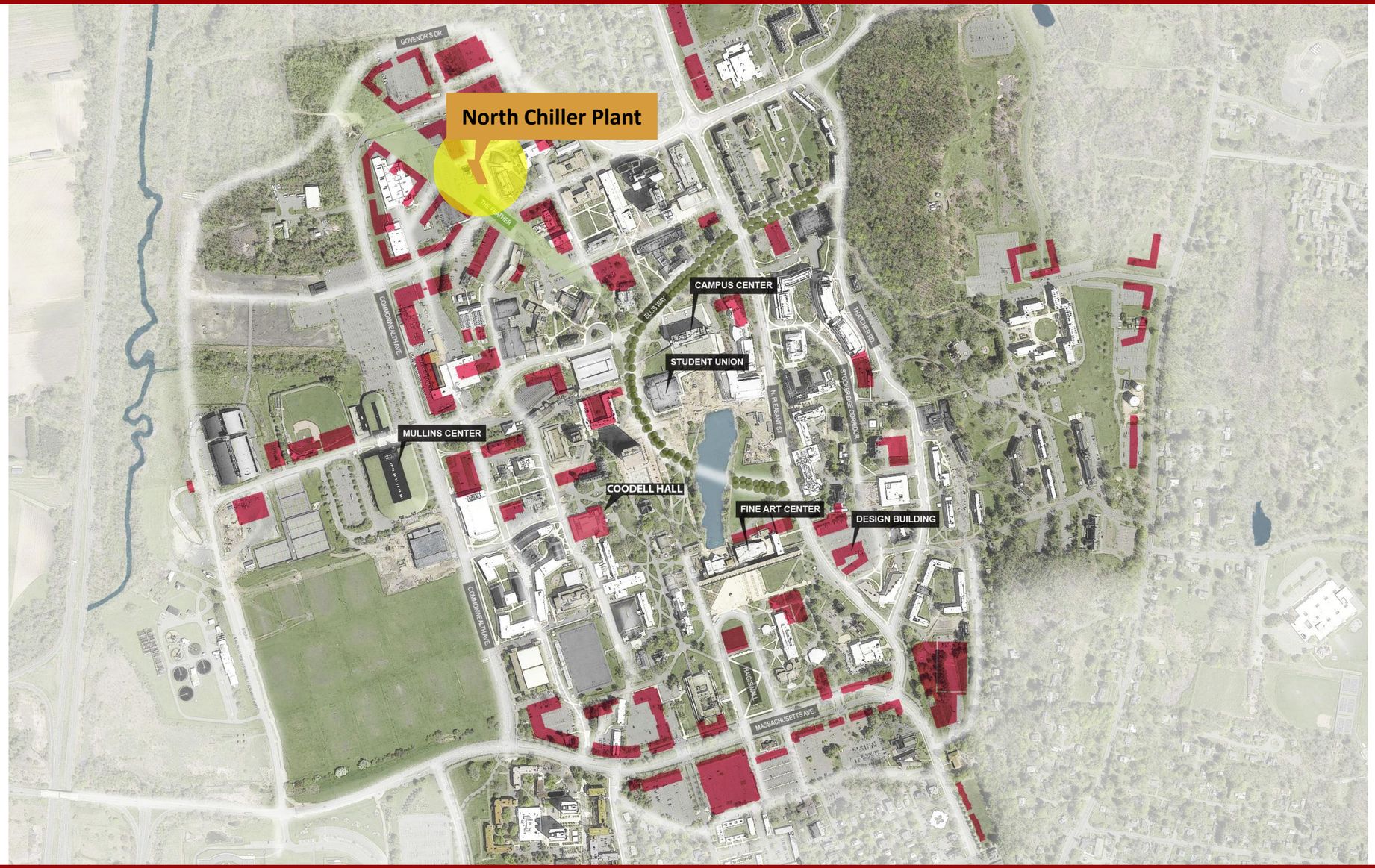
How can we make District Energy Noise less Scary?

Key Points

- **Early in project, identify and address noise concerns with noise professional.**
- **3 locations for noise control.**
  - Interior:
    - Equipment choice.
    - Equipment lagging and attenuators.
    - Absorption in plant.
      - Protect workers and comply with OSHA.
      - reduce overall plant as noise source.
  - Envelope: block or mitigate sound at the building walls/roof/openings.
  - Exterior: outside equipment choice, local barriers and enclosures.
- **Develop, review, and update noise control design throughout entire project.**



Energy Plants Are Not “Backyard” or “Elsewhere” Anymore



Plants + Their Noises!

Case Studies: UMA Chiller Plant, OU CHW Plant, Tufts CEP

CHILLED WATER

Advantage: Less air required, so roof ventilation can be used.
Challenge: Exterior Cooling Tower noise.

UMass Amherst North Chiller Plant
(UMA Chiller Plant)

Ohio University Chilled Water Plant
(OU CHW Plant)

COMBUSTION/TRI-GEN

Advantage: Interior combustion equipment.
Challenges: Large combustion air volume requires large openings in building walls.
Exterior Cooling Tower noise.

Tufts University Central Energy Plant
(Tufts CEP)

Project Steps

SD

- Requirements & Goals
- Baseline Community Survey
- Preliminary Design Recs & Specs
- Community Engagement

DD/CD

- Refine Recs & Specs

Bid

- Review & Update Estimates and Recs

CA & Commissioning

- Evaluate Equipment & Building

Noise Goals

- **Community**
- **Interior/Workplace**

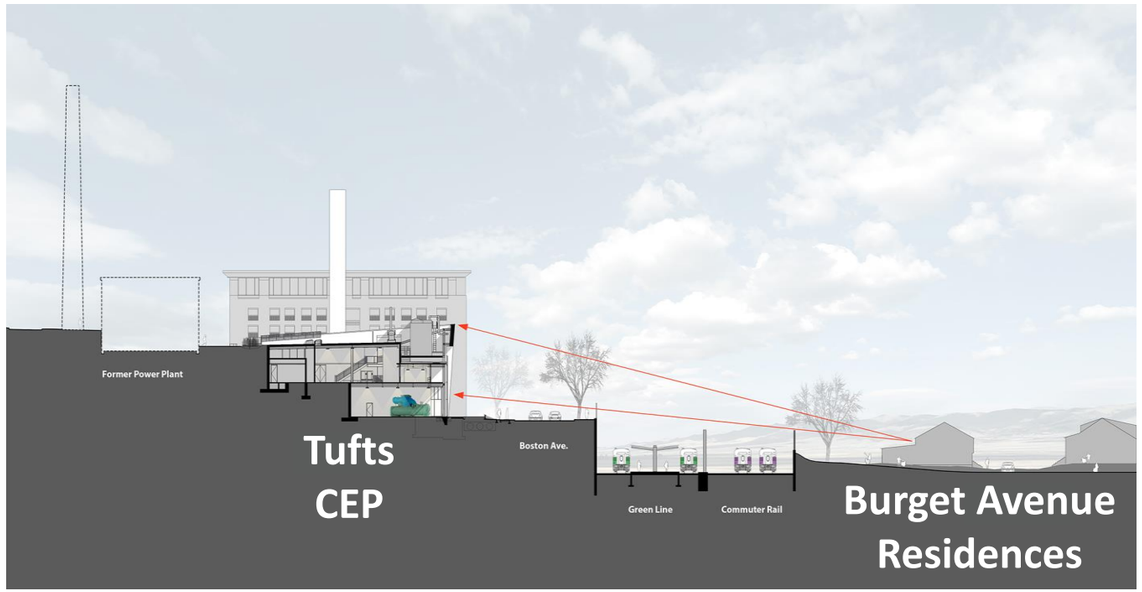
- Regulations (OSHA, State, local)
- Owner’s Policy
- Existing Conditions
- Good Practice
- Include Margin (3 to 5 dBA)

Ohio University Chilled Water Plant

Tufts Sound Goals
Case Study: Tufts CEP

Community

- 40 dBA nighttime sound levels outside Burget Avenue residences from continuous plant sources:
  43 dBA goal – 3 dBA margin.



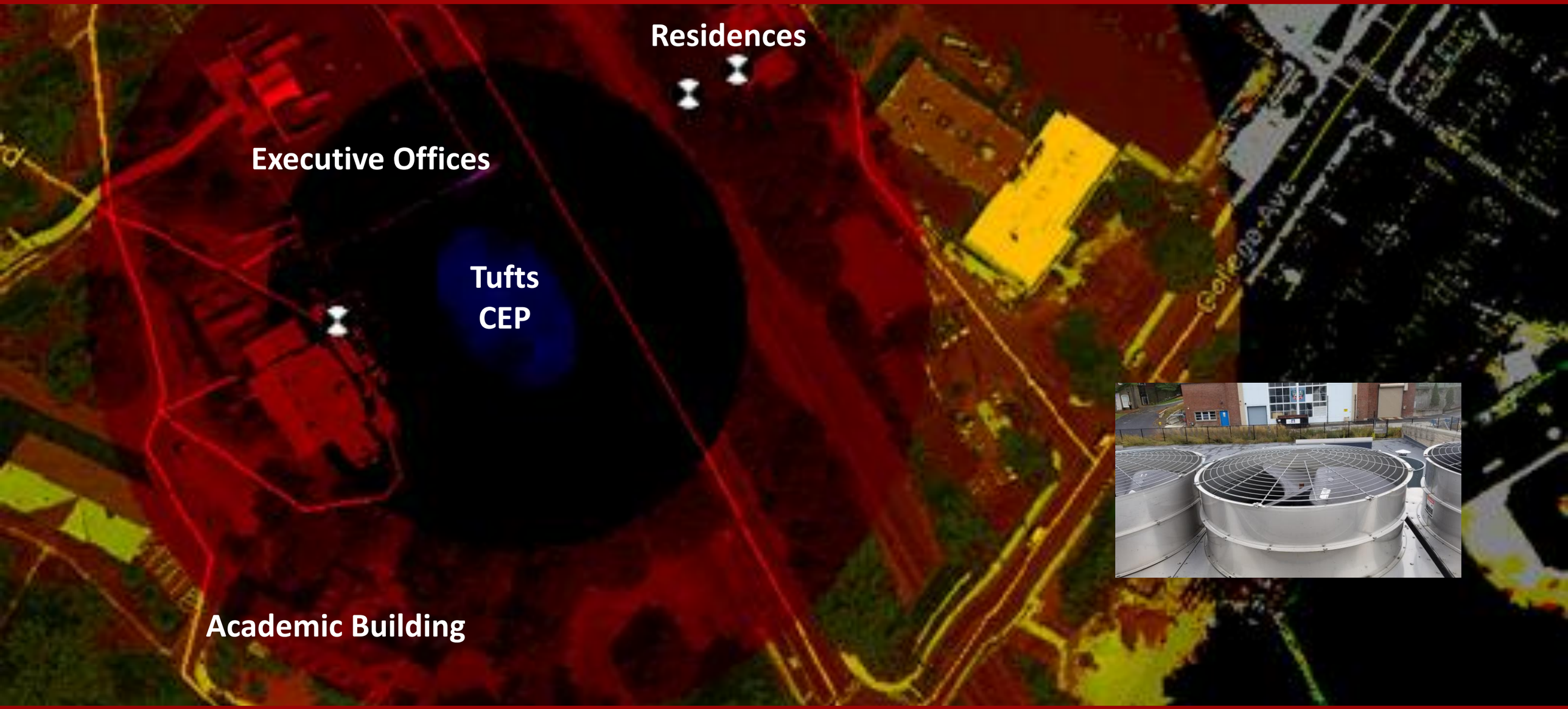
Workplace

- 55 – 60 dBA: Control and meeting rooms.
- 80 – 90 dBA: General plant floor areas.
- 95 – 105 dBA*:High noise equipment in separate room or plant area.

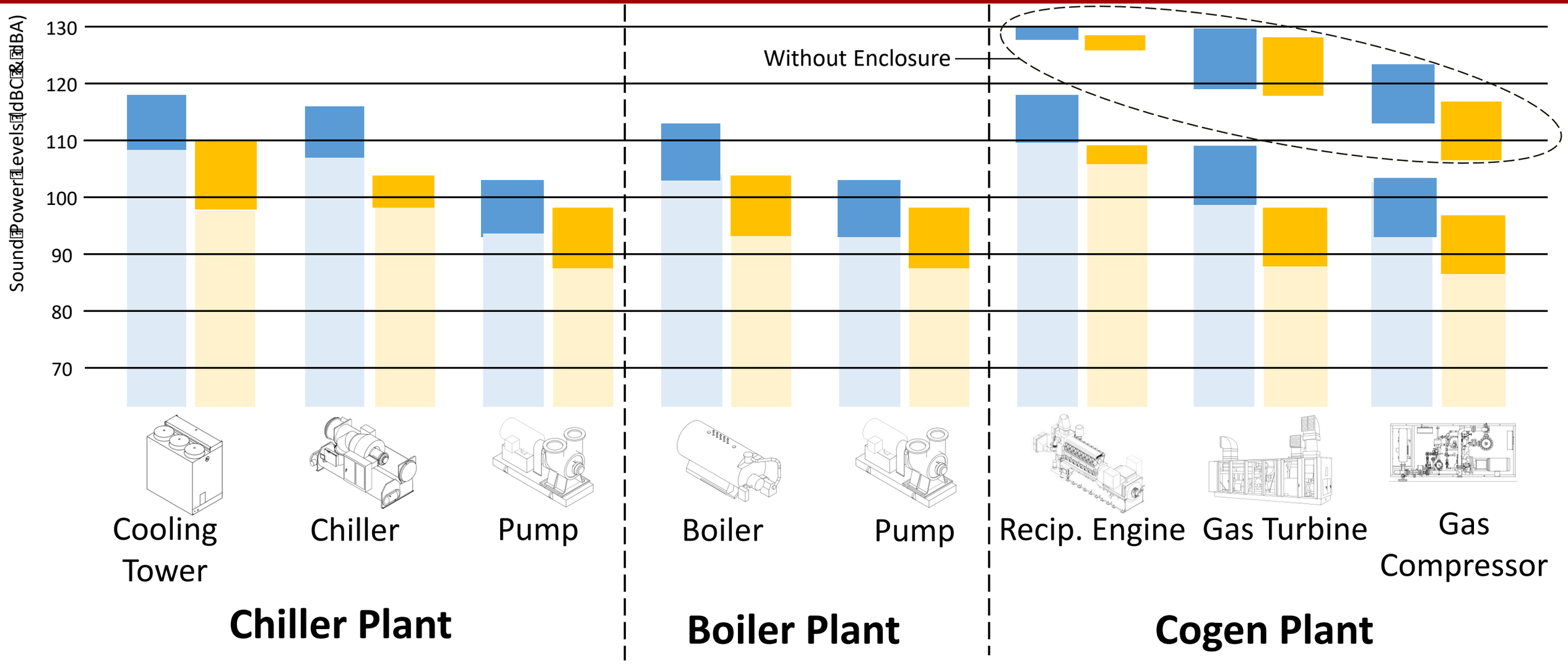
* 100 dBA is the desired maximum sound level in high noise equipment spaces, however the maximum sound levels in the Reciprocating Engine Room were expected to be about 105 dBA based on vendor and in-house data.

Preliminary Sound Estimates and Noise Control Design

Case Study: Tufts CEP



Plant Equipment Sound Power Levels, dBC and dBA

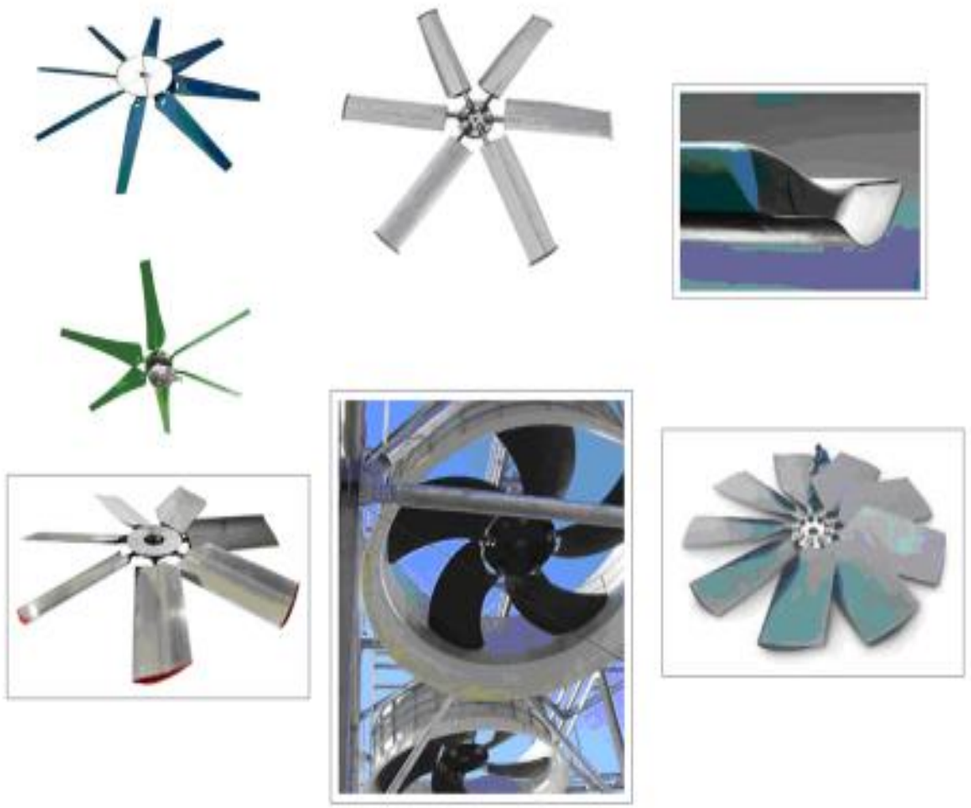


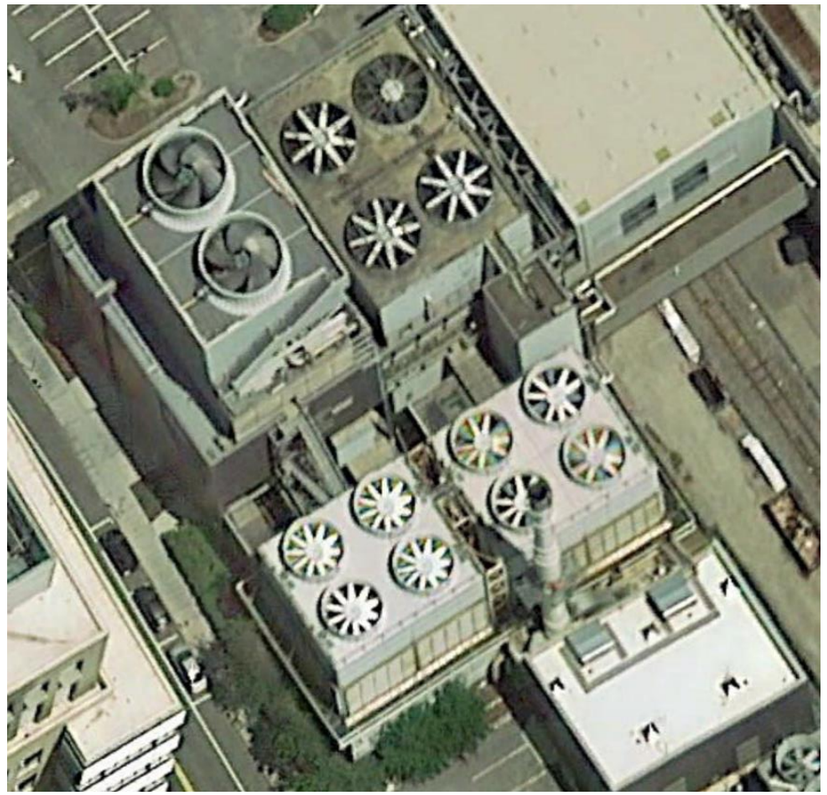
Noise Mitigation: Equipment

- 85 dBA or less at 3-ft. for most indoor equipment.
- High-efficiency motors and transformers.
- Equipment with vendor-supplied enclosure.
- Well-matched ventilation fans & mufflers.
- Low-noise cooling tower.

Cooling Towers – Special Attention (Fan, VFD)

- Low-noise design fan operating at reduced tip speed rather than narrow chord blade fan at 12,000 fpm.
- VFD or 2-speed drive motors if have excess nighttime tower capacity.





Equipment Acoustic Recommendations

- Requirements & goals with margin.
- Cooling tower and other major equipment early.
- Push vendors for reduced-noise options.
- Timely requests and updates.
- “Back-pocket” mitigation options.
- Clear Architectural & Mechanical Specifications

Noise Mitigation: Building

Interior

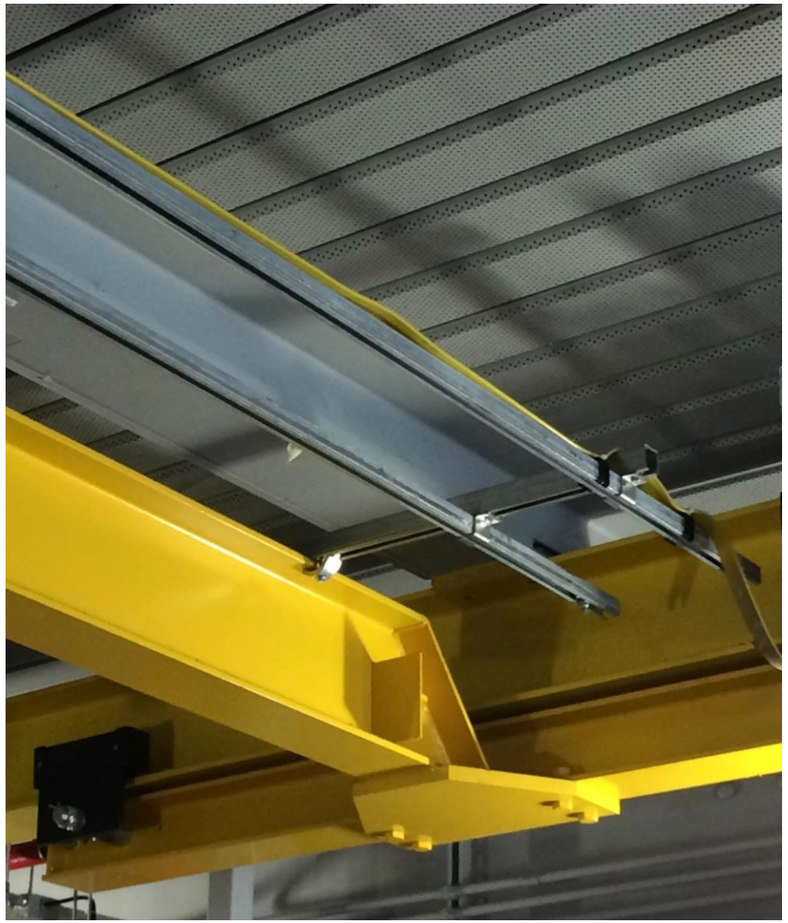
- Sound Absorption
- Sound Blocking
    - Wall
    - Floor

Exterior Envelope

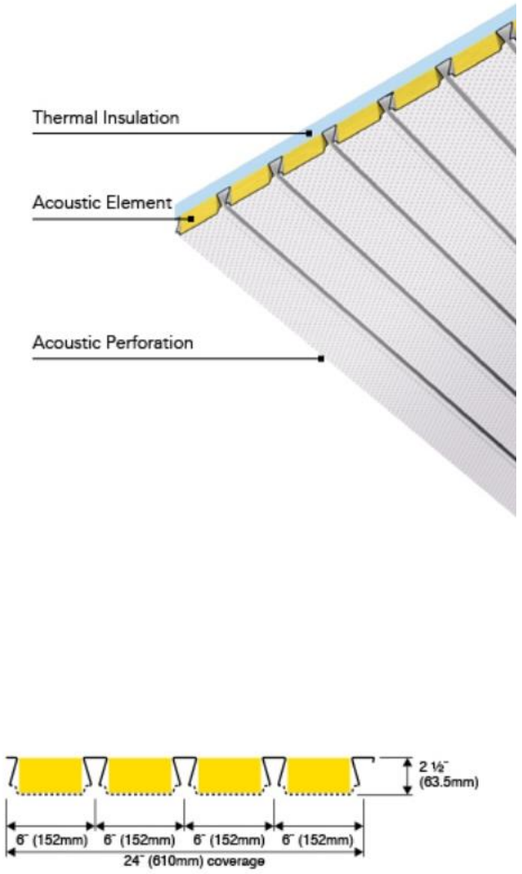
- Roof Parapet
- Sound Barrier
- Ventilation Strategies
- Maximize Wall Sound Blocking

Interior Sound Absorption

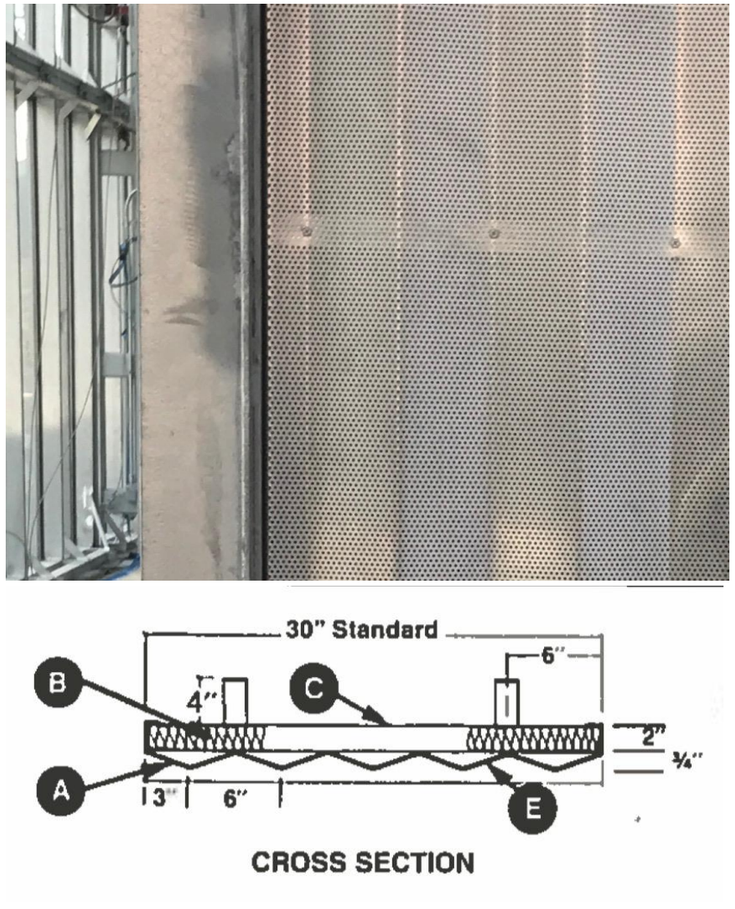
Case Study: Tufts CEP



Acoustic Deck Ceiling



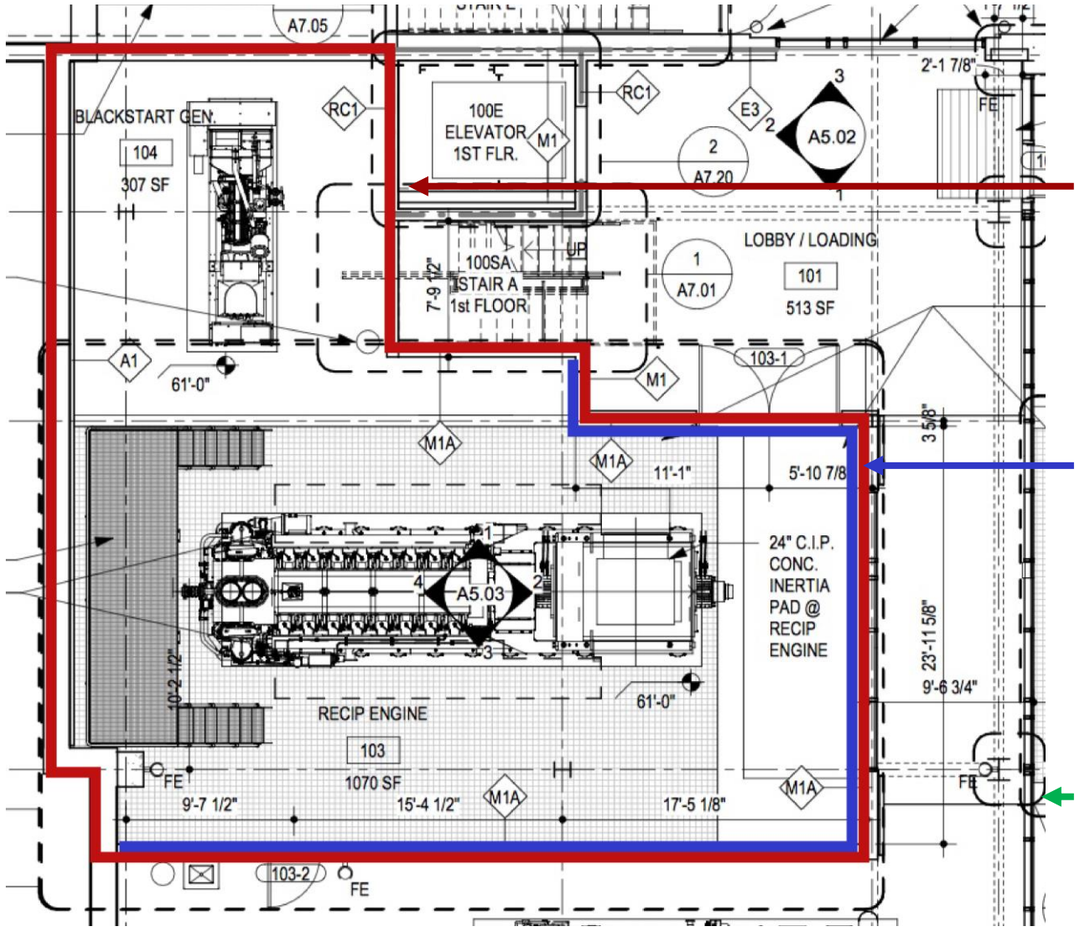
Acoustic Deck Diagram



Corrugated Aluminum Wall Panel

Interior Sound Blocking

Case Study: Tufts CEP

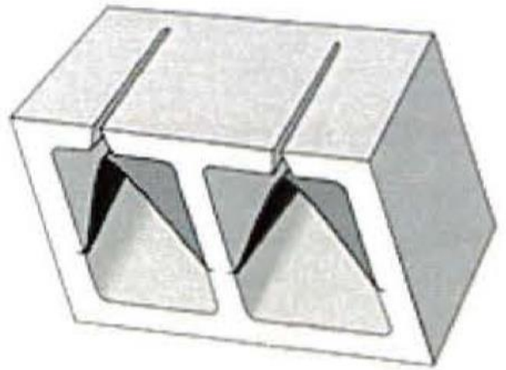


Sound Barrier, CMU & Concrete Walls

Sound Absorption, Corrugated Aluminum Wall Panel

Sound Barrier, Acoustic Glass

Plan of Reciprocating Engine Room

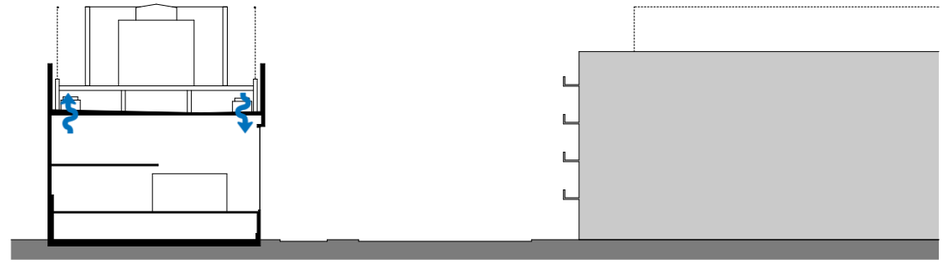


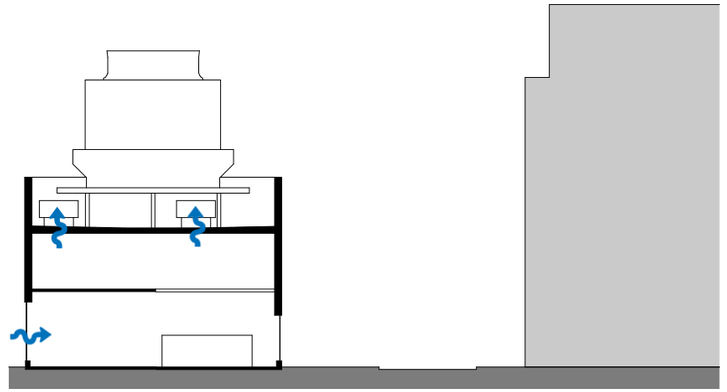
Acoustic Block

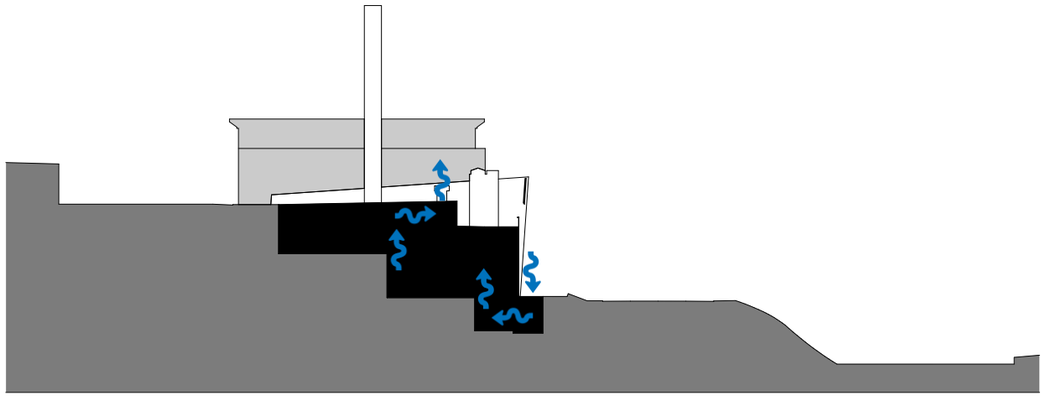
Exterior Envelope Strategies

Case Studies: UMA Chiller Plant, OU CHW Plant, Tufts CEP

- Roof Parapet
- Sound Barrier
- Reduce Wall Openings, Use Rooftop Ventilation
- Areaway Configuration
- Sound Attenuators/Silencers
- Maximize Wall Sound Blocking



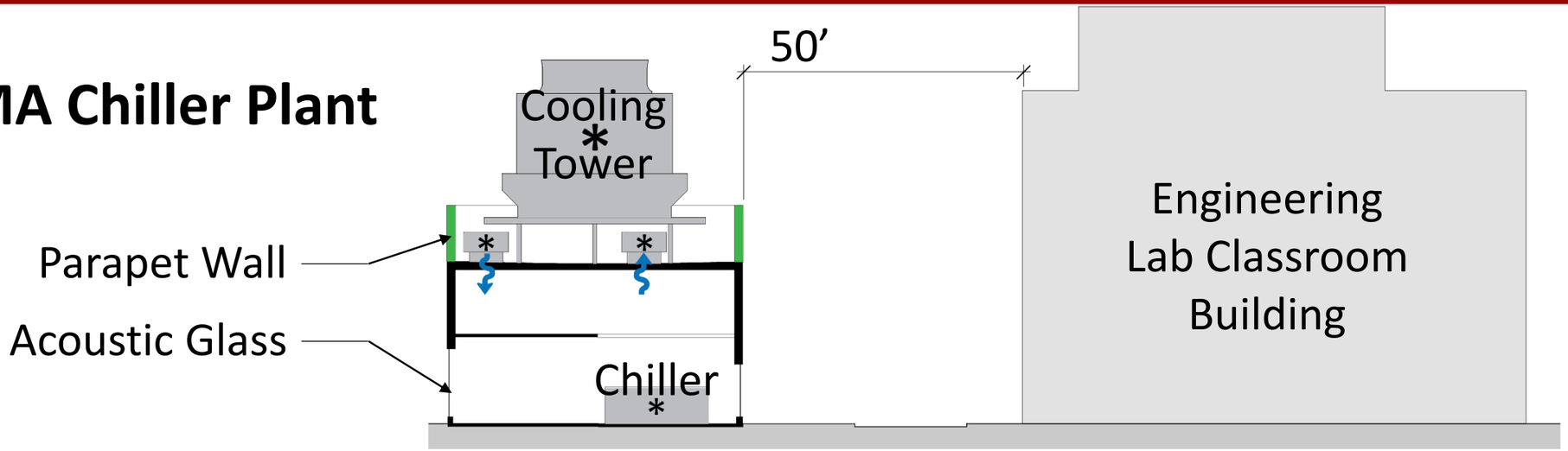




Exterior Envelope Strategies

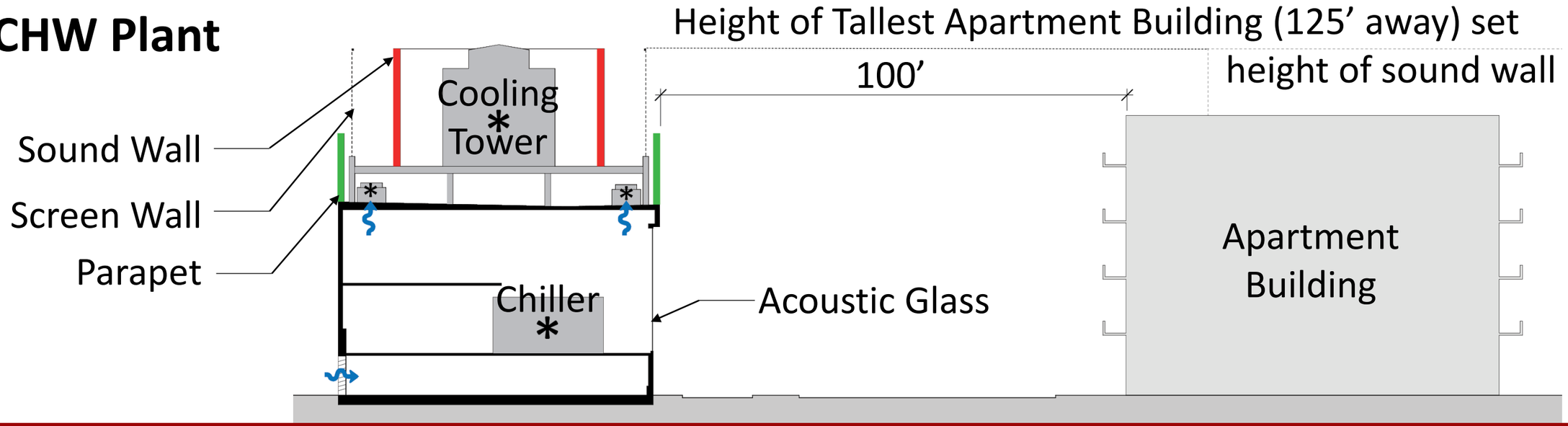
Case Studies: UMA Chiller Plant, OU CHW Plant

UMA Chiller Plant



* **Major Sound Source**

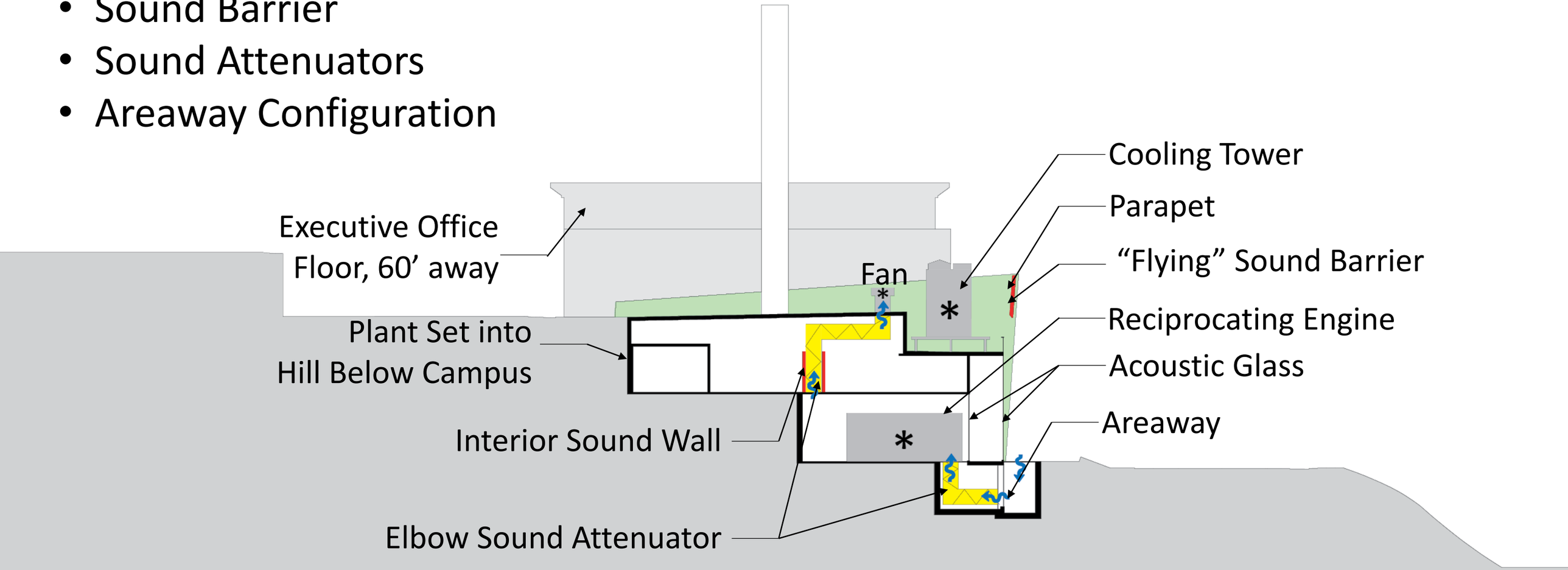
OU CHW Plant



Exterior Envelope Strategies

Case Study: Tufts CEP

- Roof Parapet
- Sound Barrier
- Sound Attenuators
- Areaway Configuration



Exterior Envelope Strategies

Case Study: Tufts CEP

Sound barriers

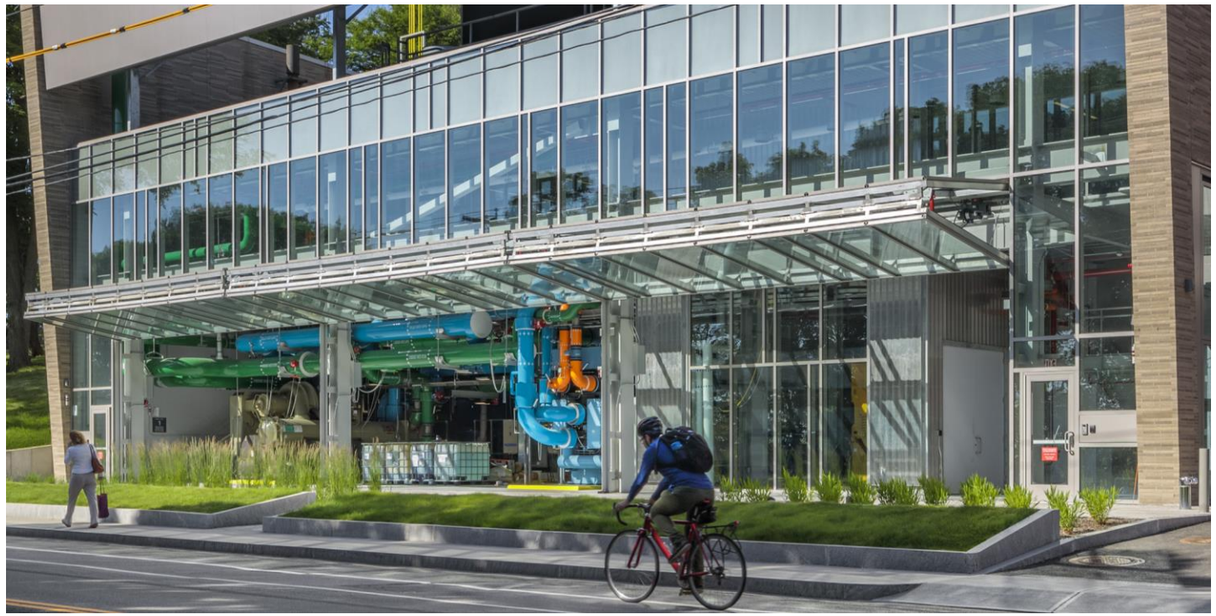
Tufts – “flying barrier”

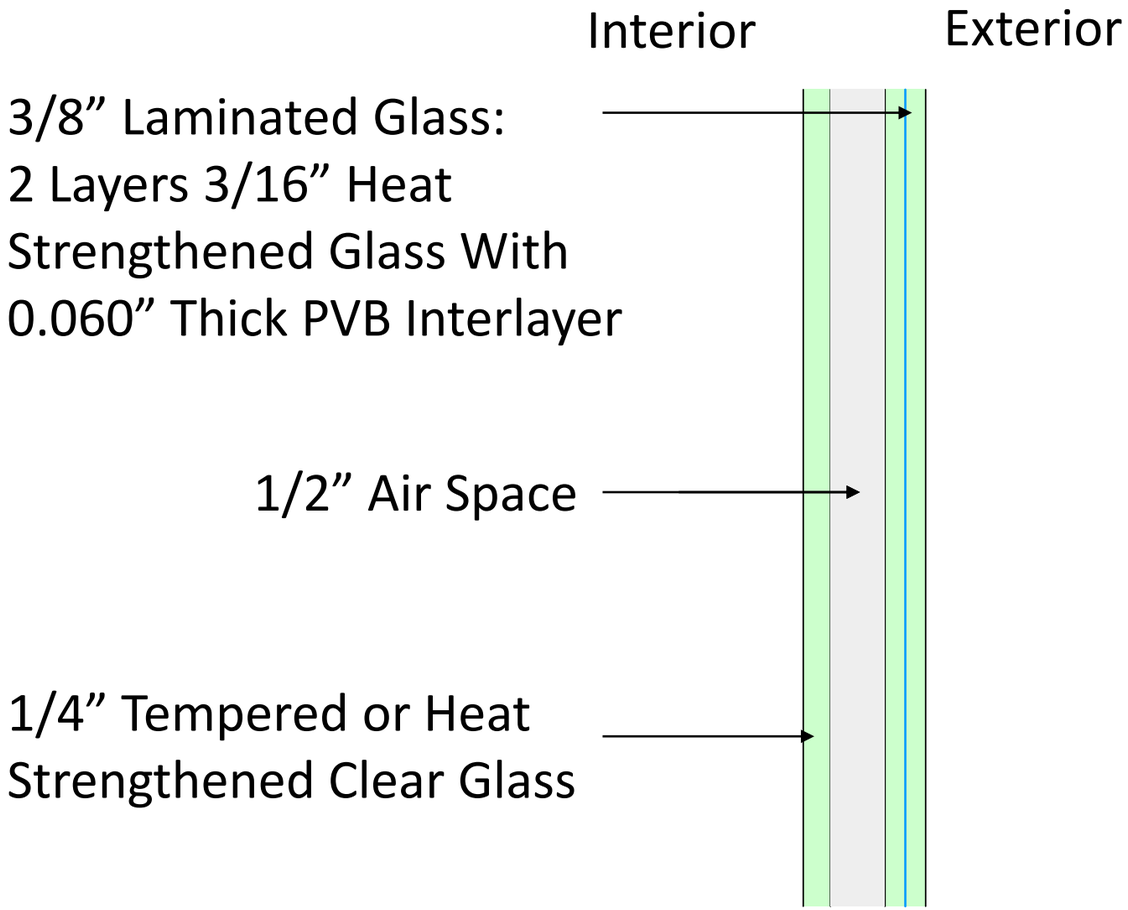
Exterior

Interior

Exterior Envelope Strategies
Case Study: Tufts CEP

Maximize Sound Blocking

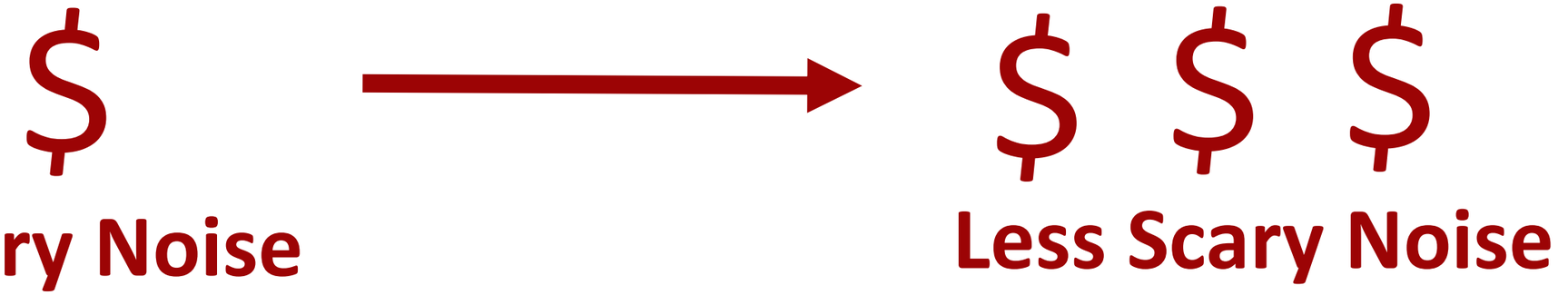




Acoustic Glazing
STC = 40

Value Engineering: Tradeoffs In Noise Control Design

Noisier Interior Environment	vs	Sound Absorption
Lower Performance Attenuators	vs	High Performance Attenuators less risk of community noise complaints.
Smallest cooling towers (High Speed Fans)	vs	Larger Cooling Tower Low-Speed Fans with VFD



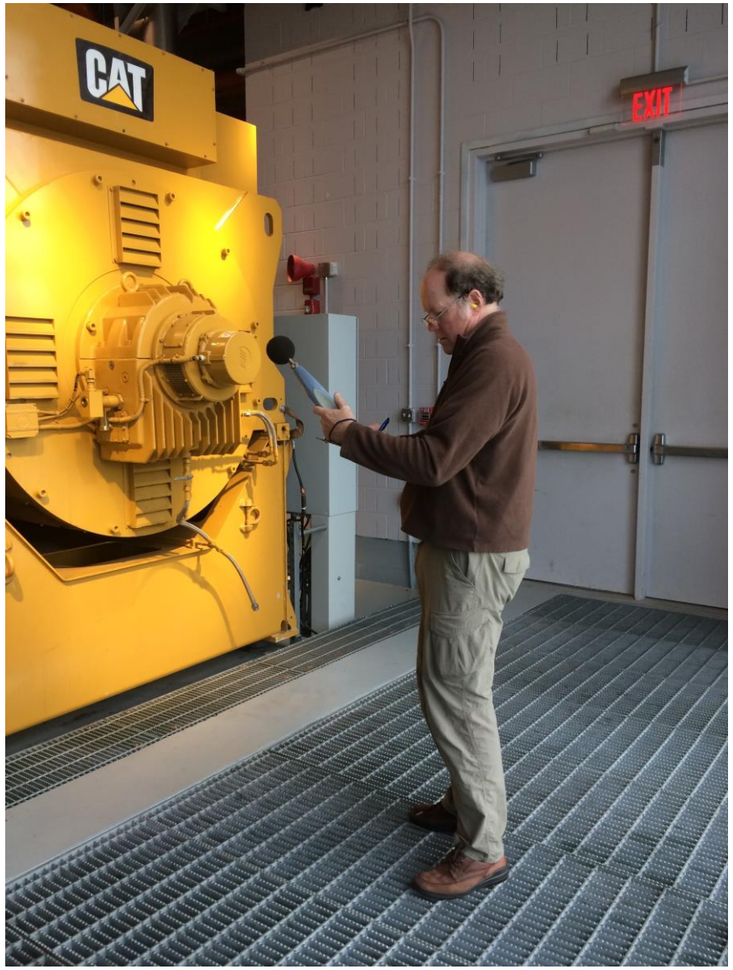
HOW DID WE DO?

Case Study: Tufts CEP

Post-Occupancy Visits and Measurements with limited equipment operating:

Tufts CEP interior sound (10/8/2019)

Goal	
55-60	• 58 dBA: Conference Rm (door closed)
55-60	• 56 to 60 dBA: Control Rm (door closed)
80-90	• 67 to 78 dBA: Boiler Hall
80-90	• 74 to 82 dBA: Chiller Hall
95-105	• 100 to 105 dBA: Recip. Engine Rm



HOW DID WE DO?

Case Study: UMA Chiller Plant

Post-Occupancy Visits and Measurements with limited equipment operating:

UMA Chiller Plant Sound (10/22/2019)

Goal	
55-60	• 63 dBA Control Room (door closed, HVAC sound)
80-90	• 69 to 77 dBA: Chiller hall
No Goal	• 57 dBA 150 ft from cooling tower - waterfall sounds

What worked?

- Tufts CEP: Noise Goals met with equipment choices and plant construction.
- UMA Chiller Plant: Noise Goals generally met with equipment choices and plant construction, except for HVAC sound in control room.

What would we do differently?

- Choose very quiet HVAC equipment for control rooms and meeting rooms.
- In future energy plants, if waterfall noise is a concern in the community, add sound barrier in addition to parapet.

Questions?

Thank You!

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