Contents

- 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.
Foreign Object Damage (FOD)

- Serious damage to rotating & static components
Problems With Airborne Contamination

**Ice**

- Similar effects as FOD
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.

Heavy Rain

- Engine Flame Out
Problems With Airborne Contamination

Snow

- **Dry Snow**
  - No Problem

- **Wet Snow**
  - Engine Flame-Out
  - Damaged Compressors

Photo courtesy Zoe Lucas
Salt Spray

- Engine Corrosion
- Component Fouling/Power Loss

Photo Courtesy Gabriel Savit
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

<table>
<thead>
<tr>
<th>Qualification</th>
<th>MIL-E-5007C</th>
<th>AC Coarse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle size of sand</td>
<td>200um</td>
<td>30um</td>
</tr>
<tr>
<td>Typical Vortex efficiency</td>
<td>96.5%</td>
<td>95.5%</td>
</tr>
<tr>
<td>Efficiency of typical IPS</td>
<td>92%</td>
<td>75%</td>
</tr>
<tr>
<td>Engine life increase with Centrisep® compared to IPS</td>
<td>2.3</td>
<td>5.5</td>
</tr>
</tbody>
</table>
Tiger Engine Test

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

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!

<table>
<thead>
<tr>
<th>Total Dust Fed</th>
<th>156Kg (344 lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Loss after test</td>
<td>Only 3%</td>
</tr>
</tbody>
</table>
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.

**Performance Comparison**

- **Old design - Large amount of dirt in Inner shaft**
  - 74 Flight Hours
  - 76 Landings
  - 8.7g of dust in hollow shaft

- **New design - Tiny amount of dirt in Inner shaft**
  - 100 Flight Hours
  - 98 Landings
  - 0.6g of dust in hollow shaft

**Standard EAPS:**

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

**New EAPS:**

- 100 Flight Hours
- 98 Landings
- 0.6g of dust in hollow 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
Typical Centrisep EAPS Applications – Super Puma

Photo Courtesy Deny Guerionne
Typical Centrisep EAPS Applications – SA315 Lama

Photo Courtesy Girish Thorat
Typical Centrisep EAPS Applications – CH47

Photos Courtesy U.S. Army
Typical Centrisep EAPS Applications – MIL Mi8 / 17

Photo Courtesy Ilivn Anton
Typical Centrisep EAPS Applications – AW139

Photo Courtesy AgustaWestland
Typical Centrisep EAPS Applications – Bell427

Photo Courtesy Pierre-Yves Jan
Typical Centrisep EAPS Applications – EC135

Photo Courtesy Pierre-Yves Jan
Typical Centrisep EAPS Applications – Sea King

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