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Problem

Background:
Following the eruption of the Eyjafjallajökull (E15) volcano, UK military operators are advised by the MAA that 'flight in areas affected by VAC is at the discretion of the operational duty holder (ODH) and should be supported by appropriate risk assessment'.

Ash Cloud on 4/19/10
Eyjafjallajökull: Impact on International Air Traffic
(http://news.bbc.co.uk/2/hi/uk_news/8625813.stm)

Exam questions:

- What is the risk of military operations being impacted by volcanic eruptions?
- What are the airworthiness and safety risks related to engines and other critical systems?
- What are the safe concentration limits for flight for a generic ash composition and aircraft/engine type?
- How long can we fly in a particular concentration (single sustained flight, cumulatively)?
- What sampling/inspection is necessary to monitor platform effects and to highlight performance/technical issues?
- What are the long-term (financial and technical) cost of ownership issues?
- What are the military-specific departures from the Civil Aviation guidelines?

MOD priorities:

Short term

- Global risk assessment of an ash encounter.
- Refine current understanding of the propulsion system impacts.
- Refine current understanding of the Air Vehicle (non-propulsion) impacts.

Medium term

- Validate the engine models for predicting exposure limits to VA.
- Assess propulsion system vulnerability to sulphidation.
- Assess the vulnerability of specific propulsion system features.

Long term

- Define standards for VA composition, testing equipment/methods and test specimen.
- Investigate novel ways to protect against VA inflicted damage.
- Understand the long-term (financial and technical) cost of ownership issues.

Current Policy

<0.2mg/m3

- Clear Zone
- Flight unrestricted

0.2-2mg/m3

- Cyan Zone
- Flight subject to additional engine inspection
- Determined by individual ODH based on 'Risk'

>2mg/m3

- Red Zone
- Flight to be completely avoided.

MOD VA sampling methodology

Engine operability model

MOD's current understanding of VA Concentration vs Exposure Duration.

Short Term Priorities

Global risk assessment

Propulsion system impacts

Air vehicle impacts

Failure Modes and Effects Analysis (FMEA) at system and major aircraft element level performed on three aircraft types: fast jet, military transport and large rotorcraft.

Fuel Tanks

- Clogging of fuel filters
- Corrosion of tank internals
- Sticking of creak valves

Antennae

- Large Particle Impact
- Erosion of Surface
- Refraction of RF Signal on VAC

Air Conditioning/Pressurisation System and Air Data Systems

- Erosion of wheels in Air Cycle Machine (ACM)
- Damage of ACM bearings
- Corrosion of internal components
- Clogging of pilot-static probes

Future Plans

SENSE:

- Investigate COTS onboard detection technologies
- Conduct probabilistic assessment of global risk assessment above

COORDINATE:
Standardisation of:

- Test rigs
- Engine tests
- Testing methodologies
- Volcanic ash composition
- Test specimens

PROTECT:

Damage Mechanisms	Phenomena	Fan	Compressor	Combustor	Turbine
		Particle Centrifuging	Erosion and Abrasion Particle impingement	VA agglomeration VA accretion	VA accretion VA shedding
Proposed Research Activities	Damage		Blade/vane damage Rotor path lining damage	Fuel system blockage	Nozzle Guide Vane blockage
	CFD	EMR activity (6-12 months)			
Sub-element test rig			Erosion Abrasion	TTCP collaboration (1-2 years)	
Sub-assembly test rig					
Engine test		US-UK Collaboration through VIPR3 (2-3years)			

NATO
US/UK PA

IRC Forums

ASNR
TTCP

Abbreviations:

- ASNR Air Senior National Representatives
- BA British Airways
- CFD Computational Fluid Dynamics
- COTS Commercial Off The Shelf
- DLR German Aerospace Center
- DSTL Defence Science and Technology Lab
- EDX Energy Dispersive X-Ray
- EMR Extramural Research
- KLM Koninklijke Luchtvaart Maatschappij
- MOD Ministry of Defence
- NATO North Atlantic Treaty Organization
- PA Project Arrangement
- SEM Scanning Electron Microscopy
- STO Science and Technology Organisation
- TTCP The Technical Cooperation Program
- VAC Volcanic Ash Cloud
- VIPR Vehicle Integrated Propulsion Research