ALPHA SYSTEMS, INC.

P5100 Adhesive Test using
ASTM C 557

3/18/98

This test report contains twenty-two (22) pages, including the cover sheet. Any additions to, alterations of, or unauthorized use of excerpts from this report are expressly forbidden.

98-540
ADHESIVE TEST

1. TITLE

Standard specification for adhesives for fastening gypsum wallboard to wood framing - ASTM C 557.

2. TEST OBJECTIVE

To perform the required tests as specified in ASTM C 557 on Alpha Systems, Inc. P5100 Adhesive.

This test result pertains only to the designated adhesive sample provided for testing from Alpha Systems, Inc. Alpha Systems, Inc. is responsible for any certification, quality control or random testing of production adhesive that may be required.

3. ADHESIVE MANUFACTURER

A. Name - Alpha Systems, Inc.
B. Address - 5120 Beck Drive
              Elkhart, IN 46516

4. TESTING ORGANIZATION

Progressive Engineering, Inc.
58640 State Road 15
Goshen, IN 46528

5. TESTING PERSONNEL

Test Engineer - Evor F. Johns, P.E.
Director of Testing - Greg A. Weeden
Assistant Director of Testing - Michelle Morris

6. ADHESIVE TESTED

Alpha Systems, Inc., P5100 One-part Polyurethane Adhesive Gap Filling
7. PLYWOOD USED

3/4" Douglas Fir Plywood, Grade EXT-DFPA-AA.
1/2" Douglas Fir Plywood, Grade EXT-DFPA-AA.
1/2" Gypsum Wallboard from United States Gypsum Corp.

8. GLUING AND CURING CONDITION

A. Moisture Content: All lumber was 10% or less.
B. Gluing: As specified in test.
C. Open Time: The lumber was assembled 30 seconds after the adhesive was applied, as test standard calls out.
D. Glue Preparation: The P5100 adhesive is a ready to use adhesive.
E. Specimens Conditioned: As specified in tests.
F. Clamping Pressure: Test samples were under a load of 15 lbs. for 15 minutes.
G. Cure Time: As specified in test.

9. TEST RESULTS

The Alpha Systems, Inc. P5100 adhesive completed all tests, except test #10, as specified in the ASTM C 557. See individual pages for results.
Date: 2/9/98

Glue No. P5100

Client: Alpha Inc.

Project No. 98-540

Test Method: Condition 3/4" plywood & 1/2" gypsum at 73 deg. F. & 50% humidity for a minimum of 48 hours. Laminate gypsum & plywood with PVA adhesive and allow to cure for 24 hours. Spread adhesive on sanded surface of plywood with a trowel having 3/16" deep V-notch spaced 3/16" on center. Adhesive ridges shall be parallel with the grain of wood. Allow the adhesive to remain exposed 30 seconds from completion of spreading assembly. Immediately assemble overlapping the coated plywood exactly 2-1/2". Following assembly, compress under a load of 15lbs for fifteen minutes. Store the specimens at 73 deg.F. & 50% humidity for 24 hours.
Date: 2/9/98  
Glue Used: P5100  
TEMP: 73.4 deg. F.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Length &quot;L&quot;</th>
<th>Width &quot;W&quot;</th>
<th>Sq. In. Glue</th>
<th>Ultimate Load</th>
<th>PSI Reached</th>
<th>Percentage Gypsum Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.555 in.</td>
<td>3.923 in.</td>
<td>10.023 sq.in.</td>
<td>517</td>
<td>51.6</td>
<td>100% gypsum</td>
</tr>
<tr>
<td>2</td>
<td>2.526 in.</td>
<td>3.846 in.</td>
<td>9.715 sq.in.</td>
<td>527</td>
<td>54.2</td>
<td>100% gypsum</td>
</tr>
<tr>
<td>3</td>
<td>2.912 in.</td>
<td>3.895 in.</td>
<td>11.342 sq.in.</td>
<td>710</td>
<td>62.6</td>
<td>100% gypsum</td>
</tr>
<tr>
<td>4</td>
<td>2.651 in.</td>
<td>3.893 in.</td>
<td>10.320 sq.in.</td>
<td>545</td>
<td>52.8</td>
<td>100% gypsum</td>
</tr>
<tr>
<td>5</td>
<td>2.259 in.</td>
<td>3.883 in.</td>
<td>8.772 sq.in.</td>
<td>610</td>
<td>69.5</td>
<td>100% gypsum</td>
</tr>
</tbody>
</table>

Average 58.2 psi
PROGRESSIVE ENGINEERING, Inc.

ASTM C 557 - TEST #2
14 DAY SHEAR

Date: 2/24/96
Glue No. P5100
Client: Alpha Inc.
Project No. 98-540

Test Method: Condition 3/4" plywood & 1/2" gypsum at 73 deg. F. & 50% humidity for a minimum of 48 hours. Laminate gypsum & plywood with PVA adhesive and allow to cure for 24 hours. Spread adhesive on sanded surface of plywood with a trowel having 3/16" deep V-notch spaced 3/16" on center. Adhesive ridges shall be parallel with the grain of wood. Allow the adhesive to remain exposed 30 seconds from completion of spreading assembly. Immediately assemble overlapping the coated plywood exactly 2-1/2". Following assembly, compress under a load of 15lbs for fifteen minutes. Store the specimens at 73 deg.F. & 50% humidity for 14 days.
Date: 2/24/98
Glue Used: P5100
TEMP: 73.4 deg. F.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Length &quot;L&quot;</th>
<th>Width &quot;W&quot;</th>
<th>Sq. In. Glue</th>
<th>Ultimate Load</th>
<th>PSI Reached</th>
<th>Percentage Gypsum Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.701 in.</td>
<td>3.974 in.</td>
<td>10.734 sq.in.</td>
<td>920</td>
<td>85.7</td>
<td>100 %</td>
</tr>
<tr>
<td>2</td>
<td>2.670 in.</td>
<td>3.981 in.</td>
<td>10.629 sq.in.</td>
<td>474</td>
<td>44.6</td>
<td>100 %</td>
</tr>
<tr>
<td>3</td>
<td>2.515 in.</td>
<td>3.970 in.</td>
<td>9.985 sq.in.</td>
<td>394</td>
<td>39.5</td>
<td>100 %</td>
</tr>
<tr>
<td>4</td>
<td>2.692 in.</td>
<td>3.948 in.</td>
<td>10.628 sq.in.</td>
<td>612</td>
<td>57.6</td>
<td>100 %</td>
</tr>
<tr>
<td>5</td>
<td>2.638 in.</td>
<td>3.915 in.</td>
<td>10.328 sq.in.</td>
<td>484</td>
<td>46.9</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Average 54.8 psi
PROGRESSIVE ENGINEERING, Inc.

ASTM C 557 - TEST #3
24 HR. TENSILE TEST

Date: 2/11/98

Glue No. P5100

Client: Alpha Inc.

Project No. 98-540

Test Method: Condition 1/2" gypsum & 2x2x3-5/8" blocks at 73 deg. F. & 50% humidity for a minimum of 48 hours. Prepare specimens by drilling a hole in the center of one end of block and insert an eye hook. Bond the back side of a 4x4 piece of gypsum wallboard to block with excessive amount of adhesive on end. Compress each specimen under a load of 15lb and scrape away all excess adhesive. Condition specimens at 73 deg. F. & 50% humidity for 24 hours.
Date: 2/23/98
Glue No. P5100
Client: Alpha Inc.
Project No. 98-540

Test Method: Condition 1/2" plywood & 2x2x3-5/8" blocks at 73 deg. F. & 50% humidity for a minimum of 48 hours. Prepare specimens by drilling a hole in the center of one end of block and insert an eye hook. Bond the back side of a 4x4 piece of gypsum wallboard to block with excessive amount of adhesive on end. Compress each specimen under a load of 15lb and scrape away all excess adhesive. Condition specimens at 73 deg. F. & 50% humidity for 14 days.
Date: 2/11/98
Glue Used: P5100
TEMP: 73.4 deg. F.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Length &quot;L&quot;</th>
<th>Width &quot;W&quot;</th>
<th>Sq. In. Glue</th>
<th>Ultimate Load</th>
<th>PSI Reached</th>
<th>Percentage Gypsum Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.553 in.</td>
<td>1.485 in.</td>
<td>2.306 sq.in.</td>
<td>189</td>
<td>82.0</td>
<td>100 %</td>
</tr>
<tr>
<td>2</td>
<td>1.553 in.</td>
<td>1.478 in.</td>
<td>2.295 sq.in.</td>
<td>107</td>
<td>46.6</td>
<td>100 %</td>
</tr>
<tr>
<td>3</td>
<td>1.569 in.</td>
<td>1.476 in.</td>
<td>2.316 sq.in.</td>
<td>165</td>
<td>71.2</td>
<td>100 %</td>
</tr>
<tr>
<td>4</td>
<td>1.559 in.</td>
<td>1.479 in.</td>
<td>2.306 sq.in.</td>
<td>133</td>
<td>57.7</td>
<td>100 %</td>
</tr>
<tr>
<td>5</td>
<td>1.576 in.</td>
<td>1.473 in.</td>
<td>2.321 sq.in.</td>
<td>177</td>
<td>76.2</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Average: **66.7 psi**
Date: 2/23/98  
Glue Used: P5100  
TEMP: 73.4 deg. F.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Length &quot;L&quot;</th>
<th>Width &quot;W&quot;</th>
<th>Sq. In. Glue</th>
<th>Ultimate Load</th>
<th>PSI Reached</th>
<th>Percentage Gypsum Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.472 in.</td>
<td>1.515 in.</td>
<td>2.230 sq.in.</td>
<td>144</td>
<td>64.6</td>
<td>100 %</td>
</tr>
<tr>
<td>2</td>
<td>1.458 in.</td>
<td>1.519 in.</td>
<td>2.215 sq.in.</td>
<td>128</td>
<td>57.8</td>
<td>100 %</td>
</tr>
<tr>
<td>3</td>
<td>1.448 in.</td>
<td>1.519 in.</td>
<td>2.200 sq.in.</td>
<td>149</td>
<td>67.7</td>
<td>100 %</td>
</tr>
<tr>
<td>4</td>
<td>1.442 in.</td>
<td>1.519 in.</td>
<td>2.190 sq.in.</td>
<td>109</td>
<td>49.8</td>
<td>100 %</td>
</tr>
<tr>
<td>5</td>
<td>1.446 in.</td>
<td>1.516 in.</td>
<td>2.192 sq.in.</td>
<td>99</td>
<td>45.2</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Average: 57.0 psi
ASTM C 557 - TEST #5
WETTING CHARACTERISTICS

Date: 2/10/98
Glue No. P5100
Client: Alpha Inc.
Project No. 98-540

Test Method: Use Douglas Fir plywood which has been conditioned for 48 hours at 73 deg.F. and 50% humidity. Place a small amount of adhesive upon a spatula and press on the conditioned piece of Douglas Fir plywood. Then reverse the pressure of the spatula from the surface and record failure as adhesion or cohesion.

Failure in: Cohesion
Date: 2/10/98

Glue No. P5100

Client: Alpha Inc.

Project No. 98-540

Test Method: A 3/8"x3/8" bead of adhesive was placed on a surface of 4"x4" gypsum that had been conditioned for 24 hours at 73 deg. F. & 50% humidity and left open for 15 minutes (manufacture recommended). After the 15 minutes place a 2"x2" piece of gypsum on bead and load a 5lb. weight for 30 minutes. Cure time for 24 hours and pull apart.

Result: 100% Gypsum paper failure.
Date: 3/9/98
Glue No. P5100
Client: Alpha Inc.
Project No. 98-540

Test Method: Condition 3/4" plywood & 1/2" gypsum at 73 deg. F. & 50% humidity for a minimum of 48 hours. Laminate gypsum & plywood with PVA adhesive and allow to cure for 24 hours. Spread adhesive on sanded surface of plywood with a trowel having 3/16" deep V-notch spaced 3/16" on center with adhesive ridges shall be parallel with the grain of wood. Allow the adhesive to remain exposed 30 seconds from completion of spreading assembly immediately overlapping the coated plywood exactly 2-1/2". Following assembly compress under a load of 15lb for fifteen minutes. Store the specimens at 73 deg. F. & 50% humidity for 14 days, then cycle as shown in table.

CYCLE TABLE

4 Hours @ 140deg. F. & 85% humidity
4 Hours @ 32deg. F. & 90% humidity
16 Hours @ 140deg. F. & uncontrolled humidity
6 Hours @ 140deg. F. & 85% humidity
18 Hours @ 140deg. F. & uncontrolled humidity

Store at 73deg. F. & 50% humidity until test
Date: 3/9/98
Glue Used: P5100
TEMP: 73.4 deg. F.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Length &quot;L&quot;</th>
<th>Width &quot;W&quot;</th>
<th>Sq. In. Glue</th>
<th>Ultimate Load</th>
<th>PSI Reached</th>
<th>Percentage Gypsum Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.534 in.</td>
<td>3.945 in.</td>
<td>9.997 sq.in.</td>
<td>416</td>
<td>41.6</td>
<td>100 %</td>
</tr>
<tr>
<td>2</td>
<td>2.667 in.</td>
<td>3.872 in.</td>
<td>10.327 sq.in.</td>
<td>534</td>
<td>51.7</td>
<td>100 %</td>
</tr>
<tr>
<td>3</td>
<td>2.509 in.</td>
<td>3.920 in.</td>
<td>9.835 sq.in.</td>
<td>572</td>
<td>58.2</td>
<td>100 %</td>
</tr>
<tr>
<td>4</td>
<td>2.586 in.</td>
<td>3.921 in.</td>
<td>10.140 sq.in.</td>
<td>512</td>
<td>50.5</td>
<td>100 %</td>
</tr>
<tr>
<td>5</td>
<td>2.531 in.</td>
<td>3.924 in.</td>
<td>9.932 sq.in.</td>
<td>572</td>
<td>57.6</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Average 51.9 psi
Date: 3/2/98
Glue No. P5100
Client: Alpha Inc.
Project No. 98-540

Test Method: Construct a test frame, 34"x48"lg. of Douglas fir lumber. Nail a stud centered between the two outer studs, but recessed 1/4". Condition assembly at 73 deg.F. & 50% humidity for 24 hours. Apply a 3/8"x3/8" bead of adhesive to the center recessed stud. After 15 min., nail 1/2" gypsum wallboard, 34"x42"lg. to the outside longitudinal studs using 10-in. nail spacing. Firmly press the wallboard over the centered recessed stud to ensure maximum deflection of the wallboard against the recessed stud. Condition the test panel for 48 hours at 73 deg.F. & 50% humidity. To test, remove nails from outside studs, grasp one edge of the wallboard at points adjacent to each side of the displaced stud and pull outwardly at 90 deg. to the stud.

Result: 100% CORE FAILURE
Date: 3/4/98

Glue No. P5100

Client: Alpha Inc.

Project No. 98-540

Test Method: Condition ten specimens for 14 days at 73.4 deg. F. & 50% humidity. Static loads in shear shall be 40lbf total at 73.4deg. F. and remain on five specimens without failure for 24 hours. Five specimens shall have 20lb total at 100deg. F. and remain on specimens without failure for 24 hours.

Result: 40lb at 73.4 deg. F. - Held for 24 hours without failure

20lb at 100 deg. F. - Held for 24 hours without failure
Date: 2/9/98

Glue No. P5100

Client: Alpha Inc.

Project No. 98-540

Test Method: The test specimen shall consist of a 1x4x15mil. dry adhesive strip deposited on a 2x6x.032" thk. strip of aluminum. Maintain the test specimen at 158deg. F. for 500 hours. Upon completion of exposure allow specimen to cool at room temp. for 1 hour. Slowly bend the specimen around a 1/4" steel mandrel with the adhesive side out.

Result: Test sample can not be formed in this nature as called out in standard using a urethane adhesive. Therefore this test could not be performed.
Date: 3/2/98

Glue No. P5100

Client: Alpha Inc.

Project No. 98-540

Test Method: Place 4oz. of material in an 8oz. can and cycle specimen at 0(zero)deg. F. for 24 hours and then at 73deg. F. for 24 hours. After three complete cycles glue up using the same procedure as 24 hour shear strength test.
Date: 3/2/98
Glue Used: P5100
TEMP: 73.4 deg. F.

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Length &quot;L&quot;</th>
<th>Width &quot;W&quot;</th>
<th>Sq. In. Glue</th>
<th>Ultimate Load</th>
<th>PSI Reached</th>
<th>Percentage Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.454 in.</td>
<td>3.973 in.</td>
<td>9.750 sq.in.</td>
<td>644</td>
<td>66.1</td>
<td>100 %</td>
</tr>
<tr>
<td>2</td>
<td>2.442 in.</td>
<td>3.975 in.</td>
<td>9.707 sq.in.</td>
<td>610</td>
<td>62.8</td>
<td>100 %</td>
</tr>
<tr>
<td>3</td>
<td>2.596 in.</td>
<td>3.951 in.</td>
<td>10.257 sq.in.</td>
<td>578</td>
<td>56.4</td>
<td>100 %</td>
</tr>
<tr>
<td>4</td>
<td>2.667 in.</td>
<td>3.931 in.</td>
<td>10.484 sq.in.</td>
<td>610</td>
<td>58.2</td>
<td>100 %</td>
</tr>
<tr>
<td>5</td>
<td>2.514 in.</td>
<td>3.986 in.</td>
<td>10.021 sq.in.</td>
<td>732</td>
<td>73.0</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Average 63.3 psi
PROGRESSIVE ENGINEERING, Inc.
ASTM C 557 - TEST #12
VINYL-COVERED GYPSUM BOARD COMPATIBILITY

Date: 3/2/98
Glue No. P5100
Client: Alpha Inc.
Project No. 98-540

Test Method: Place 6oz. of adhesive in an 16oz. tin-lined can and place into a gallon container. Place a piece of vinyl-covered gypsum board facing up and seal with vapor impermeable duct tape. Put the assembly into an oven at 110deg. F. for 24 hours.

Result: No discoloration after 10 days
Date:  3/18/98

Glue No.  P5100

Client:  Alpha Inc.

Project No.  98-540

Test Method:  Apply two dabs of adhesive approximately 2" in diameter to the face surface of vinyl-covered gypsum board in two areas. After 1 hour of application of adhesive to the vinyl surface, clean both areas with manufacturer's recommended Acetone.

Result:  No discoloration of vinyl