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Welcome to Metalcon 2004

Las Vegas, Nevada- October 21, 2004

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Metal Buildings and Condensation

Presenting on behalf of RIMA:

- David Yarbrough, R&D Services
- Michael Boulding, RIMA, rFOIL
- Robert J. Aresty- Solec
- Larry Zupon- CGI Silvercote
- Monty Millspaugh- Reflectix

Panel Discussion sponsored by RIMA

Program Objectives

A discussion of condensation in metal buildings and the role of reflective insulation.

1) Technical Factors to consider- David Yarbrough
2) Observations from the field- Michael Boulding
3) Panel Discussion and questions

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Condensation Description

- Dew Point Temperature:

Temperature at which water condenses from an air-water vapor mixture: The dew point depends on the dry bulb temperature and the humidity (or relative humidity)

- Water Vapor Transport:

Vapor phase water moves from regions of high concentration to regions of low concentration. This is usually from a high temperature region to a low temperature region.

Perms: grains/hr.ft². (in Hg)

Water Vapor Transmission: lb/hr.ft²

The water vapor transmission rate can be calculated from the "perm value" and the driving force. The driving force comes from vapor pressure data and the relative humidity. Grains to pounds (x7000) Inches Hg from psi (x2.036)

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Dew Point Temperatures

- Relative Humidity — Air Temperature (°F)

Relative Humidity	70°F	80°F
95	68.5	78.4
90	67.0	76.8
80	63.6	73.3
70	59.8	69.4
60	55.5	64.9

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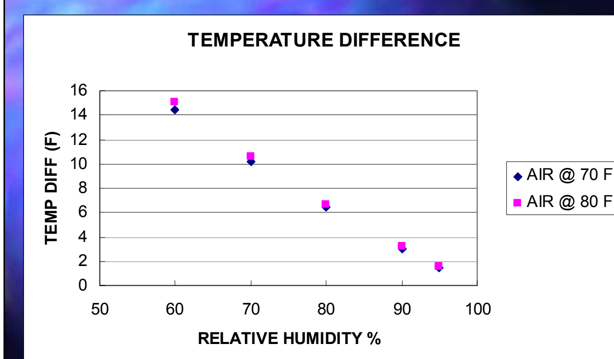

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Condensation on Lower Surface of Roof Insulation System

- Depends on the surface temperature
- Depends on the inside temperature, outside temperature, and thermal resistances
- Steady State analysis

R_{film}	Thermal resistance of air film below the insulation surface
$R_{insulation}$	Thermal resistance of the below roof insulation system
T_s	Bottom surface temperature (F)
T_{roof}	Temperature of the roof (F)
T_{inside}	Temperature of the inside air (F)

$$T_s = T_{roof} + R_{insulation}*(T_{inside}-T_{roof})/(R_{insulation}+R_{film})$$

R_{film} Values (heat flow up)

Still Air emittance=0.05	R_{film} = 1.32
Still Air emittance=0.90	R_{film} = 0.61
Air @ 7.5 mph	R_{film} = 0.25
Air @ 15 mph	R_{film} = 0.17

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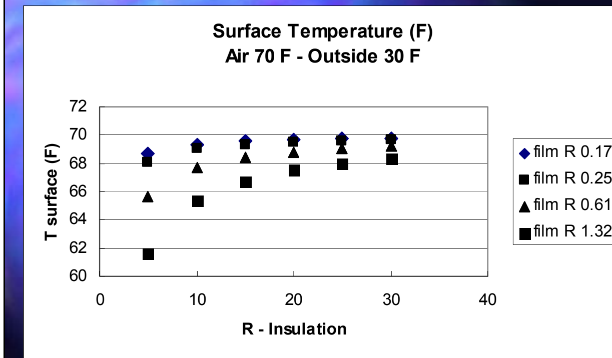

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Factors for water transfer.

The factors in the table when multiplied by area (sf) and time (hr) give the water that has passed across the assembly.

Temp (F) Interior	Temp (F) Sold sur	RH Interior	vp warm psi	vp cold psi	DP in HG	Factor
70	32	60	0.363	0.089	0.559	0.004787
70	32	70	0.363	0.089	0.559	0.005585
70	32	80	0.363	0.089	0.559	0.006383
70	32	90	0.363	0.089	0.559	0.007181
72	32	60	0.388	0.089	0.610	0.005233
72	32	70	0.388	0.089	0.610	0.006105
72	32	80	0.388	0.089	0.610	0.006977
72	32	90	0.388	0.089	0.610	0.007849
74	32	60	0.416	0.089	0.666	0.005705
74	32	70	0.416	0.089	0.666	0.006656
74	32	80	0.416	0.089	0.666	0.007607
74	32	90	0.416	0.089	0.666	0.008558
76	32	60	0.444	0.089	0.724	0.006206
76	32	70	0.444	0.089	0.724	0.007240
76	32	80	0.444	0.089	0.724	0.008275
76	32	90	0.444	0.089	0.724	0.009309
78	32	60	0.475	0.089	0.786	0.006737
78	32	70	0.475	0.089	0.786	0.007859
78	32	80	0.475	0.089	0.786	0.008982
78	32	90	0.475	0.089	0.786	0.010105
80	32	60	0.507	0.089	0.852	0.007299
80	32	70	0.507	0.089	0.852	0.008515
80	32	80	0.507	0.089	0.852	0.009732
80	32	90	0.507	0.089	0.852	0.010948

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Factors for water transferred.

Enter factor	Perm	Time	Water (lbs)
0.009309	1	24	0.223
	1	96	0.894
76 F 90%	1	240	2.234
	10	24	2.234
	10	96	8.937
	10	240	22.342
	20	24	4.468
	20	936	17.873
	20	240	44.683

Per 100 SF

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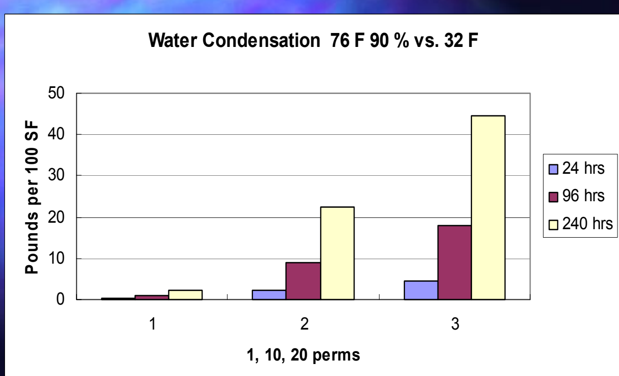

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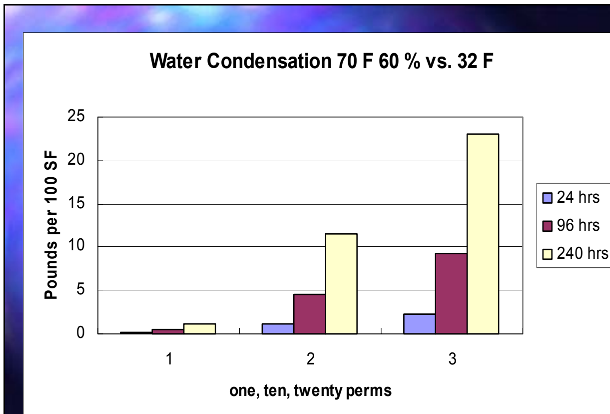

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Summary

- Dew Point temperature is readily available from air temperature and relative humidity.
- Temperature differences between the inside air and the ceiling surface depend on thermal resistances (including the film coefficient), inside temperature, and outside temperature.
- Condensation rates are determined from system perm and pressure differences.

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How Reflective Insulation and Radiant Barriers control condensation.

Mike Boulding

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Variables of Condensation

- Variables in each building affect level of condensation
- Condensation forms in both conditioned and un-conditioned buildings
- Difficult to apply well known theories because of building variables

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Variables that affect Condensation

- Indoor & Outdoor temperatures
- Building uses & occupants
- Ventilation
- External Sources of moisture in the building
- New construction or retrofit

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Problems of Condensation

- Unpleasant & uncomfortable for occupants
- Rusting of the building components
- Degrading of systems
- Mold growth
- Products can be damaged or ruined

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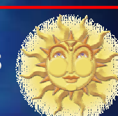
Understand the variables before you start



- Indoor / Outdoor temperatures
- Location of building
- Weather conditions – extremes
- Rainfall/Snow
- Conditioned or unconditioned

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Building uses & occupants

- Warehouse or animal confinement
- People & Plants (heat producing)
- Look for potential moisture producing operations

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Ventilation

- Is there any?
- What type?
- Air movement?
- Traffic?

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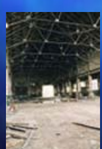
External moisture sources

- Dirt or gravel floor
- Concrete floor- with or without a vapor barrier
- Building leaks
- Moisture tightness- windows/doors



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Determine Potential for Producing Condensation (PPC)

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Condensation in Metal Buildings

- Highly conductive roof & walls offer very low resistance to heat loss or gain
- Metal framing in also highly conductive
- Metal is non-porous so condensation forms on surfaces

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Strategies to prevent or control condensation

- Prevent warm moist air from contact with cool metal. - easier said than done, it depends on PPC
- Keep moist air away from cool surfaces
- PPC will determine how many strategies need to be applied

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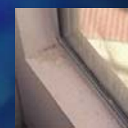
Strategy #1

- Ventilate
  - Install ridge / eave ventilation
  - Install fans
  - Check local building codes for recommended ventilation requirements

Strategy #2

- Reduce moisture sources in the building
  - Install underslab vapor barriers
- Seal around doors and windows
- Most RIMA members manufacture excellent under slab vapor barriers (most of which are also radon barriers)
  - Seal all windows / doors
  - Seal all leaks



Strategy #3

- Install a vapor barrier to prevent moisture reaching the cool metal surface

Install a vapor barrier

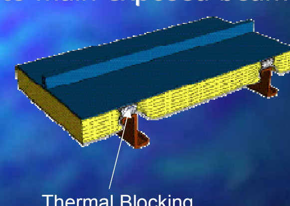
- ALL reflective insulations & Non - perforated radiant barriers are excellent vapor barriers
- Installation is critically important
- Must seal the seams and edges

Strategy #4

- Install insulation to reduce heat loss or gain from the building and protect hot & cold from coming in contact

Strategy #5

- Install thermal blocking between purlins and outer metal skin to prevent heat from conducting to main exposed beams



How do reflective insulation, radiant barriers and Radiant Control Coatings work to accomplish these strategies?

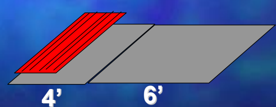
- Remember: PPC will determine how many strategies need to be installed
- Low: 1-2
- Medium: 2-3
- High: 4-5
- All strategies must be installed correctly
- RCC- Radiation Control Coatings
- Keep surface temperature at the bottom of roof or wall assembly above the dewpoint.

Usual installation is draped over top of purlins

- Reflective insulation is draped over purlins to form reflective air spaces and vapor retarders

Most manufacturers produce both 4' & 6' wide material

- For easy installation:
  - Start with a 4' section
  - Lay down 3' metal roofing
  - Continue with 6' sections



This installation not only adds a vapor barrier, but also adds thermal resistance

- Products that can be used:
- Reflective Insulation – bubble, foam or fiberglass core
- Radiant Barrier
- See manufacturer for details

For more severe instances, install under purlins

Benefits of under purlin installation

- Additional insulation
- Larger thermal break
- Insulate the purlins
- Creates a large reflective air space

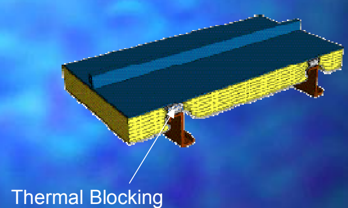
Install Insulation

- Reflective insulation is effective for many types of buildings
- To increase insulation, you can add multi-layer reflective insulation combined with other conventional insulation

All thermal insulations are generally only as good as the installation

- Use the right product
- Install as per manufacturers instructors (should be accurate and easy to follow)
- If not sure, call manufacturer for advice

Install thermal blocks



Benefits of Reflective Insulation, Radiant Barriers & Radiant Control Coatings

1) Reduce heating and cooling costs
2) Create an effective vapor barriers
3) Can include a thermal break
4) Easy to install

Additional Benefits

- Helps maintain interior temperatures by reflecting radiant heat & reducing warming effect in building.
- Available in FOIL/FOIL faced
  - Helps reduce lighting requirements
- Also FOIL/White Poly faced for the more traditional look.
- RCCs are available in silver coatings

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Thank you for attending the Metal Buildings and Condensation discussion