TEST REPORT ON

24 GA. PBR PANELS
AT 5' 0" PANEL SPANS
WITH SEALED 'N' SAFE™ THERMAL BLOCKS
IN ACCORDANCE WITH ASTM E455-04
AND AISI TS-7-02

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

TESTING DATE: September 24 & 25, 2009
REPORTING DATE: October 7, 2009
REVISED DATE: December 23, 2009
ENCON® Project C1663-4

ACCREDITED
TL-327

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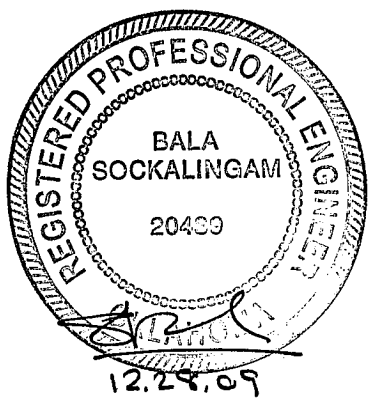


SECTION I
TEST SUMMARY

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 Sealed 'N' Safe™ thermal blocks under simulated loading conditions. These tests meet the provisions of ASTM E 455-04 and AISI TS-7-02. The tests are listed below according to date tested.

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 September 24 & 25, 2009.

The sidelap fasteners spacing for both tests was 30" o.c. The panels were fastened to the supports through 4" thick blanket insulation, thermal block and 3" thick blanket insulation. 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 24 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. (0.060") Cee supports through the 4" thick blanket insulation, thermal block and 3" thick blanket insulation 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 1/4"-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 14 ga. rake sections with #12 x 2" long hex head self-drilling screws with washers spaced at 30" o.c.

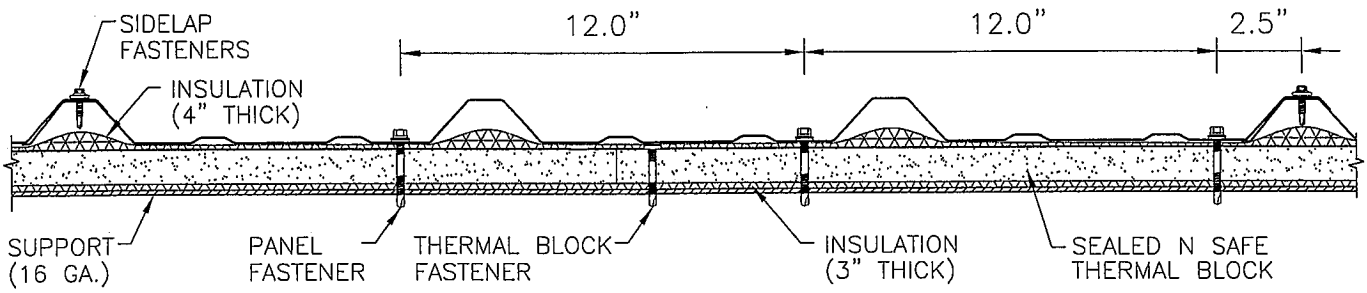
Sealed 'N' Safe™ thermal blocks consisted of two 24 ga. steel plates with polyurethane foam injected between the plates to form a 1" thick block. The length and width of these thermal blocks were 72" and 5", respectively. The blocks were fastened to the supports through 3" thick blanket insulation with #12 x 1-5/8" long pancake head self-drilling screws located at each end of the blocks.

The panels, thermal blocks and fasteners for this testing were sampled at CO Building Systems' Ephraim facility on September 11, 2009, by Bala Sockalingam of ENCON. Each panel, each bundle of 12 thermal blocks and each bag of fasteners were permanently marked with an alphabet character and followed by rotation number.

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 the shear failure of sidelap fasteners. The average ultimate shear strength from the two tests is 276.9 lb/ft and average shear stiffness is 10010.1 lb/in.

ENCON TECHNOLOGY, INC.	SEALED 'N' SAFE THERMAL BLOCKS DIAPHRAGM TEST SUMMARY	ASTM E455-04 AISI TS-7-02	2/21



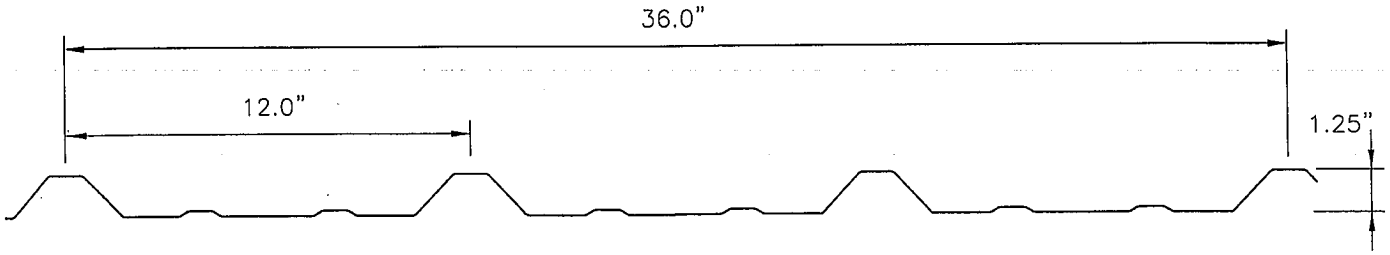
a. AT END & INTERMEDIATE SUPPORTS

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	4400	270.8	1760	0.169	9933.5
2	5.0-5.0-5.0	1	15.5	16.25	4600	283.1	1840	0.174	10086.6
					AVERAGE	276.9		AVERAGE	10010.1

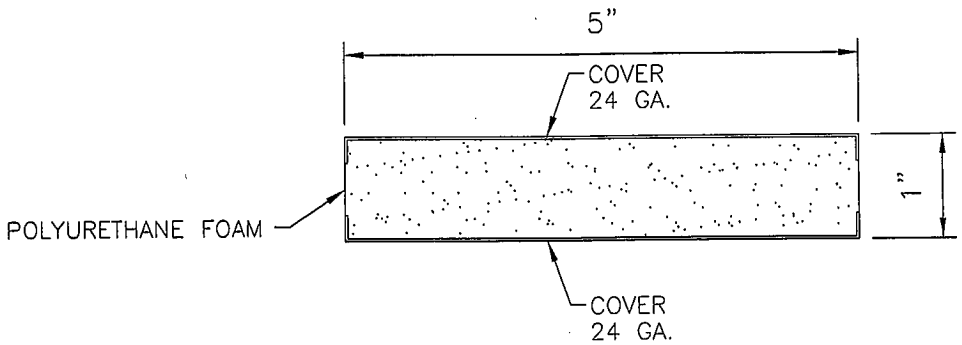
NOTES:

1. PANEL THICKNESS IS 24 GA. AND YIELD STRESS IS 50 KSI.
2. PANEL TO SUPPORT FASTENER IS #12 X 2" LONG SDS.
3. PANEL TO PANEL FASTENER IS 1/4"-14 X 7/8" LONG SDS.
4. PANEL TO PANEL FASTENER SPACING 30" OC.
5. PANEL FASTENED TO SUPPORTS THROUGH 4" THICK INSULATION, THERMAL BLOCKS AND 3" THICK INSULATION
6. THERMAL BLOCKS FASTENED TO SUPPORTS THROUGH 3" THICK INSULATION WITH #12 X 1-5/8" LONG PANCAKE HEAD SDS AT EACH END OF THE THERMAL BLOCK.

ENCON® TECHNOLOGY, INC.	SEALED 'N' SAFE THERMAL BLOCKS DIAPHRAGM TEST PANEL	ASTM E455-04 AISI TS-7-02	3/21



24 GA., PBR PANEL



SEALED 'N' SAFE THERMAL BLOCKS

SECTION II
DESCRIPTION OF TEST

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 TS-7-02.

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 400-lb increments until failure for Test #1 & #2. 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 TS-7-02.

SECTION III
TEST RESULTS

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:	24 ga.
Base Metal Thickness:	0.021"
Panel Yield Stress:	50 ksi (47.9 ksi tested)
Panel Fasteners:	#12 x 2" long hex head self-drilling screws with washers (DB Building Fasteners, Inc.)
Sidelap Fasteners:	1/4"-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 24 ga. steel plates with polyurethane foam injected between the plates to form a 1" thick block. The length and width of the thermal block were 72" and 5", respectively. Polyurethane foam was manufactured by Utah Foam and designated as X10324.
Thermal Blocks Fasteners:	#12 x 1-5/8" long pancake head self-drilling screws (DB Building Fasteners, Inc.)
Insulation:	4" thick and 3" thick blanket insulation
Support Thickness:	16 ga.

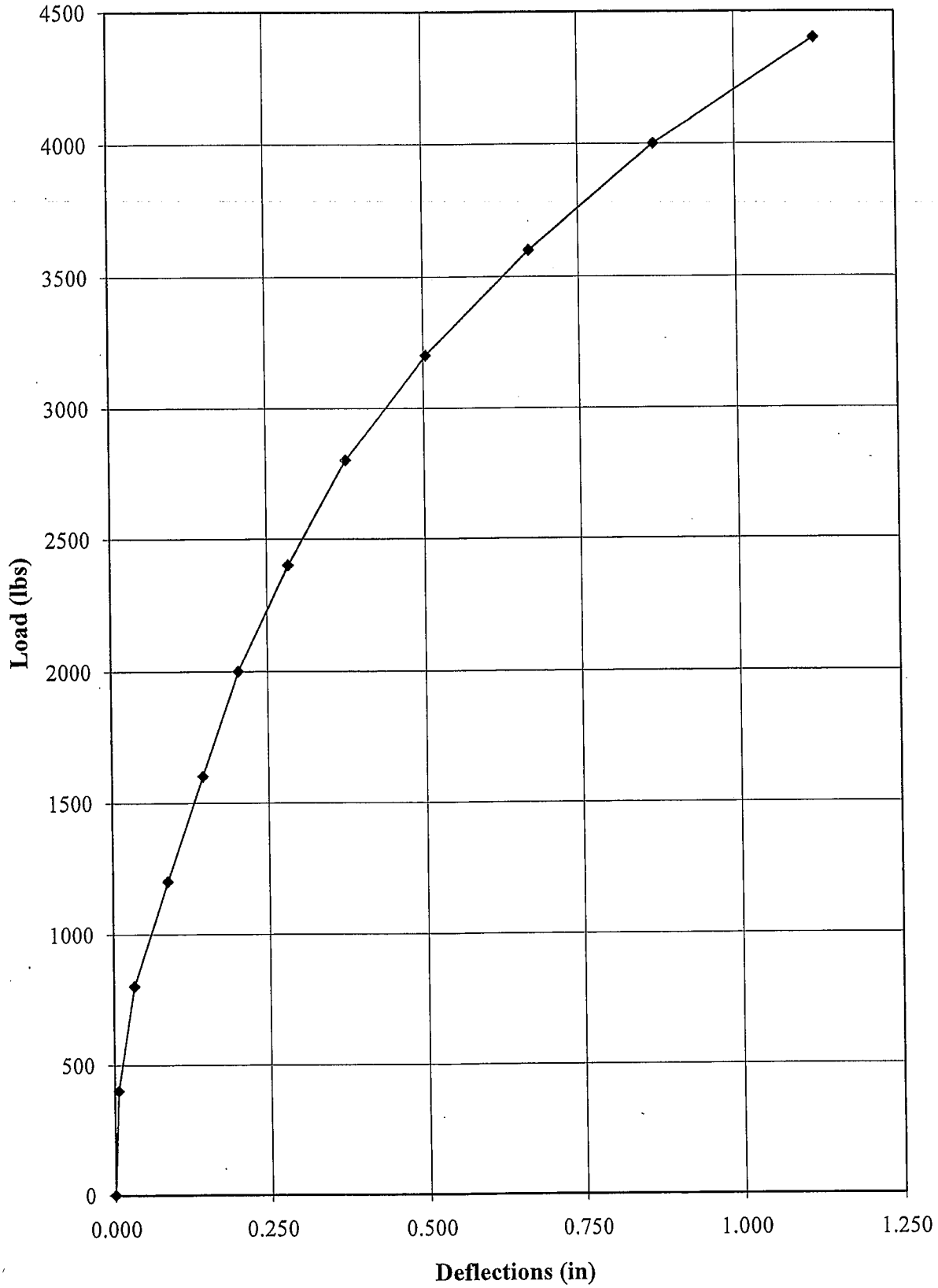
3.2 TEST #1: 24 Ga., 50 KSI PBR PANELS WITH THERMAL BLOCKS AT THREE EQUAL SPANS OF 5' 0"

Date:	9.24.09
Panel Type:	CO Building PBR panel
Gauge:	24 ga.
Thickness:	0.021"
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 and 3" thick blanket
Type of Sidelap Fastener:	1/4-14 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
400	0.025	0.058	0.238	0.157	0.006
800	0.022	0.080	0.356	0.233	0.033
1200	0.018	0.100	0.483	0.292	0.087
1600	0.009	0.119	0.604	0.347	0.145
2000	-0.003	0.130	0.704	0.391	0.204
2400	0.009	0.145	0.854	0.437	0.284
2800	0.015	0.161	1.004	0.475	0.376
3200	0.029	0.202	1.226	0.516	0.504
3600	0.038	0.230	1.456	0.545	0.670
4000	0.041	0.277	1.756	0.595	0.872
4400	0.044	0.300	2.049	0.611	1.124

Failure Mode:	Shear failure of sidelap fasteners	
Duration of test:	> 10 minutes	
	Temperature (F)	Relative Humidity (%)
At construction:	73.4	42
At testing	73.3	42

Load vs Deflection (Test #1)



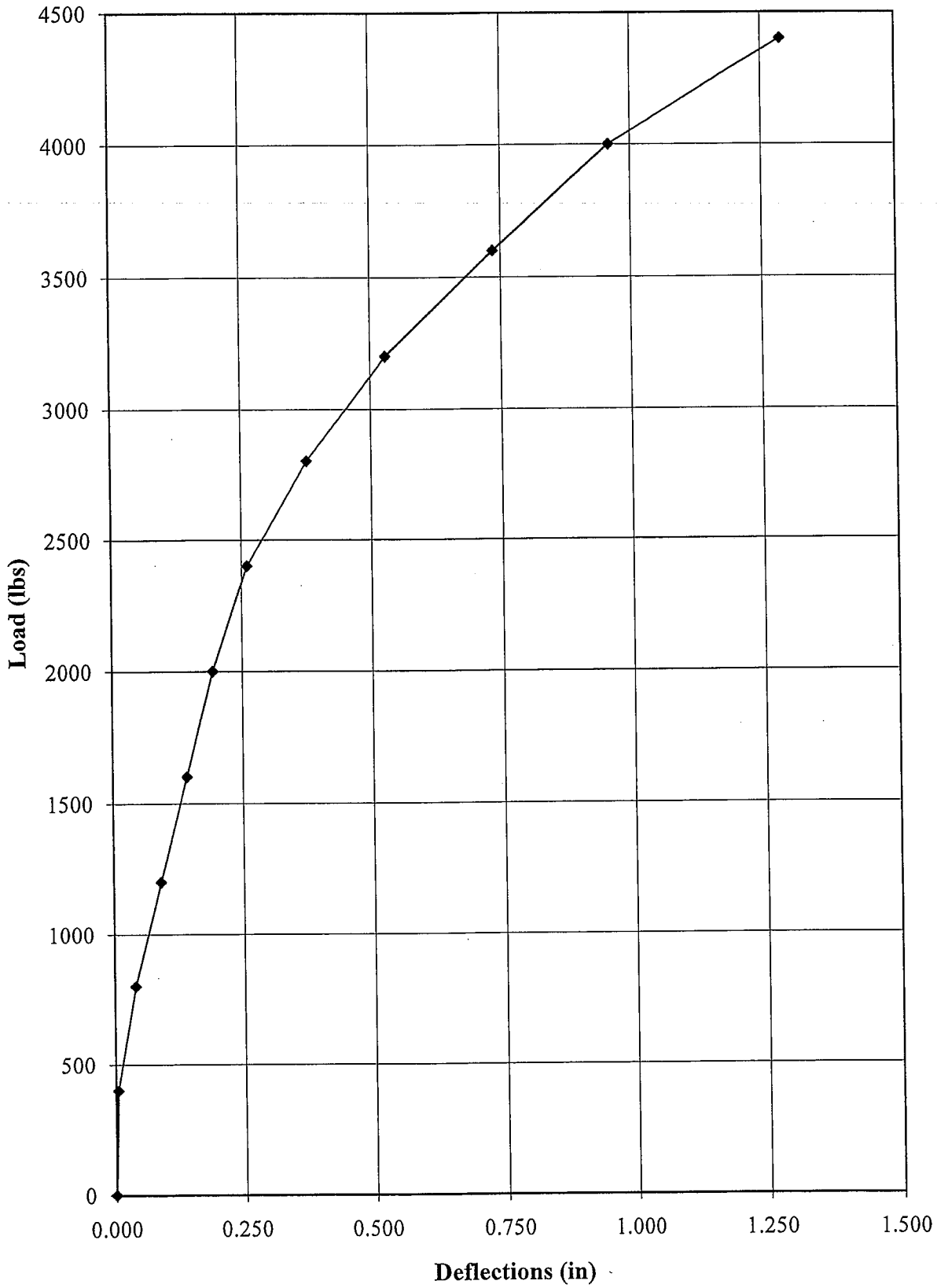
3.3 TEST #2: 24 GA., 50 KSI PBR PANELS WITH THERMAL BLOCKS AT THREE EQUAL SPANS OF 5' 0"

Date:	9.25.09
Panel Type:	CO Building PBR panel
Gauge:	24 ga.
Thickness:	0.021"
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 and 3" thick blanket
Type of Sidelap Fastener:	1/4-14 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
400	0.006	0.024	0.235	0.210	0.005
800	0.006	0.056	0.398	0.311	0.040
1200	0.003	0.074	0.518	0.368	0.090
1600	-0.004	0.088	0.614	0.406	0.143
2000	0.005	0.102	0.722	0.442	0.194
2400	0.019	0.118	0.848	0.473	0.261
2800	0.023	0.134	1.021	0.512	0.377
3200	0.019	0.242	1.316	0.552	0.529
3600	0.023	0.264	1.599	0.606	0.735
4000	0.034	0.290	1.894	0.643	0.958
4400	0.045	0.359	2.359	0.703	1.287
4600					

Failure Mode:	Shear failure of sidelap fasteners	
Duration of test:	> 10 minutes	
	Temperature (F)	Relative Humidity (%)
At construction:	72.5	49
At testing	72.5	49

Load vs Deflection (Test #2)



SECTION IV
PHOTOGRAPHS

PHOTOGRAPHS

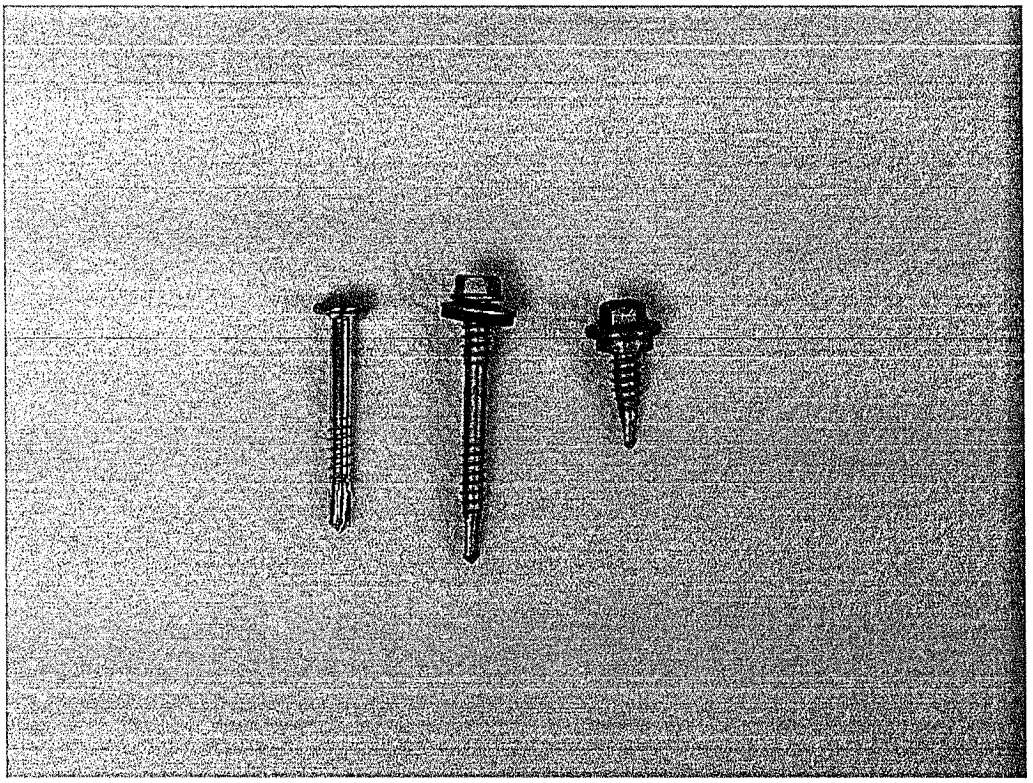


PHOTO 1 View of the Sealed 'N' Safe™ thermal blocks, panel and sidelap fasteners (left to right). (DSC00072)

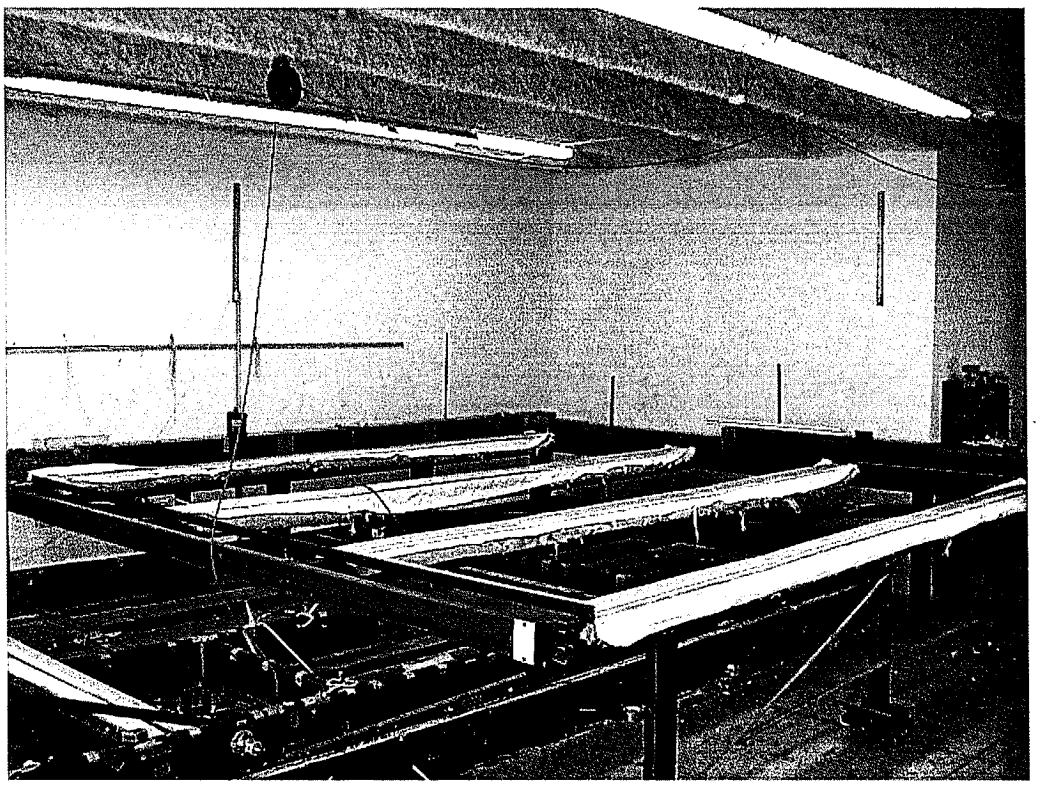


PHOTO 2 View of the Sealed 'N' Safe™ thermal blocks fastened through 3" thick blanket insulation to the supports. (DSC00067)

PHOTOGRAPHS

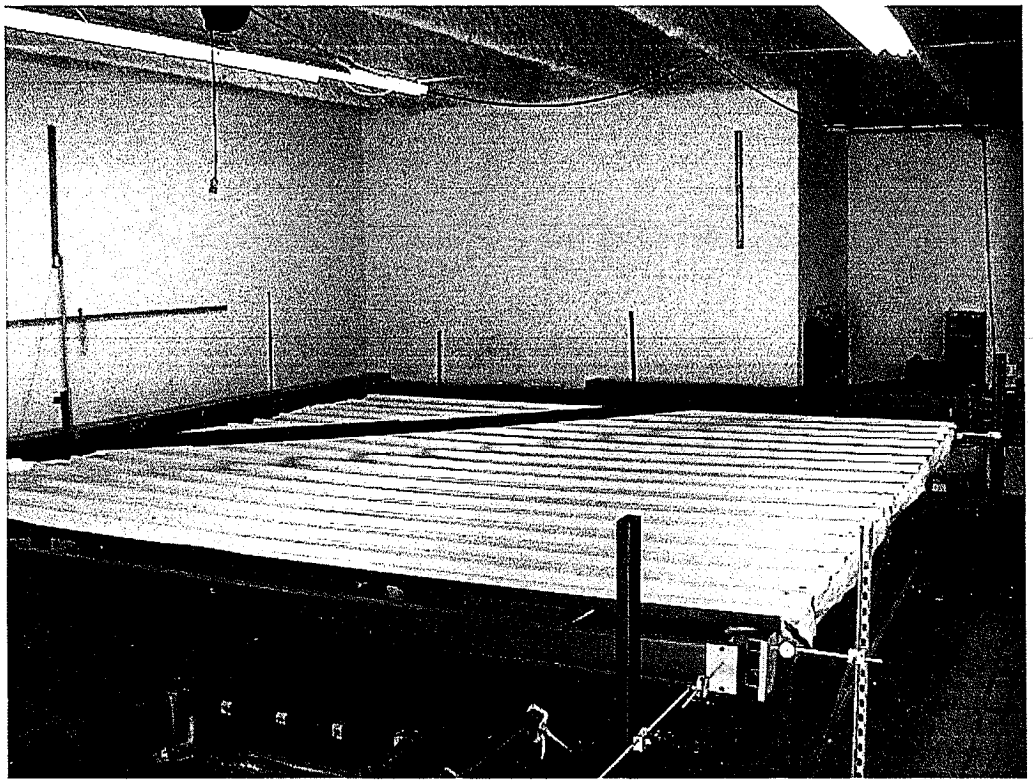


PHOTO 3 Overview of the diaphragm test setup of the PBR panels. (DSC00081)

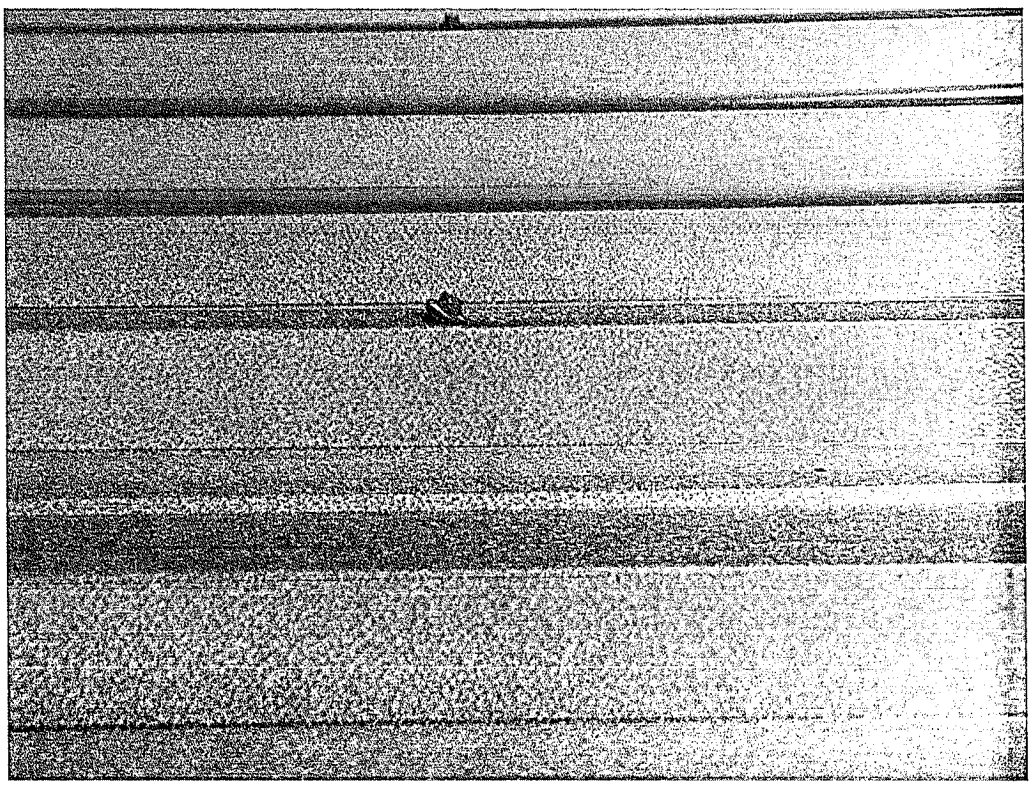


PHOTO 4 View of sidelap fastener failure in Test #1. (DSC00083)

PHOTOGRAPHS

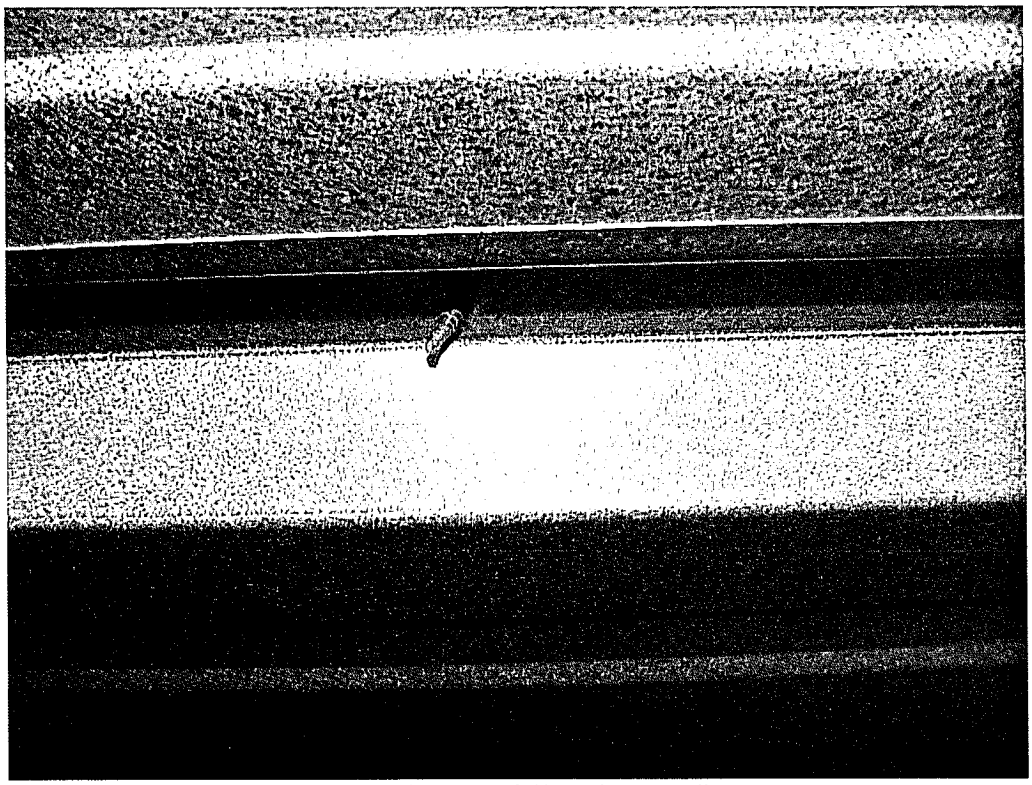
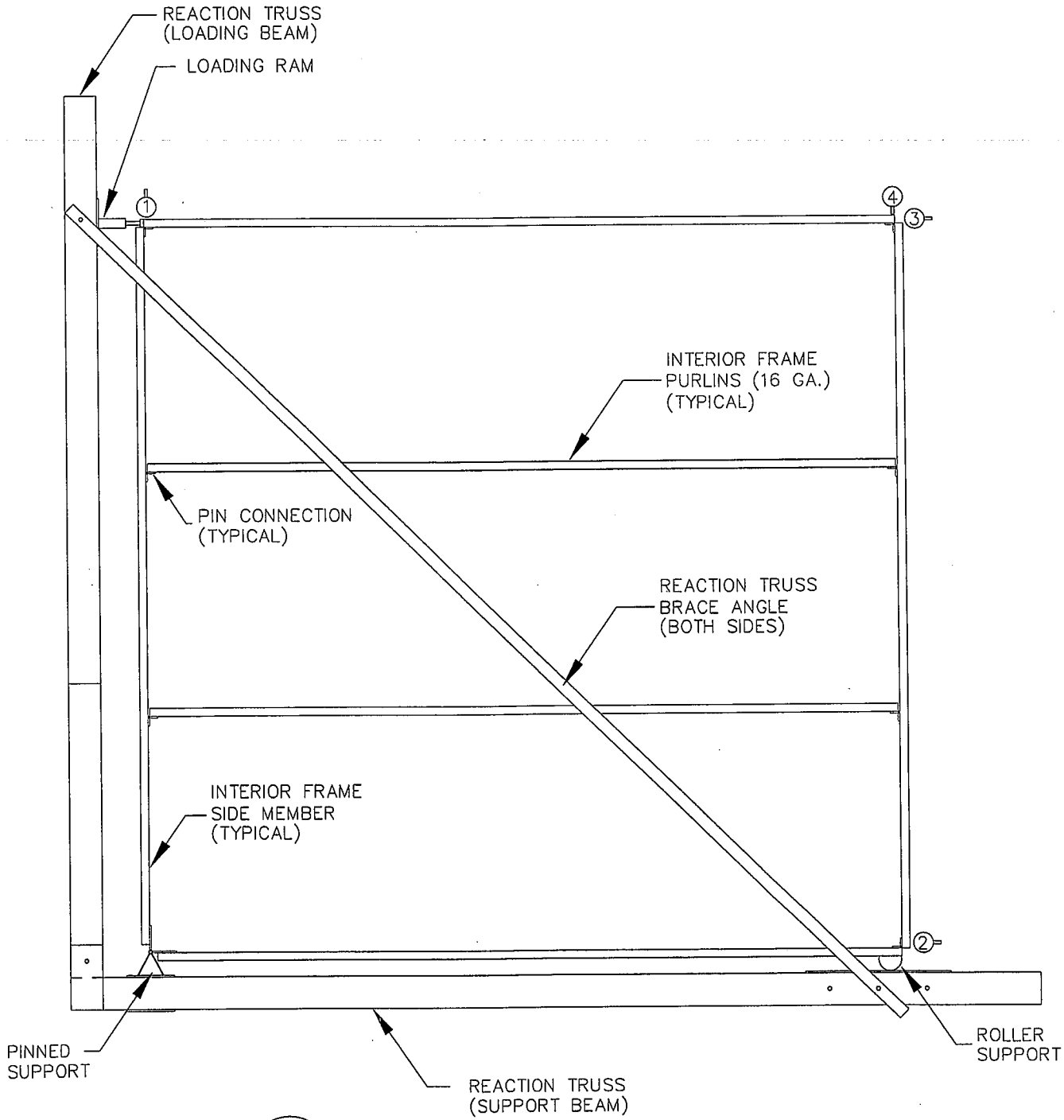


PHOTO 5 Another view of sidelap fastener failure in Test #1. (DSC00084)

PHOTO 6 View of sidelap fastener failure in Test #2. (DSC00086)

SECTION V
APPENDIX

ENCON® TECHNOLOGY, INC.	SEALED 'N' SAFE THERMAL BLOCKS DIAPHRAGM TEST SETUP	ASTM E455-04 AISI TS-7-02	15/21

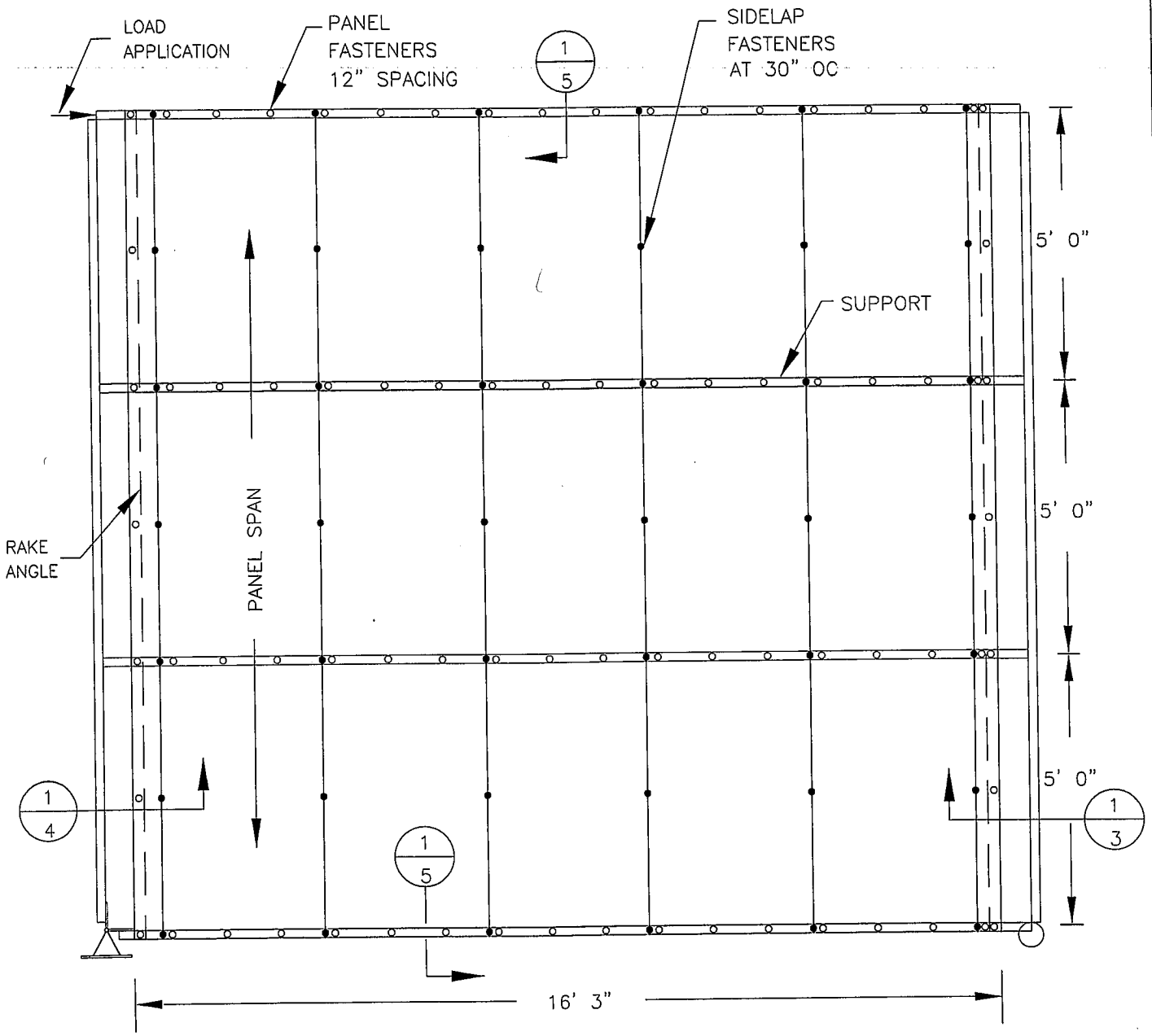


1/1 TEST SETUP PLAN VIEW

NOTES:

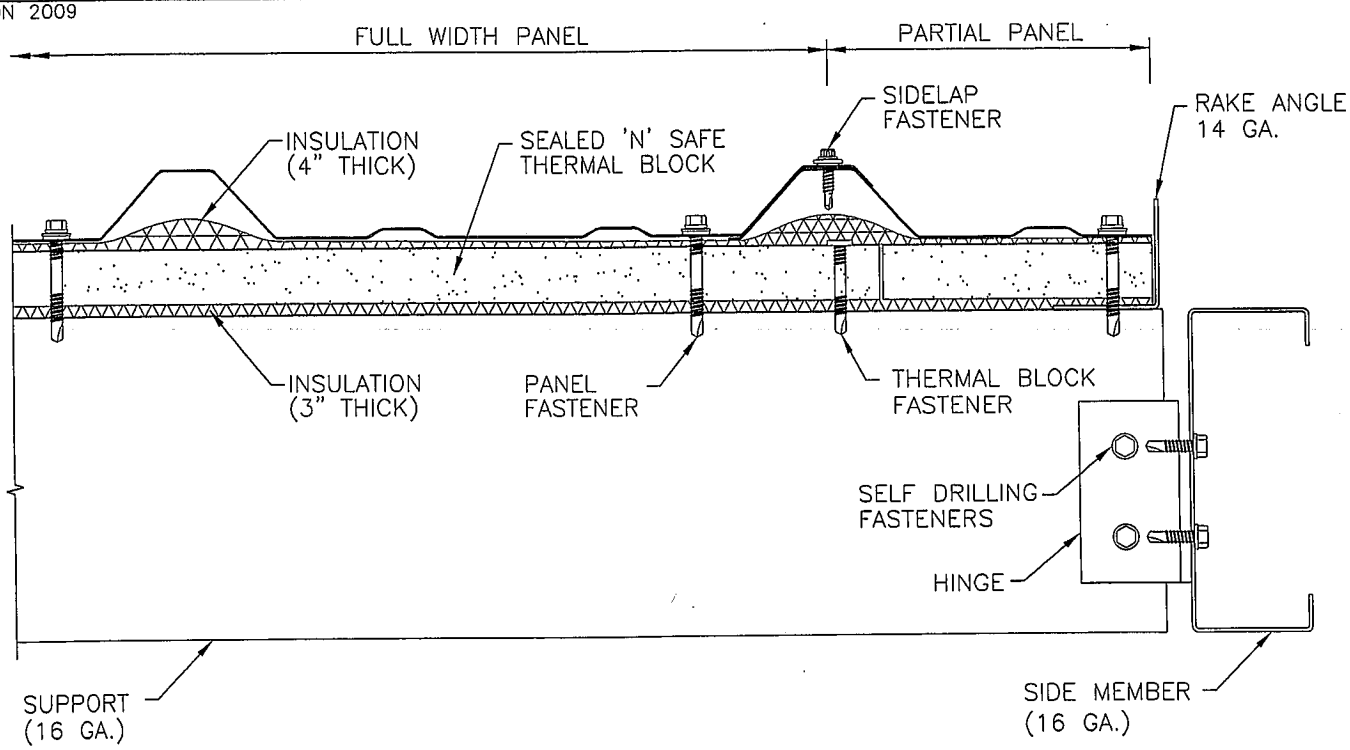
① DIAL INDICATOR LOCATION

ENCON TECHNOLOGY, INC.	SEALED 'N' SAFE THERMAL BLOCKS DIAPHRAGM TEST SETUP	ASTM E455-04 AISI TS-7-02	16/21

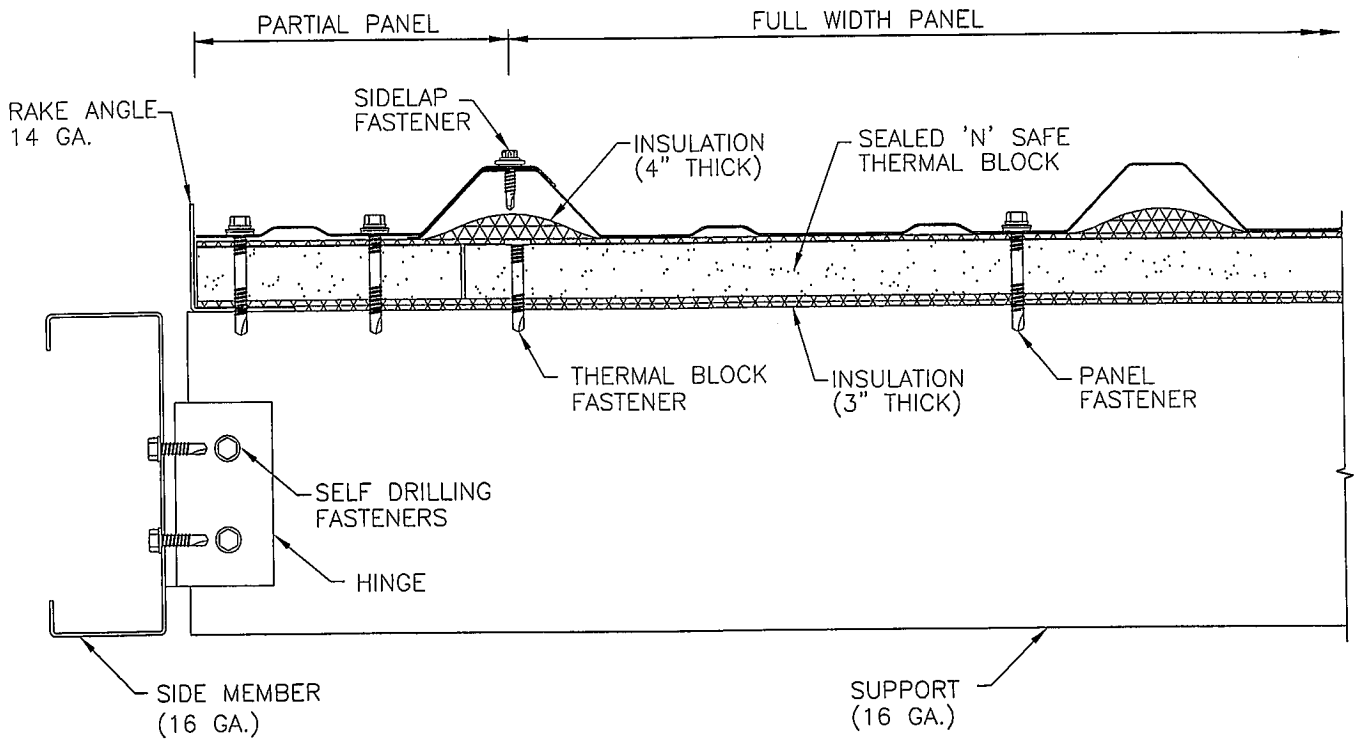


1/2 PLAN VIEW OF TEST PANEL SETUP

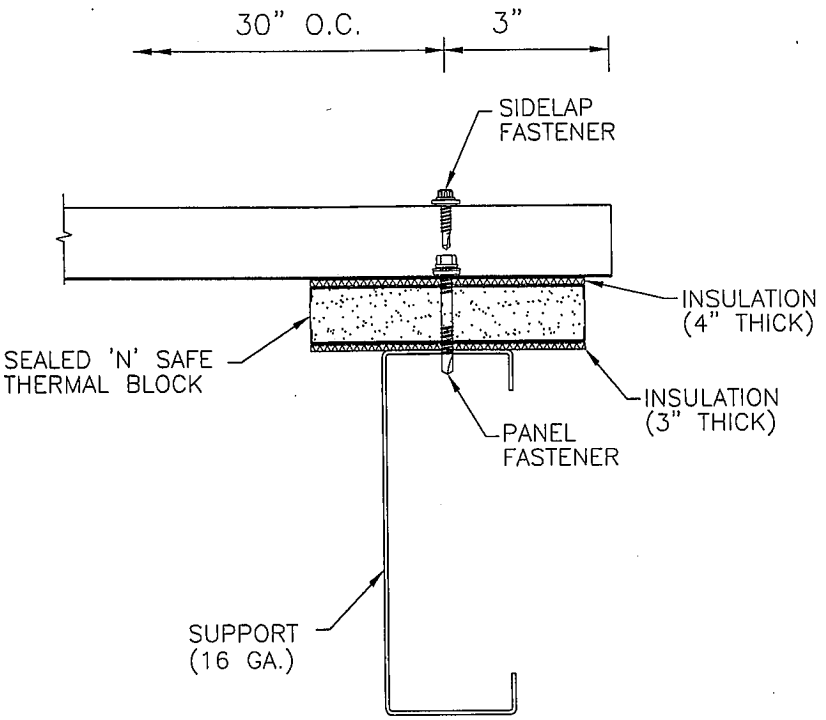
ENCON TECHNOLOGY, INC.	SEALED 'N' SAFE THERMAL BLOCKS DIAPHRAGM TEST SETUP	ASTM E455-04 AISI TS-7-02	17/21



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
3100 North Hemlock Circle
Broken Arrow, OK 74012-1115

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

Report No.: 09091068-002-v1
Date Received: 9/25/2009
Date Reported: 9/30/2009
P.O. No.: Verbal

Sample Description: (1) Test Sample, CO Building PBR(24ga.), Part No.: 2

Tensile Test (Rectangular) per ASTM E8-08

Parameter	Result
Thickness, inch	0.021
Width, inch	0.500
Tensile Strength, psi	72,500
Yield Strength, psi at 0.2% offset	47,900
Elongation in 2 inches, %	26

Approved by: Maurice Cochran
Maurice Cochran, Supervisor of Mechanical Testing
Sherry Laboratories

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.