Justin's work on blades

<table>
<tr><td colspan="2">Transmissibility FEA. Summarised in G040060.</td></tr>
<tr><td>T04024-00-K</td><td>Part 1. Initial exploration.
Modal analysis of reference blade whose frequency had been measured. FEA gave 54, measured was 55 Hz.
Modal analysis of blade from conceptual design. FEA gave 71.2 Hz, blade equation-style extrapolation gave 72.1 Hz. Loading the tip with 11 kg instead of fixing it gave 71.4.
Harmonic analysis to look at damping. First run with no damping found peak at 71.4 as expected. Damping ratio of 1e-4 gave a peak of ~4600. No change in shape of resonance curve except the very peak, for damping ratios of 1e-2 to 1e-4. Null in displacement of blade mid-point just above first bounce mode.
Tried changing blade geometry – concluded that shape factor has little effect on modes.
Tried prestress – no effect.
Effect of wire clamp mass. A 16g mass had very little effect on mode frequencies. Even a 100g had veryy little effect on transmissibility.
Nice appendix on Q, phi, etc by Norna. Conclusion: DMPRAT = 1/(2Q).</td></tr>
<tr><td>T04025-00-K</td><td>Part 2. Transmissibility of a set of blades. Built on the results at the end of part 1, did transmiss. For each of three blade/clamp/wire/mass sets and multiplied. You have to find the normal modes of each set first in order to know at what frequencies to look.</td></tr>
<tr><td>T040061-01-K (temp)</td><td>Part 3. Transmissibility of a revised set of blades. This was for the modified CP design. These value agree with T040152 which documents the CP blade design.

Alpha = 1.35

Implies beta = 0.15051

So,

Tip width = root width * 0.15051
<table>
<tr><td>length</td><td>thickness</td><td>root</td><td>tip</td><td>tipmass</td><td>testmass</td></tr>
<tr><td>0.480</td><td>0.0043</td><td>0.095</td><td>0.0143</td><td>0.01</td><td>11</td></tr>
<tr><td>0.420</td><td>0.0046</td><td>0.059</td><td>0.0089</td><td>0.01</td><td>11</td></tr>
<tr><td>0.370</td><td>0.0042</td><td>0.049</td><td>0.0074</td><td>0.01</td><td>19.2</td></tr>
</table>
peaks were, with DMPRAT=5e-5. (Q =1e4)
0.006453 at 69.444 Hz
0.009319 at 96.596 Hz</td></tr>
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	0.00523 at 113.59 Hz
T040114-00-K (temp)	Check on preloaded frequency. Showed that a horizontal preload raised the internal modes but a vertical preload did not. Also had a mesh density check.
T040116	FEA of blades for BTF and comparison with observed results. Conclusion is to use the blade equations with E=186 and alpha=1.36 for the CP.
Blade equations and designs. Mostly summarised in G040058 and G040059.	
T030285-01-K	Blade design equations.
T040115-00-K(temp)	Blade bend radius. Looks at two ways of calculating bend radius; one based on the deflection from the blade design equations (method "A") and the other (method "B") using bending radius direct. Concludes that A with accepted values of E and alpha works best; but that using more realistic values of E and geometrically correct values of alpha then B is better. Of the two A with accepted values is the best. Gives the radius used for the RAL test blades.
T040083-01-K	VIRGO references. Useful background to T040108 below.
T040108-00-K (temp)	Blade processes. Gives proposed material choice, heat treatment, max allowed stress, and Q factor for calculations. For the controls prototype, no overstressing to ameliorate creep (effects would not be detectable).
T040153	Documents the parameters of the CP blade design and shows where they came from.