Helicopter Low Speed Testing

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With the ability to deliver rapid and customer focused solutions to a range of flight test challenges, QinetiQ’s Flight Test Organisation (FTO) has CAA approval to conduct all categories of flight test on fixed and rotary wing aircraft.

Find out more at: www.QinetiQ.com/FTO

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Introductory Remark

After 25 years of flight test the biggest lesson I have learnt is that flight test is incredibly simple……………

…………….until you actually come to do it.
Why do we do helicopter low speed testing and what’s low speed?

Helicopters have a low speed envelope, typically up to ~30 to ~50 kn

Low speed performance
- Hover wind effects
- OEI minimum speeds
- Dynamic OEI ‘flyaway and reject’

To define the low speed envelope
- Control margins, typically TRP
- Engine performance (recirculation) or systems performance
Low speed reference system

Key requirement is to know the airspeed/relative wind speed at which the aircraft is traveling.

Traditionally a ground ‘pace vehicle’ has been used.
## Typical risks and mitigation

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Considerations</th>
<th>Risk Reduction measures</th>
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<tbody>
<tr>
<td>Vehicle operating in close proximity to aircraft in flight.</td>
<td>Collision with pace vehicle during low speed manoeuvres leading to:</td>
<td>1. Testing will be briefed and conducted iaw the Pace Vehicle SOP.</td>
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<td>Loss of aircraft, crew, and pace vehicle occupants.</td>
<td>2. Follow pace vehicle procedures where applicable.</td>
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<td>3. Pace vehicle crew to attend pre-flight brief.</td>
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<td>4. Pace vehicle crew to be suitably experienced and qualified.</td>
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<td>5. The handling pilot and aircrewman to keep the pace vehicle in sight at all times during the test.</td>
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<td>6. The pace vehicle to be in two way communications with the aircraft at all times.</td>
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<td>7. A minimum of 2 rotor spans clearance to be maintained between the aircraft and the pace vehicle.</td>
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<tr>
<td>Operations close to or at limits of LSFE whilst at low level.</td>
<td>Loss of control authority in any axis whilst testing at low speed causing collision with obstacles or loss of control, leading to:</td>
<td>1. Incremental approach to testing.</td>
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<td>Loss of aircraft and death/injury to personnel.</td>
<td>2. Control margins to be monitored in real time. The FTI system displays change colour to give additional warning of approaching aircraft limits.</td>
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<td>3. HOWGOZIT plot to be used, if appropriate.</td>
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<td>4. ‘Knock it off’ control margins to be defined based on control axis, aircraft height and other factors.</td>
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<td>5. Testing to be conducted in an area free of obstacles.</td>
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<td>Operations outside of OEI flight envelope whilst at low level.</td>
<td>Loss of engine power whilst operating at low speed without single engine capability causes aircraft crash.</td>
<td>1. Low speed flight limitations and OEI performance to be briefed.</td>
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<td>1. Aircraft ballasted for high AUM.</td>
<td>2. Advanced single engine recovery techniques to be practised (Sim. &amp; aircraft) i.e. workup training for all test low speed flight conditions.</td>
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<td>2. Environmental conditions decrease fly-away performance</td>
<td>3. Captain to brief crew on actions in the event of an engine failure.</td>
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<td>LSFE testing involves protracted operations at low level. Leading to:</td>
<td>4. Testing to be carried out over a suitable landing area.</td>
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<td>Loss of aircraft and death/injury to personnel.</td>
<td>5. Crew to have accurate wind speed and direction information.</td>
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<td>6. LHS crewmember to monitor power margin.</td>
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</table>
Pace vehicle issues

Accuracy
- Is the aircraft actually in formation with the vehicle?
- The relative wind at the vehicle may be different from at the aircraft (wind measured at ~10ft, aircraft at ~120ft?)

Safety
- Need to avoid pace vehicle
- Avoiding pace vehicle when off test point and getting into formation increases workload
- Relatively high workload, mental arithmetic

Rate of data acquisition
- Need to wait for pace vehicle to get on condition
- Even with a long runway, difficult to test multiple conditions on a single run
Is there a better way?

- Ambient wind
- Relative wind on aircraft
- Airflow due to aircraft motion
Low speed testing
Advantages (and disadvantages)

Higher resolution, apparent increase in accuracy
- Relative wind calculated at aircraft height
- An easier flying task

Safer – no vehicle

Quicker
- At least twice as quick as pace vehicle technique
- Multiple different test points per run (change speed or azimuth)

Ambient wind measurement is displaced from the aircraft so local variations on the airfield can negatively affect accuracy.