



Chandra Flight Note

FLIGHT NOTE #	499
SUBJECT	Day 2009/239-240 Mission Load Segment Uplink Error
DATE	07/23/2010
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Note: All times are GMT (EDT +4 hours)

This flight note describes the Mission Load Segment Uplink Error and recommends closure.

Summary:

During the realtime support starting DOY 240/0850, the FOT operations crew detected the spacecraft ObsID and quaternions seen in realtime telemetry did not match those expected, but instead indicated the spacecraft had not performed the maneuver scheduled to begin at 0850. The spacecraft was not in safemode, no other safing actions had been executed, and no errors were present in the OBC error log. A response team was assembled to investigate the problem, which showed the incorrect mission load segments were uplinked on DOY 239. New load products were built and uplinked on DOY 241, with return to science at DOY 241/0215.

1. Problem

- a. During the support on 28 August 2009 (DOY 240/0850-1105), the FOT operations crew discovered discrepancies with the expected spacecraft attitude while performing the Backstop portion of the State of Health checks.
 - i. The spacecraft ObsID and quaternions seen in realtime telemetry did not match those expected, but instead matched the ObsID and quaternions of the prior observation, indicating the spacecraft had not performed the maneuver scheduled from 0850 to 0905
 - ii. All other SOH checks nominal
 1. Spacecraft not in Safemode
 2. No other onboard safing actions executed
 3. No errors present in OBC error log

2. Response

- a. On-duty OC contacted LSE
- b. Response team assembled
- c. SOP_61020_RADBELT_ENTRY executed to fully safe ACIS instrument
- d. SCS 128 and 130 terminated (SCS 129 was already Inactive)
- e. Contents of SCS130, 129, and 128 dumped and examined
- f. After discovering uplinked mission load segments were incorrect, new load products were built and uplinked on DOY 241

3. Cause

- a. As part of the MUPS pressure drop anomaly investigation, the AUG2409A load package was superseded by the AUG2609A loads, which provided time for the FOT to conduct a test firing of the MUPS thrusters in an effort to measure thruster performance and independently assess system pressure
 - i. On DOY 233 the AUG2409A loads were approved and the first segment (CL237:1105.cld) was loaded into SCS slot 130 at 233:1948
 - ii. Remaining segments were not loaded in anticipation of a favorable “go” decision for the MUPS test firing.
 - iii. On Aug 25, community agreed to execute MUPS firing tests, thus AUG2609 loads were approved, superceding AUG2409 loads.
 - iv. AUG2609 loads were saved to OFLS database, with names distict from AUG2409 loads. However, the remaining AUG2409A load segments were not removed from the ONLS database.
- b. The first three AUG2609A load segments were successfully uplinked as follows:

LOAD SEGMENT	SCS SLOT	DATE/TIME UPLINKED
CL238:1506.cld	128	236:22:22:42
CL239:1806.cld	129	237:14:42:57
CL240:1506.cld	130	238:16:47:21

- c. The fourth load segment in the series, CL242:0206.cld was available for uplink after DOY 238 at 1655, as shown in the table below. The next realtime support following the “Load After” time was on DOY 239 from 0205-0420.

*****LOAD GENERATED*****	
Load name:	CL242:0206 Load type: ATS - A
SCS Number:	128
Number of critical Cmds:	30
Load Maximum Error Severity:	1
Number of Cmds in load:	379 (executable cmds)
Load By Time:	2009:242:02:27:19.843
Load After Time:	2009:238:16:55:30.000
First Command Time:	2009:242:02:28:19.843
Last Command Time:	2009:242:23:39:15.597
Number of Cmds to uplink:	1979 (uplinkable cmds)
Uplink Duration (seconds):	47.496
Load break was set to 2009:243:03:39:34.391	
(Previous Load Break Time + Fixed Load Duration Time)	
No uplink opportunities selected for load with name: CL242:0206	

- d. Instead of uplinking the above load segment, the on-duty operators uplinked the fourth load segment of the AUG2409A load package, CL242:0205.cld, as shown in the table below:

*****LOAD GENERATED*****	
Load name:	CL242:0205 Load type: ATS - A
SCS Number:	130
Number of critical Cmds:	30
Load Maximum Error Severity:	1
Number of Cmds in load:	379 (executable cmds)
Load By Time:	2009:242:02:27:19.843
Load After Time:	2009:238:15:09:30.000
First Command Time:	2009:242:02:28:19.843
Last Command Time:	2009:242:23:39:15.597
Number of Cmds to uplink:	1979 (uplinkable cmds)
Uplink Duration (seconds):	47.496
Load break was set to 2009:242:23:40:00	
(Absolute Load Break Time (05))	
No uplink opportunities selected for load with name: CL242:0205	

4. Impact of Incorrect Load Uplink

- a. The load segment uplink action caused the CL242:0206 information already contained in SCS 130 to be overwritten by the information contained in the CL242:0205.cld file. Overwriting SCS 130 did not result in an OBC memload reject since the contents of the CL242:0205.cld load were valid and acceptable from an OBC-code perspective.
- b. SCS 128 was activated after the CL242:0205 load uplink, but since the last command time of the previously stored CL238:1506 load segment in SCS 128 had already passed, no commands were executed.
- c. On DOY 240 at 0603, SCS 129 changed state to Inactive; the already-activated SCS 130 had a delay timer counting down that, when completed, would have allowed the next command of the CL240:1506 load to be executed, which was the ACIS stop-science command.
 - i. The information in SCS 130 had been replaced
 - ii. The next command actually executed was the ACA auto-restart disable command from the CL242:0205.cld load segment. This command execution was benign.
 - iii. SCS 130 then went into another delay state.
- d. The expected ACIS reconfiguration and spacecraft maneuver did not occur due to the misconfiguration of SCS 130.
- e. SIM table was at -99616 at start of the DOY 240/0850 support, however the ACIS instrument was still clocking data from the descending CTI measurement. The ACIS team recommended a procedure be executed as soon as possible to finish safing the instrument for the rest of the rad zone passage.
- f. SOP_61020_RADBELT_ENTRY executed to safe ACIS instrument.

- g. Since the commands from the AUG2609 load did not properly execute, on-board command load continuity was no longer correct. Therefore, SCSs 128 and 130 were terminated; stopping the science mission. Replan products were developed and uplinked on DOY 241. A total of 6 hours of science time was lost.

5. Root Causes

- a. Failure to execute uplink checks

The OC/CC did not compare the First Uplink Opportunity Time (seen on the Command Operations window) with the Load After time found in the hardcopy version of the AUG2609A load package, which should match. The file selected on the Command Operations windows showed a time of 2009:238:15:09:30. The Load After time in the load package was 2009:238:16:55:30.
- b. Insufficient training on command load contents and processing
 - i. Due to a misunderstanding of the contents of the Command Buffer window (shown below), the OC did not perform a “pseudo-checksum” validation on the hex value of the second OBDATAA command. This check allows the controller to confirm the SCS slot destination of the commands matches the desired slot. The third and fourth values from the right contain the hex values of the SCS slot into which the load segment will be sent. The hex values translate as follows:
80 = slot 128, 81 = slot 129, and 82 = slot 130

Pos	Command Mnemonic	E/D	Crit	Uplink Data (hex)
0	COBCSLDA	E		0530000
1	COBCSLDA	E		0F30000
2	COBCSLDA	E		0F30000
3	CBTDN00P	E		07FFFFFF
4	COBDATAA	E		8000500
5	CBTDN00P	E		07FFFFFF
6	COBDATAA	E		00182FD
7	COBDATAA	E		000C88C
8	COBDATAA	E		8032000
9	COBDATAA	E		930F976
10	COBDATAA	E		8030215
11	COBDATAA	E		930FA60
12	COBDATAA	E		8030220
13	COBDATAA	E		930FB4A
14	COBDATAA	E		D800003
15	COBDATAA	E		0003060
16	COBDATAA	E		3001300
17	COBDATAA	E		8030402
18	COBDATAA	E		6544061
19	COBDATAA	E		6440221
20	COBDATAA	E		655ABA1

Blocking Factor: 90

Start Stop Close Help

Pos	Command Mnemonic	E/D	Crit	Uplink Data (hex)
0	COBCSLDA	E		0530000
1	COBCSLDA	E		0F30000
2	COBCSLDA	E		0F30000
3	CBTDN00P	E		07FFFFFF
4	COBDATAA	E		8000500
5	CBTDN00P	E		07FFFFFF
6	COBDATAA	E		00180FD
7	COBDATAA	E		000C88C
8	COBDATAA	E		8032000
9	COBDATAA	E		930F976
10	COBDATAA	E		8030215
11	COBDATAA	E		930FA60
12	COBDATAA	E		8030220
13	COBDATAA	E		930FB4A
14	COBDATAA	E		D800003
15	COBDATAA	E		0003060
16	COBDATAA	E		3001300
17	COBDATAA	E		8030402
18	COBDATAA	E		6544061
19	COBDATAA	E		6440221
20	COBDATAA	E		655ABA1

Blocking Factor: 90

Start Stop Close Help

- ii. The CC did perform validation check, alerting the OC of the discrepancy in the second-OBDDATAA hex code – the value was 82, indicating the load going to slot 130, instead of 80, the desired slot of 128. However, the OC overrode the CC’s concerns regarding the OBDDATAA hex code discrepancy and directed the load segment be uplinked. The OC incorrectly assumed that if the load being uplinked was incorrect, the OBC would respond with either a memload reject or an error in the OBC Error log.
- c. Obsolete loads in database
 - i. After the AUG2409A load package was replaced with the AUG2609A load package, the AUG2409A files remained in the database instead of being deleted or archived.
 - ii. File naming resulted in only a one-digit difference between two of the load segment files as seen in the following screenshots:

The screenshots show a software interface with a menu bar (File, View, Options, Help) and a status bar (Uplink: Ready, User: Disabled, System: Disabled, Transmit: Connected, Receive: Connected, Filter: Off, Last Refresh: GMT 243:13:26:57). Below the status bar are tabs for Command Inventory, Header Inventory, Group Inventory, and File Inventory. The main area contains a table with the following data:

File Name	Type	# Cnds	Severity	Crit	First Uplink Opportunity (GMT)	Last Uplink Opportunity (GMT)	Last Update (GMT)
CL228:0904.CLD	ATS - A	320	1	C	2009:226:11:33:37	2009:228:09:33:37	225:19:20:44
CL228:0905.CLD	ATS - A	763	1	C	2009:224:23:44:23	2009:228:09:36:37	219:14:22:51
CL229:1104.CLD	ATS - A	2005	1	C	2009:225:21:45:49	2009:229:11:48:31	225:19:20:44
CL231:0204.CLD	ATS - A	1693	1	C	2009:227:22:29:42	2009:231:02:11:59	225:19:20:45
CL232:2104.CLD	ATS - A	607	1	C	2009:228:10:06:53	2009:232:21:32:54	225:19:20:45
CL234:1804.CLD	ATS - A	1442	1	C	2009:230:14:07:31	2009:234:18:55:59	225:19:20:45
CL241:0203.CLD	ATS - A	1858	1	C	2009:239:04:13:59	2009:241:02:13:59	240:21:11:48
CL242:0205.CLD	ATS - A	1979	1	C	2009:238:15:09:30	2009:242:02:27:19	231:18:39:08
CL242:0206.CLD	ATS - A	1979	1	C	2009:238:16:55:30	2009:242:02:27:19	236:21:43:29
CL242:1503.CLD	ATS - A	2028	1	C	2009:240:17:25:47	2009:242:15:25:47	240:21:11:48

Below the table are buttons for 'Uplink...' and 'Refresh'. A 'Messages' section at the bottom shows:

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GMT 243:13:26:12 F00CAXAF logged into CCP as EHS
GMT 243:13:26:15 Retrieved 2415 loads from ODE
GMT 243:13:26:58 Retrieved 2417 loads from ODE
  
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6. Mitigation Actions

- a. FOT Mission Planning changed SGP_MPS_TOO_SAFING_REPLAN such that all loads stored in the database that are superseded by newer loads are deleted or archived.
- b. FOT Operations reviewed SOP_OPS_ON_LINE_OPERATIONS, which directs load uplinks, for clarity and completeness.
 - i. An Operations Directive (OD #20, Daily Mission Load Segment Uplink) was issued to provide further guidance on proper load uplink procedures.
 - ii. SOP_OPS_ON_LINE_OPERATIONS is due for a significant update; the contents of the ops directive will be included in the update.
- c. All controllers were given simulation training designed to demonstrate and reinforce proper command load uplink techniques.
- d. A training document that provides detailed information and instructions for all command uplink products was completed.
 - i. Training was issued to every currently certified controller.
 - ii. Training was added to the initial training and certification requirements for new controllers.
- e. SOP_OPS_STATE_OF_HEALTH was updated with specific telemetry (MSID 1STAT1ST, ACIS Software Bilevel Telemetry Bit 1) as an additional check during the State of Health phase of every realtime support to ensure ACIS is safe as appropriate.

Conclusion:

The DOY 2009/239-240 Mission Load Segment Uplink Error has been sufficiently investigated, the root causes detected, and appropriate steps taken to ensure reoccurrence is unlikely. This flight note recommends that this Technical Issue be closed.