NC Department of Insurance
Office of the State Fire Marshal - Engineering Division
1202 Mail Service Center, Raleigh, NC 27699-1202
919-647-0000

R-30ci vs R38

Code: NC Energy Code **Date:** September 16, 2021
Section: R402.1.2, Table R402.1.2
Code: Residential Code
Section: N1102.1.2, Table N1102.1.2

Question:
Is it acceptable to use Footnote l ("ell") of Table R402.1.2, which allows R-30 (See Figure 1) in lieu of the base-case R-38 (See figure 3), if the R-30 is rotated up and installed at the roofline (See Figure 2) and the R-30 extends full height to the outer edge of the wall, in Zone 3,4, & 5?

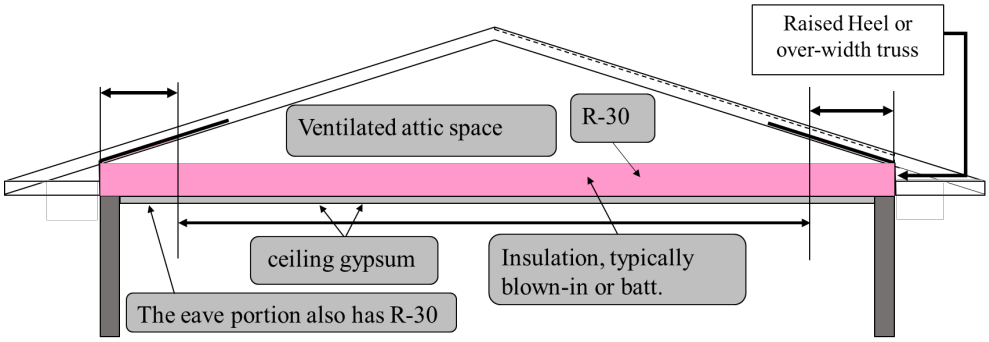

Figure 1: Illustration of Table R402.1.2 Footnote l – U-0.032 Btu/hr-ft^2-^{o}F

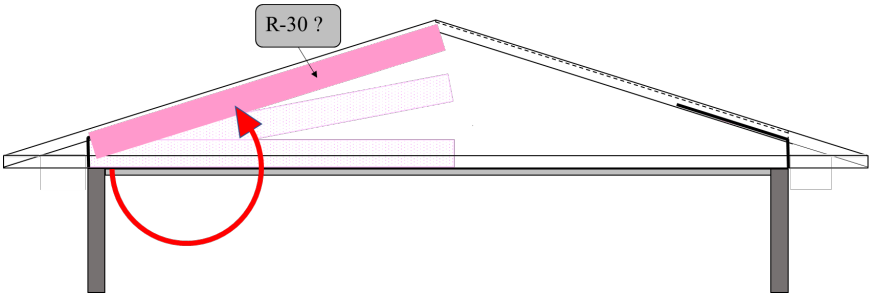

Figure 2: Insulation rotated to roofline

Answer:
No[i]. When the thermal envelope is rotated up to the roofline, several things change[ii] which make it necessary to slightly increase the R-value requirements so that the overall assembly heat transfer is no worse than the R-30 insulation at the ceiling option. Also, although Section R402.2.2 has an allowance for R-30 in **ceilings without attic spaces**, the allowance is limited to 500 SF, so allowing R-30 in a ceiling without an attic space for an unlimited area **would be in direct conflict with this code section**. However, with slight adjustments in the installed R-value, and several conditions that need to be met based on the type of insulation used, an R-32 value can be used and then the assembly would NOT be limited to only 500 SF. The following method provides a U-factor very close to the U-factor achieved by the R-30 approach of footnote l, which is U-0.032[1]. If these adjustments in R-value are not made, the actual heat transfer (U-factor) will be worse than the allowance for R-30 at the ceiling level, which is already slightly more than the base case of R-38 in Table R402.2.2, see Figure 3. This scenario can, by interpretation, be used to meet the prescriptive requirements of Table R402.1.2. as it will provide a substantially equal U-factor.

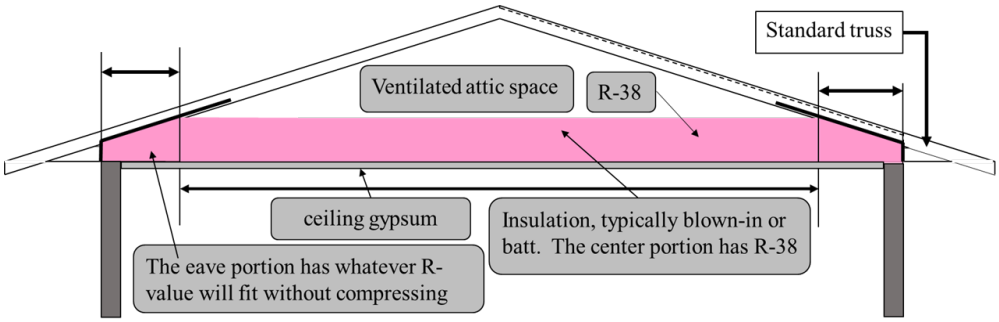

Figure 3: Illustration of base case in Table R402.1.2 – U-0.030 Btu/hr-ft^2-^{o}F

R-32 Spray Foam Option[iii]

First the spray foam option will be described because it is anecdotally the most common. Table R402.1.2, Zone 3 reads "R-38 or 30ci[l]". As discussed in the Background Section of this interpretation, the most commonly requested method does not actually provide R-30ci, but rather a combination of R-30 cavity and a lesser level of ci across the embedded truss chords. In rotating the thermal envelope up to the roof, there are several other variables that change, which necessitate increasing the R-value slightly such that the U-factor, which makes it easier to make comparisons "apples-to-apples", is essentially equivalent to the Footnote l method when the thermal envelope is at the ceiling level.

[1] The base assumption, R-38, provides a U-factor of 0.030, and the R-30 at the ceiling with fibrous insulation is providing a U-factor of 0.032, so the goal is to provide an assembly at the roofline that is no worse than the already-reduced allowance of U-0.032.

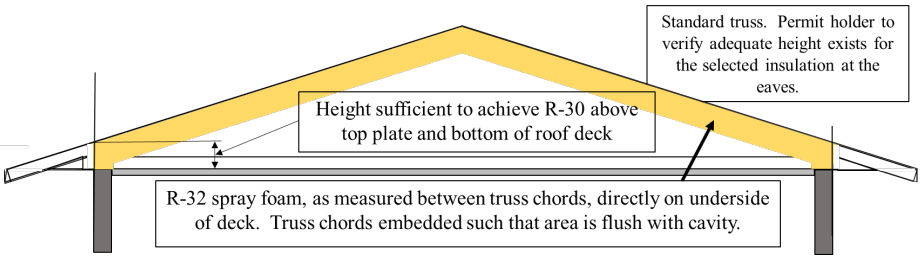

Figure 4: Footnote l option rotated up to roof deck-spray foam option – U-0.032 Btu/hr-ft^2-^{o}F

Therefore, the requirement would be to provide a roof insulation system of R-32 cavity spray foam that meets these requirements:

1. Spray foam applied directly to the underside of the deck such that it is air-impermeable, In accordance with the manufacturer's instructions and the requirements of R806.5, Item 5.1.1
2. There must be sufficient height to allow installing a full R-30 above the wall top plate, as required in Footnote l of Table R402.1.2, see Figure 3.
3. The insulation needs to be applied such that the cavities are sprayed to a depth equivalent to R-32, **and** the truss chords need to be embedded in foam such that the area below them is flush with the cavity insulation amount.
4. There may be other conceivable designs, and the user may use the U-factor Table of R402.1.4, or the code paths of Section R402.1.5, R405, or R406.

In summary, with a slight adjustment in the installed R-values, there is a potential for using a method similar to the footnote l allowance when the thermal envelope is rotated up to the roofline.

Background and code path of interpretation

Footnote 1 ("ell") states:

> **R-30 shall be deemed to satisfy the ceiling insulation requirement wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Otherwise R-38 insulation is required where adequate clearance exists, or insulation must extend to either the insulation baffle or within 1 inch of the attic roof deck.**

A problem arises, because the table value calls for R-30ci, which, by definition, means the insulation layer must maintain that full R-30 value uninterrupted by framing, and whether it is spray foam, fiberglass blown-in or fiberglass batts, all of these are interrupted by the framing, whether it is the bottom chord of a truss or the top chord of the truss. Several ways to achieve R-30ci would be to put the insulation layer above the rafters, either directly under the roof sheathing or directly on top of roof sheathing, or put it under the bottom chord of the roof trusses directly above the ceiling. The former is routinely done in commercial buildings, the latter is rarely done, but technically feasible.

> **Continuous Insulation (ci).** Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior, or is integral to any opaque surface, of the building envelope.

So, the code certainly allows the use of R-30 ci, but the more common insulation method desired to be used, spray foam insulation applied to the underside of the roof deck with the cavity layer equal to R-30, does not yield R-30 ci, since the areas over the truss chords is not the depth required to achieve R-30 for the insulation alone where there is framing. If there were an "insulation bump" of 3.5 inches at each chord location, that could meet the definition of R-30 ci, but that is rarely the installation.

In the footnote language, the "R-30" value is not shown as R-30 ci, but simply R-30, as this footnote has been in this section for several code cycles. It is assumed that the ad hoc committee did not intend to make continuous insulation the only option, so the interpretation is for this footnote to allow R-30, (in addition to R-30ci option in the Table cell) which would fill the cavity between trusses to R-30, be it foam, batt, or blown-in, and then cover the trusses whenever the thickness is greater than 3.5 inches, and the full thickness of R-30 has to cover the wall to the outer edge of said wall.

In a standard flat ceiling, this footnote is allowed, however, if we rotate the insulation level up to the roofline, this option is not directly addressed in the code. To make a logical interpretation, the assemblies that would likely be installed with R-30 to accommodate it were calculated, and the values were worse than the R-30 flat ceiling option, so that method is not being considered equivalent to the code-prescribed R-30 option. Instead, see the R-32 option described in the body of the interpretation.

Of course, the reader can use the U-factor Table R402.1.4, but it must be done correctly which includes taking into account the lower insulative qualities of embedded framing.

Filename
R402.1.2 – Ceilings R-30 vs R-38

---

[i] It is understood that, when the thermal envelope is raised to the roof, the square footage of thermal envelope necessarily increases. This is due to the increased square footage of a sloped roof versus the flat ceiling, and because the end walls of the attic now become part of the thermal envelope and are required to be insulated as walls. Therefore, there are more than the simple R-30 vs. R-38 issue. However, since the Energy Code has traditionally not imposed limitations on square footage of envelope, the added square footage of walls and roof area will not be taken into consideration for this 2018 code cycle. This logic will be revisited during the next code cycle.

[ii] The top-surface air-film value goes from a semi-interior space to an exterior space, so it is reduced from R-0.61 to R-0.25 (ResCheck Tech. Manual), the ceiling gypsum is normally not present, but the roof sheathing is, but the main

difference is the base case of fibrous insulation embeds the truss chords deeper (8.5 inches fiberglass vs. 5.5 foam), therefore they become a lesser percentage of the thermal resistance than the spray foam option, with less coverage of the truss chords. The default assumptions in ResCheck were used, except for Spray Foam an R-3.56/inch correlating to Icynene Classis Ultra was used in the comparison.

[iii] **R-32 Fiberglass Batt Option**

The code does not provide preferential treatment to one insulation product over another, but sometimes technical differences make installation requirements substantially different. In order to meet the code requirements and installation instructions for fibrous insulation, the framing options become very limited and are rarely, if ever seen in the field, so this potential scenario will not be detailed as it may simply lead to confusion. Instead we would direct the reader to Table R402.1.4 if more than the 500SF allowance of R402.2.2 is desired.