NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

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Attachment 10 – SS2 Simulator Test Plan

OPERATIONAL FACTORS

DCA15MA019

SIMULATOR TEST

DCA15MA019

Operations and Human Performance Groups

Simulator Test Plan

Date: November 4, 2014

1.0 General Notes[1]

The SS2 simulator was a fixed sim (no motion) replicating the SpacesShip2 (SS2) cockpit. Scaled Composites and Virgin Galactic pilots trained in the SS2 simulator located at the Scaled Composites facilities at Mojave, CA. The simulator had partial dome spherical projection screen visual displays and was non-motion, and did not have a "freeze" function. The simulator did not model an uncommanded feather with feathers unlocked at Mach 0.8. The seats were fixed to the floor, and pedals are only adjustable through extensive retrofitting. Most pilots required no rudder pedal adjustment, However, shorter leg length pilots could have blocks placed on pedals as an adjustment (shorter pilots). The feather lock had a gate on the right side of the quadrant, and Ops Group pilots indicated that the simulator feather lock lever in the simulator moved easier than on the vehicle. The Primary Flight Displays (PFD) incorporated new indications of trim positions that had not been present on previous powered flights.

The Ops Group conducted multiple test runs in the SS2 simulator using data from the PF04 flight to document operational procedures used by SS2 crews and document timing of those procedures.

- Data from PF04:
  - Release Altitude: (b) (4)
  - Release Airspeed: (b) (4) KEAS
  - Pitch/Roll Trim: -9.0°/0.5°
  - Burn Timer: 38 seconds
  - Drop Weight: (b) (4)
  - Drop CG: (b) (4)
  - Full Burn Landing Weight: (b) (4)
  - Full Burn Landing CG: (b) (4)
  - SS2 Limits (no wind limits for PF04)[2]:
    - VMO/MMO (b) (4) (Day of flight limits based on headwinds= (b) KEAS)
    - VMBE – (b) (4) ground speed (Nominal) / (b) (4) ground speed (emergency abort weight)
- Test card for PF04 for Co-pilot callouts:
  - Call - .80

[1] For additional notes, wee Human Performance Group Chairman's Factual Report.

[2] According to VG Test Pilot Dave Mackay, they did have wind limits for PF04; 10 knots crosswind prior to release, and post release they would have accepted upto 15 kts on runway 30.

- Call – Stabs (degrees)
- 1.4M – Feather unlock

2.0 Objectives

- Fly the test plan prescribed for the accident flight (normal)
- Replicate the accident flight (feather unlock at about 1.0 Mach)
- Document simulator fidelity and aerodynamic responses of transonic flight
  - Normal flight profile PF04
  - Accident flight profile for PF04
  - Feather unlocking at .8 and 1.4 Mach
  - Cockpit displays and Caution Alert Status (CAS) warnings
  - Timing of procedures

3.0 Simulator Test Plan SpaceShip2

Aircraft:	SpaceShip2 Simulator	
Airport:	Mojave, CA	
Participants (6):	Simulator Operator:	Mike Masucci - Virgin Galactic (VG)
	Captain Seat:	Mark Stucky – Scaled Composites
	Co-pilot's Seat:	David Mackay - VG
	Observers:	David Lawrence - NTSB
		Katherine Wilson - NTSB
		David Gerlach - FAA
		Christi Helgeson - FAA
		Clint Nichols - Scaled Composites

Initial Setup

- Performance Data - Per accident Test Card for PF04
- Simulator Start Position - mated to WK2 prior to release

3.1.1 Run 1

Procedure

1) Normal flight profile for PF04
2) Time from release to 0.8 Mach
3) Time to trimming for the Gamma turn
4) Time to 1.4 Mach (Feather unlock)

Proc.	Notes
	Timing: Release to 0.8 Mach call = 10.59 seconds[3] 0.8 Mach to trim call = 1.7 seconds Release to Mach 1.4 = 25 seconds

3.1.2 Run 2

Procedure

5) Normal flight profile for PF04
6) Time from release to Mach .8

Proc.	Notes
	Timing: Release to 0.8 Mach call = 8.2 seconds[4]

3.1.3 Run 3

Procedure

7) Normal flight profile for PF04
8) Time from release to Mach .8,
9) Time to 1.4 Mach
10) Time to CAS message

Proc.	Notes
	Timing: Release to 0.8 Mach call = 8.33 seconds 0.8 Mach to 1.4 Mach = 16.56 seconds 1.4 Mach to CAS warning light = 2.55 seconds Total 27.44 seconds

[3] Mr. Stucky used the arm and fire cadence used on his previous flights.
[4] For this run and all subsequent runs, Mr. Stucky tried to replicate the quicker arm and fire cadence used on PF04.

3.1.4 Run 4

Procedure

11) Normal flight profile for PF04
12) Leave Feather locked past 1.8 Mach
13) Time form release to 0.8 Mach
14) Time to 1.4 Mach
15) Time to CAS message

Proc.	Notes
	Timing: Release to 0.8 Mach call = 8.18 seconds 0.8 Mach to 1.4 Mach = 16.48 seconds 1.4 Mach to CAS warning light = 2.83 seconds Total 37.94 seconds

3.1.5 Run 5

Procedure

16) Normal flight profile for PF04
17) Time from release to 0.8 Mach
18) Time to 1.4 Mach
19) Time from 1.4 to end of burn (38 seconds)

Proc.	Notes
	Timing: Release to 0.8 Mach call = 9.93 seconds .8 Mach to 1.4 Mach = 15.3 seconds ignition to end of burn = 38 seconds Total 1:03.26 seconds

3.1.6 Run 6

Procedure

20) Observe readings on Nz display on the pilot's PFD (Could Nz be misinterpreted for 1.4 Mach?)

Proc.	Notes
	Observed: inconclusive

3.1.7 Run 7

Procedure

21) Observe readings on Nz display on the pilot's PFD (Compare Mach with Nz)
22) Copilot's PFD in manual (Air data with no INS switch at .80)

Proc.	Notes
	Observed: inconclusive

3.1.8 Run 8

Procedure

23) Observe transonic pitch Bobble

Proc.	Notes
	Pitch up at 0.8 Mach noticed No "xxx's" on PFD in manual going through 0.8, didn't show until around 1.4 to 1.5