Funding for Energy Code Training
THE CODE ALLOWS ANY OF THESE COMPLIANCE OPTIONS

IECC ‘Envelope’ Compliance - Four Options + One = 5 in Utah

PRESCRIPTIVE
- U-factor (tradeoffs within individual components)
- UA (tradeoffs between components)

PRESCRIPTIVE UA- Trade-off 2015 REScheck

SIMULATED PERFORMANCE
Mechanical Component

NEW 2015 ENERGY RATING INDEX (ERI)
Mechanical + all Building Energy

ERI Compliance Alternative R406

5th OPTION
UTAH 2012 RESCHECK Mechanical Option

Pass by:
3% - Jan 1, 2017 - Jan 1, 2019
4% - Jan 1, 2019 - Jan 1, 2021
5% - Jan 1, 2021

NEW IN UTAH

Insulation and Fenestration - Requirements by Climate Zone
2015 Prescriptive Table - no amendments - enclosed values are all improvements

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>FENESTRATION</th>
<th>SKYLIGHT</th>
<th>GLAZED FENESTRATION</th>
<th>CEILING</th>
<th>WOOD FRAME WALL</th>
<th>MASS WALL</th>
<th>FLOOR</th>
<th>BASEMENT</th>
<th>SLAB</th>
<th>CRAWL SPACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NR</td>
<td>0.75</td>
<td>0.25</td>
<td>30</td>
<td>13</td>
<td>0</td>
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<td>10</td>
<td>12</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>3</td>
<td>0.25</td>
<td>0.55</td>
<td>0.25</td>
<td>28</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
</tbody>
</table>

For SI: 1 ft = 0.3048 m.

- R-values are minimums. U-factors and SHGC are maximums.
- U-values are calculated for a clear window. Values are less than the label or design thickness of the insulation, the installed R-value of the insulation shall not be less than the R-value specified in the table.
- If this option is used for code compliance, use these R-values and U-factors on the Manual J Load Calculation.
**Rooms Containing Fuel-burning Appliances - OPEN COMBUSTION AIR**

*Both Residential and Commercial Buildings - IECC Requirement*

- Appliances and combustion air openings to be located outside the building thermal envelope or enclosed in a room isolated from inside the thermal envelope in Climate Zones 3-8 - ALL of Utah
- Where open combustion air ducts provide combustion air to open combustion fuel-burning appliances
  - Furnaces, boilers, water heaters
- Rooms to be sealed and insulated per envelope requirements
- Doors into the rooms fully gasketed
- Water lines and ducts insulated
- Combustion air ducts that pass through conditioned space, insulated to $\geq$ R-8
- Does not apply if combustion air is drawn from inside the home

**Exceptions:**
- Direct Vent
- Fireplaces
- Stoves

---

**Direct Vent Appliances**

![Diagram of Direct Vent Appliances]
# Tankless Water Heaters

## Tank Vs Tankless at 90° Rise

<table>
<thead>
<tr>
<th>Tank Type</th>
<th>40,000 Btu’s</th>
<th>199,900 Btu’s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>151 lbs empty</td>
<td>55 lbs</td>
</tr>
<tr>
<td></td>
<td>.62 EF</td>
<td>.82-.96 EF</td>
</tr>
<tr>
<td></td>
<td>13 Ft³</td>
<td>2 Ft³</td>
</tr>
<tr>
<td></td>
<td>67 gal 1st hour</td>
<td>222 GPH</td>
</tr>
</tbody>
</table>

Tank type:
- Less efficient- 62%
- Smaller burner- takes along time to recover
- Stored water looses heat into the space continually
- Big and heavy

Tankless type
- Increased efficiency-up to 96%
- Larger burner- requires more gas
- Make hot water instantaneously- no storage
- Compact

---

Tankless Water-heater
Section R403.3.1 - Prescriptive - Duct Insulation

- Supply and return ducts in **attics**: R-8 where ≥ 3” diameter, R-6 if < 3”
- Other areas: R-6 where ≥ 3” diameter, R-4.2 if < 3”
- Note: Commercial IECC requires R-12 for ducts outside the thermal envelope

### Examples

<table>
<thead>
<tr>
<th>Location</th>
<th>Duct Diameter &gt;3” or &lt;3”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attic</td>
<td>R-8 or R-6</td>
</tr>
<tr>
<td>Conditioned Space</td>
<td>NR</td>
</tr>
<tr>
<td>Vented Crawlspace</td>
<td>R-6 or R-4.2</td>
</tr>
<tr>
<td>Conditioned Crawlspace</td>
<td>NR</td>
</tr>
<tr>
<td>Basement – Conditioned</td>
<td>NR</td>
</tr>
<tr>
<td>Basement – Unconditioned</td>
<td>R-6 or R-4.2</td>
</tr>
<tr>
<td>Exterior Walls</td>
<td>R-6 or R-4.2</td>
</tr>
</tbody>
</table>

**Duct Loss-Gain**

- ΔT (Temperature difference or change)
  - Attic compared to inside duct
  - Inside home compared to attic
  - Insulation barrier between each
- Insulation in AH or furnace- R-2 or 3
- Duct insulation R-8
- 25’ of 8” R-8 flex – Surface area = \( \pi \times d = 3.14 \times 8 = 25.12” = 2.09' \times 25' = 52.25 \text{ sq. ft.} \)
Above or Below the Insulation?

Section R403.3.3 - Mandatory - Duct Testing

- Ducts shall be pressure tested to determine air leakage by either of the following:
  - Rough-in test
    - Total leakage measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system including manufacturer’s air handler enclosure
    - All registers taped or otherwise sealed
  - Post-construction test
    - Total leakage measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system including manufacturer’s air handler enclosure
    - All registers taped or otherwise sealed
- Exception
  - Duct air leakage test not required where ducts and air handlers are partially within the building thermal envelope
    - 50% inside - July 1, 2016 to Dec 31, 2017 we’ve passed this date
    - 65% inside - Beginning January 1, 2017
    - 75% inside - Beginning January 1, 2019 just about here
    - 80% inside - Beginning January 1, 2021
  - A written report of results of test signed by the party conducting test and provided to code official
### Duct Leakage

**Section R403.3.4 - Prescriptive**

Total leakage of ducts, where measured in accordance with Section 403.3.3 shall be as follows:

- **Rough-in test**
  - Total leakage ≤ 4.8 cfm/per 100 ft² of conditioned floor area *(previously 10 CFM)*
  - if air handler not installed at time of test
  - Total air leakage ≤ 3.6 cfm/per 100 ft² *(previously 7.5 CFM)*

- **Postconstruction test** Total leakage ≤ 4.8 cfm/per 100 ft² of conditioned floor area *(previously 10 CFM)*

**Phase In**
- 8 CFM beginning January 1, 2017
- 7 CFM beginning January 1, 2019
- 6 CFM beginning January 1, 2021

### Building Cavities

**Section R403.3.5 - Mandatory**

Framing cavities cannot be used as ducts or plenums.

State amendment allows panning

*Difficult to pass a duct test if panned*
On outdoor heated pools and outdoor permanently installed spas

- Vapor-retardant cover OR
- Other approved vapor retarder means

Exception:
- If >70% of energy from site-recovered energy
Section R403.6 - Mechanical Ventilation

Required (IRC) if blower door tested tighter than 3 ACH@50pa (State amended from 5 ACH@50pa)

✓ Ventilation
  • Building to have ventilation meeting IRC or IMC or with other approved means (previously deleted by the 2012 amendments)
  • Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating

✓ Whole-house mechanical ventilation system fans to meet efficacy in Table R403.6.1

✓ Exception
  • When fans are integral to tested and listed HVAC equipment, they shall be powered by an electronically commutated motor

Blower door testing is an optional air sealing compliance method by amendment

NEW 17

Energy Code Guide

R403.6 Mechanical Ventilation
Per IRC 303.4 & M1507 with automatic or gravity dampers on outdoor air intake and/or exhaust.
### Section R403 - Mandatory Requirements - Systems

**HVAC Controls**
- ✓ Programmable Thermostat
- ✓ Heat pump supplementary heat – outdoor ‘stat
- ✓ Hot water boiler outdoor temperature setback
- ✓ Snow melt controls
- ✓ Pools and in-ground permanently installed spas

### IECC Section R403.7 - Equipment Sizing and Efficiency Rating

**Equipment Sizing**
- ✓ Load calculations determine the proper capacity (size) of equipment
  - Goal is big enough to ensure comfort but no bigger
  - Sizing shall be performed in accordance with ACCA Manual S based on loads calculated in accordance with ACCA Manual J (other approved methods)

**Efficiency Rating**
- ✓ New or replacement heating/cooling equipment shall have an efficacy rating equal to or greater than minimum required by federal law for geographic location of installation

**R403.7 Equipment Sizing**
Per ACCA Manual S, based on loads calculated per ACCA Manual J.
ANSI/ACCA Manual J, D & S

Manual J, Energy Compliance & Plans

- It is critical that the Load Calculations, Energy Compliance Documents and Building Plans are internally consistent in regards to thermal characteristics of the building.

Manual J- Table 1A
Design Conditions for Salt Lake City

- Elevation- 4220'  
  Latitude- 40° North
- Winter  Heating 99% Dry Bulb: 11°F
- Summer  Cooling 1% Dry Bulb: 94°F
  Design Grains 45% RH: -24
  Coincident Wet Bulb: 62°F
  Daily Range: H (High)

MUST all locations in the valley use they values? NO!
Manual J

• Includes a room-by-room calculation method that allows the designer to determine the required capacity of the heating and cooling equipment.

Manual J

• Provides for an estimate of the air-flow requirements for each of the areas in the house. The estimate is then used in sizing the duct system for the types of heating and cooling units that use air as the medium for heat transfer.
Design Temperature Difference

- The difference between the inside design condition and the outside design conditions. Example: Inside 70°F, outside 5°F, Design Temperature Difference = 65°F. Will often be expressed as Delta T or ΔT.

Heat Transfer

Thermal Conduction: The process of heat transfer through a solid by transmitting kinetic energy from one molecule to the next.
Heat Transfer

Thermal Convection: Heat transmission by the circulation of a liquid or gas.

Heat Transfer

Radiant Heat: Energy radiated or transmitted as rays, waves, or in the form of particles.
Heat Transfer

Heat escapes through walls and openings when the temperature outside is lower than the temperature inside.

Winter Heat Loss

- Heat loss occurs through the building structure, including the walls, windows, doors, and roof.
- The structure requires additional heating due to the heat loss and incoming infiltrating air.
Summer Heat Gain

Heat enters through walls and openings when the temperature outside is warmer than the temperature inside. This is referred to as heat gain. Also gain heat due to solar radiant heat.

Internal Heat Gain

- Consider internal gain in a residential dwelling unit different than a commercial-
  - Hours of use
  - Use of appliances and lights
  - Average hours
  - Time of day
  - Ability to adjust use- HDY
Infiltration

- Uncontrolled leakage of outside air into the occupied space through openings in the building envelope.
- Must account for heat loss and gain due to infiltration.

Ventilation

- Air introduced into the occupied space by a controlled mechanical means. May be through the HVAC system, a heat recovery ventilator or by exhaust fans.
- HVAC system- outside air introduced into return
  
  Must include heating or cooling required for ventilation air

Supply-Only Ventilation System

May be supply, exhaust, or a combination supply and exhaust.
Latent Heat

- Heat associated with moisture in the air. Changes in latent heat are changes in relative humidity. Heat must be added to evaporate water as heat has to be removed to condense it out of the air.
- The amount of heat required to change one pound of a given substance from liquid to vapor state without change in temperature is termed the heat of vaporization.
- It requires 970 Btu to change one pound of water at 212°F to one pound of steam at 212°F.

SHR- Sensible Heat Ratio

- SHR =  \frac{\text{Sensible Heat Gain}}{\text{Total Heat Gain}}

Example: Sensible Load = 23,568 BTU  
Latent Load = 2,467 BTU

\[ \text{SHR} = \frac{23,568}{26,035} = .91 \]

That is a high latent load for Utah’s dry climates

Generally, loads for homes in Utah will have SHR = 1, i.e. no latent load
Checklists will be available on: www.utahenergycode.com

### Residual Load Calculation

#### WHY ARE HEAT LOSS AND HEAT GAIN CALCULATIONS IMPORTANT?

Achieving efficient weatherization is the principal goal of any H/TAC design. Properly functionuating required calculations includes dimensions, spaces, and key heat-resistant measures to ensure that the building is as energy efficient as possible. Comprehensive determination of the heating and cooling system equipment and the corresponding equipment must be correct to ensure that the building is as energy efficient as possible. For resiliency applications, ACCA's Manual J, Eighth Edition (2017) is the primary procedure reference for the American National Standards Institute (ANSI) and specifically required for energy-related purchases. Methods are based on critical energy conservation, and are outlined in this sub-section. All energy conservation principles are subject to local or institutional rules.

#### PROBLEM WITH OVERSIZED EQUIPMENT

Over-sizing equipment can result in oversized furnaces, air conditioners, heat pumps, and other HVAC equipment. While the temperature control of the system may be satisfactory during extreme conditions, the system is oversized by design. The oversized equipment may cause reduced life expectancy of the system, resulting in greater repair and maintenance costs. Over-sizing equipment may also reduce energy efficiency and lower energy savings. Over-sizing equipment, therefore, is not recommended for optimal system performance.

#### REASONS FOR OVERSIZED EQUIPMENT

The main reasons for oversized equipment are:

1. The system is oversized to meet the needs of the homeowner.
2. The system is oversized to meet the needs of the installer.
3. The system is oversized to meet the needs of the manufacturer.
4. The system is oversized to meet the needs of the building code.
5. The system is oversized to meet the needs of the utility company.
6. The system is oversized to meet the needs of the architect.
7. The system is oversized to meet the needs of the owner.

#### CHECKLISTS

Checklists will be available on: www.utahenergycode.com

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### Table of Contents

**Checklists will be available on: www.utahenergycode.com**

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### Table of Contents

#### 1. Design Temperatures

- Indoor Design Temperature
- Outdoor Design Temperature

#### 2. Windows & Glass Doors

- U-value and SHGC values
- Shading Coefficients

#### 3. Ventilation

- Air Exchanges
- Air Infiltration

#### 4. Insulation

- Wall Insulation
- Roof Insulation

#### 5. HVAC Equipment

- Heating Equipment
- Cooling Equipment

#### 6. Storage Systems

- Domestic Hot Water Systems
- Space Heating Systems

#### 7. Controls

- Thermostats
- Energy Management Systems

---

**Questions to Ask**

- Are the systems oversized to meet the needs of the homeowner?
- Are the systems oversized to meet the needs of the installer?
- Are the systems oversized to meet the needs of the manufacturer?
- Are the systems oversized to meet the needs of the building code?
- Are the systems oversized to meet the needs of the utility company?
- Are the systems oversized to meet the needs of the architect?
- Are the systems oversized to meet the needs of the owner?

---

**Checklist Answers**

- Yes
- No
- Not Applicable

---

**Notes:**

- Questions should be answered "Yes," "No," or "Not Applicable."
Verifying ACCA Manual S® Procedures

Why is proper equipment selection important?
Achieving occupant satisfaction is the principal goal of any HVAC design. Occupant satisfaction is maintained when the heating and cooling equipment are the correct size and size to meet the capacity requirements from the Manual J load calculations. For residential equipment selections, ACCA’s Manual S is the only procedure recognized by the American National Standards Institute (ANSI). If the Manual J load calculation is done in the next step is to select the equipment that will deliver the necessary heating and cooling.

ACCA’S Residential Design Manuals

- System Process
  - Load Calculation: ACCA Manual J
  - Equipment Selection: ACCA Manual S
  - Duct Design: ACCA Manual D
  - Air Distribution: ACCA Manual T
  - Test, Adjust, and Balance: ACCA Manual B

What problems come from the wrong size equipment?
Under-sized equipment will not meet the occupants’ comfort requirements at the design specifications.

- oversized equipment will cause other problems:
  - Dehumidification control in the summer.
  - Occupants may suffer from the effects of increased energy for small growth. These same conditions also may contribute to noise and other environmental conditions.
  - The temperature may be lower at the thermostat but the temperature in other rooms will suffer from the oversized equipment doing short operating cycles. Short cycles can cause temperature swings at the equipment over-size conditions, stop, then over-conditions, etc.
  - Hot and cold spots between rooms because the thermostat is satisfied but the room is not.
  - Oversized equipment generally requires larger ducts, increased electrical circuit sizing and larger refrigeration tubing. These causes higher installed costs and increased operating expenses.
  - The equipment starts and stops more frequently, this can cause excessive wear and increase maintenance costs / service calls.

In these unfavorable conditions occupants will experience discomfort and dissatisfaction.

What are some reasons for oversized equipment?
Manufacturers take great care in testing and testing how well their equipment performs at different operating conditions. When contractors use this data to select the equipment they will meet the heating and cooling needs of their customers.

Two main reasons for oversized equipment are the following: (1) A guess was made on the equipment’s capacity at the design conditions or (2) minimum were made in the selection process.

**Equipment Selection Checklist**

<table>
<thead>
<tr>
<th>#</th>
<th>Key Item</th>
<th>Verify</th>
<th>Verification Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design Conditions</td>
<td>Yes</td>
<td>The design conditions fall within the minimum standards for this region as found in Manual J Table 1 or 1B.</td>
</tr>
<tr>
<td>2</td>
<td>OEM’s Performance Data</td>
<td>No</td>
<td>The equipment manufacturer’s performance parameters match the design parameters used to calculate the base load.</td>
</tr>
<tr>
<td>3</td>
<td>Equipment Performance</td>
<td>Yes</td>
<td>The equipment selected includes the equipment, and the sun exposure and shading.</td>
</tr>
<tr>
<td>4</td>
<td>Auxiliary Item</td>
<td>Yes</td>
<td>The electric circuitry must provide the necessary RTU’s to made the change by comparing the heat pump’s balance to the design conditions.</td>
</tr>
</tbody>
</table>

**Equipment Selection using an Example Checklist**

**Design**

Winter Design Conditions:
- Outdoor: -27°F
- Indoor: 70°F

Summer Design Conditions:
- Outdoor: 85°F
- Indoor: 70°F

**Application Data: Equipment Capacity**

- Heat pump was selected to perform cooling and heating design and performance. Other types of equipment may be used.

- Furnace was selected by comparing heating only design and performance. Other types of equipment may be used.
Thank You!

- Questions/comments may be addressed to me at:
  - Brent Ursenbach
  - bursenbach@gmail.com
  - brentu@WC-3.com
  - C: 801-381-1449

*If you would like a copy of this or other presentations, please go to*

www.utahenergycode.com