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Report No. RD08208

Firm: Applegate Insulation
PO Box 91
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R&D Project Number: RD1028

Date of Tests: October 15, 2007 thru February 4, 2008

Specimen Number: 1028071011-3 thru 13

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March 17, 2008

Reviewed By:

Date:

Material:

Eleven factory-sealed bags of Applegate cellulose fiber insulation (CFI) were received from Applegate Insulation in Bloomer, Wisconsin on October 11, 2007. Twenty bags were witnessed and selected from a lot of 102 bags that were produced at the Applegate facility on October 8, 2007. The remainder of the twenty bags was stored at the Applegate facility for potential future use.

Tests Requested:

Tests according to CAN/ULC-S703-01 were requested by Applegate Insulation.

Type 1 Tests:

Open-flammability in accordance with CAN/ULC-S703-01, Sections 5.2.1 and 6.4.1.

Open-flammability conditioning cycles in accordance with CAN/ULC-S703-01, Section 6.4.2.4.

Open-flammability permanency in accordance with CAN/ULC-S703-01, Sections 5.2.2 and 6.4.2.

Smoulder resistance in accordance with CAN/ULC-S703-01, Sections 5.2.4 and 6.4.4 and CAN/ULC-S130.

Moisture vapour sorption in accordance with CAN/ULC-S703-01, Sections 5.2.5 and 6.4.5.

Corrosiveness in accordance with CAN/ULC-S703-01, Sections 5.2.6 and 6.4.6.

Fungi resistance in accordance with CAN/ULC-S703-01, Sections 5.2.7 and 6.4.7.

Separation of chemicals in accordance with CAN/ULC-S703-01, Sections 5.2.8 and 6.4.8.

Thermal resistivity in accordance with CAN/ULC-S703-01, Sections 5.2.9 and 6.4.9.

Design density in accordance with CAN/ULC-S703-01, Sections 5.2.10 and 6.4.10.

Surface burning characteristics in accordance with CAN/ULC S703-01, Sections 5.2.3, 6.4.3 and CAN/ULC-S102.2.

Type 2 Tests:

Density, settlement and added water –Type 2 (Open Spaces) in accordance with CAN/ULC-S703-01, Sections 5.2.12 and 6.4.12.

1.0 PRODUCT SAMPLING

Twenty factory-sealed bags of Applegate cellulose fiber insulation (CFI) were witnessed and selected from a production lot of 102 bags and marked on October 8, 2007 by Ron Graves of R & D Services, Inc. Each bag of cellulose was marked with a number, date and initials. R & D Services, Inc. is accredited as a testing facility (NVLAP Lab. Code 200265-0) by the National Voluntary Laboratory Accreditation Program (NVLAP) under the US Department of Commerce.

2.0 SAMPLE DESCRIPTION

The cellulose fiber insulation (CFI) was identified as Applegate cellulose. The cellulose was manufactured on October 08, 2007 at the Applegate facility in Bloomer, Wisconsin. **The chemical formulation was supplied to R & D Services but the information is considered confidential.**

3.0 CONDITIONING

The bags for tests were randomly selected, blown and conditioned at 24 ± 2 °C and 50 ± 5 % RH in open trays until constant mass prior to testing unless otherwise specified in the test method.

4.0 OPEN FLAMMABILITY TEST RESULTS

Open flammability was determined in accordance with CAN/ULC-S703-01, Section 6.4.1. The test was performed as described in CAN/ULC-S703-01 “**STANDARD FOR CELLULOSE FIBRE INSULATION (CFI) FOR BUILDINGS**”.

One set of three tests was performed on the cellulose (CFI). The critical radiant flux results were 0.15, 0.16 and 0.14 W/cm², with an average of 0.15 W/cm². According to CAN/ULC-S703-01, Section 5.2.1.1, the critical radiant flux should be greater than or equal to 0.12 W/cm² for at least two of the three specimens. All three specimens passed the open flammability test.

5.0 OPEN FLAMMABILITY PERMANENCY TEST RESULTS

After conditioning according to the procedure in 6.4.2.4, open flammability permanency was determined in accordance with CAN/ULC-S703-01, Section 6.4.2. The test was performed as described in CAN/ULC-S703-01 “**STANDARD FOR CELLULOSE FIBRE INSULATION (CFI) FOR BUILDINGS**”.

One set of three tests was performed on the cellulose (CFI). The critical radiant flux results were 0.14, 0.13 and 0.15 W/cm², with an average of 0.14 W/cm². According to CAN/ULC-S703-01, Section 5.2.2.1, the critical radiant flux should be greater than or equal to 0.12 W/cm² for at least two of the three specimens. All three specimens passed the open flammability test.

6.0 SMOULDER RESISTANCE TEST RESULTS

The smoulder resistance test was performed as described in CAN/ULC-S130 "STANDARD METHOD OF TEST FOR IGNITION RESISTANCE OF LOOSE-FILL INSULATION (CIGARETTE METHOD)". and CAN/ULC-S703-01 "STANDARD FOR CELLULOSE FIBRE INSULATION (CFI) FOR BUILDINGS".

Three cellulose specimens were conditioned at 24 ± 2 °C, 50 ± 5% RH for 96 hours to constant mass. Testing was completed on November 3, 2007. There was no evidence of flaming combustion.

Conditioned Material Weight (g)	98.90	98.10	98.00
Material Weight after Testing (g)	98.70	97.80	97.90
Weight Change (g)	0.20	0.30	0.10
Percent Weight Change	0.20 %	0.31 %	0.10 %
Pass / Fail	Pass	Pass	Pass

7.0 MOISTURE VAPOUR SORPTION TESTS RESULTS

The moisture vapour sorption test was performed as described in Section 6.4.5 of CAN/ULC-S703-01 "STANDARD FOR CELLULOSE FIBRE INSULATION (CFI) FOR BUILDINGS".

A preweighed inert container 230 mm by 230 mm by 130 mm deep was filled with Applegate cellulose (CFI) at a density of 1.52 lb/ft³. The container was conditioned at 50 ± 2 °C and 50 ± 2 % RH to constant mass. The container was then reconditioned at 50 ± 2 °C and 90 ± 2 % RH for 168 hours and weighed again. The test was performed from October 27 to November 3, 2007.

Material weight after 50 % RH conditioning (g)	156.8
Material weight after 90 % RH conditioning (g)	182.2
Change in weight (g)	25.4
Percent moisture gain	16.20

Pass / Fail	Pass
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8.0 CORROSIVENESS TEST RESULTS

The corrosiveness test was performed as described in CAN/ULC -S703-01, Section 6.4.6 "STANDARD FOR CELLULOSE FIBRE INSULATION (CFI) FOR BUILDINGS".

Corrosiveness tests were assembled for Applegate using coupons of aluminum, steel, copper, and galvanized steel truss plates. A truss plate control was also prepared using shredded Whatman No. 5 filter paper. Tests were placed in an oven at 50 ± 2 °C for 28 days. Testing began on October 29 and was completed on November 26, 2007.

Upon completion of testing, coupons were cleaned according to CAN/ULC -S703-01 "STANDARD FOR CELLULOSE FIBRE INSULATION (CFI) FOR BUILDINGS", Section 6.4.6.3. Inspection of the aluminum, copper, and steel coupons were performed over a 40 watt light bulb operating at $120 \pm 5V$.

Material	Comments
Aluminum	No holes or perforations present (Pass).
Copper	No holes or perforations present (Pass).
Steel	No holes or perforations present (Pass).
Galvanized Truss Plates	Test coupons did not exhibit a mass loss that exceeded that of the control coupons by more than 25 %. No perforations of zinc coating noted (Pass).

9.0 Fungi Resistance Test Results

Fungi resistance was determined in accordance with CAN/ULC-S703-01, Sections 5.4.7 and 6.4.7 which state that tests are to be performed according to ASTM C1338. Evaluations for fungi growth are based on visual examinations at 40X magnification. The examinations at 40X magnification compare fungal growth on material being evaluated with the fungal growth on an untreated comparative material that is exposed to the same environment as the test specimens. Both the material being tested and the comparative material are inoculated with a mixed spore suspension containing five specific fungal species to start the test. Since most fungi thrive in a relatively narrow range of temperature and humidity, the inoculated specimens and comparative material are maintained within temperature and relative humidity ranges specified in the test method for the 28-day growth period. The purpose of the test is to provide an evaluation of the potential for fungal growth present in the insulation material relative to common types of wood used in building construction. The fungal species used in the tests for thermal insulation are listed below.

Aspergillus niger	ATCC 9642
Aspergillus flavus	ATCC 9643
Aspergillus versicolor	ATCC 11730
Penicillium funiculosum	ATCC 11797
Chaetomium globosum	ATCC 6205

Each of the replicate test specimens shall be determined to have either no fungal growth, fungal growth not greater than the comparative material or fungal growth greater than the comparative material.

Specimen	Fungal Growth Comparison
1	No fungal growth
2	No fungal growth
3	No fungal growth

Based on the comparison all three specimens exhibited no growth therefore **the sample passed**. There were no deviations from the test method.

Reference:

ASTM C1338-00 “Standard Test method for Determining Fungi Resistance of Insulation Materials and Facings”, 2007 Annual Book of ASTM Standards, Volume 04.06, pp 704-706.

10.0 SEPARATION OF CHEMICALS TEST RESULTS

The separation of chemicals test was performed as described in **CAN/ULC-S703-01, Section 6.4.8 “STANDARD FOR CELLULOSE FIBRE INSULATION (CFI) FOR BUILDINGS”**.

One set of two tests was performed on Applegate cellulose (CFI). The percentage of chemical separation results were 0.00 and 0.00, with an average of 0.00 %. The separation of non-cellulosic components did not exceed 1.5 % by weight and therefore meets the requirements of Section 5.2.8.

11.0 THERMAL RESISTIVITY TEST RESULTS

Thermal resistivity was determined in accordance with ASTM C518

“STANDARD TEST METHOD FOR STEADY-STATE HEAT FLUX MEASUREMENT AND THERMAL TRANSMISSION PROPERTIES BY MEANS OF THE HEAT FLOW METER APPARATUS”. Prior to testing, the apparatus was calibrated against a standard traceable to NIST (NRC).

The test was performed as described in **CAN/ULC-S703-01 “STANDARD FOR CELLULOSE FIBRE INSULATION (CFI) FOR BUILDINGS”**.

Samples were prepared at a density within $\pm 5\%$ of 24.27 kg/m^3 (1.51 lb/ft^3) the design density and at a minimum thickness of 102 mm (4 in). The mean temperature of each specimen was $24 \pm 2^\circ \text{C}$ ($75 \pm 3.6^\circ \text{F}$) with a temperature difference across the specimen

of $22 \pm 2^\circ \text{C}$ ($39.6 \pm 3.6^\circ \text{F}$). Tests were performed under the R&D test numbers 07-3173, 07-5764 and 07-1217.

The results are given in SI units as defined in ASTM E380-9a MODERNIZED METRIC SYSTEM and in British units.

The results are expressed as the arithmetic mean (χ) with the number of measurements (n) indicated. The variability is presented in terms of standard deviation (σ) in the measured units, and the coefficient of variation (v).

THERMAL RESISTIVITY TESTS

The test results are summarized below.

The symbols used were:

d = thickness in mm / in.

ρ = density in kg.m^{-3} / pcf

T_H = hot surface temperature in $^\circ\text{C}$ / $^\circ\text{F}$

T_C = cold surface temperature in $^\circ\text{C}$ / $^\circ\text{F}$

T_M = mean temperature in $^\circ\text{C}$ / $^\circ\text{F}$

ΔT = temperature differential in $^\circ\text{C}$ / $^\circ\text{F}$

λ/k = thermal conductivity in W.(m.K)^{-1} / $\text{Btu.in.(h.ft}^2\text{.F)}^{-1}$

R = thermal resistance in $\text{m}^2.\text{K.W}^{-1}$ / $\text{F.ft}^2.\text{(Btu)}^{-1}$

r = thermal resistivity in m.K.W^{-1} / $\text{F.ft}^2.\text{h(Btu.in.)}^{-1}$

C = thermal conductance in $\text{W(m}^2.\text{K)}^{-1}$ / $\text{Btu(h.ft}^2\text{.F)}^{-1}$

	07-3173	07-5764	07-1217	χ
D	101.61/4.00	101.59/4.00	101.60/4.00	101.60/4.00
P	24.171/1.509	24.719/1.543	24.126/1.506	24.339/1.519
T_H	35.02/95.04	35.02/95.04	35.02/95.04	35.02/95.04
T_C	12.79/55.02	12.79/55.02	12.80/55.04	12.79/55.03
T_M	23.91/75.03	23.91/75.03	23.91/75.04	23.91/75.03
ΔT	22.23/40.02	22.23/40.02	22.22/40.00	22.23/40.01
λ/k	0.04036/0.2798	0.04005/0.2777	0.03999/0.2773	0.04013/0.2783
R	2.518/14.296	2.537/14.403	2.541/14.425	2.532/14.375
R	24.777/3.574	24.969/3.601	25.006/3.606	24.917/3.595
C	0.3971/0.0700	0.3942/0.0694	0.3936/0.0693	0.3950/0.0696

12.0 Design Density Test Results

The design density was determined as described in CAN/ULC-S703-01 "Standard for Cellulose Fibre Insulation (CFI) for Buildings". Sections 5.2.10 and 6.4.10 were followed.

Six containers, three measuring 900 mm long by 350 mm wide by 150 mm deep and three measuring 450 mm long by 350 mm wide by 300 mm deep, were filled with CFI using an electric centrifugal blowing machine.

900 mm by 350 mm by 150 mm containers

Blown Density	kg/m ³ (lb/ft ³)
20.0717	(1.2529)
19.8470	(1.2389)
19.7615	(1.2336)

450 mm by 350 mm by 300 mm containers

Blown Density	kg/m ³ (lb/ft ³)
20.4050	(1.2737)
19.7803	(1.2347)
20.5064	(1.2801)

Average Laboratory Density: 20.0620 kg/m³ (1.2523 lb/ft³)

Average Limiting Design Density: 24.2750 kg/m³ (1.5153 lb/ft³)

13.0 Design Density, Settlement and Added Water Test Results Type 2 (Open Spaces)

The design density, settlement and added water test was performed as described in CAN/ULC-S703-01 "STANDARD FOR CELLULOSE FIBRE INSULATION (CFI) FOR BUILDINGS", Section 6.4.12 "DESIGN DENSITY, SETTLEMENT AND ADDED WATER - TYPE 2 (OPEN SPACES)".

Two specimens were prepared on January 14, 2008 for the open spaces tests using a Krendl Model 500 blowing machine. The two specimens were identified as B1 and B3. Bags from the lot of cellulose selected on October 8, 2007 by R & D Services were used for the specimens. Only Box B1 was used for these tests. The settlement was 1.51 %. The average added water was 8.70 %. The average limiting design density was 30.726 kg/m³ (1.918 lb/ft³). According to CAN/ULC-S703-01, Section 6.4.12, the percentage of settlement should be no greater than 5%. Therefore, the specimen passed the Type 2 (open spaces) test in order to be classified as a stabilized cellulose product (CFI).

14.0 Surface Burning Characteristics According to CAN/ULC-S102.2.

Three bags of Applegate Insulation witnessed Type 1 cellulosic insulation were shipped to Intertek Testing Services for CAN/ULC-S102.2 tests on November 13, 2007. The CAN/ULC-S102.2 tests were completed and the report was issued on January 28, 2008. The average FSC1 was 45 and the average SD was 0. Intertek Testing Report Number 3139154COQ-001 is attached to this report.

This R&D Services, Inc. test report and the evaluation contained in the report are limited to the material tested. The extent to which the material tested is representative of the product being manufactured is the sole responsibility of the manufacturer. The test results are not purported to predict the performance of the material in a building or installation.

Table of Results: CAN/ULC-S703-01
Applegate Insulation Type 1 Cellulose

Test	Requirements	Results	Comments
Open Flammability: (W/cm²) -Specimen # 1 -Specimen # 2 -Specimen # 3	≥ 0.12 ≥ 0.12 ≥ 0.12	0.15 0.16 0.14	Pass
Open Flammability Permanency: (W/cm²) -Specimen # 1 -Specimen # 2 -Specimen # 3	≥ 0.12 ≥ 0.12 ≥ 0.12	0.14 0.13 0.15	Pass
Surface Burning Characteristics: -Flame spread index -Smoke development	Type 1 Type 2 ≤ 150 ≤ 25 None	45 0	Pass
Smoulder Resistance: (% loss) -Flaming combustion -Loss of mass (%)	None ≤ 15	None 0.20	Pass
Moisture Vapour Sorption: (%)	≤ 20	16.2	Pass
Corrosiveness: -Aluminum coupons -Copper coupons -Steel coupons -Truss plate coupons -Weight loss (%)	No Perforations No Perforations No Perforations No Perforations of Coating ≤ 125 in 1 of 3	None None None None	Pass Pass Pass Pass Pass
Fungi Resistance:	Shall exhibit no more growth than the comparative item	No growth	Pass
Separation of Chemicals: (% by Wt.)	≤ 1.5	0.0	Pass
Thermal Resistivity: (m·K/W) -Specimen # 1 -Specimen # 2 -Specimen # 3 Sample Mean	≥ 18.5	24.777 24.969 25.006 24.917	Pass
Design Density: (kg/m³)	As determined	24.275	No Comment
Design Density (Open Spaces): (kg/m³)	As determined	30.726	No Comment
Design Density (Closed Cavity): (kg/m³)	As determined	No Tests	No Comment