TEST REPORT ON

26 GA. PBR PANELS
AT 5' 0" PANEL SPANS
WITH 26 GA. SEALED 'N' SAFE™ THERMAL BLOCKS
IN ACCORDANCE WITH ASTM E455-11
AND AISI S907-08

TESTED FOR:
Sealed 'N' Safe
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Ephraim, Utah 84627
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TESTED BY:
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TEST WITNESSED BY:
Bala Sockalingam, Ph.D., P.E.

TESTING DATE: October 29 & 30, 2013
REPORTING DATE: November 12, 2013

ENCON® Project C1928-2

ACCREDITED
TL-327

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11.15.2013

TEST SUMMARY

1.1 SUMMARY

Tests were conducted on PBR Panels at ENCON® Technology, Inc. Test Facility, Tulsa, Oklahoma. The purpose of the tests was to determine the diaphragm shear strength and shear stiffness of PBR panel construction with 26 ga. Sealed 'N' Safe™ thermal blocks under simulated loading conditions. These tests meet the provisions of ASTM E455-011 and AISI S907-08 and are listed below.

Test #1 & 2: PBR panels at three equal span of 5' 0". The panel fastener spacing was 12" o.c. at the end and intermediate supports. Tested on October 29 & 30, 2013.

The sidelap fasteners spacing for both tests was 30" o.c. The panels were fastened to the supports through 4" thick blanket insulation and thermal block. The above-defined tests were witnessed by Bala Sockalingam, Ph.D., P.E. of ENCON Technology, Inc.

1.2 PANEL SYSTEM DESCRIPTION

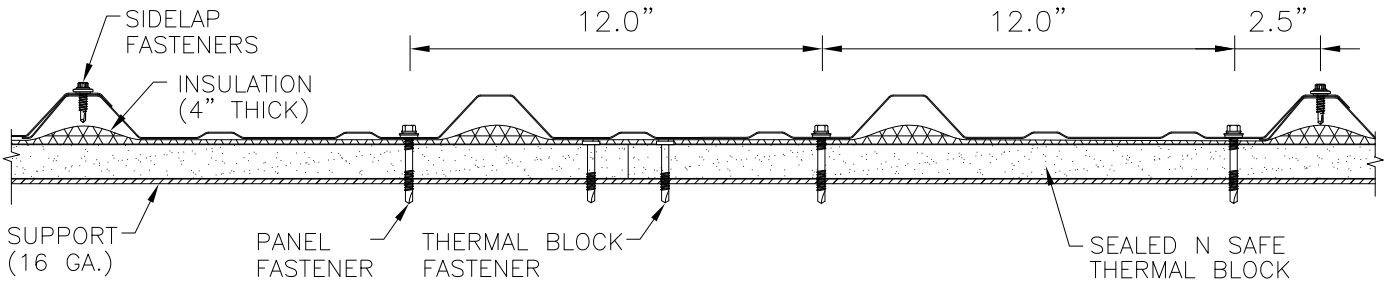
PBR panels are 26 ga., 1-1/4" high and 36" wide through fastened panels. Each panel consists of four major ribs spaced at 12" o.c. as shown on Page 3.

The panels were attached to nominal 16 ga. Cee supports through the 4" thick blanket insulation and thermal block with #12 x 2" long hex head self-drilling screws with washers. Each panel spanned over three continuous spans of 5' 0" with 3" overhang. The sidelap fasteners were #14 x 7/8" long hex head self-drilling screws with washers and were spaced at 30" o.c. The two sides of the panel assembly were attached to 16 ga. rake sections with #12 x 2" long hex head self-drilling screws with washers spaced at 30" o.c.

Sealed 'N' Safe™ thermal blocks consisted of two 26 ga. steel profiles with polyurethane foam injected between the profiles to form a 1" thick block. The length and width of these thermal blocks were 72" and 2.5", respectively. The blocks were fastened to the supports with #12 x 1-5/8" long pancake head self-drilling screws located at each end of the blocks.

1.3 TEST RESULTS

Load was applied incrementally and deflections of the test construction were recorded for 'no load' condition and at each load increment. The failure mode in both tests was shear failure of the panel fastener near the roller corner. The average ultimate shear strength from the two tests is 233.4 lb/ft and average shear stiffness is 5212.8 lb/in.

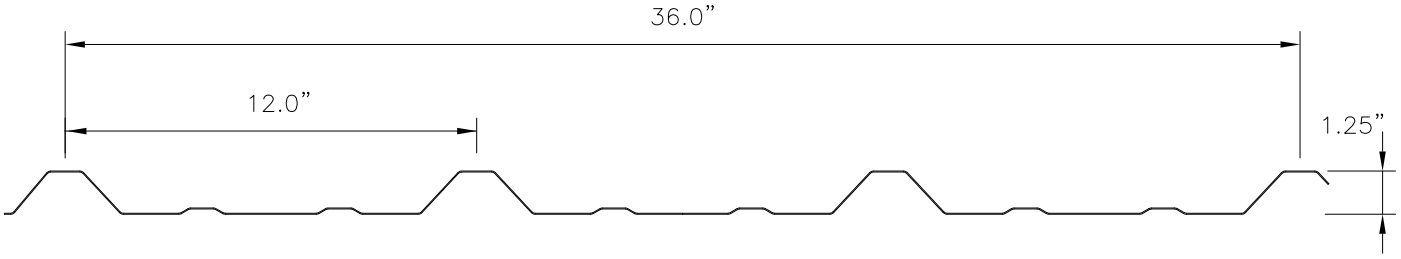


a. AT END & INTERMEDIATE SUPPORTS

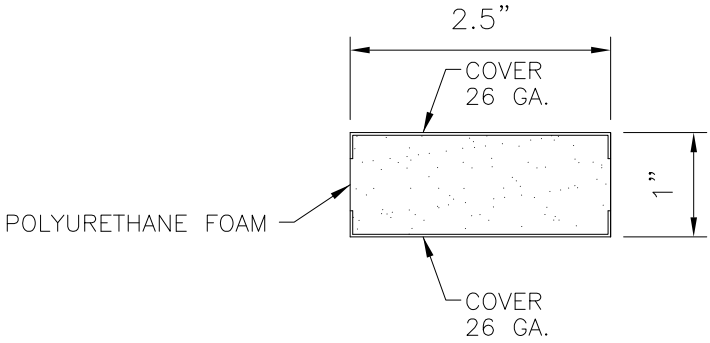
TEST SERIES	PANEL SPANS (ft)	FASTENER PATTERN	SPAN a (ft)	DEPTH b (ft)	MAX. LOAD Pu (lb)	SHEAR STRENGTH Su (lb/ft)	0.4Pu (lb)	DEFL. AT 0.4Pu (in)	SHEAR STIFFNESS G' (lb/in)
1	5.0–5.0–5.0	1	15.5	16.25	3684	226.7	1474	0.275	5111.2
2	5.0–5.0–5.0	1	15.5	16.25	3900	240.0	1560	0.280	5314.3
					AVERAGE	233.4		AVERAGE	5212.8

NOTES:

1. PANEL THICKNESS IS 26 GA. AND YIELD STRESS IS 80 KSI.
2. PANEL TO SUPPORT FASTENER IS #12 X 2" LONG SDS.
3. PANEL TO PANEL FASTENER IS #14 X 7/8" LONG SDS.
4. PANEL TO PANEL FASTENER SPACING 30" O.C.
5. PANEL FASTENED TO SUPPORTS THROUGH 4" THICK INSULATION & THERMAL BLOCKS.
6. THERMAL BLOCKS FASTENED TO SUPPORTS WITH #12 X 1–5/8" LONG PANCAKE HEAD SDS AT EACH END OF THE THERMAL BLOCK.



26 GA., PBR PANEL



SEALED 'N' SAFE THERMAL BLOCKS

2.1 DESCRIPTION OF TEST

OBJECTIVES

Tests were conducted to determine shear strength and shear stiffness of the panels under simulated loading conditions. The test method consisted of the following:

1. assembling the test panel on an interior test frame to form a typical roof or wall construction;
2. loading the test frame incrementally; and
3. observing, measuring, and recording the deflections, deformations, and nature of any failures of principal or critical elements of the test construction.

The increments of load application were chosen such that a sufficient number of readings were obtained to determine the load deformation curve of the system.

TEST SETUP

The test setup consisted of an exterior reaction truss and interior panel support frame as shown in the applicable drawings in the appendix. The L-shaped reaction truss was constructed of two built-up tube sections with cross-braced angle sections to form a truss. The panel support frame was constructed of cold-formed Cee sections having equal or lower strength and stiffness than that intended for use in the typical constructions. All the connections in the interior frame were pinned.

Both the truss and frame lay in the same horizontal plane. The reaction frame was supported by short columns, which rested on the laboratory floor. Two corners of the interior frame were connected to the exterior frame with a hinge and roller. The side opposite to these corners was held up by columns with roller bases. The intermediate girts were attached to the side post with pinned connections.

LOADING DEVICE

Load was applied using a 10 kip capacity hydraulic ram and manual pump. The load was monitored with a calibrated 10 kip capacity load cell and associated instrumentation. The accuracy of the load cell was estimated to be $\pm$ 0.01 kips. The hydraulic ram was attached to the reaction truss and the load cell was attached to the interior frame. The load was applied parallel to and in close proximity to one of the points of contact between the diaphragm web and frame.

DEFLECTION MEASUREMENT

Deflection measurements were taken by means of dial indicators calibrated to 1/1000 of an inch. Deflections were measured at locations as shown on the drawings in the appendix. The deflection locations are based on AISI S907-08.

DESCRIPTION OF TEST

DIAPHRAGM SIZE

The overall dimension of each construction was in excess of 16' 3" x 15' 6". The panels covered three equal spans of 5' 0". The construction width contained five full panels. The panels were attached to the end and intermediate Cee girt sections with self-drilling screws. The panels were not attached to the side member of the interior frame. The details of the methods of construction are depicted in the enclosed test drawings. All the material used in the construction represented a typical construction.

NUMBER OF TESTS

Minimum of two panel assemblies was tested to determine the value of a given construction.

TEST PROCEDURE

Prior to the diaphragm construction, the interior frame was loaded to determine its bare frame stiffness. The bare frame stiffness was insignificant, deflecting 1" under a 10-lb load. The loading procedure on the completed diaphragm construction consisted of loads applied in increments. The diaphragm was loaded to 20% of the anticipated ultimate load and unloaded. Deflection measurements were recorded at 'no load' conditions. The diaphragm was loaded in 300-lb increments until failure. Deflection measurements were recorded at every load increment.

TEST DURATION

The test was stopped when the test specimen was unable to carry additional load or visual failure of one or more components of the diaphragm occurred.

2.2 CALCULATIONS

The ultimate shear strength S_u (lb/ft) of a given construction is
where

$$S_u = \frac{P_u}{b}$$

P_u = maximum applied load in the cantilever beam test (lb),
b = depth of diaphragm (ft).

The net shear deflections (Δ) at any load level in the cantilever beam test is

$$\Delta = \Delta_3 - \left[\Delta_2 + \frac{a}{b}(\Delta_1 + \Delta_4) \right]$$

where Δ_1, Δ_2, Δ_3 and Δ_4 are measured deformations with appropriate signs at locations shown in the test drawings.

DESCRIPTION OF TEST

The apparent shear stiffness G' (lb/in) of a given construction is where

$$G' = \frac{P}{\Delta}\left(\frac{a}{b}\right)$$

P = $0.4P_u$ in the cantilever beam test (lb),
a = span of diaphragm (ft).
Δ = Net shear deflection of diaphragm (in) at $0.4P_u$ load.

The shear stiffness calculation is based on AISI S907-08.

TEST RESULTS

3.1 SPECIMEN IDENTIFICATION

Panel Manufacturer:	CO Building Systems, Inc.
Model Type:	PBR Panel
Dimensions:	1.25" high, 36" wide coverage
Panel Thickness:	26 ga.
Base Metal Thickness:	0.017"
Panel Yield Stress:	80 ksi (103.7 ksi tested)
Panel Fasteners:	#12 x 2" long hex head self-drilling screws with washers (DB Building Fasteners, Inc.)
Sidelap Fasteners:	#14 x 7/8" long hex head self-drilling screws with washers
Sidelap Fasteners Spacing:	30" o.c.
Thermal Blocks:	Sealed 'N' Safe™ - consisted of two 26 ga. steel profiles with polyurethane foam injected between the plates to form a 1" thick block. The length and width of the thermal block were 72" and 2.5", respectively. Polyurethane foam was manufactured by Utah Foam and designated as X10324.
Profile Thickness:	26 ga.
Base Metal Thickness:	0.0168"
Profile Yield Stress:	80 ksi (111.8 ksi tested)
Thermal Blocks Fasteners:	#12 x 1-5/8" long pancake head self-drilling screws (DB Building Fasteners, Inc.)
Insulation:	4" thick blanket insulation
Support Thickness:	16 ga. (0.058" coated)

Note: All the test materials were supplied by CO Building Systems, Inc. and Sealed 'N' Safe and were not sampled by ENCON.

3.2 TEST #1: 26 Ga., 80 KSI PBR PANELS WITH THERMAL BLOCKS AT THREE EQUAL SPANS OF 5' 0"

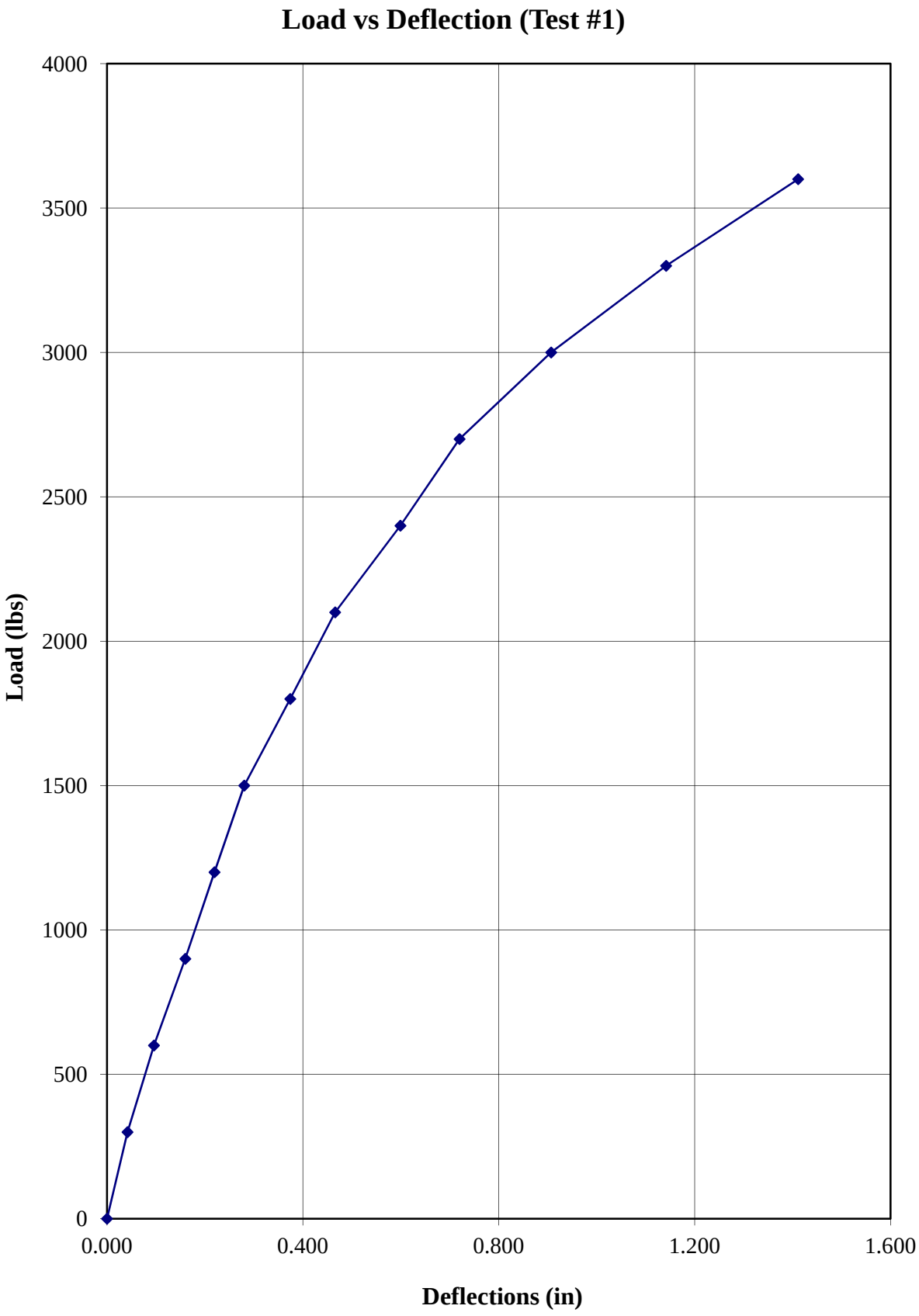
Date:	10.29.13
Panel Type:	CO Building PBR panel
Gauge:	26 ga.
Thickness:	0.017"
Panel Width:	36"
Support Spacing:	5' 0"-5' 0"-5' 0"
Type of Structural Fastener:	#12 x 2" long SDS
Fastener Spacing at End Supports:	12" o.c.
Fastener Spacing at Intermediate Supports:	12" o.c.
Insulation	4" thick blanket & Sealed N Safe 26 ga. thermal blocks
Type of Sidelap Fastener:	#14 x 7/8" long SDS
Sidelap Fastener Spacing	30" o.c
a = span length of diaphragm (ft):	15.50
b = depth of diaphragm (ft):	16.25

Load (lb)	Dial Indicator Reading (in)				Shear Deformation Δ (in)
	1	2	3	4	
0	0.000	0.000	0.000	0.000	0.000
300	0.012	0.016	0.136	0.070	0.042
600	0.016	0.049	0.348	0.197	0.096
900	0.027	0.093	0.581	0.317	0.160
1200	0.030	0.125	0.745	0.390	0.219
1500	0.031	0.157	0.895	0.449	0.280
1800	0.016	0.174	1.027	0.486	0.374
2100	0.013	0.194	1.173	0.525	0.466
2400	0.031	0.212	1.392	0.578	0.599
2700	0.043	0.237	1.594	0.625	0.720
3000	0.047	0.264	1.852	0.667	0.907
3300	0.052	0.296	2.174	0.720	1.142
3600	0.054	0.328	2.529	0.774	1.411
3684					

Failure Mode: Fastener shear failure at roller corner

Duration of test: > 10 minutes

	Temperature (F)	Relative Humidity (%)
At construction:	71.6	52
At testing	71.6	52

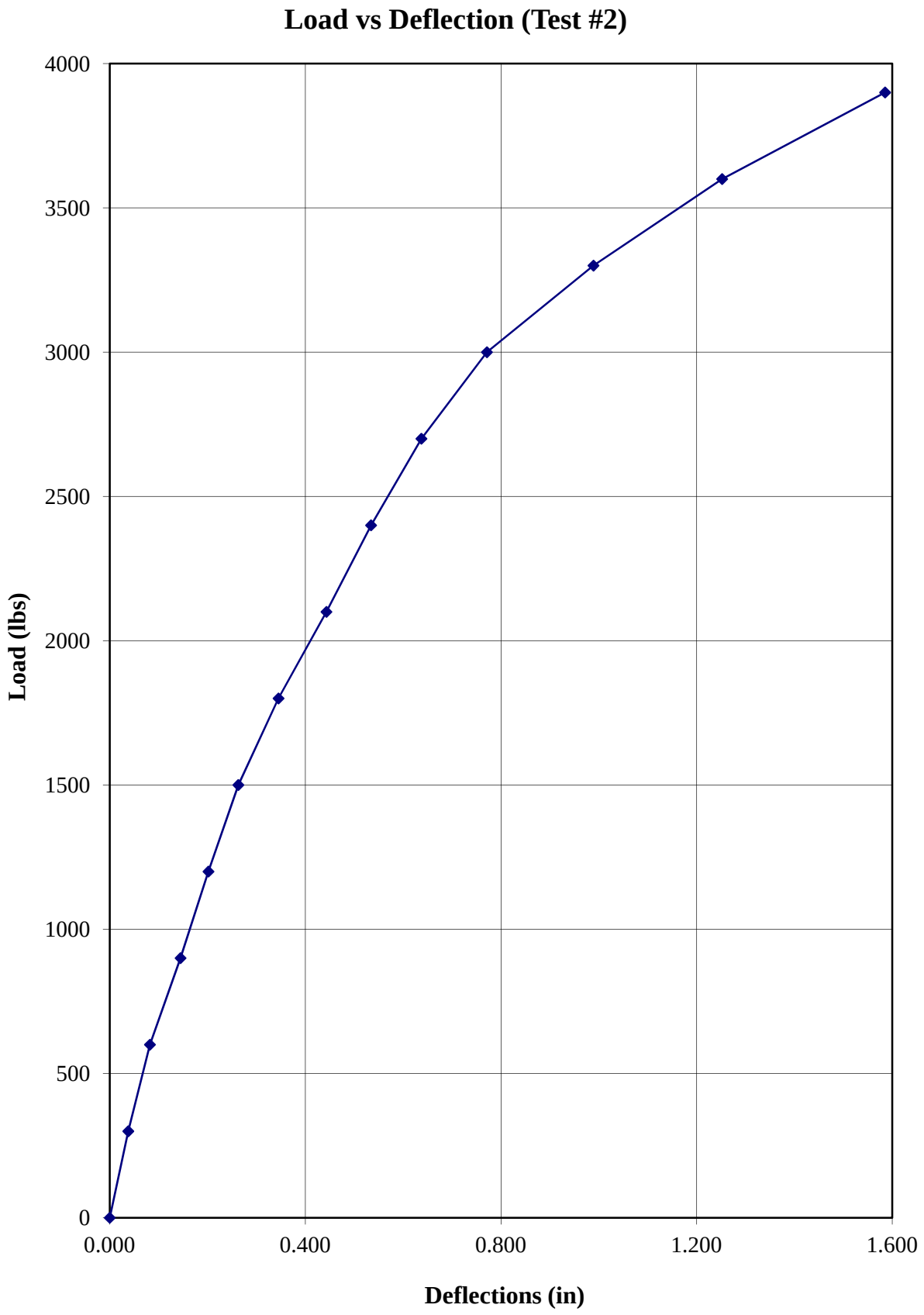

Load vs Deflection (Test #1)
Load (lbs)
4000
3500
3000
2500
2000
1500
1000
500
0
0.000
0.400
0.800
1.200
1.600
Deflections (in)

3.3 TEST #2: 26 GA., 80 KSI PBR PANELS WITH THERMAL BLOCKS AT THREE EQUAL SPANS OF 5' 0"

Date:	10.30.13
Panel Type:	CO Building PBR panel
Gauge:	26 ga.
Thickness:	0.017"
Panel Width:	36"
Support Spacing:	5' 0"-5' 0"-5' 0"
Type of Structural Fastener:	#12 x 2" long SDS
Fastener Spacing at End Supports:	12" o.c.
Fastener Spacing at Intermediate Supports:	12" o.c.
Insulation	4" thick blanket & Sealed N Safe 26 ga. thermal blocks
Type of Sidelap Fastener:	#14 x 7/8" long SDS
Sidelap Fastener Spacing	30" o.c
a = span length of diaphragm (ft):	15.50
b = depth of diaphragm (ft):	16.25

Load (lb)	Dial Indicator Reading (in)				Shear Deformation Δ (in)
	1	2	3	4	
0	0.000	0.000	0.000	0.000	0.000
300	0.024	0.011	0.129	0.060	0.038
600	0.049	0.050	0.363	0.193	0.082
900	0.053	0.073	0.542	0.287	0.145
1200	0.059	0.105	0.715	0.369	0.202
1500	0.062	0.139	0.876	0.435	0.263
1800	0.062	0.152	1.035	0.502	0.345
2100	0.065	0.162	1.186	0.544	0.443
2400	0.073	0.187	1.346	0.582	0.534
2700	0.081	0.203	1.506	0.617	0.637
3000	0.098	0.235	1.734	0.665	0.771
3300	0.106	0.272	2.047	0.718	0.989
3600	0.109	0.301	2.382	0.760	1.252
3900	0.111	0.329	2.789	0.806	1.585

Failure Mode:	Fastener shear failure at roller corner	
Duration of test:	> 10 minutes	
	Temperature (F)	Relative Humidity (%)
At construction:	73.4	58
At testing	73.4	58


Load vs Deflection (Test #2)
Load (lbs)
4000
3500
3000
2500
2000
1500
1000
500
0
0.000
0.400
0.800
1.200
1.600
Deflections (in)

PHOTOGRAPHS

PHOTO 1 View of the Sealed 'N' Safe™ thermal blocks, panel and sidelap fasteners (left to right). (DSCN1373)

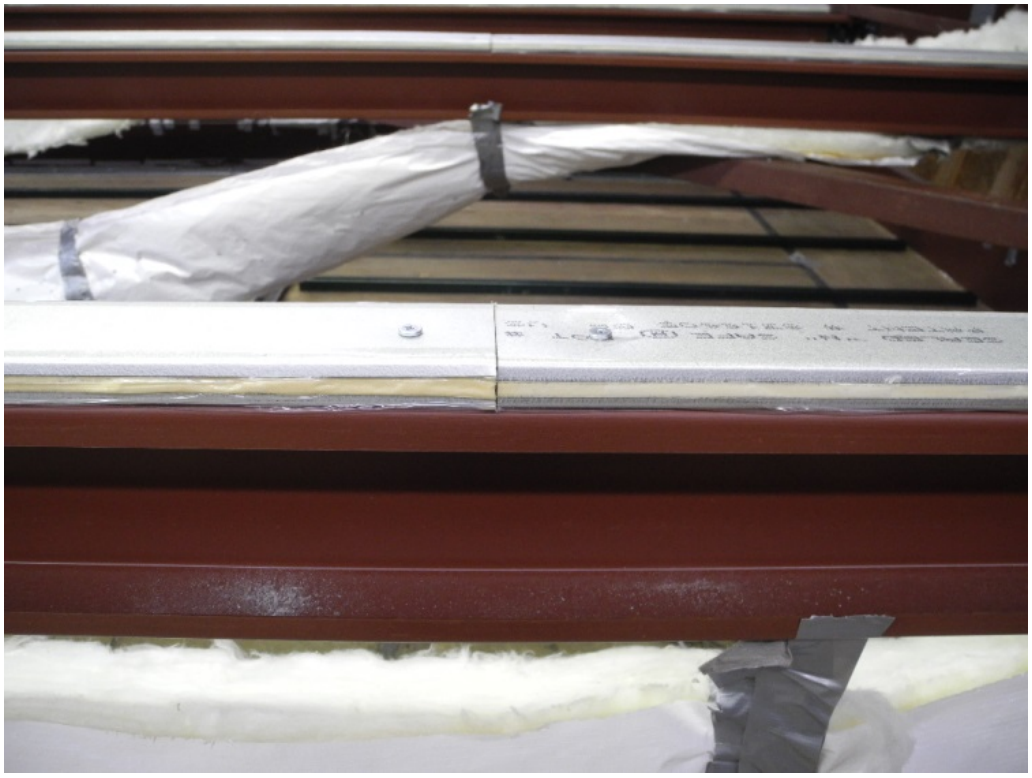


PHOTO 2 View of the Sealed 'N' Safe™ thermal blocks fastened to supports. (DSCN1369)

PHOTOGRAPHS

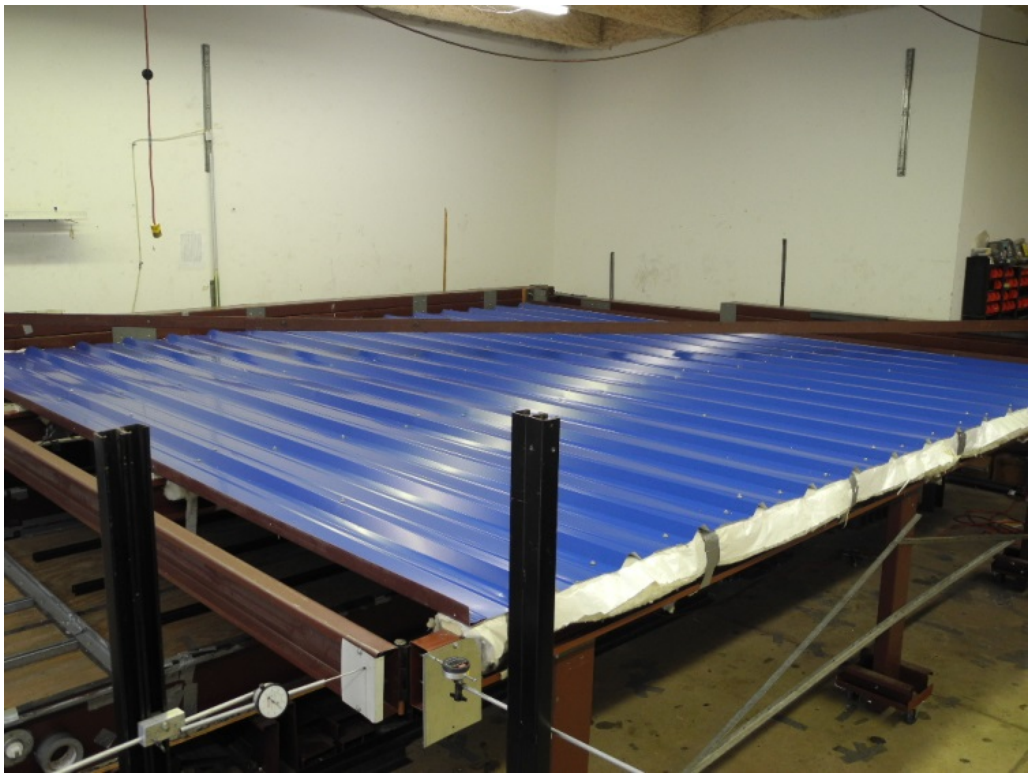


PHOTO 3 Overview of the diaphragm test setup of the PBR panels. (DSCN1362)

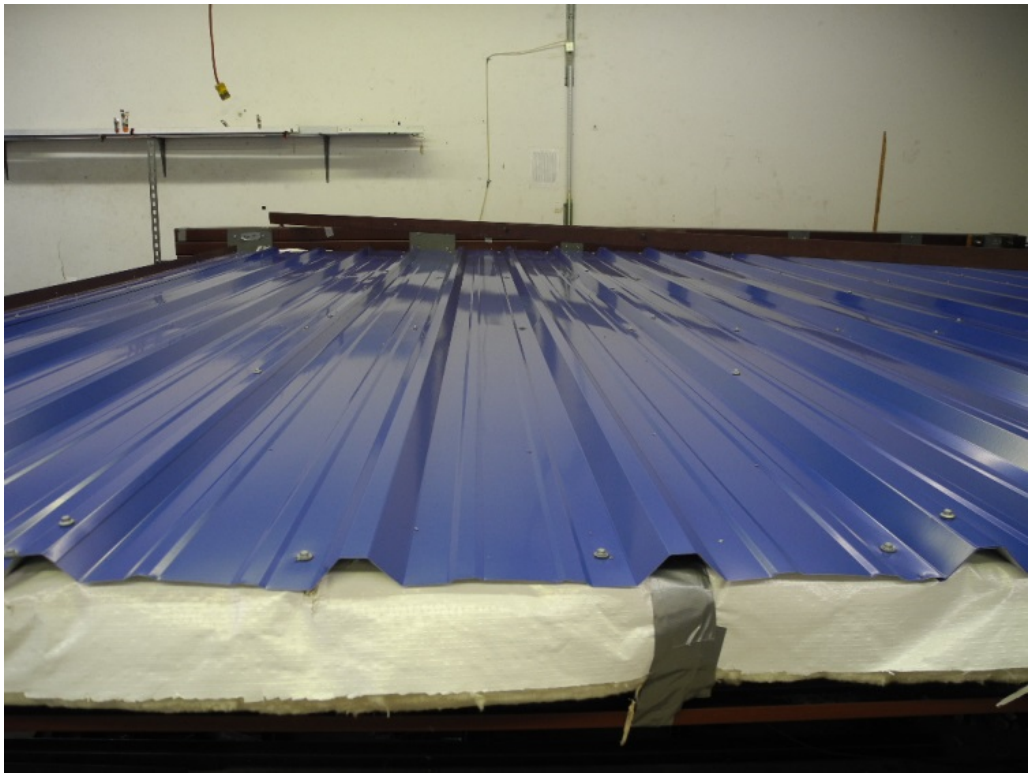


PHOTO 4 View of the panel fasteners at end and intermediate supports. (DSCN1371)

PHOTOGRAPHS

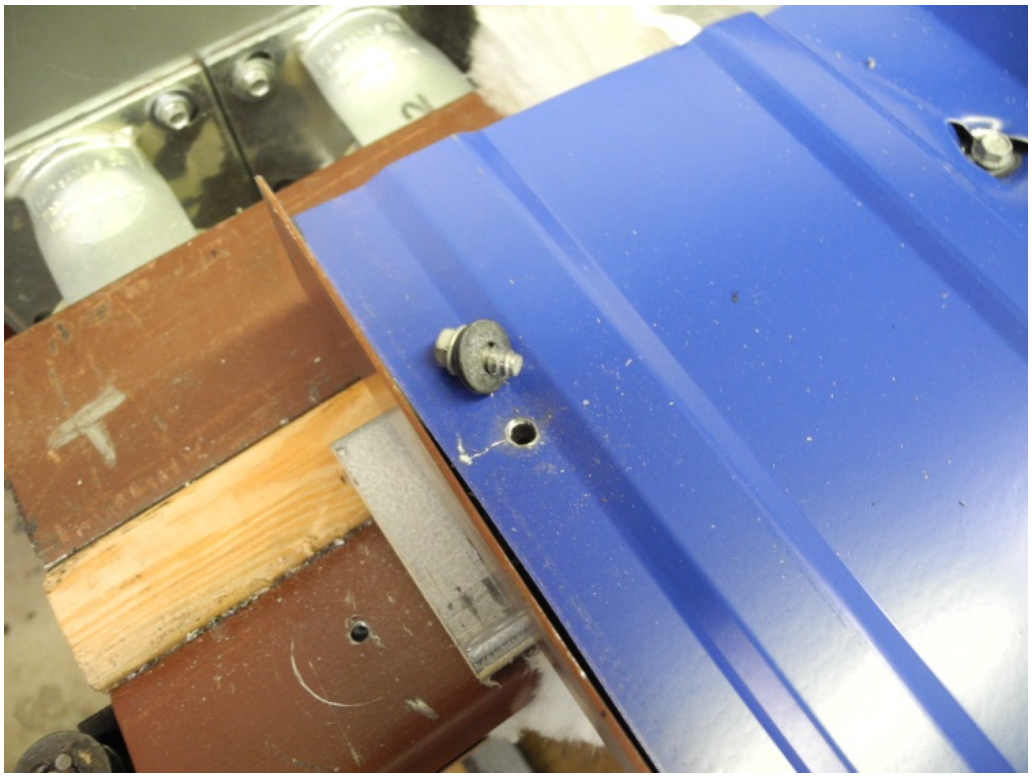
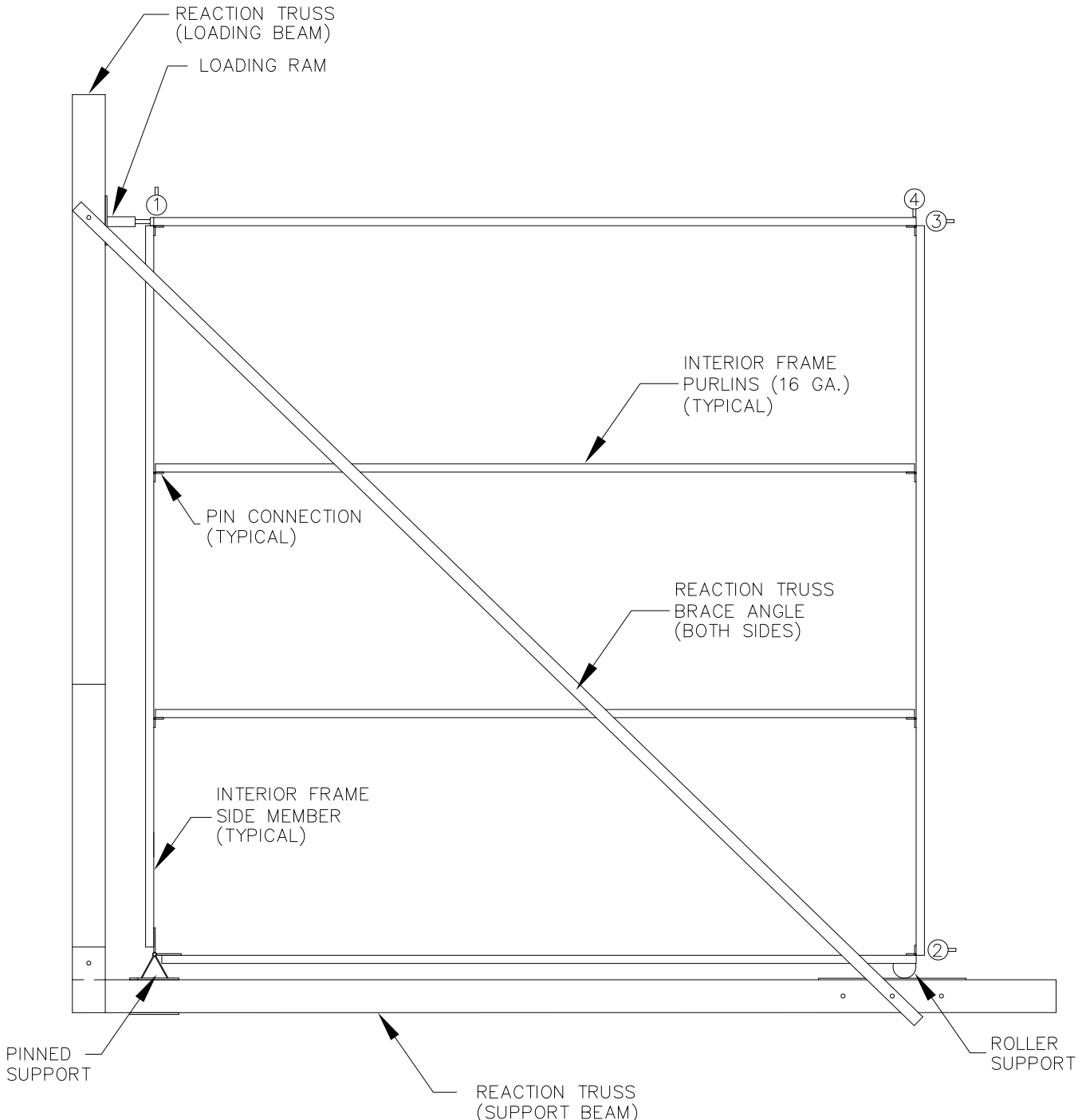


PHOTO 5 View of fastener shear failure near the roller corner in Test #1. (DSCN1368)

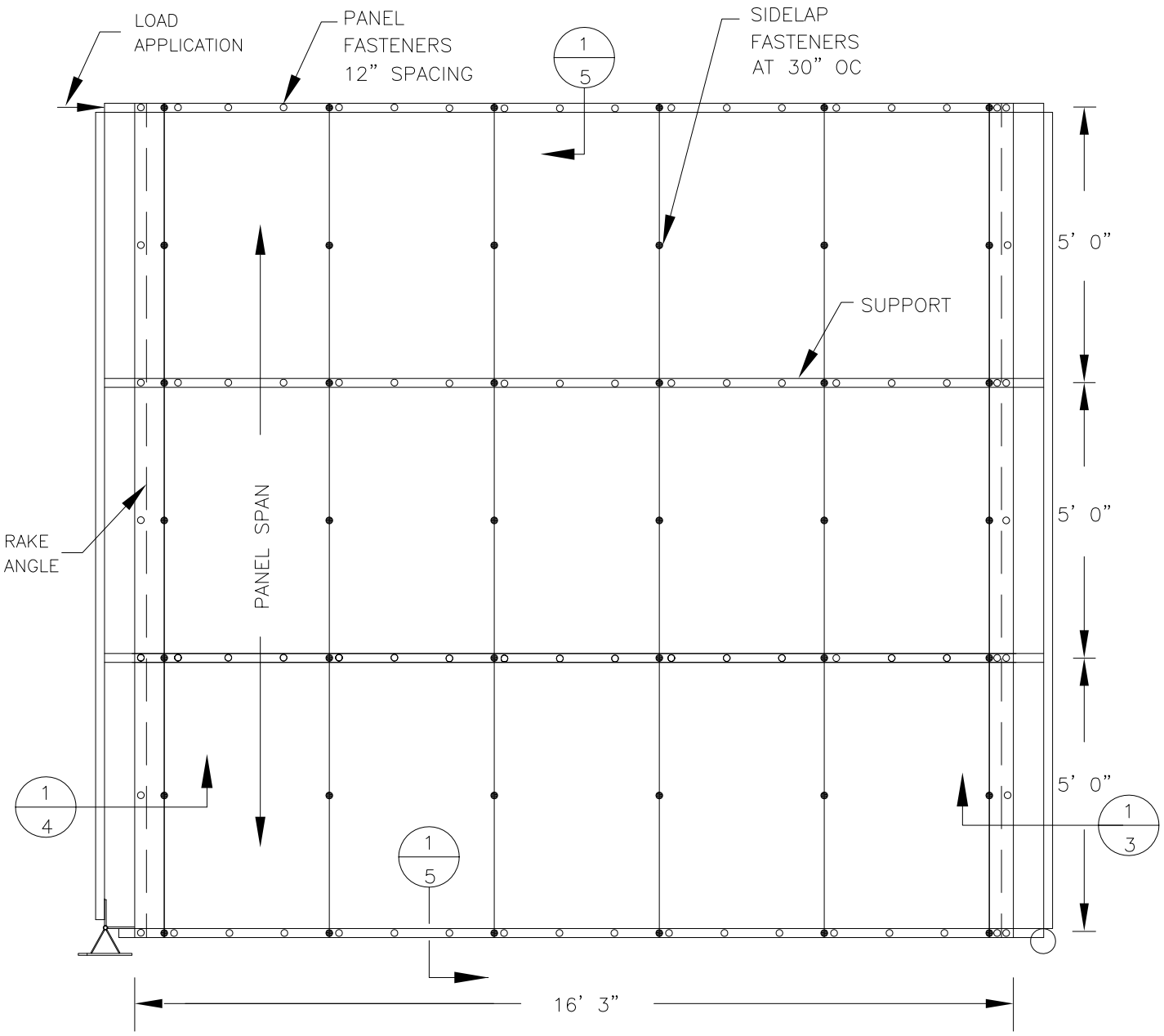
PHOTO 6 View of fastener shear failure near the roller corner in Test #2. (DSCN1373)



1/1 TEST SETUP PLAN VIEW

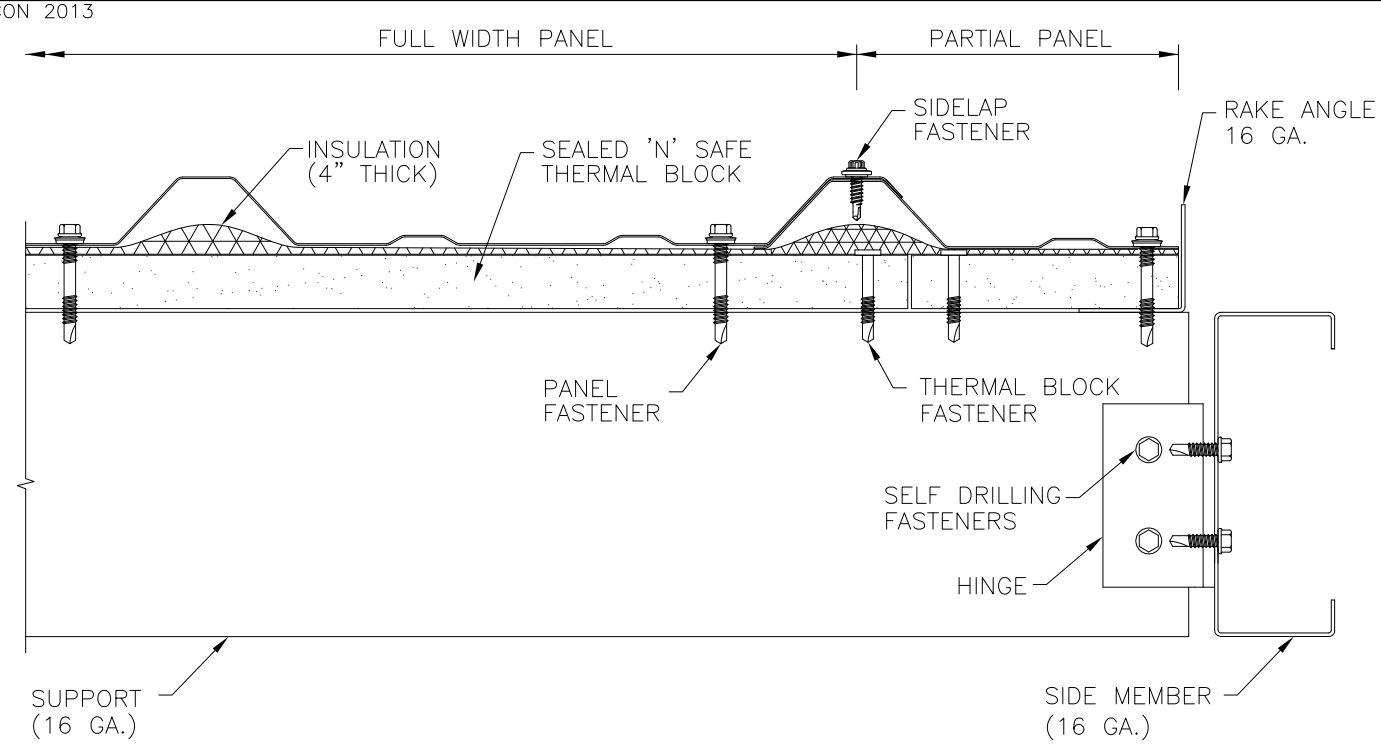
NOTES:

① DIAL INDICATOR LOCATION

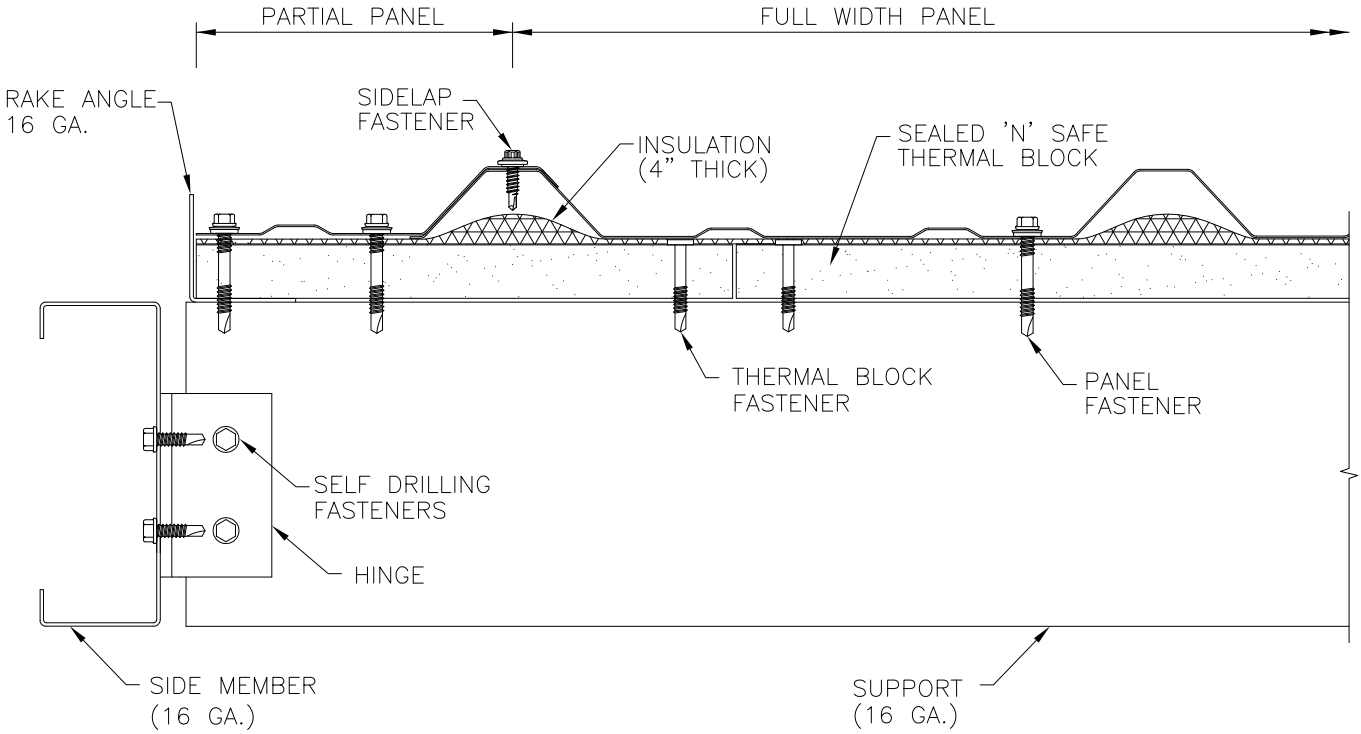


1/2 PLAN VIEW OF TEST PANEL SETUP

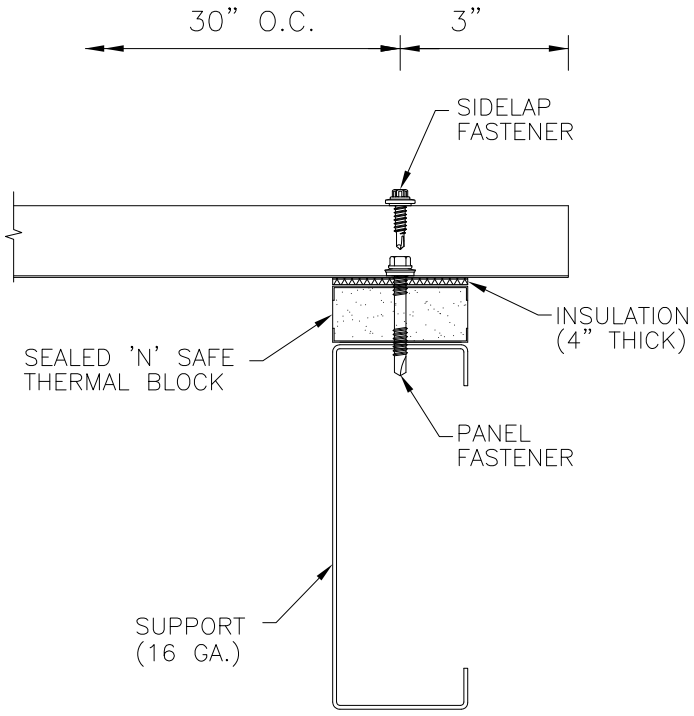
ENCON TECHNOLOGY, INC.	SEALED 'N' SAFE THERMAL BLOCKS DIAPHRAGM TEST SETUP	ASTM E455-11 AISI S907-08	17/21



1/3 DETAILS OF "STARTER RAKE" OF TEST ROOF



1/4 DETAILS OF "FINISHED RAKE" OF TEST ROOF



1/5 DETAILS OF "END SUPPORTS" OF TEST ROOF

SHERRY LABORATORIES
An Element Materials Technology Company

Western Materials, SEG, & Nonmetallics
3100 North Hemlock Circle
Broken Arrow, OK 74012-1115

TESTING TODAY, PROTECTING TOMORROW
WWW.SHERRYLABS.COM
Tel: 918-258-6066
800-982-8378
Fax: 918-258-1154

LABORATORY REPORT

Attn: **Bala Sockalingam**

ENCON Technology, Inc.
1216 N. Lansing Ave.
Suite C
Tulsa, OK 74106 United States

Report No: **B13110166**
Date Reported: **11/8/2013**
P.O. No: **Verbal**

Material: **Steel**

Description: **(2) Test Samples**

Room Temperature Tensile Testing - ASTM E8/E8M-11, Parallel to Length of the Specimen, As Received

Sample ID	Width, Initial, in	Thickness, Initial, in	Tensile Strength, psi	Yield (0.2% Offset), psi	Elongation (4W), %	Location of Fracture
Sample: 26 ga. PBR	0.502	0.0170	104600	103700	4	Outside Middle Half of Gage

Room Temperature Tensile Testing - ASTM E8/E8M-11, Parallel to Length of the Specimen, As Received

Sample ID	Width, Initial, in	Thickness, Initial, in	Tensile Strength, psi	Elongation (4W), %	Location of Fracture
Sample: 26 ga. Thermal Block Skin	0.502	0.0168	111800	2	Outside Middle Half of Gage

Specimen reached point of failure before stress v. strain reached 0.2% offset.

Approved by:

Tim Jones
Technical Specialist

APPENDIX

5.3 TEST CONDITIONS

A. OWNERSHIP OF ENCON WORK PRODUCT

All test results developed as a part of this work shall be CUSTOMER's property. All samples submitted to ENCON for testing shall become the property of ENCON. CUSTOMER understands that any test program including procedures and test machines incorporated as a part of this work is a result of continuing long-term research and development by ENCON and because of this all ENCON test procedures, test drawings and other intellectual property relating to this work is and shall remain the property of ENCON. Test samples were disposed of shortly after completion of the tests unless other arrangements were agreed to in writing prior to the test.

ENCON will use its normal procedures to retain copies of the information developed as a part of this test for a period of three years from the date the work was done. This material may be routinely destroyed thereafter.

B. ENCON GUARANTEE

ENCON guarantees it used its best effort to accomplish this test work. Work done by ENCON was carefully completed by personnel believed to be competent. ENCON tests were based on what was currently believed to be good engineering practices in use at the time of the test.

The safety factors used are generally accepted as suitable to produce safe results. However, good engineering practices and applicable codes and insurance requirements must be taken into consideration in determining if a test procedure is satisfactory for a specific end use. Applicable specifications, good engineering practices and applicable safety factors may change in the future. CUSTOMER should be alert to these changes.

The information and test results presented by ENCON in this test report are offered in good faith based on information ENCON believes to be reliable. This information is offered as a guide to assist CUSTOMER in CUSTOMER's endeavors and does not contain any warranties as to fitness by ENCON. No REPRESENTATION OF WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THOSE OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE are made by ENCON, and more specifically, ENCON hereby expressly disclaim such. In no event shall ENCON be liable for ANY CONSEQUENTIAL, INCIDENTAL OR SPECIAL DAMAGES, including, without limitation, labor, transportation, loss of use, loss of profits, harm, personnel injury and damage to property.

If any doubt exists as to the proper means of interpreting or using the test results contained herein, contact ENCON for clarification. CUSTOMER should assure themselves through careful evaluations that test results are suitable for those end uses to which CUSTOMER intends to put them.

APPENDIX

Information and material provided by CUSTOMER to ENCON was reviewed by an ENCON executive. However, ENCON does not accept the responsibility for accuracy or verification of CUSTOMER's information or the suitability of CUSTOMER materials. Materials supplied by CUSTOMER were tested as received and were not evaluated for code or insurance compliance. CUSTOMER is expected to review the ENCON drawings, tables, test results and other information provided by ENCON to CUSTOMER critically so as to assure CUSTOMER that these presentations, formulas, drawings and other information are accurate and meaningful for the purpose intended.

No other warranties or guarantees shall be issued, implied, delivered or otherwise construed to be issued, implied or delivered.