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**Fire Resistance Testing of "PURBOND HB  
E032 (3074-3)" Adhesive in Accordance With  
the AF&PA Elevated-Temperature Adhesive  
Qualification Procedure**

**Conducted For:**

**Purbond AG  
CH-6203 Sempach-Station  
Industriestrasse 17a  
Switzerland**

**WFCi Report #08019**

**Conducted On: April 3, 2008**

**Report Issued On: April 18, 2008**



**Testing • Research • Investigation • Consulting • Modeling • Animation • Litigation**

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## **INTRODUCTION**

This report documents the successful fire resistance testing of a one-hour load-bearing 10' high X 10' wide, 2 X 4 finger-jointed wood stud wall construction faced with 5/8" type X gypsum wallboard performed by Western Fire Center, Inc. (WFCi) for:

**Purbond AG  
CH-6203 Sempach-Station  
Industriestrasse 17a  
Switzerland**

Howard Stacy and Mike White of WFCi conducted the test with assistance from technicians Wayne Beres and Nick Martin (WFCi) on April 3, 2008.

The construction and testing of the test wall was witnessed by Chris Whelan and Jim Duncan, both representing Purbond.

The purpose of the test was to conduct an adhesive qualification fire test to evaluate "PURBOND HB E032 (3074-3)" urethane adhesive for use in finger-jointed wood studs. The test protocol was the AF&PA Elevated-Temperature Adhesive Qualification Procedure, approved February 27, 2007, and is based on fire testing of a loadbearing wood stud/ gypsum wallboard assembly using methodology described in ASTM E119.

For this project, the load per stud was determined using Method A described in Paragraph 3.1 of the referenced protocol.

## **SUMMARY OF TEST METHOD**

This is a vertical fire test employing the fire endurance conditions described in ASTM E 119 "Fire Tests of Building Construction and Materials". A vertical exposure furnace (described in the following section) was used to subject the sample to a standard time-temperature curve as specified in the referenced test procedures.

-The neutral pressure plane was located near the top of the wall assembly.

-For this fire endurance evaluation, the test was to be performed for a fire resistance period of one hour.

## **DESCRIPTION OF LABORATORY TEST FACILITY**

The furnace used in the test is a large-scale fire burning apparatus, fueled by natural gas (pictured below). The furnace is mounted to the floor, with the back side close to the west wall, at the south end of the laboratory facility. Inside the laboratory to the north of the furnace is a large area for specimen construction and curing. Ambient temperature in the laboratory is controlled by natural gas radiant heaters at the ceiling level.

The wall section is mounted in a vertical orientation into a steel frame specimen holder. The specimen holder is then rolled up to the furnace and secured by four pneumatic rams to the furnace opening. Combustion air and natural gas are supplied to burners through a series of pipes and valves. Internal furnace pressure is controlled by a series of dampers in the exhaust outlets. Temperature measurements are recorded by calibrated data acquisition units which pass the readings to a computer for graphical display and storage. A large roll up door is in the wall opposite the furnace area and allows for the samples to be moved approximately 40' on tracks outdoors to the area designated for hose stream testing.



## **SAMPLE DESCRIPTION**

The 10' wide x 10' high wall sample was constructed in strict accordance with the specifications detailed in the "Elevated-Temperature Adhesive Qualification Procedure (ETAQP)". The assembly consisted of nominal 2x4-in. Douglas fir end-jointed lumber spaced 16-in. O.C. (12" O.C. between first two and last two studs), with each stud containing a finger-joint located in the center third of the stud length. A single top plate and two bottom plates were used in the wall construction. The external faces of the wall were each covered with one layer of 5/8" type X gypsum wallboard (GWB) mounted horizontally on both sides (perpendicular to the supporting elements). The GWB joints on each side were covered with paper tape and gypsum joint compound in the standard manner. The screw heads were also covered with joint compound. Mineral wool batt insulation, 3-1/2" thick, nominal 2.5 PCF density, was cut to width and friction-fit in each stud cavity.

**Wood Framing:** Nominal 2 in. by 4 in. finger-jointed Select Structural Douglas fir lumber bearing the grade stamp of a nationally recognized grading agency (CMSA) were provided by the client on March 31, 2008. The studs had an average moisture content of approximately 11% percent (ranging from 9 to 12%) prior to application of the GWB on the test wall (as measured by an electrical resistance moisture meter). The weight of the vertical wood studs averaged 15.2 (+/- 1.0) lbs. There was a single finger-joint in each stud. The finger-joints were located within the middle third of the length of each stud, 43 in. and 80 in. from the base of the wall assembly, alternating the location to adjacent studs. The finger-joint length was 1-1/8" and the joint orientation was vertical. See photographs in Appendix B for depiction of finger-joint.

**Gypsum Wallboard (GWB):** Single layer 4' wide x 10' long UL labeled GP-Gypsum Tough Rock<sup>®</sup> Fireguard<sup>®</sup> 5/8" type X gypsum wallboard, with an average unit weight of 2150 lbs/MSF (as determined by WFCi). The wallboard was applied horizontally (perpendicular to studs) and fastened 12 in. OC in accordance with the referenced test protocol. For the exposed surface, two 4 x 10' pieces were attached starting at the base of the wall, followed by a 2' x 10' piece finishing the top of the wall. On the unexposed side, the 2' x 10' piece was attached at the base of the wall, followed by the two 4' x 10' pieces. There were no vertical joints in the wallboard. Paper tape and joint compound was applied to fastener heads and joints on the faces of the exposed and unexposed sides in the standard manner.

**Fasteners (GWB):** 2-1/4" Type S drywall screws spaced at 12" on center on the perimeter and in the field.

**Insulation:** Roxul mineral wool, 3.5" thick, nominal 2.5 PCF density.

## WALL LOADING AND THERMOCOUPLE INSTRUMENTATION

### Wall Loading

A superimposed axial live load of 2,567 pounds per stud (2,310 PLF, 23,106 lbs total) was applied to the assembly throughout the test. Load calculations are provided in Table 1, and a graph in Appendix A depicts the hydraulic gauge pressure throughout the test in terms of the pounds per square inch (PSI) setting of WFCi's hydraulic load application system. For this load application, the system was monitored continuously and maintained at 448 PSI gauge pressure throughout the test. The test wall was restrained between the top and bottom beams of the load frame with five hydraulic actuators pressing upwards on the moveable bottom beam until the desired load was attained. Vertical edges of the wall were left unrestrained. This axial live load was applied to the test wall approximately 30 minutes prior to the test.

Hydraulic ram gauge pressure, $P_R$ (lbs/in <sup>2</sup> )	Length of sill plate, $L_P$ (inches)	Width of sill plate, $W_P$ (inches)	Number of studs, $N_S$ (-)	Weight of test sample incl. insul. gyp., etc $W_S$ (lbs)	Effective area of each hydraulic ram $A_R$ (in <sup>2</sup> )	Number of hydraulic rams used, $N_R$ (-)	Total effective area of the hydraulic rams, $A_T$ (in <sup>2</sup> )	Weight of moveable beam, $W_B$ (lbs)
448	120	3.5	9	873.2	11.04	5	55.2	750

Total upward forces, $U_F$ (lbs force)	Total downward forces, $D_F$ (lbs force)	Total load on wall system, $L_T$ (lbs force)	Load per linear foot of wall, $L_F$ (lbs/ft)	Load per stud, $L_S$ (lbs/stud)	Load on sill plate $L_P$ (lbs/in <sup>2</sup> )
24729.6	1623.2	23106.4	2310.6	2567	55.0

**Table 1. Wall Loading Data**



## Thermocouple Layout

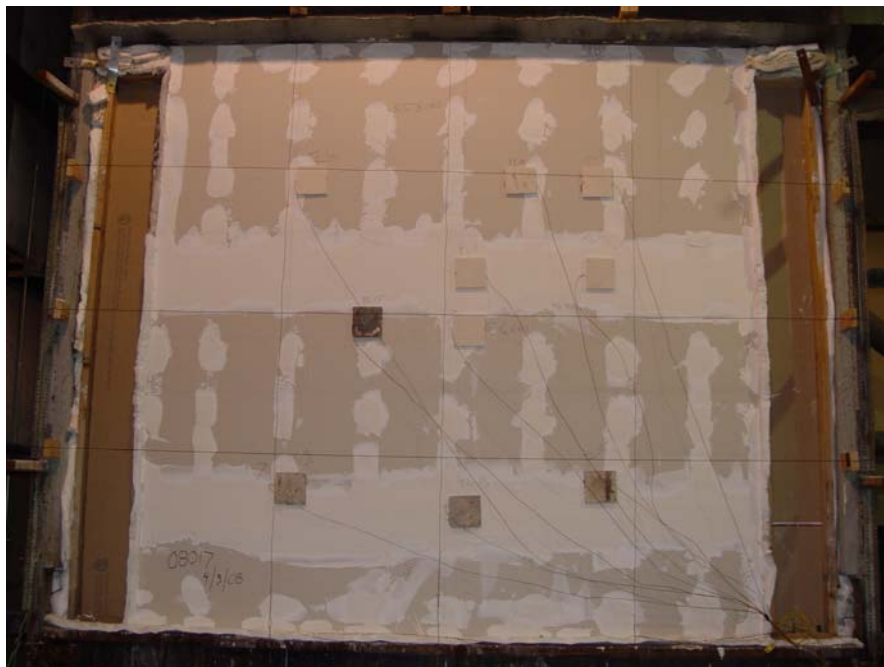
A total of 14 thermocouples were used to record temperature data during this test: 5 on the back face of the exposed sheathing attached over the studs at the four ¼-points and center-point location (finish/membrane rating) and 9 on the unexposed surface.

### *Finish Rating Thermocouples*

Thermocouples 1 through 5 were placed at the sample center and quarter-points beneath the exposed layer of GWB to obtain finish rating data.

### *Unexposed Surface*

Thermocouples 6-14 were arrayed on the unexposed surface as depicted in Figure 1. Each thermocouple was placed within approximately 1-1/2 in. from the vertical supporting elements.



**Figure 1. Unexposed Thermocouple Locations (North to the right)**

## TEST DATA

### Test Observations

**Test Date:** 4/3/08, 9:15 am

**Specimen Tested:** 10'X10' Finger-Jointed Stud Wall with Single Layer 5/8" Type X GWB on Each Side

**Furnace:** Vertical Exposure Furnace

**Cameras:** 1 digital still camera, 1 video camera, 1 IR camera

**Wood Stud Moisture Content:** 11%

**Ambient Conditions:** Lab room Temp: 17°C / 35% RH

Test Time (h:mm:ss)	Event
	Load applied approximately 30 min. prior to test; no axial (vertical) deflection recorded.
0:00:00	Start test
0:01:15	Face paper ignition
0:01:44	Flame out
0:10:00	Light surface cracking in joint compound; no deflection
0:15:00	Jt. Compound remains affixed; no deflection of wall
0:18:00	Approx. 4' of lower GWB joint exposed
0:20:00	Approx. 50% upper joint exposed, 80% lower joint exposed; light flaming along lower joint, gap approx. ¼ - 3/16"
0:25:00	100% joints exposed with light flaming along both joints
0:25:45	Finish rating attained, flame diminishing along joints
0:30:00	Light flaming reappears along lower joint, board appearance flat along surface, no cracks evident, gaps at ¼"
0:35:00	¼" deflection at center and upper S quarter pt., flame increasing
0:40:00	Flame increasing, ¼" deflection bottom S qtr. Pt.
0:45:00	½" deflection at center of wall
0:50:00	Exp'd GWB remains solidly in place, slight tearing at fasteners
0:55:00	Vertical and horizontal deflection increasing, hor. Defl. at 1-1/4" at center of wall
1:00:30	Test terminated at request of client; wall continues to carry axial load, unexposed temperatures well within limits: <b>Pass 60 minute fire resistance</b>

## Post-Test Observations

Following the test, the test assembly was detached from the furnace and the fire extinguished. Upon removal of the wallboard and cavity insulation, the studs were visually evaluated. No evidence of finger-joint failure was observed. The wood studs exhibited charring to approximately 25% of the stud depth on the fire exposed side, and all studs were consistent in appearance. All studs were evenly bowed outward (away from the fire exposure) along their length; no fracturing or other signs of breakage were noted. See photographs provided in Appendix B.

## Deflection Measurements

During the test, horizontal deflection measurements (Table 2) were taken every five minutes at five locations on the unexposed sample surface to monitor horizontal movement and/or buckling of the sample. Vertical (axial) deflection was recorded by two linear displacement transducers placed at each end of the load beam and recorded continuously. Vertical deflection is reported graphically in Appendix A.

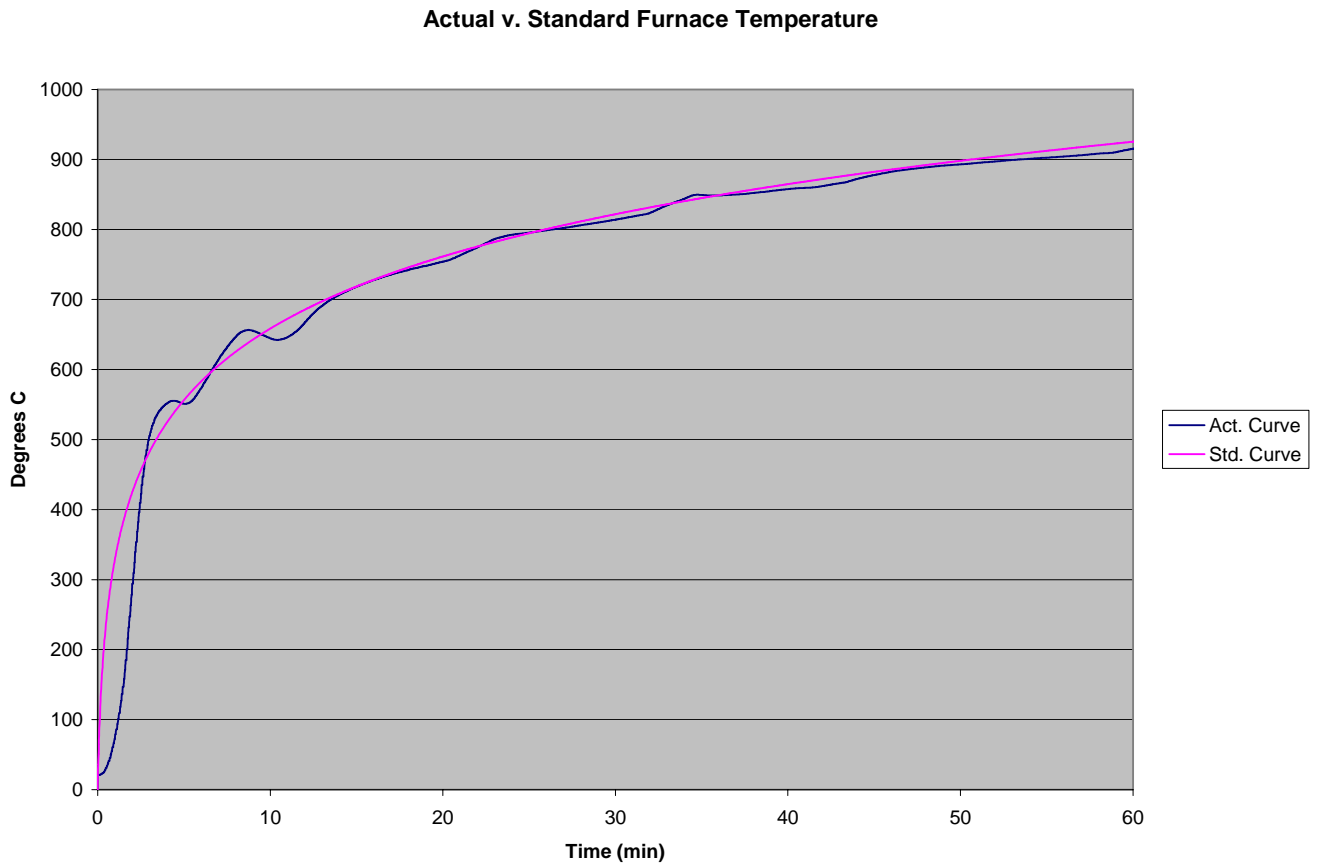
**Table 2. Horizontal Deflection Measurements**

Locations: 1=upper south ¼ pt.; 2=upper north ¼ pt.; 3=center; 4=lower south ¼ pt.; 5= lower north ¼ pt.

Time	Measurement (inches)				
	Loc #1	Loc #2	Loc #3	Loc #4	Loc #5
0:00:00	0	0	0	0	0
0:05:00	0	0	0	0	0
0:10:00	0	0	0	0	0
0:15:00	0	0	0	0	0
0:20:00	0	0	0	0	0
0:25:00	0	0	0	0	0
0:30:00	0	0	0	0	0
0:35:00	0.25	0	0.25	0	0
0:40:00	0.25	0	0.25	0.25	0
0:45:00	0.5	0.25	0.5	0.25	0.25
0:50:00	0.5	0.5	1.0	0.5	0.5
0:55:00	0.75	0.75	1.25	0.75	0.75
1:00:00	1.5	1.25	<b>2.25</b>	1.5	1.25

*All deflection measurements indicate deflection (bowing) outward from furnace. Maximum deflection of 2.25 inches noted from center location (location 3).*

## Furnace Temperatures



The area under the actual time-temperature curve was determined to be within 1% of standard. The required area under the standard time-temperature curve is **45,740 deg. C-minutes**, and the area under the actual curve was **45,421 deg. C-minutes**.

## Membrane Rating Thermocouple Temperatures

Thermocouples 1-5 were placed on the exposed (furnace) side of the wood studs beneath the base layer of GWB to obtain finish rating data during the test.

### Limiting Temperature Criteria (°C)

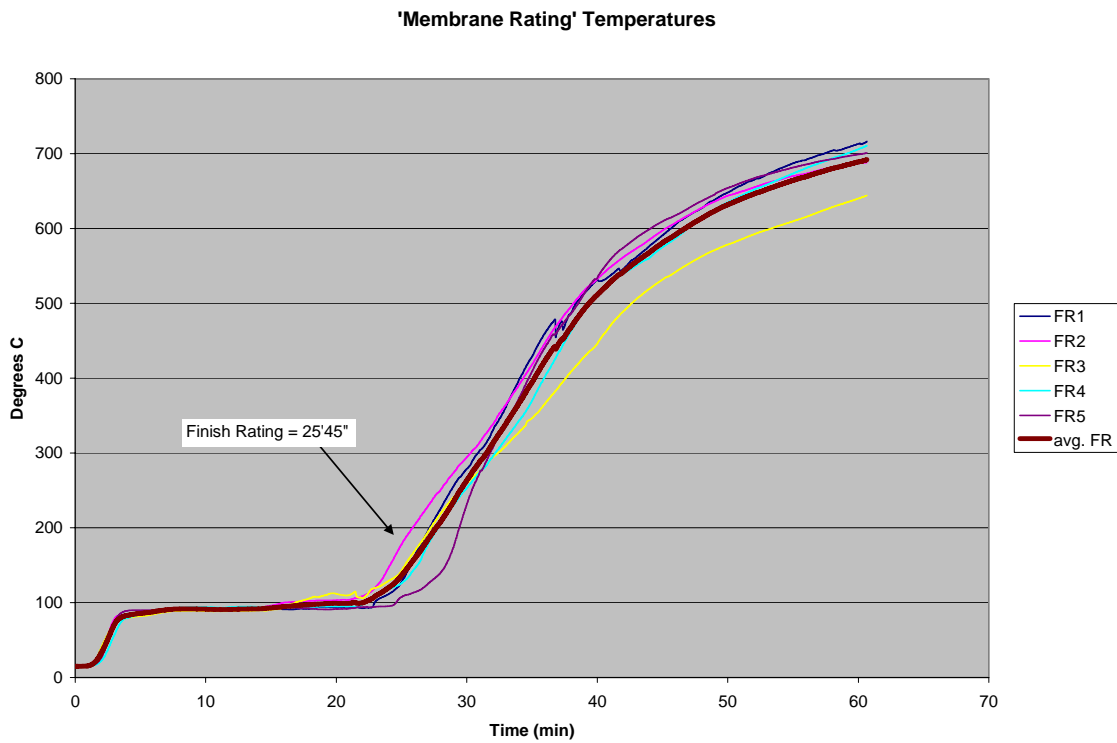
Average: 139°C + Ambient

Individual: 181°C + Ambient

### Temperature Limits Reached (mm:ss):

Average: N/A

Individual: 25:45, TC#2 (upper S Qtr.Pt.)



## Unexposed Face Thermocouple Data

### Limiting Temperature Criteria (°C)

Average: 139°C + Ambient

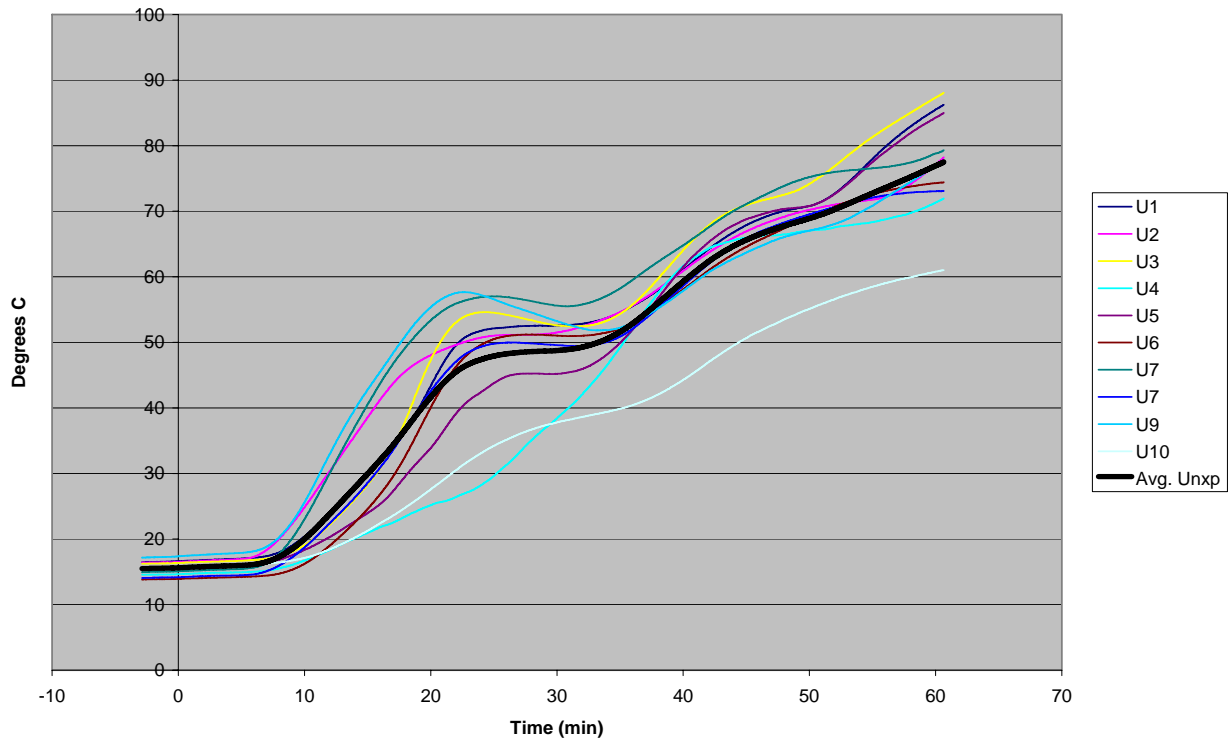
Individual: 181°C + Ambient

### Temperature Limits Reached (mm:ss):

Average: N/A

Individual: N/A (TC No. N/A)

Unexposed Surface Temperatures



## **TEST RESULTS AND CONCLUSION**

Graphs depicting load pressure, furnace pressure and axial deflection data collected from the test are included in Appendix A. Photographs from the test are provided in Appendix B.

- The wall assembly supported the applied load for the **full 60 minute fire test duration**.
- Maximum horizontal deflection: **2.25 inches**
- Maximum vertical deflection: **0.23 inches**
- Finish (Membrane Protection) Rating: **25 minutes, 45 seconds**.
- Temperatures on the unexposed face remained within the allowed single-point temperature rise of 181°C (325°F) above the starting temperature throughout the test.
- The average temperature rise for the unexposed face thermocouples remained within the allowable limit of 139°C (250°F) above the starting temperature throughout the test.

***The "PURBOND® HB E032 (3074-3)" adhesive met the fire test requirements of the "Elevated-Temperature Adhesive Qualification Procedure", based on the load per stud being determined using Method A as described in Paragraph 3.1 of the protocol.***

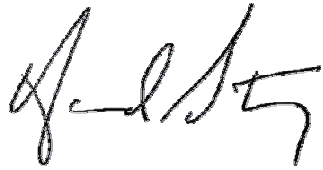
**SIGNATURES**

Testing Conducted by,



Mike White  
Laboratory Manager

Reviewed and Approved by,



Howard Stacy  
Director, Testing Services

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

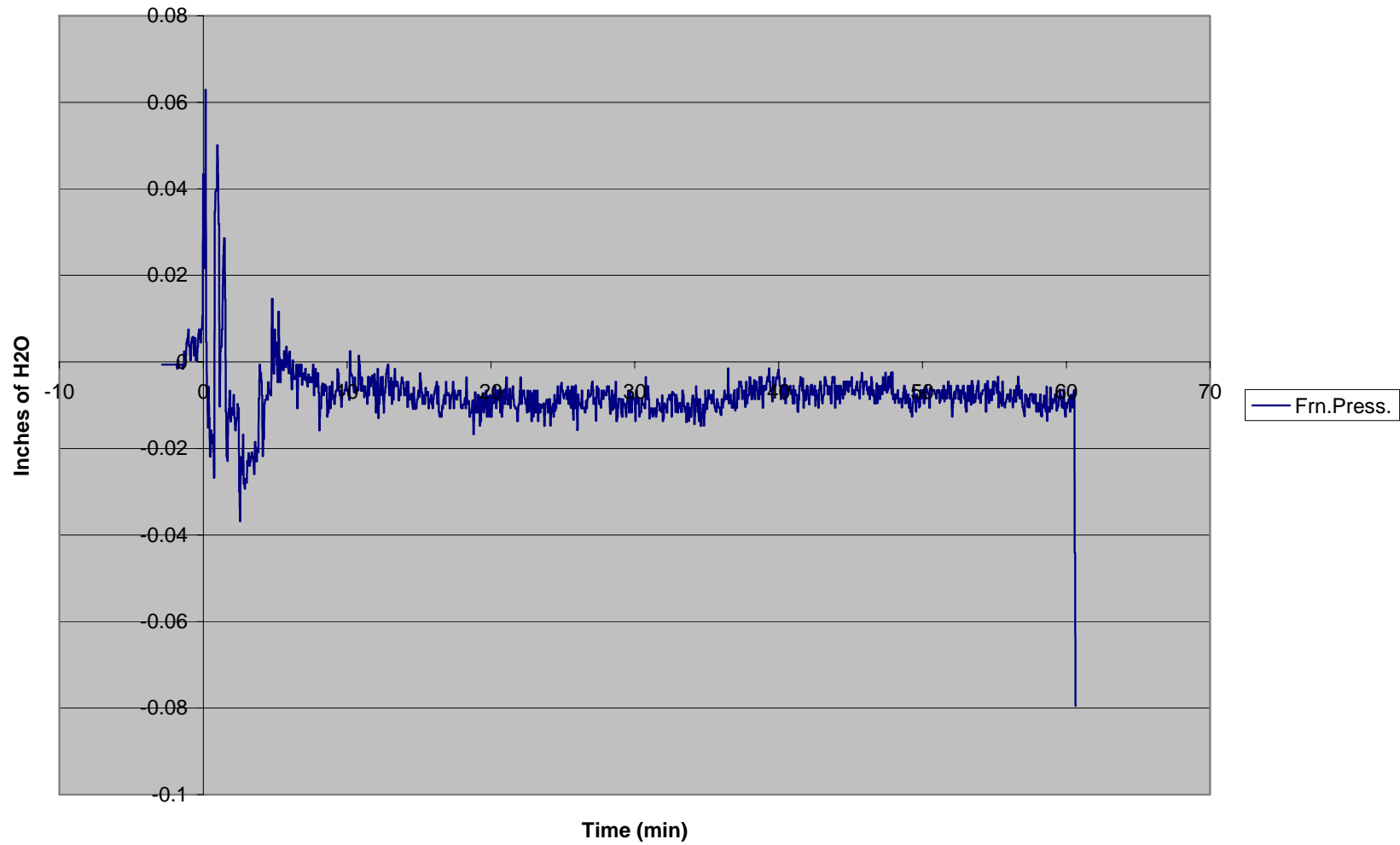
***The test specimen identification is as provided by the client and  
WFCi accepts no responsibilities for any inaccuracies therein. WFCi  
did not select the specimen and has not verified the composition,  
manufacturing techniques or quality assurance procedures.***



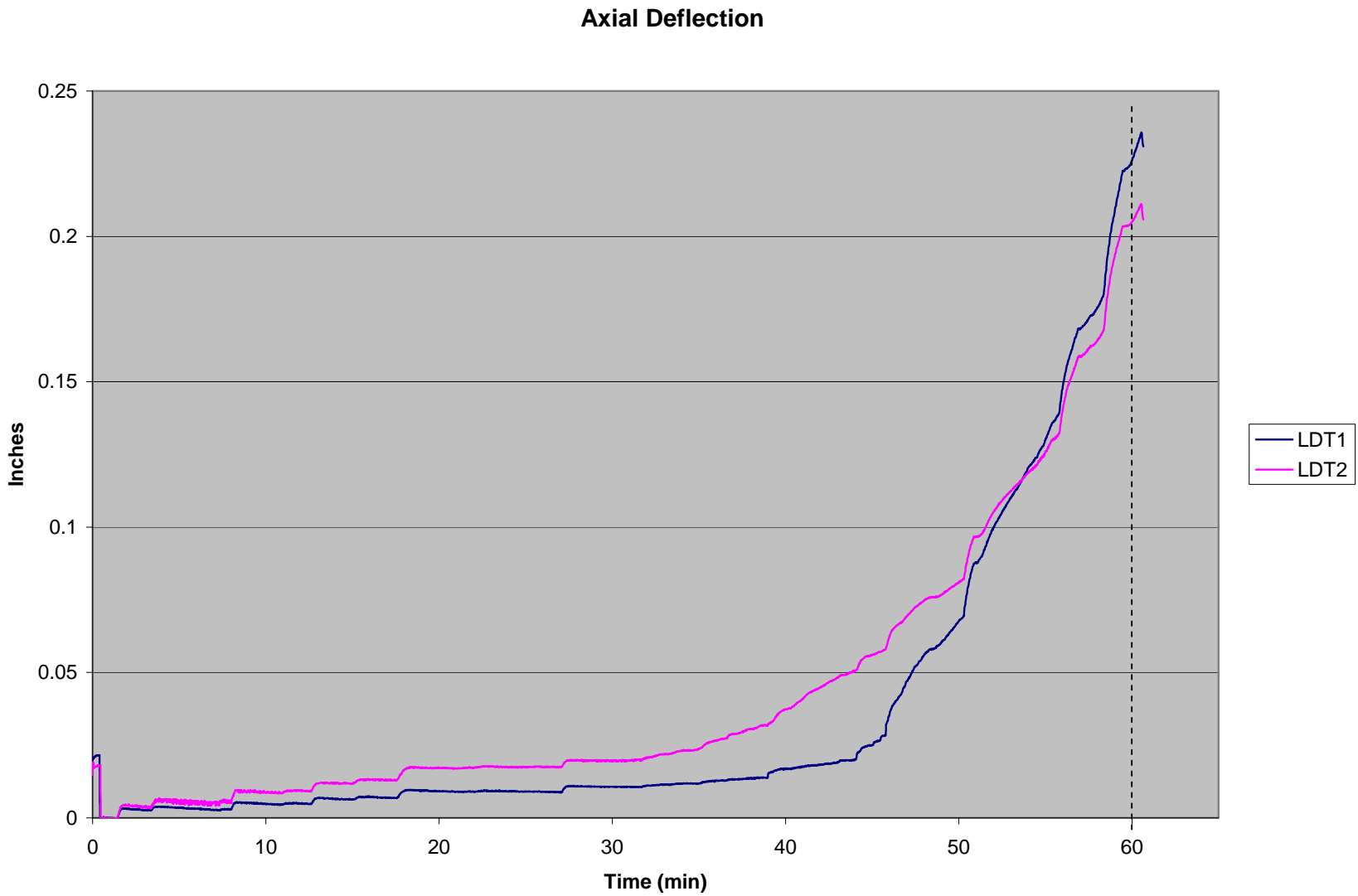
**APPENDIX A:**  
**GRAPH**

### Graph 1: Furnace Pressure at Top of Wall

Furnace Pressure at Top of Wall



### Graph 2: Sample Displacement



**APPENDIX B:**  
**PHOTOGRAPHS**



**Sample construction: wood studs**



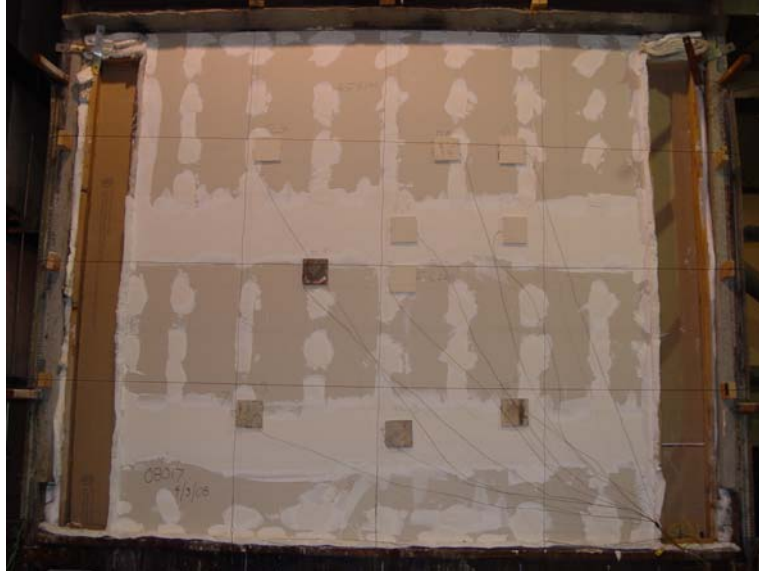
**Finger-joint**



**Sample construction, addition of GWB**



**Sample construction: exposed face**



**Sample construction: unexposed face**



**Post exposure, cavity exposed**



**Charred stud at finger-joint**