

STS-6
GNC QUICK-LOOK REPORT
APRIL 1983

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L OMS Secondary TVC

At 94 + 19 + 16 GMT during the post OMS 2 gimbal check both left OMS secondary pitch and yaw TVC failed the gimbal test. The post OMS 1 gimbal check had shown no TVC problems.

Subsequent analysis showed that when the left OMS secondary was powered for the gimbal check, a 30 AMP current spike was seen for 3 seconds. These symptoms indicate that an electrical short existed in the left OMS secondary TVC.

A decision was made to do no further troubleshooting on the left OMS secondary TVC as long as the primary TVC was available and the left OMS engine therefore usable. Also of concern was the automatic power up of the OMS TVC during the postlanding OPS 9 main engine repositioning. Because an electrical short could provide an ignition source if any flammable was present, it was decided to preclude the automatic OMS power up. Turning "OFF" MDM FF2 precluded powering up of the LOMS SEC TVC.

The left OMS secondary will be replaced prior to STS-7.

Recommendation:

Continue to perform OMS TVC gimbal checks following every OMS burn until the TVC system demonstrates better reliability.

Failure to Set ET SEP Complete Flag

At 8 minutes 37 seconds after liftoff the automatic external tank separation was initiated with all downfiring jets. Four seconds later four plus X jets began firing and the downfiring jets stopped. The plus X translation lasted 0.5 seconds. The automatic switch to MM104 did not occur because the required delta velocity (-4 FT/SEC) had not been attained in the Z axis. The crew manually selected MM104 and performed a 10 second plus X burn.

Anytime the THC is taken out of detent during the ET SEP sequence the automatic sequence is inhibited. The data indicates the crew inadvertently took the THC out-of-detent in the X-axis, and inhibited the automatic SEP burn at a delta V of -2.28 FT/SEC in the Z axis.

PLT HSI Primary Miles

During the FCS checkout the crew reported the PLT's HSI primary miles hundreds digit did not go barberpole at the appropriate time. It also did not go barberpole upon being powered down. No further reports were made regarding the function of that digit although it did function correctly during the HSI HI/LO test. At this time the malfunction is thought to be a sticky wheel or failed BP drive coil.

CDR HSI Glideslope

During the FCS checkout the CDR reported his glideslope indicator to read .2 to .3 dots low during the low test, but correctly at other times. He also indicated it read like the SMS. The SMS HSI is not flight hardware and its

behavior and failure modes may not be indicative of flight hardware performance. The test voltages going to the HSI are on telemetry and were of the correct magnitude. No further reports were made by the crew regarding GS indicator performance. The malfunction is thought to be with the HSI itself.

RPTA

The rudder peddles during FCS checkout indicated full deflection in one direction, but slightly less than full direction in the other. Telemetry as well as onboard indications showed left rudder deflections of about 9 percent less than right rudder deflections. All six transducers indicated the output to be less than the 100 percent expected. The anomalous readings could be due to some restriction to full rudder peddle movement. Checkout at the Cape a T-18 hours showed right rudder at 100 percent and left rudder at 96.8⁰, which passes the Cape's 86 percent requirement for good RPTA output. KSC plans to retest rudder pedal deflection.

Non-Execution of PTI-11

An automatic inhibit of the entry program test input maneuvers occurs if a PTI is executed near or during a roll reversal. The specific requirement is that the delta azimuth angle has to be less than 13.9 degrees for 8.85 seconds after the specific PTI window opens. The PTI-11 window opened at mach 9 with a delta azimuth of 12.9 degrees. Prior to 3.85 seconds elapsing, the delta azimuth angle exceeded the 13.9 degree limit and PTI-11 was inhibited.

COAS

COAS performance during the STS-6 COAS calibrations was excellent. The calibration accuracy and ease appeared to be enhanced by the crew's use of the discrete rate/pulse rather than the pulse/pulse DAP option used on previous flights. The narrow spread of the marks made at both the +X and -Z stations, and the reduced time and effort to accomplish the calibrations indicate that the discrete rate/pulse option should be baselined for subsequent flights.

Recommendations:

- a. Update checklists with the discrete rate/pulse calibration technique.
- b. Updates STS-7 COAS calibration vector I-loads to reflect the OV-099 vector as determined on STS-6.

Thrift

A large percentage of the near real-time thrift formats (NRT formats) were unreadable. This hinders problem analysis and wastes money because the thrift format must be rerun. See enclosed hardopies. A DR is in work.

IMU 3 Bite

During entry an IMU 3 BITE/TEMP alert was issued. When the ground received telemetry the cause of the alert was no longer present. IMU 3 performed nominally throughout the remainder of entry. Currently, awaiting thrift data to further analyze the IMU 3 bite alert.

Star Tracker Self-Test

The real-time/near real-time ground evaluation of star tracker self-test was not successful because the -Z tracker acquired the self-test star so late in the cycle that the data was valid for only a fraction of a second. We were able to confirm that the angles were nominal using superthrift at 5 samples/sec. This evaluation was accomplished 6 to 8 hours after the self-test-- long after star data had already confirmed good star data.

Recommendation:

Self-test should not be used as a routine daily tool for confirming that trackers are good. Self-test should be scheduled before the first and the last alignments. Additionally, self-tests should be done during flight to aid in tracker evaluation if star data indicates a possible problem.

IMU Alignment Cancellations

The evening IMU alignment was cancelled on the second, third, and fourth flight days. This was done in accordance with the established policy that planned alignments can be cancelled as long as that alignment is not required by the rule pertaining to maintaining a maximum misalignment at entry interface of $.5^{\circ}$, in case an emergency entry is required with no time to perform an alignment. Ground computed delta angles between IMU's (supported by star of opportunity data on the second and third days) indicated the worst platform misalignment was under $.2^{\circ}$ at the evening alignment time. Assuming no major change in drift characteristics the maximum expected error would be under $.4^{\circ}$ by the next morning. If there were a significant change, the $.2^{\circ}$ improvement that could have been gained would probably not be important and the resetting of the RM thresholds would probably lead to an alarm during the sleep period.

There are three primary reasons for cancelling an alignment when it can be done safely:

- a. Propellant savings
- b. Timeline relief
- c. Improved drift compensation data

Reasons a and b were not important this flight although there was some interest in gaining timeline relief in case the EVA had been extended. Reason c was the deciding factor.

All three IMU's displayed very low drift rates after the initial compensation. The worst total misalignment even after 24 hours of drift was $.35^{\circ}$. IMU 3 was never more than $.104^{\circ}$ misaligned. These low drift rates were the product of very good hardware and a continuous attitude profile (-ZLV). All previous flights have demonstrated that a change of attitude profile (for example: -ZLV to tail sun) is accompanied by a change in drift rates. In order to determine if there existed a small but constant remaining drift rate it was necessary to permit the platforms to drift long enough to get the individual torquing angles well away from the noise levels of the alignment data.

Recommendations:

Continue the practice of scheduling alignments twice per day with the option to cancel based on small drifts or on star of opportunity alignments.

Payload Bay G-Level Test

The payload bay g-level test was initiated from -ZLV auto track into manual/norm attitude hold with $.1^{\circ}$ deadband at which time DAP errors went to zero, and immediately began cycling from one side of the deadband to the other with periods of 2 sec to 10 sec from one side to the other (in each axis). There were some cases that did not fit the rapid side to side pattern such as two successive pitch firings on the same side of the deadband and occasional longer periods between deadband crossings caused by cross coupling, but generally each axes returned to cycle periods of 3 to 5 seconds. Universal plots show such a scatter that it is difficult to determine if there was any change in firing rates throughout the test, but the digital data from superthrift shows that there is no clear trend toward settling out to less frequent firings. The deadband limits were violated in roll frequently by 50 to 80 percent. The other two axis began regular violation of limits by 20 to 40 percent after about 2 minutes into the test. The vernier jet $.01^{\circ}$ db portion of the test was entered with total DAP errors of over $.1^{\circ}$. After all axes had collapsed to $.01^{\circ}$ and for approximately the next one minute continuous violations of deadband of 100 percent were observed. Thereafter, there was a steady improvement leading to a settled condition consisting of generally good control with occasional deadband violations of 20 to 60 percent (about 3 per minute-sum of all axes).

The tail only norm $.1^{\circ}$ db test was initiated from the $.01^{\circ}$ db vernier test with very low rates. The first jet firing (PITCH) was 30 seconds into the test. A little over one minute (and 5 more pitch firings) later the other two axes began oscillating between deadband extremes. During the last one minute of the test firing, frequency was about 7 per axis and deadbands were violated during the last 10 seconds by about 30 percent. Control and firing frequency appeared to be getting worse.

Fuel usage did not match the predicted usage for the first two tests. For the 5 minute norm $.1^{\circ}$ db nose and tail test the SSFS model predicted 183 lbs, and for this test plus the vernier test the SVDS predicted 162 lbs. (Separate numbers were not available for the two tests from SVDS). Actual usage was 556 lbs. There is currently no explanation for the large difference between predicted and actual. The SSFS predicted 154 lbs usage during the 20 minute vern $.01^{\circ}$ db test and actual usage was 40 lbs. For the 3 minute norm $.1^{\circ}$ db tail only test the SSFS 77 lbs., the SVDS predicted 80 lbs., and an actual usage was 50 lbs. It must be noted, however, that because the previous control mode was vernier $.01^{\circ}$ db (with $.02$ rate db) there were only 6 jet firings during the first 1 minute 40 seconds and about 25 firings during the last 1 minute 15 seconds. Neglecting the observation that the test appeared to still be diverging at the end of the 3 minutes, it would be more representative of the propellant rate to divide the total by about 1.3 rather than the full 3 minutes. This yield an usage rate of 31 lbs per minute, comparing favorably with both model predictions.

Payload bay accelerometer data is not yet available to qualify the stress caused

by primary jets, but crew reports indicate it was substantial. It seems reasonable to assume that payloads requiring such precision in attitude would likely be especially sensitive to the vibration, shock, and possible Orbiter structural bending. While the vernier test shows that it is feasible to get near $.01^\circ$ deadband, users must not assume that this means $.01^\circ$ pointing accuracy. Immediately after an alignment the best that can be expected from the IMU's in absolute pointing accuracy is $.05^\circ$.

Recommendation:

Unless a specific controllable cause can be found for the high propellant usage in the first test and the regular deadband violations in all three tests, the $.1^\circ$ primary and $.01^\circ$ vernier deadbands should not be considered operational. Deadbands of $.2^\circ$ primary and $.02^\circ$ vernier can probably control well enough to stay within limits resulting in an actual deadband 25 to 50 percent larger than this test indicates the tighter deadbands deliver considering the deadband violations. Propellant usage should be one-half or less, and stress to the Orbiter on primary jets should be much less severe.

Distribution:

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 DF7/J. E. Saultz
 DG/J. W. Bilodeau
 DH/J. W. O'Neill
 DH3/C. F. Deiterich

GNC-01	A	94:19:11	GMBL FAIL MSG - WEBB	CL				099	303
			CREW REPORTED LEFT OMS SECONDARY PITCH AND YAW GIMBAL FAIL DURING THE POST/OMS 2 GIMBAL CHECK. STILL AWAITING PLAYBACK.						304
			VIEWED PLAYBACK OF POST/OMS 2 GIMBAL CHECK. VERIFIED LEFT SECONDARY TVC WAS ENABLED (SAW GPC OUTPUT), POSITION FEEDBACK FROM PRIMARY TO SECONDARY LVDVT SHOWED NO MOVEMENT OF LEFT OMS ENGINE WITH SEC TVC ENABLED.						305
			UPDATE AT 95:05:00:00						306
			PLAYBACK INDICATED MNB APC2 POWER SPIKE WHEN L OMS SECONDARY SELECTED. L OMS SECONDARY IS CONSIDERED NO GO.						307
GNC-02		96:28:25	PLT'S HSI PRIMARY MILES FLAG - A. H. ZERTUCHE	CL				099	308
			DURING OPS 8 SELF TEST, DEDICATED DISPLAY C/O; THE PLT'S PRIMARY MILES HUNDRETH'S DIGIT DID NOT SHOW A FLAG. ALL OTHER DIGITS SHOWED FLAGS. SINCE THE FLAGS TO THE OTHER DIGITS WORKED FINE THEN PRESUMABLY THE OMD FROM THE GPC TO THIS HDW WAS VALID.						309
GNC-03		96:28:25	CDR HSI GLIDESLOPE - A. H. ZERTUCHE	CL				099	310
			DURING OPS 8 SELF TEST, DEDICATED DISPLAY C/O, THE CDR'S GLIDESLOPE INDICATOR DURING THE LOW TEST MOVED 1.2 TICKS DOWN. IT SHOULD HAVE ONLY MOVED 1 TICK DOWN.						311

LEFT OMS FAILED SECONDARY GIMBAL

CHECK IN PITCH AND YAW

(FTP 6-4 ; CAR 06F029)

- 0 HISTORY/DESCRIPTION
 - 0 FAILURE AFTER 2ND OMS BURN
 - 0 HIGH CURRENT INDICATED TRIPPED RPC TO CONTROLLER
 - 0 OPERATED ON PRIMARY SYSTEM
 - 0 RETURNED CONTROLLER TO VENDOR
- 0 TESTING AND ANALYSIS
 - 0 POWER TRANSISTOR FOUND SHORTED IN INVERTER CIRCUIT
 - 0 TRANSISTOR DROPPED DURING TEARDOWN - PROBLEM LOST
- 0 CONCLUSION:
 - 0 CAUSE -- MOST PROBABLY A CONDUCTING PARTICLE INSIDE TRANSISTOR
 - 0 FUTURE UNITS WILL BE BUILT WITH BETTER SCREENED TRANSISTORS
 - 0 CONTROLLERS IN SERVICE WILL BE REFURBISHED WHEN RECYCLED TO MFGR
 - 0 CLOSE CAR

FLIGHT TEST PROBLEM REPORT

NO. STS-6-4

Statement of problem: Left OMS (Orbital Maneuvering Subsystem) Failed Secondary Gimbal Check In The Pitch And Yaw Axes.

Discussion: The crew reported that during the secondary Gimbal check on the left OMS, a fail indication was noted in both the pitch and yaw axes. All of the left OMS burns were performed on the primary system. Troubleshooting isolated the problem to the controller electronics unit, which was replaced. Analysis of the failed unit showed that the driver output transistor in the pitch axis developed a hard short which opened 2 RPC's, causing both the pitch and yaw axes to issue fail flags.

Conclusions: The driver output transistor in the pitch axis was shorted.

Corrective action: The controller was replaced. Component analysis of the driver output transistor will be tracked on CAR 06F029.

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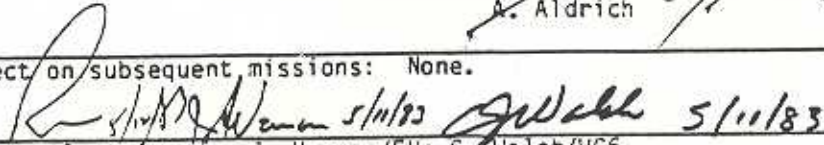


A. Aldrich

5-16-93

Date

Effect on subsequent missions: None.



Personnel assigned: J. Vernon/EH; C. Walsh/WC6

Resolution: CLOSED 05/18/83

Statement of problem: The HUD (Heads Up Display) Deceleration Scale Pointers Were Pegged.

Discussion: The crew reported that the deceleration display scale pointers on the HUD, both commanded and actual, did not respond during rollout. An evaluation of the software implementation showed that when the OPS-8 checkout was performed on-orbit, the I-load maximum deceleration command value was set to zero because of the test values used in the OPS-8 program. This value was maintained in the OPS-3 program and since the value is used in the denominator of the commanded and actual deceleration computations, both values were pegged during entry and rollout.

Conclusions: The problem was caused by a maximum deceleration command value being set at zero during on-orbit checkout and carried over into the entry program.

Corrective action: A software change is being implemented which removes the OPS-8 maximum deceleration command value from the OPS-3 program. For STS-7 & 8 a patch will be incorporated in the flight software. A source update will be included in the software on STS-9 & subsequent missions.

APPROVED

[Signature]
A. Aldrich

5-16-83

Date

Effect on subsequent missions: None.

Personnel assigned: *R. Burghduff 5/11/83*
R. Burghduff/ENS C. Walsh/WC6

Resolution: CLOSED 05/18/83 *R. J. Ward 5/11/83*

Statement of problem: Rudder Pedal Deflection On Orbit Out Of Limit.

Discussion: OPS 8 checkout of the RPTA (Rudder Pedal Transducer Assembly) systems indicated a shift to the left for maximum rudder pedal deflection such that the FCS (Flight Control System) checkout limit (greater than 91 percent) was not quite obtainable on orbit. Postlanding troubleshooting indicated acceptable deflection results essentially identical to preflight results. Analysis of OV-102 data revealed similar shifting of the deflection capabilities, but just within the FCS on-orbit checkout limits. Structural/mechanical analysis revealed that the observed shifting is within normal bounds considering the tolerances of the pedal rigging and the structural bending which could be expected by the cabin in the zero external pressure environment present for the on-orbit FCS checkout. The on-orbit FCS checkout limits were specifically designed to be compatible with the entry RM limits, and did not take into consideration the potential structural bending shifts in the zero pressure environment. The entry FCS design provides adequate gains to allow full rudder authority for an 85 percent deflection input, so that even with the observed shifts, command capability for OV-099 is fully adequate.

Conclusions: The RPTA system on OV-099 (STS-6) operated normally, but on-orbit FCS checkout limits did not account for structural bending effects in zero pressure environments.

Corrective action: The on-orbit FCS checkout requirements will be revised to account for the analytical/observed RPTA deflection characteristics.

APPROVED


 A. Aldrich

 JUN 6 1983
 Date

Effect on subsequent missions: None.

Personnel assigned: J. Boykin/EM12; C. Walsh/WC6
J. Boykin - 6/2/83 *C. Walsh 6/1/83*

Resolution: CLOSED 06/08/83

Statement of problem: IMU 3 BITE/T Message During Entry.


Discussion: After communications were re-established the IMU BITE/T message was noted to have occurred twice, one second apart, starting at 94:18:27:28. Postflight analysis indicated that the velocity limit fail flag was set for IMU 3. This IMU BITE/T message occurred near transition to major mode OPS 304.

Preflight and ascent analysis of data indicated that the IMU 3 Z accelerometer had 5000 micro g noise. There is no accelerometer specification limit on noise. This noise level is not considered excessive although it is higher than experienced on other flight accelerometers.

Conclusions: It is possible that the velocity under limit test was failed on IMU 3 during entry due to the Z accelerometer noise. A transient is also possible due to transition to major mode OPS 304.

Corrective action: IMU 3 S/N 019 was replaced by S/N 001 IMU. S/N 019 IMU has been returned to the vendor for analysis. This problem will be tracked on CAR 06F022.

APPROVED


A. Aldrich

 5-16-83
Date

Effect on subsequent missions: None.

Personnel assigned: S. Bachman/EH6; R. J. Ward/WA3

Resolution: CLOSED 05/18/83

Statement of problem: Erratic Data Good Messages On ADTA's.

Discussion: During the Flight Readiness Firing (FRF-1) on OV-099, the events monitor CRT showed all of the Air Data Transducer Assemblies (ADTA's) had "Data Good" dropouts during the test. Several items within the ADTA (BITE, power supply, etc.) are "anded" together to make up the "Data Good" output. All these items were good and the air data system was operational. The "Data Good" is generated internally to the ADTA. Testing and analysis is continuing at the Flight Systems Laboratory (FSL) and at the vendor. In addition, the ADTA internal design providing the timing scheme for the data good word is being reviewed along with the software operating system.

The "Data Good" dropouts appear to be a function of the CPU (Central Processing Unit) loading and the timing scheme internal to the ADTA making up the "Data Good" output. Variations of the computer minor cycle such as 40 ± 2 ms will cause the dropouts. The most recent ADTA's appear to be more sensitive to computer minor cycle than the older types, (same part number).

Review of the OV-102 flight data showed no "Data Good" dropouts during the on-orbit self test or entry. However, review of the OV-102 SIT and DIT runs showed occasional dropouts. The ADTA "Data Good" output does not affect air data system performance and it is not used on board by the crew during entry. The "Data Good" input and output is monitored by the ground. A dropout may be detected by the crew during the on-orbit self test in OPS 8 prior to entry. "Data Good" dropouts during entry would not affect crew procedures or flight system operations.

Conclusions: The "Data Good" dropouts appear to be a function of the CPU loading and the timing scheme internal to the ADTA making up the "Data Good" output. This output does not affect air data system performance and it is not used on board by the crew during entry. The "Data Good" output is monitored by the ground.

Corrective action: Testing and analysis is continuing at FSL and the vendor. The ADTA internal timing scheme along with the software operating system is being reviewed. The STS-6 crew will be briefed and procedures will be reviewed to account for "Data Good" dropouts.

APPROVED ^{1/4/83}

A. Merich

2-8-83
Date

Effect on subsequent missions: None.

Personnel assigned: O. P. Littleton/EH6; R. J. Ward/WA3
C. P. [Signature] 11/24/82 Robert J. Ward 1/26/83

Resolution: CLOSED for STS-6 02/09/83

FLIGHT TEST PROBLEM REPORT

NO. OV-099-FRF-6A

Statement of problem: Erratic Data Good Messages On ADTA's.

Discussion: During the Flight Readiness Firing (FRF-1) on OV-099, the events monitor CRT showed all of the Air Data Transducer Assemblies (ADTA's) had "Data Good" dropouts during the test. Several items within the ADTA (BITE, power supply, etc.) are "anded" together to make up the "Data Good" output. All these items were good and the air data system was operational. The "Data Good" is generated internally to the ADTA.

Testing at the Flight Systems Laboratory (FSL) has verified that the problem is the result of infrequent incompatibilities between the internal ADTA computation cycle and a short digital processing system (DPS) minor cycle time. A short DPS minor cycle will result in a 40 msec staleness of air data pressure which has no effect on air data system performance.

Review of the OV-102 and OV-099 flight data showed no "Data Good" dropouts during the on-orbit self test or entry. However, review of the OV-102 SIT and DIT runs showed occasional dropouts. The ADTA "Data Good" output does not affect air data system performance and it is not used on board by the crew during entry. The "Data Good" input and output is monitored by the ground. A dropout may be detected by the crew during the on-orbit self test in OPS 8 prior to entry. "Data Good" dropouts during entry would not affect crew procedures or flight system operations.

Conclusions: The "Data Good" dropouts are the result of infrequent timing incompatibilities between the DPS and the ADTA. The "Data Good" bit is not used by either the primary avionics system software (PASS) or backup flight control system (BFS) to determine the health of the ADTA data and has no effect on air data system performance.

Corrective action: ADTA tests have been completed at FSL. Proposed hardware fixes will be tracked on CAR 4902-010.

APPROVED

A. Aldrich

5-31-83

Date

Effect on subsequent missions: None

Personnel assigned: O. P. Littleton/EH6; R. J. Ward/WA3

Resolution: CLOSED 06/08/83