Failure of Return to the Earth of Space Shuttle 'COLUMBIA'

Feb. 1st, 2003, High Above Texas

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(Summary)

Space shuttle Columbia disintegrated in midair over Texas while it was returning to the earth after killed. (See, Fig. 1) This became the second tragedy in the 113 flights of the Space Shuttles, the first tragedy being the midair explosion of Challenger soon after the lift-off in January 1986. The Independent Accident Investigation Committee concluded that damage that had occurred to the leading edge of the left wing at the moment of lift-off was the cause of the accident.

1. Components

Space Shuttle Columbia was the first space shuttle launched by NASA. The first flight was made in April 1981. The flight on February 1st, 2003 was her 28th flight. The total flight time was to be 284 days, 19 hours and 19 minutes. The shuttle had been repaired in the spring of 2002 at the maintenance field to fix a liquid H_2 leak that had occurred in 1999. Columbia was the space shuttle that carried Mrs. C. Mukai, the first Japanese woman astronaut, in 1994 and Mr. T. Doi in 1997.

2. Event

Columbia was launched on January 16th, 2003 from Kennedy Space Center. Seven crew, led by captain Rick Husband, were on board. The crew carried out the scientific experiments that comprised their mission while on the orbit around the earth for sixteen days.

The scheduled time for landing at the space center was 9:16 February 1st. However, contact with the control center at Johnson Space Center was lost about a half an hour before the designated landing time. At the same time, all data on its flight condition were not received thereafter.

At around 9 am, small glittering pieces like meteors were observed from the ground, and some wreckage from the space shuttle was also recovered in Texas afterward. Then it was concluded that Columbia had disintegrated in midair.

3. Course

Just after lift-off, a piece of the insulator of the external fuel tank came off and hit the leading edge of the left wing of the orbiter. (See, Fig. 2) At that time, NASA made the following statement in a press interview: "There is no problem and the space shuttle will land as scheduled".

Regarding the communication between the control center and the space shuttle at that time, NASA officially announced on June 30th that the flight director of Kennedy Space Center had sent following message to captain Rick Husband on January 23rd, a week after lift-off: " A block of insulator hit the

leading edge of the left wing of the orbiter. However, from photographic analysis, we have concluded that there has been no harmful effect on the insulation properties of the orbiter." The captain's reply was simply "Thank you".

4. Cause

The Independent Accident Investigation Committee issued its final report on 26th of August, 2003. The report concluded that damage to the left wing of the orbiter at the moment of lift-off was the initial cause of the accident. The report also concluded that NASA's lack of attention for safety was another cause. As a condition for resuming the space shuttle flights, the Committee advised twenty-nine items for revision in order to prevent the recurrence of the accident.

On January 16th, about eighty seconds after lift-off, a piece of the insulator of the external fuel tank came off and hit the leading edge of the left wing of the orbiter with the speed of 850 km/h. It was concluded that the orbiter disintegrated at the moment of reentry on February 1st, because air with very high temperature blew in from the damaged area.

Although pieces of insulator had fallen off frequently in the past, NASA ignored many concerns raised by people about the possible damage that could occur and did not take any steps to cope with the issue. The Committee severely criticized NASA's attitude, stating that this failure to cope with the issue was one of the main factors contributing to the accident.

5. Immediate Action

The final report by the Independent Accident Investigation Committee concluded that the widespread reduction in attention to the mission safety issue by NASA was due in part to budget cuts and high priority placed on keeping to the launching schedule.

The report advised that an independent section should be set up to supervise the safety of the flight plan, maintenance situation and other critical parts of the space shuttle operation.

6. Countermeasure

The final report by the Independent Accident Investigation Committee highlighted the following items in addition to the setting up the above-mentioned independent safety supervision section.

- Periodical inspection of the leading edge of the orbiter wings
- Photographing the moment of lift-off using a high sensitivity camera
- Observation of the orbiter in orbit utilizing a reconnaissance satellite
- Live coverage of the entire surface of the orbiter from reentry to landing using onboard cameras.
- Establishing a system to repair the space shuttle in orbit

The administrator of NASA made a statement that they would do everything in their power to follow the recommendations given in the report.

7. Knowledge

Although pieces of insulator had fallen off frequently in the past, NASA did not take any actions to cope with the issue. This failure to cope with the issue was apparently a part of a widespread tendency in NASA to place higher priority on keeping the schedule than on safety issues.

The accident of the Space Shuttle Columbia can be summarized by the tendency to place higher priority not on quality but on profits, which is a typical kind of failure of enterprise management.

8. Sequel

On February 19th, 2004, NASA announced that they would reserve another space shuttle on the ground to comply with the emergency, when the project resumed. This is the first example in the history of the shuttle project of a back-up system for assuring that the crew would be able to avoid serious problems in space.

As a countermeasure for the accident of Columbia in February 2003, NASA hurried to establish a system for inspecting and repairing the fuselage of the orbiter at the International Space Station (ISS) that is in orbit 400km above the earth.

However, if the problems are beyond the scope of repairs that can be done by the ISS, there is no other alternative to the rescue by another Space Shuttle launched from the earth. NASA concluded that it is necessary to reserve a space shuttle for rescue of stranded crew, before the food, water and oxygen of ISS become depleted.

9. On the Side

On January 14th, 2004 President Bush announced a new ambitious strategy for space development. That is:

- The USA will complete the ISS project by the year 2010, thereby allowing the Space Shuttle Program to be retired. Research that had been carried out in the Space Shuttles, such as the effect of space flights on human health, will be continued on the ISS.

  ・The USA will begin the development of large-scale rockets and space ships. Unmanned test flights and manned flights will be started by 2008 and 2014, respectively. Although the primary objective of the project is to make possible the flight to outer orbit from the earth, the space ships will be able to play the role of transportation to the ISS, when the Space Shuttle is retired.
- In relation to the exploration to the moon, several unmanned lunar surveyors will be launched by the year 2008, and a lunar landing by manned vehicle is scheduled for sometime between 2015 and 2020. After that, the USA aims to construct a lunar base that can support long-term habitation.
- The USA aims to send surveyors to Mars and other planets using rockets launched from the lunar base.

These programs seemed to be rather ambitious proposals, particularly before the presidential election, requiring the huge amount of money that is necessary to pursue the programs.

However, it is possible that the failure of Columbia to return to earth may be the trigger that finalizes the retirement of the Space Shuttle Program.

10. Information Source

(1) Final Report, Independent Accident Investigation Committee on Space Shuttle 'Columbia', (Aug. 26, 2003).

11. Primary Scenario

01. Poor Value Perception
02. Poor Safety Awareness
03. Poor Sense of Risk
04. Insufficient Analysis or Research
05. Insufficient Prior Research
06. Lack of Evaluation/Revision
07. Usage
08. Operation/Use
09. Launching of Space Shuttle
10. Failure
11. Fracture/Damage
12. Coming out of Insulation material of External Fuel Tank
13. Damage of Left Wing Leading Edge
14. Usage
15. Operation/Use
16. Reentry of Space Shuttle
17. Failure
18. Large-Scale Damage
19. Flow-in of Ultra-high Temperature Air
20. Midair Disintegration
21. Loss to Organization
22. Economic Loss
23. Retirement of Space Shuttle
24. Damage to Society
25. Change in Perception
26. Loss of Credit to Science/Technology

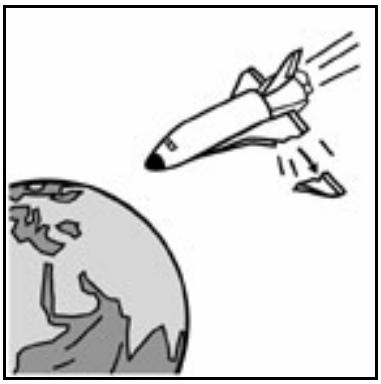

Fig. 1 Midair Disintegration of Columbia.

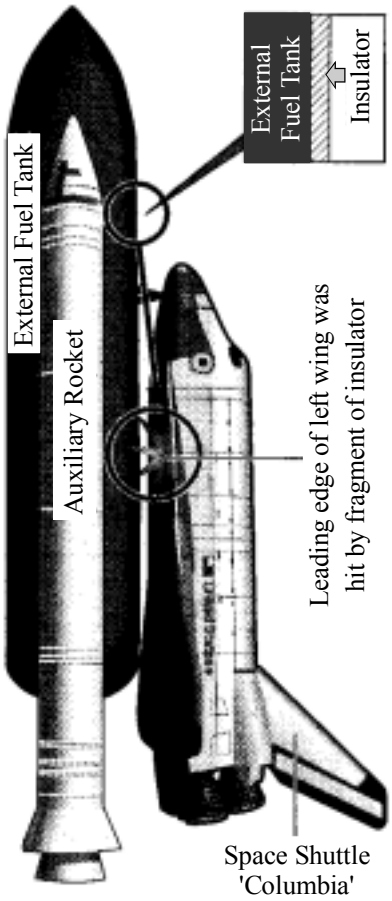

Fig. 2 Insulator Fragment of External Tank Hit the Leading Edge of Left Wing.