Bushfire test on a roof system

Test Report

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Clients: Delta Panels Pty Ltd

Commercial-in-confidence

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Bushfire test on a roof system
Sponsored Investigation No. FSZ 2411

1 Introduction

1.1 Identification of specimen

The sponsor identified the specimen as a 45-degree pitched Delta Panels roof system that included a roof valley and a roof ridge detail.

1.2 Sponsor

Delta Panels Pty Ltd
731 Boundary Road
Richlands, QLD 4077

1.3 Manufacturer(s)

Manufacturer(s)	*Product*
Delta Panels Pty Ltd	DeltaTrim Thermosetting Phenolic Composite Insulated Panels (TPC)

1.4 Test standards

Australian Standard 1530, Methods for fire tests on building materials, components and structures;

Part 8.1-2018: Tests on elements of construction for buildings exposed to simulated bushfire attack – radiant heat and small flaming sources.

Clause 17: Specific Procedures for Roofs, Fascia and Gutter details.

1.5 Test number

CSIRO Reference test number FS 5305/4909

1.6 Test date

The bushfire test was conducted on 18 October 2023.

2 Description of specimen

2.1 General

The sponsor identified the specimen as a 45-degree pitched steel framed roof, clad with Delta Panels that measured nominally 2000-mm wide x 1550-mm deep that incorporated a 150-mm wide x 50-mm thick valley gutter located 450-mm from the right barge edge of the exposed face.

Supporting construction

The Delta Panels roof system was fixed to a DeltaTrim TPC test frame (TPC-R011) that measured 2040-mm wide x 880-mm deep x 1590-mm high at the back and 480-mm high at the front, fabricated using 65-mm x 65-mm SHS, 50-mm x 50-mm x 3-mm thick angled base and 1.2-mm BMT Beam cap (200-BEAM) located at the top, as shown in drawing number TPC-R011', dated 30 May 2023, by Delta Panel. The test frame was lined on both sides and the bottom with 6-mm thick fibre cement sheeting (TPC-R009 and TPC-R013) and a 100-mm thick DeltaCool -TPC insulated panel wall at the front.

Specimen Details

The roof was fabricated from three 100-mm thick DeltaTrim-TPC panels cut to 1550-mm length, the centre of the roof used a full width panel measuring 1000-mm wide (DeltaTrim-TPC Opp Cut), and two part width panels measuring 400-mm wide (DeltaTrim-TPC LH Cut) and 450-mm wide (DeltaTrim-TPC RH Cut) were used on the left and right hand edges of the roof respectively. The DeltaTrim-TPC panels comprised a thermosetting phenolic composite core (TPC) with a stated density of 38-42 kg/m^3. The core was bonded on both sides to 0.6-mm thick roll formed steel skins using two-part polyurethane adhesive, the underside of the panel was flat, and the top steel skin had a Trimdeck profile, as shown in drawing 'DeltaTrim-TPC Opp Cut' dated 17/01/2018 by Delta Panels.

The bottom edge of the DeltaTrim-TPC panels were protected with profiled 1.2-mm thick roll formed steel skin DeltaTrim Fascia flashing (TPC-003) fixed with 13g x 25-mm self-drilling steel screws at 200-mm centres , and the exposed roof ribbing edges were covered with Delta TrimEnd Caps (TPC-R015) that were fully sealed with Boss FireSilicone-EMA sealant. The DeltaTrim-TPC panels were fixed to the steel frame using TEK 14 x 175 Hex screws and cyclone clips. All the joints on the underside of the roof were filled with a bead of FireSilicone-EMA sealant.

The left and right barge edges of the roof were fitted with x 0.6-mm thick roll formed profiled steel skin DeltaTrim 100-mm side barge trims (TPC-R006 and TPC-006-RH) fixed with TEK 14 x 175 Hex screws at 200-mm centres.

The right side of the roof incorporated a 150-mm wide valley gutter located 450-mm from the right barge edge. The valley gutter consisted of a 50-mm thick x 150-mm wide mineral wool core with a stated density of 38-42 kg/m^3 covered on the top side with a 30-mm x 50-mm 150-mm wide x 0.6-mm thick roll formed steel skin (TPC-R005) fixed with Tex screws at 200-mm centres and a 230-mm wide x 0.6-mm thick roll formed steel skin Valley gutter flashing (TPC-R010) on the underside fixed with stainless steel rivets at 200-mm centres and the edges covered with FireSilicone-EMA sealant.

Located at the ridge of the roof was a x 0.6-mm thick roll formed profiled steel skin ridge cap (TPC-R014) fixed screws. All exposed gaps between the DeltaTrim-TPC panels and the ridge cap and the fibre cement sheeting on the sides were filled with a bead of FireSilicone-EMA sealant.

The roof specimen was fitted with a 120-mm wide x 140-mm high standard steel roof gutter.

The roof structure was enclosed at the back of the test frame with oriented strand board (OSB) that incorporated a 100-mm x 100-mm vent opening located at the base of the roof and a 200-mm x 200-mm glass vision panel.

2.2 Orientation

The roof specimen was tested with the exterior face of the roof exposed to the radiant heat source.

2.3 Crib size

The crib size selected by the test sponsor for the relevant BAL level was Class AA, as specified in Table 3.2 of Section 3.8 of AS 3959:2018.

Four cribs were used for the test, crib #1 was positioned in the roof gutter adjacent to the ridge edge of the valley gutter, while Cribs #2 and 3 were positioned in the valley gutter 700-mm and 1200-mm from the drip edge. Crib # 4 was positioned just below the ridge cap detail mid span as shown in Photograph 4 (Appendix A).

2.4 Conditioning

The roofing part of the specimen did not include exposed timber elements.

The specimen construction was delivered on 10th October 2023 and stored under standard laboratory atmospheric conditions until the test date.

2.5 Level of radiant heat exposure

The level of radiant heat exposure selected by the test sponsor was Very high - 29 kW/m².

2.6 Selection, construction and installation of the specimen and the supporting construction

The construction was organised by the sponsor, CSIRO was not involved in the selection of the materials.

3 Documentation

The following documents were supplied or referenced by the sponsor as a complete description of the specimen and should be read in conjunction with this report:

- Drawings reference 'Delta Trim TPC-RA01', sheets 1 and 2, Revision D, dated 30 May 2023, by Delta Panels.
- Drawings for various components '200 Beam', 'DeltaCool Wall', 'Delta Trim-TPC Opp Cut LHS', 'Delta Trim-TPC Opp Cut', 'Delta Trim-TPC Opp Cut RH', 'TCP-R001 to TCP-R015', 'TCP-R006-RH', 'TCP-R008-LH, by Delta Panels.

No confidential information about the test specimen has been submitted to CSIRO Infrastructure Technologies

4 Equipment

4.1 Furnace

The furnace had a nominal opening of 3000-mm x 3000-mm for the attachment of vertical specimens.

The furnace was lined with refractory bricks and materials with the thermal properties as specified in AS 1530.4:2014 and was heated by combustion of a mixture of natural gas and air.

4.2 Temperature

The temperature in the furnace chamber was measured by eight type K, 3-mm diameter, and 310 stainless steel Mineral Insulated Metal Sheathed (MIMS) thermocouples. Each thermocouple was housed in high-nickel steel tubes opened at the exposed end.

4.3 Radiant heat source

The radiant heat source consisted of a 3-mm thick mild steel sheet mounted into a refractory frame in two sections with a vertical joint at its centre. The frame housing the steel sheet was positioned and sealed up against the front of the furnace aperture.

4.4 Radiant heat flux calibration

Prior to the test, the positions of the specimen (relative to the radiant heat source) were established that corresponded to the required radiant heat flux levels.

Radiation distribution was also established by measuring radiant heat flux levels at the centre and the centre of each quarter section of the specimen in a plane approximating the intended position of the specimen such that the central value will be approximately equal to the rest of the radiant heat flux.

4.5 Measurement system

The primary measurement system comprised multiple-channel data loggers, scanning at five second intervals during the test.

5 Ambient temperature

The temperature of the test area was 21°C at the commencement of the test.

6 Departure from standard

There were no departures from the requirements of AS 1530.8.1-2018.

7 Termination of the test

The test was terminated at 60 minutes in accordance with the standard.

8 Test results

8.1 Critical observations

The following observations were made during the fire-resistance test:

0 minutes -	Alight cribs placed in position.
29 seconds -	Specimen moved into position – exposure to 29 kW/m².
2:36 minutes -	Specimen moved into position – exposure to 21 kW/m².
3:29 minutes -	Specimen moved into position – exposure to 14 kW/m². Crib #1 (inside the gutter) has ceased flaming.
4:18 minutes -	Crib #4 has ceased flaming.
4:29 minutes -	Specimen moved into position – exposure to 11 kW/m².
5:29 minutes -	Specimen moved into position – exposure to 8 kW/m².
6:47 minutes -	Crib #3 has ceased flaming. Smoke is observed inside the roof cavity.
7 minutes -	Smoke is observed at the top of the roof.
10 minutes -	Smoke has ceased being emitted from the specimen.
15 minutes -	Radiant heat source shielded from the specimen. No flaming, cracking or signs of any 3-mm through gaps.
16 minutes -	Radiometer is positioned 250-mm from the centre of the exposed face of the roof specimen.
20 minutes -	Pilot flame was applied over the exposed face of the specimen – no ignition was noted at this time.
33 minutes -	Pilot flame was applied over the exposed face of the specimen – no ignition was noted at this time.
60 minutes -	Test terminated.
	Post test, the back face of the roof assembly was removed to check for any gaps around the vents from inside the roof cavity. No through gaps >3-mm were found in the specimen.

8.2 Radiant heat flux

Figure 1 shows the curves of target and incident radiation versus time recorded during the test period.

Figure 2 shows the curve of received radiation versus time at 250-mm from the fire exposed face of the specimen.

8.3 Specimen temperature

Figure 3 shows the temperature versus time recorded on the non-fire side of the specimen.

8.4 Performance

Performance observed in respect of Clause 14.4 of AS 1530.8.1-2018 criteria:

Performance Criteria		Time to failure (min)	Position of failure
A gap from the fire exposed face to the non-fire exposed face greater than 3-mm		No failure	-
Sustained flaming for 10 seconds on the non-fire side		No failure	-
Flaming on the fire-exposed side at the end of the 60 minutes test period		No failure	-
Radiant heat flux 365-mm from the non-fire side exceeding 15-kW/m²		Not Applicable	-
Mean and maximum temperature rises greater than 140 K and 180 K		No failure	-
Radiant heat flux 250-mm from the specimen, greater than 3-kW/m² between 20 minutes and 60 minutes		No failure	-
Mean and maximum temperature of internal faces exceeding 250°C and 300°C respectively between 20 minutes and 60 minutes after the commencement of the test		Not Applicable	-
Crib class	**AA**	**Peak heat flux**	**29 kW/m²**

For the purpose of building regulations in Australia, the test specimen achieved a **Bushfire Attack Level (BAL) of AA29**.

This report details the methods of construction, the test conditions and the results obtained when the specific element of construction described herein was tested in accordance with the test method of AS 1530.8.1.

9 Tested by

Peter Gordon
Testing Officer

Appendices

Appendix A – Test photographs

PHOTOGRAPH 1 – THE ROOF CAVITY VIEWED FROM THE UNEXPOSED FACE OF THE SPECIMEN

PHOTOGRAPH 2 – SPECIMEN PRIOR TO TESTING

PHOTOGRAPH 3 – INSTRUMENTATION OF THE ROOF CAVITY

PHOTOGRAPH 4 – EXPOSED FACE OF THE SPECIMEN SHOWING CRIB LOCATIONS PRIOR TO TESTING

PHOTOGRAPH 5 – EXPOSED FACE OF SPECIMEN DURING 29 KW/M² EXPOSURE

PHOTOGRAPH 6 – EXPOSED FACE OF SPECIMEN DURING 24 KW/M² EXPOSURE

PHOTOGRAPH 7 – EXPOSED FACE OF SPECIMEN DURING 16 KW/M² EXPOSURE

PHOTOGRAPH 8 – EXPOSED FACE OF SPECIMEN DURING 12 KW/M² EXPOSURE

PHOTOGRAPH 9 – EXPOSED FACE OF SPECIMEN DURING 8.5 KW/M² EXPOSURE

PHOTOGRAPH 10 – EXPOSED FACE OF SPECIMEN DURING 7 KW/M² EXPOSURE

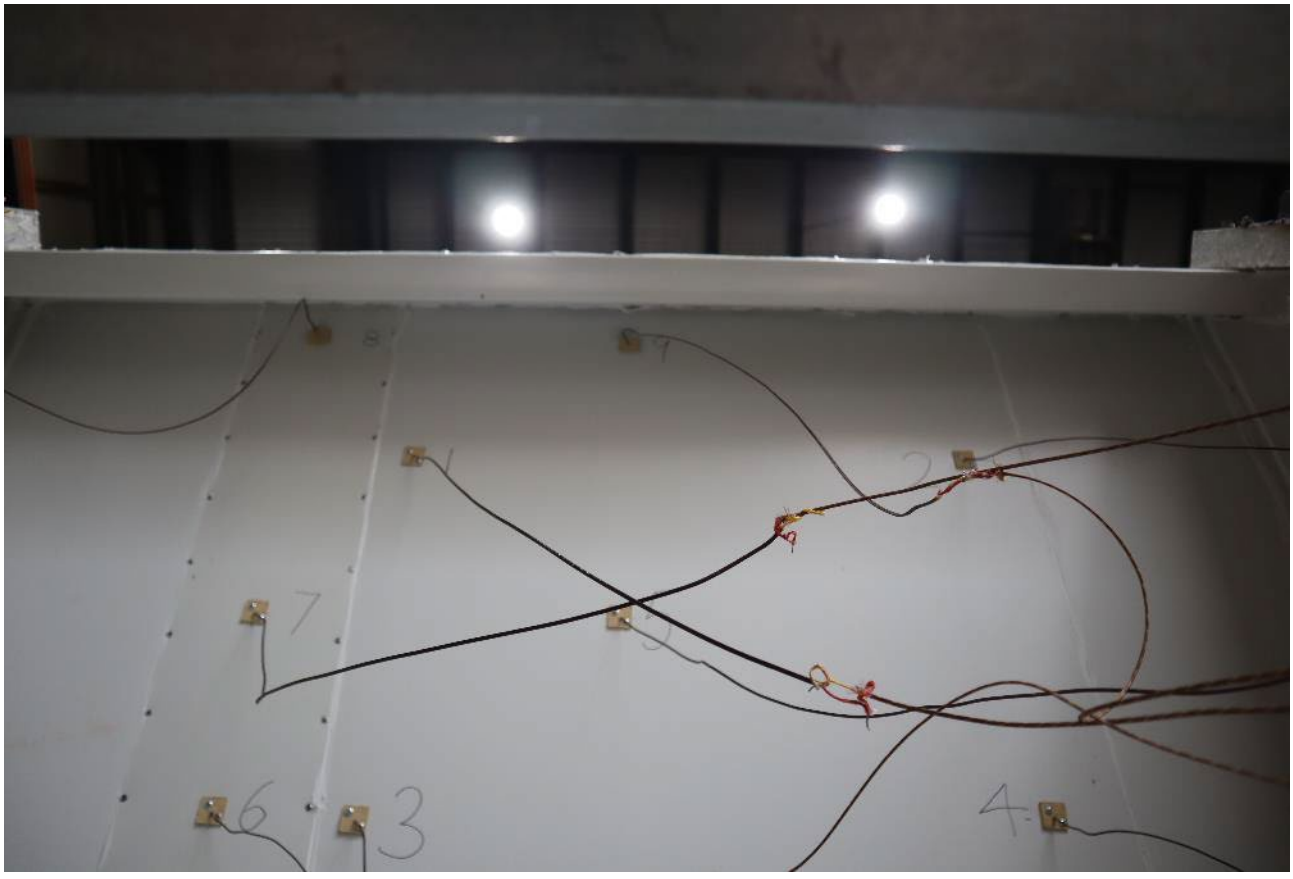
PHOTOGRAPH 11 – EXPOSED FACE SPECIMEN AT 5 MINUTES INTO THE TEST

PHOTOGRAPH 12 – EXPOSED FACE OF SPECIMEN AT 15 MINUTES INTO THE TEST

PHOTOGRAPH 13 – EXPOSED FACE OF SPECIMEN AT 15 MINUTES INTO THE TEST

PHOTOGRAPH 14 – EXPOSED FACE OF THE SPECIMEN AT 32 MINUTES INTO THE TEST

PHOTOGRAPH 15 – EXPOSED FACE OF THE SPECIMEN AT THE CONCLUSION OF TESTING



PHOTOGRAPH 16 – UNEXPOSED FACE OF THE ROOF CAVITY AFTER THE CONCLUSION OF TESTING

PHOTOGRAPH 17 – UNEXPOSED FACE OF THE ROOF CAVITY AFTER THE CONCLUSION OF TESTING

PHOTOGRAPH 18 – UNEXPOSED FACE OF THE ROOF CAVITY AFTER THE CONCLUSION OF TESTING

PHOTOGRAPH 19 – UNEXPOSED FACE OF THE ROOF CAVITY AFTER THE CONCLUSION OF TESTING

Appendix B – Test data charts

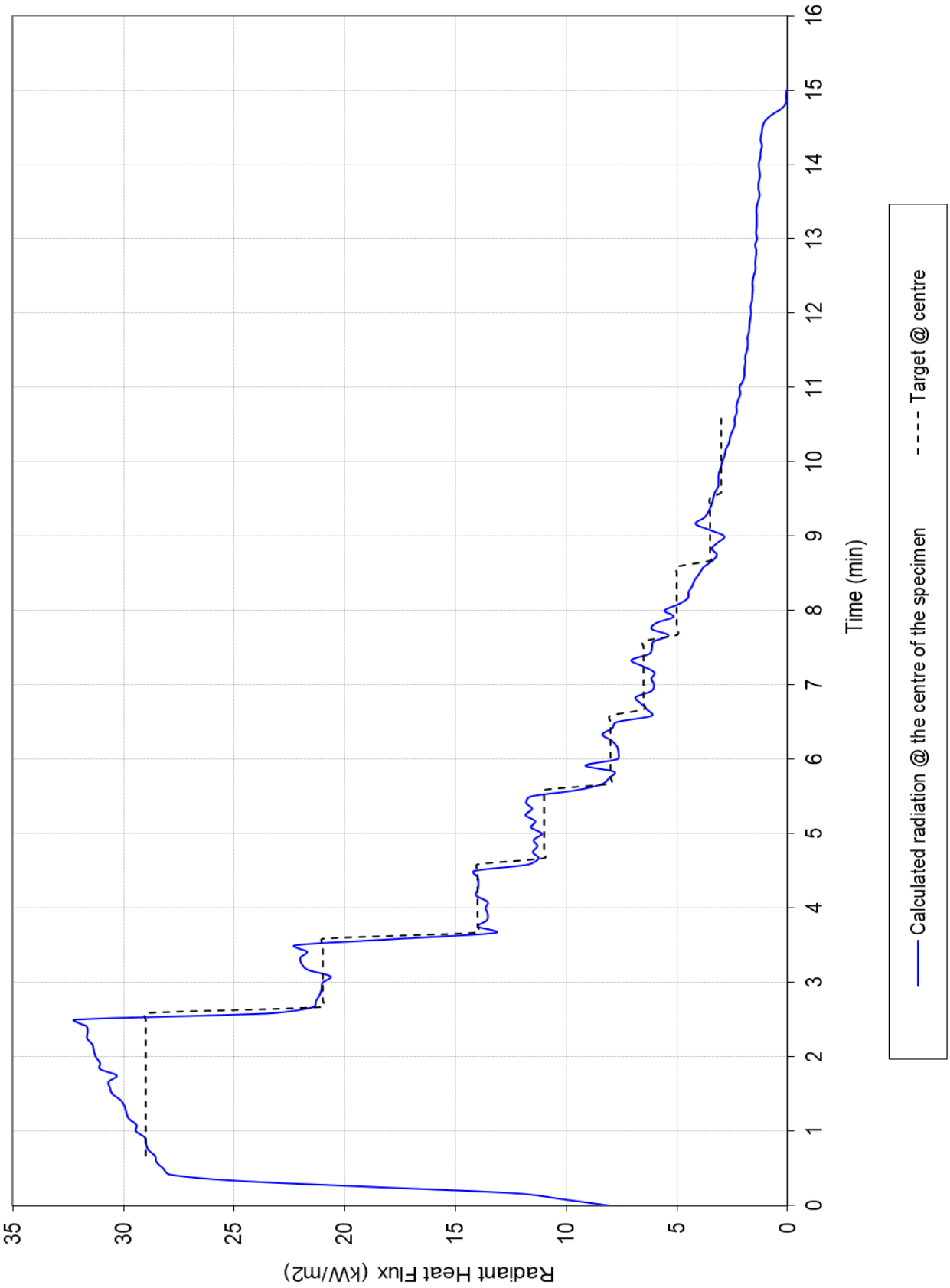


FIGURE 1 – RADIANT HEAT FLUX

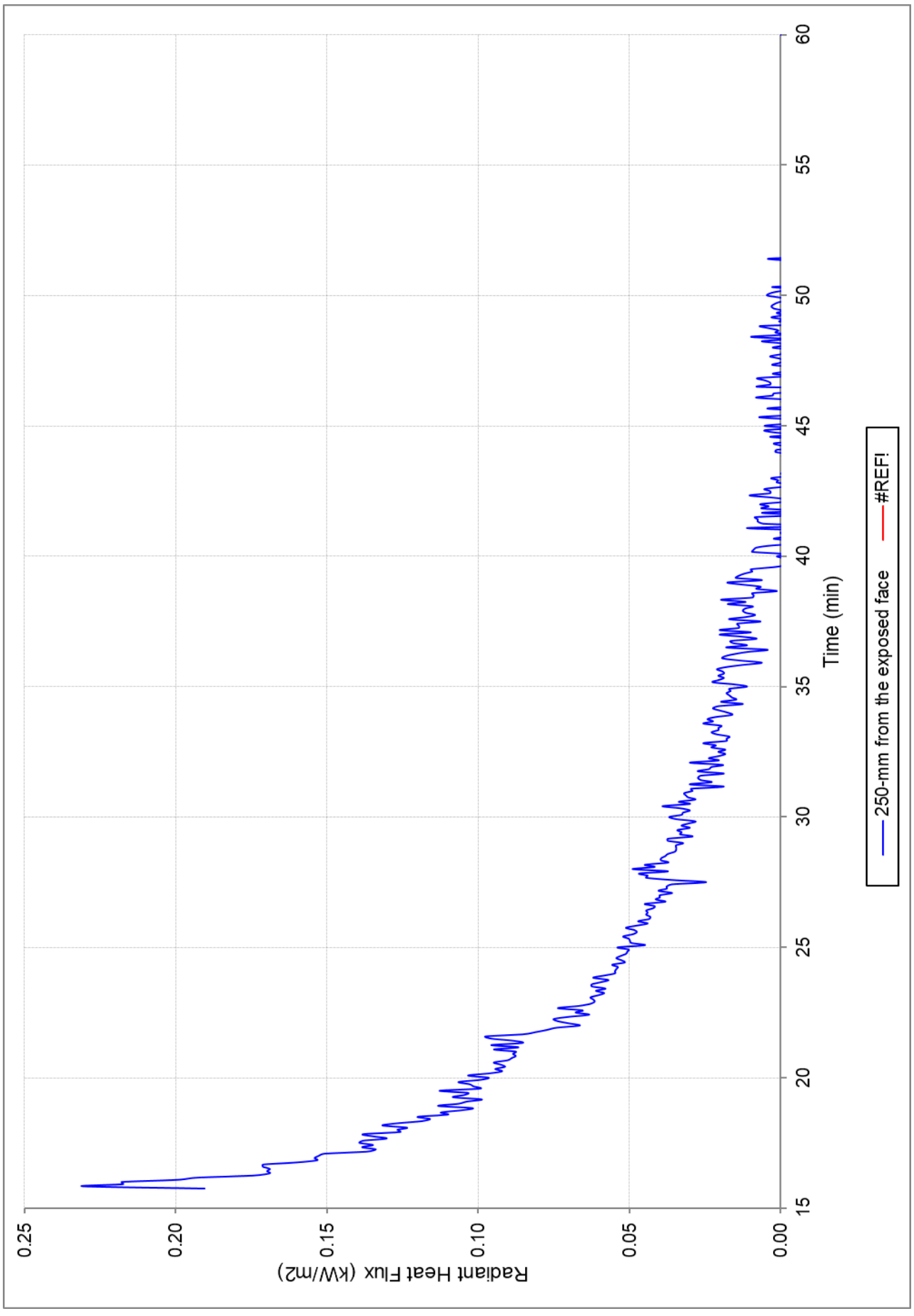


FIGURE 2 – RADIANT HEAT FLUX RECEIVED AT 250-MM FROM THE EXPOSED FACE

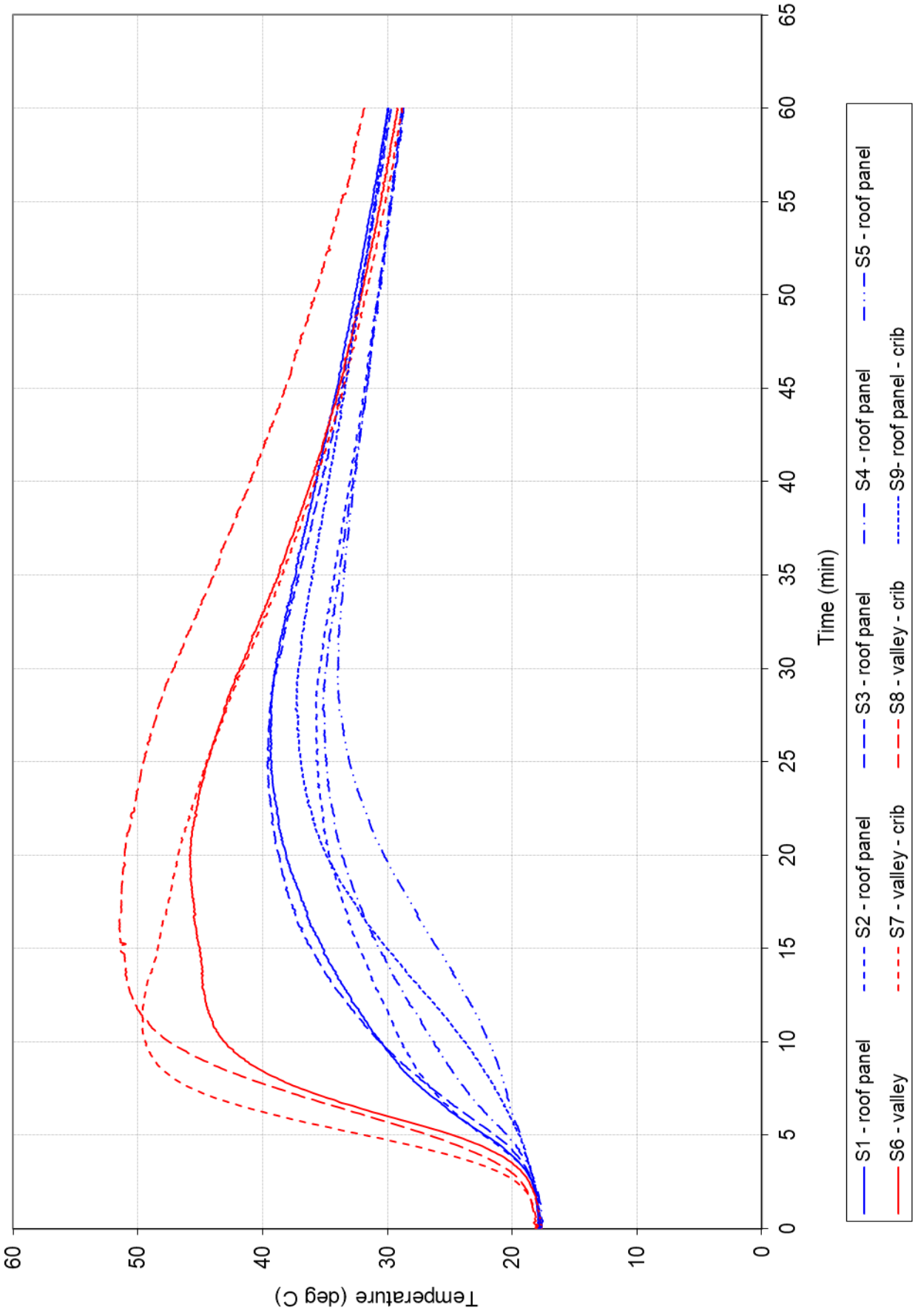
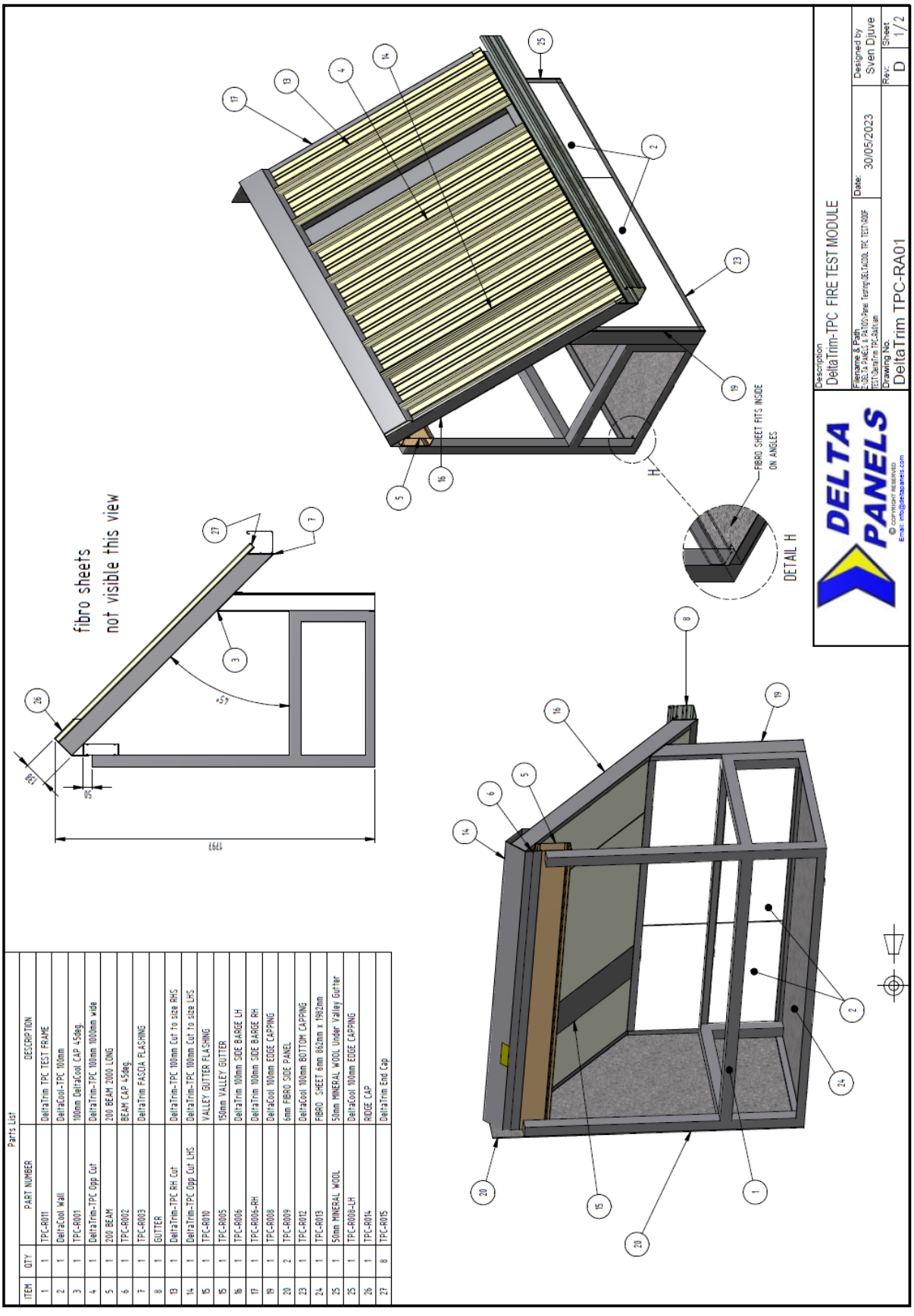


FIGURE 3 – TEMPERATURE VERSUS TIME ASSOCIATED WITH THE UNEXPOSED FACE OF THE ROOF

Appendix C – Specimen drawings



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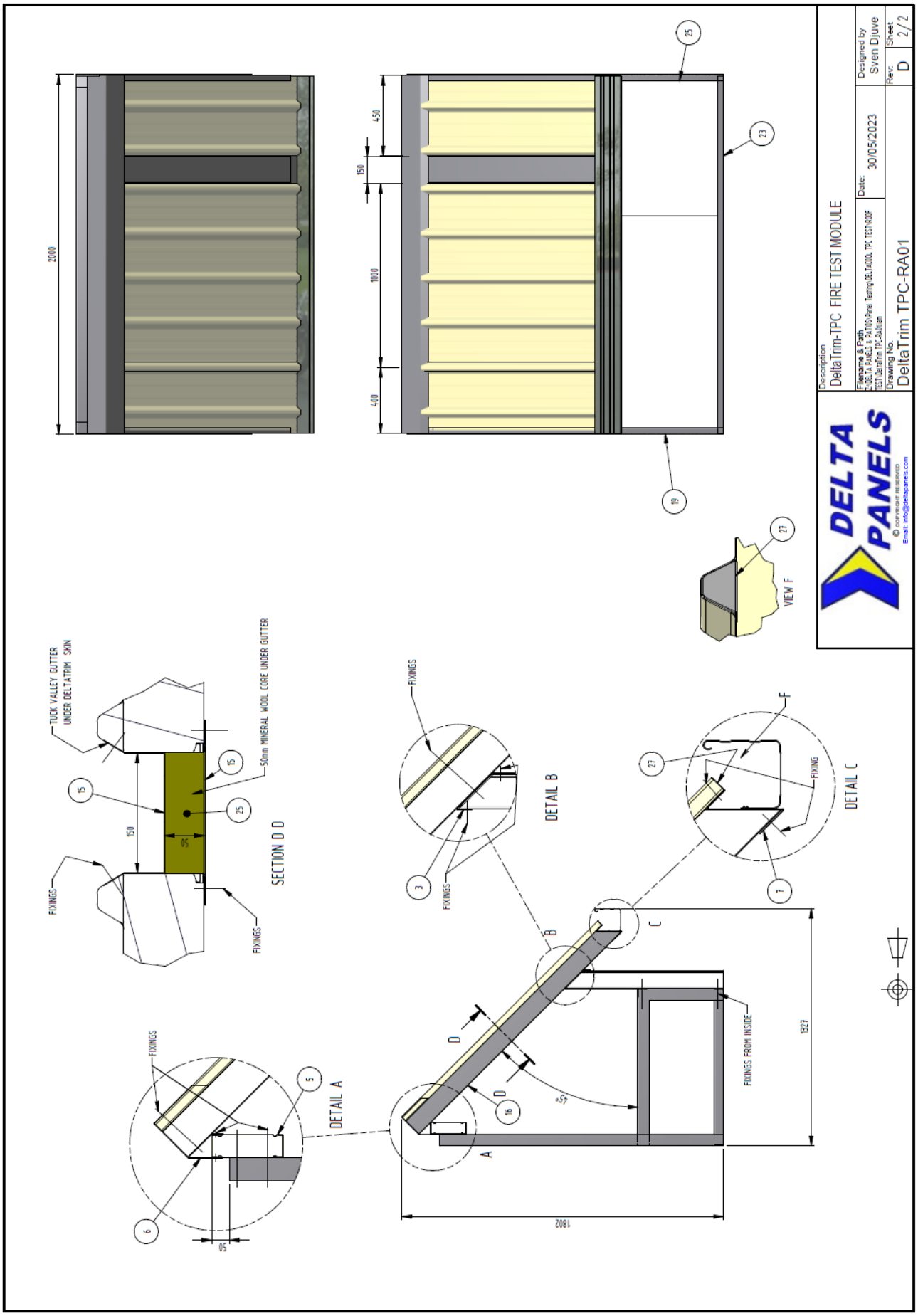

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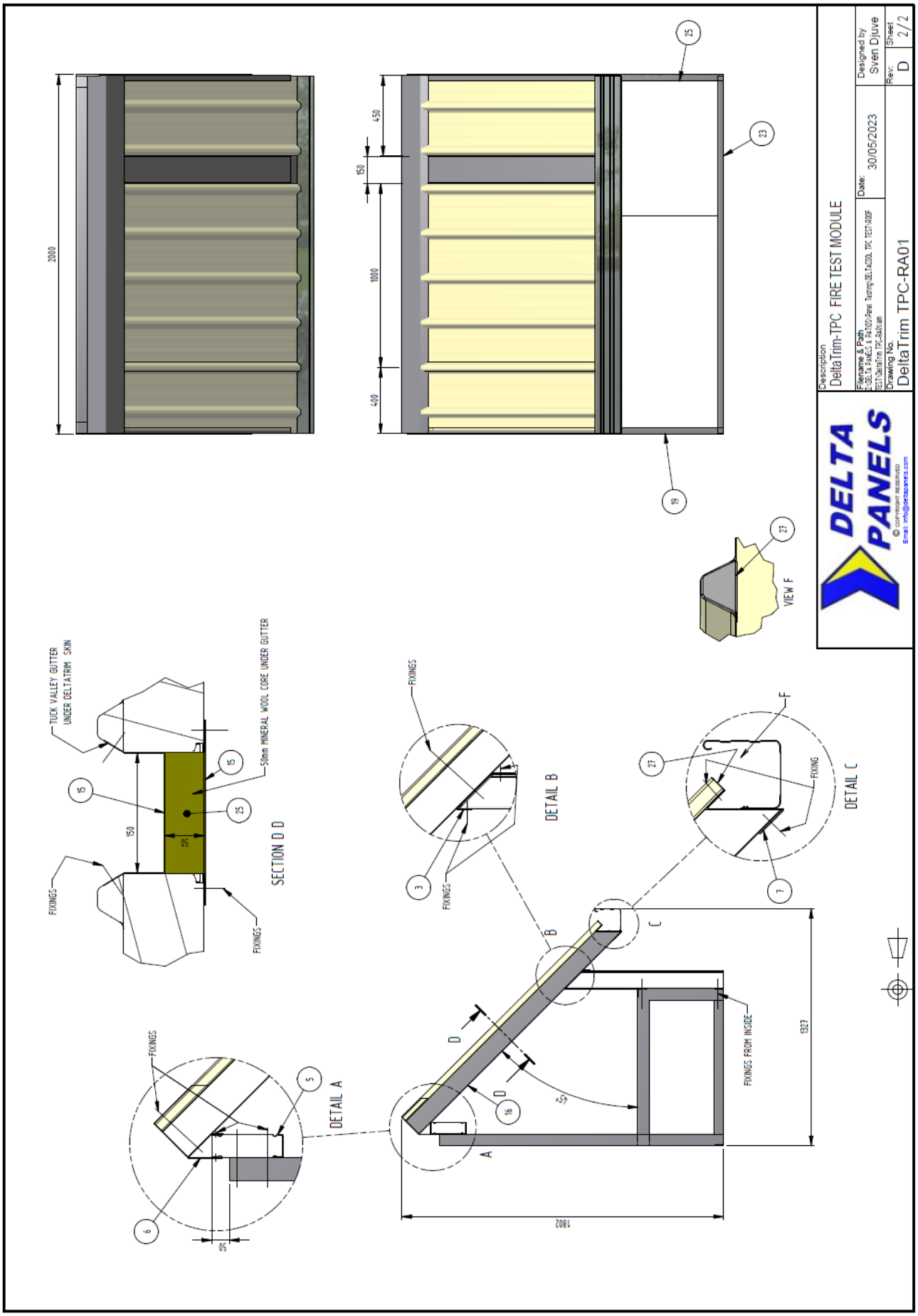

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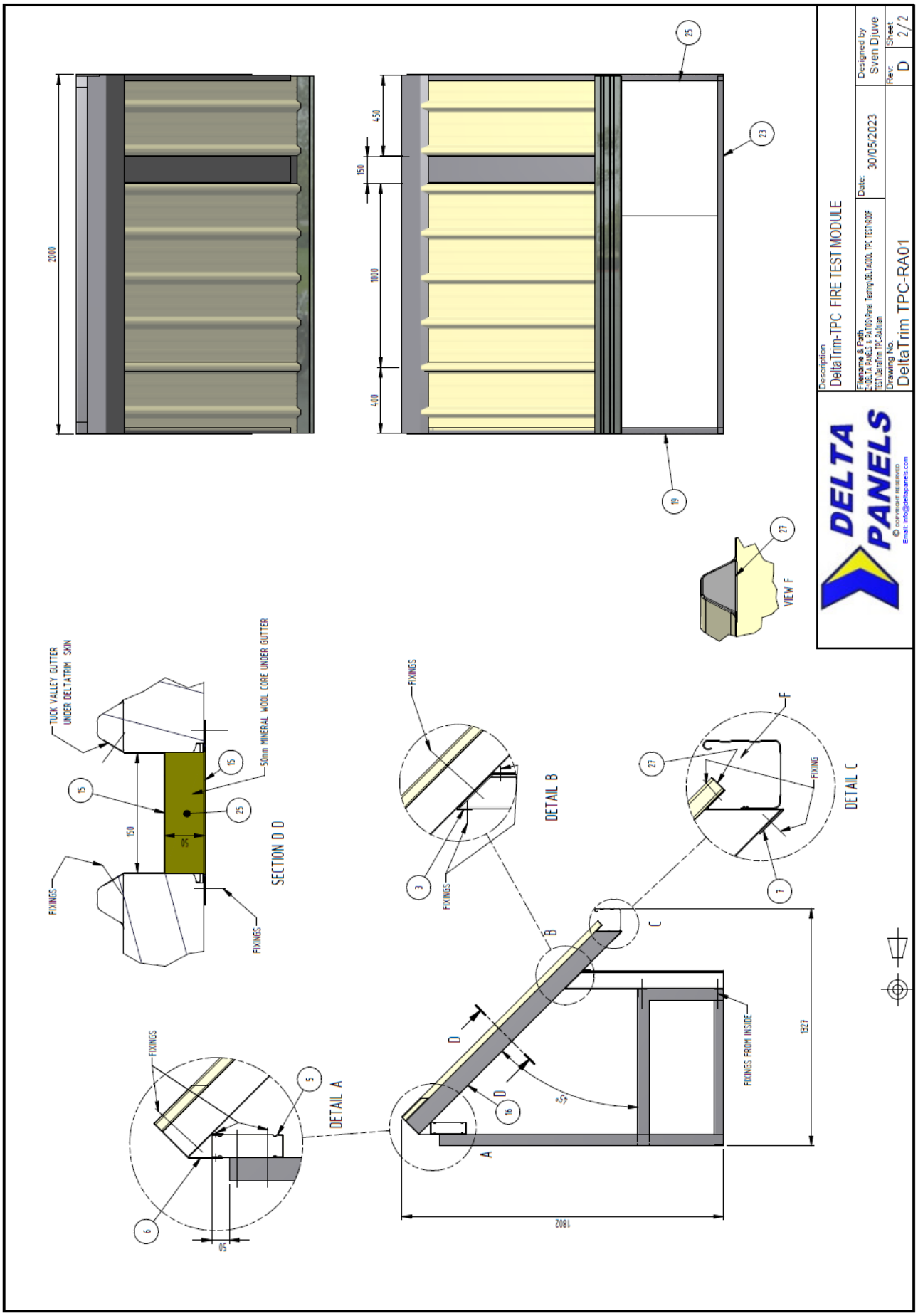

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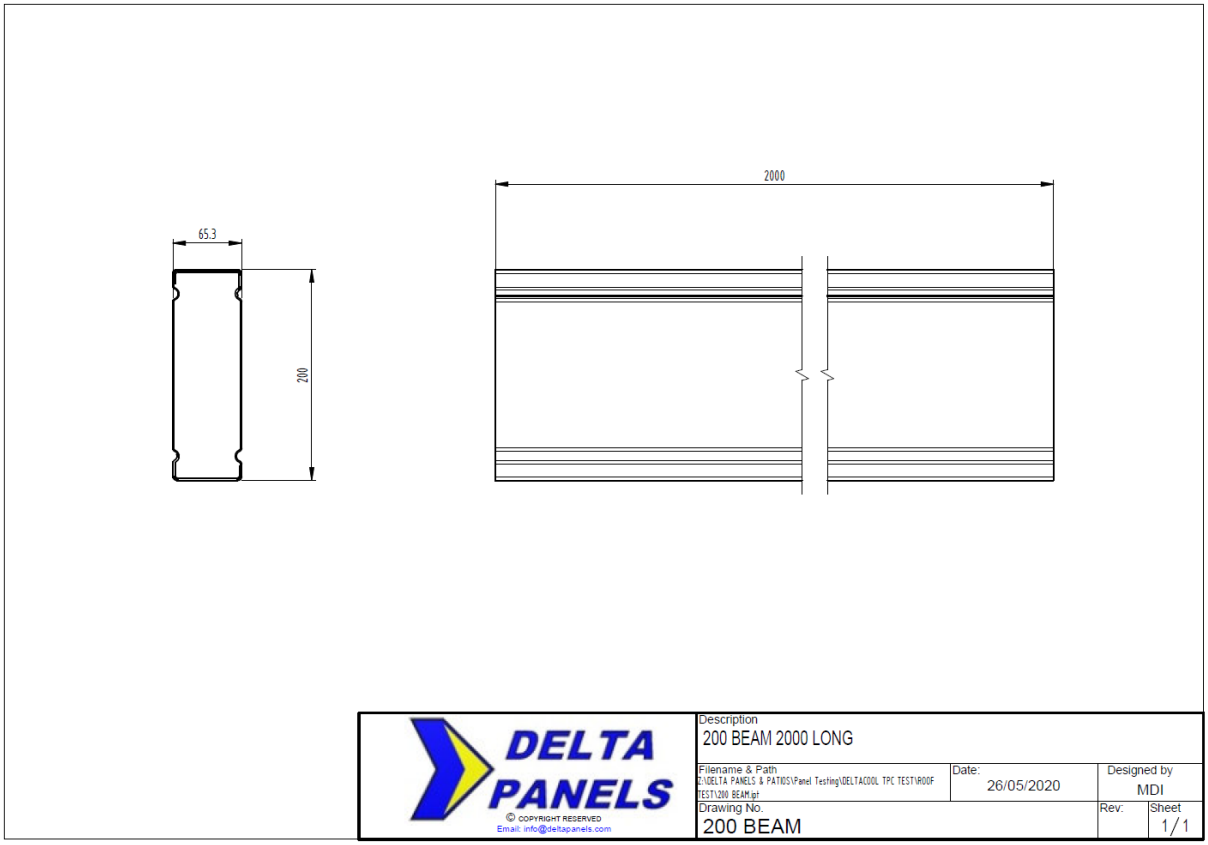

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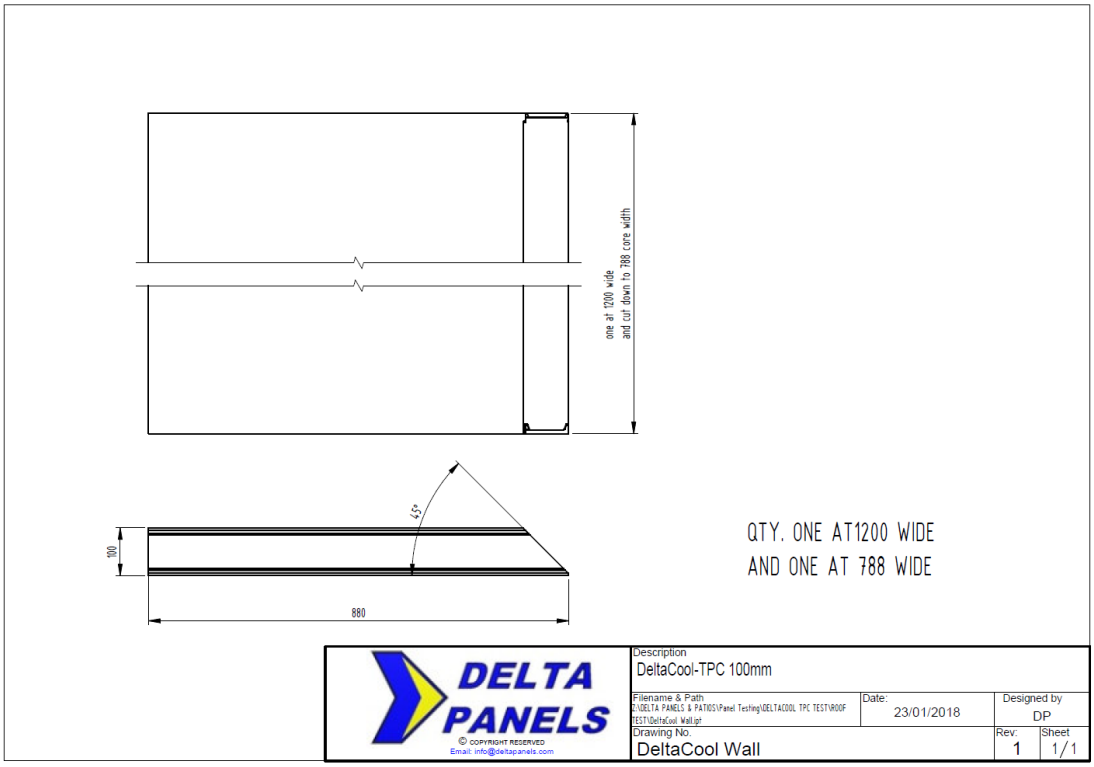

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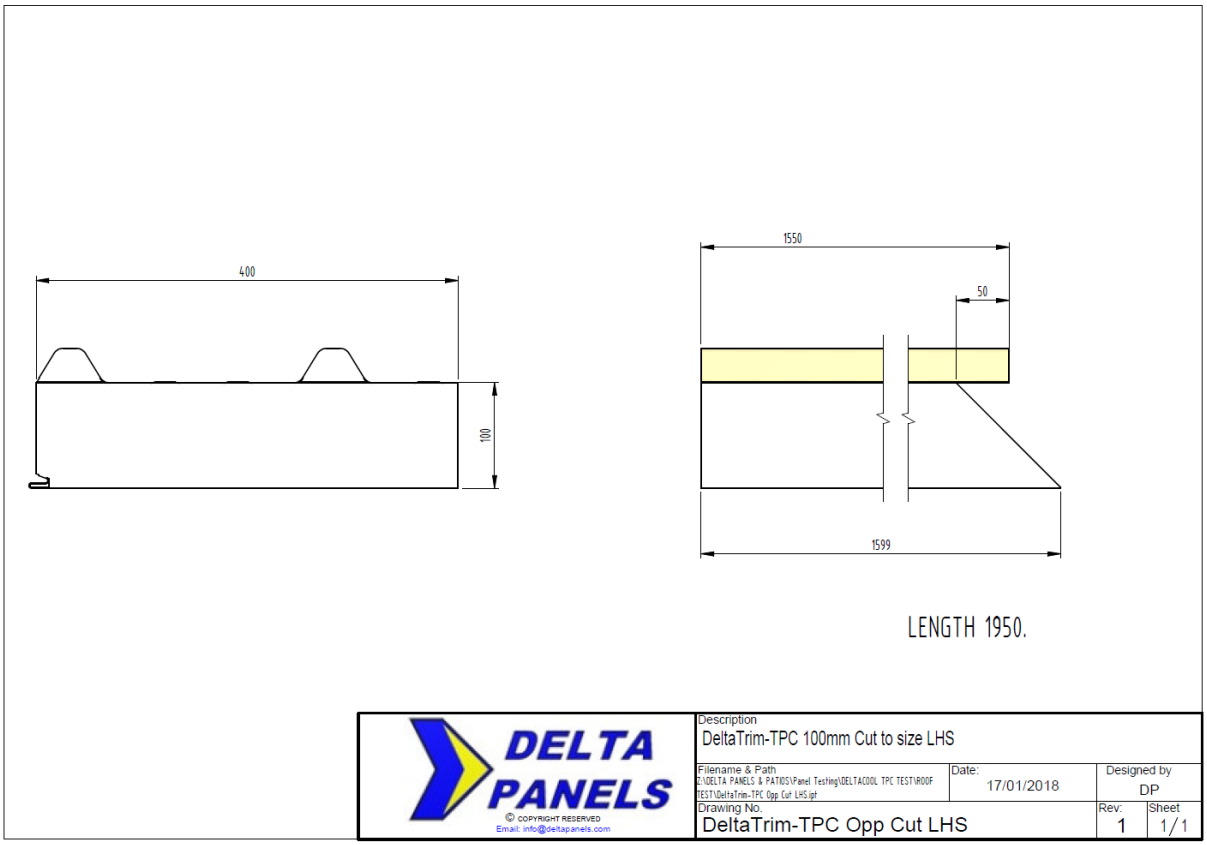

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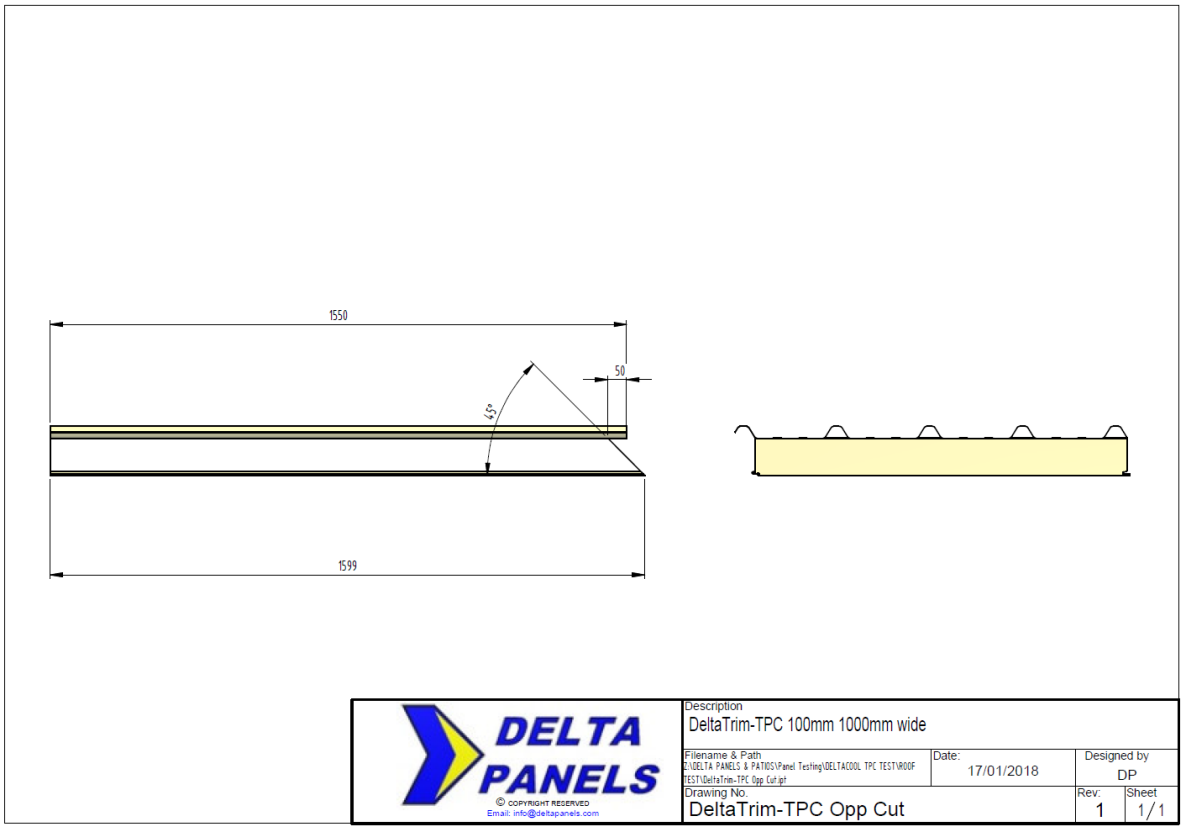

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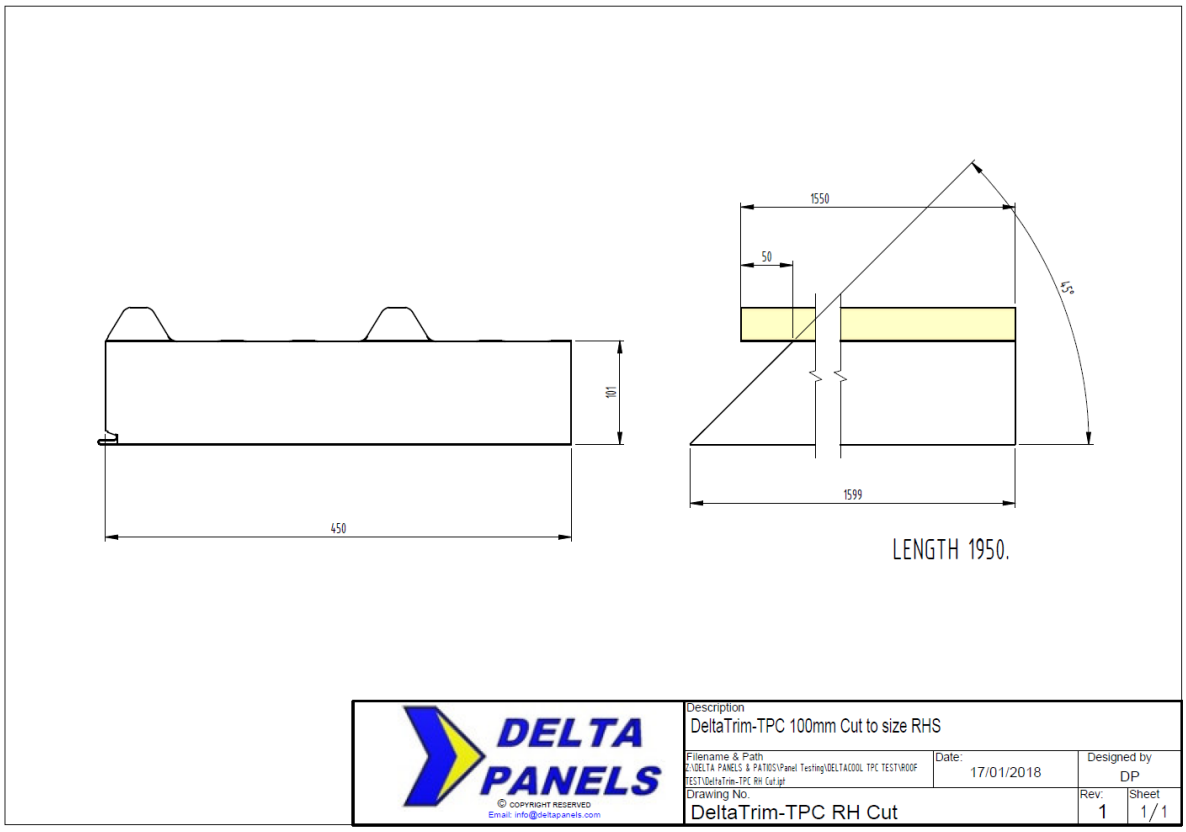

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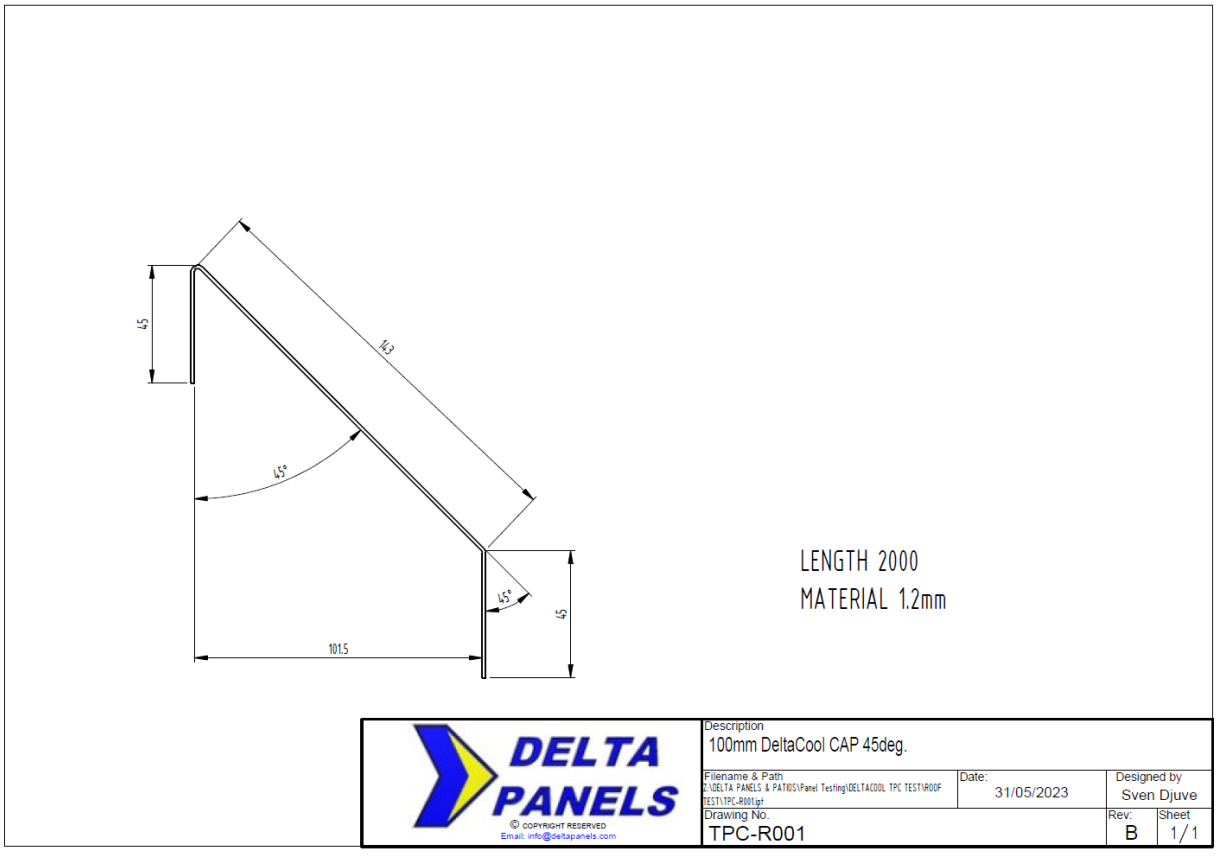

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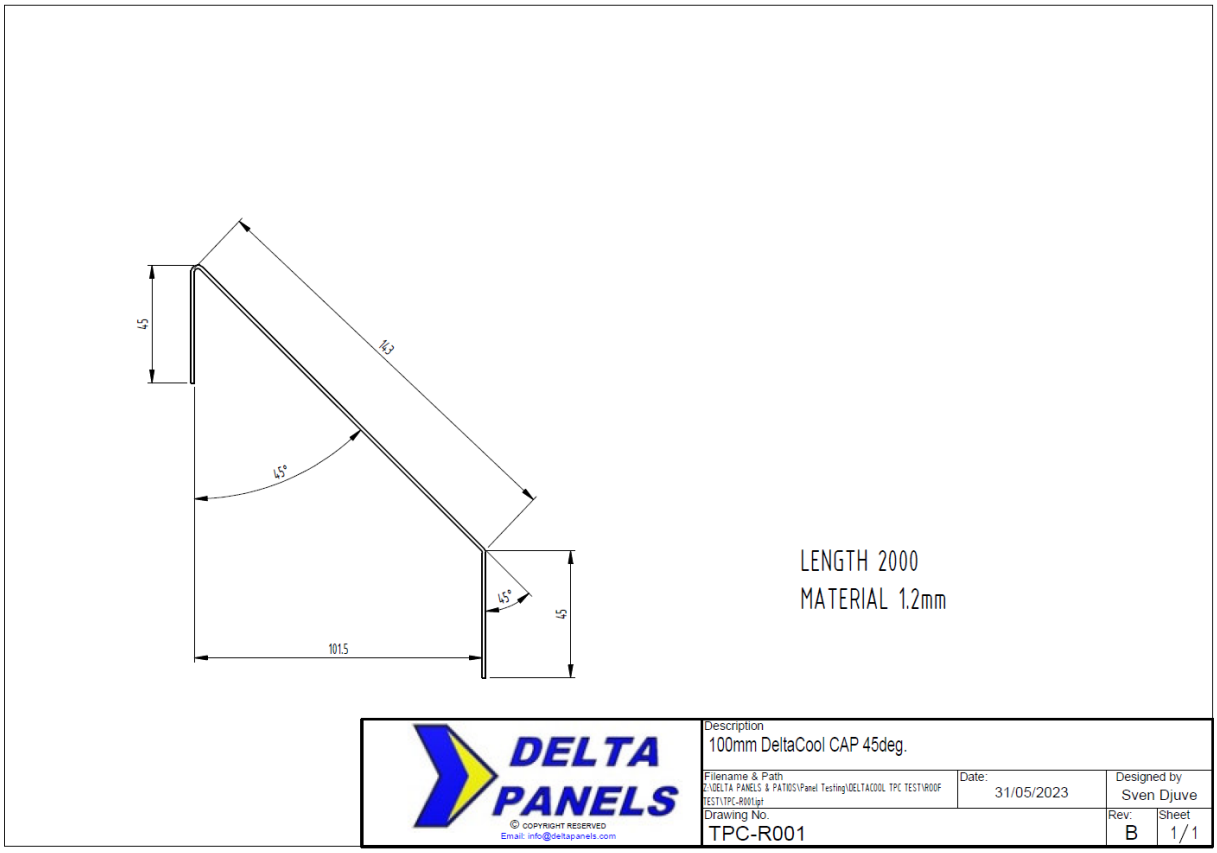

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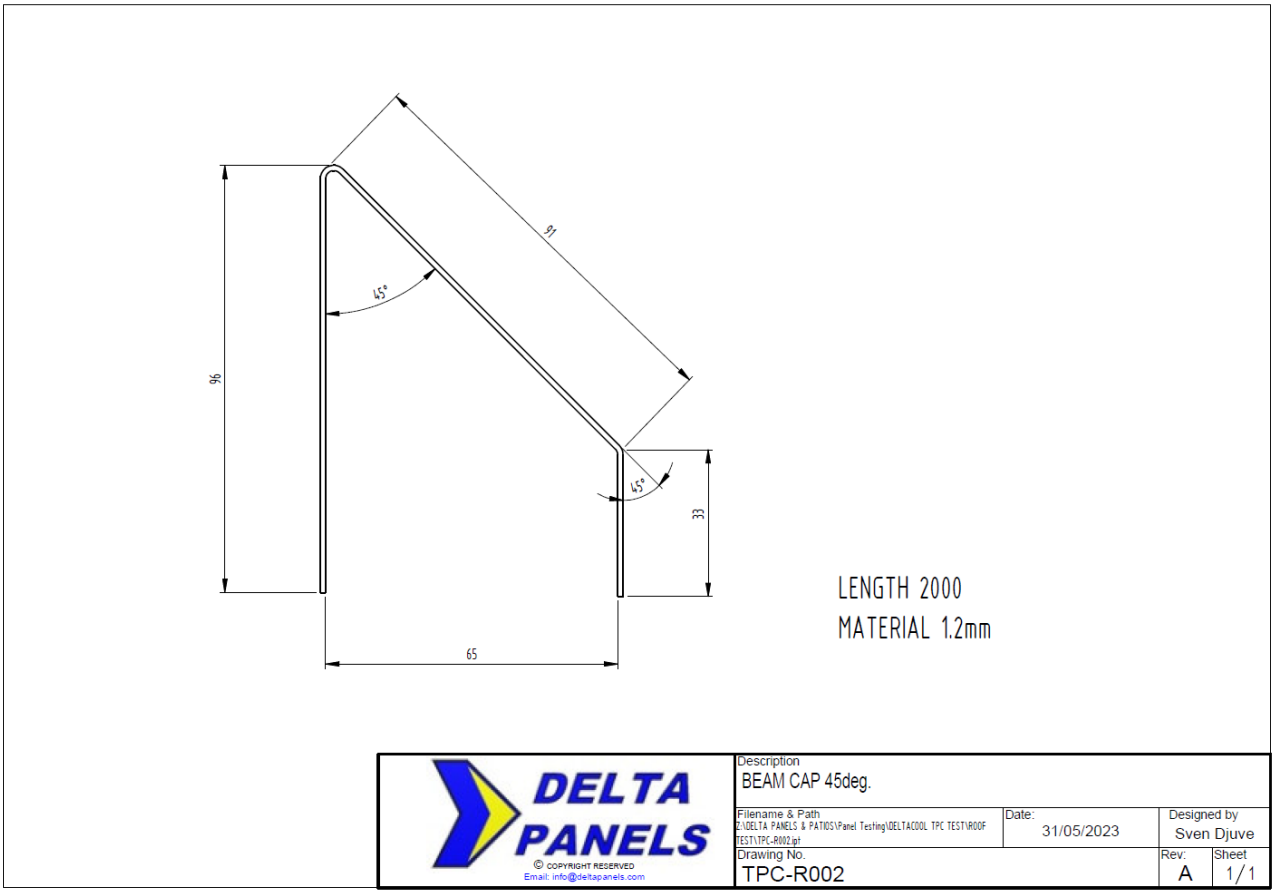

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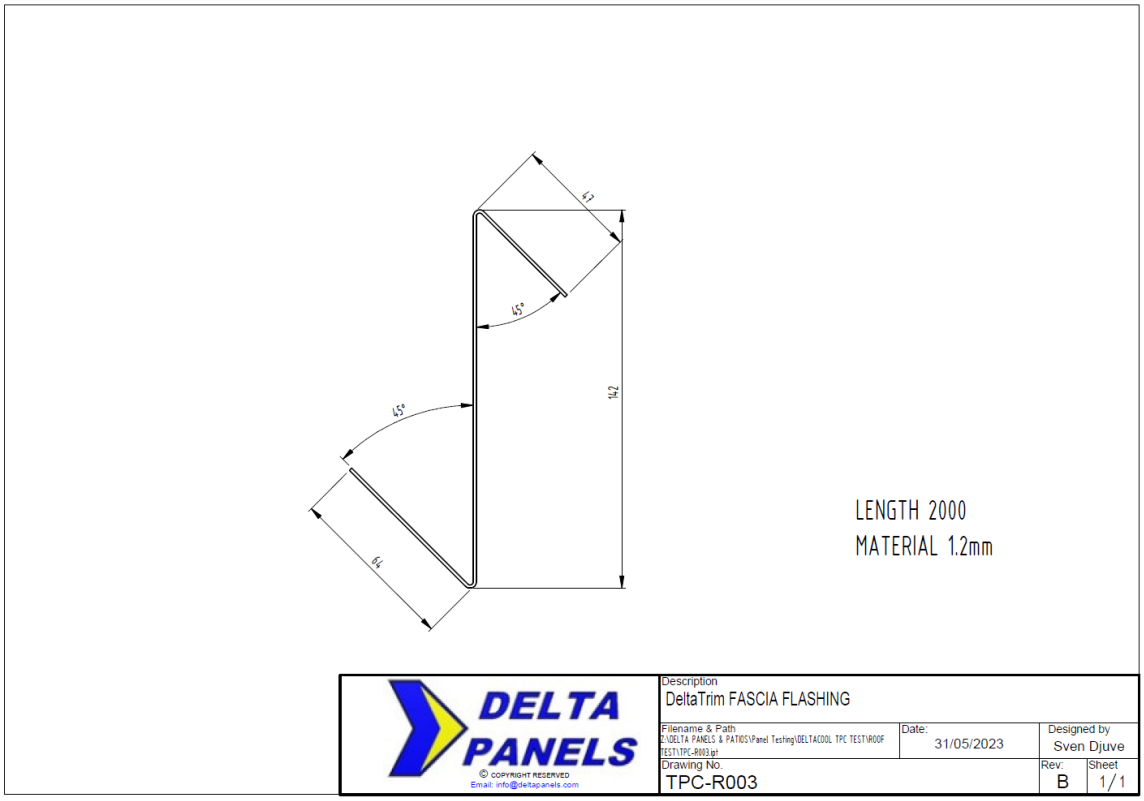

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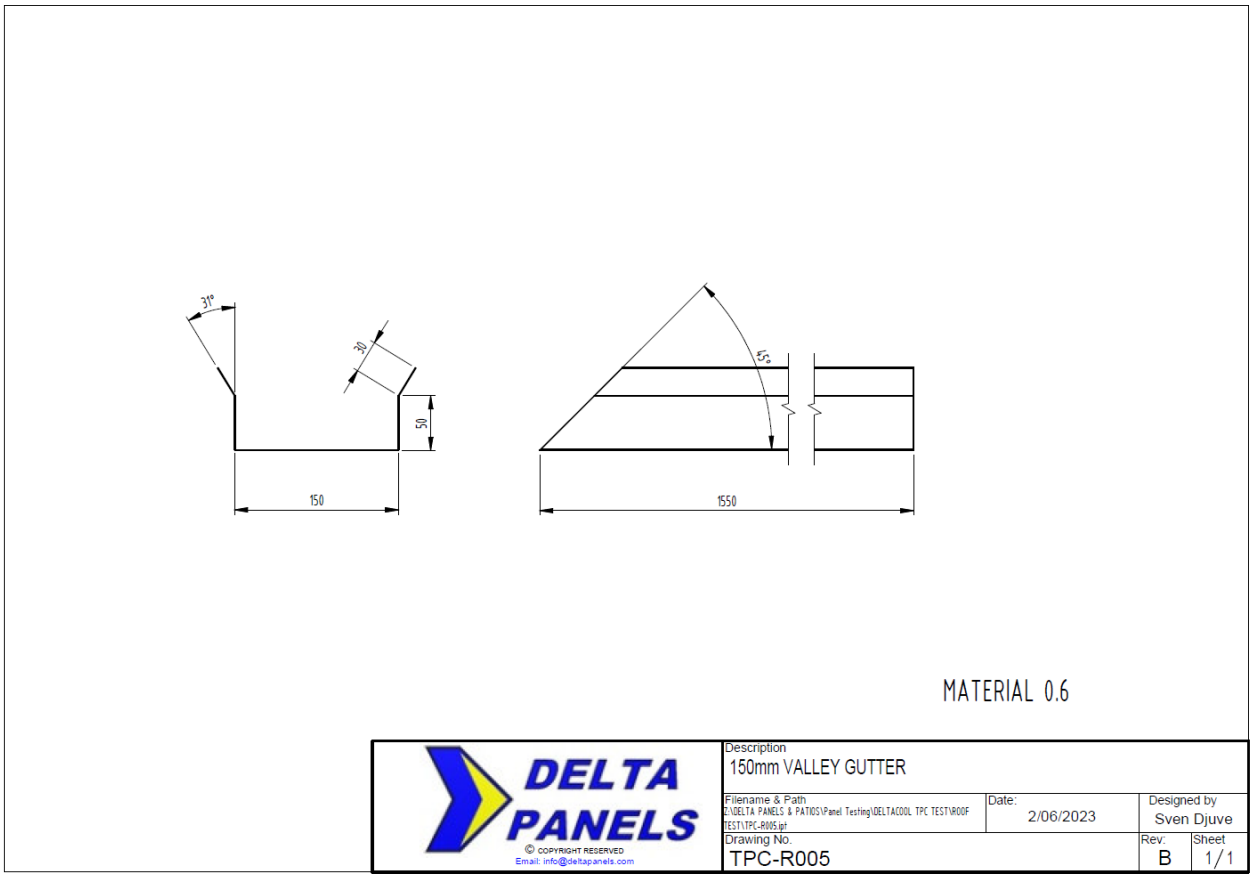

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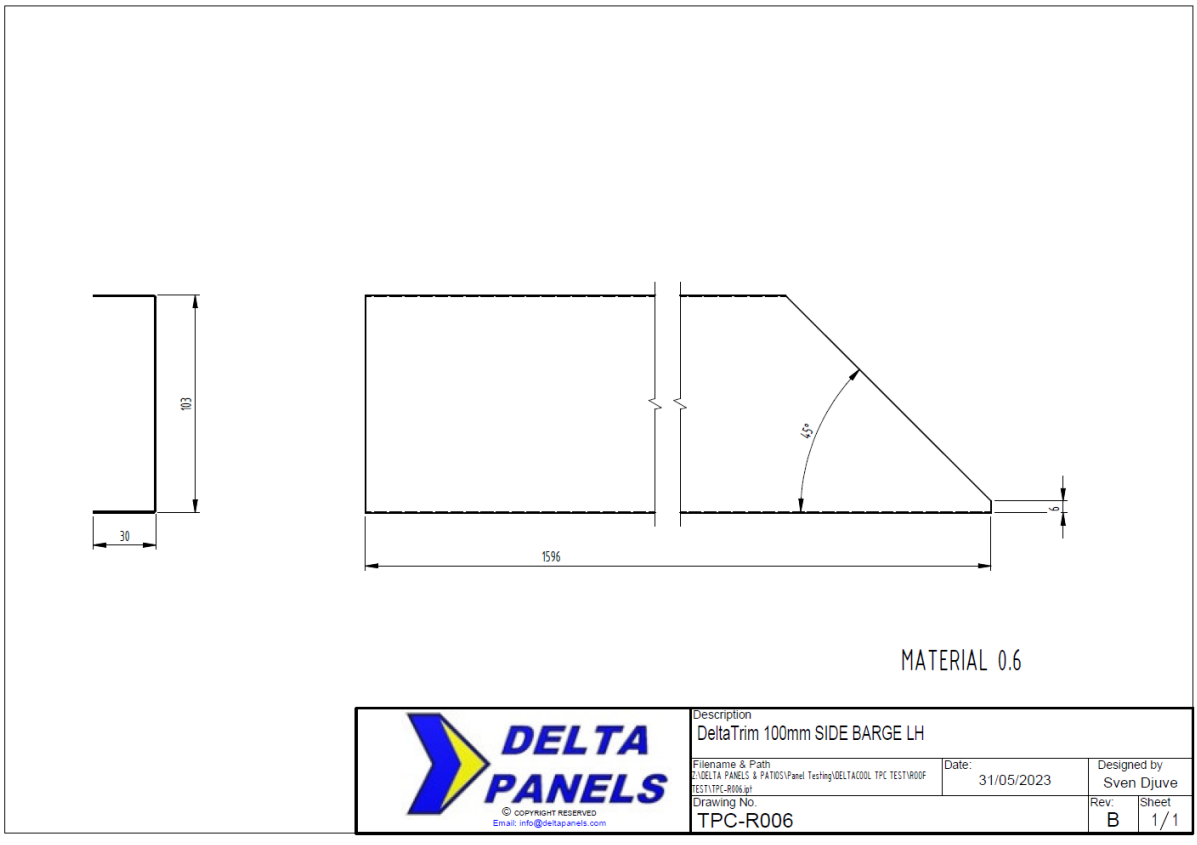

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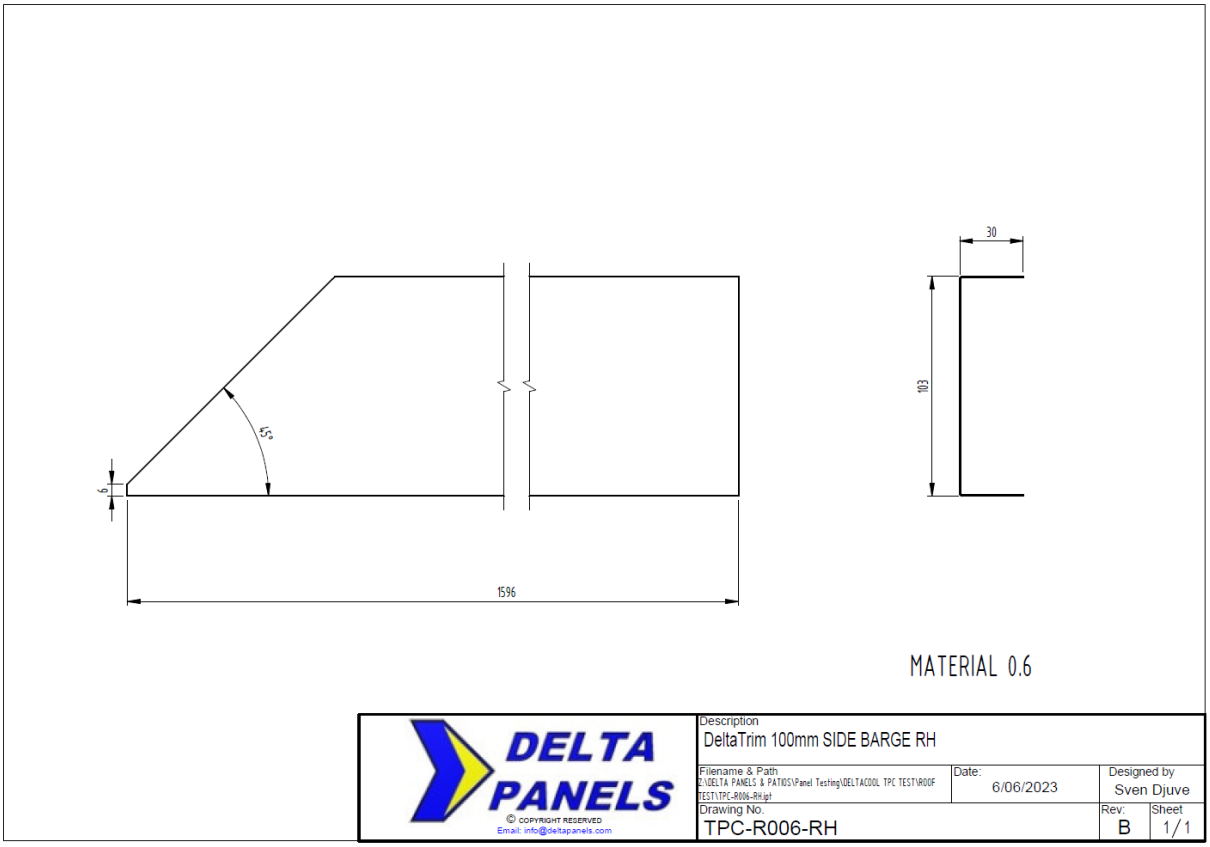

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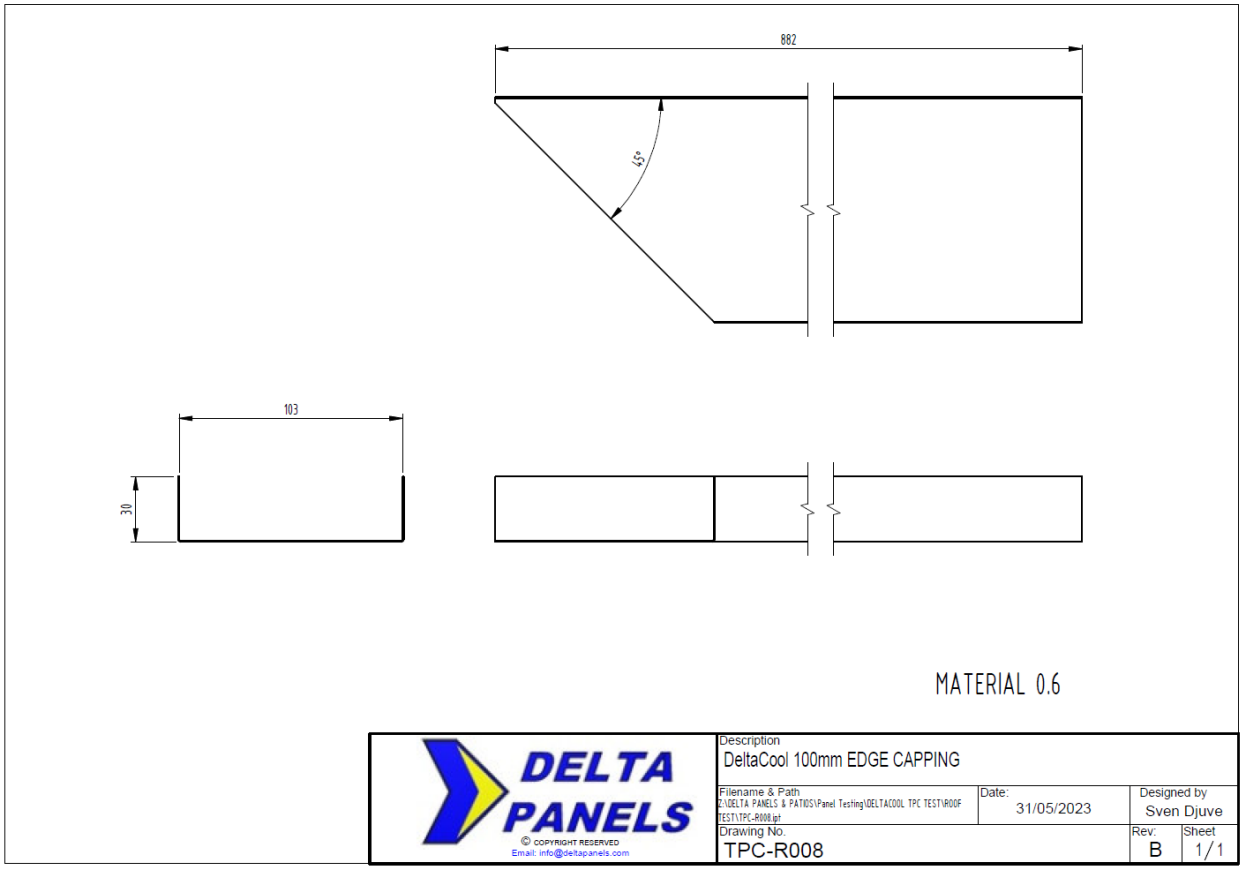

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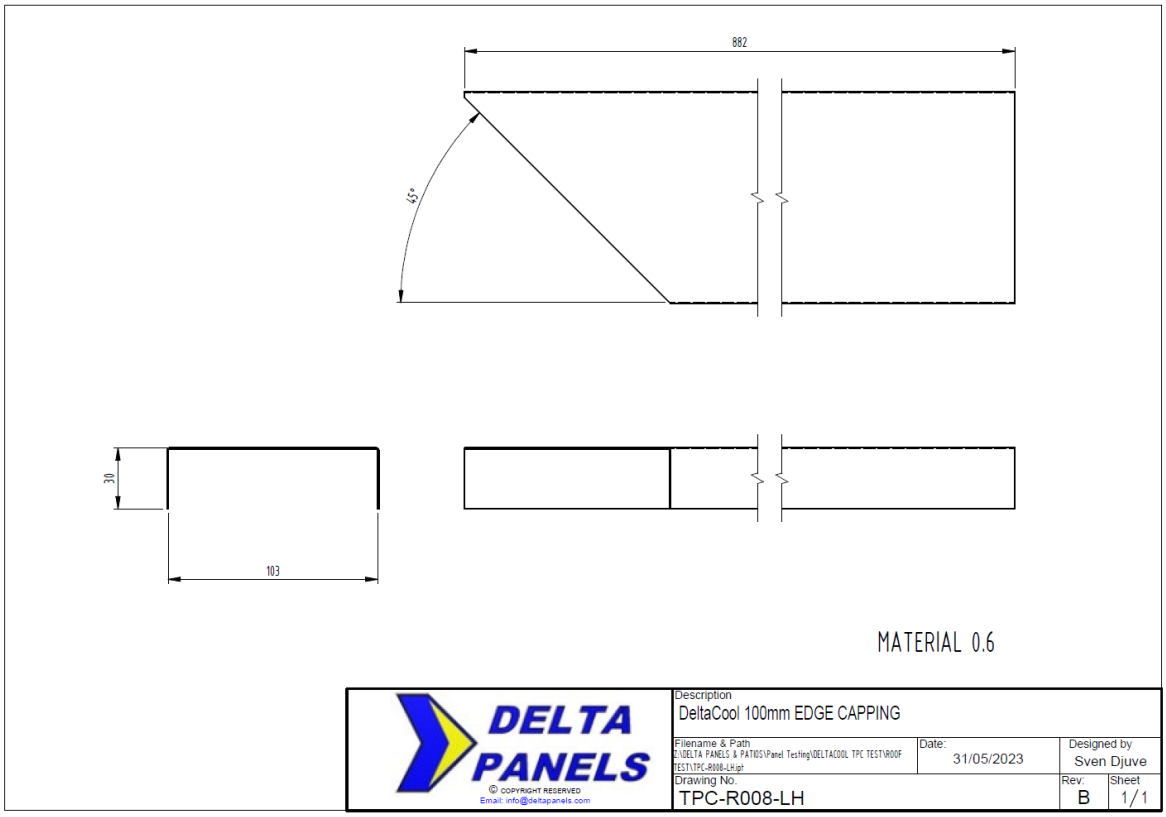

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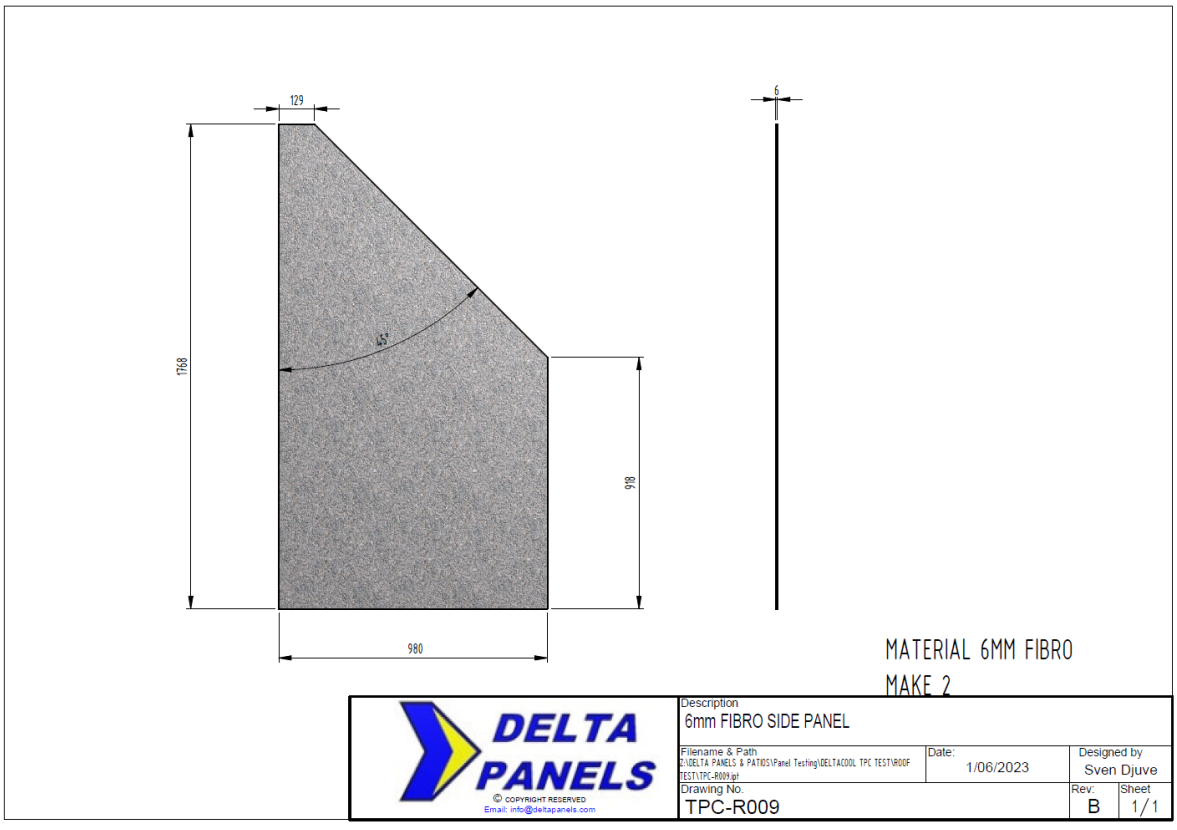

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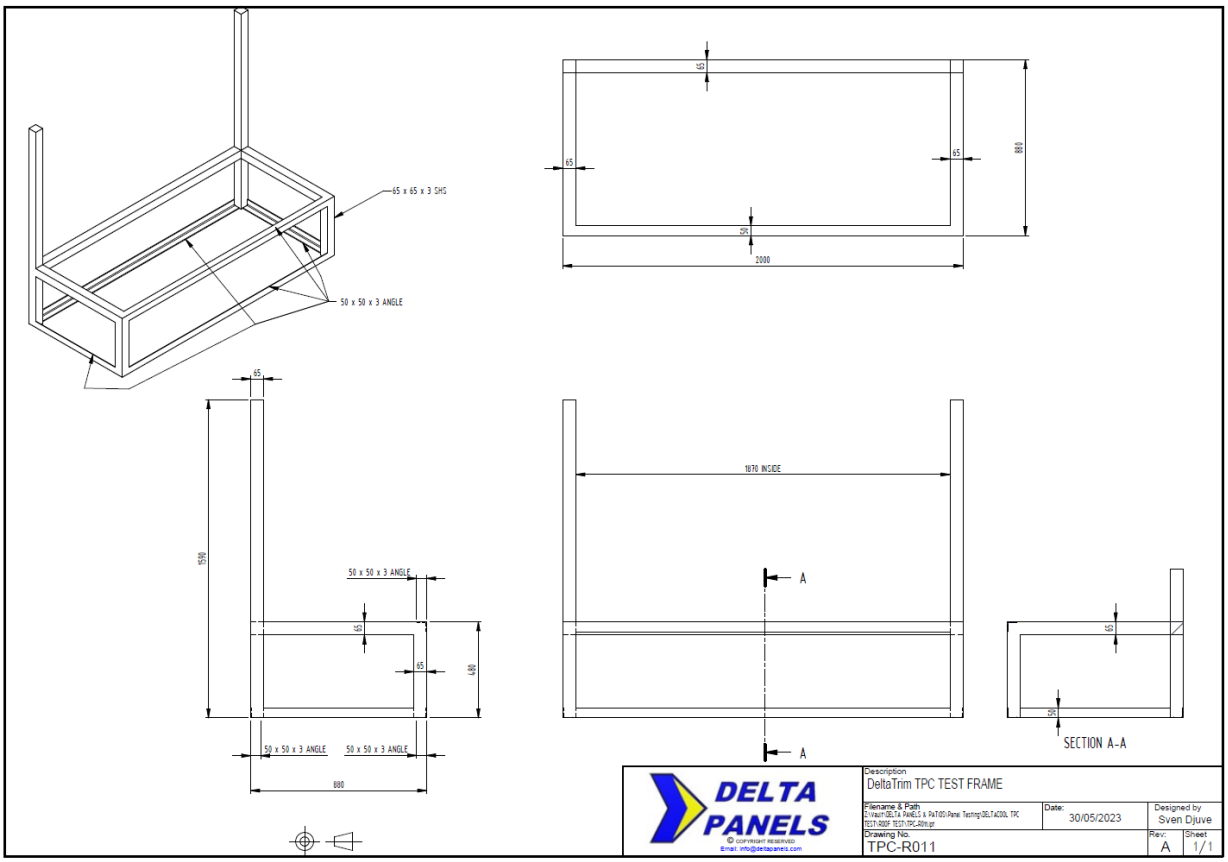

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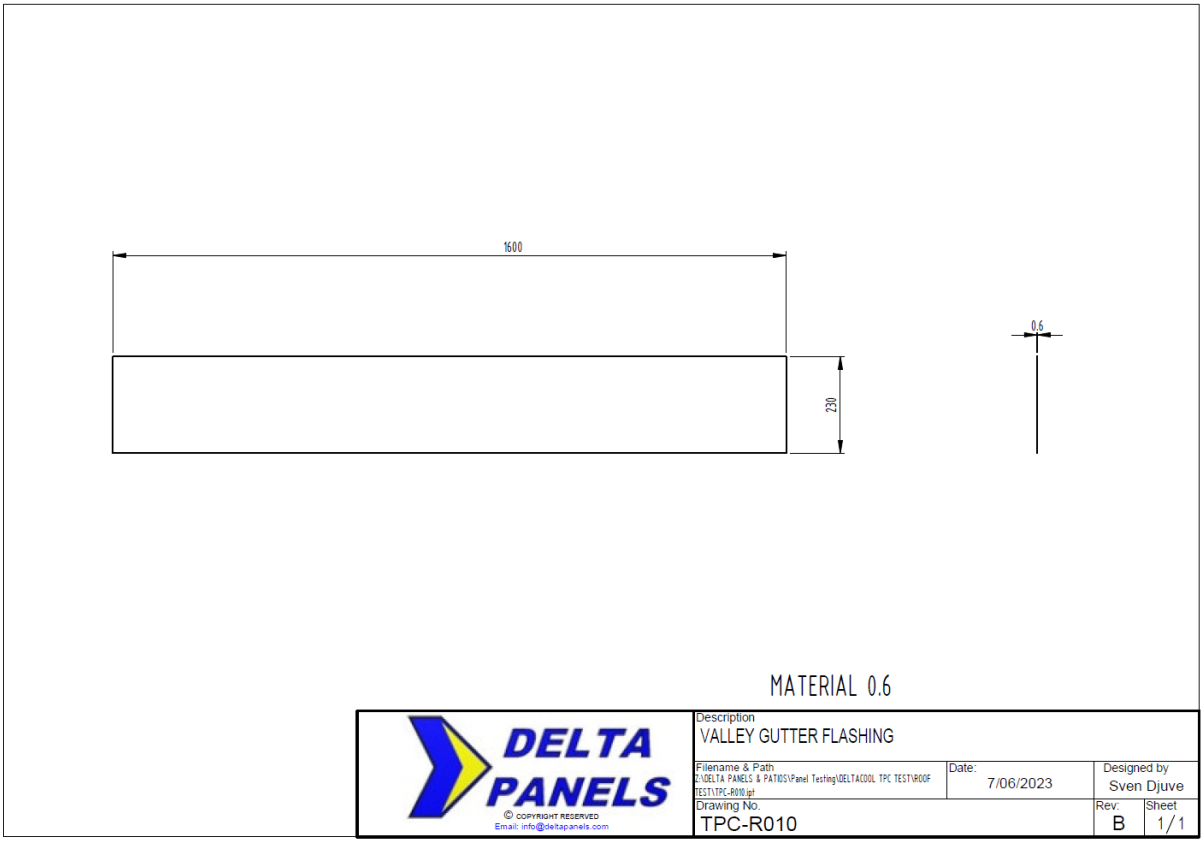

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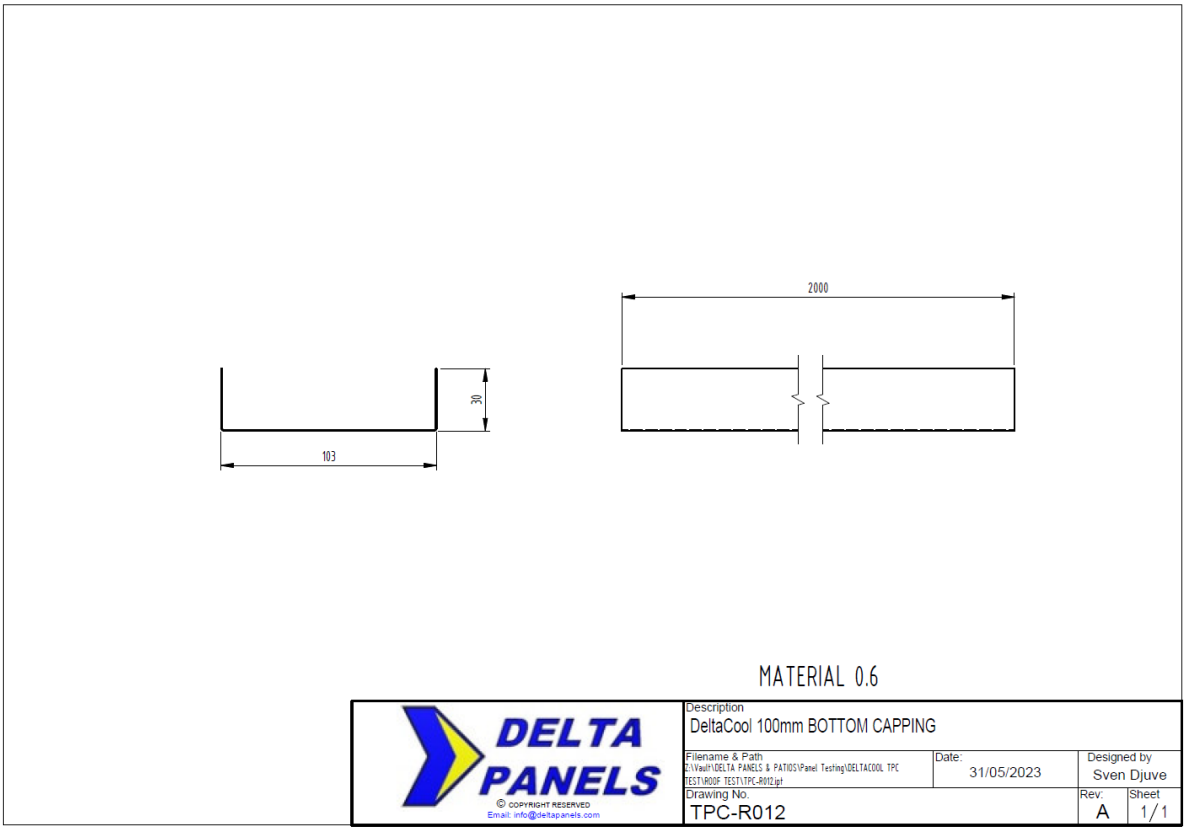

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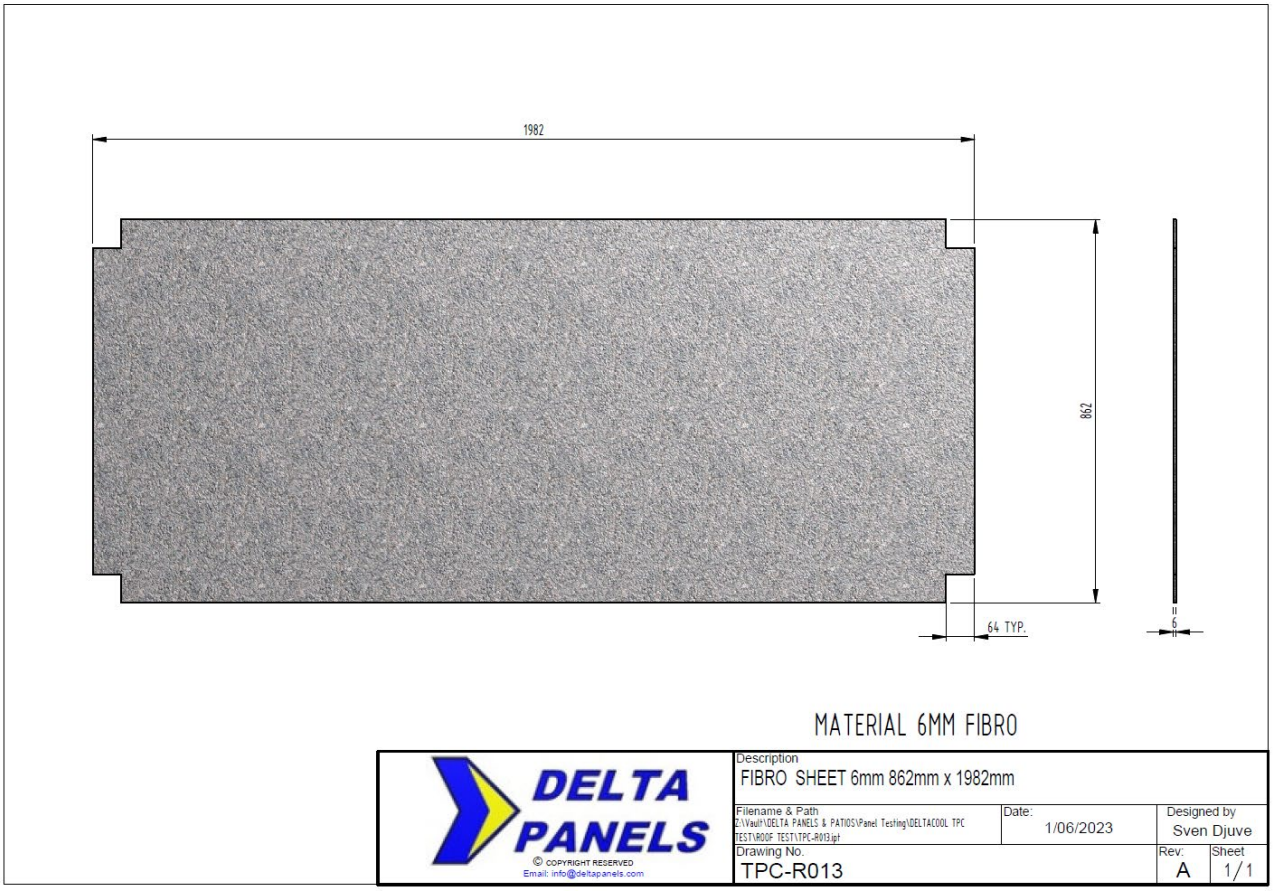

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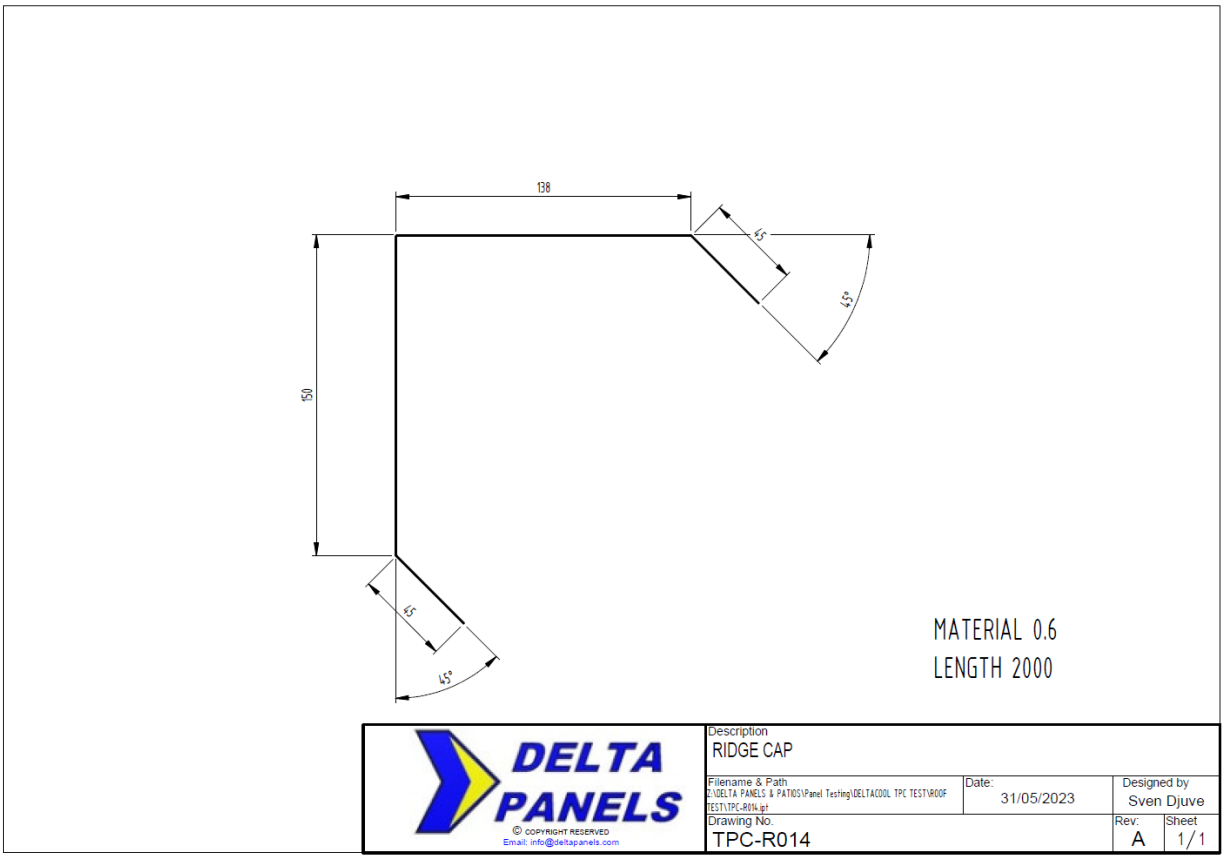

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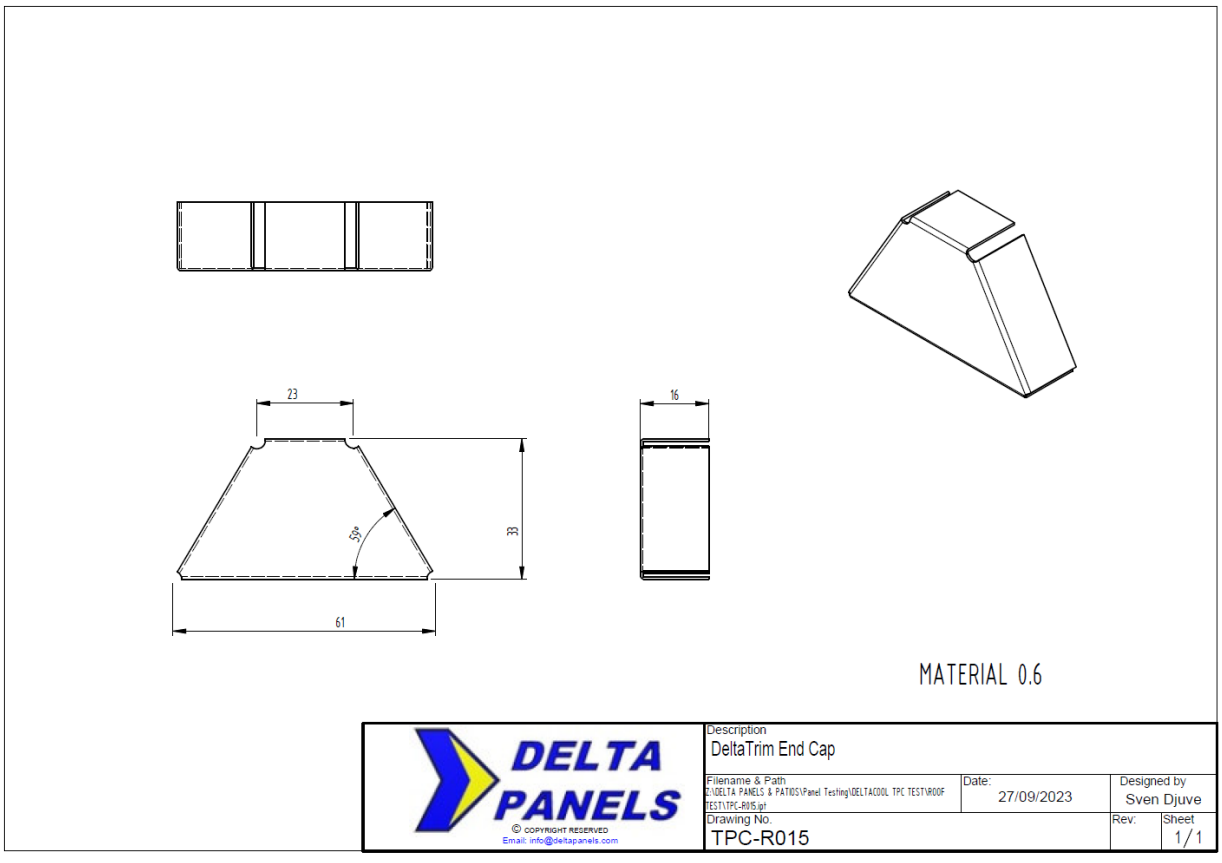

DRAWING NUMBER 'TPC-R015', DATED 27 SEPTEMBER 2023, BY DELTA PANELS

References

The following informative documents are referred to in this Report:

AS 1530.8.1-2018	Methods for fire tests on building materials, components and structures. Part 8.1: Tests on elements of construction for buildings exposed to simulated bushfire attack – Radiant heat and small flaming sources
AS 3959:2018	Construction of buildings in bushfire prone areas

*** end of report ***

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