WESTERN FIRE CENTER, INC.
2204 Parrott Way, Kelso, Washington 98626
Phone: 360-423-1400 | Fax: 360-423-5003

Fire Testing of Photovoltaic Modules

Indicative testing conducted in accordance with the test methodology described in UL 1703

Class C Spread of Flame, Class C Burning Brand

Slope: 5/12 (Unlimited)

Conducted For:

CSA International
13799 Commerce Parkway
Richmond, British Columbia
Canada, V6V 2N9

Manufacturer: LG Electronics

VDE Project: 181850

WFCi Report #13038

Test Date: April 15, 2013

Report Issued: April 23, 2013

ACCREDITED
TL-180

Testing · Research · Investigation · Consulting · Modeling · Animation · Litigation

TABLE OF CONTENTS

INTRODUCTION

Class C spread of flame and Class C burning brand testing (in accordance with the requirements of UL 1703) was conducted at a slope of 5 in per horizontal foot (5/12) on solar photovoltaic module specimens as received. Testing followed criteria established in Section 31 of the UL1703 standard, *Flat-Plate Photovoltaic Modules and Panels*.

31.1 Spread-of-flame test

31.1.1 A module or panel intended for roof mounting, and designated for installation above, upon or integral with a building roof structure having a surface consisting of a Class A, Class B, or Class C type roof covering material, shall be subjected to a spread-of-flame test described in Tests for Fire Resistance of Roof Covering Materials, UL 790. At no time during or after the tests shall:

a) Any portion of the module or panel be blown off or fall off the test deck in the form of flaming or glowing brands;

b) Portions of the roof deck, or portions of a module or panel intended for installation integral with or forming a part of the building roof structure, fall away in the form of glowing particles;

c) The flame spread beyond 6 ft (1.82 m) for Class A, 8 ft (2.4 m) for Class B, or 13 ft (3.9 m) for Class C rating. The flame spread is to be measured from the leading edge of the sample; or

d) There be significant lateral spread-of-flame from the path directly exposed to the test flame. Spread-of-flame includes flaming on both the top surface (the surface to which the external flame is applied) and in any intermediate channel, such as the space between stand-off or integral modules and a shingle roof.

31.1.2 For a module or panel intended for installation above a building roof structure, the Spread-of-Flame Test is to be conducted with the module or panel oriented with respect to the test flame such that the flame impinges only on the top surface of the module or panel.

31.2 Burning-brand test

31.2.1 A module or panel intended for roof mounting, and designated for installation above, upon, or integral with a building roof structure having a surface consisting of a Class A, Class B, or Class C type roof covering material, shall be subjected to a burning-brand test as described in Tests for Fire Resistance of Roof Covering Materials, UL 790. At no time during or after the tests shall:

a) Any portion of the module or panel be blown off or fall off the test deck in the form of flaming or glowing brands;

b) The brand burn a hole through the roof covering or through any part of the module or panel;

c) Portions of a module or panel intended for installation with, or forming a part of, the building structure fall away in the form of glowing particles; or

d) There be sustained flaming of the module or panel.

TEST APPARATUS AND PROCEDURE

The essential elements of the UL 790 Fire Test Apparatus include a test deck mounted on an adjustable pitch steel frame, a gas burner or wood brand ignition source, a wind tunnel duct, and variable speed blowers to provide a controlled air flow across the test specimen. Airflow was measured at three locations across the test deck midway up the slope of the deck at its center and two outside edges. The measurements were made using an OMEGA-FLO™, Model No. HH-30, vane anemometer manufactured by Omega Engineering, Inc. The airflow is maintained at 12 ± 0.5 mph (5.4 ± 0.2 m/s) throughout the duration of the test.

For the **Class C Spread of Flame Test** a luminous gas flame is applied to the deck at a temperature of 1300 ± 50 °F (704 ± 28°C) as measured by a type K 14 gauge thermocouple located 1 in above the surface and ½ in toward the test flame from the lower edge of the first board of a noncombustible calibration deck. The flame covers approximately the width of the bottom portion of the deck and extends in a triangular pattern with flames extending upward a distance of 4 $^{1}/_{3}$ ft from the lower edge of the deck prior to any contribution (if any) from the deck. The flame is applied for 4 minutes for the Class C test. The flame attached to the deck is monitored for length of travel along the deck over the duration of the test.

For the **Class C Burning Brand Test**, each of the Class C brands were ignited on a gas burner and then placed on the deck at 20 locations at intervals of 1 to 2 minutes with the 12-mile per hour wind passing over them. The test continued until the brands were totally consumed and until all evidence of flaming, glowing, and smoke disappeared from both the exposed surface of the material being tested and the underside of the test deck, or until failure occurred.

UL 1703 provides for single exposures to UL 790 spread of flame and burning brand test conditions. The testing in this project were conducted on self-supporting photovoltaic module panels. Calibration on the test apparatus was also performed on each day of testing.

SAMPLE DESCRIPTIONS

Modules were delivered to WFCi to perform fire testing to be tested for both the spread of flame test and the burning brand test. Module specifications are detailed in the Table 1 and Figure 1 below.

Table 1. Photovoltaic module specifications for spread of flame and burning brand tests.

Manufacturer	LG Electronics
Model Type	LG265S1W-A3
Serial Number	K21133152601 (spread of flame) K21133152590 (burning brand)
Description of Materials	Metal-framed PV module sample, glass front, polymer back
Dimensions	64¾" × 39⅜" × 1⅜"
Date Received	March 28, 2013

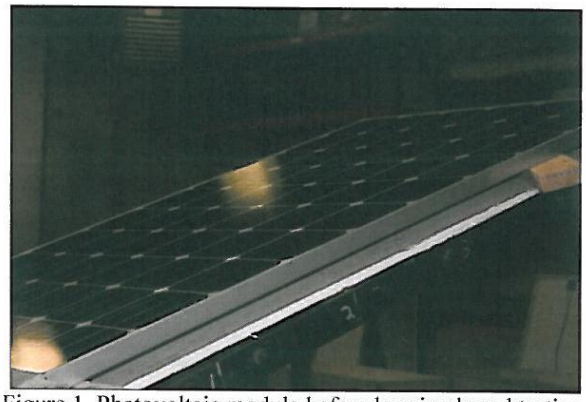

Figure 1. Photovoltaic module before burning brand testing.

TEST RESULTS

The solar panels were tested as received by WFCi personnel to UL1703 test specifications. Class C spread of flame and burning brand tests were conducted with the test sample at a slope of 5/12. The sample panels were tested in a self-supporting condition resting atop simulated stand-offs over a noncombustible deck construction. This was intended to simulate an "above-roof" mounting configuration. The test apparatus was calibrated in accordance with the standard. The spread of flame test and burning brand tests were performed on April 15, 2013.

Calibrations

The tables below show the calibrations and conditions of the test apparatus on the day of testing.

Table 2. Calibration of UL790 test apparatus. '±' indicates standard deviation.

Calibration Date	April 15, 2013
Air Velocity	5.20 ± 0.02 m/s
Average flame temperature	701.6 ± 4.8°C
Gas flow rate (natural gas)	13.0 SCFM
Laboratory air temperature	13°C

Spread of Flame Test

Class C Spread of Flame: **Pass**

The test item complied with the conditions for Class C spread of flame. At 0:48 (min:sec) into the test, the material began to warp, followed by bubbling on the back side at 1:43. The glass popped at 3:04 and warped downward. No flames were observed from the material during the 4 min test. Resultant damage to the material showed charring and discoloration on the exposed side extending about 2.5 ft, and melting of the polymeric backing about 2.0 ft (Figure 2).

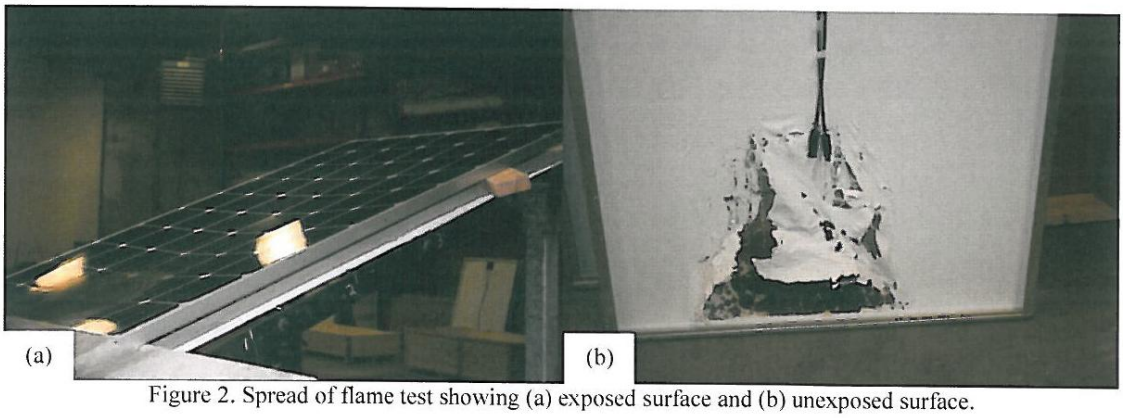

Figure 2. Spread of flame test showing (a) exposed surface and (b) unexposed surface.

Burning Brand Test

Class C Burning Brand: **Pass**

The test item complied with the conditions for Class C burning brand. The test terminated at 26 minutes upon cessation of all signs of combustion of the brands. Ignition of the test sample did not occur on the exposed or underside surface. Glowing particles or flaming/glowing brands that originated from the module were not produced during brand exposure. Scorch marks and discoloration were observed on the exposed surface that had direct exposure to the Class C brands. Blistering of the underside of the panel was observed along with melting of the polymer backing, but through penetration of the module did not occur (Figure 3).

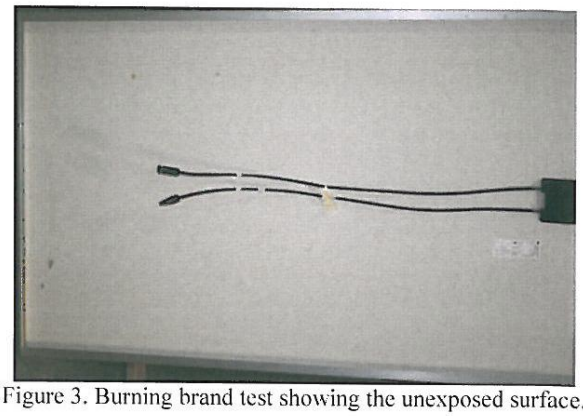

Figure 3. Burning brand test showing the unexposed surface.

CONCLUSION

The sample panels submitted and tested as described above in this report successfully met the criteria for Class C classification (spread of flame and burning brand) at the 5/12 slope in accordance with UL 1703. A summary of the testing results for each fire test is shown in Table 3 below.

Table 3. Summary of Class C test results.

Model Type	Dimensions	Spread of Flame Passage	Burning Brand Passage
LG265S1W-A3	64¾" × 39⅜" × 1⅜"	Yes	Yes

SIGNATURES

Testing performed by,

Mike White

Laboratory Manager

Reviewed and Approved by,

Brent M. Pickett, Ph.D.

Technical Director

WESTERN FIRE CENTER AUTHORIZES THE CLIENT NAMED HEREIN TO REPRODUCE THIS REPORT ONLY IF REPRODUCED IN ITS ENTIRETY

The test specimen identification is as provided by the client, and WFCi accepts no responsibility for any inaccuracies therein. WFCi did not select the specimen and has not verified the composition, manufacturing techniques, or quality assurance procedures.