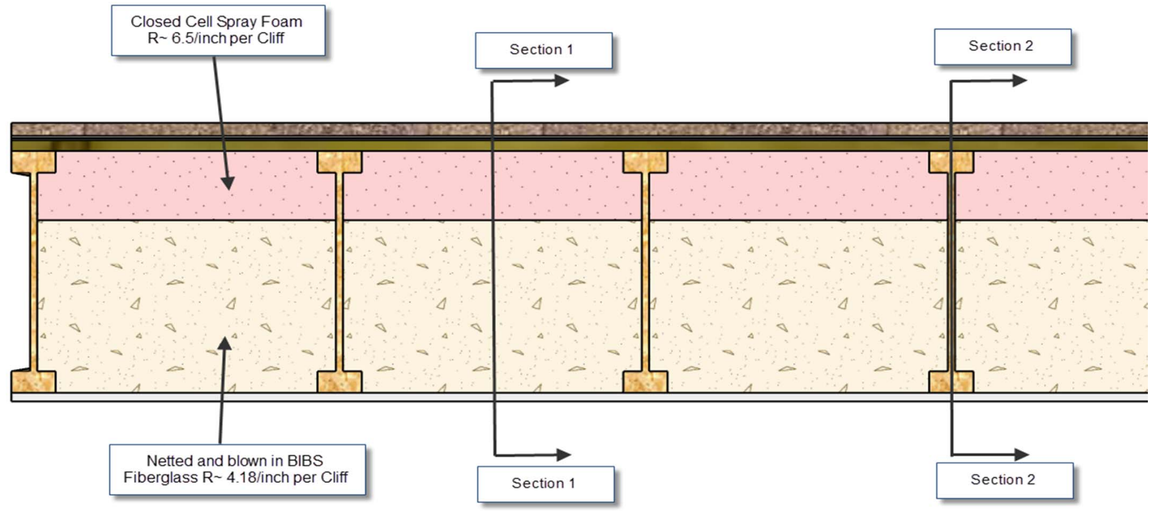
Traditional - Roof Section Thermal Resistance Calculations

Thermal Resistance of Roof

USER INPUTS
CALCULATED
RESULTS

Roof Dimenional Data		
Roof Length	10	**ft**
Roof Width	15	**ft**
Stud Centers	16	**in**

Material Data					
Material No	**Type**	**Nominal Size**	**Actual Size**		**R Rating per Inch (in^{-1})**
			Thickness (in)	**Height (in)**	
1	Snow Load	0"	4	NA	2
2	Shingles	2 x 3/16"	0.375	NA	0.44
3	OSB Nail Board	1/2"	0.5	NA	1.25
4	EPS Foam	0"	0	NA	4
5	XPS Foam	0"	0	NA	5
6	Netted Blown BIBS Fiberglass	9"	9	NA	4.18
7	OSB Structural	5/8"	0.625	NA	1.25
8	Gypsum wall board	1/2"	0.5	NA	0.9
9	2x10 Rafter	2"x10"	1.5	9.25	1.25
10	Spray Foam (closed cell)	5"	5	NA	6.2
11	14" TGI 230	14" x 3/8"	0.375	14	1.25



Area Calculations		
Number of Rafter	11	
Rafter Length	10	**in**
Rafter Width	0.375	**in**
Stud Area (Section 2)	41.25	**in^2**
Roof Cavity Area (Section 1)	21558.75	**in^2**

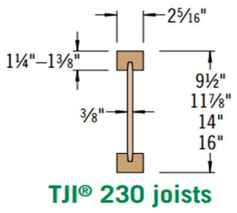
Total Area of Wall	**21600**	**in^2**

Per the 2015 IRC Code Table N1102.1.2 Zone 6 Roofs need to be R49 minimum.

Per the 2015 IRC Code Section R806.5 unvented attics need R-25 minimum air-impermeable insulation or a ratio of 51% of the whole roof R value for condensation control.

Condensation calculations are done using inside air at 68F and outside is the average of the 3 coldest months.

The goal is to keep the air impermeable insulation above the dew point to prevent condensation forming on the underside of the closed cell foam.



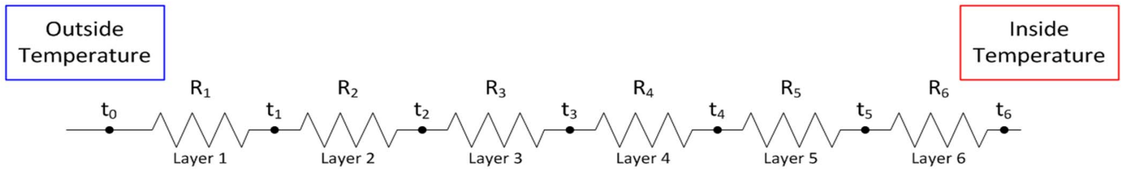
Section 1 - Rafter Cavity					
Area	**21558.75**	**in^2**	**Nominal Size**	**Thickness (in)**	**R Rating**
Layer	**Type**	**R Rating/in**			
1	Snow Load	2	0"	0	0
2	Shingles	0.44	2 x 3/16"	0.375	0.165
3	OSB Structural	1.25	5/8"	0.625	0.78125
4	Spray Foam (closed cell)	6.2	5"	5	31
5	Netted Blown BIBS Fiberglass	4.18	9"	9	37.62
6	Gypsum wall board	0.9	1/2"	0.5	0.45
				Section 1 Total R:	70.01625
				Section 1 Total U:	0.014282
				Area Factor:	0.99809
				U contribution:	0.014255

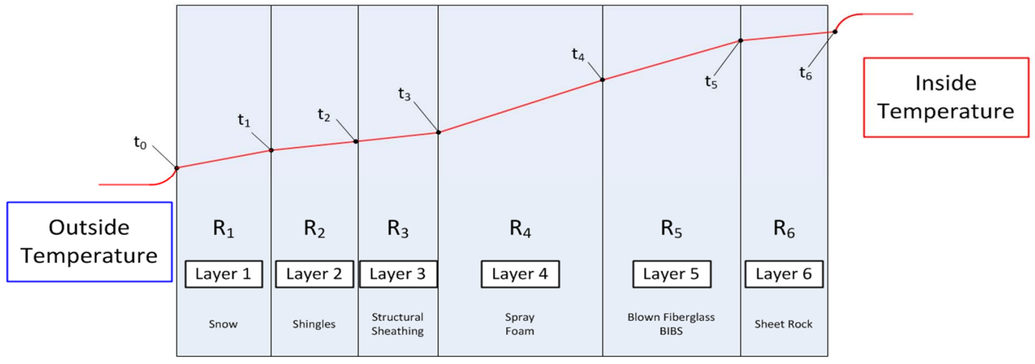
Ratio of air impermeable to whole roof: 44% Goal is 51%

Section 2 - Through TGI's					
Area	**41.25**	**in^2**	**Nominal Size**	**Thickness (in)**	**R Rating**
Layer	**Type**	**R Rating/in**			
1	Shingles	0.44	2 x 3/16"	0.375	0.165
2	OSB Structural	1.25	5/8"	0.625	0.78125
3	14" TGI 230	1.25	14" x 3/8"	14	17.5
4	Gypsum wall board	0.9	1/2"	0.5	0.45
				Section 1 Total R:	18.89625
				Section 1 Total U:	0.052921
				Area Factor:	0.00191
				U contribution:	0.000101

TOTAL U:	**0.014**
AVERAGE WALL R-VALUE:	**69.66**

Heat Loss Calculations - Unvented - Closed Cell & BIBS





Assumptions:

1) Conduction analysis only
2) No convection at inside/outside walls
3) Only looking at Roof Cavity - Section 1

Symbol	Units
Q or $\dot{Q}$	Btu/hr
R	degF-ft^2-hr/Btu
t_x	degF

Thermal Resistance Units (R Value Units)

$$R = \frac{F \times ft^2 \times hr}{BTU}$$

Heat Transfer Rate Equation:

$$\dot{Q} = \frac{A \times \Delta T}{R}$$

Check of Heat Transfer Rate ($\dot{Q}$) Units:

$$\dot{Q} = \frac{A \times \Delta T}{R}$$

$$\dot{Q} = \frac{ft^2 \times F}{\frac{F \times ft^2 \times hr}{Btu}}$$

$$\dot{Q} = \frac{ft^2 \times F \times Btu}{F \times ft^2 \times hr}$$

$$\dot{Q} = \frac{Btu}{hr}$$

Outside Temperature (t_0):	22	°F
Inside Temperature (t_5):	68	°F

Based on 99.6% cold day -19.8°C = -3.6°F

Total Section Thermal Resistance, R_{total}	70.02	degF-ft^2-hr/Btu
Layer 1 Thermal Resistance, R_1	0.00	degF-ft^2-hr/Btu
Layer 2 Thermal Resistance, R_2	0.17	degF-ft^2-hr/Btu
Layer 3 Thermal Resistance, R_3	0.78	degF-ft^2-hr/Btu
Layer 4 Thermal Resistance, R_4	31.00	degF-ft^2-hr/Btu
Layer 5 Thermal Resistance, R_5	37.62	degF-ft^2-hr/Btu
Layer 6 Thermal Resistance, R_6	0.45	degF-ft^2-hr/Btu

Average Day Data taken from Evanston Wyoming.
99% cold day = 2.6°F
Average Temps are:
Dec = 21.8°F
Jan = 21.8°F
Feb = 22.5°F

Average 3 Coldest Months = 22.0°F

Heat Transfer Rate per Unit Area, Q/A: $(t_6-t_0)/R_{total}$

Heat Transfer Rate per Unit Area, Q/A:	**0.66**	**Btu/hr**

t_0 =	**22.0**	**°F**
t_1 =	**22.0**	**°F**
t_2 =	**22.1**	**°F**
t_3 =	**22.6**	**°F**
t_4 =	**43.0**	**°F**
t_5 =	**67.7**	**°F**
t_6 =	**68.0**	**°F**

The goal is to keep t_4 above dew point which at 68°F and 35% humidity is 39°F and 68°F and 45% humidity is 46°F