

PUREair

FEATURING  TECHNOLOGY
Aerospace

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- Problems with airborne contamination
- Engine Air Intake Solutions
 - Other Technologies
 - Pall *PUREair*
 - Pall Dry Inlet Barrier Filter
- Pall Helicopter Applications

Threats to Helicopter Engines



Challenges

- Engine power loss (compressor erosion or damage)
- Blade corrosion
- Turbine blade glazing
- FOD or bird strike damage

Solution – the *PUREair* system

- Increased operational availability & reduced downtime
- Increased engine reliability
- Safe operation
- Protection against engine erosion
- Reduced maintenance & operational costs

Threats to Helicopter Engines – Sand / Dust



Effects

- Erosion of rotating components, especially compressor blades
- Blockage of turbine blade cooling passages
- Turbine blade glazing
- Fouling of Combustion chamber
- Accumulation in inner shaft causing imbalance and unwanted vibration

Threats to Helicopter Engines – Brownout



“Brownouts have claimed more helicopters in recent military operations than all other threats combined.”

(Rotor & Wing, 2005)

- 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 that create suspended sand/dust

Threats to Helicopter Engines – Foreign Object Damage (FOD)

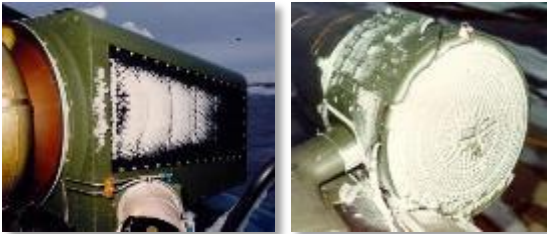


Effects

- Serious damage to rotating & static engine components
 - Potential for catastrophic component failure

FOD damage to a Lycoming LTS-101 turboshaft engine in a Bell 222 helicopter

Threats to Helicopter Engines – Ice



Effects

In-flight icing results from super-cooled water droplets impacting aircraft surfaces and freezing

Solid ice contamination can form in the helicopter engine air inlet duct due to the lower temperature created by the inlet depression

- If ingested into engine air system, ice has same impact as FOD, causing serious damage to the engine compressor
- Ice build-up in air intake can cause air starvation to engine
- Ice build-up on flight surfaces can cause flight instability

Threats to Helicopter Engines – Heavy Rain



Cause:

- In certain conditions, rain can accumulate on the fuselage at a stagnation point upstream of the engine air inlet. Periodically this water can be ingested as a slug.

Effect:

- A **mere half cup-full** of water, ingested as a slug is enough to cause **engine flame out**.
- Helicopter engine air inlets with a flat surface in the air entry point are more prone to this problem
- In some countries, helicopters are grounded in heavy rain

Threats to Helicopter Engines – Snow



Cause:

- Wet Snow can accumulate in the fuselage in front of the engine air inlet, which can then be ingested into the engine as concentrated slush

Effect:

- Potential for compressor damage
- Potential for Engine Flame-Out if sufficient snow is ingested into the combustor system
- Dry Snow is generally not a problem

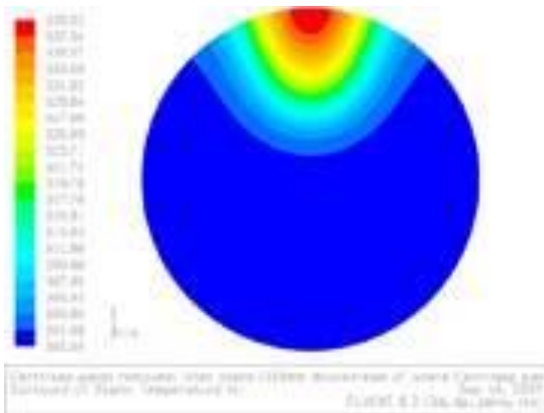
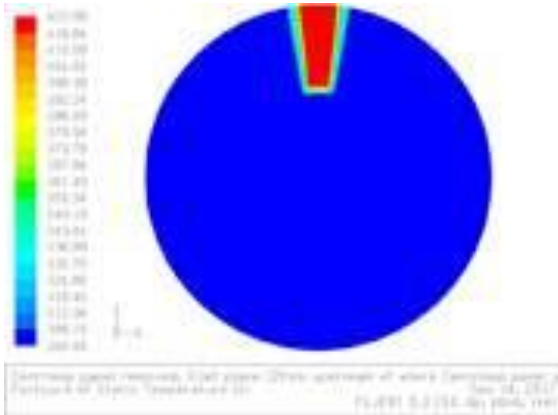
Threats to Helicopter Engines – Salt Spray



Effects

- Formation of salt deposits on engine components (compressors, etc.)
 - Engine component corrosion damage
 - Fouling of passages in engine air system
 - Rotating component (compressor) imbalance due to salt deposits
 - Power loss due to above

Threats to Helicopter Engines – Hot Gas Ingestion

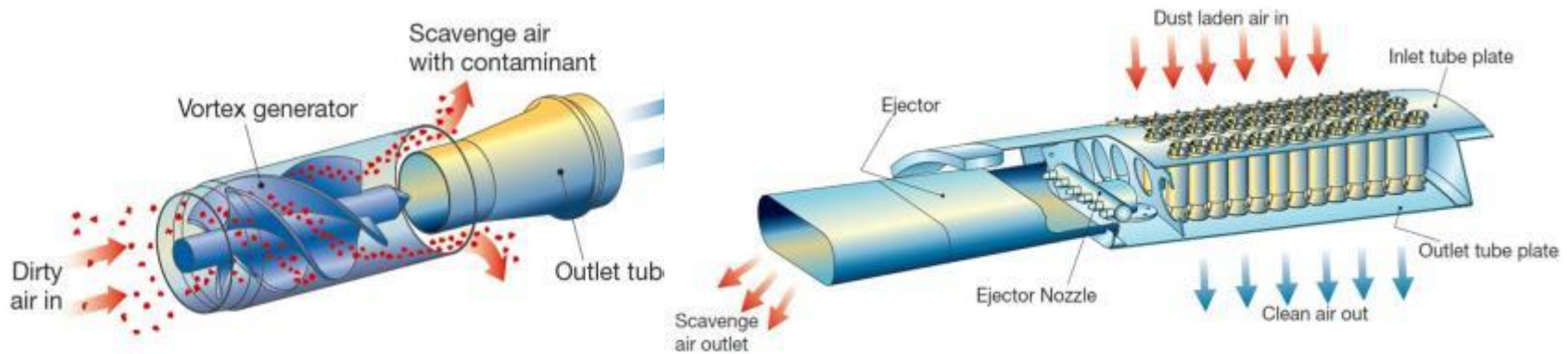


- Hot gas ingestion occurs when the engine exhaust gases are re-ingested into the engine inlet air system
 - Attitude and flight direction of helicopter
 - Wind direction – tail winds
- Effects and Potential Impact on engine operation
 - Significant increase in engine inlet gas temperature
 - An increase of 40° F in inlet temperature can lead to an reduction in engine power of 15 %
 - Temperature and flow distortion in engine inlet gas stream at compressor entry plane
 - Spatial or temporal temperature/flow distortion can lead to compressor stall and potential for engine failure

Principles of Operation

1. Contaminated air enters the Vortex Tube
2. The Vortex tube imparts a swirl
3. Particles and water are separated to the outside
4. Contamination is removed from the system by scavenge airflow
5. *PURE*air travels to the engine

The principle is simple ... optimizing the system is critical for max performance

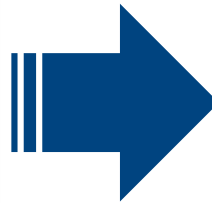


Pall *PUREair* System

- First *PUREair* Engine - Designed by Pall in the late 60's (previously known as Centrisep EAPS).
- 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



1968



2010



PUREair System Benefits

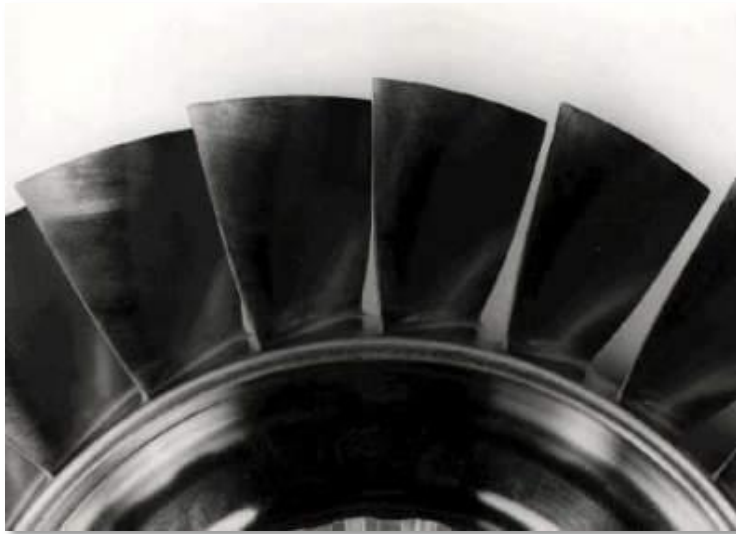
Benefits:

- 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

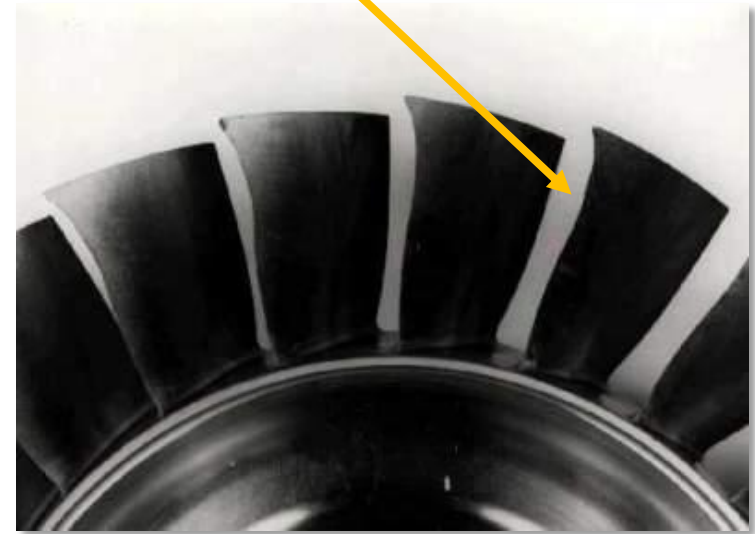
Proven Dust & Sand Separation Efficiency - RTM322 engine test

PUREair Systems vs. Inlet Particle Separators (IPS)

Compressor blade “as good as new”
with *PUREair* system



Compressor blade erosion with IPS



Test Contaminant	MIL-E-5007C	ISO Coarse Test Dust
Typical <i>PUREair</i> Efficiency (%)	96.5	95.5
Typical IPS System Efficiency (%)	92	75
Compressor wheel service life increase with <i>PUREair</i> system compared to IPS	2.3	5.5

Proven Dust & Sand Separation Efficiency

Tiger Engine Test

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



Total Dust Fed	156Kg (344 lbs)
Power Loss after test	Only 3%

**3% POWER LOSS
= TEST PASSED**

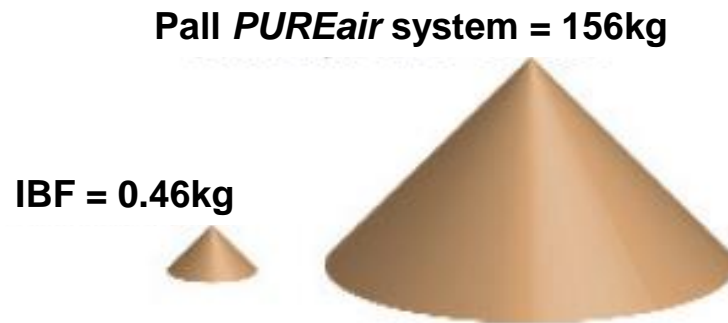
This shows only 1/10 of the test dust actually injected into engine air inlet (156kg).

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

Oil Wetted Barrier Filter - Dirt Holding Capacity

By contrast, the same test with an oil wetted inlet barrier filter¹ (IBF)

- IBF would have required cleaning **300 times** during the test.
- IBF would have required replacement **at least 20 times**
- The test would have **stopped every 2 minutes** for barrier filter maintenance. With the *PUREair* system, it went all the way through without interruption.



Barrier filter maintenance is a serious burden for the operator.

¹ Based on barrier filter with dirt holding capacity of 0.46 Kg (AP23207) and maximum 15 cleanings

Performance Comparison - 30 year old Design and latest Design

2006 Trans-African Rally

Compressor as good as new after 100 hours and

98 desert landings on unprepared sites in the Sahara with the new *PUREair* system.



Old design

*Large amount of dirt
in Inner shaft*



New design

*Tiny amount of dirt
in Inner shaft*

Standard *PUREair* system:

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

New *PUREair* system:

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

Pall *PUREair* - Cold Weather Operation

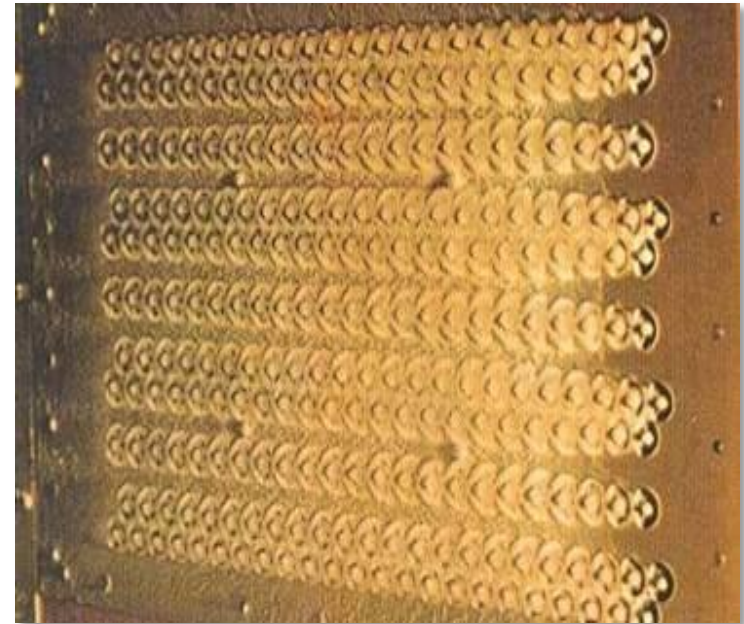
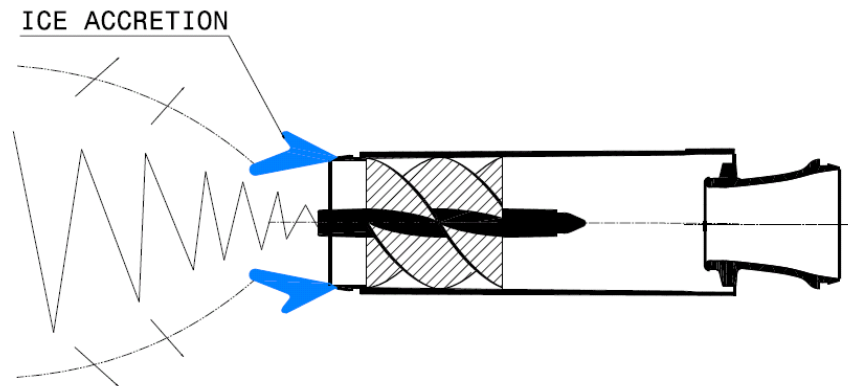
Pall *PUREair* system has good operational capability in **Snow** and **Ice** conditions.



This fully de-iced helicopter was forced to land, not because of *PUREair* system blockage, but through the rotor blades icing up.

Pall *PUREair* - Cold Weather Operation

Vortex tube (Hover Condition)



**Diagram and photo show ice accretion in
hover**

Pall *PUREair* - Cold Weather Operation

Vortex tube (Forward Flight)

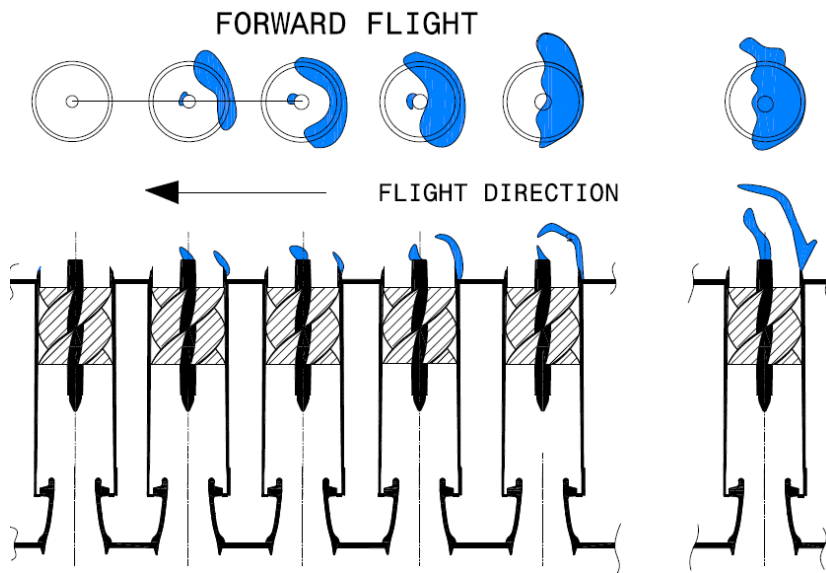


Diagram and photo show ice accretion in forward flight

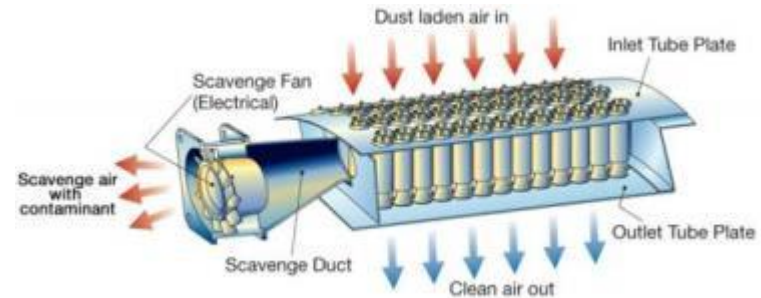
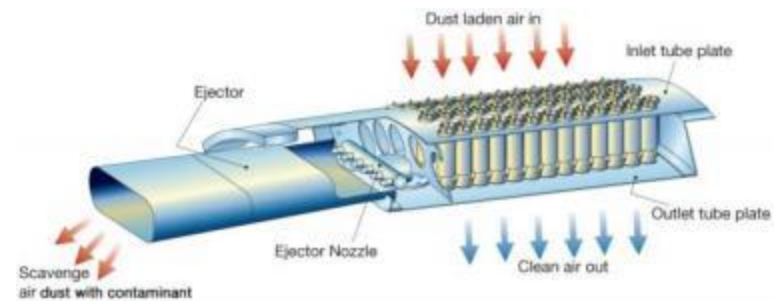


Barrier Filters - Cold Weather Operation

- Barrier filters tend to get blocked by Ice / Snow.
- When blocked by ice or snow, engines rely on by-pass doors.
- By-pass doors have to be reliable and designed in such a way that ice/snow does not accumulate on them.
- Our competitor now provides coarse screens to replace their barriers on some helicopter models for winter operation.

Scavenge Systems

Scavenge is achieved either by P2 air activated ejector or scavenge fan.





Pall *PUREair* - Sample of Current Operators

Over 9000 *PUREair* 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

Over 50 Helicopter Air Intake Solutions



Photo courtesy of Maverick Helicopters.



© Barry Chambers Dreamstime



Photo Courtesy of Agusta Westland



Eurocopter ©



Photo Courtesy of Agusta Westland



Photo Courtesy of US Army

Pall *PUREair* Applications – EC135

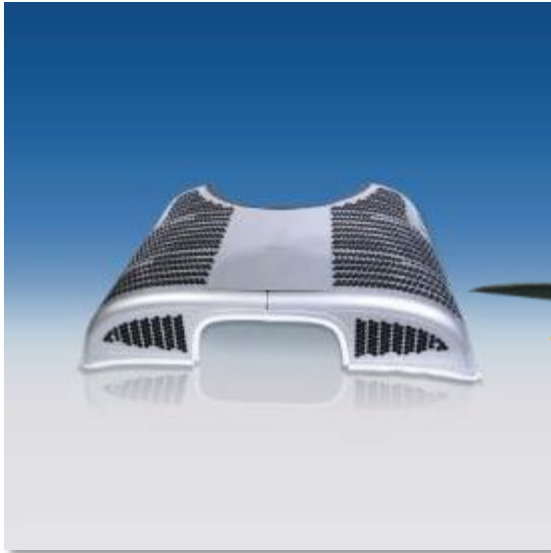


Photo Courtesy Pierre-Yves Jan

Pall *PUREair* Applications – CH-47 Chinook



Pall *PUREair* Applications – MIL Mi8 / 17



Photo C

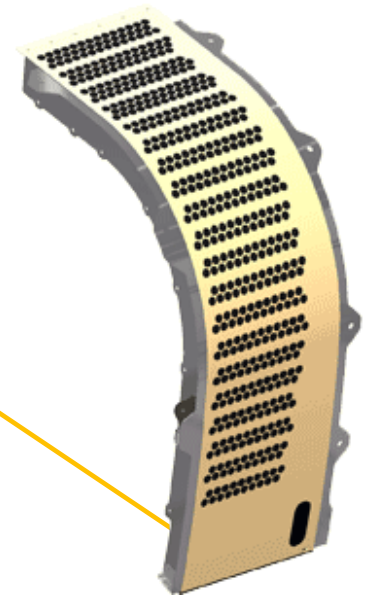
Pall *PUREair* Applications – Sea King / S61



Photo Courtesy AgustaWestland



Pall *PUREair* Applications – Bell 427



Pall *PUREair* Applications – AS332 Super Puma

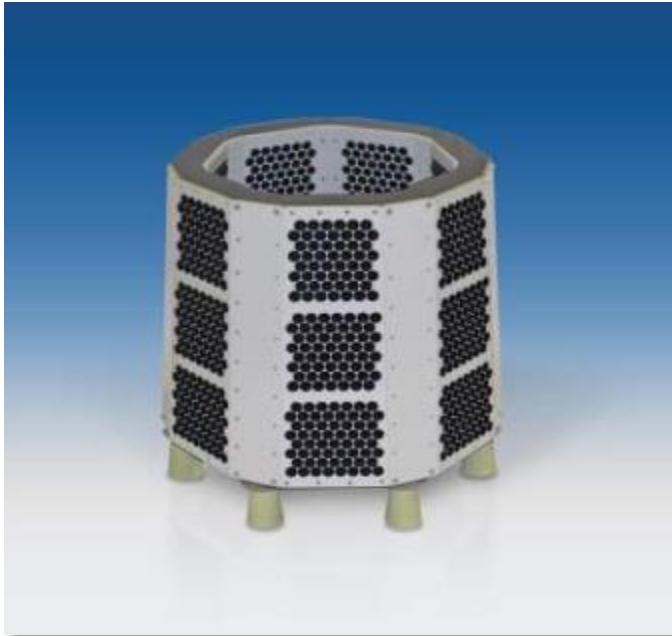


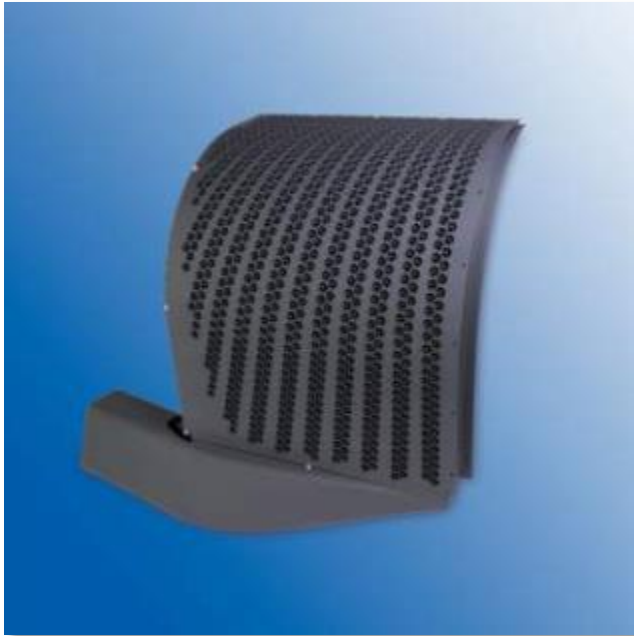
Photo Courtesy Deny Guerionne

Pall *PUREair* Applications – SA315 Lama

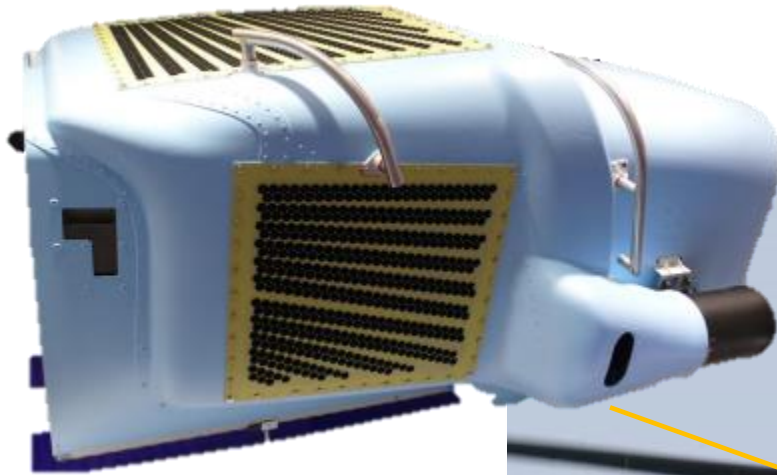


(Photo Courtesy Girish Thorat)

Pall *PUREair* Applications – AW139



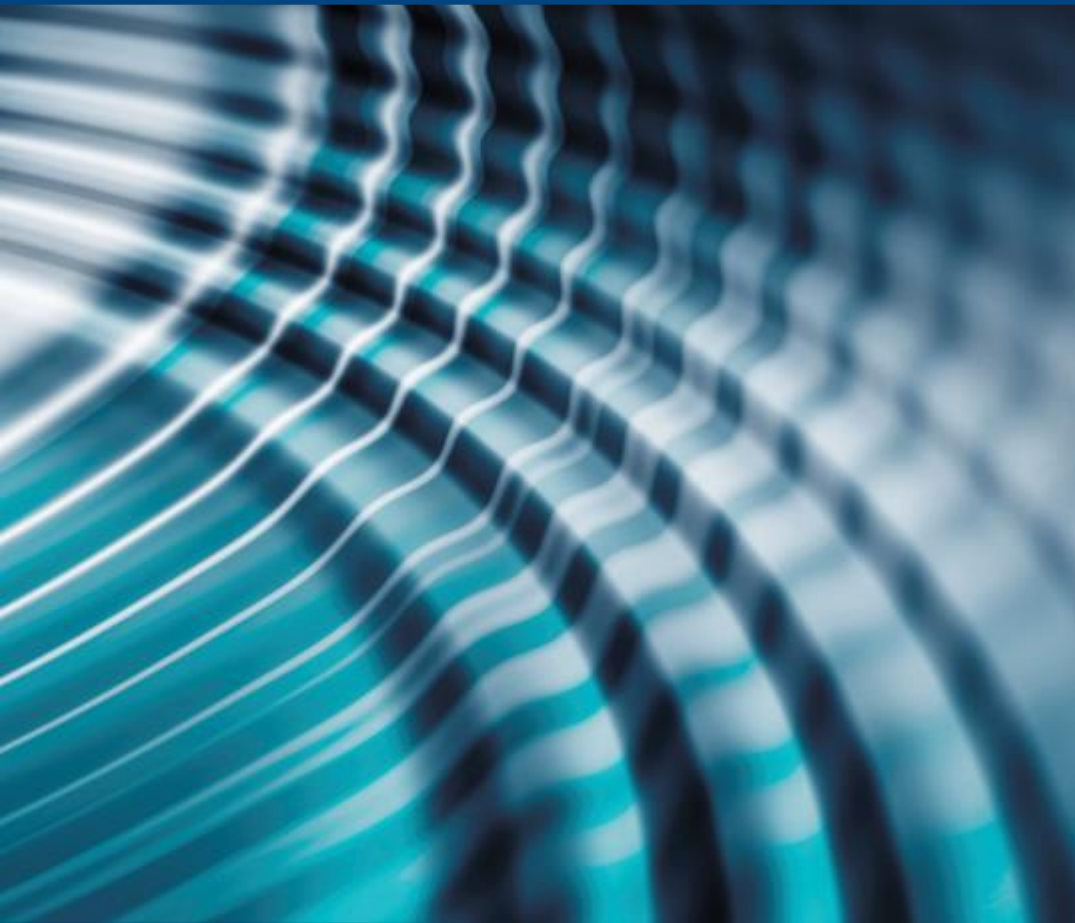
Pall *PUREair* Applications – NH90



Courtesy Martin Eadie

Pall *PUREair* Applications – Mi24





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