

# SMS Accident Decomposition



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*Quickly Decomposing*

# Decomposition of Aviation Accident to Clarify SRM and SA functions

Purpose: develop a real-life example to clarify the intent behind SMS implementation at a D&M organization

Select a transport category aircraft accident from the FAA Lessons Learned Database and decompose the accident by tracing the causal factors back through to the initial hazards. Outline specific elements of SRM, and SA that applied (or should have). Selection of the accident should consider two aspects: 1) should not involve any of the pilot project participant products; and 2) the accident should touch upon all 3 categories of hazards (product, process and organizational).

# Approach Steps

- Select Accident
- Mine Findings and Recommendations
- SRM
  - Develop Hazard List
  - Use Hazards to Develop Risks
  - Use Risks to Develop Controls
- SA
  - Use Risks to Develop Measures
  - Use Measures to Develop Monitoring & Auditing
- Final Deliverables
  - Written Report
  - PowerPoint Presentation

# Accident



- NTSB DCA96MA068
- July 6, 1996
- Uncontained Engine Failure, Delta MD-88 (engine debris from the front compressor front hub (fan hub) of the No. 1 (left) engine penetrated the left aft fuselage. Two passengers killed and two others seriously injured. The takeoff was rejected, and the airplane was stopped on the runway.
- Features
  - Significant D&M Issues
  - Major Investigation (i.e., significant time and expense)
  - 30 findings and 15 related recommendations

# Mine Findings/Recommendations

- Organize Findings/Recommendations by:
  - D&Ms involved:
    - Airplane manufacturer
    - Engine manufacturer
    - Rotor hub forger
    - Rotor hub finisher
  - Operations:
    - Airline
    - Maintenance
- Focus on D&M findings for SMS analysis

# SRM

- Armed with known outcome of accident:
  - Develop hazards leading to accident
  - Develop hazards into risks leading to accident
  - Develop controls that avoid accident
- Hazards will be organized based on:
  - Product
  - Process
  - Design
  - Organization

# SA

- Again, armed with known accident outcome:
  - Develop measurements to avoid accident
  - Develop monitoring to avoid accident
  - Develop audits to avoid accident

# Table 1 Findings and Recommendations That can be Traced to a D&M Organization

ID	Finding or Recommendation
DM1F	Some form of drill breakage or drill breakdown, combined with localized loss of coolant and chip packing, occurred during the drilling process, creating the altered microstructure and ladder cracking in the accident fan hub. Fatigue cracks initiated from the ladder cracking in the tierod hole and began propagating almost immediately after the hub was put into service in 1990.
DM2F	Although the altered microstructure in the accident hub tierod hole was detectable by blue etch anodize inspection methods, Volvo did not identify it as rejectable because the appearance of the tierod hole did not match any of the existing inspection templates showing rejectable conditions. Although the additional templates will assist blue etch anodize inspectors in detecting potential defects similar to the one that existed on the accident hub, this accident suggests that there may be additional rejectable conditions that have not yet been identified.
DM3F	Drilling damage in this accident hub extended much deeper into <u>hole sidewall</u> material than previously anticipated by Pratt & Whitney.
BOTH1F	The crack was large enough to have been detectable during the accident hub's last fluorescent penetrant inspection at Delta.
DM4F	Significant questions exist about the reliability of flash drying in removing water

## Table 2 Findings and Recommendations Attributable to Other than D&M Organization

ID	Finding or Recommendation
BOTH1F	The crack was large enough to have been detectable during the accident hub's last fluorescent penetrant inspection at Delta.
BOTH2F	One or more procedural deficiencies in the cleaning, drying, processing, and handling of the part might have reduced or prevented the effectiveness of Delta's fluorescent penetrant inspection process in revealing the crack. The potential deficiencies identified in the Delta fluorescent penetrant inspection process may exist at other maintenance facilities and be, in part, the reason for the failure to detect cracks in other failed engines identified in this investigation.
BOTH3F	An inadvertent failure of the inspector to systematically search and complete <u>followup</u> diagnosis when necessary on all surfaces of the hub might have caused the FPI inspector to overlook the crack. A low expectation of finding a crack in a -219 series fan hub might have caused the FPI inspector to overlook or minimize the significance of an indication. The duration of inspections and the amount and duration of rest periods may indeed affect inspector performance, but this potential has not been adequately studied in the aviation domain.
BOTH4F	Because of the potentially catastrophic consequences of a missed crack in a critical rotating part, testing methods that evaluate inspector capabilities in visual

# Table 3 Hazards by Product, Process, Design and Organization

Product	Process	Design	Organization
R1) JT8D Engine	C1) Drilling of holes in compressor fan hub	D1) Compressor fan hub high rotational speed	O1) Outsourcing of steps in manufacturing process
R2) High cycle compressor fan hub	C2) Inspection of holes in compressor fan hub	D2) Failure of compressor fan hub at high speeds	O2) Personnel training in manufacturing processes
R3) Emergency evacuation lighting	C3) Final assembly of compressor fan hub in JT8D engine	D3) Wiring harnesses passing near engine	O3) Personnel fatigue in repetitive inspection tasks
R4) Crew-cabin communication systems	C4) Configuration management of in-house manufacturing processes	D4) Hydraulic lines passing near engine	O4) Outsourced supplier recordkeeping and information exchange
	C5) Configuration management of out-sourced manufacturing processes		
	C6) In-service inspections of compressor fan-hubs		

# Deliverables

- **Written Report**
  - Detailed narrative introducing accident
  - Description of SMS process
- **PowerPoint Presentation**
  - Standalone summary of SMS
  - Suggests to audience to read accompanying SMS written report

# Issues / Questions

- **Scope and Depth**
  - How detailed should analysis go?
  - How many hazards to develop?
  - How many different companies should be analyzed?
- **Delimitations**
  - Should exercise be limited to facts/analysis in the NTSB report of the accident?
  - If exercise goes beyond NTSB report, where does expertise come from?
- **Hypothetical vs. Factual**
  - Should exercise emphasize instructional value over factual accuracy? That is:
    - Should weakly supported suggestions be made to illustrate a feature of SMS?