

STS-107 Mishap Investigation - Summary Time Line
-BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Sum No.	GMT GMT Day 32	Milestone	Entry Event	Remarks	MSID
1	13:10:39	TIG-5	APU 2 Start		
2	13:15:30	TIG	OMS TIG		
3	13:18:08		OMS End of Burn		
4	13:31:25	EI-13	APU 1 Start		
5	13:31:29		APU 3 Start		
6	13:44:09	EI	Entry Interface (400,000 ft)	Mach 24.57	
----- 32:13:50:00 -----					
7	13:50:53	Start of Peak Heating		Determined by analysis	
----- 32:13:51:00 -----					
7.3	13:51:19 / 13:52:49		Remote sensors indicate off-nominal external event	L2L, L3L, and R2R jet firings occurred near event.	n/a
7.35	13:51:46		Inertial Beta goes and stays Negative until LOS		V90H2249C
----- 32:13:52:00 -----					
7.4	13:52:05		First clear indication of off-nominal aero increments	Delta yawing moment coefficient only (as compared to nominal aero). Derived by analysis.	n/a
7.5	13:52:17	Approx Vehicle Ground Location: 39.0 N / -129.2 W	Altitude 236,800 ft / Mach 23.6 - Over the Pacific Ocean, approx 300 miles West of California Coastline	Approx vehicle position when first off-nominal data was seen; Data source: STS-107 GPS Trajectory Data	
8	13:52:17 / 52:41		LMG Brake Line Temps (D, A, C) (3) - start of off nominal trend	Unusual Temperature Increase	V58T1703A V58T1702A
8.5	13:52:32/55		Supply H2O Dump Nozzle Temps (A, B) (2) and Vacuum Vent Temp (1) - transient (15 to and 23 seconds, respectively) increase in typical rise rates.	GMT shown indicates initial rise duration. Supply H2O Dump Nozzle temps took additional 48 secs to return to nominal temp rise, vacuum vent temps took additional 40 secs to return to nominal rise.	V58T1700A V62T0440A V62T0439A V62T0551A
9	deleted				
10	13:52:59		Left INBD Elevon Lower Skin Temp (1) - OSL	Began trending down 3 secs earlier	V09T1006A
----- 32:13:53:00 -----					
10.5	13:53:01		First clear indication of off-nominal rolling moment increment	Start of steady (-) growth in roll moment. Derived by analysis.	n/a
11	13:53:10 / 36		Hydraulic System Left Outbd / Inbd Elevon Return Line Temps (4) - OSL	OSL was preceded by Nominal Temp rise.	V58T0394A V58T0193A V58T0157A V58T0257A
11.2	13:53:26	Approx Veh Grd Location: 38.7 N / -123.5 W	Altitude 231600 ft / Mach 23.0 - Crossing the California Coastline	Data source: STS-107 GPS Trajectory Data	
11.5	13:53:44 / 54:11		1st reported debris (5) observed leaving the Orbiter just aft of Orbiter envelope (Debris # 1 thru 5)	EOC video # EOC2-4-0026, 0056, & 0064. No evidence of jet firings near events.	n/a
----- 32:13:54:00 -----					
12	deleted				
13	13:54:10 / 55:12		Left Main Gear Brake Line Temp B (1) / Strut Actuator Temp (1) / Sys 3 LMG Brake Sw Viv Ret Line Temp (FWD) (1) - start of off nominal trend	Unusual Temperature Increase	V58T1701A V58T0405A V58T0842A
14	13:54:20		Start of slow aileron trim change; Reversal in trend of derived rolling moment coefficient.	GMT is approximate (+/- 10 sec) for aileron. Observed roll moment changed from a negative to positive slope. Derived by analysis.	V90H1500C
15	13:54:22		Mid Fuselage LT BondLine Temp at x1215 (1) & LH Aft Fus Sidewall Temp at x1410 (1) - start of off nominal trend	Unusual increase in temperature rise rate	V34T1106A V09T1724A
15.3	13:54:33.3 / 37		Flash #1 - Orbiter envelope suddenly brightened (duration 0.3 sec), leaving noticeably luminescent signature in plasma trail; plus Debris # 6 - report of very bright debris observed leaving the Orbiter just aft of the Orbiter envelope.	EOC video # EOC2-4-0026, 0034, & 0009B. R3R and R2R jet firings occurred near events. Debris events 6 & 14 are visually the biggest, brightest events & therefore may indicate the most significant changes to the Orbiter of the western debris events.	n/a
----- 32:13:55:00 -----					
15.35	13:55:04 / 55:30		Debris # 7 thru 10 observed leaving the Orbiter just aft of Orbiter envelope. Debris #8 event was followed by momentary brightening of plasma trail. Debris #9 event was followed by multiple secondary plasma trails.	EOC video # EOC2-4-0005, 0017, 0021, 0028, and 0030. No evidence of jet firings near events.	n/a
15.4	13:55:30		Remote sensors indicate off-nominal external event	GMT is approximate. Preliminary match to debris shedding seen in video #10 (Ivins, UT). No evidence of jet firings near event.	n/a

STS-107 Mishap Investigation - Summary Time Line
-BASELINE-

02/27/2003 6 PM

Integ Time Line Team - REV 14 BASELINE

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Sum No.	GMT GMT Day 32	Milestone	Entry Event	Remarks	MSID
15.45	13:55:36 / 56:13		Debris # 11 thru 15 observed leaving the Orbiter just aft of Orbiter envelope. Debris #12 event was preceded and followed by secondary plasma trails. Debris #13 event was followed by momentary brightening of plasma trail adjacent to debris. Debris #14 event consisted of very bright debris observed leaving the Orbiter.	EOC video # EOC2-4-0005, 0017, 0021, 0028, 0030, and 0050. No evidence of jet firings near events. (Nearest jet firings occur at 56:17.) Debris events 6 & 14 are visually the biggest, brightest events & therefore may indicate the most significant changes to the Orbiter of the western debris events.	n/a
15.5	13:55:41		Mid Fuselage Port (Left) Sill Longerons Temp at X1215 - start of off nominal trend	Unusual Temperature Increase	V34T1118A
----- 32:13:56:00 -----					
16	13:56:03 / 56:24		Left Lower/Upper Wing Skin Temps - Trending down (2)	Indication of potential measurement failures	V09T1002A V09T1024A
16.5	13:56:16 / 56:53		Hyd Sys 1 LMG Uplock Actuator Unlock Line Temp; Sys 3 LMG Brake Sw Vlv Ret Line Temp (FWD); LMG Brake Line Temp C; LMG Brake Line Temp B; Sys 3 Left Main Gear Strut Actuator Temp - all show a temp rise rate change.	Significant increase in temp rise rate on all four lines	V58T0125A V58T1701A V58T0842A V58T0405A V58T1702A
----- 32:13:57:00 -----					
16.7	13:57:19 / 24		MLG LH Outbd Tire Pressures 1 & 2 - start of small increase in pressures	Not seen in previous flights	V51P0570A V51P0572A
17	13:57:28 / 43		Left Lower/Upper Wing Skin Temps (2) - OSL		V09T1002A V09T1024A
18	deleted				
19	13:57:54		Sys 2 LH Brake Sw Vlv Return Temp (1)	Unusual Temperature Increase	V58T0841A
----- 32:13:58:00 -----					
20	13:58:03		Start of sharp aileron trim Increase	GMT is approximate (+/- 10 sec)	V90H1500C
20.5	13:58:09		Increase in derived rolling and yawing moment increments	Substantial increase in observed growth rate of both roll and yaw moment increments. Derived by analysis.	n/a
21	deleted				
22	deleted				
22.5	13:58:16		LMG Brake Line Temp D - Temp rise rate change	Significant increase in temp rise rate.	V58T1703A
23	13:58:32 / 54		MLG LH Inbd / Outbd Tire Pressures (4) - Decay to OSL		V51P0570A V51P0573A V51P0571A V51P0572A
24	deleted				
25	13:58:39 / 48		MLG LH Inbd/Outbd Wheel Temps (2) - OSL		V51T0574A V51T0575A
25.5	13:58:40		BFS Fault Msg (4) - Tire Pressures - 1st Message		
26	13:58:56		BFS Fault Msg (4) - Tire Pressures - Last Message		
----- 32:13:59:00 -----					
27	13:59:06		Left Main Gear Downlocked Indication - Transferred ON		V51X0125E
27.5	13:59:23		Loss of MCC real-time data to the workstations in the FCR and MER		
28	13:59:30.66 / 30.68		Start of two yaw jets firing (R2R and R3R)	Fired continuously until end of data at 13:59:37.4	V79X2634X V79X2638X
29	13:59:31		Observed elevons deflection at LOS	Left: -8.11 deg (up) Right: -1.15 deg (up)	
29.3	13:59:31.4 / 34.5		Several events and PASS and BFS FSM messages during this time period all indicate the failure signature of ASA 4	ASAs responded appropriately. However, signature is indicative of failure of ASA 4.	V57H0253A (5 Hz)
29.5	13:59:32		Observed aileron trim at LOS	-2.3 degrees	
30	deleted				
31	deleted				
32	deleted				
32.5	13:59:32	Approx Veh Grd Location: 32.9 N / -99.0 W	Altitude ~200700 ft / Mach ~18.1 - Near Dallas TX	Approximate Vehicle Ground Location at Loss of Signal based on GMT; Data source: STS-107 GPS Trajectory Data	n/a
33	13:59:32.136	LOS	Last valid downlink frame accepted by ODRC - OI / BFS / PASS. Start of reconstructed data.	Nominal loss of comm at this GMT (for ~15 sec max based on previous fit data)	
34	deleted				
35	13:59:35/36		Sideslip on vehicle changes sign.	The event occurred between the two times listed. Aerodynamic forces due to sideslip are now reinforcing aerodynamic asymmetry.	n/a
36	13:59:36		Growth in Bank attitude error	Up until this time the flight control had been able to maintain the Bank error around 5 deg.	

STS-107 Mishap Investigation - Summary Time Line

-BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Sum No.	GMT GMT Day 32	Milestone	Entry Event	Remarks	MSID
37	13:59:36.8		Aerojet DAP Requests Third Right Yaw RCS Jet (R4R)	This additional jet is required to counteract the increasing aerodynamic moments on the vehicle. Fired continuously until end of data at 13:59:37.4	
38	13:59:37.3		Aerojet DAP Requests Third Right Yaw RCS Jet (R1R)	This additional jet is required to counteract the increasing aerodynamic moments on the vehicle. Fired continuously until end of data at 13:59:37.4	
39	13:59:37.n		Last aileron data	The aileron position is now approx -5.2 deg with approx -2.5 deg of aileron trim. The rate of change of aileron trim had reached the maximum allowed by the flight control system.	
40	13:59:37.396	End of 5-second period of reconstructed data	End of first 5-seconds of the 32-second period of post-LOS data. Start of approximately 25 seconds of no data available	GMT derived by MER data personnel	n/a
41	13:59:46.347 / 14:00:01.900*		PASS Fault Message annunciation - ROLL REF PASS Fault Message annunciation - L RCS LEAK BFS Fault Message annunciations - L RCS LEAK (2)	*Time info corrupted for 14:00:01.900 GMT event.	
----- 32:14:00:00 -----					
42	14:00:02/06	Beginning of 2-second period of reconstructed data	Debris A observed leaving the Orbiter - Large debris seen falling away from the Orbiter envelope.	EOC videos # EOC2-4-0024, EOC2-4-0018 & EOC2-4-0118	n/a
43	14:00:02.654		PASS Fault Message annunciation - L RCS LJET		
44	14:00:02.660		Start of last 2-seconds of the 32 second period of post-LOS data.		
<p>During this final 2 second period of reconstructed data, the data indicates the following systems were <u>nominal</u>: APUs were running and WSB cooling was evident. MPS integrity was still evident. Fuel cells were generating power and the PRSD tanks/lines were intact. Comm and nav aids systems in the forward fuselage were performing nominally. RSB, Body Flap, main engine, and right wing temps appeared active. ECLSS performance was nominal.</p> <p>During this final 2 second period of reconstructed data, the data indicates the following systems were <u>off-nominal</u>: All three Hyd systems were lost. The left inbd/outbd elevon actuator temps were either OSL or no data exists. Majority of left OMS pod sensors were either OSH or OSL or no data exists. Elevated temps at bottom bondline centerline skin forward and aft of the wheel wells and at the port side structure over left wing were observed. EPDC shows general upward shift in Main Bus amps and downward shift in Main Bus volts. AC3 phase A inverter appeared disconnected from the AC Buss.</p> <p>GNC data suggests vehicle was in an uncommanded attitude and was exhibiting uncontrolled rates. Yaw rate was at the sensor maximum of 20 deg/sec. The flight control mode was in AUTO. (Note that all Nav-derived parameters (e.g., alpha) are suspect due to high rates corrupting the IMU state.)</p>					
45	14:00:03.470 / 14:00:03.637		BFS Fault Message annunciation - L OMS TK P BFS Fault Message annunciation - SM1 AC VOLTS PASS Fault Message annunciation - L RCS PVT		
46	14:00:03.637		PASS Fault Message annunciation - DAP DOWNMODE RHC	The s/w process which logs the PASS message runs every 1.92 seconds, so this event could have occurred as early as 14:00:01.717 GMT. However, during the 2 sec period, available vehicle data indicates RHC was in detent and DAP was in AUTO.	
47	14:00:04.826	End of 2-second period of reconstructed data	Last OI Downlink frame		n/a
48	14:00:17 / 22		Debris B and C observed leaving the Orbiter	EOC videos # EOC2-4-0024 & -0118 (for both B and C)	n/a
49	14:00:21 / 25		Vehicle Main Body break-up	EOC videos # EOC2-4-0024, -0018 & -0118	n/a
50	14:00:53	End of Peak Heating		Determined by analysis	

█ = Nominal/Expected Event or Performance

STS-107 Mishap Investigation - Master Time Line -BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
1	1	13:10:39	TIG-5	APU 2 Start - Low Press		
2	2	13:15:30	TIG	OMS TIG		
3	3	13:18:08		OMS End of Burn		
4		13:26:09		FRCS Dump Start		
5		13:27:12		FRCS Dump Complete		
6	4	13:31:25		EI-13	APU 1 Start - Low Press	
7	5	13:31:29	APU 3 Start - Low Press			
8		13:31:57		APU 1 Norm Press		
9		13:31:59		APU 2 Norm Press		
10		13:32:01		APU 3 Norm Press		
11		13:32:29		SSME Engine Stow sequence start	Sequence was completed with closure of TVC Iso Vlv 1 at 13:33:30 GMT.	
12		13:39:09		EI-5 (304 PRO)	Mach 24.40	V90Q8001C
13		13:39:11		Speedbrake close & Rudder cmded to zero		
14	6	13:44:09	EI	Entry Interface (400,000 Ft)	Mach 24.57	
15		13:46:48	Qbar 0.5 psf		Mach 24.66	
16		13:47:52	Qbar 2.0 psf	Elevon, BF active	Mach 24.66	
17		deleted				
17.5		13:49:07	ISELECT = 2	Closed-Loop Guidance		
18		13:49:16	Qbar 10 psf	Roll Jets Deactivated	Mach 24.57	
19		deleted				
20		13:49:32		Initial Roll	Mach 24.51	
20.5		13:50:30	1st Entry Heating Indication	Nominal Rise in Center Line Bond Temp (1) due to Entry Heating	Aft fuselage center bottom bond line	V90H1044C V09T1702A
21	7	13:50:53	Start of Peak Heating		Determined by analysis	
21.5	7.3	13:51:19 / 13:52:49		Remote sensors indicate off-nominal external event - earliest known event	Note: L2L jet firing at 13:51:45.38 / 51.45.62. L3L jet firing at 13:51:45.36 / 41.45.60. R2R/R3R jet firings between 13:52:08 / 52:15 during data loss (firings determined by inj temp). R2R/R3R jet firings between 13:52:24 / 52:32 during data loss (firing determined by inj temps). (RCS data taken from Atlas analysis and plotted data).	
22	7.35	13:51:46		Inertial sideslip angle (Beta) goes and stays Negative until LOS	While the magnitude of the observed Beta is not outside the flight history (41G & 42), the almost linear negative ramp prior to the first roll reversal is not consistent with other flights reviewed. This is consistent with a negative rolling and yawing torque on the vehicle.	V90H2249C

STS-107 Mishap Investigation - Master Time Line -BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
22.5	7.4	13:52:05		First clear indication of off-nominal aero increments	Delta yawing moment coefficient only (as compared to nominal aero). Derived by analysis.	
23		deleted				
23.3		13:52:15	2nd Entry Heating Indication	Nominal Rise in Center Line Bond Temps (2) due to Entry Heating	Mid Fus Lower "Mid" Skin Temp Mid Fus Bottom Center Bond Line Temp X1214	V34T1110A V34T1112A
23.5	7.5	13:52:17	Approx Vehicle Ground Location: 39.0 N / -129.2 W	Altitude 236,800 ft / Mach 23.6 - Over the Pacific Ocean, approx 300 miles West of California Coastline	Approx vehicle position when first off-nominal data was seen; Data source: STS-107 GPS Trajectory Data	
24	8	13:52:17		LMG Brake Line Temp D - On wheel well inbd sidewall (aft of sw vlvs) - Start of off nominal trend	Initiation of temp rise - off nominal based on rise rate comparison with flight experience.	V58T1703A
24.5		deleted				
24.7		deleted				
24.8	8.5	13:52:32		Supply H2O dump Nozzle temps A/B show temporary increase in temp rise rate (15 second duration of high rise rate).	High rise rate is bounded by data loss. Increase in rise rate not observed on previous flights. GMT shown indicates start of initial rise duration. Reference event seq no. 26.6 for termination of event.	V62T0440A V62T0439A
24.9	8.5	13:52:32		Vacuum vent temp shows temporary increase in temp rise rate (23 second duration of high rise rate).	High rise rate is bounded by data loss. Increase in rise rate not observed on previous flights. GMT shown indicates start of initial rise duration. Reference event seq no. 26.65 for termination of event.	V62T0551A
25	8	13:52:41		LMG Brake Line Temp A - On strut facing MLG door - start of off nominal trend	Initiation of temp rise - off nominal based on rise rate comparison with flight experience.	V58T1700A
25.5		deleted				
26	8	13:52:41		Left Main Gear Brake Line Temp C - Start of off nominal trend	Unusual Temp Rise	V58T1702A
26.5		deleted				
26.6	8.5	13:52:47		Supply H2O dump Nozzle temps A/B return to typical rise rates.	High rise rate is bounded by data loss. GMT shown indicates end of initial rise duration. Temp took additional 48 seconds to return to nominal temp rise (53:35 GMT).	V62T0440A V62T0439A
26.65	8.5	13:52:55		Vacuum vent temp returns to typical rise rate.	High rise rate is bounded by data loss. GMT shown indicates end of initial rise duration. Temp took additional 40 seconds to returns to nominal temp rise (53:35 GMT).	V62T0551A
26.7		13:52:56		Left INBD Elevon Lower Skin Temp - Start of off nominal trend	Temp trending down	V09T1006A
27	10	13:52:59		Left INBD Elevon Lower Skin Temp - OSL		V09T1006A

STS-107 Mishap Investigation - Master Time Line -BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID	
		GMT Day 32					
27.2	10.5	13:53:01		First clear indication of off-nominal rolling moment increment	Start of steady (-) growth in roll moment, derived by analysis	n/a	
27.5		13:53:02		Hyd Syst 1LH INBD Elevon Actr Ret Ln Temp - start of off nominal trend Hyd Syst 3 LOE Ret LN Temp - start of off nominal trend	Temp trending down Temp trending down	V58T0157A V58T0394A	
28	11	13:53:10		Hyd Syst 3 LOE Ret LN Temp - OSL	OSL was preceded by Nominal Temp rise	V58T0394A	
29	11	13:53:11		Hyd Syst 1LH INBD Elevon Actr Ret Ln Temp - OSL	OSL was preceded by Nominal Temp rise	V58T0157A	
29.3		13:53:24	Alpha Modulation Approx Veh Grd Location: 38.7 N / -123.5 W	Angle of attack modulation active	Data source: STS-107 GPS Trajectory Data	V90H0803C	
29.5	11.2	13:53:26		Altitude 231600 ft / Mach 23.0 - Crossing the California Coastline			
30	11	13:53:31 / 53:34		Hyd Syst 1 LOE Return Line Temp - OSL	OSL was preceded by Nom Temp rise plus data loss 3 sec's prior to event	V58T0193A	
30.3		13:53:34 / 55:57	3rd Entry Heating Indication	Nominal Rise in Center Line Bond Temps (3) due to Entry Heating	13:53:34 - V09T1016A (Mid Fus Bot Port BL T X 620); 13:54:00 - V09T1022A (Mid Fus Bot Port BL T X 777); 13:55:57 - V09T1624A (Fwd Fus Lwr Skin Bot CL T)	V09T1016A V09T1022A V09T1624A	
30.5	11	13:53:34		Hyd Sys 2 LIE Return Ln Temp - Start of Off Nominal Trend	Temp trending down	V58T0257A	
31		13:53:36		Hyd Sys 2 LIE Return Ln Temp - OSL		V58T0257A	
31.5		deleted					
31.7		deleted					
32		deleted					
32.1	11.5	13:53:44 / 48		Debris #1 - First report of debris observed leaving the Orbiter	Seen just aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	EOC2-4-0064 EOC2-4-0056	
32.3	11.5	13:53:46 / 50		Debris #2 - Second report of debris observed leaving the Orbiter	Seen just aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	EOC2-4-0064 EOC2-4-0056	
32.5		13:53:46		LMG Brake Line Temp A - On strut facing MLG door - Start of off nominal trend (temp rise rate change)	Temp rise rate change from 1.4 F/min to 5.5 F/min and increasing to LOS	V58T1700A	
32.7	11.5	13:53:54 / 58		Debris #3 - Third report of debris observed leaving the Orbiter. Event followed by momentary brightening of plasma trail.	Seen just aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	Debris: EOC2-4-0056, 0026 Trail: EOC2-4-0064, 0056	
32.8	11.5	13:54:00 / 04		Debris #4 - Fourth report of debris observed leaving the Orbiter	Seen just aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	EOC2-4-0056 EOC2-4-0026	
32.9	11.5	13:54:07 / 11		Debris #5 - Fifth report of debris observed leaving the Orbiter	Seen just aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	EOC2-4-0056 EOC2-4-0026	
33	13	13:54:10		LMG Brake Line Temp B - Start of off nominal trend	Temp Increase	V58T1701A	

STS-107 Mishap Investigation - Master Time Line -BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
34	14	13:54:20		Start of slow aileron trim change	GMT is approximate (13:54:20 +/- 10 seconds) Observed moment changed from a negative slope to positive slope. Derived by analysis.	V90H1500C n/a
34.5	14	13:54:20		Reversal in growth trend of derived roll moment coefficient		
35	15	13:54:22		M-FUS LT BL Temp at x1215 - start of off nominal trend (increased rise rate)	Unusual Temp Rise (Rise rate higher than STS-109 & 87). Rise rate increased from 1 F/min (typical) to 7.6 F/min.	V34T1106A
35.2	15	13:54:22		LH Aft Fus Sidewall Temp at x1410 - start of off nominal trend (increased rise rate)		
35.5	13	13:54:24		Sys 3 Left Main Gear Strut Actuator Temp - start of off nominal trend	Unusual Temp Rise	V58T0405A
35.7		13:54:25	Approx Veh Grd Location: 38.3 N / -119.0 W	Altitude 227400 ft / Mach 22.5 - Crossing the California / Nevada State Line	Data source: STS-107 GPS Trajectory Data	
36		deleted				
36.5	15.3	13:54:33.3 / 33.9		Flash #1 - Orbiter envelope suddenly brightened (duration 0.3 sec), leaving noticeably luminescent signature in plasma trail	Note: R3R and R2R 0.24 sec jet firings occurred at 13:54:33.52 / 33.76 and 13:54:33.54 / 33.78 respectively (ref: RCS Atlas analysis).	EOC2-4-0026 EOC2-4-0034 EOC2-4-0009B
36.6	15.3	13:54:35 / 37		Debris #6 - Very bright debris seen leaving the Orbiter	Seen just aft of Orbiter envelope. Also, reference note in item # 36.5 above. Debris events 6 and 14 are visually the biggest, brightest events and therefore may indicate the most significant changes to the Orbiter of the western debris events.	EOC2-4-0026 EOC2-4-0009B EOC2-4-0030
37		deleted				
37.5		deleted				
37.7		13:54:53		MLG LH Outbd Wheel Temp - start of off nominal trend	2 bit flips up (ref #56.5 when temp starts to trend down)	V51T0574A
37.75	15.35	13:55:04 / 10		Debris #7 - Seventh report of debris observed leaving the Orbiter	Seen just aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	EOC2-4-0030
37.8	13	13:55:12		Sys 3 LMG Brake Sw Vlv Ret Line Temp (FWD) - start of off nominal trend	Temp Increase	V58T0842A
38		deleted				
39		deleted				
40		13:55:21	Drag 11 fps2	Drag Measurement Incorporation	Mach 21.nn	

STS-107 Mishap Investigation - Master Time Line -BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
40.1	15.35	13:55:21 / 27		Debris #8 - Eighth report of debris observed leaving the Orbiter. Event was followed by momentary brightening of plasma trail.	Seen just aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	Debris: EOC2-4-0030; trail: EOC2-4-0005, 0017, 0021, 0028, and 0030
40.2	15.35	13:55:25 / 29		Debris #9 - Ninth report of debris observed leaving the Orbiter. Event was followed by multiple secondary plasma trails.	Seen just aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	EOC2-4-0030, 0050
40.3	15.35	13:55:26 / 30		Debris #10 - Tenth report of debris observed leaving the Orbiter	Seen well aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	EOC2-4-0005
40.4	15.4	13:55:30		Remote sensors indicate off-nominal external event	GMT is approximate. Preliminary match to debris shedding seen in video from Ivins, UT (Debris #10). Strong confidence that this is an off-nominal event. No evidence of RCS jet firings (ref Atlas data).	
40.5		13:55:32	Approx Veh Grd Location: 37.4 N / -114.1 W	Altitude 223400 ft / Mach 21.8 - Crossing the Nevada / Utah State Line	Data source: STS-107 GPS Trajectory Data	
41		deleted				
41.5	15.45	13:55:36 / 42		Debris #11 - Eleventh report of debris observed leaving the Orbiter	Seen well aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	EOC2-4-0050
42	15.5	13:55:41		Mid Fus Port (Left) Sill Longn Temp at x1215 - start of off nominal trend	Unusually high temp rise with respect to STS-87 & 109. Went to 2.6 F/min from 0 F/min.	V34T1118A
42.3	15.45	13:55:45 / 49		Debris #12 - Twelfth report of debris observed leaving the Orbiter. Event was preceded and followed by secondary plasma trails.	Seen aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	EOC2-4-0028, 0050
42.5		13:55:55	Approx Veh Grd Location: 37.0 N / -112.4 W	Altitude 222100 ft / Mach 21.5 - Crossing the Utah / Arizona State Line	Data source: STS-107 GPS Trajectory Data	
42.7	15.45	13:55:55 / 59		Debris #13 - Thirteenth report of debris observed leaving the Orbiter. Event was followed by momentary brightening of plasma trail adjacent to debris.	Seen well aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data).	EOC2-4-0005, 0017, 0021

STS-107 Mishap Investigation - Master Time Line -BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
42.8	15.45	13:55:58 / 56:00		Debris #14 - Very bright debris observed leaving the Orbiter.	Seen just aft of Orbiter envelope. Debris events 6 and 14 are visually the biggest, brightest events and therefore may indicate the most significant changes to the Orbiter of the western debris events.	EOC2-4-0005, 0017, 0021, 0028, 0030
43		13:56:02	Qbar 40 psf	Aft RCS Pitch Jets Deactivated		
44	16	13:56:03		Left Lower Wing Skin Temp - start of off nominal trend	Temp reading trending down (potential sensor/wire damage)	V09T1002A
44.2	15.45	13:56:09 / 13		Debris #15 - Fifteenth report of debris observed leaving the Orbiter.	Seen just aft of Orbiter envelope. Nearest jet firings: R2R jet firing at 032:13:56:17.30 / 56:17.54 for 0.24 seconds, & R3R jet firing at 032:13:56:17.28 / 56:17.52 for 0.24 seconds.	EOC2-4-0017
44.5	16.5	13:56:16		Hyd Sys 1 LMG UpLK Actr Unlk Ln Temp - Temp rise rate change	Temp rise rate change from 0.7 F/min (nominal) to 3.9F/min and increasing to LOS	V58T0125A
44.6	16.5	13:56:17		Sys 3 LMG Brake Sw Vlv Ret Line Temp (FWD) - Temp rise rate change	Temp rise rate change from 1.5 F/min to 8.8 F/min (stayed at this rate to LOS)	V58T0842A
44.7	16.5	13:56:20		LMG Brake Line Temp C - Temp rise rate change	Temp rise rate change from 1.3 F/min to 9.9 F/min (stayed at this rate to LOS)	V58T1702A
44.8	16.5	13:56:22		LMG Brake Line Temp B - Temp rise rate change	Temp rise rate change from 2.1 F/min to 9.1 F/min increasing to LOS	V58T1701A
45	16	13:56:24		Left Upper Wing Skin Temp - start of off nominal trend	Temp reading trending down (potential sensor/wire damage)	V09T1024A
46		13:56:30		1st Roll Reversal Initiation	Mach 21.13	V90H1044C
46.5		13:56:45	Approx Veh Grd Location: 36.1 N / -109.0 W	Altitude 219000 ft / Mach 20.9 - Crossing the Arizona / New Mexico State Line	Data source: STS-107 GPS Trajectory Data	
46.7	16.5	13:56:53		Sys 3 Left Main Gear Strut Actuator Temp - Temp rise rate change	Temp rise rate change from 1.7 F/min to 12.9 F/min (stayed at this rate to LOS)	V58T0405A
47		13:56:55	Roll Reversal #1	1st Roll Reversal Complete	Mach 20.76	V90H1044C
48		13:56:58		IMU Velocity Increase	Reflects accelerations imparted during roll reversal. Same signature observed on STS-109. Nominal event.	
49		13:57:nn		Bodyflap deflection up 3 degrees	Matches nominal aero simulation	V90H6410C
49.5		deleted				

STS-107 Mishap Investigation - Master Time Line

-BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
49.6		13:57:19		MLG LH Outbd Tire Pressure 1 - start of off nominal trend	Bit flip up - off nominal thru comparison with previous flights	V51P0570A
49.7		13:57:24		MLG LH Outbd Tire Pressure 2 - start of off nominal trend	Bit flip up - off nominal thru comparison with previous flights	V51P0572A
50	17	13:57:28		Left Lower Wing Skin Temp - OSL		V09T1002A
51		deleted			Rationale for deletion: Originally indicated as "Start of Roll trim in elevons". Inserted independently early in the investigation, but is better defined by sequence no. 54. "Roll trim" is better indicated with aileron trim.	
52	17	13:57:43		Left Upper Wing Skin Temp - OSL		V09T1024A
53	19	13:57:54		Sys 2 LH Brake Switching Vlv Return Temp (AFT) - start of off nominal trend	Temp increase	V58T0841A
54	20	13:58:03		Start of "sharp" aileron trim increase	Mach 19.79; GMT is approximate (13:58:03+/-10 seconds)	V90H1500C
54.3	20.5	13:58:09		Increase in derived rolling and yawing moment increments	Substantial increase in observed growth rate of both roll and yaw moment increments. Derived by analysis.	n/a
54.5	22.5	13:58:16		LMG Brake Line Temp D - Temp rise rate change	Temp rise rate change from 0.9 F/min to 11.7 F/min (stayed at this rate to LOS)	V58T1703A
55		deleted				
55.5		13:58:20	Approx Veh Grd Location: 34.2 N / -103.1 W	Altitude 209800 ft / Mach 19.5 - Crossing the New Mexico / Texas State Line	Data source: STS-107 GPS Trajectory Data	
56		deleted				
57	23	13:58:32		MLG LH Outbd Tire Pressure 1 - pressure trending down (to OSL)	Trending to OSL following 7 sec LOS (initiation time not exact) - ref #60	V51P0570A
58	23	13:58:32		MLG LH Inbd Tire Pressure 1 - pressure trending down (to OSL)	Trending to OSL following 7 sec LOS (initiation time not exact) - ref #64	V51P0571A
58.5		13:58:32		MLG LH Outbd Wheel Temp - temperature trending down (to OSL)	Trending to OSL following 7 sec LOS (initiation time not exact) - ref #62	V51T0574A
58.7		13:58:32 / 59:22		Sys 2 LH Brake Switching Vlv Return Temp (AFT) - temp rise rate change	Temp rise rate change from 2.5 F/min to 40.0 F/min until 13:59:22 (temp peak) - ref #70.5	V58T0841A
59		13:58:36		MLG LH Inbd Wheel Temp - start of temperature trending down (to OSL)	Start of trend to OSL - ref #66	V51T0575A
60	23	13:58:38		MLG LH Outbd Tire Pressure 1 - OSL		V51P0570A
61		deleted			Rationale for deletion: Moved to seq no. 63.5 after further data review.	
62	25	13:58:39		MLG LH Outbd Wheel Temp - OSL		V51T0574A
63	23	13:58:39		MLG LH Outbd Tire Pressure 2 - start of pressure trending down (to OSL)	Start of trend to OSL - ref #68	V51P0572A

STS-107 Mishap Investigation - Master Time Line

-BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT		Milestone	Entry Event	Remarks	MSID / ID
		GMT Day	GMT 32				
63.5	25.5	13:58:40			BFS Fault Msg (4) - Tire Pressures - First Message	32/13:58:39.94 - SM0 Tire P LOB 32/13:58:41.84 - SM0 Tire P LIB 32/13:58:49.54 - SM0 Tire P LIB 32/13:58:56.26 - SM0 Tire P LOB	
64	23	13:58:40			MLG LH Inbd Tire Pressure 1 - OSL		V51P0571A
65		13:58:41			MLG LH Inbd Tire Pressure 2 - start of off nominal trend	Press rose ~3.5 psia in 2 sec's	V51P0573A
65.5	23	13:58:43			MLG LH Inbd Tire Pressure 2 - start of pressure trending down		V51P0573A
66	25	13:58:48			MLG LH Inbd Wheel Temp - OSL		V51T0575A
67	23	13:58:48			MLG Inbd Tire Pressure 2 - OSL		V51P0573A
68	23	13:58:54			MLG LH Outbd Tire Pressure 2 - OSL		V51P0572A
69	26	13:58:56			BFS Fault Msg (4) - Tire Pressures - Last Message		
70	27	13:59:06			Left Main Gear Downlocked Indication - Transferred ON	Uplock indicated no change	V51X0125E
70.3	27.5	13:59:23			Loss of MCC real-time data to the workstations in the FCR and MER		
70.5		13:59:22			Sys 2 LH Brake Switching Vlv Return Temp (AFT) - start of sharp downward temperature trend	Temp trending down until loss of signal - ref #81	V58T0841A
71	28	13:59:30.66			Start of R2R yaw firing	Last pulse before LOS (stayed on to end of first 5-sec period of recon data at 032/13:59:37.4 GMT)	V79X2634X
72	28	13:59:30.68			Start of R3R yaw firing	Last pulse before LOS (stayed on to end of first 5-sec period of recon data at 032/13:59:37.4 GMT)	V79X2638X
73	29	13:59:31			Observed elevons deflection at LOS	Left: -8.11 deg (up); Right: -1.15 deg (up)	V90H7505C V90H7555C
73.1	29.3	13:59:31.400			FCS Channel 4 Aerosurface position measurements start trending towards their null values	Indicates worsening failure of transducer excitation via a wiring short conditions	V57H0253A (5 Hz)
73.2	29.3	13:59:31.478			All FCS Channel 4 Bypass valves close (indicating bypassed)	Leading indicator of ASA fail (high-rate data)	V58P0915A
73.3	29.3	13:59:31.7			Speedbrake channel 4 OI position measurement indicated successively 19, 20, 24 degrees over last three samples prior to LOS (should be closed / 0°).	Speedbrake was commanded to "overclose" (-10 degrees), position measurements for Channels 1 thru 3 were 0 degrees. Secondary delta pressure on Ch 4 went to zero, which indicates that the channel was bypassed. This is real data and the ASAs were responding appropriately.	V57H0253A (5 Hz)

STS-107 Mishap Investigation - Master Time Line

-BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
73.5	29.5	13:59:32		Observed aileron trim at LOS	Trim: -2.3 deg (V96H2045C - V90H1500C)	
74		13:59:32		M-FUS LT BL Temp at x1215 - LOS	LOS	V34T1106A
74.5		13:59:32		LH Aft Fus Sidewall Temp at x1410 - LOS	LOS	V09T1724A
75		13:59:32		LMG Brake Line Temp A - LOS	LOS at 172.2 F	V58T1700A
76		13:59:32		LMG Brake Line Temp B - LOS	LOS at 154.2 F	V58T1701A
77		13:59:32		LMG Brake Line Temp C - LOS	LOS at 104.8 F	V58T1702A
78		13:59:32		LMG Brake Line Temp D - LOS	LOS at 88.3 F	V58T1703A
79		13:59:32		Left Main Gear Strut Actuator Temp - LOS	LOS at 76.3 F	V58T0405A
80		13:59:32		Hyd Sys 1 LMG Upk Actr Unlk Ln Temp - LOS	LOS at 52.2 F	V58T0125A
81		13:59:32		Sys 2 LH Brake Sw Vlv Return Temp (AFT) - LOS	LOS at 62.8 F	V58T0841A
82		13:59:32		Sys 3 LMG Brake Sw Vlv Return Line Temp (FWD) - LOS	LOS at 67.3 F	V58T0842A
82.7	32.5	31:59:32	Approx Veh Grd Location: 32.9 N / -99.0 W	Altitude ~200700 ft / Mach ~18.1 - Near Dallas TX	Approximate Vehicle Ground Location at Loss of Signal based on GMT; Data source: STS-107 GPS Trajectory Data	
82.8	29.3	13:59:32.130		FCS Channel 4 fail flags raised (1 Hz) on all aerosurface actuators	Lagging indicator of ASA position measurement discrepancy	V79X3263X V79X3268X V79X3273X V79X3278X V79X3334X V79X3339X
83	33	13:59:32.136	LOS (Loss of Signal)	Last valid downlink frame accepted by ODRC - OI / BFS / PASS (This time has been referred to as "LOS" throughout the investigation.) Start of reconstructed data	Upper Right Aft (URA) Quad Antenna was selected by BFS Antennae Manage S/W to communicate with TDRS-W. The pointing angle to TDRS-W was off the Orb tail at -65 degs and trending further into blockage. Prev experience / eng calcs predict probable loss of comm at elevation angles greater than -60 degrees. Loss of comm at this GMT is therefore considered nominal.	
84	29.3	13:59:32.195		ASA 4 RPC A&C Trip Indication	Lagging indicator of ASA transducer excitation short condition	V79X4210E V76X4211E
85	29.3	13:59:33.560		BFS Fault Message annunciation (1) - FCS CH 4	TDRS-E Data	

STS-107 Mishap Investigation - Master Time Line -BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
85.5	29.3	13:59:32.598		Left Outboard bypass valve reopens. A force fight between channels 1/2/3 and channel 4 begins, resulting in a difference of up to 0.5 degrees observed between the left outboard and inboard elevons	Indicates a short in bypass valve has grown sufficient to drop below voltage threshold of valve; RPC B is current limiting.	V58P0865A
86	29.3	13:59:33.863		PASS Fault Message annunciation (1) - FCS CH 4	TDRS-E Data	
87		13:59:33.976		Master Alarm noted.	D&C analysis is continuing to determine cause of alarm.	
88	29.3	13:59:34.518		Left Outboard force fight ends, driver currents go to zero. (RPC B trip indication).	Leading indicator of RPC B trip / ASA power down. I.e., indicates opening of all bypass valves (due to RPC B trip removing power) on ASA 4. Force fight goes away since actuators are already at the last commanded position (so channel 4 has no hyd load on the servo asking for position change).	V58P0865A
89	29.3	13:59:34.561		Speedbrake force fight begins (continues to LOS)	Indicates opening of all bypass valves (due to RPC B trip removing power) on ASA 4. Since the speedbrake is at zero but is being commanded to "over-close" position (-10) this results in a force fight between channels 1,2,3 and channel 4.	V57P0260A V57P0261A V57P0262A
90	35	13:59:35/36		Sideslip on vehicle changes sign.	The event occurred between the two times listed. Just prior to initial LOS the magnitude of the negative Sideslip started to decrease and between 59:34 and 59:37 sideslip grew from -.6 to +.8 deg. With this change, the normal roll and yaw moments on the vehicle would change sign. Aerodynamic forces due to sideslip are now reinforcing aerodynamic asymmetry.	
91	36	13:59:36		Growth in Bank attitude error	Up until this time the flight control had been able to maintain the Bank error around 5 deg. Aerojet DAP drops left wing to compensate for increasing aerodynamic moments, creating a bank attitude error.	

STS-107 Mishap Investigation - Master Time Line -BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
92	37	13:59:36.8		Aerojet DAP Requests Third Right Yaw RCS Jet (R4R)	This additional jet is required to counteract the increasing aerodynamic moments on the vehicle. The RCS jet fired, as expected and stayed on to end of first 5-sec period of recon data at 032/13:59:37.4 GMT.	
93	38	13:59:37.3		Aerojet DAP Requests Fourth Right Yaw RCS Jet (R1R)	This additional jet is required to counteract the increasing aerodynamic moments on the vehicle. The RCS jet fired, as expected and stayed on to end of first 5-sec period of recon data at 032/13:59:37.4 GMT.	
94	39	13:59:37.n		Last aileron data	The aileron position is now approx -5.2 deg with approx -2.5 deg of aileron trim. The rate of change of aileron trim had reached the maximum allowed by the flight control system.	
95	40	13:59:37.396	End of 5 second period of reconstructed data	End of first 5-seconds of the 32-second period of post-LOS data. Start of approximately 25 seconds of no data available	GMT derived by MER data personnel	
96	41	13:59:46.347		PASS Fault Message annunciation - ROLL REF	Message retrieved from "fault message buffer" received between 14:00:04 and 14:00:05. The ROLL REF message is triggered when Roll command req'd to fly reference profile falls below 37 degs. Message generation less than 10 secs (5 guidance cycles) after start of 4 yaw jets firing suggests rapid change in Lift to Drag ratio.	
97	41	13:59:52.114		PASS Fault Message annunciation - L RCS LEAK	Data located in PASS fault message buffer. Data is potentially error prone.	
98	41	14:00:01.540		BFS Fault Message annunciation - L RCS LEAK	Data located in BFS fault message buffer. Data is potentially error prone.	
99	41	14:00:01.900*		BFS Fault Message annunciation - L RCS LEAK	Data located in BFS fault message buffer. Data is potentially error prone. *Time info corrupted.	
100	42	14:00:02/06		Debris A observed leaving the Orbiter - Large debris seen falling away from the Orbiter envelope.		EOC2-4-0024 EOC2-4-0018 EOC2-4-0118

STS-107 Mishap Investigation - Master Time Line -BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
101	43	14:00:02.654		PASS Fault Message annunciation - L RCS LJET	Data is potentially error prone.	
102	44	14:00:02.660	Beginning of 2 second period of reconstructed data	Start of last 2-seconds of the 32 second period of post-LOS data.	GMT derived by MER data personnel.	
				<p>CAUTION: Data from this period is suspect because multiple bit errors were evident in this reconstructed data. Many of the parameters were 1 Hz data and therefore only one data sample was available. Where possible, high rate data and/or corroborating data were used to draw subsystem performance conclusions. However, some of the conclusions drawn below may be in error or misinterpreted.</p> <p>During this final 2 second period of reconstructed data, the data indicates the following systems were <u>nominal</u>: APUs were running and WSB cooling was evident (although potentially overcooling). MPS integrity was still evident. Fuel cells were generating power and the PRSD tanks/lines were intact. Comm and nav aids systems in the forward fuselage were performing nominally. RSB, Body Flap, main engine, and right wing temps appeared active. With the exception of an apparent FES shutdown, ECLSS performance was nominal.</p> <p>During this final 2 second period of reconstructed data, the data indicates the following systems were <u>off-nominal</u>: All three Hyd systems were lost (zero pressure/zero rsrv qty's). The left inbd/outbd elevon actuator temps were either OSL or no data exists. WSB's appeared to be overcooling APU lube oil. The FES appeared to have shutdown. Majority of left OMS pod sensors were either OSH or OSL or no data exists. Multiple BFS and PASS fault message annunciations for left pod hardware were found in the buffer. Elevated temps at bottom bondline centerline skin forward and aft of the wheel wells and at the port side structure over left wing were observed. EPDC shows general upward shift in Main Bus amps and downward shift in Main Bus volts. AC3 phase A inverter appeared disconnected from the AC Buss.</p> <p>GNC data suggests vehicle was in an uncommanded attitude and was exhibiting uncontrolled rates. Yaw rate was at the sensor maximum of 20 deg/sec. The flight control mode was in AUTO. (Note that all Nav-derived parameters (e.g., alpha) are suspect due to high rates corrupting the IMU state.)</p> <p>Based on the nominal and off-nominal system performance described above, it appears that the fwd/mid/aft fuselage, right wing, and right pod were still intact.</p>		
103	45	14:00:03.470		BFS Fault Message annunciation - L OMS TK P	Data located in BFS fault message buffer after acquisition of data. Data is potentially error prone.	
104	45	14:00:0n.nnn		BFS Fault Message annunciation - SM1 AC VOLTS	Occurred after L OMS TK P message. Data is potentially error prone.	
105	45	14:00:03.637		PASS Fault Message annunciation - L RCS PVT	Data is potentially error prone.	

STS-107 Mishap Investigation - Master Time Line

-BASELINE-

Integ Time Line Team - REV 14 BASELINE

02/27/2003 6 PM

Note: Rev 14 BASELINE corrects typo's, pinpoints last pt that MCC/MER received real-time data, adds new debris data & assoc jet firings, adjusts GMTs for BFS entry messages and adds post LOS data (including GNC). Rev 14 was approved by the OVE Working Group on 2/26/03.

Seq No.	Sum No.	GMT	Milestone	Entry Event	Remarks	MSID / ID
		GMT Day 32				
106	46	14:00:03.637		PASS Fault Message annunciation - DAP DNMODE RHC	The software process which logs the PASS message runs every 1.92 seconds, so event could have occurred as early as 14:00:01.717 GMT. The fault message was corroborated by an initialization flag for the aerojet DAP roll stick function. However, during the 2 sec period, available vehicle data indicates RHC was in detent & DAP was in AUTO.	
107	47	14:00:04.826	End of 2 second period of reconstructed data	Last OI Downlink frame	GMT derived by MER data personnel. Last Downlist frame (BFS & PASS) was approx 60 ms earlier.	
108	48	14:00:17/21		Debris B observed leaving the Orbiter	Time is for debris first seen well aft of Orbiter envelope.	EOC2-4-0024 EOC2-4-0118
109	48	14:00:18/22		Debris C observed leaving the Orbiter	Time is for debris first seen well aft of Orbiter envelope.	EOC2-4-0024 EOC2-4-0118
110	49	14:00:21/25		Vehicle Main Body break-up	Onset of vehicle main body break-up	EOC2-4-0024 EOC2-4-0018 EOC2-4-0118
111	50	14:00:53	End of Peak Heating		Determined by analysis	

= Expected/Nominal performance or event

nn = data still needed