

DSET LABORATORIES

A Division of Atlas Material Testing Technology LLC
45601 North 47th Avenue
Phoenix, Arizona 85087 U.S.A.
Phone: +1 623-465-7356
Toll Free: 800-255-3738 (U.S. only)
Fax: +1 623-465-9409
www.atlas-mts.com

Report No.: 35782-B-0-Revised

Order No.: AE35782-B

Client Ref. No.: PO# 295018

Date: February 16, 2016

**NEAR-NORMAL/HEMISPHERICAL SPECTRAL TRANSMITTANCE,
HEMISPHERICAL SPECTRAL REFLECTANCE,
AND TOTAL EMITTANCE REPORT**

prepared for:

TUFF INDUSTRIES INC.
9570 Bottom Wood Lake Road
Lake Country, BC V4V 1S7

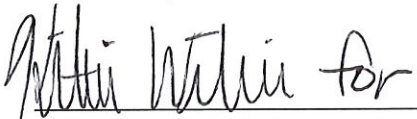
presented by:

Atlas Weathering Services Group
DSET Laboratories
45601 North 47th Avenue
Phoenix, AZ 85087-7042
Phone: 622-465-7356
FAX: 622-465-9409

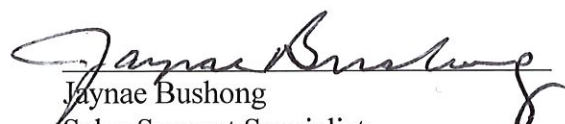
This test report contains only findings and results arrived at after employing the specific test procedures and standards listed herein. It does not constitute a recommendation for, endorsement of, or certification of the product or material tested. Atlas Weathering Services Group makes no warranty, expressed or implied, except that the test has been performed, and a report prepared, based upon the sample or samples furnished by the client. Extrapolation of data from the sample or samples relating to the batch or lot from which it was obtained may not correlate and should be interpreted accordingly with extreme caution. We assume no responsibility for variations in quality, composition, appearance, performance, or other feature of similar subject matter produced by persons or under conditions over which we have no control. This report shall not be reproduced except in full without the written approval by Atlas Weathering Services Group.

This report contains 7 pages

Prepared by:


Erika Wunderlich
Group Leader Evaluation Service

Approved by:


Jaynae Bushong
Sales Support Specialist

DSET LABORATORIES

A Division of Atlas Material Testing Technology LLC
45601 North 47th Avenue
Phoenix, Arizona 85087 U.S.A.
Phone: +1 623-465-7356
Toll Free: 800-255-3738 (U.S. only)
Fax: +1 623-465-9409
www.atlas-mts.com

TUFF INDUSTRIES INC.

Report No.: 35782-B-0
Order No.: AE35782-B
Client Ref. No.: PO# 295018
Date: February 16, 2016
Page 2 of 7

**NEAR-NORMAL/HEMISPHERICAL SPECTRAL TRANSMITTANCE,
HEMISPHERICAL SPECTRAL REFLECTANCE,
AND TOTAL EMITTANCE REPORT**

1.0 INTRODUCTION

This report presents results of spectral reflectance, transmittance and emittance measurements on the following thirteen vinyl specimens coded:

Tufdek TX60
Tufdek D Sand
Tufdek Sanibel
Tufdek Almond
Tufdek Valencia
Tufdek Walnut
Tufdek Carrera
Tufdek Slate
Tufdek Pearl
Tufdek Graphite
Tufdek Driftwood
Tufdek Rustic

DSET LABORATORIES

A Division of Atlas Material Testing Technology LLC
45601 North 47th Avenue
Phoenix, Arizona 85087 U.S.A.
Phone: +1 623-465-7356
Toll Free: 800-255-3738 (U.S. only)
Fax: +1 623-465-9409
www.atlas-mts.com

TUFF INDUSTRIES INC.

Report No.: 35782-B-0
Order No.: AE35782-B
Client Ref. No.: PO# 295018
Date: February 16, 2016
Page 3 of 7

**NEAR-NORMAL/HEMISPHERICAL SPECTRAL TRANSMITTANCE,
HEMISPHERICAL SPECTRAL REFLECTANCE,
AND TOTAL EMITTANCE REPORT**

2.0 TEST METHODS AND PROCEDURESOptical Property Measurements

Hemispherical spectral transmittance and reflectance measurements were performed on the specimen in accordance with ASTM Standard Test Method E903 (2012). The measurements were performed with a PerkinElmer Lambda 950 Spectrophotometer utilizing an integrating sphere (FigureX1.3 of E903). Transmittance measurements were obtained in the solar spectrum from 2500nm to 250nm at an incident angle of 0°. The measurements are properly denoted as being 'near normal/hemispherical spectral transmittance'. Total reflectance measurements were obtained in the solar spectrum from 2500nm to 250nm at an incident angle of 8°. The measurements employ a detector-baffled, wall-mounted integrating sphere that precludes the necessity of employing a reference standard except to define the instrument's 100% line. The measurements are properly denoted as being 'hemispherical spectral reflectance'. All spectral data are submitted herewith in the original.

The spectral data were obtained by integrating the spectral data against Air Mass 1.5 direct (ASTM G159) solar spectrum utilizing 105 weighted ordinates.

The absorptance is calculated from Kirchhoff's Relationship where:

$$\rho + \alpha + \tau = 1$$

DSET LABORATORIES

A Division of Atlas Material Testing Technology LLC
45601 North 47th Avenue
Phoenix, Arizona 85087 U.S.A.
Phone: +1 623-465-7356
Toll Free: 800-255-3738 (U.S. only)
Fax: +1 623-465-9409
www.atlas-mts.com

TUFF INDUSTRIES INC.

Report No.: 35782-B-0
Order No.: AE35782-B
Client Ref. No.: PO# 295018
Date: February 16, 2016
Page 4 of 7

**NEAR-NORMAL/HEMISPHERICAL SPECTRAL TRANSMITTANCE,
HEMISPHERICAL SPECTRAL REFLECTANCE,
AND TOTAL EMITTANCE REPORT**

2.0 TEST METHODS AND PROCEDURES (cont'd)Total Emittance Measurements

Near-Normal infrared reflectance measurements were performed in accordance with ASTM E408, Method A. A Gier Dunkle Instruments Infrared Reflectometer Model DB 100 was utilized for the measurements.

Inside the detector portion are two semi-cylindrical cavities. One of the cavities is heated by an electrical heater and the other stabilizes at approximately room temperature. Thus, the two cavities are maintained at different temperatures. As the cavities rotate, the sample is alternately irradiated at 13 Hz. A vacuum thermocouple views the sample through an optical system that focuses through slits in the ends of the cavities. The detector receives energy emitted by the sample and energy reflected by the sample. Only the reflected energy contains an alternating component as the sample is alternately irradiated by the hot and cold cavities. An amplifier is synchronized with the cavity rotation to pass only the desired alternating signal, which is then rectified and filtered. The zero and gain are set with standards of known emittance. The calibration is rechecked at several intervals during the measurement. The Gier Dunkle Infrared Reflectometer is calibrated using high and low emittance standards. The standards were calibrated at and obtained from the National Physical Laboratory in England. The emittance value for the glass standard equals 0.89. The emittance value for the mirror standard equals 0.01.

Near-Normal emittance for the client's specimens was calculated from Kirchhoff's Relationship where:

$$\rho + \alpha + \tau = 1, \alpha = \varepsilon$$

Since the specimens have no transparency in the far IR, the preceding equation reduces to

$$\rho + \varepsilon = 1 \text{ and } 1 - \rho = \varepsilon$$

DSET LABORATORIES

A Division of Atlas Material Testing Technology LLC
45601 North 47th Avenue
Phoenix, Arizona 85087 U.S.A.
Phone: +1 623-465-7356
Toll Free: 800-255-3738 (U.S. only)
Fax: +1 623-465-9409
www.atlas-mts.com

TUFF INDUSTRIES INC.

Report No.: 35782-B-0
Order No.: AE35782-B
Client Ref. No.: PO# 295018
Date: February 16, 2016
Page 5 of 7

**NEAR-NORMAL/HEMISPHERICAL SPECTRAL TRANSMITTANCE,
HEMISPHERICAL SPECTRAL REFLECTANCE,
AND TOTAL EMITTANCE REPORT**

2.0 TEST METHODS AND PROCEDURES (cont'd)**SRI**

The Solar Reflectance Index is calculated from ASTM E1980. The procedure defines a Solar Reflectance Index (SRI) that measures the relative “steady-state surface temperature” of a surface with respect to the standard white (SRI=100) and the standard black (SRI=0) under the standard solar and ambient conditions. The program used for the calculations was provided by Lawrence Berkeley Laboratory in California.

3.0 OBSERVATIONS, DEVIATIONS, AND WAIVERS

The measurements were performed on the uncoded side of the specimens. Emittance results are an average of four readings.

* = Samples with transmittance may have a higher SRI with a backing.

Measurements on the unbacked samples are from test AE35782. Samples with transmittance were backed with 5/8 inch plywood.

CAUTION: ASTM Test Method E903 (2012), paragraph 5.4 clearly states “this test method has been found practical...except for those materials that are inhomogeneous, patterned, or corrugated”. In that the specimen exhibits inhomogeneities, the client is cautioned when utilizing the reported measurement values.

With all test methods, there typically is a level of uncertainty for the test data due to the acceptable operating tolerances of the instrumentation and variation caused by the test method. The estimated tolerances are expected to be less than plus or minus 2% for most materials tested to ASTM E903.

DSET LABORATORIES

A Division of Atlas Material Testing Technology LLC
 45601 North 47th Avenue
 Phoenix, Arizona 85087 U.S.A.
 Phone: +1 623-465-7356
 Toll Free: 800-255-3738 (U.S. only)
 Fax: +1 623-465-9409
 www.atlas-mts.com

TUFF INDUSTRIES INC.

Report No.: 35782-B-0
 Order No.: AE35782-B
 Client Ref. No.: PO# 295018
 Date: February 16, 2016
 Page 6 of 7

**NEAR-NORMAL/HEMISPHERICAL SPECTRAL TRANSMITTANCE,
 HEMISPHERICAL SPECTRAL REFLECTANCE,
 AND TOTAL EMITTANCE REPORT**

4.0 RESULTS
Optical Property Data

Specimen Code	% Solar Transmittance	% Solar Reflectance	% Solar Absorptance	SRI
Tufdek TX60	0.0	83.2	16.8	105
Tufdek D Sand (with Backing)	0.0	57.8	42.2	70
Tufdek D Sand	1.2	56.8	42.0	*69
Tufdek Sanibel	0.0	51.7	48.3	62
Tufdek Almond (with Backing)	0.0	47.6	52.4	57
Tufdek Almond	1.5	47.3	51.2	*56
Tufdek Valencia (with Backing)	0.0	46.4	53.6	55
Tufdek Valencia	1.4	45.9	52.7	*54
Tufdek Walnut	0.0	42.2	57.8	49
Tufdek Slate	0.0	35.8	64.2	41
Tufdek Carrera	0.0	35.8	64.2	41
Tufdek Pearl	0.0	33.9	66.1	39
Tufdek Graphite	0.0	30.9	69.1	35
Tufdek Driftwood	0.0	26.8	73.2	30
Tufdek Rustic	0.0	22.6	77.4	25
Tufdek Birch (with Backing)	0.0	20.0	80.0	21
Tufdek Birch	0.1	20.7	79.2	*21

DSET LABORATORIES

A Division of Atlas Material Testing Technology LLC
 45601 North 47th Avenue
 Phoenix, Arizona 85087 U.S.A.
 Phone: +1 623-465-7356
 Toll Free: 800-255-3738 (U.S. only)
 Fax: +1 623-465-9409
 www.atlas-mts.com

TUFF INDUSTRIES INC.

Report No.: 35782-B-0
 Order No.: AE35782-B
 Client Ref. No.: PO# 295018
 Date: February 16, 2016
 Page 7 of 7

**NEAR-NORMAL/HEMISPHERICAL SPECTRAL TRANSMITTANCE,
 HEMISPHERICAL SPECTRAL REFLECTANCE,
 AND TOTAL EMITTANCE REPORT**

4.0 RESULTS (cont'd)
Total Emittance Data

Specimen Code	Infrared Reflectance Measured	Near-Normal Emittance Calculated
Tufdek Almond	.06	.94
Tufdek Almond (with Backing)	.06	.94
Tufdek Birch	.06	.94
Tufdek Birch (with Backing)	.06	.94
Tufdek Carrera	.06	.94
Tufdek Driftwood	.06	.94
Tufdek D Sand	.06	.94
Tufdek D Sand (with Backing)	.06	.94
Tufdek Graphite	.06	.94
Tufdek Pearl	.06	.94
Tufdek Rustic	.06	.94
Tufdek Sanibel	.06	.94
Tufdek Slate	.06	.94
Tufdek TX60	.06	.94
Tufdek Valencia	.06	.94
Tufdek Valencia (with Backing)	.06	.94
Tufdek Walnut	.06	.94