SMEI Flight Model Cameras

Effect of Dimensional Tolerances on Mechanical Envelope

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1. Introduction

The purpose of this report is to provide a preliminary assessment of the effect of build-up of manufacturing tolerances on the overall mechanical envelope of the SMEI Cameras, and in particular the tolerance limits on the positions of the extremities of the baffle stack relative to the Spacecraft interface datum.

The motivation for performing this assessment is concern on the part of Spectrum Astro regarding the small mechanical clearance between the baffle extremities and the launcher fairing for one camera.

This report does **not** address issues related to the **optical** alignment of the cameras, e.g. errors in boresight direction and reference cube orientation.

2. Estimates of the Tolerance Build-Up along each Camera Axis

The following sections list the build-up of worst-case manufacturing tolerances between the Spacecraft interface datum (dowel positions) and the baffle extremities. Both linear and, where appropriate, angular errors are considered.

2.1 Shift along Camera X-Axis

(i) Strongbox to Baffle 0, and Baffle 0 through Baffle 7 (top section) $\Rightarrow$ a total of 8 interface joints.

Each joint may shift by $\pm$ 0.013 mm due to dowel-to-hole clearance **plus** a further $\pm$ 0.2 mm due to out-of-symmetry relative to centre line of hole positions on each mating baffle face (or Baffle 0 to Strongbox face).

$\Rightarrow$ 8 x (0.013 + 0.2) = $\pm$ **1.704 mm**

(ii) Assuming that the Door is accurately aligned (by mechanical adjustment) to be symmetrical with the edges of Baffle 7 then an extra $\pm$ **0.05 mm** must be allowed due to the manufacturing tolerance of $\pm$ 0.1 mm on the Door length.

(iii) Assuming that there is a similar dowel-to-hole clearance and out-of-symmetry of hole positions at the Spacecraft to Strongbox interface as exists between the baffle sections, then a further $\pm$ **(0.013 + 0.2) mm** must be allowed.

(iv) Dowel-to-hole clearance and out-of-symmetry of hole positions at the Spacecraft to Strongbox interface **in the Z-axis direction** can potentially cause a **rotation** of the camera about the Y-axis. In the worst-case the rotation is 0.066° which results in a shift along the X-axis at the baffle extremities of $\pm$ **0.38 mm**.

(v) Dowel-to-hole clearance and out-of-symmetry of hole positions at each baffle interface can potentially cause a rotation of the baffle sections about the Z-axis. In the worst-case the rotation at the Door is 0.42° which results in worst-case shifts along the X-axis at the baffle extremities of $\pm$ **0.59 mm**.

The total worst-case error due to manufacturing tolerance build-up along the Camera X-axis at the baffle extremities is therefore:

$$1.704 + 0.05 + 0.213 + 0.38 + 0.59 \Rightarrow \pm \mathbf{\underline{2.937}}\ \mathbf{mm}$$

2.2 Shift along Camera Y-Axis

(i) As per item (i) in Section 2.1 the total shift along the Y-axis at the baffle interface joints is ± **1.704 mm**

(ii) As per item (ii) in Section 2.1 an extra ± **0.05 mm** must be allowed due to the manufacturing tolerance of ± 0.1 mm on the Door width.

(iii) As per item (v) in Section 2.1 the rotation of the baffle sections about the Z-axis results in worst-case shifts along the Y-axis at the baffle extremities of ± **1.74 mm**

The total worst-case error due to manufacturing tolerance build-up along the Camera Y-axis at the baffle extremities is therefore:

$$1.704 + 0.05 + 1.74 \Rightarrow \pm \mathbf{\underline{3.494}}\ \mathbf{mm}$$

2.3 Shift along Camera Z-Axis

(i) Manufacturing tolerance on height of each baffle section is ± 0.1 mm, giving a total over 8 baffles of ± **0.8 mm.**

(ii) Two Door Hinge Block tolerances and Door thickness tolerance of ± 0.1 mm each, result in a further ± **0.3 mm.**

(iii) There are adjustable shims between the Hinge Block and the Door with an adjustment range of **0.5 mm** (actually in one direction only).

(iv) As per item (iii) in Section 2.1 above the dowel-to-hole clearance and out-of-symmetry of hole positions at the Spacecraft to Strongbox interface adds a further ± **(0.013 + 0.2) mm**.

(v) As per item (iv) in Section 2.1 above the rotation about the Y-axis at the Spacecraft to Strongbox interface results in a worst-case shift along the Z-axis at the baffle extremities of ± **0.275 mm**.

The total worst-case error due to manufacturing tolerance build-up along the Camera Z-axis at the baffle extremities is therefore:

$$0.8 + 0.3 + 0.5 + 0.213 + 0.275 \Rightarrow \pm \mathbf{\underline{2.088}}\ \mathbf{mm}$$

3. Summary

The total errors in the positions of the baffle extremities due to manufacturing tolerance build-up are estimated at -

Along Camera	X-Axis:	± **2.9 mm**
"	Y-Axis:	± **3.5 mm**
"	Z-Axis:	± **2.1 mm**

It should be noted that these are **worst-case** figures, i.e. they assume that all errors build up in the same direction. In practice the likely errors **are expected to be much less that these values**.
