Integ Time Line Team - REV 15 BASELINE Note: Rev 15 BASELINE corrects typo's, adds S-Band comm drop out data, & adds new debris observations & jet firings nearest the debris observations.

Rev 15 was been baselined by the OVE Working Group Team as of 3/10/03.

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15 Was b	een basenned by		Group Team as of 3/10/03.			3/10/03						Measurement				
	CMT	Milastana		Bomerke		Sor	CMT	MSID	Hostor Bk		L costion ID		Somple Date	Bit Value	Danga	Temp Rise Rates / Add
q Sum	GMT Day 32	Milestone	Entry Event	Remarks	MSID / ID	-	GMT GMT Day 32	MSID	Heater Bk ID	x	Location ID	Z	Sample Rate Hz	(R/256)	Range	Comments
1	13:10:39	TIG-5	APU 2 Start - Low Press				13:10:39			~	· ·	<u>L</u>	112	(1(/230)		
	13:15:30	TIG	OMS TIG				13:15:30									
3	13:18:08		OMS End of Burn				13:18:08									
	13:26:09		FRCS Dump Start				13:26:09									
	13:27:12		FRCS Dump Complete			5	13:27:12									
4	13:31:25	EI-13	APU 1 Start - Low Press			6	13:31:25									
	13:31:29	EI-13	APU 3 Start - Low Press				13:31:29									
Ŭ	10.01.20					· '	10.01.20									
	13:31:57		APU 1 Norm Press			8	13:31:57									
	13:31:59		APU 2 Norm Press				13:31:59									
)	13:32:01		APU 3 Norm Press			10	13:32:01									
	13:32:29		SSME Engine Stow sequence start	Sequence was completed with closure of TVC Iso VIv 1 at 13:33:30 GMT.		11	13:32:29									
						10										
2	13:39:09		EI-5 (304 PRO)	Mach 24.40	V90Q8001C		13:39:09	V90Q8001C		nn	nn	nn	nn	nn	nn	
3	13:39:11	E1	Speedbrake close & Rudder cmded to zero	Mach 24 EZ			13:39:11									
6	13:44:09 13:46:48	El Obor 0 5 pcf	Entry Interface (400,000 Ft)	Mach 24.57 Mach 24.66			13:44:09 13:46:48									
	13:46:48 13:47:52	Qbar 0.5 psf Qbar 2.0 psf	Elevon, BF active	Mach 24.66 Mach 24.66			13:46:48									
7	deleted	Qual 2.0 psi					deleted									
.5	13:49:07	ISELECT = 2	Closed-Loop Guidance				13:49:07									
3	13:49:16	Qbar 10 psf	Roll Jets Deactivated	Mach 24.57			13:49:16									
	deleted						deleted									
6.3	13:49:32		Initial Roll	Mach 24.51	V90H1044C	20	13:49:32	V90H1044C		nn	nn	nn	nn	nn	nn	
3 65	13:50:00 / 43		Five events of unexpected Return link comm	On upper left aft antenna (TDRS 171/W)		20.3	13:50:00 / 43									
0.0			drop-out.	S-Band comm drop-outs considered out-of-		20.0										
			Event 1 - 13:50:00 (1 sec); Event 2 - 13:50:04	family based on comparison with previous												
			/ 06; Event 3 - 13:50:16/22: Event 4 -	102 flight data at 39 degrees, into KSC,												
			13:50:25/28; Event 5 - 13:50:42 (1 sec)	descending node and similar look angles to TDRS.												
				IDRS.												
_																
.5	13:50:30	1st Entry Heating	Nominal Rise in Center Line Bond Temp (1) due to Entry Heating	Alt fuselage center bottom bond line	V09T1702A	20.5	13:50:30	V09T1702A		1140	-108	309	1	1.46	-75 / +300	
		Indication													1000	
7	13:50:53	Start of Peak		Determined by analysis		21	13:50:53									
		Heating														
5 7.3	13:51:19 /		Remote sensors indicate off-nominal external			21.5	13:51:19 / 13:52:49									
	13:52:49		event - earliest known event	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).												
2 7.35	13:51:46		Inertial sideslip angle (Beta) goes and stays		V90H2249C	22	13:51:46	V90H2249C		nn	nn	nn	nn	nn	nn	
			Negative until LOS	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.												
5 74	13:52:05		First clear indication of off-nominal aero	Delta yawing moment coefficient only (as		22.5	13:52:05									
- ··· (increments	compared to nominal aero). Derived by												
				analysis.												
6 7.45	13:52:09 / 15		Unexpected Return link comm drop-out	On upper left aft antenna (TDRS 171/W).		22.6	13:52:09 / 15									
			(Event 6)	S-Band comm drop-out considered out-of-												
				family based on previous flt data (same										1		
				remarks as seq # 20.3 above).												
3	deleted					23	deleted									
	13:52:15	2nd Entry	Nominal Rise in Center Line Bond Temps (2)	Mid Fus Lower "Mid" Skin Temp	V34T1110A			V34T1110A		nn	nn	nn	nn	nn	nn	
.3		Heating		Mid Fus Bottom Center Bond Line Temp	V34T1112A			V34T1112A		nn	nn	nn	nn	nn	nn	
.3				X1214												
.3		Indication					and the second									
.3	13:52:17	Indication Approx Vehicle	Altitude 236,800 ft / Mach 23.6 - Over the	Approx vehicle position when first off-		23.5	13:52:17									
.3		Indication Approx Vehicle Ground	Pacific Ocean, approx 300 miles West of	Approx vehicle position when first off- nominal data was seen; Data source: STS-		23.5	13:52:17									
.3		Indication Approx Vehicle	Pacific Ocean, approx 300 miles West of California Coastline	Approx vehicle position when first off-		23.5	13:52:17									

8	3 1	13:52:17		LMG Brake Line Temp D - On wheel well inbo sidewall (aft of sw vlvs) - Start of off nominal	Initiation of temp rise - off nominal based on rise rate comparison with flight	V58T1703A	24	13:52:17	V58T1703A	1183	-108	312	1	1.46	-75/+300
3 7.4	45 1	13:52:25 / 31		trend Two events of unexpected Return link comm drop-out	experience. On upper left aft antenna (TDRS 171/W). S-Band comm drop-out considered out-of- family based on previous flt data (same		24.3	13:52:25 / 31							
5 7 8 8.	c	deleted deleted 13:52:32		Supply H2O dump Nozzle temps A/B show temporary increase in temp rise rate (15 second duration of high rise rate).	remarks as seq # 20.3 above). 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	24.7	deleted deleted 13:52:32	V62T0440A V62T0439A						
8.	.5 1	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	24.9	13:52:32	V62T0551A						
8	3 1	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	13:52:41	V58T1700A	1116	-140.4	282.8	1	1.46	-75/+300
	C	deleted			- + - · · · · · · · · ·		25.5	deleted							
8	3 1	13:52:41		Left Main Gear Brake Line Temp C - Start of off nominal trend	Unusual Temp Rise	V58T1702A			V58T1702A	1140	-108	309	1	1.46	-75/+300
5 6 8.		deleted 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		deleted 13:52:47	V62T0440A V62T0439A						
63 7.4	45 1	13:52:49 / 55		Unexpected Return link comm drop-out (Comm event 9)	On upper left aft antenna (TDRS 171/W). S-Band comm drop-out considered out-of- family based on previous flt data (same remarks as seq # 20.3 above).		26.63	13:52:49 / 55							
65 8.:	.5 1	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	26.65	13:52:55	V62T0551A						
7	1	13:52:56		Left INBD Elevon Lower Skin Temp - Start of off nominal trend	Temp trending down	V09T1006A	26.7	13:52:56							
10	0 1	13:52:59		Left INBD Elevon Lower Skin Temp - OSL		V09T1006A		13:52:59	V09T1006A	nn	nn	nn	1	2.54	- 200/+450
		13:53:01		moment increment	Start of steady (-) growth in roll moment, derived by analysis	n/a		13:53:01							
5	1	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	27.5	13:53:02	V58T0157A V58T0394A	1350 nn	-219 nn	118 nn	1	1.46 nn	-75/+300 nn
		13:53:10 13:53:11			OSL was preceded by Nominal Temp rise OSL was preceded by Nominal Temp rise	V58T0394A V58T0157A		13:53:10 13:53:11	V58T0394A V58T0157A	1368 1350	-368 -219	nn 118	1	1.46 1.46	-75/+300 -75/+300
		13:53:24	Alpha	- OSL Angle of attack modulation active		V90H0803C			V90H0803C	nn	nn	nn	nn	nn	nn
5 11	.2	13:53:26		Altitude 231600 ft / Mach 23.0 - Crossing the California Coastline	Data source: STS-107 GPS Trajectory Data		29.5	13:53:26							
	Ę	13:53:31 / 53:34 13:53:32 / 34		Unexpected Return link comm drop-out	OSL was preceded by Nom Temp rise plus data loss 3 sec's prior to event On upper left aft antenna (TDRS 171/W). S-Band comm drop-out considered out-of- family based on previous flt data (same remarks as seq # 20.3 above).	V58T0193A		13:53:31 / 53:34 13:53:32 / 34	V58T0193A	1377	-367	436	1	1.46	-75/+300
3		13:53:34 / 55:57		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)	V09T1022A		13:53:34 / 55:57	V09T1016A V09T1022A V09T1624A	nn nn nn	nn nn nn	nn nn nn	nn nn nn	nn nn nn	nn nn nn
5	1	13:53:34		Hyd Sys 2 LIE Return Ln Temp - Start of Off Nominal Trend	Temp trending down	V58T0257A	30.5	13:53:34	V58T0257A	nn	nn	nn	nn	nn	nn
5		13:53:36 deleted		Hyd Sys 2 LIE Return Ln Temp - OSL		V58T0257A		13:53:36 deleted	V58T0257A	1348	-219	116	1	1.46	-75/+300
7		deleted deleted						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 and plots).	0064 EOC2-4-	32.1	13:53:44 / 48							
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 and plots).	0056 EOC2-4- 0064 EOC2-4- 0056	32.3	13:53:46 / 50							
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	32.5	13:53:46	V58T1700A	1116	-140.4	282.8	1	1.46	-75/+300
32.7	11.5	13:53:54 / 58			Seen just aft of Orbiter envelope. No evidence of RCS jet firings (ref Atlas data and plots).	Debris: EOC2-4- 0056, 0026 Trail: EOC2-4- 0064, 0056	32.7	13:53:54 / 58							
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 and plots).	EOC2-4- 0056 EOC2-4- 0026	32.8	13:54:00 / 04							
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 and plots).	0026 EOC2-4- 0056 EOC2-4- 0026	32.9	13:54:07 / 11							
33	13	13:54:10		LMG Brake Line Temp B - Start of off nominal	Temp Increase	0026 V58T1701A	33	13:54:10	V58T1701A	1116	-139.6	282.8	1	1.46	-75/+300
33.5	11.3	13:54:14 / 22		trend Unexpected Return link comm drop-out (Comm event 11)	On upper left aft antenna (TDRS 171/W). S-Band comm drop-out considered out-of- family based on previous flt data (same remarks as seq # 20.3 above).		33.5	13:54:14 / 22							
34	14	13:54:20		Start of slow aileron trim change	GMT is approximate (13:54:20 +/- 10	V90H1500C	34	13:54:20	V90H1500C	nn	nn	nn	nn	nn	nn
34.5	14	13:54:20		Reversal in growth trend of derived roll moment coefficient	seconds) Observed moment changed from a negative slope to positive slope. Derived by analysis.	n/a		13:54:20							
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	13:54:22	V34T1106A	1215	nn	nn	1	nn	nn
35.2	15	13:54:22		LH Aft Fus Sidewall Temp at x1410 - start of off nominal trend (increased rise rate)	Unusual Temp Rise (Rise rate higher than STS-109 & 87). Rise rate increased from 2.7 F/min (typical) to 5.5 F/min.	V09T1724A	35.2	13:54:22	V09T1724A	1410	nn	nn	nn	nn	nn
35.5	13	13:54:24		Sys 3 Left Main Gear Strut Actuator Temp - start of off nominal trend	Unusual Temp Rise	V58T0405A	35.5	13:54:24	V58T0405A	1183	-115	315	1	1.46	-75/+300
35.7		13:54:25		Altitude 227400 ft / Mach 22.5 - Crossing the California / Nevada State Line	Data source: STS-107 GPS Trajectory Data		35.7	13:54:25							
35.8		13:54:26	vv	S-Band switched from upper left aft antenna to upper right aft antenna	TDRS 171/W		35.8	13:54:26							
36		deleted						deleted							
36.5		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 and plots).	EOC2-4- 0026 EOC2-4- 0034 EOC2-4- 0009B	36.5	13:54:33.3 / 33.9							
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 RCS jet firing 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-	36.6	13:54:35 / 37							
37		deleted deleted						deleted							
37.5 37.7		deleted 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		deleted 13:54:53	V51T0574A	1074	-115	nn	1	0.98	-75/+300
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 and plots).	EOC2-4- 0030	37.75	13:55:04 / 10							
37.8 38		13:55:12 deleted		Sys 3 LMG Brake Sw VIv Ret Line Temp (FWD) - start of off nominal trend	Temp Increase	V58T0842A		13:55:12 deleted	V58T0842A	1156	-110	314	1	1.46	-75/+300
39		deleted					39	deleted							
40		13:55:21	Drag 11 fps2	Drag Measurement Incorporation	Mach 21.nn		40	13:55:21							

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 and plots).	Debris: EOC2-4- 0030; trail: EOC2-4- 0005, 0017,	40.1 13:55:21 / 27						
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.		0021, 0028, and 0030 EOC2-4- 0030, 0050	40.2 13:55:25 / 29						
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 and plots).	EOC2-4- 0005	40.3 13:55:26 / 30						
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 and plots).		40.4 13:55:30						
40.5 13:55:32 Approx V Location: 37.4 N / -		Data source: STS-107 GPS Trajectory Data		40.5 13:55:32						
40.6 13:55:33 / 35	Return link comm drop-out (Comm event 12)	First comm drop out after switched to upper right aft antenna (TDRS 171/W). While uncommon to have a drop out at this point, inconclusive if drop-out is off-nominal based on previous flt data.		40.6 13:55:33 / 35						
41 deleted 41.5 15.45 13:55:36 / 42	Debris #11 - Eleventh report of debris observed leaving the Orbiter		EOC2-4- 0050	41 deleted 41.5 13:55:36 / 42						
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	V34T1118A	42 13:55:41	V34T1118A	nn	nn nn	nn	nn nn	
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.			42.3 13:55:45 / 49						
42.5 13:55:55 Approx V Location: 37.0 N / - W		Data source: STS-107 GPS Trajectory Data		42.5 13:55:55						
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.	evidence of RCS jet firings (ref Atlas data	EOC2-4- 0005, 0017, 0021	42.7 13:55:55 / 59						
42.8 15.45 13:55:58 / 56:00	Debris #14 - Very bright debris observed leaving the Orbiter.		0030	42.8 13:55:58 / 56:00						
42.9 13:56:00 / 03	Return link comm drop-out (Comm event 13)	On upper right aft antenna (TDRS 171/W). While uncommon to have a drop out at this point, inconclusive if drop-out is off-nominal based on previous flt data.		42.9 13:56:00 / 03						
43 13:56:02 Qbar 40	psf Aft RCS Pitch Jets Deactivated			43 13:56:02						
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 13:56:03	V09T1002A	1280.1 2	40 LWR	1	2.54 - 200/+450	
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	0017	44.2 13:56:09 / 13						
		seconds. (Ref: RCS Atlas data analysis and plots).								
44.5 16.5 13:56:16	Hyd Sys 1 LMG UpLK Actr Unlk Ln Temp - Temp rise rate change	and plots). Temp rise rate change from 0.7 F/min (nominal) to 3.9F/min and increasing to	V58T0125A	44.5 13:56:16	V58T0125A	1159 -^	24 315	1	1.46 -75/+300	
 44.5 16.5 13:56:16 44.6 16.5 13:56:17 44.7 16.5 13:56:20 		and plots). Temp rise rate change from 0.7 F/min (nominal) to 3.9F/min and increasing to LOS Temp rise rate change from 1.5 F/min to 8.8 F/min (stayed at this rate to LOS)	V58T0842A	 44.5 13:56:16 44.6 13:56:17 44.7 13:56:20 	V58T0125A V58T0842A V58T1702A	1156 -	24 315 10 314 08 309	1	1.46 -75/+300 1.46 -75/+300 1.46 -75/+300	

3 16.5 1	3:56:22		LMG Brake Line Temp B - Temp rise rate	Temp rise rate change from 2.1 F/min to	V58T1701A	44.8	13:56:22	V58T1701A	1116	-139.6	282.8	1	1.46	-75/+300
16 1	3:56:24		change Left Upper Wing Skin Temp - start of off	9.1 F/min increasing to LOS Temp reading trending down (potential	V09T1024A	45	13:56:24	V09T1024A	1280.1	240	UPR	1	2.54	
	3:56:30		nominal trend	sensor/wire damage)	V90H1044C		13:56:30	V90H1044C	nn	nn	nn	nn		200/+450 nn
			Altitude 219000 ft / Mach 20.9 - Crossing the				13:56:45							
		Location: 36.1 N / -109.0	Arizona / New Mexico State Line	Data										
7 16.5 1	3.26.23	W	Sys 3 Left Main Gear Strut Actuator Temp -	Temp rise rate change from 1.7 F/min to	V58T0405A	46 7	13:56:53	V58T0405A	1183	-115	315	1	1.46	-75/+300
			Temp rise rate change	12.9 F/min (stayed at this rate to LOS)								'		
	<mark>3:56:55</mark> 3:56:55 / 57		1st Roll Reversal Complete Return link comm drop-out (Comm event 14)	Mach 20.76 On upper right aft antenna (TDRS 171/W).	V90H1044C		<mark>13:56:55</mark> 13:56:55 / 57	V90H1044C	nn	nn	nn	nn	nn	nn
	0.00.00701			While uncommon to have a drop out at this point, inconclusive if drop-out is off-nominal based on previous flt data.		11.0								
				Note: No further comm drop-out events are listed in the timeline thru LOS, since they are not considered out-of-family at this time.										
1	3:56:58		IMU Velocity Increase	Reflects accelerations imparted during roll reversal. Same signature observed on STS-109. Nominal event.		48	13:56:58							
1	3:57:nn		Bodyflap deflection up 3 degrees	Matches nominal aero simulation	V90H6410C	49	13:57:nn	V57HxxxxC	nn	nn	nn	nn	nn	nn
-	leleted						deleted							
5 16.8 1	3:57:19 / 29		Debris # 16 - Very faint debris observed leaving just aft of Orbiter (occurred over NM)	Starfire Optical Range (Kirtland Air Force Base, NM). Note: nearest jet firings: L2L jet firing at 032:13:56:54.71 / 57:01.12 & 032:13:57:46.35 / 57:53.12 & L3L jet firing at 032:13:56:54.66 / 57:01.07 & 032:13:57:46.33 / 57:53.10 (all 4 occurred during data dropouts & were determined	EOC2-4- 0148-2	49.55	13:57:19 / 29							
				based on injector temps alone). Also, R2R at 032:13:57:43.94 / 57:44.42 & R3R at 032:13:57:43.92 / 57:44.40 for 0.48 secs ea. (Ref Atlas data analysis and plots.)										
6 16.9 1	3:57:19		MLG LH Outbd Tire Pressure 1 - start of off nominal trend	Bit flip up - off nominal thru comparison with previous flights	V51P0570A	49.6	13:57:19	V51P0570A	1074	-160	nn	1	0.67	230 / 401
16.9 1	3:57:24		MLG LH Outbd Tire Pressure 2 - start of off	Bit flip up - off nominal thru comparison	V51P0572A	49.7	13:57:24	V51P0572A	1074	-160	nn	1	0.67	230 / 401
17 1	3:57:28		nominal trend Left Lower Wing Skin Temp - OSL	with previous flights	V09T1002A	50	13:57:28	V09T1002A	1280.1	240	LWR	1	2.54	
c	leleted			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.		51	deleted							200/+450
17 1	3:57:43		Left Upper Wing Skin Temp - OSL		V09T1024A	52	13:57:43	V09T1024A	1280.1	240	UPR	1	2.54	200/+450
19 1	3:57:54		Sys 2 LH Brake Switching VIv Return Temp	Temp increase	V58T0841A	53	13:57:54	V58T0841A	1173	-107	313	1	1.46	-75/+300
	3:57:53.7 / 5.7		(AFT) - start of off nominal trend Flare 1: Asymmetrical brightening of Orbiter shape observed (occurred over NM)		EOC2-4- 0148-4	53.5	13:57:53.7 / 55.7							
	3:57:59.5 / 8:01.5		Flare 2: Asymmetrical brightening of Orbiter shape observed (occurred over NM)		EOC2-4- 0148-4	53.7	13:57:59.5 / 58:01.5							
20 1	3:58:03		Start of "sharp" aileron trim increase		V90H1500C	54	13:58:03	V90H1500C	nn	nn	nn	nn	nn	nn
3 20.5 1	3:58:09		Increase in derived rolling and yawing moment increments	Sustantial increase in observed growth rate of both roll and yaw moment increments. Derived by analysis.	n/a	54.3	13:58:09							
5 22.5 1			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			V58T1703A	1183	-108	312	1	1.46	-75/+300
	leleted 3:58:20	Approx Veh Grd	Altitude 209800 ft / Mach 19.5 - Crossing the	Data source: STS-107 GPS Trajectory			deleted <mark>13:58:20</mark>							
		Location: 34.2 N / -103.1	New Mexico / Texas State Line	Data										

					_								
56 57 23	deleted 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		deleted 13:58:32	V51P0570A	1074	-160	nn	1	0.67	230 / 401
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	13:58:32	V51P0571A	1074	-115	nn	1	0.67	230 / 401
58.5	13:58:32	MLG LH Outbd Wheel Temp - temperature	Trending to OSL following 7 sec LOS	V51T0574A	58.5	13:58:32	V51T0574A	1074	-160	nn	1	0.67	230 / 401
58.7	13:58:32 / 59:22	trending down (to OSL) Sys 2 LH Brake Switching VIv Return Temp (AFT) - temp rise rate change	(initiation time not exact) - ref #62 Temp rise rate change from 2.5 F/min to 40.0 F/min until 13:59:22 (temp peak) - ref	V58T0841A	58.7	13:58:32 / 59:22	V58T0841A						
59	13:58:36	MLG LH Inbd Wheel Temp - start of	#70.5 Start of trend to OSL - ref #66	V51T0575A	59	13:58:36	V51T0575A	1074	-115	nn	1	0.98	-75 /
60 23	13:58:38	temperature trending down (to OSL) MLG LH Outbd Tire Pressure 1 - OSL		V51P0570A	60	13:58:38	V51P0570A	1074	-160	nn	1	0.67	+175 230 / 401
61	deleted		Rationale for deletion: Moved to seq no. 63.5 after further data review.		61	deleted							
62 25	13:58:39	MLG LH Outbd Wheel Temp - OSL		V51T0574A	62	13:58:39	V51T0574A	1074	-115	nn	1	0.98	-75 / +175
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	63	13:58:39	V51P0572A	1074	-160	nn	1	0.67	230 / 401
63.5 25.5	5 13:58:40	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		63.5	13:58:40							
64 23 65	13:58:40 13:58:41	MLG LH Inbd Tire Pressure 1 - OSL MLG LH Inbd Tire Pressure 2 - start of off	Press rose ~3.5 psia in 2 sec's	V51P0571A V51P0573A		13:58:40 13:58:41	V51P0571A V51P0573A	1074 nn	-115 nn	nn nn	1 1	0.67 0.67	230 / 401 230 / 401
65.5 23	13:58:43	nominal trend MLG LH Inbd Tire Pressure 2 - start of pressure trending down		V51P0573A	65.5	13:58:43	V51P0573A	nn	nn	nn		0.67	230 / 401
	13:58:48	MLG LH Inbd Wheel Temp - OSL		V51T0575A		13:58:48	V51T0575A	nn	nn	nn	1	0.67	230 / 401
	13:58:48	MLG Inbd Tire Pressure 2 - OSL		V51P0573A		13:58:48	V51P0573A	nn 1074	nn 160	nn	1	0.67	230 / 401
68 23	13:58:54	MLG LH Outbd Tire Pressure 2 - OSL		V51P0572A	00	13:58:54	V51P0572A	1074	-160	nn		0.67	230 / 401
69 26	13:58:56	BFS Fault Msg (4) - Tire Pressures - Last Message			69	13:58:56							
70 27	13:59:06	Transferred ON	Uplock indicated no change	V51X0125E		13:59:06	V51X0125E	1189	-135	nn	1	n/a	0 / 1
	5 13:59:23	Loss of MCC real-time data to the workstations in the FCR and MER				13:59:23							
70.5	13:59:22	Sys 2 LH Brake Switching VIv Return Temp (AFT) - start of sharp downward temperature trend	Temp trending down until loss of signal - ref #81	V58T0841A	70.5	13:59:22	V58T0841A	1173	-107	313	1	1.46	-75/+300
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	71	13:59:30.66	V79X2634X	nn	nn	nn	nn	n/a	0/1
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	72	13:59:30.68	V79X2638X	nn	nn	nn	nn	n/a	0/1
73 29	13:59:31	Observed elevons deflection at LOS	Left: -8.11 deg (up); Right: -1.15 deg (up)	V90H7505C V90H7555C	73	13:59:31							
73.1 29.3	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		73.1	13:59:31.400							
73.2 29.3	3 13:59:31.478	All FCS Channel 4 Bypass valves close (indicating bypassed)	Leading indicator of ASA fail (high-rate data)	V58P0915A	73.2	13:59:31.478							
73.3 29.3	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 / 0º).	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)	73.3	13:59:31.7	V57H0253A	nn	nn	nn	5	nn	nn
73.5 29.5	5 13:59:32	Observed aileron trim at LOS	Trim: -2.3 deg (V96H2045C - V90H1500C)		73.5	13:59:32							
74	13:59:32		LOS	V34T1106A		13:59:32	V34T1106A	1215	nn	nn	1	nn	nn
74.5 75	13:59:32 13:59:32	LH Aft Fus Sidewall Temp at x1410 - LOS LMG Brake Line Temp A - LOS	LOS LOS at 172.2 F	V09T1724A V58T1700A		13:59:32 13:59:32	V09T1724A V58T1700A	1410 1116	nn -140.4	nn 282.8	nn 1	nn 1.46	nn -75/+300
75 76	13:59:32	LMG Brake Line Temp A - LOS LMG Brake Line Temp B - LOS	LOS at 172.2 F LOS at 154.2 F	V5811700A V58T1701A		13:59:32 13:59:32	V58T1700A V58T1701A	1116 1116	-140.4 -139.6	282.8 282.8	1	1.46 1.46	-75/+300 -75/+300
77	13:59:32	LMG Brake Line Temp C - LOS	LOS at 104.8 F	V58T1702A	77	13:59:32	V58T1702A	1140	-108	309	1	1.46	-75/+300
78 79	13:59:32 13:59:32	LMG Brake Line Temp D - LOS Left Main Gear Strut Actuator Temp - LOS	LOS at 88.3 F LOS at 76.3 F	V58T1703A V58T0405A		13:59:32 13:59:32	V58T1703A V58T0405A	1183 1183	-108 -115	312 315	1	1.46 1.46	-75/+300 -75/+300
79 80	13:59:32	•	LOS at 76.3 F LOS at 52.2 F	V58T0405A V58T0125A		13:59:32	V58T0405A V58T0125A	1183	-115 -124	315 315	1	1.46 1.46	-75/+300
81	13:59:32	Sys 2 LH Brake Sw Vlv Return Temp (AFT) - LOS		V58T0841A		13:59:32	V58T0841A	1173	-107	313	1	1.46	-75/+300
82	13:59:32	Sys 3 LMG Brake Sw VIv Return Line Temp	II OS at 67 3 F	V58T0842A	00	13:59:32	V58T0842A	1156	-110	314	1	1.46	-75/+300

8	2.7	32.5	31:59:32	Approx Veh Grd Location: 32.9 N / -99.0 W	Dallas TX	Approximate Vehicle Ground Location at Loss of Signal based on GMT; Data source: STS-107 GPS Trajectory Data		82.7	31:59:32	
8	2.8	29.3 [,]	13:59:32.130			measurement discrepancy	V79X3263X V79X3268X V79X3273X V79X3278X V79X3278X V79X3334X V79X3339X	< < < <	3 13:59:32.13	30
	83	33	13:59:32.136	(Loss of Signal)	(This time has been referred to as "LOS" thoughout the investigation.) Start of reconstructed data	Upper Right Aft (URA) Quad Antenna was selected by BFS antenna management 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.		83	13:59:32.13	
			13:59:32.195			excitation short condition	V79X4210E V76X4211E	Ξ	13:59:32.19	95
	85	(deleted			Rationale for deletion: moved to 85.6 after further data review.		85	deleted	
{	5.5	29.3	13:59:32.598		fight between channels 1/2/3 and channel 4	grown sufficient to drop below voltage threshold of valve; RPC B is current	V58P0865A	A 85.5	5 13:59:32.59	98
8	5.6	29.3	13:59:33.680		CH 4	TDRS-E Data. Error is detected by ATVC/ASA hardware when sensed delta pressure across actuator exceeds a limit indicating the FCS channel is no longer driving the actuator. FCS CH 4 failure will annunicate for any of the following: LIB / LOB / RIB / ROB elevon actutor 4, rudder actuator 4, speedbrake actuator 4, SSME 1/2/3 P/Y Actuator D, & L/R SRB R/T actuator D.		85.6	5 13:59:33.68	
	86	29.3 ⁻	13:59:33.863		PASS Fault Message annunciation (1) - FCS CH 4	TDRS-E Data		86	13:59:33.86	63
	87		13:59:33.976		Master Alarm noted.	D&C analysis is continuing to determine cause of alarm.		87	13:59:33.97	76
	38	29.3	13:59:34.518		(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	88	13:59:34.51	
	89	29.3	13:59:34.561		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.		4	13:59:34.56	61

90	35	13:59:35/36			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 from6 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.	90	13:59:35/36
91	36	13:59:36			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 aerodymanic moments, creating a bank attitude error.	91	13:59:36
92	37	13:59:36.8		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.	92	13:59:36.8
93	38	13:59:37.3			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	13:59:37.3
94	39	13:59:37.n			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.	94	13:59:37.n
95	40	13:59:37.396	period of	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	95	13:59:37.396
96	41	13:59:46.347		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 profiile 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. Note: BFS does not have this message in the Fault message stack. It is likely that BFS annunciated this message during the 25 second gap of no data, but that if it was annunciated it was pushed out of the downlist stack by additional fault messages (at least 5) annunciated during the gap.	96	13:59:46.347
97	41	13:59:52.114			Data located in PASS fault message buffer. Data is potentially error prone.	97	13:59:52.114
98	41	14:00:01.540*			Data located in BFS fault message buffer. Data is potentially error prone. *Time info corrupted.	98	14:00:01.540*
99	41	14:00:01.900*			Data located in BFS fault message buffer. Data is potentially error prone. *Time info corrupted.	99	14:00:01.900*

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-	100	14:00:02/06				
101	43	14:00:02.654	PASS Fault Message annunciation - L RCS LJET		0118	101	14:00:02.654				
102	44	14:00:02.660	Start of last 2-seconds of the 32 second f period of post-LOS data.	GMT derived by MER data personnel.		102	14:00:02.660				
			CAUTION: Data from this period is suspect be this reconstructed data. Many of the paramete data sample was available. Where possible, h used to draw subsystem performance conclus drawn below may be in error or misinterpreted	rs were 1 Hz data and therefore only one gh rate data and/or corroborating data were ons. However, some of the conclusions	•						
			During this final 2 second period of reconstruct systems were <u>nominal</u> : APUs were running an potentially overcooling). MPS integrity was still and the PRSD tanks/lines were intact. Comm fuselage were performing nominally. RSB, Bot appeared active. With the exception of an app was nominal.	d WSB cooling was evident (although evident. Fuel cells were generating power and navaids systems in the forward dy Flap, main engine, and right wing temps							
			During this final 2 second period of reconstruct systems were <u>off-nominal</u> : All three Hyd system The left inbd/outbd elevon actuator temps were appeared to be overcooling APU lube oil. The of left OMS pod sensors were either OSH or O PASS fault message annunciations for left poor Elevated temps at bottom bondline centerline at the port side structure over left wing were of in Main Bus amps and downward shift in Main disconnected from the AC Buss.	ms were lost (zero pressure/zero rsvr qty's). e either OSL or no data exists. WSB's FES appeared to have shutdown. Majority SL or no data exists. Multiple BFS and I hardware were found in the buffer. skin forward and aft of the wheel wells and oserved. EPDC shows general upward shift							
			GNC data suggests vehicle was in an uncommuncontrolled rates. Yaw rate was at the senso mode was in AUTO. (Note that all Nav-derived to high rates corrupting the IMU state.) Based on the nominal and off-nominal system	maximum of 20 deg/sec. The flight control parameters (e.g., alpha) are suspect due							
103	45	14:00:03.470*	that the fwd/mid/aft fuselage, right wing, and ri BFS Fault Message annunciation - L OMS TK	ght pod were still intact.		103	14:00:03.470				
103.	5 45	14:00:0n.nnn	BFS Fault Message annunciation - In- determinant			103.5	14:00:0n.nnn				
104	45	14:00:0n.nnn*		Occurred after L OMS TK P message. Data is potentially error prone. *Time info corrupted. Note: Error message indicates that AC Bus 3 phase A, B, or C voltage (V76V1700A, V75V1701A, V76V1702A) is out of limits high or low. Low limit for all 3 parameters is 108VAC; High limit is 123VAC.		104	14:00:0n.nnn				
105	45	14:00:03.637	PASS Fault Message annunciation - L RCS PVT	Data is potentially error prone.		105	14:00:03.637				

6 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 wa 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. Data is potentially error prone. Note: BFS downlist bits indicating CSS mode are initialized to "ON" for entry because BFS does not have an "Auto" mode, is always CSS, and will drive the eyebrow panel lights ON if engaged. Thes bits are always on in BFS through all of OPS 3 until touchdown.	s	106	14:00:03.637			
07 47 14:00:04.826	End of 2 second Last identifiable OI Downlink frame period of reconstructed data	GMT derived by MER data personnel. Las recognizable Downlist frame (BFS & PASS) was approx 60 ms earlier.	t	107	14:00:04.826			
08 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	108	14:00:17/21			
09 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	109	14:00:18/22			
10 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	110	14:00:21/25			
11 50 14:00:53	End of Peak Heating	Determined by analysis		111	14:00:53			