

PERFORMANCE TEST REPORT

Rendered to:

TUBELITE, INC.
P.O. Box 118
Reed City, Michigan 99677

Report No: ATI-13360
Test Completion Date: 03/24/94
Report Date: 04/15/94

Project: Series 400 Curtain Wall

Project Summary: Architectural Testing, Inc. (ATI) was contracted by Tubelite, Inc. to conduct performance testing in accordance with the test methods listed below on a mock-up of the Series 400 curtain wall. The referenced drawings represent the "As Built" mock-up after all remedial work was performed. A comprehensive compilation of the test results are contained herein.

Drawing Reference: Tubelite, Inc. Drawing Number T-879, dated 1/7/94, Sheets 1 thru 5. A set of "As Built" drawings are attached to this report.

MOCK-UP DESCRIPTION

Type: Aluminum and glass curtain wall comprised of nine fixed insulating glass lites and six fixed single glazed lites.

Overall Size: 15' 2-1/2" wide by 27' 8-1/2" high

Glazing:

Insulating Glass Lites: The insulating glass was comprised of 1/4" clear tempered sheets and a desiccant-filled metal spacer. The overall thickness was 1".

Single Glazed Lites: The single glazed lites were a single sheet of 1/4" clear tempered glass.

Framing Members: All framing members, corner connections and fasteners were in conformance with the attached set of "As Built" mock-up drawings.

Anchorage: All anchors and anchor bolts were in conformance with the "As Built" details.

Sealant: All perimeter seals, metal-to-metal seals and gasket seals were in conformance with the "As Built" details. The "As Built" details delineate the additional sealant added as "Remedial Work" and is described in the text of this report.

Drainage: All weeps and drainage provisions were in conformance with the details delineated on the "As Built" drawings.

Test Methods:

Air Infiltration - ASTM E283, "Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors." Testing was conducted at 6.24 psf positive static air pressure difference.

Water Resistance - ASTM E331, "Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference." Testing was conducted at 9.0, 12.0 and 15.0 psf positive static air pressure difference for a 15 minute duration each pressure. Water was applied to the mock-up at a minimum rate of 5 gal/ft²/hr.

Water Resistance - AAMA 501.1-83, "Standard Test Method for Metal Curtain Walls for Water Penetration using Dynamic Pressure." Testing was conducted with a dynamic pressure equivalent of 12.0 psf.

Structural Performance - ASTM E330, "Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference." Testing was conducted with positive and negative loads of 30.0 psf and 45.0 psf.

Witnesses: The following witnesses were present for all or part of the testing:

Mack Canady	Tubelite, Inc.
Ray Kelly	Tubelite, Inc.
Bob McNamara	Tubelite, Inc.
Bill Shuta	Tremco
Bruce Croak	Architectural Testing, Inc.
Joe Wise	Architectural Testing, Inc.

TEST RESULTS

(All observations made are referenced from the interior.)

March 23, 1994

<u>Title of Test</u>	<u>Measured</u>	<u>Allowed</u>
Air Infiltration		
@ 1.57 psf (25 mph)	0.01 cfm/ft ²	---
@ 6.40 psf (50 mph)	0.02 cfm/ft ²	---
Static Water Resistance @ 9.0 psf	See Note #1 and Sketch #1	No uncontrolled leakage

Note #1: Water penetrated the interior at the five vertical to horizontal intersections delineated on Sketch #1.

Remedial Work:

1. At leak areas 1, 2, 4 and 6 on Sketch #1, the glazing gasket corners were pulled at the corners, re-sealed and reset.
2. At leak area 3 on Sketch #1, the horizontal pressure plate was removed and the end dam was re-sealed. The horizontal plate and snap cover were replaced.

<u>Title of Test</u>	<u>Measured</u>	<u>Allowed</u>
Static Water Resistance @ 9.0 psf	No uncontrolled leakage	No uncontrolled leakage
@ 12.0 psf	See Note #2 and Sketch #2	No uncontrolled leakage

Note #2: Water penetrated the interior at the two areas delineated on Sketch #2.

Remedial Work:

At each leak area on Sketch #2, the horizontal pressure plates were removed and the end dam areas were re-sealed. The pressure plates and snap covers were then replaced.

March 24, 1994

<u>Title of Test</u>	<u>Measured</u>	<u>Allowed</u>
Static Water Resistance @ 12.0 psf	No uncontrolled leakage	No uncontrolled leakage
@ 15.0 psf	See Note #3 and Sketch #3	No uncontrolled leakage

Note #3: Water penetrated the interior at the three areas delineated on Sketch #3.

Remedial Work:

The glazing gaskets at the leak areas on Sketch #3 were pulled at the corners, re-sealed and reset.

<u>Title of Test</u>	<u>Measured</u>	<u>Allowed</u>
Static Water Resistance @ 15.0 psf	See Note #4 and Sketch #3	No uncontrolled leakage

Note #4: Water penetrated the interior at leak area #2 on Sketch #3.

Remedial Work:

The exterior horizontal cover was removed at the leak area and the vertical to horizontal intersection of the pressure plates were re-sealed.

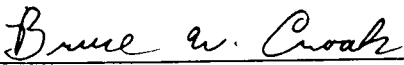
<u>Title of Test</u>	<u>Measured</u>	<u>Allowed</u>
Static Water Resistance @ 15.0 psf	No uncontrolled leakage	No uncontrolled leakage

March 29, 1994

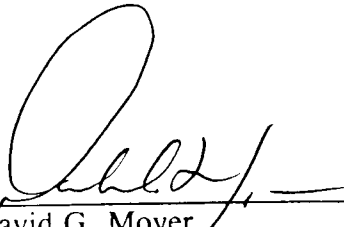
<u>Title of Test</u>	<u>Measured</u>	<u>Allowed</u>
Dynamic Water Resistance @ 12.0 psf	<i>ea:</i> No uncontrolled leakage	No uncontrolled leakage
Uniform Load Deflection @ ± 30.0 psf	Meets allowable criteria see Table #1 and Sketch #4	L/175 of span
Repeat Static Water Resistance @ 15.0 psf	No uncontrolled leakage	No uncontrolled leakage
Structural Overloads @ ± 45.0 psf	Meets allowable criteria see Table #1 and Sketch #4	0.4% of span

The "As Built" 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. Results obtained are tested values and do not constitute an opinion or endorsement by this laboratory.

For ARCHITECTURAL TESTING, INC.:



Bruce W. Croak
Project Manager



David G. Moyer
Director of Testing Services

BWC:bjy
13360

TABLE #1

DEFLECTION DATA

I. Uniform Load Deflection

	30.0 PSF <u>Positive</u>	30.0 PSF <u>Negative</u>	
<u>Location</u>	<u>Net Deflection</u>	<u>Net Deflection</u>	<u>Allowable</u>
1	0.330"	0.420"	0.651"
2	0.270"	0.200"	0.651"
3	0.050"	0.070"	0.329"

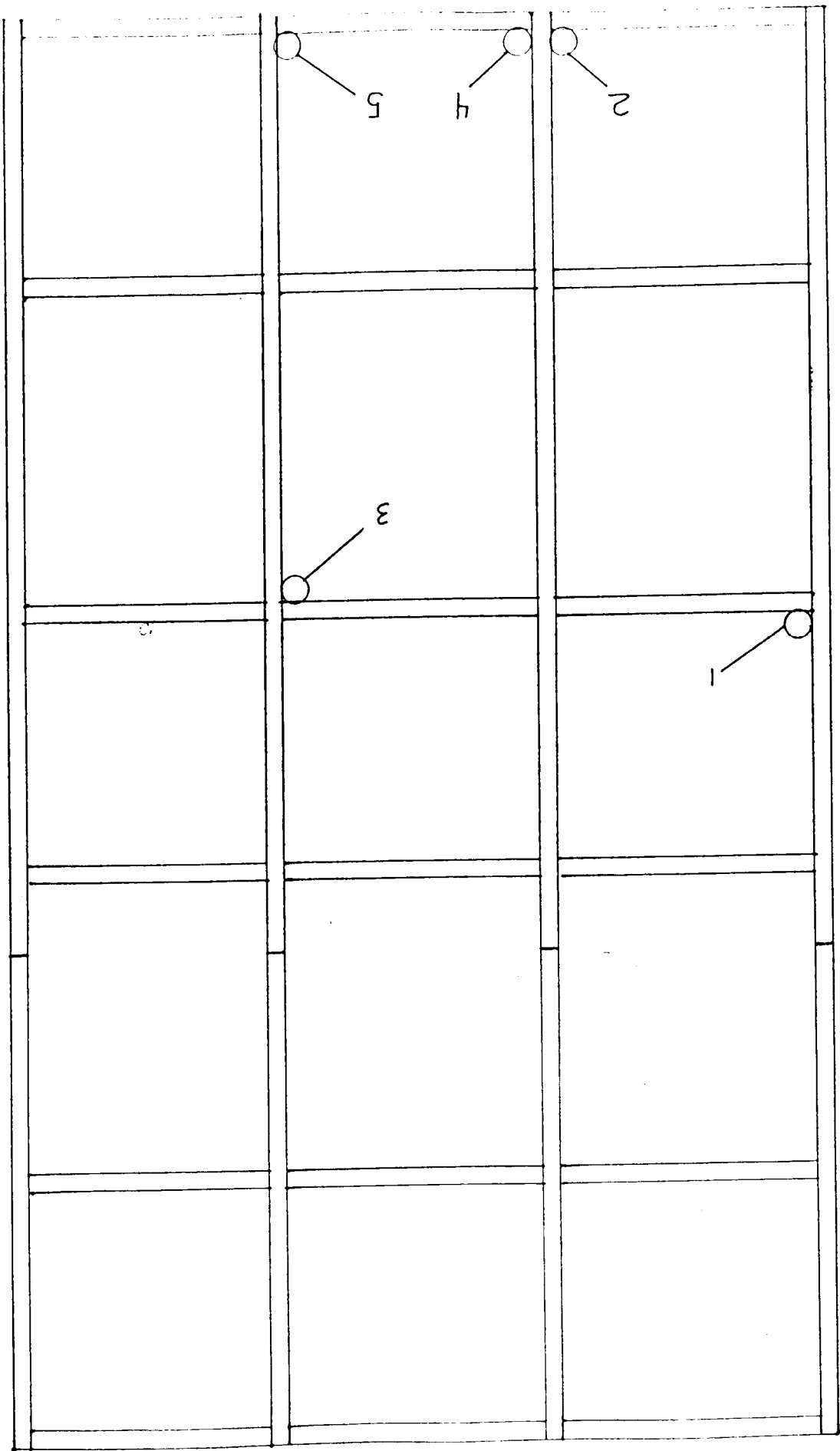
Note: See Sketch #4 for measurement locations. The allowable deflection is based on L/175 of clear span.

II. Structural Overload

	45.0 PSF <u>Positive</u>	45.0 PSF <u>Negative</u>	
<u>Location</u>	<u>Net Perm. Set</u>	<u>Net Perm. Set</u>	<u>Allowable</u>
1	0.025"	0.015"	0.456"
2	0.010"	0.010"	0.456"
3	0.005"	0.010"	0.230"

Note: See Sketch #4 for measurement locations. The allowable permanent set is based on 0.4% of clear span.

Sketch # 1



PROJECT NUMBER
13360

PROJECT NAME
CLIENT NAME

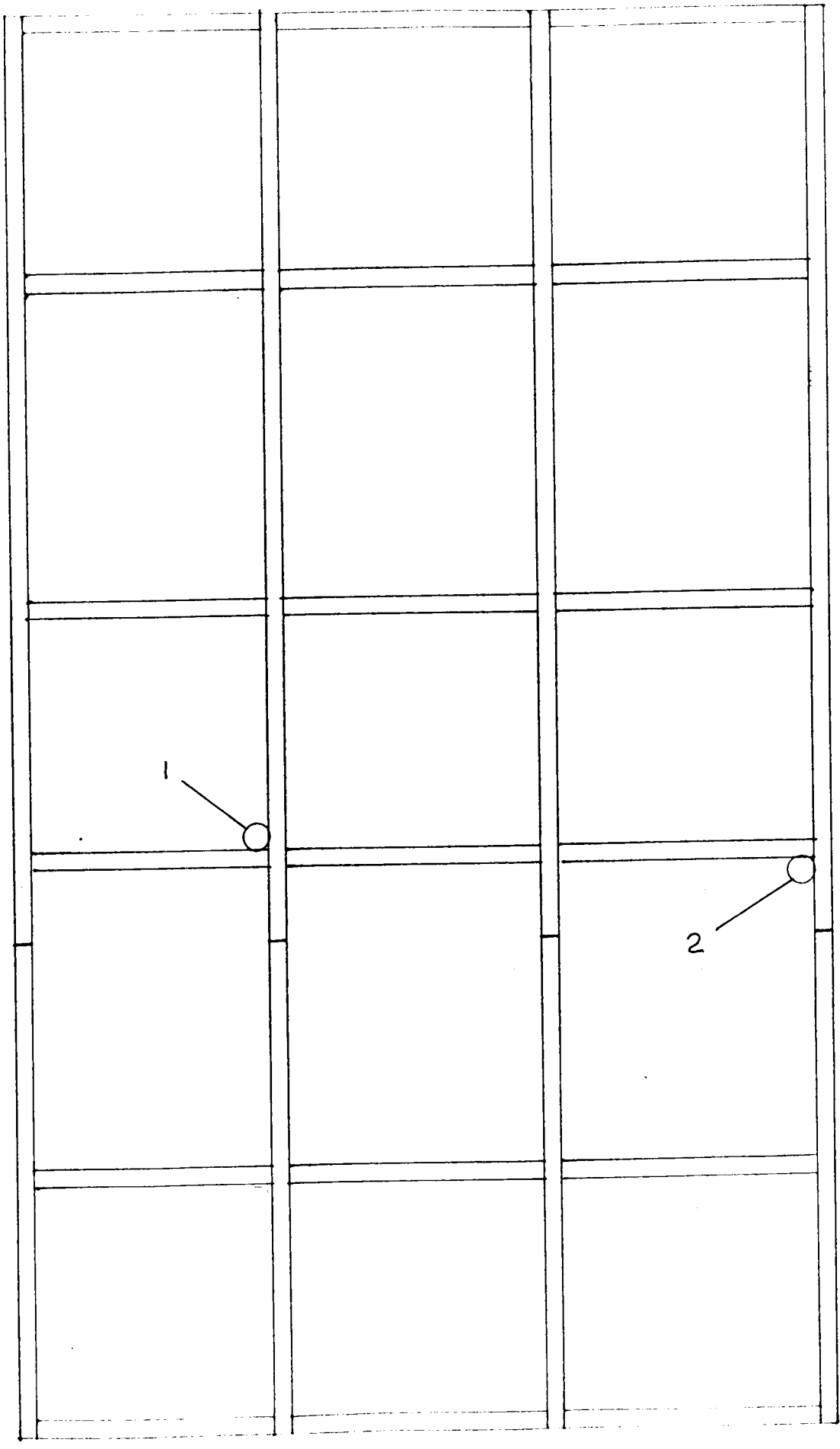
Tubelite Inc.

ARCHITECTURAL
TESTING INC.

NOTES: Static water test @ 90psf

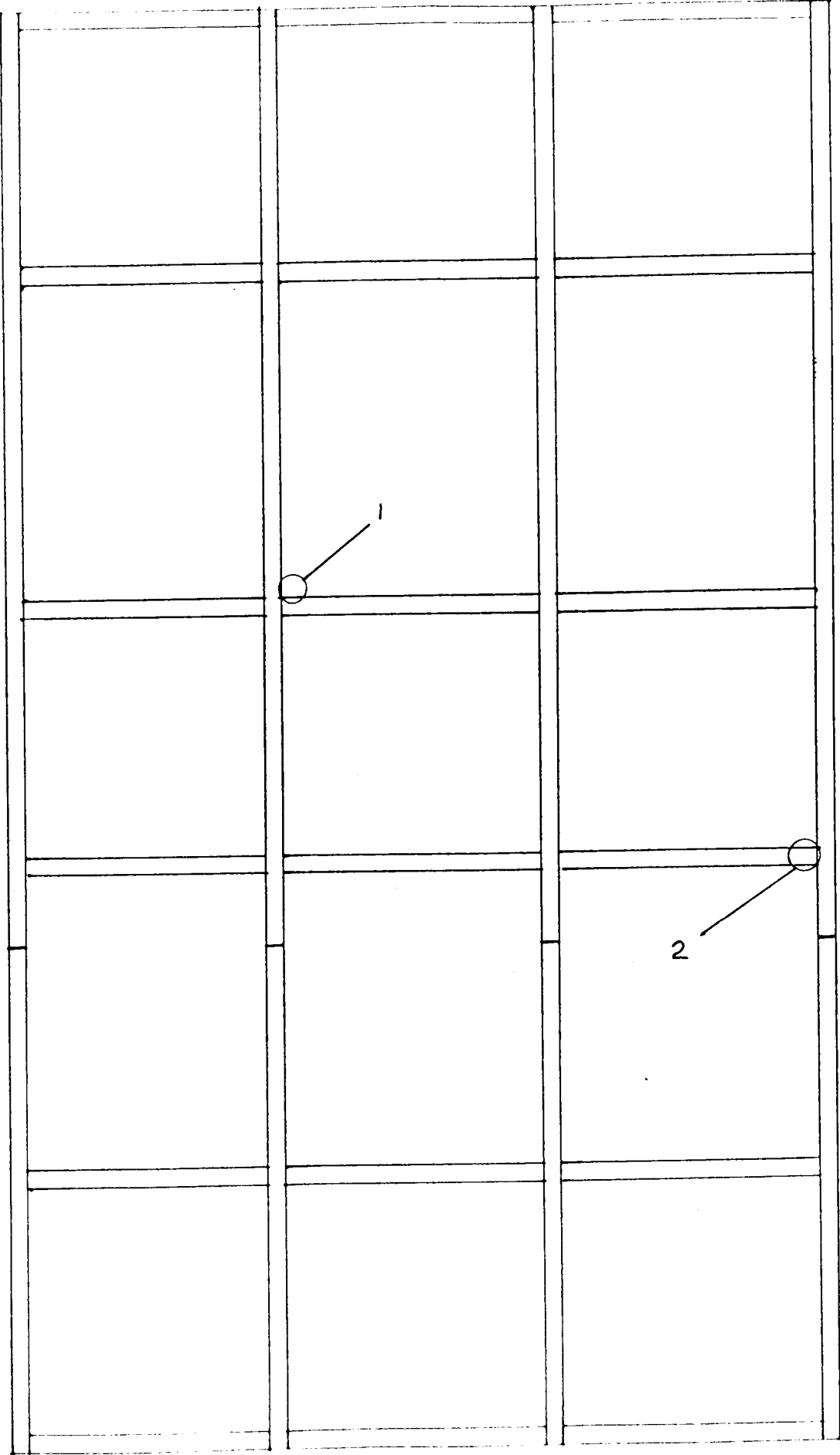
DRAWN BY: BC
DATE: 3-17-94

Sketch # 2



PROJECT NAME 3360	CLIENT NAME Tubelite Inc.	ARCHITECTURAL TESTING INC.	NOTES Static Water test @ 12.0psf	DRAWN BY BC	DATE 3-17-94

SKETCH #3



PROJECT NO. 3360

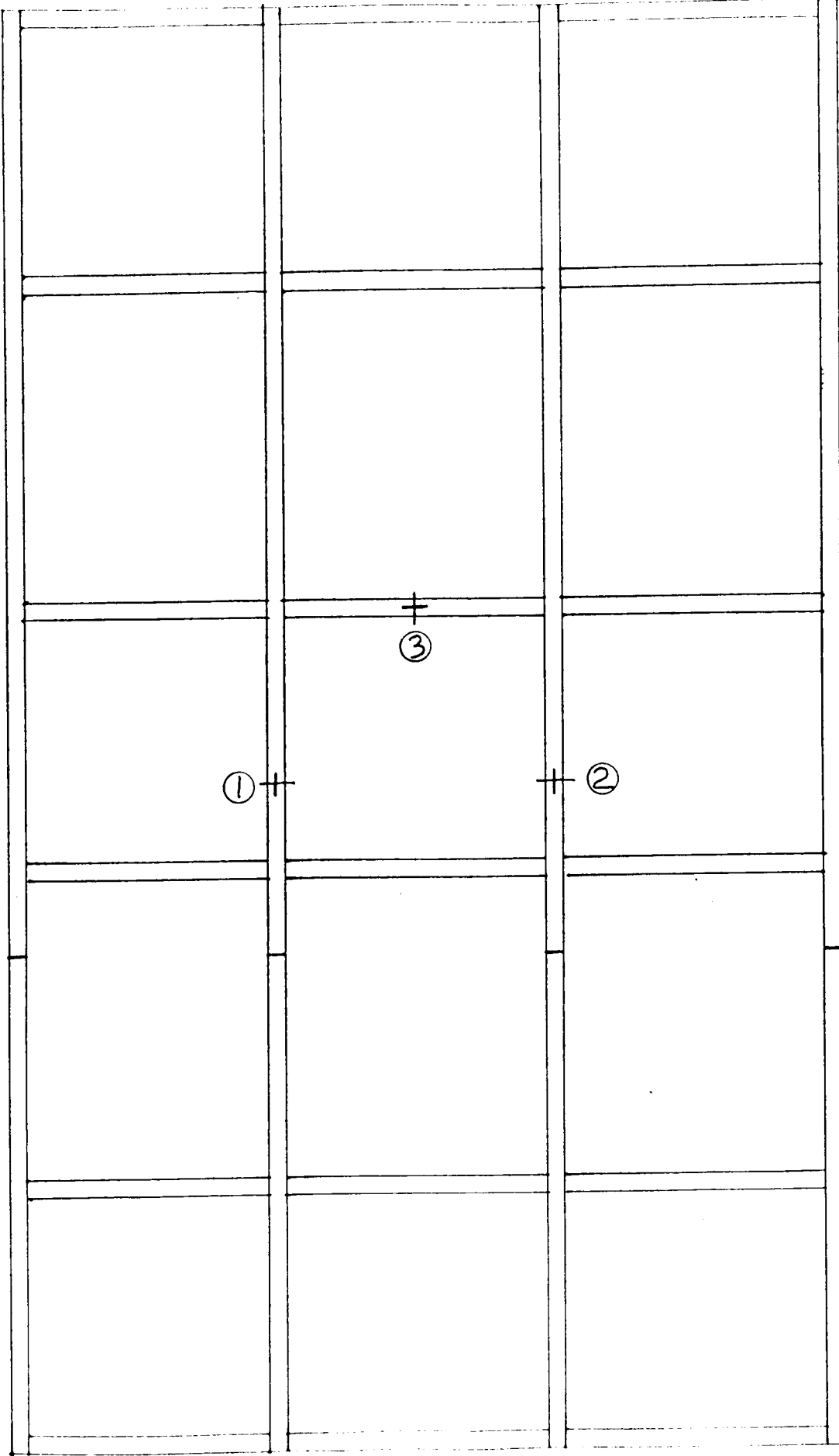
PROJECT NAME Tubelite Inc.

ARCHITECTURAL TESTING INC.

NOTES Static water test @15.0psf

DRAWN BY BC
DATE 3-17-94

SKETCH # 4



3360

PROJECT NAME
ESTIMATE

Tubelite Inc.

ARCHITECTURAL
TESTING INC.

NOTES

Deflection Locations

DRAWN BY

B.C.

DATE

3-17-94

BILL OF MATERIALS	FINISH	EXTRUSION/PART	QTY.	LENGTH/SIZE	DESCRIPTION	NOTES
1	DA	C-2486	3	57 1/2"	SKEL	1
2	DA	C-2486	3	57 1/2"	SKEL	2
3	DA	C-2486	3	57 1/2"	SKEL	3
4	DA	C-2486	3	57 1/2"	SKEL	4
5	DA	C-2486	3	57 1/2"	SKEL	5
6	DA	C-2486	3	57 1/2"	SKEL	6
7	DA	C-2486	3	57 1/2"	SKEL	7
8	DA	C-2486	3	57 1/2"	SKEL	8
9	DA	C-2486	3	57 1/2"	SKEL	9
10	DA	C-2486	3	57 1/2"	SKEL	10
11	DA	C-2486	3	57 1/2"	SKEL	11
12	DA	C-2486	3	57 1/2"	SKEL	12
13	DA	C-2486	3	57 1/2"	SKEL	13
14	DA	C-2486	3	57 1/2"	SKEL	14
15	DA	C-2486	3	57 1/2"	SKEL	15
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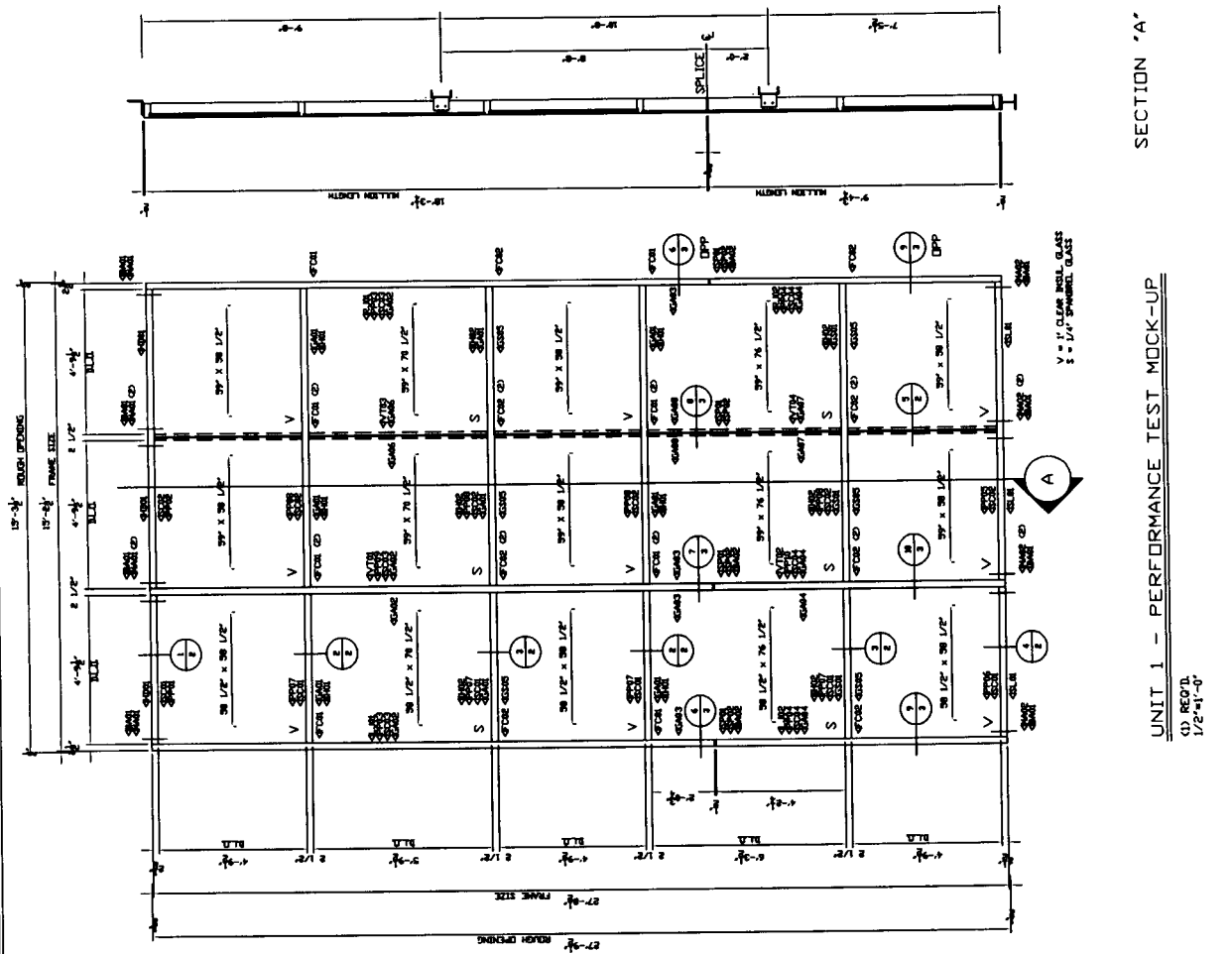
GENERAL NOTES

- 1) TYPICAL GLASS BITE = 1/2"
- 2) GLASS BITE @ BUTT GLAZED MILLIONS = 1"
- 3) VERTICAL GASKETS RUN THROUGHOUT
- 4) SEAL ENDS OF HORIZONTAL GASKETS TO VERTICAL GASKETS BY SEALANT
- 5) VERTICAL GASKETS LOCATED @ 1/4 POINTS OF D.L.D. SET. HUBS TO BE 1/4" DIA. & LOCATED @ 1/4 POINTS OF D.L.D.
- 6) ATTACH PRESSURE PLATE @ 10" O.C.
- 7) FINISH TO BE 204-RI CLEAR ANODIZED (DA)

TEST SPECIFICATIONS

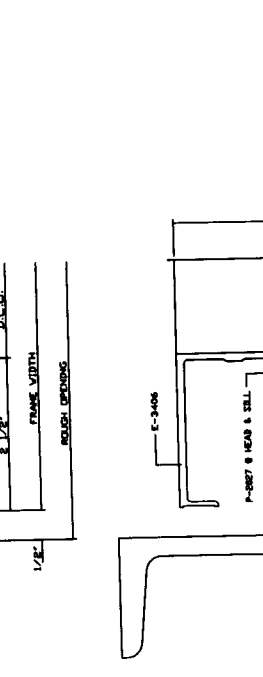
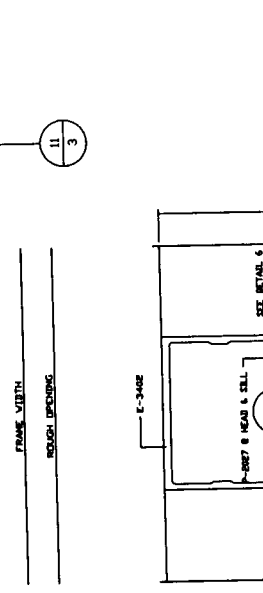
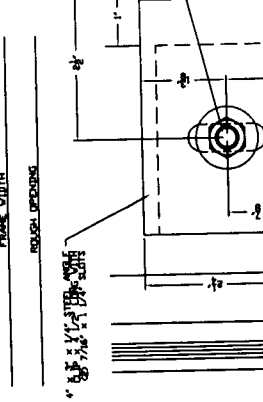
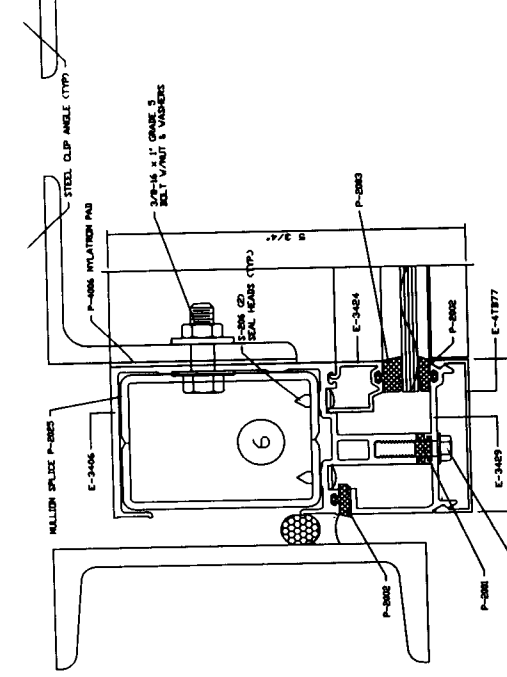
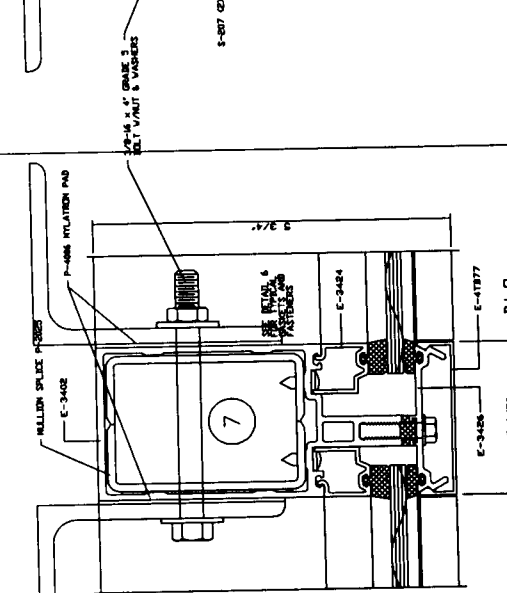
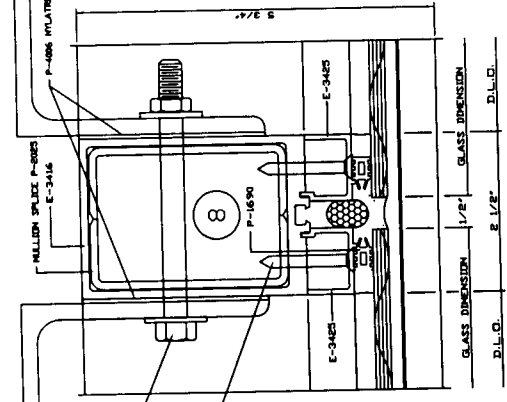
- 1) PRELOAD
15 PSF STATIC PRESSURE (50% OF THE POSITIVE DESIGN LOAD FOR 10 SECONDS)
- 2) STATIC AIR INFILTRATION
(ASTM E283-83) @ 6.24 PFS. AIR INFILTRATION SHALL NOT EXCEED 0.06 CFM/SQ.FT. OF FIXED WALL
- 3) STATIC WATER PENETRATION
(ASTM E331-83) @ 8.00 PFS, 12.00 PFS AND 15.00 PFS. NO UNCONTROLLED WATER.
- 4) DYNAMIC WATER PENETRATION
(ANNA 5011-83) PERFORMANCE
STRUCT. E330 @ 50% AND 100% OF DESIGN LOAD (DESIGN LOAD = 30 PSF)
- 5) STATIC WATER PENETRATION
(ASTM E331-83) @ 8.00 PFS, 12.00 PFS AND 15.00 PFS. NO UNCONTROLLED WATER.
- 6) STRUCTURAL OVERLOAD
(ASTM E330) @ 75% OF DESIGN LOAD (DESIGN LOAD = 30 PSF)

DATE: 1/27/94
 DRAWN BY: TUBELITE INC.
 CHECKED BY: TUBELITE INC.
 TUBELITE INC.
 1-7-94
 SHEET 1 OF 5
 PROJECT NO. 1-878



UNIT 1 - PERFORMANCE TEST MOCK-UP
 (D) REPT. 1/27-94

TEST DATE:



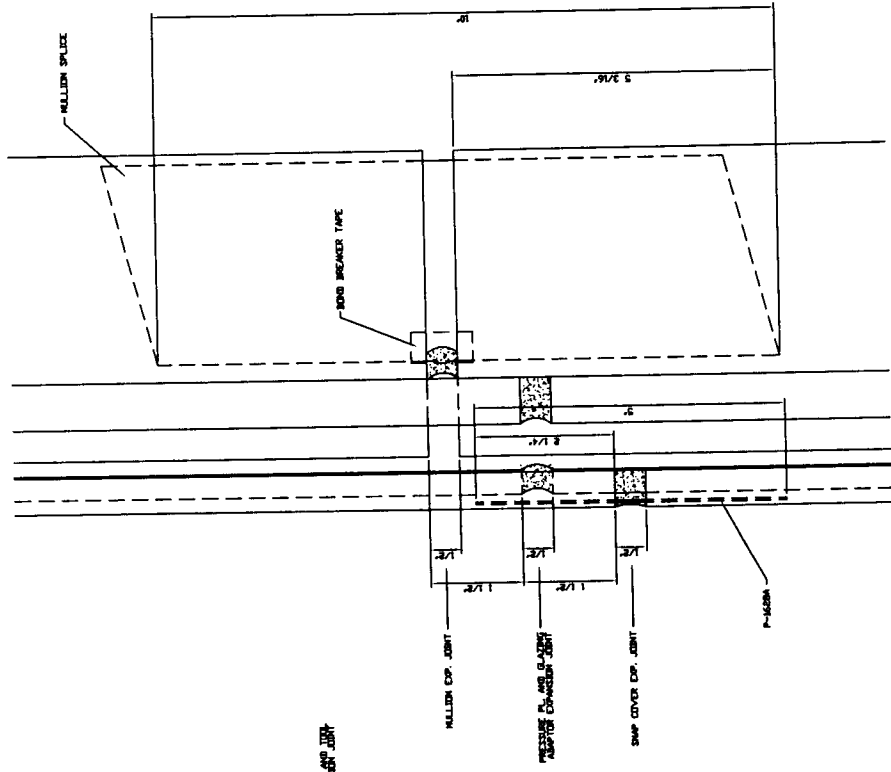
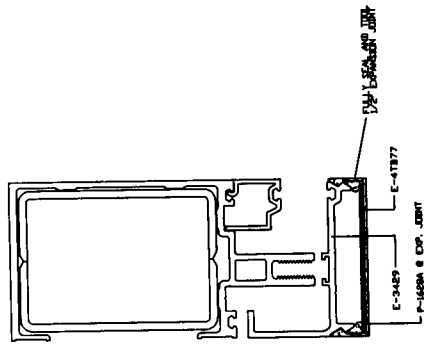
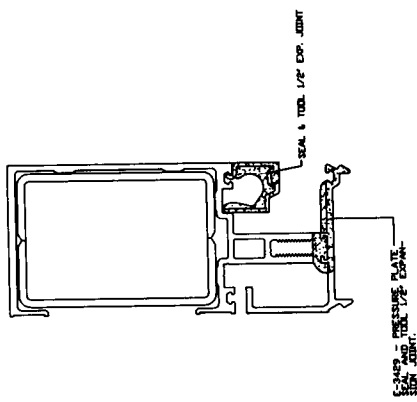
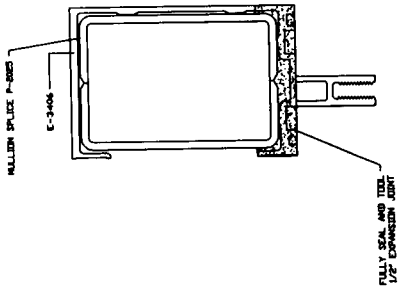
FACTORY ORDER NO. 310470A
 QTY 1000
 400 SERIES CURTAINWALL PERFORMANCE TEST MOCK-UP
 LOCATION YORK, PENNSYLVANIA
 DRAWN BY
 CHECKED BY
 DATE 1-7-94

SCALE FULL SIZE
 DRAWN BY STEVE DE VORSE
 REVISIONS

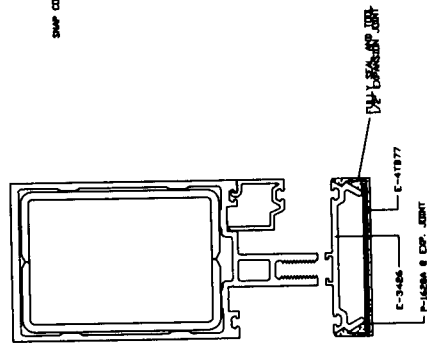
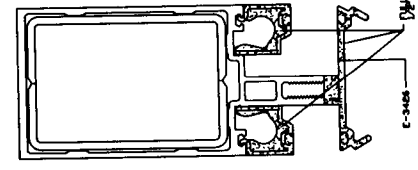
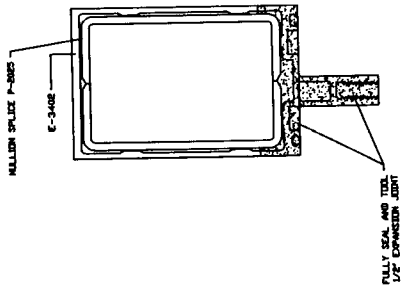
TUBELITE INC.
 6800 MICHIGAN TRAIL, P.O. BOX 100
 REED CITY, MICHIGAN 49677
 616-832-2811

DATE 1-7-94 SHEET 3 OF 5 DRAWING NO. T-878

NOTE:
 PERIMETER SEALANTS TO BE
 SUPPLIED BY CONTRACTOR.
 POLYURETHANE EDIT BACKER ROD.



SEALANT INSTRUCTIONS @ JAMB EXPANSION JOINT



SEALANT INSTRUCTIONS @ MULLION EXPANSION JOINT

SCALE	FULL
DESIGNED BY	STEVE DE YOUNG
REVISED	
DATE	
PROJECT	STAINWALL FOR SERVICE FOR SERVICE TEST MCK-UP
LOCATION	TOBY, PENNSYLVANIA
CONTRACT	
DATE	
TUBELITE INC. 888 MCKINNEY AVE. STE. 105 REEDY CREEK, PENNSYLVANIA 15077 412-832-2211	
DRAWING NO. T-878 SHEET 5 OF 5 DATE 1-7-94	

SUMMARY OF THERMAL PERFORMANCE TEST REPORT ATI-13533

TUBELITE, INC.

Test Date: 05/25/94

SERIES/MODEL: "400" (DG Clear)

TYPE: Two-Lite Aluminum Curtain Wall System

OVERALL SIZE: 9' 9-1/4" wide by 9' 9" high

FINISH: Clear anodized.

GLAZING: The mock-up was exterior glazed using interior/exterior glazing gaskets, snap-fit beads, and sealed insulating glass.

NOTE: A more detailed description was not available due to the client's request to retain the unit intact.

TEST PROCEDURE: The condensation resistance factor (CRF) was determined in accordance with AAMA Specification 1503.1-1988; the thermal transmittance coefficient (U) was determined in general accordance with ASTM C236-89 and AAMA 1503.1-1988 under the following conditions:

- | | | |
|--|------|---|
| 1. Average warm side ambient temperature | 68.0 | F |
| 2. Average cold side ambient temperature | 17.9 | F |
| 3. 15 mph dynamic wind applied to test specimen exterior. | | |
| 4. 0.0 inches H ₂ O static pressure drop across specimen. | | |

TEST RESULTS:

- | | | |
|-----------------------------------|------|---|
| 1. Average frame temperature (FT) | 49.7 | F |
| 2. Average glass temperature (GT) | 46.0 | F |

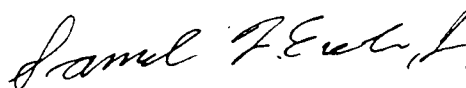
THERMAL PERFORMANCE RATINGS:

- | | |
|---|------|
| 1. Condensation resistance factor - Frame (CRF _f) | 63 |
| Condensation resistance factor - Glass (CRF _g) | 56 |
| 2. Thermal transmittance due to conduction (U _c)
(U values expressed in BTU/HR·FT ² ·F) | 0.54 |

The test results indicate compliance with a CRF Class C55 and a U-Class U60 per AAMA 1504-88 standard.

Reference should be made to Report ATI-13533 for complete test description and data.

ARCHITECTURAL TESTING, INC.



Samuel F. Eveler, Jr.
Technician

THERMAL PERFORMANCE TEST REPORT

Rendered to:

TUBELITE, INC.
4878 Mackinaw Trail
Reed City, Michigan 49677

Report No: ATI-13533
Test Date: 05/25/94
Report Date: 06/30/94
Expiration Date: 05/25/98

SERIES/MODEL: "400" (DG Clear)

TYPE: Two-Lite Aluminum Curtain Wall System

OVERALL SIZE: 9' 9-1/4" wide by 9' 9" high

FINISH: Clear anodized.

GLAZING: The mock-up was exterior glazed using interior/exterior glazing gaskets, snap-fit beads, and sealed insulating glass.

FIXED LITE SIZE: (2) 4' 6-1/2" wide by 9' 3-1/2" high (daylight opening)

FRAME CONSTRUCTION: The frame was assembled from continuous vertical members. All corners were of butted construction.

DRAINAGE:

<u>Description</u>	<u>Quantity</u>	<u>Location</u>
1/2" long by 1/4" wide weepslot	6	Equally spaced across the head

NOTE: *A more detailed description was not available due to the client's request to retain the unit intact.*

CONDENSATION RESISTANCE FACTOR: CRF tests were conducted in accordance with AAMA 1503.1-1988.

1. Environmental systems started at 1415 hr., 05/24/94.
2. System was determined to be stable between 0630 and 0830 hr., 05/25/94.

The following information, condensed from the test data, was used to determine the condensation resistance factor:

T_h	=	Warm side ambient air temperature	68.0	F
T_c	=	Cold side ambient air temperature	17.9	F
FT_p	=	Average of pre-specified frame temperatures (14)	49.8	F
FT_r	=	Average of roving thermocouples (4)	47.6	F
W	=	$\frac{FT_p - FT_r}{FT_p - (T_c + 10)}$	X 0.40	0.400
FT	=	$FT_p (1 - W) + W (FT_r)$	=	Frame Temperature 49.7 F
GT	=	Glass Temperature	46.0	F
CRF_g	=	Condensation resistance factor - Glass	56	
CRF_g	=	$\frac{GT - t_c}{t_h - t_c}$	X 100	
CRF_f	=	Condensation resistance factor - Frame	63	
CRF_f	=	$\frac{FT - t_c}{t_h - t_c}$	X 100	

The CRF number was determined to be 56. A 56 CRF is a "CRF Class C55" per AAMA 1504-88. When reviewing this test data, it should be noted that the Glass temperature (GT) was colder than the Frame temperature (FT) therefore controlling the CRF number. Attached to this report is a copy of the data sheet and an isometric drawing indicating thermocouple locations and average surface temperatures.

THERMAL TRANSMITTANCE: Tests to determine thermal transmittance (U) were performed in general accordance with ASTM C236-89 and AAMA 1503.1-1988 under the following conditions:

t_h	=	Average warm side ambient temperature	=	68.0	F
t_c	=	Average cold side ambient temperature	=	17.9	F
P	=	Static pressure difference across test specimen	=	0.0	psf
		15 mph dynamic wind at exterior			
		Nominal sample area		95.06	FT ²
		Total measured input to calorimeter		2787.1	BTU/HR

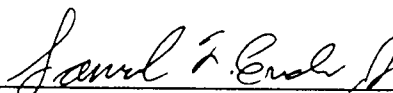
THERMAL TRANSMITTANCE: (Continued)

Calorimeter correction	200.4	BTU/HR
Net specimen heat loss	2586.7	BTU/HR
Thermal Transmittance (U_c)	0.54	BTU/HR·FT ² ·F


The thermal transmittance (U_c) of 0.54 is a "U-Class U60" per AAMA 1504-88 standard.

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. Results obtained are tested values and do not constitute an opinion or endorsement by this laboratory.

For ARCHITECTURAL TESTING, INC.:



Samuel F. Eveler, Jr.
Technician



David G. Moyer
Director of Testing Services

SFE:sdb
13533

ARCHITECTURAL TESTING, INC
C.R.F. Report

ATI test # : 13533

Disk :2972

5/25/1994

Client Name: Tubelite

Room :C

Model/Desc.: "400" Two Lite Curtainwall (DG Clear)

Time:	06:30	07:00	07:30	08:00	08:30	AVG
Pre-Specified Thermocouples - Frame						
1	48.5	48.5	48.5	48.5	48.5	48.5
2	47.1	47.4	47.1	47.5	47.7	47.4
3	49.4	49.6	49.4	49.6	49.7	49.5
4	52.2	52.2	52.2	52.2	52.1	52.2
5	50.8	51.0	50.7	51.0	50.9	50.9
6	52.5	52.6	52.6	52.6	52.7	52.6
7	51.1	51.1	51.0	51.1	51.0	51.1
8	50.3	50.1	50.3	50.2	50.2	50.2
9	48.0	48.0	47.9	47.9	48.0	48.0
10	48.5	48.4	48.5	48.4	48.7	48.5
11	48.3	48.1	48.3	48.2	48.2	48.2
12	47.4	47.5	47.5	47.5	47.5	47.5
13	52.9	52.8	52.9	52.8	52.9	52.9
14	49.7	49.7	49.6	49.7	49.6	49.7
FTP	49.8	49.8	49.8	49.8	49.8	49.8

Pre-Specified Thermocouples - Glass						
15	43.1	43.2	43.1	43.1	43.2	43.1
16	48.9	48.9	48.9	48.9	48.9	48.9
17	44.4	44.4	44.5	44.6	44.6	44.5
18	44.2	44.1	44.2	44.3	44.3	44.2
19	50.1	50.1	50.0	50.1	50.1	50.1
20	45.2	45.2	45.2	44.9	45.0	45.1
GT	46.0	46.0	46.0	46.0	46.0	46.0

Cold Point (Roving) Thermocouples						
21	47.1	47.4	47.1	47.5	47.7	47.4
22	47.4	47.5	47.5	47.5	47.5	47.5
23	47.8	47.9	47.9	47.9	47.8	47.9
24	47.7	47.8	47.8	47.6	47.7	47.7
FTR	47.5	47.7	47.6	47.6	47.6	47.6
W	.0410	.0390	.0400	.0400	.0400	.0400
FT	49.7	49.7	49.7	49.7	49.7	49.7

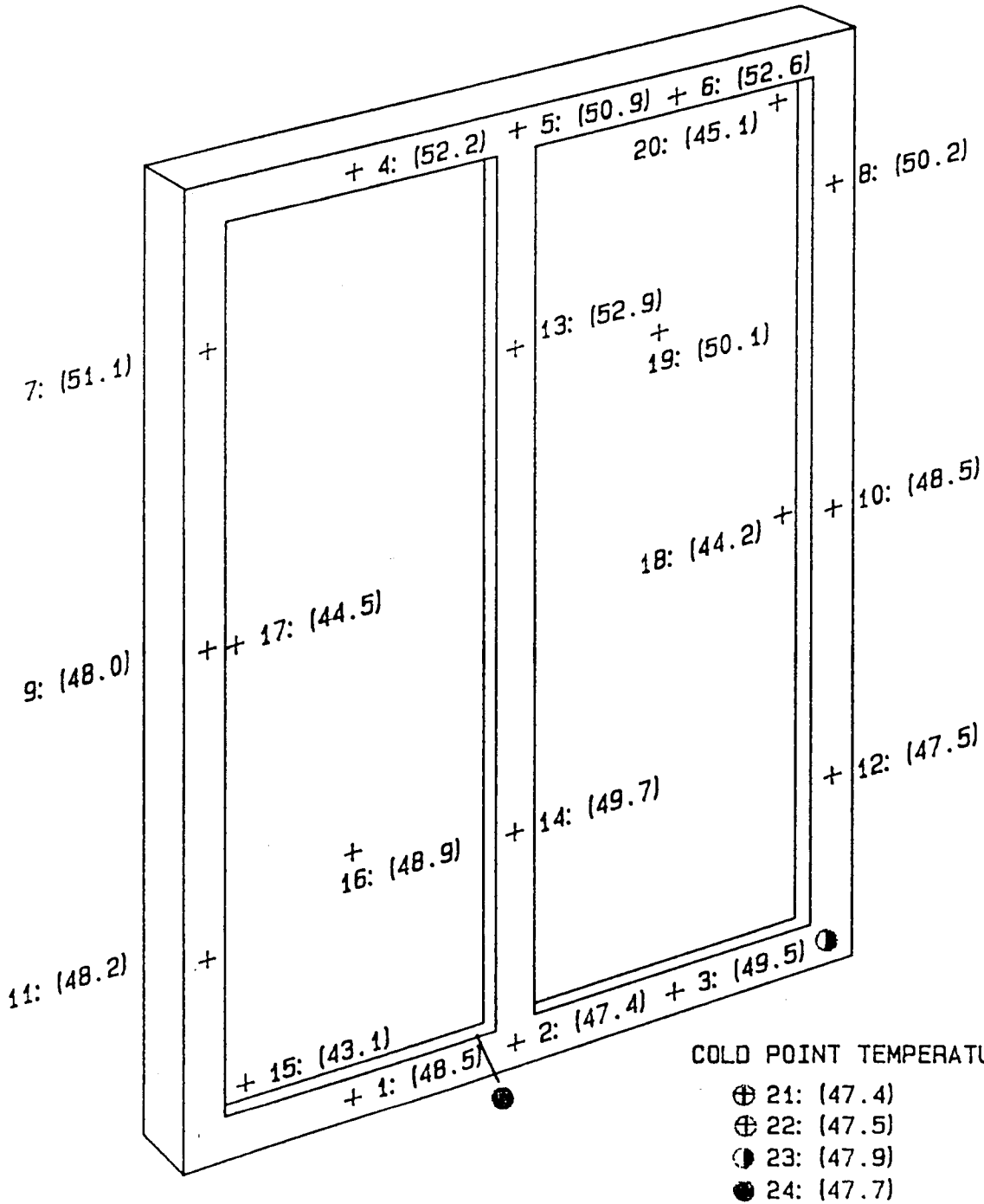
Indoor - Room Ambient Air Temperature						
	67.9	68.0	68.0	68.0	68.0	68.0

Outdoor - Room Ambient Air Temperature						
	18.0	17.9	17.9	17.9	17.9	17.9

CRFf	63.45	63.47	63.37	63.54	63.53	63.47
CRFg	56.04	56.02	56.00	56.07	56.08	56.04

**ARCHITECTURAL
TESTING INC**

"400" Two Lite Curtainwall (DG Clear)



Average Test Point Temperatures - Used to calculate Condensation Resistance Factor for the frame and glass.

Computer generated drawing by the ATI Analysis Center using ATI's proprietary software on Hewlett-Packard Computer Systems and Plotting Equipment.

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