

# Introduction to Helicopter Engine Inlet Protection



Pall Aerospace, 2009

- Problems with airborne contamination
- Pall Solution
- Costs of airborne contamination
- In-service Experience (operators & helicopters)





## **Sand / Dust** (and other solid particulate contamination)

- Compressor erosion
- Turbine blade glazing
- Turbine blade vibration & fatigue problems
- Blockage of blade cooling passages



## **Brownout!**

- Similar effects as Sand / Dust

Brownout is the term used to describe the result of helicopter rotorwash as it kicks up a cloud of dust while landing. Brownout causes accidents during helicopter landing and take-off operations in desert terrain, dust storms or general vehicle movements



*Image Courtesy Alan Radecki*

## Foreign Object Damage (FOD)

- Serious damage to rotating & static components





## Ice

- Similar effects as FOD





## Heavy Rain

- Engine Flame Out

In certain conditions, where water accumulates on the fuselage at a stagnation point upstream of the engine air inlets, a mere half cup-full ingested as a slug is enough to cause engine flame out.



*Photo courtesy Zoe Lucas*

## Snow

- *Dry Snow*
  - No Problem
- *Wet Snow*
  - Engine Flame-Out
  - Damaged Compressors





*Photo Courtesy Gabriel Savit*

## Salt Spray

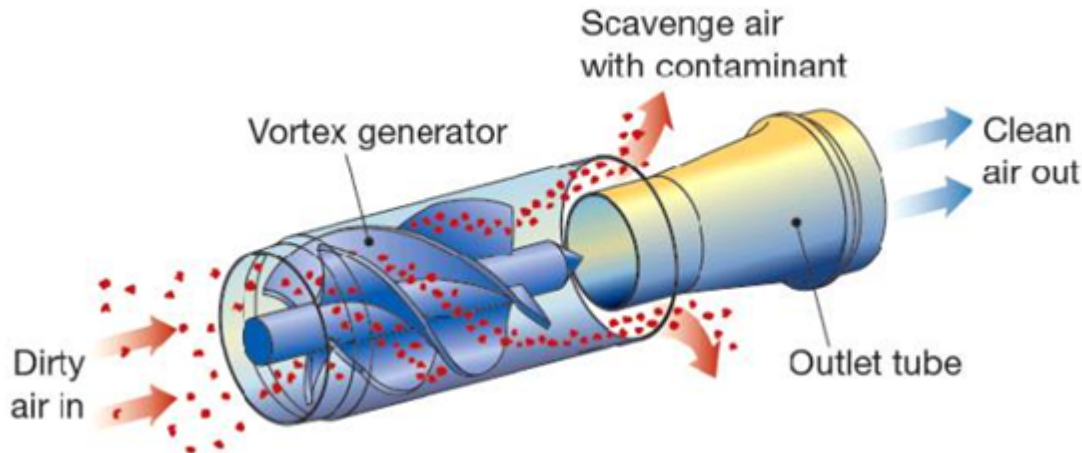
- Engine Corrosion
- Component Fouling/Power Loss

All of the previously described problems are **Flight-Safety** relevant and can induce excessive **Maintenance Costs**

*Therefore*

**It is imperative to protect Engine Air Inlets**

- First Centrisep Engine - Advanced Protection System (EAPS) was designed by Pall in the late 60's.
- Continuous improvements in Technology and Design have translated into dramatic progress in overall performance & efficiency in a given space envelope.
- Latest aerodynamic designs offer optimal overall protection to latest generation of high tech helicopter engines



## Benefits:

- Self cleaning device, virtually maintenance free.
- Excellent **F.O.D. protection**. => Improved Flight Safety
- Protects engine by removing harmful solid and liquid contamination
- Excellent **Snow / Icing** protection.
- Easy user installation with available installation kit.
- Increased engine MTBUR for erosion... substantial increase in engine compressor erosion life. (reduced component wear)
- Reduced unscheduled engine removals
- Increased **aircraft availability**
- Pall's Engineering experience provides optimum performance in given space envelope

Scheduled Engine Overhaul costs from  
\$160,000 to \$350,000 (per engine)

Unscheduled engine repair costs from  
\$70,000

Installing the Centrisep EAPS will improve  
protection of your helicopter's most critical  
component – the engine

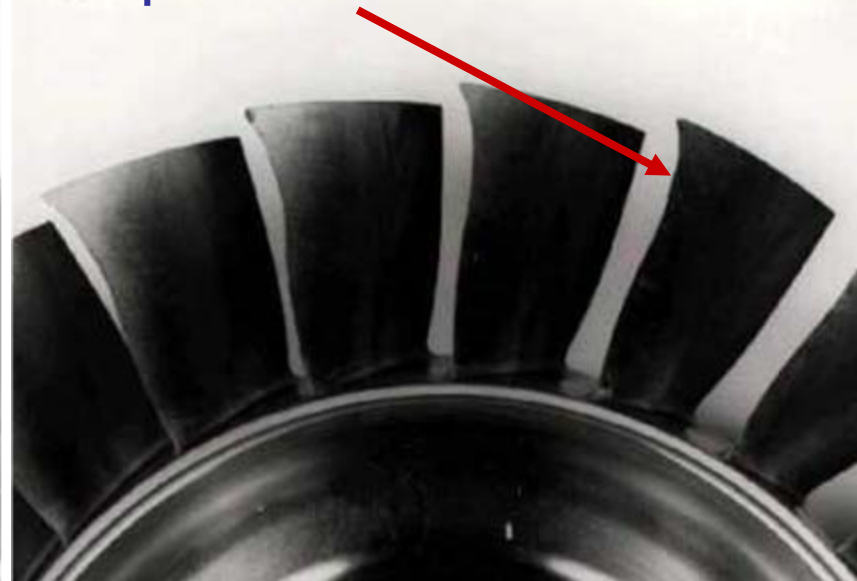


## Centrisep EAPS vs Inlet Particle Separators (IPS)

Compressor blade “as good as new”  
with EAPS



Compressor blade erosion with IPS



| Qualification  | MIL-E-5007C | AC Coarse |
|--|-------------|-----------|
| Particle size of sand                                | 200um       | 30um      |
| Typical Vortex efficiency                            | 96.5%       | 95.5%     |
| Efficiency of typical IPS                            | 92%         | 75%       |
| Engine life increase with Centrisep® compared to IPS | 2.3         | 5.5       |

## Tiger Engine Test

Challenge: engine had to survive 10 hrs in brownout conditions with a power degradation of <5%



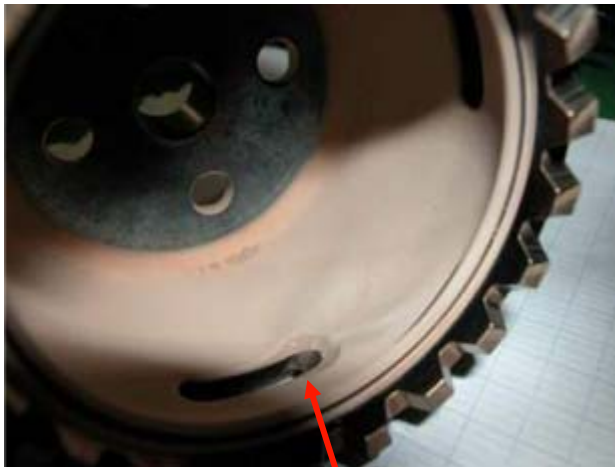
|                              |                            |
|------------------------------|----------------------------|
| <b>Total Dust Fed</b>        | <b>156Kg<br/>(344 lbs)</b> |
| <b>Power Loss after test</b> | <b>Only 3%</b>             |

*This shows only 1/10 of the test dust actually injected into engine air inlet (15.6kg).*

**Trial was equivalent to a minimum of 300 landings in brownout!**

## 2006 Trans-African Rally

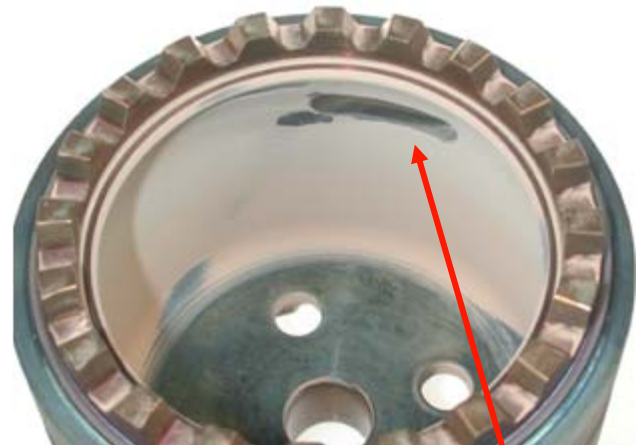
Compressor as good as new after **100 hours** and **98 desert landings** on unprepared sites in the Sahara with new Centrisep EAPS.



### Standard EAPS:

- 74 Flight Hours
- 76 Landings
- 8.7g of dust in hollow shaft

*Old design - Large amount of dirt in Inner shaft*

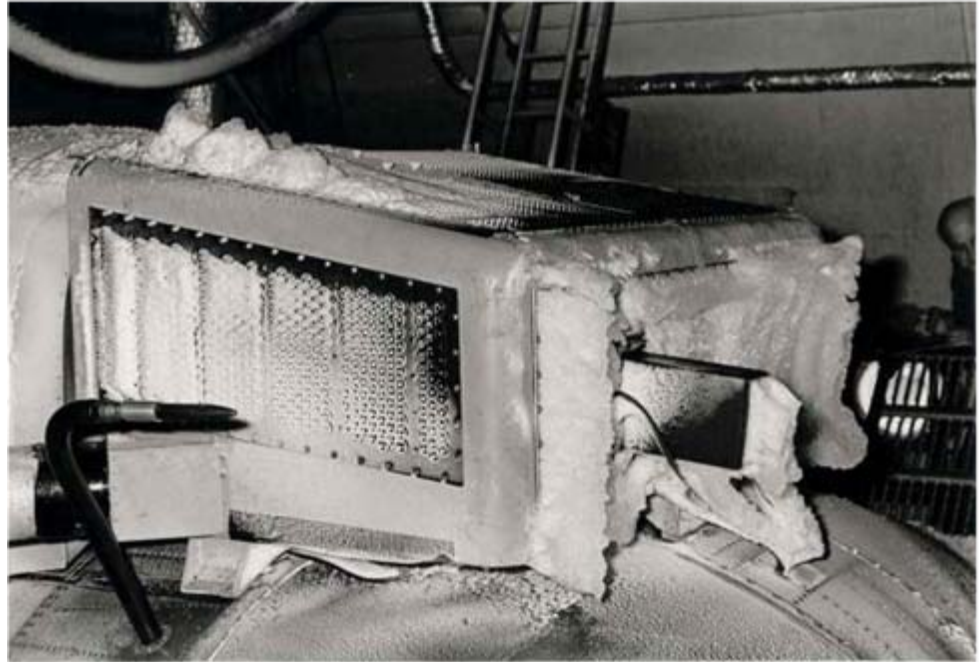


### New EAPS:

- 100 Flight Hours
- 98 Landings
- 0.6g of dust in hollow shaft

*New design - Tiny amount of dirt in Inner shaft*

**Centrisep EAPS has good operational capability in  
Snow and Ice conditions.**



Over 9000 Centrisep units have been supplied to date.

Customers include:

US Army

UK RAF

Royal Netherlands Air Force

Egyptian Air Force

Royal Australian Navy

NAMSA

Heli Union

Maverick Helicopters

Eurocopter

AgustaWestland

Bell

Boeing

Sikorsky

Kazan

Ulan Ude

Mil Helicopter Plant

MD Helicopters





*Photo Courtesy Deny Guerionne*



*Photo Courtesy Girish Thorat*



*Photos Courtesy U.S. Army*





*Photo Courtesy Iliyn Anton*



*Photo Courtesy AgustaWestland*





*Photo Courtesy Pierre-Yves Jan*



*Photo Courtesy Pierre-Yves Jan*



*Photo Courtesy AgustaWestland*



For the technical features of your particular helicopter, please ask your sales representative for the specific presentation.

For Further Information,  
Please visit <http://www.pall.com/contact>