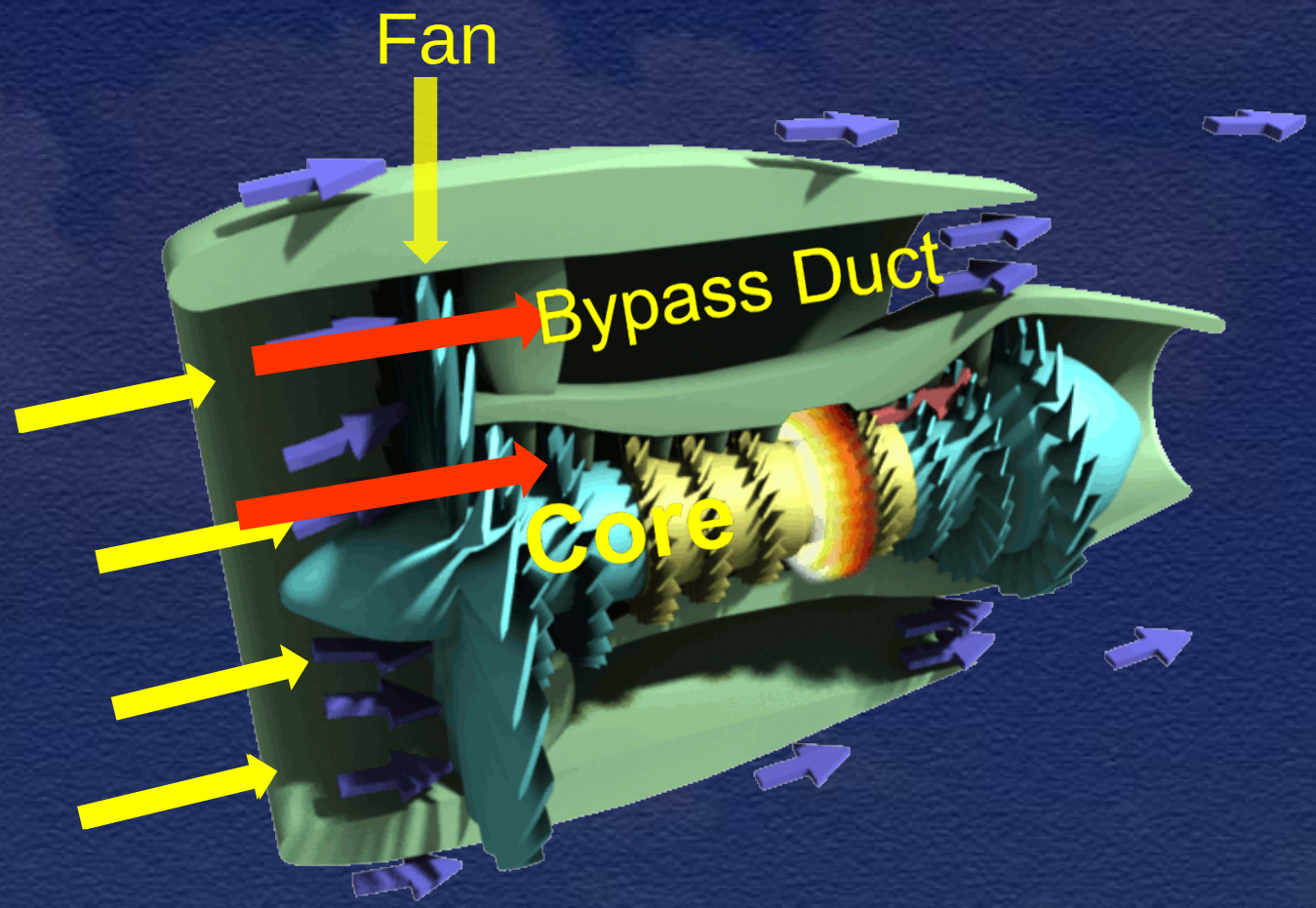
NTSB National Transportation Safety Board

Office of Aviation Safety

US Airways Flight 1549 Ditching on the Hudson River January 15, 2009

Harald Reichel
Powerplants

Turbofan Engine Overview



NTSB

Bird Ingestion Summary

- Each engine bypass duct ingested at least one Canada goose
  - Dented fan blades but intact
  - Fan capable of continued operation
- Each engine core ingested at least one Canada goose
  - High-pressure compressor variable guide vanes critically damaged
  - Engine airflow disrupted
  - Not capable of continued operation

CFM56-5B4 Certification Comparison

- CFM56-5B4 certificated in 1993
- Bird-ingestion tests:
  - Large-bird test - fan ingestion - 4 lbs.
    - Engine must shut down safely
    - No fire, fragments, safe shut-down loads
  - Medium-bird test - core ingestion - 2 1/2 lbs.
    - Acceptable for engine to supply 75% power
- Accident engines ingested 8-lb. birds
  - Significantly heavier than certification requirements
- Accident engines safely shut down

NTSB

Bird-Ingestion Certification Rule History

- Engine bird-ingestion standards introduced in 14 CFR Part 33 in 1974
- Two significant revisions:
  - Amendment 20 in 2000
    - FAA, EASA, industry bird-threat studies from 80s to 90s
  - Amendment 24 in 2007
    - Used bird-threat studies up to 1999
- Bird threats not evaluated since 1999
- FAA initiated bird-ingestion regulation reevaluation in 2009 after flight 1549
  - 11,000 data points gathered and presently being evaluated - next meeting in September 2010

Engine Status and Guidance

- No flameout in combustor
- Engine Dual Failure Checklist relight guidance ineffective
- Relight attempt time not used effectively
- Engine monitoring system to guide flight crew
- FADECs programmed to give guidance
- Work done in this field

Certification Rules for Medium Bird Test

- Present medium-bird certification test procedure does not impart highest loads on core hardware
- FAA test requires at least 100% fan speed during all bird-ingestion tests
- Core inlet located just aft of fan rotor
- Medium-bird test requires maximum bird mass to pass through fan
- Low fan speed to increase slice mass and avoid centrifuging effect of fan
- 82% fan speed during climb

NTSB