MOCK-UP TEST REPORT

Rendered to:

SMITH-MIDLAND CORPORATION

PROJECT: Slenderwall Precast Concrete Panel

ARCHITECTURAL TESTING INC.

Laboratories in Pennsylvania, Minnesota & California

Architectural Testing

MOCK-UP TEST REPORT

Rendered to:

SMITH-MIDLAND
P.O. Box 300
Midland, Virginia 22728

Report No:01-41071.03
Test Completion Date: 07/29/02
Report Date: 09/04/03

Project: SlenderWall Panels

Project Summary: Architectural Testing, Inc. (ATI) was contracted by Smith-Midland to conduct performance testing on a mock-up. This report summarizes the evaluation.

Mock-up Description: The mock-up consisted of three rows of precast panels vertically stacked. Each row was comprised of two separate panels. Each panel contained punched opening(s) for the installation of window units. Reference should be made to the attached drawings.

Overall Size: Total width of 30' 6" by 29' 4" high

Drawing Reference: Smith-Midland drawing MUE-1

Test Methods:

Air Infiltration: ASTM E 283-99, *Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen*. Testing was conducted at 6.24 psf positive static air pressure difference.

***Note #1**: One common Industry standard for air infiltration for a glazed aluminum curtain wall is 0.06 cfm/ft^2 maximum allowed.*

***Note #2**: One common industry standard for allowable amount of deflection while under uniform design loads is L/240, where L is the length of the unsupported member.*

***Note #3**: One common industry standard for allowable amounts of permanent deformation following release of uniform design overloads (1.5 times design load) is 0.2% of length of the unsupported member.*

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Test Methods: (Continued)

Static Pressure Water Resistance: ASTM E 331-93, *Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference*. Water was applied to the mock-up at a minimum rate of 5 gal/ft^2/hr.

Dynamic Pressure Water Resistance: AAMA 501.1-94, *Standard Test Method for Exterior Windows, Curtain Walls and Doors for Water Penetration Using Dynamic Pressure*. Water was applied to the mock-up at a minimum rate of 5 gal/ft^2/hr.

Interstory Differential Movement: AAMA 501.4-2000, *Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts*. Testing was conducted by completing six complete cycles of movement in the vertical and horizontal plane.

Structural Performance: ASTM E 330-96, *Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference*.

Thermal Cycling/Condensation Evaluation: AAMA 501.5-98, *Thermal Cycling of Exterior Walls*.

Test Procedure:

Step	Test and Test Method

1. **Preload (ASTM E330)**: Preload the mock-up at positive and negative 50% of the design pressure (±30.0 psf) for a period of 10 seconds.
2. **Static Pressure Air Infiltration and Exfiltration (ASTM E283)**: Air infiltration and exfiltration tests will be conducted at 6.24 psf positive pressure differential.
3. **Static Pressure Water Resistance (ASTM E331)**: Water penetration tests will be conducted on the system with a minimum water application rate of 5 gal/hr/ft^2 at a pressure differential of 15.0 psf. No uncontrolled water penetration is allowed.

   Water penetration shall be defined as; penetration of water beyond a plane parallel to the vertical plane intersecting the innermost projection of the test specimen under the specified conditions of air pressure difference across the specimen.

   (This definition is relevant to all water tests (static and dynamic) throughout the test procedure.)

Test Procedure: (Continued)

Step	Test and Test Method

4. **Dynamic Pressure Water Resistance (AAMA 501.1-83)**: Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft^2 and dynamic air stream equivalent to static pressure of 15.0 psf. No uncontrolled water penetration is allowed.

5. **Uniform Load Deflection Test (ASTM E330)**: Deflection of the system shall be measured at design pressure.

   Each load shall be held as follows:

   +30.0 psf - 50% Positive Design Load (ten seconds)
   +60.0 psf - 100% Positive Design Load (one minute)
   -30.0 psf - 50% Negative Design Load (ten seconds)
   -60.0 psf - 100% Negative Design load (one minute)

6. **Repeat Static Pressure Air Infiltration (ASTM E283)**: Air infiltration and exfiltration tests will be conducted at 6.24 psf pressure differential.

7. **Repeat Static Pressure Water Resistance (ASTM E331)**: Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft^2 at a pressure differential of 15.0 psf. No uncontrolled water penetration is allowed.

8. **Repeat Dynamic Pressure Water Resistance (AAMA 501.1-83)**: Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft^2 and dynamic air stream equivalent to static pressure of 15.0 psf. No uncontrolled water penetration is allowed.

9. **Interstory Differential Movement Vertical and Horizontal Displacement Test**: Six complete cycles shall be performed.

   9a. Live load deflection of the floor span will be down 0.215" (measured at the mid-span between columns) with 0.171" column shortening. Following downward movement, the beam will be taken back to zero and the floor span will be raised 0.215" without movement at the columns. The beam will be returned to zero (one cycle).

   9b. Vertical movement of the entire floor span will be 0.485" up, back to zero, 0.485" down, and back to zero (one cycle). The horizontal joint shall remain in the open position at the conclusion of the test.

   9c. Horizontal movement shall be 0.293" to the left, back to zero, 0.293" to the right, and back to zero (one cycle).

10. **Repeat Static Pressure Air Infiltration (ASTM E283)**: Air infiltration and exfiltration tests will be conducted at 6.24 psf pressure differential.

Test Procedure: (Continued)

Step	Test and Test Method

11. **Repeat Static Pressure Water Resistance (ASTM E331)**: Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft^2 at a pressure differential of 15.0 psf. No uncontrolled water penetration is allowed.

12. **Repeat Dynamic Pressure Water Resistance (AAMA 501.1-83)**: Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft^2 and dynamic air stream equivalent to static pressure of 15.0 psf. No uncontrolled water penetration is allowed.

13. **Condensation Resistance**: Condensation resistance tests will be conducted and maintained on a portion of the mock-up for two hours after equilibrium has been maintained under the following conditions:

    Outdoor: 15°F ambient temperature
    15 mph wind
    Indoor: 72°F ambient temperature

    There shall be no excessive condensation on the indoor face of the mock-up. Excessive condensation is defined as water, ice or frost on more than 5% of the interior surface of any component, or accumulation of uncontrolled flow of water from condensation or melted frost on the mock-up at any location. "Controlled" water or condensation is that which is demonstrably drained harmlessly to the exterior of the work without endangering or wetting adjacent surfaces or insulation, and not visible in the final construction. Due to the unpredictable humidity levels at the time of testing the specified indoor relative humidity may be difficult to achieve. Therefore, a subjective qualitative analysis will be conducted. Analysis of the inside surface temperature as compared to the dewpoint temperature shall be utilized to assist in determination of condensation areas.

14. **Thermal Cycles**: The entire mock-up shall be subjected to six thermal cycles; each cycle shall consist of:

    14a. Nominal exterior air temperature of -10°F and nominal interior air temperature of 55°F to 100° F for two hours after achieving air temperature specified.

    14b. Nominal exterior metal surface temperature of 150°F (based on light color finish) and nominal interior air temperature of 55°F to 100°F for two hours after achieving metal temperature specified.

    14c. The mock-up shall be inspected for detrimental effects.

15. **Repeat Static Pressure Air Infiltration (ASTM E283)**: Air infiltration and exfiltration tests will be conducted at 6.24 psf pressure differential.

Test Procedure: (Continued)

Step	Test and Test Method

16. **Repeat Static Pressure Water Resistance (ASTM E331)**: Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft^2 at a pressure differential of 15.0 psf. No uncontrolled water penetration is allowed.

17. **Repeat Dynamic Pressure Water Resistance (AAMA 501.1-83)**: Water penetration tests will be conducted on the system with a water application rate of 5 gal/hr/ft^2 and dynamic air stream equivalent to static pressure of 15.0 psf. No uncontrolled water penetration is allowed.

18. **Supplemental Static Pressure Water Resistance (ASTM E331)**: Sealant shall be removed from locations determined by the architect or representative and water penetration tests will then be conducted on the system with a water application rate of 5 gal/hr/ft^2 at a pressure differential of 15.0 psf. No uncontrolled water penetration is allowed.

19. **Supplemental Dynamic Pressure Water Resistance (ASTM E331)**: Dynamic test will be conducted on the system with a water application rate of 5 gal/hr/ft^2 at a pressure differential of 15.0 psf. No uncontrolled water penetration is allowed.

20. **Uniform Structural Overload (ASTM E330)**: Each load will be held for ten seconds as follows:

    +45.0 psf-(75% of Design Pressure) - to remove slack
    +90.0 psf-(150% of Design Pressure) - overload
    -45.0 psf-(75% of Design Pressure) - to remove slack
    -90.0 psf-(150% of Design Pressure) - overload

21. **Seismic Load Test**: Six complete cycles shall be performed. Horizontal movement will be 0.438" to the left, back to zero, 0.438" to the right, and back to zero (one cycle). The mock-up shall be visually inspected after the Seismic Load Test.

Test Results:

General Note: *Window openings were excluded from the evaluation.*

Step/Title of Test	Test Results	Allowed
1. Preloads @ ±30 psf	No Apparent Damage	No Damage
2. Static Pressure		
Air Infiltration @ 6.24 psf	<0.01 cfm/ft^2	See Note #1
Air Exfiltration @ 6.24 psf	<0.01 cfm/ft^2	See Note #1
3. Static Pressure Water Resistance @ 15.0 psf	No Leakage	No Leakage
4. Dynamic Water Resistance Air Stream Equivalent to 15.0 psf	No Leakage	No Leakage
5. Uniform Load Deflection @ ±60.0 psf	No Deflection Beyond L/240	See Note #2
6. Repeat Static Pressure		
Air Infiltration @ 6.24 psf	<0.01 cfm/ft^2	See Note #1
Air Exfiltration @ 6.24 psf	<0.01 cfm/ft^2	See Note #1
7. Repeat Static Pressure Water Resistance @ 15.0 psf	No Leakage	No Leakage
8. Repeat Dynamic Water Resistance Air Stream Equivalent to 15.0 psf	No Leakage	No Leakage
9. Interstory Differential Movement Live Load Displacement of 0.386"	No Apparent Damage	No Damage
Interstory Differential Movement Vertical Displacement of 0.485"	No Apparent Damage	No Damage
Interstory Differential Horizontal Displacement of 0.293"	No Apparent Damage	No Damage
10. Repeat Static Pressure Water Resistance @ 15.0 psf	No Leakage	No Leakage

Test Results: (Continued)

Title of Test	Test Results	Allowed
11. Repeat Dynamic Water Resistance Air Stream Equivalent to 15.0 psf	No Leakage	No Leakage
12. Repeat Static Pressure Air Infiltration @ 6.24 psf Air Exfiltration @ 6.24 psf	 <0.01 cfm/ft^2 <0.01 cfm/ft^2	 See Note #1 See Note #1
13. Thermal Cycles (6 cycles) -10°F Exterior Air Temperature 150°F Exterior Metal Surface temperature	No Apparent Damage	No Damage
14. Condensation Evaluation	No Apparent Damage See Table #4 See Sketch #2	See Note #2
15. Repeat Static Pressure Air Infiltration @ 6.24 psf Air Exfiltration @ 6.24 psf	 <0.01 cfm/ft^2 <0.01 cfm/ft^2	 See Note #1 See Note #1
16. Repeat Static Pressure Water Resistance @ 15.0 psf	No Leakage	No Leakage
17. Repeat Dynamic Water Resistance Air Stream Equivalent to 15.0 psf	No Leakage	No Leakage
18. Supplemental Static Pressure Water Resistance @ 15.0 psf	No Leakage	No Leakage
19. Supplemental Dynamic Water Resistance Air Stream Equivalent to 15.0 psf	No Leakage	No Leakage
20. Uniform Structural Overloads @ ±90.0 psf	No Permanent Deformation Beyond 0.2%	See Note #3
21. Seismic Movement Horizontal Movement Displacement of 0.438"	No Apparent Damage	No Damage

The mock-up drawings and a copy of this report will be retained by ATI for a period of four years. This report is the exclusive property of the client so named herein and is applicable to the sample tested. For a comprehensive report detailing the performance of the project specific mock-up from which this condensed reports was taken, reference ATI report #01-41071.01. Results obtained are tested values and do not constitute an opinion or endorsement by this laboratory. This report may not be reproduced, except in full, without the approval of Architectural Testing.

For ARCHITECTURAL TESTING, INC.:

Digitally Signed by: Jeffrey L. Dideon

Jeffrey L. Dideon
Project Manager

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Joseph W. Wise
Director - Project/Curtain Wall Testing

JLD:jld/baw
01-41071.03

DOCUMENT CONTROL ADDENDUM #01-41071.00

Current Issue Date: 09/04/03

Report No.: 01-41071.01

Requested by: Rick Groves, Smith-Midland
Purpose: Mock-up performance testing for the Executay, New York, New York project.
Issued Date: 12/12/02
Comments:

Report No.: 01-41071.02

Requested by: Rick Groves, Smith-Midland
Purpose: Mock-up performance test marketing report.
Issued Date: 12/12/02
Comments:

Report No.: 01-41071.03

Requested by: Rick Groves, Smith-Midland
Purpose: Mock-up performance test marketing report.
Issued Date: 09/04/03
Comments:

TABLE #1
Indicator Details

Indicator #	Member Description	Length (inches)
1	Single stud	102
2	Single stud	
3	Single stud/Bottom plate	
3	Single stud/Bottom plate	Panel Offset
4	Top plate	
5	Double stud	100
6	Double stud	
7	Double stud/Bottom plate	
7	Double stud/Bottom plate	Panel Offset
8	Top plate	
9	Bottom plate	Panel Offset
10	Top plate	
11	Header	59
12	Header	
13	Header	
14	Bottom plate	59
15	Bottom plate	
16	Bottom plate	
17	Tube steel grid pattern	115.25
18	Tube steel grid pattern	
19	Tube steel grid pattern	
20	Double stud	100
21	Double stud	
22	Double stud/Bottom plate	
22	Double stud/Bottom plate	Panel Offset
23	Top plate	
24	Header	75
25	Header	
26	Header	
27	Bottom plate	75
28	Bottom plate	
29	Bottom plate	

TABLE #2

Uniform Load Deflection

(Deflection in inches)

Indicator #	Positive 60.0 psf (inches)	Net Deflection (inches)	Negative 60.0 psf (inches)	Net Deflection (inches)
1	0.015	0.025	0.000	0.045
2	0.050		0.060	
3	0.035		0.105	
3	0.035	0.020	0.105	0.105
4	0.015		0.000	
5	0.250	0.145	0.250	0.177
6	0.305		0.040	
7	0.070		0.185	
7	0.070	0.040	0.185	0.110
8	0.030		0.075	
9	0.045	0.045	0.130	0.105
10	0.000		0.025	
11	0.250	0.047	0.275	0.312
12	0.325		0.035	
13	0.305		0.420	
14	0.115	0.007	0.200	0.000
15	0.095		0.210	
16	0.090		0.220	
17	0.000	0.050	0.020	0.050
18	0.120		0.140	
19	0.070		0.160	
20	0.110	0.040	0.210	0.052
21	0.105		0.210	
22	0.020		0.105	
22	0.020	0.020	0.105	0.095
23	0.000		0.010	
24	0.105	0.032	0.215	0.037
25	0.260		0.335	
26	0.350		0.380	
27	0.065	0.010	0.150	0.002
28	0.100		0.180	
29	0.115		0.215	

TABLE #3
Uniform Structural Overloads
(Permanent set in inches)

Indicator #	Positive 90 psf (inches)	Net Perm Set (inches)	Negative 90 psf (inches)	Net Perm Set (inches)
4	0.000	0.000	0.000	0.000
5	0.005	0.005	0.000	0.000
6	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000
8	0.000	0.005	0.010	0.007
9	0.010		0.020	
10	0.010		0.015	
18	0.010	0.002	0.010	0.000
19	0.015		0.010	
20	0.015		0.010	

TABLE #3
Condensation Evaluation
(Reference Sketch #2)

Wire #	Time							Average Temp. (°F)
	12:31 (°F)	1:03 (°F)	1:35 (°F)	2:03 (°F)	2:32 (°F)	3:01 (°F)	3:30 (°F)	
1	47.6	47.1	46.8	46.7	46.5	46.3	46.6	46.8
2	53.2	52.7	52.5	52.5	52.3	52.2	51.9	52.5
2A	74.2	74.2	74.3	74	73.6	73.3	74.0	73.9
3	53.1	52.6	52.4	52.3	52.2	52.1	51.9	52.4
3A	68.1	68.0	67.7	67.9	67.8	67.6	69.1	68.0
4	53.1	52.6	52.3	52.1	52.1	51.9	51.9	52.3
5	63.6	63.3	63.2	63.3	63.3	62.9	63.2	63.3
6	55.9	55.5	55.3	55.3	55.4	55.3	55.3	55.4
7	34.4	33.8	34.3	33.8	33.5	33.5	33.4	33.8
8	42.5	41.8	41.5	41.5	41.4	41.1	41.2	41.6
9	56.2	55.7	55.5	55.6	55.7	55.5	55.4	55.7
10	56.1	55.6	55.4	55.3	55.4	55.1	55.2	55.4
11	51.1	50.7	50.4	50.7	51.4	50.4	50.6	50.8
12	62.3	62.1	61.9	62.0	62.1	62.0	62.0	62.1
12A	64.3	64.0	64.4	64.2	64.2	64.2	64.3	64.2
12B	72.2	72.0	72.0	72.0	72.0	71.9	72.0	72.0
13	65.4	65.5	65.5	65.7	65.6	65.6	65.9	65.6
14	58.1	57.7	57.6	57.7	57.7	57.7	57.5	57.7
14A	71.3	71.1	71.0	71.1	71.2	71.2	71.8	71.2
15	57.8	57.2	57.2	57.2	57.4	55.9	55.7	56.9
16	57.0	56.5	56.5	56.5	56.5	56.1	55.9	56.4
17	40.7	40.1	40.4	40.3	39.9	39.9	39.7	40.1
18	48.6	48.3	48.1	48.2	48.1	47.9	47.9	48.2
19	54.4	54.1	53.8	53.8	53.9	53.7	53.7	53.9
20	47.5	47.2	47.1	47.0	46.9	46.6	46.7	47.0
21	49.8	49.4	49.3	49.3	49.1	49.0	49.0	49.3
22	58.4	58.2	58.1	58.1	58.1	58.0	58.0	58.1
Average Air	76.7	76.4	76.6	76.7	76.9	76.6	77.1	76.7

TABLE 4
Condensation Evaluation

Wire #	Time							Average Temp.
	12:31	1:03	1:35	2:03	2:32	3:01	3:30	
1	47.6	47.1	46.8	46.7	46.5	46.3	46.6	46.8
2	53.2	52.7	52.5	52.5	52.3	52.2	51.9	52.5
2A	74.2	74.2	74.3	74	73.6	73.3	74.0	73.9
3	53.1	52.6	52.4	52.3	52.2	52.1	51.9	52.4
3A	68.1	68.0	67.7	67.9	67.8	67.6	69.1	68.0
4	53.1	52.6	52.3	52.1	52.1	51.9	51.9	52.3
5	63.6	63.3	63.2	63.3	63.3	62.9	63.2	63.3
6	55.9	55.5	55.3	55.3	55.4	55.3	55.3	55.4
7	34.4	33.8	34.3	33.8	33.5	33.5	33.4	33.8
8	42.5	41.8	41.5	41.5	41.4	41.1	41.2	41.6
9	56.2	55.7	55.5	55.6	55.7	55.5	55.4	55.7
10	56.1	55.6	55.4	55.3	55.4	55.1	55.2	55.4
11	51.1	50.7	50.4	50.7	51.4	50.4	50.6	50.8
12	62.3	62.1	61.9	62.0	62.1	62.0	62.0	62.1
12A	64.3	64.0	64.4	64.2	64.2	64.2	64.3	64.2
12B	72.2	72.0	72.0	72.0	72.0	71.9	72.0	72.0
13	65.4	65.5	65.5	65.7	65.6	65.6	65.9	65.6
14	58.1	57.7	57.6	57.7	57.7	57.7	57.5	57.7
14A	71.3	71.1	71.0	71.1	71.2	71.2	71.8	71.2
15	57.8	57.2	57.2	57.2	57.4	55.9	55.7	56.9
16	57.0	56.5	56.5	56.5	56.5	56.1	55.9	56.4
17	40.7	40.1	40.4	40.3	39.9	39.9	39.7	40.1
18	48.6	48.3	48.1	48.2	48.1	47.9	47.9	48.2
19	54.4	54.1	53.8	53.8	53.9	53.7	53.7	53.9
20	47.5	47.2	47.1	47.0	46.9	46.6	46.7	47.0
21	49.8	49.4	49.3	49.3	49.1	49.0	49.0	49.3
22	58.4	58.2	58.1	58.1	58.1	58.0	58.0	58.1
Average Air	76.7	76.4	76.6	76.7	76.9	76.6	77.1	76.7

Photo No. 1
Completed Mock-up During Chamber Calibration

Photo No. 2
Dynamic Water Test

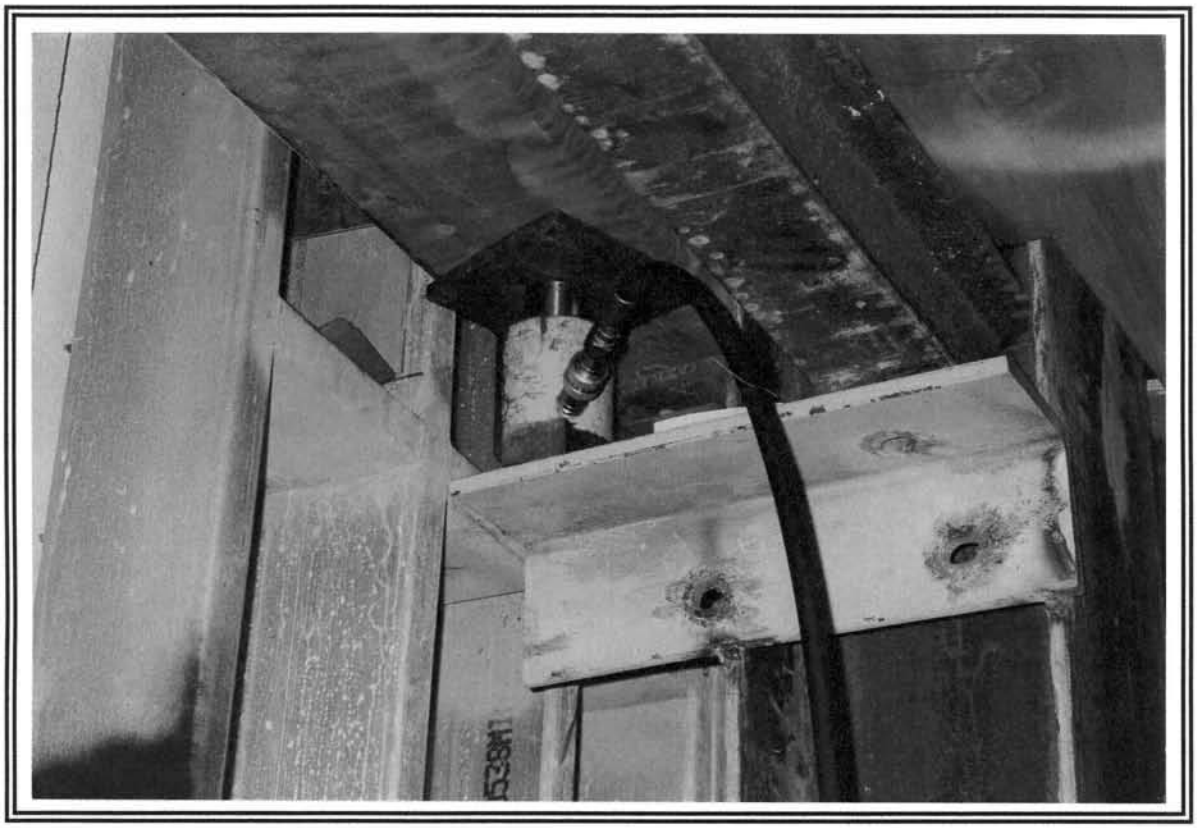


Photo No. 3
Installation of New Panels

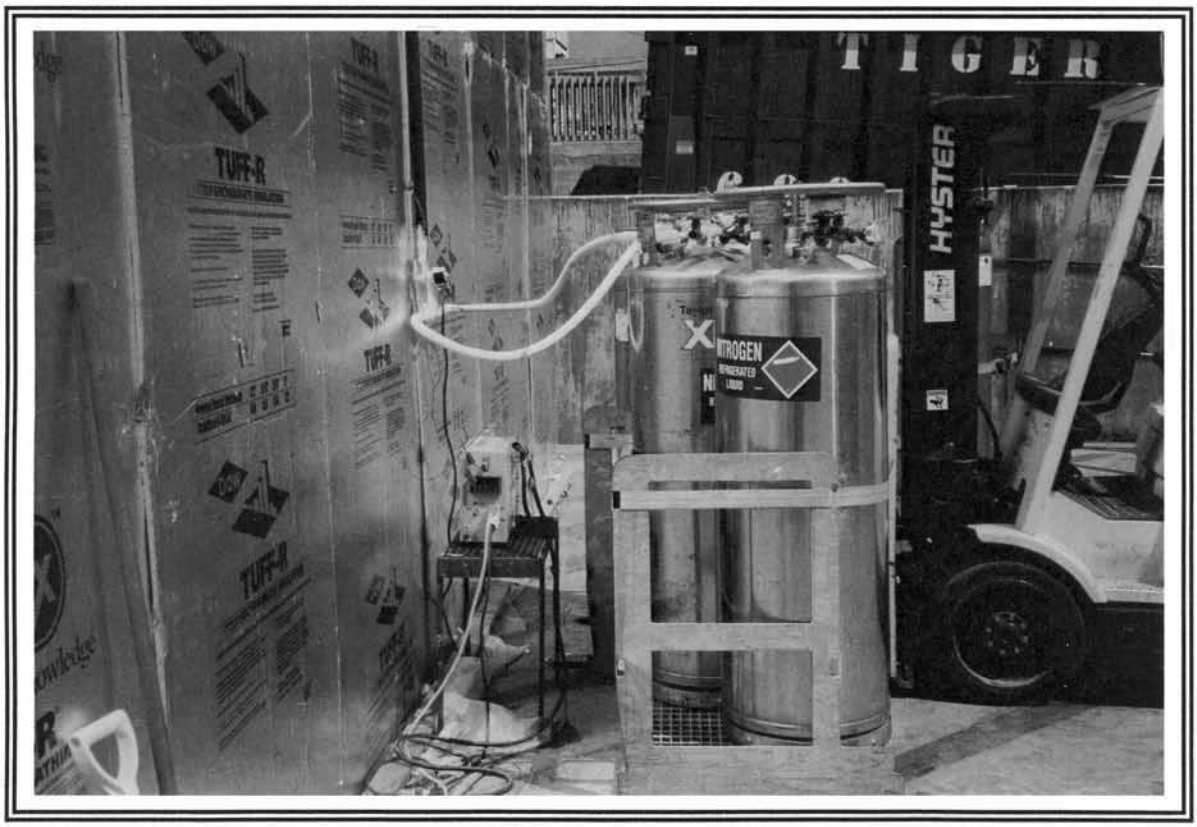


Photo No. 4
Thermal Condensation Evaluation Setup

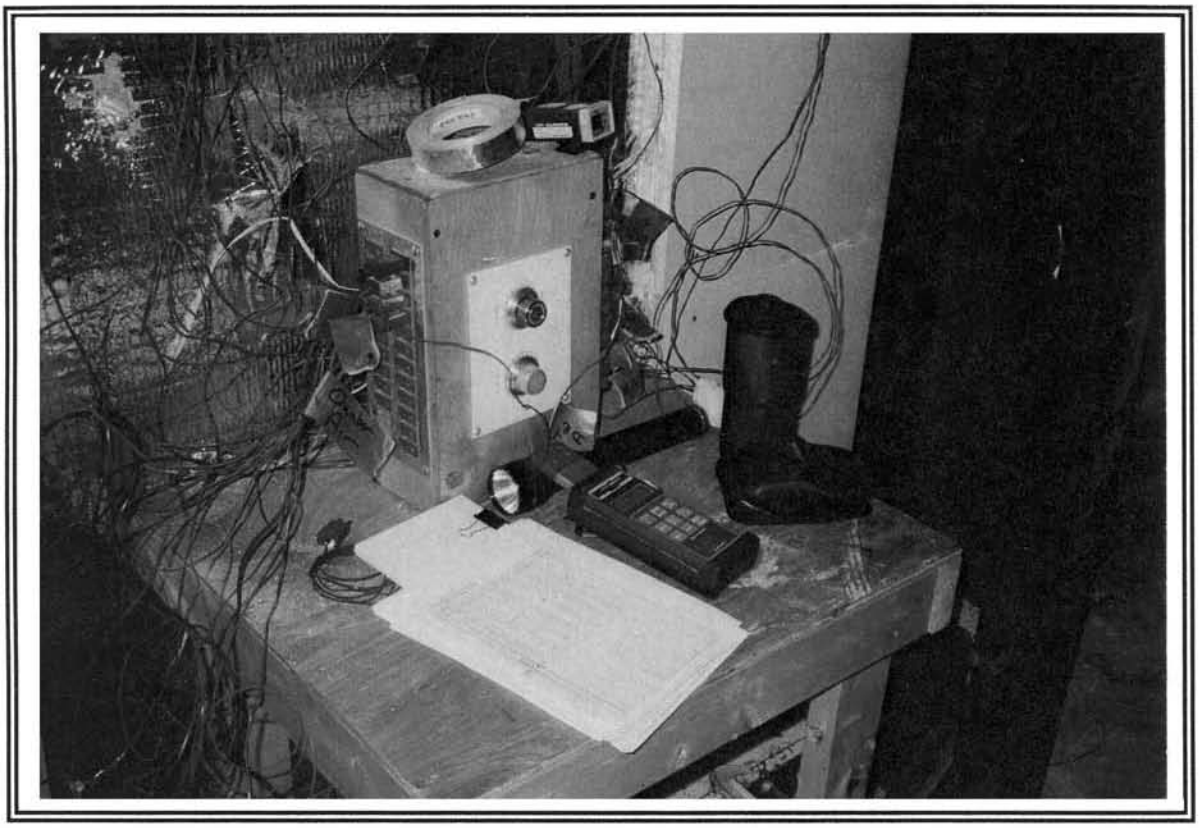
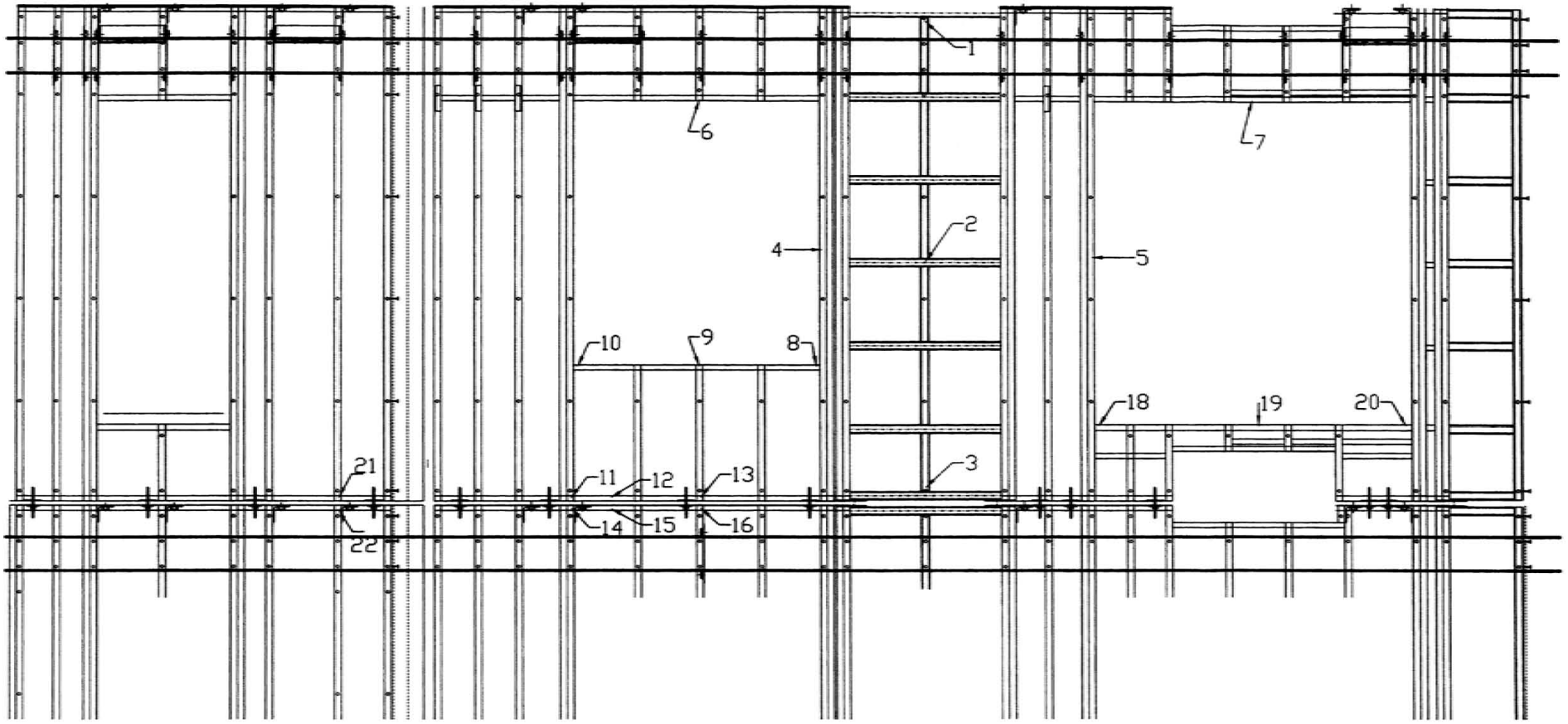


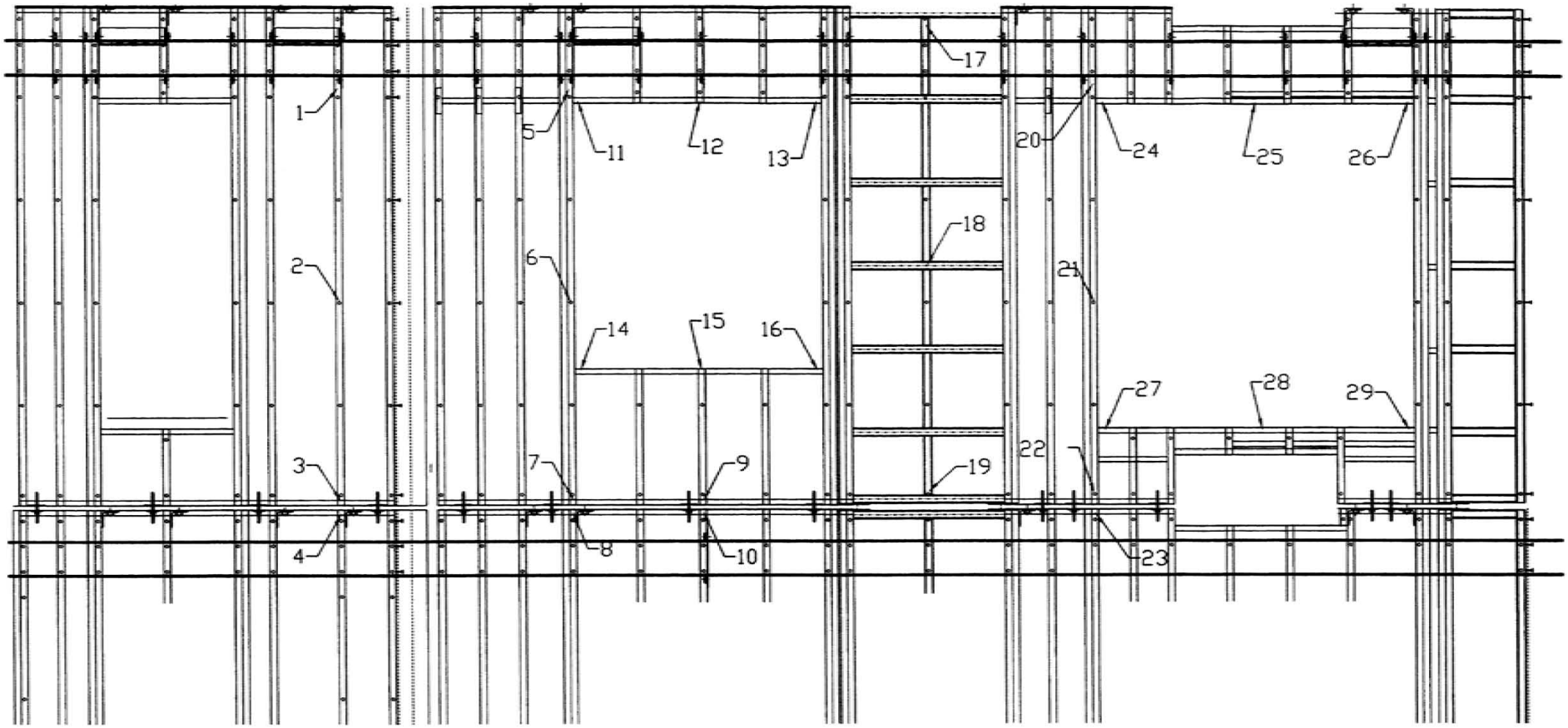
Photo No. 5
Thermal Condensation Evaluation Setup



Sketch # 1

Uniform Design Loads May 3, 2002

Approximate Location of Indicators



Sketch # 2

Uniform Design Loads May 29, 2002

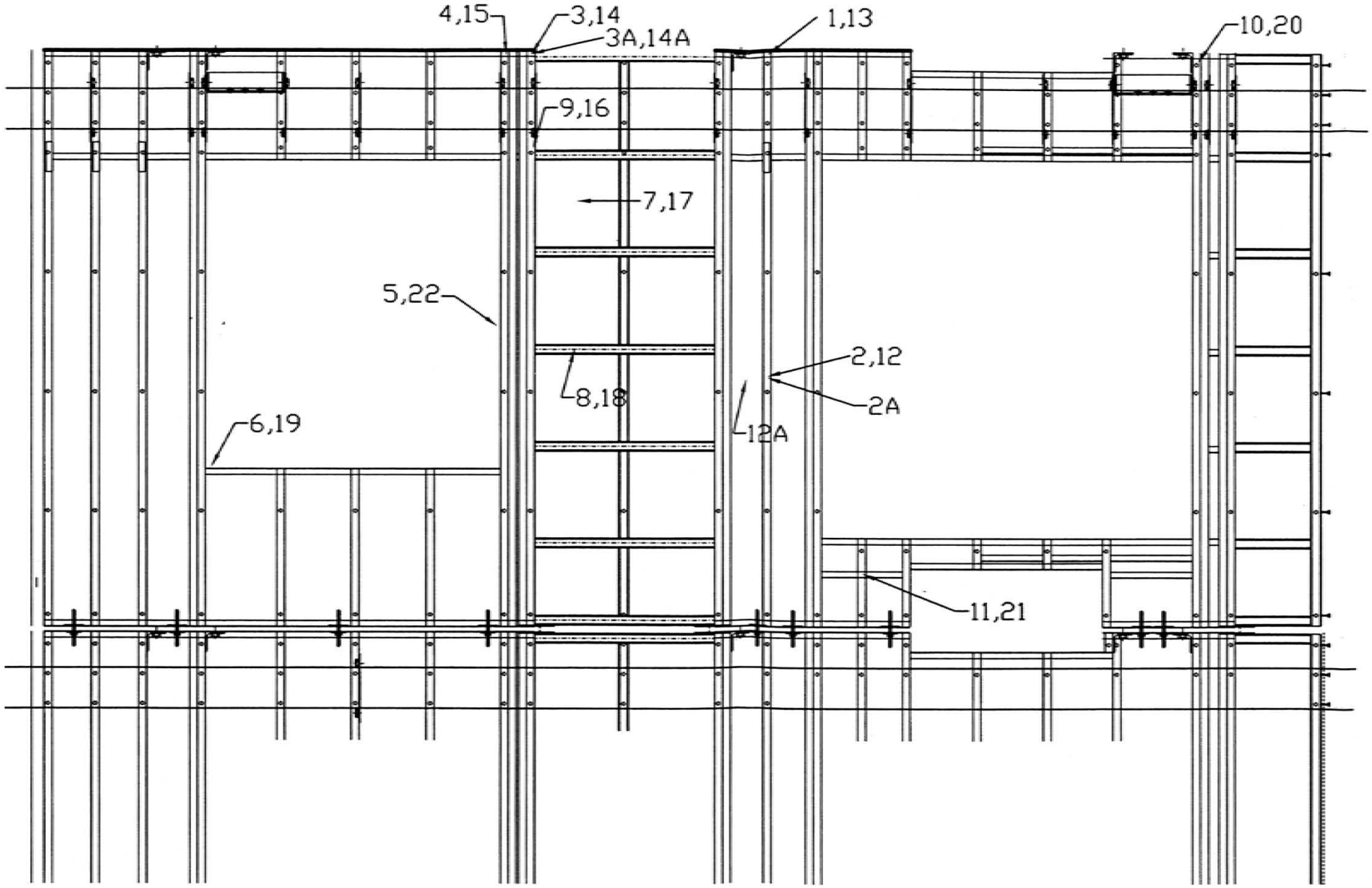
Approximate Location of Indicators

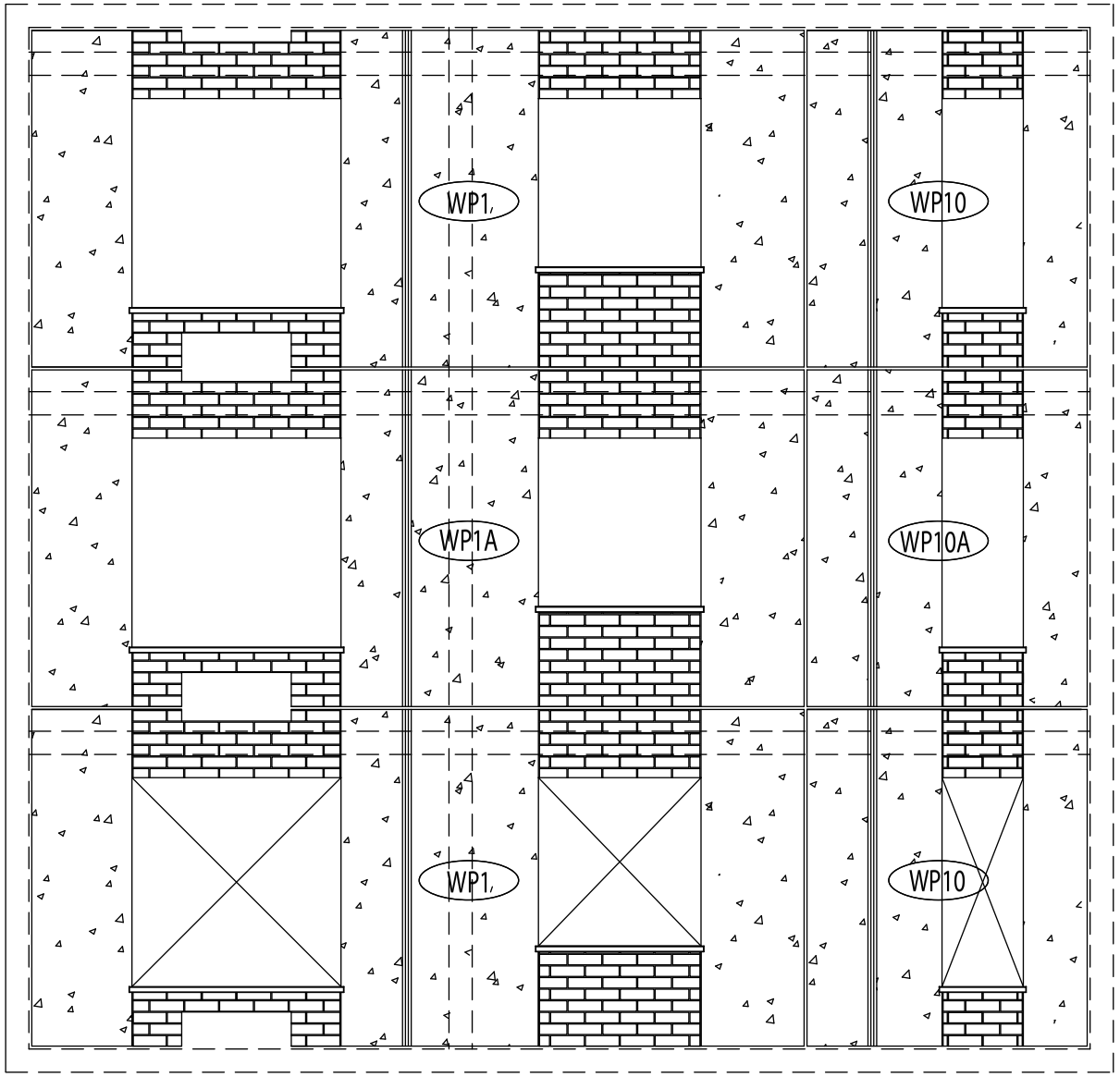
Thermal sensors 1 through 11, 2A and 3A were taken on the bottom row

Thermal sensors 12 through 22, 12A and 14A were taken on the middle row

All thermal sensors were measuring metal surface temperature unless otherwise noted

Sensors 2A, 3A and 14A measured gypsum face temerature Sensor12A measured cavity air temperature





D-1 - ▼ - GRAVITY CONNECTION

D-2 - I - PANEL TO PANEL CONNECTION

D-3 - o - LANDING POINT

MOCK-UP ELEVATION

VIEWED FROM THE FACE OF THE PANEL
SC: 3/8"=1'-0"

ems# 0132

ems engineering & marketing services s.a.r.l.
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DATE	REVISION
FEB. 14, 02	1
APR. 01, 02	TEST AS-BUILT
AUG. 19, 02	TEST AS-BUILT

EXECUSTAY PROJECT
554-556 THIRD AVENUE
NEW YORK, NY

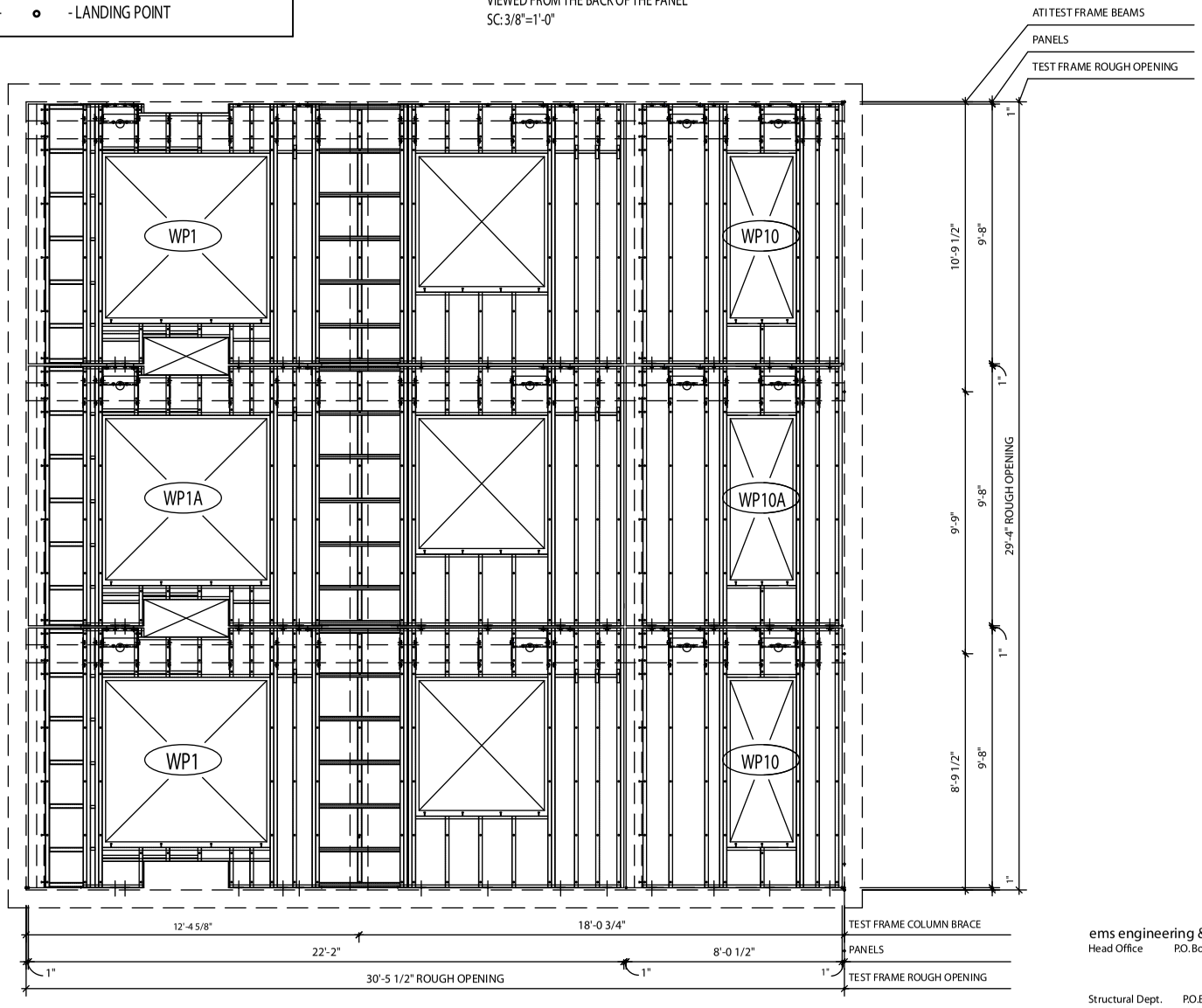
MOCK-UP

DRAWN BY: JBC
ENGINEER: JBC
CHECKED BY: JBC
ISSUE DATE: AUGUST 19, 02
PROJECT NO.: 9154
SHEET NUMBER: MUE-1

D-1 - ▼ - GRAVITY CONNECTION
D-2 - I - PANEL TO PANEL CONNECTION
D-3 - o - LANDING POINT

MOCK-UP FRAMING ELEVATION

VIEWED FROM THE BACK OF THE PANEL
SC: 3/8"=1'-0"



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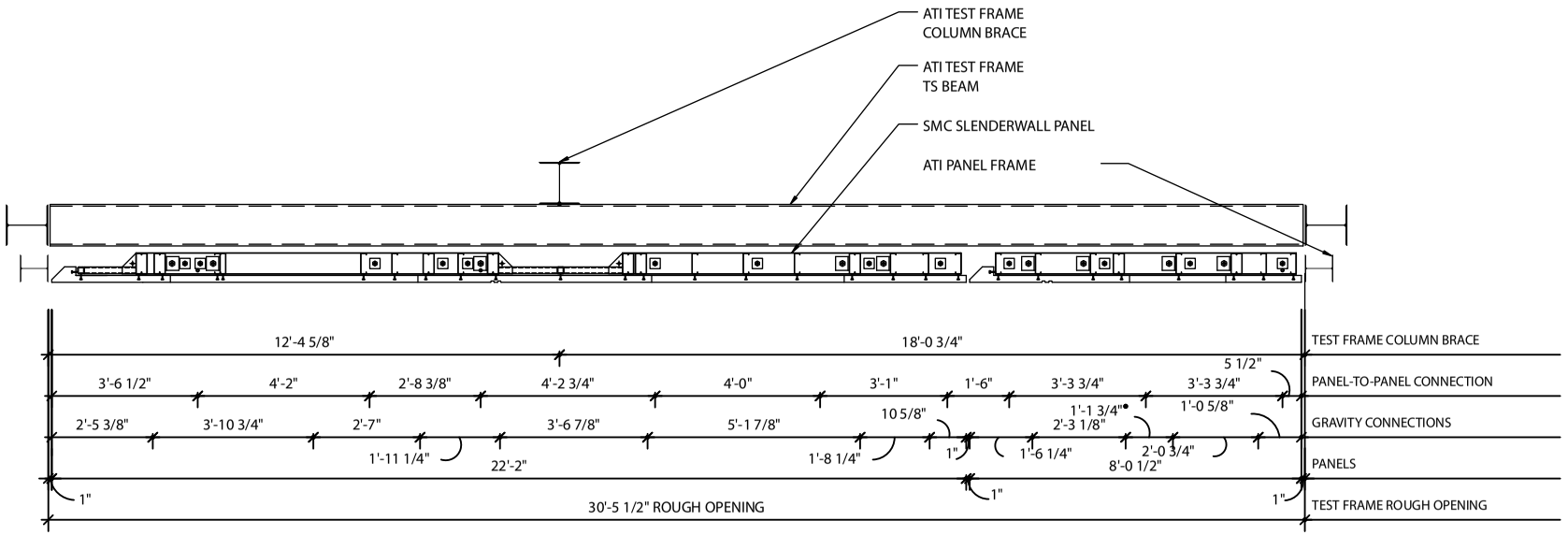

MOCK-UP FRAMING PLAN

SC: 3/8"=1'-0"

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