World Sailing

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Olympic Quality Workstream

Scanner report: Nacra 17 Daggerboard

Project				
Olympic Quality Workstream				
Title				
Scanner report: Nacra 17 Daggerboard				
Revision	**By**	**Date**	**Description of change**	**Checked**
A	A.S.	17/09/2023	Draft Issue	J.N.

Purpose

This report serves to provide the Class Association and the Equipment Committee a summary of the Nacra 17 daggerboard inspections performed by World Sailing's Technical Department at: 2023 production, the 2023 Test Event and the 2023 Sailing World Championships.

Recommendations

Given the differences observed between DNA and E6 daggerboards, noting that access and availability of DNA daggerboards is limited and given the wider range of tolerances observed within DNA daggerboards, the Class is advised to consider the following proposals:

1- Discuss the option to change the class rules to only permit E6 daggerboards at the Paris 2024 Olympic Games.
2- Discuss the option to include tolerances within the Class Rules that would permit inspections with the scanner to determine compliance with the rules.

Background

As part of the Olympic Quality Workstream project, which focuses on improving the quality of Olympic Equipment, World Sailing Technical Department performed an audit to Element 6, in Thailand, where Nacra 17 hulls and hull appendages are produced. In addition, World Sailing Technical Department collaborated with the Technical Committees during the 2023 Test Event (France) and 2023 Sailing World Championships (Netherlands), performing inspections of the competitor's equipment.

Figure 1 – World Sailing 3D scanner during Element 6 audit

Measurements and control points

In this document the daggerboards scanned during the events are compared against the reference baseline obtained from the daggerboards scanned during the audit at the manufacturer.

The following table shows the number of daggerboards scanned:

Production/Event	No. E6	No. DNA
Scanned at production	9	-
Scanned at event	21	29

The analysis presented in this report is limited to a number of control points on specific cross sections. To be mentioned that the output of the scanner permits to analyse much more aspects and areas of the geometry of the foils. Below the list of measurements are presented.

Control points:

- 12 Cross Sections were defined:

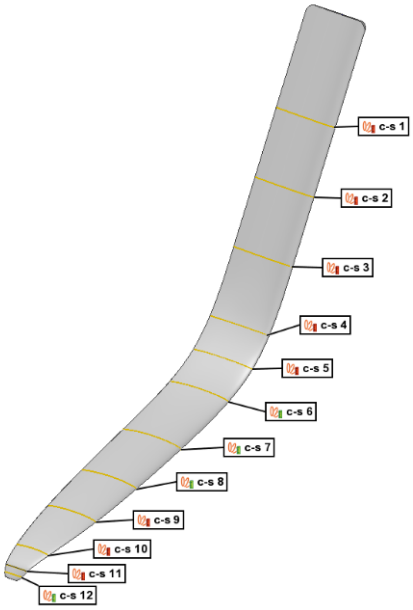


Figure 2 – Cross Sections and Surface Points positioning

- 3 thickness measurements are recorded for each cross section: Leading Edge Thickness at 5 mm, Maximum Thickness and Trailing Edge Thickness at 5 mm.

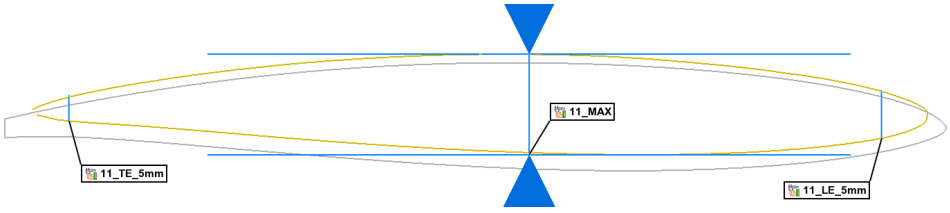


Figure 3 – Callipers positioned on a Cross Section

- For each cross section, the location of 2 Surface Points (IN & OUT) is recorded. The surface points are located at the maximum thickness of each cross sections on the upper (IN) and lower (OUT) surfaces.

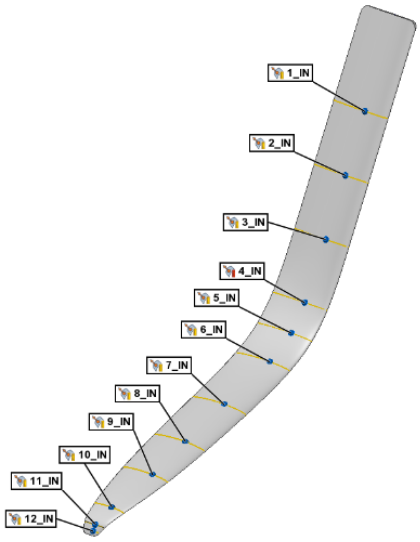


Figure 4 – Upper (IN) surface points for each cross section

The distance between these Surface Points and their equivalents in the reference CAD model represents the location of the cross section in space, the same as shown by the colour map in figure 7.

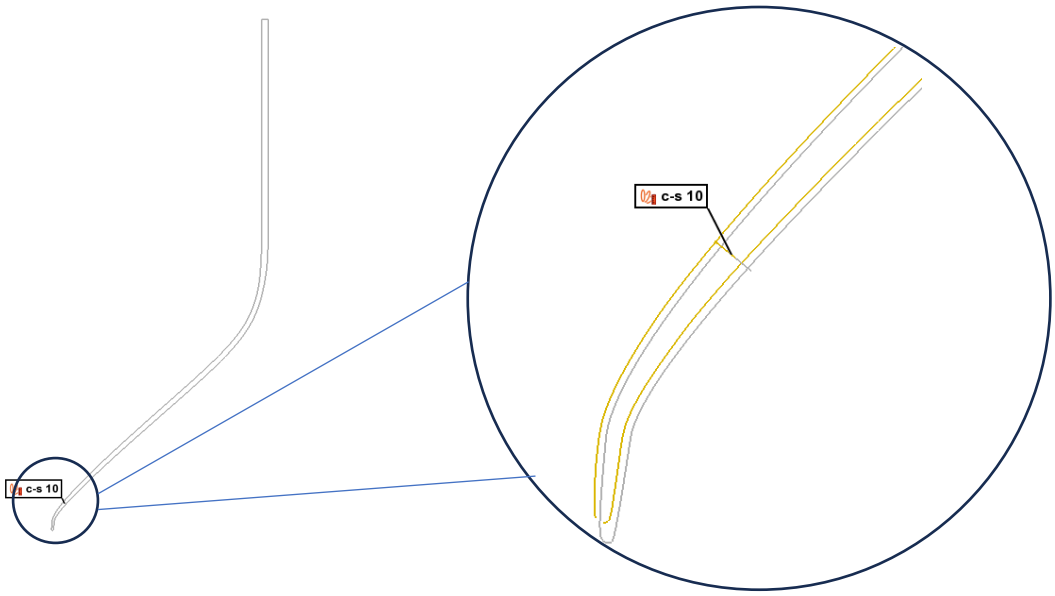


Figure 5 – Frontal view of the scanned data (yellow) and CAD (grey) noting cross section 10.

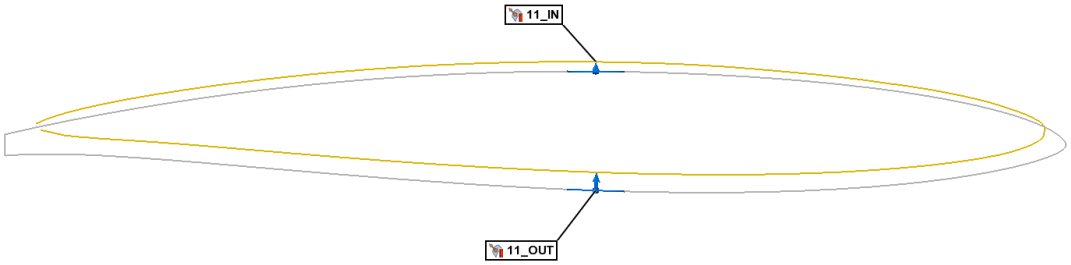


Figure 6 – Surface Points (IN & OUT) on a Cross Section

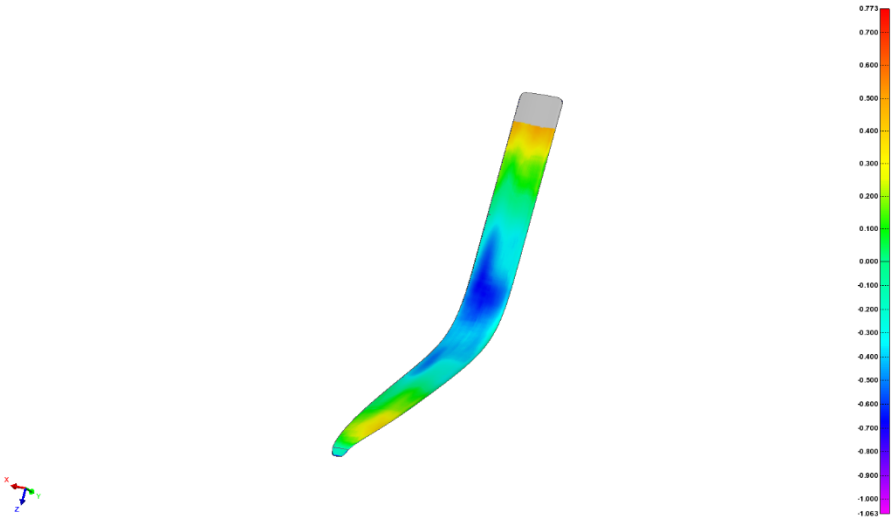


Figure 7 – Surface Points Colour Map example against the design file (CAD)

Analysis

From the daggerboards scanned at production, the average (Mean) of the measurements at each of the control points is recorded.

From the daggerboards scanned at events, the measurements (Values) are plotted to obtain the following charts. The charts also include a graphic representation of the average values derived from the daggerboards scanned at production as well as a visualisation of an upper and lower tolerance (LSL and USL).

$$LSL = Mean - Tolerance \qquad USL = Mean + Tolerance$$

A tolerance of 0.4 mm has been selected for visualisation purposes.

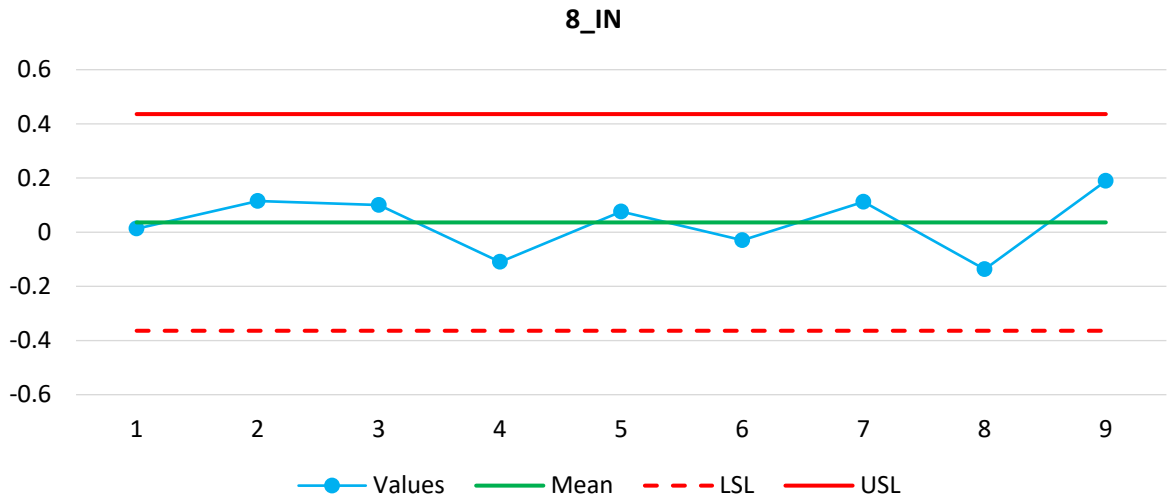


Figure 8 – Cross section 8: Inner Surface point distance plotted for each of the 9 daggerboards scanned at production.

Results

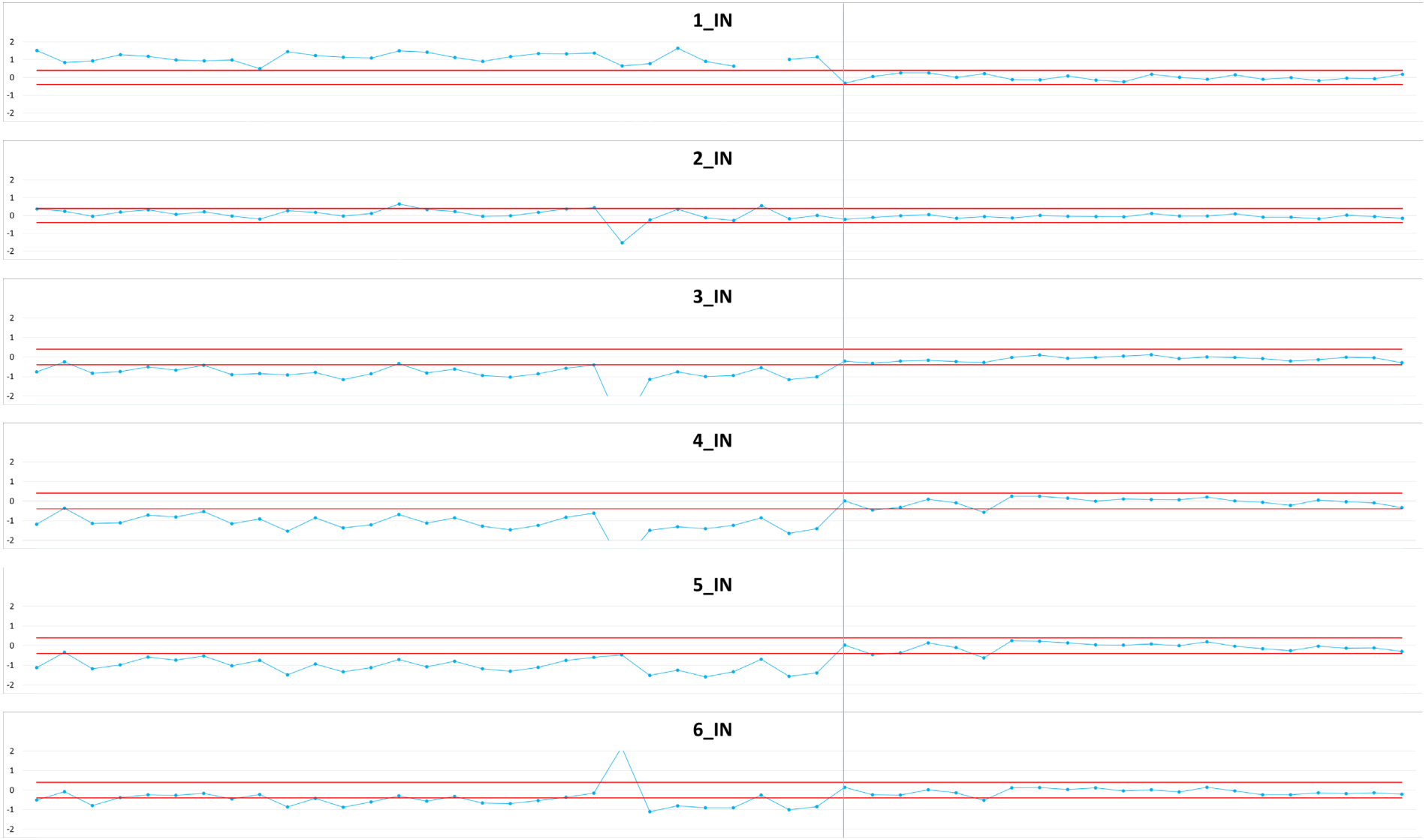
The following pages show the measurements derived from the scans conducted at the events for:

- Surface Point Distances (IN=upper and OUT=lower surfaces)
- Leading Edge Thickness (at 5mm from leading edge)
- Maximum Thickness
- Trailing Edge Thickness (at 5mm from trailing edge)

The results are plotted in chronological order of production. The vertical line represents the change of production from DNA to Element 6.

The values in the charts represent the difference, in mm, between the Element 6 production average and the measurements on the specific daggerboard.

Distance in mm to average from production for <u>Inner Surface</u> for each of the 12 control points on each cross section:



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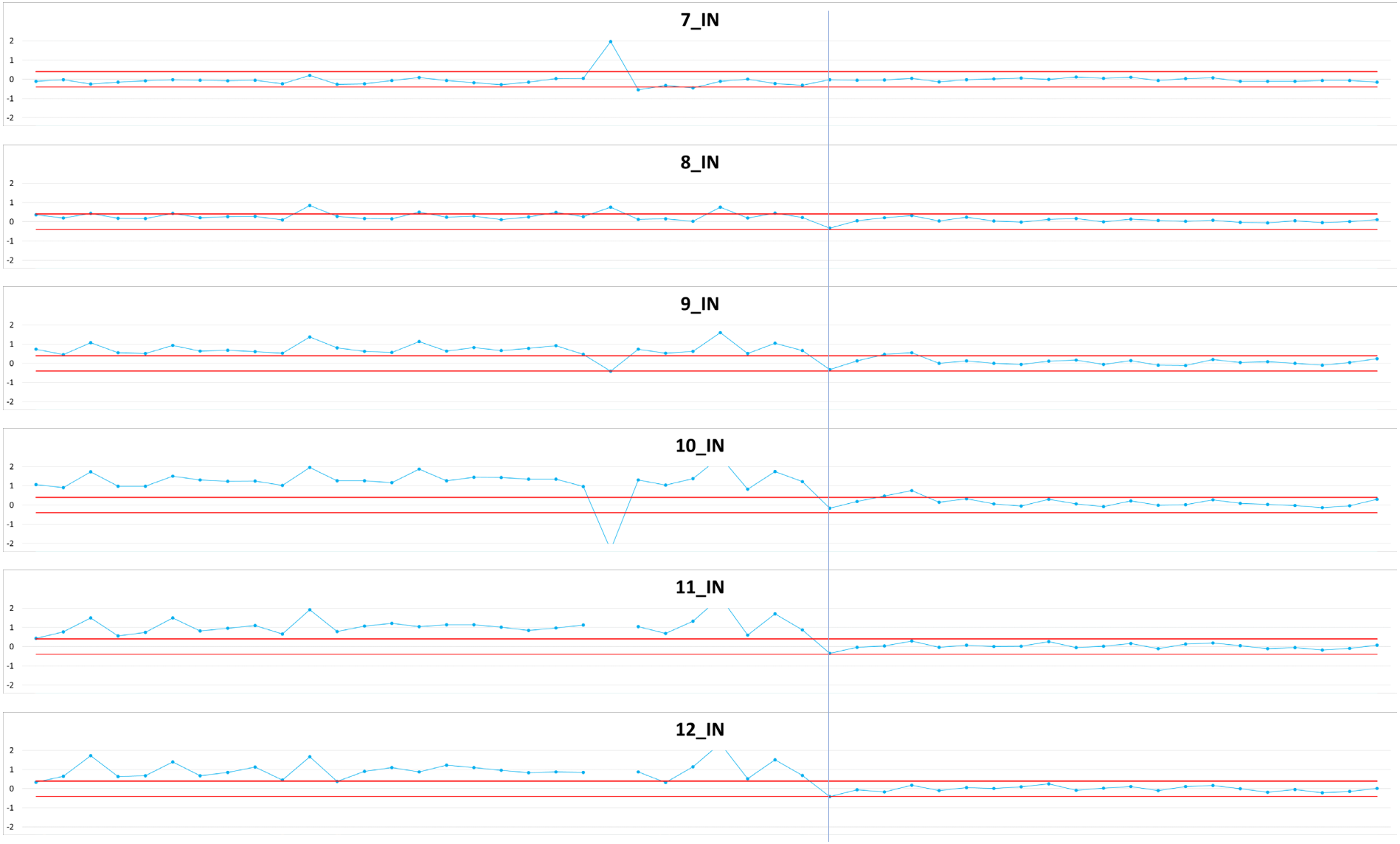
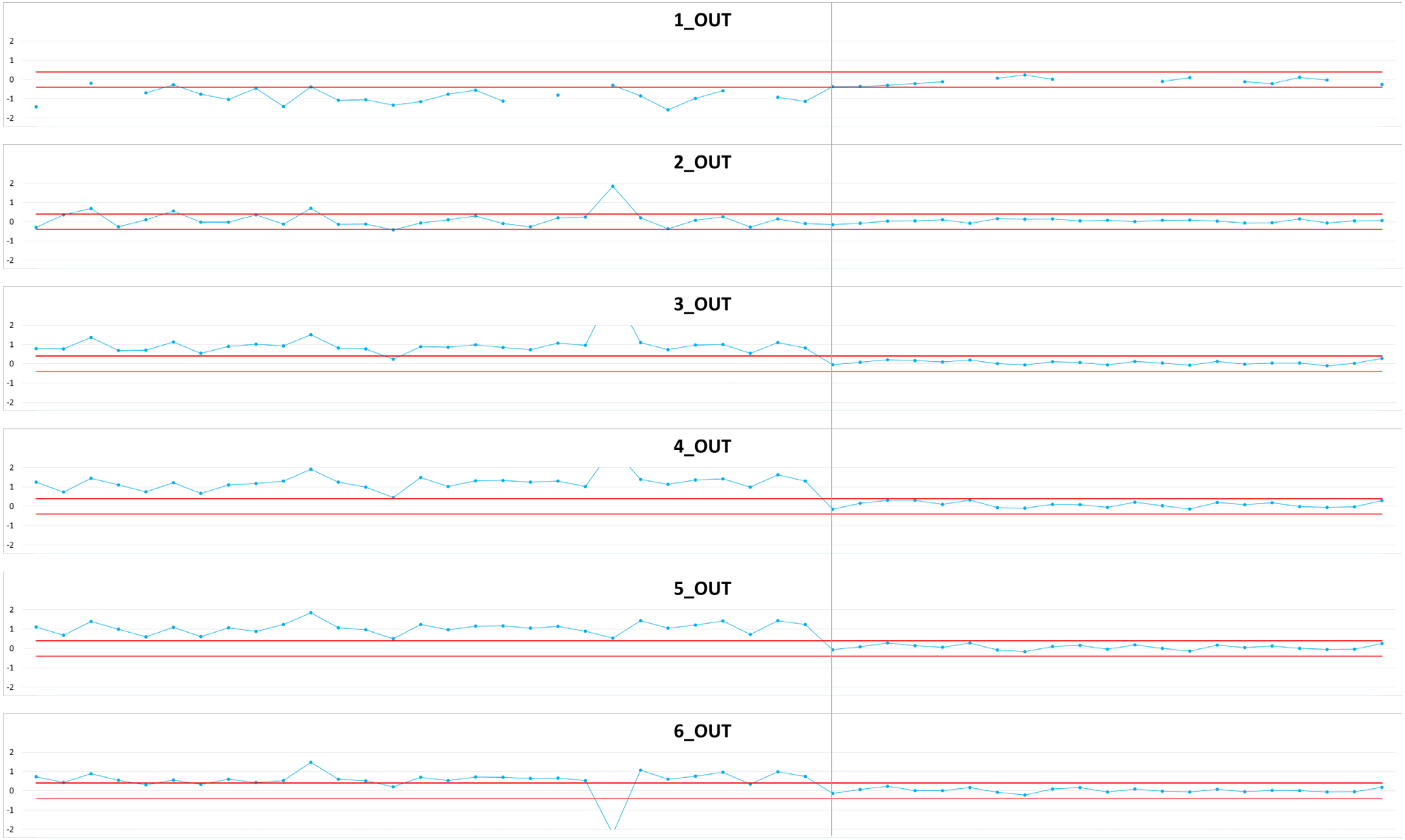
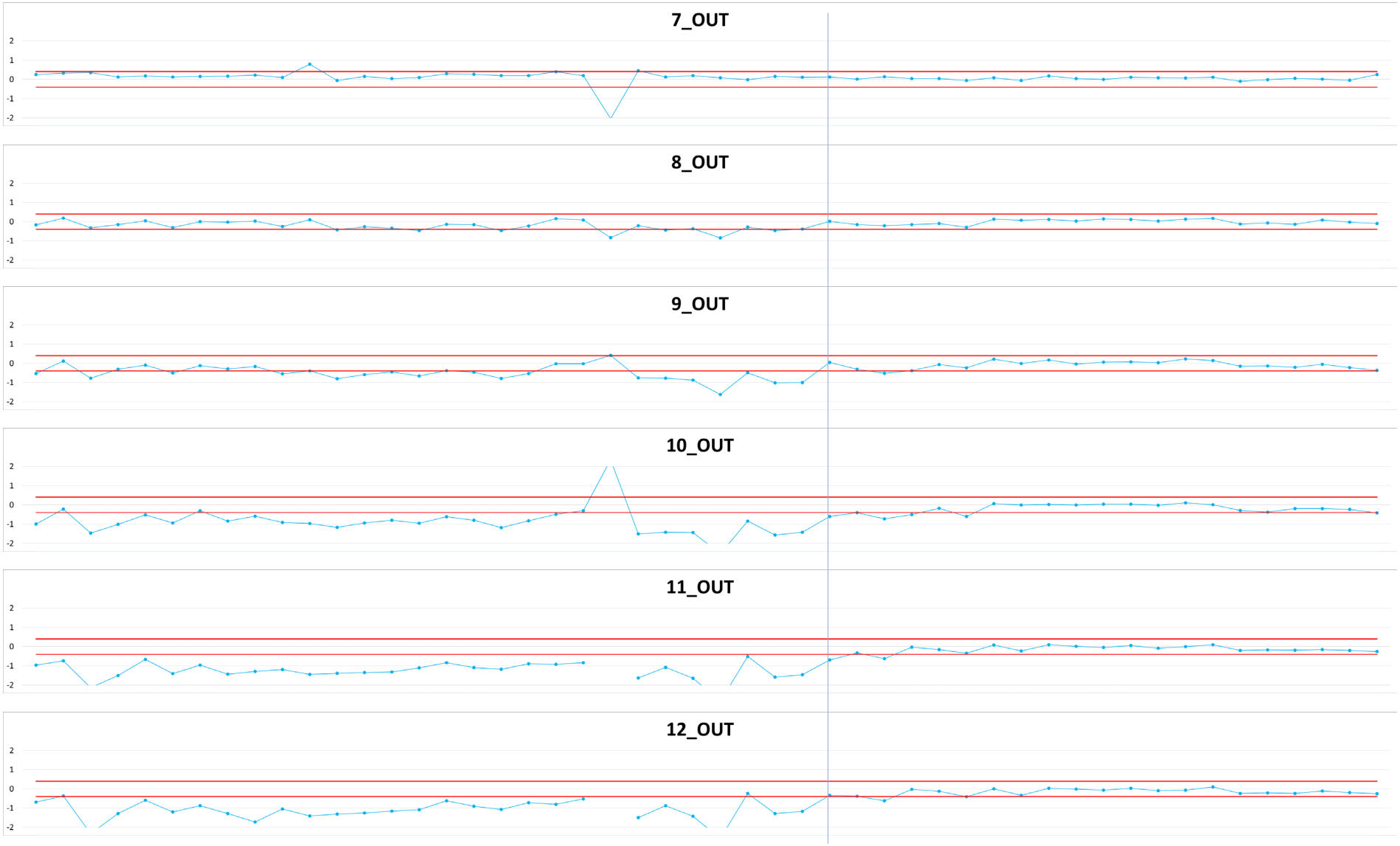
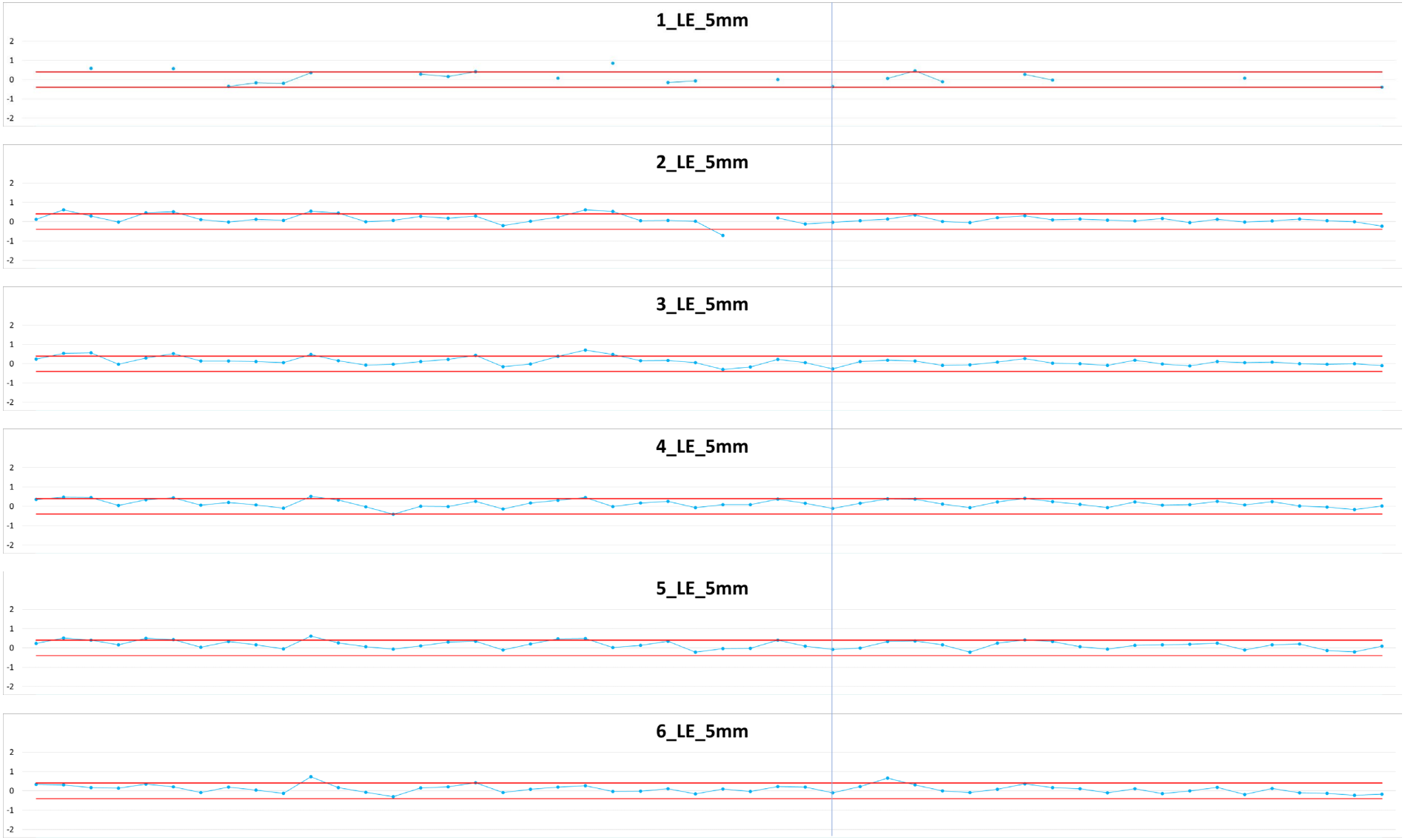


Distance in mm to average from production for <u>Outer Surface</u> for each of the 12 control points on each cross section:




7_OUT
8_OUT
9_OUT
10_OUT
11_OUT
12_OUT

<u>Leading Edge Thickness (mm):</u> Measured minus production average for each of the 12 cross section:



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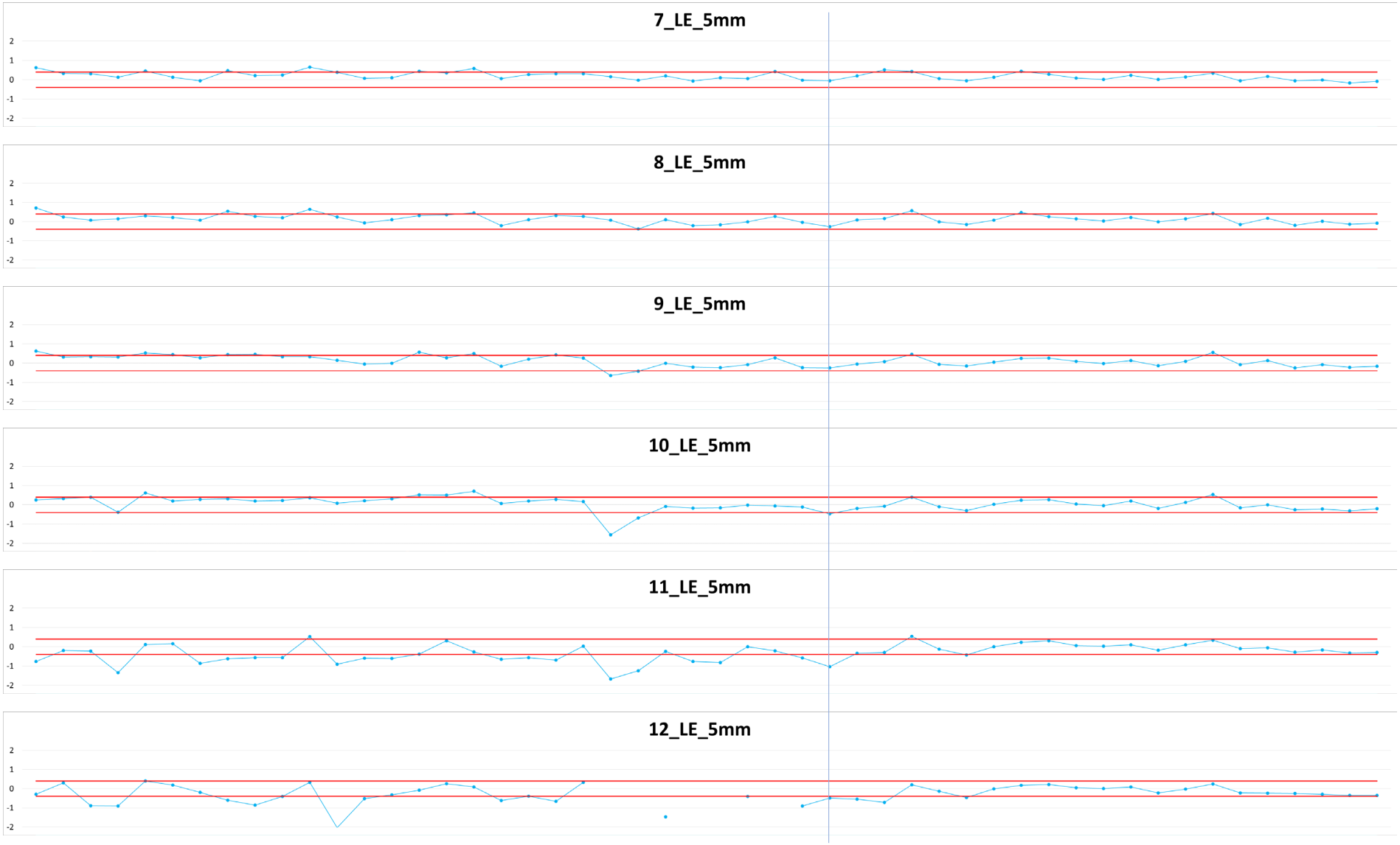
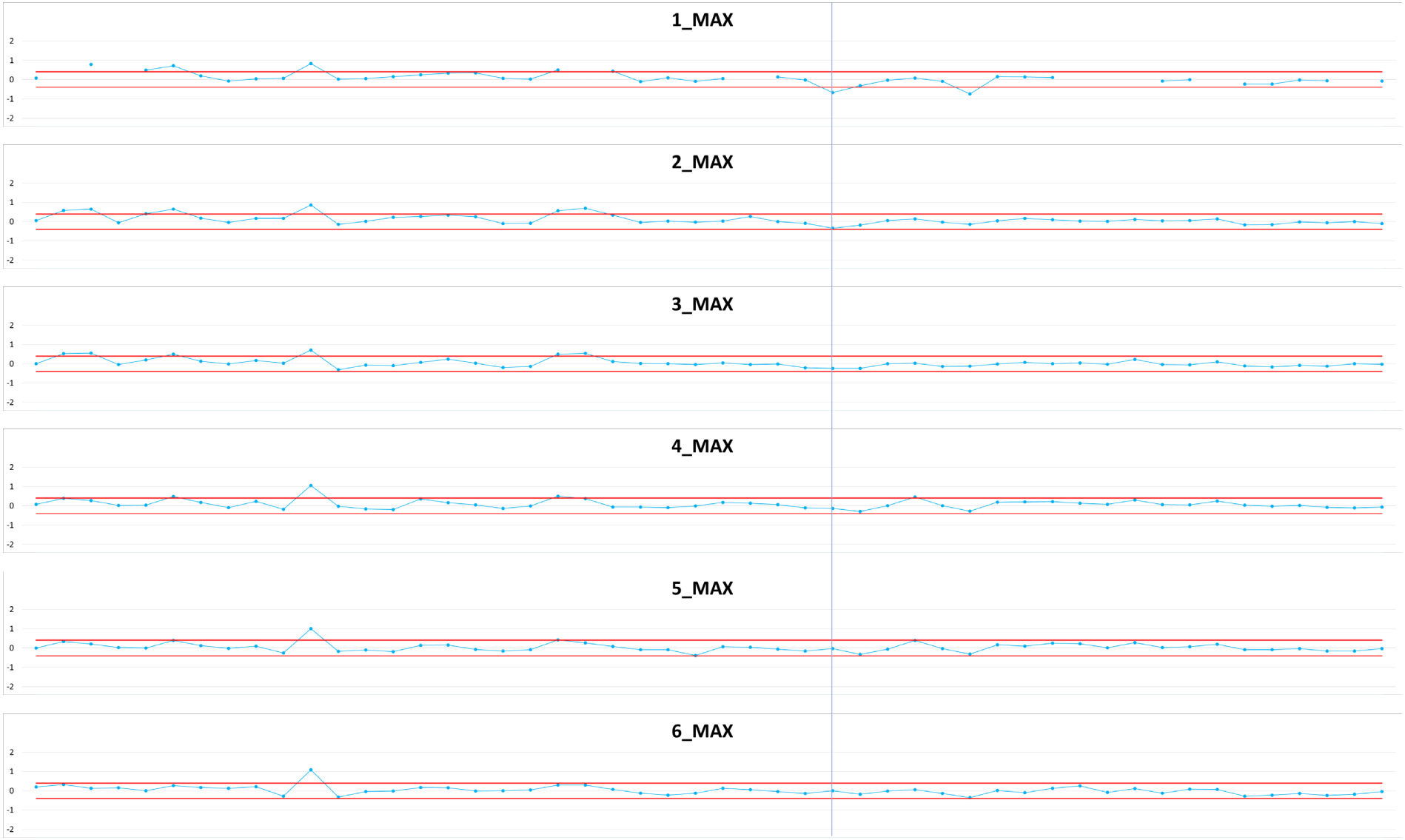


<u>Maximum Thickness (mm):</u> Measured minus production average for each of the 12 cross section:



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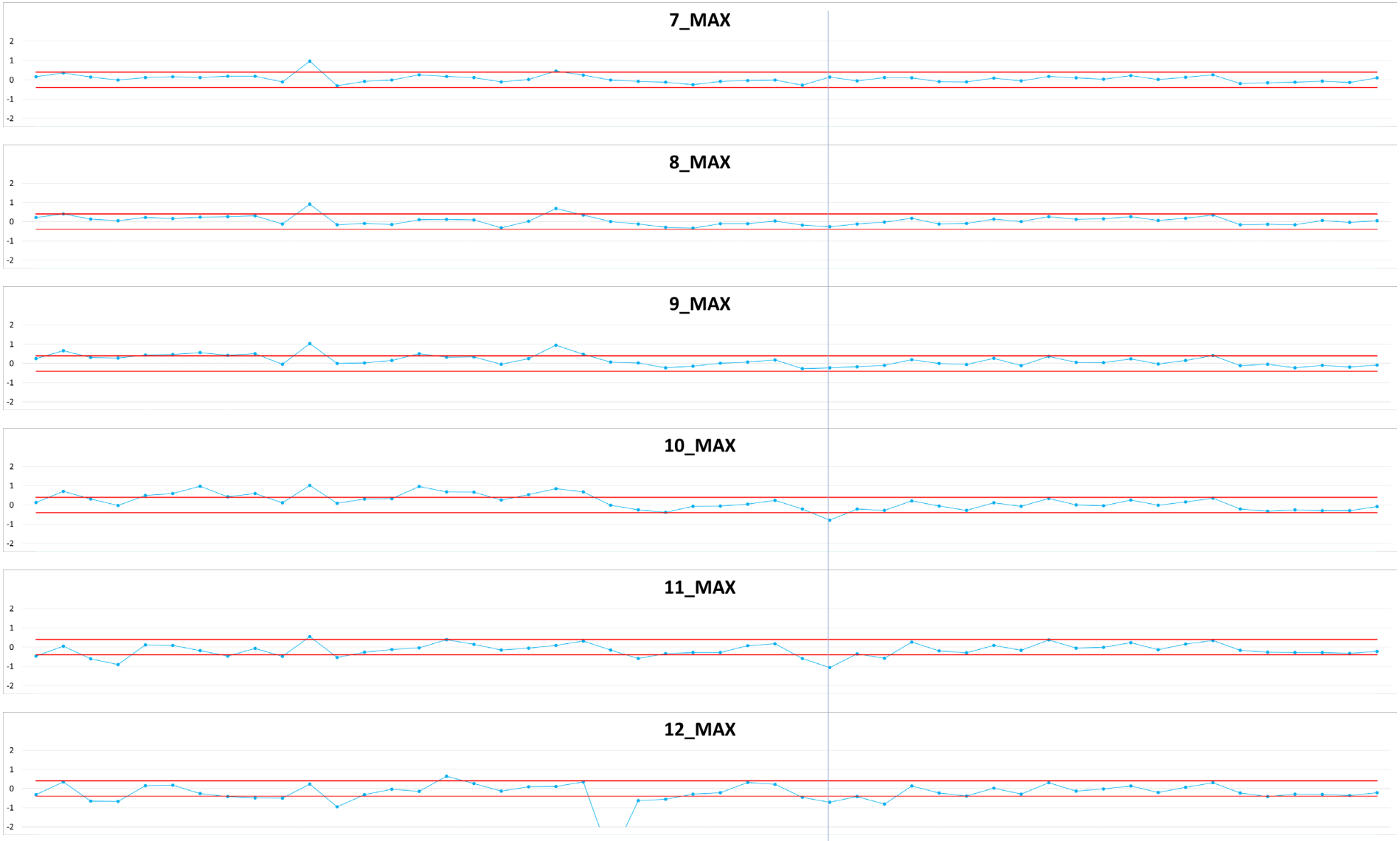
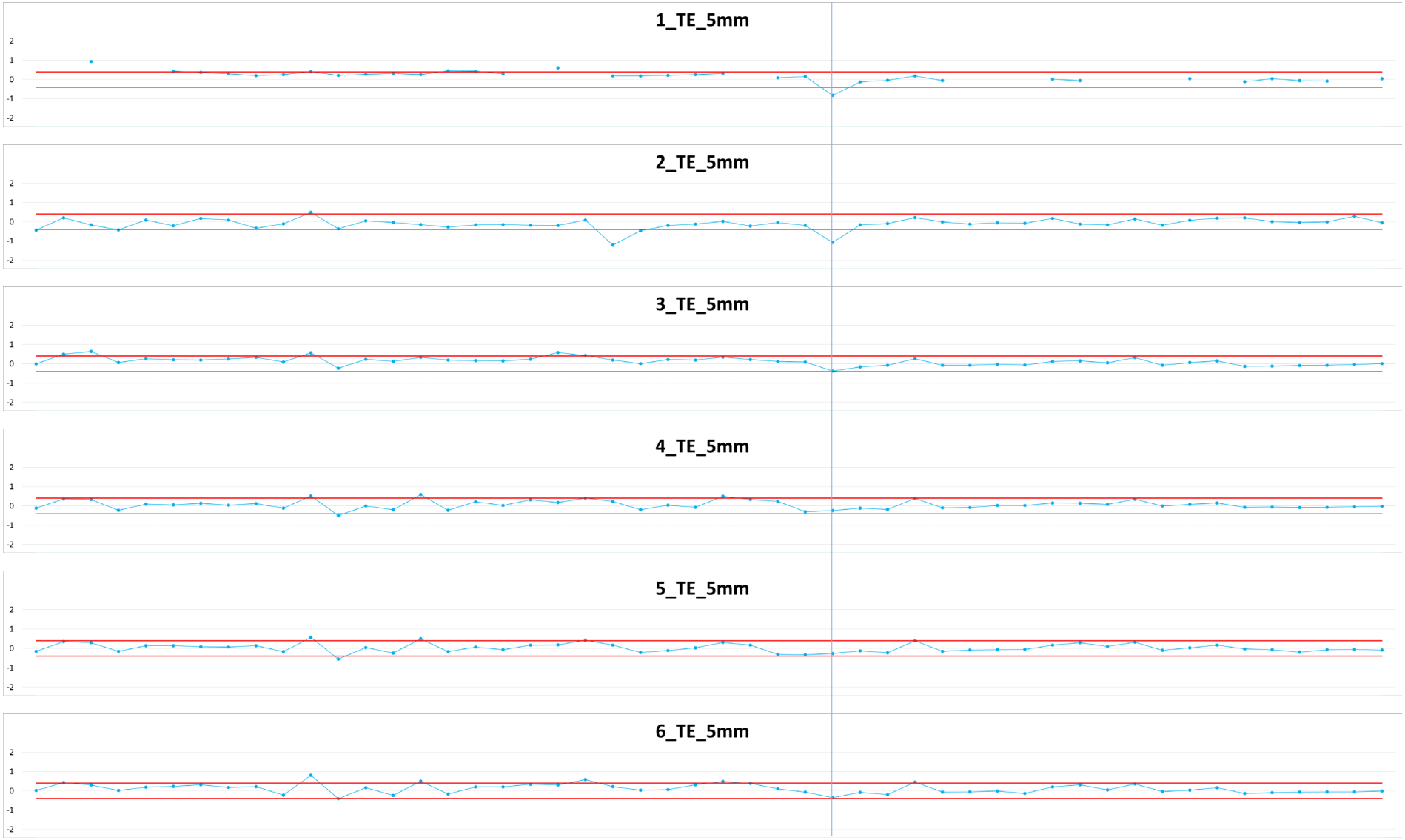


<u>Trailing Edge Thickness (mm):</u> Measured minus production average for each of the 12 cross section:



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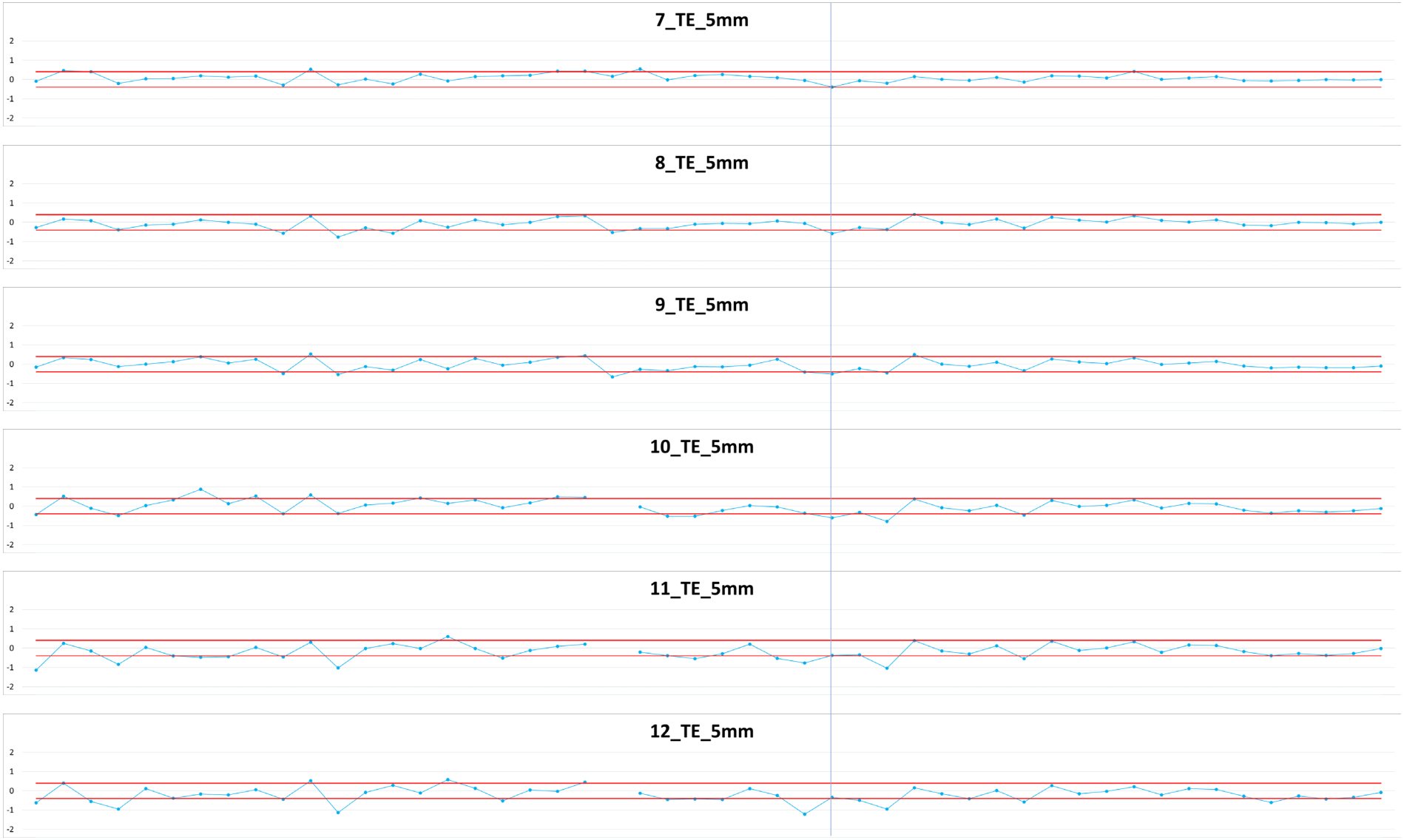

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The following table shows the percentages of measurements from the daggerboards scanned at the **events** of the **Surface Point Distances** that fall within the tolerances of +/- 0.4 mm and +/- 0.8 mm.

	Tol. = 0.4 mm		Tol. = 0.8 mm	
Control	DNA	E6	DNA	E6
1_IN	0%	100%	14%	100%
2_IN	86%	100%	97%	100%
3_IN	7%	100%	45%	100%
4_IN	3%	90%	17%	100%
5_IN	3%	90%	38%	100%
6_IN	38%	95%	72%	100%
7_IN	90%	100%	97%	100%
8_IN	72%	100%	97%	100%
9_IN	0%	90%	69%	100%
10_IN	0%	90%	0%	100%
11_IN	0%	100%	29%	100%
12_IN	11%	95%	36%	100%
1_OUT	17%	100%	42%	100%
2_OUT	83%	100%	97%	100%
3_OUT	3%	100%	34%	100%
4_OUT	0%	100%	14%	100%
5_OUT	0%	100%	21%	100%
6_OUT	14%	100%	79%	100%
7_OUT	90%	100%	97%	100%
8_OUT	76%	100%	93%	100%
9_OUT	34%	95%	83%	100%
10_OUT	10%	71%	28%	100%
11_OUT	0%	90%	11%	100%
12_OUT	7%	90%	25%	100%

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The following table shows the percentages of measurements from the daggerboards scanned at the **events** of the **Section Thicknesses** that fall within the tolerances of +/- 0.4 mm and +/- 1.1mm.

	Tol. = 0.4 mm		Tol. = 1.1 mm	
Control	DNA	E6	DNA	E6
1_LE_5mm	71%	88%	100%	100%
2_LE_5mm	71%	100%	100%	100%
3_LE_5mm	76%	100%	100%	100%
4_LE_5mm	79%	95%	100%	100%
5_LE_5mm	76%	95%	100%	100%
6_LE_5mm	93%	95%	100%	100%
7_LE_5mm	76%	86%	100%	100%
8_LE_5mm	86%	86%	100%	100%
9_LE_5mm	66%	90%	100%	100%
10_LE_5mm	79%	90%	97%	100%
11_LE_5mm	38%	86%	90%	100%
12_LE_5mm	50%	81%	92%	100%
1_MAX	76%	88%	100%	100%
2_MAX	76%	100%	100%	100%
3_MAX	79%	100%	100%	100%
4_MAX	90%	95%	100%	100%
5_MAX	93%	100%	100%	100%
6_MAX	97%	100%	100%	100%
7_MAX	93%	100%	100%	100%
8_MAX	90%	100%	100%	100%
9_MAX	66%	95%	100%	100%
10_MAX	55%	95%	100%	100%
11_MAX	69%	90%	100%	100%
12_MAX	62%	81%	97%	100%
1_TE_5mm	73%	92%	100%	100%
2_TE_5mm	83%	95%	97%	100%
3_TE_5mm	83%	100%	100%	100%
4_TE_5mm	83%	100%	100%	100%
5_TE_5mm	86%	95%	100%	100%
6_TE_5mm	79%	95%	100%	100%
7_TE_5mm	79%	95%	100%	100%
8_TE_5mm	86%	90%	100%	100%
9_TE_5mm	79%	86%	100%	100%
10_TE_5mm	61%	86%	100%	100%
11_TE_5mm	57%	90%	96%	100%
12_TE_5mm	54%	71%	93%	100%

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The following table shows the percentages of measurements from the daggerboards scanned during the **audit** of the **Surface Point Distances** that fall within the tolerances of +/- 0.4 mm and +/- 0.8 mm.

	Tol. = 0.4 mm	Tol. = 0.8 mm
Control	E6 (Audit)	E6 (Audit)
1_IN	100%	100%
2_IN	100%	100%
3_IN	89%	100%
4_IN	78%	100%
5_IN	78%	100%
6_IN	89%	100%
7_IN	100%	100%
8_IN	100%	100%
9_IN	100%	100%
10_IN	78%	100%
11_IN	100%	100%
12_IN	100%	100%
1_OUT	89%	100%
2_OUT	100%	100%
3_OUT	100%	100%
4_OUT	78%	100%
5_OUT	100%	100%
6_OUT	100%	100%
7_OUT	100%	100%
8_OUT	100%	100%
9_OUT	89%	100%
10_OUT	78%	100%
11_OUT	100%	100%
12_OUT	100%	100%

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The following table shows the percentages of measurements from the daggerboards scanned during the **audit to E6** of the **Section Thicknesses** that fall within the tolerances of +/- 0.4 mm and +/- 0.5mm.

	Tol. = 0.4 mm	Tol. = 0.5 mm
Control	E6 (Audit)	E6 (Audit)
1_LE_5mm	100%	100%
2_LE_5mm	100%	100%
3_LE_5mm	100%	100%
4_LE_5mm	100%	100%
5_LE_5mm	100%	100%
6_LE_5mm	100%	100%
7_LE_5mm	100%	100%
8_LE_5mm	100%	100%
9_LE_5mm	100%	100%
10_LE_5mm	100%	100%
11_LE_5mm	89%	100%
12_LE_5mm	78%	100%
1_MAX	100%	100%
2_MAX	100%	100%
3_MAX	100%	100%
4_MAX	100%	100%
5_MAX	100%	100%
6_MAX	100%	100%
7_MAX	100%	100%
8_MAX	100%	100%
9_MAX	100%	100%
10_MAX	100%	100%
11_MAX	100%	100%
12_MAX	100%	100%
1_TE_5mm	100%	100%
2_TE_5mm	100%	100%
3_TE_5mm	100%	100%
4_TE_5mm	100%	100%
5_TE_5mm	100%	100%
6_TE_5mm	100%	100%
7_TE_5mm	100%	100%
8_TE_5mm	100%	100%
9_TE_5mm	100%	100%
10_TE_5mm	100%	100%
11_TE_5mm	100%	100%
12_TE_5mm	100%	100%

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Summary

A total number of 9 daggerboards were scanned at production (E6) and 50 daggerboards (29 DNA and 21 E6) from the fleet were scanned at events. Based on the result displayed above the following conclusion can be drawn:

Surface Distance Points

E6 Daggerboards across the fleet are more consistent than DNA.

On the 24 controls in place, the following measurements fall within the specific tolerances of +/- 0.4 mm and +/- 0.8 mm.

Daggerboard Type	Tol. = +/- 0.4 mm	Tol. = +/- 0.8 mm
DNA	27%	51%
E6	96%	100%

Section Thicknesses

E6 Daggerboards are more consistent than DNA but the difference is not as relevant compared to the Surface Distance Points.

On the 36 controls in place (leading edge, trailing edge and max thickness), the following measurements fall within the specific tolerances of +/- 0.4 mm and +/- 1.1 mm.

Daggerboard Type	Tol. = +/- 0.4 mm	Tol. = +/- 1.1 mm
DNA	75%	99%
E6	93%	100%

Production tolerances

From the daggerboards scanned at production at E6, for each of the control points:

- Surface distance points: 63% within +/- 0.4mm and 100% within +/- 0.8mm
- Section thicknesses: 94% within +/- 0.4mm and 100% within +/- 0.5mm

The Technical Department in consultation with the manufacturer will define the agreed production tolerances for inclusion in the Manufacturer Control System.

Colour Maps

Colour Maps show visually the consistency of E6 Daggerboards against the design CAD and how the DNA differ from the E6 ones and between each other.

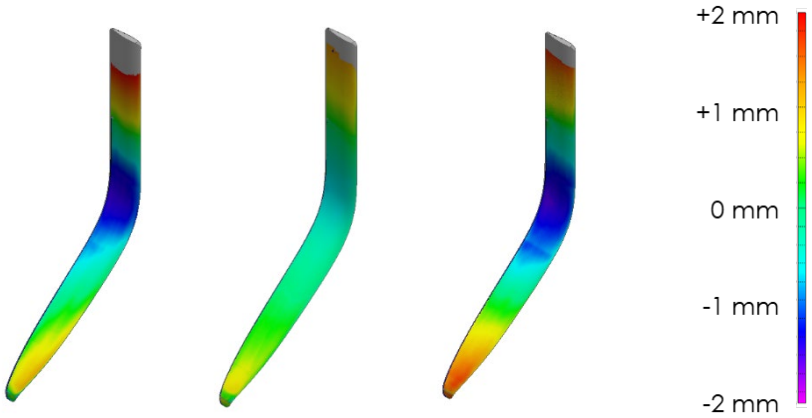

Figure 9 – DNA random examples (colour map extremes at +/-2mm)

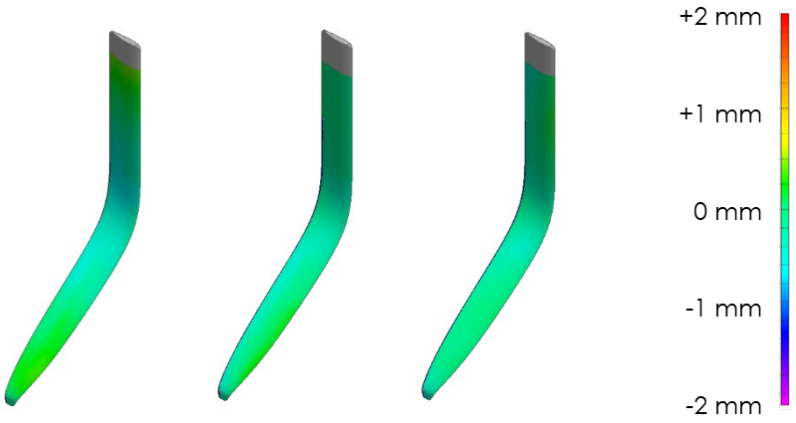

Figure 10 - E6 random examples (colour map extremes at +/-2mm)