

This post-mission summary briefly describes the systems performance and mission operations during STS-1 from the standpoint of the Guidance, Navigation and Control Systems engineer (GNC). This report is intended as a quick look only and will be followed by in-depth studies of each system's performance as the analysis becomes complete. Any questions or comments concerning this report should be addressed to the appropriate STS-1 MOCR operator: Rich Fitts (ascent), Harry Clancy (orbit), and Don Bourque (entry).

### Mission Timeline Summary

A brief mission timeline overview, detailed by MCC shift, is given below. A more detailed discussion of the described problems is contained in subsequent sections.

#### Prelaunch (Friday)

TACAN 2 exhibited a 3 deg bearing bias on the pad when locked on to the KSC mobile unit. We discussed this with KSC and they advised us that this was caused by multipathing from looking through the tower structure. According to KSC, this behavior had been observed previously during pad operations.

Because of the GPC problems, the countdown was held for a considerable time to troubleshoot. This forced us to consider relaxing the IMU hold constraints by evaluating the real time performance against the required accuracies. A detailed description of the problem and associated analysis is given in a later paragraph.

As part of the GPC recovery procedure, there were some people that wanted to reform the redundant set by taking the ~~3~~ PASS GPCs to halt and doing a re-IPL. Because of problems with the OPS 9 software, however, this would require that the IMUs first be powered off. A significant amount of discussion followed concerning whether or not this power cycle could be done without requiring the preflight cal to be repeated. The GNC position was that recalibration would be required if power was removed. Further details on this issue are given under the SPAN/MER Interface heading

## Prelaunch (Sunday)

We discovered a problem with the flight controller power switch that caused some last minute concern. There's been discussion for some time about a THC problem that caused transient jet fire commands whenever the controller power was cycled on. However, we found out that the RHC also had a problem associated with turning power off. This action could cause erroneous RHC outputs that potentially could force unwanted DAP downmodes to manual in OPS 2 and MM304. We briefed the crew about this latter problem and advised them that the DAP rotation mode PBI's should be left in the pulse mode whenever possible to minimize the RCS cost of an inadvertent switch.

The procedures used by the DPS people to work around the timing problem impacted our operations to some degree. Because of the timing concern, the redundant set was formed the day prior to launch and a number of OPS 9 to 1 transitions were performed. These procedures caused large numbers to be retained in the downlisted M50 velocity words. The impact of this was to cause our displayed values to overflow. The MCC processing displays a "T" (for truncated) over the least significant digit for this case. When this happens, we lose the granularity to perform some of the calibration procedures and force us to rely on hardcopies to compute the required updates. We plan to reevaluate our display requirements to insure that this problem doesn't occur again.

This velocity overflow caused additional problems. When the transition to OPS 1 occurred, the IMU 2 velocity did not get initialized to the same value as IMUs 1 & 3. This caused KSC to be concerned about the health of IMU 2. This error did not affect the MCC comps since our initialization is performed manually after the transition is complete. We assured KSC that the IMU performance was nominal and that we were go for launch.

## Ascent

Shortly after liftoff, both OMS Pc's showed off scale hi pressure. The crew reported that the

pressures were nominal (zero) onboard. This is discussed further in the description of MCC calibration problems.

First stage load relief was more active than expected. This function biases the commanded vehicle attitude to minimize wing loads in response to a predefined profile and sensed loads from the AAV. The attitude errors as displayed on the ADI error needles exceeded 7 degrees.

The crew reported a vehicle oscillation sometime between MECO and the completion of the MPS dump. At first this was thought to probably be due to the MPS TVC stow (preflight predictions were that this could cause vehicle rate oscillations on the order of .2 deg/sec). However, we are still in the process of examining the entire post-MECO time period to determine the exact cause of the disturbance.

MPAD reported that their analysis showed a 1200 ppm (30 $\sigma$ ) z axis accelerometer scale factor error on IMU 3. Our MCC processing did not confirm this error. Although MPAD was urging us to update this term with a memory write, we did not agree with their recommendation. Later analysis indicated that no scale factor error existed and that IMU 3 actually had some sort of resolver or heading sensitivity error. A detailed discussion of the IMU 3 performance and associated analysis is given in a subsequent paragraph.

### Orbit Shift 1 (Orbit Adjust & FCS checkout)

The -y star tracker target suppress bit was observed to be set. The target suppress function is designed to close the shutter if too much light is sensed inside the tracker field of view. Complete details are given in the hardware anomaly descriptions below. The impact of this anomaly was that we were unable to track stars of opportunity. The crew had to manually open the shutter prior to each scheduled tracker wedge.

The right OMS primary TVC system pitch axis failed RM during the gimbal drive check prior to the OMS 3 burn. The TVC system was later determined to be degraded, but still usable as a backup. A complete summary of this problem is given below under hardware anomalies.

New REFSMMATs were computed for IMUs 1 & 2 to achieve the desired  $\sqrt{6}$  skew to optimize RM. These values were uplinked and the crew performed an alignment to the new values.

An IMU accelerometer cal was performed and new biases were uplinked.

A gyro drift update was computed and uplinked for IMU 3. IMUs 1 & 2 were not updated since their alignment was changed when the  $\sqrt{6}$  skew was implemented.

The RCS hot fire test was performed and the crew reported no problems.

### Ascent Team Shift 2 (Crew Sleep)

Playback of the RCS hot fire test showed four jets that were not fired (L2D, R2D, L2L, R2R). A test was scheduled on day two to fire the two yaw jets. (The down firing jets were observed during ET Sep).

Manual check on the IMU 3 accelerometer performance reconfirmed that no scale factor error existed.

IMU 1 & 2 gyro drift errors were measured and compensation values were uplinked.

An accelerometer cal was performed and values computed.

Gravity gradient test was initiated ( $x$  axis towards the earth, omicron angle of 105 deg).

### Entry Team Shift 1 (Day Two Activities)

The gravity gradient test was very well behaved. The maximum oscillations were in the roll axis ( $\pm 60$  deg). Preflight predictions were that the oscillations would be  $\pm 20$  deg. This difference may be due to the fact that the initial conditions weren't optimum for the flight conditions. (The roll oscillations were centered about 135 degrees instead of the initialization point of 105 degrees). The pitch and yaw oscillations were within  $\pm 10$  degrees. The oscillation period was approximately 1 hour 30 min.

IMU accelerometer bias compensations computed from the previous cal were uplinked.

The OPS 8 checkout revealed a problem with the CDR's HSI heading card. Details are provided below in the hardware anomaly section.

The RCS 5 burn was attempted in OPS 2 (instead of OPS 3). A combination of incompatibility with the 4 RJD configuration and the lack of the thrust monitor software in OPS 2 caused difficulties with the execution.

### Orbit Team Shift 2 (Day 2 Activities Continued)

An HSI test was performed to isolate the problem to either the DDU or the instrument. Test results suggested an instrument failure.

The -y star tracker acquired its first star of opportunity.

An IMU gyro drift update was computed and uplinked. A program input error caused incorrect compensation to be applied to some axes.

### Ascent Team Shift 3 (Crew Sleep)

The IMU gyro drift compensation was recomputed and uplinked.

The -y star tracker target suppress list remained not set. Two additional stars of opportunity were acquired over the sleep period (-ELV, tail forward).

### Entry Team Shift 2 (Entry)

The OPS 8 checkout showed the CDR's HSI to be functioning correctly at that time. Instrument subsequently stuck again during entry.

An IMU accelerometer cal was performed. No update was required.

The BFS values for IMU gyro and accelerometer compensation

were uplinked.

The IMU gyro drifts were measured. No update was required.

The deorbit burn was performed using secondary TVC on both engines.

The TACAN 2 bearing failed RM. The failure was subsequently determined to be a transient. A detailed analysis of this problem is given below in the hardware anomalies section.

## Hardware Anomalies

### OMS TVC

The right OMS pitch axis primary TVC system exhibited off-nominal performance from midway into the OMS 2 burn through the end of the mission.

The first indication of a problem came when the crew performed a routine gimbal drive check prior to the OMS 3 burn. (Gimbal drive checks are not done prior to OMS 1 & 2). During this drive, OMS TVC RM declared the right OMS primary pitch actuator to be failed (RM looks for a difference between commanded and actual position of greater than 2 degrees for at least 4.8 seconds). The gimbal drive was repeated several times and the RM fails did not repeat. The OMS 3 burn was performed using the primary TVC. Subsequent analysis showed that the primary system was degraded and the recommendation was made to perform the deorbit burn on the secondary TVC.

Detailed analysis showed that the prelaunch gimbal drive checks (on both Friday and Sunday) were good on all axes of all systems. The performance during OMS 1 was also nominal (as observed in real-time in the MCC). OMS 2 was done during LOS, but the crew reported that the burn was nominal. However, playbacks of OMS 2 showed that the right OMS pitch actuator "locked up" at the null position (zero degrees) 38 seconds into the burn and stayed locked for the remaining 35 seconds. The associated pitch command went to +1.56 deg (no RM declared failure occurred since the command/position  $\Delta$  was less than 2 degrees).

Since the command and position differed by more than .4 degrees (the TVC hysteresis limit), a command was continuously issued to drive to the correct value. The hardware drives with full motor power (182 watts) for the first 8 seconds. After this initial time, the drive power drops to 25% (about 45 watts) and remains at this level until either the gimbal is commanded to drive in the opposite direction or until the associated TVC system is powered off.

A software problem exists (documented by DR 39845L) where the right OMS TVC is left powered after an OPS transition to OPS 2. The requirement originally called for power to be removed at this transition. Since the power remained on continuously, the TVC continued to drive at one quarter power until ~~the~~ midway through the pre OMS 3 gimbal drive check.

The OMS 3 gimbal check was performed first on the primary TVC system. The initial part of the drive check commands the gimbal full positive with a +5.39 degree command. However, since power was never removed and the drive command was still positive, the motor power still remained at 25% and the gimbal position did not change. At this point, RM declared the right OMS primary pitch axis to be failed. When the negative pitch command was issued as the second part of the drive check, the positive drive command was removed and the gimbal drove nominally.

Subsequent positive drive checks using the primary TVC were successful, but the drive rates were reduced. These rates continued to decrease with each use. The pre OMS 3 gimbal check showed 2 deg/sec, the OMS 4 rate was 1.9 deg/sec, and the deorbit burn gimbal check gave 1.47 deg/sec. The nominal gimbal drive rate is 3.2 deg/sec.

Several possible failure modes could have caused the observed responses. These include failures in the extend channel electronics, a mechanical problem between the primary pitch no-back device and the primary drive motor, or a mechanical problem in the jack-screw which normally rotates when the actuator is in the primary drive mode.

## Star Tracker

The star tracker is designed with built-in protection to preclude too much light from being sensed in the field of view. This protection takes two forms.

A bright object sensor (BOS) monitors light intensity over an area somewhat larger than the tracker field of view. If light levels above a certain threshold are sensed, a command is issued to close the shutter to protect the tracker. Once the light level drops back below the threshold, the shutter is automatically reopened. This function is designed to protect against vehicle motion moving a bright object (sun, sunlit earth or sunlit moon) into the tracker field of view.

A second level of protection is afforded by the target suppress function. If light above a threshold (lower than that of the BOS) is sensed, this function also causes the shutter to be commanded closed. However, unlike the BOS, this shutter close command is latched. This latching is necessary since the target suppress detector is located behind the shutter. If the command were not latching, the shutter would reopen immediately after closing when the light level was cut off.

The problem we experienced with the -Y tracker doesn't appear to be the result of any hardware failure. (The crew reported the -Z tracker also exhibited this characteristic). Data indicates that the problem resulted from the tracker viewing a scene that was gradually increasing in brightness. Since the target suppress function responds to a lower level of light intensity, it responds first, latching the shutter closed.

This problem is a design oversight in that the bright object protection was intended to protect the tracker against bright objects. However, if the light intensity gradually increases, the target suppress function will always respond first. This impacts tracker operation in the sense that the shutter will normally be closed and stars of opportunity will not be tracked. The crew can use the trackers for nominal alignments by manually opening the shutter via an item entry.

Consideration should be given to redesigning the bright object sensor to respond to lower light levels or to removing the target suppress function altogether.

## TACAN 2 Bearing Failure

Following 3 or 4 minutes of solid TACAN lock-on to EDW with all three units, TACAN 2 bearing was declared failed by RM. Within seconds after the failure announcement there was no longer any noticeable sign of bearing disagreement. Post flight data reduction indicates that the TACAN 2 bearing exceeded the 6 degree limit for exactly 10 computer cycles (which satisfied the RM fail criteria). One second later the delta had dropped below 6 deg, with only a few subsequent points exceeding the threshold.

Close inspection of all  $\Delta$ 's above the threshold suggest values very close to increments of 40 deg, which represent classical TACAN glitches. We have also found a correlation between the occurrence of these glitches and vehicle roll angle.

## CDR's HSI

During the OPS 8 dedicated display checkout on rehearsal day, the CDR reported a 5 degree error on the heading card of the HSI in low test mode (instrument read 25 deg vs 20 deg command). The high test performed prior to that point was successful. The crew repeated the self-test, and the card did not move at all.

Using playback data, the MCC verified that the self-test commands from software were correct. A test was performed to isolate the failure between the electronics and the instrument. Results indicate that the problem was probably in the instrument.

The self-test was repeated on entry day and the HSI responded correctly. The crew later reported that the operation was correct for some time, but froze again during the latter part of entry.

## MCC Processing

### Cal Curves

#### OMS P<sub>c</sub>

During first stage ascent, the MCC display of both left and right OMS engine P<sub>c</sub>'s showed off-scale hi readings. The outputs started at a positive value (11 percent) prelaunch, decreased gradually to zero during launch, then jumped to off-scale hi. Crew readouts onboard showed nominal values. P<sub>c</sub> measurements showed

nominal values during burns, both onboard and in the MCC.

The cause of this discrepancy has been traced to MCC processing of the telemetry data. The words are documented as, 10 bit AMU GPC analog measurements, and the MCC processes them as such. AMU type analog will always yield a positive number. However, analysis of the real time data showed that the data was in the AMB form with negative values in the 2's complement form. Since the MCC processing expected a positive number, it interpreted the 2's complement telemetry as out of range. Correct processing would have shown the values of  $-4.16\%$  and  $-2.24\%$  for the left and right engines, which would agree with the outboard crew readout.

For subsequent flights, the MCC processing of these parameters should be corrected. There may be other measurements with a similar problem and we need to investigate this possibility and make corrections were required. We've checked all of our parameters and we're clean in this regard.

### Star Tracker Angles

The MCC star tracker angle calibration was found to be in error by  $3.9\%$ . This error did not impact our operations since we weren't required to use this data for any quantitative purpose (manual alignment computation, etc.). However, we plan to fix the cal for subsequent flights.

### TACAN/RADAR Range Comparison

The MCC comparison between TACAN range from each LRU and equivalent RADAR derived range has had problems for some time. When initial lock on occurs, all three TACANs would show nearly a one mile error with respect to the RADAR. The magnitude of this error decreases with time. We had written several DRs against this problem, but very little progress was made towards finding the source of the error.

This error was still evident with the flight data. The initial range error post-blackout was .8 nm. We have initiated a new DR on this problem and hopefully this can be cleared up prior to STS-2.

## IMU/RADAR Comparison

During simulations just prior to flight, a problem was discovered with the IMU/RADAR velocity comparison computation. Whenever any IMU lost the operate mode discrete, all RADAR comparisons are terminated. This is not consistent with the requirements and makes the comp invalid for many cases of two IMU operation.

A DR was written against this problem prior to the flight but GDSD was unwilling to make any program change that close to flight. To work around this anomaly, we were forced to override the operate mode discrete on telemetry to preclude their loss. However, overriding the discrete in the comps also overrode it for display. This meant that we lost insight into the mode configuration during this time. This is not a satisfactory long range workaround and the comp should be fixed for subsequent flights.

Otherwise, the IMU/RADAR comps performed as expected. RADAR velocity noise was evident, but it was within the predicted levels. The MDAC computed thresholds proved to be very accurate in terms of expected RADAR errors. We believe that the comp was fully adequate to resolve any onboard dilemmas had it been required.

## Operations

### Playbacks/THRIFT

A number of times throughout the flight, we were required to analyze an event using either playback or dump data. The tools we had available made this task much more difficult than it should have been.

Playbacks of telemetry data could be used for some purposes, but the turnaround time was a significant problem due to the number of requests and the fact that playbacks had to be performed sequentially. It was not uncommon to have to wait 8 to 16 hours to see an item of interest. Playback priority was set by the data integrator, but they had to rely on each

operator's assessment of their data's criticality. In the future, some cognizant FCD element (OIO's?) need to be the ones to set playback priorities.

For many purposes, THRIFT data was required to provide the necessary sample rates and data correlation. This worked to some extent, but again we were severely limited as to turnaround time, number of formats available, and time interval restrictions.

As mission durations are extended and flight complexity increases, it will become even more important to have an adequate near real time data evaluation tool. A terminal system similar to the Skylab MDRS would be ideal.

### Hardcopies

Hardcopies were totally unreliable. We never received a large percentage of the copies that were requested. Those that were received were often illegible and could not be used.

There are some tasks that we perform, such as accelerometer cal and IMU scale factor determination, that require hardcopies. We are trying to modify our procedures to use other data recording methods (tapes, delogs, etc.), but in some cases this isn't possible. For future operations, the hardcopy system must be upgraded, both from a standpoint of print quality and copy distribution. A dot matrix printer such as is available at the SMS and in the MER would be a great improvement.

### MER Interface

As previously mentioned, the Friday launch attempt caused some issues to be raised regarding the requirement to recalibrate the IMUs. To resolve the DPS problem, some people wanted to take the PASS GPCs to halt and re-IPL the redundant set. This reinitialization however, would cause the IMU operate mode discretized to be reset (removing gyro and accelerometer power and caging the IMUs). The question was then raised whether IMU recalibration would be required if this procedure was followed. (Recalibration is normally required anytime an IMU is taken to standby since the instrument characteristics change somewhat with each

power cycle). Performing a recal would require an additional 3 hours of OPS 9 time and could not be accomplished and still allow a launch on that day.

The MCC position was that a recal would be required if the operate mode was lost. However, our MER counterparts had given KSC a verbal okay to skip the cal, unknown to us. These differing inputs caused considerable confusion at KSC. Our input was eventually accepted and the reIPL did not occur.

The problem with this situation was that we in the MCC were completely unaware of the MER inputs, but their thoughts were being taken as the JSC position. The MER/SPAN/MCC loop works adequately in flight because all inputs to the vehicle must flow through the MCC. This same flow needs to be established prelaunch to insure that all ideas are considered and to allow a joint position to be developed.

Another MER interface problem involved a constant barrage of questions (via black phone) wanting details about our displays, processing, and operations. In the future, we need to make sure that all such questions are first filtered through SPAN.

### Comm Loop Discipline

Misuse of the comm loops was a repeated problem. Conversations between the GNC and GNC SSR personnel (on our dedicated loop) were interrupted a number of times by calls from operators in other disciplines (ONAV, Guidance Support, Timeline, Pointing, ...). The GNC SSR loop is intended only as the communications link between the MOCR and SSR positions. All other traffic should come on the MOCR call loops (MOCR ~~or~~ DPS/GNC in this case). A loop audit needs to be done prior to STS-2 and unauthorized talk capability on SSR loops should be removed.

### IMUs

#### Prelaunch Performance

Because of the DPS problems, an extended hold was

required in MM101. The prelaunch IMU hold constraints had been advertised as 85 minutes total time in MM101 (20 minutes count time, 10 minutes built in hold, 55 minutes contingency hold). This constraint was designed to protect a 1000 arc-sec maximum misalignment error at liftoff. This limit represents the two level attitude fault detection threshold. If the misalignment was allowed to exceed this value, and an IMU subsequently failed during ascent, the RM would erroneously declare a two level failure and could potentially prime select a single IMU for the remainder of ascent.

The IMU performance was much better than predicted and after the 85 minute limit the maximum misalignments were on the order of only 180 arc seconds. Therefore, we were willing to extend the hold by some additional amount if the DPS problem could be resolved. However, this hold capability can not be extended indefinitely. Other constraints such as the 3 level attitude threshold continuing to ramp will eventually become the limiting factor. Holds greater than 2 hours probably represent the maximum allowable time to still allow MECO box protection.

After holding in MM101 for 1.5 hours, the decision was made to recycle back to OPS 9 to attempt to recover the redundant set/BFS sync. Since OPS 9 was selected, the decision was made to perform another alignment at that point.

### IMU 3

As previously discussed, MPAD analysis of ascent IMU performance showed what appeared to be a 1200 ppm (30%) accelerometer scale factor on the IMU 3 z axis. They discovered this running their off-line program that functionally duplicates the onboard RM. However, our MCC comp did not verify this error. Later analysis revealed the reason for this difference.

Both the onboard RM and the MPAD ground program use gimbal angles to determine the orientation of the IMU accelerometers relative to one another. This way, gyro drifts which cause platform misalignments will not result in apparent accelerometer errors. On the other hand, the MCC accelerometer comps assume that all IMU alignments are perfect (aligned to the REFSMMAT). This comp difference was intentional to allow both attitude and velocity errors to be

isolated using the RADAR velocity comparisons.

The error that MPAD observed was most likely a resolver bias or heading sensitivity error that did not affect the alignment of the IMU, but did give an error in our readout of this alignment. The magnitude of this error was on the order of .06 deg (240 sec). Since the onboard RM and MPAD's program use this resolver information to resolve the accelerometer data, this error would cause an apparent scale factor error. However, since the IMUs are really not misaligned, the accelerometer data to navigation was not affected. The MCC comp was not impacted since REFMMATS are used to perform the accelerometer common frame transformation.

Based on their analysis, MPAD was strongly suggesting that we perform a memory write to update the accelerometer scale factor. This case points out another advantage of having different formulations between the ground and the onboard to analyze IMU RM problems.

### Inflight Calibration

A summary of the inflight IMU calibrations is given below.

#### Accelerometer Biases ( $\Delta$ 's/ $\sigma$ )

<u>IMU/axis</u>	<u>MET(D:H:M)</u>	
	0:09:04	1:01:34
1x	31 $\mu$ g (.62 $\sigma$ )	-3 $\mu$ g (-.06 $\sigma$ )
1y	-6 $\mu$ g (-.12 $\sigma$ )	3 $\mu$ g (.06 $\sigma$ )
1z	3 $\mu$ g (.06 $\sigma$ )	-15 $\mu$ g (-.3 $\sigma$ )
2x	-21 $\mu$ g (-.42 $\sigma$ )	1 $\mu$ g (.02 $\sigma$ )
2y	60 $\mu$ g (1.2 $\sigma$ )	1 $\mu$ g (.02 $\sigma$ )
2z	13 $\mu$ g (.26 $\sigma$ )	-2 $\mu$ g (-.04 $\sigma$ )
3x	59 $\mu$ g (1.18 $\sigma$ )	-4 $\mu$ g (-.08 $\sigma$ )
3y	24 $\mu$ g (.48 $\sigma$ )	3 $\mu$ g (.06 $\sigma$ )
3z	24 $\mu$ g (.48 $\sigma$ )	-2 $\mu$ g (-.04 $\sigma$ )

Gyro Drifts ( $\Delta$ 's /  $\sigma$ )

IMU/axis

MET (D:H:M)

	0:12:52	0:21:57	1:12:19	1:15:20
1x		.008 %/hr (.4 $\sigma$ )	.01 %/hr (.5 $\sigma$ )	0
1y		-.02 %/hr (1 $\sigma$ )	.098 %/hr (4.9 $\sigma$ )	-.09 %/hr (-4.5 $\sigma$ )
1z		.016 %/hr (.8 $\sigma$ )	-.006 %/hr (-.3 $\sigma$ )	.008 %/hr (.4 $\sigma$ )
2x		.027 %/hr (1.35 $\sigma$ )	-.008 %/hr (-.4 $\sigma$ )	.01 %/hr (.5 $\sigma$ )
2y		-.005 %/hr (.25 $\sigma$ )	-.01 %/hr (-.5 $\sigma$ )	.004 %/hr (.2 $\sigma$ )
2z		.001 %/hr (.05 $\sigma$ )	-.004 %/hr (-.2 $\sigma$ )	0
3x	-.002 %/hr (-.1 $\sigma$ )		.038 %/hr (1.9 $\sigma$ )	-.02 %/hr (-1.0 $\sigma$ )
3y	.006 %/hr (.3 $\sigma$ )		-.021 %/hr (-1.05 $\sigma$ )	.007 %/hr (.35 $\sigma$ )
3z	.033 %/hr (1.65 $\sigma$ )		.008 %/hr (.4 $\sigma$ )	-.004 %/hr (-.2 $\sigma$ )

ANOMALY LOG

FOR

STS-1 LAST ORBIT TEAM RPT

DATE/TIME VALID

104/01:00Z

CONTACT OIO ON "OPS COORD" LOOP FOR COMMENTS.

7 pages

Item	Anomaly No.	Time (GMT/PET)	Description/Impact/Resolution	Status
	EECOM-1	100/07400 (L-4150 <sup>M</sup> )	Flash Evap. Feedline B(V63T1877A) sometimes reading 1° below LCC limit. THE SEGMENT OF THE LINE ON WHICH IT IS INSTALLED HAS A HTR ACTIVATED BY A SINGLE THERMOSTAT. OTHER TEMPS IN THIS LINE READ $\approx 68^{\circ}\text{F}$ INDICATING THE THERMOSTAT IS NOT OPERATING OR OPERATING AT LOWER TEMP. THE ALTERNATE HTR SYSTEM WILL BE SELECTED (B2). IF B2 HTR FAILS, GO BACK TO B1 (MAY GET ADEQUATE HEATING). IF NOT SELECT CHECK THAT USES THAT FEEDLINE TO ALTERNATE THE	CLOSE
2	BFS-1	T-17 <sup>M</sup> 40 <sup>S</sup>	BFS NOT TRACKING PASS CMDS TO STRINGS 1 AND 3. RANDOM DIFFERENCE BETWEEN BFS AND PASS. NSP POLLING IS SCHEDULED EVERY FOURTH MINOR CYCLE BY SSIP CYCLE COUNTER (BFS) AND BY TIME (PASS); THUS WE CAN HAVE PASS SW. INITIALIZATION WITH NSP POLLING ON THE WRONG MINOR CYCLE (AS SEEN BY BFS). CAN DETECT W/PASS MEM DUMP THEN GO STDBY $\rightarrow$ RUN. (IF TIME UPDATE $>$ 15 MSEC IN) OPS 0 COULD GET TIMING PROBL.	CLOSE
3.	EGIL-1	114312	FIC 3 PH HIGH LIGHT AT $\approx$ T-9 <sup>M</sup> FOR APPROXIMATELY 2 1/2 MIN. INDICATION OF METAL IONS WHEN LOAD INCREASED ON THE FIC. THIS CONDITION HAS BEEN OBSERVED EARLIER. FIC LOOKS GOOD. DON'T EXPECT TO SEE THE LIGHT DURING THE FLIGHT.	CLOSE
4.	EECOM-3		CABIN PRESS CYCLE TRIPS BFS LIMIT. THE BFS LIMIT ON CABIN PRESS WILL BE UPDATES VIA TMBU CMDS AT T-5 <sup>M</sup> 30 <sup>S</sup> FROM 15.2 PSIA TO 15.4 PSIA. DONE.	CLOSE
5	EECOM-4		LOW BODY FLAP ACTUATOR TEMPS. EECOM SAYS THIS CAUSED BY CRYO VENTING (AFT) COOLING THE ACTUATORS. FRF DATA IS BEING COMPARED TO DETERMINE IF CONDITION ALSO WAS EXPERIENCED. EXPECT TEMP TO INCREASE AFTER APUL START. AT APUL START TEMPS AS LOW AS $-40^{\circ}$ IS ACCEPTABLE.	CLOSE
6.	EECOM-5		WSB # 2 STEAM VENT TEMP $<$ 130° REDLINE AT WHICH POINT WSB O.I. IS LOST. AT T-5 WHEN APUL FUL ISOL VLV IS OPEN MAY NOT HAVE APUL READY INDICATION BUT APUL IS GO AND NORMAL START PROCEDURES WILL BE USED. AT $\approx$ T-6 WILL KNOW IF AN APUL READY CAN BE EXPECTED. THIS PARAMETER WILL BE MASKED IN THE GLS.	CLOSE

Item	Anomaly No.	Time (GMT/PET)	Description/Impact/Resolution	Status
7	STDN-1	L-3 <sup>00</sup> 05 <sup>S</sup>	MIL LOST S-BAND HI SPEED TRK DATA. WAIVED THE FR AND WENT WITH C-BAND DATA. HAND-OVER EARLY TO RDA TO REGAIN S-BAND TRK. KSC REQUESTED MIL TO OUTPUT TDPS DATA TO KSC RUNWAY CAMERAS, THIS INHIBITED WCC OUTPUT.	CLOSED
8	PROP-1	3430 PET	OMS P <sub>2</sub> BOTH ENGS INDICATED OFF SCALE HIGH ON TM. CREW REPORTED ONBOARD INDICATION OF OFF SCALE LOW (AS EXPECTED). DURING OMS 1 BURN P <sub>2</sub> INDICATION ON BOTH ENGINES INDICATED NOMINAL. (L OMS 102, R OMS 101) MCC PROBLEM, WILL RECD CORRECTLY AFTER IGN.	CLOSED
9	EGIL-1	14+05 PET	DFI/OF4 SIGNAL CONDITIONOR MAIN B. I.C.B. popped ON PANEL #15. ALTERNATE POWER SOURCE AVAILABLE, EGIL CONFIRMED A 50-AMP SHORT. DO NOT RESET CB. DATA INDICATES SHORT MAY BE INTERNAL TO SIG. COND.	CLOSED
10	BSE-1	38+14 <sup>S</sup> PET	CREW REPORTED POGO EFFECT CLOSE TO MECO (BUT AFTER MECO). THIS MAY HAVE OCCURRED DURING OMS-1 BURN. CAUSE UNEXPLAINED. <b>After oms-1 leaving engine stow?</b>	
11	DPS-2	39+00	PASS AND BFS DIDN'T GET A PORT BYPASS ON EIU'S 1 AND 2. EXPECTED TO GET PORT BYPASS ON ALL EIU'S, ALL PORTS. IN OPS 2 EIU BYPASS INDICATIONS APPEARED NOMINAL. DETERMINED THAT SYSTEM PERFORMED AS IT SHOULD. NO PROBLEM.	CLOSED
12	INCO-1	14 41 <sup>M</sup>	DFI RM RCDR PLACED TO STOP AND TB STILL INDICATED GRAY. CB9 AN11 WAS OPENED TO REMOVE POWER FROM THE RCDR. BP TAKEBACK INDICATION RECEIVED. RCDR STUCK IN CONTINUOUS RECORD. CONTROL RCDR WITH CB. PLAN FOR ENTRY IN WORK. DECIDED TO CHANGEOUT THIS RCDR WITH DFI WB ASCENT RCDR. CREW WAS UNABLE TO LOOSEN ALL SCREWS. SCRUB CHANGEOUT.	

Item	Anomaly No.	Time (GMT/PET)	Description/Impact/Resolution	Status
-13	EECOM-6	1 <sup>H</sup> +52 <sup>M</sup>	CREW REPORTED SOME TILES OFF ON THE STARDWARD AND PORT OMS PODS. TV DOWN LINK CLEARLY SHOWED AREAS. CREW REPORTED COLOR AT AREA OF MISSING TILES ON STAR POD AS RED. CREW WAS ADVISED. NOT CRITICAL FOR ENTRY.	
14	EGIL-2	3 <sup>H</sup> 03 <sup>M</sup>	LOW FLOW RATE ON FIC'S 1, 2, AND 3 DIDN'T ALLOW AUTO FIC PURGE TO FUNCTION. MANUAL AIRGE WAS INITIATED, AND IS REQ'D FOR ALL FURTHER FIC PURGES.	CLOSED
15	EECOM-7	3 <sup>H</sup> 06 <sup>M</sup>	AIRLOCK PRESSURE REDUCER (AIRLOCK-TO-AMBIENT) FAILED. HATCH ΔP GAGE SHOWS ZERO ∴ GOOD HATCH/AIRLOCK.	CLOSED
16	EECOM-8	3 <sup>H</sup> +03 <sup>M</sup>	CABIN TEMP READS 81° F WITH ALARM. CREW REPORTS FEELS COOLER THAN THAT. CLW LIMIT WILL BE UPDATED. DONE.	CLOSED
17	EGIL-3	2 <sup>H</sup> +36 <sup>M</sup>	PURGE LINE TEMP ON FIC READING HIGHER THAN EXPECTED. READING UP TO 330° F. NO CONCERN FOR UPPER LIMIT, WILL UPDATE CLW LIMIT. DONE.	CLOSED
18	BSE-2	THROTTLE DOWN	L GH2 OLT PRESS AND TEMP measurements FAILED. SUSPECT XDLCS. OTHER SNR ON OAZ MDM INDICATE THERE IS NOT AN MDM OR CARD PROBLEM	CLOSED

Item	Anomaly No.	Time (GMT/PET)	Description/Impact/Resolution	Status
19	BSE-3	0 <sup>H</sup> 1 <sup>M</sup> 25 <sup>S</sup>	L SSME PURGE ANCILLARY SYSTEM POGO PRECHARGE. PRESS A & B FAILED LIMITS. NEED MSFC ANALYSIS OF SSME TLM TO RESOLVE THIS. NO IMPACT ON FLIGHT, POST-FLIGHT ANALYSIS REQUIRED.	CLOSE
20	GNC-1	3 <sup>H</sup> 2 <sup>M</sup> 9 <sup>H</sup> 35 <sup>M</sup>	Y STAR TR SHUTTER IS CLOSED. SHOULD BE OPEN. TARGET SUPPRESSION BIT WAS LATCHED "ON". MUST MANUALLY CMD SHUTTER TO OPEN, THEN RESELECT AUTO MODE. PROBLEM MAY RE-OCCUR ANY TIME. APPARENTLY LIGHT LEAK BY SHUTTER SET "TGT SUPPRESS" BIT.	
21	EGIL-4	6 <sup>H</sup> 11 <sup>M</sup>	AFT MN C AMPS OFF SCALE HIGH. NO OTHER INDICATIONS". INSTRUMENTATION FAILURE.	CLOSED
22	MCC-1 (EECOM)	6 <sup>H</sup> 6 <sup>M</sup>	SEVERAL PARAMETERS DISPLAYED AS "0" VALUE BY MOC, BUT ONBOARD + TPC READ OK. V58P 0115A HYD 1 MN PUMP P B 0215A } 2 } } } B 0314A } 3 } } } A 0315A } 3 } } } B V46R 0135A AP4 1 TURB SPD CAUSED BY MED OVERRIDE. NOT A PROBLEM.	CLOSE
23	STDN-2	35 <sup>M</sup> 50 <sup>S</sup>	NO IOS S-BAND PM TLM. UHF VOICE ONLY. ORBIT 8 WAS OK. TRACED TO IOS GETTING/USING WRONG POINTING DATA.	CLOSE
24	STDN-3	1 <sup>H</sup> 1 <sup>M</sup> 30 <sup>S</sup>	WEAK ORR UPLINK VOICE. SWAPPED DMS CHANNELS AND RESTORED VOICE.	CLOSE

Item	Anomaly No.	Time (GMT/PET)	Description/Impact/Resolution	Status
25	MCC-2	7 <sup>H</sup> 07	DSC DID NOT RESUME AFTER MCC CHECK-POINT; DUE TO TAPE HANG-UP. RELEASED DSC EARLY. OLD DR# 62393.	CLOSE
26	PL-1	7 <sup>H</sup> 50 <sup>M</sup> 19 <sup>S</sup>	HAD TO SEND ACIP OFF COMMAND (DSM 2000) TWICE BEFORE ACIP RESPONDED. GOT MCC/BWC CMD VALS. CMDS WERE SENT 22 SECONDS APART. COMMANDED 3 OR 4 TIMES SINCE TAEW (USING SPL'S) AND ACIP RESPONDED NOMINALLY.	CLOSE
27	MCC-3	7 <sup>H</sup> 24 <sup>M</sup>	UNABLE TO U/L TO TELEPRINTER SINCE GOT NO RETURN TONE. MCC COMM LINE SWITCH SUFFERED A RANDOM CKT PATCH ERROR. RE-PATCHED AND RESUMED TELEPRINTER U/L.	CLOSE
28	GNC-2	6 <sup>H</sup> 6 <sup>M</sup> 27 <sup>S</sup>	R OMS PITCH GMBL MSG. ENGINE DID NOT GIMBAL WHEN COMMANDED. DURING GIMBAL CHECK, ENGINE RESPONDED TO 2 <sup>ND</sup> GIMBAL CMD. GIMBALS SHOWS ERRATIC RESPONSE. THIS IS A GO CONDITION FOR CONTINUATION TO EDM. CONSIDERATION WILL BE GIVEN TO USING SEC GIMBALS ON R OMS FOR DEORBIT.	CLOSE
29	PROP-2	9 <sup>H</sup> 33 <sup>M</sup>	OMS POD TEST He/Ox 1 (R POD 92.9; L POD 85 BUT WAS ↑ EARLIER). MCC VALUES ARE LOWER. REVISED OIB LIMITS TO ELIMINATE NUISANCE ALARMS. CALIBRATION IN ERROR OIB, WILL READ ≈ 16° > THAN ACTUAL TEMP.	CLOSE
30	PROP-3	11 <sup>M</sup> 40 <sup>S</sup>	OMS FUEL GAGE (BOTH PODS) LAGGING ACTUAL. OX IS OK. USE OX FOR IMAGING AND CREW WILL ALSO USE OX QUANTITY FOR XFEED CUE. CREW ADVISED.	CLOSE

Item	Anomaly No.	Time (GMT/PET)	Description/Impact/Resolution	Status
31	PROP-4	12 <sup>H</sup> 30 <sup>M</sup>	POTENTIAL OMS XCEED THERMOSTAT <sup>N</sup> CREEP FAILURE. IF A FAIL OFF OCCURS FROM THE CREEP, THE LINE WOULD FREEZE WITHIN X 30 MIN. BOTH A & B OMS XFD HTRS WERE ENABLED AT 103/0026Z. A HTR WAS TURNED OFF AT 01/00:06. STAY ON B HTR UNTIL PRIOR TO ENTRY, THEN GO BACK TO BOTH HTRS.	Close
32	GNC-3	8 <sup>H</sup> 00 <sup>M</sup>	IMU 3 Z AXIS ACC SCALE FACTOR ERROR > 3σ AS DETERMINED BY MPAD ANALYSIS. IMU 3 ATT ERROR OBSERVED IN COMPARISON WITH IMU'S 1 AND 2. IMU #3 IS CONSIDERED GOOD. MPAD ANALYSIS WAS BASED ON BAD TLM DATA.	Close
33	EELCOM-9		APU 1 FEEDLINE HTR B ABNORMAL CTRL CYCLE. SWITCHED TO SYSTEM A ON APU 1. TEMPERATURES ARE CYCLING NORMALLY. HTR B THERMOSTAT HAS SHIFTED A LITTLE LOW.	Close
34	EELCOM-10	16 <sup>H</sup> 00 <sup>M</sup>	CABIN TEMP CTRLR NOT MAINTAINING SELECTED TEMP. PROCEDURE AVAILABLE TO WARM UP CABIN. TURNED THE CTRLR OFF AND WENT TO MANUAL CONTROL.	Close
35	EELCOM-11	22 <sup>H</sup> 23 <sup>M</sup>	SYSTEM 1 O <sub>2</sub> REG PRESS Hi (168PSI). INCREASED TO 212-PSI by 22 <sup>H</sup> 46 <sup>M</sup> .	
36	BSE-4	23 <sup>H</sup> 40 <sup>M</sup>	DURING THE 2 <sup>ND</sup> MPS VACUUM INERTING, THE LEFT Helium TANK PRESSURE DECREASED 450 PSI. HE LEAK IS SUSPECTED. RATE NOT YET DETERMINED.	

Item	Anomaly No.	Time ( <del>GMT</del> / PET)	Description/Impact/Resolution	Status
17	GMC-4	01/00+M4	CDR'S HSI WAS 5° OFF IN heading during Low TEST; The first Hi-TEST RUN WAS OK, SECOND TEST THE CARD DID NOT MOVE (Sitting at ~ 350 heading). SOFTWARE WAS RETESTED AND WORKS PROPERLY.	
38	MCC-4	01/05h	RIGHT Eidophon WENT DOWN. ETO TO REPLACE CATHODE IS 10 MIN	CLOSE
39	STDN-4	1/11:42	RATTY IOS PASS CAUSED LOSS OF DP5 RCDR CONFIG. CMD ; LOSS OF DATA 103/23482 THRU 104/00182. TRACED TO DSIS OUTAGES.	CLOSE

Statement of problem:	
Star tracker shutters not cycling open and closed as expected.	
Discussion:	
<p>The star tracker shutter closed upon receipt of a bright object sensor alert and/or target suppression discrete. The sensor is set to the light intensity of the brightest horizon expected, -21 visual magnitude, and the discrete is set at a -8 visual magnitude. (For comparison, Sun is -28.8, Moon -12.6, Venus -4.4, Sirius -1.6, Aldebaran +0.9.)</p> <p>At 102:16:53 G.m.t., the -Y star tracker shutter had been closed for over an hour, and the target suppression bit was set. The shutter was opened by an override command.</p> <p>A simultaneous -Y star tracker target suppress bit was set and the shutter closure was observed at 103:10:26:20 G.m.t., indicating that the shutter was not being closed by the bright object sensor. At 104:09:35:03 G.m.t., the -Z star tracker shutter target suppression bit was found set after power up. The crew used the override to open the shutter and align the inertial measurement units. Analysis indicates that the -Z star tracker was pointed towards sunlit earth at that time.</p>	
Required date for resolution:	CLOSED <i>Claron Cohen 6/3/81</i>
Personnel assigned:	D. Brown/EH7 X-3254, A. Reubens/WA3 X-4323
Action progress:	Reexamination of alert and suppression design thresholds for later missions.
Effect on subsequent missions:	May require manual override.
Conclusions:	Low earth brightness at certain geometries was the cause of target suppress activation, but not sufficiently bright to activate the bright object sensor.
Corrective action:	Fly as is for STS-2.

## Statement of problem:

TACAN 2 bearing fail indication

## Discussion:

The bearing value during terminal area energy management (TAEM) was in error in multiples of 40 degrees. There were 10 such errors in a row followed by one good value and then another error. After 10 seconds of unreasonable data, the redundancy management (RM) deselected the TACAN 2 bearing data.

The TACAN 2 (automatic gain control AGC) indicated low signal strength, but systems 1 and 3 AGC signal strengths were up and they were locked on the same ground station (Edwards AFB) as system 2. Data indicates all 3 systems were operating on lower antennas.

The Orbiter's turn and banking angles, at TAEM caused the system 2 antenna not to have the optimum look angle to the ground station. (System 2 antenna is on the starboard side of the underside of the orbiter.) Immediately after the errors, the system 2 bearing data were good and could have been manually reselected by the crew.

Required date for resolution: CLOSED

*Completed 6/3/81*

Personnel assigned:

B. Hood/EH4 X-3254, R. Drown/EE6 X-5561, A. Reubens/WA3 X-4323

Action progress:

None

Effect on subsequent missions:

None

Conclusions:

At or near TAEM, the Orbiter attitude maneuvers caused the Orbiter-to-ground station look angles to be in low gain zones of the airborne antenna radiation pattern. This results in low signal strength and resultant dropouts with the characteristic bearing errors in multiples of 40°.

Corrective action:

None required. The deselected TACAN system could have been manually reselected immediately, but was not required. (After the 12-second period, system 2 bearing data agreed with the other 2 systems.)

## Statement of problem:

Vehicle response overshoot poorly damped during first roll.

## Discussion:

Lateral roll/yaw oscillation after the first roll maneuver at a dynamic pressure of about 12 psf was poorly damped with a maximum peak-to-peak beta of 7° and a period of 13 seconds.

An unexpected roll torque from the yaw engines is the primary cause. The estimated roll torque is much closer to vacuum thrust levels at low dynamic pressure than provided for in the Aero Data Book. This results in an inability of the autopilot to coordinate the maneuver properly due to inadequate roll authority.

For STS-2, the initial roll will be performed manually at a reduced rate allowing for additional data gathering before modifications are made to the flight control software.

## Required date for resolution:

CLOSED for STS-2 6/10/81

## Personnel assigned:

D. Gilbert/EH4 X-3254, R. J. Ward/WA3 X-4323

## Action progress:

## Effect on subsequent missions:

Dependent on STS-2 results.

## Conclusions:

Roll torque from the yaw engines exceeds autopilot roll authority at low dynamic pressure.

## Corrective action:

Use manual control at reduced rates for STS-2.

Modify flight control software for STS-3 and subsequent after evaluation of STS-2 manual flight test data.

## Statement of problem:

Orbiter touchdown was about 3200 ft beyond planned point.

## Discussion:

The Orbiter touched down 6053 ft past the threshold on EDW Runway 23. This touchdown point was about 3000 ft farther down the runway than premission planning had predicted even though the touchdown speed and approach trajectory were near nominal. Analysis based on the onboard trajectory data, ground based measurements of touchdown point, wind and atmospheric density from a balloon released 2 minutes after landing, and onboard speed brake position information indicated that the Orbiter lift-to-drag ratios were higher than expected both in and out of ground effects.

Postflight reconstruction simulations indicated that about 2000 ft of the 3000 ft deviation could be accounted for the additive minor operational and environmental dispersions and the higher lift-to-drag ratios appear to account for the remaining 1000 ft. Additional analyses based on control stick inputs and aerodynamic coefficient identification techniques generally confirmed that the Orbiter's basic drag was lower than expected and ground effects normal force and axial force coefficients were slightly different than those defined in premission aero data books.  
(continued, page 2)

## Required date for resolution:

CLOSED for STS-2 7/22/81 *SCJ 8/15/81*

*Campbell*

Personnel assigned: J. West, B. Redd, L. Hayman/EX3 X-5181, R. J. Ward/WA3 X-4323

## Action progress:

Simulations continuing using the revised aerodynamics.

## Effect on subsequent missions:

None

## Conclusions:

Predicted landing aerodynamics were different from the actual for STS-1.

## Corrective action:

Aerodynamic data base being revised to reflect STS-1 results. SMS and Shuttle training aircraft to include revised data base. Steep glide slope being revised from 20° to 19°.

#37 (continued)

Discussion:

Postmission simulations confirm that these aerodynamic coefficient adjustments result in the equivalent of 900 to 1000 ft more range at touchdown.

The aerodynamic coefficients which have been adjusted include:

- a. Axial force coefficient  $CD_0$  reduced 0.0040.
- b. Speed brake drag effectiveness higher than predicted.
- c. Ground effects for normal and axial force coefficients less than expected.

## Statement of problem:

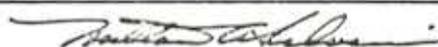
Body flap exceeded planned trim attitude by over 5° at hypersonic entry speeds

## Discussion:

The body flap extended to 14°, exceeding the planned trim attitude of 8 to 9° during entry from Mach 22 through 12. Postflight analysis of longitudinal trim characteristics indicates that aerodynamic predictions for pitch trim at hypersonic speeds were in error. The additional body flap deflection increased the body flap heating environment. Elevon trim position will be changed from -1° to +1° above Mach 10 for STS-2.

## Required date for resolution:

CLOSED 6/3/81



## Personnel assigned:

L. Hayman/EX3 X-5181, R. J. Ward/WA3 X-4323

## Action progress:

Body flap pulses during aero stick inputs (ASI's) on STS-2 will provide data to evaluate longitudinal effectiveness of individual control surfaces.

## Effect on subsequent missions:

None

## Conclusions:

Aero pitch trim predictions in error.

## Corrective action:

Elevon schedule will be adjusted on STS-2 to relieve body flap heating.