Scientific studies show that the X-band frequency radar is comparatively susceptible to attenuation by water vapor and precipitation. This may be particularly true when precipitation covers the antenna radome. If a pilot fails to consider this limitation, he may misinterpret the display in the process, which is a significant reason why airborne radar should not be used as a storm penetration aid. For maximum effectiveness, interpretation of X-band radar displays should be accomplished when the aircraft is in areas free of water vapor or precipitation.

For local service carriers operating on short flights, such as Southern Airways, radar display interpretation can be critical. As demonstrated in this accident, the aircraft can frequently be in precipitation much of the flight. Therefore, flightcrew training on the limitations of the airborne radar is vital. Since little was contained in the Bendix manuals about the effects of attenuation on the RDR-1E radar, the flightcrew of Flight 242 may not have been fully aware of these limitations. We believe, therefore, that existing airborne radar should not be relied on exclusively for severe weather detection under these circumstances.

3. CONCLUSIONS

3.1 Findings

1. Flight 242 penetrated a severe thunderstorm between 17,000 and 14,000 ft near Rome, Georgia, while en route from Huntsville, Alabama, to Atlanta, Georgia.

2. The ingestion of intense rain and hail into N1335U's engines caused the rotational speed of both engines to decrease below the engine-driven electrical generator operating speeds, and resulted in normal electrical power interruption for 36 secs.

3. Rotational speed on at least one engine increased sufficiently to restore its generator to operation and provide normal electrical power.

4. The rotation speed of one or both engines was probably increased by advancement of the thrust lever(s).

5. Shortly after the initial loss of rotational speed, both engines' high-pressure compressors began to stall severely.

6. The stalls probably resulted from a change in high-pressure compressor operating characteristics induced by trust lever advancement and ingestion of massive quantities of water.

7. The severe compressor stalls produced an overpressure surge which deflected the compressor blades forward in the sixth stage of the low-pressure compressors; these blades clashed against the fifth-stage stator vanes and broke pieces from the blades and vanes.

8. Pieces of blades and stator vanes were then ingested into the high-pressure compressors and damaged them severely.

9. Continued high thrust settings following the severe damage to the high-pressure compressors probably caused severe overheating in the turbine sections of both engines, and the engines ceased to function.

10. Normal electrical power was again lost for 2 min 4 sec until the APU-driven generator restored electrical power.

11. After the engines failed, an accident was probably inevitable because Southern Airways' flightcrews had not received, nor were they required to receive, training or information on emergency landings with all engines inoperative.

12. Before departing Huntsville, the flightcrew of Flight 242 had no information on thunderstorms immediately west of the Rome VOR.

13. While en route to the Rome VOR, the flightcrew received no information on the existence of the storms immediately west of the Rome VOR except for the indications displayed on their airborne radar system.

14. Based on information from the airborne radar, the captain of Flight 242 initially decided that the storms just west of the Rome VOR were too severe to penetrate.

15. Shortly after his initial assessment of the storm system, the captain decided to penetrate the storm area near the Rome VOR.

16. Insufficient evidence precluded a positive determination regarding the possible effects of fatigue on the flightcrew's reactions and decisions.

17. The captain's decision to penetrate the storm area was probably based on his interpretation of the weather radar display.

18. At least 20 min before Flight 242 departed Huntsville, the NWS had identified by radar the precipitation in the Rome area as very strong and intense with indications of hail and cloud tops over 40,000 ft.

19. Southern Airways' flight dispatch personnel did not monitor adequately the storm system which moved into the Rome area, and the information that the dispatch section provided to Flight 242 did not alert the flightcrew to the weather hazards along their route.

20. The Atlanta Center controllers had insufficient information about the storm system in the Rome area.

21. Atlanta Center's surveillance radars were of limited value in displaying severe weather systems.

22. The Atlanta Center controllers acquired limited knowledge of the storm system in the Rome area from the surveillance radar.

23. The Atlanta Center controllers provided no information to Flight 242 about the storm system in the Rome area, and the flightcrew of Flight 242 did not request any information from the controllers.

24. The accident was partially survivable.

25. The flight attendants acted commendably for initiating a comprehensive emergency briefing of the passengers for their protection in preparation for a crash landing. This contributed to the number of survivors.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the total and unique loss of thrust from both engines while the aircraft was penetrating an area of severe thunderstorms. The loss of thrust was caused by the ingestion of massive amounts of water and hail which in combination with thrust lever movement induced severe stalling in and major damage to the engine compressors.

Major contributing factors included the failure of the company's dispatching system to provide the flightcrew with up-to-date severe weather information pertaining to the aircraft's intended route of flight, the captain's reliance on airborne weather radar for penetration of thunder storm areas, and limitations in the Federal Aviation Administration's air traffic control system which precluded the timely dissemination of real-time hazardous weather information to the flightcrew.

4. RECOMMENDATIONS

As a result of this accident, the Safety Board, on September 27 and September 28, 1977, recommended that the FAA:

"Expedite the development and implementation of an aviation weather subsystem for both en route and terminal area environments, which is capable of providing a real-time display of either precipitation or turbulence, or both, and which includes a multiple-intensity classification scheme. Transmit this information to pilots either via the controller as a safety advisory or via an electronic data link. (Class II - Priority Followup) (A-77-63)

"Establish a standard scale of thunderstorm intensity based on the NWS' six-level scale and promote its widespread use as a common language to describe thunderstorm precipitation intensity. Additionally, indoctrinate pilots and air traffic control personnel in the use of this system. (Class II - Priority Followup) (A-77-64)

"Transmit SIGMET's more frequently on navaids so that pilots can receive more timely information about hazardous weather. (Class II - Priority Followup) (A-77-65)

"Code, according to geographic applicability, Severe Thunderstorm Bulletins and Tornado Watch Bulletins issued by the National Severe Storms Forecast Center so that they may be transmitted to appropriate air traffic control facilities by the FAA Weather Message Switching Center; thus, air traffic control facilities can relay the earliest warning of severe weather to flightcrews. (Class II - Priority Followup) (A-77-66)

"Require that each air traffic control facility depict on the map portion of its radar displays, those airports immediately outside of that facility's jurisdiction to the extent that adjacent facilities depict those airports on their displays. (Class II - Priority Followup) (A-77-67)