## 2.2 Conclusions

### a. Findings

1. The flight operated without reported difficulty and in a routine manner until the diversion to Dulles Airport from Washington National Airport was approved.

2. The crew of Flight 514 reviewed the approach chart for the VOR/DME approach to runway 12 at Dulles several times before beginning the approach.

3. The Washington Air Route Traffic Control Center controller vectored the flight to intercept the 300° radial of the Armel VOR at a point about ~~80 nmi~~ from the VOR. This portion of the radial was not part of the published instrument approach.

4. The crew of Flight 514 intercepted the radial and tracked inbound on it, and control of the flight was passed to the Dulles approach controller.

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~~13~~/ Subsequent to the accident the FAA amended 14 CFR 91.75(a) to reemphasize that "If a pilot is uncertain of the meaning of an ATC clearance, he shall immediately request clarification from ATC."

5. The Dulles approach controller cleared the flight for a VOR/DME approach to runway 12 when the aircraft was about 44 nmi from the airport. The clearance contained no altitude restrictions.

6. The captain assumed that the flight could descend to 1,800 feet, immediately. The first officer, who was flying the aircraft, initiated an immediate descent to 1,800 feet.

7. The flight encountered icing and turbulence during the descent. Neither of these conditions should have appreciably endangered or restricted the control of the aircraft, but contributed in the apparent inability of the crew to arrest the descent at 1,800 feet,

8. The first officer allowed the aircraft to descend below the target altitude of 1,800 feet and did not take sufficient corrective action to regain and maintain that altitude.

9. The first officer's altimeter was set properly.

10. It is possible that wind velocity over the hilly terrain may have induced an altimeter error which could have caused the instrument to indicate that the aircraft was higher than its actual altitude. However, the crew's last comments regarding altitude indicated that they knew they were below 1,800 feet.

11. The altitude alerting system and the radio altimeter aural warnings sounded at appropriate altitudes to indicate to the pilots that the aircraft was below 1,800 feet and that the aircraft was within 500 feet and 100 feet of the ground. These latter warnings occurred 7 seconds and 1 second, respectively, before impact.

12. The flightcrew apparently did not have sufficient time to avoid the accident after these warnings.

13. The approach clearance was given to the flight without altitude restrictions because the flight was not being handled as a radar arrival and because the controller expected the crew to conduct the approach as it was depicted on the approach chart.

14. Procedures contained in FAA's Terminal Air Traffic Control Handbook were not clear and resulted in the classification and handling of TWA 514 as a "nonradar" arrival. The terms "radar arrival" and "nonradar arrival" were not defined.

15. In view of the available ATC facilities and services and since the flight was receiving radar service in the form of radar monitoring while under the jurisdiction of a radar approach control facility, the procedure should have provided for giving altitude restrictions in an approach clearance for an aircraft operating on an unpublished route prior to its entering a segment of the published approach procedure.

16. The ATC system was deficient in that the procedures were not clear as to the services the controllers were to provide under the circumstances of this flight.

17. The flightcrew believed that the controller would not clear them for an approach until they were clear of all obstructions.

18. The depiction on the profile view of the approach charts neither indicated the position of Round Hill intersection nor did it contain all minimum altitudes associated with the approach procedure. This information was available on the plan view of the approach chart.

19. The captain noticed the minimum altitude associated with the approach segment from Front Royal to Round Hill but he decided that the flight could descend to 1,800 feet without regard for the 3,400-foot minimum altitude depicted on the chart because he was not on that segment.

20. The captain of Flight 514 did not question the controller after receiving the approach clearance, regarding the action the flightcrew was expected to take. Another crew that questioned a similar clearance received further instructions and information which resulted in their accepting a radar surveillance approach to Dulles.

21. Both military and civil aviation officials for several years had indicated concern regarding a lack of understanding on their part of what the Air Traffic Control procedures and terminology were intended to convey to the pilots. They were also concerned about the possibility of misunderstandings which could result in pilots descending prematurely.

22. The FAA was not responsive to the long standing, expressed needs and concerns of the users of the Air Traffic Control System with regard to pilot/controller responsibilities pursuant to the issuance of an approach clearance for a nonprecision approach. Furthermore, the FAA did not provide users of the Air Traffic Control System with sufficient information regarding the services provided by the system under specific conditions.

23. The FAA did not utilize the capability of the ARTS III system to insure terrain clearance for descending aircraft conducting nonprecision instrument approaches in instrument meteorological conditions.

24. The flightcrew of Flight 514 was not familiar with the terrain west and northwest of Dulles. However, they did have information regarding the elevation of obstacles west of Round Hill intersection depicted on the plan view of the approach procedure.

b. Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the crew's decision to descend to 1,800 feet before the aircraft had reached the approach segment where that minimum altitude applied. The crew's decision to descend was a result

of inadequacies and lack of clarity in the air traffic control procedures which led to a misunderstanding on the part of the pilots and of the controllers regarding each other's responsibilities during operations in terminal areas under instrument meteorological conditions. Nevertheless, the examination of the plan view of the approach chart should have disclosed to the captain that a minimum altitude of 1,800 feet was not a safe altitude.

Contributing factors were:

(1) The failure of the FAA to take timely action to resolve the confusion and misinterpretation of air traffic terminology although the Agency had been aware of the problem for several years;

(2) The issuance of the approach clearance when the flight was 44 miles from the airport on an unpublished route without clearly defined minimum altitudes; and

(3) Inadequate depiction of altitude restrictions on the profile view of the approach chart for the VOR/DME approach to runway 12 at Dulles International Airport.