

Specification Information for Modular Radiant Panels using Self-Consolidating Lightweight Concrete and Heatflex Pipe

Regulatory requirements for modular heating products are the known commercial standards for construction products. MRT's modular heating products are designed and manufactured to meet or exceed these standards.

Evaluations have been performed by a number of certification and regulatory organizations: These include a NYSEDA Five Star Certification, Harvard Thermal Laboratory tested heat storage, isotherm distribution, reaction time, heat stripping, BTU output and computerized digital thermal imaging, the American Concrete Institute (ACI) tested cementitious mix design, flexural strength, density, and psi (see below), and United States Green Building Counsel (USGBC) and Leadership in Energy and Environmental Design (LEED®) listings.

Radiant Panel ACI Test Results:

WATER ABSORPTION: Tested in accordance with ASTM C-642. Absorption factors will vary between product types.

FREEZE/THAW CHARACTERISTICS: Tested in accordance with ASTM C-666. The product yielded a durability factor of 92 or better.

NONCOMBUSTIBLE: Tested and listed by Omega Laboratories, Inc., in accordance with ASTM E-84. The product exhibited 0 flame spread and <5 smoke developed.

COMPRESSIVE STRENGTH: Tested in accordance with ASTM C-39. Test results averaged over 2200 psi or 15.6 Mpa on flat and corner pieces.

SPLITTING TENSILE STRENGTH: Tested in accordance with ASTM C-496. Test results averaged over 155 psi or 1.07 Mpa.

THERMAL PROPERTIES: Tested in accordance with ASTM C-177 and relate to thermal storage capacity in relation to the cementitious aggregates and admixtures. Consequently, the thermal storage properties will have minimal variance.

Harvard Thermal Laboratory Radiant Panel Test Results: (see appendix A)

NYSEDA – New York ENERGY STAR® Home Analysis (see appendix B)

HEATFLEX Pipe Technical Specifications:

Heatflex tubing is a 5 layer tubing consisting of 2 layers of polyethylene copolymer resin (the inner and outer most layers), 2 layers of adhesive and one layer of EVOH (the oxygen barrier layer). This structure provides the outstanding hydrostatic design strength demanded by hydronic heating applications.

The outer layer of polyethylene (DOWLEX 2344) provides a protective shield for the EVOH to ensure your radiant piping system has the best possible protection from oxygen permeation causing oxidation of the heating system



<u>Physical Properties</u>	<u>Unit</u>	<u>Test Method</u>	<u>Values</u>
Density	lb/ft ³	ASTM D-792	58.745
Thermal Conductivity at 140 F	BTU (h-ft ² F/in)	DIN 52612-1	2.7734
Thermal Expansion Coefficient F (68 °F to 158 °F)		DIN 5375	0.0000394
Oxygen Diffusion Rate with O ² Barrier at 100 °F	Mg/in ² x24h	DIN 4726	Better than 0.0002
Oxygen Diffusion Rate with O ² Barrier at 180 °F	Mg/in ² x24h	DIN 4726	Better than 0.0004

<u>Mechanical Properties</u>	<u>Unit</u>	<u>Test Method</u>	<u>Values</u>
Tensile Yield	psi	ISO 527-2	2,988
Ultimate Tensile	psi	ISO 527-2	5,221
Percentage of Elongation	%	ISO 527-2	760
Modulus of Elasticity	psi	ISO 178	138,511

Available Industry Based Technical and Application Testimonials and Test Results:

Proof of results and Analytical Data:

- Radiant Panel Association (RPA), Dr. Fatauzzi, Board Chair 07/94 to 10/96
- ECR International, Carl Saunders, Chief Technical Trainer
- Frederickson Construction, Ellicottville, NY, Kelly Fredrickson
- Wendel Duchscherer Architects, Amherst, NY, Daniel Culross, LEED AP
- Left Coast Design Studio Architects, Lancaster, NY, John Lydon
- Heartland Homes, Amherst, NY Richard Burgmann
- Aurora Architectural Design, East Aurora, NY, Gregory Schneider
- UB School of Architecture, Master Thesis Project on a Radiant Install in Quad Space on Howell St., Buffalo, NY
- Steve and Debbie Valentine, South Wales, NY



Additionally:

This radiant product uses a self-consolidating lightweight concrete that contains recycled and post consumer materials. These materials have a beneficial use determination (B.U.D.) by the EPA. Empire State Development awarded a two hundred thirty thousand dollar grant to develop this material design which reduces landfill burden and saves land fill space.

Our radiant product has been used with wind, solar, and geo-thermal equipment. It enhances the performance of the equipment by significantly reducing the demand output.

Our company is currently working with Dr. Kosny at the D.O.E. (Dept. of Energy) in Oakridge, TN on radiant heating and cooling using phase change materials (PCM).

Our radiant product is installed in a residential home on Grand Island, NY. The home was monitored and tested by NYSERDA and BPI (Todd Blackley, HERS rater). By using our panels and a natural gas boiler, the heating bill for this thirty-one hundred square feet home is approximately two thirds less than the average home of this size . This amount also includes the domestic hot water use for the home. This home cost 1.3% more to build than the average. It has been awarded a 5 star rating by NYSERDA (See Appendix B).

Our products can contribute to points for LEED[®] certifications, Green Globes ratings, NYSERDA New York ENERGY STAR[®] Home Ratings, GreenGuard[®] Building Construction Certification, and are acceptable in National Register of Historic Places renovations.

MRT is an approved Regional AIA/CES Provider.





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Appendix A

Summary from the Harvard Thermal Laboratory Test Results
MRT SCLC Radiant Panel

Dated October 7, 2003



Summary

- The Thermal Conductivity (k) of the concrete was tested to be:

$$k = 0.381 \text{ Btu/hr-ft-}^\circ\text{F}$$

- The Specific Heat (Cp) of the concrete was tested to be:

$$C_p = 0.19 \text{ Btu/lbm-}^\circ\text{F}$$

- The heat transfer rate to the room, per panel, was analyzed to be:

0.5 gpm,	90 °F water:	12.1 Btu/hr-ft ²	(38 W/m ²)
0.5 gpm,	140 °F water:	41.9 Btu/hr-ft ²	(132 W/m ²)
2.0 gpm,	90 °F water:	14.9 Btu/hr-ft ²	(47 W/m ²)
2.0 gpm,	140 °F water:	42.7 Btu/hr-ft ²	(135 W/m ²)

- The equivalent heat transfer coefficient to the room, per panel, based on a temperature differential between the inlet water temperature and room temperature:

0.5 gpm,	90 °F water:	0.551 Btu/hr-ft ² -°F	(3.13 W/m ² -°C)
0.5 gpm,	140 °F water:	1.905 Btu/hr-ft ² -°F	(3.30 W/m ² -°C)
2.0 gpm,	90 °F water:	0.679 Btu/hr-ft ² -°F	(3.85 W/m ² -°C)
2.0 gpm,	140 °F water:	1.941 Btu/hr-ft ² -°F	(3.37 W/m ² -°C)

- One third of the heat is transferred through the subfloor
- Adding insulation to the subfloor will improve the heat rate to the room



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Appendix B

NYSERDA – New York ENERGY STAR[®] Home Analysis
and FIVE STARS Certificate

Dated November 25, 2006



Home Energy Rating Certificate



Five Stars Plus Site Visit

Site: 796 Ransom Road, Grand Island, NY 14074

Certified Energy Rater: Todd Blackley

Rating Date: November 25, 2006

Rating Ordered For: Riggs

Uniform Energy Rating System						Energy Efficient		
1 Star	1 Star Plus	2 Stars	2 Stars Plus	3 Stars	3 Stars Plus	4 Stars	4 Stars Plus	5 Stars Plus
0-19	20-39	40-49	50-59	60-69	70-79	80-81	81- 85	66-100

HERS Score: 89.8 / HERS Index: 51

General Information

Conditioned Area: 4100 Sq. Ft. Housetype: Single-Family Detached

Conditioned Volume: 35726 Cubic Ft Foundation: Conditioned Basement

Bedrooms: 2

Mechanical Systems Features

Heating: Fuel-Fired Hydronic Distribution, Natural Gas, 92.0 % EFF.

Water Heating: Instant Water Heater, Natural Gas, 0.85 EF.

Cooling: Air Conditioner, Electric, 13.0 SEER.

Duct Leakage To Outside: . Supply And Return: 15.00, 15.00 CFM @ 25 Pascals

Ventilation System: Balanced: ERV, 150 cfm, 147.0 watts

Programmable Thermostat: Heating: Yes Cooling: Yes

Building Shell Features

Ceiling Flat: R-41 Exposed Floor: NA

Vaulted Ceiling: R-35 Window Type: EE Homes

Above Grade Walls: R-20 Infiltration

Foundation Walls: R-12.0 Rate: Htg: 674 Clg: 674 CFM50

Slab: R-7. 0 Edge, R-0.0 Under Method: Blower Door Test



Lights And Appliance Features

Percent Fluorescent Pin-Based:	10.00	Clothes Dryer Fuel:	Natural
Percent Fluorescent CFL:	25.00	Range/Oven Fuel:	Natural Gas
Refrigerator (KWh/Yr):	775.00	Ceiling Fan (cfm/Watt):	0.00
Dishwasher Energy Factor:	0.46		

The Home Energy Rating Standard Disclosure For This Home Is Available From The Rating Provider.

REM/Rate - Residential Energy Analysis And Rating Software V12.33 New York

This Information Does Not Constitute Any Warranty Of Energy Cost Or Savings.

Estimated Annual Energy Cost

Use	MM Btu	Cost	Percent
Heating	40.1	621	22%
Cooling	3.5	\$151	5%
Hot Water	12.2	\$187	7%
Lights/Appliances	44.9	\$1764	62%
Photovoltaics	-0.0	\$-0	-0%
Service Charges		\$120	4%
Total		\$2844	100%