Multifamily Mid-rise

GENERAL DESCRIPTION

The multifamily mid-rise prototype is intended to represent a multifamily building w/ 90% market rate apartments and 10% affordable apartments. It is an 8-story building with podium on the ground floor consisting of a residential lobby, residential amenity, and core & shell commercial space which is to be priced as a cold white box. 84 apartments are on floors 2 through 8 in a double loaded corridor configuration. The building has a below grade parking garage under the building's ground floor.

The building geometry has been defined to be representative for semi-urban sites in the State of Massachusetts. The multifamily mid-rise geometry includes **71,100 gross sf** in eight (8) stories above grade plus an unconditioned below grade parking garage beneath the building's ground floor. The building is slab below-grade. There are six (6) variations of this building typology listed below. These are summarized below:

Base Case - 2018 IECC (Gas-Heat & DHW): Multifamily mid-rise Base Case Scenario is a **code-compliant building**. This building is expected to meet all code requirements of IECC 2018 prescriptive path and current MA amendments. Primary heating for the building is in-unit gas-fired single packaged vertical units in each apartment plus gas fired furnaces for air delivered to common spaces. Primary DHW for the building is a central gas boiler plant.

Base Case - 2018 IECC (All Electric): Multifamily mid-rise Base Case Scenario is a **code-compliant building**. This building is expected to meet all code requirements of IECC 2018 prescriptive path and current MA amendments. Primary heating for the building is provided via one-to-one heat pumps. Primary DHW for the building is a central electric boiler plant.

Base Case - 2021 IECC (Gas-Heat & DHW): Multifamily mid-rise Base Case Scenario is a future **code-compliant building**. This building is expected to meet all code requirements of IECC 2021 prescriptive path and both current and future MA amendments. Primary heating for the building is in-unit gas-fired single packaged vertical units in each apartment plus gas fired furnaces for air delivered to common spaces. Primary DHW for the building is a central gas boiler plant.

Base Case - 2021 IECC (All Electric): Multifamily mid-rise Base Case Scenario is a future **code-compliant building**. This building is expected to meet all code requirements of IECC 2021 prescriptive path and both current and future MA

amendments. Primary heating for the building is provided via one-to-one heat pumps. Primary DHW for the building is a central heat pump water heating plant.

Passive House (Electric Heat, Gas-DHW): This building is expected to exceed current Stretch Energy Code requirements including MA amendments. Primary heating for the building is a central variable refrigerant flow (VRF) system with terminal evaporator units in each apartment. Primary DHW for the building is a central gas boiler plant.

Passive House (All Electric): This building is expected to exceed current Stretch Energy Code requirements including MA amendments. Primary heating for the building is a central variable refrigerant flow (VRF) system with terminal evaporator units in each apartment. Primary DHW for the building is a central heat pump water heater plant.

BUILDING ENVELOPE

The exterior envelope consists of cold formed steel framed back up walls with a metal panel rainscreen facade, built-up roof, and slab on grade assemblies.

Envelope System	Gross Area (GSF)	Net Area (SF)
Above Grade Wall	47,478	39,716
Windows		Total = 7,761 (16% WWR) Punched Fixed = 2,319 Punched Operable = 4,059 Storefront = 1,383
Opaque Doors		342
Roof		13,477
Parking Garage Ceiling		12,453
Parking Garage Floor		In Conditioned Space = 904 Unconditioned Space = 12,453

A. Above Grade Exterior Wall: The multifamily mid-rise prototype assumes a cold formed steel framed back up wall construction with a metal panel rain screen façade system for all cases. The table below summarizes design differences among the various scenarios.

IECC 2018 Cases (gas heat / DHW & all electric)
Façade Attachment: non-thermally broken clip system Exterior Insulation: 2" of mineral wool Cavity Insulation: R-13 batt insulation *Effective Assembly R-value = R-11 *with thermal bridging accounted for*
IECC 2021 Cases (gas heat / DHW & all electric)
Façade Attachment: non-thermally broken clip system Exterior Insulation: 3" of mineral wool Cavity Insulation: R-13 batt insulation *Effective Assembly R-value = R-13 *with thermal bridging accounted for*
Passive House Cases (gas DHW & all electric)
Façade Attachment: fiberglass girt system (ie. GreenGirts) Exterior Insulation: 6" of mineral wool Cavity Insulation: 6" of mineral wool Additional Interior Insulation: 1.5" of mineral wool (continuous) *Effective Assembly R-value = R-40 *with thermal bridging accounted for*

A. Below Grade Parking Elevator Vestibule Wall:
   a. **Base Cases IECC 2018** – poured in place concrete foundation wall with R-7.5 continuous rigid exterior insulation.
   b. **Base Cases IECC 2021** – poured in place concrete foundation wall with R-10 continuous rigid exterior insulation.
   c. **Passive House Cases** – poured in place concrete foundation wall with R-10 continuous rigid exterior insulation.

B. Roof:
   i. **Bases Cases IECC 2018 and Base Cases IECC 2021**: Built-up roof with roof membrane, R-30 insulation, composite metal decking. Assembly effective R-value = R-25 when thermal bridging is accounted for.
   ii. **Passive House**: 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 effective R-value = R-40 when thermal bridging is accounted for.

B. Parking Ceiling Slab:
   i. **Base Cases IECC 2018** – concrete slab with R-12.5 continuous closed cell spray foam underneath slab.
   ii. **Base Cases IECC 2021** – poured in place concrete foundation wall with R-16.7 continuous closed cell spray foam underneath slab.
   iii. **Passive House Cases** – poured in place concrete foundation wall with R-30 continuous closed cell spray foam underneath slab.

C. Below Grade Slab at Parking Level:
   i. **Base Cases IECC 2018** – Uninsulated slab.
   ii. **Base Cases IECC 2021** – Uninsulated slab.
   iii. **Passive House Cases** – R-10 continuous XPS insulation underneath slab

D. Windows:

Base Cases IECC 2018 (gas heat / DHW & all electric)

Punched windows – 6,378 SF (36% fixed, 64% operable)
- Average double-glazed, uPVC frame
  ○ Operable U-value = 0.45
  ○ Fixed U-value = 0.38
  ○ Center of glass SHGC = 0.35
Storefront windows – 1,383 SF (all fixed w/ exception of entry door)
- Good double-glazed, thermally broken aluminum frame, U-value = 0.38
- Center of glass SHGC = 0.35

Base Cases IECC 2021 (gas heat / DHW & all electric)

Punched windows – 6,378 SF (36% fixed, 64% operable)
- Good double-glazed, uPVC frame
  ○ Operable U-value = 0.45
  ○ Fixed U-value = 0.36
  ○ Center of glass SHGC = 0.35
Storefront windows – 1,383 SF (all fixed w/ exception of entry door)
- Good double-glazed, thermally broken aluminum frame, U-value = 0.38
- Center of glass SHGC = 0.35

Passive House Cases (gas DHW & all electric)

Punched windows – 6,378 SF (36% fixed, 64% operable)
- Great triple-glazed, uPVC frame
  - Operable U-value = 0.16
  - Fixed U-value = 0.14
  - Center of glass SHGC = 0.40

Storefront windows – 1,383 SF (all fixed w/ exception of entry door)
- Good double-glazed, thermally broken aluminum frame, U-value = 0.38
- Center of glass SHGC = 0.40

E. Infiltration: Whole building air infiltration rates are:
   i. **Base Cases IECC 2018** – 0.40 CFM / SF @ 75 Pa.
      i. No whole building air-leakage testing.
   ii. **Base Cases IECC 2021** – 0.25 CFM / SF @ 75 Pa.
      i. In order to achieve this level of air leakage performance, a scope for basic envelope commissioning.
   iii. **Passive House Cases** - 0.09 CFM / SF @ 75 Pa (0.6 ACH50)
      i. In order to achieve this level of air leakage performance, a scope for enhanced envelope commissioning and whole building air leakage testing should be assumed.

STRUCTURAL SYSTEM

Steel-framed construction; 130’ X 90’ L-shaped building with 8 floors above grade plus an interior conditioned rooftop mechanical penthouse and one level of below grade parking with the following floor to floor heights:

- Below Grade Parking = 15’ 0”
- Ground floor = 17’ 10”
- Typical floors 2 through 7 = 9’ 8”
- Floor 8 = 15’ 6”

All applicable codes and load criteria should be applied.

MECHANICAL SYSTEM

DESCRIPTION

A. **Base Case IECC 2018 (Gas Heat & DHW):** Gas-fired single packaged vertical units with a space heating efficiency of 88% and a cooling SEER of 13.5 are provided in each apartment (one per apt.). Common areas are heated via 88% efficient gas furnaces and cooled via DX cooling coils. Domestic water heating is provided via an 95% efficient gas fired condensing boiler plant. Ventilation is provided to the residential floors via exhaust from each apartment going through a 55% efficient energy recovery ventilator (ERV) and supply air being provided to corridors from the ERV.

B. **Base Case IECC 2018 (All Electric):** One to one heat pumps for space heating and cooling are provided in each apartment (one per apt.). Common spaces are heated via electric furnaces and DX cooling coils. Domestic water heating is provided via a central electric resistance boiler plant. Ventilation is provided to the residential floors via exhaust from each apartment going through a 55% efficient energy recovery ventilator (ERV) and equal supply air from the ERV being provided to the building's corridors. All amenity and back of house spaces are ventilated at code minimum rates via a 55% efficient ERV.

C. **Base Case IECC 2021 (Gas Heat & DHW):** Exactly the same as the IECC 2018 (Gas Heat & DHW) case.

D. **Base Case IECC 2021 (All Electric):** Exactly the same as the IECC 2018 (All Electric) case with the one exception that DHW is being provided via a central heat pump water heating plant that is sized to meet year-round loads, including during peak conditions.

E. **Passive House (Electric Heat, Gas DHW):** Heating and cooling is provided via ducted variable refrigerant flow (VRF) heat pumps located in each apartment (one per apt.). Domestic water heating is provided via a central gas-fired condensing boiler plant with a nominal efficiency of 95%. Ventilation is provided to the residential floors via central exhaust from each apartment going through an 85% efficient energy recovery ventilator (ERV) and equal supply air from the ERV being provided to each apartment. All corridors, amenity, and back of house spaces are ventilated at code minimum rates via a 85% efficient ERV.

F. **Passive House (All Electric):** Exactly the same as the Passive House (Electric Heat, Gas DHW) case with the one exception that domestic water heating is provided via a central air sourced heat pump water heating plant that is sized to meet year-round loads, including during peak conditions.

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. Apartment Exhaust: central exhaust systems, 25 CFM per kitchen + 20 CFM per bathroom (3 bedroom apts. have two bathrooms, 65 CFM exhaust)
    b. Make-up Air
        i. **Base Cases IECC 2018**: bathroom exhaust connected to ERV system, Make-up air delivered to corridors.
        ii. **Base Cases IECC 2021:** bathroom exhaust connected to ERV system, Make-up air ducted to apartments, includes fire damper.
        iii. **PH Cases:** bathroom & kitchen exhaust connected to ERV system, cost additional ductwork to connect kitchen exhaust to ERV system, make-up air ducted to apartments, includes fire damper, and air-sealing / testing of ductwork.
    c. Common Areas: ASHRAE minimum by space type
4. Filtration**:** MERV 6 pre-filters and MERV-13 final filters
5. Noise: All MEP systems shall be designed to maximum 30dBA permissible background noise.
6. Unit Mix
    a. Studios = 7 (each unit contains 1 bathroom)
    b. 1 BR = 35 (each unit contains 1 bathroom)
    c. 2 BR = 35 (each unit contains 1 bathroom)
    d. 3 BR = 7 (each unit contains 2 bathrooms)
7. Common Areas - total area = 15,740 SF
    a. Corridors / stairwells / transition areas = 7,220 SF
    b. Lobby = 300 SF
    c. Restrooms = 200 SF
    d. Offices = 100 SF
    e. Community Room = 500 SF
    f. Back of House = 4,420 SF

    g. Core and Shell Commercial = 3,000 SF
8. Occupancy – 217 total. According to RESNET (# of bedrooms + 1, studios count as one bedroom in occupancy calc.
9. Building peak total space heating load
    a. **Base Cases IECC 2018** = 1,936,000 Btu/hr
    b. **Base Cases IECC 2021** = 1,644,000 Btu/hr
    c. **Passive House Cases** = 451,000 Btu/hr
10. Building peak total space cooling load (sensible + latent)
    a. **Base Cases IECC 2018** = 1,913,000 Btu/hr
    b. **Base Cases IECC 2021** = 1,856,000 Btu/hr
    c. **Passive House Cases** = 1,139,000 Btu/hr
11. Domestic hot water consumption – 15 gallons of hot water per person per day. “Hot water” refers to water @ 140 degF.
12. Apartment Loads
    a. Miscellaneous Loads – 0.62 Watts/sf of dwelling area
    b. Refrigerators – 1 per apt. Energy Star
    c. Dishwashers – 1 per apt. Energy Star
    d. In-Unit Clothes Dryer – 1 per apt. Energy Star. Electric ventless condensing dryer.
    e. In Unit Clothes Washer – 1 per apt. Energy Star. Hot water feed from DHW system.
    f. Cooking – Electric conduction range
    g. Lighting – 1.1 Watts/sf of dwelling area
13. Common Loads
    a. Common Clothes Dryers – 23 total. Electric resistance direct exhaust with dedicated make up air to dryer room(s).
    b. Common Clothes Washers – 23 total. Energy Star. Hot water
    c. Lighting & Plugs
        i. Corridors / stairwells / transition areas = 7,220 SF @ 0.66 Watts/SF
        ii. Lobby = 300 SF @ 1.00 Watts/SF
        iii. Restrooms = 200 SF @ 0.85 Watts/SF
        iv. Offices = 100 SF @ 0.93 Watts/SF
        v. Community Room = 500 SF @ 1.33 Watts/SF
        vi. Back of House = 4,420 SF @ 0.43 Watts/SF
        vii. Core and Shell Commercial = 3,000 SF @ 0.60 Watts/SF
14. Duct leakage
    a. **Base Cases IECC 2018 and Base Cases IECC 2021**: All ductwork to be sealed according to mechanical code requirements.

b. **Passive House Cases**: 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

HEATING & COOLING TERMINAL SYSTEMS

IECC 2018 (Gas Heat and DHW):

Gas-fired single packaged vertical units in each apartment (1 per apt.) provide heating and cooling to the dwelling units. These units have a space heating efficiency of 88% and cooling SEER = 13.5 are sized according to apartment type:

- Studios – heating = 12,000 BTUH / cooling = 12,000 BTUH (incl. latent)
- 1 BR – heating = 16,000 BTUH / cooling = 16,000 BTUH (incl. latent)
- 2 BR – heating = 20,000 BTUH / cooling = 20,000 BTUH (incl. latent)
- 3 BR - heating = 24,000 BTUH / cooling = 24,000 BTUH (incl. latent)

Common spaces will be heated via an 88% efficient gas-fired furnace in the common area AHU with a heating capacity of 410,000 BTUH. Common spaces are cooled via DX cooling coils in the common area AHU connected to outdoor condensing units with a cooling SEER of 16.5 and a cooling capacity of 410,000 BTUH.

IECC 2018 (All Electric):

One-to-one heat pumps in each apartment provide space heating and cooling to each apartment. The heat pumps have a heating COP of 2.6 and a cooling SEER of 16.5. The outdoor condensing units for these one-to-one heat pumps are located either on the roof of the building or in the building's unconditioned below grade parking garage.

- Studios – heating = 11,000 BTUH / 1-1 HP cooling = 10,000 BTUH (incl. latent)
- 1 BR – heating = 18,000 BTUH / 1-1 HP cooling = 16,000 BTUH (incl. latent)
- 2 BR – heating = 25,000 BTUH / 1-1 HP cooling = 22,000 BTUH (incl. latent)
- 3 BR – heating = 32,000 BTUH / 1-1 HP cooling = 28,000 BTUH (incl. latent)

Common spaces will be heated via an electric furnace in the common area AHU with a heating capacity of 410,000 BTUH. Common spaces are cooled via DX cooling coils in the common area AHU connected to outdoor condensing units with a cooling SEER of 16.5 and a cooling capacity of 410,000 BTUH.

IECC 2021 (Gas Heat and DHW):

Gas-fired single packaged vertical units in each apartment (1 per apt.) provide heating and cooling to the dwelling units. These units have a space heating efficiency of 88% and cooling SEER = 13.8 are sized according to apartment type:

- Studios – heating = 12,000 BTUH / cooling = 12,000 BTUH (incl. latent)
- 1 BR – heating = 16,000 BTUH / cooling = 16,000 BTUH (incl. latent)
- 2 BR – heating = 20,000 BTUH / cooling = 20,000 BTUH (incl. latent)
- 3 BR - heating = 24,000 BTUH / cooling = 24,000 BTUH (incl. latent)

Common spaces will be heated via an 88% efficient gas-fired furnace in the common area AHU with a heating capacity of 360,000 BTUH. Common spaces are cooled via DX cooling coils in the common area AHU connected to outdoor condensing units with a cooling SEER of 16.5 and a cooling capacity of 410,000 BTUH.

IECC 2021 (All Electric):

One-to-one heat pumps in each apartment provide space heating and cooling to each apartment. The heat pumps have a heating COP of 2.6 and a cooling SEER of 16.5. The outdoor condensing units for these one-to-one heat pumps are located either on the roof of the building or in the building's unconditioned below grade parking garage.

- Studios – heating = 11,000 BTUH / 1-1 HP cooling = 10,000 BTUH (incl. latent)
- 1 BR – heating = 18,000 BTUH / 1-1 HP cooling = 16,000 BTUH (incl. latent)
- 2 BR – heating = 25,000 BTUH / 1-1 HP cooling = 22,000 BTUH (incl. latent)
- 3 BR – heating = 32,000 BTUH / 1-1 HP cooling = 28,000 BTUH (incl. latent)

Common spaces will be heated via an electric furnace in the common area AHU with a heating capacity of 360,000 BTUH. Common spaces are cooled via DX cooling coils in the common area AHU connected to outdoor condensing units with a cooling SEER of 16.5 and a cooling capacity of 410,000 BTUH.

Passive House Cases:

Ducted variable refrigerant flow (VRF) heat pump units will be provided in each unit (1 per apt.). The VRF units will be sized according to apartment type:

- Studios – heating = 9,000 BTUH / cooling = 8,000 BTUH (incl. latent)
- 1 BR – heating = 11,000 BTUH / cooling = 10,000 BTUH (incl. latent)
- 2 BR – heating = 13,500 BTUH / cooling = 12,000 BTUH (incl. latent)
- 3 BR - heating = 16,000 BTUH / cooling = 14,000 BTUH (incl. latent)

Common spaces will be heated and cooled with ducted VRF units with a total capacity of heating = 260,000 BTUH / cooling = 235,000 BTUH.

CENTRAL PLANT HEATING AND COOLING SYSTEMS

IECC 2018 (Gas Heat and DHW):

No central plant assumed for space heating and cooling. Central DHW plant consists of x3 gas fired condensing boilers with a total capacity of 750 kBtu/hr and an efficiency of 95%.

IECC 2018 (All Electric):

No central plant assumed for space heating and cooling. Central DHW plant consists of x3 electric resistance boilers with a total capacity of 750 kBtu/hr.

IECC 2021 (Gas Heat and DHW):

No central plant assumed for space heating and cooling. Central DHW plant consists of x3 gas fired condensing boilers with a total capacity of 750 kBtu/hr and an efficiency of 95%.

IECC 2021 (All Electric):

No central plant assumed for space heating and cooling. Central DHW plant consists of a central air source heat pump water heater plant (HPWH units located outdoors) with a total capacity of 750 kBtu/hr.

Passive House (Electric Heat, Gas DHW):

Heating – a central VRF system with outdoor condensing units will provide heating and cooling to the building and have a total heating capacity of = 1,100 kBtu/hr. Note – this assumes a combination ratio of approximately 115% (evaporator capacity : condenser capacity).

Cooling – a central VRF system with outdoor condensing units will provide heating and cooling to the building and have a total cooling capacity of = 1,000 kBtu/hr. Note – this assumes a combination ratio of approximately 115% (evaporator capacity : condenser capacity).

DHW - Central DHW plant consists of a central air source heat pump water heater plant (HPWH units located outdoors) with a total capacity of 750 kBtu/hr.

AIR-HANDLING UNITS

IECC 2018 Cases:

Each apartment is continuously exhausted at a rate of 45 CFM per bathroom and should comply with code minimum requirements. The apartment exhaust goes through the building's energy recovery units (ERVs). An equal volume of outdoor is supplied to the residential corridors from the ERVs, however due to fire code requirements restricting airflow from corridors to the apartments, it is assumed that approximately half of the supply air to the corridors is not ever reaching the apartments. As a result, the additional makeup air is pulled through air leaks in the exterior envelope.

The supply and exhaust fans in the ERV are to be equipped with variable frequency drives to maintain a constant flow of air to the building. A DX heating and cooling coil is provided in each ERV to temper supply air to room neutral temperatures before it is delivered to the building. The ERV is provided with a 100% economizer to directly bring in outdoor air when free cooling potential exists.

Common areas are to receive constant balanced ventilation through an ERV according to code minimum rates.

All ductwork is to be sealed to industry standard minimum levels and limit duct leakage to 10%. All ductwork is assumed to have fire dampers at all locations where required by code.

Air Handler	# of units	Supply Flow rate (cfm)	Outdoor Air flow rate (cfm)	Htg. Coil Capacity (kbtu/h)	Clg. Coil Capacity (tons)	Unit type/ Efficiency	Economizer	Sensible Energy Recovery Eff.	Total Fan Eff. (Watts/CFM)
ERV	**2**	**4,000**	**4,000**			**HW coil, CW coil**	**Yes**	**55%**	**1.00**

IECC 2021 Cases:

The ventilation design is assumed to be exactly the same as the 10% cases with the one exception to the ERV total fan efficiency indicated in the table below.

Air Handler	# of units	Supply Flow rate (cfm)	Outdoor Air flow rate (cfm)	Htg. Coil Capacity (kbtu/h)	Clg. Coil Capacity (tons)	Unit type/ Efficiency	Economizer	Sensible Energy Recovery Eff.	Total Fan Eff. (Watts/CFM)

ERV	**2**	**4,000**	**4,000**			**HW coil, CW coil**	**Yes**	**55%**	**1.50**

Passive House:

Each apartment is continuously exhausted at a rate of 25 CFM per kitchen plus 20 CFM per bathroom and comply with code minimum requirements. The apartment exhaust goes through the building's ERVs. An equal volume of outdoor is supplied to each apartment. At each apartment supply and exhaust register, constant air flow regulators (CAR dampers) are provided to ensure proper airflows are maintained year-round.

The supply and exhaust fans in the ERV are to be equipped with variable frequency drives to maintain a constant flow of air to the building. A DX heating and cooling coil is provided in each ERV to temper supply air to room neutral temperatures before it is delivered to the building. The ERV is provided with a 100% economizer to directly bring in outdoor air when free cooling potential exists.

Common areas are to receive constant balanced ventilation through an ERV according to code minimum rates.

All ductwork is to be sealed to industry standard minimum levels plus receive additional air sealing via the Aeroseal process to limit duct leakage to 3% maximum. All ductwork is assumed to have fire dampers at all locations where required by code.

Air Handler	# of units	Supply Flow rate (cfm)	Outdoor Air flow rate (cfm)	Htg. Coil Capacity (kbtu/h)	Clg. Coil Capacity (tons)	Unit type/ Efficiency	Economizer	Sensible Energy Recovery Eff.	Total Fan Eff. (Watts/CFM)
ERV	**2**	**3,500**	**3,500**			**HW coil, CW coil**	**Yes**	**85%**	**0.80**

ELECTRICAL SYSTEMS

Total Transformer loads

- **IECC 2018 (Gas-Heat & DHW):** 476 kVA
- **IECC 2018 (All Electric):** 693 kVA
- **IECC 2021 (Gas-Heat & DHW):** 469 kVA

- **IECC 2021 (All Electric):** 637 kVA
- **Passive House (Elec-Heat & Gas DHW):** 477 kVA
- **Passive House (All Electric):** 533 kVA

A. Lighting and Electrical system controls are required to meet IECC2018 with MA Amendments. Standard code compliant lighting controls - Occupancy, vacancy sensors and daylighting controls are to be provided in common areas

DOMESTIC WATER / PLUMBING SYSTEMS

All plumbing fixtures are to be low flow fixtures. All cases are assumed to have a central domestic water heating (DHW) system, with continuous hot water recirculation year-round. Thermostatic balancing valves are to be provided on every hot water riser to ensure a properly balanced system. DHW circulation piping is to be laid out in a “box-format” to improve the system’s distribution efficiency. Total DHW recirculation piping is estimated to be 2,615 linear feet and is insulated to code minimum levels. All branch piping / crotons to the apartments are to be insulated to code minimum levels.

The recirculation pumping system will have a total pumping power of 1.5 BHP.

Domestic pressure booster pumps will be provided with a total pumping power of 10.0 BHP and will be equipped with a variable frequency drive.

IECC 2018 (Gas Heat and DHW):

Domestic water heating will be provided via x3 95% efficient gas fired condensing boilers with a total capacity of 750 kBtu/hr. 1,000 gallons of domestic hot water storage will be provided and will store water at a minimum temperature of 140 degF.

The hot plant shall be arranged as primary/secondary pumping system. All pumps will be provided with variable frequency drives.

IECC 2018 (All Electric):

Domestic water heating will be provided via x3 electric resistance boilers with a total capacity of 750 kBtu/hr. 1,000 gallons of domestic hot water storage will be provided and will store water at a minimum temperature of 140 degF.

The hot plant shall be arranged as primary/secondary pumping system. All pumps will be provided with variable frequency drives.

IECC 2021 (Gas Heat and DHW):

Domestic water heating will be provided via x3 95% efficient gas fired condensing boilers with a total capacity of 750 kBtu/hr. 1,000 gallons of domestic hot water storage will be provided and will store water at a minimum temperature of 140 degF.

The hot plant shall be arranged as primary/secondary pumping system. All pumps will be provided with variable frequency drives.

IECC 2021 (All Electric):

Domestic water heating will be provided via a central air sourced heat pump water heating plant located outdoors with a total capacity of 750 kBtu/hr. 3,000 gallons of domestic hot water storage will be provided and will store water at a minimum temperature of 140 degF. An electric resistance heating element within the storage tanks will be provided to help keep the tank temperature above the minimum temperature threshold.

The hot plant shall be arranged as primary/secondary pumping system. All pumps will be provided with variable frequency drives.

Passive House (Electric Heat, Gas DHW):

Domestic water heating will be provided via x3 95% efficient gas fired condensing boilers with a total capacity of 750 kBtu/hr. 1,000 gallons of domestic hot water storage will be provided and will store water at a minimum temperature of 140 degF.

The hot plant shall be arranged as primary/secondary pumping system. All pumps will be provided with variable frequency drives.

Passive House (All Electric):

Domestic water heating will be provided via a central air sourced heat pump water heating plant located outdoors with a total capacity of 750 kBtu/hr. 3,000 gallons of domestic hot water storage will be provided and will store water at a minimum temperature of 140 degF. An electric resistance heating element within the storage tanks will be provided to help keep the tank temperature above the minimum temperature threshold.

The hot plant shall be arranged as primary/secondary pumping system. All pumps will be provided with variable frequency drives.

RENEWABLE ENERGY

No renewable energy systems are assumed in the IECC 2021 and Passive House cases.

IECC 2018 (Gas Heat & DHW): A 25 kW photovoltaic located on site to meet the requirements of IECC 2018 C406.5.

IECC 2018 (All Electric): A 15 kW photovoltaic located on site to meet the requirements of IECC 2018 C406.5.