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SpaceShipTwo Accident Fact Sheet

General Background

- Scaled Composites (a Northrop Grumman subsidiary) designed, built and operated SpaceShipTwo, serial number one (SS2-001) under contract to Virgin Galactic.
- Virgin Galactic is currently building a second spaceship (SS2-002) destined for commercial operations. Virgin Galactic will be solely responsible for all future testing and operations of serial number two and subsequent vehicles.
- Documentation of this accident was exceptional. Telemetered data from the vehicle included cockpit video and hundreds of parameters from all relevant systems.

Probable Cause

- The **Probable Cause** of this accident was the copilot's unlocking of SpaceShipTwo's feather locks at 0.92 Mach, approximately 14 seconds prior to the flight manual minimum speed of 1.4 Mach.

Contributing Causes

- **Feather Lock system design.** The Feather Lock system design did not have an automatic mechanical inhibit to prevent premature movement of the feather system.
- **Crew Resource Management.** Scaled Composites' aircrew procedures did not require a challenge/response protocol prior to moving the feather lock handle.

Non-Factors

- **Rocket Motor**. The evidence indicates that the hybrid propulsion system performance was normal, including rocket ignition, and that system pressures were at normal levels prior to vehicle breakup.
- **Vehicle Structures**. All data clearly support that the vehicle structures withstood forces well in excess of design limits prior to breakup.
- **Avionics Displays**. Information that was being presented to the flight crew via the on-board instruments and displays did not show any anomalous behavior during playback of the telemetric data. The copilot annunciated "Point Eight Mach" on the cockpit video recorder at the same time the telemetry data indicated the vehicle accelerating through that speed.
- **Vehicle Systems**. The vehicle systems were performing nominally throughout the flight and examination of recovered components revealed no evidence of any preexisting system or structural failures.
- **Aircrew Medical.** No evidence indicated any pre-existing medical or physical condition that might have adversely affected the flight crew's performance during the accident flight.
- **Weather.** The weather conditions at the time of the accident flight were within limits and deemed to not be a factor in the accident.

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VG's Post-Accident Recommendations

1) Modify the SpaceShipTwo feather lock system with an automatic mechanical inhibit to prevent unlocking or locking the feather locks during safety-critical phases of flight.
   Status: Completed by VG

2) Add to the SpaceShipTwo Normal Procedures checklist and Pilot's Operating Handbook an explicit warning about the consequences of prematurely unlocking the feather lock.
   Status: Completed by VG

3) Implement a comprehensive Crew Resource Management (CRM) approach to all future Virgin Galactic SpaceShipTwo operations in a manner consistent with the pre-existing CRM program VG has employed for WK2 operations. This includes, as a minimum:
   - Standardized procedures and call outs
   - Challenge/response protocol for all safety-critical aircrew actions, to include feather lock handle movement
   - Formalized CRM training

   Status: Completed by VG

4) Conduct a comprehensive internal safety review of all SpaceShipTwo systems to identify and eliminate any single-point human performance actions that could result in a catastrophic event.
   Status: An initial assessment was completed and modifications to SS2-002 are in progress. Virgin Galactic will continually evaluate and improve System Safety throughout SpaceShipTwo's lifecycle.

5) Conduct a comprehensive external safety review of Virgin Galactic and The Spaceship Company's engineering, flight test and operations as well as SpaceShipTwo itself.
   Status: Initial Assessment Completed. The external review team will review the program both prior to commencement of flight test activities as well as prior to entering commercial service.

6) Ensure Virgin Galactic employs pilots who meet or exceed the highest standards and possess a depth and breadth of experience in high performance fighter-type aircraft and/or spacecraft. Minimum VG qualifications during the flight test program shall be:
   - A long course graduate of a recognized test pilot school with a minimum of 2.5 years post-graduation experience in the flight test of high performance, military turbojet aircraft and/or spacecraft.
   - A minimum of 1000 hours pilot in command of high performance, military turbojet aircraft.
   - Experience in multiengine non-centerline thrust aircraft
   - Experience in multi-place, crewed aircraft and/or spacecraft

   These criteria are based on industry best practices for flight testing, using DCMA INST 8210.1C, paragraph 4.3 as guidance.
   Status: Completed. All current Virgin Galactic pilots exceed the above minimum VG standards.