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**APU failure after more than 7 days parking of aircraft**

## APU failure after more than 7 days parking of aircraft

The Covid-19 pandemic caused airlines worldwide to keep their aircraft grounded for a longer period of time. Entire fleets were parked and stored. OEM's provided specific measures to preserve aircraft, engines and parts during storage.

These measures aim at flawless fleet recovery. Depending on the areas, when the consequences of Covid-19 seem to diminish, aircraft are taken out of storage. As air travel picks up, so do airlines' operations. Many aircraft are taking off again and do so without any major problems.

However, at EPCOR -one of the world's main suppliers of APU maintenance, repair and overhaul- a trend in post-storage failure of APU's has been detected.

Due to inadequate preservation measures during storage, APU's suffer from full seizure and are rendered out of order.

This has occurred with the Honeywell GTCP 131-9B, the APU operated on Boeing 737 aircraft, and may occur with other APU types as well.

In this document, APU Shop Engineer Ruud Jansen of EPCOR shares his expertise and explains all about this specific form of APU failure.



## Can you describe the problem in a nutshell?

"The APU of aircraft that have been parked for a longer period of time might be damaged during start-up, due to a combination of humidity, temperature and inadequate preservation measures."

## How did you detect this problem?

"During incoming inspection of an APU, we found the rotating assembly was completely seized. The load compressor, which is the middle section of the APU, got stuck with its knife edges in the abradable seal surrounding it."

## What caused this seizure?

"After thorough inspection, we found corrosion on the gears. This usually indicates a humidity issue, and consequently inadequate preservation and storage measures. We consulted Honeywell, the OEM of this particular APU.

They confirmed our presumption that a lack of preservation measures may result in corrosion and the swelling of any abradable coating. Once the abradable seal is swollen, the knife edges of the load compressor have too little room to rotate freely. They run into the abradable seal and cause the rotating assembly seizure and the APU failure."

## These preservation measures, what do they consist of?

"The measures are described in Service Bulletin 49-7997 and the Aircraft Maintenance Manual (AMM). During long term storage, the measures consist mainly of sealing certain parts and of an APU start-up and operation procedure once every 7 days. If the aircraft is stored in a so called severe environment, this should be done every 3 days."

## What is meant by 'severe environment'?

"The APU of aircraft that have been parked for a longer period of time might be damaged during start-up, due to a combination of humidity, temperature and inadequate preservation measures."

## How did you detect this problem?

"Actually, that is an environment which is pretty common in large parts of the world during many months of the year: a humidity of over 40% or a temperature below 0° Celsius or 32° Fahrenheit. The aircraft and APU where we first encountered this problem, had been stored in Northern Europe in wintertime. Since the average humidity in the region is above 90% from September onwards, the environment there should be considered severe. Therefore, APU's should get a start-up and operation procedure once every 3 days. Unfortunately, in this case the operator had done it only once every 7 days."

## In what other regions would you encounter these severe conditions?

"In winter and fall in just about all of Europe. And, depending on the seasons, in Asia and parts of the Americas as well. I should think that only desert conditions could be considered as a mild environment for storing aircraft and APU's."

## Do you expect to see a lot of APU's that have suffered this specific post-storage damage in the near future?

"At EPCOR we are already observing a trend. In a short period of time we have encountered this failure with incoming APU's of operators from Europe, South America and Africa. That does not come as a surprise. The cause of the damage is clear. So any operator, who has not taken the right preservation measures during long-term storage, is exposed to the risk of this specific kind of failure. Especially now many of them are recovering their fleets from storage to scale up operations again."

## **What is the extent of the damage?**

"Due to humidity, the abradable seal of the load compressor expands. The knife edges will no longer rotate freely beside the abradable seal, but run right into it. This immediate damage is local. No other parts of the APU are affected.

Still, this damage requires the APU to be taken apart completely. The whole power section, consisting of the combustion chamber and turbine, has to be dismantled. It is the only way to reach the load compressor section where the damage is located."

Denise George, advanced in-service engineer at Honeywell Aerospace says on this topic: "I think this type of APU seizure is directly connected to the lack of APU preservation. It is critical that the APU is properly preserved in order to prevent corrosion and swelling of any abradable coatings causing seizure. If the APU is stored in what we categorize as a "severe environment", then extra precautions are needed for preservation to prevent corrosion. The oil wetted surfaces, such as the gearbox, are primarily exposed to corrosion, so it is not surprising to see corroded gears on a bad preserved unit."

Boeing describes, in AMM temporary revision 49-1014: "It is recommended that you do an APU starting and operation procedure a minimum of once every 7 days if the airplane has not operated and you did not do the APU preservation procedure during this time. You must operate the APU for a minimum of five minutes under a "no-load" condition and then do the APU shutdown procedure. In most conditions, the operation of the APU during this monthly interval will prevent internal/external corrosion and damage to the fuel and oil seals/components."

"If the APU is in a severe environment of high moisture or salt air, it is recommended that you start the APU once every 3 days to prevent corrosion; which can lead to an APU no-start condition, due to seizure of the rotating group."

## **Is it possible to operate an aircraft without an APU?**

"Technically it is. Aviation regulations allow this for a maximum of 10 days. So at a certain moment in time, each and every APU that has suffered this damage will have to be replaced and sent in for repairs."

## **What impact will this problem have on the operations of airlines?**

"An APU has two functionalities. The first is the main engine start, or MES. The second concerns the environmental control system, or ECS. So if an APU is out of order, there is no electricity and no air conditioning on board. There is a quick fix for this. A ground cart at the gate will also supply electricity and air pressure. But such a mobile unit may not be available at all times. Furthermore, the use of local ground support equipment involves costs. So from this perspective, it would be advisable to have the APU up and running again soon. And don't forget some airports have no a/c ground carts or jet starters available at all. Aircraft without a serviceable APU cannot fly to these destinations. This may involve operational costs as well."

## **Is there any advice you could give to airlines?**

"Primarily the advice is to read the documentation on preservation in the SB and AMM really well. Determine how long an aircraft will be stored and what the corresponding preservation measures should be. Most operators will think of their engines, but how many forget about the APU? An alternative is to seal off the APU completely or insert desiccant bags that will keep the APU dry."

## What if an operator has not taken any of these measures during storage, wants to fly an aircraft again and encounters an APU failure?

"First rule out any other root causes. This can be done quite easily, with an on-wing check. Just try to turn the rotating assembly manually. If it rotates, the failure might be caused by a defect fuel control unit. This unit may be replaced on-wing. However, if it does not rotate, chances are it is caused by inadequate storage measures and a swollen abradable seal. Unfortunately this cannot be fixed on-wing. The only action left to be taken, is to replace the APU and send it in for repairs."



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## About EPCOR

EPCOR is an Air France KLM Engineering & Maintenance subsidiary and a centre of excellence in maintenance, repair and overhaul of APU's and pneumatic components. In 15 years, the 190 employees of EPCOR performed over 2.000 APU shopvisits for 94 airlines from around the world. Additionally, 1.000 APU's of some 30+ customers are monitored daily in real time. All in all, EPCOR has gathered an enormous amount of experience and expertise.

EPCOR features capabilities for 5 types of APU's from Honeywell and for 3 types of APU's from Pratt & Whitney. More than 20% of the worldwide Boeing 777 APU repairs are performed by EPCOR and over 30% of the worldwide Boeing 787 APU are serviced in the EPCOR shop. EPCOR is one of the 3 licensed shops of Boeing 787 APU repair and overhaul and exclusively licensed for all Honeywell A330 APU repair and overhaul. The latest addition to EPCORs APU Capability is Honeywell 131-9C, the sole APU for Airbus A220.

EPCOR ensures quality, offers availability and a flexible work scope to meet customer demands.

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