NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Washington, DC
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Debris Trajectory Study

Dennis Crider

A. ACCIDENT

Location:	New York, NY
Date:	September 11, 2001
Time:	Approximately 9:02 Local Time
Aircraft:	Boeing 767-200ER
Operator:	United Airlines Flight 175, Registration N612UA
NTSB#:	DCA-01-MA-063

B. GROUP

No Group was formed for this activity.

C. SUMMARY

On September 11, 2001 at approximately 9:02 AM local time, a Boeing 767-200ER, N612UA registered to and operated by United Airlines as flight 175 crashed into the South World Trade Center Tower. The aircraft had departed Boston Logan airport at approximately 8:14 AM in route to Los Angeles Ca. Visual meteorological conditions prevailed at the time of impact. The airplane was destroyed by impact forces and a post-crash fire. All aboard were fatally injured.

D. DETAILS OF INVESTIGATION

A photo was published on the Airliners.net web site that showed the path of an object coming out of the World Trade Center after the impact of American Airlines flight 175. This photo is displayed in figure 1. From the shape of the trajectory it was apparent that the object has a high ballistic coefficient (defined below) similar to the flight data recorders. Accordingly, it was desired to predict the impact point of this object in the hopes that the flight recorder might be found nearby.

Figure 1: Picture showing debris path

The path of a ballistic object[1] is determined by its initial velocity (speed, heading and flight path angle), its initial position (East, North, and height) and its ballistic coefficient[2]. The initial position used for the trajectory study was the Northeast corner of the South World Trade Center building. An initial altitude of 1109 ft was used based on the impact floors.

[1] An object that falls without a stable lift vector.
[2] Ballistic coefficient is defined as Weight/(drag coefficient x area)

The photograph indicated that the initial flight path angle was nearly level so a zero flight path angle was used. Though impact speed was known from radar and video analysis, it was not possible to account for speed and heading changes as the aircraft passed through the building. Accordingly, speed was found through iteration to match the path recorded in the photo. The position of a point along this path (at the left edge of the photo) was obtained and used as a reference point for this iteration. Since both speed and ballistic coefficient were unknown, the shape of the trajectory in the photo and the picture point were matched iterating on ballistic coefficient and speed. The results of the iteration are shown in figure 2 which shows a result based on a 120 Kt initial speed. The low trajectory in this figure corresponds to a ballistic coefficient of 40 while the high trajectory in this figure corresponds to a ballistic coefficient of 60.

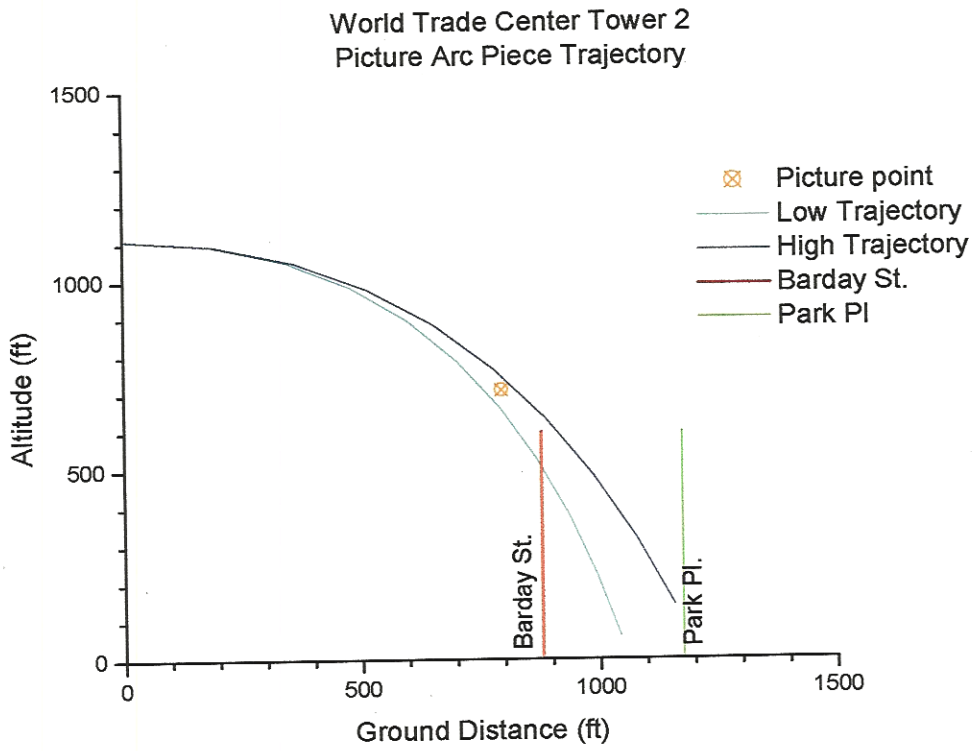

Figure 2: Trajectory solution

The ground track of the airplane at impact was known from the radar study[3]. The ground track from the radar is extrapolated past the impact site in figure 3. The change in the ground track due to the impact is unknown.

[3] See Radar Data Impact Speed Study (AA11 & UA 175) by Dr. Dan Bower, Feb, 7, 2002

Figure 3: Extrapolated ground track

[redacted]

Dennis Crider
National Resource Specialist
Aircraft Simulation