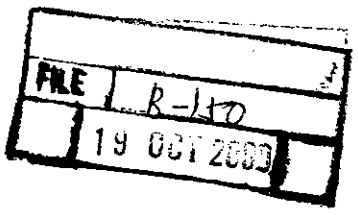
The Boeing Company
P.O. Box 3707
Seattle, WA 98124-2207

13 October 2000
B-H200-17074-ASI



Mr. Y. K Leung
Civil Aviation Department
10/F Commercial Building
Airport Freight Forwarding Centre
2 Chun Wan Road
Chek Lap Kok
Hong Kong

BOEING

Subject: Sink Rate Calculations - China Airlines MD11 B-150 Accident Hong Kong – 23 September 1999

Reference: E-mail Jim Adams to Rick Howes, item ii, 25 September 2000

Dear Mr. Leung:

Per the reference request, the following provides the methodology used to calculate the sink rate of the subject airplane. The sink rate calculation uses an Adams-Bashforth 2-integration scheme, starting 35 seconds before the airplane contact with the runway. The initial sink rate is determined by using the change in radio altitude over one second. When the initial sink rate has been established, the vertical acceleration is integrated using the following equations from the Adams-Bashforth 2-integration scheme:

$$Vz(1) = radalt(2) - radalt(1)$$
$$Vz(i) = vz(i-1) + (1.5 * nz(i) * g - 0.5 * nz(i) * g) * dt$$

Where vz is the sink rate, nz is the vertical acceleration – 1, g is the gravitational acceleration of 32.2 ft/s^2, and dt is the time difference between samples.

A script was created to loop through these calculations to develop a time history of the sink rate for the final 35 seconds of the flight. Since the impact (right main landing gear contact with runway surface) sink rate is dependent on the value used for the starting sink rate, the starting point is moved forward by one second and the sink rate is recalculated using the new starting point.

To verify the calculated sink rate is accurate, it is integrated to calculate the radio altitude. This calculated radio altitude is then compared with the radio altitude recorded on the DFDR. Any difference in these values is corrected by adding a bias to the vertical acceleration and recalculating the sink rate and radio altitude.

A calculated sink rate of approximately 18 feet per second was determined using the above methods for this accident. The attached plots show the sink rate calculations for each of the starting points, which is approximately 18 feet per second. The second plot shows the radio altitude calculations with the recorded radio altitude (raw and adjusted for terrain height).

If you have any further questions, please do not hesitate to contact me.

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Very truly yours,

for: Ronald J. Hinderberger
Director, Airplane Safety
Org. B-H200, MC 67-PR
Telex 32-9430, STA DIR AS
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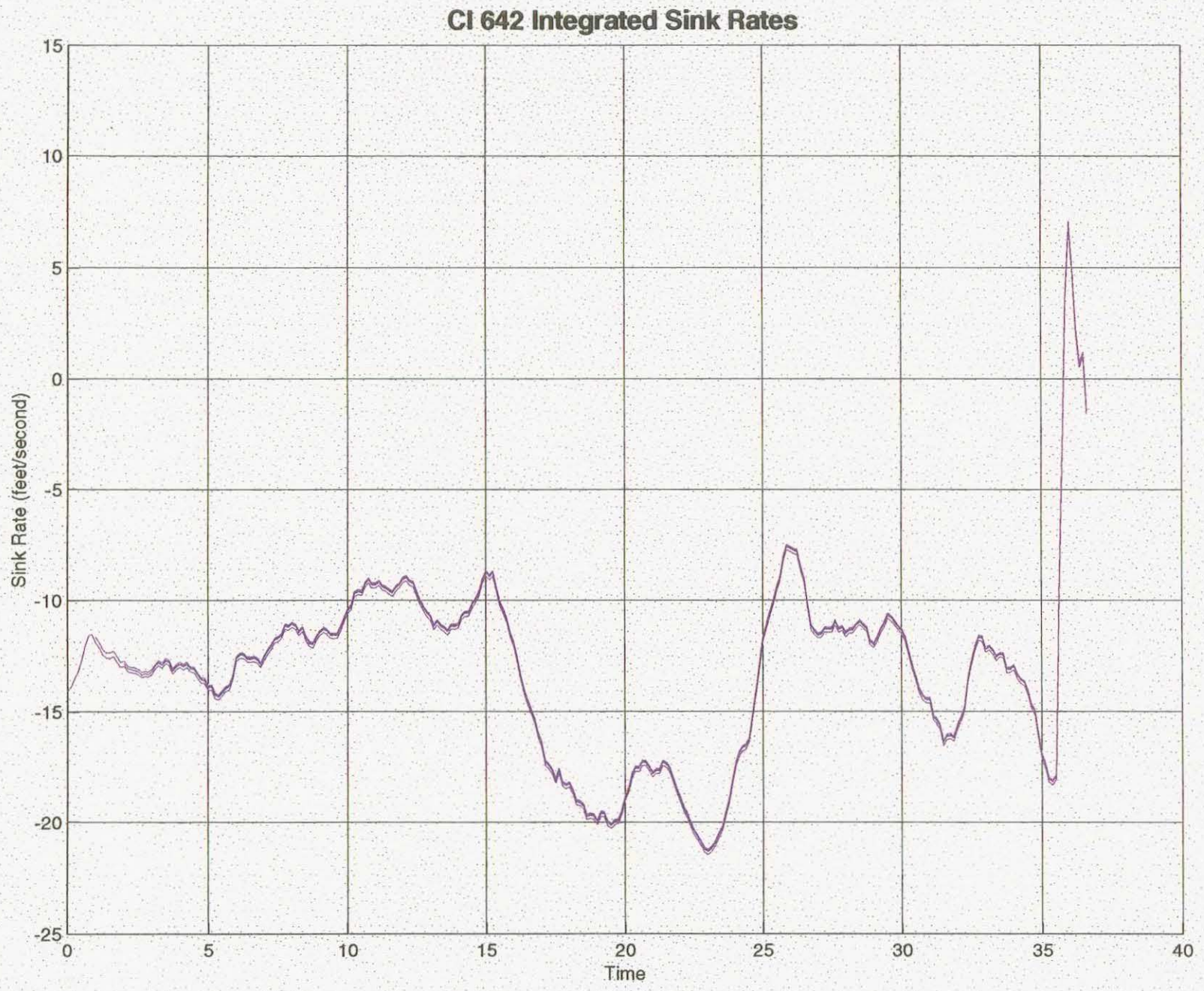
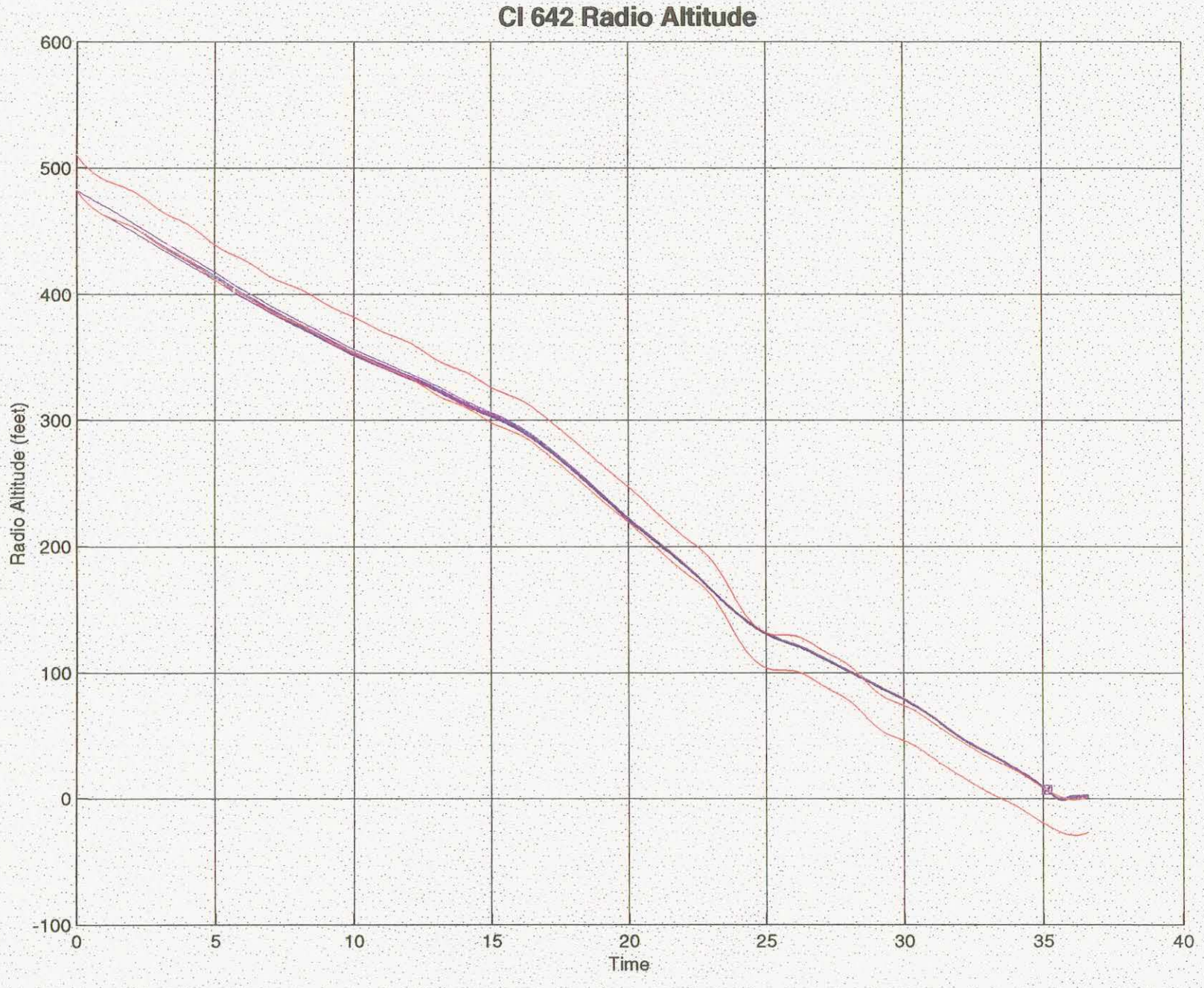
Encl:

- Boeing Figure 1, C*HI 642 Integrated Sink Rates*, and Figure 2, *CHI 642 Radio Altitude*

cc: Mr. Bob Benzon, NTSB, AS-10 (for Mr. John O'Callaghan)
Dr. Kay Yong, Taiwan ASC,
Captain Samson Yeh, China Airlines


CI 642 Integrated Sink Rates
Sink Rate (feet/second)
15
10
5
0
-5
-10
-15
-20
-25
0
5
10
15
20
25
30
35
40
Time


CI 642 Radio Altitude
Radio Altitude (feet)
600
500
400
300
200
100
0
-100
0
5
10
15
20
25
30
35
40
Time