

# Maryland Transportation Authority Police Training Facility



Leah C. Clark  
Lighting/Electrical Option  
Senior Thesis 2008



# Overview



Location: Hawkins Point, Baltimore, Maryland

Size:

- 42,100 square feet
- 2 stories above grade

Project Team:

- Owner: Maryland Transportation Authority
- Mechanical and Electrical: Johnson, Mirmiran, & Thompson
- Architectural: Rubeling & Associates
- Civil and Structural: Carroll Engineering, Inc.

Cost: \$15.2 Million



# Classroom Lighting

# Classroom

## Design Criteria

### Light Distribution of Task Plane

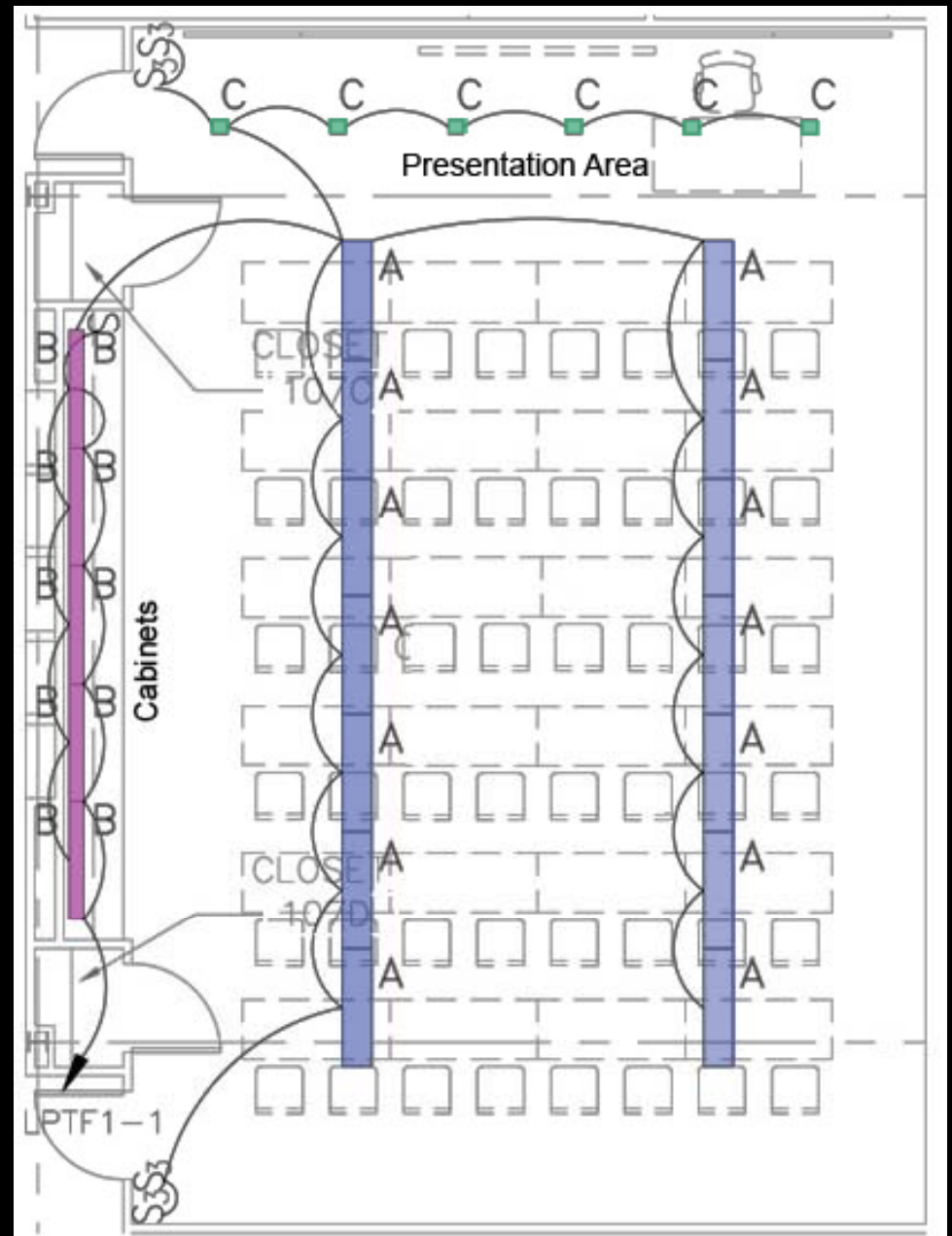
Uniformity on task plane

### Peripheral Emphasis

### Control and Flexibility

- 1) Examination Scene
- 2) Audio/Visual Presentation Scene
- 3) Lecturing Scene

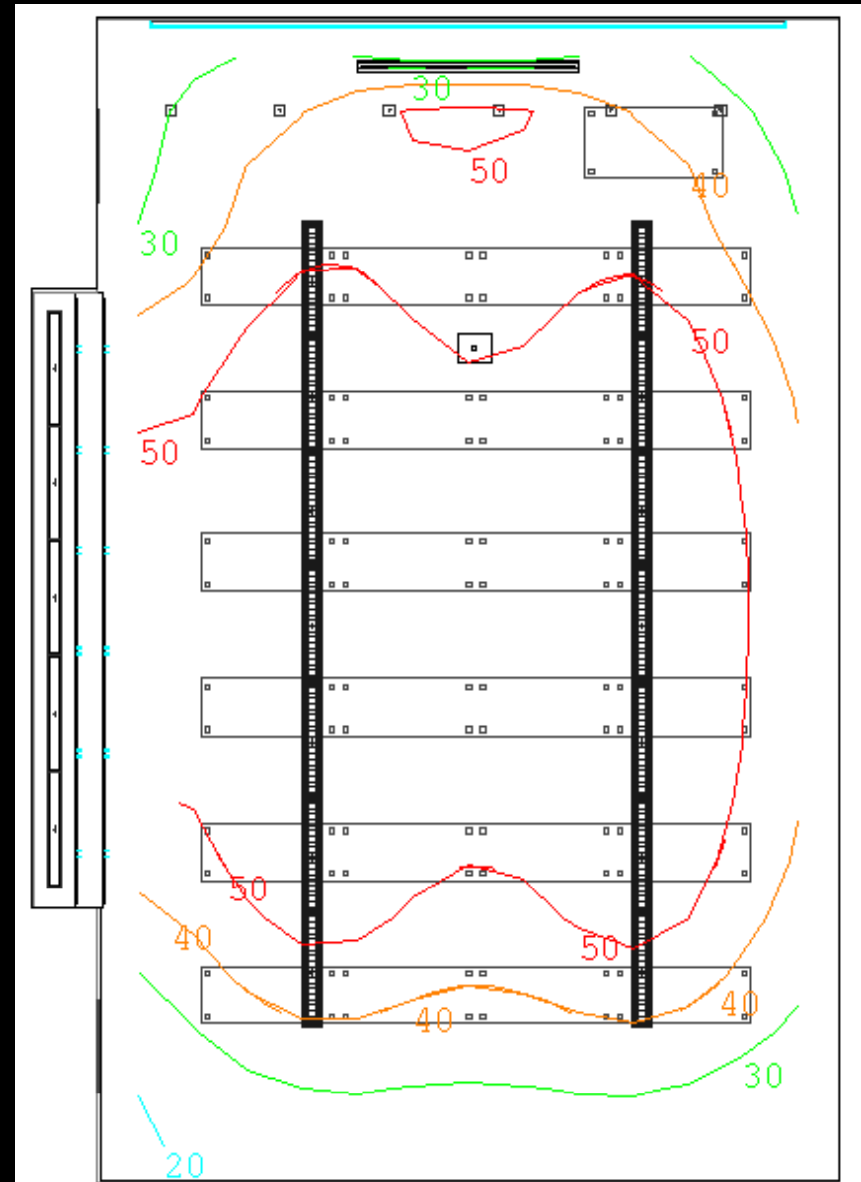
### Illuminance Levels (to perform task)



# Classroom

## Examination Scene

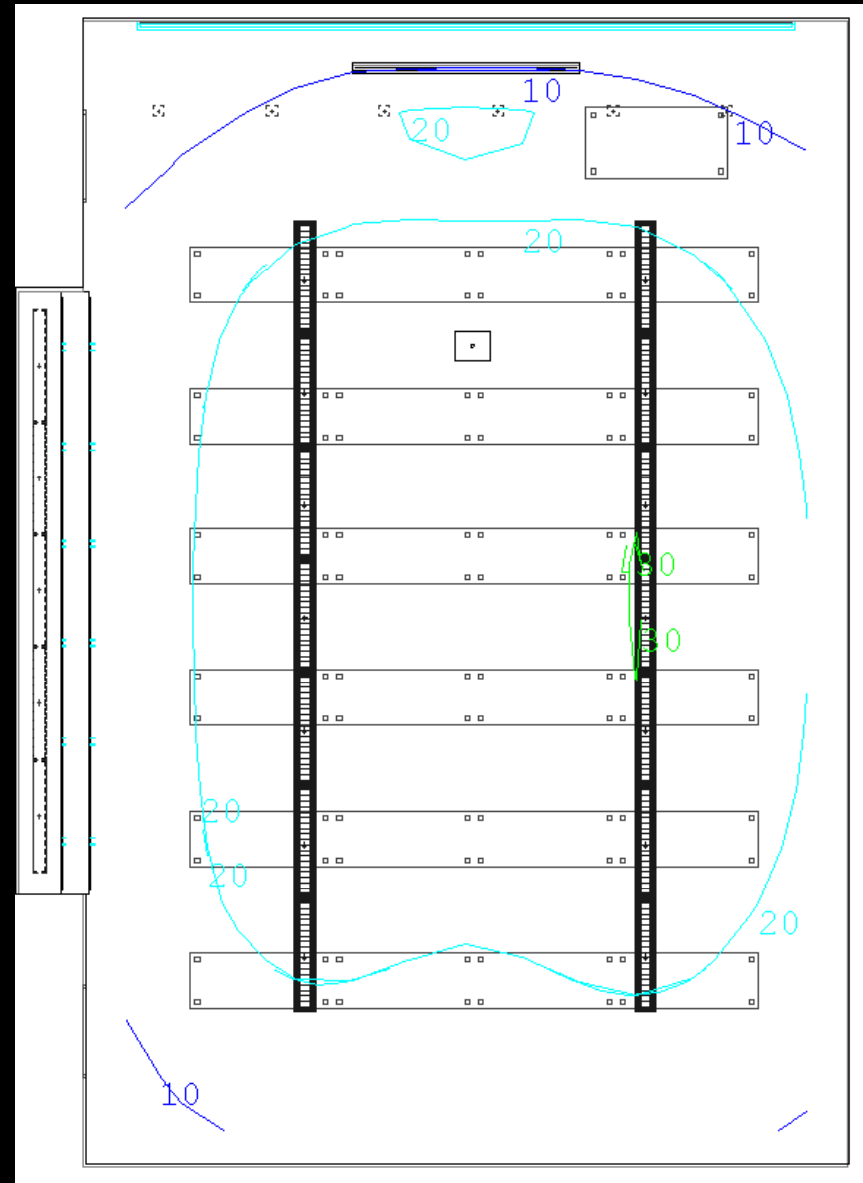
- A) Linear semi-indirect – 100%
- B) Cabinet lighting – 100%
- C) Square downlights – 100%



# Classroom

## Audio/Visual Presentation Scene

- A) Linear semi-indirect – 50%
- B) Cabinet lighting – 0%
- C) Square downlights – 0%

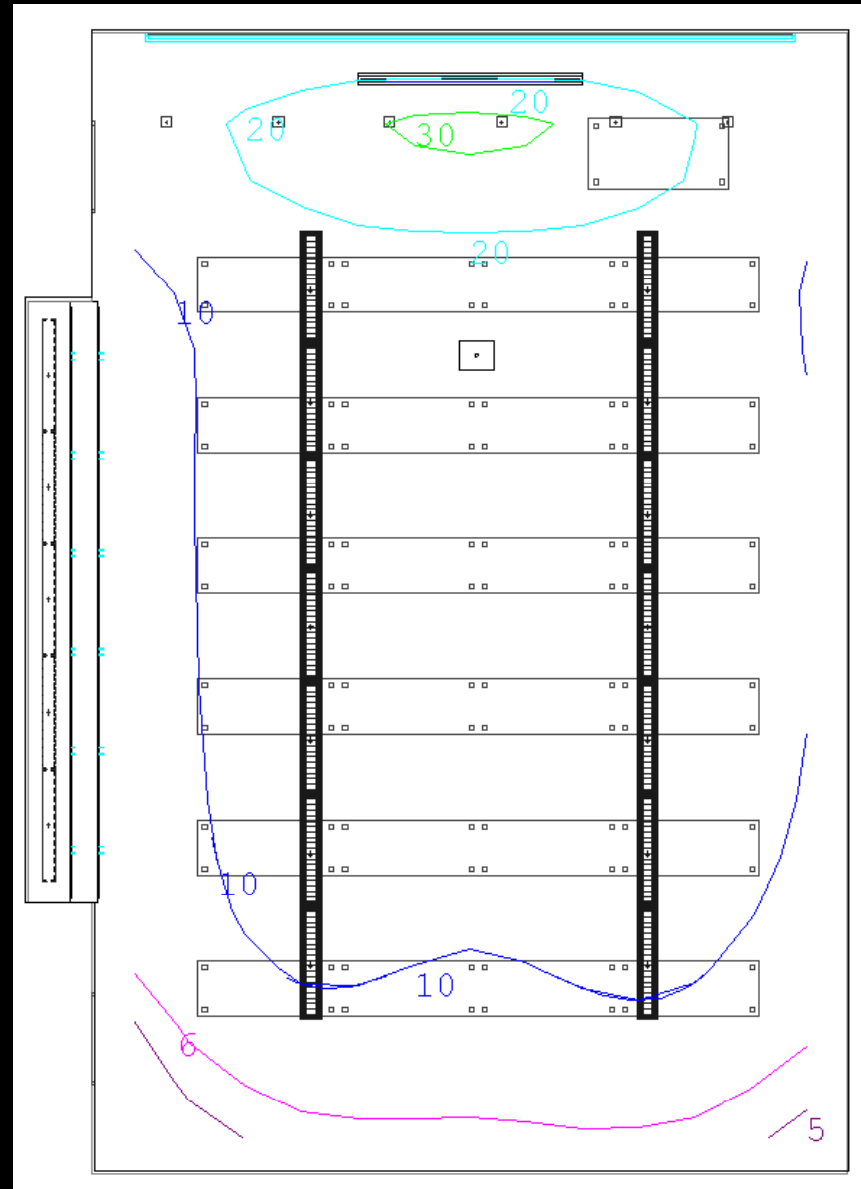




# Classroom

## Lecturing Scene

- A) Linear semi-indirect – 25%
- B) Cabinet lighting – 0%
- C) Square downlights – 100%





# Firing Range Lighting

# Firing Range

## Design Criteria

### Control and Flexibility

- Pseudo-realistic training environments
  - 1) Night-time Condition
  - 2) Typical Interior Condition
  - 3) Glare Condition

### Light Distribution on Task Plane

Distribution will vary based on the real-life situation being simulated

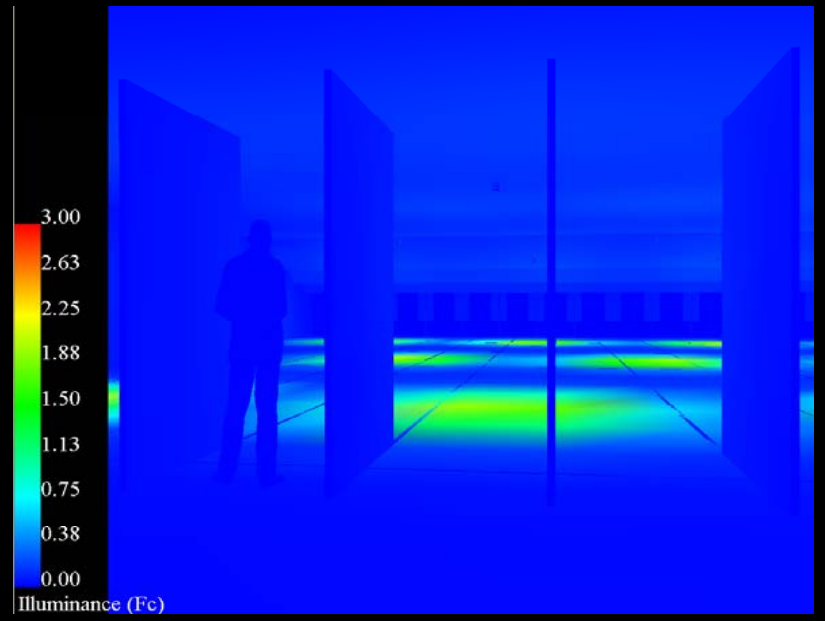
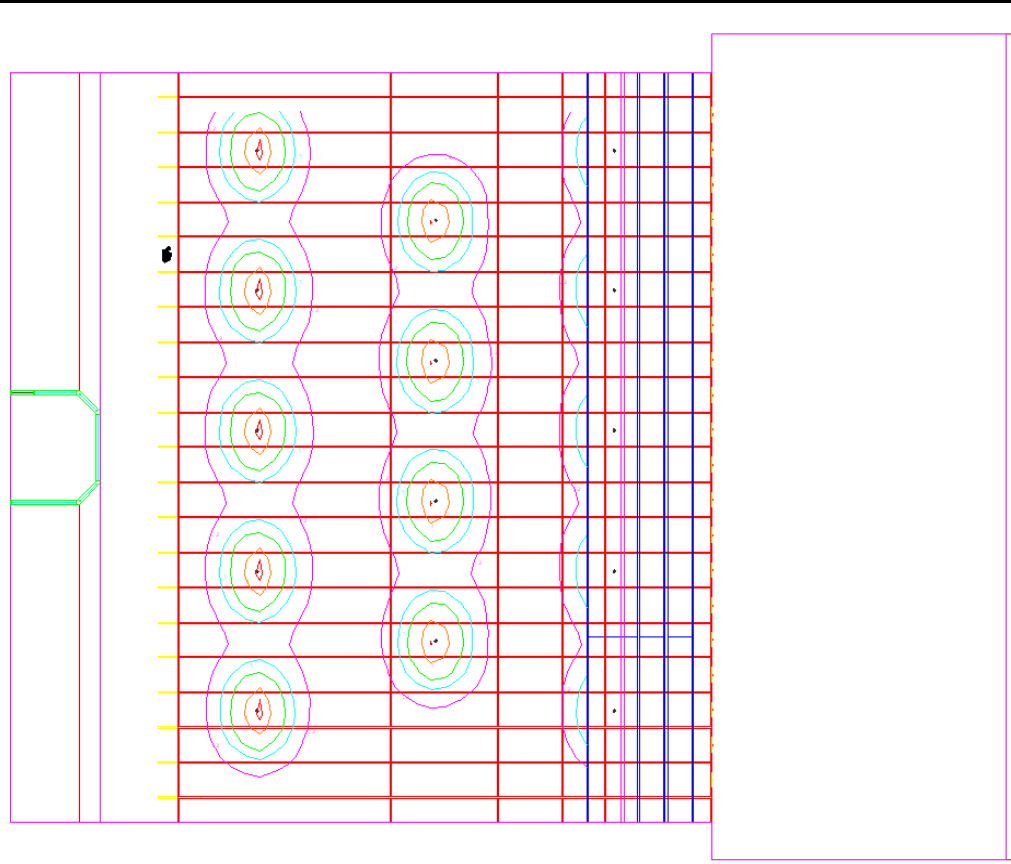
### Illuminance Levels

Night-time Condition – less than 5 fc  
Typical Interior Condition – avg 30 fc  
Glare Condition – avg 30 fc + glare



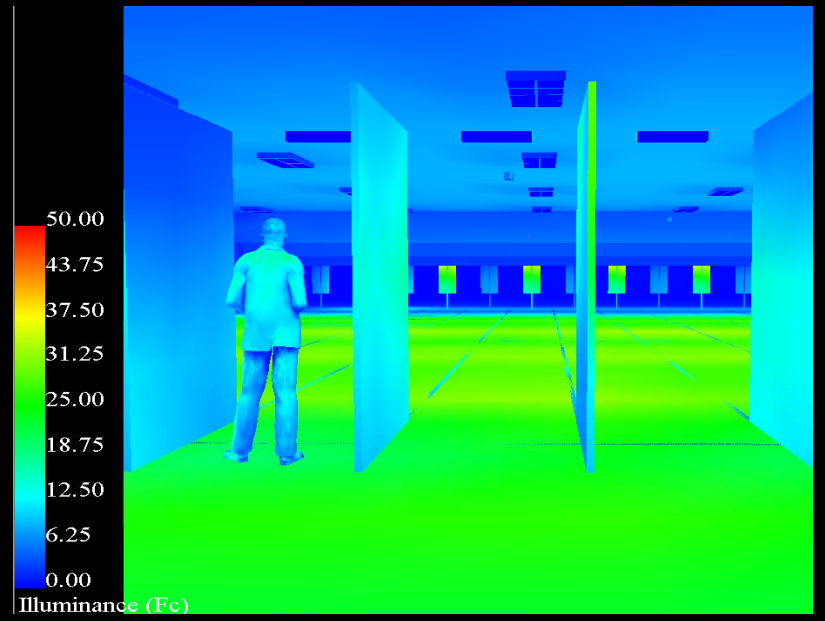
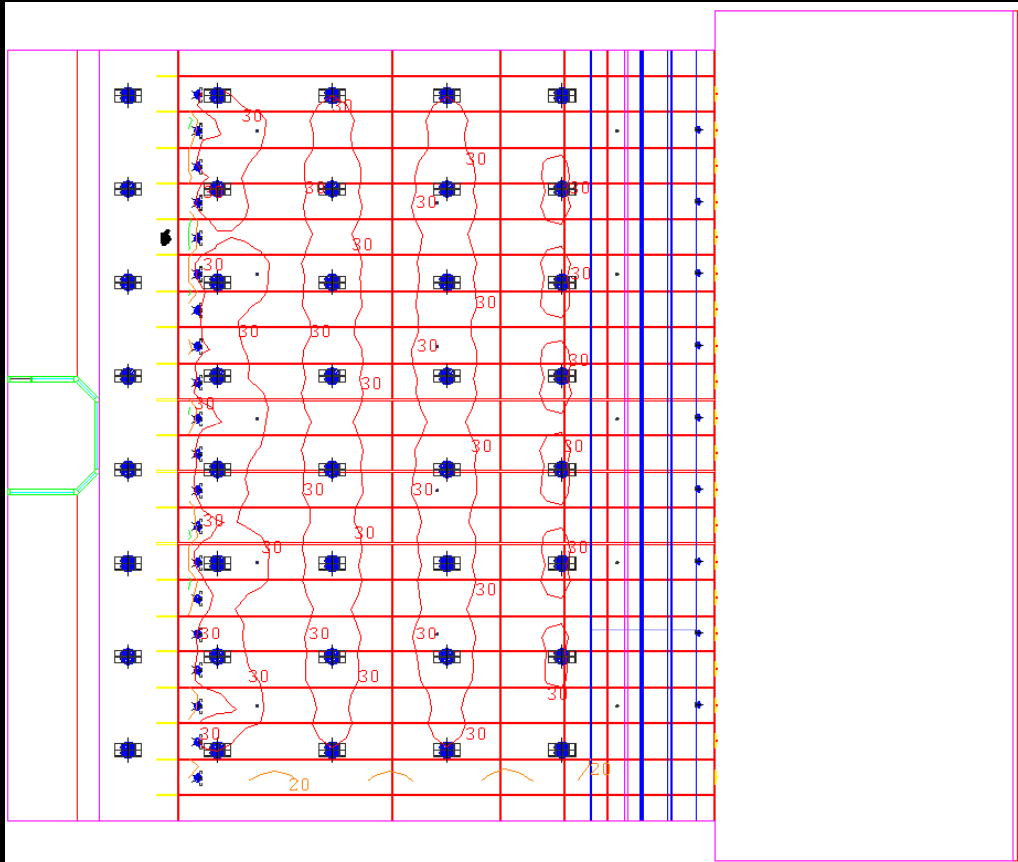
# Firing Range

Night-time Condition



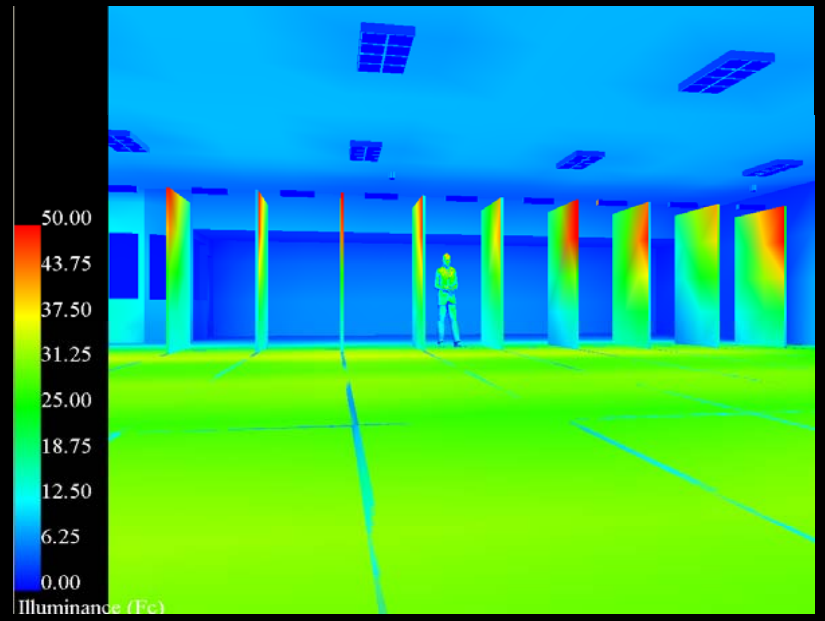
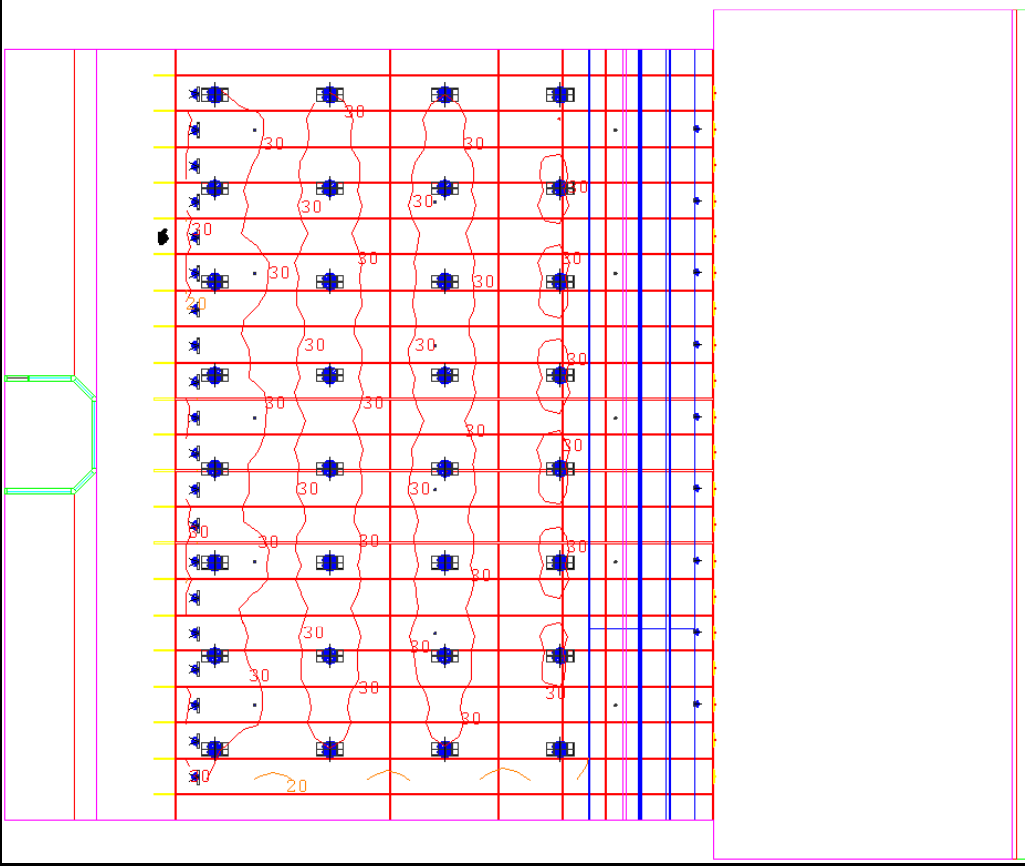
# Firing Range

## Typical Interior Condition



# Firing Range

## Glare Condition



# Range Ventilation

# Range Ventilation

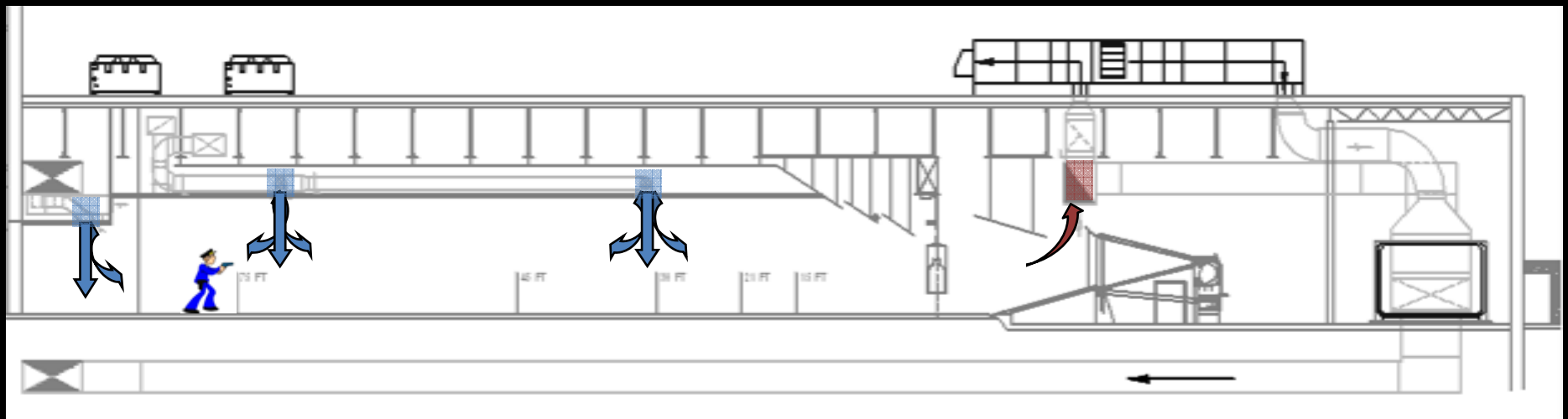
## Range Ventilation Guidelines

- Optimum ventilation rate is 75 fpm at the firing line with a minimum of 50 fpm should be maintained at the firing line.
- Air should be distributed at least 15 feet behind the shooter with the supply air inlets placed on the back wall.
- High Efficiency Particulate (HEPA) filters should be used to filter all air being exhausted from the firing range.
- The range should have a dedicated ventilation system so as not to contaminate other spaces in the building.
- Supply and return air systems should be electrically interlocked so that one can not be in use without the other.
- High efficiency heating and cooling coils lower the interference with air flow balance.



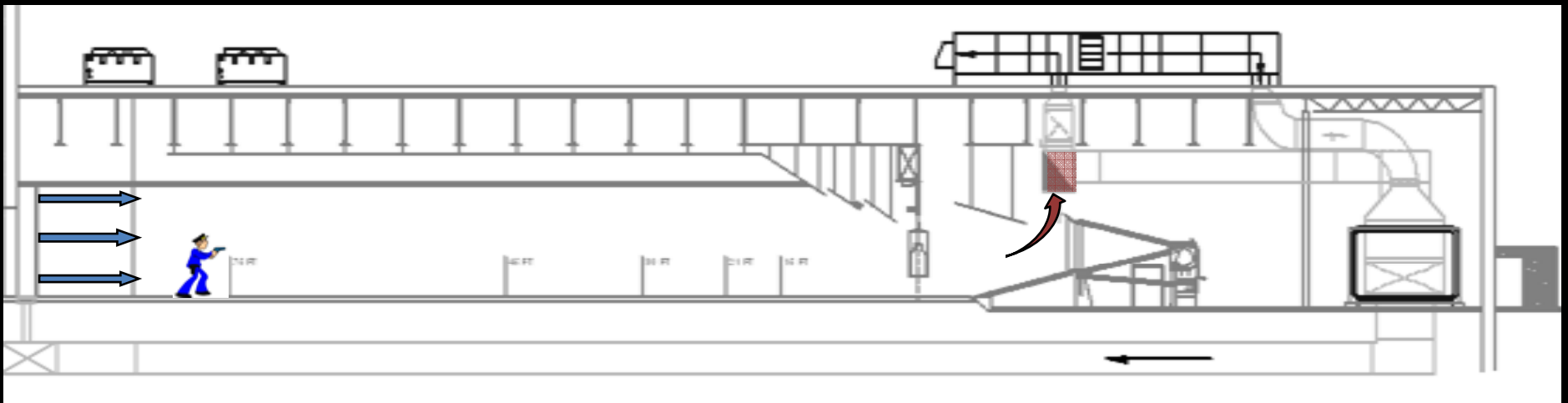
# Range Ventilation

## Existing System



# Range Ventilation

## Proposed Solution



# Range Ventilation

## Sizing of the Proposed System

$$Q = vA = (75 \text{ ft/min}) * (100\text{ft}) * (11\text{ft}) = 82,500 \text{ ft}^3/\text{min}$$

2 AHUs supplying 42,000 cfm

Affinity laws were applied to determine the motor size to power the AHUs

$$\frac{HP_1}{HP_2} = \left( \frac{cfm_1}{cfm_2} \right)^3$$

$$\frac{50}{HP_2} = \left( \frac{33,000}{42,000} \right)^3$$

$$HP_2 = 103 \text{ hp}$$

125 hp motor

# Electrical Resizing for Mechanical

# Electrical Resizing for Mechanical

## Resizing for Mechanical Breadth

$$\text{MCA} = \text{FLC} * 125\% = 156\text{A} * 1.25 = 195\text{A}$$

### Branch Circuits

(4) 3/0 AWG and (1) #3 AWG ground in 2" conduit

$$\text{MOPD} = 156\text{A} * 250\% = 156\text{A} * 2.50 = 390\text{A (max)}$$

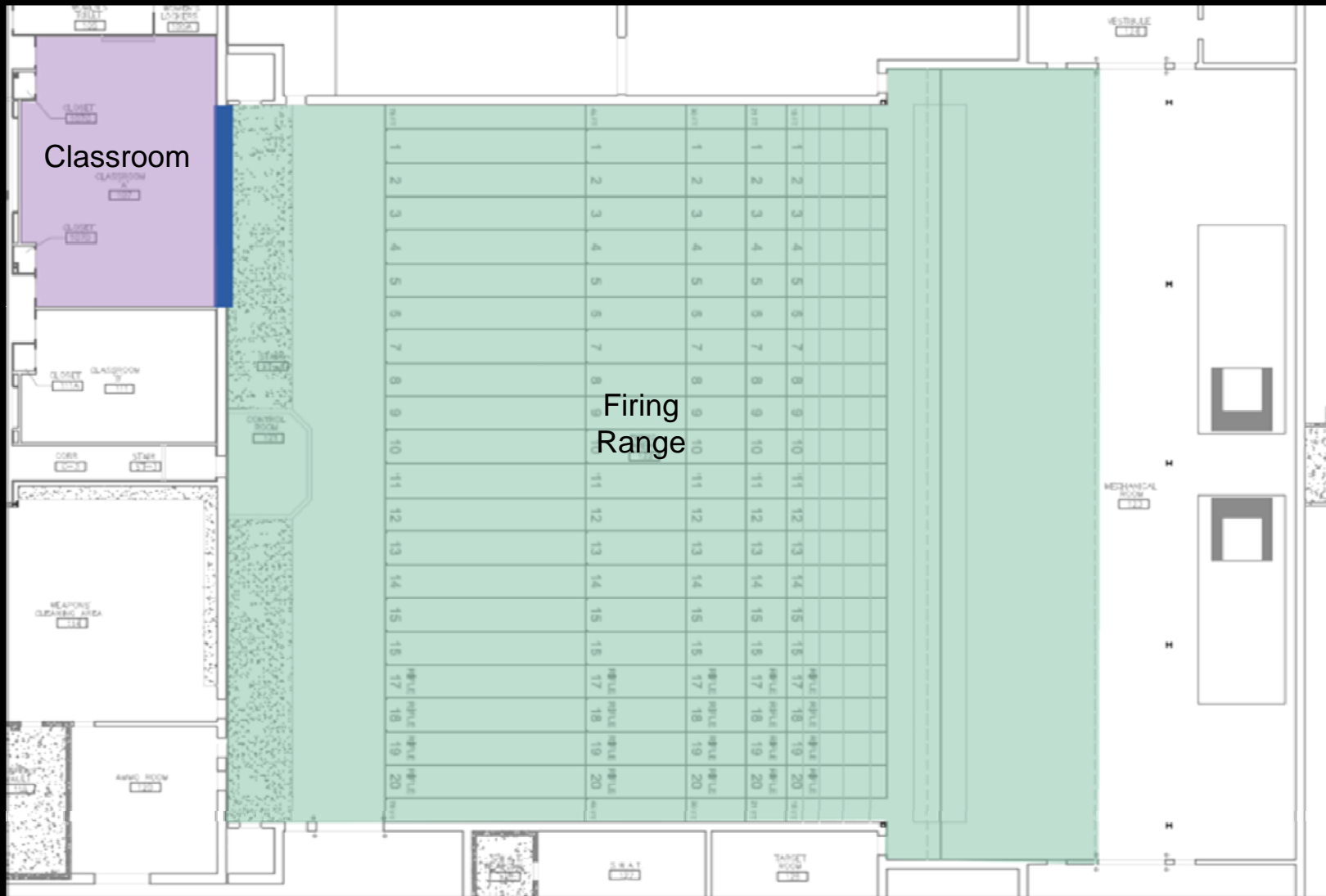
Circuits 7 and 8 serving AHU-1 and AHU-2  
350A 3-pole circuit breakers

### Panelboard MDP

5 sets of (4) 400 MCM and (1) 4/0 AWG ground in 3" conduit

# Acoustical Considerations

# Acoustical Considerations





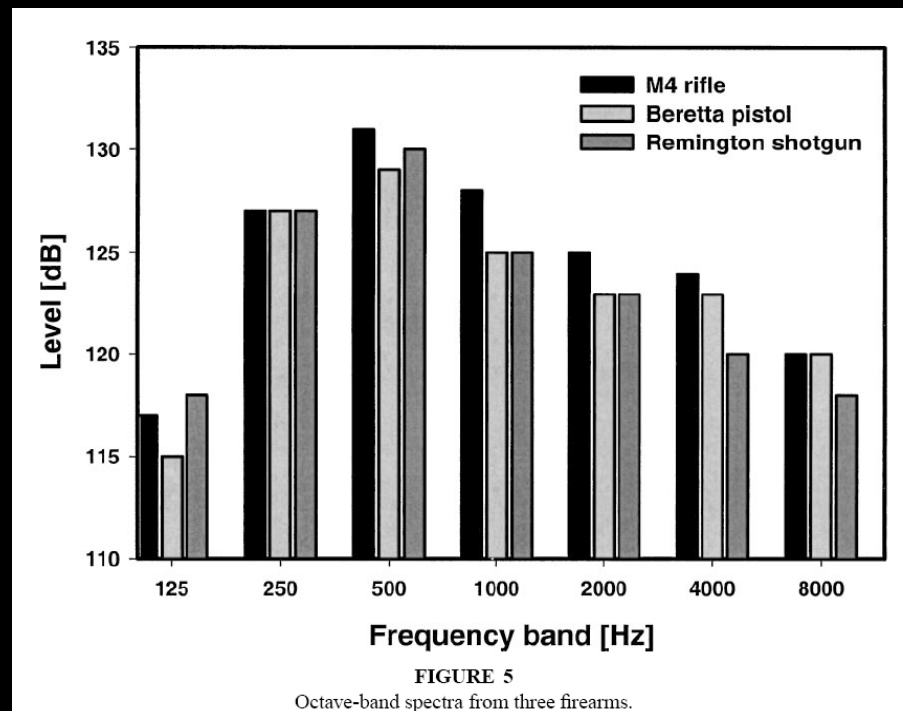
# Acoustical Considerations

Noise Criterion (NC) for classrooms greater than 750 ft<sup>2</sup>  
Less than NC-35

Basic Method used to calculate Noise Reduction (NR)

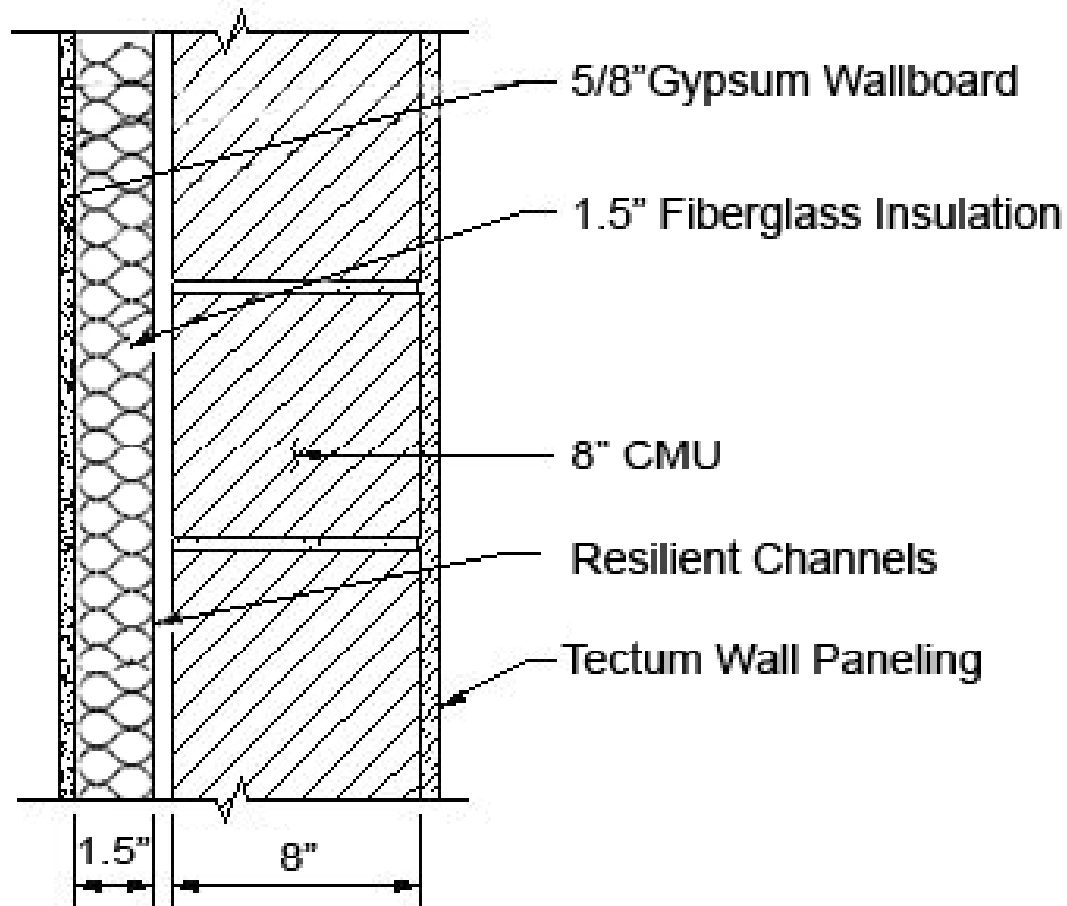
$$NR = TL + 10 \log (A_{\text{rec}}/S_{\text{common wall}})$$

Source Sound Pressure Levels for Firearms



# Acoustical Considerations

## Conventional Wall Assembly



# Acoustical Considerations

## Conventional Wall Assembly

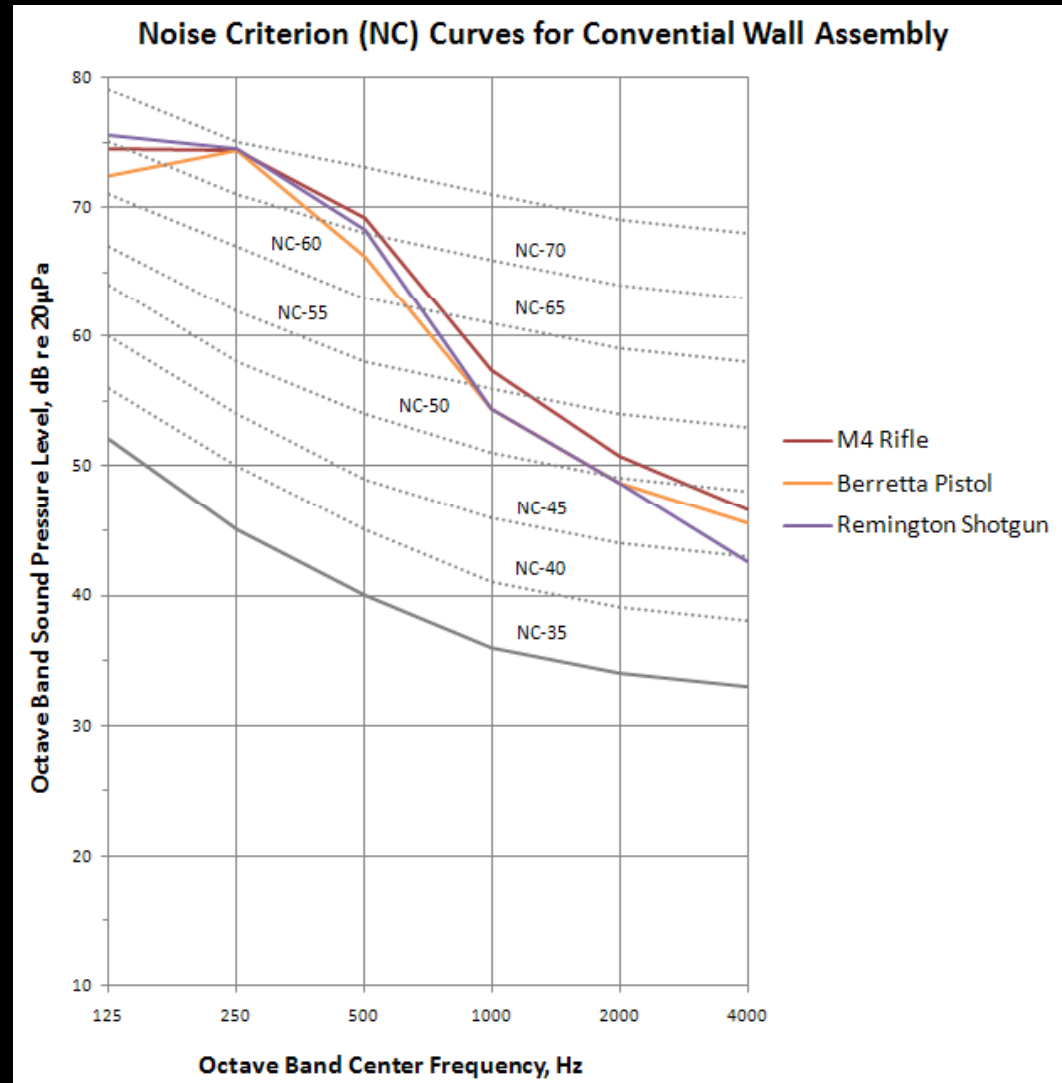
Transmission Loss Between Firing Range and Classroom						
Wall Assembly	Frequency					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Hollow (8") CMU Painted 5/8" Gypsum Board on Resilient Channels 1-1/2" Fiberglass Furring	41	49	58	66	69	72
<b>Total Transmission Loss</b>	<b>41.0</b>	<b>49.0</b>	<b>58.0</b>	<b>66.0</b>	<b>69.0</b>	<b>72.0</b>

$$NR = TL + 10 \log (A_{rec}/S_{common\ wall})$$

Resulting dB Levels in Classroom						
Source	Frequency					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
M4 Rifle	74.5	74.4	69.2	57.4	50.7	46.6
Beretta Pistol	72.5	74.4	66.2	54.4	48.7	45.6
Remington Shotgun	75.5	74.4	68.2	54.4	48.7	42.6

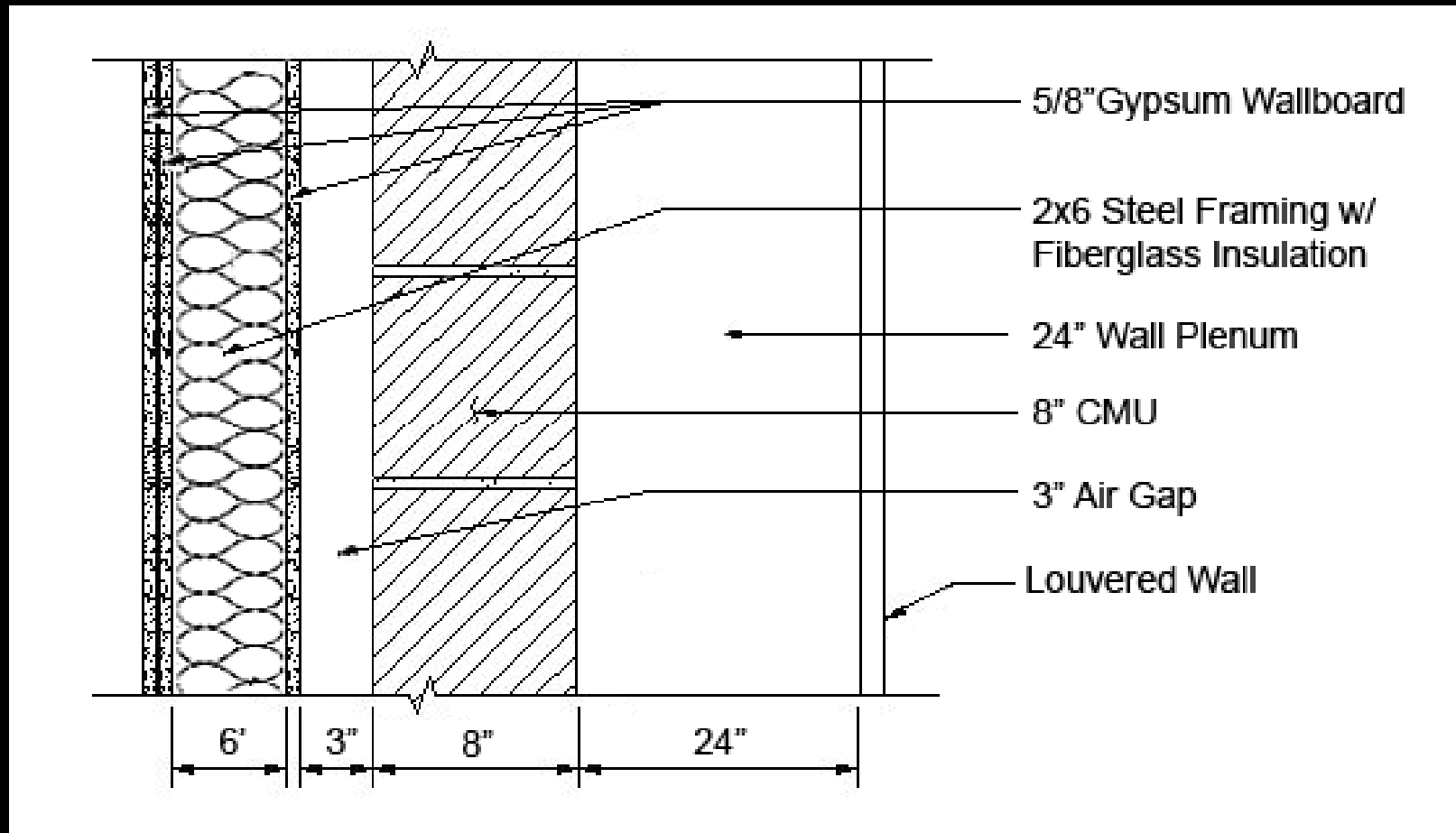
# Acoustical Considerations

## Conventional Wall Assembly



# Acoustical Considerations

## Proposed Wall Assembly



# Acoustical Considerations

## Conventional Wall Assembly

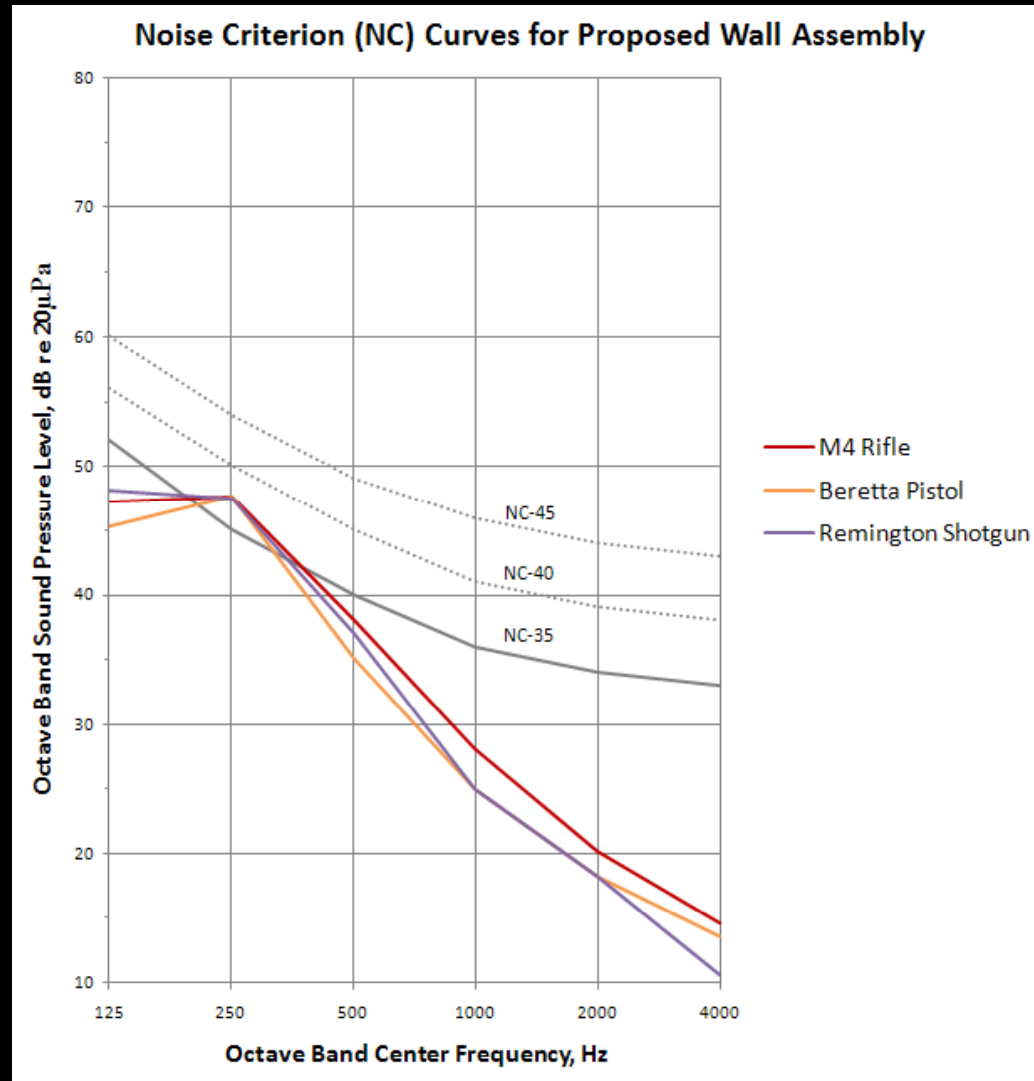
Transmission Loss Between Firing Range and Classroom						
Wall Assembly	Frequency					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Hollow (8") CMU Painted	38	38	45	50	52	55
3" Air Gap	-6.2	-9.6	-10.0	-10.0	-9.2	-9.5
6" 20 Gauge Metal Stud Resilient Channel on One Side 5" Fiberglass Insulation 1 + 2 Layers of 5/8" Gypsum Board	38	51	58	60	62	64
<b>Total Transmission Loss</b>	<b>69.8</b>	<b>79.4</b>	<b>93.0</b>	<b>100.0</b>	<b>104.8</b>	<b>109.5</b>

$$NR = TL + 10 \log (A_{rec} / S_{common\ wall})$$

Resulting dB Levels in Classroom						
Source	Frequency					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
M4 Rifle	47.2	47.6	38.0	28.0	20.2	14.5
Beretta Pistol	45.2	47.6	35.0	25.0	18.2	13.5
Remington Shotgun	48.2	47.6	37.0	25.0	18.2	10.5

# Acoustical Considerations

## Conventional Wall Assembly





# Conclusions

Classroom

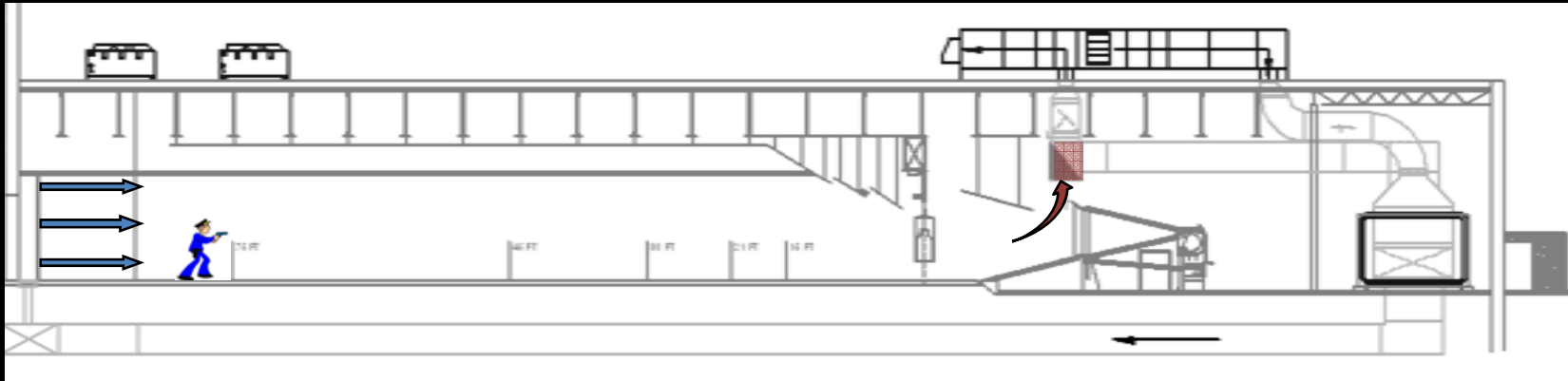


Firing Range

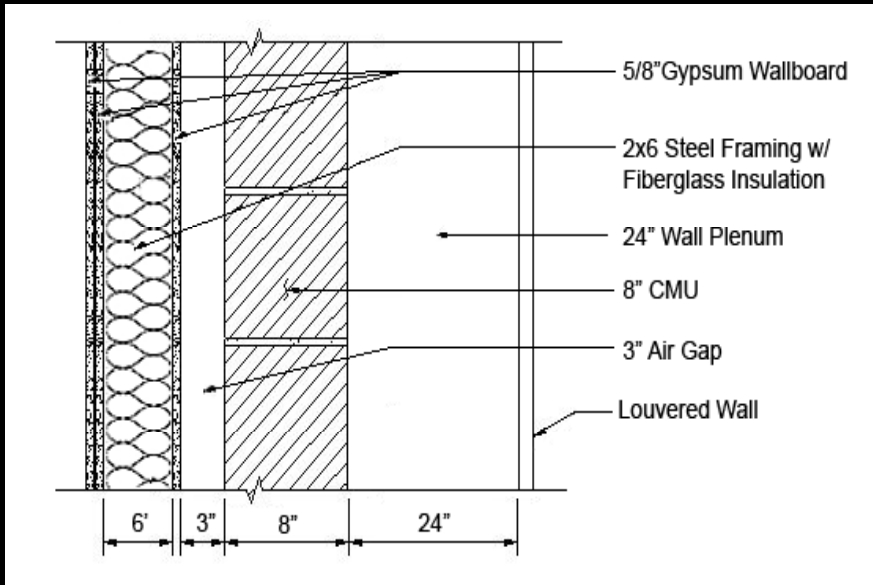


# Conclusions

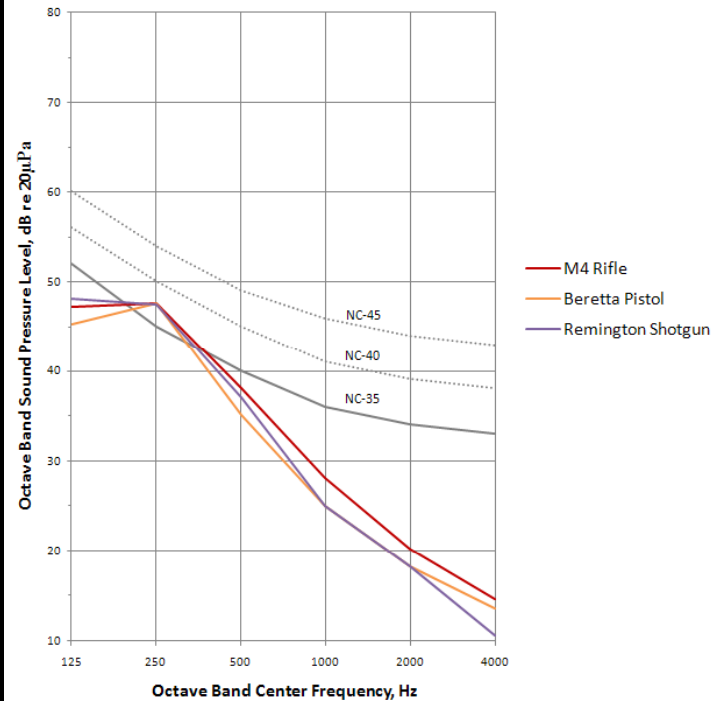
## Range Ventilation



## Acoustical Considerations



Noise Criterion (NC) Curves for Proposed Wall Assembly



# Acknowledgements

Thanks!

Maryland Transportation Authority  
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AE Classmates

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# Questions?



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