

## Heating and Hot Water Systems

- There is no electric resistance heat in any location or application.
- Basement heat is generally not recommended; if installed, it is controlled with a thermostat capable of set points as low as 45 degrees.
- Where air conditioning is desired, wiring for seasonally installed window-mounted units is encouraged. Air conditioning requires custom analysis by Efficiency Vermont. If central air conditioning is used, high-efficiency units are recommended.

### **Boilers**

- New central oil-fired or natural gas boiler(s) are ENERGY STAR<sup>®</sup> labeled\* with an Annual Fuel Utilization Efficiency (AFUE) of 85.0% or greater. If a different strategy is employed, please call Efficiency Vermont.
- Low-mass (< 5 gallons of boiler water content) cold-start boilers are recommended in small single-boiler installations (approximately 4 apartments or less) where circulating loops are not necessary. Microprocessor controls (such as Logamatic control for Buderus, Tekmar or equivalent controls) must be used to control high-mass (> 5 gallons of boiler water content) boilers. These controls are encouraged, but not required, for low mass systems as well.
- Heating system sizing is based on Manual J calculations or equivalent. Sizing calculations provided to Efficiency Vermont on request. Buildings with heating loads larger than 250,000 Btu/hr use staged multiple boilers.
- Boilers are provided with ducted combustion air ducted directly from outdoors to the burner or to an "air-tight" boiler room. The combustion air requirements of the boiler are separate from the building and there is no chance of back drafting.

### **Pumps & Piping**

- In multiple boiler systems, boilers are piped with primary/secondary piping to isolate them from each other.
- In buildings of fewer than eight apartments, pumps are controlled to operate only when there is a call for heat (intermittent primary pump operation).
- Motors of 1 hp or greater are NEMA premium efficiency. Pumps for system are appropriately sized and sizing calculations with head and flow will be provided to Efficiency Vermont, if requested.

- All hot water hydronic distribution piping is insulated to following ASHRAE standards:
  - nominal pipe diameter < 4" has 1" insulation
  - nominal pipe diameter > 4" 1.5" insulation
  - Pipe insulating values based on material with insulating value of R-3.7 per inch (conductivity not exceeding 0.27 Btu per inch/h · ft<sup>2</sup> · °F)

### **Boiler Controls**

- Multiple-boiler installations have controls and are programmed to (1) stage boilers; (2) alternate lead/lag; (3) modulate boiler water temperature based on outside temperature; and (4) shut off the primary circulator when outside temperature rises above a pre-set outdoor temperature.

### **Thermostats**

- All thermostats are non-mercury type.
- Each residential unit is individually zoned; apartments with two or more levels have individual zones per level.
- Common area heat is controlled with programmable setback thermostats protected with lock-boxes or remotely located.

### **Domestic Hot Water**

- Domestic hot water is provided by central indirect-fired water heater(s) off the central boiler(s) or very high-efficiency (greater than 80%) central standalone system. DHW tanks have insulation with a minimum R-value of R-14.
- Circulating domestic water heating loops are installed only when the run is greater than 50 feet to the furthest tap. Pumps are appropriately sized and control with a 24-hour timer is recommended but not required. All loop piping is insulated to ASRAE standards:
  - nominal pipe diameter <= 1.5" has .5" insulation
  - nominal pipe diameter >1.5" has 1" insulation
  - Pipe insulating values based on material with insulating value of R-3.7 per inch (conductivity not exceeding 0.27 Btu per inch/h · ft<sup>2</sup> · °F)Pipe insulating values based on material with insulating value of R-3.7 per inch (conductivity not exceeding 0.27 Btu per inch/h · ft<sup>2</sup> · °F)

## Water Conservation

- Water heating systems without circulating loops have:
  - bathroom faucets at 1.5-2.0 gallons per minute (gpm)
  - kitchen faucets at 1.5-2.0 gpm
  - showerheads at 2.0 gpm
  
- Water heating systems with circulating loops have:
  - bathroom faucets at 0.5-0.7 gpm
  - kitchen faucets at 1.5 gpm
  - showerheads at 2.0 gpm
  - Toilets are rated 1.6 gallons per flush.

\*A listing of ENERGY STAR<sup>®</sup> labeled products can be found at [www.energystar.gov](http://www.energystar.gov). Not all products that meet ENERGY STAR<sup>®</sup> criteria carry an actual label on the product. Efficiency Vermont considers any product with a make and model listed on the ENERGY STAR<sup>®</sup> website to be “ENERGY STAR<sup>®</sup> labeled.” If you have questions, please contact Efficiency Vermont at (888)-921-5990.

## Thermal Shell - New Construction

- Project design meets or exceeds Vermont Residential Building Energy Standards (required by law). At end of project, Vermont Residential Building Energy Standards Certificate is filed with Vermont Department of Public Service and town.

### Insulation

- Buildings are insulated to Vermont Residential Building Energy Standards.
  - Flat ceilings are insulated to R-38 or better (12" - 14" of blown cellulose).
  - Sloped ceilings are insulated to R-30 or better.
  - Walls are insulated to R-19 or better.
  - Any floors over unheated spaces are insulated to R30 or better.
  - Foundation or slab edge on grade is insulated to R-10 or better on foundation to footing. Slab edge detail may not allow heat loss through uninsulated cross sections. Detail approved by Efficiency Vermont.
  
- If radiant heat slab is installed, insulation under slab shall be R-10 or better.

### Air-Sealing

- All penetrations through exterior surfaces are sealed per Vermont Residential Building Energy Standards.
  
- Air leakage rate is blower-door tested and shown to be 0.35 natural air changes per hour (n ach) or less. Blower door air leakage testing provided by Efficiency Vermont. Air sealing will involve (but not be limited to) effective sealing with appropriate products in the following areas:
  - All plumbing, electrical, electric box, dryer duct or bath fan duct penetrations in exterior walls and attic with caulk or minimally expanding foam
  - Any chases open to the attic
  - Sealing the gap between the top plates of interior and exterior walls and ceiling sheetrock in the top story with caulk or minimally expanding foam
  - Rigid air barrier sealed and installed behind tubs or showers located on exterior walls
  - Bottom edge of sheetrock sealed to subfloor or slab on exterior walls with minimally expanding foam
  - Metal bath fan housings sealed to sheetrock with caulk or minimally expanding foam
  - Around window rough opening, minimally expanding foam with bead size to seal window frame to rough opening, do not try to fill depth of gap.

**Doors & Windows (new construction, cont'd)**

- All windows have NFRC U value rating of .35 or less and are ENERGY STAR<sup>®</sup> labeled\* for northern climate. Typical energy features include double glazing, low-E coating argon filling, and warm edge spacers.
- All rough openings are air-sealed with minimally expanding foam between rough opening and window or doorframe. (Foam bead should only be large enough to form an air seal, trying to fill the depth of the gap can result in frame bowing.)
- Doors are exterior rated with polystyrene or urethane core. Glass sections of exterior doors will have Low-E coating.

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## Thermal Shell - Major Rehabilitation

### Insulation

- Buildings are insulated as follows:
  - Flat ceilings are insulated to R-38 or better (12" - 14" of blown cellulose).
  - Sloped ceilings are insulated to R-30 or better.
  - Walls are insulated to R-11 or better. (Note that this may be difficult in brick-walled buildings unless a new interior wall system is constructed. These projects are custom analyzed and insulation strategies are reviewed and approved by EFFICIENCY VERMONT.)
  - Any floors over unheated spaces are insulated to R-30 or better.
  - Foundation or slab edge on grade is insulated to R-10 or better on foundation to footing. Slab edge insulation provides a minimum R-5 thermal break. Slab edge detail must be approved by Efficiency Vermont.
  
- If radiant heat slab is installed, insulation under slab is R-10 or better.

### Air-Sealing

- If new windows and/or doors are installed, all rough openings are air-sealed with minimally expanding foam upon installation.
  
- Air leakage rate is blower-door tested and shown to be 0.45 natural air changes per hour (nach) or less. Blower door air leakage testing provided by Efficiency Vermont. Air sealing will involve (but not be limited to) effective sealing with appropriate products in the following areas:
  - All plumbing, electrical, electric box, dryer duct or bath fan duct penetrations in exterior walls and attic with caulk or minimally expanding foam
  - Any chases open to the attic
  - Sealing the gap between the top plates of interior and exterior walls and ceiling sheetrock in the top story with caulk or minimally expanding foam
  - Rigid air barrier sealed and installed behind tubs or showers located on exterior walls
  - Bottom edge of sheetrock sealed to subfloor or slab on exterior walls with minimally expanding foam
  - Metal bath fan housings sealed to sheetrock with caulk or minimally expanding foam
  - Around window rough opening, minimally expanding foam with bead size to seal window frame to rough opening, do not try to fill depth of gap.

**Doors & Windows (Major Rehabilitation, cont'd)**

- Newly installed doors are exterior-rated with polystyrene or urethane core. Glass sections of exterior doors will have Low-E coating.
- Where new doors are not installed, retained doors are fully weather stripped (three sides, plus well-adjusted sweep). Effective storm doors are recommended, but not required.
- Where new windows or sashes are installed, they have an NFRC U value rating of .35 or less and are ENERGY STAR<sup>®</sup> labeled\* for northern climate. Typical energy features include double glazing, low-E coating argon filling, and warm edge spacers.
- Where new windows are not installed, the following are installed:
  - minimal expanding foam around rough-opening, if possible
  - interior weather-strip / jamb liner
  - sash locks that provide tight seal
  - storm windows (exterior or interior)

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## Ventilation

- Each unit has, at minimum, an exhaust-only ventilation system (usually qualified low wattage bath fan with 24-hour control). Central ventilation is allowed and heat recovery is encouraged, but these are handled on a custom basis.
- All bedroom and bathroom doors are undercut by a minimum of ½” clear space after carpet installation to allow free airflow. Transfer grilles to allow free airflow are also acceptable.
- Ducted kitchen range hoods are recommended for health and safety reasons; they are not required for Efficiency Vermont incentives. Kitchen range hoods are properly ducted per manufacturer’s specifications.

## Fans & Controls

- All fans (in unit and in common spaces) are low-noise, energy-efficient (see detailed specifications) and have a split capacitor motor designed for continuous duty operation.
- All fans are sized to be capable of providing 0.35 air changes per hour or 15 cfm per person, whichever is larger. Number of persons assumed for a unit is number of bedrooms plus one.
- All fans are controlled by a 24-hour timer programmed to operate consistently while residents are home. Controls are programmed so that fans are on a minimum of 8 hours per day while residents are home. During first year of “drying out” after construction, you may wish to specify a longer--or even continuous--run time. Locating controls remotely with local override switch is a strategy that has been successfully used by many projects.

## Ducting

- All ventilation ducting is smooth-wall rigid metal or PVC with a minimum of elbows.
- All ductwork in unconditioned spaces must be effectively insulated to a minimum of R-8 to meet the VT Residential Building Energy Standards and pitched to the outside.
- All duct joints are sealed with mastic or PVC glue. No duct tape shall be used.
- Ducting terminates at exterior wall of building at a dampered terminus (dryer vent style cap). Fans are NOT ducted out through soffits.
- Fan housing perimeter is sealed to bathroom sheetrock for air leakage control.

## **Resident-Controlled Lighting**

### **Interior Lighting**

- Hard-wired energy-efficient fluorescent lighting fixtures (T-8, compact fluorescent, or circline) are installed in all rooms or areas, including
  - all kitchens
  - all dining rooms or areas
  - all living rooms or areas
  - all bedrooms
  - all lit hallways
- T-8 fixtures are strongly recommended in kitchens and bathroom (vanities) for their superior light levels and tested long-term performance.
- All compact fluorescent fixtures meet ENERGY STAR<sup>®</sup> criteria. All magnetic ballasted fixtures will use instant on lamps.
- If used at all, T-12 fixtures are only used in areas of extremely low usage (for example, closets).
- Recessed light fixtures installed in the thermal boundary
  - are certified for insulation contact (IC-rated)
  - have airtight design compliant with the Washington State Energy Code
  - use compact fluorescent lamps
- If recessed fixtures are installed to protrude into attic, attic insulation details need special attention to ensure proper insulation values.
- Each fixture has its own switch. Dual vanity fixtures (one on either side of the mirror) or paired sconces can be controlled with a single switch.
- There are no switched outlets.

### **Exterior Lighting**

Resident-controlled exterior lighting is compact fluorescent and properly rated for exterior conditions. (Suggestion: An integrated photocell is a good idea for both savings and security by preventing daytime operation.)

## **Common Area Lighting**

### **Interior Lighting**

- Exit signs are LED or electroluminescent.
- All lighting fixtures are hard-wired energy-efficient fluorescent lighting fixtures (T-8, compact fluorescent, or circline).
- “Super T-8” fixtures are recommended for common area lighting, particularly common hallways, for improved energy savings and long-term performance. “Super T-8” fixtures are specific lamp/ballast combinations that offer longer life and less energy use over standard electronically ballasted T-8s. Lamp/ballast systems are offered by Sylvania and GE and can be integrated with most manufacturers’ fixtures. Contact Efficiency Vermont for a list of lamp/ballast combinations.

### **Exterior Lighting**

- Common area exterior lighting fixtures are high-intensity discharge (HID) pulse-start metal halide, high pressure sodium, or compact fluorescent.

### **Lighting Controls**

- All common space lighting (interior and exterior) is efficiently controlled with time clocks, photocells, and/or motion sensors. Large common spaces, particularly hallways have bi- or multi level switching options to reduce lighting during low use periods.
- Ceiling-mounted motion sensors are recommended where there are concerns about resident intervention.
- Time clocks are located in remote locations not accessible by residents.

## **Lamps (For Resident Controlled and Common Area Lighting)**

- Fixtures that carry the ENERGY STAR<sup>®</sup> label\* have the following characteristics. An ENERGY STAR<sup>®</sup> labeled\* fixtures will meet Efficiency Vermont criteria.
- All lamps in residential spaces have a minimum color-rendering index (CRI) of 75. Where possible, CRI is greater than 80 for resident acceptance.
- All lamps in residential spaces have a color temperature in the range of 2700-3500K.
- All lamps within a room have a similar color temperature for aesthetics.
- Electrical specifiers are encouraged to minimize the number of replacement lamp types required at a property (e.g., use all circline and T-8, or all PL 13 and T-8.)
- Bid and contract documents specify that the electrical contractor provides a minimum of 15% replacement lamp for each installed lamp at the project. (Example: If project has 20 T-8s and 40 PL3x13s fixtures, then electrical contractor provides 3 T-8s and 18 PL13 lamps as replacements.) Replacement lamps are the same color and CRI rating as originals. Developer should ensure that lamps are stored properly and that project manager knows their location.

### **Resident-Owned Lighting**

- Rental agreements/leases should prohibit halogen torchieres for reasons of both safety and energy efficiency.
- For qualifying low-income multifamily apartments, Efficiency Vermont will provide at no cost to owner or management or residents direct installation of efficient lamps in resident-owned fixtures once project is fully tenanted.

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## Appliances

### **Refrigeration**

- Each apartment is equipped with an ENERGY STAR<sup>®</sup> labeled\* refrigerator.
- All refrigerators installed in any central kitchen facilities or common areas are ENERGY STAR<sup>®</sup> labeled.
- All old refrigerators are properly disposed (disposal receipt required).

### **In-Unit Laundry Equipment**

- In-unit laundry appliances shall be ENERGY STAR<sup>®</sup> labeled\*.
- In-unit dryer hook-ups shall provide the option for natural gas, where available. Propane-fired dryer hook-ups are encouraged for in-unit dryers where natural gas is not available.
- Dryers are ducted outdoors with smooth-walled rigid ducting and backflow dampers at wall terminus.

### **Common Laundry Facilities**

- Common laundry facilities are equipped with ENERGY STAR<sup>®</sup> labeled\* front-loading washing machines.
- Common laundry facilities are equipped with natural gas or propane dryers.
- Dryers are ducted outdoors with smooth-walled rigid metal ducting and backflow dampers at wall terminus.

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