



AEROSPACE

Pall Engine Air Particle Separator used by Royal Netherlands Air Force on CH-47F Chinook.

Operation Report N°475/24-CH47-RNLAF



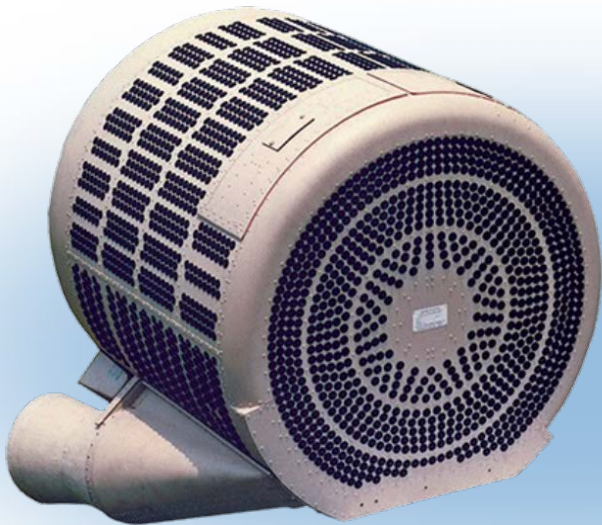
PALL CORPORATION

AEDSCH47ENRNLAF

The CH-47, equipped with Pall EAPS have been operated by RNLAf since the early 2000s, across various operating theatres, terrains and environments. Including flights at or above 3,000 metres mean sea level, operating in arduous desert climates and dusty terrain/brow-nout and flying during rainfall. Approximately 8% of flying was in brown-out, zero visibility dust conditions. With some operations performed at night. At present there are 20 CH-47F helicopters equipped with Pall EAPS operating with the RNLAf, who aim to have EAPS installed where possible on 100% of all operations.

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1. Introduction

This report was compiled by the Engineering Department of The Royal Netherlands Air Force (RNLAf), based on the operational experience of the Pall Engine Air Particle Separator (EAPS), utilised on the CH-47F Chinook.

2. Pall Engine Air Particle Separator

The Engine Air Particle Separator, or Pall EAPS, is made up over 3,200 approximately 3/4 -inches vortex generators tubes which continuously remove sand, dirt, water, salt-water and other foreign object damage (FOD) that have the ability to damage turbine engines. The system relies on a electrical scavenge system (known as the scavenge fan), to discharge contaminant overboard - away from the engine inlet, allowing cleaner, uncontaminated air to reach the engines.

3. General information

The Pall EAPS for the Boeing CH-47 Helicopter, utilised by the RNLAf in this report, was designed by Pall Corporation, together with the US Army for the latest CH-47F model. The system was based on a several previous design iterations that originally entered service on earlier CH-47 models in the 1980s.

The Pall EAPS is able to achieve the following:

- ✓ High dust and dirt separation efficiency that leads to premature compressor blade erosion
- ✓ Provides protection against foreign object damage (FOD), often caused by bird strikes, hail stones and other man-made objects.

- ✓ Engine protection is provided with a constant efficiency level - unlike other inlet protection alternatives that can block over time
- ✓ Calculated power penalty averages 5 percent torque at a hover.
- ✓ The EAPS is self-cleaning and virtually maintenance free.

4. Place and duration of CH-47F operation with Pall EAPS

CH-47F with Pall EAPS have been operating by RNLAf for the last 19 years in various environments across the world including mountain flights at or above 3,000 meters mean sea level, flying in dusty environment at sea level and flying in rainfall. Approximately 8% of the flying was in brown-out zero visibility dust conditions, with some flying at night. At the present time there are 20 CH-47F helicopters used by RNLAf equipped with Pall EAPS. RNLAf strives to have EAPS installed during 100% of its flights.

5. Results of operation

- ✓ With Pall EAPS installed, the engines met or exceed all power limits, called for in the aircraft performance charts. Additionally, both engines passed the Power Assurance Test (which is performed on every flight prior to departure to determine engine condition from a predetermined set of parameters developed from the results of the maximum power check) and maintained power assurance during the entire flight test without any changes in computation.
- ✓ The Pall EAPS saves engines and substantially lower operating and support cost to operating units. In addition to protecting the engine against sand and dirt, icing, bird strikes and other FOD sources, the EAPS defends against the negative effects of salt spray and its potential for engine corrosion, fouling or power loss.
- ✓ Even though the Pall EAPS has been designated as mission equipment, the full-time operation of the EAPS would serve to protect the engines, given the aircraft are routinely required to operate outside their mission profiles in unforeseeable adverse conditions.
- ✓ The multitube system balances the airflow, resulting in a more stable engine operation in all transient and steady-state modes.

6. Conclusion

Based on the results obtained, the following conclusions were made:

- ✓ All Pall EAPS performance as well as improvement of the helicopter engine lives with Pall EAPS are confirmed, including hot climate and high altitude environment.
- ✓ Pall EAPS plays a crucial role in extending engine live. It tremendously slows down engine internal erosion during sand and dust operations.
- ✓ RNLAf has installed Pall EAPS on all our CH-47F for full-time operation.

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