Architectural Testing

# GUARDRAIL SYSTEM PERFORMANCE TEST REPORT

**Rendered to:**

**CUSTOM DECORATIVE MOULDING**

**PRODUCT: 12 ft. *Custom* Guardrail System**

**Report No: 01-48834.01**
**Report Date: 02/12/04**

130 Derry Court
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# GUARDRAIL SYSTEM PERFORMANCE TEST REPORT

Rendered to:

CUSTOM DECORATIVE MOULDING
12136 Sussex Highway
Greenwood, Delaware 19950

Report No.: 01-48834.01
Test Date: 12/23/03
Report Date: 02/12/04

**Product**: 12 ft. *Custom* Guardrail System

**Project Summary**: Architectural Testing, Inc. (ATI) was contracted by Custom Decorative Moulding to conduct structural performance tests on their 12 ft. *Custom* guardrail system. The system was evaluated for the design load requirements of the following building codes and standards:

IBC-2000 / ICC - *International Code Council*

BOCA-1999 - *Building Officials and Code Administrators* (Reference ASCE 7-95)

SBC-1999 / SBCCI - *Southern Building Code Congress International*

All tests performed are to evaluate the structural performance of the railing assembly to carry and transfer imposed loads to the supports (posts). The test specimen evaluated includes the pickets, rails, rail brackets and attachment to the post. The support posts are not a tested component and are included in the test specimen only to facilitate anchorage of the rail brackets.

**Test Specimen (Railing Assembly) Description**: The railing consisted of a reinforced PVC top and bottom rail with an overall length of 152". The top and bottom rail members had a 0.125" thick open section aluminum reinforcement which ran the entire length of the rail. The railing measured 40-11/16" high overall bottom rail to top rail. Spaced pickets, which were solid PVC and measured 1-1/4" x 1-1/4", were secured to the top and bottom aluminum reinforcement with #8 x 2" stainless steel screws providing a 3-1/2" clearance between pickets. The top and bottom rail were attached to an aluminum post, supplied by Custom Decorative Moulding, with aluminum brackets. A modification was made before Test #4, in which a #8 x 3/4" retainer screw was placed on the interior side at each end of the bottom rail. (Reference drawings in Appendix A and photographs in Appendix B for additional detail.)

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**Equipment**: Railing assemblies were tested in a self-contained structural frame designed to accommodate anchorage of the rail assembly and application of the required test loads. The specimen was loaded using an electric winch mounted to a rigid steel test frame. High strength cables, nylon lifting straps and load distribution beams were used to impose test loads on the specimen. Applied load was measured using an electronic load cell located in-line within the loading system. Deflections were measured to the nearest 0.01" using electronic linear transducers.

**Set-Up**: All railing assemblies were installed and tested as a single railing section by directly securing the posts into a rigid steel test frame. The test fixture rigidly restrained the posts from deflecting. Transducers mounted to an independent reference frame were located to record movement of reference points on the railing system components (ends and mid-point) to determine net component deflections. Uniform distributed loads with simple end supports were simulated with 1/4-point loading. (See photographs for individual test setups).

**Test Procedure**: The test specimen is inspected prior to testing to verify size and general condition of the materials, assembly and installation. Any potentially compromising defects observed are noted prior to the load test. The assembly is preloaded up to a level not exceeding design load. After pre-loading, all load is released and any necessary fixture adjustments are made. An initial load, not exceeding 20% of design load, is applied and initial deflections are recorded or transducers are zeroed. Loads are then applied at a steady uniform rate stopping at 20% design load increments to record deflections. The load/deflection procedure continues until reaching 2.0 times design load within a time period of 5-10 minutes. At 2.0 times design load, the load is released. After allowing a minimum period of one minute for stabilization, load is reapplied to the initial load used at the start of the load/deflection procedure and deflections are recorded. These deflections are used to analyze recovery. For tests that require ultimate loads greater than 2.0 times design load, loading is reapplied and increased at a steady uniform rate until failure occurs or the required ultimate load is reached. The testing time is continually recorded from the application of initial test load until the maximum test load is reached.

**Test Results**: The following tests were performed on the rail assemblies for the design load requirements of each code as referenced. Rail and picket test results are mid-point deflections for the given test load. Deflection and permanent set are component deflections relative to their end-points. They are not overall system displacement. All loads are horizontal except the SBC top rail design load (see results). All displacement measurements are horizontal. Deflection analysis uses linear regression through the linear range of the load/deflection data. The test results apply only to the components tested, which include the top rail, bottom rail, rail brackets and pickets. Posts are not a tested component and are included in the test setup only to facilitate the rail bracket anchorage.

**Test Results**: (Continued)

**Test #1 - Test Date: 12/23/03**
**Specimen #1 - 12 ft. Custom Rail**
**50# / 1 sq. ft. In-Fill at Center (Three Pickets) / IBC and BOCA**

| Load Level[1] | Test Load (lbs) | Test Data - Deflection (inches) | | | | Deflection Analysis | |
|---|---|---|---|---|---|---|---|
| | | Top | Mid | Bottom | Net | y = mx | Deflection |
| 0.0 | 0 | - | - | - | - | 0.00 | 0.00 |
| 0.1 | 31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.17 |
| 0.8 | 40 | 0.03 | 0.10 | 0.06 | 0.05 | 0.24 | 0.22 |
| 1.0 | 51 | 0.09 | 0.28 | 0.18 | 0.14 | 0.31 | 0.31 |
| 1.2 | 61 | 0.15 | 0.42 | 0.29 | 0.20 | 0.37 | 0.37 |
| 1.4 | 70 | 0.19 | 0.53 | 0.37 | 0.25 | 0.42 | 0.42 |
| 1.6 | 81 | 0.25 | 0.69 | 0.49 | 0.32 | 0.49 | 0.48 |
| 1.8 | 91 | 0.30 | 0.85 | 0.62 | 0.38 | 0.55 | 0.55 |
| 2.0 | 100 | 0.36 | 0.98 | 0.74 | 0.44 | 0.60 | 0.60 |
| 0.1 | 33 | 0.02 | 0.04 | 0.04 | 0.01 | 97% Recovery | |
| 2.5 | 128 | Maximum Test Load - *Sustained without failure.* | | | | | |

[1] *Load level represents % of design load.*

**Test #2 - Test Date: 12/23/03**
**Specimen #1 - 12 ft. Custom Rail**
**200# / 1 sq. ft. In-Fill at Center (Three Pickets) / SBC**

| Load Level[1] | Test Load (lbs) | Test Data - Deflection (inches) | | | | Deflection Analysis | |
|---|---|---|---|---|---|---|---|
| | | Top | Mid | Bottom | Net | y = mx | Deflection |
| 0.0 | 0 | - | - | - | - | 0.00 | 0.00 |
| 0.1 | 31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | -0.04 |
| 0.6 | 128 | 0.51 | 1.38 | 1.07 | 0.59 | 0.56 | 0.55 |
| 0.8 | 162 | 0.68 | 1.80 | 1.42 | 0.75 | 0.71 | 0.71 |
| 1.0 | 201 | 0.88 | 2.25 | 1.78 | 0.92 | 0.88 | 0.89 |
| 1.2 | 245 | 1.13 | 2.80 | 2.21 | 1.13 | 1.08 | 1.09 |
| 1.4 | 282 | 1.33 | 3.21 | 2.53 | 1.28 | 1.24 | 1.24 |
| 1.6 | 326 | 1.59 | 3.74 | 2.98 | 1.46 | 1.43 | 1.42 |
| 1.8 | 368 | 1.86 | 4.29 | 3.45 | 1.63 | 1.62 | 1.59 |
| 2.0 | 400 | 2.06 | 4.67 | 3.77 | 1.75 | 1.76 | 1.71 |
| 0.1 | 35 | 0.07 | 0.18 | 0.15 | 0.07 | 96% Recovery | |
| 2.0 | 400 | Maximum Test Load - *Sustained without failure.* | | | | | |

[1] *Load level represents % of design load.*

**Test Results**: (Continued)

**Test #3 - Test Date: 12/23/03**
**Specimen #1 - 12 ft. Custom Rail**
**50 plf Uniform Load on Top Rail [1] / BOCA**

| Load Level[2] | Test Load (lbs) | Test Data - Deflection (inches) | | | | Deflection Analysis | |
|---|---|---|---|---|---|---|---|
| | | End-1 | Mid | End-2 | Net | y = mx | Deflection |
| 0.0 | 0 | - | - | - | - | 0.00 | 0.00 |
| 0.1 | 51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.00 |
| 0.2 | 125 | 0.04 | 0.42 | 0.04 | 0.38 | 0.60 | 0.39 |
| 0.4 | 243 | 0.11 | 1.15 | 0.12 | 1.04 | 1.17 | 1.04 |
| 0.6 | 361 | 0.18 | 1.89 | 0.19 | 1.70 | 1.73 | 1.70 |
| 0.8 | 481 | 0.26 | 2.57 | 0.27 | 2.30 | 2.31 | 2.30 |
| 1.0 | 603 | 0.35 | 3.26 | 0.34 | 2.91 | 2.89 | 2.92 |
| 1.2 | 726 | 0.44 | 3.94 | 0.42 | 3.51 | 3.48 | 3.51 |
| 1.4 | 841 | 0.53 | 4.57 | 0.50 | 4.06 | 4.04 | 4.06 |
| 1.6 | 961 | 0.63 | 5.19 | 0.58 | 4.59 | 4.61 | 4.59 |
| 1.8 | 1084 | 0.74 | 5.88 | 0.67 | 5.18 | 5.20 | 5.18 |
| 2.0 | 1200 | 0.86 | 6.61 | 0.78 | 5.79 | 5.76 | 5.80 |
| 0.1 | 51 | 0.05 | 0.17 | 0.12 | 0.08 | 99% Recovery | |
| 2.5 | 1514 | Maximum Test Load - *Sustained without failure.* | | | | | |

[1] *Tested with equivalent 1/4-point loads.*

[2] *Load level represents % of design load.*

**Test Results**: (Continued)

**Test #4 - Test Date: 12/23/03**
**Specimen #1 - 12 ft. Custom Rail**
**(50 Horizontal + 100 Vertical) plf Uniform Load [1] on Top Rail / SBC**

| Load Level[2] | Test Load (lbs) | Test Data - Deflection (inches) | | | | Deflection Analysis | |
|---|---|---|---|---|---|---|---|
| | | End-1 | Mid | End-2 | Net | y = mx | Deflection |
| 0.0 | 0 | - | - | - | - | 0.00 | 0.00 |
| 0.1 | 105 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.68 |
| 0.2 | 283 | 0.03 | 0.32 | 0.03 | 0.29 | 0.66 | 0.97 |
| 0.4 | 539 | 0.07 | 0.82 | 0.07 | 0.75 | 1.25 | 1.43 |
| 0.6 | 823 | 0.12 | 1.42 | 0.14 | 1.29 | 1.91 | 1.97 |
| 0.8 | 1084 | 0.17 | 2.00 | 0.19 | 1.82 | 2.52 | 2.49 |
| 1.0 | 1350 | 0.23 | 2.68 | 0.28 | 2.43 | 3.14 | 3.10 |
| 1.2 | 1638 | 0.31 | 3.43 | 0.37 | 3.09 | 3.81 | 3.77 |
| 1.4 | 1883 | 0.39 | 4.11 | 0.45 | 3.69 | 4.37 | 4.36 |
| 1.6 | 2151 | 0.48 | 4.88 | 0.54 | 4.37 | 5.00 | 5.05 |
| 1.8 | 2424 | 0.59 | 5.71 | 0.64 | 5.10 | 5.63 | 5.78 |
| 2.0 | 2690 | 0.71 | 6.81 | 0.78 | 6.06 | 6.25 | 6.74 |
| 0.1 | 107 | 0.10 | 0.48 | 0.17 | 0.35 | 94% Recovery | |
| 2.0 | 2690 | Maximum Test Load - *Sustained without failure.* | | | | | |

[1] *Tested with resultant load = 112 plf. @ -63.4° from horizontal. Uniform load simulated with equivalent 1/4-point loads.*

[2] *Load level represents % of design load.*

**Summary and Conclusions**: Using a performance criteria of 75% recovery from 2.0 times design load and an ultimate load not less then 2.5 times design load (2.0 for SBC), the test results, in our opinion, substantiate compliance with the design load requirements of the referenced building codes applicable to railing lengths up to 12 ft.

A copy of this report and all supporting data 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 only to the sample tested. 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 written approval of Architectural Testing.

For ARCHITECTURAL TESTING, INC.

Digitally Signed by: Travis Hoover

Travis A. Hoover
Project Engineer

Digitally Signed by: Joseph A. Reed

Joseph A. Reed, P.E.
Director - Engineering and Product Testing

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
JOSEPH A. REED
No. PE-044401-E

2/13/04

GDB:gdb/tah/nlb
01-48834.01

Attachments (pages)
Appendix A: Drawings (4)
Appendix B: Photographs (4)

DOCUMENT CONTROL ADDENDUM #01-48834.00

**Current Issue Date: 02/12/04**

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**Report No.: 01-48834.01**

**Requested by**: Jeff Davis, Custom Decorative Moulding
**Purpose**: Structural performance testing of a 12 ft. guardrail system.
**Issued Date**: 02/12/04
**Comments**: P.E. review and seal required on report.

# APPENDIX A

## Drawings

Architectural Testing

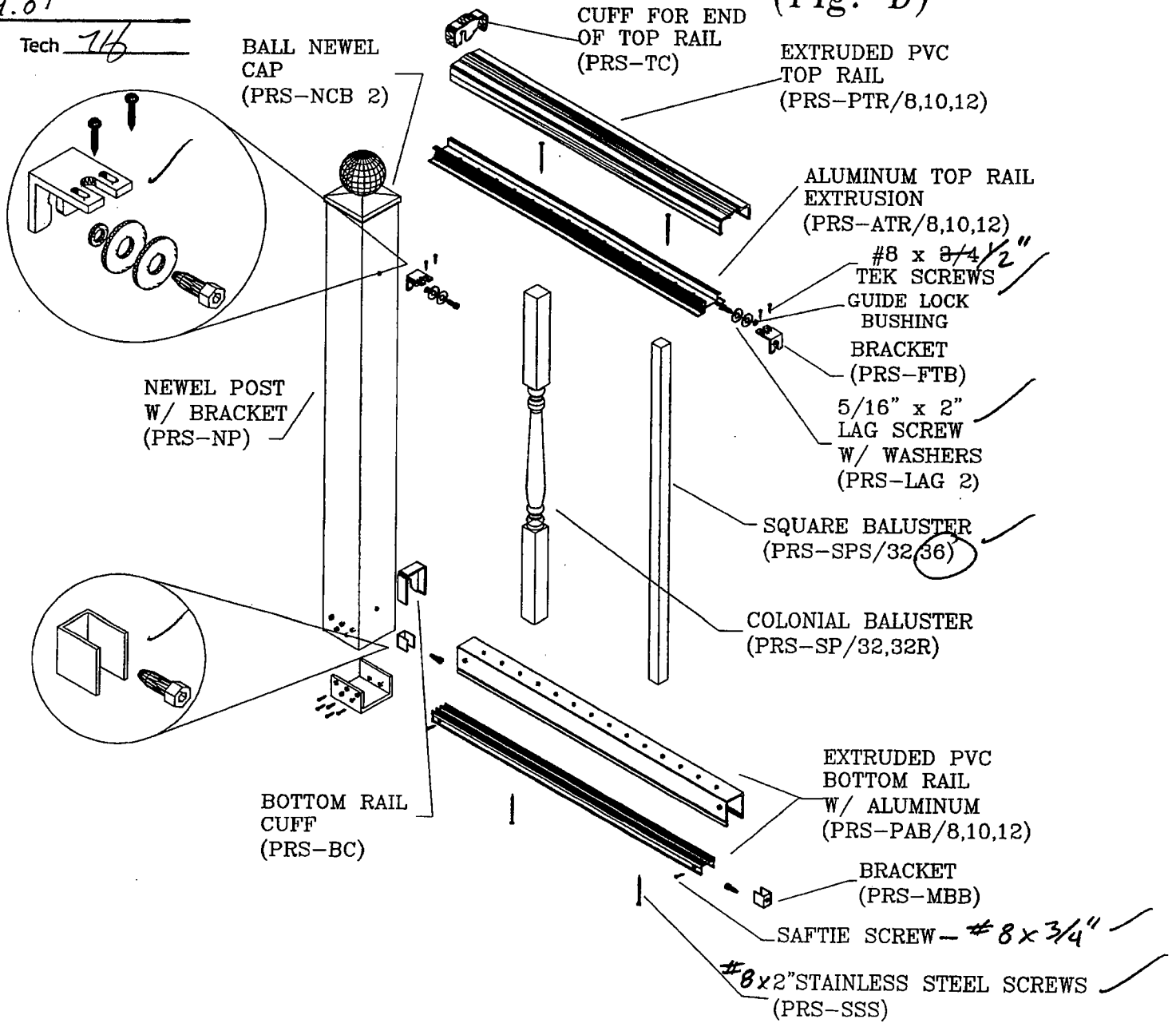
Test sample complies with these details.
Deviations are noted.

Report# 48834.01

Date 2/10/04 Tech TH

# CUSTOM RAIL DIAGRAM

(Fig. D)



Architectural Testing

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Deviations are noted.

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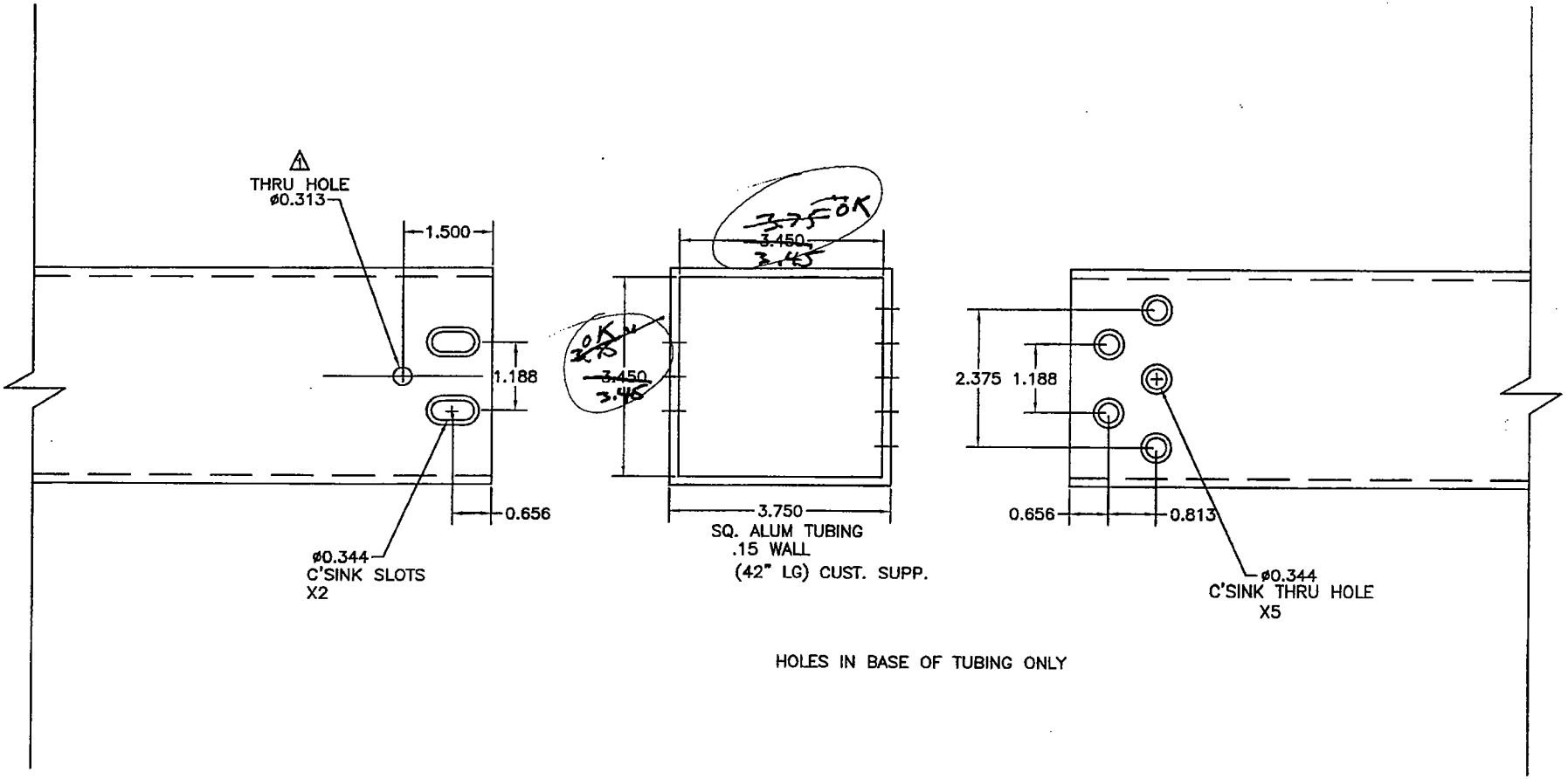



HOLES IN BASE OF TUBING ONLY

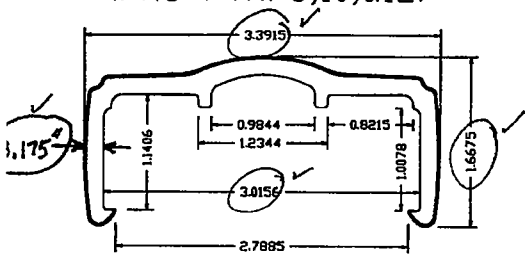
Architectural Testing

Test sample complies with these details.
Deviations are noted.

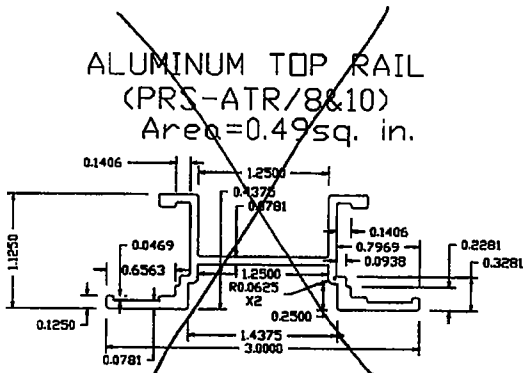
Report# 48834.01

Date 2/10/04 Tech TG

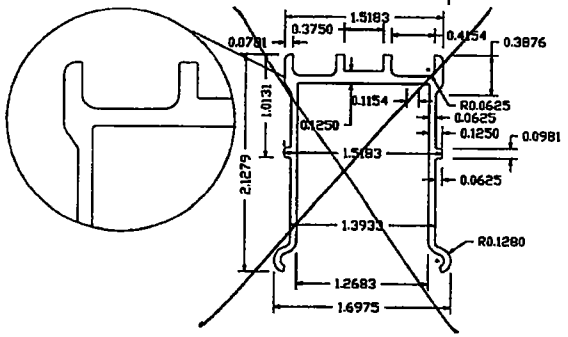
PVC TOP RAIL
(PRS-PTR/8,10,&12)



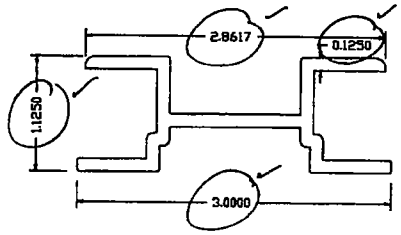

ALUMINUM TOP RAIL
(PRS-ATR/8&10)
Area=0.49sq. in.




ALUMINUM BOTTOM RAIL
(PRS-ABR/8&10)
Area=0.46sq. in.



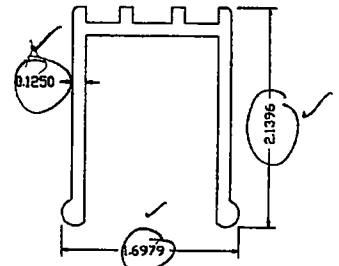

ALUMINUM TOP RAIL
(PRS-ATR/12)




Area=0.7870sq. in.

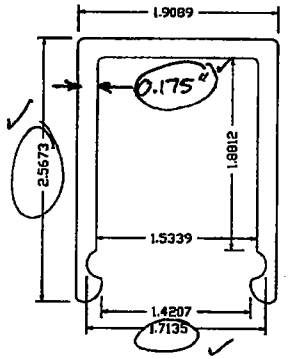
1"=1"

ALUMINUM BOTTOM RAIL
(PRS-ABR/12)




Area=0.7615sq. in.

PVC BOTTOM RAIL
(PRS-PBR/8,10,&12)



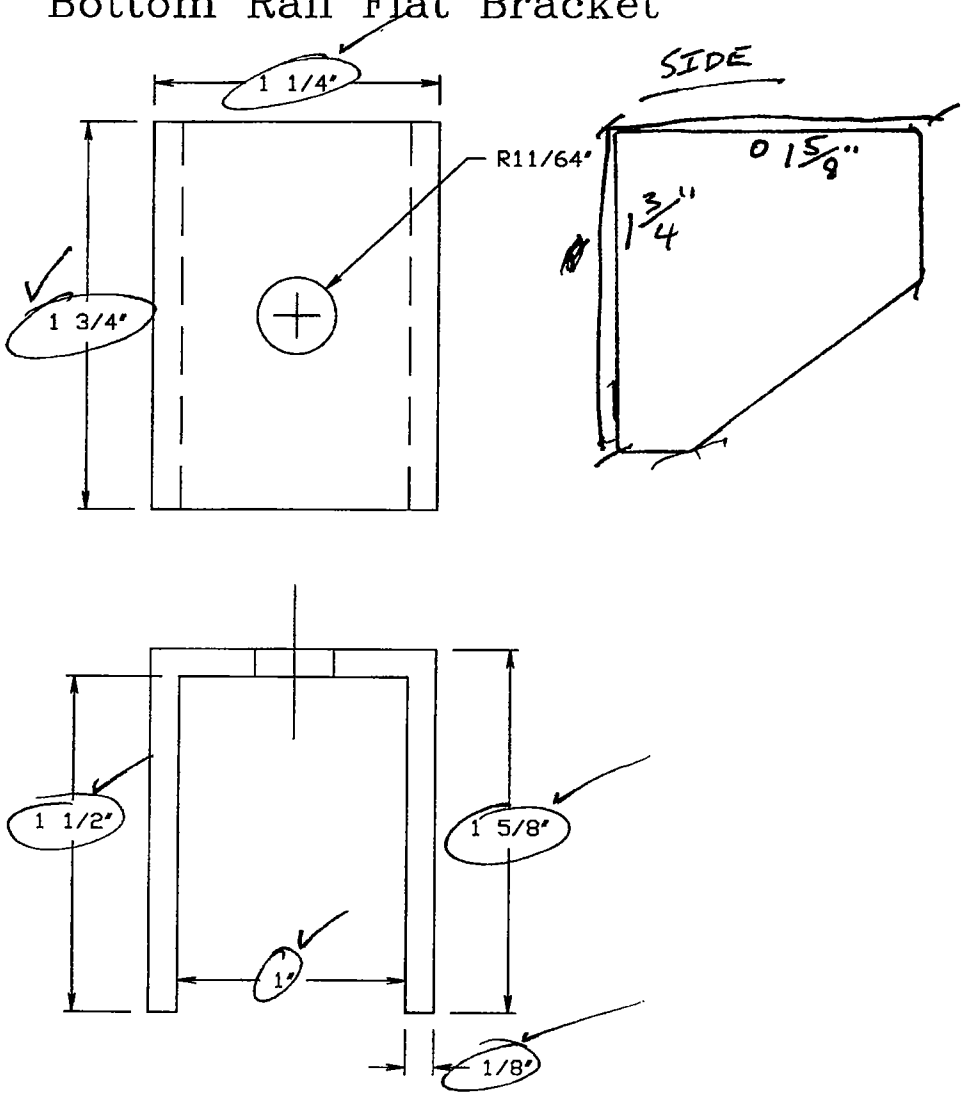
Architectural Testing

Test sample complies with these details.
Deviations are noted.

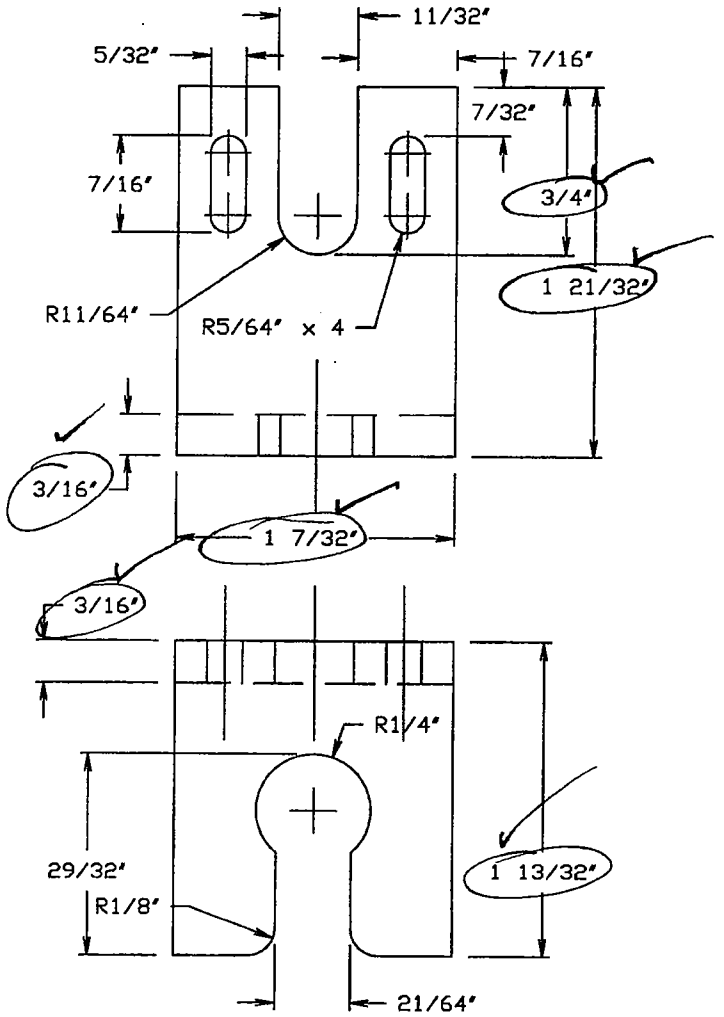
Report# 48834.01

Date 2/10/04 Tech PRS

# PRS–FBB
## Bottom Rail Flat Bracket




# PRS–FTB
## Top Rail Flat Bracket



# APPENDIX B

## Photographs

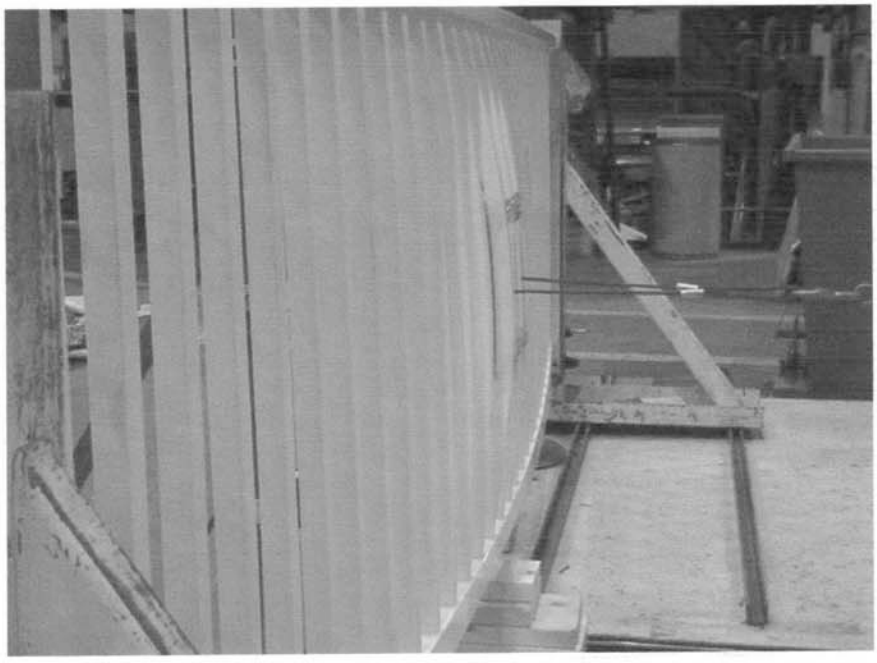


**Photo No. 1**
**In-Fill Load Test**

**Photo No. 2**
**50 plf Top Rail Load Test**

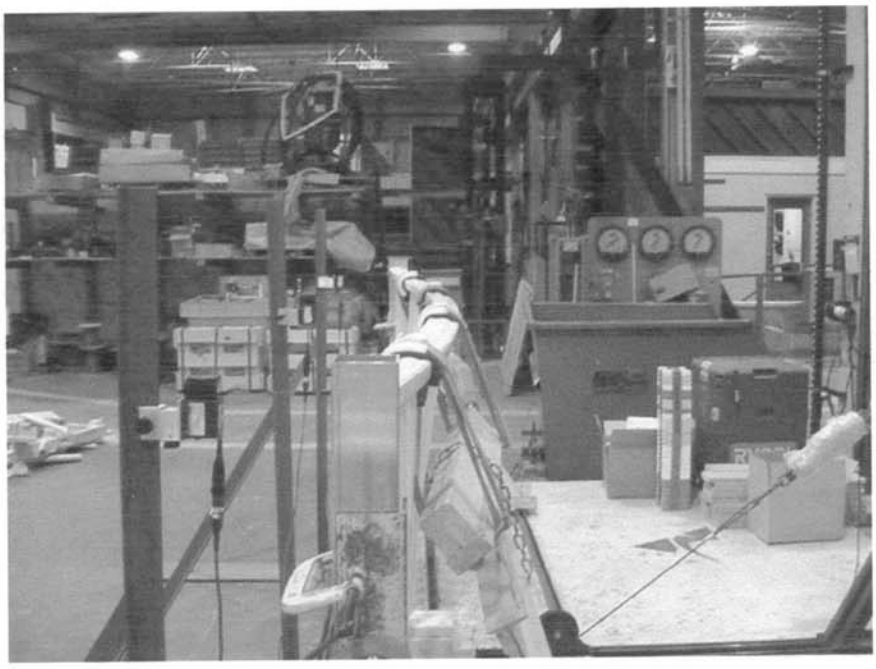


**Photo No. 3**
**SBC Top Rail Load Test**

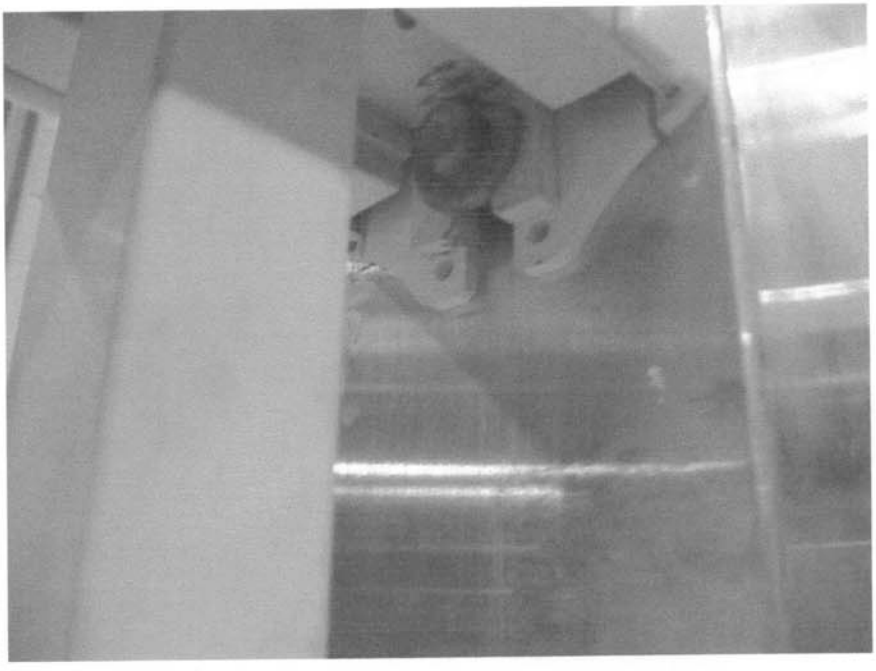


**Photo No. 4**
**Top Rail Bracket Assembly**

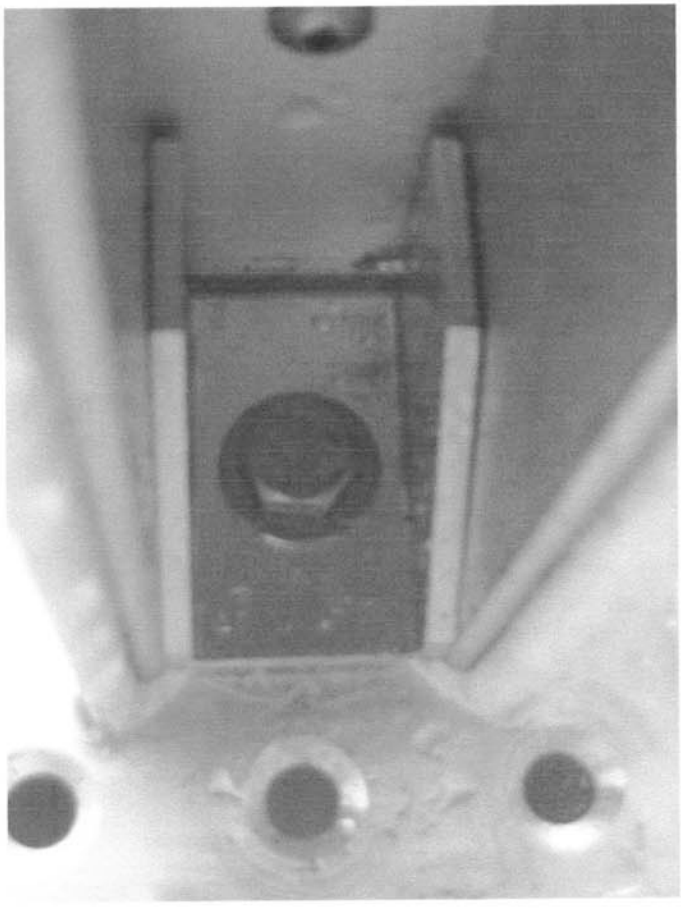


**Photo No. 5**
**Bottom Rail Bracket Assembly**

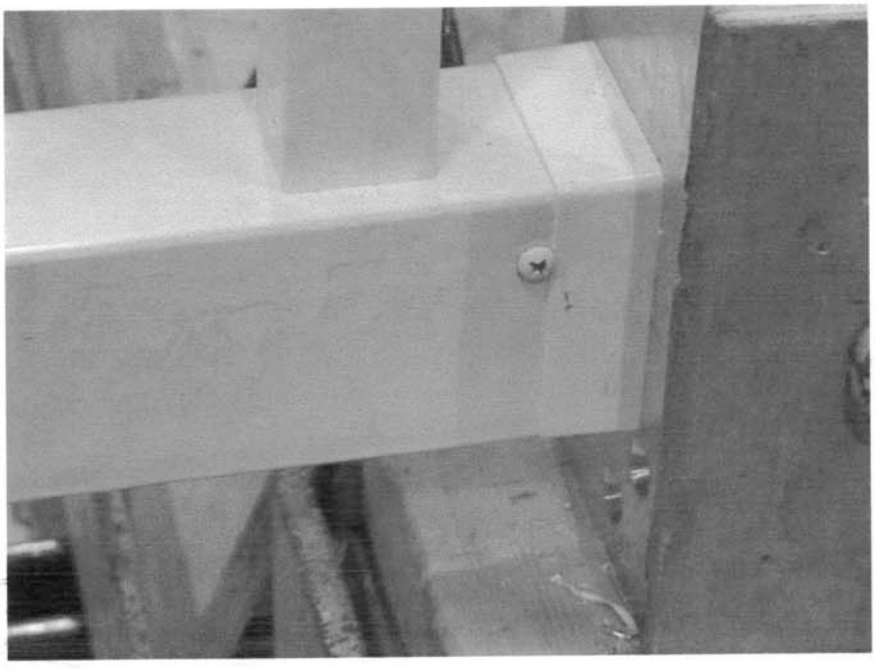


**Photo No. 6**
**Retainer Screw**