National Transportation Safety Board

Emerging technologies for safer flight

Robert L. Sumwalt

NTSB is an independent federal agency, charged by Congress to investigate transportation accidents, determine probable cause, and issue safety recommendations.

NTSB

The Board

Earl Weener

Bella Dinh-Zarr
Vice Chairman

Chris Hart
Chairman

Robert Sumwalt

NTSB

Our mission:

Prevent Accidents

Reduce Injuries

Save Lives

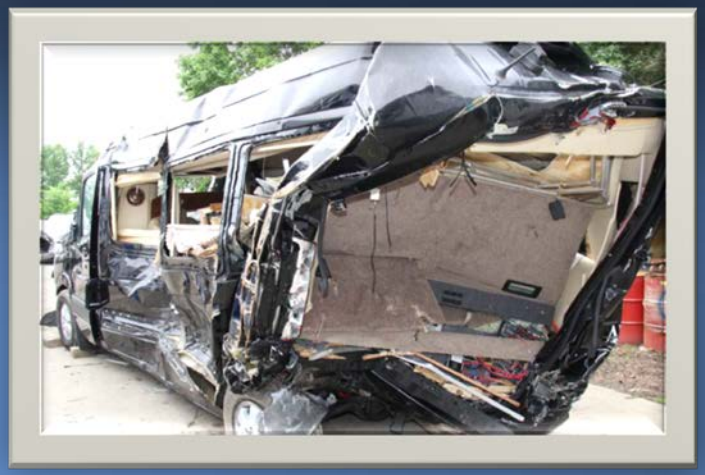
Breaking News: A plane has crashed.

The Launch

Boots on the Ground

Board Meeting

August Board Meeting



September Board Meeting

Gulfstream G-IV Crash
Bedford, MA
May 31, 2014

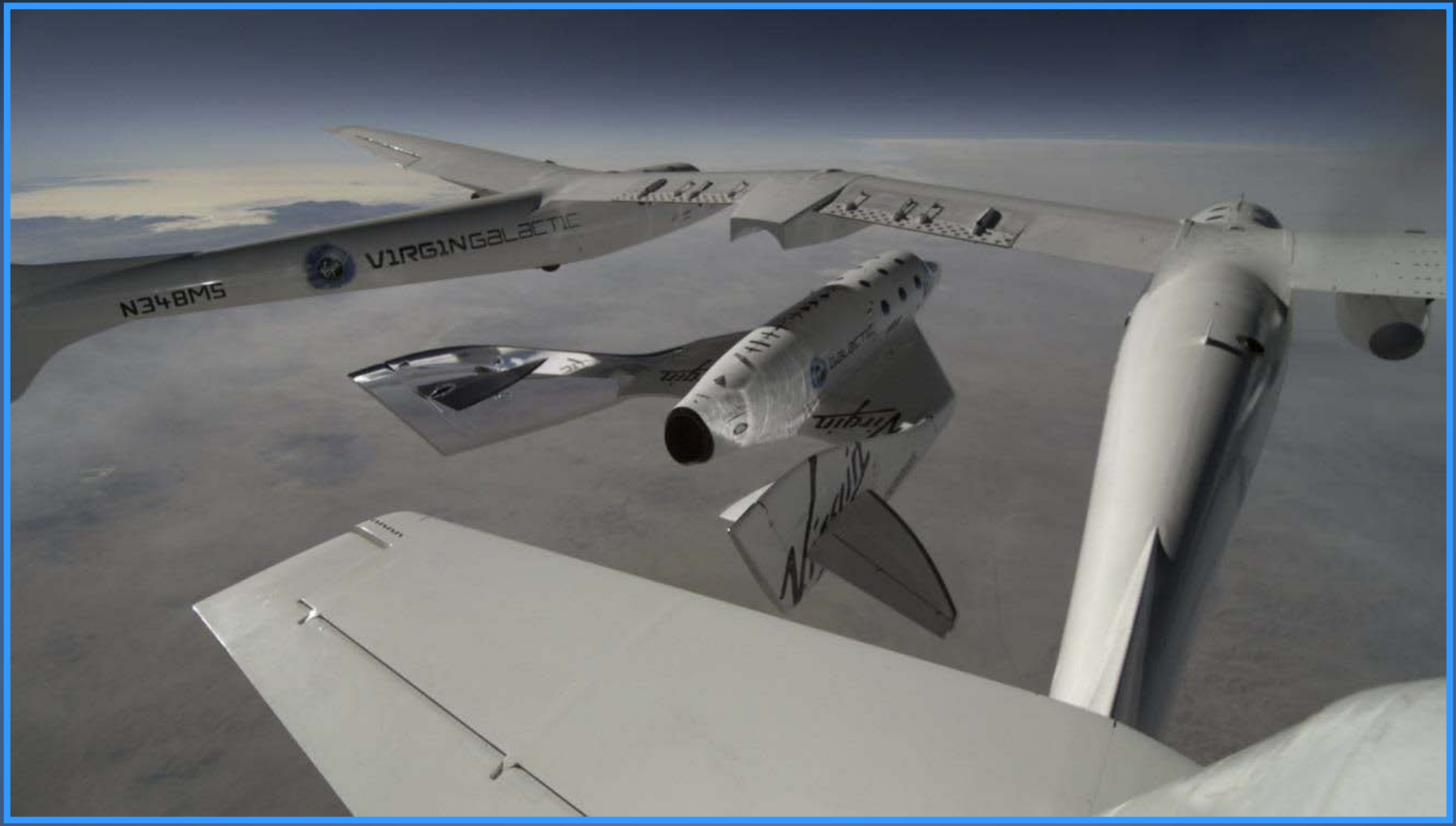
NTSB

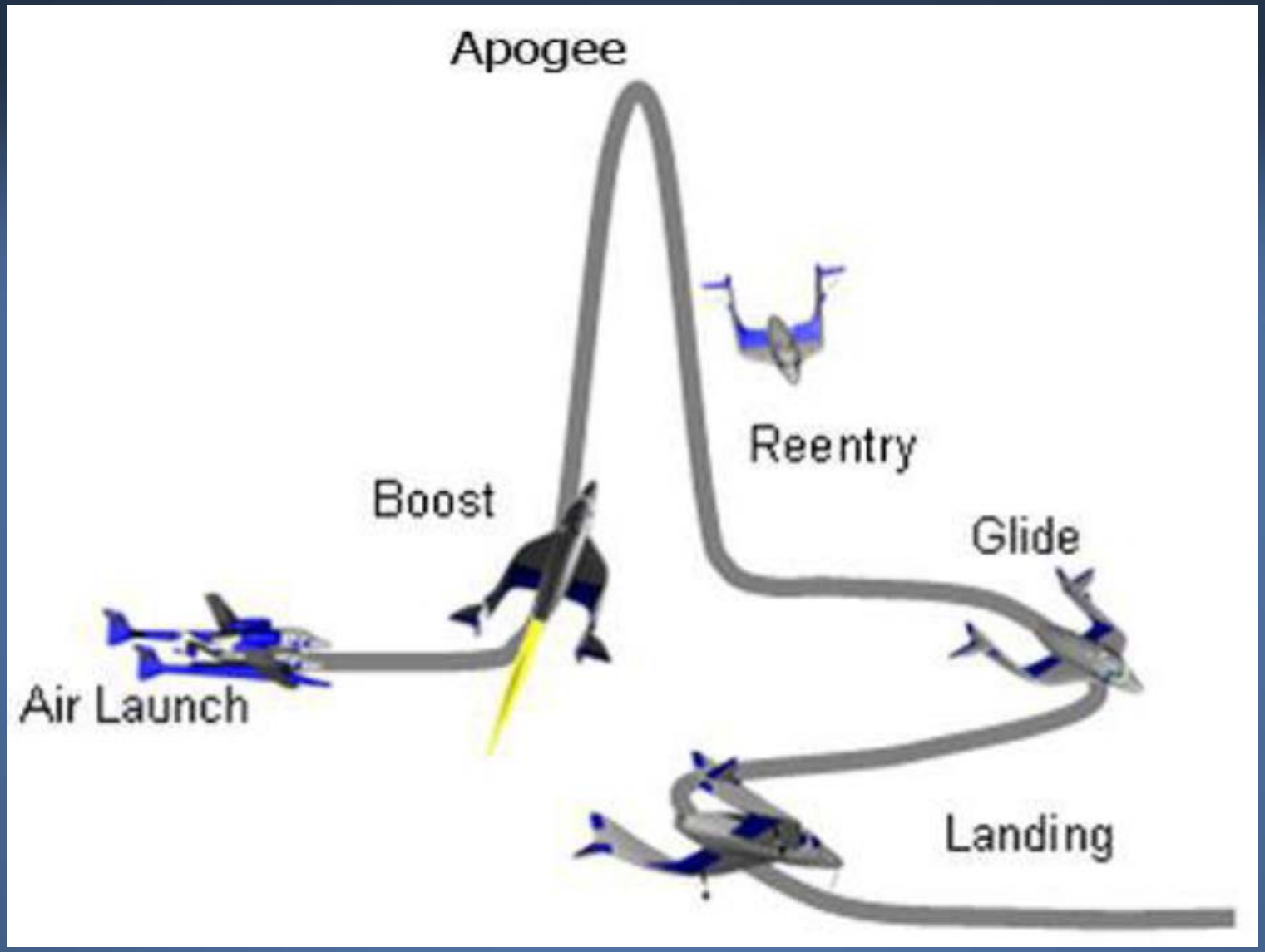
July Board Meeting: In-Flight Breakup During Test Flight

October 31, 2014

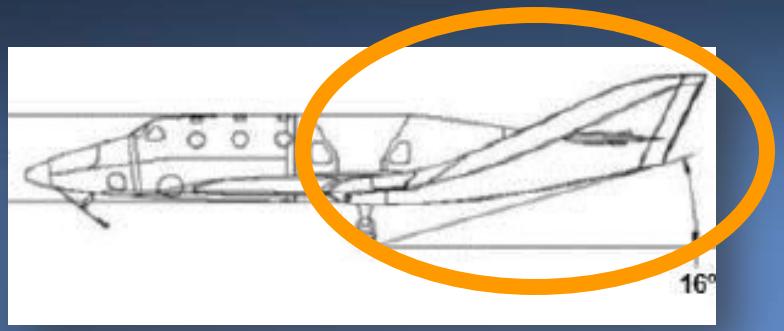
NTSB

N348MS
N339SS
N348MS

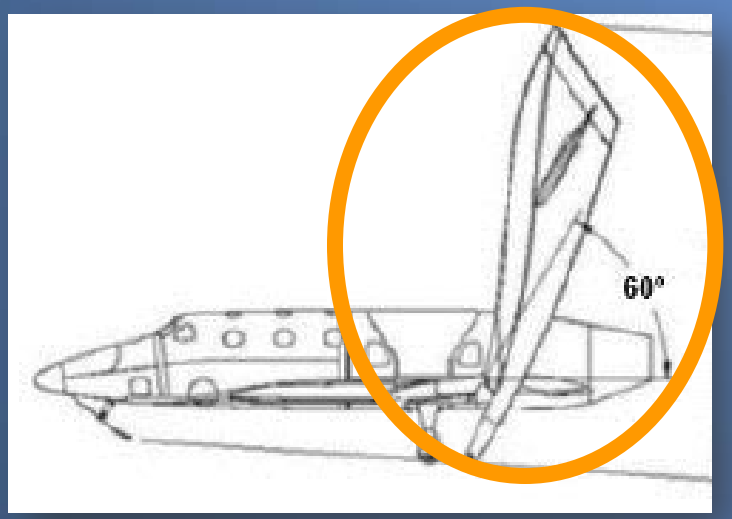

N348MS
VIRGINGALACTIC


Apogee
Reentry
Boost
Glide
Air Launch
Landing

SpaceShipTwo Feather System



Feather retracted



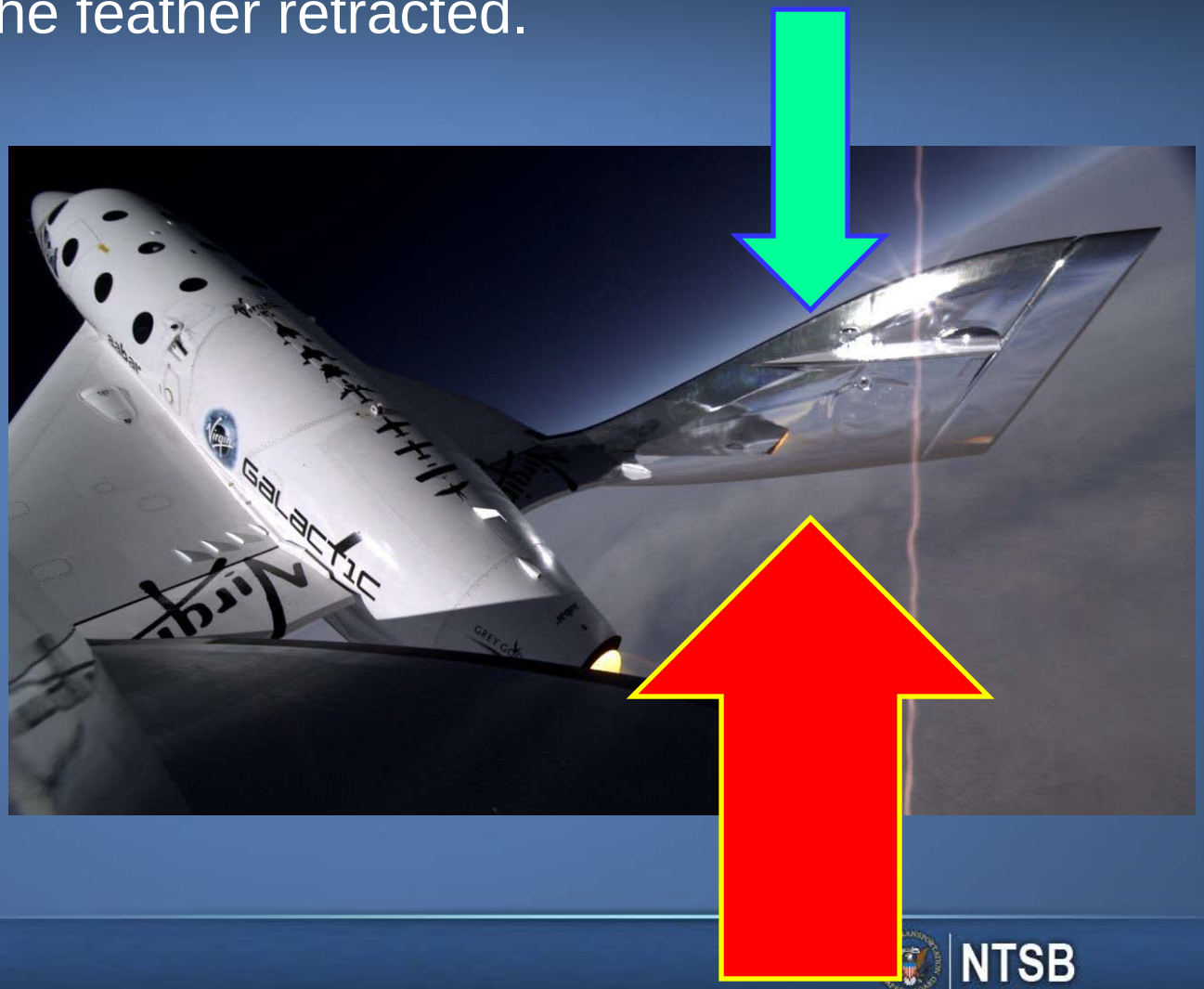
Feather extended

SpaceShipTwo Flight Deck

Feather extend handle

PROBLEM: During the transonic region, the upward aerodynamic forces acting on the feather exceeded the ability of the feather actuators to keep the feather retracted.

SOLUTION: Provide mechanical locks to keep feather retracted during this region.



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Feather Lock Handle

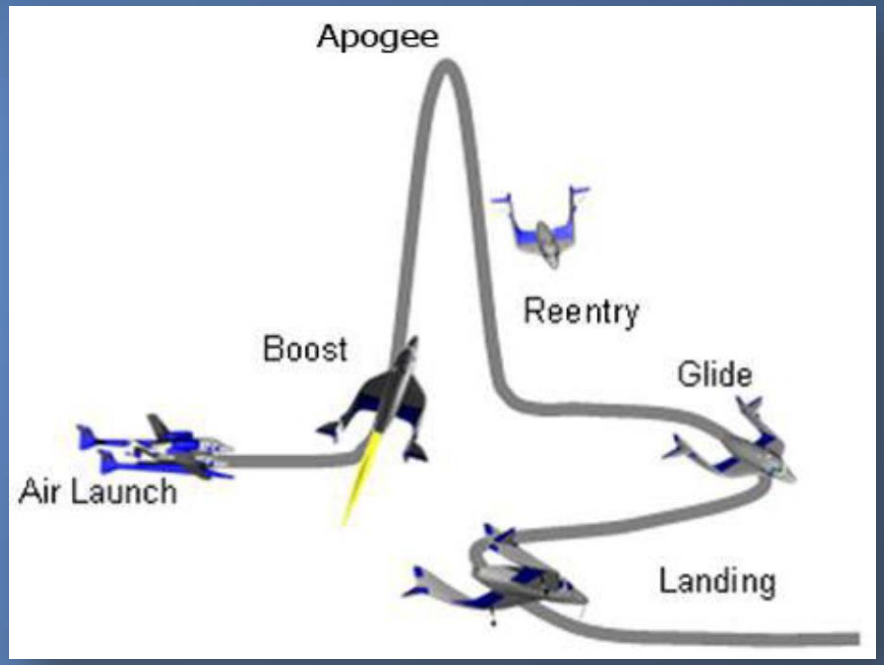
Feather Locked

Lock

Unlock

Feather Unlocked

PROBLEM: If feather could not be unlocked, it would pose a very high risk (probably catastrophic) reentry.



SOLUTION: Unlock feather at 1.4 Mach.

If not unlocked at 1.5 Mach, cockpit alert.

If not unlocked at 1.8 Mach, mission abort.

- High emphasis on making sure feather was unlocked.
  - Cockpit visual and aural alerting
  - Training and procedures
  - Mission abort if not unlocked by 1.8 Mach
- Not great concern placed on low speed unlocking.
  - Relied on pilots to do it right

Specified Flight Crew Procedures

PILOT

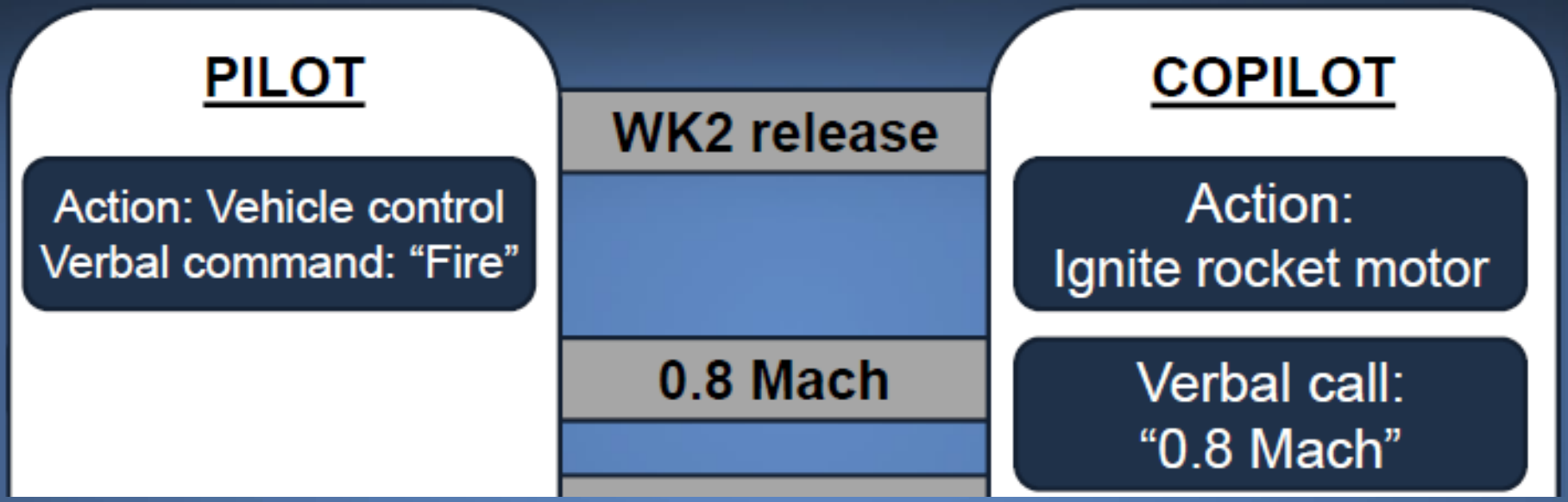
Action: Vehicle control
Verbal command: “Fire”

WK2 release

COPILOT

Action:
Ignite rocket motor

Specified Flight Crew Procedures



Specified Flight Crew Procedures

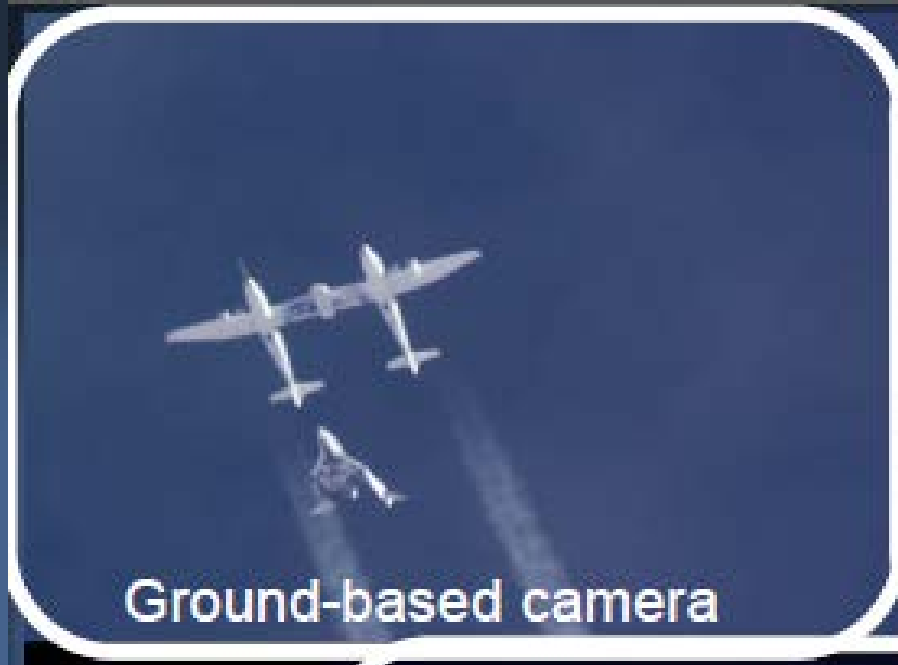
PILOT		COPILOT
Action: Vehicle control Verbal command: “Fire”	WK2 release	Action: Ignite rocket motor
	0.8 Mach	Verbal call: “0.8 Mach”
	Transonic bobble	
Action: Trim stabilizer		Verbal call: “Stabs (degrees)”

Specified Flight Crew Procedures

PILOT		COPILOT
Action: Vehicle control Verbal command: “Fire”	WK2 release	Action: Ignite rocket motor
	0.8 Mach	Verbal call: “0.8 Mach”
	Transonic bobble	
Action: Trim stabilizer		Verbal call: “Stabs (degrees)”
	1.4 Mach	Action: Unlock feather

What actually occurred

- Copilot made 0.8 Mach callout
- At 0.82 Mach, called out "unlocking" and moved feather handle to unlocked position
- Video and telemetry stopped


Ground-based camera

WhiteKnightTwo camera

SpaceShipTwo camera
galactic

- A single-point mechanical failure with catastrophic consequences would be unacceptable.
- However, Scaled Composited failed to consider that a single human error could be catastrophic.

NTSB Finding

"By not considering human error as a potential cause of uncommanded feather extension on the SpaceShipTwo vehicle, Scaled Composites missed opportunities to identify the design and/or operational requirements that could have mitigated the consequences of human error during a high workload phase of flight."

Probable Cause of the Accident

- “Scaled Composites’ failure to consider and protect against the possibility that a single human error could result in a catastrophic hazard to the SpaceShipTwo vehicle.
- This failure set the stage for the copilot’s premature unlocking of the feather system as a result of time pressure and vibration and loads that he had not recently experienced, which led to uncommanded feather extension and the subsequent aerodynamic overload and in-flight breakup of the vehicle.”

How did technology help solve this accident?

- Onboard image recorders

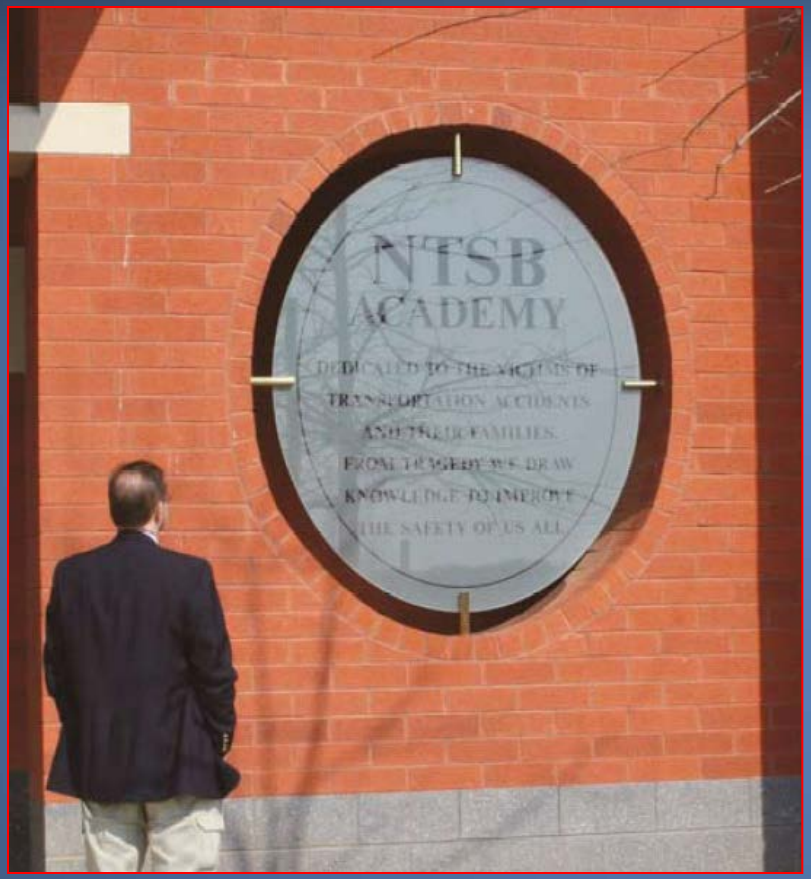
Emerging Flight Data and Locator Technology

NTSB Recommendation to FAA

- Require aircraft used in extended overwater operations (EOW) to be equipped with temper-resistant method to broadcast position information (within 6 miles) in the event of an accident.

NTSB Recommendation to FAA

- Require aircraft used in EOW to be equipped with an airframe low frequency underwater locating device that will function for at least 90 days.



"From tragedy we draw knowledge to improve the safety of us all."

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