Aviation Safety Council
Taipei, Taiwan

SQ006 Accident Investigation

Factual Data Collection

Group Report

Recorders Group

February 21, 2001

ASC-FRP-01-01-008

I. Team Organization

A.CVR Group

CVR Group Chairman:

Steven Su
Engineer, Aviation Safety Council

Members:

1. Dennis R. Grossi
   National Resource Specialist
   National Transportation Safety Board
2. Joe MacDonald
   Captain, Chief Pilot 747
   The Boeing Company
3. Quek Tong Huat
   Airworthiness Manager
   Civil Aviation Authority of Singapore
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4. Edward Yeo Tin Ngiah
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   Captain, 747-400
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6. Leong Kwok Hon
   Manager, Flight Safety
   Singapore Airlines
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7. Yeo Kern Yong
   Executive, Flight Data
   Singapore Airlines
   MCIT, Singapore

B.FDR Group

FDR Group Chairman:

Michael, Guan
Engineer, Aviation Safety Council

Members:

1. Dennis R. Grossi
   National Resource Specialist
   National Transportation Safety Board
2. Steven, Su
   Aviation Safety Council
3. Yeo Kern Yong
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   Singapore Airlines
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II. History of Activities

A. CVR Group Activities

Date	Activities
11/01/2000	1. CVR found at 1330 2. CVR back to ASC headquarter at 1600 3. Start readout of the CVR
11/02/2000	1. CVR readout and downloaded successfully
11/03/2000	1. Completed the last 4 minutes transcript.
11/04/2000	1. Finished the first 5 minutes and 30 seconds of CVR transcript.
11/06/2000	1. Flight Ops Group CVR listening 2. Draft transcript
11/07/2000	1. Human Factors Group CVR listening 2. CVR transcript refined
11/08/2000	1. Completed the CVR transcript verification.
11/09/2000	1. CVR final transcript available to all groups.
11/10/2000	1. Sent copy of CVR transcript for Dr.Barry Strauch, NTSB and Singapore Accredit Representative
01/30/2001 01/31/2001	1. CVR Group Factual Report Verification Meeting

. FDR Group Activities

Date	Activities
11/01/2000	1. The FDR was found at the tail section of the aircraft at 1330. It was brought back to the ASC lab about 1600. 2. The FDR was checked for damage 3. The raw data was downloaded with the recorder manufacturers standard hardware and software. 4. A B747-400 FDR database template obtained from EVA and engineering unit conversion was carried out.
11/02/2000	1. The AlliedSignal SSFDR RAW data was downloaded successfully. 2. The formal FDR database was obtained from Singapore Airlines and parameter validation process commenced. 3. In preparation for the progress meeting, the listing of 300 engineering parameters was compiled using Singapore Airlines database and ADRAS software.
11/03/2000	1. The FDR raw data was imported into RAPS for analysis (tabulating, plotting) and for the generation of animation. 2. The FDR data was double checked with ADRAS and RAPS database. 3. The CVR was synchronized with the FDR UTC time by using the microphone keying data recorded during the last 4 minutes of flight.
11/04/2000	1. The following three group FDR parameters were checked: A: General: Time, Airspeed, Ground Speed, Pitch, Roll, Heading, Vertical acceleration, VHF B: Flight Control: Aileron, Elevator, Rudder, Control Column Position and Control Wheel Position, Airspeed, Ground Speed. C: Engine Parameters: EGT, EPR, N1, N2, Ground Speed. 2. A 3D animation was created using FDR data on the RAPS. 3. The flight path was created by calculation using drift angles,

ground speeds and magnetic headings.

4. The CVR audio was incorporated into the 3D animation.

11/06/2000

1. Accomplished extracting data from FDR
2. Update the RAPS database for the parameters of EGT, EPR, N1 and N2, based on Boeing' s FDR system.
3. The accuracy of recorded ground speed was crosschecked by calculation using the recorded longitude acceleration data.
4. The satellite map, CVR, FDR and air-photography data were successfully integrated to produce the 3D animation of the flight.

11/07/2000

1. The last one-second' s FDR raw data was sent to AlliedSignal and ATSB for replay and verification.
2. The QAR box, was sent to Penny & Giles UK for data extraction.
3. The readout was accomplished and a plot of the localizer deviation, ground speed, and heading and vertical acceleration data was produced for the take-off phase.
4. The final draft version of the 3D animation was completed by integrating the CVR, FDR data with information obtained from the air-photo of CKS airport.

11/8/2000

1. The last four minutes 3D animation of SQ006 accident was finalized.

III. Factual Description. Recorders Group responsible for 1.11.

1.1-1.10(N/A to Recorders Group)

1.11 Flight recorders

1.11.1 Cockpit Voice Recorder

The airplane was equipped with a Fairchild model A200S CVR, SN 00744. The recording, which contained good quality audio information, consisted of four channels including the relief pilot's microphone, the first officer's microphone, and the captain's microphone. The fourth channel included the cockpit area microphone. The external surface and interior of the CVR was found without any damage or contamination. The CVR consists of 123 minutes of recording. Only 16 minutes and 30 seconds of information relevant to the accident flight were transcribed (see section 1.11.1.2). Timing of transcript was based on the ATC UTC that was correlated to microphone keying that are common to the CVR and FDR.

1.11.1.1. Description of Investigation

The recorder was properly seated in the rack when ASC personnel arrived at the crash site. There is no evidence of heat or impact damage on the exterior of CVR. There was also no contamination caused by rescue process.

The prosecutors viewed and recorded the model, part number and serial number of the CVR after the recorder was removed from aircraft. The recorder was released from the prosecutor officer to ASC on November 1, 2000.

The recorder arrived at the ASC Recorder Laboratory approximately 4:00 PM November 1, 2000 local time. Inspection of the CVR exterior was immediately conducted. There was no apparent damage found. The under water locator was attached to the CVR. CVR specialist then proceeded to open the CVR and inspected the inside of the CVR. The rear connector, pins, memory module and all circuit board were not damaged. There were no evidence of heat, impact damage or

contamination on the circuit board and memory module.

The recording was downloaded successfully with the original recorder and standard equipment. This recorder had 123 minutes of recording. All recording were recorded on the digital audiotape with 44.1 kHz sampling rate. CVR was powered when number one engine was started. （see appendix 8A-1 Description of CVR ON/OFF logic）. Only the 16 minutes and 30 seconds of recording related to accident flight. All of the flight crews were using their hot microphone system. Advanced audio filtering and amplification techniques were applied to enhance readability of all data.

CVR time is correlated with the Solid State Flight Data Recorder (SSFDR) information and the Air Traffic Control (ATC) transcript（see appendix 3-11~3-13） developed by CAA.

Only the 16 minutes and 30 seconds of recording that related to accident flight was transcribed. The recording and transcript started ATC UTC 1500:53 as the flight pushed back from gate B5 at C.K.S. International Airport. The transcript continued uninterrupted until ATC UTC 1517:22, shortly after time of the first impact. The transcript contains push back, engines starting, taxi to runway zero five right via Sierra Sierra, West Cross, November Papa and N1. The recording ended shortly after the aircraft' s first impact.

1.11.1.2. CVR Transcript

Transcript of Fairchild model A200S CVR, SN 00744, installed on a B-747-400, 9V-SPK, which was involved in a take off and crashed on a closed runway at Chiang Kai Shek (CKS) International Airport, Taiwan, on October 31, 2000.

Legend for SQ006 CVR Transcript

CM-1 PF	Channel 3 (Occupied left hand seat, Captain) Pilot flying
CM-2 PNF	Channel 2 (Occupied right hand seat, First Officer) Pilot non-flying
CM-3 OBS	Channel 1 (Occupied first observer seat, Relief Pilot) Observer
CAM	Channel 4 (Cockpit area microphone on P6 panel)
RDO-2	Radio transmission from CM-2 PNF
MAINT	Ground Maintenance interphone
TWR	Radio transmission from CKS Tower
GND	Radio transmission from CKS Ground Control
CI 004	Call sign of China Airlines flight CI 004（Dynasty zero zero four）
CX 2043	Call sign of Cathay Pacific Airlines flight CX 2043（Cathay two zero four three）
----	Unintelligible
△	Conversations between Ground/Tower and CI 004/CX 2043 that relate to ATC clearances
****	Expletives

ATC UTC	SOURCE	CONTENTS
15:00:53	CM-1 PF	Light up
15:00:54	CM-2 PNF	Check
15:01:12	CAM	(Sound similar to that of starter switch in)
15:01:12	CM-1 PF	Fifty percent N two
15:01:14	CM-2 PNF	Valve closed
15:01:16	CM-1 PF	Starting Engine two
15:01:18	MAINT	Roger, start two
15:01:18	CM-2 PNF	OK Starting two
15:01:19	CM-1 PF	See if you can get…what's the latest weather. Can you write it down What's the latest ... ATIS eh
15:01:23	CM-3 OBS	OK yah
15:01:25	ATIS	Taipei international Airport information Tango one four five four Zulu runway zero five left is in use. Runway zero six for departure only expect ILS runway zero five left category two approach wind zero two zero at three six gust five two visibility five hundred meters, runway zero five left RVR four hundred fifty meters runway zero six five hundred meters with heavy rain cloud broken two hundred feet overcast five hundred feet temperature two one dew point two zero QNH one zero zero one Hectopascal departure frequency one two five point one caution wind shear on runway zero five left final due to radio interference tower frequency change to one two nine point three caution taxiway November Sierra has been remarked aircraft using November Sierra advise taxi slowly with caution. Taxiway November Papa behind Alpha one and Alpha three closed, runway zero five right between November four and November five closed due to work in progress, taxiway November four and November five still available. Inform Taipei approach or tower initial contact you have tango.
15:01:29	CM-1 PF	Write up…write behind here
15:01:29	CAM	Write up
15:01:30	CM-3 OBS	I got it.
15:01:33	CAM	(Clicking sound -similar to the sound of chronometer resetting)

ATC UTC	SOURCE	CONTENTS
15:01:38	MAINT	Number two N one rotation
15:01:40	CM-1 PF	Thank you
15:01:41	CM-2 PNF	Oil pressure number two
15:01:43	CX 2043	Ground Cathay two zero four three request the wind and RVR of runway zero six
15:01:49	CM-1 PF	Light up
15:01:49	CM-2 PNF	Check
15:01:51	GND	Cathay two zero four three runway zero six RVR five hundred fifty meters and wind zero two zero at three eight gust five one
15:02:04	CM-1 PF	Ok lah, this is better still, Fifty percent N two
15:02:04	CAM	(Sound similar to that of starter switch in)
15:02:06	CX 2043	Cathay two zero four three
15:02:07	CM-2 PNF	Valve closed
15:02:09	CM-1 PF	Ok starting three
15:02:11	MAINT	Roger start three
15:02:12	CM-1 PF	Zero two zero better for us
15:02:13	CM-2 PNF	Ya
15:02:14	CM-1 PF	Starting three please
15:02:16	CM-1 PF	So resolved already it become less
15:02:21	CAM	(Clicking sound -similar to the sound of chronometer resetting)
15:02:31	CM-2 PNF	Oil pressure number three
15:02:31	CAM	(Clicking sound -similar to the sound of chronometer resetting)
15:02:33	CM-1 PF	Roger N one
15:02:38	MAINT	Number three N one rotation and set the brake
15:02:42	CM-1 PF	Confirm set parking brakes
15:02:44	MAINT	Yes
15:02:46	CAM	(Sound similar to that of parking brake being set)
15:02:47	CM-1 PF	OK light up
15:02:48	CM-1 PF	Check, parking brake set
15:02:49	MAINT	Roger
15:03:01	CAM	(Sound similar to that of starter switch in)
15:03:01	CM-1 PF	Fifty percent N two
15:03:03	CM-2 PNF	Valve closed
15:03:04	CM-1 PF	Ya
15:03:05	CM-1 PF	Starting four

ATC UTC	SOURCE	CONTENTS
15:03:08	MAINT	Roger, starting four
15:03:09	CM-1 PF	Ok start first, four
15:03:24	CAM	(Clicking sound -similar to the sound of chronometer resetting)
15:03:27	CM-2 PNF	N one and oil pressure
15:03:30	CM-1 PF	Fuel on
15:03:34	MAINT	Number four N one rotation
15:03:35	CM-1 PF	Thank you
15:03:37	CM-1 PF	Light up
15:03:38	CM-2 PNF	Check
15:03:55	CM-1 PF	Zero two zero is better
15:03:55	CAM	(Sound similar to that of starter switch in)
15:03:56	CM-1 PF	Fifty percent N two
15:03:58	CM-2 PNF	Valve closed
15:04:00	CI 004	(Dynasty Zero zero four conversation with ground control)△
15:04:04	GND	(Ground control conversation with Dynasty zero zero four)△
15:04:06	CI 004	(Dynasty zero zero four with conversation Ground control)△
15:04:14	GND	(Ground control conversation with Dynasty zero zero four)△
15:04:17	CI 004	(Dynasty zero zero four with conversation Ground control)△
15:04:18	CAM	(Clicking sound similar to that of chronometer resetting)
15:04:21	CAM	(Sound similar to that of seat motor)
15:04:26	CM-1 PF	Today can put on
15:04:33	CM-1 PF	Wait first huh
15:04:34	CM-2 PNF	Ok
15:04:35	CM-1 PF	Ok cockpit to ground we normal start, remove ground equipment hand signal thank you bye bye
15:04:39	MAINT	Roger all equipment removed standby left bye bye
15:04:42	CM-1 PF	Ok
15:04:43	CM-1 PF	What's the trim you got there, seven point…
15:04:45	CM-2 PNF	Seven point six…
15:04:48	CAM	(Unknown click sound)
15:04:51	CM-1 PF	Seven point..., Waa pretty high huh today

ATC UTC	SOURCE	CONTENTS
15:04:54	CM-2 PNF	Point six
15:04:56	CM-1 PF	Ok thanks
15:04:57	CM-1 PF	What's the.. ok.. ok
15:04:58	CM-3 OBS	……t his is the latest zero two zero three six gust fifty two lah still within limit
15:05:02	CM-1 PF	Yah, zero two zero better
15:05:02	CM-3 OBS	Yah
15:05:02	CM-1 PF	More, more on head wind side
15:05:03	CM-3 OBS	The rest no significant change
15:05:03	CM-1 PF	Ok,
15:05:07	GND	(Cathay two zero four three conversation with ground control)△
15:05:08	CM-3 OBS	Visibility and RVR still the same four fifty meters
15:05:09	GND	(Ground control conversation with Cathay 2043)△
15:05:12	CX 2043	(Cathay 2043 conversation with ground control)△
15:05:15	GND	(Ground control conversation with Cathay 2043)△
15:05:21	CM-1 PF	Ha ha Ok
15:05:22	CM-1 PF	Ok after start check list
15:05:24	CM-2 PNF	After start check, APU
15:05:25	CM-1 PF	Off
15:05:26	CM-2 PNF	Number four demand pump
15:05:27	CM-1 PF	Auto
15:05:28	CM-2 PNF	Anti-ice
15:05:29	CM-1 PF	Off
15:05:29	CX 2043	(Cathay 2043 conversation with ground control)△
15:05:30	CM-2 PNF	Aft cargo heat
15:05:31	CM-1 PF	On
15:05:32	CM-2 PNF	Packs
15:05:32	CM-1 PF	Normal
15:05:33	CM-2 PNF	Recall check huh
15:05:34	CM-1 PF	Check
15:05:34	CM-2 PNF	Check
15:05:35	CM-2 PNF	Trims
15:05:36	CM-1 PF	So we got seven point eight, err seven point six units, zero zero set.
15:05:42	CM-2 PNF	Auto brake
15:05:43	CM-1 PF	Ok RTO
15:05:44	CM-2 PNF	Ground equipment

ATC UTC	SOURCE	CONTENTS
15:05:45	CM-1 PF	Ok, your side gone already ah
15:05:47	CM-1 PF	Is he there, ok alright ok huh gone away
15:05:48	CM-2 PNF	This guy that guy out this side on the right side
15:05:50	CM-1 PF	Ok huh
15:05:50	CM-2 PNF	Ok, wah "terok" (terrible) man
15:05:51	CM-1 PF	Ok lights cabin going off
15:05:52	CAM	(Click)
15:05:53	CM-2 PNF	Ok
15:05:55	RDO-2	Singapore six request taxi.
15:05:57	GND	Singapore six taxi to runway zero six via taxiway.., correction runway zero five left via taxi way Sierra Sierra, West Cross and November Papa.
15:06:08	CM-2 PNF	I missed that man, what is it
15:06:09	CM-1 PF	Sierra Sierra West Cross and November Papa
15:06:12	RDO-2	Taxi via Sierra Sierra
15:06:14	CM-1 PF	West Cross
15:06:14	RDO-2	West Cross
15:06:15	CM-1 PF	And November Papa
15:06:15	RDO-2	And November Papa for runway zero five left Singapore six
15:06:21	CM-2 PNF	Sierra Sierra West Cross November Papa
15:06:25	CM-1 PF	Yah, so you go straight down.
15:06:26	CM-2 PNF	Roger that
15:06:26	CM-1 PF	Hit West Cross, go across the West Cross then November Papa all the way down ok
15:06:26	CM-2 PNF	Ok
15:06:29	CM-2 PNF	Then come down further south ah
15:06:29	CM-1 PF	Ok, alright
15:06:30	CM-2 PNF	Ok, yes sir zero five..-----
15:06:34	GND	(Ground conversation with Dynasty Zero zero four) △
15:06:35	CI 004	(Dynasty Zero zero four conversation with Ground) △
15:06:36	GND	(Ground conversation with Dynasty Zero zero four) △
15:06:36	CM-1 PF	Ok, left is clear ah
15:06:38	CM-2 PNF	Ok right side is.. clear, except for this vehicle-lah down here

ATC UTC	SOURCE	CONTENTS
15:06:42	CM-1 PF	Ok
15:06:49	CI 004	(Dynasty Zero zero four conversation with Ground) △
15:07:00	GND	(Ground conversation with Dynasty Zero zero four) △
15:07:05	CM-1 PF	Taxi slowly
15:07:10	CAM	(Sound similar to that of parking brake release)
15:07:10	CI 004	Taipei ground from Dynasty Zero zero four, can we check out your wind and RVR please.
15:07:13	CM-1 PF	OK turn left skidding right passing heading about zero two four zero now
15:07:13	CM-2 PNF	Checked
15:07:16	GND	Dynasty Zero zero four runway zero five left RVR is four hundred fifty meters and wind zero two zero at two five and gust four one
15:07:21	CM-3 OBS	Actually we have to nominate a return alternate because below landing minimum
15:07:25	CM-1 PF	Landing mim…
15:07:25	CM-2 PNF	Below landing minimum
15:07:27	CM-1 PF	Ah, because er Kaohsiung CAT two we still can go CAT two, no problem.
15:07:28	CM-2 PNF	CAT two lah, CAT two…
15:07:33	CI 004	(Dynasty zero zero four conversation with Ground) △
15:07:38	CM-2 PNF	Still ok lah, CAT two
15:07:40	CM-1 PF	CAT two yah, you can look yah ...five left huh
15:07:40	GND	(Ground conversation with Dynasty zero zero four) △
15:07:43	CI 004	(Dynasty zero zero four conversation with Ground) △
15:07:47	CM-1 PF	Can still take Kaohsiung you see
15:07:49	CM-2 PNF	Kaohsiung is closed...the airport
15:07:49	CM-1 PF	Kaohsiung I think, is closed is it
15:07:52	CM-2 PNF	We can take Naha or, yah I think CAT two..
15:07:53	CM-1 PF	But we are CAT two, we can still come back, we can still come back
15:07:55	CM-2 PNF	Yah, yah
15:07:56	CM-1 PF	Ok, flaps twenty please.

ATC UTC	SOURCE	CONTENTS
15:07:56	CAM	(Sound similar to that of flap lever through the detent positions)
15:08:04	CM-1 PF	Ok checking rudder er
15:08:06	CM-1 PF	Full left
15:08:07	CM-2 PNF	Full left
15:08:08	CM-1 PF	Center
15:08:09	CM-2 PNF	Center
15:08:10	CM-1 PF	Ok full right
15:08:11	CM-2 PNF	Full right
15:08:12	CM-1 PF	Center
15:08:13	CM-2 PNF	Center
15:08:14	CM-2 PNF	My controls checks ah
15:08:24	CM-1 PF	Hongkong is closed man, ha ha... worse
15:08:27	CM-3 OBS	Hongkong closed ah
15:08:27	CM-1 PF	That' s what he said not accepting any
15:08:29	CM-2 PNF	I see
15:08:30	CM-1 PF	I think some people might have diverted there lah I think
15:08:40	CM-2 PNF	Ok column coming back
15:08:47	CM-1 PF	If the RVR five left was two hundred right just now we checked
15:08:50	CM-3 OBS	RVR yah two hundred
15:08:50	CM-1 PF	Correct, yah two hundred meters ah, ok lah
15:08:54	CAM	(Sound similar to that of seat motor)
15:08:55	CM-1 PF	Ok man before take off checklist
15:08:56	CM-2 PNF	Roger sir
15:08:58	CM-2 PNF	Before..take off checks, flaps
15:09:02	CM-1 PF	Twenty green
15:09:03	CM-2 PNF	Twenty green
15:09:06	CM-2 PNF	Flight control
15:09:07	CM-1 PF	Check
15:09:07	CM-2 PNF	Check
15:09:08	CM-2 PNF	EPR and speeds
15:09:09	CM-1 PF	Ok, EPR one point five two ah, Vee one, one forty two, Vee R one five six and Vee two, one six nine set
15:09:15	CM-2 PNF	EPR one point five two ah, Vee one, one forty two, rotate one five six and Vee two, one six nine

ATC UTC	SOURCE	CONTENTS
15:09:19	CX 2043	(Cathay two zero four three conversation with ground control)△
15:09:22	CM-2 PNF	Speed set
15:09:24	CM-2 PNF	Departure routing
15:09:25	CM-1 PF	Ok ah Taipei runway zero six left huh
15:09:27	CM-2 PNF	Zero five left
15:09:28	GND	(Ground control conversation with Cathay two zero four three)△
15:09:29	CM-1 PF	Zero five left
15:09:29	CM-3 OBS	Zero five left
15:09:31	CM-1 PF	And er we got Anpu three departure Kikit transition huh
15:09:32	CX 2043	(Cathay 2043 conversation with ground control)△
15:09:34	GND	(Ground control conversation with Cathay 2043)△
15:09:35	CX 2043	(Cathay 2043 conversation with ground control)△
15:09:38	CM-1 PF	Looks like I got to go..
15:09:40	CM-2 PNF	Next one got to go right is it
15:09:41	CM-1 PF	Yah, go right turn right here, all the way to West Cross lah right turn here
15:09:46	CM-2 PNF	Runway is zero five left..Kikit transition initially two hundred ah level alpha one squawk two six five seven, will be two nine zero by Bulan
15:09:58	CM-1 PF	A lot of rudder work man here.. really ah
15:10:01	CM-3 OBS	Cross wind ah..
15:10:02	CM-1 PF	Yah
15:10:03	CM-2 PNF	Transponder TA RA, set, checks down to the line
15:10:06	CM-1 PF	Ok, thanks.
15:10:08	CM-2 PNF	West Cross correct, Sierra Sierra West Cross
15:10:14	CM-1 PF	Everybody waiting for each other for take off you see haha
15:10:18	CM-1 PF	The bugger heard us..er going..that fellow also
15:10:21	CM-3 OBS	Yah, it is coming in ah, the longer they delay the worse it is lah
15:10:23	CM-1 PF	Yah, worse if we are going to get out, if don't take off ah…..I am going to go very slow here, ok, because you going get skid
15:10:24	CM-2 PNF	Ok nine knots
15:10:33	CM-3 OBS	Ok, to catch the wind

ATC UTC	SOURCE	CONTENTS
15:10:35	CM-2 PNF	That's all the moisture
15:10:41	CM-2 PNF	Turning left skidding er turning right err skidding left two seven zero
15:10:42	CM-3 OBS	The weather radar will be all red ha ha
15:10:43	CM-1 PF	Ok, passing ah two eight zero now, ah needles tracking and turn right skidding left now ah, past heading of about two.. three hundred now ah
15:10:45	CM-2 PNF	Yah that's right ah
15:10:56	CAM	(Sound of clicks)
15:11:00	CM-2 PNF	My speed excursion is more than the left side, because the wind is coming from here
15:11:03	CM-1 PF	Ah, yah
15:11:03	CM-3 OBS	Your pitot on the other side ah . just pick up
15:11:10	CM-2 PNF	Roger that
15:11:12	CM-1 PF	For the take off use autopilot better
15:11:22	CM-1 PF	Typhoon man, ok tomorrow the guys coming in will be "terok" (terrible) man
15:11:28	CM-3 OBS	Yah, tomorrow morning Singapore five
15:11:29	GND	(Ground control conversation with Cathay two zero four three)△
15:11:36	CX 2043	(Cathay two zero four three conversation with ground control)△
15:11:38	GND	(Ground control conversation with Cathay two zero four three)△
15:11:42	CX 2043	(Cathay two zero four three conversation with ground control)△
15:11:47	CX 2043	(Cathay two zero four three conversation with ground control)△
15:11:49	CM-1 PF	The five left also imp..imp.. improve already the visibility to five hundred fifty meters
15:11:52	GND	(Ground control conversation with Cathay two zero four three)△
15:11:54	CX 2043	(Cathay two zero four three conversation with ground control)△
15:11:55	CM-3 OBS	Five left..wait ah
15:11:56	CM-1 PF	Ya, the guys said improved already went up
15:11:59	CM-3 OBS	Now is four fifty
15:12:00	CM-1 PF	Just now the guys ask him over the tower

ATC UTC	SOURCE	CONTENTS
15:12:01	CM-2 PNF	Yah
15:12:02	ATIS	Taipei Chiang Kai Shek International Airport information uniform one five zero zero zulu runway zero six for departure only runway zero five left for category two approach and departure wind zero two zero at three six gust five six visibility six hundred meters runway zero five RVR four hundred fifty meters downward runway zero six RVR five hundred fifty meters downward with heavy rain cloud broken two hundred feet overcast five hundred feet temperature two one dew point two zero QNH one zero zero one Hectopascal
15:12:06	CM-2 PNF	Coming up er.. November Papa eh..
15:12:07	CM-1 PF	Ok, all the way down left turn all the way down
15:12:10	CM-2 PNF	Left ah
15:12:10	CM-1 PF	Yah
15:12:17	CM-2 PNF	One two five one departure
15:12:20	GND	(Ground control conversation with Cathay 2043)△
15:12:21	CAM	(Sound similar to that of radio frequency selection)
15:12:22	CM-1 PF	Ok, first left
15:12:23	CX 2043	(Cathay 2043 conversation with ground control)△
15:12:23	CM-2 PNF	Affirm first left
15:12:24	CM-1 PF	Left
15:12:25	CM-2 PNF	Left
15:12:26	GND	(Ground control conversation with Cathay 2043)△
15:12:33	CAM	(Sound similar to that of seat motor)
15:12:38	CX 2043	(Cathay 2043 conversation with ground control)△
15:12:41	CAM	(Sound similar to that of nose gear scrubbing)
15:12:47	CAM	(Sound similar to that of nose gear scrubbing)
15:12:47	GND	(Ground control conversation with Cathay 2043)△
15:12:56	CM-3 OBS	The latest QNH is one zero zero one
15:12:56	CM-2 PNF	Clearing that huh
15:12:58	GND	Singapore six contact tower one two nine point three, good day.
15:13:02	RDO-2	One two nine point three good day sir, Singapore six.
15:13:13	CM-2 PNF	One zero zero one one two nine point.. one two nine point three ah….ok ah

ATC UTC	SOURCE	CONTENTS
15:13:25	RDO-2	Taipei Tower, good evening, Singapore six.
15:13:28	TWR	Singapore six, good evening, Taipei Tower hold short runway zero five left.
15:13:33	RDO-2	Hold short runway zero five left, Singapore six.
15:13:38	TWR	Singapore six, for information now surface wind zero two zero at two four, gust four three, say intention.
15:13:44	CM-1 PF	Gusting four three ah
15:13:46	RDO-2	Thank you sir, Singapore six.
15:13:47	CM-1 PF	Ok, ok better less
15:13:48	CM-3 OBS	Less, less gust already
15:13:54	CM-1 PF	Zero two zero it's from left lah
15:13:56	CM-3 OBS	Two four gust four three
15:14:05	CM-2 PNF	Zero two zero
15:14:08	CM-1 PF	Ok this one will be here ah
15:14:18	CM-1 PF	Zero two zero
15:14:20	CM-3 OBS	Ya, left lah
15:14:21	CM-1 PF	Go right to the end of the runway, end of the runway then turn, ok.
15:14:31	CM-3 OBS	Quite a bit of aileron for the take off
15:14:35	CM-2 PNF	OK
15:14:40	CM-2 PNF	The next one
15:14:41	CM-2 PNF	Next one is November one
15:14:42	CM-1 PF	Ok second right
15:14:44	CM-2 PNF	Second right, that’ s right
15:14:47	CM-1 PF	In Australia, to them, next one is this, first one you know
15:14:50	CM-2 PNF	Next one this one
15:14:51	CM-1 PF	Yah..ha ha
15:14:52	CM-1 PF	Australian
15:14:53	CM-1 PF	I think the best is to say second right ah first right second right ah
15:14:55	CM-2 PNF	Clearing that Satvoice
15:14:58	CM-1 PF	Tell them we are ready lah
15:15:02	RDO-2	Singapore six ready.
15:15:04	TWR	Singapore six roger, runway zero five left, taxi into position and hold.
15:15:08	RDO-2	Taxi into position and hold, Singapore six

ATC UTC	SOURCE	CONTENTS
15:15:12	CM-2 PNF	I get them seated ah
15:15:12	CM-1 PF	Ok below the line please ..yah
15:15:15	CM-2 PNF	Cabin crew to your takeoff station thanks
15:15:20	CAM	(Sound similar to that of door closing)
15:15:21	CAM	(Sound of chime)
15:15:22	TWR	Singapore six, runway zero five left, wind zero two zero at two eight, gust to five zero, cleared for take off.
15:15:30	RDO-2	Cleared for take off, Runway zero five left Singapore six.
15:15:31	CM-1 PF	OK man
15:15:34	CM-2 PNF	OK checks below the line, cabin announcement complete
15:15:37	CM-2 PNF	Packs
15:15:38	CM-1 PF	Ok norm eh
15:15:39	CM-2 PNF	Norm
15:15:40	CM-2 PNF	Strobes on, landing lights all on
15:15:44	CM-2 PNF	Take off clearance
15:15:45	CM-1 PF	Obtained hah
15:15:46	CM-2 PNF	Obtained sir
15:15:47	CM-1 PF	OK thanks
15:15:48	CM-2 PNF	Before take off checklist completed
15:15:50	CAM	(Sound of click)
15:15:50	CM-2 PNF	OK green lights are here
15:15:52	CM-1 PF	It going to be very slippery I am going to slow down a bit, slow turn here
15:15:53	CM-2 PNF	Turning that
15:16:07	CM-2 PNF	And the PVD hasn't lined up ah
15:16:10	CM-1 PF	Yeah we gotta line up first
15:16:12	CM-3 OBS	We need forty five degrees
15:16:15	CM-2 PNF	I see, excellent man
15:16:16	CM-1 PF	Yah
15:16:23	CM-1 PF	Not on yet er PVD huh never mind we can see the runway, not so bad. Ok, I am going to put it to high first. OK ready eh, so zero one zero is from the left lah Ok
15:16:27	CM-2 PNF	Ok
15:16:30	CAM	(Sound similar to that of wipers going to high speed)

ATC UTC	SOURCE	CONTENTS
15:16:31	CM-2 PNF	Ready sir zero two zero check ok
15:16:33	CM-1 PF	Left wing into aileron, left aileron into wind. Huh OK Cabin reported eh.
15:16:37	CM-3 OBS	Yah cabin is ready.
15:16:37	CM-1 PF	Ok thanks
15:16:37	CM-2 PNF	Yup thanks
15:16:43	CM-3 OBS	Ok –thrust ref toga toga
15:16:43	CM-2 PNF	Thrust ref toga toga
15:16:44	CM-1 PF	Ok –thrust ref toga toga
15:16:44	CAM	(Sound similar to that of engines spooling up)
15:16:54	CM-3 OBS	Hold
15:16:54	CM-2 PNF	Hold
15:16:54	CM-1 PF	Roger
15:16:55	CM-3 OBS	Eighty knots
15:16:55	CM-2 PNF	Eighty knots
15:16:56	CM-1 PF	Ok my control
15:17:13	CM-2 PNF	Vee one
15:17:13	CM-3 OBS	Vee one
15:17:16	CM-1 PF	**** something there
15:17:17	CAM	Sound of the first impact
15:17:18	CAM	****waaah****
15:17:18	CAM	Sound of a series of impacts
15:17:22		End of Recording

1.11.2 Flight Data Recorder

The accident airplane's flight data recorder (FDR) is an AlliedSignal Solid-State flight data recorder (SSFDR), part number 980-4700-033, and serial number 1634. Investigator found the FDR at the tail section, and carried it back to ASC Lab in Taipei, Taiwan.

Readout of the FDR was accomplished using the laboratory's standard hardware and software, these systems including the AlliedSignal hand-Held download unit (HHDLU), ADRAS and RAPS.

Data plots and tabular listings of each data parameter for the entire accident flight are included in this report. Penny & Giles Aerospace Ltd. has finished the OQAR NVM data readout on November 22, they have confirmed that the OQAR NAM data stopped at UTC 15:16:40 (before start takeoff). According to FDR readout data, the FDR stopped at UTC 15:17:12.16, both existing FDR and QAR data are consistent.

The time synchronization between cockpit voice recorder (CVR) timing was compared to the FDR VHF microphone keying and a time correction developed.

1.11.2.1. FDR Information

FDR Manufacturer: AlliedSignal Solid State Flight Data Recorder (SSFDR)

Part No.: 980-4700-033 （2X, 128 Words/sec）

Serial No.: 1634

Boeing P/N: S283T003-1

Data Size: 52.14 hour (187706 sec)

DFDAC: Boeing, P/N 285U0071-203

1.11.2.2. FDR Parameters

Database Source: Singapore Airlines

Recorded Parameters: 318

Database List: Appendix 8B-1

1.11.2.3. Readout Findings:

1. Flight ID: SIA006

2. Start recording: UTC15:00:00
3. B5 gate position: N25.0777, E121.2377 (UTC 15:00:00)
4. Aircraft stayed on NP for taxi: UTC 15:13:47 ~15:15:25
5. Start acceleration: UTC15:16:34, Magnetic heading 50.6 deg
6. FDR stop condition: UTC 15:17:12; Magnet heading 48.0 deg, CAS 158 Knots, Ground speed 130.8 Knots, Radio Alt –8 ft, pitch attitude 0.53 deg, roll attitude 0.0 deg.
7. 15:17:13 unsynchronized FDR data: Magnetic heading 48.7 deg, CAS 158 Knots, Ground speed 130.8 Knots, Radio Alt –8 ft, pitch attitude CAS 18 Knots, Ground speed 272.5 Knots, Radio Alt –2 ft, pitch attitude 2.99 deg, roll attitude 0.7 deg.
8. Gross weight at first impact time: 755840 Lbs
9. According to AIP (RCTP 2-3) the recorded the gate B5 position of CKS airport is N25°04' 50.38", E121°14' 22.37"。 The relative position difference between the AIP gate B5 position and FDR recorded at UTC 15:00:00 is 10.7 meters (delta North) and 6.2 meters (delta East).

1.11.2.4. Time synchronization between CVR and FDR

The CVR local time reference was established through the correlation of the last three VHF radio transmissions made by SQ006 which event recorded by the FDR, CVR and ATC transcript. The following table displays the time coordination among FDR UTC, ATC UTC and CVR time. There is 4 seconds difference between FDR UTC and ATC UTC. Timing used on FDR recording description, plots and tables is base on FDR UTC.

CVR Time	FDR UTC	ATC UTC
00:28:24	15:14:58	15:15:02
00:28:30	15:15:04	15:15:08
00:28:52	15:15:26	15:15:30

1.11.2.5. Data Printout

Table 1（Table 1 to Table 4 referred to appendix 8B-2） contains a tabular printout of generic parameters from 15:00:00 to the end of data recorded for flight SQ006:

UTC Time	Altitude	Airspeed	Ground Speed
Roll Attitude	Pitch Attitude	Mag. Heading	TAT（total air temp.）
Wind direction	Wind Speed	Drift	Longitude Acc.

Lateral Acc.	Vertical Acc.	Longitude	Pos. Latitude Pos.
Localizer Dev			

Table 2 contains a tabular printout of flight control parameters from 15:00:00 to the end of data recorded for flight SQ006:

UTC Time	Aileron-LIB	Aileron-LOB	Aileron-RIB
Aileron-ROB	Air/Ground	Control Column	Control Wheel
Elevator-RIB	Elevator-ROB	Rudder Pedal	Rudder-DWR
Rudder-UPR			

Table 3 contains a tabular printout of engine parameters from 15:00:00 to the end of data recorded for flight SQ006:

UTC Time	EPR1	EPR2	EPR3
EPR4	N1-1	N1-2	N1-3
N2-4	N2-1	N2-2	N2-3
EGT1	EGT2	EGT3	EGT4

Last two columns of Table 1, 2 and 3 at UTC 15:17:13 are unsynchronized data. AlliedSignal is working with FDR group to readout the last second data.

1.11.2.6. Data Plots

Fig. 1 （Fig.1 to Fig.6 referred to appendix 8B-3）shows the seven generic parameters plotted as a function of UTC time, from 15:14:18 to the end of data recorded at 15:17:13。 These parameters are listed as follows:

VHF Keying	Pitch	Mag. Heading	Longitude Acceleration
EPRs	Computed Airspeed	Ground Speed	

Fig. 2 shows the several flight control parameters plotted as a function of UTC time, from 15:14:18 to the end of data recorded at 15:17:13。 These parameters are listed as follows:

Aileron	Elevator	Rudder	Rudder Pedal
Pitch	Mag. Heading	Control Column	Control Wheel

Fig. 3 shows the four engine parameters plotted as a function of UTC time, from 15:14:18 to the end of data recorded at 15:17:13。 These

parameters are list as follows:

EGT	N1	N2	Fuel Flow
Mag. Heading			

Fig. 4 shows the last 40 seconds' FDR parameters plotted as a function of UTC time。 These parameters are listed as follows:

VHF Keying	Vertical Acceleration	Longitude Acceleration	Localizer Dev
Mag. Heading	Computed Airspeed	Ground Speed	
Integrated Ground Speed			

1.11.2.7. OQAR data

After SQ006 accident, FDR group received the QAR from ground operation group on November 5. There were no damage to the optical disk. We copied the original disk raw data for backup, and then sent the OQAR raw data to Singapore airlines and Penny & Giles Aerospace Ltd. FDR group received the QAR engineering parameters on November 8. The data showed that the OQAR data stopped at UTC 15:16:23 (before takeoff). Both existing FDR and QAR data are consistent. (Appendix 2: SQ006 Technical Inspection Report-SQ006 OQAR).

Penny & Giles Aerospace Ltd. has finished the OQAR NVM data readout on November 22, they have confirmed that the OQAR NAM data stopped at UTC 15:16:40 (before takeoff). Both existing FDR and QAR data are consistent. Table 4 contains a tabular printout of OQAR parameters from 15:15:05 to the end of data recorded for flight SQ006:

PALT	PTCH	RALT	ROLL
RUDDL	RUDDU	SPLL	SPLR
SYNC	THDG	UTC	VHF1

1.11.2.8. FDR Flight Path and Sat. Map

Fig 5. Shows the smoothed latitude and longitude position of FDR data (yellow line), based on the related satellite image with taxiways, and runways. Fig 5 also shows the ground scars of the SQ006 and wreckage distributions.

FDR group combined the satellite map, CVR audio and FDR data for 3D animation in RAPS. Due to limitation of recorded latitude and longitude

position, we apply the ground speed, magnetic heading, and drift angle to calculate the flight path. We also used the air-photography data to correct the position of the A/C' s flight path (ref. Fig 6).

1.11.2.9. CVR, FDR and OQAR Power Source

CVR Power Source: 115VAC from Bus #1; 28VDC from bus #1
FDR Power Source: 115VAC from Bus #3; 28VDC from bus #3
OQAR Power Source: 115VAC from Bus #3

1.12-1.18 (N/A to Recorders Group)

IV. Appendices

8A-1 Description of CVR ON/OFF logic

8B-1 FDR Parameters Listing

8B-2 SQ006 FDR and QAR Parameters Tabular Listings

- Table1 Singapore Airline flight SQ006 B747-412, FDR Generic Parameter Listings
- Table2 Singapore Airline flight SQ006 B747-412, FDR flight Control Parameter Listings
- Table3 Singapore Airline flight SQ006 B747-412, FDR Engine Parameter Listings
- Table 4 Singapore Airline flight SQ006 B747-412, OQAR Generic Parameter Listings [readout from NVM memory chip]

8B-3 SQ006 FDR Parameters Plots

- Fig 1 FDR generic parameters Plot and Related CVR transcripts
- Fig 2 FDR flight control parameters plot and related CVR transcripts
- Fig 3 FDR four engine parameters plot and related CVR transcripts
- Fig 4 FDR last 40 seconds parameters plot and related CVR transcripts
- Fig 5 Singapore SQ006 accident: Flight path Vs. Sat. Map with ground scars, and wreckage distribution
- Fig 6 3D animation with air-photography, flight path and generic panels

8B-4 SQ006 Technical Inspection Report-SQ006 OQAR