



Submittal Cover Form

Project: GUC New Engineering and Operations Center

Date of Submittal: August 1, 2019

Project #: 1100417

Architect (name & address): CT Consultants, Inc. 1120 Kenwood Road Cincinnati, OH 45242

Contractor (name & address): Barnhill Contracting Company 800 Tiffany Blvd., Suite 200

Rocky Mount, NC 27804

Subcontractor (name & address): HUDSON BROTHERS CONST. CO.

1450 E. ARLINGTON BLVD, GREENVILLE, NC 27858

Supplier (name & address): BUTLER MFG Co. / CHEMISTERS CONSET GROUT

Manufacturer (name & address): " "

SPECIFICATION SECTION	SPECIFICATION PARAGRAPH	DESCRIPTION OF ITEM SUBMITTED
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133419	<u>1.6 A 1.9 dB</u> <u>1.6 A 1. d</u> <u>2.10 I 3</u>	<u>METAL ROOF SHEET PANELS - PRODUCT DATA</u> <u>THERMAL INSULATION VAPOR RETARDER - PROD. DATA</u> <u>NON SHRINK GROUT</u>
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We warrant the following:

- a We have personally investigated the proposed product and determined that it is equal in all respects to that specified and/or performance specification requirements
- b We will provide the specified guarantee for this product
- c We will coordinate installation of this product into the work, making such changes as may be required for the work to be complete in all aspects
- d We have clearly indicated by marking as "Non-Complying Feature" each and every requirement of the specifications that this product does not meet
- e And, we waive all claims for additional costs related to this product which subsequently become apparent

Submitted by: *Phil Miles*
(Your Signature)

Barnhill Contracting Company's Review

Architect/Engineer's Review Stamp

<div style="border: 2px solid blue; padding: 5px;"> <p style="margin: 0;">SUBMITTAL REVIEW BARNHILL CONTRACTING COMPANY</p> <hr/> <p style="margin: 5px 0;"> <input type="checkbox"/> APPROVED <input type="checkbox"/> NOT APPROVED <input checked="" type="checkbox"/> APPROVED AS NOTED <input type="checkbox"/> REVIEWED <input type="checkbox"/> REVISE AND RESUBMIT <input type="checkbox"/> FOR REVIEW AND COMMENT </p> <hr/> <p style="margin: 0;"> BY chardison DATE 8/5/2019 </p> <p style="font-size: small; margin-top: 5px;"> APPROVAL OF SHOP DRAWINGS AND SUBMITTALS BY CONSTRUCTION MANAGER, ARCHITECT, OR ENGINEER WILL NOT RELIEVE SUPPLIER OF RESPONSIBILITY FOR DIMENSIONAL ACCURACY, QUANTITIES, OR CONFORMANCE TO THE CONTRACT DOCUMENTS. CHANGES INVOLVING EXTRA COST DUE TO REVIEW COMMENTS REQUIRE WRITTEN APPROVAL PRIOR TO PROCESSING. </p> </div>	<div style="border: 2px solid green; padding: 5px;"> <table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 50%; padding: 2px;"><input checked="" type="checkbox"/> NO EXCEPTIONS TAKEN</td> <td style="width: 50%; padding: 2px;"><input type="checkbox"/> REVISE & RESUBMIT</td> </tr> <tr> <td style="padding: 2px;"><input type="checkbox"/> APPROVED AS NOTED</td> <td style="padding: 2px;"><input type="checkbox"/> REJECTED</td> </tr> </tbody> </table> <p style="font-size: x-small; margin-top: 5px;"> Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project. The contractor is responsible for confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner. </p> <hr/> <p style="text-align: center; margin: 0;">CT CONSULTANTS, INC.</p> <p style="margin: 0;"> DATE: 8/26/2019 BY: C. Knight PROJECT #: 160681 133419-1.0 </p> </div>	<input checked="" type="checkbox"/> NO EXCEPTIONS TAKEN	<input type="checkbox"/> REVISE & RESUBMIT	<input type="checkbox"/> APPROVED AS NOTED	<input type="checkbox"/> REJECTED
<input checked="" type="checkbox"/> NO EXCEPTIONS TAKEN	<input type="checkbox"/> REVISE & RESUBMIT				
<input type="checkbox"/> APPROVED AS NOTED	<input type="checkbox"/> REJECTED				

This is from a past RFI and only is listed to provide an understanding of material procurement

The remaining questions as asked by Hudson Brothers are addressed below. Please note that the designer of record takes no exception to the roof system, wall system, insulation system or exposed secondary framing as listed below. Please note that Hudson and Butler will still be required per contract to provide engineered shop drawings for review and approval by the designer of record as part of the project.

1. Roof system is **24 gauge Butler MR-24 standing seam trapazodial rib roof panel utilizing movable X-tall clips with R-5.0 thermal spacer block at each clip.** (CT TAKES NO EXCEPTION TO THE PROPOSED ROOF SYSTEM). Clips and thermal spacer blocks occur where each seam (seams are 24" on center) crosses a purlin (purlins are typically ~5' on center). The thermal spacer block is shown on the U-Facts Assembly Snapshot and again listed on the ASTM C 1363 Thermal Test Report. This system utilizing 9.5" R-30 fiberglass insulation and was tested using Lamtec WMP-VR facing (facing is sometimes referred to as backing). The first page of this test report indicates the $U = .043$ which is the U value required on the ComCheck sheets 3A004 and 4A004. Other Lamtec facings are available can be found at Lamtec.com.

2. Wall system is based on communications from you that Alternates 30 and 31 will be accepted to use the exposed fastener system. Wall system proposed is **Butler 26 gauge Shadowwall panel with 6" of R-19 fiberglass insulation installed between the girt and wall panel.** (CT TAKES NO EXCEPTION TO THE PROPOSED WALL SYSTEM). Same facing on wall as in roof. Note that the insulation will be compressed at the girt. Although the R-19 as used the ASTM C1363 is not quite R-20 as per the specification, more importantly the test report proves that this system does provide better insulating value of U factor of .075 as compared to the .079 on the ComCheck sheets. (the lower the U number the better the insulating value)

3. The secondary framing system (roof purlins and wall girts), will be **G-30 galvanized acrylic coated components.** (CT TAKES NO EXCEPTION TO THE PROPOSED UNPAINTED GALVANIZED FINISHED PURLINS AND GIRTS) A product data sheet is included. Note the purlins and girts will be exposed. Most owners and users are satisfied with leaving the galvanized purlins and girts exposed as they blend well with the white faced insulation. If field painting is required, the acrylic coating serves as a primer. It has been our experience that over trades prefer the exposed purlins and girts because of the ease of attaching their hangers and exposed piping/conduits.



A BlueScope Steel Company

BUILDING IN A NEW LIGHT™

SHADOWALL WALL SYSTEM

Combine striking exterior aesthetics with enhanced energy efficiency.

The Shadowall™ wall system is ideal for creating architecturally pleasing exteriors, particularly in instances where energy efficiency inside is a key concern. The system features unique design elements that enhance thermal performance and accommodate added insulation.

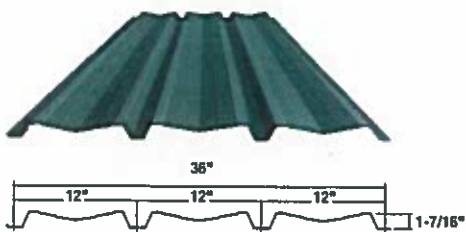
Choose the smooth, clean lines of the Shadowall system to add beauty and lifecycle cost savings in applications such as distribution centers, warehouses, and office complexes.

CREATE A UNIFORM APPEARANCE

The Shadowall system is designed with a unique profile that creates smooth, clean lines for striking beauty. The fasteners are recessed deep in the panel corrugation to further enhance the system's uniform appearance.

USE FEWER FASTENERS

The Shadowall system is designed to require up to 33% fewer fasteners than most ribbed panels. In addition to lowering installation costs, this also results in reduced heat loss through the wall for enhanced thermal performance.



ADD EVEN MORE ENERGY EFFICIENCY

Using the Shadowall system enables you to add up to 6 inches of fiberglass blanket insulation. The deep 1-7/16-inch corrugations provide strength to resist billowing when fasteners are installed. No additional inside framing is needed to support the insulation.

ASSURE FAST AND ACCURATE INSTALLATION

Each Shadowall system panel and supporting structure can be factory punched for greater speed and precision in the installation process. Accurate installation leads to long-term building performance.

ENHANCE WINDOW AND DOOR INSTALLATION

Predesigned and factory-fabricated transition materials assure that windows and doors fit precisely with the Shadowall panels. To enhance energy efficiency, a window frame with a thermal break is also available.

COMPARE OUR WARRANTY

All Shadowall panels feature the high-quality Butler-Cote™ premium finish. Made with a 70% Kynar 500® or Hylar 5000® resin, this incredibly durable Fluoropon® coating includes a 25-year warranty against blistering, peeling, cracking, or chipping of the paint coating.



SHADOWWALL™ WALL SYSTEM

KEY BENEFITS

- ✓ Panel design creates smooth, clean lines for striking beauty
- ✓ Up to 33% fewer fasteners lowers installation costs and reduces heat loss
- ✓ Accommodates 6 inches of blanket insulation for enhanced energy efficiency
- ✓ Transition pieces allow for precise window and door installation
- ✓ Superior-performing Butler-Cote™ 25-year fluoropolymer finish resists chalking and fading
- ✓ Recessed fasteners enhance panel appearance



BUTLER OFFERS YOU MORE

Butler Builders® provide complete construction services with single-source responsibility

- Reputable professionals with extensive knowledge of local building codes

Maximize your building's performance with a complete Butler® system solution

- Innovative structural, wall, and roof systems
- Precision engineered for seamless integration



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Form No. 5126 08/08

MR-24[®] ROOF SYSTEM

Exclusive factory-punched precision in the most-specified standing-seam roof system.

The MR-24[®] roof system is specified twice as often as any other standing-seam roof system—more than 2 billion square feet have been installed since 1969. It is the standard by which all other roofing systems are judged. And as a material-efficient, recyclable, low-maintenance, and long-life roof solution, it also offers compelling green attributes.

The MR-24 roof system acts like a single steel membrane to protect your entire building with exclusive features that ensure weathertightness—factory punching, moveable roof clips, 360-degree Pittsburgh double-lock standing seams, and staggered endlaps. All accessories and integrated panels are also engineered for exact fit.

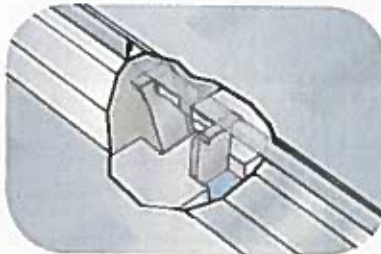


The Pittsburgh double-lock standing seam produces exceptional weathertightness.

The MR-24 system offers complete design flexibility and can be used with—

- Z-purlins
- Truss purlins
- Retrofit subsystems

With the best roof warranty available in the industry—25 years for panel finish protection and weathertightness—the MR-24 roof system is the best insurance for the long life of your building.



Engineered for thermal expansion and contraction.



Butler's exclusive Roof Runner[®] completes the industry's only field-formed 360-degree Pittsburgh double-lock seam.

APPLICATIONS

- Retail
- Warehouses
- Manufacturing plants
- Schools
- Gymnasiums
- Airplane hangars
- Other larger structures

KEY ATTRIBUTES

- Factory punching ensures precise alignment
- Mechanically seamed 360°
- Roof clip is super secure, yet allows roof movement
- Splices over supporting steel for strength
- Staggered panel splices prevent exposed seams
- Butler Scrubolt[™] fasteners have twice the pullout strength of self-drillers
- Optional thermal spacer blocks avoid "thermal short circuit" between purlin and roof panel

PROFILE

- 24" wide
- 2 major 2"-high corrugations
- Cross-flutes on 6" centers reduce wind noise and improve walkability
- Roof slope minimum 1/4" in 12"
- 24 gauge standard, 22 gauge optional

MEETS ALL PERFORMANCE STANDARDS

- Complies with U.S. Army Corps of Engineers Unified Facilities Guide Specifications (UFGS) for Structural Standing Seam Metal Roof (SSSMR) Systems
- UL Class 90 Uplift Rating
- Uplift testing performed in accordance with ASTM E 1592
- FM Global Roof Panel System
- Miami-Dade County, Florida, approved

FINISH CHOICES

- Unpainted Galvalume[®]
- ~~Butler-Cote[™] finish system of 70% repair 500[®] or Hylar 5000[®] fluoropolymer coating guaranteed not to blister, peel, crack, chip, or experience material rust-through for 25 years~~
- ~~Standard colors and custom color options available~~

FM Global and UL ratings may result in lower wind damage insurance premiums for your new building.

Acrylic-coated galvanized secondaries lighten the appearance of the building's frame.



Galvanized Steel is Good. Acrylic-Coated Galvanized Steel Is GREAT!

That's why Butler now provides c/z secondary structural parts for its buildings in galvanized, acrylic-coated steel.

WHAT DOES THIS MEAN TO YOU?

You already know why galvanized steel is good. The galvanized coating protects the steel from corrosion. The clear acrylic finish protects the galvanized coating from "white rust" or discoloration from handprints. So what you'll have is a building with superior corrosion resistance and better-looking exposed steel. The color of the parts blends well with Butler® gray-painted primary structural steel and most insulation facings, for a lighter, brighter interior.

WHAT ARE "SECONDARY" STRUCTURAL STEEL PARTS?

Any parts of the building's structural skeleton that are not part of the primary load-bearing frame. (Principally, any "cold-formed" steel parts such as "C" and "Z" purlins and girts.)

CAN THIS COATING BE PAINTED?

Easily! No need for priming or etching the surface first, as there is with galvanized-only steel. The acrylic coating easily accepts common post paint and dry-fall paint applications.

Ask your Butler Builder® to show you a sample of our new, acrylic-coated galvanized steel.

CONSIDER THE POSSIBILITIES

TWO-IN-ONE CORROSION PROTECTION

The galvanized coating helps protect your building against ordinary rust. The clear acrylic finish helps protect it against the "white rust" associated with a galvanized-only finish.

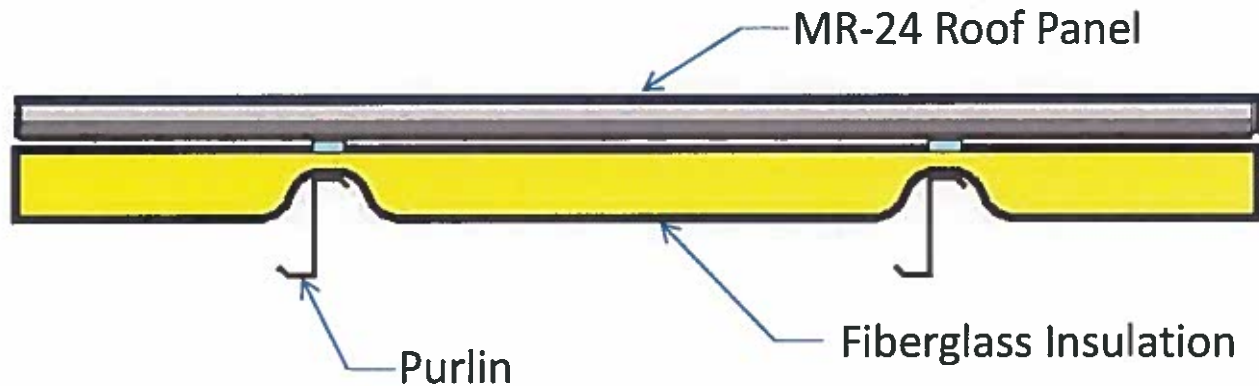
GREAT LOOKING

No more dark, rust-red steel! Acrylic-coated galvanized steel blends exceptionally well with most insulation facings, and with the gray-painted steel Butler furnishes for its primary structural parts. The double finish also reduces the hand marks and smudges associated with galvanized-only materials.

EASY TO PAINT

The clear acrylic finish acts as a primer, so if you want to paint your exposed steel, there are no extra coats, priming or preparation involved.

U-Facts™ Assembly Snapshot



MR-24® Roof System with Thermal Spacer Block
R30 Fiberglass on Z-Purlin and X-Tall clip

U-Factor: 0.043

Not intended for Construction. See test report for full details





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Butler Manufacturing
Research Center
13500 Botts Road
Grandview, MO 64030-2897
Phone 816-968-5700

ASTM C 1363 Thermal Performance Test Report

Test Number: 2011-57

Sponsor: Butler Research Center

→ **MR-24 R-30 Single Layer**

MR-24® roof system panels, nominal R-30 faced fiberglass insulation, X-Tall panel clips, thermal spacer blocks.

Test Date: 10/10/2011 ✓

Responsible Party: Mark J. Henry

Operator: Larry Krueger

Witness: Mark Henry

Summary of Results:

Thermal Transmittance, U:	0.243 W/m ² K (0.043 Btu/ hr ft ² F)
Overall Thermal Resistance, Ru:	4.1 m ² K/W (23.3 hr ft ² F/Btu)



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ASTM C 1363 Thermal Performance Test Report Summary

Prepared For:
Butler Research Center
13500 Botts Road
Grandview, Missouri 64030

Test Number: 2011-57
Test Start Date: 10/10/2011
Test End Date: 10/13/2011
Report Date: 10/18/2011

Test Information:
MR-24 R-30 Single Layer
MR-24® roof system panels, nominal R-30 faced fiberglass insulation, X-Tall panel clips, thermal spacer blocks.

Test Orientation / Heat Flow Direction:
Normal Roof / Inside to Outside

Specimen Size:
2.44 m x 3.05 m (8.00 ft x 10.00 ft)

→ **Test Procedure:** The Thermal Transmittance (U) and Thermal Resistance (Ru) were determined in general accordance with ASTM C 1363-05, *Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.*

ASTM Exceptions, if any:

Summary of Test Setup:

Average Warm Side Ambient Temperature	37.75 deg C (99.95 deg F)
Average Cold Side Ambient Temperature	10.00 deg C (50.00 deg F)
Average Warm Side Air Velocity	0.27 m/s (52.89 fpm)
Average Cold Side Air Velocity	1.27 m/s (250.88 fpm)

Summary of Results:

Thermal Transmittance, U:	0.243 W/m ² K (0.043 Btu/ hr ft ² F)
Overall Thermal Resistance, Ru:	4.1 m ² K/W (23.3 hr ft ² F/Btu)



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Specimen Size: 2.44 m x 3.05 m (8.00 ft x 10.00 ft)

Panel Type: MR-24 roof system

Insulation: Fiberglass, 1-layer

Framing System: Z-purlins

Specimen Construction: The purlins were installed in the test frame. One edge of the insulation facing was attached to the inside face of the test frame. The insulation was laid over the purlins and the depth of the drape was checked. The other end of the facing was attached to the test frame. The panel clips were installed. The thermal spacer blocks were placed over the purlins. The panels were seamed. Rubber blocks were inserted in the ends of the panel ribs. The perimeter of the panels was taped to prevent air leakage.

Specimen Conditioning: The assembly was built at the Butler Research Center and remained there until it was tested. The insulation was unrolled and was in environmental conditions for at least 12 hours before being enclosed in the test assembly. The insulation was "fluffed" in a manner similar to the NAHB procedure for quality testing of faced insulation, in order to promote the recovery of the insulation thickness.

Materials Used:

Material Name	Description
Roof Panel	MR-24® roof system panel, 24 gauge, 24 inch wide, Galvalume Plus® finish
2.9-B6 Thermal Spacer Block	Extruded polystyrene foam, 3/4" x 3-14" Nominal Thermal Resistance: R-5 per inch
R-30 Fiberglass	Nominal R-30 faced fiberglass blanket insulation Measured thermal resistance: 28.25 hr ft² F/Btu

Sources for Materials Used: Butler Manufacturing supplied the roof panels, thermal spacer blocks, panel clips, fasteners, and purlins.

Bay Insulation Systems, Inc supplied the faced fiberglass insulation. The original manufacturer of the fiberglass was Owens Corning.

The original manufacturer of the extruded polystyrene was the Dow Chemical Company.



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Measured Test Data

Test Times

Test Start Time	10/10/2011 1:54 PM
Test End Time	10/13/2011 7:53 AM
Time Required to Reach Steady State	55.2 Hours
Steady State Start Time	10/12/2011 8:03 PM
Steady State End Time	10/13/2011 3:59 AM

Test Information

Metered Area	10.48 m ² (112.75 ft ²)
Specimen Area	7.43 m ² (80.00 ft ²)
Average Warm Side Ambient Temperature	37.75 deg C (99.95 deg F)
Average Cold Side Ambient Temperature	10.00 deg C (50.00 deg F)

Input

75.63 watts (258.06 Btu/hr)

Warm Side Heaters	67.46 watts (230.17 Btu/hr)
Warm Side Fans	6.92 watts (23.62 Btu/hr)
Warm Side AVT & RH Sensor Power	1.25 watts (4.27 Btu/hr)

Loss

25.47 watts (86.91 Btu/hr)

Surround Panel and Flanking Loss	19.79 watts (67.53 Btu/hr)
Side of Test Specimen Frame Adjustment	5.70 watts (19.45 Btu/hr)
Meter Wall and Flanking Loss	-0.02 watts (-0.07 Btu/hr)
Thermopile Voltage (<i>E</i>)	-0.242 mV
Thermopile Null (<i>E₀</i>)	-0.2536 mV
Thermopile Slope (<i>m</i>)	-1.8550

Total Heat Flow Through Test Specimen

50.16 watts (171.15 Btu/hr)

Calculated Thermal Properties

Specimen Thermal Transmittance (<i>U</i>)	0.243 W/m ² K (0.043 Btu/ hr ft ² F)
Specimen Overall Thermal Resistance (<i>R_u</i>)	4.1 m ² K/W (23.3 hr ft ² F/Btu)

The estimated uncertainty of the results is ± 7.3%



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Accreditations:

Test Specification	Description	Accredited By
ASTM C 1363-05	Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus	International Accreditation Service, Inc.

Latest Apparatus Calibration Date: August 2010

Butler Manufacturing will retain a copy of this test report for a minimum of four years. This report is the property of the Test Sponsor as mentioned in this test report and relates only to the products and assemblies as tested. This report may not be reproduced, except in full, without the prior written consent of Butler Manufacturing. The results obtained are tested values. This report is not an endorsement about the tested products and does not constitute a certification of the products tested.

For Butler Manufacturing

Mark J. Henry
Senior Research Engineer

Attachments:

Revision Log

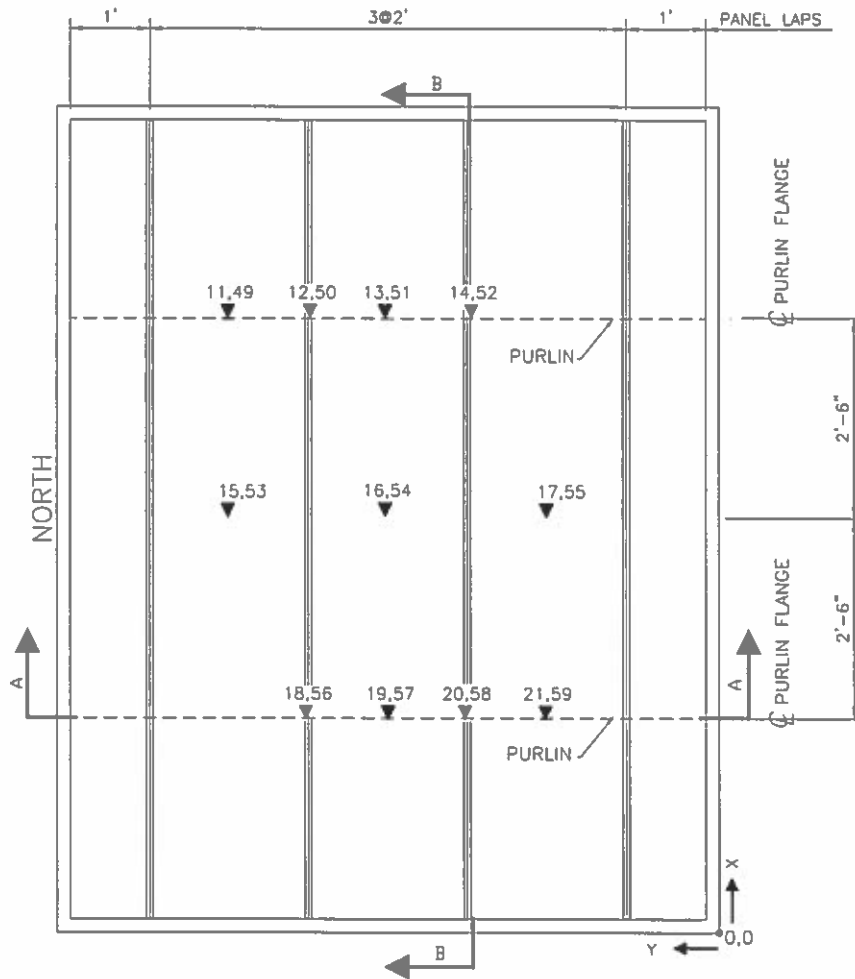
Rev #	Date	Page(s)	Revision(s)
Original	10/18/2011	All	
1	9/24/2012	6	Section B-B, Panel clip call-out
2	10/6/2017	5, 6	Corrected "TALL CLIPS" to "X-TALL CLPS" in header



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DRAWING A – PLAN VIEW
MR-24 X-TALL CLIPS R-30 SPACER BLOCKS



NOTES

- (TC) 11 THRU 21 ARE ON THE CLIMATE SIDE
- (TC) 49 THRU 59 ARE ON THE METER SIDE
- ▲ ## INDICATES LOCATION OF THERMO COUPLES (TC)

TEST 2011-57

Rev. 2

Test Number: 2011-57

Test Results ID: Standard Results-10/18/2011 11:02

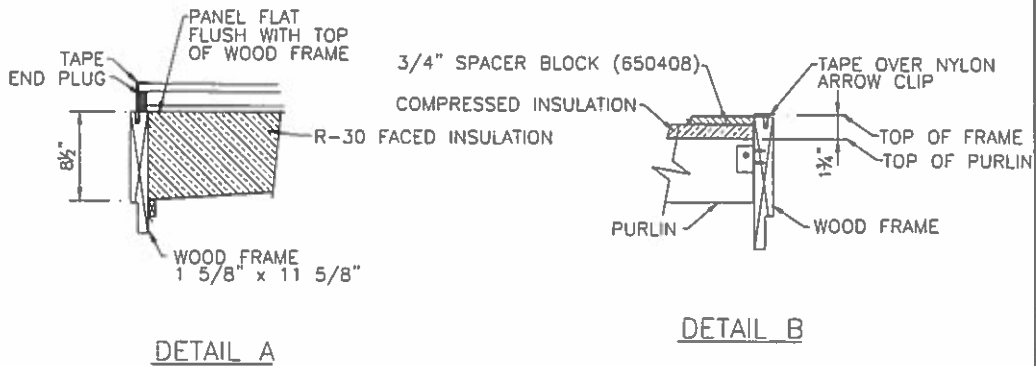
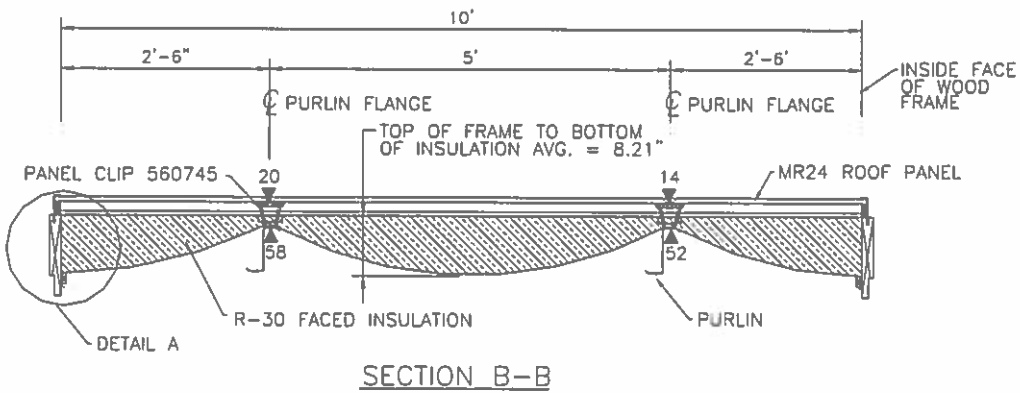
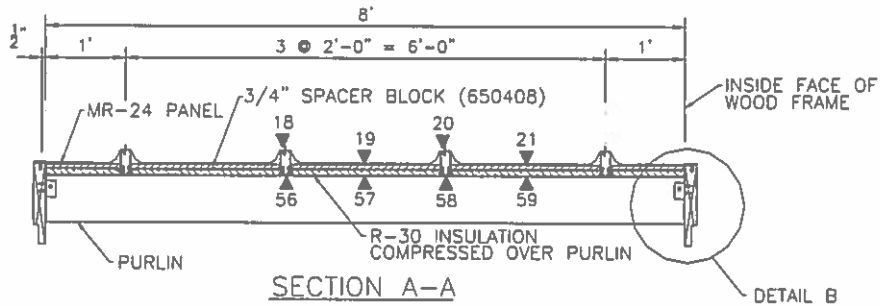
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DRAWING B - SECTIONS THRU TEST FIXTURE
MR-24 X-TALL CLIPS R-30 STD SPACER BLOCKS



TEST 2011-57

▲ ## INDICATES LOCATION OF THERMO COUPLES (TC)

Rev. 1, 2

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Test Number: 2011-57

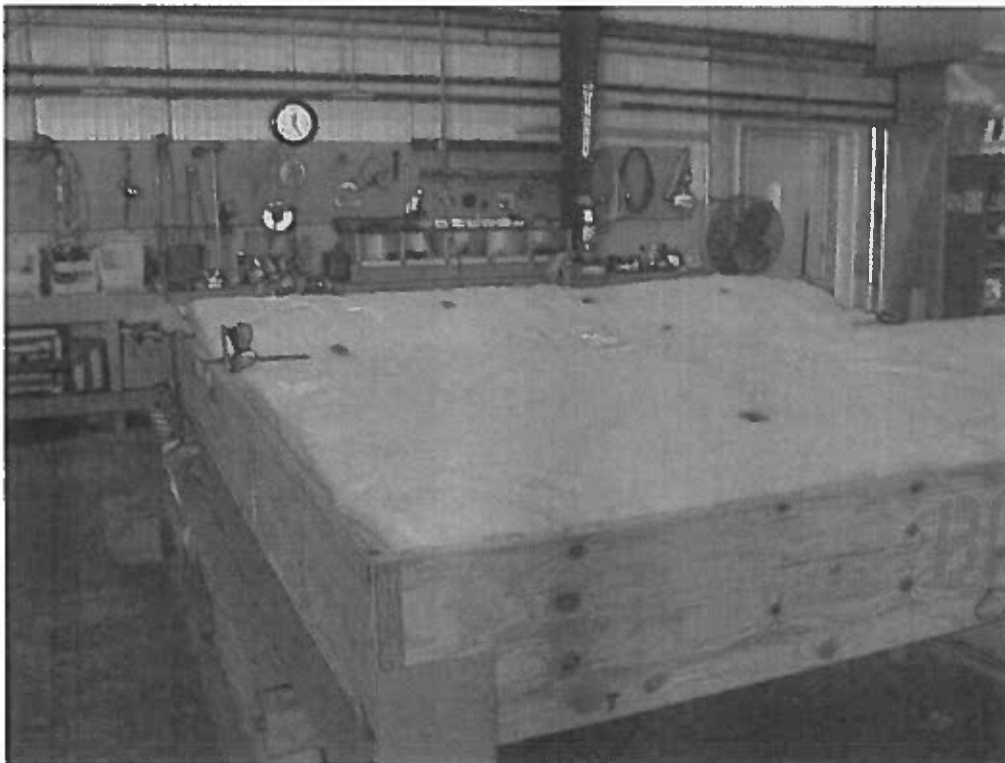
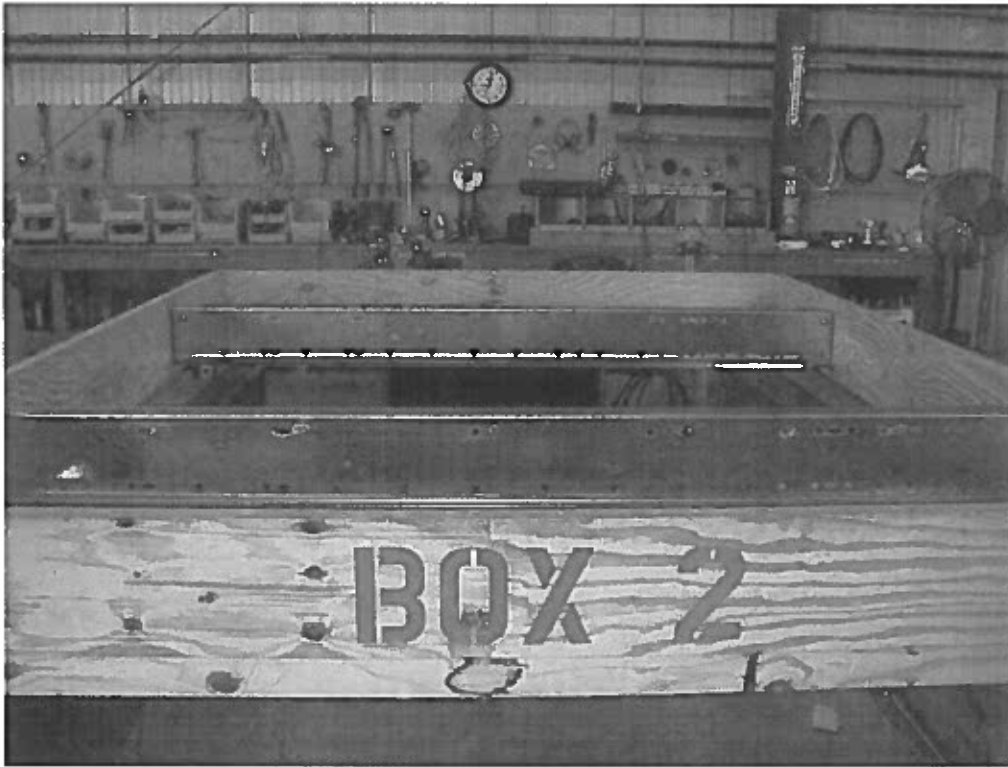
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Test Number: 2011-57

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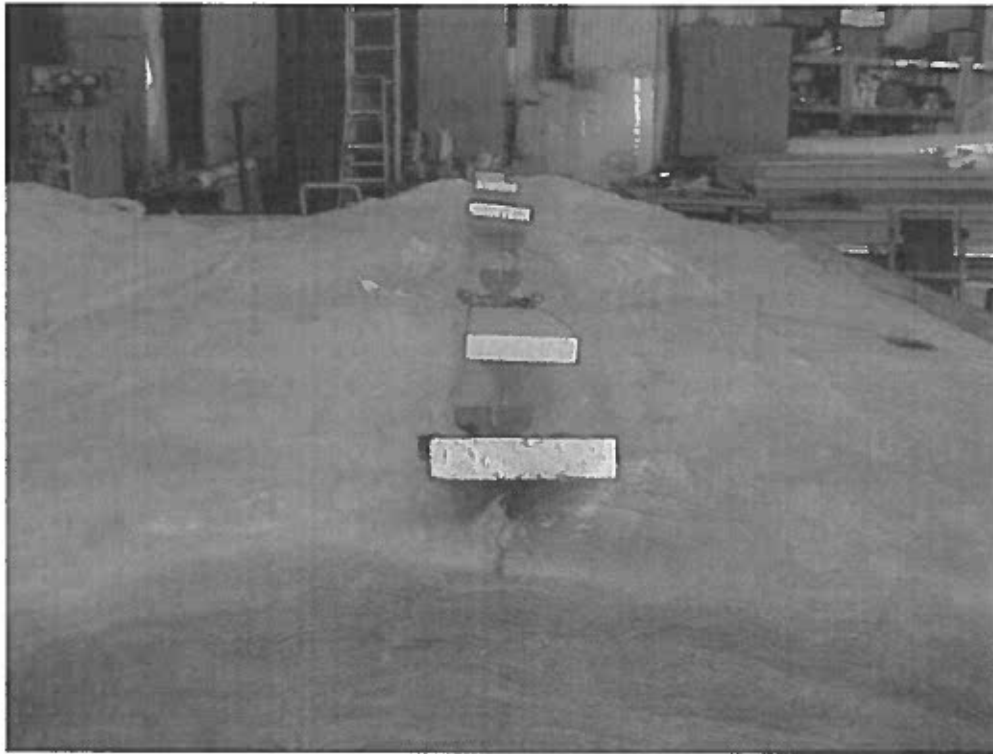
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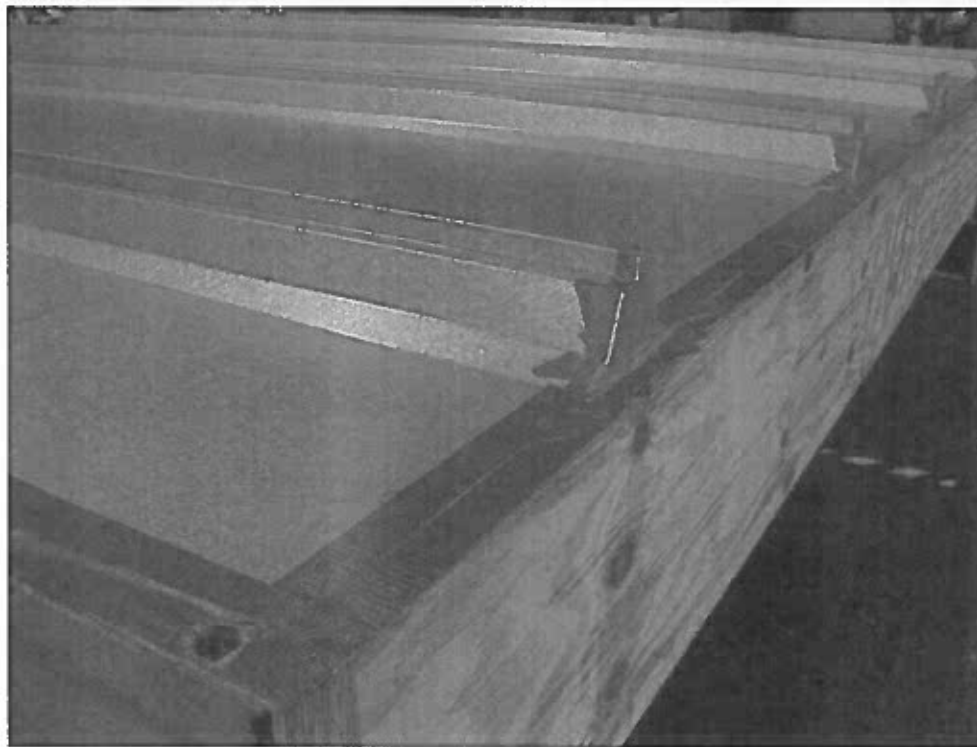
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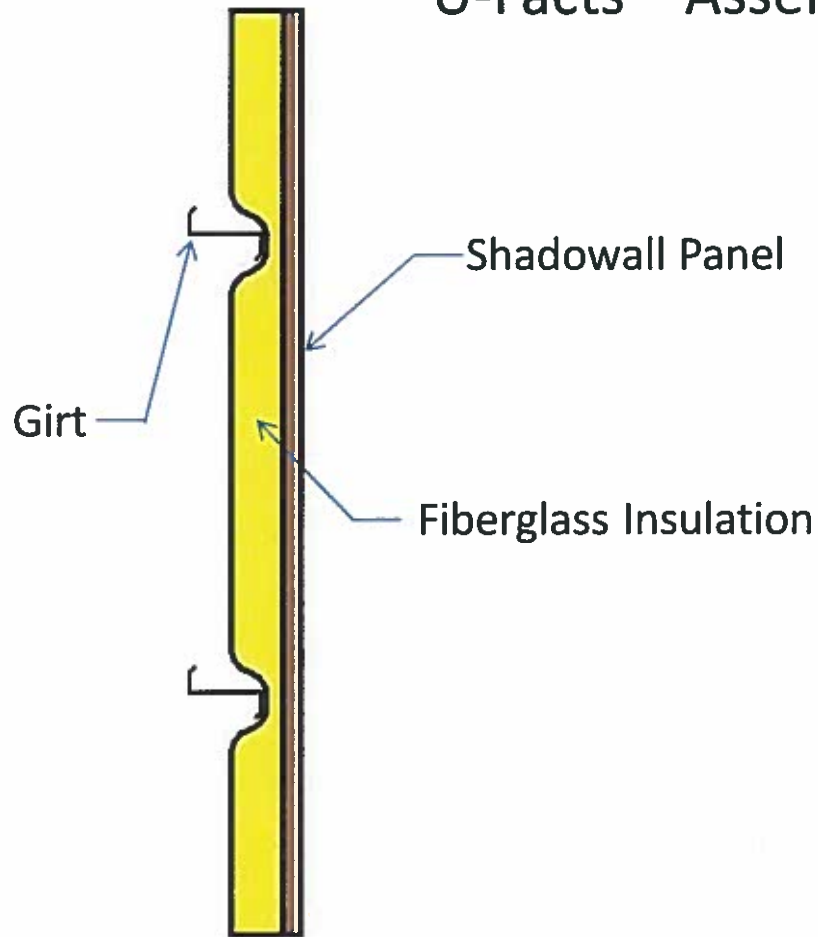
Test Number: 2011-57

Test Results ID: Standard Results-10/18/2011 11:02

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U-Facts™ Assembly Snapshot



Shadowwall™ Wall System
R-19 fiberglass insulation

U-Factor: 0.075

Not intended for Construction. See test report for full details





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**ASTM C 1363
Thermal Performance Test Report**

Shadowall Wall Panel R-19 Insulation
*Shadowall™ wall system panels, nominal R-19 faced fiberglass
insulation*

Test Numbers:
2012-07 and 2012-08

Prepared for:
Butler Research Center
13500 Botts Road
Grandview, Missouri

Report Date: ✓
5/2/2012

Butler Manufacturing Research Center
13500 Botts Road
Grandview, Missouri 64030
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13500 Botts Road
Grandview, MO 64030-2897
Phone 816-968-5700

ASTM C 1363 Thermal Performance Test Report Summary

Test Information:

Shadowall Wall Panel R-19 Insulation

Shadowall™ wall system panels, nominal R-19 faced fiberglass insulation

Test Number	2012-07	2012-08
Test Start Date	3/6/2012	3/12/2012
Test End Date	3/9/2012	3/5/2012
Report Date	3/12/2012	4/3/2012

Test Orientation	Vertical Wall
Heat Flow Direction	Inside to Outside
Specimen Size	2.44 m X 3.05 m (8.00 ft x 10.00 ft)

Test Procedure: The Thermal Transmittance (U) and Thermal Resistance (Ru) were determined in general accordance with ASTM C 1363-05, *Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus*.

Summary of Test Setup:

	Test	Test
Average Warm Side Air Temp.	37.78 °C (100.00 °F)	37.77 °C (99.98 °F)
Average Cold Side Air Temp.	10.02 °C (50.03 °F)	10.03 °C (50.05 °F)
Average Warm Side Air Velocity	0.32 m/s (62.92 fpm)	0.31 m/s (60.19 fpm)
Average Cold Side Air Velocity	1.29 m/s (253.35 fpm)	1.30 m/s (255.69 fpm)
Girt Spacing	10'-0"	5'-0"

Summary of Results:

→ Thermal Transmittance, U	0.389 W/m ² K (0.069 Btu/ hr ft ² °F)	0.479 W/m ² K (0.084 Btu/ hr ft ² °F)
→ Overall Thermal Resistance, Ru	2.6 m ² K/W (14.6 hr ft ² °F/Btu)	2.1 m ² K/W (11.9 hr ft ² °F/Btu)



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The following table shows the values calculated from the above test results.

Summary of Test Results Calculated for a 7'-0" Girt Spacing

Thermal Transmittance, U	0.075 Btu/ hr ft² °F
Overall Thermal Resistance, Ru	13.3 hr ft² °F/Btu

The Overall Thermal Resistance, Ru, is the effective R-value of the wall assembly.

Method of Calculation:

The U-factor for a 7'-0" girt spacing is calculated from the results of the tests using 5' and 10' girt spacings. It uses a linear relationship between the U-factor and the inverse of the girt spacing. This method was developed by the Building Technology Center at the Oak Ridge National Laboratory and is based on hot box tests performed for through-fastened roofs.

Original Test Reports:

Copies of the original test reports are included below.

Revision Log

Rev #	Date	Page(s)	Revision(s)
Original	5/5/2012	All	
Rev. 1	11/5/2015	3	

Rev. 1



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**ASTM C 1363
Thermal Performance Test Report**

Test Number: 2012-07

Sponsor:
Butler Research Center
13500 Botts Road
Grandview, Missouri 64030

Shadowall 1 Girt R-19
*Shadowall™ wall system panels, 1 girt, nominal R-19 faced fiberglass
insulation*

Test Date: 3/6/2012
Report Date: 3/12/2012 ✓

Butler Manufacturing Research Center
13500 Botts Road
Grandview, Missouri 64030
816-968-5701



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Grandview, MO 64030-2897
Phone 816-968-5700

ASTM C 1363 Thermal Performance Test Report Summary

Prepared For:
Butler Research Center
13500 Botts Road
Grandview, Missouri 64030

Test Number: 2012-07
Test Start Date: 3/6/2012
Test End Date: 3/9/2012

Test Information:
Shadowall 1 Girt R-19
Shadowall™ wall system panels, 1 girt, nominal R-19 faced fiberglass insulation

Test Orientation / Heat Flow Direction:
Vertical Wall / Inside to Outside

Specimen Size:
2.44 m x 3.05 m (8.00 ft x 10.00 ft)

Test Procedure: The Thermal Transmittance (U) and Thermal Resistance (Ru) were determined in general accordance with ASTM C 1363-05, *Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.*

Summary of Test Setup:

Average Warm Side Ambient Temperature	37.78 deg C (100.00 deg F)
Average Cold Side Ambient Temperature	10.02 deg C (50.03 deg F)
Average Warm Side Air Velocity	0.32 m/s (62.92 fpm)
Average Cold Side Air Velocity	1.29 m/s (253.35 fpm)

Summary of Results:

Thermal Transmittance, U:	0.389 W/m ² K (0.069 Btu/ hr ft ² F)
Overall Thermal Resistance, Ru:	2.6 m ² K/W (14.6 hr ft ² F/Btu)



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Grandview, MD 64030-2897
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Specimen Size: 2.44 m x 3.05 m (8.00 ft x 10.00 ft)

Panel Type: Shadowwall wall system

Insulation: Fiberglass, 1-layer

Framing System: Z-girt

Specimen Construction: The girt was installed in the test frame. One end of the insulation facing was attached to the inside of the test frame. The test frame was rotated to vertical. The depth of the drape of the insulation was checked. The other end of the facing was attached to the inside of the test frame. The test frame was rotated back to horizontal. The wall panels were installed with self-drilling screws. The side laps of the panel and the perimeter of the panel area were taped to prevent air leakage.

Specimen Conditioning: The assembly was built at the Butler Research Center and remained there until it was tested. The insulation was unrolled and was in environmental conditions for at least 12 hours before being enclosed in the test assembly. The insulation was "fluffed" in a manner similar to the NAHB procedure for quality testing of faced insulation, in order to promote the recovery of the insulation thickness.

Materials Used:

Material Name	Description
Wall Panel	Shadowwall™ wall system panel, 26 gauge, painted Birch White finish
R-19 Fiberglass	Nominal R-19 faced fiberglass blanket insulation Measured thermal resistance: 18.42 hr ft ² F/Btu

Sources for Materials Used: Butler Manufacturing supplied the girt, the wall panels, and fasteners. Bay Insulation Systems, Inc supplied the faced fiberglass insulation. The original manufacturer of the fiberglass was Owens Corning.



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Grandview, MO 64030-2897
Phone 816-968-5700

Measured Test Data

Test Times

Test Start Time	3/6/2012 11:14 AM
Test End Time	3/9/2012 7:15 AM
Time Required to Reach Steady State	55.8 Hours
Steady State Start Time	3/8/2012 7:00 PM
Steady State End Time	3/9/2012 3:55 AM

Test Information

Metered Area	10.48 m ² (112.75 ft ²)
Specimen Area	7.43 m ² (80.00 ft ²)
Average Warm Side Ambient Temperature	37.78 deg C (100.00 deg F)
Average Cold Side Ambient Temperature	10.02 deg C (50.03 deg F)

Input 112.06 watts (382.35 Btu/hr)

Warm Side Heaters	89.65 watts (305.88 Btu/hr)
Warm Side Fans	21.16 watts (72.20 Btu/hr)
Warm Side AVT & RH Sensor Power	1.25 watts (4.26 Btu/hr)

Loss 31.86 watts (108.72 Btu/hr)

Surround Panel Loss	19.85 watts (67.73 Btu/hr)
Specimen Flanking Loss	12.02 watts (41.02 Btu/hr)
Meter Wall and Flanking Loss	-0.01 watts (-0.05 Btu/hr)
Thermopile Voltage (<i>E</i>)	-0.473 mV
Thermopile Null (<i>E₀</i>)	-0.4800 mV
Thermopile Slope (<i>m</i>)	-1.8810

Total Heat Flow Through Test Specimen 80.20 watts (273.64 Btu/hr)

Calculated Thermal Properties	
Specimen Thermal Transmittance (U)	0.389 W/m ² K (0.069 Btu/ hr ft ² F)
Specimen Overall Thermal Resistance (Ru)	2.6 m ² K/W (14.6 hr ft ² F/Btu)

The estimated uncertainty of the results is ± 7.3%



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Accreditations:

Test Specification	Description	Accredited By
ASTM C 1363-11	Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus	International Accreditation Service, Inc.

Latest Apparatus Calibration Date: August 2011

ASTM Exceptions, if any:

Responsible Party: Mark J. Henry

Operator: Larry Krueger

Witness: Mark Henry

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For Butler Manufacturing

Mark J. Henry
Senior Research Engineer

Attachments:

Revision Log

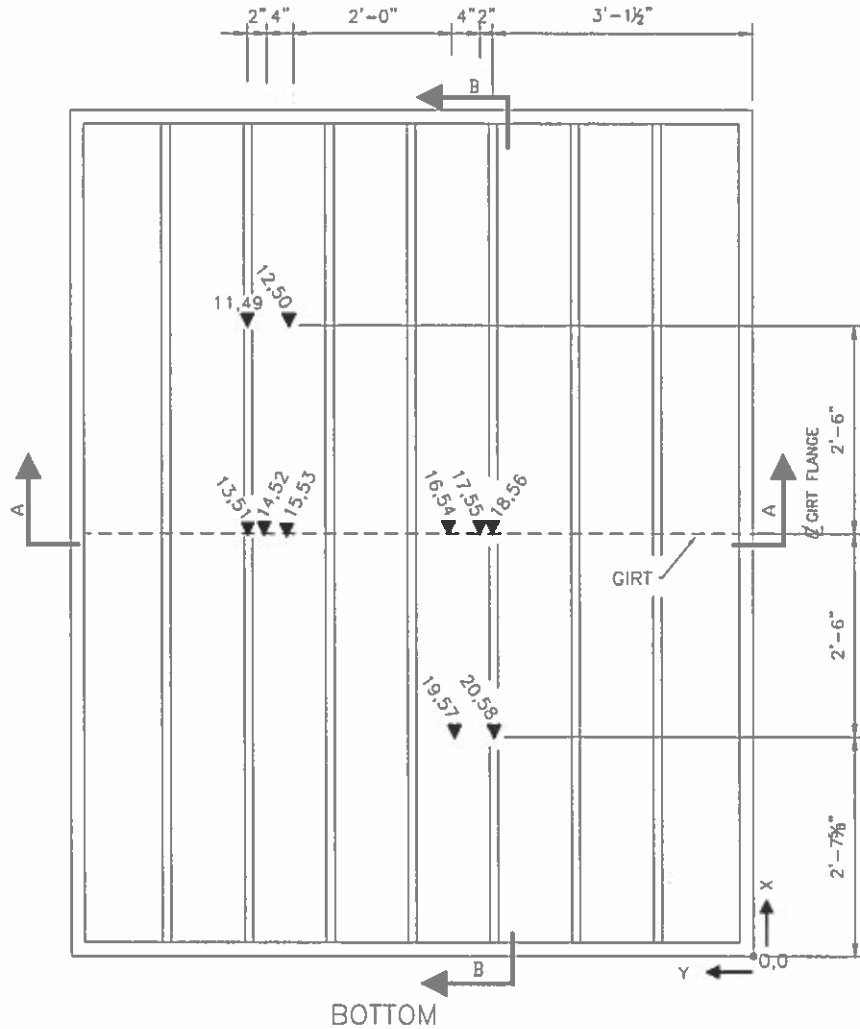
Rev #	Date	Page(s)	Revision(s)
Original	3/12/2012	All	



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DRAWING A - ELEVATION
SHADOWWALL 1 GIRT R-19



NOTES

- (TC) 11 THRU 20 ARE ON THE CLIMATE SIDE SURFACE
- (TC) 49 THRU 58 ARE ON THE METER SIDE SURFACE

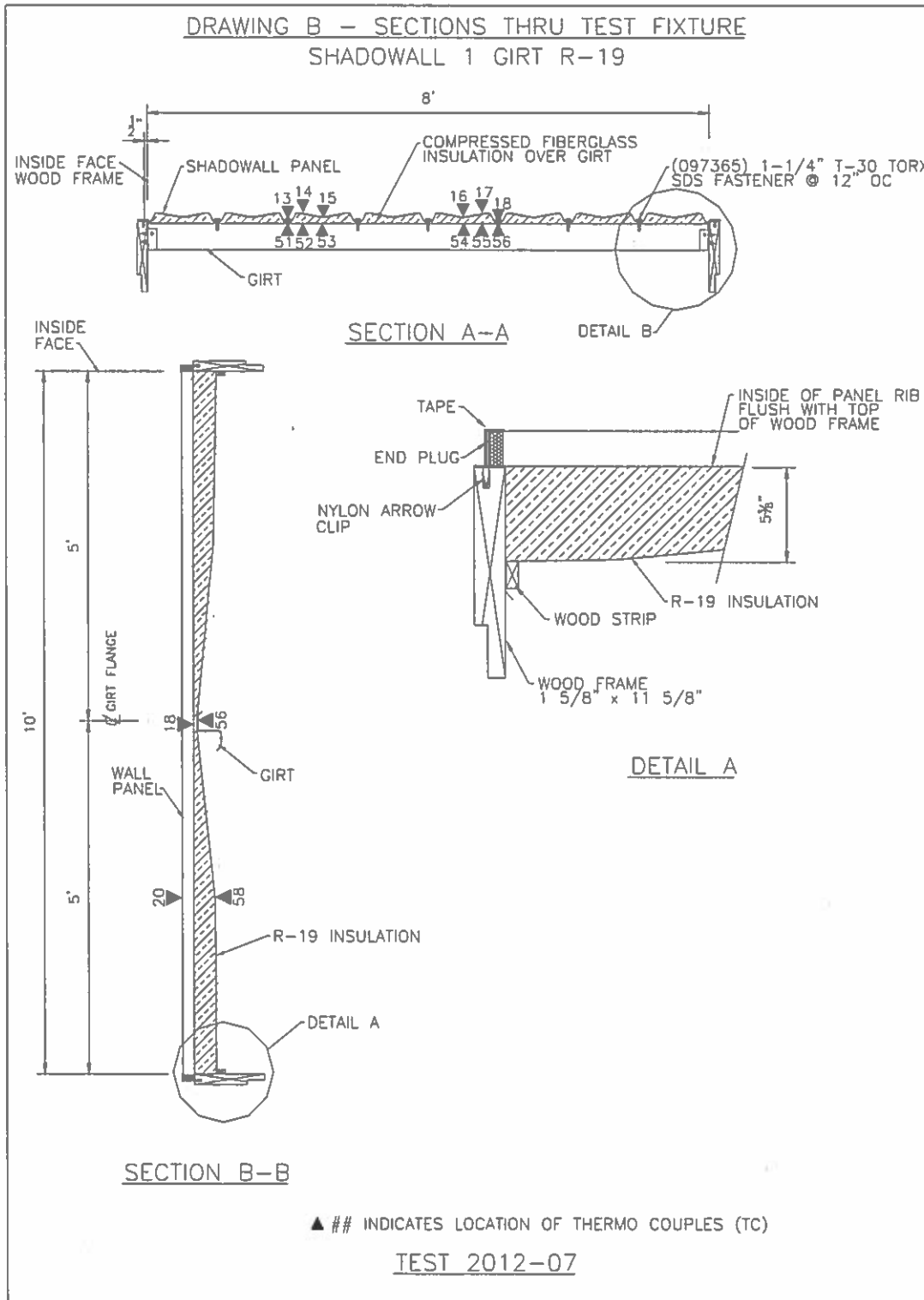
▲ ## INDICATES LOCATION OF THERMO COUPLES (TC)

TEST 2012-07



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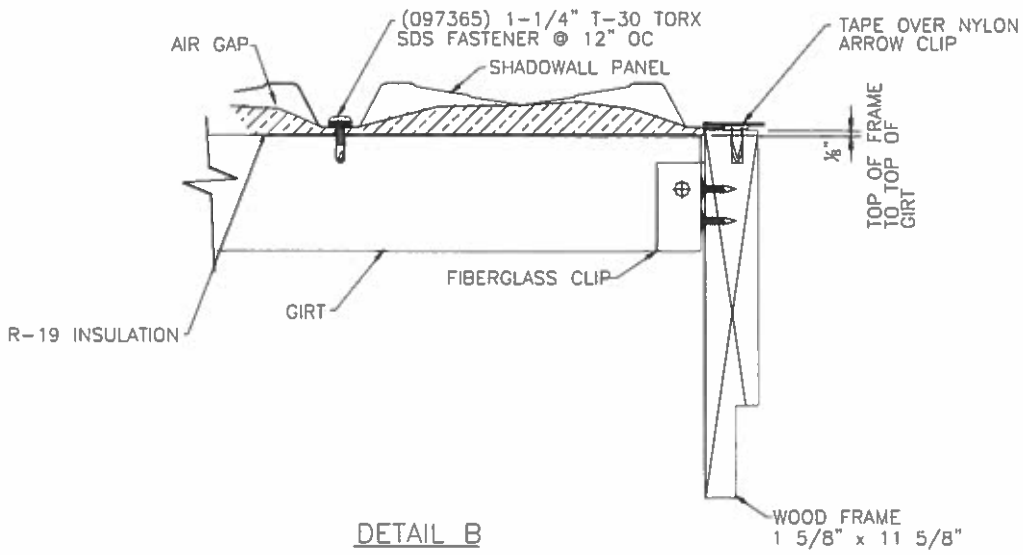




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DRAWING C – SECTIONS THRU TEST FIXTURE
SHADOWALL 1 GIRT R-19



TEST 2012-07



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**ASTM C 1363
Thermal Performance Test Report**

Test Number: 2012-08

Sponsor:
Butler Research Center
13500 Botts Road
Grandview, Missouri 64030

Shadowall 2 Girts R-19
*Shadowall™ wall system panels, 2 girts, nominal R-19 faced fiberglass
insulation*

Test Date: 3/12/2012
Report Date: 4/3/2012

Butler Manufacturing Research Center
13500 Botts Road
Grandview, Missouri 64030
816-968-5701



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Grandview, MO 64030-2897
Phone 816-968-5700

ASTM C 1363 Thermal Performance Test Report Summary

Prepared For:
Butler Research Center
13500 Botts Road
Grandview, Missouri 64030

Test Number: 2012-08
Test Start Date: 3/12/2012
Test End Date: 3/15/2012

Test Information:
Shadowwall 2 Girts R-19
Shadowwall™ wall system panels, 2 girts, nominal R-19 faced fiberglass insulation

Test Orientation / Heat Flow Direction:
Vertical Wall / Inside to Outside

Specimen Size:
2.44 m x 3.05 m (8.00 ft x 10.00 ft)

Test Procedure: The Thermal Transmittance (U) and Thermal Resistance (Ru) were determined in general accordance with ASTM C 1363-05, *Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus*.

Summary of Test Setup:

Average Warm Side Ambient Temperature	37.77 deg C (99.98 deg F)
Average Cold Side Ambient Temperature	10.03 deg C (50.05 deg F)
Average Warm Side Air Velocity	0.31 m/s (60.19 fpm)
Average Cold Side Air Velocity	1.30 m/s (255.69 fpm)

Summary of Results:

Thermal Transmittance, U:	0.479 W/m ² K (0.084 Btu/ hr ft ² F)
Overall Thermal Resistance, Ru:	2.1 m ² K/W (11.9 hr ft ² F/Btu)



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Specimen Size: 2.44 m x 3.05 m (8.00 ft x 10.00 ft)

Panel Type: Shadowall™ wall system

Insulation: Fiberglass, 1-layer

Framing System: Z-girt

Specimen Construction: The girts were installed in the test frame. One end of the insulation facing was attached to the inside face of the test frame. The test frame was rotated to vertical. The insulation was allowed to hang down under its own weight. The dimension of the drape of the insulation was checked. The other end of the insulation facing was attached to the test frame. The test frame was rotated back to horizontal. The wall panels were fastened to the girts with self-drilling screws. The side laps of the panels and the perimeter of the panel area were taped to prevent air leakage.

Specimen Conditioning: The assembly was built at the Butler Research Center and remained there until it was tested. The insulation was unrolled and was in environmental conditions for at least 12 hours before being enclosed in the test assembly. The insulation was "fluffed" in a manner similar to the NAHB procedure for quality testing of faced insulation, in order to promote the recovery of the insulation thickness.

Materials Used:

Material Name	Description
Wall Panel	Shadowall™ wall system panel, 26 gauge, Painted Birch White finish
R-19 Fiberglass	Nominal R-19 faced fiberglass blanket insulation Measured thermal resistance: 18.42 hr ft ² F/Btu

Sources for Materials Used: Butler Manufacturing supplied the girts, wall panels, and fasteners. Bay Insulation Systems Inc. supplied the insulation. The original manufacturer of the fiberglass insulation was Owens Corning.



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Measured Test Data

Test Times

Test Start Time	3/12/2012 11:27 AM
Test End Time	3/15/2012 7:43 AM
Time Required to Reach Steady State	51.6 Hours
Steady State Start Time	3/14/2012 3:00 PM
Steady State End Time	3/14/2012 11:55 PM

Test Information

Metered Area	10.48 m ² (112.75 ft ²)
Specimen Area	7.43 m ² (80.00 ft ²)
Average Warm Side Ambient Temperature	37.77 deg C (99.98 deg F)
Average Cold Side Ambient Temperature	10.03 deg C (50.05 deg F)

Input 131.59 watts (449.00 Btu/hr)

Warm Side Heaters	118.51 watts (404.38 Btu/hr)
Warm Side Fans	11.82 watts (40.33 Btu/hr)
Warm Side AVT & RH Sensor Power	1.26 watts (4.30 Btu/hr)

Loss 32.79 watts (111.88 Btu/hr)

Surround Panel Loss	19.85 watts (67.73 Btu/hr)
Specimen Flanking Loss	12.95 watts (44.20 Btu/hr)
Meter Wall and Flanking Loss	-0.01 watts (-0.05 Btu/hr)
Thermopile Voltage (<i>E</i>)	-0.472 mV
Thermopile Null (<i>E₀</i>)	-0.4800 mV
Thermopile Slope (<i>m</i>)	-1.8810

Total Heat Flow Through Test Specimen 98.80 watts (337.12 Btu/hr)

Calculated Thermal Properties	
Specimen Thermal Transmittance (U)	0.479 W/m ² K (0.084 Btu/ hr ft ² F)
Specimen Overall Thermal Resistance (Ru)	2.1 m ² K/W (11.9 hr ft ² F/Btu)

The estimated uncertainty of the results is ± 7.3%



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Accreditations:

Test Specification	Description	Accredited By
ASTM C 1363-11	Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus	International Accreditation Service, Inc.

Latest Apparatus Calibration Date: August 2011

ASTM Exceptions, if any:

Responsible Party: Mark J. Henry

Operator: Larry Krueger

Witness: Mark Henry

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For Butler Manufacturing

Mark J. Henry
Senior Research Engineer

Attachments:

Revision Log

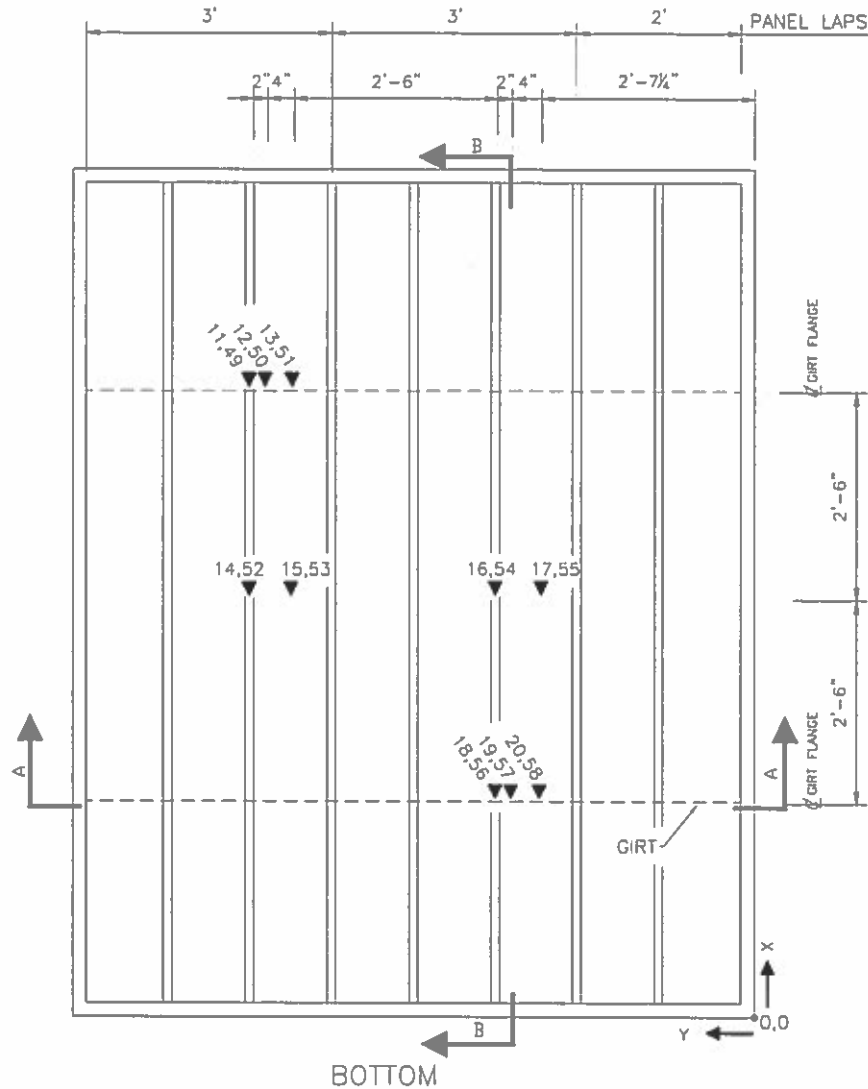
Rev #	Date	Page(s)	Revision(s)
Original	4/3/2012	All	



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DRAWING A – ELEVATION
SHADOWWALL 2 GIRTS AND R-19



NOTES

- (TC) 11 THRU 20 ARE ON THE CLIMATE SIDE SURFACE
- (TC) 49 THRU 58 ARE ON THE METER SIDE SURFACE

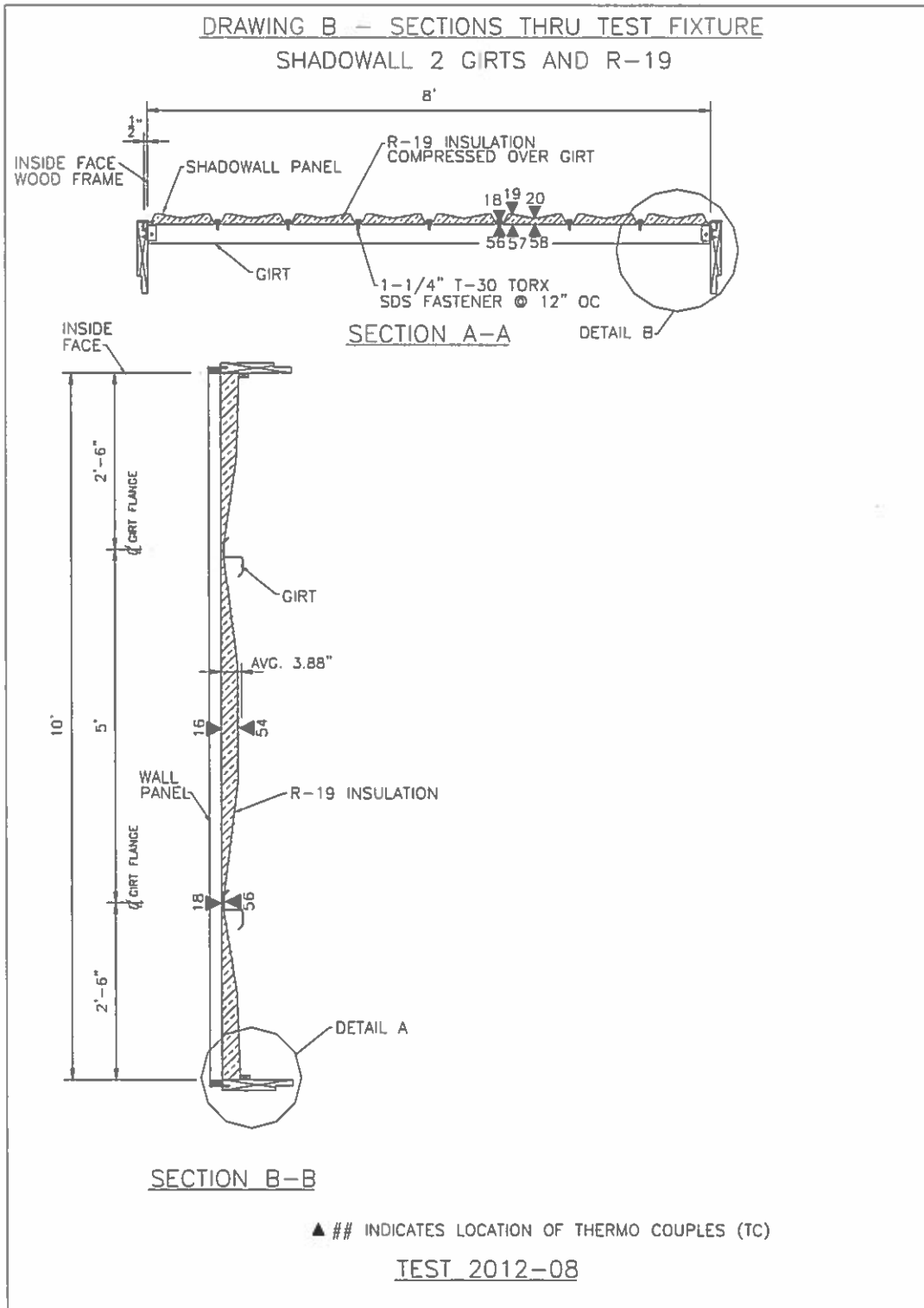
▲ ## INDICATES LOCATION OF THERMO COUPLES (TC)

TEST 2012-08



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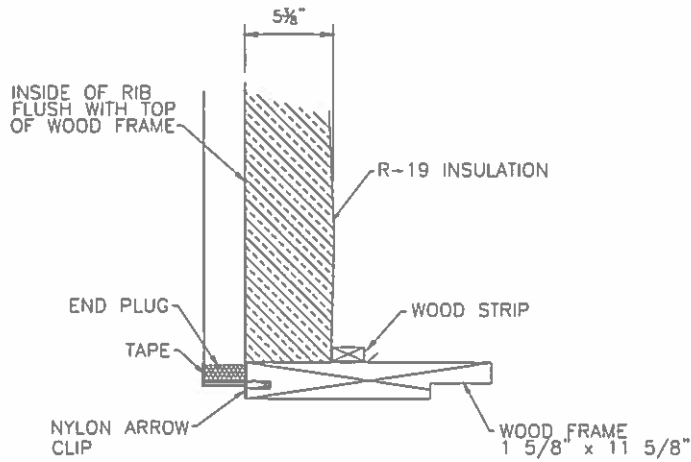




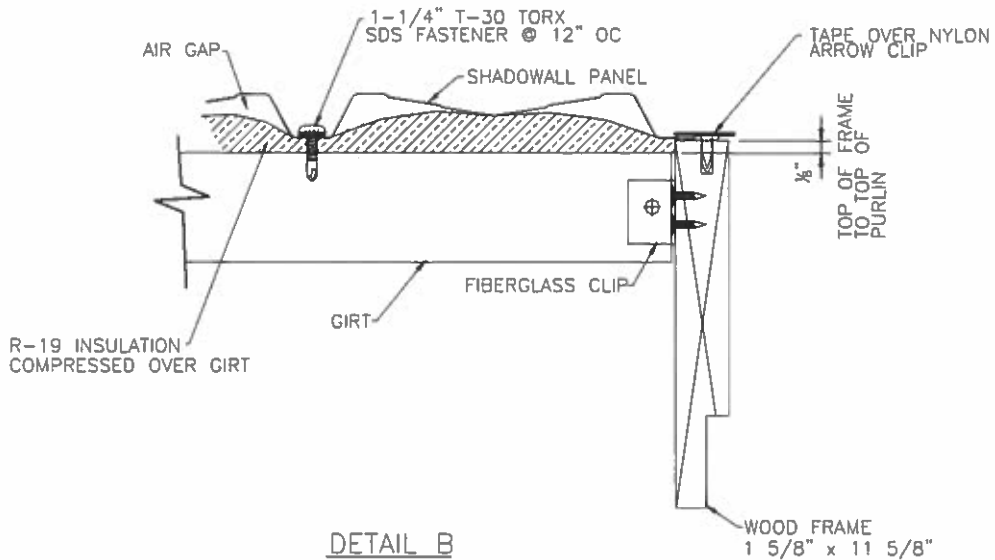
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DRAWING C - DETAILS
SHADOWWALL 2 GIRTS AND R-19



DETAIL A



DETAIL B

TEST 2012-08



ChemMasters®

Conset Grout™

Non-shrink, Non-metallic
Cementitious Construction Grout

SPECIALTY CONSTRUCTION PRODUCTS

PRODUCT DATA

DESCRIPTION

ChemMasters' Conset Grout, is a non-shrink, non-metallic, construction grout used at dry pack, plastic, flowable, or fluid consistency. Meets or exceeds ASTM Standards C1107 and CRD C-621.

ADVANTAGES

- Flowable and self consolidating
- May be placed at plastic consistency for increased strength requirements – up to 7,150 psi after 28 day cure
- Non-shrink for maximum load bearing
- Can be extended 50% for placements over 2 inches (5 cm) deep
- Natural aggregate matches the color of concrete
- Contains no oxidizing components, will not rust
- Pumpable for rapid placement on large projects

USES

Building Columns	Hand Rails
Bridge Beams	Boiler Plates
Sewers	Precast Beams
Precast Columns	Dowels
Fence Posts	Highway Barriers
Anchor Bolts	Base Plates
Bed Plates	Underpinnings
Wall Panels	Pipes/Sleeves

TECHNICAL DATA

Packaging			
Container	lbs / kg	Pallet	Item#
Moisture proof bags	50 / 22.7	60	F2310.50
Bulk bags 1 cubic yard	3000 / 1364	na	F2310.30

Yield per 50 lb (22.7 kg)		
	ft ³	m ³
Plastic	0.42	0.012
Flowable	0.43	0.012
Fluid	0.45	0.013

Flow ASTM C 230 Flow Table, water per 50 lb bag

	Pints	Liters	5 drops
Plastic	8	3.8	107%
Flowable	9	4.3	145%
fluid	9 to 10	4.3 to 4.7	30 seconds **

* For Ohio D.O.T. keyway grouting use a maximum of 8.5 pints (4L) water per 50 lb (23kg bag) ** Flow Cone

Set Times ASTM 191/Vicat Method—Hours to Set

	Initial	Final
Plastic	2.2	3.5
Flowable	2.2	3.5
Fluid	3.2	4.0

Compressive Strength ASTM C 109 / C 109M 2" Cubes - psi @ x days to cure

	1	7	28
Plastic	2,775	6,160	7,150
Flowable	2,590	5,260	6,870
Fluid	2,100	4,920	6,030

Expansion ASTM 1090 / CRD C 621 Moist Cured

	24 hrs	3days	14 days	28days
Fluid	0.03%	0.03%	0.02%	0.02%

ASTM C827 Early Height Change

Average of two 3" x 6" cylinders	+ 1.2%
----------------------------------	--------

VOLUME GROUTING

For applications over 2 inches (5 cm) deep, Conset Grout may be extended with up to 25 lbs (11 kg) of clean, SSD 3/8" (0.95 cm) pea gravel per bag. With 9 pints (4.3L) of water yield will increase to approximately 0.6ft³ (0.017m³). When including pea gravel in the mix, flow will decrease significantly.



ChemMasters®

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Nov 2013

DIRECTIONS

Grouting is best accomplished at temperatures from 40° to 90°F (4° to 32°C). For extremely low or high temperatures, follow the ACI 305 Hot Weather Concreting or ACI 306 Cold Weather Concreting or consult ChemMasters' Technical Service Department for additional recommendations.

15 minute working time is based on 70°F (21°C) "as mixed" temperature. Mix water may be adjusted to maintain a consistent 70°F (21°C) "as mixed" temperature. At 90°F (32°C), mix water may be adjusted to 33°F (1°C). At 40°F (4°C), mix water may be adjusted to 90°F (32°C). Proportional mix water temperature adjustments may be made within this range to maintain a 70°F (21°C) "as mixed" temperature.

PREPARATION: The concrete substrate where the grout will be placed must be clean and free of any curing or sealing compounds, dust, dirt, oil or grease. The base should be textured where possible using a small chipping hammer. Presoak the substrate with water for 24 hours to prevent premature drying of the grout. Cover with wet burlap or polyethylene sheeting to retain moisture.

FORMING: Forms will be required for most grouting applications. Top edges of forms must be higher than bottom of base plate to be grouted. Seal bottom edges of forms to prevent grout from leaking. Construct forms with a larger gap, at least 2" (5 cm), between form and base being grouted. Use a slant board or construct a head box to direct flow of grout from front to back. Allow at least a 1" (2.5 cm) gap at backside of form to facilitate flow and allow air to escape in front of grout flow. All forms in contact with the grout must be coated with ChemMasters' Release or Safe-Slip.

MIXING: A paddle type mortar mixer, grout pump, or heavy duty 1/2" drill with mixing prop are required. Place approximately 80% of required water into clean pre-wet mixer or container. Use only as much water as needed to properly place the grout. Adding excess water decreases strength and expansion. For Ohio Department of Transportation keyway grouting applications, use a maximum of 8.5 pints (4L) of water per bag of Conset Grout.

When using aggregate add it to the water. Do not add sand or cement to Conset Grout. With mixer blades operating, open bag, gradually empty into mixer, mix for about 1 minute, add remaining water, and mix for 2 to 3 minutes. Following this sequence should eliminate lumping and keep mixer clean and free of excess buildup.

PLACEMENT: Always place grout from one side at a steady, continuous flow to push air out in front of grout flow, ensuring maximum surface bearing of the plate or base. Do not vibrate grout.

CURING: Proper curing is required! As soon as grout placement is complete, wet cure or use a ChemMasters' ASTM C 309 Liquid Membrane Forming Curing Compound. Contact ChemMasters Technical Service Department for recommendations.

If wet curing wet burlap may be used following the guidelines in ACI 351, *Grouting for Support of Equipment and Machinery*.

CLEANUP: Clean tools and equipment with warm water before material dries and hardens.

LIMITATIONS

- Do not apply to frost covered or frozen surfaces or at substrate or ambient temperatures below 40°F (4°C). Follow ACI 305 *Hot Weather Concreting* and 306 *Cold Weather Concreting* guidelines for placement when temperature is below 40°F (4°F) or above 90°F (32°C).
- ChemMasters recommends the use of ChemGrout mixers and pumps for placements under large base-plates or with a difficult configuration
- Contact ChemMasters' Technical Service Staff for special recommendations on precision grouting, dry pack situations or unusual circumstances
- For close tolerance placement or heavy duty applications subjected to extreme thermal shock, chemical resist, extreme high strength or dynamic loading, consider the use of ChemMasters' Gorilla Grout, Kemset, Met-Ox, Polytops CR, Polytops HF or Polytops CR Grout

Storage: Store in a cool dry location off the ground. Unopened bags can be stored for up to 2 years when kept dry.

CAUTIONS

May cause eye and respiratory tract irritation. Over exposure may cause skin irritation. Do not take internally. See current MSDS for additional precautions.

Keep out of reach of children.

Proper application is the responsibility of the user. ChemMasters can only make technical recommendations and cannot provide quality control on the jobsite.

This Product is Formulated and Labeled for Industrial and Commercial Use Only

FOR BEST RESULTS AND SAFEST USAGE, USER IS SPECIFICALLY DIRECTED TO CONSULT THE CURRENT PRODUCT & SAFETY DATA SHEETS AND PACKAGE LABEL FOR THIS PRODUCT. We warrant our products to meet our published specifications and to be free from defects in materials and workmanship to the acceptable quality levels defined in these specifications. If acceptable quality levels are not specified, the acceptable quality levels will be those normally supplied by us for the product. We make no guarantee of the results to be obtained from the use of our products. The determination as to the adaptability of any of our products to the specific needs of the Buyer is solely Buyer's prerogative and responsibility. We are glad to offer suggestions on the use of our products. Nevertheless, there are no warranties given except such expresses warranties offered in connection with the sale of a particular product. Our liability shall be limited to replacement of, or refund of an amount not to exceed the purchase price attributed to, the goods as to which such claim is made. Our selection of one of these alternatives shall be Buyer's exclusive remedy. IN NO CASE SHALL WE BE LIABLE FOR CONSEQUENTIAL OR SPECIAL DAMAGES, EVEN IF WE HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, GUARANTEES, CO-CONDITIONS AND REPRESENTATIONS, EITHER EXPRESSED OR IMPLIED, WHETHER ARISING UNDER ANY STATUTE, COMMON LAW, USAGE OR TRADE, COURSE OF DEALING OR OTHERWISE, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.