



**Aviation Safety Council
Taipei, Taiwan**

**SQ006 Accident Investigation
Factual Data Collection
Group Report**

Ground Operation Group

**February 21, 2001
ASC-FRP-01-01-002**

I. Team Organization

Chairman:
DAVID LEE Aircraft Accident Investigator, ASC
Members:
1. SEAN HSU Air Safety Engineer, ASC
2. JOSEPH M. SEDOR Aerospace Engineer, NTSB
3. SIMON LIE Air Safety Investigator, BCAG
4. IVAN NEO SEOK-KOK Senior Manager Quality, SIAEC
5. LECK TEA KIANG Base Maintenance Supt, SIAEC
6. CHARLES CHONG Manager Quality, SIAEC
7. CHOW HOCK LIN Quality Superintendent, SIAEC
8. LEONG CHEE CHEW Asst Manager Quality, SIA
9. KONG CHAN CHEW Technical Manager, SIA

ASC – Aviation Safety Council, Taiwan, R.O.C.

NTSB – National Transport Safety Board, United States of America

BCAG – Boeing Commercial Airplanes Group, United States of America

SIA – Singapore Airlines, Singapore

SIAEC – SIA Engineering Company, Singapore

II. History of Activities

Date	Activities
10/31/00~ 11/01/00	<p>Notification</p> <ol style="list-style-type: none">1. 2317 hours local time - Accident occurred2. 2340 hours - Notified by duty officer3. 0020 hours - Arrived at accident site
11/01/00~ 11/08/00	<p>Site survey</p> <ol style="list-style-type: none">1. Aerial photography2. Wreckage identification3. Wreckage distribution area mapping4. Tire track mapping5. Deflation of stored energy devices on the site.6. Structure failure analysis
11/09/00~ 11/12/00	<p>Wreckage removal</p> <ol style="list-style-type: none">1. Wings and tail section of wreckage were cut to smaller pieces to facilitate transportation.2. Engines, landing gears, door slides and tagged parts are kept in six 20-foot locked containers.3. All other parts were kept in an open and secured area.
2/02/01	<p>Technical review meeting</p> <ol style="list-style-type: none">1. ASC investigators and MCIT representatives reviewed and fine tuned the factual report.2. Group members attending the meeting agreed with the contents of the report by signature.

III. Factual Description

1.3 Damage to aircraft

The aircraft was completely destroyed by impact force and post-crash fire.

1.4 Other damage

The construction crew had left 6 units of ground equipment (ref. Table 1.4-1) on site of runway 5R, namely 2 excavators (Fig. 1.4-1,2), 2 vibrating rollers (Fig. 1.4-3,4,5), 1 small bulldozer (Fig. 1.4-6) and 1 air compressor. All 6 equipment suffered serious impact damage. With the exception of one excavator and the bulldozer, the rest of the equipment had been scattered from their original positions in the various pits.

Table (1.4-1) Ground equipment on site of runway 5R

Name	Unit	Qty	Length(M)	Width (M)	Height(M)
Excavator KOMATSU PC200-6	EA	1	4.15	2.65	2.75
Excavator KOMATSU PC200-5	EA	1	4.15	2.65	2.75
Bulldozer KOMATSU D21-A6	EA	1	3.35	2.3	1.5
Vibrating Roller SAKAI SW25	EA	1	3	1.23	1.65
Vibrating Roller KOMATSU JV100WA-1	EA	1	5.05	2.55	2.65
Air Compressor	EA	1	3	1.45	1.5



Fig. 1.4-1 Excavator (in No.5 pit)



Fig. 1.4-2 Excavator (in No.11 pit)



Fig. 1.4-3 Vibrating Roller (in pit No.11)



Fig. 1.4-4 Vibrating Roller



Fig. 1.4-5 Vibrating Roller



Fig. 1.4-6 Bulldozer (in pit No.11)

1.6 Aircraft Information

1	Aircraft Registration Mark	Singapore-registered 9V-SPK
2	Type of Aircraft	Boeing 747-412B
3	Manufacturer	Boeing Commercial Airplane Group
4	Manufacturer' s Serial Number	28023
5	Delivery Date	21 January 1997
6	Operator	Singapore Airlines Limited Airline House, 25 Airline Road, Singapore 819829
7	Owner	Singapore Airlines Limited Airline House, 25 Airline Road, Singapore 819829
8	Certificate of Registration Number	S151
9	Certificate of Airworthiness Number Validity Period	AWC431 21 January 2000 ~20 January 2001
10	Total Flight Hours	18459 hours (as at 29 Oct 2000)
11	Total Cycles	2274 cycles (as at 29 Oct 2000)
12	Last Maintenance Check	A Check
13	Last Maintenance Check Date	16 Sep 2000 @ 17838 flight hours / 2187 cycles
14	Hours / Cycles Elapsed Since Last Maintenance Check	621 flight hours / 87 cycles (as at 29 Oct 2000)

1.6.1 Weight and Balance

Weight and Balance calculations for SQ006 were performed by the China Airlines load agent at Taipei. ASC investigators reviewed load sheet for the accident flight and found that the aircraft Weight and Balance were within operational limits.

Dry Operating Weight:	187,334 kg
Payload:	31,327 kg
Zero Fuel Weight Actual:	218,661 kg
Max. Zero Fuel Weight Limit:	244,939 kg
Fuel on Board:	124,800 kg
Ramp Weight:	343,461 kg
Take Off Weight Actual:	342,461 kg
Max. Take Off Weight Limit:	396,200 kg
Estimated Weight at the time of Accident:	342,461 kg
Estimated Fuel at the time of Accident:	123,800 kg
MACTOW:	16.4 % MAC
Fore and Aft CG Limits:	8.5 ~ 33.0 % MAC

1.6.2 Maintenance Records

Aviation Safety Council investigators reviewed the Flight technical log book records covering a 3-month period from August 1, 2000 to October 31, 2000 (Appendices 5-8 and 5-9) . Review of the maintenance log books revealed no deferred or open items for the flight. The review also showed no evidence indicating that the aircraft was un-airworthy.

1.12 Wreckage and Impact Information

Ground survey of the wreckage field, including aircraft wreckage and ground marks were conducted from N1 through N8, and documented the marks made by the landing gear tires on the runway from the beginning of taxiway N1 through runway 5R threshold to the initial impact point.

The group contracted with a local survey company (Hunter Survey Company) to survey all runway marks, construction wreckage, and airplane wreckage using a differential GPS. Each point designated by the group to be surveyed was numbered and a short description assigned for future reference. A wreckage distribution chart was produced from the data collected from this

survey (Appendix 1.12-1, Wreckage Distribution Chart) .

The survey group was divided into two teams, each comprising a minimum of three people from MCIT advisors¹, two ASC members and the survey service support personnel – each covering one half of the runway breadth. The surveyed area along runway 5R extended from the threshold to the point where the forward fuselage came to rest and also beyond the edge of the paved area, stretching as far as any significantly sized debris resided (5 ft x 3 ft and larger).

A total of 396 pieces of wreckage was identified and logged with details of part numbers (where required or available), latitudinal and longitudinal co-ordinates. They were also individually photographed with designated identification markings (Appendix 1.12-2, Wreckage Identification List).

Except for parts that had been destroyed or consumed by fire, all major parts had been accounted for and identified.

1.12.1 Runway 5R

Runway 5R is a concrete non-grooved runway that had been undergoing repairs prior to the accident. The runway consists of individually poured concrete sections approximately 20 feet wide by 23 feet in length. Several of the concrete sections had been removed from the runway between N4 and N5 by the construction crew prior to the accident. The removed concrete sections formed 11 different pits that existed at the time of the accident. The group numbered each pit sequentially along the path of the airplane (Fig. 1.12.1-1).

Concrete jersey barriers had been set up around the construction site on

¹ MCIT(Ministry of Communications and Information Technology) advisers are from SIA and SIAEC.

runway 5R to close that section of the runway. Each jersey barrier is 32" high by 49" long. Dimension of the barrier is shown in Fig.1.12.1-2. There was a red light on the top of each jersey barrier around the perimeter of the construction area. One of these lights was found on the ground and was still operational when ASC investigators reached the site.



Fig.1.12.1-1 Removed Concrete Sections formed 11 different pits.

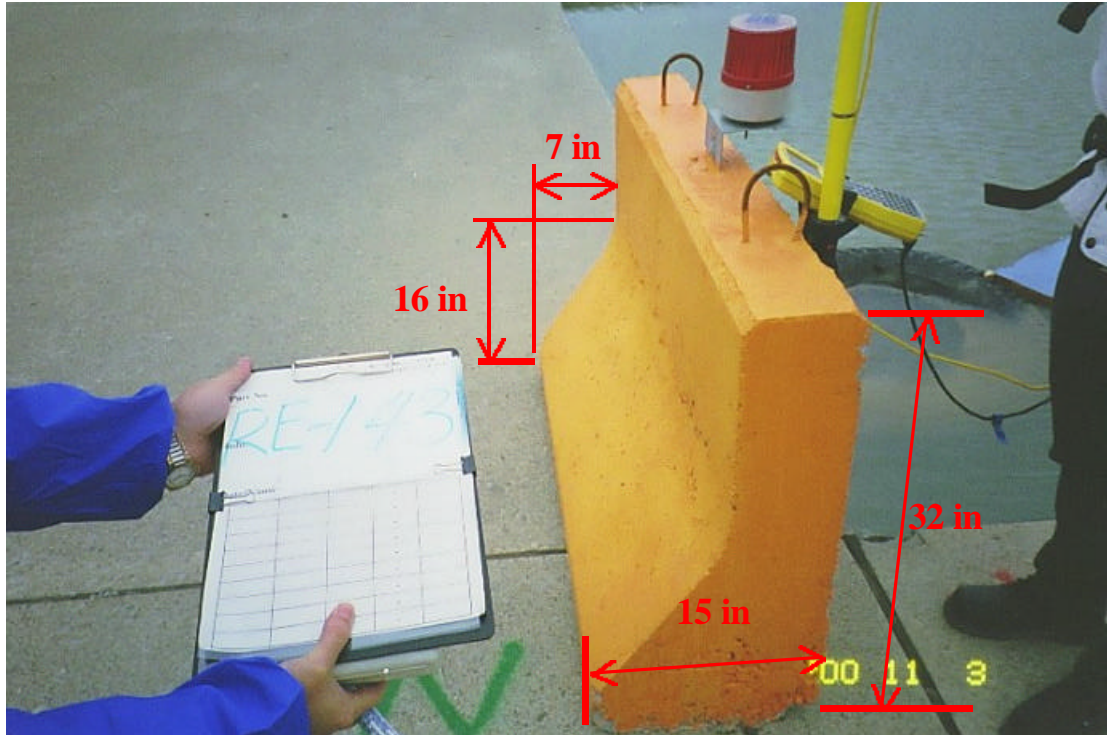


Fig.1.12.1-2 Dimension of jersey barrier

1.12.2 Wreckage Distribution and Impact Information

The aircraft wreckage was distributed along runway 5R (Fig. 1.12.2-1), beginning at initial impact point (Fig. 1.12.2-2) approximately 4,080 feet from the runway threshold. The airplane broke into two main sections at about fuselage Body Station 1560 and came to rest approximately 6,840 feet from the runway threshold. The left and right wings remained attached to the forward fuselage section, which came to rest on a heading of approximately 085°. The tail section (aft of Body Station 1560) was found upright on a heading of approximately 40°. It was reported that this section had been moved by the rescue personnel and high winds, and that the original orientation was on a heading of approximately 130° resting on its left side (Fig. 1.12.2-3,4,5). The rest of the major components were scattered along runway 5R (Fig. 1.12.2-1).



Fig.1.12.2-1 Wreckage and Airport Related Location

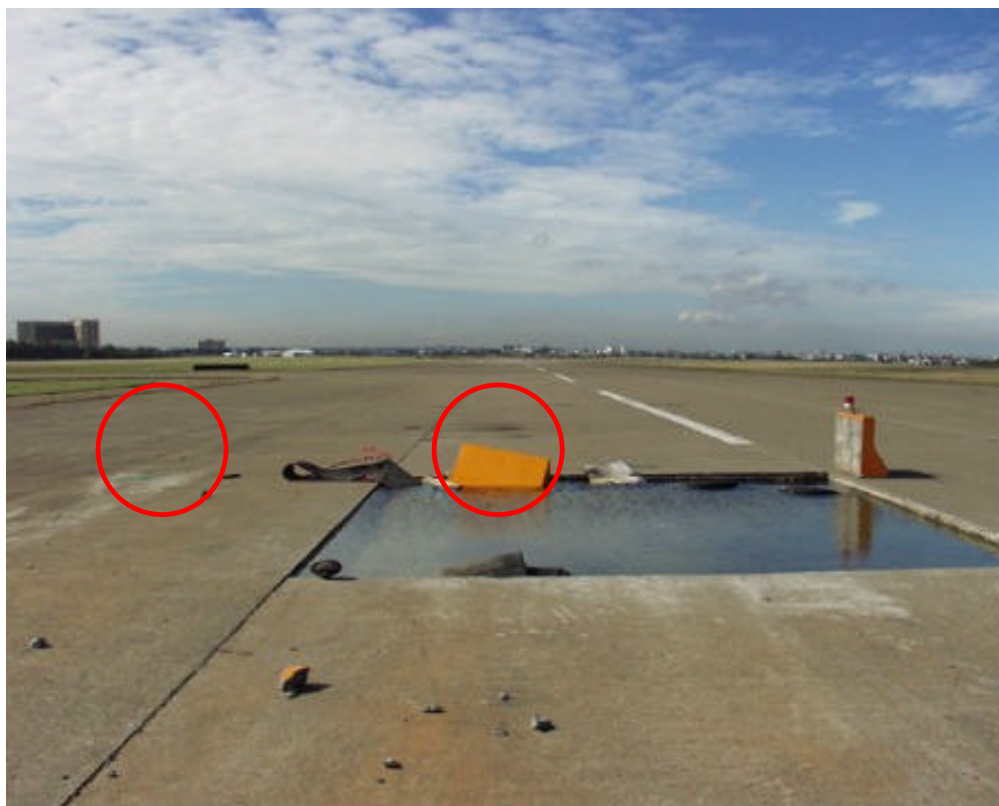


Fig. 1.12.2-2 Initial Impact Point (Shown circled)



Fig1.12.2-3 Wreckage Distribution from Beginning

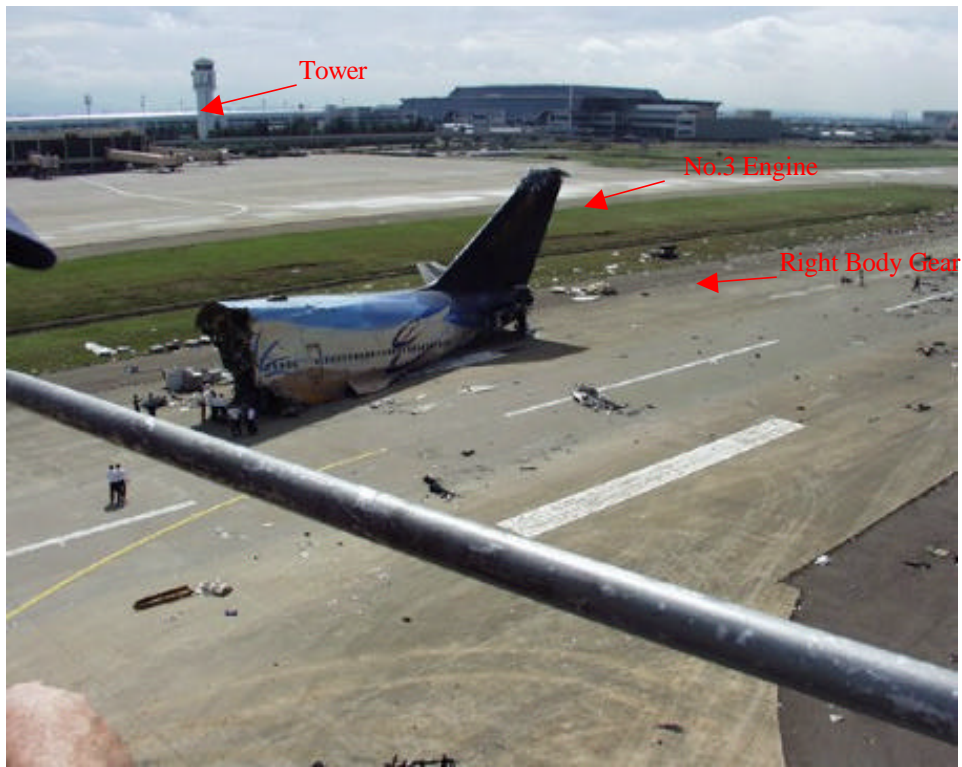


Fig. 1.12.2-4 Wreckage Distribution towards the End

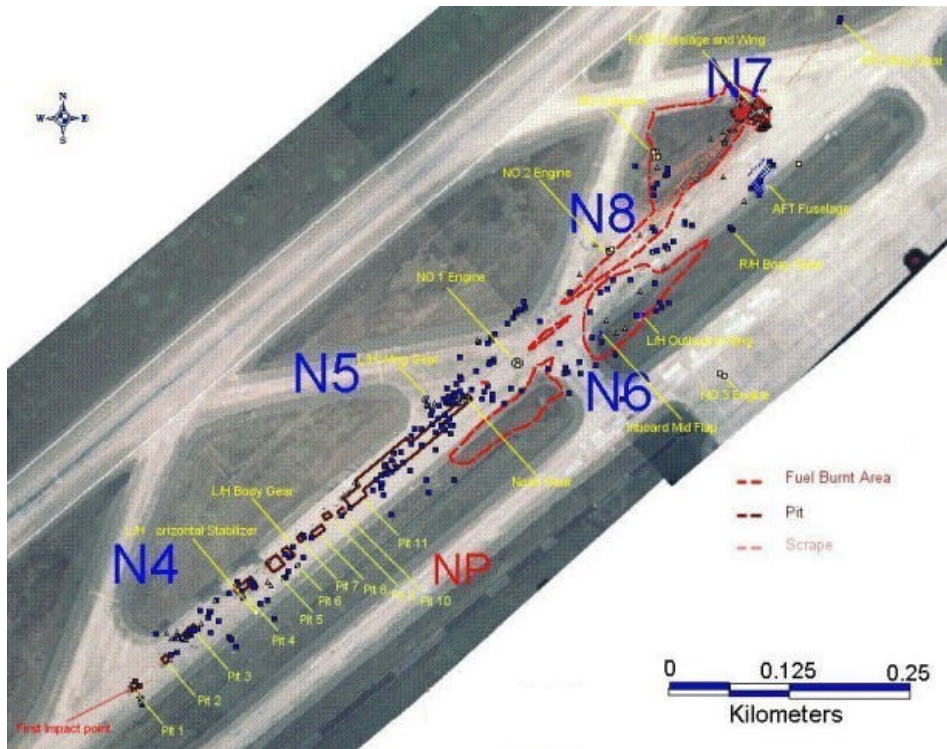


Fig. 1.12.2-5 Major Components Distribution and Construction Pits, Post-fire Zone Related Location

Table (1.12.2-1) Major Components Distribution Location

A/C Components	Lat.	Lon.	Alt.
LW gear	25-04'53.44537"N	121-13'47.19523"E	42.352
LB gear	25-04'48.30244"N	121-13'42.03626"E	42.096
RB gear	25-04'59.50242"N	121-13'58.30453"E	41.167
RW gear	25-05'06.50239"N	121-14'02.23095"E	39.958
NO.1 engine	25-04'54.83561"N	121-13'50.60190"E	42.596
NO.2 engine	25-04'58.66950"N	121-13'53.82520"E	41.805
NO.3 engine	25-04'54.59410"N	121-13'57.99425"E	42.567
NO.4 engine	25-05'01.83064"N	121-13'55.47426"E	39.662
Left outboard wing	25-04'56.64086"N	121-13'55.29190"E	40.848
Inboard mid flap	25-04'55.91551"N	121-13'53.64071"E	41.685
Left horizontal stabilizer outboard end	25-04'46.61528"N	121-13'41.14042"E	42.477

1.12.3 Wreckage Examination

1.12.3.1 Front portion

- 1 The portion comprising remains of Sections 41² and 42, and part of Section 44 and the wings came to rest on the left side of runway 5R (Fig. 1.12.3.1-1).
- 2 Extensive fire damage to these sections was observed.
- 3 The RH side of the fuselage from the forward pressure bulkhead up to the RH wing root area, the main equipment center and forward cargo compartment had been completely damaged by fire.
- 4 The LH side of the fuselage above the main deck floor structure from Body Station 130³ to approximately Body Station 1284 remained intact but in a badly burnt state.
- 5 Approximately 30% of the main deck floor structure from Body Station 320 to 1000 was visible but in a badly burnt and distorted condition.
- 6 The right hand wing was extensively damaged by fire. Some portions of the front and rear spars and the winglet were still visible. (Fig. 1.12.3.1-2)
- 7 The profile of the LH wing was still visible with most of the fire damage occurring on the outer portion. The outboard portion of the LH wing outboard of Wing Station 1360⁴ had broken off. (Fig. 1.12.3.1-3)

1.12.3.2 Aft Portion

1. The aft portion comprising part of the Sections 46 and 48 of the aircraft came to rest on the right side of the centerline of runway 5R. (Fig.

² A certain section of the fuselage, ref. Appendix 1.12.3, Fuselage Station & Section Diagram

³ Distance measured in inches along aircraft longitudinal centreline, ref. Appendix 1.12.3, Fuselage Section & Station Diagram

⁴ Distance measured in inches along wing front spar, ref. Appendix 1.12.4, Wing Station Diagram

1.12.3.2-1,2)

2. The fuselage broke off forward of the #4 door, with a fracture running from approximately Body Station 1560 on the left side diagonally aft across the fuselage.
3. The left side of the belly skin including supporting frames and stringers had separated and the right hand belly skin was crushed, from door 4 all the way to door 5. There were severe skin abrasions and skin loss at the belly areas from Body Station 2410 to 2742. The left side of the fuselage had a large area of abrasion marks around the passenger window area and above.
4. Fire damage was visible at the Section 48 area and the empennage.
5. The RH horizontal stabilizer was still intact but was damaged by fire. The portion of the LH horizontal stabilizer outboard of approximately Stabilizer Station 270⁵ had broken off. (Fig. 1.12.3.2-3,4)
6. The vertical stabilizer was blackened by fire but was still attached the fuselage. The upper portion had broken off.
7. There were no longitudinal scrape marks on the lower skin on Body Section 48.

1.12.3.3 Major components

Major components scattered along the crash path on runway 5R were found in a heavily damaged shape condition caused by impact force and post-crash fire.

1. No. 1 Engine (Fig. 1.12.3.3-1).

⁵ Distance measured in inches along horizontal stabilizer front spar, ref. Appendix 1.12.5, Horizontal Stabilizer Station Diagram

2. No. 2 Engine (Fig. 1.12.3.3-2,3).
3. No. 3 Engine (Fig. 1.12.3.3-4,5)
4. No. 4 Engine (Fig. 1.12.3.3-6).
5. Nose Gear (Fig. 1.12.3.3-7,8).
6. Right Body Gear (Fig. 1.12.3.3-9).
7. Right Wing Gear (Fig. 1.12.3.3-10).
8. Left Body Gear (Fig. 1.12.3.3-11).
9. Left Wing Gear (Fig. 1.12.3.3-12).



Fig. 1.12.3.1-1 Front Portion of Aircraft



Fig. 1.12.3.1-2 Right Wing



Fig. 1.12.3.1-3 Left Wing



Fig. 1.12.3.2-1 Aft Portion of Aircraft



Fig. 1.12.3.2-2 Aft Portion of Aircraft (front view)



Fig. 1.12.3.2-3 RH Horizontal Stabilizer



Fig. 1.12.3.2-4 LH Horizontal Stabilizer



Fig. 1.12.3.3-1 No. 1 Engine



Fig. 1.12.3.3-2 No. 2 Engine



Fig. 1.12.3.3-3 No. 2 Engine



Fig. 1.12.3.3-4 No.3 Engine



Fig. 1.12.3.3-5 No.3 Engine



Fig. 1.12.3.3-6 No. 4 Engine



Fig. 1.12.3.3-7 Nose Gear (in pit No. 11)

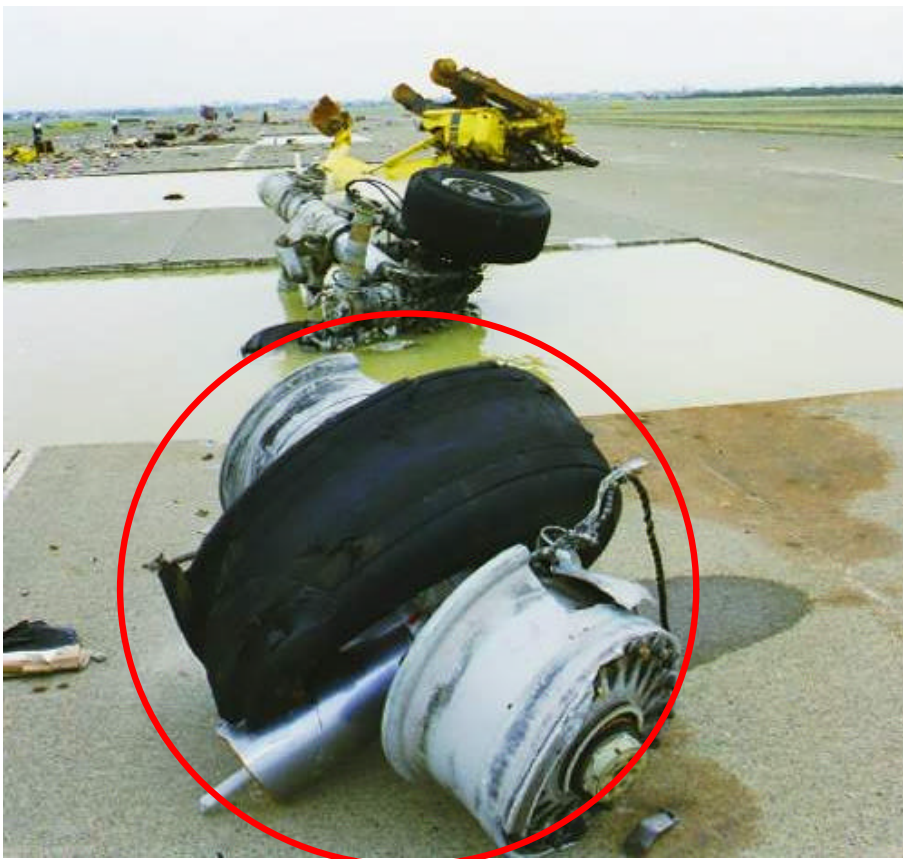


Fig. 1.12.3.3-8 Nose Gear (Shown circled)



Fig. 1.12.3.3-9 Right Body Gear



Fig. 1.12.3.3-10 Right Wing Gear



Fig. 1.12.3.3-11 Left Body Gear



Fig. 1.12.3.3-12 Left Wing Gear

1.12.4 Runway Edge Light Wire Strands

2 wire strands were retrieved from the right hand side and left-hand side of the runway edge lights at locations identified by the grids RE239 (Fig. 1.12.4-1) and RE 240 (Fig. 1.12.4-2) respectively. The runway edge light at grid RE240 was located in the path of the aircraft wreckage.



Fig. 1.12.4-1 RE239 Runway Edge Light



Fig. 1.12.4-2 RE240 Runway Edge Light

1.12.5 Tire Tracks

The group documented the marks made by the nose landing gear (NLG) and the main landing gear (MLG) tires on the runway from the beginning of taxi way N1 through runway 5R threshold to the initial impact point 4,080 feet from the runway threshold (Fig. 1.12.5-1). The tire marks were cleaner than the surrounding areas and no rubber deposits were found.

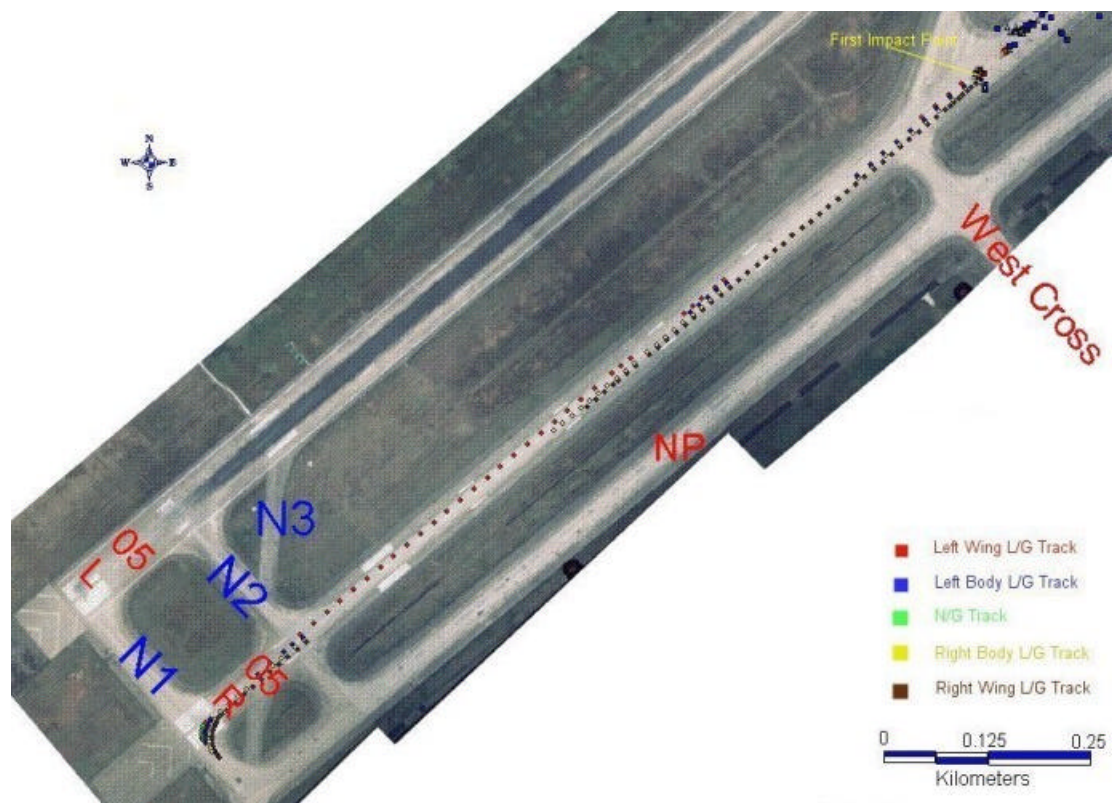


Fig. 1.12.5-1 Mapping of Tire Tracks

IV. Appendices

1.12-1	Wreckage Distribution Chart
1.12-2	Wreckage Identification List
1.12-3	Fuselage Section & Station Diagram
1.12-4	Wing Station Diagram
1.12-5	Horizontal Stabilizer Station Diagram