

3. RECOMMENDATIONS AND CORRECTIVE MEASURES

By letter dated July 11, 1969, the Chairman of the Safety Board recommended to the Administrator of the FAA that the automatic switching of essential power to standby power upon loss of all generators be made a mandatory requirement for all turbine-powered aircraft. It was further recommended that until such time as the above requirement could be implemented throughout the industry, the emergency checklists for all airlines pertaining to "Loss of all Generators" require that the second officer, or captain if appropriate, check to assure that the battery switch is ON, then immediately switch essential power to the standby or emergency position. It was the Safety Board's view that this would give the captain the instruments and lights necessary to fly the aircraft while the second officer could "troubleshoot" the electrical system.

In his response of July 28, 1969, the Administrator stated that the FAA had been investigating electrical emergency operating procedures for some time and action was being taken to prescribe procedures for the B-727 consistent with Safety Board recommendations. 32/ With regard to automatic switching for essential flight instruments, the Administrator's letter referred to Sections 25.1309 and 25.1333 of Notice of Proposed Rule Making (NPRM) 68-18, which provide for the immediate availability of essential instruments after electrical failures and which apply to aircraft with a date of application for type certification after adoption of the proposed rule. For inservice aircraft, the FAA had issued NPRM 69-26 which provides for the installation in large turbojet-powered airplanes used in the air carrier service of a third independently powered attitude indicator. 33/ The Administrator expressed the belief that this action, combined with specified airplane flight manual emergency procedures, will provide for a satisfactory level of safety for inservice aircraft.

In order to remove any doubt as to the status of the standby system during a "Loss of all Generators" emergency, it is further recommended that the second officer on a B-727 be provided with a positive indication on

- 32/ The FAA issued an Airworthiness Directive, effective August 1, 1969, requiring revision of the Boeing 727 Airplane Flight Manual, Emergency Procedures Section, Loss of all Generators paragraph, to include procedures which would direct the flightcrew to switch to the standby power system, insure the battery switch is "ON", and reduce loads.
- 33/ The proposal embodied in NPRM 69-26 was adopted on January 8, 1970, and became effective on February 5, 1970, as Section 121.305(j) of the FAR, which requires that the additional attitude indicator be installed on all large turbojet aircraft after August 5, 1971.

his panel when the standby system is being powered from the battery. Such an indication could take the form of a light, such as that installed on the B-747 aircraft for the same purpose. The light would become illuminated when the standby system is activated. Another alteration which might be considered in connection with the foregoing recommendation would be the transfer of the standby feature from the essential power selector (4) switch to a separate ON-OFF toggle switch, which again is the arrangement on the B-747. The addition of such a switch would not *only* serve to simplify activation of the standby system, but would also facilitate troubleshooting the generators when the standby system is on.

The FAA also took several other actions relating to the subject accident. As a result of information developed during the early stages of the investigation, the FAA issued an Airworthiness Directive by telegram on January 31, 1969, requiring B-727 operators to provide a means to prevent inadvertent operation of the battery switch in those aircraft in which the battery switch is located within 10 inches of the galley power switch.

On August 1, 1969, the FAA proposed an Airworthiness Directive requiring the installation of a capacitor, in accordance with Boeing Service Bulletin No. 24-47 (March 3, 1969), for the purpose of filtering out electrical interference which may be present to a sufficient extent on some B-727 aircraft that, under an overloaded condition, the generator control panel may disable the generator before opening the bus tie circuit breaker.

On September 10, 1969, the FAA proposed an Airworthiness Directive which would require replacement of both silicon controlled switches CR 10 and CR 28 with a transistorized amplifier and a miniature two-pole relay on B-727 airplanes, in accordance with Westinghouse Service Bulletin 103, dated September 15, 1966. As a reason for this replacement, the FAA cited failures of the generator overload protection circuit silicon controlled rectifiers, causing a single generator system lockout on B-727 aircraft.

During the investigation, a considerable amount of attention was focused on the Minimum Equipment List (MEL) and, more specifically, on the question of whether the MEL, with regard to the required number of operative generators, was adequate in light of the subject accident. The MEL for the E727 was established through extensive ground and flight testing, after which it was agreed through meetings with the involved parties, including the FAA, Boeing, and United, that the aircraft would be airworthy with two generators. An additional margin of safety was provided by the standby system, through which electrical power could be supplied from the battery to those instruments and components necessary to enable the pilot to make an approach and landing under instrument conditions. The third generator was included on the B-727, not as a

matter of safety, but rather to enhance schedule dependability. For example, if one of the three generators should become disabled, the aircraft would still be able to operate without delay through small fields which lack the maintenance capability to repair an inoperative generator.

Subsequent to certification, the B-727 electrical system has been altered in minor respects *only*, which primarily involved changes in procedures rather than increases in loading. Furthermore, the flight tests conducted after the accident substantiated the ability of the aircraft to carry design loads during one and two generator operation. Finally, and perhaps most importantly, the fact that Flight 266 departed with one generator inoperative cannot be classified as a causal factor in the accident. The shutdown of the No. 1 engine, the **loss** of the No. 2 generator, and the nonactivation of the standby system are **all** unrelated to the No. 3 generator in terms of cause.

In view of the foregoing, the Board believes there is no basis upon which to recommend that the MEL for the B-727 be revised to require that **all** three generators be operative. At the same time, we believe **that** repairing components beyond those required by the MEL, as soon as practicable, is consistent with sound maintenance and engineering practices. Furthermore, it can even be said **that** maintaining such components in operating condition has the added effect of enhancing safety, inasmuch as it increases the available degree of redundancy.

Finally, a brief comment is warranted concerning the overall electrical system on the B-727. Recommendations have been made and corrective measures adopted, as described hereinabove, to correct those discrepancies and procedures uncovered during the investigation which **might** have contributed to the accident. The Board believes **that** these steps should go a long way toward preventing the occurrence of a similar accident. At the same time, we recognize **that** effective prevention is limited by the fact that the lack of physical evidence has not allowed a conclusive determination of why the No. 2 generator was lost and why the standby system was not activated or failed to function. Our concern in this instance is increased by the several incidents subsequent to the accident involving loss of all three generators on B-727 aircraft. Despite the generally excellent performance history of the B-727 electrical system, the possibility remains, unless and until the reasons underlying these