APU System Update

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Honeywell
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Agenda – Auxiliary Power Units

- 36-150 Compressor Carbon Seal
- 36-150[BD] Inlet Heat Distress
- 36-150[G/GIV] G450 APU Starter Motor
- Un-commanded High Oil Temperature (HOT) Shutdown of the RE100[CS] and RE100[XL]
- RE220[GX] EGT Probe Failures
- RE220[GV] Ignition Unit Reliability
- RE220[GV and GX] Turbine Oil Tube Leaks
- 36-150 [CL] [FN] [G] [GIV] Impeller Erosion
- Q&A
36-150 APU Compressor Carbon Seal

• Issue
  – APU compressor carbon seals are leaking into the gas path causing oil smell in the cabin

• Action
  – Develop and validate solutions for leaks
    • Phase 0: Enhanced balance procedure
    • Phase 1: Hydrodynamic seal design, de-oil functionality, improved ejector, gearbox baffles

• Status
  – Seal engine test complete with good results
  – 1000/2000 cycle endurance test build in-process
  – Decision point (solution development completion) November 26, 2014

Typical seal leak symptom

Development and Testing On-going
CL300 36-150[BD] Inlet Heat Distress

• Issue
  – Challenger 300 APU has inhibited shut downs when in-flight
  – One of them is the “No Flame” fault for a no start condition
  – Potential for fuel accumulation in plenum and reverse flow through APU compartment
  – Subsequent successful start can result in inlet heat distress as shown

• Action / Status
  – Temporary Revision No. TR-72 (May 2014) to the Airplane Flight Manual (AFM) adds a new limitation prohibiting a second APU start attempt in-flight following a failed or hung start

Example of heat distress at inlet
36-150[GIV] G450 APU Starter Motor

• Issue
  – Early wear out of starter brushes causes no start condition

• Action
  – Continue AMM 500 hour brush wear checks
  – Replace starter as necessary

• Status
  – Service Bulletins (SB) 49-2396 and 49-8116 have been released for the P/N 2704458-1 starter
  – SB 49-2396 is the rework to a -2
  – SB 49-8116 is the swap out from the -1 to the -2

The Starter SB is an Attrition SB and Not a Campaign
Un-commanded High Oil Temperature (HOT) Shutdown of the RE100[CS] and RE100[XL]

• Issue
  – Reports stating that APUs have experienced un-commanded HOT shutdowns
  – Variability in oil servicing can contribute to high oil temperatures resulting in un-commanded shutdowns

• Action
  – Use SIL to adjust the oil level to the recommended level

• Status
  – SIL D201308000026 has been released (Jan 2014)
RE220 EGT Probe Failures

• Issue
  – Numerous events reported of thermocouple failures on various aircraft using RE220 APU

• Action
  – Root cause investigation followed by applicable corrective action

• Status
  – Two failure conditions identified: wet and dry
    • Wet failure mode testing complete and failure mechanism understood
      – SIL APU-87 revised for interim relief
    • Dry failure mode requires further root cause analysis - ongoing
  – Solution development will be based on final root cause determination

Root Cause Investigation Underway
RE220[GV] Gulfstream Ignition Unit Reliability

• Issue
  – RE220[GV] Ignition Unit WE3876295-6 monitored for reliability issues

• Action
  – Root cause determined to be low input voltage provided by the aircraft
  – Re-design ignition unit to operate at a lower voltage

• Status
  – WE3876295-7 ignition unit service bulletin 49-8071 released in October 2013

Service Bulletin Released
RE220[GV and GX] Turbine Oil Tube Leaks

• Issue
  – Turbine oil pressure and scavenge tubes leaking:
    • Failure mode location different than previous Service Bulletin corrective action
    • Can cause high oil consumption (HOC) and/or low oil pressure (LOP)
  – Impacting all RE220 APU installations

• Action
  – Improved tube design

• Status
  – Service Bulletin 49-8085 is released to remedy this issue

Typical oil leak symptoms

Service Bulletin Released
36-150 [CL] [FN] [G] [GIV] Impeller Erosion

• Issue
  – Compressor blade erosion that causes no operational issues

• Action
  – Contact your Aircraft OEM for a disposition to continue operation
  – Honeywell will be contacted by the OEM to review the photos and recommend any actions
  – The OEM will then give you the operator the disposition

• Status
  – Honeywell Inspection and Repair Manual revised to add erosion limits (for shop use only – not on-wing dispositions)

Fly-on Disposition Available
Questions?
Portal New Look for Software Downloads

APU Engine Software

Honeywell Proprietary
36-150[CL] Turbine Plenum/LCV Leak

• Issue
  – Bleed air leaks have been discovered between the APU turbine housing flange and the load valve flange (occurs in production and overhaul)
  – Interference between the V-band clamp and the APU turbine housing flange:
    • Occurs when parts (Turbine Housing Flange, Clamp, LCV) are at the extreme ends of their respective tolerance bands
    • Interference causes the V-band clamp to deform the turbine housing flange making it difficult to form a tight seal

Deformation and buckling due to clamp forces
36-150[CL] Turbine Plenum/LCV Leak (Cont)

- **Action**
  - New Clamp (PN 234-538-9650) Introduced
  - Allows for more clearance between the turbine housing flange outer diameter and the inside diameter of the clamp
  - Clearance allows more force to be transmitted axially acting to push the sealing surfaces of the turbine housing flange and LCV flange together more tightly helping to prevent bleed air leaks
  - Clamp torque value is 5 in-lb less than original clamp (40 in-lb vs. 45 in-lb)
  - Clamp change does not affect APU TSO (FAR 21.611(a))

- **Status**
  - New Clamp approved for use via (SB 36-49-8048) (May 2012)
  - 36-150[CL] APU SN P-300 first cut in S/N to receive new clamp
Unapproved Oil Filters Reminder

• Honeywell Part Number oil filters are designed to flow oil at the minimum temperatures specified in the Approved Oils Table in each Maintenance Manual

• Use of an oil filter not approved by Honeywell may be the cause of Low Oil Pressure (LOP) shutdown on the first start of the day in cold weather or if starting in flight after cold soaking. The second start attempt is usually successful
This ECU part number is used for the Challenger 300/601/604/605, G-IV 150G, G280, G450 and 7X

• The ECUs produce any number of faults during APU operations. Most if not all logged faults are “nuisance in nature” unless you have a shut down or no start

• **There is no requirement to do periodic downloads**

• Faults and shut down faults logged in the ECU are to be IGNORED if the APU starts, runs, gives bleed air and carries the generator load

• No maintenance actions are to be taken from a download, even when ECU has logged internal faults, unless the APU will not start or has had an uncommanded shut down

• You cannot predict any future failures with downloaded data from the ECU

• Information on how to order download cables is contained in:
Technical Tips 36-150 APU

- **Gulfstream IV with 36-150[G] APU upgrade and Challenger 601/604/605 with the 36-150[CL] APU upgrade**
  - Oil Filter SOAP KIT (SIL 49 Rev 9) is still the same part number as the 36-100 series APU. Kit P/N 831139
  - Do not order a SOAP kit for a 36-150 as the filter will not fit your APU

- **Challenger 601/604/605 with 150[CL] APU. The Igniter plugs are on condition but, frequently operators ask for specific inspection criteria**
  - A Pubs Change Request has been submitted to add this to the APU Maintenance Manual
  - Contact your local Honeywell FSE and ask for the inspection criteria from the Gulfstream G-IV 150G Maintenance Manual. The plugs are the same for both. And both are on condition for either model
**Technical Tip Falcon 2000 36-150[F2M]**

- **APU no starts, hung starts** — Do not overlook the Generator Control Unit (GCU). It can cause starting issues. Also be sure that all your GCU’s can start the APU. One scenario is APU light off and the RPM stalls out with the EGT stable and not continuing to climb.

- **No bleed air** — Be sure your trouble shooting includes running the main engine air valves to the “open then closed” position. Their internal contacts must be open for the APU bleed valve to open.

- **High EGT for Main Engine Start** — Check that the Variable Guide Vanes are returning to Zero once air conditioning shuts off. If they do not then check the switch on the Ejector Valve for the Heat Exchangers. It must be closed or the APU ECU thinks you still want air conditioning and the VG’s will not move causing the higher EGT. You view this on the ECU LED Display window under data and scroll to VG to view.
Gulfstream GV/500/G550 and Global Express RE220 APU

- **Combustor Wash (When Do I Do It?)**
  - Combustor washes for the RE220 APU are not mandated by the Maintenance Review Board or Maintenance Planning Document from Gulfstream or Bombardier. The procedure to complete a combustor wash is in the Maintenance Manuals from both OEMs.
  - Symptoms that the APU needs a combustor wash include APU shut downs with Load Changes. Starting Main Engines and as the start valve closes the APU shuts down. On GV/550 Brake Power transfers can happen.
  - The APU bypasses the normal cool down during a routine shut down.
  - A good indicator of this is when Maintenance Computer messages report the APU failed to RELIGHT after a uncommanded shut down.
  - Honeywell SIL 97 recommends 2000 hour intervals.
  - Operators should look at their environmental climates and adjust the interval as needed.
RE220 GV and GX Oil Tube R&R Tip

• When complying with Service Bulletin 49-8085 keep this tip in mind
• The gaskets are very fragile
• When running the tube bolts down do both at the same time to keep an even load on the gasket
• If you cannot do that then once you reach 30 inch pounds it is advised to alternate but to not exceed 5 inch pound increments to the final torque of 60 inch pounds
• **Inlet Temperature Sensor:**
  – The Inlet Temperature Sensor reports incoming air temperature to the ECU. If the air gets too hot the ECU will command a shut down.
  – A uncommanded shut down scenario can come into play when the sensor or wiring has an issue. The APU will shut down almost immediately upon selecting BLEED AIR ON.
  – When using the FSM software to download faults, an INLET SENSOR fault may or may not be seen. But, if the above is happening perform wiring checks first and then replace the sensor.

• **High Oil Temperature Sensor:**
  – **HIGH OIL TEMP (HOT)** shutdowns in almost all cases is caused by a broken wire in the wiring harness P10 connector. Disassemble the connector and check for broken, frayed wiring or loose pins. It is rare that the sensor itself is the problem.
36-150 Carbon Formation

• Issue
  – Carbon formations originating in the combustion chamber can liberate and cause:
    • Impact damage to Turbine Wheel Blades and Turbine Nozzle
    • Popping noises due to “surging”

• Action
  – The investigation findings has not conclusively identified a single root cause for carbon formation
  – The investigation leads us to believe that root cause is due to combinations of variation in hardware

• Status
  – It is recommended that operators borescope APU if they experience surging with no related LRU faults
  – If carbon is found it is recommended to replace the combustor and all fuel nozzles