DESIGN AND CONSTRUCTION GUIDELINES AND STANDARDS

DIVISION 23 • HEATING VENTILATION AND AIR CONDITIONING

23 80 00 • AIR SOURCE HEAT PUMP

SECTION INCLUDES

Air Source Heat Pump System (Ductless Mini-Splits)

RELATED SECTIONS

26 00 00 Electrical

Filed Sub Bid

M.G.L. c.149 §44F

Heating, Ventilating, and Air Conditioning and as a separate category, associated Electrical are stipulated filed sub-bid categories under M.G.L. Chapter 149, §44F. If the cumulative estimated value of the work in this section ***exceeds $20,000*** *and the projects total cost is over $100,000.it triggers the filed sub-bid requirement.*

In addition, if any subcategories of this trade, such as pipe Insulation, sheet metal, duct insulation, temperature controls, etc. are estimated to cost ***over $10,000*** *the filed sub-bidders for this trade shall be explicitly instructed to list sub-subs on their Form for Sub-bid.*

INTRODUCTION

The capacity and efficiency of air source heat pumps (ASHPs) has improved dramatically in the past several years with the notable introduction of “cold climate” versions that are now acceptable for all temperature zones in the Commonwealth (IECC climate zones 4 and 5). As of April, 2016, three of the primary manufacturers – Fujitsu, Mitsubishi and Daikin – have invested the requisite research to develop residential models that meet DHCD’s capacity and efficiency guidelines. ASHPs are a cost effective alternative to electric baseboard heat and to thermal block storage units. They are most favorable in one and two story buildings.

ASHP SUSTAINABILITY GRANTS

DHCD’s Sustainability Initiative works with housing authorities interested in installing ASHPs, with supplemental funding from the sustainability fund when available. In some cases, housing authorities may be approached by third party administrators.

THIRD PARTY ADMINISTRATORS AND INSTALLERS

The Low Income Energy Affordability Network (LEAN), also commonly referred to as the Low Income Multi-Family program, has been funded by the utility companies to install energy efficient and cost effective ASHPs at LHAs. The installation is administrated through two major entities – Action, Inc. (in NGrid territory) and ABCD (in EverSource and EverSource West territory). ASHPs are most likely to be offered to LHA’s for developments with electric heat and very high electric bills. About 900 systems have been installed at LHAs as of May, 2016. ASHPs can provide significant savings on electric usage/costs. However, we have learned that close attention needs to be paid to the design, installation, and maintenance of these systems to avoid potential performance issues.

SYSTEM DESIGN CONSIDERATIONS

SELECTING MODELS

At this point DHCD is installing only residential, ductless models, as these are the most applicable to the residential heating loads of our units. They are also currently the only models that meet our capacity and efficiency criteria. Commercial models are not being considered, as they generally are more expensive and don't meet the performance criteria. Ducted systems have proven to be extremely expensive to date and are not currently under consideration.

PERFORMANCE CRITERIA

DHCD is using minimum performance criteria established by the Massachusetts Clean Energy Center (MassCEC). These models are generically referred to as "Cold Climate" systems.

Capacity	100% capacity at 5◦ F
Seasonal Cooling Efficiency	[1]SEER ≥ 20 for single head, ≥ 17 for multi-head
Static Cooling Efficiency	[2]EER ≥ 12 @ 95◦ F
Seasonal Heating Efficiency	[3]HSPF ≥ 10 for single heat ductless systems and ≥ 9 for multi-head
Static Heating Efficiency	[4]COP 5◦ F ≥ 1.75 @maximum capacity
ENERGY STAR Certification	Must be ES Certified

[1]SEER = Seasonal Energy Efficiency Rating: BTU cooling output during a typical cooling season/watt-hours electricity used during that season

[2]EER = Energy Efficiency Ratio: output cooling energy/electrical energy

[3]HSPF = Heating System Performance Factor: BTU heat output over the heating season/watt-hours of electricity used during that season

[4]COP = Coefficient of Performance: heat transferred/electrical energy supplied

Note: the Northeast Energy Efficiency Partnerships (NEEP) is proposing an increased requirement of COP 5◦ F ≥ 2.0 by January, 2017 in an effort to send a signal to the manufacturers that NEEP stakeholders are interested in seeing progression in cold-climate heat pump technology. The MassCEC has not indicated whether they would also increase their criteria. DHCD will follow the lead of the MassCEC.

INTERIOR FAN COIL UNITS

All indoor units are connected to each other (in the case of multi-head systems) and to the outdoor unit via a four line, line set - electrical, two refrigerant and condensate – which are housed in Line-Hide™.

Indoor units should be installed as high on the wall as is practical to allow sufficient air flow around the units – typically approximately 8-12" below the ceiling. The units need to be unimpeded by any fixed feature (e.g. cabinets), or movable features (swinging doors) to allow for uninterrupted air flow. The location within the apartment where the indoor unit is hung will be unique to the apartment lay-out. The objective is to install the unit in the optimal spot to minimize the run length of the line set that will connect to the outdoor unit, as long as any single head unit is located in the room with the highest heat load (see below). Any of the following are acceptable installations of the line hides that house the line set:

- a direct through-wall penetration from the unit to the exterior;
- directed out the back of the unit into the wall cavity and then down into a crawl space;
- directed vertically to the junction of the wall and ceiling (similar to a crown molding) Note: this will require the use of a manufactures accessory, mini condensate pump to create the vertical lift of the condensate, making this choice less desirable;
- directed vertically into a chase or attic above the ceiling. Note: this will also require the use of a pump to create the vertical lift of the condensate, making this choice less desirable.

Single head: Single head systems refer to one outdoor unit and one indoor unit. To qualify for this configuration, the apartment must have a common wall between the two major rooms that are being heated and cooled – i.e. the LR and BR. Single head interior units should be located in the LR – not the BR. The location of the unit in the LR is critical because the unit will work most effectively in heating/cooling the largest space, and then transferring that heated/cooled air via a switch-controlled fan located in the common wall.

Multi-head: Multi-head systems refer to multiple indoor units and one outdoor unit. These systems will be required in several situations:

- when there is not a common wall between the BR and LR;
- when closet or cabinet obstructions restrict or prevent the installation of the unit;
- in apartments with multiple bedrooms.

Fan in common wall for single head installations: To date DHCD has only used the brand Tjernlund, model "AireShare" as the fan and grill that is installed in the common wall in order to transfer heat and cooling between two rooms. A fan with a sone rating of 1.2-1.5 or less is also acceptable. This fan should be installed within the top one-third of the wall in order to allow optimal air transfer. This fan should be controlled by an ON/OFF switch which is located in the bedroom, on the same wall as the fan.

Thermostat control for the interior unit: Most of the interior units come supplied with a remote control thermostat. DHCD's experience is that the remote can be confusing and instead requires a fixed, wall mounted thermostat with direct visual sight to the unit. There are two options: the Mitsubishi units have a thermostat that communicates via infrared with the interior unit. However, if Fujitsu or Daikin units are used, the thermostats will need to be hard-wired to the unit. Fujitsu anticipates creating an infrared-communicating thermostat by 2017. In multi-head installations there will be a thermostat for each indoor unit in the same room as the wall unit.

OUTDOOR UNITS

Location relative to the building orientation: Whenever practically feasible, the outdoor units should be located at the rear of the building – primarily for aesthetic and for noise considerations. Placement at the front of the building can sometimes be preferable to creating an extensive run of the line set within the apartment.

Ideally the outdoor units would not be installed directly under any drip line from the roof which would subject them to falling snow or extensive rain. This is especially important if the roof has no gutters on it. If this cannot be avoided, a shield should be installed (see topic below).

All cold climate outdoor units have heated drip pans, which are essential to prevent the condensate from freezing within the drip pan. However, the drainage from the perforated pan can cause frozen puddles during winter conditions. Outdoor units should not be installed near a walkway where there is insufficient clearance to allow for drainage water to flow away from the walkway and prevent pooling and freezing. The outdoor unit should not be placed in an area in which it will be in the direct path of snow from a snow blower or grass clippings from a lawn mower.

Location hung on the wall or on the ground: The outdoor units should be placed on a stand which is installed on a concrete pad. Wall hung units are not recommended. The stand should be a minimum of 24" tall. The stand needs to be no wider than the outdoor unit in order to allow proper drainage. The most commonly used stand for residential applications is made by a local company called Quick-Sling, LLC.

Ideally outdoor units will not be installed on a balcony or patio. When this can't be avoided, outdoor units need to be installed on a stand which sits on the balcony or patio. Some arrangement for defrost drip from the drip pan needs to be made to contain the water so that it doesn't flow to the path of travel on the balcony and freeze into ice. A curb or pan system which distributes the water off the balcony should be used.

In no case should the outdoor unit block a window.

The color of exterior line-hides should be chosen match the aesthetics of the building.

Shields: Outdoor units need to be installed with shields approved by the manufacturer when there is any possibility of snow or water drip from the roof – i.e. under a roof valley or a roof without gutters.

MATERIALS

Models meeting above criteria, as of May, 2016:

For each manufacturer, several sizes exist, as identified in the following chart. Multi-zone systems can accommodate up to 8 interior heads. In multi-head systems, one outdoor unit is connected to multiple indoor units.

The following are models from these three manufacturers that meet the performance criteria. This list is for ductless models only.

Single zone	Outdoor unit	Indoor unit	BTU size
Mitsubishi, Hyper heat (H2i)	MUZ-FH12 NA	MSZ-FH12NA	12 identifies 12 kBTU; available in 9, 12, & 18 kBTU
Mitsubishi, Hyper heat, floor model (not common)	MUZ-FH12 NA	MFZ-KA12NA	12 identifies 12 kBTU; available in 9, 12, & 18 kBTU
Fujitsu, Cold Climate	AOU12RLS3H	ASU12RLS3H	12 identifies 12 kBTU; available in 9, 12, & 15 kBTU
Fujitsu, Cold Climate, floor model – not common, and not yet used by DHCD	AOU12RLFF	ASU12RLF	12 identifies 12 kBTU; available in 9, 12, & 15 kBTU
Daikin 20 Series, wall or floor mounted	RXL12QMVJU	FTX12NMVJU	12 identifies 12 kBTU; available in 9, 12 & 15 kBTU
Daikin LV Series, wall mounted	RXS12LVJU	FTXS12LVJU	12 identifies 12 kBTU; available in 9, 12, 15, 18 & 24 kBTU

Multi zone	Outdoor unit	Indoor unit	BTU size
Mitsubishi, Hyper heat (H2i), 2-8 heads	MXZ-4C36NAHZ	Multiple models	4C refers to 4 heads, but may be any number 2-8. Outdoor unit available in 24, 30, 36, 42 & 48 kBTU. Indoor units available in 7, 9 & 12 kBTU
Fujitsu, Cold Climate, 2-4 heads	AOU18RLXFZ	ASU12RLF1+ ASU7RLF1	Outdoor units available in 18, 24 & 36 kBTU. Indoor unit available in 7, 9, & 12 kBTU
Fujitsu Halcyon Hybrid Flex, 2-8 heads	AOU48RLXFZ 1	Multiple models	Outdoor units available in 18, 24, 36 & 48 kBTU
Daikin 2 or 3 heads	2 (or 3) MXL18QMVJU	FFQ12LVJU	Outdoor units available in 18 or 24 kBTU; indoor units available in 9, 12, 15 or 18 kBTU
Daikin 2, 3, 4 or 8 heads	2 (up to 8) MXS18NMVJU	FFQ12LVJU	Outdoor units available in 18, 24, 36 or 48 kBTU; indoor units available in 9, 12, 15 or 18 kBTU

Multi-zone Air Handler to replace furnace in 689s and Community Rooms	Outdoor unit	Indoor unit	BTU size
Mitsubishi Hyper Heat (H2i) 2-8 heats	MXZ-2C20NAHX	MVZ-A12AA4	Outdoor units are available in 20, 24, 30, 36, 42 & 48 kBTU; indoor units are available in 12, 18, 24, 30 & 36 kBTU

EXISTING ELECTRIC BASEBOARD HEAT

The bathroom heat should remain operational. All other electric baseboards should be made non-functional, but be capable of being restored by the LHA maintenance staff in the event it is needed.

LHA MAINTENANCE

Routine LHA maintenance and service requirements of the installed equipment need to be reviewed with the LHA.

ASHP Maintenance

While ASHPs have a reputation of reliability, the LHA will be responsible for performing the following maintenance tasks:

- **Filter cleaning:** Maintenance staff needs to clean internal filters in the indoor fan coil unit twice each year. Ideally one of these cleanings should be close to the start of the cooling season. Filters pop out easily and should be rinsed under warm water.
- **Check for water pooling early in the cooling season:** At the time of the filter cleaning, the interior fan coil unit should be checked to make sure drainage to the condensate line is operating correctly.
- **Outdoor unit cleaning:** The interior of the outdoor unit needs to be kept free of grass clippings, leaves, dirt, excessive pollen or other materials. The outdoor unit should be located in a place that will be primarily free of this debris. However, if debris is entering the unit, it should be sprayed down with a hose once a year during the shoulder or summer months.
- **Outdoor unit check post major snow or ice storms:** DHCD recommends that shields be installed on outdoor units which are subject to roof water drainage. These shields will deflect the drip of water from the front of the grill. In the case of high winds, the water

might be blown inside the unit and freeze the unit. In this scenario, if icicles form on the tip of the fan paddles and grills they should be broken (using a thin object such as a ruler or screwdriver) to restore operation of the unit. Preventive shielding is critical to making sure this doesn't become a systematic problem.

In the case of snow storms with >2' snow accumulation, the LHA may need to verify that the unit has not become covered and need snow to be shoveled away from the front of any outdoor unit mounted on a 2' stand.

- **Outdoor unit coils:** The exterior coils should be inspected every two years for leaks or other damage.

LHA SUCCESSFUL ASHP OPERATION

In apartments which have a single head and a common wall with a fan, the resident should be encouraged to leave open the door between the bedroom and living room whenever possible. This will promote good air flow between both rooms and make for a more consistent temperature between rooms.