SUPERIOR PRODUCTS
INTERNATIONAL II, INC.

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Preventing Condensation on Pipes and Walls

The point of condensation developing on the surface of pipes or walls is directly related to ambient air temperature and relative humidity. From these two factors is derived the dew point that dictates the condensation level.

On a surface, SUPER THERM® is applied to reflect and repel the ambient heat off the coated surface while stabilizing the surface temperature on the cool pipe or wall to be more in line with the ambient air temperature and to maintain the smallest difference of temperature between the room ambient and surface temperature of the pipe or wall. The smaller the spread of temperature, the less chance of meeting the dew point and forming condensation on the cool surface. Maintaining a 5 degree F temperature above the dew point is the goal to avoid condensation.

Warmer air holds more moisture which relates to a higher dew point and creates condensation at higher ambient temperatures. Colder air holds less moisture which relates to a lower dew point and causes condensation at a lower ambient temperature.

Goal for the HVAC operating system for interior of the boat is:
- Ambient temperature at 70 degrees F
- Relative Humidity at 30%
- This gives a Dew Point of 37 degrees F.

Written explanations are attached as well as actual in field usage and results.

Regards,
J.E. Pritchett

Dew Point

Dew point is the temperature at which condensation forms. When air comes in contact with a surface that is at or below its Dew Point temperature, condensation will form on that surface. To determine the Dew Point from the charts below, find the temperature of the air on the left and the relative humidity of the air at the top of the table. The intersection of these two numbers in the matrix gives the temperature at which Dew Point is reached.

<u>Example</u>
If the temperature in a facility is 75° F and the relative humidity is 35%, the Dew Point is reached at 45° F or below. This means that moisture vapor in the 75° F & 35% relative humidity air will condense on any surface that is at or below the Dew Point temperature of 45° F. At night outside temperature drops. It is not likely that the inside air of a building will cool from 75° F to 45° F. But the framing and any exposed exterior surfaces will reach the Dew Point temperatures, creating condensation.

Air Temperature in Degrees Fahrenheit

Air Temp °F	% Relative Humidity																		
	100	**95**	**90**	**85**	**80**	**75**	**70**	**65**	**60**	**55**	**50**	**45**	**40**	**35**	**30**	**25**	**20**	**15**	**10**
110	110	108	106	104	102	100	98	95	93	90	87	84	80	76	72	65	60	51	41
105	105	103	101	99	97	95	93	91	88	85	83	80	76	72	67	62	55	47	37
100	100	99	97	95	93	91	89	86	84	81	78	75	71	67	63	58	52	44	32
95	95	93	92	90	88	86	84	81	79	76	73	70	67	63	59	54	48	40	32
90	90	88	87	85	83	81	79	76	74	71	68	65	62	59	54	49	43	36	32
85	85	83	81	80	78	76	74	72	69	67	64	61	58	54	50	45	38	32	
80	80	78	77	75	73	71	69	67	65	62	59	56	53	50	45	40	35	32	
75	75	73	72	70	68	66	64	62	60	58	55	52	49	45	41	36	32		
70	70	68	67	65	63	61	59	57	55	53	50	47	44	40	37	32			
65	65	63	62	60	59	57	55	53	50	48	45	42	40	36	32				
60	60	58	57	55	53	52	50	48	45	43	41	38	35	32					
55	55	53	52	50	49	47	45	43	40	38	36	33	32						
50	50	48	46	45	44	42	40	38	36	34	32								
45	45	43	42	40	39	37	35	33	32										
40	40	39	37	35	34	32													
35	35	34	32																
32	32																		

How to prevent condensation in hot humid buildings

What is the underlying physics of condensation?

Normal air is a mixture of dry air and water vapor. There is a maximum amount of water vapor which can be retained in a given volume of air at any given temperature. This maximum amount of saturated condition is defined as 100% relative humidity. The higher the temperature, the more water vapor it takes to reach saturation.

The temperature that corresponds to 100% saturation is called dew-point temperature. When a mixture of air and water vapor is cooled, the temperature drops until saturation is reached at dew-point temperature. If temperature is further reduced, vapor leaves the mixture as condensation. If the surface temperature of any area is below the dew-point temperature of the air and water vapor mixture surrounding it, the air in contact with that area will be cooled to the dew-point and condensation occurs.

What is the fundamental methods of preventing condensation?

Condensation occurs only when moist air reaches the saturation point by the presence of a cold surface. Condensation is a surface phenomenon. The hot air is not the problem - The cold surface is. Therefore, in order to prevent condensation, the 'temperature difference' between the air and surface must be reduced.

(1) Circulation Method

The idea here is to induce air circulation (convection) inside where condensation occurs. If the air is induced from outside, the induced air has less water vapor than the air inside. Therefore when mixed, the overall air humidity is reduced. But this is not the only reason why air circulation is important.

If properly installed, the air circulation can cool the air and, at the same time, warm the cold surface. As a result, the 'temperature difference' between the air and cold surface is reduced. It is important to bear this in mind. If the temperature difference between the surface and air around it is small, condensation does not occur.

With this in mind, have the air intake duct at the top of attic run horizontally with the exhaust fans at the end of the duct to outdoors - sideways. In this way, fresh cool air is induced into the attic and then the induced air is mixed with hot air inside and warm the cold surface by circulation. The net result is that air becomes cooler and the cold surface becomes warmer, thereby reducing the temperature difference between the two.

If a short vertical fan is installed at the top of the attic, it will allow outside cold air in. This is ok in summer. In winter time, however, the moisture in this air will then go through a daily freeze-melt cycle. This can make the condensation problem worse than better. This is not good.

The fans do not have to be big. They only need to have enough power to suck trapped stagnant air that vertically enters the duct and exhaust on the side. The rule of thumbs is that 1 sq. ft ventilation area is needed for 150 sq. ft attic floor area.

If the fan is installed in a long attic, the air is then circulated inside by both forced and natural convection. For natural convection, the air circulation will create a series of circulation loops along the length of attics. For visualization purpose, one can imagine that, if the length of the attic is six times of the height and width, there can be six air circulation loops so to speak.

One may be able to take advantage of this circulation loops by making six air-intake openings for the horizontal duct suspended from the attic ceiling. In this way, the hot moist air moves to the top, get trapped in the duct, then forced out by the fan at both ends of the duct. No need to use generators here.

(2) Insulation Method

The air always contains water vapor. We can not prevent that. But we can reduce the amount of water vapor in the air by air circulation as suggested above. At the same time, we reduce the temperature difference between the air and cold surface.

However, if the surface temperature in contact with inside air is too cold to begin with, the air circulation alone may not be sufficient to reduce the temperature difference between the air and cold surface thereby prevent condensation. Therefore it is important to insulate the attic. Outside insulation should be considered for summer and inside insulation should be considered for winter.

- HVAC NOT IN Operation

Summer

In summer time, outside is hotter than inside. If there is no insulation on the roof, the inside temperature will go up significantly by the thermal radiation from the Sun. At night time, outside temperature cools down. Since the metal roof has a significantly higher thermal conductivity, it cools down much quicker than the air mass inside. As a result, the roof gets much cooler than the hot air inside at night. As a result of this big temperature difference, condensation occurs under the roof.

Fans for Air movement

If the roof is coated with SuperTherm, more than 90% of thermal radiation is blocked out. Therefore, the inside air temperature remains relatively cool compared with un-coated roof. Also the roof metal itself remains relatively cool. Therefore, the small temperature difference between the air and roof metal prevents condensation during the daily temperature cycle.

Winter

In winter time, outside is colder than inside. In this case, the insulation should be under the roof, not outside the roof (as a rule of thumb, insulation coating should be always on the hot side). SuperTherm coated on the outside a roof blocks the sun's radiation. Therefore, the inside temperature is colder than the case of uncoated roof. As a result, the bigger temperature difference between the inside air and cold surface under the roof causes condensation. This doe not happen for the uncoated surface because it gets the benefits of solar heating in day time.

How about Fiberglass insulation to prevent condensation?

This brings out the question of SuperTherm as an insulator. SuperTherm is not a traditional insulator like fiberglass in terms of thermal conductivity. In fact, SuperTherm's thermal conductivity (0.54-0.65 (W/m K) is 10 times higher than fiberglass (0.04 (W/m K). But SuperTherm is the best radiation blocker there is. If radiation is accounted for and we calculate the 'effective' thermal conductivity, 10 mil of SuperTherm coating is close to 6" of fiberglass (effective thermal conductivity = 0.31 (Btu in / hr sqft F)).

No matter what, fiberglass is not recommended here. In fact, fiberglass is not recommended in any humid conditions. Its creates the worst nightmare when moisture penetrates fiberglass. A mere 5% of moisture in it can deteriorate its performance by 30-40%. It also creates a serious corrosion problem if installed around metals.

Where do we coat to prevent condensation?

Therefore, it is recommended to coat both sides of the roof. SuperTherm coated outside will help condensation in summer time. For inside, I recommend HPC. HPC is for reducing thermal conduction and SuperTherm is for reducing thermal radiation. The radiation from inside sources are small. Therefore HPC is better than SuperTherm for inside insulation.

Please note that most condensation in industry takes place outside a storage tank. This is because the tank is made of metal which fluctuates in temperature with daily or seasonal temperature cycle. Inside the tank is usually filled with liquid so condensation problem occurs only when the tank is empty. In this kind of situation, SuperTherm coated outside prevents condensation almost always.

Recommendations

1. Use a fan to circulate the air inside.

2. Coat outside the roof with SuperTherm.

3. Coat underneath the roof with HPC.*

In reality, only one or two of the above methods will be sufficient to eliminate condensation problem. It all depends on each case.

* USE WITH SUPER THERM WHEN THERE IS A 100°F TEMP DIFFERENCE IN AIR AND SURFACE TEMPS.

ASHRAE 90.1 CODE COMPLIANCE STATEMENT

Take a look at what ASHRAE says about fiberglass and how it performs when placed in steel structures. Whether it be steel stud walls or full steel wall with all the connections, joints and support beams, **fiberglass is dramatically reduced by engineering standards** because it cannot effectively block the lost or gain of heat.

We are still working on the **changes of temperature on metal structures** to show the additional problems fiberglass has in performing in those conditions and not just at it's tested 73 F rating.

Not only does this question approval of using fiberglass on the walls and structure of the boat itself, but does question the use of fiberglass directly with **duct work** and such for air handling of any kind which ASHRAE is all about.

ASHRAE COMPLIANCE
for SUPER THERM.

ASHRAE 90.1 COMPLIANCE attachment from Roberto Guerra after studying the compliance rules and matching the testing already performed on SUPER THERM to have the numbers to meet the compliance.

Testing required to prove the RE value:

A. ASTM C 236-89 "Standard test method for Steady-State Thermal Performance of building Assemblies by Means of a Guarded Hot Box".

B. ASTM 1269 "Differential Scanning Calorimeter"
ASTM E1461-92 "Thermal Diffusivity"

SUPER THERM has a "U" (Thermal Flow) value of 0.052
Summarized from testing that SUPER THERM is RE19 (1/RE) = 0.052 Thermal Flow.
ASHRAE 90.1 COMPLIANCE variance cannot go over 0.061 for Thermal Flow.
Therefore, SUPER THERM falls within the ASHRAE 90.1 COMPLIANCE rating and is accepted.

ASHRAE 90.1 COMPLIANCE --"-attachment "

After having to fight the "R" value dogma for many years, I recently decided to research and find the proper category where to place Super Therm, without facing descent from the glass industry and other insulators manufacturers. The biggest complaint was that "R" rated materials must have thickness of 25mm, or one inch for this value to be calculated, this does not forward our cause since Super Therm is barely 10 mils thick or about 1/100th of the necessary thickness. However, I was recently asked to comply with the ASHRAE 90.1 standard for Super Therm coating to be considered as usable in a new mid-rise construction in Tempe Arizona. Further research guided me to find the rules to be met in order to claim compliance with the ASHRAE 90.1 standard.

My communication with this organization established that independent approved laboratories tests, are all that is needed to be able to claim compliance with the ASHRAE 90.1, **(provided that these tests reveal the required insulation properties for the application)**. Our **ASTM C236-89** "Standard test method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box", and the

ASTM 1269 "Differential Scanning Calorimeter" plus the **ASTM E1461-92** "Thermal Diffusivity" tests,
gives Super therm precisely the requirements to claim ASHRAE 90.1 compliance.
With a single coat of Super Therm having a "U" (Thermal Flow) value of 0.052 ", Super Therm exceeds
the maximum "U" value of 0.061 required, (remember lower is better).
Because the "U" value is used to measure "area-weighted average", insulated walls or roofs will have a
less favorable "U" value than the one suggested by the type of insulation used, here is why:
Metal or wood studs and rafters have less resistance "R" value, as well a higher "U" (Thermal Flow)
making the assembly having a lower "R" value than the one proposed by the insulation fillers, glass,
foam, etc.
When Super Therm is applied in lieu of the wall filler, or as enhancement for the existing insulation, the
"U" value is homogeneous through the whole surface, thus the "U" value given for Super Therm will be
the same for the whole assembly. Super Therm has a more consistent "R" **value equivalence** for the
assembly. The kick, is the **lower "U" value** for the "**area-weighted average**". That is the proper
argument to make with architects and engineers.
Now you have the tools to eat some detractors for lunch. The chart below will show you how to calculate
any values you may need to make your case, remember ST thickness and "U" value never changes.
Bon Appetite!
Roberto Guerra
Design Engineer

INSULATION: VALUES, TERMS AND CALCULATIONS

Thermal Resistance m_2 °C / W or m_2 K / W 'R' Value
'R'=d/K i.e. the "R" value can be calculated by dividing the thickness in meters by the **K** value
Thermal Conductivity W / mK 'K' Value
'K'= d/R i.e. the "K" value can be calculated by dividing the thickness in meters by the "R" value.
Thermal Flow Reciprocal of "R" **`U' Value**
'U' = 1/R i.e. the "U" value can be calculated as the reciprocal of "**R**".
To calculate the required thickness of insulation Required thickness
'd'=(t°C x K)/Q
i.e. Required thickness can be calculated by multiplying the temperature differential in °C
(**t°C**) by the insulation material's "K" value, and dividing the result by **Q**, (**a number between 8 and 10**) that relates desired efficiency where **8** is efficient and **10** is less efficient.
To calculate the required thickness of insulation Required thickness
d = "R" x K
i.e. a material's required thickness can be calculated by multiplying the known "R" value
by the material's "**K**" value.
Note: **d** = thickness in meters,

i.e. 25mm = 0.025m. “R” factors may be added together to determine the total “R” or thermal resistance
`Note:` a **lower K** value (**conductivity**) = **better**-----------a **higher** “R” value (**thermal resistance**) = **better**.
*Glass wool batts and blankets' stated “R” values have ±**10%** tolerance. ST ±**1%**

ASHRAE 90.1 Code Compliance

U-FACTORS AND R-VALUES

When it is colder on one side of an envelope element, such as a wall, roof, floor, or window, heat will conduct from the warmer side to the cooler side. Heat conduction is driven by temperature differences and is a major component of heating and cooling loads in buildings. The building envelope requirements of the 90.1 Code address heat conduction by specifying minimum R-values (thermal resistance to heat flow) for insulation or maximum U-factors (the rate of steady-state heat flow) for building envelope construction assemblies.

Basic Concepts

U-factor

The U-factor is the rate of steady-state heat flow. It is the amount of heat in Btu (British thermal units) that flows each hour through one square foot, when there is a one degree temperature difference between the inside air and outside air. The heat flow can be in either direction, as heat will flow from the warmer side to the cooler side. Steady-state heat flow assumes that temperatures on both sides of a building envelope element (while different) are held constant for a sufficient period of time so that heat flow on both sides of the assembly is steady. The steady-state heat flow method is a simplification, because in the real world, temperatures change constantly. It can, however, predict average heat flow rates over time, and is used by the 90.1 Code to limit conductive heat losses and gains. Because they are easy to understand and use, the terms for steady-state heat flow are part of the basic vocabulary of building energy performance.

Each layer of a building assembly, such as the sheathing and the insulation, has its own *conductance*, or rate of heat transfer. The conductance for an individual layer is like the U-factor, and it has the same units. The difference is that it is only for a single element or layer. The U-factor includes the conductance of every element of the building assembly, including the air films on the interior and exterior surfaces of the construction assembly. The surface conductances quantify the rate at which heat is transferred between the surface of the construction assembly and the surrounding environment.

For light frame walls, the steady-state U-factors provide an adequate description of heat transfer. For heavy concrete and masonry walls, however, this is only true under constant or average temperature conditions. The dynamic heat storage properties of the concrete and masonry alter the thermal behavior of the wall, and the U-factor becomes less accurate as a predictor of heat flow rates.

R-value

Steel Framing, walls, Construction

Fiberglass "R" value is significantly lower for walls because of studs, connections, support beams that have no covering and in contact w/ exterior surface temperatures.

R-values are also used to describe steady-state heat flow, but in a slightly different way. The R-value is the *thermal resistance* to heat flow. A larger R-value has greater thermal resistance, or more insulating ability, than a smaller R- value. The big advantage of R-values is that they can be added together. For homogeneous assemblies, the total R-value of a construction assembly is the sum of the R-values of each of the layers. The layers should include the sheathing and finishes, the insulation and weatherproofing elements, and the surface air films. The U-factor is the inverse of the total R-value.

$$\text{U - Value} = \frac{1}{\text{Total R - Value}}$$

The R-value is widely recognized in the building industry and is used to describe insulation effectiveness. The insulation R-value is not the total R-value of the wall, however. It only describes the thermal resistance of the insulation material. The R-

ASHRAE 90.1 Code Compliance

value of the entire wall assembly can be significantly lower when metal framing penetrates the insulation.

Framing Effects

Most construction assemblies include more than one material in the same layer. For example, a wood stud wall includes cavity areas where the insulation is located and other areas where there are solid wood framing members. The wood areas have a lower R-value, and conduct heat more readily than the insulated areas. It is incorrect to neglect framing members when calculating the U-factor for the wall, roof, or floor assembly. The correct U-factor includes the insulation portion of the wall and the U-factors through the solid (or framed) portion of the wall. The 90.1 Code requires that the U-factor of each envelope assembly be calculated taking into account framing and other thermal bridges within the construction assembly.

Default U-factors

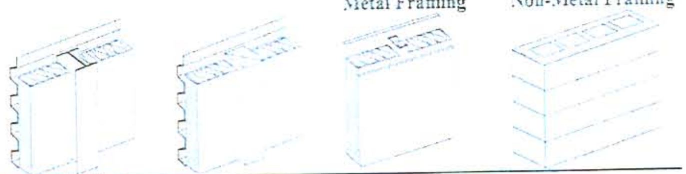
Precalculated U-factors are provided in this section for typical construction assemblies, including roofs, floors, and doors. These values are calculated using acceptable methods, and may be used for compliance with the code.

ASHRAE 90.1 Code Compliance

Acceptable Calculation Methods

The 90.1 Code specifies acceptable calculation methods for determining U-factors, and makes a distinction between construction assemblies with metal framing members, and assemblies with non-metal framing such as wood or concrete. It also distinguishes between metal sheathing and non-metal sheathing. Heat flow through construction assemblies with metal framing and/or sheathing is more complex and requires special consideration. Table 402Q shows the calculation methods that can be used with each general type of construction.

Table 402Q Applicability of U-factor Calculation Methods



	Metal Sheathing Metal Framing	Metal Sheathing Non-Metal Framing	Non-Metal Sheathing Metal Framing	Non-Metal Sheathing Non-Metal Framing
Laboratory Tests	x	x	x	x
Series-Parallel Path (Isothermal Planes)		x		x
Parallel Path Correction Factors			x	
Two-Dimensional Models	x	x	x	x
Zone Method			x	

Laboratory Tests

In this test Head To Head Testing
- Fiberglass R value 1.92 /inch
Based on 3 inches.
- SUPER THERM R value 4.76
Per 20 mils DRY thickness.

Laboratory tests are the most accurate way to determine the U-factor of a construction assembly, and are acceptable for all types of construction. An 8 ft by 8 ft sample of the construction assembly is placed in a test unit. For steady-state measurements, the temperatures on either side of the wall are held constant until temperatures within the construction have stabilized; then the rate of heat flow is measured. The biggest advantage of laboratory testing is that it gives equally good data for any type of construction assembly. The major disadvantage is that it is costly and time consuming. There is a large variety of possible construction assemblies, and it is impractical to test them all. For this reason, it is usually more cost effective to use calculation methods. Laboratory measurements must use one of the following test procedures: Guarded Hot Plate (ASTM C-177-85), Heat Flow Meter (ASTM C-518-85), Guarded Hot Box (ASTM C-236-87), or Calibrated Hot Box (ASTM C-976-82).

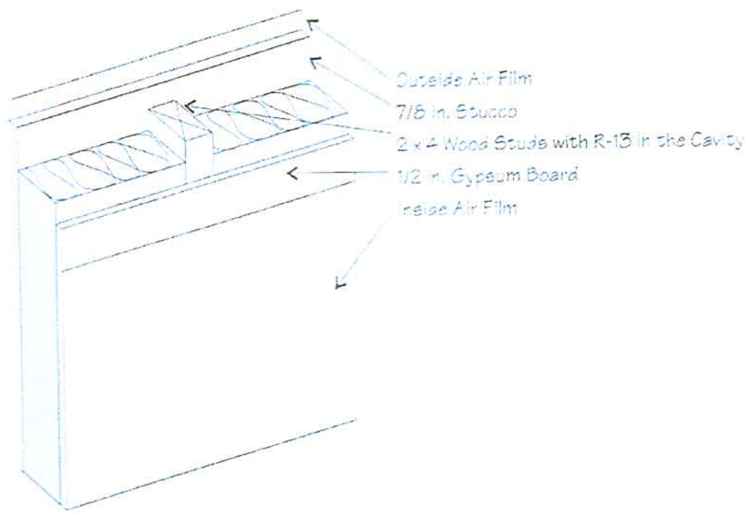
Series-Parallel Path (Isothermal Planes) Method

The *series-parallel method* is a reasonably accurate procedure for calculating the U-factor when one or more elements in a construction are relatively conductive. It may be used for wood framed walls and for concrete and masonry walls. Hollow masonry units are a good example of when this calculation method is appropriate. The solid webs connecting the faceshells are quite conductive compared to the air spaces in the hollow cores, and the faceshells conduct heat laterally. The heat, in effect, flows around the hollow cores. The series-parallel method divides the construction assembly into a series of layers. For a masonry unit, the layer containing the webs and cores is treated with a parallel path calculation to arrive at an average

R-value for the layer. This is then added to the R-values of the two faceshells, as in a series method calculation. Finally, the total R-value is inverted to the U-factor. This method is also referred to as the isothermal planes method, because it assumes uniform temperature across the planes separating the layers.

Example 402M U-factor Calculation – Series - Parallel Path

Q What is the thermal transmittance of the wood framed wall shown in the following drawing?



A The series and parallel path method may be used for this type of construction. The U-factor is calculated separately for the cavity and framing portions of the wall based on the thermal resistance of each element of the wall. These calculations are made in the following table:

	Cavity	Framing
Outside air film	0.17	0.17
7/8 in. stucco	0.18	0.18
Building paper	0.06	0.06
Cavity insulation	13.00	
Framing		4.375
1/2 in. gypsum board	0.45	0.45
Inside air film	0.68	0.68
Sum of thermal resistance	14.54	5.01

The estimated framing is 15% of the wall area and the U-factor may be calculated as shown below.

$$U = \frac{0.15}{5.01} + \frac{1-0.15}{14.54} = 0.088$$

ASHRAE 90.1 Code Compliance

Parallel Path Correction Factors

The 90.1 Code provides a simple way to calculate the thermal resistance (R-value) of certain types of roofs and walls with metal framing. Tables 402.1.2.1a and 402.1.2.1b in the code contain two sets of parallel path correction factors: one for metal trusses surrounded by insulation and one for metal wall studs. The correction factor is essentially a multiplier times the insulation R-value. It provides a very easy way of accounting for the effect of metal framing in wall and roof construction assemblies. These tables are repeated below as Tables 402R and 402S.

Two Dimensional Heat Flow

Two-dimensional heat flow analysis may be used to accurately predict the U-factor of a complex construction assembly. While the series-parallel path calculation method assumes that heat flows in a straight line from the warm side of the construction to the cooler side, with two dimensional models, heat can also flow laterally in the construction, following the path of least resistance. Calculating two-dimensional heat flow involves advanced mathematics and is best performed with a computer. A model is set up by dividing the construction into a large number of small pieces, and defining the thermal resistance between each piece. The result is analyzed with electric circuit theory. The network consists of a rectangular array of nodes connected by resistances. As in the real material, the energy flow will take the path of least resistance. The computer can perform the complicated calculations necessary to solve the network, yielding the U-factor for the unit at steady state. It can also solve the network for dynamic energy conditions. Short of performing laboratory tests, this is the most accurate method available for determining the U-factors of concrete and masonry walls.

Zone Method

For conditions for which there are no parallel path correction factors, the zone method may be used. It may be used for construction assemblies with metal framing and non-metallic sheathing, such as concrete or masonry. The use of this method is documented in the ASHRAE Fundamentals Handbook (1985) and involves dividing the construction assembly into zones. Heat flow in the zone near the metal framing is assumed to be conducted toward the framing and the thermal resistance is smaller.

Compressed Insulation

Insulation that is compressed must be derated in accordance with Table 402T. or the reduction may be calculated in accordance with the procedures in the ASHRAE Fundamentals Handbook (1985).

ASHRAE 90.1 Code Compliance

Table 402R Parallel Path Correction Factors for Metal Roof Trusses

Size of Members	Spacing of Framing (inches o.c.)	Insulation R-value	Correction Factor	Effective R-value
All	48	R-0	1.00	R-0
		R-5	0.96	R-4.8
		R-10	0.92	R-9.2
		R-15	0.88	R-13.2
		R-20	0.85	R-17.0
		R-25	0.81	R-20.3
		R-30	0.79	R-23.7
		R-35	0.76	R-26.6
		R-40	0.73	R-29.2
		R-45	0.71	R-32.0
		R-50	0.69	R-34.5
		R-55	0.67	R-36.0

Table 402S Effective R-values for Wall Insulation Installed Between Metal Framing

Fiberglass Loses 63%-67% when applied To metal walls and Framing

Nominal Framing Depth	Nominal Insulation R-value	Correction Factor	Effective R-value
4"@16"o.c.	R-11	0.50	R-5.5
	R-13	0.46	R-6.0
	R-15	0.43	R-6.4
4"@24"o.c.	R-11	0.60	R-6.6
	R-13	0.55	R-7.2
	R-15	0.52	R-7.8
6"@16"o.c.	R-19	0.37	R-7.1
	R-21	0.35	R-7.4
6"@24"o.c.	R-19	0.45	R-8.6
	R-21	0.43	R-9.0
8"@16"o.c.	R-25	0.31	R-7.8
8"@24"o.c.	R-25	0.38	R-9.6

Correction down

The correction factors for metal framed walls may be used with metal studs of 16 ga. or lighter.

Table 402T Effective R-value of Fiberglass Batts Compressed in Various Depth Cavities (h-ft²-°F/Btu)

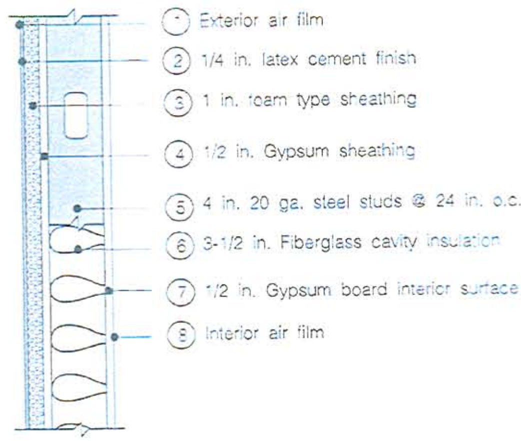
Nominal Lumber Size	Actual Depth of Cavity	Insulation R-values at Standard Thickness													
		38C	38	30C	30	25	22	21	19	15	13	11	8	5	3
2" × 12"	11-1/4"	38	37												
2" × 10"	9-1/4"		32	30											
2" × 8"	7-1/4"		27		26	24									
2" × 6"	5-1/2"				21		20	21	18						
2" × 4"	3-1/2"						14		13	15	13	11			
2" × 3"	2-1/2"										10				
2" × 2"	1-1/2"										6.5	6.0	5.7		
2" × 1"	1/2"													3.2	3.0

The standard thicknesses are as follows: 10-1/4" for R-38C, 12" for R-38, 8-1/4" for R-30C, 9-1/2" for R-30, 8" for R-25, 6-3/4" for R-22, 5-1/2" for R-21, 6-1/4" for R-19, 3-1/2" for R-15, 3-1/2" for R-13, 3-1/2" for R-11, 2-1/2" for R-8, 1-1/2" for R-5 and 3/4" for R-3.

ASHRAE 90.1 Code Compliance

Example 402N U-factor Calculation – Parallel Path Correction Factors

Q What is the thermal transmittance of the metal framed wall shown in the following drawing?



Component	R-value
(1) Exterior air film	0.17
(2) Latex cement finish	0.21
(3) Foam sheathing	4.00
(4) Gypsum sheathing	0.45
(5) 2×4 steel studs 24 in. o.c.	N.A.
(6) Fiberglass insulation	11.00
(7) Gypsum board interior	0.45
(8) Interior air film	0.68

A The parallel path correction factors may be used for this type of construction. This calculation method is available for wall sections with non-metal skin attached to metal stud framing. It is a modified form of the equivalent circuit method. It uses the parallel path correction factors listed in Table 402.1.2.1b. The correction factor for a 2×4 metal stud framing at 24 in. o.c. with R-11 fiberglass cavity insulation is 0.60. The thermal transmittance of this assembly is given by the following equations:

$$R_e = R_{insulation} \times F_c = 11.0 \times 0.60 = 6.6$$

The thermal resistance of the framing and insulation with thermal bridging accounted for. The parallel path correction factor of 0.60 is taken from Table 402.1.2.1b of the code.

$$\sum_i R_i = 0.17 + 0.21 + 4.00 + 0.45 + 6.60 + 0.45 + 0.68 = 12.56$$

The thermal resistance of the materials in "series"

$$U_t = \frac{1}{R_t} = \frac{1}{12.56} = 0.0796$$

The overall thermal transmittance of the assembly

R11 Fiberglass corrects down to R 6.6 due to the metal supports and connections.

ASHRAE 90.1 Code Compliance

Two Dimensional Heat Flow

Two-dimensional heat flow analysis may be used to accurately predict the U-factor of a complex construction assembly. While the series-parallel path calculation method assumes that heat flows in a straight line from the warm side of the construction to the cooler side, with two dimensional models, heat can also flow laterally in the construction, following the path of least resistance. Calculating two-dimensional heat flow involves advanced mathematics and is best performed with a computer. A model is set up by dividing the construction into a large number of small pieces, and defining the thermal resistance between each piece. The result is analyzed with electric circuit theory. The network consists of a rectangular array of nodes connected by resistances. As in the real material, the energy flow will take the path of least resistance. The computer can perform the complicated calculations necessary to solve the network, yielding the U-factor for the unit at steady state. It can also solve the network for dynamic energy conditions. Short of performing laboratory tests, this is the most accurate method available for determining the U-factors of concrete and masonry walls.

Zone Method

For conditions for which there are no parallel path correction factors, the zone method may be used. It may be used for construction assemblies with metal framing and non-metallic sheathing, such as concrete or masonry. The use of this method is documented in the ASHRAE Fundamentals Handbook (1985) and involves dividing the construction assembly into zones. Heat flow in the zone near the metal framing is assumed to be conducted toward the framing and the thermal resistance is smaller.

All Fiberglass, when installed is compressed and reduces the "R" factor dramatically before being reduced up to 67% more due to steel construction.

Compressed Insulation

Insulation that is compressed must be derated in accordance with Table 402T or the reduction may be calculated in accordance with the procedures in the ASHRAE Fundamentals Handbook (1985).

Table 402U Effective R-value of Fiberglass Batts Compressed in Various Depth Cavities (h-ft^2-°F/Btu)

Nominal Lumber Size	Actual Depth of Cavity	Insulation R-values at Standard Thickness													
		38C	38	30C	30	25	22	21	19	15	13	11	8	5	3
2" × 12"	11-1/4"	38	37												
2" × 10"	9-1/4"		32	30											
2" × 8"	7-1/4"		27		26	24									
2" × 6"	5-1/2"				21		20	21	18						
2" × 4"	3-1/2"						14		13	15	13	11			
2" × 3"	2-1/2"										10				
2" × 2"	1-1/2"										6.5	6.0	5.7		
2" × 1"	1/2"													3.2	3.0

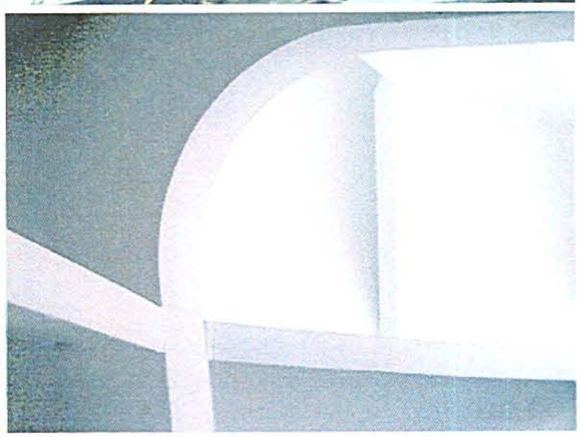
The standard thicknesses are as follows: 10-1/4" for R-38C, 12" for R-38, 8-1/4" for R-30C, 9-1/2" for R-30, 8" for R-25, 6-3/4" for R-22, 5-1/2" for R-21, 6-1/4" for R-19, 3-1/2" for R-15, 3-1/2" for R-13, 3-1/2" for R-11, 2-1/2" for R-8, 1-1/2" for R-5 and 3/4" for R-3.

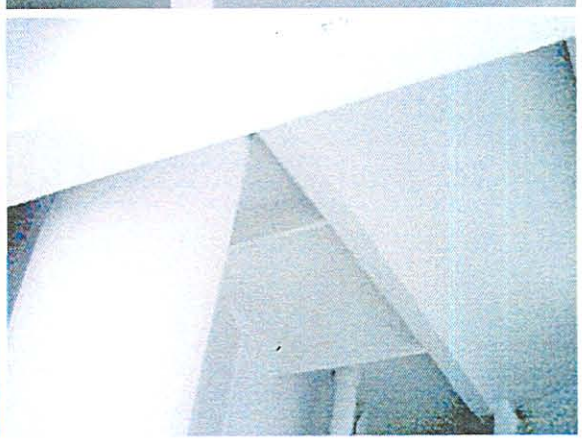
「クールサーム」の結露防止効果

Place:場　所	：	キリンビール㈱滋賀工場　５・６号空ビン上家 Kirin Brewery Co., Ltd.　Shiga Plant　Wing 5&6
Date:施　工	：	１９９８年１２月 December, 1998 (Wing 6)
Area Size:床 面 積	：	各棟２，５００㎡，同形状。　屋根面積：合計６，０００㎡ Total: 6,000sq.m.
Roof Type:屋根形状	：	高さ１０～１５mの瓦棒鉄板１枚板の丸屋根，裏地なし Batten seam metal roof
Inside:内　部	：	熱源なし，壁スレート，床コンクリート No heat source, slate wall, concrete floor
Person in charge:担　当	：	エンジニアリング担当　水谷氏 Engineering Div. Mr. Mizutani
Result:結　果	：	Our purpose of applying Super Therm was to reduce the temperature in summer and to stop the condensation. We applied Wing 6 first and compared with uncoated Wing 5 in January, 1999. When it was below freezing Wing 5 had terrible condensation, but Wing 6 did not have condensation at all.

These two new tugs under construction have specified SuperTherm on the hulls for condensation control.

This comes as a direct result of solving the condensation problem on their personal work boat which has an aluminum cabin and was literally raining inside. SuperTherm permanently solved that problem. A successful application was also applied to the new Kootenay Ferry in the passageways.





HOME

WATER BARRIER TEST

-----Next four pages-----

Test #1:

OBJECTIVE:

Evaluate the hydrostatic pressure resistance of a submitted water proof coating over concrete interior surface to prevent exterior rain driven water from penetrating the wall from exterior to interior during construction.

ASTM PROCEDURE:

ASTM D 7088
Superseded Federal Specification TT-P-1411A Paint, Copolymer-Resin, Cementitious ofr Waterproofing and Masonry Walls.

TEST RESULTS LISTING:

Blistering	Adhesion Loss	Softening
Discoloration	Water Droplets	Frequency

Test # 2:

OBJECTIVE:

Evaluate a submitted coating for Resistance to Wind Driven Rain as outlined in ASTM D 6904

ASTM PROCEDURE:

ASTM D 6904, "Standard Practice for Resistance to Wind-Driven Rain for Exterior Coatings Applied to Masonry". Without block filler used in test blocks.
Superseded Federal Specification TT-C-555B.

TEST RESULTS:

Property	Requirement	Results
Weight Gain	0.32 lbs. max	0.25 lbs.
Dampness As recorded on interior surface of block	None	None

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Accredited by National Voluntary Laboratory Accreditation Program - Lab Code 100252
ISO / IEC 17025 and relevant requirementsof ISO 9002

LABORATORIES

November 20, 2005

Superior Products International, Inc.
10835 W. 78th Street
Shawnee, Kansas 66214

Att: **Mr. Tim Cappel**

Re: DL-14666B
Via FAX (913) 962-6767

OBJECTIVE

To evaluate the hydrostatic pressure resistance of a submitted water proof coating.

PRODUCT TESTED

The following coating was submitted by Superior Products for testing:

Super Therm
Color: White
Batch No. 060405A

PROCEDURE

Testing for resistance to hydrostatic pressure was conducted in accordance with procedures outlined in ASTM D 7088, "Standard Practice for Resistance to Hydrostatic Pressure for Coatings Used in Below Grade Applications Applied to Masonry" with the following exceptions:

1) The coating was applied to commercially available masonry test blocks The blocks were a nominal 8"X8" X8" in size, with 1 inch thick walls.

2) The coating was applied in two coats, each coat approximately 8 mils wet film thickness with an overnight dry between coats.

3) The coating was allowed to cure for twenty-one days before introduction of water into the coated blocks.

4) Testing was conducted at 4 psi as outlined in the method.

TEST RESULTS

ASTM D 7088 does not have any requirements. The method is based on the superseded Federal Specification TT-P-1411A Paint, Copolymer-Resin, Cementitious for Waterproofing and Masonry Walls, which specifies the requirements as outlined below:

The coating exhibited the following hydrostatic pressure resistance characteristics:

Testing at 4 PSI

Test	Requirement	Results
Blistering	None	None
Adhesion Loss	None	None
Softening	None	None
Discoloration	None	None
Water Droplets	6 max.	8
Frequency	Medium max.	Slight

CONCLUSIONS

1) Sample of Super Therm does not exhibit any blistering or adhesion loss, when tested in accordance with procedures outlined in ASTM D 7088.

2) The sample of conforms to the requirements as stated in the superseded Federal Specification TT-P-1411A Paint, Copolymer-Resin, Cementitious for Waterproofing and Masonry Walls, when tested as above.

DL Labs, Inc.

Thomas J. Sliva
Vice President/
Technical Director

cc: M. Lazaro, Jr.

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Brooklyn, New York 11222-1517

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Accredited by National Voluntary Laboratory Accreditation Program - Lab Code 100252
ISO / IEC 17025 and relevant requirementsof ISO 9002

November 29, 2005

Superior Products International, Inc.
10835 W. 78th Street
Shawnee, Kansas 66214

Att: **Mr. Tim Cappel**

Re: DL-14666E
Via FAX (913) 962-6767

OBJECTIVE

To evaluate a submitted coating for Resistance to Wind Driven Rain as outlined in ASTM D 6904, "Standard Practice for Resistance to Wind-Driven Rain for Exterior Coatings Applied to Masonry".

PRODUCT TESTED

Super Therm
Color: White
Batch No. 060405A

TEST PROCEDURE

Testing was conducted in accordance with procedures outlined in ASTM D 6904, except that no block filler was used. The coating was applied in two coats, each coat approximately 8 mils wet film thickness with an overnight dry between coats. The coating was allowed to cure for twenty-one days before testing was conducted.

Superior Products
Re: DL – 14666E

TEST RESULTS

ASTM D 6904 does not have any requirements. The method is based on the superseded Federal Specification TT-C-555B and its requirements are shown below:

The resistance to wind driven rain for the coating tested was as follows:

Property	Requirement	Results
Weight Gain	0.32 lbs. max.	0.25 lbs.
Dampness	None	None

CONCLUSIONS

1) The submitted coating, namely; Super Therm, exhibited a 0.25 lb weight gain and no visible dampness on the uncoated side, when tested in accordance with ASTM D 6904.

2) The submitted coating conforms to the requirements of the superseded Federal Specification TT-C-555B, as tested.

DL Labs, Inc.

Thomas J. Sliva
Vice President/
Technical Director

cc: M. Lazaro, Jr.