



Fire Safety in the Built Environment

REPORT NO.: FSRG 2019/035

Description of Test:

A non-loadbearing fire resistance test with fire from four sides of five (5) short sections of steel Column with H_p/A of $89m^{-1}$, $89m^{-1}$, $134m^{-1}$, $134m^{-1}$ and $180m^{-1}$, claim to be coated with multiple thickness of Unique Intumescent Paint-S, in accordance to ISO 834 Part 1:1999.

Sponsor:

Unique Products (Thailand) Co., Ltd.
104/35-36 Moo 12 Bangpla,
Bangplee Samutprakarn, 10540,
Thailand

Test Performed by:

Fire Science Research Group
No. 31, Jalan Perindustrian 5,
Sakinas Industrial Park, Off Jalan Haji Abdul Manan,
5 ½ Miles, Jalan Meru, 41050 Klang, Selangor,
MALAYSIA.

Date of Test:

30th of August 2019

Date of Report:

1st December 2019



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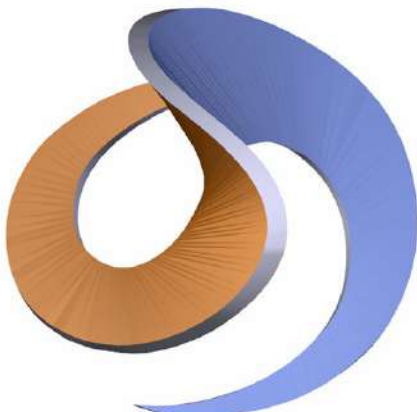
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SUMMARY

On 30th August 2019, a non-loadbearing fire resistance test, with fire from four sides, was carried out on five (5) short sections of steel Column, all of which are of 1000mm in height and spray coated with different thickness of Unique Intumescent Paint-S.

The five specimens were of different section factors (H_p/A) and as below:

Specimen A: 486mm x 200mm x 17mm, $H_p/A=89\text{m}^{-1}$ spray coated with 1.05mm of Unique Intumescent Paint-S

Specimen B: 486mm x 200mm x 17mm, $H_p/A=89\text{m}^{-1}$ spray coated with 2.02mm of Unique Intumescent Paint-S

Specimen C: 506mm x 200mm x 11.5mm, $H_p/A=134\text{m}^{-1}$ spray coated with 0.84mm of Unique Intumescent Paint-S

Specimen D: 506mm x 200mm x 11.5mm, $H_p/A=134\text{m}^{-1}$ spray coated with 2.03mm of Unique Intumescent Paint-S

Specimen E: 200mm x 200mm x 8mm, $H_p/A=180\text{m}^{-1}$ spray coated with 2.48mm of Unique Intumescent Paint-S

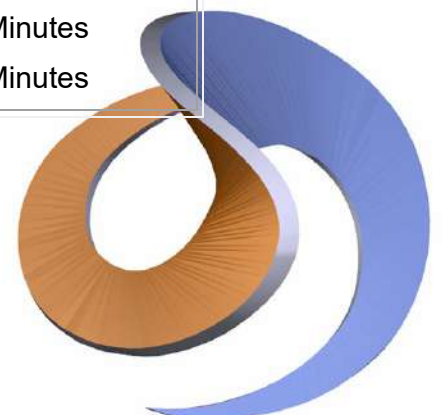
A steel plate of 600mm x 400mm x 10mm thick and 400mm x 400mm x 10mm thick was fully welded to the bottom of the H-Column to act as its base.

The specimen was subjected to a fire resistance test in accordance with the heating conditions and the relevant criteria specified in ISO 834 Part 1:1999. The Standards describe methods for the determination of the fire resistance of elements of building construction-General requirement. The temperature of the column was recorded with thermocouples type K fixed to the column.

The table below summarises the details of the protective coating and time recorded for the column to reach critical temperature of 550°C for mean temperature:

<i>Description of specimen</i>	<i>Time to reach 550°C for mean temperature</i>	<i>Time to reach 650°C for mean temperature</i>
Specimen A	60 Minutes	83 Minutes
Specimen B	37 Minutes	90 Minutes
Specimen C	31 Minutes	64 Minutes
Specimen D	28 Minutes	68 Minutes
Specimen E	28 Minutes	67 Minutes

The test was terminated at 95 minutes.



1 TEST SPECIMEN

1.1 General

The specimen consists of five short steel columns of different section factors (H_p/A). All are of 1000mm in height and spray coated with different thickness of Unique Intumescent Paint-S.

The five specimens were positioned inside a furnace with an opening size of 4100mm x 3100mm and with minimum 500mm clearance between them and the furnace wall.

Materials for specimen construction were shown in the Figure 1, Figure 5, Figure 9 and Figure 13. For any discrepancy, the below written details of construction material will take precedence over the listed figure.

1.2 Material

1.2.1 Short Steel Column

There are five different steel columns of 1000mm height each with their bases were welded to 600mm x 400mm x 10mm thick steel plate and 400mm x 400mm x 10mm thick. The steel H-column serial sizes are:

Specimen A: 486mm x 200mm x 17mm, $H_p/A=89\text{m}^{-1}$ spray coated with 1.05mm of Unique Intumescent Paint-S

Specimen B: 486mm x 200mm x 17mm, $H_p/A=89\text{m}^{-1}$ spray coated with 2.02mm of Unique Intumescent Paint-S

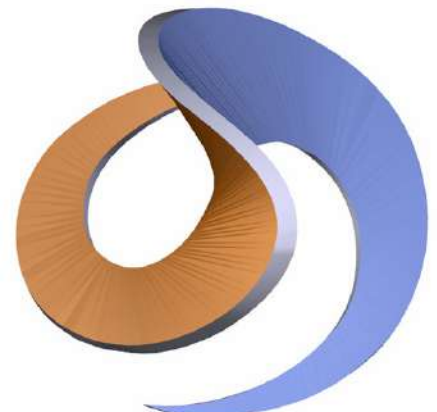
Specimen C: 506mm x 200mm x 11.5mm, $H_p/A=134\text{m}^{-1}$ spray coated with 0.84mm of Unique Intumescent Paint-S

Specimen D: 506mm x 200mm x 11.5mm, $H_p/A=134\text{m}^{-1}$ spray coated with 2.03mm of Unique Intumescent Paint-S

Specimen E: 200mm x 200mm x 8mm, $H_p/A=180\text{m}^{-1}$ spray coated with 2.48mm of Unique Intumescent Paint-S

1.2.2 Unique Intumescent Paint-S

Unique Intumescent Paint-S is an intumescent type paint supplied by the sponsor. The intumescent paint was applied at the factory, observation was made after the specimen reached the laboratory.



1.2.3 TOA-CHUGOKU UNIVAN Silver primer

TOA-CHUGOKU UNIVAN Silver primer is a type of epoxy mastic primer supplied by the sponsor. The steel column was claimed to be coated all over with an average thickness of 0.3mm thick. The claimed thickness are:

Specimen A: 0.310mm

Specimen B: 0.301mm

Specimen C: 0.301mm

Specimen D: 0.302mm

Specimen E: 0.308mm

1.2.4 UNY MARINE HS topcoat

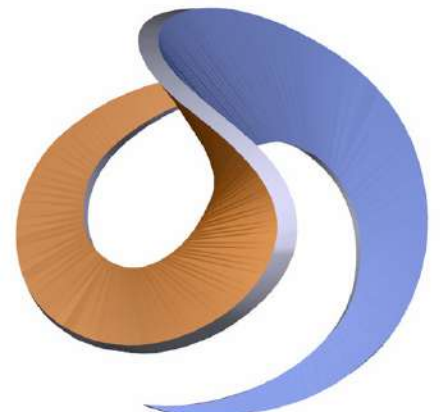
UNY MARINE HS is an aliphatic polyurethane topcoat type paint supplied by the sponsor. The topcoat paint was applied at the factory, observation was made after the specimen reached the laboratory.

1.2.5 Ceramic Fibre Blanket

Ceramic fibre blanket with the density of 96kg/m^3 , with a nominal thickness of 25mm was utilized to insulate the top surface and the base plate of the column to prevent inappropriate heat transfer.

1.2.6 Sand

The base of each column was covered by fine sand up to 50mm height to prevent inappropriate heat transfer.



1.3 Specimen Assembly

1.3.1 Steel Columns with Unique Intumescent Paint-S spray coated.

For the fire-resistance test, there are five specimens assembled, each with different steel columns of different section factors (H_p/A). All are of 1000mm in height and spray coated with different thickness of Unique Intumescent Paint-S.

Each steel column was cut into 1000mm length and four steel plate of 600mm x 400mm x 10mm thick and a steel plate 400mm x 400mm x 10mm thick were then welded to its bases. At the top of the specimen, on its web, a section of 76mm x 38mm x 6.7kg/m steel C-channel of 10mm wide was welded onto it to act as a hook.

The specimen was then claimed to be spray coated with Unique Intumescent Paint-S paint protection. A layer of UNY MARINE HS topcoat was claimed to be applied onto the specimens. Only the total average thickness of the specimens were measured at the laboratory which are:

Specimen A: 486mm x 200mm x 17mm, $H_p/A=89\text{m}^{-1}$, 1.05mm

Specimen B: 486mm x 200mm x 17mm, $H_p/A=89\text{m}^{-1}$, 2.02mm

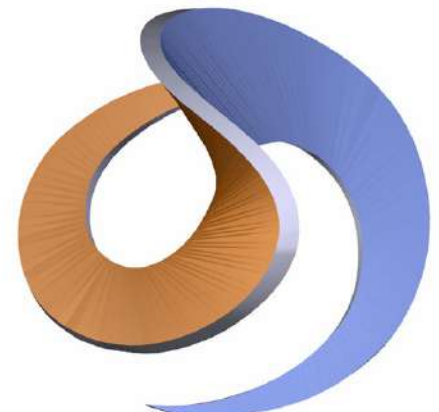
Specimen C: 506mm x 200mm x 11.5mm, $H_p/A=134\text{m}^{-1}$, 0.84mm

Specimen D: 506mm x 200mm x 11.5mm, $H_p/A=134\text{m}^{-1}$, 2.03mm

Specimen E: 200mm x 200mm x 8mm, $H_p/A=180\text{m}^{-1}$, 2.48mm

The columns are subsequently positioned inside the furnace with its base rest on a layer of 15mm thick fibre cement board and two layers of ceramic fiber. The base was then covered on top with another layer of 25mm thick ceramic fiber and 50mm high fine-sand to act as heat insulator. At the top, its topmost surface was covered with three layers 25mm thick ceramic fiber and a layer of 15mm thick fibre cement board as insulator to prevent heat entering from the top during fire resistance test. All five specimens were arranged in such position allowing each of them a minimum clearance of 500mm from each other and the furnace walls.

Specimen construction drawing and specimen thermocouple positions are shown in Figure 1 to Figure 120, while their arrangement for the test is shown in Photo 3. For any discrepancy, the written details of construction will take precedence over the drawing.



1.4 Specimen Conditioning

1.4.1 General

The test specimen was received and installed between 27th August 2019 and 29th August 2019. The environmental conditions consisted of an ambient temperature between 24.8°C ~ 32.1°C and a relative humidity of 35% ~ 75%.

2 PERFORMANCE CRITERIA

2.1 Expression of Results

The fire resistance test was conducted according with reference to relevant procedure within ISO 834 Part 1:1999.

For the duration of the test, the specimens were subjected to four sides fire exposure.

Fire resistance of the specimen shall be the duration, in minutes, of heating until the occurrence of failure or critical temperature according to the performance criteria stated in referenced standard or until the termination of test, whichever is shortest.

2.1 Critical Temperature or Insulation

Insulation failure or Critical Temperature deemed to have occurred when one of the following occurs: -

- If the measured mean temperature of protected steel column reached 550 °C; or
- If the measured mean temperature of protected steel column reached 650 °C.

3 TEST PROCEDURE

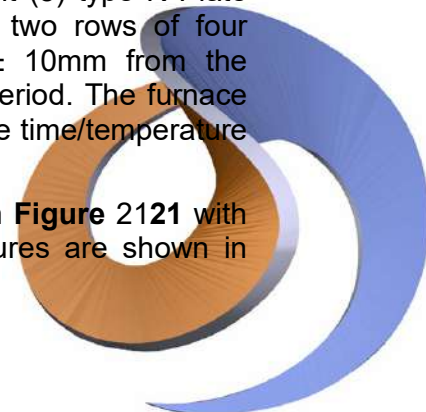
3.1 General

The test was carried out on 30th August 2019. The ambient temperature and relative humidity at the start of the test was 29.77°C and 67% respectively.

3.2 Furnace Control

The furnace temperature was measured by means of eight (8) type K Plate thermocouples arranged symmetrically in the furnace in two rows of four thermocouples with their measuring junctions 100mm ± 10mm from the exposed face of the specimen at the start of the heating period. The furnace was controlled so that the average temperature followed the time/temperature relationship specified in ISO 834 Part 1:1999.

The average furnace temperature is plotted against time in **Figure 2121** with the specified curve for comparison. The actual temperatures are shown in **Table 1**.



3.3 Furnace Pressure

After the first five minutes of testing, positive pressure is established within the furnace and the pressure in the furnace at the top of the specimen was maintained at a level of $16 \pm 2\text{Pa}$ for the duration of the test.

3.4 Specimen Temperatures

The temperatures of the specimen were measured by means of fixed specimen thermocouples consisting of Type K thermocouple cable fixed to the H-Column.

Total of six (6) high temperature specimen thermocouples were attached to the specimen at one third and two third of its's height. The positions of the thermocouples are shown in Figure 3, Figure 3, Figure 3, Figure 3 and Figure 3.

4 TEST RESULTS

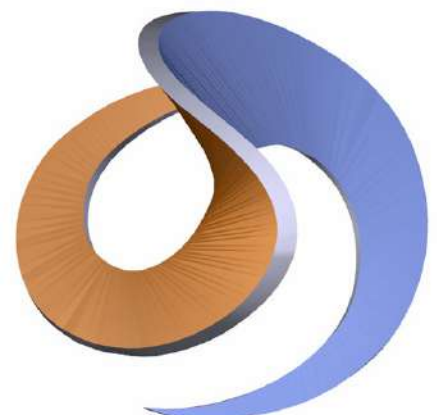
4.1 Temperature Measurements

Fixed high temperature specimen thermocouples No. 1 to 30 were used to derive the mean and maximum temperatures of the specimen.

The mean and maximum temperatures measured on the by fixed specimen thermocouples are plotted against time in **Figure 22**, with mean and individual thermocouple temperatures are shown in **Table 2** to **Table 6**.

4.2 Observations

Observations made during the test are tabulated in **Table 7**.



5 CONCLUSION

A non-loadbearing fire resistance test was carried out on five (5) short sections of steel Column, all of which are of 1000mm in height and spray coated with different thickness of Unique Intumescent Paint-S of below:

Specimen A: 486mm x 200mm x 17mm, Hp/A-89m⁻¹ spray coated with 1.05mm of Unique Intumescent Paint-S

Specimen B: 486mm x 200mm x 17mm, Hp/A-89m⁻¹ spray coated with 2.02mm of Unique Intumescent Paint-S

Specimen C: 506mm x 200mm x 11.5mm, Hp/A-134m⁻¹ spray coated with 0.84mm of Unique Intumescent Paint-S

Specimen D: 506mm x 200mm x 11.5mm, Hp/A-134m⁻¹ spray coated with 2.03mm of Unique Intumescent Paint-S

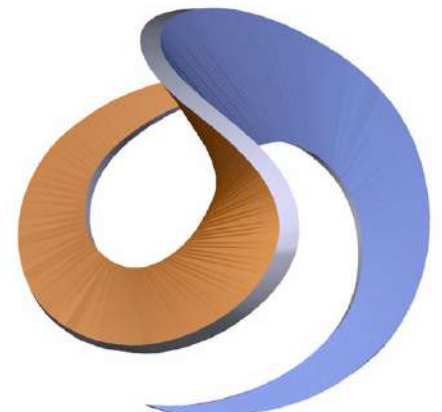
Specimen E: 200mm x 200mm x 8mm, Hp/A-180m⁻¹ spray coated with 2.48mm of Unique Intumescent Paint-S

- with fire from four sides, in accordance to the relevant criteria of ISO 834 Part 1:1999, The Standards describe methods for the determination of the fire resistance of elements of building construction-General requirement is found to have the following result:

<i>Description of specimen</i>	<i>Time to reach 550°C for mean temperature</i>	<i>Time to reach 650°C for mean temperature</i>
Specimen A	60 Minutes	83 Minutes
Specimen B	37 Minutes	90 Minutes
Specimen C	31 Minutes	64 Minutes
Specimen D	28 Minutes	68 Minutes
Specimen E	28 Minutes	67 Minutes

All specimens were tested for the duration of 95 minutes.

Note: Time to reach 550°C mean temperature and 650°C mean temperature is an absolute temperature and makes no allowance for the initial ambient temperature.

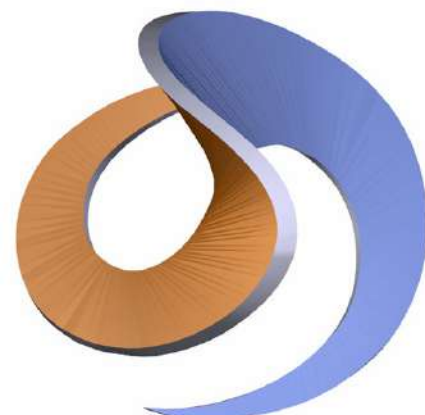


The specification and interpretation of fire test methods are the subject of on-going development and refinement. Changes in associated legislation may also occur. For these reasons it is recommended that the relevance of test reports over 5 years old should be considered by the user. The laboratory that issued the report will be able to offer, on behalf of the legal owner, a review of procedures adopted for the particular test to ensure that they are consistent with current practices, and if required may endorse the report.

The results of the fire test may be used to directly assess fire hazard, but it should be recognised that a single test method will not provide a full assessment of fire hazard under all fire conditions.

This report details the methods of construction, test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in ISO 834 Part 1:1999. Any significant variation with respect to size, constructional details, loads, stresses, edge or end conditions, other than those allowed under the field of direct application in the relevant test method, is not covered by this report.

Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible to provide a stated degree of accuracy of the result.



6 REFERENCES

1. Fire-Resistance Tests- Elements of building construction.

Part 1: General Requirements. ISO 834 Part 1:1999.
International Organization for Standardization,
Geneva, Switzerland. 1999.

7 INSTRUMENTATIONS

1. Fire Resistance Furnace System – iFix 5.9.
2. Pressure Transmitter
3. Ambient Thermocouple
4. Digital Thermohygrometer
5. Prova® 125 Temperature Calibrator
6. Thickness Gauge

8 SIGNATURES

Tested and reported by:

A handwritten signature in black ink, appearing to be 'Ubaidah Alwi'.

Ubaidah Alwi

Test Engineer

1st December 2019

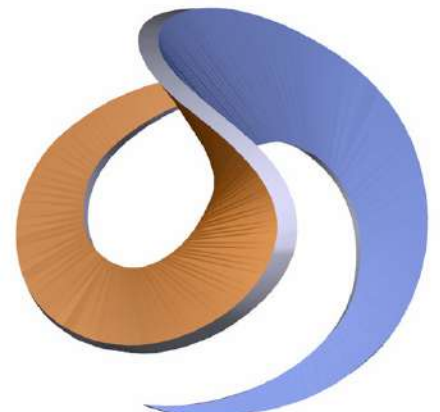
Approved by:

A handwritten signature in black ink, appearing to be 'Mohd Aliff Mustaffa'.

Mohd Aliff Mustaffa

Assistant Laboratory Manager

1st December 2019



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A. FIGURE

Figure 1: Specimen A- Legend.

[illegible]

Figure 2: Specimen A- Isometric, front view.

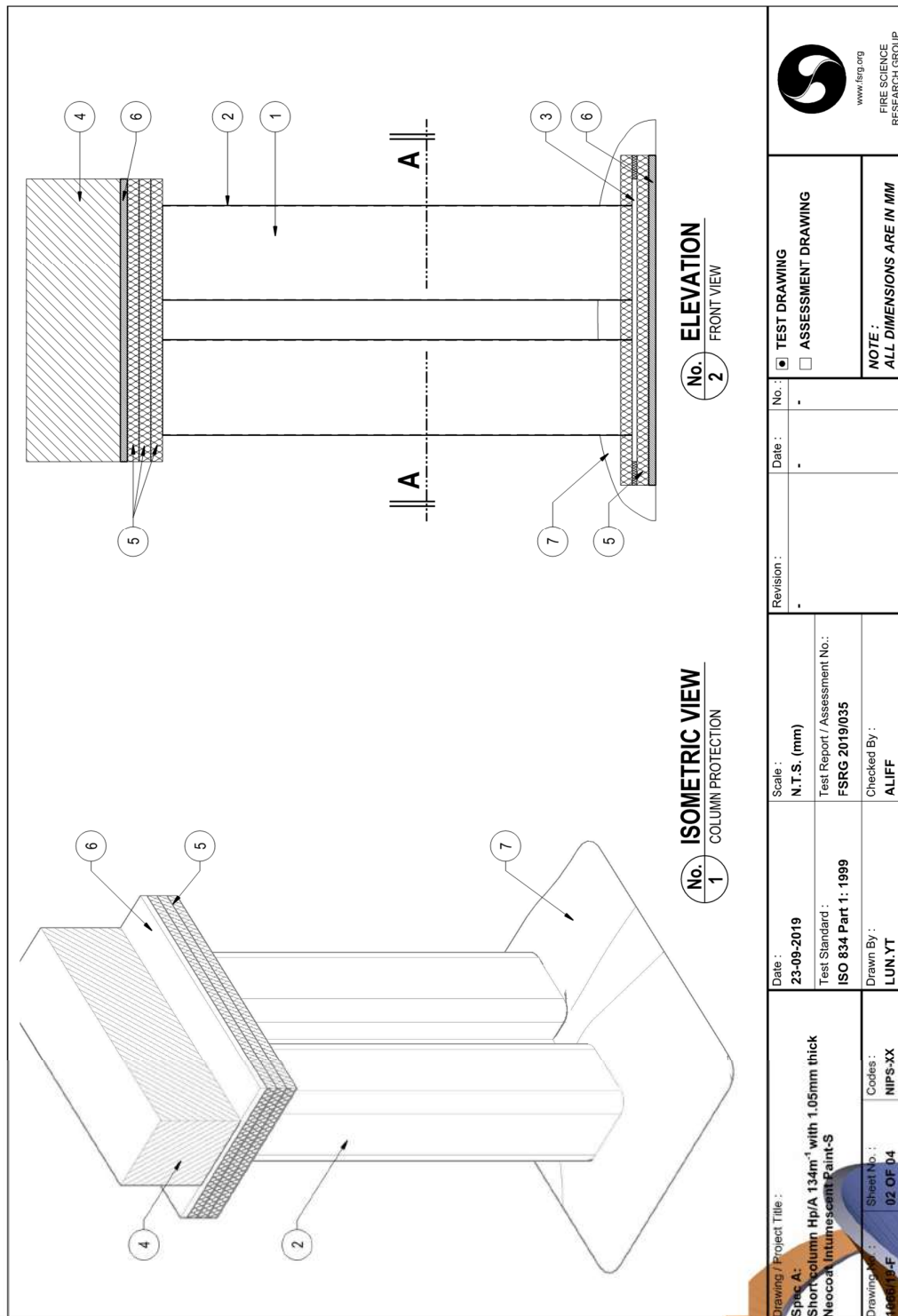


Figure 3: Specimen A- elevation and cross-section

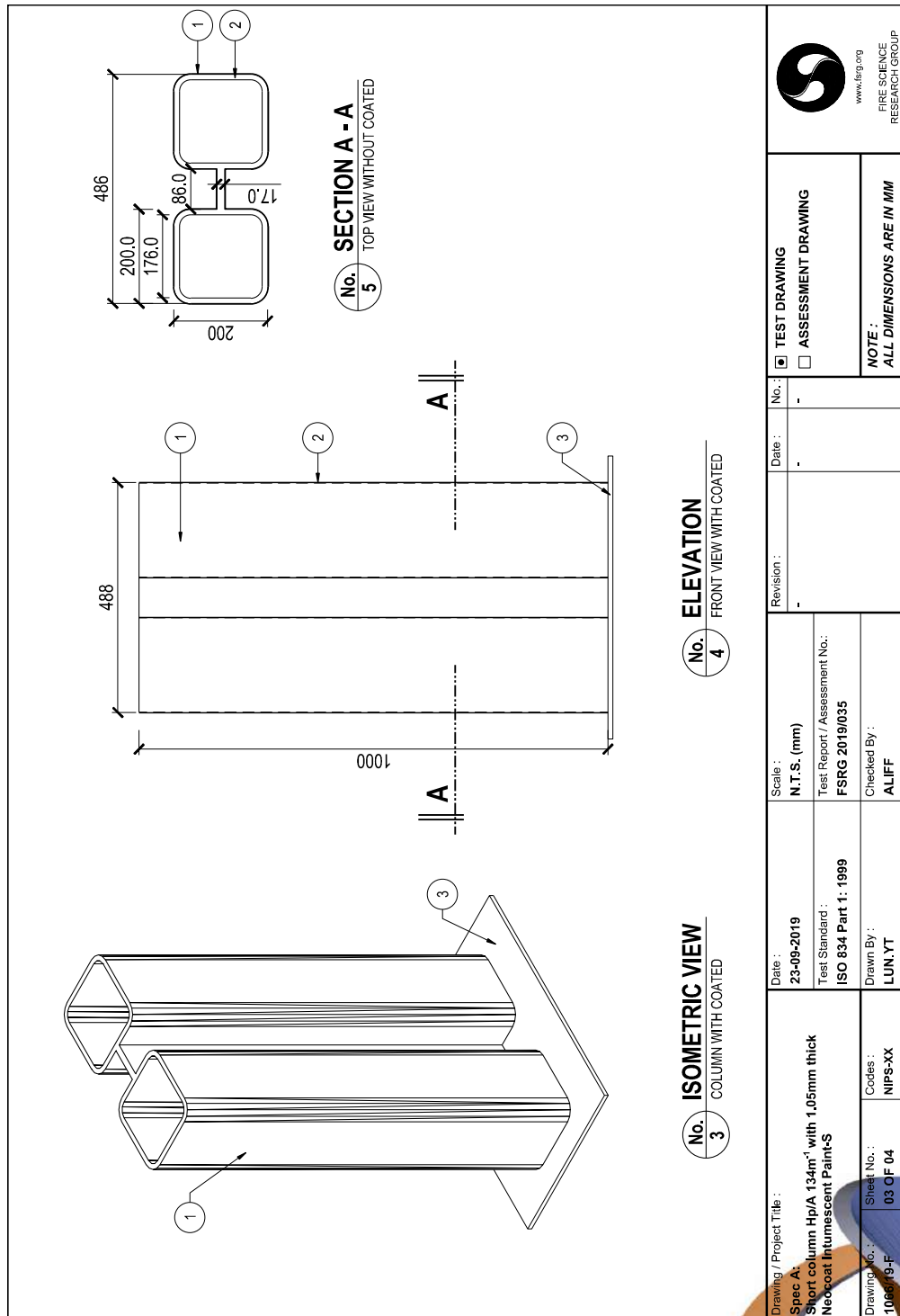
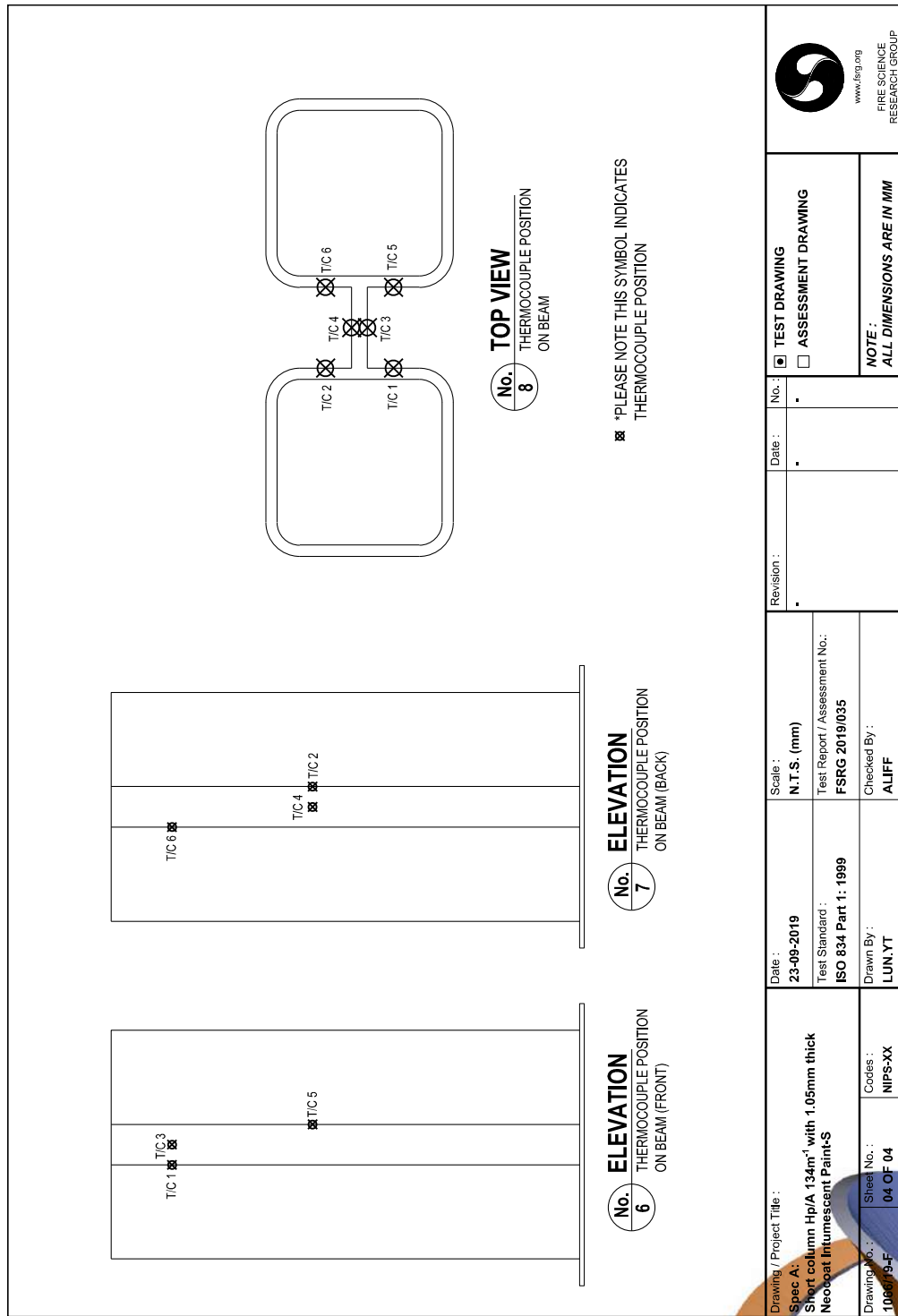


Figure 4: Specimen A - Specimen thermocouple positions.



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Figure 5: Specimen B- Legend.

[illegible]

Figure 6: Specimen B- Isometric, front view.

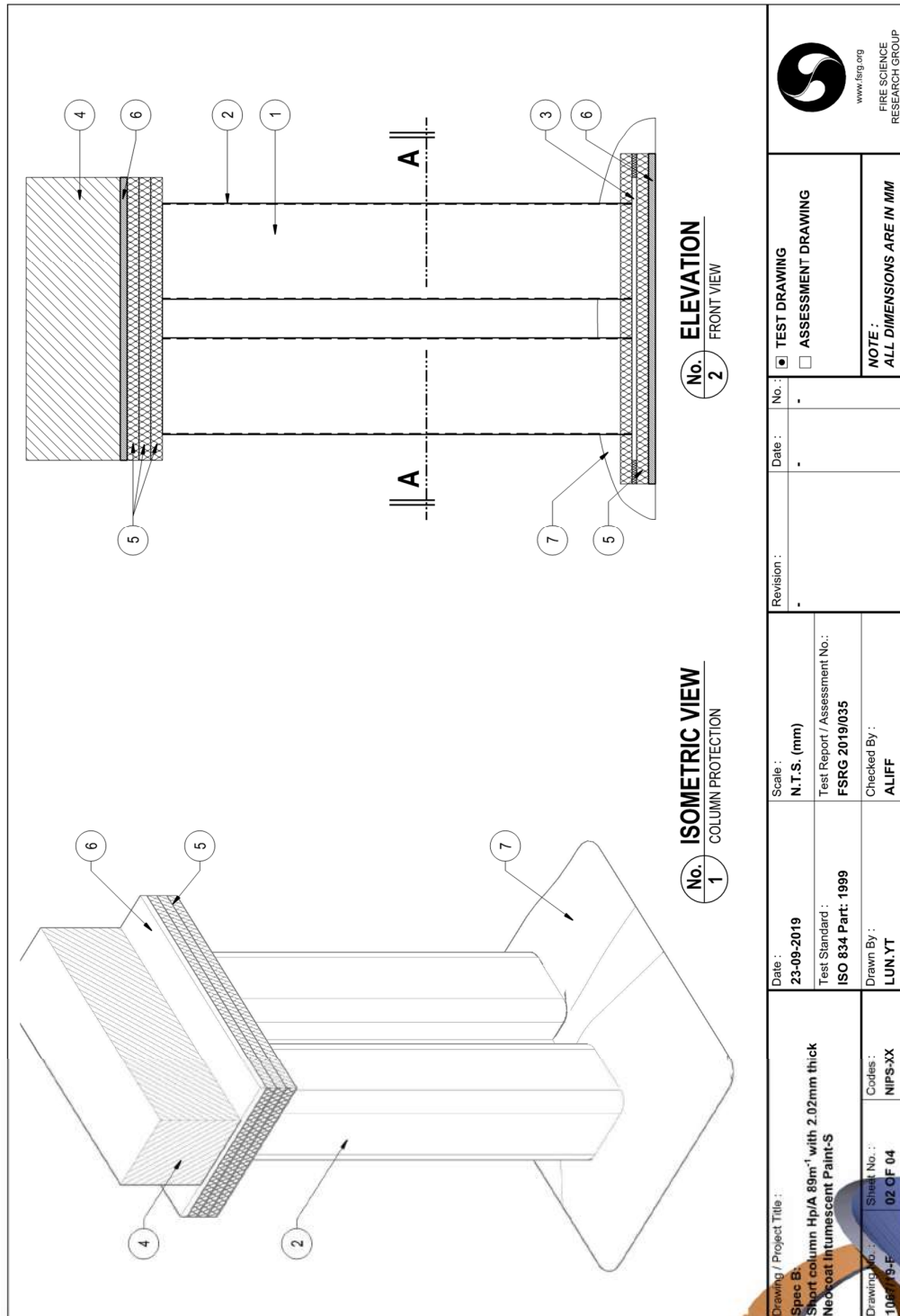


Figure 7: Specimen B - elevation and cross-section

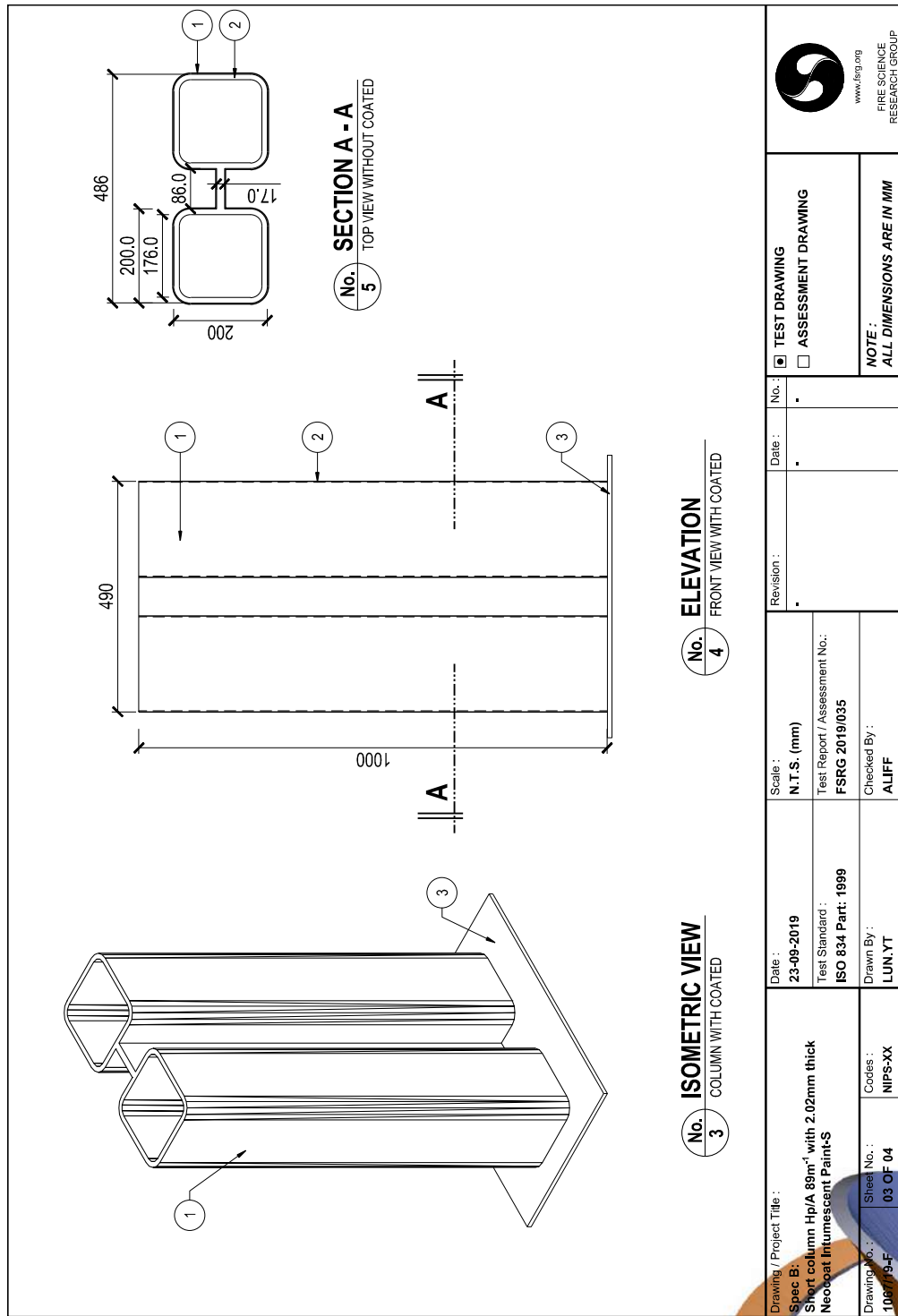


Figure 8: Specimen B - Specimen thermocouple positions.

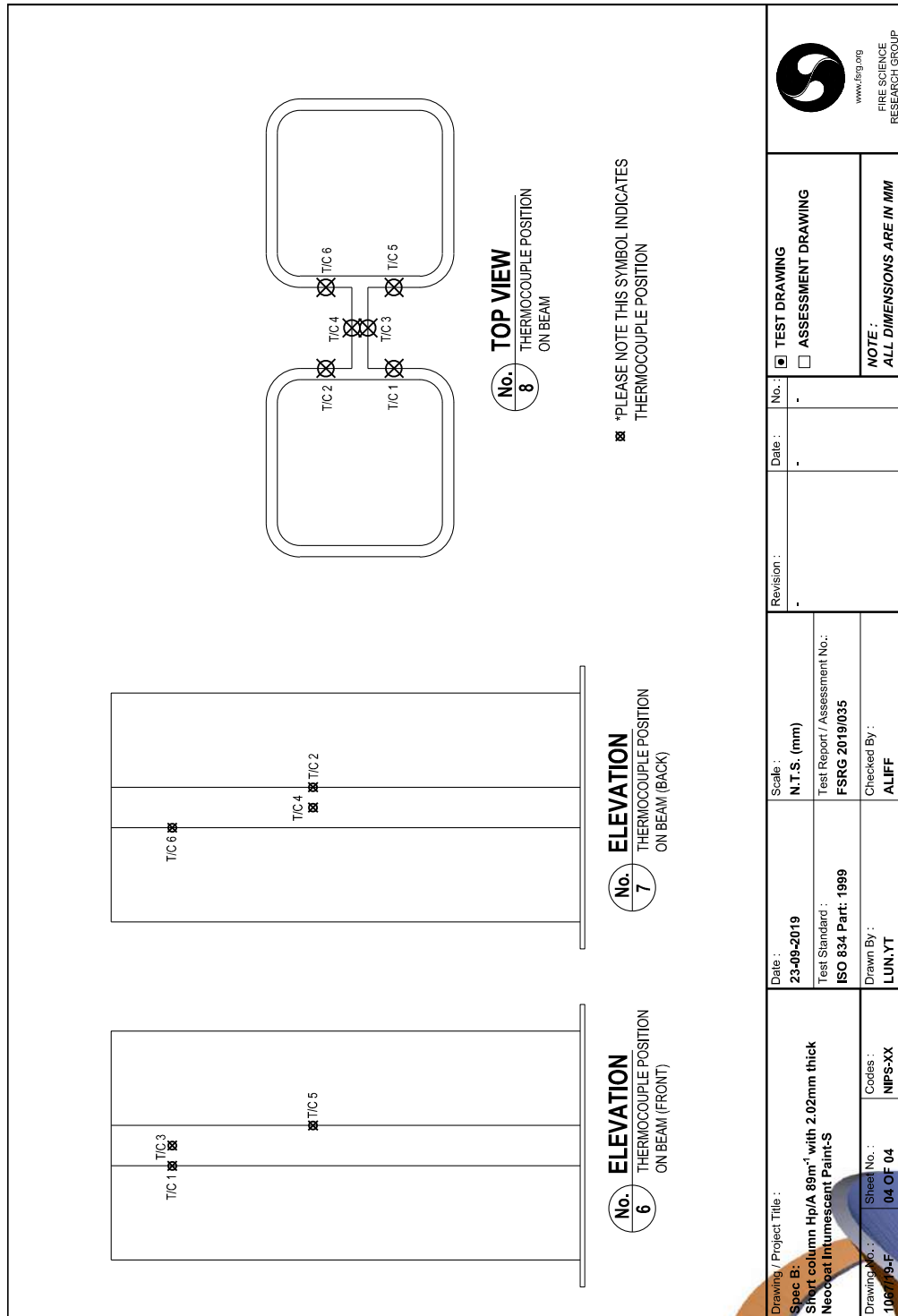


Figure 10: Specimen C- Isometric, front view.

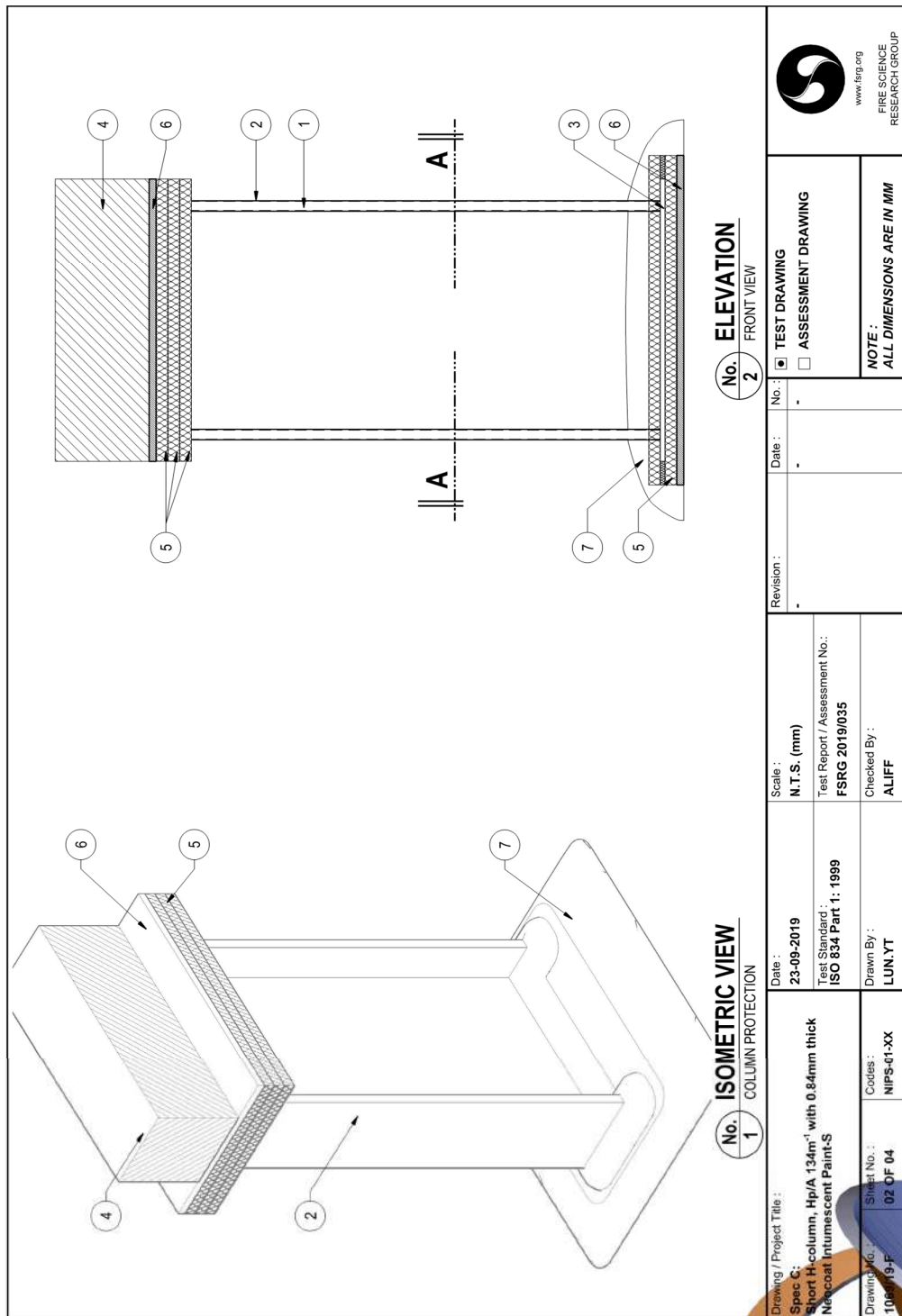


Figure 11: Specimen C- elevation and cross-section.

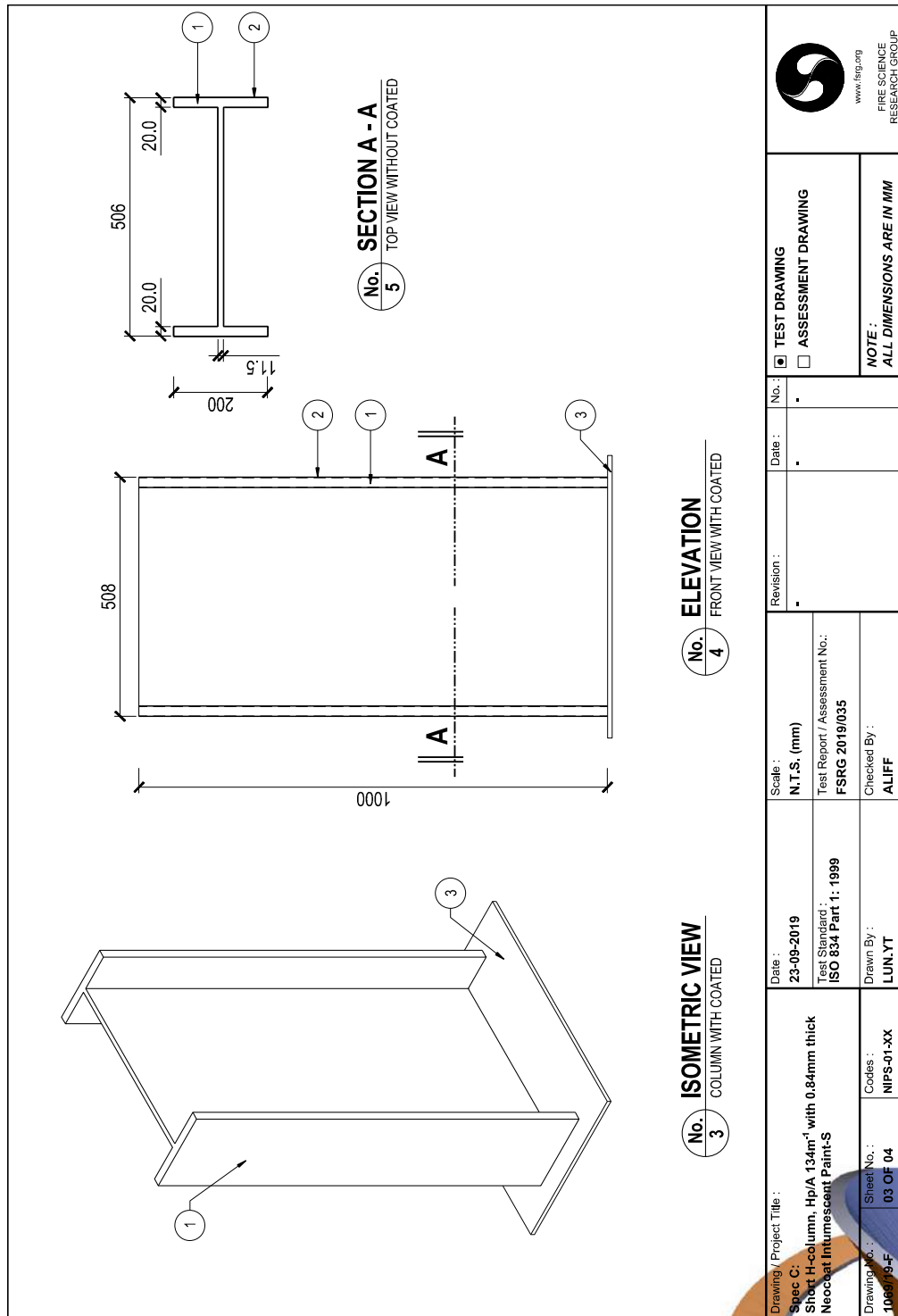
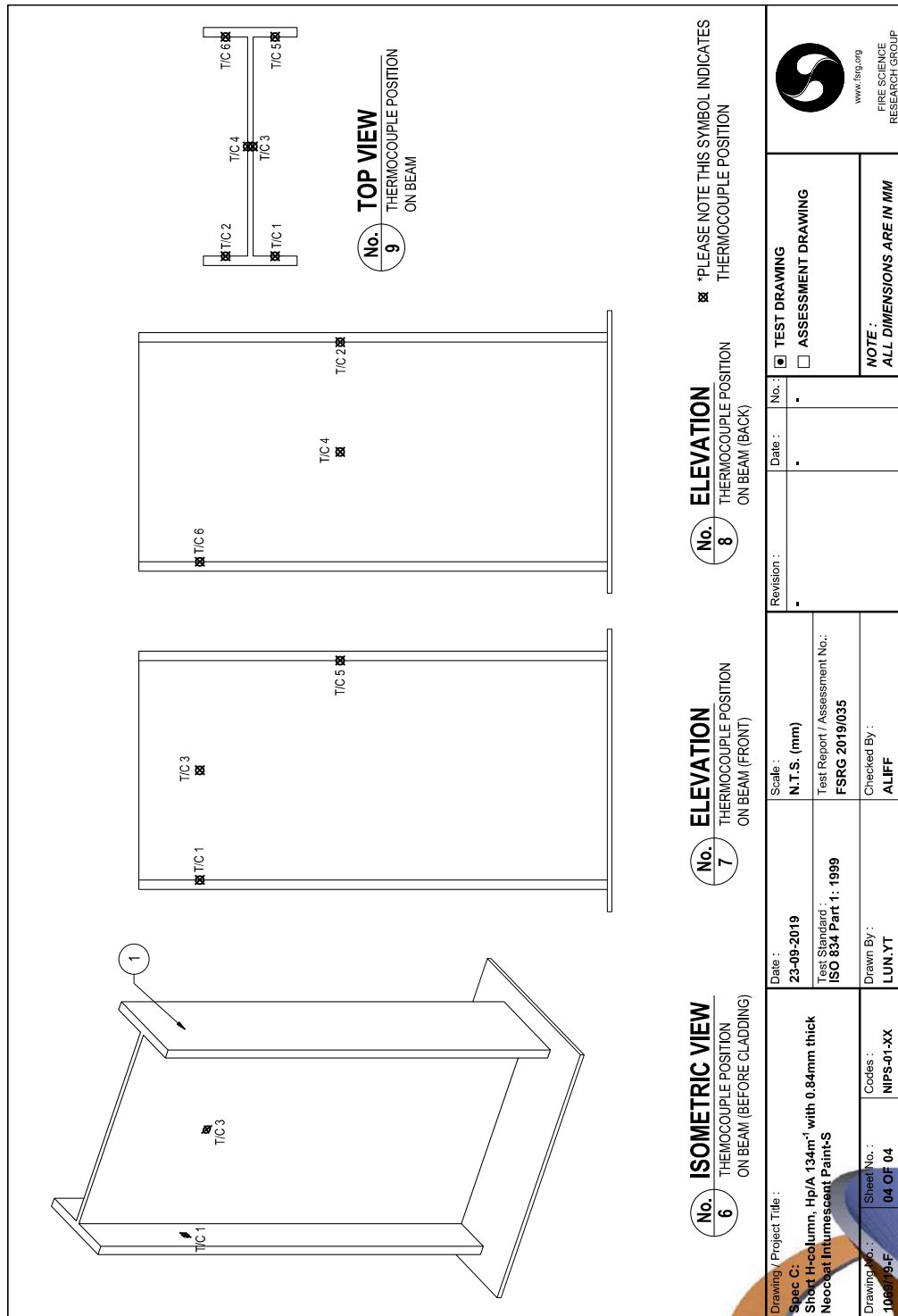


Figure 12: Specimen C- Specimen thermocouple positions.



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Figure 13: Specimen D- Legend.

[illegible]

Figure 14: Specimen D- Isometric, front view.

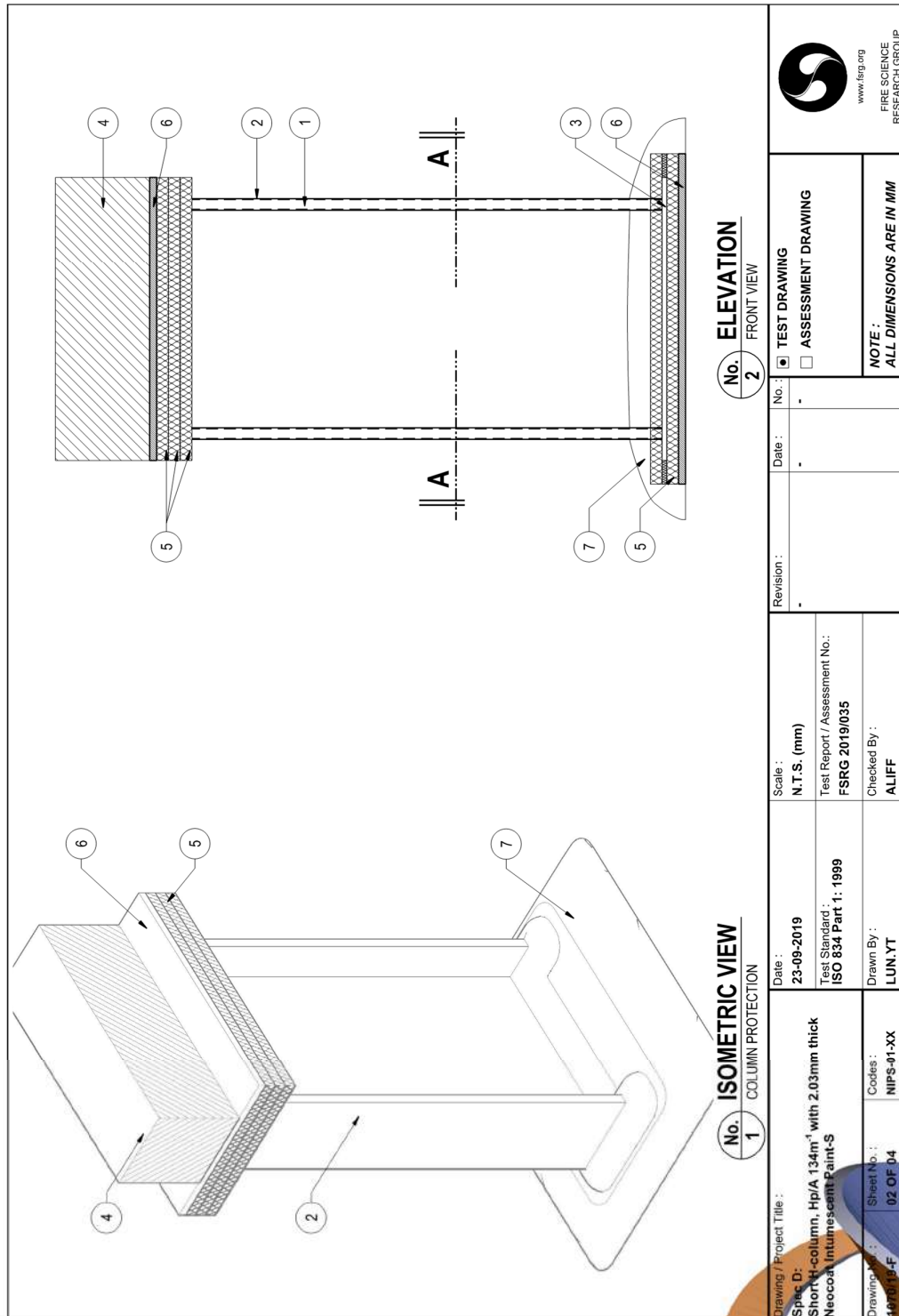


Figure 15: Specimen D- elevation and cross-section.

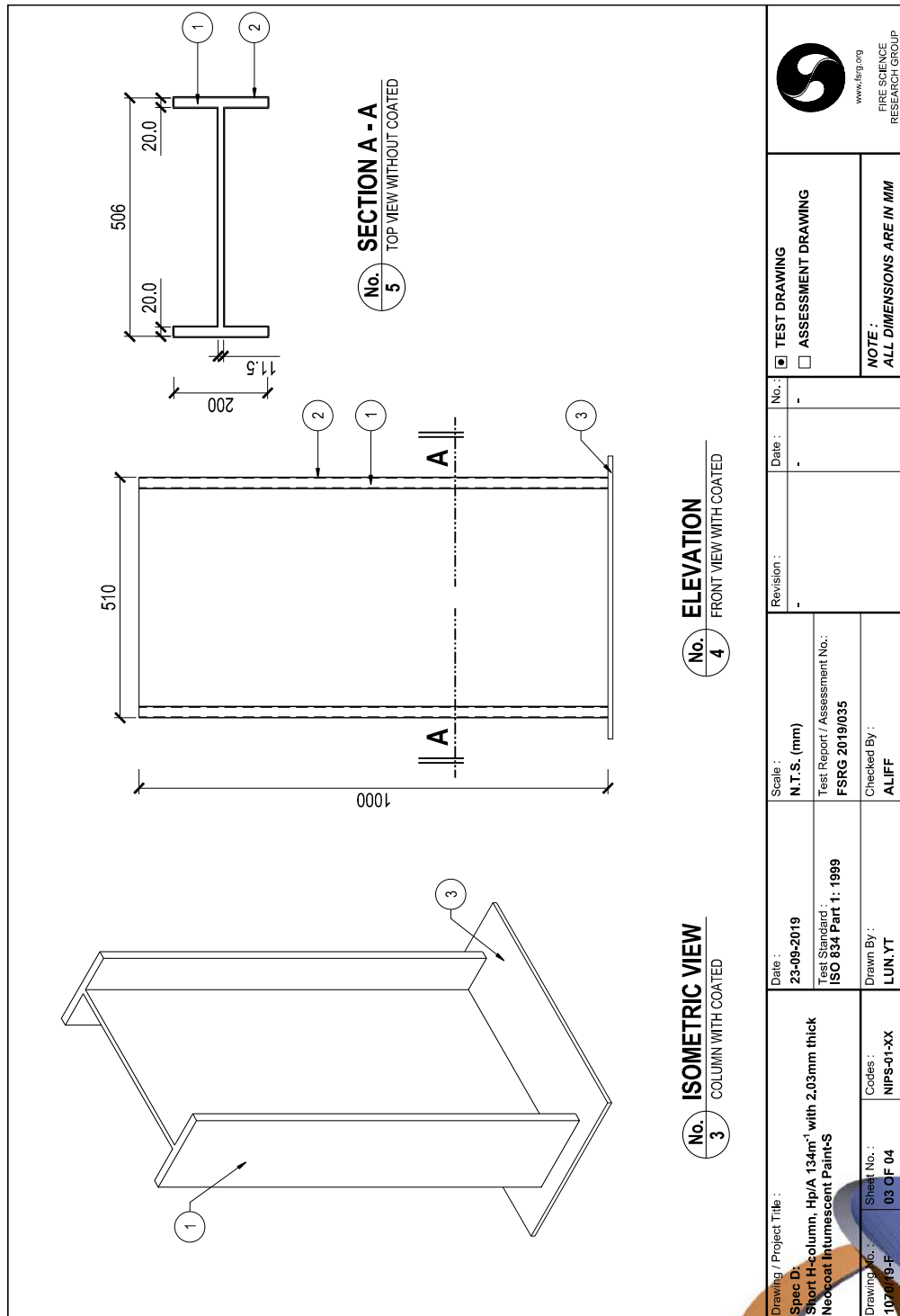


Figure 16: Specimen D- Specimen thermocouple positions

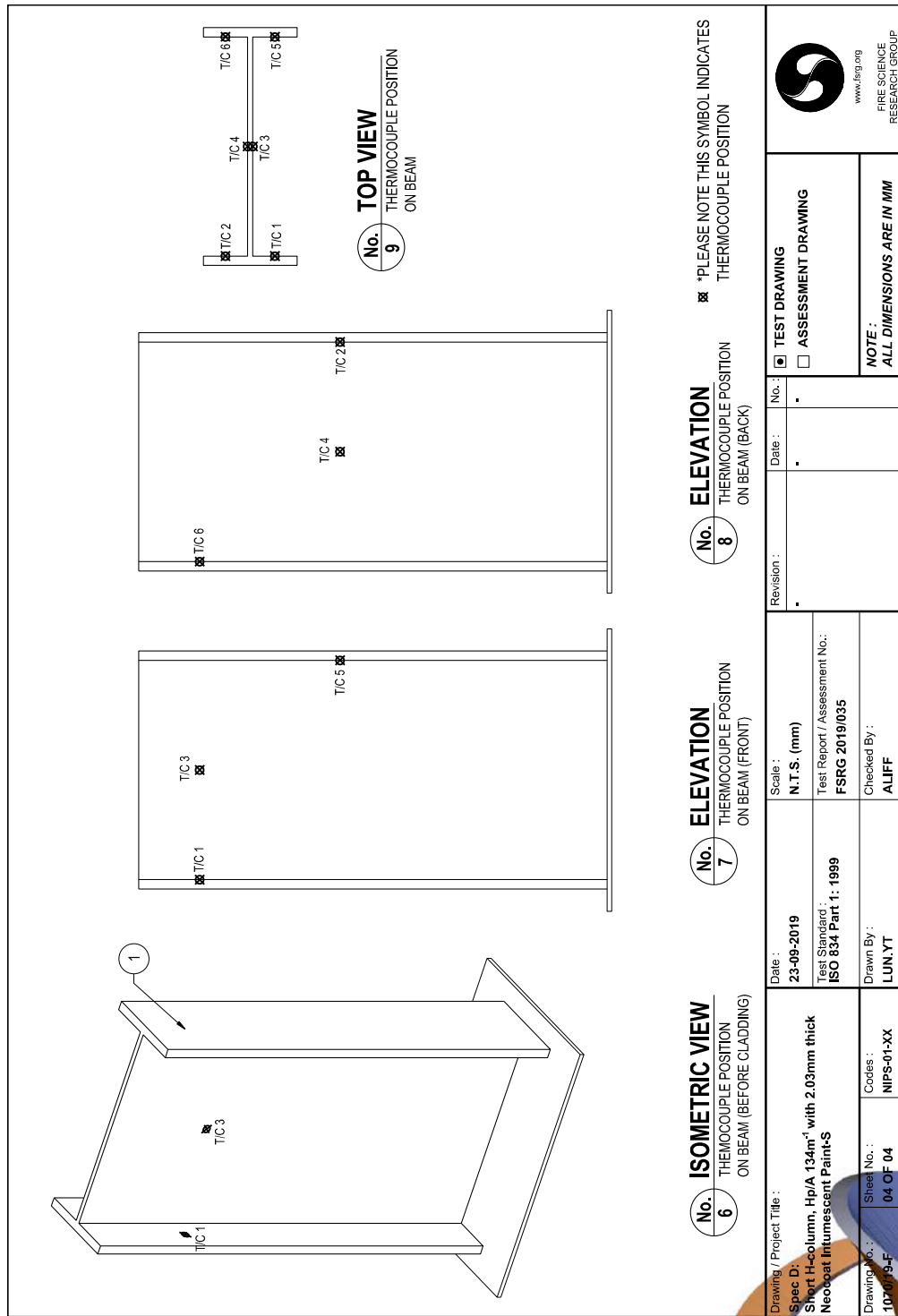


Figure 18: Specimen E- Isometric, front view.

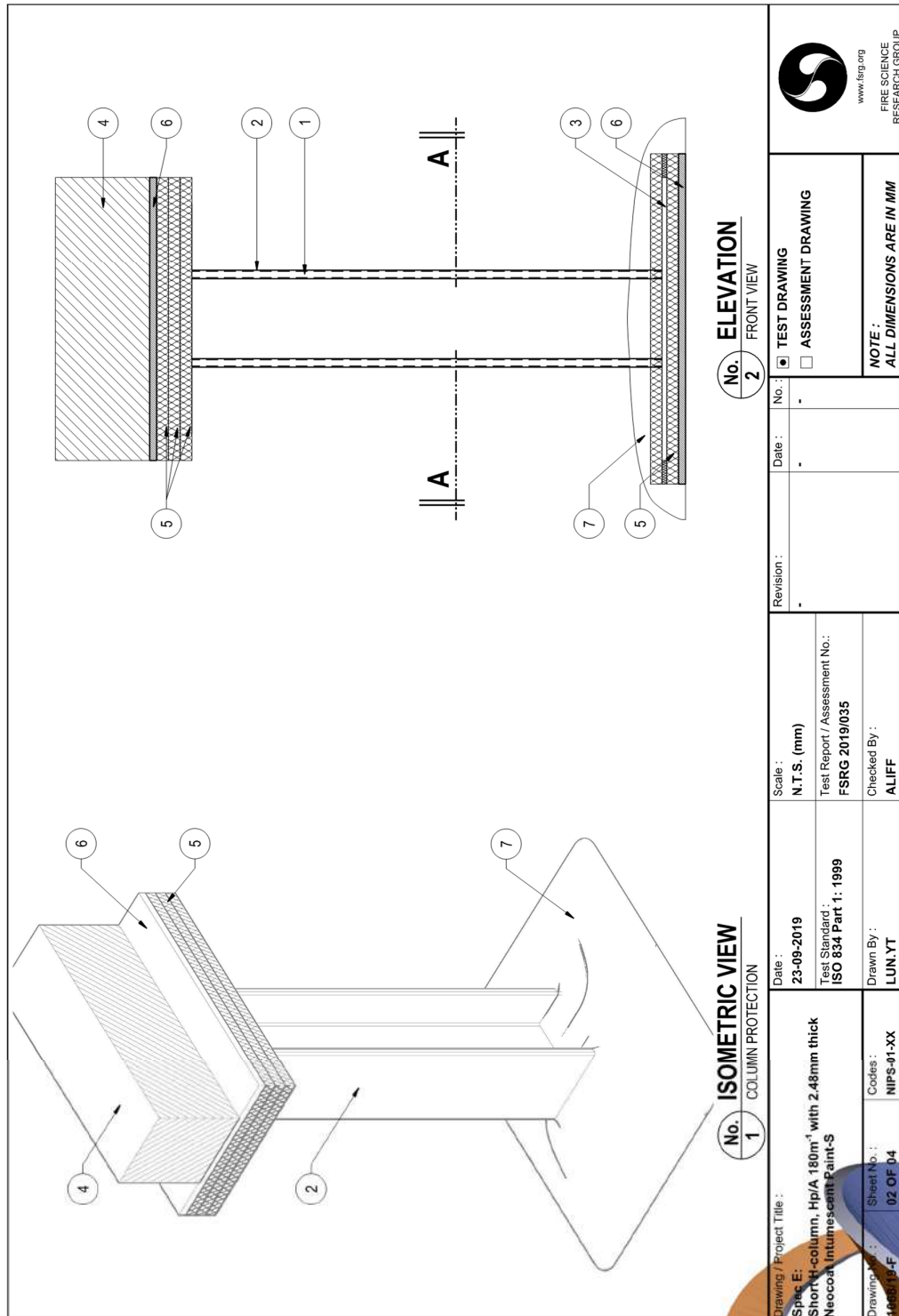


Figure 19: Specimen E- elevation and cross-section.

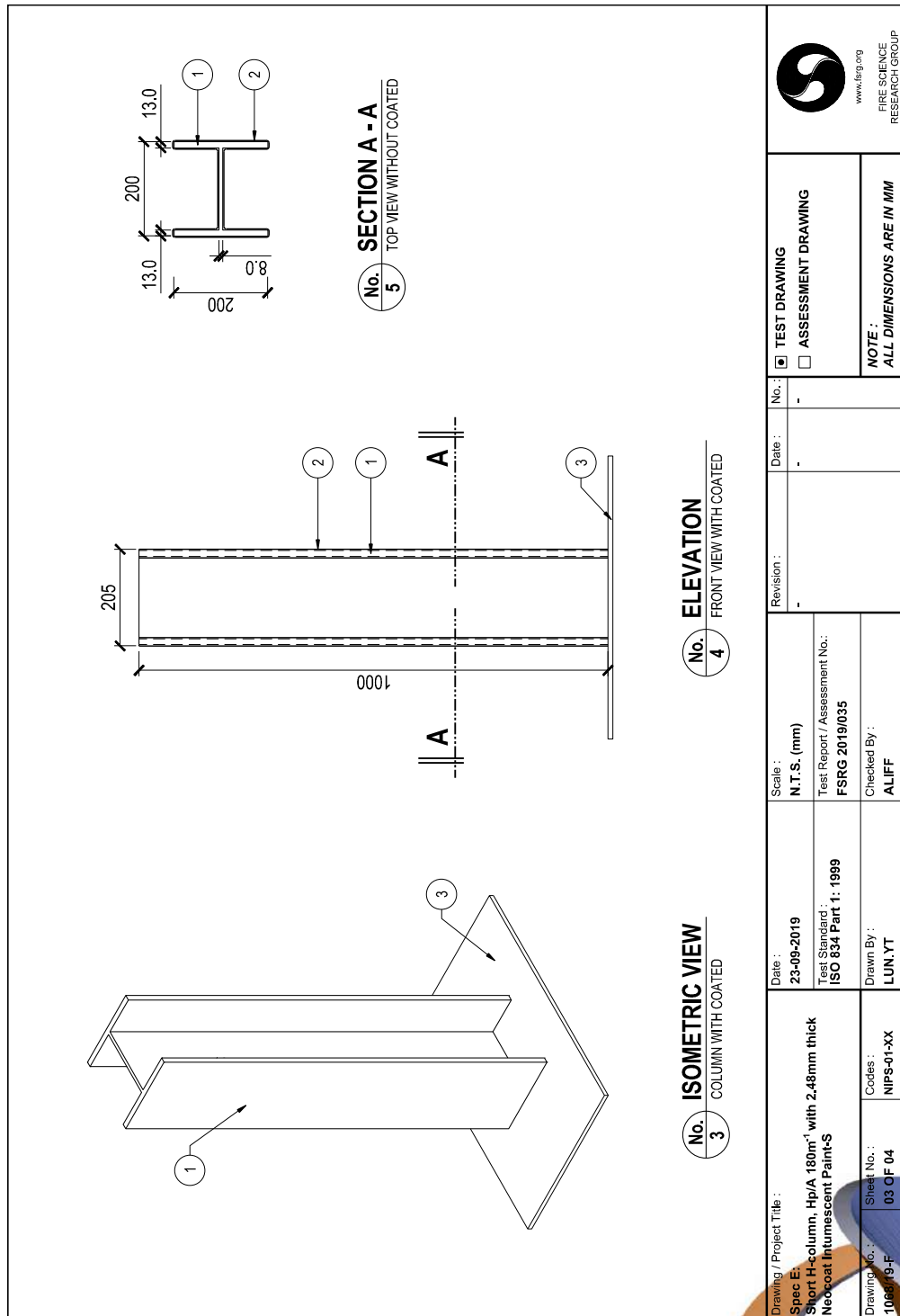


Figure 20: Specimen E- Specimen thermocouple positions

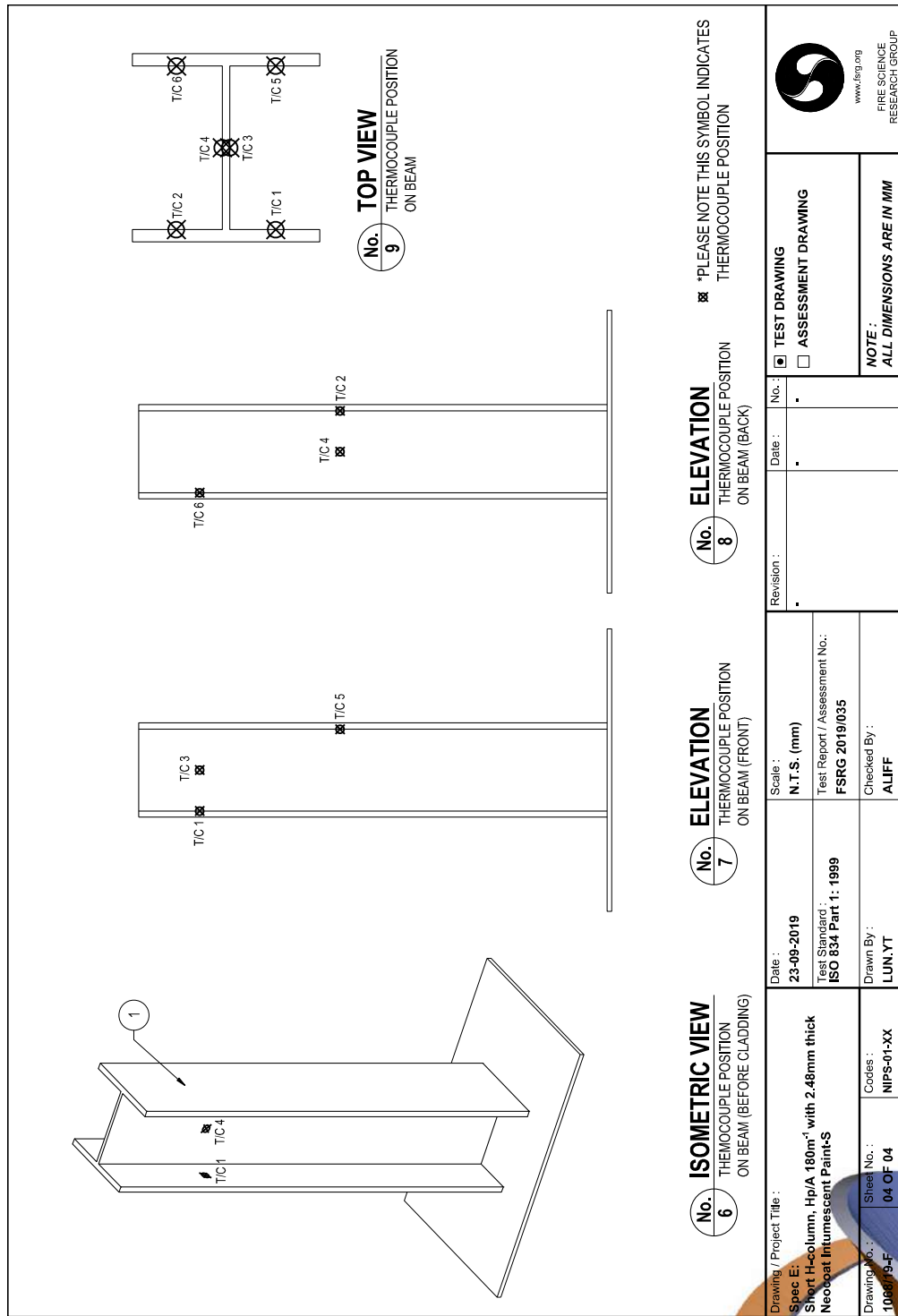


Figure 21: Mean furnace temperatures

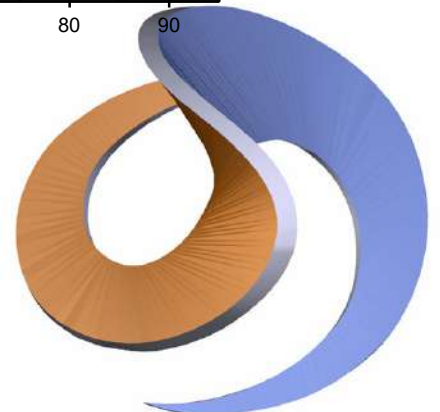
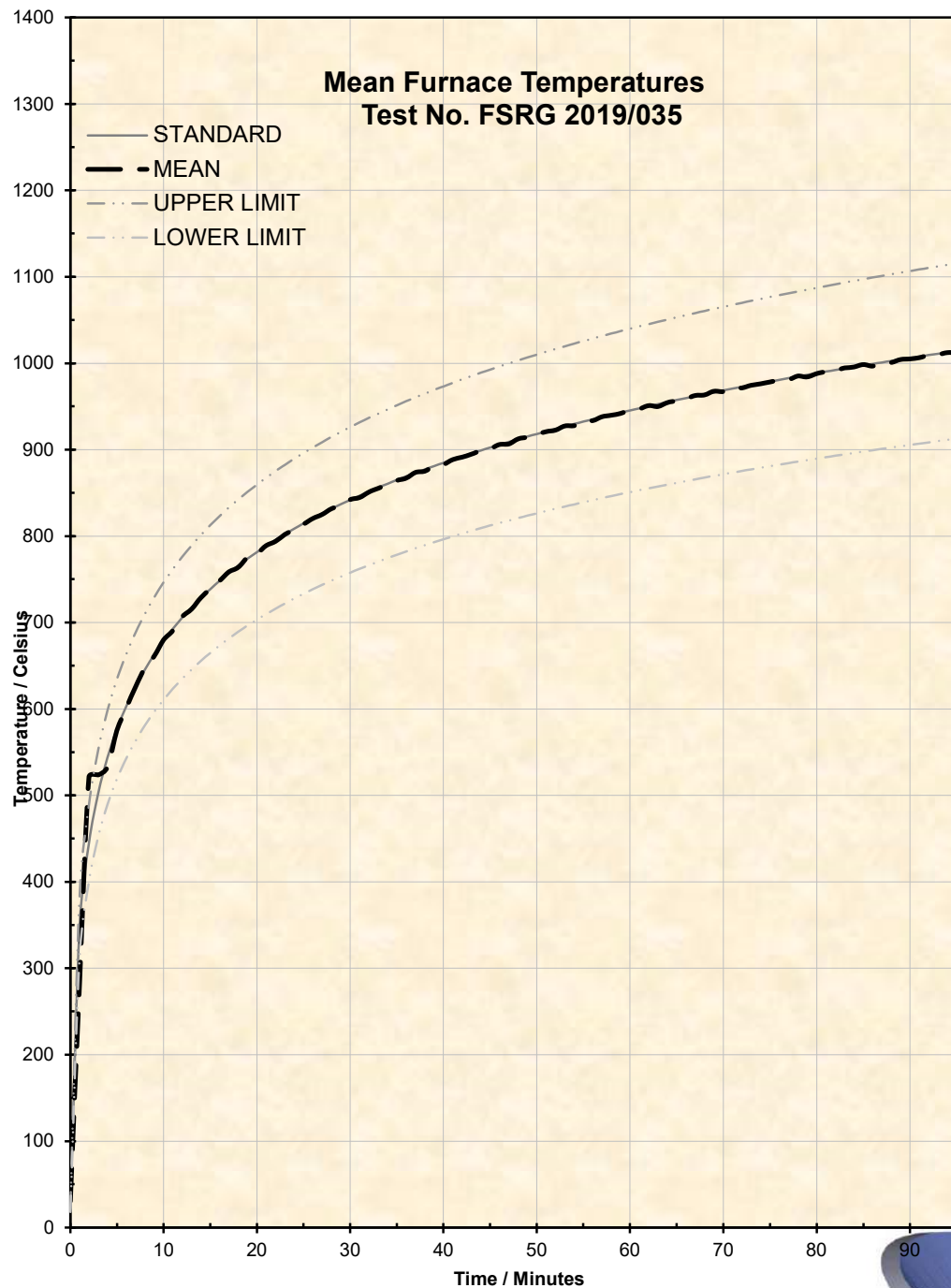


Figure 22: Mean and maximum unexposed specimen temperatures (fixed surface thermocouples)

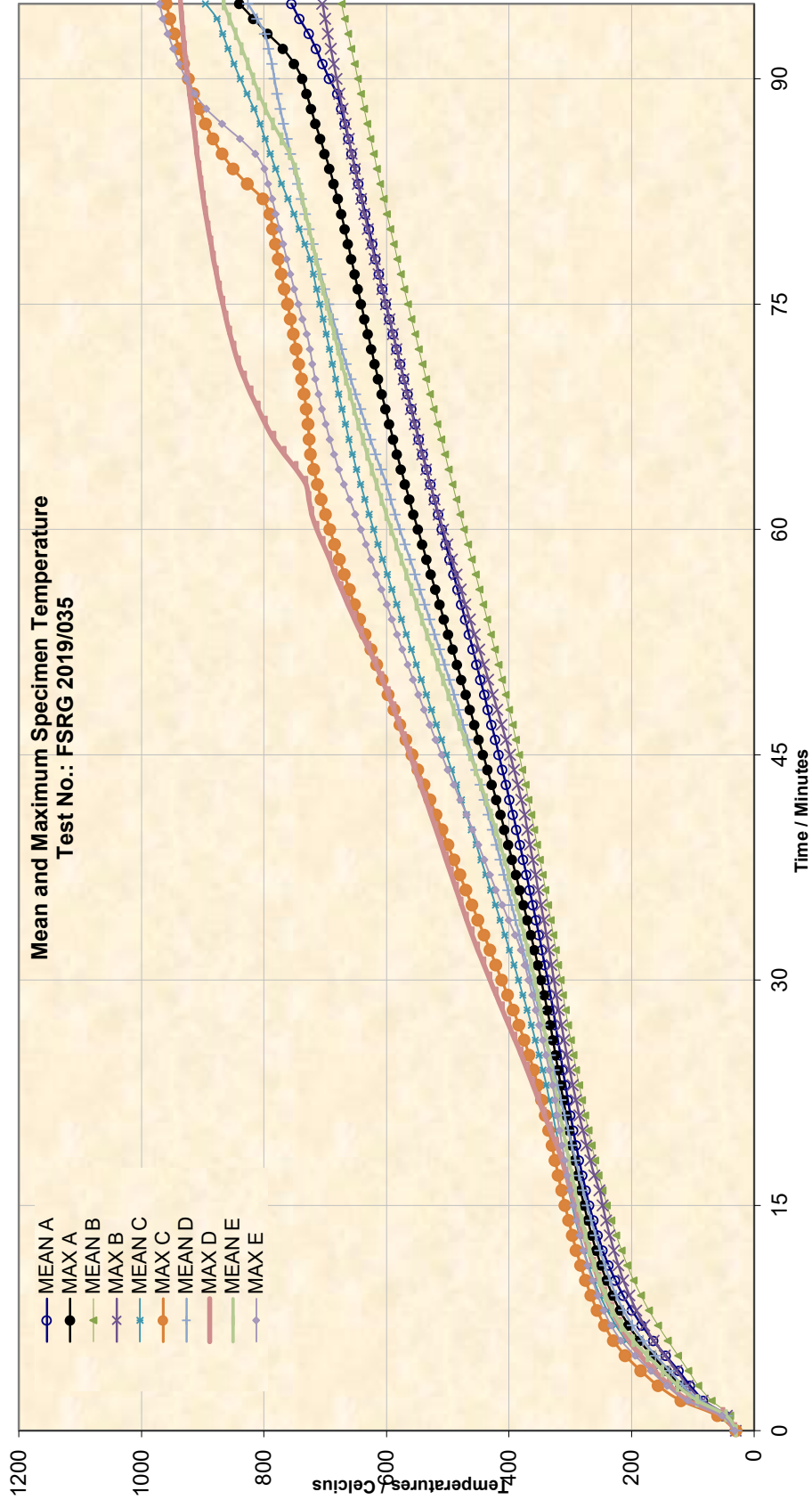
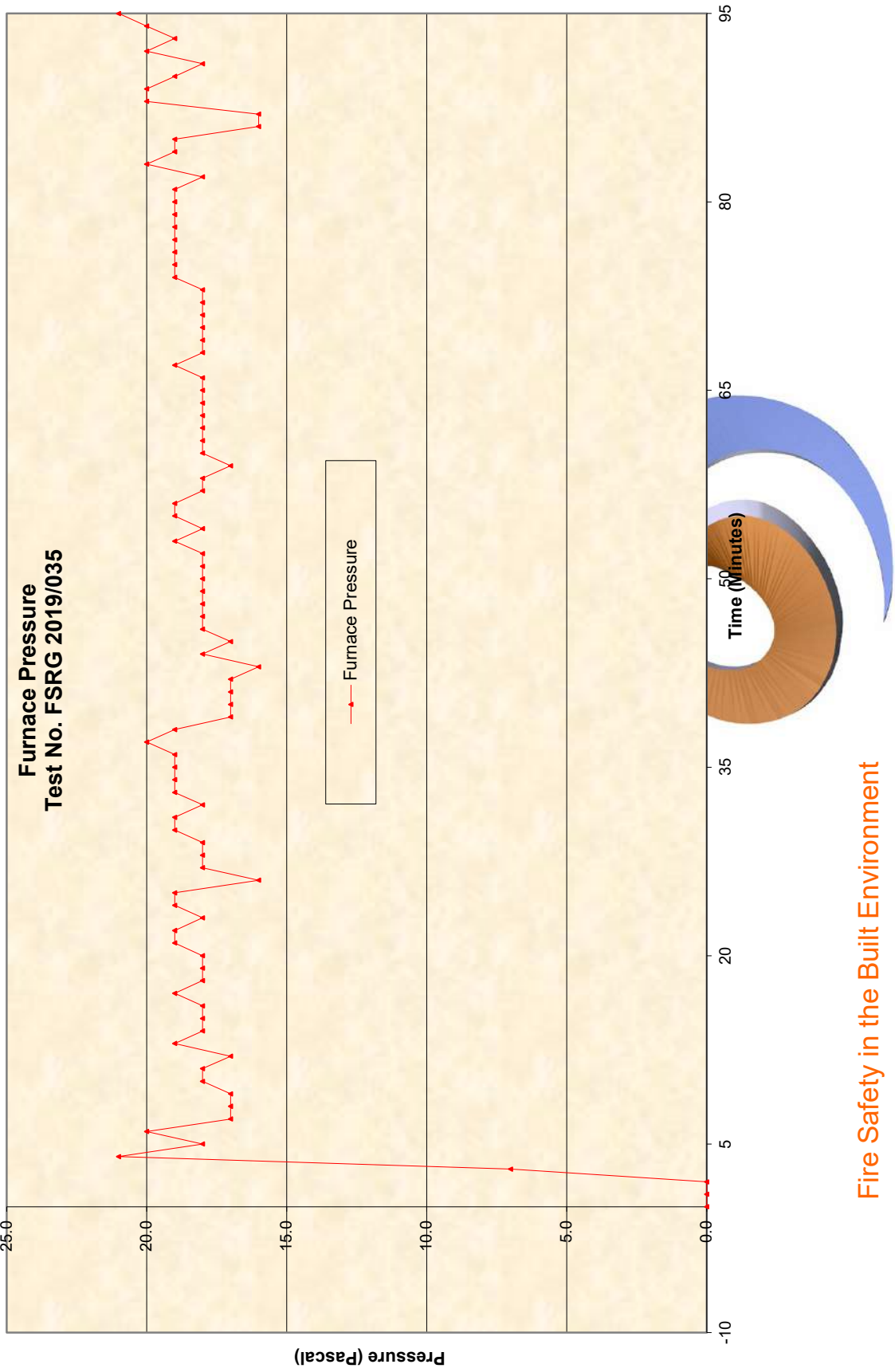


Figure 23: Pressure inside furnace at 100mm below specimen bottom surface.



B. TABLE

Table 1: Mean Furnace Temperature and Individual Furnace Thermocouple Temperature (T_{CF})

TIME (Minute)	BS476 (°C)	MEAN (°C)	T _{CF} 1 (°C)	T _{CF} 2 (°C)	T _{CF} 3 (°C)	T _{CF} 4 (°C)	T _{CF} 5 (°C)	T _{CF} 6 (°C)	T _{CF} 7 (°C)	T _{CF} 8 (°C)
0	25.5	30.3	29.9	30.2	30.1	30.1	30.7	30.4	30.3	30.7
1	349.2	284.9	194.9	363.8	231.4	155.8	305.0	402.5	334.0	291.4
2	444.5	521.1	388.8	575.2	515.0	431.4	545.8	615.4	582.5	514.5
3	502.3	523.5	448.2	540.6	510.5	466.1	542.7	573.5	555.1	551.2
4	543.9	533.0	477.5	541.3	522.0	485.8	546.9	569.5	551.3	569.3
5	576.4	574.7	519.6	575.6	577.0	533.4	589.0	605.2	588.9	609.2
6	603.1	601.1	549.6	597.1	608.5	565.4	613.4	627.5	612.8	634.4
7	625.8	625.6	579.6	621.5	637.0	596.0	632.3	647.2	635.2	656.3
8	645.2	647.4	604.7	645.3	660.2	622.4	653.1	664.0	655.3	674.5
9	662.5	661.1	626.3	658.0	671.5	637.8	668.4	674.7	665.7	686.0
10	678.1	679.7	646.8	677.5	690.3	660.4	683.2	692.6	684.5	702.4
11	692.3	690.5	662.3	690.5	701.4	673.7	692.0	699.9	693.0	710.8
12	705.2	706.6	677.0	705.6	719.7	691.4	705.3	715.5	711.0	726.9
13	717.1	715.4	688.2	716.3	732.7	703.4	708.8	721.2	717.6	735.3
14	728.1	728.8	703.0	728.1	745.9	718.8	723.3	731.9	731.0	748.1
15	738.4	738.6	713.1	739.8	755.8	731.1	729.6	742.2	740.7	756.8
16	748.2	748.0	725.9	747.1	761.6	741.9	745.1	748.9	748.3	765.0
17	757.2	758.4	736.1	758.8	773.7	754.7	750.2	759.2	759.0	775.2
18	765.7	763.7	744.4	764.9	778.0	759.7	754.6	763.7	763.7	780.3
19	773.7	775.0	752.6	774.9	789.0	774.3	760.4	776.3	780.0	792.5
20	781.4	779.5	760.6	780.6	793.2	778.4	766.6	778.2	781.6	797.1
21	788.6	788.9	769.5	790.3	804.3	790.0	776.8	786.5	788.8	804.7
22	795.6	793.9	776.6	796.2	807.9	795.4	782.1	791.0	792.8	809.2
23	802.2	801.8	784.2	803.0	814.5	803.7	789.2	799.9	802.1	817.5
24	808.5	807.6	789.9	807.9	821.4	808.7	792.5	806.1	810.6	823.9
25	814.6	813.6	796.3	813.7	827.3	816.0	799.7	811.0	814.4	830.7
26	820.5	820.3	802.1	820.5	834.2	823.9	805.0	816.2	822.9	837.8
27	826.1	825.0	808.3	823.4	839.1	828.8	809.7	821.1	827.2	842.6
28	831.5	831.7	812.7	829.3	845.3	836.9	818.8	826.6	834.1	849.6
29	836.7	835.0	817.7	833.7	850.2	840.3	821.3	828.7	835.0	852.8
30	841.8	842.1	823.5	840.3	857.7	848.0	827.7	836.0	843.3	860.4
31	846.7	844.5	827.4	842.1	860.5	851.4	830.5	836.5	845.0	862.7
32	851.4	850.9	833.7	849.7	867.7	858.6	836.8	842.7	849.3	868.3
33	856.0	855.4	837.5	851.8	873.0	864.0	840.8	847.1	855.0	873.9
34	860.5	859.5	842.7	856.6	875.0	867.5	845.4	852.2	858.7	877.7
35	864.8	864.3	846.9	861.0	881.8	873.6	850.4	855.7	862.9	881.7
36	869.0	866.9	850.9	863.6	883.6	876.2	852.5	858.5	865.3	884.4
37	873.1	873.5	854.9	870.3	891.7	884.4	858.8	863.4	872.8	892.0
38	877.1	875.1	858.7	870.9	892.7	885.7	861.8	865.5	873.2	892.6
39	881.0	881.2	863.1	876.9	899.9	893.0	866.2	871.3	880.3	899.0
40	884.7	882.9	866.5	878.5	900.9	894.4	869.0	873.2	881.0	899.9
41	888.4	888.5	871.3	884.4	907.6	901.3	874.1	878.5	885.6	905.5
42	892.0	891.2	874.1	886.8	909.2	903.1	876.8	881.8	889.0	908.6

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TIME (Minute)	BS476 (°C)	MEAN (°C)	TC _F 1 (°C)	TC _F 2 (°C)	TC _F 3 (°C)	TC _F 4 (°C)	TC _F 5 (°C)	TC _F 6 (°C)	TC _F 7 (°C)	TC _F 8 (°C)
43	895.5	894.6	879.2	889.7	911.8	906.1	880.5	885.8	892.6	911.2
44	899.0	898.9	882.2	893.4	917.7	911.9	886.5	888.7	896.3	914.5
45	902.3	901.0	885.6	894.6	917.2	912.8	887.9	892.2	898.6	918.7
46	905.6	905.9	889.7	901.4	923.1	918.3	894.4	895.8	902.9	921.9
47	908.7	906.4	891.9	900.4	923.1	918.9	893.6	896.6	903.1	923.7
48	911.9	912.4	896.7	907.3	930.1	925.7	900.4	902.7	908.3	927.7
49	915.0	914.5	899.5	909.2	932.5	927.8	901.9	904.4	910.4	929.9
50	918.0	917.6	902.9	910.2	934.2	930.7	905.5	907.6	915.2	934.3
51	921.0	920.9	905.7	916.0	937.6	933.5	910.2	910.9	916.9	936.3
52	923.9	922.6	908.7	916.6	939.5	935.7	911.1	912.5	918.2	938.1
53	926.8	927.5	912.2	922.1	945.0	941.3	917.1	917.4	923.1	941.4
54	929.6	927.8	914.7	921.6	943.9	940.6	916.8	918.2	923.6	943.0
55	932.3	933.5	919.1	928.5	951.3	946.4	922.5	924.1	928.9	946.8
56	935.0	933.7	920.5	928.2	950.2	946.9	924.2	923.7	928.3	947.2
57	937.7	937.9	923.9	932.0	954.1	950.9	928.5	927.9	933.3	952.7
58	940.3	939.7	925.7	934.7	956.6	953.3	930.1	929.3	934.1	953.5
59	942.8	941.8	928.9	935.3	958.5	955.1	932.0	931.5	936.8	955.9
60	945.3	945.6	931.4	939.2	962.5	958.9	934.7	935.6	941.5	960.9
61	947.8	947.2	934.2	939.8	963.4	960.6	936.7	937.4	942.3	962.8
62	950.2	951.0	936.9	944.4	969.0	964.4	940.7	939.8	944.8	967.7
63	952.6	949.8	936.5	941.3	972.1	961.5	938.0	938.3	943.1	967.3
64	955.0	954.5	939.8	947.3	974.3	968.6	944.8	941.9	948.2	971.1
65	957.3	956.4	941.8	950.5	975.3	970.9	945.6	944.9	950.3	971.9
66	959.6	958.9	945.2	952.5	977.8	973.5	947.9	947.9	953.1	973.4
67	961.8	962.6	947.4	955.7	981.8	977.5	952.3	951.6	956.9	977.2
68	964.1	963.3	950.2	956.7	981.4	977.2	954.9	951.8	957.1	977.1
69	966.2	967.7	953.5	961.3	985.0	981.5	957.7	957.4	962.4	982.4
70	968.4	967.2	954.7	960.2	984.3	980.7	958.5	956.4	961.1	981.3
71	970.5	971.4	957.9	964.9	989.4	985.1	962.4	960.3	965.7	985.4
72	972.6	971.4	958.6	964.1	988.0	984.9	961.9	961.1	966.1	986.4
73	974.7	974.4	961.7	967.5	991.6	988.6	966.1	963.7	968.6	987.4
74	976.7	976.1	962.9	969.7	993.8	990.5	967.6	965.0	970.0	989.3
75	978.7	978.2	965.5	971.5	994.8	991.8	969.3	967.2	972.2	993.3
76	980.7	980.6	967.5	974.4	997.9	994.9	972.7	969.6	974.3	993.4
77	982.6	981.1	969.1	974.6	998.1	995.2	974.5	969.5	974.4	993.7
78	984.6	985.0	971.7	977.8	1001.9	999.3	976.2	974.5	979.8	999.1
79	986.5	984.0	972.2	977.6	1000.8	998.8	973.4	972.3	978.0	999.2
80	988.4	988.1	975.1	980.9	1006.3	1003.7	977.5	976.4	982.4	1002.4
81	990.2	990.2	976.7	983.4	1008.0	1005.4	978.2	979.0	984.8	1005.7
82	992.1	991.5	979.1	984.5	1009.0	1007.2	980.6	980.1	985.6	1005.6
83	993.9	994.4	980.4	988.4	1013.0	1009.9	983.3	982.6	988.6	1008.7
84	995.7	995.4	982.5	989.2	1014.0	1011.5	984.0	983.3	989.2	1009.6
85	997.4	998.5	984.9	991.6	1016.1	1014.0	988.7	987.2	992.6	1012.6
86	999.2	996.7	985.0	989.9	1014.4	1011.6	987.2	985.3	990.2	1009.7
87	1000.9	1000.6	987.5	994.3	1018.6	1015.5	991.4	988.9	994.0	1014.6
88	1002.6	1000.9	987.9	993.8	1018.5	1016.2	991.3	989.3	994.4	1015.8
89	1004.3	1004.4	990.5	996.8	1021.9	1019.7	993.9	993.9	998.7	1019.5
90	1006.0	1005.1	991.1	997.0	1023.5	1021.5	994.5	993.4	998.6	1020.8

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TIME (Minute)	BS476 (°C)	MEAN (°C)	TC _F 1 (°C)	TC _F 2 (°C)	TC _F 3 (°C)	TC _F 4 (°C)	TC _F 5 (°C)	TC _F 6 (°C)	TC _F 7 (°C)	TC _F 8 (°C)
91	1007.6	1006.2	993.1	998.0	1024.1	1022.1	996.2	995.3	999.4	1021.6
92	1009.3	1009.5	995.0	1000.4	1027.2	1025.3	1000.9	999.1	1003.2	1025.0
93	1010.9	1009.9	996.6	997.9	1027.6	1025.3	1001.5	1000.1	1004.3	1025.6
94	1012.5	1012.2	999.2	1000.2	1029.0	1025.0	1005.1	1003.8	1007.2	1028.1
95	1014.1	1012.0	999.1	1000.0	1027.8	1024.3	1005.1	1003.8	1007.1	1028.7

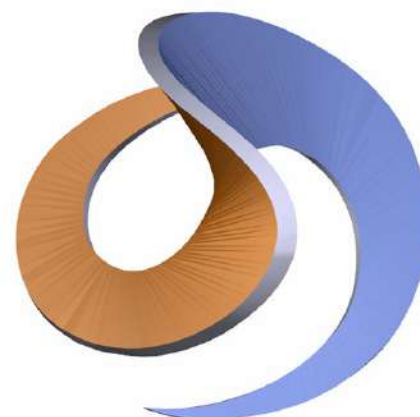


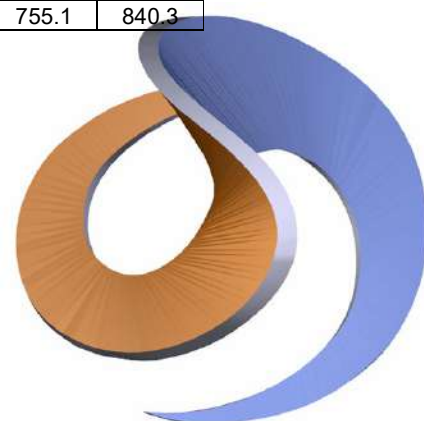
Table 2: Specimen A- Mean, Maximum and Individual Specimen Thermocouple Temperatures (TC_{SA})

TIME (Min.)	TC _{SA1} (°C)	TC _{SA2} (°C)	TC _{SA3} (°C)	TC _{SA4} (°C)	TC _{SA5} (°C)	TC _{SA6} (°C)	MEAN A (°C)	MAX A (°C)
0	30.4	30.4	28.8	29.8	30.7	30.6	30.1	30.7
1	48.5	49.4	44.5	41.7	44.7	48.7	46.3	49.4
2	91.9	94.0	71.1	65.7	81.6	94.0	83.1	94.0
3	117.8	119.1	84.2	78.9	107.0	119.8	104.5	119.8
4	139.7	140.7	98.2	92.2	125.2	142.7	123.1	142.7
5	162.2	163.7	116.2	108.7	146.8	165.8	143.9	165.8
6	183.9	185.6	134.6	125.6	168.8	187.1	164.3	187.1
7	202.3	204.2	153.7	144.2	189.9	204.9	183.2	204.9
8	217.1	218.8	172.5	163.0	207.5	218.7	199.6	218.8
9	229.0	230.8	190.6	181.4	221.8	230.4	214.0	230.8
10	239.2	240.9	207.5	199.0	233.0	240.2	226.6	240.9
11	247.8	249.8	221.3	214.5	242.3	248.9	237.4	249.8
12	256.0	257.9	232.9	227.2	250.4	256.9	246.9	257.9
13	262.6	264.9	242.4	238.0	257.7	264.2	255.0	264.9
14	268.7	271.3	250.5	247.1	264.3	270.6	262.1	271.3
15	274.5	277.5	258.0	255.2	270.6	276.7	268.8	277.5
16	280.0	283.0	264.3	262.1	276.5	282.3	274.7	283.0
17	285.2	288.2	270.0	268.4	281.9	287.7	280.2	288.2
18	290.3	293.0	275.4	274.1	287.2	292.9	285.5	293.0
19	295.0	297.6	280.4	279.2	292.2	297.8	290.4	297.8
20	299.6	302.0	285.1	283.9	296.9	302.2	295.0	302.2
21	304.0	306.4	289.4	288.3	301.6	306.9	299.4	306.9
22	308.4	310.7	293.5	292.6	305.9	311.3	303.7	311.3
23	312.7	314.8	297.6	296.4	310.3	315.7	307.9	315.7
24	316.9	319.0	301.4	300.3	314.5	319.9	312.0	319.9
25	321.1	322.9	305.2	303.8	318.6	323.9	315.9	323.9
26	325.2	327.1	308.8	307.6	322.6	328.2	319.9	328.2
27	329.4	331.4	312.3	311.0	326.7	332.6	323.9	332.6
28	333.8	335.9	315.9	314.6	330.8	337.5	328.1	337.5
29	338.7	340.8	319.5	318.0	335.2	342.4	332.4	342.4
30	343.8	345.9	322.9	321.3	339.8	347.6	336.9	347.6
31	349.1	350.9	326.5	324.7	344.5	352.9	341.4	352.9
32	354.6	356.1	330.1	328.2	349.3	358.6	346.2	358.6
33	360.5	361.5	333.9	331.8	354.4	364.4	351.1	364.4
34	366.6	367.0	337.6	335.3	359.5	370.2	356.0	370.2
35	372.7	372.5	341.4	338.7	364.9	376.4	361.1	376.4
36	379.1	378.2	345.2	342.2	370.2	382.4	366.2	382.4
37	385.7	383.8	349.2	345.9	375.9	388.7	371.5	388.7
38	392.4	389.5	353.3	349.5	381.7	394.8	376.9	394.8
39	399.3	395.2	357.5	353.1	387.5	401.1	382.3	401.1
40	406.4	401.1	361.9	356.9	393.3	407.3	387.8	407.3
41	413.5	406.8	366.6	360.9	399.2	413.6	393.4	413.6
42	420.7	412.7	371.6	365.0	405.0	420.1	399.2	420.7
43	427.9	418.4	376.7	369.1	411.1	426.2	404.9	427.9
44	435.2	424.2	382.1	373.6	417.0	432.7	410.8	435.2
45	442.3	430.0	387.8	378.1	422.7	439.1	416.7	442.3
46	449.4	435.6	393.6	382.6	428.5	445.5	422.5	449.4
47	456.5	441.3	399.5	387.3	434.0	451.9	428.4	456.5
48	463.7	447.2	405.7	392.4	439.7	458.3	434.5	463.7
49	470.6	452.9	412.0	397.3	445.4	464.6	440.5	470.6
50	477.7	458.8	418.4	402.5	451.3	471.1	446.6	477.7

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TIME (Min.)	TC _{SA1} (°C)	TC _{SA2} (°C)	TC _{SA3} (°C)	TC _{SA4} (°C)	TC _{SA5} (°C)	TC _{SA6} (°C)	MEAN A (°C)	MAX A (°C)
51	484.8	464.7	424.9	407.9	457.2	477.6	452.9	484.8
52	491.8	470.4	431.2	413.3	462.9	483.9	458.9	491.8
53	499.1	476.5	438.0	419.0	469.0	490.6	465.4	499.1
54	506.1	482.2	444.5	424.4	474.8	497.0	471.5	506.1
55	513.4	488.0	451.3	430.0	480.8	503.6	477.9	513.4
56	520.4	493.8	458.0	435.4	486.7	510.1	484.1	520.4
57	527.6	499.6	464.7	441.0	492.7	516.7	490.4	527.6
58	534.7	505.4	471.4	446.6	498.6	523.3	496.7	534.7
59	541.7	511.3	478.3	452.2	504.7	530.1	503.1	541.7
60	548.8	517.2	485.0	457.9	510.6	536.7	509.4	548.8
61	556.0	523.0	491.6	463.6	516.5	543.4	515.7	556.0
62	562.8	528.9	498.4	469.2	522.4	549.9	521.9	562.8
63	569.5	534.8	505.1	474.9	528.4	556.5	528.2	569.5
64	576.2	540.7	512.0	480.8	534.4	563.1	534.5	576.2
65	582.8	546.5	518.6	486.5	540.3	569.6	540.7	582.8
66	589.0	552.4	525.3	492.3	546.3	576.2	546.9	589.0
67	595.5	558.5	532.0	498.3	552.5	582.6	553.2	595.5
68	601.4	564.2	538.4	503.9	558.4	589.0	559.2	601.4
69	607.6	570.1	545.0	509.8	564.5	595.5	565.4	607.6
70	613.3	575.9	551.4	515.5	570.4	601.5	571.3	613.3
71	619.2	581.8	558.0	521.3	576.6	607.7	577.4	619.2
72	624.6	587.4	564.3	527.2	582.7	613.7	583.3	624.6
73	630.3	593.2	570.7	532.9	588.7	619.6	589.2	630.3
74	635.9	598.9	577.2	538.8	594.9	625.5	595.2	635.9
75	641.3	604.5	583.6	544.5	600.6	631.1	600.9	641.3
76	646.7	610.0	589.9	550.2	606.4	636.6	606.6	646.7
77	652.0	615.3	596.3	555.9	611.8	641.8	612.2	652.0
78	657.4	620.7	602.5	561.6	617.4	647.3	617.8	657.4
79	662.7	625.8	608.7	567.2	622.8	652.0	623.2	662.7
80	668.0	631.2	614.9	572.9	628.4	657.2	628.8	668.0
81	673.8	636.6	621.6	578.9	634.1	662.3	634.6	673.8
82	679.6	641.5	627.7	584.1	639.3	667.0	639.9	679.6
83	686.1	646.7	634.2	589.9	644.6	671.8	645.6	686.1
84	692.9	651.5	640.2	595.5	649.4	676.5	651.0	692.9
85	700.6	656.7	646.3	601.1	654.3	681.3	656.7	700.6
86	708.0	661.5	651.7	606.3	658.9	685.8	662.0	708.0
87	715.9	666.8	657.6	612.1	664.1	690.8	667.9	715.9
88	723.1	672.4	663.4	617.8	669.7	696.1	673.8	723.1
89	730.7	678.2	669.1	623.8	677.6	702.9	680.4	730.7
90	737.5	683.5	674.3	629.3	723.5	711.8	693.3	737.5
91	742.9	689.4	680.4	635.6	750.5	727.7	704.4	750.5
92	744.8	696.0	687.2	642.8	768.9	748.7	714.7	768.9
93	747.1	702.0	694.0	650.2	793.7	773.8	726.8	793.7
94	754.6	708.8	701.5	659.0	816.9	811.2	742.0	816.9
95	762.7	715.4	708.8	668.4	834.8	840.3	755.1	840.3



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Table 3: Specimen B Mean, Maximum and Individual Specimen Thermocouple Temperatures (TC_{SB})

TIME (Min.)	TC _{SB1} (°C)	TC _{SB2} (°C)	TC _{SB3} (°C)	TC _{SB4} (°C)	TC _{SB5} (°C)	TC _{SB6} (°C)	MEAN B (°C)	MAX B (°C)
0	29.4	29.3	28.5	29.9	29.1	29.5	29.3	29.9
1	44.2	35.4	38.5	35.7	42.2	37.8	39.0	44.2
2	83.8	62.5	61.9	55.2	81.0	70.6	69.2	83.8
3	108.4	86.0	77.0	69.9	106.8	98.6	91.1	108.4
4	126.4	102.7	90.6	82.4	126.5	114.8	107.2	126.5
5	144.9	117.6	104.9	96.5	145.5	133.7	123.9	145.5
6	162.3	137.3	119.5	108.5	163.8	152.7	140.7	163.8
7	176.8	157.0	136.1	122.2	178.8	168.7	156.6	178.8
8	189.1	174.2	152.7	138.3	191.8	181.9	171.3	191.8
9	199.7	188.8	168.5	154.1	203.3	193.4	184.6	203.3
10	209.1	201.1	183.2	169.1	213.2	203.4	196.5	213.2
11	217.6	211.5	195.9	182.7	221.3	212.4	206.9	221.3
12	225.5	220.8	206.6	194.9	228.8	220.8	216.2	228.8
13	232.7	229.0	216.2	205.9	235.6	228.6	224.7	235.6
14	238.9	236.6	226.8	215.3	241.6	236.1	232.6	241.6
15	245.2	244.5	236.2	223.9	247.1	242.9	240.0	247.1
16	251.9	252.4	243.8	231.9	252.3	249.0	246.9	252.4
17	257.6	260.7	250.7	239.5	257.5	254.8	253.5	260.7
18	263.0	267.4	256.6	246.1	262.0	260.9	259.3	267.4
19	268.5	273.6	262.1	252.3	266.9	266.3	265.0	273.6
20	273.9	279.6	267.0	258.1	271.6	271.7	270.3	279.6
21	279.0	285.2	271.8	263.4	276.0	277.2	275.4	285.2
22	284.1	290.7	276.7	268.5	280.6	282.6	280.5	290.7
23	289.2	296.0	281.6	273.4	284.8	287.8	285.5	296.0
24	294.0	300.9	286.3	278.3	289.0	292.7	290.2	300.9
25	298.5	305.5	290.8	282.7	293.0	297.6	294.7	305.5
26	303.1	310.1	295.3	287.1	297.0	302.3	299.2	310.1
27	307.5	314.4	299.8	291.0	300.8	306.8	303.4	314.4
28	311.9	318.7	304.3	294.8	304.7	311.1	307.6	318.7
29	316.2	322.7	308.9	298.7	308.3	315.1	311.7	322.7
30	320.5	326.8	313.2	302.4	312.1	319.1	315.7	326.8
31	324.6	330.7	317.7	306.0	315.8	323.0	319.6	330.7
32	328.9	334.8	322.1	309.6	319.4	327.4	323.7	334.8
33	333.1	339.0	325.9	312.0	323.4	332.0	327.6	339.0
34	337.8	343.3	331.9	313.9	327.4	336.5	331.8	343.3
35	342.5	347.6	336.5	317.0	331.4	341.2	336.0	347.6
36	347.4	352.2	340.5	320.6	336.0	346.0	340.5	352.2
37	352.4	356.5	344.2	324.5	340.5	351.1	344.9	356.5
38	357.7	361.2	347.4	329.0	345.3	356.5	349.5	361.2
39	363.2	365.8	350.8	333.9	350.2	361.7	354.3	365.8
40	368.8	369.9	354.1	338.7	354.8	367.0	358.9	369.9
41	374.4	373.6	357.4	343.3	359.4	372.5	363.4	374.4
42	380.0	377.7	360.9	347.9	364.3	378.3	368.2	380.0
43	385.8	382.2	364.5	352.3	369.4	384.2	373.1	385.8
44	391.8	387.1	368.1	356.7	375.3	390.5	378.3	391.8
45	398.4	392.1	371.3	361.2	380.8	396.8	383.4	398.4
46	404.9	397.0	374.5	365.6	386.5	403.1	388.6	404.9
47	411.8	401.9	378.3	370.1	392.4	409.7	394.0	411.8
48	418.9	407.0	382.5	374.5	398.4	416.3	399.6	418.9
49	426.4	412.2	387.4	378.9	404.0	423.2	405.4	426.4
50	433.8	417.4	392.7	383.6	410.1	429.9	411.3	433.8

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TIME (Min.)	TC _{SB1} (°C)	TC _{SB2} (°C)	TC _{SB3} (°C)	TC _{SB4} (°C)	TC _{SB5} (°C)	TC _{SB6} (°C)	MEAN B (°C)	MAX B (°C)
51	441.1	422.8	398.2	388.3	416.0	436.8	417.2	441.1
52	448.6	428.0	404.1	393.1	421.9	443.7	423.2	448.6
53	456.2	433.6	410.4	398.1	428.0	450.7	429.5	456.2
54	463.7	439.0	416.7	403.1	433.8	457.5	435.6	463.7
55	471.3	444.7	423.3	408.4	439.6	464.4	442.0	471.3
56	478.6	450.0	429.9	413.9	445.3	471.2	448.2	478.6
57	485.9	455.5	437.0	419.3	451.1	478.1	454.5	485.9
58	493.3	461.2	443.7	424.9	456.7	484.8	460.8	493.3
59	500.5	466.7	450.5	430.5	462.3	491.5	467.0	500.5
60	507.7	472.4	457.5	436.3	468.0	498.5	473.4	507.7
61	514.7	477.9	464.3	442.0	474.0	505.2	479.7	514.7
62	521.7	483.5	471.2	447.7	479.2	512.1	485.9	521.7
63	528.5	489.0	478.0	453.2	484.9	518.9	492.1	528.5
64	535.2	494.7	484.9	459.0	490.4	525.8	498.3	535.2
65	541.6	500.5	491.7	464.7	496.0	532.7	504.5	541.6
66	547.8	506.1	498.6	470.4	501.7	539.6	510.7	547.8
67	554.1	511.8	505.6	476.4	507.3	546.5	517.0	554.1
68	560.1	517.3	512.2	482.0	512.9	553.4	523.0	560.1
69	566.3	523.1	519.0	487.9	518.4	560.4	529.2	566.3
70	572.0	528.5	525.6	493.4	524.0	567.0	535.1	572.0
71	577.9	534.2	532.2	499.3	529.9	573.9	541.2	577.9
72	583.6	539.8	538.8	505.0	535.5	580.6	547.2	583.6
73	589.3	545.4	545.3	510.7	541.1	587.2	553.2	589.3
74	594.9	550.9	551.8	516.4	546.9	593.9	559.1	594.9
75	600.3	556.6	558.2	522.0	552.6	600.5	565.0	600.5
76	605.7	562.0	564.5	527.7	558.3	606.8	570.8	606.8
77	611.0	567.5	570.7	533.2	564.0	612.8	576.5	612.8
78	616.3	573.2	576.9	538.8	569.7	619.0	582.3	619.0
79	621.3	578.6	582.9	544.3	575.3	624.7	587.9	624.7
80	626.6	584.2	588.9	550.0	581.2	630.5	593.6	630.5
81	631.9	589.8	595.0	555.8	587.2	636.1	599.3	636.1
82	636.9	595.1	600.7	561.1	592.5	641.2	604.6	641.2
83	641.9	600.6	606.7	566.7	598.6	646.4	610.2	646.4
84	646.9	605.8	612.3	572.1	604.2	651.5	615.5	651.5
85	651.9	611.1	618.1	577.6	609.1	656.6	620.7	656.6
86	656.7	616.0	623.8	582.8	614.4	661.5	625.9	661.5
87	661.8	621.4	629.6	588.3	619.7	666.6	631.2	666.6
88	666.6	626.7	635.3	593.6	624.5	671.5	636.4	671.5
89	671.8	632.1	640.9	598.9	629.4	676.6	641.6	676.6
90	676.5	637.3	646.7	604.2	634.2	681.3	646.7	681.3
91	681.6	643.0	652.4	609.6	638.6	686.0	651.9	686.0
92	686.7	649.3	658.4	615.0	643.7	690.9	657.3	690.9
93	692.0	655.2	664.3	620.2	648.1	695.5	662.6	695.5
94	698.0	661.8	670.2	625.5	652.7	700.1	668.1	700.1
95	704.6	668.0	675.4	630.5	657.6	704.6	673.5	704.6

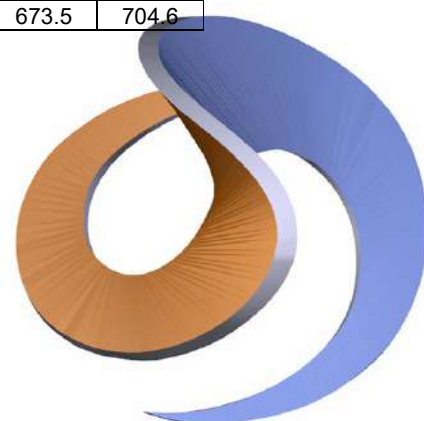


Table 4: Specimen C Mean, Maximum and Individual Specimen Thermocouple Temperatures (TC_{sc})

TIME (Min.)	TC _{sc} 1 (°C)	TC _{sc} 2 (°C)	TC _{sc} 3 (°C)	TC _{sc} 4 (°C)	TC _{sc} 5 (°C)	TC _{sc} 6 (°C)	MEAN C (°C)	MAX C (°C)
0	28.2	28.3	28.3	28.5	29.4	29.3	28.7	29.4
1	53.9	46.8	59.6	54.9	53.2	48.5	52.8	59.6
2	105.3	91.2	119.4	115.6	104.4	94.4	105.1	119.4
3	135.0	120.1	156.7	154.2	133.1	122.7	137.0	156.7
4	158.7	144.6	185.1	182.9	156.3	145.9	162.3	185.1
5	181.9	171.6	210.2	208.1	180.1	171.5	187.2	210.2
6	201.6	196.9	229.5	227.3	201.3	194.2	208.5	229.5
7	217.3	217.5	244.2	241.9	218.2	213.8	225.5	244.2
8	231.3	234.1	256.1	254.0	231.8	230.2	239.6	256.1
9	244.0	247.1	266.1	264.1	243.2	243.5	251.3	266.1
10	254.7	257.7	275.2	273.4	253.5	254.6	261.5	275.2
11	264.3	266.5	283.0	281.3	262.7	263.9	270.3	283.0
12	272.4	274.3	290.2	288.5	271.0	272.1	278.1	290.2
13	279.5	281.0	296.6	295.0	278.5	279.2	285.0	296.6
14	285.9	287.1	302.6	301.2	285.2	285.5	291.3	302.6
15	291.9	292.6	308.5	307.2	291.4	291.4	297.2	308.5
16	297.8	298.0	314.1	312.7	297.2	296.9	302.8	314.1
17	302.9	302.8	319.6	318.2	302.6	302.1	308.0	319.6
18	308.1	307.7	324.9	323.3	308.2	307.4	313.3	324.9
19	313.3	312.6	329.9	328.1	313.2	312.3	318.2	329.9
20	318.4	317.4	335.2	333.1	318.5	317.4	323.3	335.2
21	323.5	322.3	340.8	338.0	323.7	322.3	328.4	340.8
22	328.7	327.1	346.8	343.2	328.9	327.3	333.7	346.8
23	334.1	332.1	353.3	348.5	334.3	332.5	339.1	353.3
24	339.8	337.3	359.9	354.3	339.5	337.7	344.8	359.9
25	345.5	342.5	367.2	360.7	345.1	343.0	350.7	367.2
26	351.4	347.8	375.3	367.9	350.8	348.5	357.0	375.3
27	357.3	353.2	383.8	375.8	356.4	354.0	363.4	383.8
28	363.4	358.7	393.0	384.2	362.4	359.7	370.2	393.0
29	369.6	364.4	402.4	393.3	368.4	365.6	377.3	402.4
30	375.9	370.1	411.9	402.6	374.7	371.8	384.5	411.9
31	382.2	376.1	421.4	411.9	380.7	377.9	391.7	421.4
32	388.9	382.2	431.0	421.3	387.1	384.4	399.2	431.0
33	395.6	388.5	440.8	430.6	393.6	391.1	406.7	440.8
34	402.5	394.9	450.6	440.0	400.2	398.0	414.4	450.6
35	409.7	401.4	460.5	449.3	406.8	405.0	422.1	460.5
36	416.9	407.9	470.3	458.6	413.5	412.0	429.9	470.3
37	424.2	414.6	480.1	467.7	420.3	419.3	437.7	480.1
38	431.4	421.3	489.8	476.9	427.3	426.7	445.6	489.8
39	438.9	427.9	499.7	486.0	434.2	434.0	453.5	499.7
40	446.5	434.7	509.4	495.1	441.2	441.6	461.4	509.4
41	454.1	441.7	519.0	504.1	448.4	449.3	469.4	519.0
42	461.9	448.7	529.0	513.0	455.6	457.1	477.6	529.0
43	469.7	455.8	538.8	522.0	462.8	464.9	485.7	538.8
44	477.6	462.9	548.5	531.0	470.0	472.9	493.8	548.5
45	485.5	469.9	558.5	539.8	477.3	480.8	502.0	558.5
46	493.5	477.1	568.3	548.7	484.6	488.8	510.2	568.3
47	501.5	484.3	578.0	557.5	491.9	497.1	518.4	578.0
48	509.6	491.6	587.7	566.3	499.3	505.1	526.6	587.7
49	517.5	499.0	597.3	575.1	506.7	513.4	534.8	597.3
50	525.8	506.3	606.9	583.7	513.9	521.6	543.0	606.9

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TIME (Min.)	TC _{sc1} (°C)	TC _{sc2} (°C)	TC _{sc3} (°C)	TC _{sc4} (°C)	TC _{sc5} (°C)	TC _{sc6} (°C)	MEAN C (°C)	MAX C (°C)
51	533.7	513.6	616.2	592.3	521.2	529.8	551.1	616.2
52	541.6	520.9	625.4	600.7	528.6	538.0	559.2	625.4
53	549.7	528.3	634.6	609.3	535.9	546.3	567.4	634.6
54	557.7	535.4	643.4	617.5	543.2	554.4	575.3	643.4
55	565.6	542.7	652.1	625.6	550.2	562.3	583.1	652.1
56	573.6	550.0	660.6	633.7	557.4	570.3	590.9	660.6
57	581.3	557.1	668.8	641.7	564.4	578.4	598.6	668.8
58	589.0	564.3	676.9	649.5	571.3	586.2	606.2	676.9
59	596.5	571.3	684.6	657.2	578.1	594.0	613.6	684.6
60	604.0	578.5	692.3	664.9	584.7	601.6	621.0	692.3
61	611.3	585.4	699.6	672.4	591.4	609.3	628.2	699.6
62	618.4	592.5	706.5	679.8	598.0	616.9	635.4	706.5
63	625.4	599.3	712.6	686.7	604.6	624.3	642.2	712.6
64	632.3	606.2	718.8	693.6	611.1	631.6	648.9	718.8
65	639.0	612.7	723.9	700.1	617.3	638.7	655.3	723.9
66	645.6	619.3	726.0	706.3	623.6	645.7	661.1	726.0
67	652.0	625.7	727.8	712.2	629.8	652.4	666.7	727.8
68	658.5	632.1	730.8	717.8	635.8	659.0	672.3	730.8
69	664.7	638.2	734.6	722.7	642.0	665.5	678.0	734.6
70	670.8	644.2	738.6	725.4	647.7	671.8	683.1	738.6
71	676.9	650.1	743.2	726.6	653.5	678.3	688.1	743.2
72	682.6	655.8	747.4	728.3	659.2	684.8	693.0	747.4
73	688.4	661.4	752.0	731.0	664.8	691.4	698.2	752.0
74	694.2	667.0	756.8	734.5	670.5	697.8	703.5	756.8
75	700.1	672.6	761.6	738.3	676.0	703.9	708.8	761.6
76	706.2	678.3	766.6	742.7	681.4	709.4	714.1	766.6
77	712.1	683.9	771.6	747.1	686.8	714.6	719.4	771.6
78	717.8	689.6	776.4	751.6	692.2	719.4	724.5	776.4
79	731.6	709.3	781.1	756.4	697.5	723.3	733.2	781.1
80	751.1	725.9	785.8	761.3	702.6	726.4	742.2	785.8
81	777.7	734.1	790.6	766.3	708.0	729.0	751.0	790.6
82	802.0	750.2	795.3	771.1	713.4	732.5	760.8	802.0
83	827.1	767.7	800.1	775.8	718.4	737.0	771.0	827.1
84	850.2	784.1	804.6	780.0	722.6	742.8	780.7	850.2
85	868.4	799.8	809.4	784.6	726.1	749.9	789.7	868.4
86	883.0	815.5	814.0	788.8	728.1	758.8	798.0	883.0
87	895.3	830.5	818.8	793.2	730.8	769.3	806.3	895.3
88	905.6	843.8	823.5	797.5	739.8	786.2	816.1	905.6
89	915.2	855.8	828.1	801.7	757.5	807.3	827.6	915.2
90	923.3	866.2	832.7	806.0	776.2	827.3	838.6	923.3
91	931.1	875.9	837.4	810.4	794.1	844.5	848.9	931.1
92	938.4	884.8	842.2	815.2	812.1	858.0	858.5	938.4
93	946.0	892.3	847.4	820.3	829.8	869.5	867.6	946.0
94	953.5	900.4	853.6	826.5	846.1	879.7	876.6	953.5
95	959.6	908.7	881.9	863.6	859.9	897.6	895.2	959.6

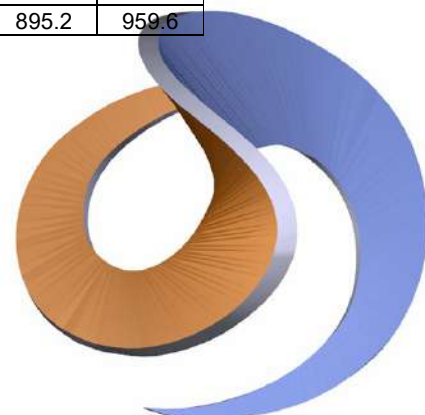
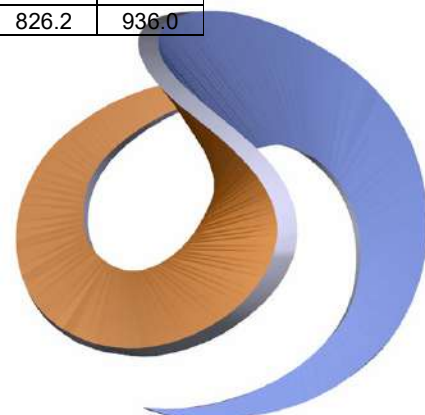


Table 5: Specimen D Mean, Maximum and Individual Specimen Thermocouple Temperatures (TC_{SD})

TIME (Min.)	TC _{SD1} (°C)	TC _{SD2} (°C)	TC _{SD3} (°C)	TC _{SD4} (°C)	TC _{SD5} (°C)	TC _{SD6} (°C)	MEAN D (°C)	MAX D (°C)
0	30.9	31.2	30.5	30.4	30.4	30.7	30.7	31.2
1	43.8	42.8	51.0	43.2	40.7	42.8	44.1	51.0
2	81.8	82.9	107.2	92.8	76.3	85.2	87.7	107.2
3	108.9	111.2	137.8	125.5	101.8	112.5	116.3	137.8
4	129.1	131.1	162.6	151.4	121.8	132.2	138.0	162.6
5	150.5	152.7	185.6	176.3	144.0	153.9	160.5	185.6
6	171.2	173.1	204.2	198.3	166.1	173.2	181.0	204.2
7	189.3	190.6	219.2	215.3	186.5	189.7	198.4	219.2
8	204.8	205.4	231.9	228.0	203.6	203.5	212.9	231.9
9	217.4	217.8	243.2	238.2	217.3	215.3	224.9	243.2
10	227.9	228.2	253.0	247.3	228.6	225.7	235.1	253.0
11	236.5	236.9	261.7	254.8	237.6	234.6	243.7	261.7
12	244.1	244.8	269.8	262.5	245.4	242.6	251.5	269.8
13	250.8	251.9	277.5	270.4	252.3	249.9	258.8	277.5
14	257.3	258.6	285.4	278.6	258.6	256.9	265.9	285.4
15	263.4	264.7	292.7	286.5	264.6	263.6	272.6	292.7
16	269.0	270.5	299.6	293.4	270.2	269.9	278.8	299.6
17	274.4	275.9	306.4	304.0	275.5	275.8	285.3	306.4
18	279.5	281.2	313.4	312.6	280.4	281.2	291.4	313.4
19	284.4	286.2	320.6	322.2	285.2	286.3	297.5	322.2
20	289.3	291.1	327.1	332.5	289.9	291.4	303.6	332.5
21	294.0	295.8	333.4	342.2	294.3	296.3	309.3	342.2
22	298.6	300.4	340.2	351.4	298.9	301.2	315.1	351.4
23	303.0	305.0	347.1	360.7	303.4	306.0	320.9	360.7
24	307.3	309.5	354.4	370.1	307.8	310.7	326.6	370.1
25	311.7	314.1	361.7	379.8	312.4	315.5	332.5	379.8
26	316.2	318.8	369.8	389.9	316.9	320.3	338.7	389.9
27	320.7	323.4	378.1	400.4	321.3	325.1	344.8	400.4
28	325.2	327.9	386.8	410.7	325.9	330.0	351.1	410.7
29	329.6	332.5	396.3	420.9	330.3	334.9	357.4	420.9
30	334.3	337.0	406.4	431.1	334.9	339.7	363.9	431.1
31	338.7	341.5	416.4	440.9	339.2	344.7	370.2	440.9
32	343.5	346.1	427.0	451.0	344.0	349.9	376.9	451.0
33	348.1	350.8	436.5	460.1	348.4	354.8	383.1	460.1
34	352.7	355.2	446.1	469.1	353.0	360.3	389.4	469.1
35	357.5	359.9	455.3	477.7	357.6	365.9	395.7	477.7
36	362.3	364.5	464.3	485.9	362.2	371.4	401.8	485.9
37	367.1	369.4	473.0	494.2	367.1	377.2	408.0	494.2
38	372.5	374.3	481.5	502.5	371.9	382.8	414.3	502.5
39	377.6	379.3	489.7	510.5	376.8	388.7	420.4	510.5
40	383.1	384.7	497.9	518.8	382.1	395.0	426.9	518.8
41	388.7	390.1	506.3	527.2	387.7	401.2	433.5	527.2
42	394.5	395.6	514.8	535.8	393.4	407.6	440.3	535.8
43	400.5	401.1	523.2	544.6	399.0	413.9	447.1	544.6
44	406.9	406.8	531.7	553.3	404.9	420.3	454.0	553.3
45	413.3	412.3	539.9	561.8	411.0	427.0	460.9	561.8
46	419.9	417.9	548.0	570.6	417.2	433.8	467.9	570.6
47	426.5	423.7	556.4	579.1	423.2	440.7	474.9	579.1
48	433.3	429.5	564.9	587.5	429.4	447.7	482.1	587.5
49	440.2	435.5	573.7	596.9	435.7	454.8	489.5	596.9
50	447.1	441.5	583.6	607.3	442.1	462.1	497.3	607.3

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TIME (Min.)	TC _{SD1} (°C)	TC _{SD2} (°C)	TC _{SD3} (°C)	TC _{SD4} (°C)	TC _{SD5} (°C)	TC _{SD6} (°C)	MEAN D (°C)	MAX D (°C)
51	454.0	447.8	593.5	617.4	448.7	469.6	505.2	617.4
52	461.2	453.9	603.3	628.4	454.9	476.8	513.1	628.4
53	468.4	460.2	613.3	640.4	461.8	484.3	521.4	640.4
54	475.4	466.3	623.0	651.8	468.2	491.8	529.4	651.8
55	482.9	472.6	632.7	662.9	474.8	499.4	537.6	662.9
56	490.2	479.0	642.1	673.5	481.4	506.8	545.5	673.5
57	497.5	485.2	651.5	683.9	488.1	514.5	553.5	683.9
58	504.9	491.4	662.3	692.3	494.7	522.2	561.3	692.3
59	512.3	497.8	674.5	703.2	501.5	529.9	569.9	703.2
60	519.7	504.2	685.8	713.6	508.3	537.7	578.2	713.6
61	527.3	510.5	696.2	722.0	514.9	545.3	586.0	722.0
62	534.9	517.0	705.7	726.7	521.8	553.1	593.2	726.7
63	542.4	523.2	714.2	731.5	528.6	560.8	600.1	731.5
64	550.1	529.9	721.8	747.3	535.7	568.6	608.9	747.3
65	557.9	536.4	727.6	766.6	542.7	576.2	617.9	766.6
66	565.6	542.9	731.8	783.8	549.4	583.8	626.2	783.8
67	573.3	549.5	737.7	797.6	556.7	591.4	634.4	797.6
68	580.8	556.0	744.9	809.1	563.6	598.9	642.2	809.1
69	588.4	562.5	753.1	821.1	570.9	606.7	650.5	821.1
70	595.8	568.8	761.0	831.6	577.9	613.9	658.2	831.6
71	603.2	575.2	769.2	841.1	585.3	621.5	665.9	841.1
72	610.7	581.7	776.9	848.6	592.4	629.0	673.2	848.6
73	618.0	588.1	784.5	855.6	599.5	636.1	680.3	855.6
74	625.4	594.5	792.0	861.7	606.9	643.6	687.4	861.7
75	632.6	600.8	799.2	867.1	614.0	650.6	694.1	867.1
76	639.7	607.2	806.6	872.6	621.3	657.9	700.9	872.6
77	646.7	613.4	813.9	877.6	628.2	664.7	707.4	877.6
78	653.7	619.7	821.3	882.4	635.2	671.5	714.0	882.4
79	660.5	625.9	828.5	886.5	642.0	678.0	720.2	886.5
80	667.3	632.3	835.6	891.0	649.1	684.6	726.7	891.0
81	674.1	638.5	842.5	895.2	656.2	691.0	732.9	895.2
82	680.5	644.5	849.0	898.9	663.4	697.1	738.9	898.9
83	687.1	650.9	855.2	902.6	670.8	703.2	745.0	902.6
84	693.8	657.1	861.6	906.0	678.0	708.5	750.8	906.0
85	700.4	663.5	867.7	909.3	685.8	713.9	756.8	909.3
86	706.7	669.6	873.1	911.8	693.7	719.0	762.3	911.8
87	712.9	676.1	878.2	915.1	702.4	723.8	768.1	915.1
88	719.1	682.5	882.4	918.1	711.3	727.4	773.5	918.1
89	724.4	688.9	886.6	921.2	720.0	729.8	778.5	921.2
90	728.6	695.2	890.7	924.4	727.6	731.4	783.0	924.4
91	731.4	701.6	894.5	927.1	733.8	733.4	787.0	927.1
92	734.6	708.5	898.1	930.0	746.3	736.9	792.4	930.0
93	738.7	714.9	901.0	932.1	763.8	740.8	798.6	932.1
94	745.1	721.3	903.8	934.2	795.8	768.3	811.4	934.2
95	752.8	727.3	906.9	936.0	829.3	804.6	826.2	936.0



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Table 6: Specimen E Mean, Maximum and Individual Specimen Thermocouple Temperatures (TC_{SE})

TIME (Min.)	TC _{SE1} (°C)	TC _{SE2} (°C)	TC _{SE3} (°C)	TC _{SE4} (°C)	TC _{SE5} (°C)	TC _{SE6} (°C)	MEAN E (°C)	MAX E (°C)
0	28.8	29.1	31.4	31.3	28.2	28.3	29.5	31.4
1	44.8	43.1	52.3	47.8	40.7	44.2	45.5	52.3
2	92.9	85.3	108.1	97.0	81.5	91.7	92.8	108.1
3	125.7	115.7	142.2	128.8	112.3	123.4	124.7	142.2
4	151.1	139.3	168.6	152.7	135.4	148.0	149.2	168.6
5	175.9	164.1	194.4	177.4	160.0	172.5	174.1	194.4
6	198.5	187.9	217.2	201.8	183.6	194.2	197.2	217.2
7	216.9	208.8	233.4	222.6	204.5	212.5	216.5	233.4
8	231.0	225.0	245.3	237.6	221.1	226.8	231.1	245.3
9	242.1	237.4	255.1	248.8	233.9	237.9	242.5	255.1
10	251.6	247.6	263.7	258.2	244.3	247.6	252.2	263.7
11	259.9	256.3	271.5	266.8	253.0	256.1	260.6	271.5
12	267.5	264.3	278.7	274.6	260.9	263.8	268.3	278.7
13	274.5	271.4	284.6	281.2	268.0	271.0	275.1	284.6
14	280.6	277.7	290.1	287.0	274.4	277.6	281.2	290.1
15	286.5	283.8	295.1	292.1	280.3	283.6	286.9	295.1
16	292.0	289.5	300.1	296.7	285.7	289.3	292.2	300.1
17	297.4	294.7	304.6	301.1	290.9	294.8	297.3	304.6
18	302.5	299.8	309.2	305.5	296.0	300.1	302.2	309.2
19	307.8	304.9	313.3	309.6	300.9	305.3	307.0	313.3
20	313.0	309.7	317.6	313.7	306.0	310.5	311.8	317.6
21	318.2	314.6	321.5	317.6	310.8	315.7	316.4	321.5
22	323.5	319.5	325.1	321.5	315.7	320.8	321.0	325.1
23	328.9	324.1	328.9	325.2	320.6	326.2	325.7	328.9
24	334.4	329.2	332.5	328.6	325.6	331.7	330.3	334.4
25	339.7	334.0	336.0	331.8	330.4	337.1	334.8	339.7
26	345.2	338.9	339.1	335.0	335.4	342.6	339.4	345.2
27	350.7	344.0	342.1	338.0	340.3	348.2	343.9	350.7
28	356.2	348.9	345.3	340.9	345.3	354.0	348.4	356.2
29	362.1	354.0	348.1	343.5	350.7	359.9	353.1	362.1
30	368.0	359.1	350.9	346.1	358.6	366.3	358.2	368.0
31	374.2	364.3	353.7	348.6	368.2	372.9	363.7	374.2
32	380.6	369.8	356.5	351.1	378.9	379.8	369.5	380.6
33	387.2	375.5	359.2	353.3	389.8	387.1	375.4	389.8
34	393.6	381.4	362.1	355.6	400.6	394.9	381.4	400.6
35	400.3	387.4	365.4	357.8	411.1	403.2	387.5	411.1
36	407.0	393.4	369.4	360.4	421.3	411.8	393.9	421.3
37	414.0	399.4	373.9	363.4	431.0	420.7	400.4	431.0
38	421.0	405.4	379.2	366.8	440.5	429.6	407.1	440.5
39	428.1	411.6	385.8	370.6	449.8	438.8	414.1	449.8
40	435.3	417.6	393.3	374.7	459.3	448.3	421.4	459.3
41	442.8	423.8	402.3	379.6	469.2	457.9	429.3	469.2
42	450.1	429.8	412.2	384.7	479.6	467.7	437.4	479.6
43	457.9	436.2	423.3	391.1	490.0	477.7	446.0	490.0
44	465.2	442.2	434.3	397.9	500.1	487.4	454.5	500.1
45	472.8	448.5	445.3	406.0	510.0	497.3	463.3	510.0
46	480.6	454.6	455.7	415.2	519.7	507.3	472.2	519.7
47	488.4	460.9	465.9	424.8	529.3	517.1	481.1	529.3
48	496.5	467.3	475.9	434.8	538.6	527.1	490.0	538.6
49	504.6	473.7	485.7	444.5	547.7	536.9	498.9	547.7
50	512.9	480.2	495.6	454.1	556.6	546.7	507.7	556.6

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TIME (Min.)	TC _{sd1} (°C)	TC _{sd2} (°C)	TC _{sd3} (°C)	TC _{sd4} (°C)	TC _{sd5} (°C)	TC _{sd6} (°C)	MEAN D (°C)	MAX D (°C)
51	521.1	486.7	505.5	463.2	565.4	556.6	516.4	565.4
52	529.4	493.3	515.2	471.7	574.0	566.2	525.0	574.0
53	537.9	500.2	525.1	480.6	582.7	576.2	533.8	582.7
54	546.3	506.8	534.4	488.8	591.1	585.6	542.2	591.1
55	554.8	513.5	543.8	497.2	599.6	595.1	550.7	599.6
56	563.2	520.2	552.8	505.3	608.3	604.6	559.1	608.3
57	571.6	527.1	561.9	513.6	616.7	613.7	567.4	616.7
58	580.0	533.8	570.7	521.6	625.1	623.0	575.7	625.1
59	588.3	540.5	579.6	529.8	633.5	632.2	584.0	633.5
60	596.7	547.3	588.3	537.7	641.7	641.5	592.2	641.7
61	604.8	554.1	596.8	545.4	649.5	650.8	600.2	650.8
62	613.0	560.9	605.2	553.2	656.9	660.2	608.2	660.2
63	621.2	567.6	613.6	560.9	663.9	669.3	616.1	669.3
64	629.4	574.6	621.9	568.5	670.8	677.8	623.8	677.8
65	637.3	581.3	629.9	575.9	677.5	685.4	631.2	685.4
66	645.1	587.9	637.8	583.3	684.2	692.4	638.5	692.4
67	653.1	594.8	645.8	590.8	690.7	698.9	645.7	698.9
68	660.8	601.3	653.1	597.9	697.6	705.2	652.7	705.2
69	668.4	607.9	660.6	605.2	704.1	711.0	659.5	711.0
70	676.0	614.4	667.9	612.4	710.8	716.3	666.3	716.3
71	683.2	620.7	675.1	619.4	717.1	720.8	672.7	720.8
72	690.5	627.2	682.2	626.5	723.7	724.9	679.2	724.9
73	697.4	633.5	689.0	633.6	730.2	728.1	685.3	730.2
74	703.8	639.8	695.8	640.4	736.9	731.1	691.3	736.9
75	710.0	646.1	702.5	647.4	743.8	734.9	697.5	743.8
76	715.6	652.3	708.7	654.0	750.5	739.3	703.4	750.5
77	720.7	658.5	714.9	660.6	756.6	744.4	709.3	756.6
78	725.4	664.5	720.7	666.9	762.7	749.9	715.0	762.7
79	729.8	670.5	726.1	673.1	768.6	755.5	720.6	768.6
80	734.4	676.4	730.7	679.1	774.6	761.5	726.1	774.6
81	739.9	682.3	734.8	685.5	780.7	768.0	731.9	780.7
82	745.6	687.9	737.7	691.3	786.7	774.6	737.3	786.7
83	751.6	693.8	741.1	697.2	793.1	781.5	743.1	793.1
84	757.5	699.4	745.3	703.0	799.2	788.4	748.8	799.2
85	764.0	705.3	751.3	708.9	814.1	805.1	758.1	814.1
86	770.0	710.9	757.9	714.8	839.0	834.8	771.2	839.0
87	776.1	716.4	766.6	721.7	862.2	868.1	785.2	868.1
88	781.6	721.7	777.6	729.6	880.6	894.1	797.5	894.1
89	787.4	726.9	790.3	736.5	895.4	913.0	808.3	913.0
90	793.0	731.2	802.4	742.7	907.3	927.1	817.3	927.1
91	799.0	736.2	814.7	752.9	917.7	938.3	826.5	938.3
92	805.4	743.1	827.5	766.7	926.6	948.0	836.2	948.0
93	812.0	750.7	840.3	781.9	934.8	957.0	846.1	957.0
94	819.4	759.2	854.2	797.8	942.3	964.7	856.3	964.7
95	827.3	768.4	867.8	812.6	948.4	970.3	865.8	970.3

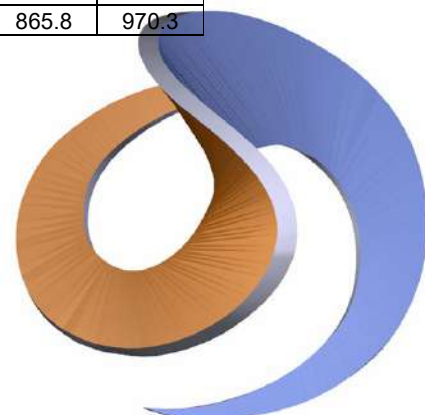


Table 7: Fire Test Observations

Time (Minutes)	Observations
Pre Test	Average specimen temperature - Specimen A: 30.0°C, Specimen B: 29.3°C, Specimen C: 28.4°C, Specimen D:30.6°C Specimen E:29.3°C
0	Test commenced
4	Furnace pressure at the top of specimen brought within 18±2 Pa.
5	White bubble start to appear
15	Top flange of Specimen C started to crack.
20	Flame observed on all specimen surfaces
30	Vertical crack along right flange tip of specimen E
50	Specimen C reached mean temperature of 550°C.
53	Flames have rested except for at the bottom of Specimen B,D and E.
54	Specimen E reached mean temperature of 550°C.
56	Specimen D reached mean temperature of 550°C.
66	Specimen A reached mean temperature of 550°C.
72	Specimen B reached mean temperature of 550°C.
80	Left flange of Specimen C intumescent have peeled off.
90	Specimen A surface peeled off.
95	Test terminated.



C. PHOTOGRAPHS



Photo 1: Steel section during specimen thermocouple installation.



Photo 2: Specimens during test preparation.

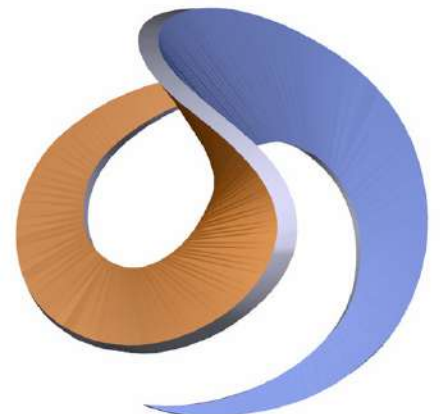




Photo 3: Specimen arranged in furnace.

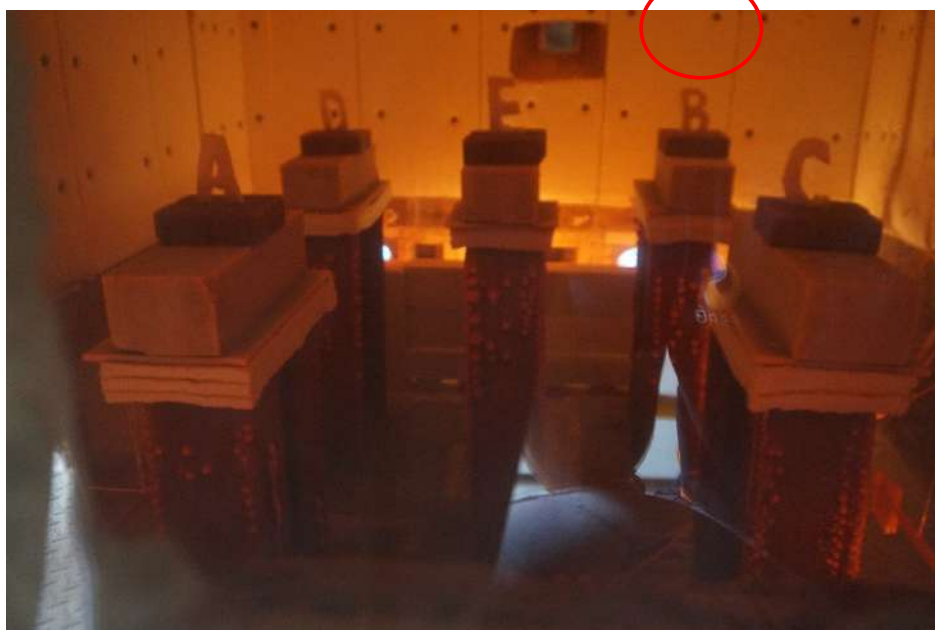


Photo 4: Specimen after 5 minutes of test.

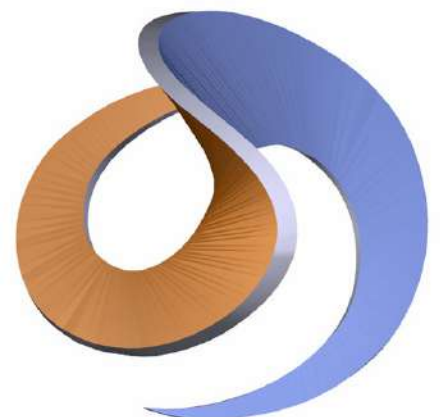




Photo 5: Specimen after 20 minutes of test.



Photo 6: Specimen after 45 minutes of test.

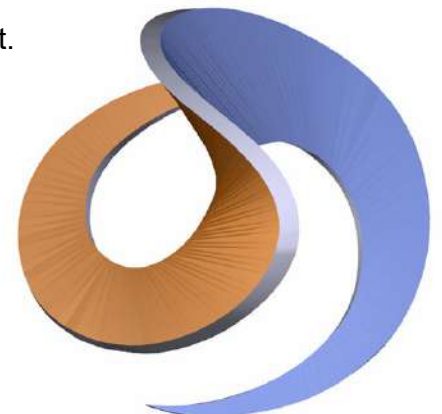




Photo 7: Specimen after 60 minutes of test.

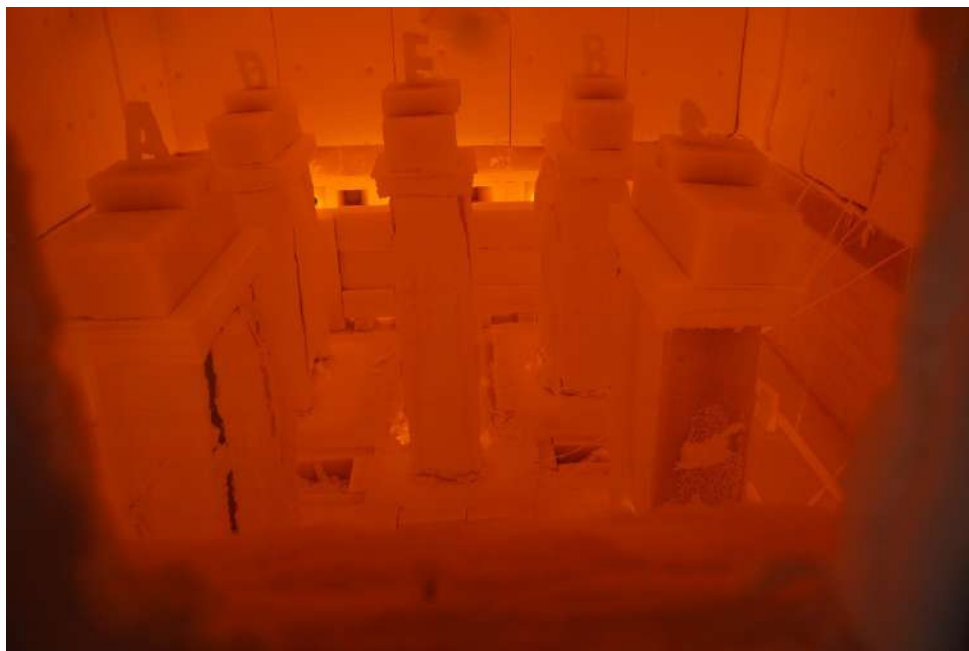


Photo 8: Specimen after 85 minutes of test.





Photo 9: Specimen after 95 minutes of test. (Test terminated)



Photo 10: Specimen 12 hours after test termination.