3. CONCLUSIONS

3.1 Findings

1. The airplane was certificated, equipped, and maintained in accordance with Federal regulations and approved procedures, although the Hamilton Standard model 14RF propeller does not comply with the purpose of the certification requirements of 14 CFR Section 35.21 because of unforeseen failure modes that result in the propeller blade angle going below the flight idle position.

2. There was no failure or malfunction in the airplane, its systems or power-plants that contributed to the accident prior to loss of propeller control.

3. The flightcrew was certificated, experienced and qualified for their respective duties.

4. Events in the lives of the captain and the first officer during the **3-day** period prior to the accident did not adversely affect their performance on the accident flight.

5. The left propeller blade angle at the time of impact was about 3 degrees, which is below the range for normal flight. The right propeller blade angle was above the flight idle low pitch stop.

6. The left propeller actuator did not respond to a PCU action to increase blade angle because the PCU quill spline teeth were severely worn and could not engage the transfer tube spline.

7. The titanium-nitrided coating on the transfer tube was selected to improve manufacturing efficiency compared to the originally certificated nitrided transfer tube.

8. Hamilton Standard's engineering analysis and testing of the titanium-nitrided transfer tube indicated that the use of this coating would not compromise the safety of the propeller system.

9. Mechanical wear of the transfer tube, quill, or servo ballscrew was not considered a factor during the certification process due to the relatively low torque loading on these components and the manufacturer's analysis indicating that the propeller blade angle would go to the feather position if a failure occurred.

10. The extreme and rapid wear of the nitrided quill spline teeth was the result of the sliding contact with the harder **titanium-**nitrided surface of the transfer tube spline.

11. The left propeller blades moved to lower blade angles due to centrifugal and aerodynamic forces during the approach to the airport. The airplane became uncontrollable at the lower blade angles because of asymmetric lift and drag forces that exceeded the limits of the airplane's lateral control authority.

12. The pilots of flight 23 11 could not have prevented the accident.

13. During flight tests, the propeller blade angles decreased until restrained by the 22-degree safety stops with a disengaged ballscrew quill. Contrary to the FAA's fail-safe design requirements, the propeller system did not feather as predicted by the manufacturer's analysis and propeller simulation model.

14. Certification testing of the titanium-nitrided coated transfer tube, accomplished in a test cell, using a different engine than that certificated for the EMB-120, did not simulate the in-flight loads and vibration environment of actual service.

15. The titanium-nitrided transfer tube used in the certification testing had a relatively smooth surface finish on its splines and did not represent the range of possible finishes that could be expected in service.

16. The transfer tube, quill, and servo ballscrew were certificated without a requirement for periodic inspection.

17. Commuter air carriers, including **ASA,** use the reduced rest provisions of 14 CFR Part 135 to routinely schedule reduced rest periods in daily operations, contrary to the purpose of the regulation, which is primarily to allow for scheduling flexibility.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the loss of control in flight as a result of a malfunction of the left engine propeller control unit which allowed the propeller blade angles to go below the flight idle position. Contributing to the accident was the deficient design of the propeller control unit by Hamilton Standard and the approval of the design by the Federal Aviation Administration. The design did not correctly evaluate the failure mode that occurred during this flight, which resulted in an uncommanded and uncorrectable movement of the blades of the airplane's left propeller below the flight idle position.