TESTING APPLICATION STANDARD (TAS) No. 105-11

TEST PROCEDURE FOR FIELD WITHDRAWAL RESISTANCE TESTING

1. Scope

1.1 This Testing Application Standard (TAS) covers procedures for withdrawal resistance testing of fasteners used for attachment of various components to various substrate materials.

1.2 All testing shall be conducted by an approved testing agency, and all test reports shall be signed by a Professional Engineer or Registered Roof Consultant.

1.3 For the purposes of the testing required in TAS 105, design pressures calculated in accordance with ASCE 7 are permitted to be multiplied by 0.6.

2. Definitions

2.1 For definitions of terms used in this application standard, refer to ASTM D 1079; Chapters 2, & 15 of the *Florida Building Code, Building*.

3. Referenced Documents

3.1 Testing Application Standard TAS 105 Appendix A, Field Withdrawal Resistance Test Results Report.

4. Terminology & Units

4.1 Initial Failure: The point at which the recorded load decreases by 5% or more of the most recent, highest reading.

4.2 Units - For conversion of U.S. customary units to SI units, refer to ASTM E 380.

5. Significance and Use

5.1 The test procedures outlined in this TAS provide a means of determining whether a particular mechanical fastener, when used to attach any Roofing Component to a specific substrate, provides sufficient resistance to static uplift force to meet the wind-load requirements of this code for a specific building.

6. Apparatus

6.1 Insulation and Membrane Attachment Testing

6.1.1 The test apparatus shall consist of a hydraulic or mechanically operated dynamometer ("pull-tester") fitted with a hydraulic gauge cell to measure force. The resulting force shall be recorded on a digital or analog gauge. For anchor or base sheet fasteners (commonly referred to as "base ply" fasteners) and other fastener anchors with an anticipated withdrawal resistance less than 100 lbf., the tester and test procedure shall be in compliance with the requirements set forth in this TAS.

6.1.2 Hydraulic dynamometers shall be operated by a screw or pump handle or shall be automatically rising at 2 in. (50 mm) + 0.1 in. per minute for steel and wood decks and $^1/_2$ in. (12.5 mm) + 0.1 in. per minute for concrete, gypsum and cementitious wood fiber decks.

6.2 Anchor or Base Sheet Attachment Testing

6.2.1 The test apparatus shall consist of a minimum $3^1/_2$ in. x $3^1/_2$ in. octagon nylon mesh or 15 mil coated polyester fabric test pad, with a center hole through which the fastener is driven into the deck. The internal hole shall be of sufficient size to allow the fastener legs to pass through without touching the test pad.

6.2.2 The test pad shall be reinforced where attached to the dynamometer to resist tearing.

6.2.3 The dynamometer shall be hydraulic or mechanical and shall be fitted with a hydraulic gauge cell. The resulting force shall be re-

corded on a digital or analog gauge. The dynamometer shall automatically rise at $^1/_2$ in. (12.5 mm) + 0.1 in. per minute for lightweight concrete, gypsum and cementitious wood fiber testing and 2 in. (50 mm) + 0.1 in. per minute for all other nailable deck types.

6.3 Hydraulic dynamometers ("pull-testers") shall be calibrated within three (3) months prior to conducting the test procedures outlined in this TAS. Facsimiles of the calibration shall be kept with the tester for examination by the authority having jurisdiction, upon request. A copy of the calibration certificate shall be attached to each test report. Calibration shall be in compliance with ASTM E 74, Grade B.

7. Test Limitations and Precautions

7.1 This TAS may involve hazardous operations and equipment. This TAS does not address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

8. Test Procedure for Anchor or Base Sheet, Insulation, and Membrane Attachment testing

8.1 On roof decks of 100 squares or less, ten (10) withdrawal resistance tests shall be conducted, not less than three (3) of which shall be in the perimeter areas (2), three (3) in corner areas (3), the remainders in the field areas (1) as defined in ASCE 7.

8.2 For every additional 50 squares, an additional three (3) withdrawal resistance tests shall be conducted. (This ratio of 50:3 shall be maintained with each additional increase in samples.)

8.3 The number of test samples required in shall be increased by 125% for all gypsum, lightweight insulating concrete and cementitious wood fiber deck types.

8.4 Testing shall also take place in any low areas that are, or may be, subjected to ponding water. All such areas shall be noted on a roof plan attached to the final test report.

8.5 If more than one deck type is on a single roof area, each deck type shall be treated as a separate roof area.

8.6 Stair towers, mechanical penthouses and mechanical rooms shall have a minimum of four (4) withdrawal resistance tests, two of which shall be taken at perimeter areas 2 & 3, as defined in ASCE 7.

9. Calculations

9.1 Mean Failure Load ($\overline{F}$) and Sample Standard Deviation

9.1.1 Determine the mean failure load ($\overline{F}$) and sample standard deviation (S_F) using tabulated data and the following equations.

$$\overline{F} = \frac{1}{N}\sum_{i=1}^{N} F_i \qquad \text{and,}$$

$$S_F = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\left(F_i - \overline{F}\right)^2} \qquad \text{where,}$$

F = mean failure load (lbf);

S_F = sample standard deviation (lbf);

N = total number of pulls;

F_i = recorded failure load on pull number i; and,

i = 1, 2, 3, ..., N = pull number

9.2 Minimum Characteristic Resistance Force (F')

9.2.1 Determine the minimum characteristic resistance force (F') using the following equation.

$$F' = \overline{F} - t_{v,p}x\left(\frac{S_F}{\sqrt{N}}\right)$$

where,

F' = minimum characteristic resistance force (lbf);

$\overline{F}$ = mean failure load (lbf);

t_{Qp} = t-estimator based on 95% precision level;

v = degrees of freedom = (N-1);

P = probability level = 95%; and,

S_F = sample standard deviation.

9.2.1.1 The t-estimator noted above is a function of probability (P) and degrees of freedom (v). Values for a 95% probability level are noted in Table 1, below.

TABLE 1
VALUES FOR T-ESTIMATOR AT 95% PROBABILITY

DEGREES OF FREEDOM (v)	t_v95
9	2.26
10	2.23
11	2.20
12	2.18
13	2.16
14	2.15
15	2.13
16	2.12
17	2.11
18	2.10
19	2.09
20	2.09
21	2.08
22	2.07
23	2.07
24	2.06
25	2.06
26	2.06
27	2.05
28	2.05
29	2.05
30	2.04
40	2.02
60	2.00

1 degrees of freedom is equal to the number of pulls minus one (v = N - 1)

10. Report

10.1 The final test report shall include the following items:

10.1.1 Certification of dynamometer ("pull-tester") calibration within three (3) months prior to conducting the test, including calibration data.

10.1.2 The final test report shall be signed and sealed by a Professional Engineer or Registered Roof Consultant.

10.1.3 A description of the name, location, height, dimensions and deck type(s) and/or substrate type(s) of the building on which the test is being conducted.

10.1.4 The fastener type and manufacturer and a description of the Roofing Component which the fastener is intended to secure.

10.1.5 The number of withdrawal resistance tests; the tabulated test results; and a statistical analysis of the raw data, including the mean failure load; the sample standard deviation; and the minimum characteristic resistance force.

10.1.6 If a hole is pre-drilled, data on the size and type of bit shall be included together with the depth of the hole and the type of equipment used to pre-drill.

10.1.7 If the fastener is self-drilling, include the type and speed of the installation tool. Literature on the fastening device shall be attached to the test report.

10.1.8 Failure of the fastener shall be recorded at "initial failure load." The ultimate failure load (the greatest resistance to pullout recorded prior to withdrawal) shall not be recorded.

10.1.9 Indicate on a roof plan the locations where all withdrawal resistance tests were taken with an "identifier" and include the "identifier" with the data submitted.

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APPENDIX A
FIELD WITHDRAWAL RESISTANCE TEST RESULTS REPORT

GENERAL INFORMATION:

Job Name: _____

Job Address: _____

_____

Contact Individual at
job site (if any): _____

TESTING AGENCY/EQUIPMENT INFORMATION:

Note: The undersigned acknowledges that all testing has been conducted and results have been reported in compliance with TAS 105 or TAS 105 Appendix A.

Testing Agency Name: _____

Address: _____

_____

Telephone: (_____) - _____ - _____

Fax: (_____) - _____ - _____

Representative Name: _____

Title: _____

Signature: _____

Test Apparatus (General Description):

_____

_____

_____

BUILDING/ROOF SYSTEM INFORMATION:		**Area No.** ______
Roof Area Height:	height	= ______ ft
Roof Area Dimensions:	length	= ______ ft
	second largest dimension	= ______ ft
	total roof area	= ______ ft^2
		= ______ sqs.
	perimeter area	= ______ ft^2
	(see RAS 117)	

BUILDING/ROOF SYSTEM INFORMATION:		**Area No.** ______
Roof Area Height:	height	= ______ ft
Roof Area Dimensions:	length	= ______ ft
	second largest dimension	= ______ ft
	total roof area	= ______ ft^2
		= ______ sqs.
	perimeter area	= ______ ft^2
	(see RAS 117)	

BUILDING/ROOF SYSTEM INFORMATION:		**Area No.** ______
Roof Area Height:	height	= ______ ft
Roof Area Dimensions:	length	= ______ ft
	second largest dimension	= ______ ft
	total roof area	= ______ ft^2
		= ______ sqs.
	perimeter area	= ______ ft^2
	(see RAS 117)	

Note: If more than three roof areas are tested, attach additional page(s) having this format to identify all roof areas.

FASTENER INSTALLATION INFORMATION:

Is the fastener a self-driller? yes no

If yes, list the type of tool used for fastener installation:

_____

Speed of Tool: _____ rpm's

TEST INFORMATION:

Number of Tests Conducted: n = _____

- *See Section 8 of TAS 105*
- *Note the location of all tests on "Building Information" Detail #2, attached.*

FIELD WITHDRAWAL RESISTANCE TEST RECORDING SHEET

Area No. _____ Fastener Type: _____

(Refer to deck dimensions referenced on page __) Fastener Manufacturer: _____

Component to be secured: Pre-drilled? Yes ___ No ___

Insulation

Membrane If Yes: Drill bit size: _____ " dia.

Anchor or Base Sheet

Woodblocking Hole Depth: _____ "

Metal Profiles

See Section 8 to determine number of tests (If drill bit is high tolerance, include range in $^{1}/_{1000}$" tolerances)

SAMPLE NO.	PLAN IDENTIFIER	INITIAL FAILURE LOAD (lbf)	FIELD PERIMETER OR CORNER ARE (circle one)		
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C
			F	P	C

STATISTICAL ANALYSIS:

Mean Failure Load: F = _____ lbf

Sample Standard Deviation: S_F = _____ lbf

Minimum-Characteristic Resistance Force: F' = _____ lbf

Notes:

1. **Use of the results herein to determine the required number of fasteners for insulation attachment or an acceptable anchor or base sheet fastener spacing, as outlined in TAS 117, shall utilize the minimum characteristic resistance force (*F'*), determined in compliance with Section 9 of TAS 105. No margin of safety shall be applied to field withdrawal resistance test results determined in compliance with TAS 105.**

2. **A safety factor of 2 to 1 shall be applied to all results of laboratory testing.**

3. **The following pages shall be completed for each roof area and included with all Field Withdrawal Resistance Test Recording Sheets.**

Notes: _____

_____

_____

ROOF AREA NO. _____
INSERT BUILDING AND PARAPET HEIGHTS.
(IF NO PARAPET EXISTS, INSERT "N/A")