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CHEMISTRY AND CHEMICAL ENGINEERING

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FIRE PERFORMANCE EVALUATION OF WIEHAG CONNECTION HARDWARE LOADED BEAM-TO-COLUMN CONNECTION WITH A CLT PANEL FLOOR, TESTED IN GENERAL ACCORDANCE WITH ASTM E119-24, *STANDARD TEST METHODS FOR FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS*

FINAL REPORT
Consisting of 22 Pages

SwRI® Project No. 01.29393.01.001b
Test Date: April 22, 2025
Report Date: July 3, 2025

Prepared for:

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1.0 OBJECTIVE

The objective of the test described in this report was to determine the fire resistance of a beam-to-column connection assembly in general accordance with ASTM E119-24, *Standard Test Methods for Fire Tests of Building Construction and Materials*, for The Neutral Project LLC, located in Madison, Wisconsin . Testing is considered in general accordance because ASTM E119 does not address beam-to-column connections. Testing was conducted by Southwest Research Institute's® (SwRI®) Fire Technology Department, located in San Antonio, Texas. The assembly was identified by The Neutral Project LLC as *Wiehag Connection Hardware Beam-to-Column Connection Assembly*.

2.0 TEST METHOD

The ASTM E119 test method is intended to evaluate the duration for which a building element will contain a fire, or retain its structural integrity, or display both properties dependent upon the type of building element involved, during a predetermined fire exposure time. The test exposes a specimen to a standard fire controlled to achieve specified temperatures throughout a specified period. When required, the fire exposure is followed by the application of a specified standard fire hose stream applied in accordance with ASTM E2226, *Standard Practice for Application of Hose Stream*.

Testing under this project is in general accordance with ASTM E119. The testing is considered in general accordance due to ASTM E119 not addressing beam-to-column connections. As such, there are no temperature requirements of the assembly and all thermocouples (TCs) used to measure the assembly are engineering TCs, which are used for engineering purposes only. However, the furnace curve requirement was maintained in accordance with ASTM E119 standard.

The ASTM E119 standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled laboratory conditions but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions.

This report describes the test results obtained for a beam-to-column connection. The performance of the assembly is expressed in terms of the assembly's ability to maintain a load during the standard fire exposure. The results presented in this report apply specifically to the materials tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when used in combination with other materials.

3.0 TEST ASSEMBLY

The *Wiehag Connection Hardware Beam-to-Column Connection Assembly* consisted of a glulam beam, glulam column, and a cross-laminated timber (CLT) floor and connected using Wiehag hardware. All of the materials were provided by The Neutral Project LLC, and received by SwRI on April 10, 2025. The materials used in the construction of the connection assembly are described in Table 1.

Table 1. Material Description.

Material	Provided By	Received On
Steel Connectors: One set (male and female) *Self-Made Wiehag Connector*, 7.48 × 27.48 in.	The Neutral Project LLC	April 10, 2025
Glulam Loaded Beam: 20.47 × 14.17 × 96 in., Manufactured by Wiehag.	The Neutral Project LLC	April 10, 2025
Glulam Column: 20.47 × 14.19 × 96 in., Manufactured by Wiehag.	The Neutral Project LLC	April 10, 2025
CLT Floor Panel/7 Ply: 78.75 × 73 × 9.5 in., Manufactured by Stora Enso.	The Neutral Project LLC	April 10, 2025
Structural Screws for CLT to Beam (12-in. SDWS screws)	The Neutral Project LLC	April 10, 2025
Structural Screws for CLT Spline (DSWS .22 × 12 in.)	The Neutral Project LLC	April 10, 2025
Rothoblaas Graphite Fire Strips (25 mm)	The Neutral Project LLC	April 10, 2025
Metacaulk 150+ Firestop Sealant for column to CLT seams	SwRI	N/A
⅝-in. Type X Gypsum and Ceramic Fiber Insulation	SwRI	N/A

3.1 Sample Description

The assembly consisted of a Glulam Column that measured 20.47 × 14.17 in. (W ×D) with the male portion of the *Self-Made Wiehag Connector* preinstalled by Wiehag, a loaded beam that measure 20.47 × 14.19 in. (W ×D) with the female portion of the *Self-Made Wiehag Connector* preinstalled.

The column also had one Rothoblass Graphite Fire strip installed on the beam-to-column interface. The strip was a single run that filled the cut-out on the sides and bottom. The strip adhered to the wood in a section that was routed out for a flush fit on the beam-to-column interface.

CD Smith personnel started the construction of the beam-to-column assembly by installing the beam onto the column. First the column was placed on the test frame, then the beam was installed into the column by sliding the beam onto *Self-Made Wiehag Connector*. The average gap between the beam-to-column was ⅛ in. on the sides and bottom. Once the beam-to-column connection was complete, the CLT panels were then installed. The CLT panels consisted of two panels with one half-lap joint. The half-lap joint was installed by first placing the larger section of CLT onto the beam and

securing it to the beam using 12-in. SDW screws installed 12 in. on center. The two sections of CLT are then fastened with 6.25-in. SDCP Timber-CP screws fastened 3 in. on center. The column was insulated with two layers of a ⅝-in. Type X gypsum and two layers of ceramic insulation blanket starting 12 in. below the beam to improve furnace control. Two layers of ⅝-in. Type X gypsum was also added to the underside of the CLT floor connection area, approximately 1 ft in width so that the half lap joint was covered. Any slots or holes left were filled with ceramic insulation, and a bead of Metacaulk Firestop Sealant was used to prevent flame through on the column and floor connection.

SwRI used a steel self-reacting load frame that supported the base of the column on one end inside the furnace and the loaded beam on the other end outside of the furnace. The portion of the load frame that was inside the furnace was insulated and water-cooled to protect the load frame from the heat exposure. The load was applied with a servo-controlled hydraulic actuator attached to the upper load frame beam. The load output was calibrated to input pressure values prior to the test, and pressure was monitored to maintain the target load during testing. A string potentiometer was used to measure the deflection of the test assembly during the test. An additional jack was placed on the underside of the beam outside of the furnace to allow for the beam to stay level as it deflected.

For application of the load, a 12 × 12 × 1-in. steel plate was positioned on the top of the CLT panel located directly over the loaded beam and the load was applied to the steel plate.

Additional information pertaining to the construction of the samples and the materials included in the assemblies is provided in Appendix A. Selected photographs are provided in Appendix B. A list of calibrated equipment used is provided in Appendix D.

4.0 INSTRUMENTATION

The Client provided the test item, TC locations, and drilled the holes in the wood members for installation of ⅛-in. Inconel sheathed, Type K grounded junction TCs. The Inconel sheathed TCs were used for engineering purposes only as ASTM E119 does not address beam-to-column connections. Once the TC locations were prepared, SwRI inserted the TCs in the drilled holes until they made contact with the wood temperature measurement locations. Figure 1 shows the TC locations as provided for by the Client. Four additional ASTM E119 furnace temperature probes were used to record the furnace temperature. The probes were positioned 12 in. from the exposed face of the beam and at the bottom of the beam elevation. A computer-based data acquisition system was used to record the applied load, displacement, and temperature measurements.

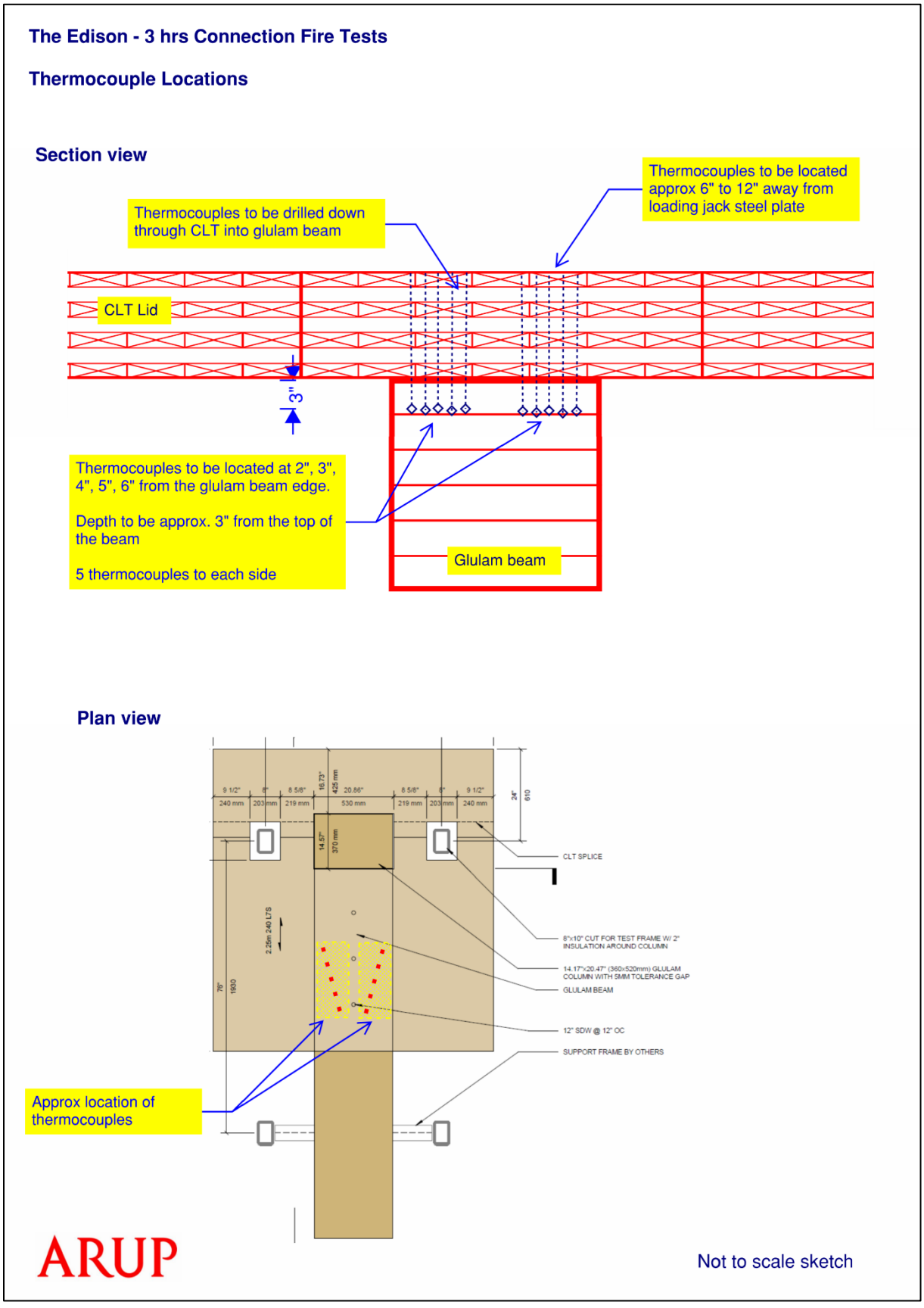

Figure 1. Client-Provided TC Locations

5.0 TEST RESULTS

Test Date: April 18, 2025

Test Witnesses: Messrs. Karl Rend and Nathan Van Buren, representing CD Smith; David Barber, representing ARUP

Ambient Temperature: 73.8 °F

Relative Humidity: 85%

Instrumentation: 10 Engineering TCs were installed at varying locations according to The Neutral Project LLC drawings. (See Figure 1 for Thermocouple Details)

Load: 18,000 lb applied to the beam

Moisture Content: 10.0%

Observations: Refer to Table 2.

Table 2. Fire Resistance Test Visual Observations.

Time (h:min:s)	Observations
Pretest	Pretest application of the 18,000 lb load resulted in 0.168 in. deflection.
0:00:00	Start of test, furnace ignited, and data acquisition initiated. (8:32am) deflection now at 0.176 in.
0:01:16	Ignition of sample.
0:03:20	More of sample ignites, causing furnace temperature and pressure spike.
0:04:00	Some smoking out of assembly.
0:04:30	Two furnace burners off.
0:07:10	All furnace burners off, furnace temperature being driven by sample combustion.
0:15:00	Deflection at 0.201 in.
0:17:00	Furnace gas supply reintroduced via single burner.
0:19:30	Furnace gas supply reintroduced via second furnace burner.
0:30:00	0.211-in. deflection. No visible change.
0:45:00	0.214-in. deflection. No visible change.
1:00:00	0.219-in. deflection.
1:04:00	Beam leveled.
1:15:00	0.236-in. deflection. No visible change.
1:24:00	Beam leveled.
1:30:00	0.294-in. deflection.
1:33:34	Deflection string potentiometer physically disturbed.
1:36:33	Deflection string potentiometer back in place.
1:45:00	0.294-in. deflection.
2:00:00	0.294-in. deflection.
2:07:30	Furnace gas turned off; furnace temperature being driven by sample combustion.
2:15:00	0.294-in. deflection.
2:30:00	0.297-in. deflection.
2:45:00	0.304-in. deflection.
3:00:00	Test ended, furnace off, 0.319-in. deflection.
Posttest	A chainsaw was used to cut the beam to take posttest measurements of wood remaining. Refer to Table 3 for posttest measurements.

Table 3. Posttest Measurements.

Test Items	Measurements
Beam Original Dimensions	20.47 × 14.17 in.
Posttest Beam Measurements	10.25 × 9.5 in.

Hose Stream Test: Not Conducted

Duration: 180 min

Results: The acquired data is located in Appendix C in graphical form.

6.0 CONCLUSION

Based on the test results, the glulam loaded beam-to-column connection, and a CLT panel floor assembly constructed as described in this report, endured the fire-endurance test throughout the 180 min duration while maintaining the required load when tested in general accordance with ASTM E119.

APPENDIX A

CLIENT-PROVIDED DRAWING

(CONSISTING OF 1 PAGE)

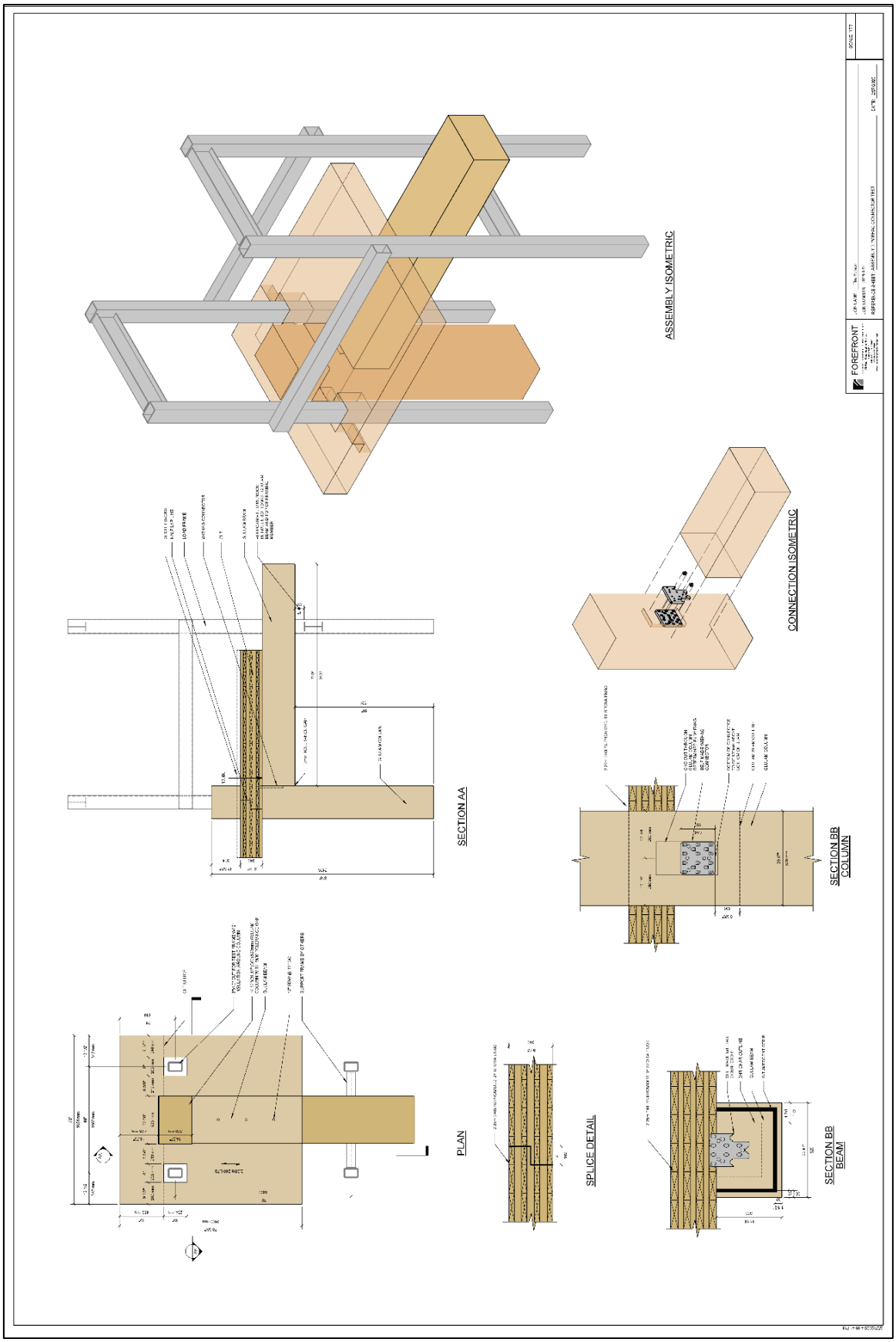

Figure A-1. Client-Provided Drawing Assembly.

APPENDIX B

TEST PHOTOGRAPHS

(CONSISTING OF 6 PAGES)

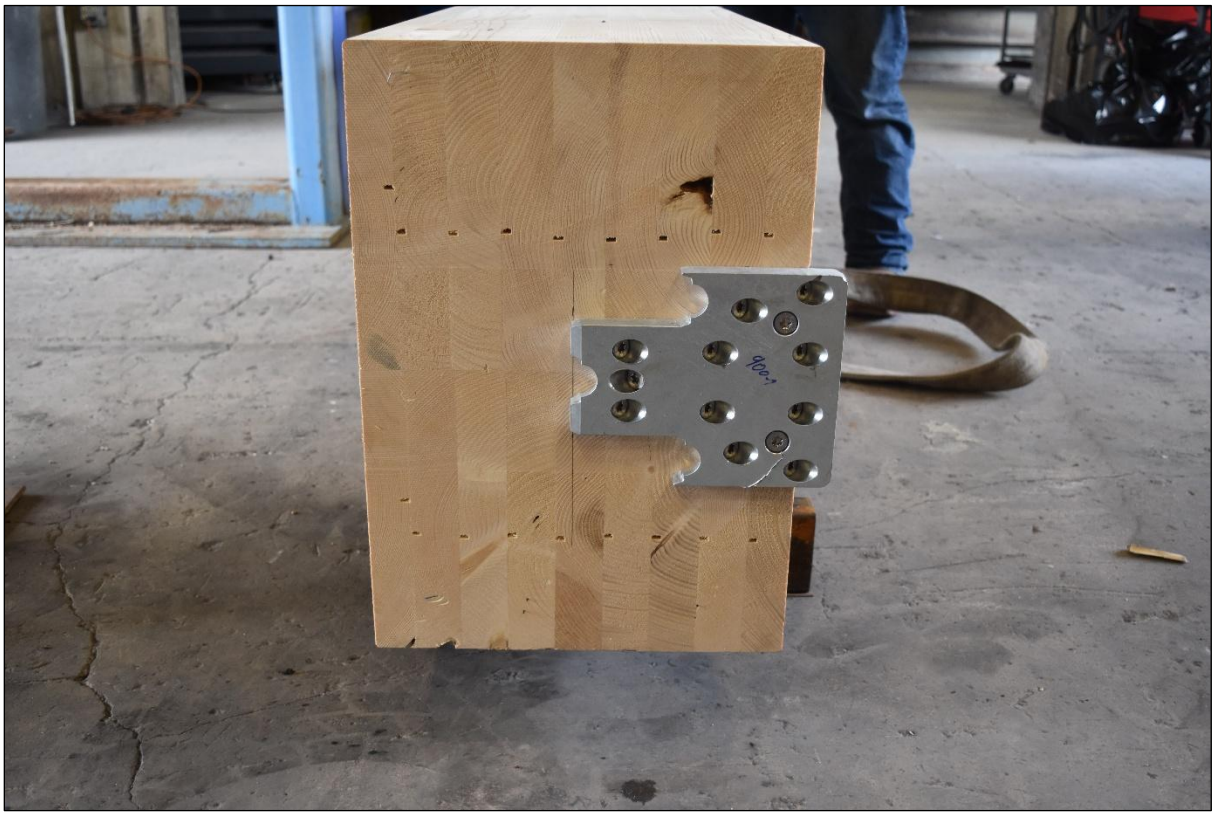

Figure B-1. Beam with Female *Self-Made Wiehag Connector*.

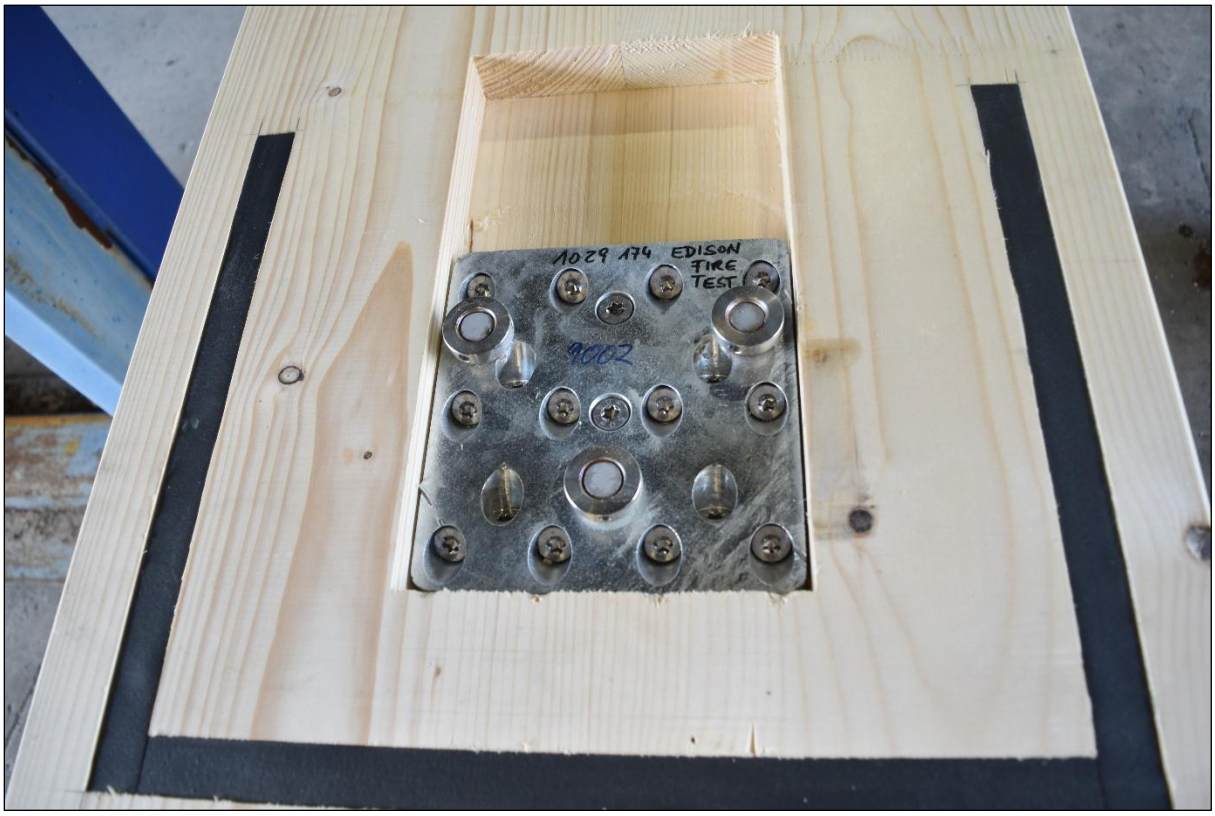

Figure B-2. Column with Male *Self-Made Wiehag Connector*.

Figure B-3. Beam and Column, and CLT Panel Installed in Frame.

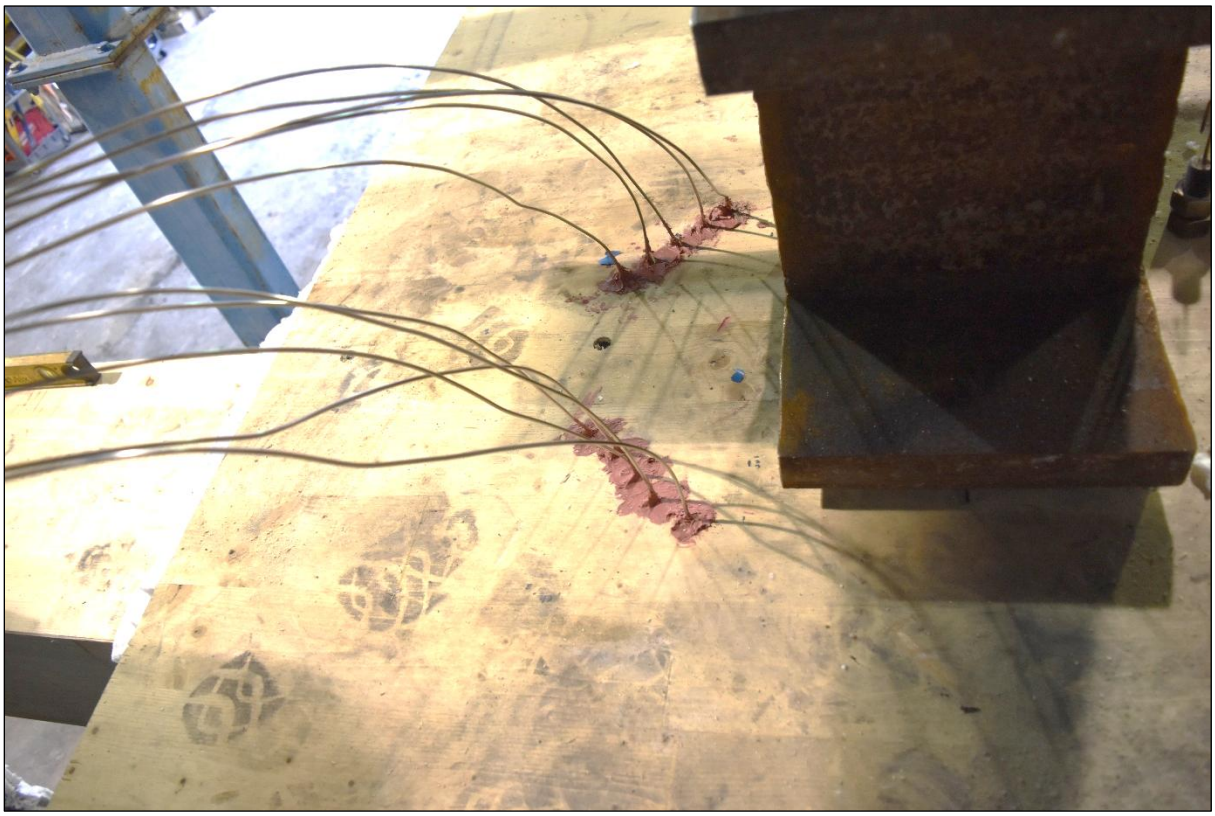

Figure B-4. TCs Installed into Top of CLT Panel.

Figure B-5. View of Assembly prior to Testing.

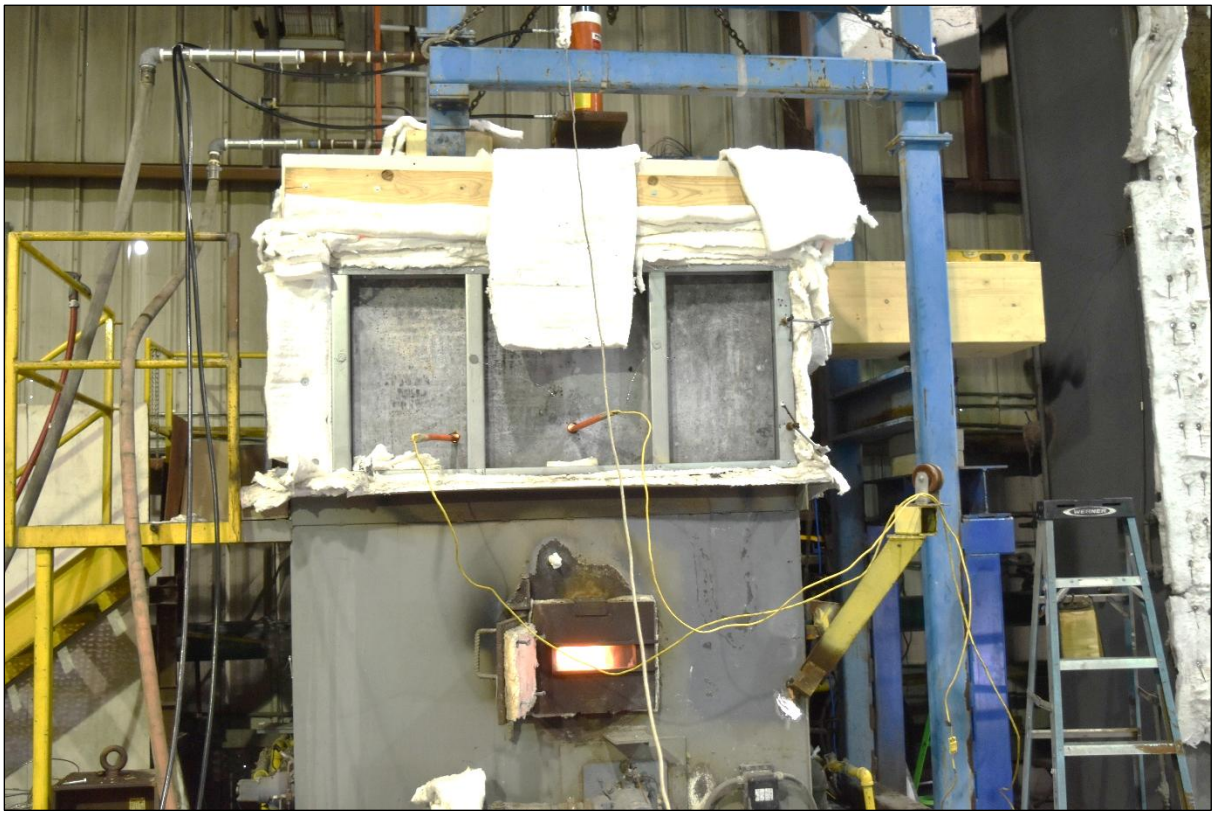

Figure B-6. View of Assembly at End of Test.

Figure B-7. View of Assembly during Removal from Furnace.

Figure B-8. View of Assembly after Cool-Down.

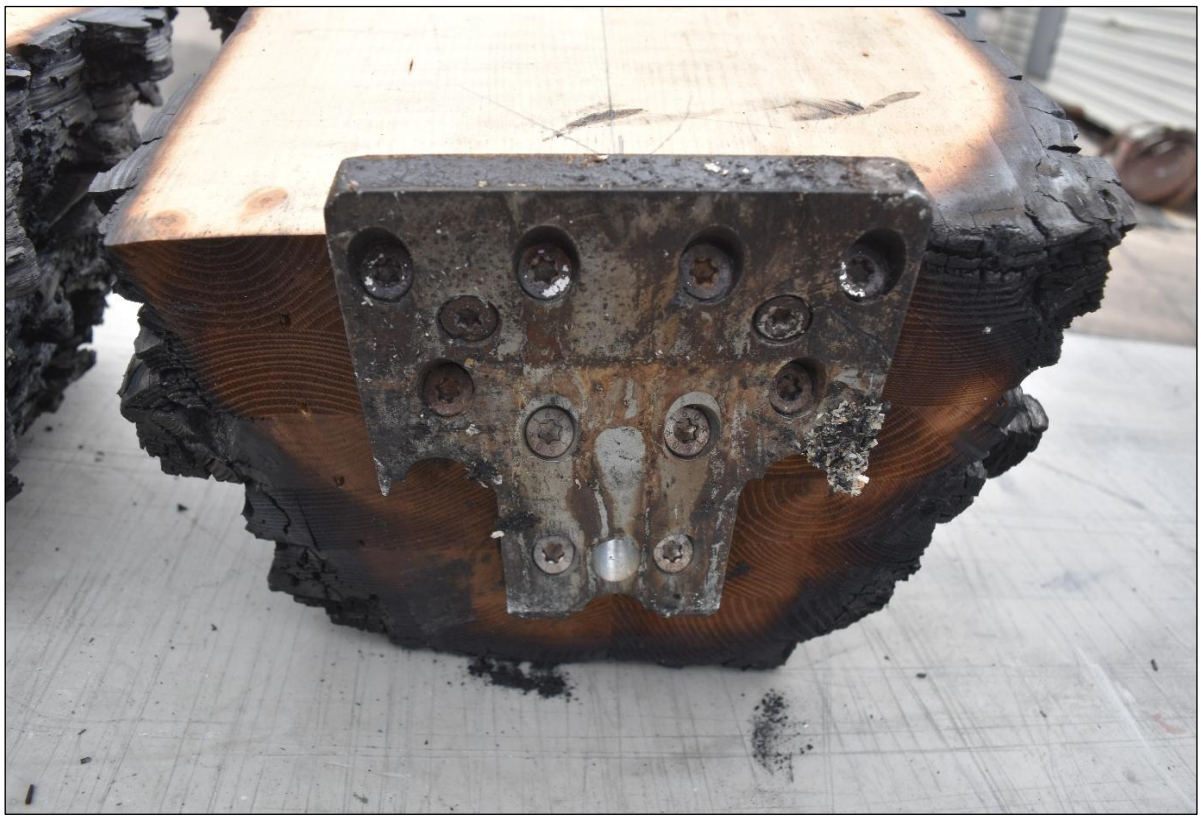

Figure B-9. Beam with Female *Self-Made Wiehag Connector,* Posttest.

Figure B-10. Column with Male *Self-Made Wiehag Connector,* Posttest.

Figure B-11. View of Beam Cut 12 in. from End of Beam, Exposed 10.25 in. of Good Wood.

Figure B-12. View of Beam Cut 12 in. from End of Beam, Exposed 9.5 in. of Good Wood.

APPENDIX C

GRAPHICAL TEST DATA

(CONSISTING OF 3 PAGES)

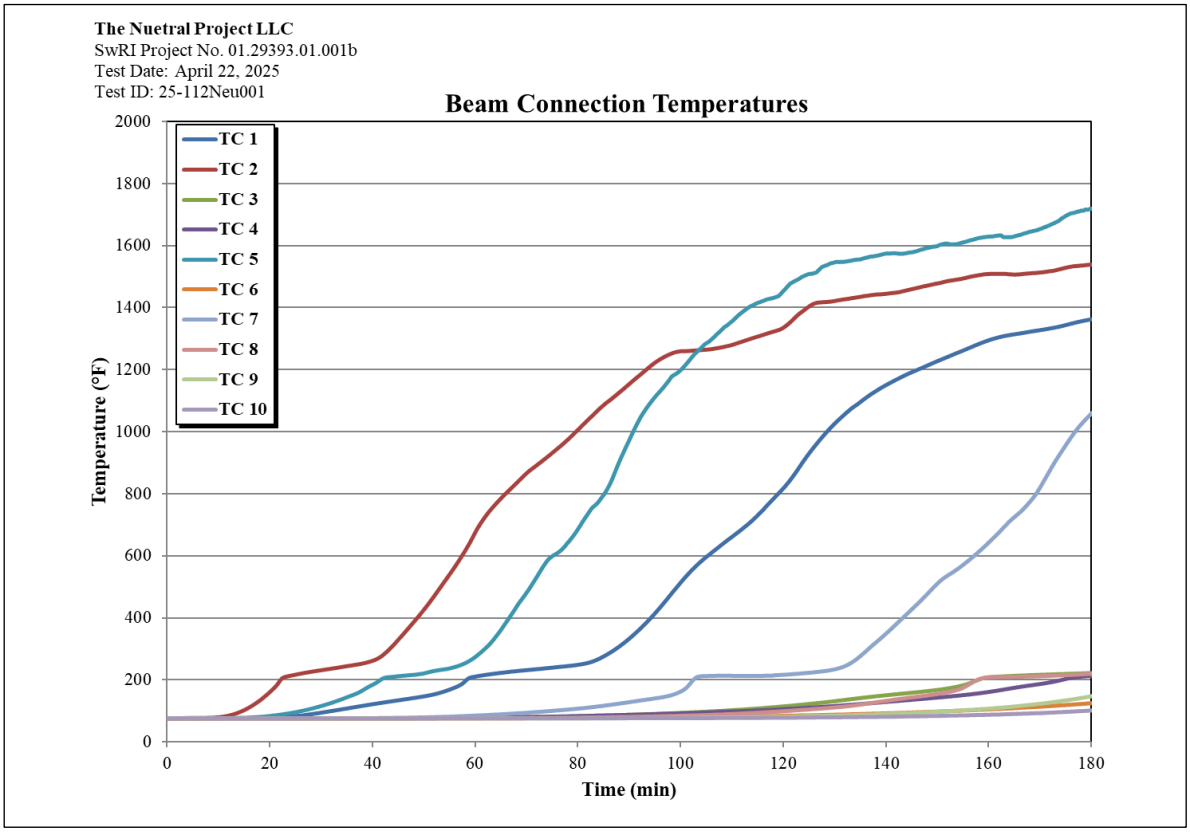

Figure C-1. Beam Temperatures vs. Time.

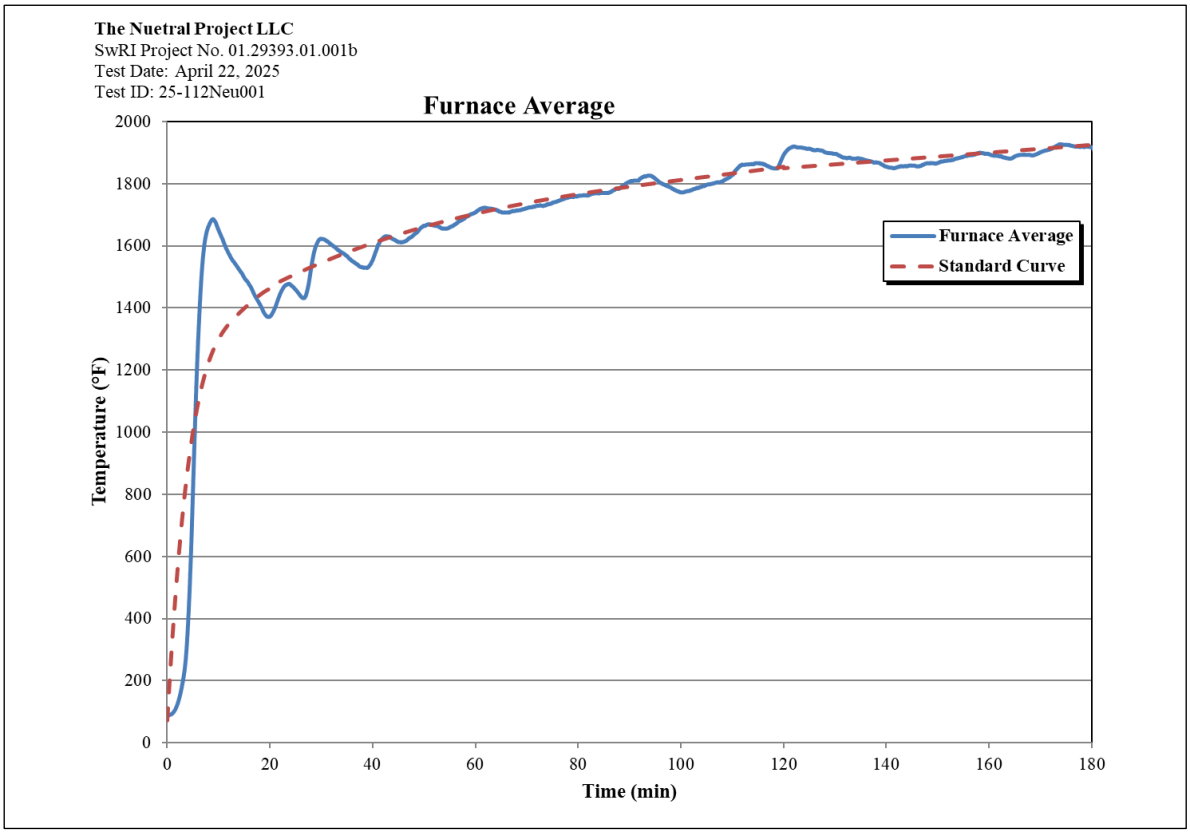

Figure C-2. Furnace Temperatures vs. Time.

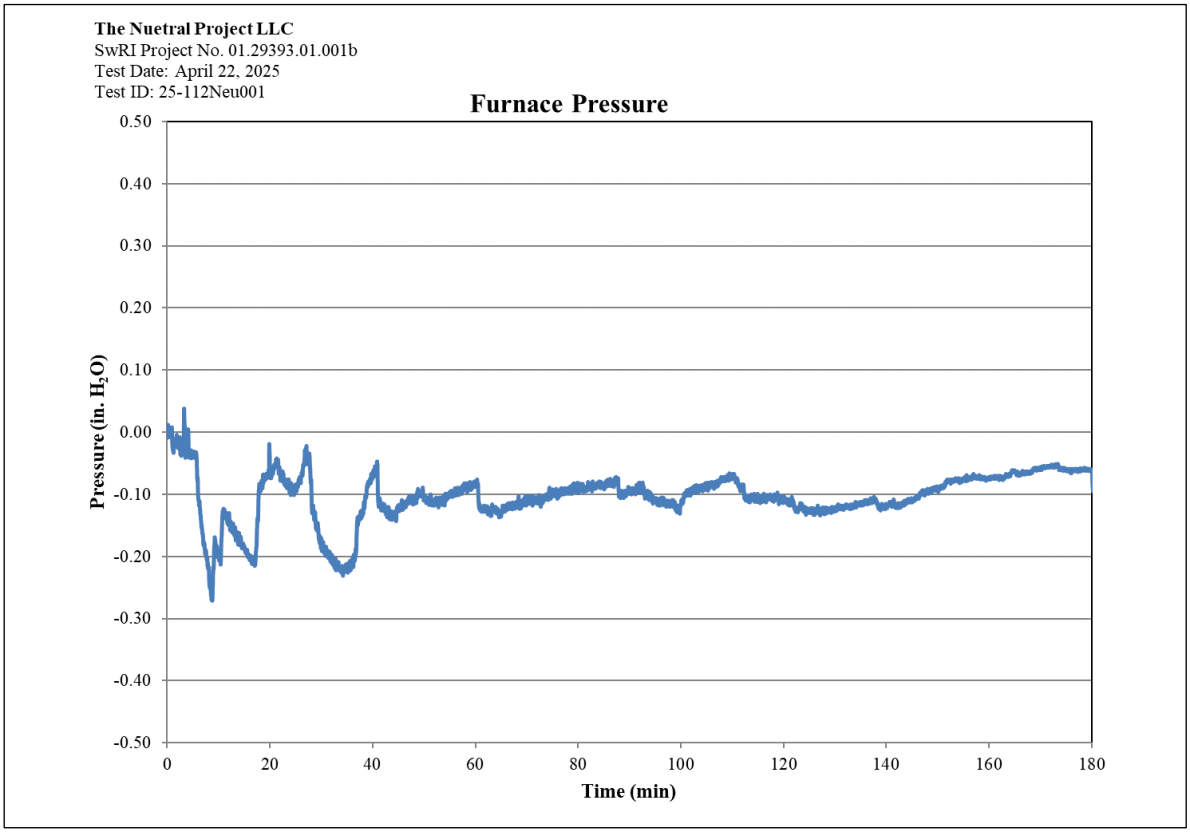

Figure C-3. Furnace Pressure vs. Time.

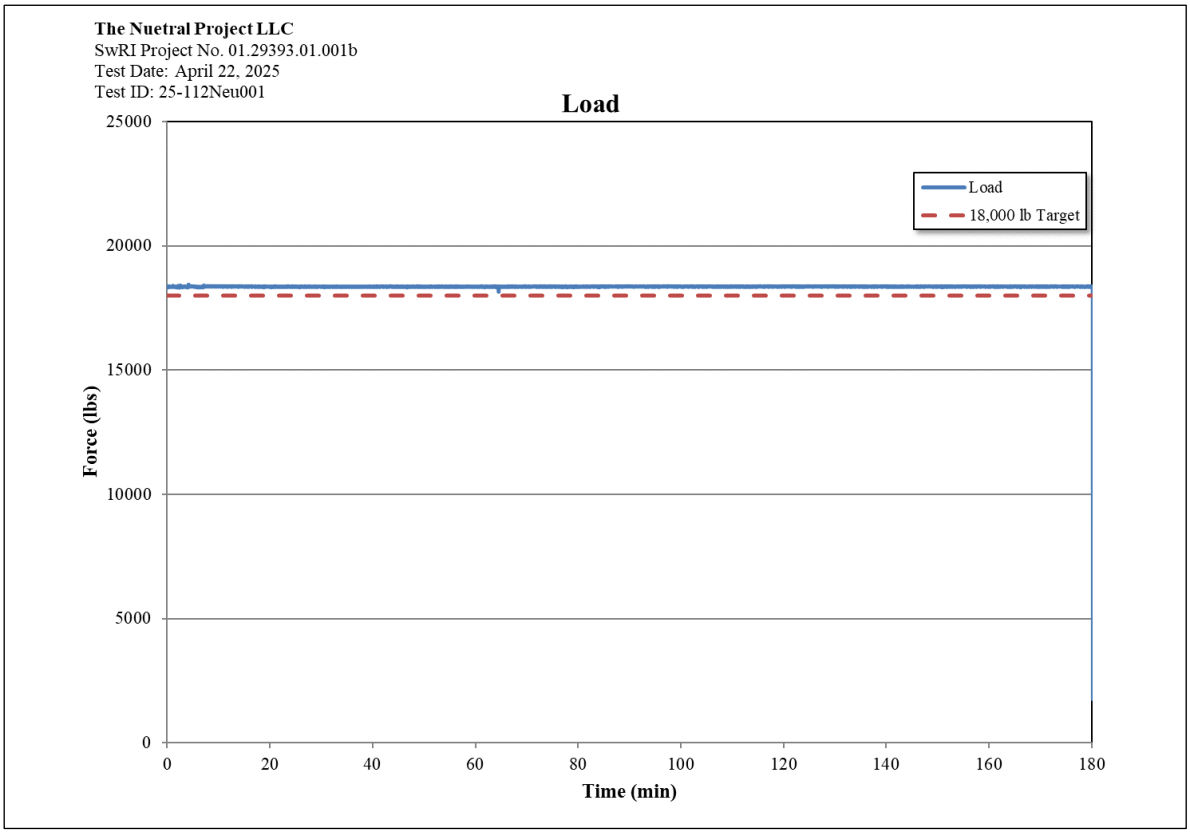

Figure C-4. Beam Load vs. Time.

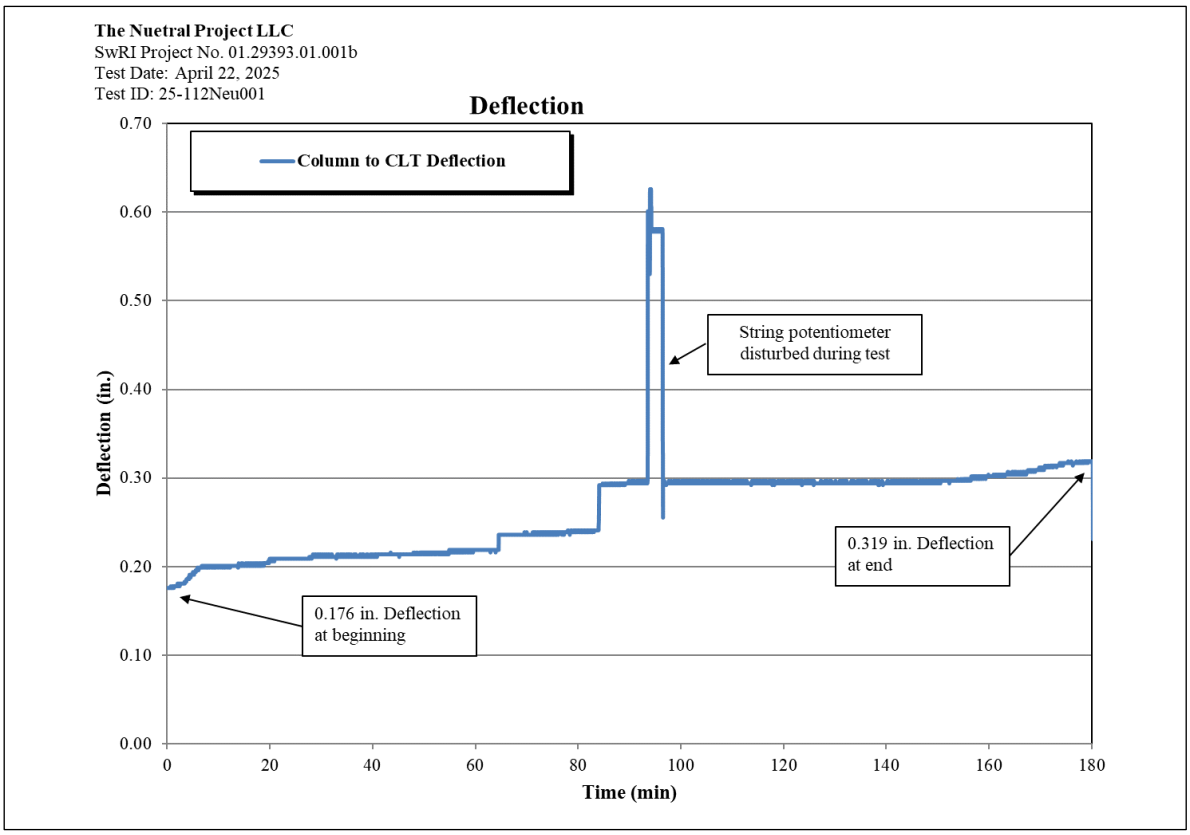

Figure C-5. Beam Deflection vs. Time.

APPENDIX D

EQUIPMENT CALIBRATION DOCUMENTATION

(CONSISTING OF 1 PAGE)

Table D-1. Equipment Calibration Documentation.

Item	Make	Model	Serial No.	Cal Due
Input Module	Yokogawa	DU100-11	27DC37922	Feb 20, 2026
Position Transducer	TE	SPD-25-3	G2961880	Nov 07, 2025
Pressure Transducer	Honeywell	TJE	1936496	Apr 09, 2026
Temperature/Humidity	Digi-Sense	20250-31	220318660	Sep 16, 2026
Stopwatch	Control Company	1051	230590883	Aug 31, 2025
Input Module	Yokogawa	DU100-11	27DC45768	Feb 20, 2026