

**ANALYSIS AND DIAGNOSIS OF VIBRATION INDUCED UNEVEN
COMMUTATOR WEAR ON A COMUTER JET APU**

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ABSTRACT

Significantly uneven radial wear patterns on several commutator copper surfaces of 10 KW DC starter-generator units of Auxiliary Power Units (APU) of a specific commuter jet necessitated an intensive engineering investigation to cure this problem. In service, the circumferentially uneven radial wear typically progressed to a degree where the brushes could no longer track the commutator radial profile to maintain continuous rubbing electrical contact with the commutator, rendering the APU DC starter-generator inoperable. A commutator-brush dynamics-wear model and corresponding new computer code were developed to simulate commutator wear as a function of operating time, and several design and operating parameters for this APU. This new analysis code was used to simulate commutator time-dependent radial wear patterns around the commutator 360° arc of contact, specifically to study the influences of various parameters, including (a) initial as-manufactured commutator radial run-out and (b) imposed unit vibration. The results of these simulations strongly suggested that the root cause of the uneven commutator wear problem was excessive unit vibration imposed by the small 60,000rpm gas turbine that connects to the APU's 12,000rpm DC starter-generator through a planetary-gear 5:1 speed reducer. Subsequent vibration information from the turbine manufacturer confirmed this conclusion and the commutator wear problem thereby eliminated by curing the root cause of the turbine rotor vibration. The turbine manufacturer's fix was a change in material for the turbine rotor axial retaining bolt to eliminate a severe bolt material creep phenomenon that allowed the turbine rotor to become loose in operation. Implementation of this turbine fix in the fleet resulted in elimination of the commutator uneven wear problem. Clearly, it was thereby determined not to be a deficiency in the DC starter-generator manufacturer's product but a deficiency in bolt material of the turbine manufacturer's unit. This paper presents development and formulation of the commutator-brush dynamics-wear model analysis as well as simulation results that closely replicate wear measurements on excessively worn APU commutator units.

Keywords: APU, DC starter-motor, commutator wear, turbine bolt creep, vibration