RADCO TEST REPORT
Test Report No. RAD-5245
Project No. C2401A
Lab TL No. 3567

Testing of UnderDuct Fiberglass Reinforced Plastic (FRP) Duct per ICC-ES PMG LC1014

Prepared for

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by

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ACCREDITED

1.0 INTRODUCTION

At the request of Monoxivent, RADCO conducted the tests outlined below on UnderDuct Fiberglass Reinforced Plastic (FRP) Duct in accordance with ICC-ES PMG LC1014, *PMG Listing Criteria For Underground Plastic Air Ducts*, Approved June 2008 (Revised March 2011).

2.0 MATERIAL DESCRIPTION & FEATURES

The product is UnderDuct. It is available in round sizes 2" through 144" diameters in 2" increments and also in rectangular and oval of any size. All shapes are available in either single wall or factory insulated double wall duct. Double wall duct is available with standard 1", 1-1/2" or 2" insulation. UnderDuct has been successfully tested for both low smoke and low flame spread which classifies it as a Class 1 duct. Designed for direct burial, the duct is a filament wound product which gives it tremendous hoop strength, negating the need for concrete encasement when using round duct. It is corrosion resistant and impervious to water, acidic or alkaline soil conditions.

Products Submitted for Testing

Type	Nominal Inner Dia. (in)	Nominal Wall Thickness (in)	Description
1	20	0.25	UnderDuct Single Wall (FRP only)
2	20	1.25	UnderDuct Double Wall (FRP / 1" EPS, FRP)
3	6	0.125	UnderDuct Single Wall (FRP only)
4	6	1.25	UnderDuct Double Wall (FRP, 1" EPS, FRP)

3.0 TEST PROGRAM

	Tests	Referenced Standards
1	Strength Test	ASTM D2412
2	Thermal Transmission Test	ASTM C518
3	Leakage Test	ICC-ES PMG LC1014

4.0 TEST SETUP & RESULTS

4.1 Strength Test, ASTM D2412

Testing was conducted in accordance with ASTM D2412, *Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading* and ICC-ES PMG LC1014, *PMG Listing Criteria for Underground Plastic Air Ducts.*

Test Setup

Each specimen was prepared for testing by bonding a small steel plate to the inside edge, to be used for measuring deflection by a digital caliper during the test. The tests were conducted using a United Universal Testing Machine (UTM) equipped with an electronic load cell and a computerized data acquisition system. The speed of testing was 0.5 ± 0.02 in./min (12.7 ± 0.5 mm/s). Load and deflection were both measured incrementally throughout each test, until the deformation reached 8% of the samples inside diameter. The tests were conducted between June 7 and October 1, 2013. The results are shown in the table below.

Test Results

20" ID Single wall			20" ID Double wall		
Sample	Load at 5% Defln. (lbs)	Pipe Stiffness at 5% Delfn. (psi)	Sample	Load at 5% Defln. (lbs)	Pipe Stiffness at 5% Delfn. (psi)
1	135	11.3	1	450.0	37.5
2	138	11.5	2	440.0	36.7
3	170	14.2	3	412.0	34.3
Average	148	**12.3**	**Average**	434.0	**36.2**
Std. Dev.	19.4	1.6	Std. Dev.	19.7	1.6
6" ID Single wall			6" ID Double wall		
Sample	Load at 5% Defln. (lbs)	Pipe Stiffness at 5% Delfn. (psi)	Sample	Load at 5% Defln. (lbs)	Pipe Stiffness at 5% Delfn. (psi)
1	920	256	1	813	226
2	1084	301	2	833	231
3	955	265	3	839	233
Average	986	**274**	**Average**	828	**230**
Std. Dev.	86.4	24.0	Std. Dev.	13.6	3.8

Conclusion

The minimum pipe stiffness shall be 8 psi at 5 percent deflection of the inner diameter, therefore the average values listed **meet** the requirements specified in ICC-ES PMG LC1014 for air duct with inner diameter ranging from six inches up to 20 inches.

4.2 Thermal Transmission, ASTM C518

Test Equipment

1. Steel rule graduated to 1mm
2. Sartorius Model GP3202 electronic digital scale
3. Holometrix Micromek (Metrisa Company) Lambda 2000 Series heat flow meter thermal conductivity instrument

Description

Three (3) 12" x 12" (304.8 mm x 304.8 mm) samples were prepared for both the Single Wall and Double Wall products. Thickness measurements are as reported by the test apparatus. The recorded data and the results are shown in the following table.

Test Results

Underduct Single wall material			
Sample No.	1	2	3
Date of test	1/29/13	1/30/13	1/30/13
Hot plate temperature °F:	94.66	94.04	94.87
Cold plate temperature °F:	55.13	54.54	55.18
Mean temperature during test °F:	74.90	74.29	75.02
Temperature gradient during test °F:	39.53	39.49	39.70
Specimen thickness as tested (in):	1.0995	1.1203	1.9815
Duration of measurement portion of test (hrs:min:sec):	00:50:12	01:10:32	00:50:11
Final specimen mass (wt.) after test (gms):	3569.2	3666.6	3745.8
Specimen percent mass (wt.) change:	-0.067	-0.008	-0.080
Thermal conductivity "k": BTU·in/(Hr·ft²·°F)	1.19	1.17	1.06
Thermal resistance "R" per specimen thickness :(Hr·ft²·°F)/BTU	0.93	0.96	1.09
Thermal resistance "R" per 1 inch thickness: (Hr·ft²·°F)/BTU	0.84	0.85	0.94
Average Thermal resistance "R" per 1 inch thickness: (Hr·ft²·°F)/BTU	0.9		
Density of Specimen (pcf)	92.23	91.39	90.25

Underduct Double Wall material			
Sample No.	1	2	3
Date of test	1/30/13	1/30/13	1/30/13
Hot plate temperature °F:	93.94	93.92	93.94
Cold plate temperature °F:	52.23	53.21	53.27
Mean temperature during test °F:	73.58	73.57	73.60
Temperature gradient during test °F:	40.71	40.71	40.66
Specimen thickness as tested (in):	1.1769	1.2347	1.1903
Duration of measurement portion of test (hrs:min:sec):	00:49:31	00:54:05	00:39:00
Final specimen mass (wt.) after test (gms):	964.34	1102.19	1039.29
Specimen percent mass (wt.) change:	-0.004	-0.004	-0.004
Thermal conductivity "k": BTU·in/(Hr·ft²·°F)	0.20	0.21	0.20
Thermal resistance "R" per specimen thickness :(Hr·ft²·°F)/BTU	5.79	5.88	5.81
Thermal resistance "R" per 1 inch thickness: (Hr·ft²·°F)/BTU	5.00	4.76	4.88
Average Thermal resistance "R" per 1 inch thickness: (Hr·ft²·°F)/BTU	4.9		
Density of Specimen (pcf)	21.67	24.02	22.87

4.3 Leakage Test, ICC-ES PMG LC1014

Leakage testing was conducted on each of the four (4) product variations described in section 2.0. In accordance with LC1014, each product was to be tested externally with water for a hydrostatic pressure equal to two times the burial depth for which recognition was sought.

Sample Preparation

A minimum of four (4) fittings were attached to five (5) straight duct sections in order to create the required sample necessary for this test. The samples were prepared by Monoxivent personnel and shipped to RADCO's Long Beach test facility.

Test Procedure

Before submerging each sample, a pneumatic vaccuum fitting was attached and sealed with epoxy to allow a water-tight flow of air to exit through an orifice located approximately two (2) feet above the water surface. To provide additional protection from water entry, a PVC pipe was installed over the vaccuum fitting and epoxy sealed to the sample. Next, the sample was submerged in water at ambient conditions and held rigidly in place to control any bouyant force. Lastly, the vaccuum was applied and set to exert a negative pressure equal to twelve feet of water (5.2 psi) for a period of 24 hours.

After a period of 24 hours, the sample was depressurized, removed from the fixture and dried thoroughly. The samples were then inspected by cutting them open to determine if any water had entered during testing.

Conclusion

No leakage was observed within any of the four (4) materials described in section 2.0 of this report, therefore the UnderDuct FRP samples **meet** the requirements set forth in section 4.3 of ICC-ES PMG LC1014 for a burial depth of up to six (6) feet.

5.0 CONCLUSION

The UnderDuct FRP samples which were tested **meet** the requirements of the tests outlined in the test program in section 4.0 as specified in ICC-ES PMG LC1014 for the recognition outlined in this report.

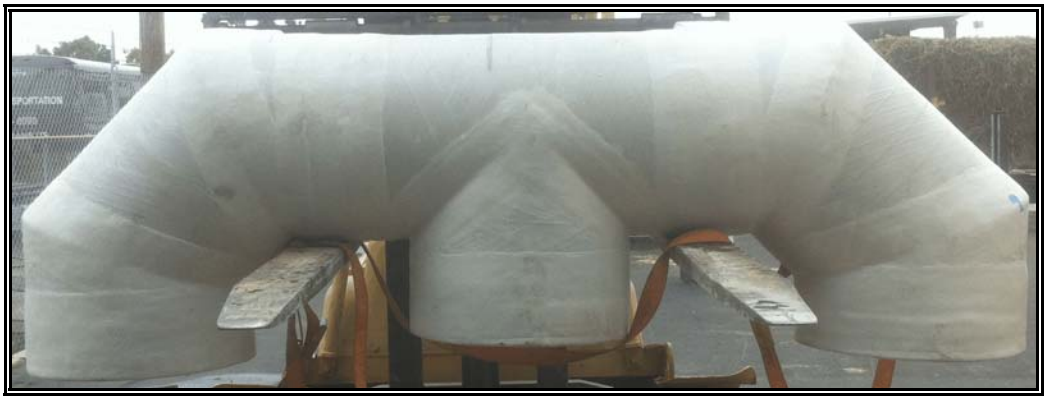
*******END OF REPORT*******

6.0 PHOTOGRAPHS

ASTM D2412, Strength Test, UTM Test Setup

ASTM C518, Thermal Transmission Fixture

ICC-ES PMG LC1014, Leakage Test Sample



ICC-ES PMG LC1014, Leakage Test Fixture

ICC-ES PMG LC1014, Leakage Test, Pneumatic Vaccuum Fitting