Be careful, you might just find what you're looking for...

Flight Lieutenant Dane Petersen
Flight Test Engineer
Aircraft Research and Development Unit
RAAF Base Edinburgh, SA 5111, Australia

Squadron Leader Darren Hughes
Test Pilot
Aircraft Research and Development Unit
RAAF Base Edinburgh, SA 5111, Australia

Abstract

The flight test program for the AF/A-18 Hornet upgrade program, HUG 2.2, required the End-to-End assessment of numerous advanced stores, including the 1000 lbs. Guided Bomb Unit (GBU) 16. It was during the End-to-End evaluation of the GBU-16, whilst manoeuvring onto the required target heading, that the Test Pilot experienced the sudden onset of an excessive and objectionable lateral cockpit vibration. The magnitude of the vibration caused the immediate termination of the test point, and when a similar vibration was experienced during a repeat of the same point, the sortie too was terminated. The consequence for the GBU-16 was its prohibition from operational use – in the tested configuration – until further investigation could be completed.

This was 2006, now in 2010 the time had come to conduct the investigation required to achieve an unrestricted clearance for the GBU-16. Unfortunately – not least due to the passage of 4 years – the test team faced significant unknowns that cast serious doubt over how, and if, an unrestricted clearance could be achieved. The main, and undeniable problem, was that a number of foreign Hornet operators had cleared and been operating the particular store configuration in question for upwards of 20 years; leading to the opinion that the 2006 event was simply an ambiguous and unrepeatable abnormality. In addition, factors such as the lack of relevant instrumentation and the unknown serviceability of the store and its pylon helped to give weight to the consensus that the event was simply a 'one off' and not repeatable. The consequence of which was to question the scope of – even the need for – the proposed flight test program.

In contrary, the qualitative description of the 'objectionable vibration' was unnervingly similar to the experience of Limit Cycle Oscillation (LCO) flight. Perhaps fortunately, the test team was highly proficient in the methods required for the safe conduct of flight test in the flutter/LCO envelope. A key 'real time' monitored parameter during such testing is lateral acceleration at the pilot's seat, where persistent oscillations above ±0.1 g are proven to inhibit the ability of the pilot to perform normal cockpit operations; and consequently, are considered unacceptable.

On 08 Apr 2010, during the second investigation flight into the 'objectionable vibration', whilst accelerating to 485 KIAS in a +2.0 g level turn at 9000 ft Hp, the test director requested that the pilot perform a lateral stick rap. The response to the stick rap was a 'cliff edge' divergent oscillation that resulted in lateral accelerations at the pilot's seat reaching ±0.16 g in 2 seconds, orders of magnitude faster than the test team had ever previously

experienced. Interestingly, these exact conditions had just been evaluated – in the prior test point – with no abnormal response observed; the only difference was that a function within the Hornet's flight control computer, known as Active Oscillation Control (AOC), had initially been disabled. The implication was disturbing; the divergent oscillation appeared to be, at least in part, caused by a fundamental element within the AF/A-18's flight control system.

This paper discusses the risk based approach that the test team took in investigating an unacceptable, but relatively mysterious, captive carriage characteristic of a proven store configuration; and, endeavours to highlight the dangers that a complacent attitude could have on the conduct of safe flight test.