

# BLUEPRINT

CALIFORNIA ENERGY COMMISSION  
EFFICIENCY DIVISION

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## CENTER OF GLASS CALCULATIONS FOR LOW-RISE RESIDENTIAL BUILDINGS

Center of glass calculations have a limited application in low-rise residential projects and require extra documentation to support the calculated values. The process for using this approach is described in Reference Appendices Nonresidential Appendix **NA6** (NA6).

Low-rise residential center of glass calculations can only be used for a total site-built window area of up to 250 ft<sup>2</sup> or 5 percent of the conditioned floor area (CFA), whichever is greater, per NA6. Site-built fenestration is defined in **Section 100.1** of the *2016 Building Energy Efficiency Standards* (Energy Code) as fenestration designed using factory cut pieces manufactured with the intention of being assembled at the construction site. This is not to be confused with field-fabricated fenestration, which is entirely built in the field. The U-factor and solar heat gain coefficient (SHGC) of site-built fenestration products may either be rated by the National Fenestration Rating Council (NFRC), come from the default values listed in the tables in **Section 110.6**, or be calculated using NA6.

NA6.5 includes a comprehensive list for the builder and installer to follow to ensure:

the energy consultant is given the proper information for the manufacturer and type of glass; accurate documentation is provided to the enforcement agency; and that the correct product is installed. The manufacturer's literature should be submitted with the certificate of compliance documentation and worksheets.

To calculate the U-factor and SHGC, use Equations NA6-1, NA6-2, and Table NA6-5 to determine the values and create a default label for each window.

### Equation NA6-1

$$U\text{-factor} = C1 + (C2 \times \text{Center of Glass U-factor})$$

### Equation NA6-2

$$SHGC = 0.08 + (0.86 \times \text{Center of glass SHGC})$$

**Table NA6-5 – U-factor Coefficients**

Product Type	Frame Type	C <sub>1</sub>	C <sub>2</sub>
Site-built vertical fenestration	Metal	0.311	0.872
	Metal thermal break	0.202	0.867
	Non-metal	0.202	0.867
Skylights with a curb	Metal	0.711	1.065
	Metal Thermal Break	0.437	1.229
	Non-Metal	0.437	1.229
Skylights with no curb	Metal	0.195	0.882
	Metal thermal break	0.310	0.878
	Non-metal	0.310	0.878

For the performance method, the values needed for center of glass calculations depend on the compliance software used. For CBECC-Res or Right-Energy, use Equations NA6-1 and NA6-2, and Table NA6-5 to determine the values to input into the software.

Alternatively, EnergyPro allows an input for center of glass values, and the calculations from NA6 are incorporated into the software. The CF1R-PRF-01-E form will list the adjusted values being modeled by EnergyPro. Note that the modeled center of glass efficiencies of site-built fenestration products could result in a compliance penalty, and the mandatory requirement in **Section 150.0(q)** of a maximum 0.58 U-factor cannot be traded off.

When using the prescriptive method, start with either the CF1R-NCB, CF1R-ALT, or CF1R-ADD form, and then include the CF1R-ENV-02 and CF1R-ENV-03 form if using an area weighted average or shading to comply. These forms along with the default labels will document if the fenestration meets the prescriptive requirements per **Section 150.1**.

When the enforcement agency receives the certificate of compliance documentation, the plan checker confirms:

1. The U-factor and SHGC values are on the plans and forms.
2. The center of glass values of the fenestration product on the manufacturer's documentation.
3. The area limits (greater of 250 ft<sup>2</sup> or 5 percent of CFA).

The building inspector later verifies the installed fenestration efficiency values match the compliance documentation and the actual area of site-built fenestration does not exceed the allowed limit.

## RESIDENTIAL REPLACEMENT WINDOW INSULATION

For residential replacement and retrofit windows, the 2016 Energy Code require insulation to be installed between the new fenestration product and the rough opening. When retrofit windows are installed into existing frames, a new void is created that did not previously exist. The rough opening in a window retrofit is the inside-to-inside dimensions of the existing frame, commonly referred to as the pocket.

The fenestration product manufacturer's installation specifications should be followed when installing retrofit windows. The space between the new window and rough opening shall be completely filled with insulation and the cavity must be airtight. See Figure 1. When batt insulation is used, it should be cut to size and placed properly around the fenestration product. Stuffing of the insulation is not permitted. Low expanding foam may be used to fill the gaps and voids when allowed by the manufacturer.

For more on the installation requirements for retrofit windows, see the **CF2R** installation forms.

## NEW VIDEOS FOR NONRESIDENTIAL HVAC MANDATORY REQUIREMENTS

New educational videos are available at the **Online Resource Center** (ORC). These videos review the 2016 Energy Code mandatory requirements for HVAC in nonresidential, high-rise residential, and hotel and motel buildings.

### *Mandatory Requirements for Nonresidential Space Conditioning Systems*

- » Course 1A: Introduction - Mandatory, Prescriptive and Performance Requirements: Understanding the Differences
- » Course 1B: Requirements for Ventilation
- » Course 1C: Required Controls for Space Conditioning Systems
- » Course 1D: Requirements for Pipe Insulation
- » Course 1E: Requirements for Air Distribution System Ducts and Plenums
- » Course 1F: Required Nonresidential Mechanical System Acceptance

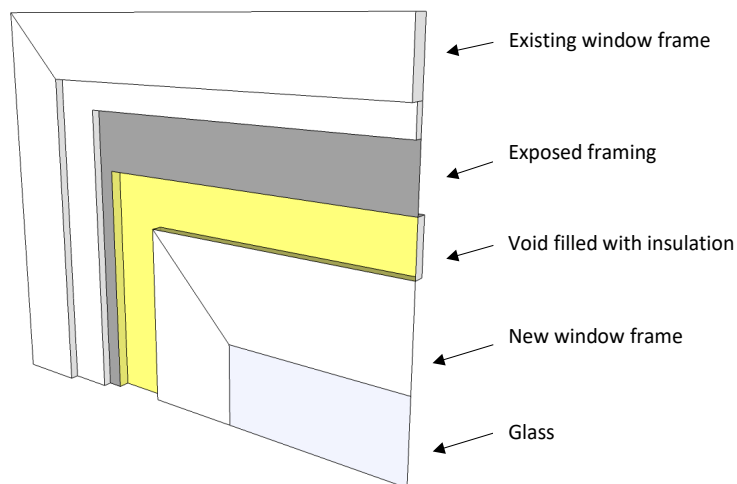


Figure 1 - Retrofit window insulation

## TOWNHOUSE CLASSIFICATIONS

Historically, the low-rise residential requirements of the Energy Code have been applied to townhouses as single-family dwellings with an R-3 building occupancy classification, regardless of the number of stories. However, due to changes in the California Building Code, the high-rise residential requirements of the Energy Code may apply to taller townhouses. Title 24, Part 2 and 2.5, classify townhouses three or less stories above grade, with a separate means of egress, as occupancy group R-3, and townhouses more than three stories as occupancy group R-2.

The Energy Code defines a low-rise residential building as a building, other than a hotel or motel, that is occupancy group R-2, multifamily with three or less habitable stories; or occupancy group R-3, single family; or an occupancy group U building, located on a residential site. A high-rise residential building is defined as a building, other than a hotel or motel, occupancy group R-2 or R-4, with four or more habitable stories. High-rise residential buildings must meet the Energy Code requirements for nonresidential buildings, and dwelling units within the building must meet the low-rise residential Energy Code requirements for water-heating and lighting.

Determining whether a townhouse will need to meet the low-rise residential or high-rise residential requirements of the Energy Code depends on how the townhouse is classified by the enforcement agency and the number of habitable stories. If the townhouse is classified as R-3, the low-rise residential standards will apply. If the townhouse is classified as R-2 and has four or more habitable stories, the high-rise residential standards will apply. If the townhouse is classified as R-2 and has three or less habitable stories, the low-rise residential standards will apply.



Figure 2 - Occupancy Group R-2 Townhouses

## Q&A

### TOWNHOUSES: HIGH-RISE OR LOW-RISE

**Townhouses with four conditioned stories above grade that have an R-2 group occupancy will be constructed, but one story is an entry landing with stairs. Are these townhouses classified as low-rise residential or high-rise residential buildings?**

This is low-rise residential. This is an R-2 group occupancy with three habitable stories or less. See Figure 2. A habitable story is defined as space in which humans may work or live in reasonable comfort with 50 percent or more of its volume is above grade. Additionally, habitable space is defined as space for living, sleeping, eating, or cooking. Bathrooms, toilets, hallways, storage areas, closets, utility rooms, and similar areas are not considered habitable space. A conditioned story with only an entry landing and stairs is not considered a habitable story.

**If there are multiple R-2 group occupancy townhouses in one building and only one of them is four stories, is the entire building a four story, high-rise residential building or is each unit looked at individually?**

This is high-rise residential. This building is an R-2 group occupancy with four or more habitable stories. Any townhouses that are attached and sharing common walls, and that consist of one structure are considered to be one building. A building with an R-2 group occupancy that has four or more habitable stories is considered a high-rise residential building.

**A project consists of townhouses that are broken up into two levels that are connected by an unconditioned, sometimes exterior, walkway. The project description labels these townhouses as having four stories, but only three are habitable. Would the townhouses in this project be considered high-rise residential buildings?**

No. These townhouses will be considered low-rise residential buildings. It is up to the enforcement agency to determine the building group occupancy. Regardless of an R-2 or R-3 group classification, these townhouses have three habitable stories and will be considered low-rise residential buildings.

**Townhouses that are all R-2 group occupancy will be built into a steep hillside with more than four stories above the grade plane, however only three stories are habitable space. See Figure 3. Are these townhouses low-rise residential buildings?**

Yes. Buildings with an R-2 group occupancy and three habitable stories or less will be classified as low-rise residential buildings.

For more information see, the **Energy Code for Townhomes** presentation on the ORC.

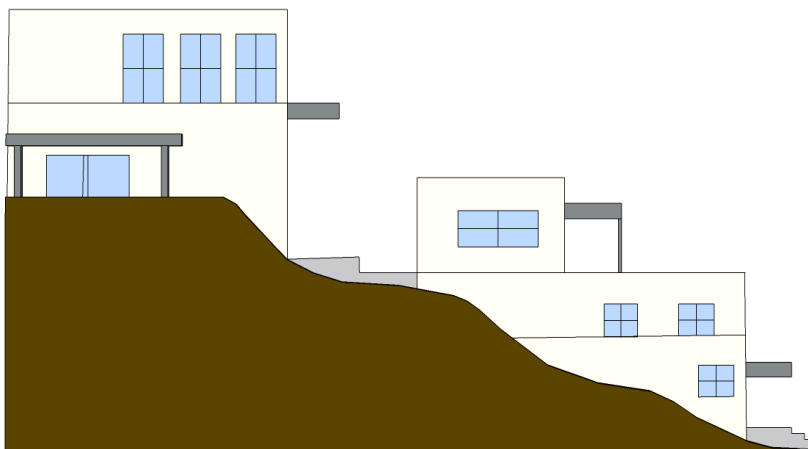


Figure 3 - Townhouses built into steep hillside

## NATURAL GAS AND WATER HEATER INSTALLATION IN ADUs

**I am converting a detached garage into an accessory dwelling unit (ADU). Natural gas is connected to the existing home but not the detached garage. Is natural gas considered available to the ADU?**

It depends on the method used to document compliance. If using the **addition alone** prescriptive or performance compliance pathway, then it assumes no natural gas is available. If using the **existing plus addition plus alteration** method to document compliance, since the existing building has natural gas available, the addition does as well. For clarification, **Section 100.1** of the 2019 Energy Code now defines natural gas availability as:

*“...For additions and alterations, natural gas is available if a gas service line is connected to the existing building.”*

**I am converting an attached garage into an ADU. Natural gas is connected to the building. Can I prescriptively install a heat pump water heater?**

No. Per **Section 150.2(a)1Di** when complying prescriptively, a gas water heater that meets the requirements of **Section 150.1(c)8** must be installed.

However, when using the performance method to document compliance, **Section 150.2(a)1Div** allows installation of any water heater as long as the proposed energy budget is equal or less than the standard energy budget. In the performance method the standard water heating energy budget is based on **Section 150.1(c)8Ai**.

**I am converting a detached garage into an ADU. Natural gas is not connected to the garage. Can I prescriptively install a heat pump water heater?**

Yes. **Section 150.2(a)1Dii** allows for an electric water heater to be installed. Note that a heat pump water heater is a very efficient type of electric water heater to install.

## CONCRETE WALL INSULATION

**I have a low-rise residential building with concrete walls. Do the mandatory wall insulation requirements of Section 150.0(c) apply to concrete and mass walls?**

No. The 2016 Energy Code does not have mandatory insulation requirements for concrete or mass walls for low-rise residential buildings. This includes concrete stem walls. However, there are prescriptive requirements in **§150.1(c)1B** of the 2016 Energy Code for insulating concrete and mass walls.

## APPROVED POOL PUMPS

### Can I issue a final permit for a pool pump that does not appear in the Energy Commission's Modernized Appliance Efficiency Database System (MAEDBS) approved list?

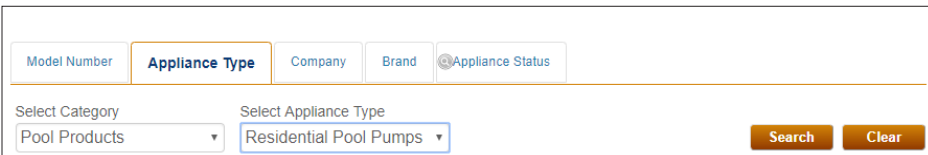
Yes, if the pool pump appears on the MAEDBS archived list. Per **Section 150.0(p)1A** all pool pumps and pump motors installed shall be listed in the Energy Commission's directory of certified equipment.

Due to a change in federal law, the Energy Commission moved all pool pumps certified prior to February 5, 2018, from the MAEDBS approved list to the archived list.

Code officials should review both the approved list and archived list on MAEDBS. Pool pumps appearing on either list are permissible to be installed in California. For more information see the pool pump **FAQ**.

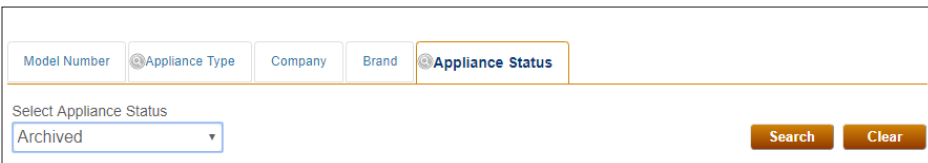
### How do I find the archived list for residential pool pumps on MAEDBS?

Under the search feature in **MAEDBS** click on the appliance type tab. In the category, select pool products, in the appliance type select residential pool pumps. Figure 4. Next, under the appliance status tab, select archived, then click the search button and the list will populate. Figure 5.



The screenshot shows a search interface with tabs for Model Number, Appliance Type, Company, Brand, and Appliance Status. The 'Appliance Type' tab is active. Below the tabs, there are two dropdown menus: 'Select Category' (set to 'Pool Products') and 'Select Appliance Type' (set to 'Residential Pool Pumps'). There are 'Search' and 'Clear' buttons to the right of the dropdowns.

Figure 4 - MAEDBS Appliance Type Tab



The screenshot shows the same search interface as Figure 4, but with the 'Appliance Status' tab selected. The 'Select Appliance Status' dropdown is set to 'Archived'. The 'Search' and 'Clear' buttons are still present.

Figure 5 - MAEDBS Appliance Status Tab

## FOR MORE INFORMATION

**Home Energy Rating System:**  
<http://www.energy.ca.gov/HERS/>

**Acceptance Test Technician Certification Provider Program:**  
<http://www.energy.ca.gov/title24/attcp/>

**Approved Compliance Software:**  
[http://www.energy.ca.gov/title24/2016standards/2016\\_computer\\_prog\\_list.html](http://www.energy.ca.gov/title24/2016standards/2016_computer_prog_list.html)

**The California Energy Commission welcomes your feedback on Blueprint. Please contact Amie Brousseau at: [Title24@energy.ca.gov](mailto:Title24@energy.ca.gov)**

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