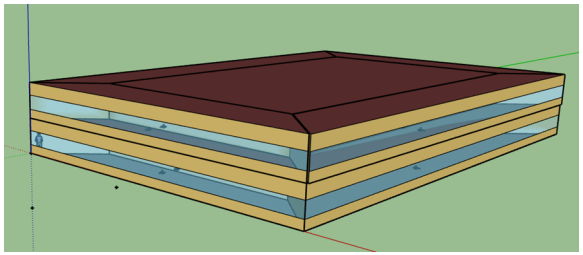
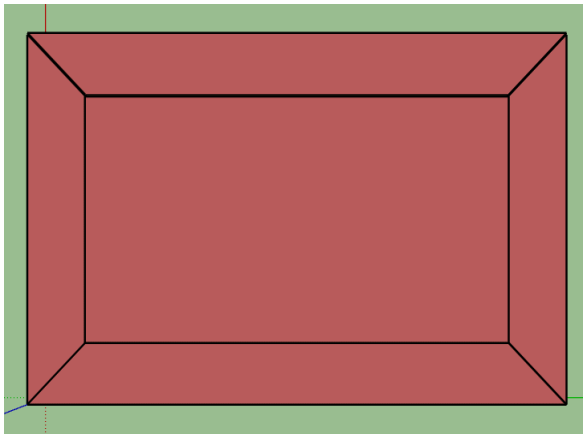
Small Office Prototype

GENERAL DESCRIPTION





This Small Office prototype is intended to serve primarily as office space. The program consists of perimeter, core offices located across two-floors+. The wings attach to common areas such as cafeteria, library, gymnasiums, restrooms, and staff office spaces.

The building geometry has been defined to be representative for rural and suburban 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 2018 IECC and 2021 IECC with MA Amendments. 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 Small Office geometry includes **25,200 gross sf** in two (2) stories above grade. The building is slab on grade.

Base Case- IECC2018 (Gas-Heat): Small Office Base Case Scenario is a **code-compliant building**. This building is expected to meet all code requirements of Massachusetts energy code (IECC2018) which includes MA amendments. Primary heating for the building is gas.

Base Case- IECC2021 (Gas-Heat): Small Office Base Case Scenario is a future **code-compliant building**. This building is expected to meet all IECC2021 code requirements of Massachusetts energy code (IECC2021) with one anticipated MA amendments (Window U-0.3). Primary heating for the building is gas.

Passive House (Gas-Heat): This building is expected to exceed code requirements of Massachusetts Energy Code (IECC2018) which includes 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 code requirements of Massachusetts Energy Code (IECC2018) which includes 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. The primary design change is window thermal performance and reduced ventilation heat recovery and related HVAC impacts.

Optimized (Electric-Heat): is a high-performance **alternate** to Passive house Electric-Heat scenario. The primary design change is window thermal performance and reduced ventilation heat recovery and related HVAC impacts.

BUILDING ENVELOPE

Exterior envelope consists of steel framed walls with punched windows, built-up roof, and slab on 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	13,312	7,987
Windows		5,325
Roof	12,601	12,601
Slab-on-Grade		12,601

A. Steel-framed wall: Exterior wall is Steel- framed construction with 2x 6 framing at 16” O.C. Exterior finish consists of metal panel finish system. Assembly includes the following components:
   - Metal panel
   - Exterior Sheathing on 6” Steel Stud wall with 1 ½” air gap (stud cavity insulation described below)
   - Membrane applied air-vapor barrier
   - Exterior insulation (exterior insulation values described below)
   - Metal panel framing system
   - Gypsum wall board

   i. Base Case (IECC2018 & IECC2021):
      i. Stud Cavity: R-19 batt insulation
      ii. Exterior Insulation: 2” mineral wool insulation (R-8.4) - total assembly U-value of U-0.055

ii. Optimized / Passive House:
    i. Stud Cavity: R-19 batt insulation
    ii. Exterior Insulation: 5” mineral wool insulation (R-21) - total assembly U-value of U-0.055 derated with thermal bridge accounting
    iii. Apply thermal bridging mitigation strategies:
        1. employ thermal isolation pads behind metal panel framing system.

B. Glazing assembly are provided at 40% Window to wall ratio and are expected to consist of operable and fixed type window frames.
    i. Base Case-IECC2018:
        i. Assembly window U-factor U-0.36, SHGC-0.38
    ii. Base Case-IECC2021:
        i. Assembly window U-factor U-0.30, SHGC-0.38
    iii. Passive House:
        i. Include thermal bridge mitigation strategies from Optimized – Step 2
        ii. Assembly Window U-factor 0.17, SHGC-0.30
        iii. Passive House Window assumed properties:
            1. triple pane w/ Argon gas fill and at least one low-e coating,
            2. Non-metal or hybrid glazing spacer,
            3. uPVC / fiberglass / or thermally broken metal window frames
    iv. Optimized – step 1:
        i. Assembly window U-factor U-0.30, SHGC-0.30
    v. Optimized – step 2:
        i. Uses same window performance as Optimized – step 1
        ii. Include thermal bridge mitigation strategies for window & skylight installation:
            1. Structural thermal insulation pads at windowsills
            2. Non-structural thermal insulation pads at jambs and head

C. Roof:
    i. Base Case-(IECC2018 & IECC2021): 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.

D. Below grade assemblies:
    i. Base Case-IECC2018, Optimized, Passive House: (All options except Basecase IECC2021): Slab on grade is composed of 6" concrete slab with R-10 insulation for 24" vertical. No insulation is assumed underneath the slab.
    ii. Basecase-IECC2021: Slab on grade is composed of 6" concrete slab with R-15 insulation for 24" vertical. No insulation is assumed underneath the slab.

E. Infiltration reduction: Whole building air infiltration rates are:
    i. Base Case-IECC2018 – 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/ Basecase IECC2021: 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; 140' X 90' rectangular building with 2 floors above grade 26' height. All applicable codes and load criteria should be applied.

MECHANICAL SYSTEM

DESCRIPTION

A. **Base Case-IECC2018 /Basecase- IECC2021:** HVAC system in the building consists of Packaged rooftops (PSZ).
B. **Passive House / Optimized (Gas-Heat)**: HVAC system consists of DOAS Air handler and packaged single-zone (dx/furnace) units.
C. **Passive House / Optimized (Electric-Heat):** HVAC system consists of DOAS Air handler and ducted VRF indoor/outdoor units.

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 cfm/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- 1.4 Watts/ sf. (General)
    b. Lighting- 0.6 watts/ sf.
    c. Occupancy- 43 sf./ person
7. **Duct leakage**
    a. Base Case-IECC2018/ Basecase-IECC2021: 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

No Chiller plant.

HOT WATER HEATING SYSTEM

No boiler plant.

AIR-HANDLING UNITS

A. **Base Case-IECC2018 & Base Case-IECC2021:**
Packaged Single Zone - units are provided for each office space with **integrated outside air**, dx coils and furnace. Supply & Return Fans are constant volume and provide fully conditioned air to meet zone thermostat requirements.

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
PSZ-Typical	5	5,000	1,000	250	15	DX: 13.3 EER; Furnace: 88% eff	No	None.

B. **Passive House (Gas-Heat):** DOAS units provide ventilation air to the spaces while individual Packaged Single Zone (PSZ) units provide heating and cooling requirements. DOAS system required energy recovery at 80%.

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
DOAS	1	5,000	5,000	70	6	DX: 13.3 EER; Furnace: 88% eff	Yes	Yes, 80%
PSZ	5	5,000	0	40	13	DX: 14.5 EER. Furnace: 97.4% eff	-	-

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

D. **Passive House (Electric-Heat):** DOAS units provide ventilation air to the spaces while Variable refrigerant (VRF) units provide heating and cooling requirements. DOAS system required energy recovery at 80%.

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
DOAS	1	5,000	5,000	70	6	DX: 13.2 IEER; Heat Pump: 3.2 COP	Yes	Yes, 80%
VRF-Indoor*	23	1,000	-	7	3	-	-	-
VRF Outdoor unit	5			35	12	10.6 EER; 3.35 COP@47F	-	-

*based on non-ducted VRF units serving 25,000 sf. Alternate configuration consideration – assume ducted units for 13,000 sf. + non-ducted for 12,000 sf. Total capacity = 60 tons (cooling)

E. **Optimized (Electric-Heat):** Same air-handling units defined under the Passive House (Electric-Heat) scenario, but energy recovery is 75%.

TERMINAL UNITS / DISTRIBUTION

A. **Base Case-IECC2018 & Base Case-IECC2021:** Constant volume dampers provide supply air to each zone through ductwork distribution. Each system has a single thermostat that is centrally located to maintain temperature.
B. **Passive House / Optimized (Gas-Heat)**: constant volume dampers provide ventilation from DOAS. Additional duct work connected to air handling units (dx & furnace) provide cooling and heating.
C. **Passive House / Optimized (Electric-Heat)**: constant volume dampers provide ventilation from DOAS. Ceiling mounted VRF units provide heating and cooling.

ELECTRICAL SYSTEMS

Total Transformer load (All cases) = (1) 225 kVA

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

   Lighting A total of 14,616 watts of interior lighting is to be provided in the building. Exterior lighting of 600watts is to be provided. Based on 20-watt CF fixture, 30 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 18,900 watts of plug loads.
C. Elevator: Building shall have a total of 1 hydraulic elevator.
D. HVAC:
   a. Base Case: Mechanical panel load (Cooling +Fan peak): 82 kW
   b. Passive House / Optimized (Gas-Heat): Mechanical panel load (Cooling +Fan peak): 76 kW
   c. Passive House / Optimized (Electric-Heat): Mechanical panel load (Cooling +Fan peak): 92 kW
E. Kitchen loads: None.
F. Domestic Water System
   Building shall have restrooms located at each floor. Hot water is to be provided to restroom and kitchen spaces. Domestic hot water will be generated from (2) 20-gallon storage water heaters(electric) located in each floor. Water heater provides 140F hot water. Standard plumbing fixtures, routing, pipe insulation, distribution pumping systems are applicable.

PLUMBING SYSTEMS

A. HVAC(Gas service):

   a. Base Case-IECC2018 & Base Case-IECC2021: Mechanical system load: 1,400 MBH
   b. Passive House / Optimized (Gas-Heat): Mechanical system load: 515 MBH
   c. Passive House / Optimized (Electric-Heat): Mechanical system load: None.