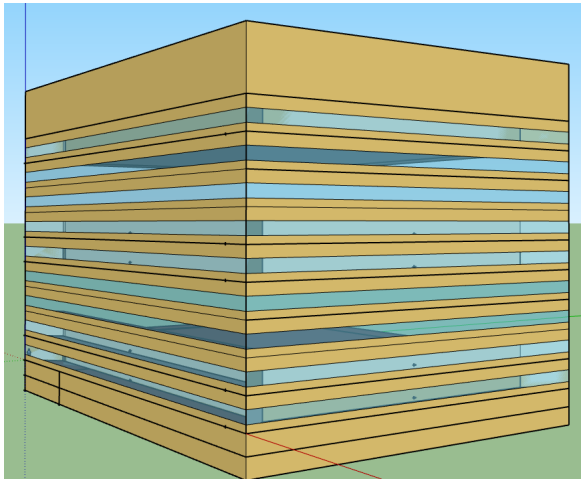
Office/Lab

GENERAL DESCRIPTION



The Office/Lab prototype is intended to serve primarily as Lab & Office spaces with a programming distribution of 55% office, 45% lab space. The program consists of open-plan configuration for 9-floors above grade and 2-levels of parking in the basement. This typology is to be considered as Core & Shell construction.

The building geometry has been defined to be representative for urban sites in the State of Massachusetts. There are six (6) variations of this building typology listed below. Two energy code minimum Base Cases use a code minimum performance industry standard system relative to Stretch Energy Code requirements of 10% energy savings above ASHRAE 90.1 2013 Performance Rating Method (Appendix G) and 20% energy savings as represent to potential Stretch Energy Code update. The Passive House and Optimized variations outline both a higher performance, lower capacity Gas-Heating system and an Electric-Heating alternative system along with envelope system improvements. The Office/Lab geometry includes **422,400 gross sf** in nine (9) stories above grade and 2 floor basement levels. Additional 38,357 sf. of penthouse space houses mechanical equipment. The building is slab below grade.

Base Case-10% (Gas-Heat): Office Highrise Base Case Scenario is a **code-compliant building**. This building is expected to meet all code requirements of ASHRAE 90.1 2013 and current MA amendments as well as a 10% site energy improvement. Primary heating for the building is gas.

Base Case-20% (Gas-Heat): Office Highrise Base Case Scenario is a future **code-compliant building**. This building is expected to meet all code requirements of ASHRAE 90.1 2013 and both current and projected future MA amendments as well as a 20% site energy improvement. Primary heating for the building is gas.

Passive House (Gas-Heat): This building is expected to exceed current Stretch Energy Code requirements including MA amendments. **Primary heating** for the building is **gas** and main heating distribution is a reduced capacity hydronic perimeter heating system.

Passive House (Electric-Heat): This building is expected to exceed current Stretch Energy Code requirements including MA amendments. **Primary heating** for the building is **electric zone-heating systems** with heat pumps.

Optimized (Gas-Heat): is a high-performance **alternate** to Passive house Gas-Heat scenario. Primary change is reflected in envelope system performance.

Optimized (Electric-Heat): is a high-performance **alternate** to Passive house Electric-Heat scenario. Primary change is reflected in envelope system performance.

BUILDING ENVELOPE

Exterior envelope consists of curtain wall/glazing, built-up roof, and slab below grade assemblies. Envelope components defined for Passive House and Optimized models apply to both the Gas-Heat and Electric-Heat variations.

Envelope System	Gross Area (GSF)	Net Area (SF)
Above Grade Wall	93,571	56,142(40% WWR)
		46,785 (50% WWR)
Windows		37,428 (40% WWR)
		46,785 (50%WWR)
Roof		38,357
Slab-on-Grade		38,357
Below-grade Wall		12,797
Penthouse (26' extension)	20,793	

A. Curtain wall: The Office prototype assumes a modular unitized curtainwall system with exterior glazing for all variations. The system includes vision glass for 40% or 50% of the total wall area, and the remaining exterior finish area is a metal finish panel to match the curtainwall framing finish. The vision panels are structurally glazed units. The framing system is thermally broken with pressure equalized chambers and integral water management.

i. Base Case-10% & Basecase-20%:

40% Vision Glass – Metal Panel Fill	**50% Vision Glass – Metal Panel Fill**
Structural Glazing **Center of Glass is U-0.30, SHGC-0.38** across 40% of the curtainwall	**Center of Glass is U-0.25, SHGC-0.38** across 50% of the curtainwall
Formed metal finish panel to match curtainwall framing finish in remaining 60% of the curtainwall	Formed metal finish panel to match curtainwall framing finish in remaining 50% of the curtainwall
6x8 modular unitized curtainwall framing system, thermally broken.	6x8 modular unitized curtainwall framing system, thermally broken.
5” semi-rigid mineral fiber insulation, continuous vapor barrier, sealed all around (R-21)	**5” semi-rigid mineral fiber insulation**, continuous vapor barrier, sealed all around (R-21)
Firestopping insulation at slab edges	Firestopping insulation at slab edges

ii. Passive House:

6’ x 8’ module sizes with center of glass U-factor of U-0.11 (very good triple pane). There will be 9” of mineral wool infill between curtain wall framing behind interior metal backpan. Curtain wall framing assumed to be thermally broken aluminum at all shadow box locations. An additional 4” of interior mineral wool insulation is included in board of the metal pack pan. This interior mineral wool is foil faced and completely sealed to the adjacent curtain wall mullions and slab to form a vapor tight connection.

40% Vision Glass – Metal Panel Fill	**50% Vision Glass – Metal Panel Fill**
Structural Glazing Center of Glass is **U-0.11, SHGC-0.30** across 40% of the curtainwall	Center of Glass is **U-0.11, SHGC-0.30** across 50% of the curtainwall
Formed metal finish panel to match curtainwall framing finish in remaining 60% of the curtainwall	Formed metal finish panel to match curtainwall framing finish in remaining 50% of the curtainwall
6x8 modular unitized curtainwall framing system, thermally broken.	6x8 modular unitized curtainwall framing system, thermally broken.
9” semi-rigid mineral fiber insulation, continuous vapor barrier, sealed all around	**9” semi-rigid mineral fiber insulation**, continuous vapor barrier, sealed all around
Firestopping insulation at slab edges	Firestopping insulation at slab edges
Additional 4” foil-faced mineral wool insulation at mullion covers adjacent to structure.	**Additional 4” foil-faced mineral wool insulation at mullion covers adjacent to structure.**

iii. Optimized:

6’ x 8’ module sizes with center of glass U-factor of U-0.25/U-0.20 (very good double pane). There will be 5” of mineral wool infill between curtain wall framing behind interior metal backpan. Curtain wall framing assumed to be thermally

broken aluminum at all shadow box locations. An additional 4” of interior mineral wool insulation is included in board of the metal pack pan. This interior mineral wool is foil faced and completely sealed to the adjacent curtain wall mullions and slab to form a vapor tight connection.

40% Vision Glass – Metal Panel Fill	**50% Vision Glass – Metal Panel Fill**
Structural Glazing Center of Glass is **U-0.25, SHGC-0.30** across 40% of the curtainwall	Center of Glass is **U-0.20, SHGC-0.30** across 50% of the curtainwall
Formed metal finish panel to match curtainwall framing finish in remaining 60% of the curtainwall	Formed metal finish panel to match curtainwall framing finish in remaining 50% of the curtainwall
6x8 modular unitized curtainwall framing system, thermally broken.	6x8 modular unitized curtainwall framing system, thermally broken.
5” semi-rigid mineral fiber insulation, continuous vapor barrier, sealed all around	**5” semi-rigid mineral fiber insulation**, continuous vapor barrier, sealed all around
Firestopping insulation at slab edges	Firestopping insulation at slab edges
Additional 4” foil-faced mineral wool insulation at mullion covers adjacent to structure.	**Additional 4” foil-faced mineral wool insulation at mullion covers adjacent to structure.**

B. Roof:
   i. Base Case-10% / Basecase -20%: Built-up roof with roof membrane, R-40 insulation, composite metal decking. Assembly U-0.025.
   ii. Passive House & Optimized: Built-up roof with roof membrane, R-45 insulation, composite metal decking. Thermal bridge mitigation with thermal isolation pads at mechanical dunnage and parapet structural thermal breaks. Assembly U-0.025 when thermal bridging is accounted for.

C. Below grade assemblies: (All options): Slab on grade is composed of 6” concrete slab with R-10 insulation for 24” vertical. No insulation is assumed underneath the slab.

D. Infiltration reduction: Whole building air infiltration rates are:
   i. Base Case-10% & Basecase-20% – 1.00 CFM / SF @ 75 Pa no whole building air-leakage testing
   ii. Passive House - 0.077 CFM / SF @ 75 Pa (0.6 ACH50)
      i. In order to achieve this level of air leakage performance, a scope for enhanced envelope commissioning should be assumed.
   iii. Optimized: assume air-leakage testing to code minimum: 0.4 CFM/sf @ 75 pa which would require a whole-building air-leakage test at minimum.

STRUCTURAL SYSTEM

Steel-framed construction; 240’ X 160’ rectangular building with 9 floors above grade 117’ + 26’ penthouse. All applicable codes and load criteria should be applied.

MECHANICAL SYSTEM

DESCRIPTION

A. **Base Case-10%:** HVAC system for general spaces consists of Air Handling units (VAV), perimeter radiator system, chillers, boilers, and cooling towers. Data closets are cooled with packaged single-zone systems.
B. **Basecase-20% /Passive House / Optimized (Gas-Heat)**: HVAC system for general spaces consists of DOAS & fan coils units, chillers, boilers, and cooling towers. Data closets are cooled with packaged single-zone systems.
C. **Passive House / Optimized (Electric-Heat):** HVAC system for general spaces consists of DOAS & fan coils units, chillers, boilers, and cooling towers. Data closets are cooled with packaged single-zone systems.

MECHANICAL DESIGN CRITERIA:

The following mechanical design criteria is for reference only.

1. Space temperature and Humidity
    a. Summer: 75F, 55% RH maximum
    b. Winter: 70F
2. Ambient design Conditions
    a. Summer: 87F DB; 71F WB
    b. Winter: 7F
3. Ventilation
    a. Office- 0.18 cf,/sf.
4. **Filtration:** MERV 6 pre-filters and MERV-14 final filters
5. **Noise:** All MEP systems shall be designed to maximum 40dBA permissible background noise.
6. Internal load
    a. Equipment- Office: 2.0 Watts/ sf.; Lab: 8 W/sf.
    b. Lighting- Office: 0.6 watts/ sf.; Lab: 1.33 W/sf.
    c. Occupancy- Office: 200 sf./ person; Lab: 294 sf./person.
7. **Duct leakage**

a. Baseline: All ductwork to be sealed according to mechanical code requirements.
b. Passive House (Gas & Electric-Heat): All ductwork to be sealed according to mechanical code requirements. In addition, all ventilation air ductwork to be Aerosealed in order to further reduce duct leakage. An Aersoseal specification can be found here - https://aeroseal.com/wp-content/uploads/2018/05/aeroseal-com-specs-180522.pdf
c. Optimized (Gas & Electric-Heat): All ductwork to be sealed according to mechanical code requirements.

CHILLED WATER SYSTEM

Base Case-10% / Base Case-20%/ Passive house/ Optimized: Chilled water requirement for conditioned spaces is provided via chiller/ cooling tower plant. During shoulder months, chilled water supply temperature shall be reset to 54F via BMS controls. Chilled water plants are configured as primary/ secondary pumps. Primary pumps interlock with cooling tower for heat rejection.

4- water cooled chillers with a capacity of 825 tons each provide 44°F water to the Air handling units. The system capacity will be approximately sized for 10°F temperature differential. Variable-speed cooling tower provided a total of 4,200 tons capacity of heat rejection.

Hydronic Cool Component	Capacity
Central Plant: Chiller-centrifugal—water cooled – 6.6 COP efficiency.	(4) 825 tons each
Central Plant: Cooling tower (Variable-speed).	4200 tons capacity
CHW primary secondary pumps, Cooling tower pump.	

Passive house/ Optimized (Gas-Heat): Chilled water requirement for conditioned spaces is provided via chiller/ cooling tower plant. During shoulder months, chilled water supply temperature shall be reset to 54F via BMS controls. Chilled water plants are configured as primary/ secondary pumps. Primary pumps interlock with cooling tower for heat rejection.

3- water cooled chillers with a capacity of 825 tons each provide 44°F water to the Air handling units. The system capacity will be approximately sized for 10°F temperature differential. Variable-speed cooling tower provided a total of 3,100 tons capacity of heat rejection.

Hydronic Cool Component	Capacity
Central Plant: Chiller-centrifugal—water cooled – 6.6 COP efficiency.	(3) 825 tons each
Central Plant: Cooling tower (Variable-speed).	3100 tons capacity
CHW primary secondary pumps, Cooling tower pump.	

Passive house/ Optimized (Electric-Heat): Chilled water requirement for conditioned spaces is provided via water cooled chiller/ cooling tower plant and Air-Water heat pumps. During shoulder months, chilled water supply temperature shall be reset to 54F via BMS controls. Chilled water plants are configured as primary/ secondary pumps. Primary pumps interlock with cooling tower for heat rejection.

2- water cooled chillers with a capacity of 1050 tons each provide 44°F water to the Air handling units. The system capacity will be approximately sized for 10°F temperature differential. Variable-speed cooling tower provided a total of 3,100 tons capacity of heat rejection.

Hydronic Cool Component	Capacity
Central Plant: Chiller-centrifugal—water cooled – 6.6 COP efficiency.	(2) 1050 tons each
Central Plant: Cooling tower (Variable-speed).	3100 tons capacity
Air-Water Heat pump capacity	(10) 40-ton modules.
CHW primary secondary pumps, Cooling tower pump.	

HOT WATER HEATING SYSTEM

A. **Base Case-10%**Hotwater boiler provides hot water to baseboard radiators and air handling units. Baseboards are provided at the perimeter to provide primary heating to zones. Control valves are provided to each space to provide temperature control. A total of 7,200 lineal feet (4032 MBH) of capacity is to be provided with perimeter radiator. Costs to include architectural enclosure for perimeter system.

The hot water plant shall be arranged as primary/secondary variable pumping system and provided with variable frequency drives.

Hydronic Heat Component	Capacity
Central Plant: Gas-fired Boiler – 90% thermal efficiency	(7) 5,400 kBTU/h each
Fin-Tube Radiators (baseboards) Office/Lab Zones for perimeter heat	7,200 lineal feet
Hot Water Loop Pump	

B. **Basecase-20%:** Hotwater boiler provides hot water to baseboard radiators, fan coils units and air handling units. Baseboards are provided at the perimeter to provide thermal comfort to zones. Fan coils units provide primary heating. Control valves are provided to each space to provide temperature control. A total of 7,200 lineal feet (4032 MBH) of capacity is to be provided with perimeter radiator. Costs to include architectural enclosure for perimeter system.

   The hot water plant shall be arranged as primary/secondary variable pumping system and provided with variable frequency drives.

Hydronic Heat Component	Capacity
Central Plant: Gas-fired Boiler – 90% thermal efficiency	(7) 5,400 kBTU/h each
Fan coil units	
Fin-Tube Radiators (baseboards) Office/Lab Zones for perimeter heat	7,200 lineal feet

C. **Passive House & Optimized (Gas-Heat)**: Boiler provides hot water to fan-coils units and air handling units. Control valves are provided to each space to provide temperature control. Supply temperature shall be reset to 150 F based on outside temperature (180F at 20F and below, 150 F at 50F and above, ramped linearly in-between)

   The hot water plant shall be arranged as primary/secondary variable pumping system and provided with variable frequency drives.

Hydronic Heat Component	Capacity
Central Plant: Gas-fired condensing Boiler – 95% thermal efficiency	(5) 5,400 kBTU/h each

Fan coil units	
Hot Water Loop Pump	4400

D. **Passive House & Optimized (Electric-Heat)**: Boiler provides hot water to fan-coils units and air handling units. Control valves are provided to each space to provide temperature control. Supply temperature shall be reset to 150 F based on outside temperature (180F at 20F and below, 150 F at 50F and above, ramped linearly in-between)

The hot water plant shall be arranged as primary variable pumping system with an estimated 207 gpm flow rate total. All pumps will be provided with variable frequency drives.

Hydronic Heat Component	Capacity
Central Plant: Air-Water heat pump Boiler* – 3.2 COP efficiency	(10) 500 kBTU/h each
Fan Coil units	
Hot Water Loop Pump	
Freeze Protection	(1)2,000 MBH Oil based generator

*Air-Water heat pumps to provide cooling capacity along with heating. Cooling plant capacity to be adjusted.

AIR-HANDLING UNITS

A. **Base Case-10%:**
Variable air volume air (VAV) air handling units are provided with integrated outside air, chilled water and hotwater coils. Supply & Return Fans are equipped with Variable frequency drives for variable flow. Heating coil is provided to temper outside air to 55F. Each unit is provided with 100% economizer.

Air Loop	# of units	Supply Flow rate (cfm)	Outdoor Air flow rate (cfm)	Htg. Coil Capacity (kbtu/h)	Clg. Coil Capacity (tons)	Unit type/ Efficiency	Economizer	Energy recovery
VAV-Typical	8	70,000	51,000	2940	410	CHW, HW coils	Yes	Yes, 45% heat recovery only on Lab stream; 50% energy recovery on office stream

B. **Basecase-20%/ Passive House (Gas-Heat)/ Passive House (Electric-Heat):**
DOAS-Typical: units are provided for to serve outside air (DOAS). CHW cooling and hot water coils are provided in each unit. Supply & Return Fans are equipped with Variable frequency drives for variable flow. Heating coil (HW) is provided to temper outside air to 55°F. Each unit is provided with 100% economizer and energy or heat recovery. Dampers in offices spaces ramp down supply with CO2 based zone sensors.

Air Loop	# of units	Supply Flow rate (cfm)	Htg. Coil Capacity (kbtu/h)	Clg. Coil Capacity (tons)	Unit type/ Efficiency	Economizer	Energy recovery
DOAS- Typical	6	73,000	1820	412	CHW/ HW coils	Yes	Office air stream: 80% Sensible & latent. Lab air: 62% heat recovery only.

C. **Optimized (Gas-Heat)/ Optimized (Electric-Heat)**: Same air-handling units defined under the Passive House (Gas-Heat), but energy recovery on office stream is 75%.

TERMINAL UNITS / DISTRIBUTION

A. **Base Case-10%:** VAV terminal units provide supply air to each zone through ductwork distribution. Each terminal unit is controlled via zone thermostat within respective zone. VAV boxes and thermostats are to be considered as tenant fit-out while the duct work distribution is part of Core & Shell.

B. **Base Case-20%/ Passive House / Optimized (Gas-Heat)**: Damper boxes provide ventilation air to each zone through ductwork distribution. Four-pipe fan coils provide cooling & heating loads for the building. Each unit is controlled via zone thermostat. Chilled water and hotwater piping distribution is to be considered for core& shell while fan-coils units are tenant-fit out.

C. **Passive House / Optimized (Electric-Heat)**: Same as Passive house/Optimized (Gas-heat).

DATA CLOSETS (ALL OPTIONS): Data closets of 7.8 kW are provided at each floor. Cooling is provided to these spaces via (9) 2.5-ton rooftop units.

ELECTRICAL SYSTEMS

Total Transformer load (All cases) = (4) 2000 kVA

A. Lighting and Electrical system controls are required to meet IECC2018 with MA Amendments.

   Lighting A total of 313,000 watts of interior lighting is to be provided in the building. Exterior lighting of 301,000 watts is to be provided. Based on 20-watt CF fixture, 15,000 fixtures are estimated. Standard code compliant lighting controls- Occupancy, vacancy sensors and daylighting controls are to be provided.

B. Electrical: Electrical systems are designed for a total of 70 kW data closet +2,733 kW of plug loads.
C. Elevator: Building shall have a total of 12 traction elevator. (240 kW)
D. HVAC: Mechanical panel load (Cooling +Fan peak): 3,900 kW
E. Domestic Water System (Electric): Building shall have restrooms located at each floor. Domestic hot water will be generated from electric water heaters (9) 50 gallon located in each floor. Water heater(electric) provide 140F hotwater to restrooms. Standard routing, pipe insulation, distribution pumping systems are applicable. Plumbing fixtures are considered as part of core & shell. Electric panel load: 4.5 kW each; total= 40.5 kW

PLUMBING SYSTEMS

A. Heating peak demand
   Basecase-10% & Basecase-20%: 38,000 kBtu/h

   Passive House / Optimized (Gas-Heat): 27,000 kBtu/h

   Passive House / Optimized (Gas-Heat): None.