Leading edge - length: 146 mm; thickness: 0.68 mm (root), 0.48 mm (tip)
Trailing edge - length: 156 mm; thickness: 0.37 mm (root), 0.22 mm (tip)
Tip length: 73.7 mm
Root - cord length: 81.0 mm
Root thickness (centre): 7.1 mm
Tip thickness (centre): 1.3 mm

Fig. 1 Geometry of the ‘control’ blade
Min. Surf. 1
Boundary edges as in the Control Blade

Min. Surf. 2
Tip thicker in the centre by 1mm

Min. Surf. 3
Root thicker in the centre by 1mm

Min. Surf. 4
Root and tip 1mm thicker in the centre

Min. Surf. 5
Both edges thicker in the centre by 1 mm

Min. Surf. 6
Root, tip and edges 1 mm thicker in the centre

Min. Surf. 7
Root and tip 1 mm, and edges 2 mm thicker in the centre

Min. Surf. 8
As Min Surf 6, but with thickening of edges 1/3 way from the root

Fig.2. (a) Description of the ‘minimal’ blade family (b) Shape contours of selected ‘minimal’ blades versus the ‘control’
Fig. 3. ‘Minimal’ blade 7. Cross-sectional profiles (solid line), relative to the ‘control’ (dotted)
Fig. 4. Pressure data - untwisted blade (a) Nett pressure, (b) Fitted nett pressure
‘Pressure’ Surf. 9
Pressure parameters:
\[ k = 0.7328 \]
Blade volume 93% off ‘control’ blade.

‘Pressure’ Surf. 10
Pressure parameters:
\[ k = 0.7431 \]
Blade volume 95% off ‘control’ blade.

‘Pressure’ Surf. 11
Pressure parameters:
\[ k = 0.7534 \]
Blade volume 97% off ‘control’ blade.

Fig.5. Shape contours of the ‘pressure’ blades versus the ‘control’
Fig. 6. ‘Pressure’ blade 10. Cross-sectional blade profiles (solid line), relative to the ‘control’ (dotted)
Fig. 7 Variations in volume of material in form-found blades relative to the ‘control’ blade volume of 30898.71 mm$^3$
Fig. 8. Finite element modelling in *Cosmosworks*. (a) Static loading position (b) Loading direction and restraints. (Dimensions in mm)
Fig. 9. Case 1. Displacement of form-found blades relative to the ‘control’ blade displacement of 0.74 mm
Fig. 10. Case 1. Maximum values of principal stresses, P1, P2 and P3, for form-found blades, relative to the ‘control’ blade with the corresponding stress values of: $1.88 \times 10^7$ N/mm$^2$, $6.7 \times 10^6$ N/mm$^2$, and $3.42 \times 10^6$ N/mm$^2$ respectively.
Fig. 11. Case1. Distribution of stresses and displacements in selected ‘minimal’ and ‘pressure’ blades versus the ‘control’
Fig. 12. Case 2. Displacement of form-found blades relative to the ‘control’ blade displacement of 4.71 mm
Fig. 13. Case 2. Maximum values of principal stresses, P1, P2 and P3, for form-found blades, relative to the ‘control’ blade with the corresponding stress values of: 3.93×10^8 N/mm^2, 1.87×10^8 N/mm^2, and 1.57×10^8 N/mm^2 respectively.
Fig. 14. Case 2. Distribution of stresses and displacements in selected ‘minimal’ and ‘pressure’ blades versus the ‘control’
Fig. 15. Case 3. Displacement of form-found blades relative to the ‘control’ blade displacement of 4.81 mm
Fig. 16. Case 3. Maximum values of principal stresses P1, P2 and P3, for form-found blades, relative to the ‘control’ blade with the corresponding stress values of: $2.98 \times 10^8$ N/mm$^2$, $1.14 \times 10^8$ N/mm$^2$, and $9.24 \times 10^7$ N/mm$^2$ respectively.
Fig. 17. Modal shapes corresponding to the first six natural frequencies for:
(a) ‘Minimal’ blade 7, (b) ‘Pressure’ blade 10, and (c) ‘Control’ blade
Fig. 18  First six natural frequencies for form-found blades versus the ‘control’