Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-61-V-01	OI - Sensors
None	GMT:		SPR 61RF05	UA	Manager:
			IPR 59V-0005	PR APU-104	
					Engineer:

Title: APU 3 X-Axis Accelerometer Data Clipped (ORB)

Summary: DISCUSSION: The auxiliary power unit (APU) 3 X-axis accelerometer (V46D0380A) data recorded during the mission indicated anomalous vibration levels in the APU. During the last 19 minutes of the 22 minute APU ascent run the signal was essentially zero with occasional spikes in the 0 to 5 g peak-to-peak range. A similar signature was seen during entry. A closer review of the acceptance test program (ATP) and confidence run data traces of this APU also revealed similar signatures. Postflight troubleshooting revealed no anomalies in the instrumentation from the signal conditioner connection to the APU interface. The accelerometer and the wire harness were removed and sent to the JSC Analysis and Testing Laboratory for further examination.

CONCLUSION: A faulty accelerometer or wire harness is the most probable cause of the erratic accelerometer measurement. CORRECTIVE_ACTION: The accelerometer and wire harness were removed and replaced and verification testing was successfully completed. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-61-V-02	OMS/RCS
PROP-02	GMT:		SPR 61RF04	UA	Manager:
			IPR 59V-0002	PR	x39031
					Engineer:

Title: Right OMS Helium Tank Pressure Indication Failed Low (ORB)

Summary: DISCUSSION: During the orbital maneuvering system (OMS) 3 rendezvous maneuver, the right OMS helium tank pressure 2 indication (V43P5122C) failed low, with a drop from a good reading of 3500 psia to a low reading of 100 psia. A redundant sensor for this tank was used for the remainder of the burn. Just prior to the

OMS-6 firing, when the right OMS helium isolation valves were opened, the indication recovered. One firing had been performed using this engine between the time of the failure and the recovery of the measurement. The problem did not recur.

These measurements offer the only insight into a leak in the high-pressure helium system. If both measurements had failed, no helium leak detection would have been available on the right OMS. Review of the failure history of this transducer, serial number 502, revealed that it failed off-scale low (-628 psia) during the OMS-2 firing on STS-32. It recovered following the firing and operated nominally for the remainder of that mission. The pod was not removed at that time and flew two more times on that vehicle (OV-102). The pod (RP04) was then removed, and since the problem could not be duplicated and had not recurred, no corrective action was taken. RP04 was then installed on OV-105, where it has flown five flights including STS-61. No further anomalous behavior of this transducer had been observed until this occurrence. Postflight troubleshooting will be performed under CAR 61RF04 to determine the cause of the problem. The suspect causes of the problem are the sensor, wiring, and the signal conditioner. If the cause of failure cannot be isolated, then the transducer will be removed and replaced. CONCLUSION: The most likely cause is an intermittent connection in the wiring of either the pressure transducer or the signal conditioner. CORRECTIVE_ACTION: Troubleshooting will be performed to isolate the cause of the failure. If no cause is identified, the transducer will be removed and replaced. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	**Time**	**Classification**	**Documentation**		**Subsystem**
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-61-V-03	OMS/RCS
PROP-03	**GMT:**		**SPR** 61RF03	**UA**	**Manager:**
			IPR	**PR** LP03-17-0390	
					Engineer:

Title: RCS Thruster L2U Fail Off (ORB)

Summary: DISCUSSION: Reaction control subsystem (RCS) primary thruster L2U was declared failed-off when used during the NH rendezvous firing at approximately 338:02:34:20 G.m.t. (early on flight day 3). This was the first attempted firing of thruster L2U during the mission. The telemetry format load (TFL 179) being used at the time of the firing downlisted chamber pressure from thruster L2U at only 1 sample/sec (full rate is 25 samples/sec). Therefore, when the fire command was initiated, no thruster chamber pressure was detected prior to deselection by redundancy management (RM) at 240 msec. RM declares a thruster failed-off after receiving three consecutive chamber-pressure discretes indicating a chamber pressure of less than 36 psia. The nominal chamber pressure for a primary thruster is approximately 152 psia.

Injector tube temperature data indicate both fuel and oxidizer flow. The temperature data also indicate that the thruster did not fire nominally due to the absence of soakback heating associated with nominal thruster operation (that is, the data does not indicate that the fail-off was due to Pc tube damage). The oxidizer flow seen was most probably pilot-valve-only (or limited) flow, which accounted for the low chamber pressure. The oxidizer valve main stage probably failed to open fully due to iron nitrate contamination of the pilot stage. The RCS oxidizer valve has a pressure- operated main stage and a failure to operate due to iron nitrate contamination is the most common failure mode. The thruster was left deselected for the remainder of the mission. Orbital maneuvering system (OMS) pod LP-03 has been removed from OV-105 and transferred to the hypergolic maintenance facility (HMF) for its Orbiter maintenance down period (OMDP). Thruster L2U has not yet been removed and replaced; however, a pressure test was performed which confirmed that the Pc tube was not damaged. Thruster L2U (S/N 420) has flown 12 missions, the last 9 with the same oxidizer valve. The thruster is typically flown in a low priority and therefore its equivalent mission use is only 1.08 missions. The oxidizer valve is a -506 configuration and upon removal, the thruster will be sent to the White Sands Test Facility (WSTF) for valve flushing. If flushing is successful in clearing the contamination, the thruster will be returned to service. If the flushing fails, the thruster will be returned to the vendor for refurbishment. CONCLUSION: The most probable cause of the thruster fail-off was iron nitrate contamination in the oxidizer-valve pilot-stage that prevented its proper operation. CORRECTIVE_ACTION: KSC will replace thruster L2U, which will be transferred to the WSTF for the thruster-flush program. The primary thruster oxidizer valves have a pressure-operated main stage and are susceptible to failure due to iron nitrate contamination. Iron nitrate formation is assisted by the presence of water (moisture) in the oxidizer valve. Therefore, the primary thruster throat plugs are installed during turnaround to reduce the likelihood of moisture intrusion into the propellant system. Also, a program to develop a direct-acting valve, which would be less susceptible to failure from iron nitrate contamination, is currently in progress. Results of the thruster flush at the WSTF and any necessary failure analysis will be documented in CAR 61RF03. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	**Time**	**Classification**	**Documentation**		**Subsystem**
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-61-V-04	OMS/RCS
PROP-01	**GMT:**		**SPR** 61RF06	**UA**	**Manager:**
			IPR 59V-0004	**PR**	
					Engineer:

Title: Left OMS Total Fuel Quantity Incorrect (ORB)

Summary: DISCUSSION: At 336:10:10:45 G.m.t., approximately 15 seconds after initiation of the orbital maneuvering system (OMS)-2 maneuver, the left OMS total fuel quantity indication dropped suddenly from 94 to 44.6 percent. The time of the failure corresponds to the end of the 15-second lock-out period during which time the quantity gaging system totalizer uses burn time integration instead of inputs from the probes for quantity determination. The 44.6 percent quantity indicates a dry forward probe, that is, it corresponds to all of the propellant that can be located in the aft compartment plus the ungageable region.

A subsequent rendezvous maneuver (NC-1) using the OMS engines was performed at 336:14:54:29 G.m.t. and during this burn the quantity indication remained at the failed value of 44.6 percent. However, during a rendezvous maneuver (NSR) using the OMS engines at 337:13:11:00 G.m.t., the quantity indication returned to the correct value at the end of the 15-second lock-out period. The indication continued to operate nominally for the remainder of the mission. STS-61 was the sixteenth flight of OMS pod LP03. Similar problems occurred on the second and third flights of LP03, STS-41D and STS-51A, respectively. During each of these missions, the total fuel quantity indication dropped suddenly to 45.8 percent during the OMS-1 burn and began indicating the correct value during subsequent burns. Following STS-51A, the cause of the failure was isolated to a damaged wire at pin 1 on the forward fuel probe electronics connector J202. The failure mode was attributed to excessive flexing and improper handling during assembly. Corrective action was implemented to bring the failure mode to the attention of test and inspection personnel. OMS pod LP03 has been removed from OV-105 and transferred to the hypergolic maintenance facility (HMF) for its Orbiter maintenance down period (OMDP). At the HMF, troubleshooting will be performed. The problem is intermittent and, based on the prior failure history and the failure signature seen on STS-61, is suspected to be in the forward fuel probe electronics or a connector between the probe and the fuel totalizer. CONCLUSION: The OMS pod has been removed and sent to the HMF for its OMDP. Troubleshooting of the fuel quantity gaging system will be performed. The problem is intermittent and is suspected to be in the forward fuel probe electronics module or an electrical connector (bent pin) between the probe and the fuel totalizer. CORRECTIVE_ACTION: The corrective action, if any, is yet to be determined. However, based on previous failures of this type, it should be replacement of the electronics module or repair of the appropriate connector pin. Note that work-arounds exist for loss of the gaging system on-orbit and during preflight propellant loading. Burn time integration is used to calculate propellant quantity on-orbit and ground support equipment (GSE) flowmeters can be used to load propellants to the required preflight level. Results of troubleshooting and any necessary failure analysis will be documented in CAR 61RF06. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-61-V-05	APU
MMACS	GMT:		SPR 61RF07	UA	Manager:
			IPR 59V-0006	PR APU-0105	x33947
					Engineer:

Title: APU 2 Fuel Pump/GGVM System A Heater Failure (ORB)

Summary: DISCUSSION: At approximately 340:15:10 G.m.t. (04:05:43 MET), the auxiliary power unit (APU) 2 fuel line, fuel pump, and gas generator valve module (GGVM) system A heaters did not activate at the expected cycle-on temperatures. The bypass line temperature dropped from its expected cycle-on temperature of 83?F to 66?F over a 6-hour period and had reached a steady decay rate of 1?F/hour. The lower fault detection and annunciation (FDA) limit for this measurement is 60?F. The crew switched to the B heaters at 341:00:06 G.m.t. (04:14:39 MET), and proper operation was observed.

To aid in troubleshooting, the APU 2 fuel line, fuel pump and, GGVM system heaters were switched back to the system A at 345:04:15 G.m.t. (08:18:48 MET) The system A heaters did not turn on, and the APU 2 bypass line temperature decreased to 68?F, well below the activation temperature of the thermostat. Heater control was switched back to system B. Postflight troubleshooting duplicated the failure and isolated the problem to the system A thermostat. The failed system A thermostat was removed from the Orbiter and sent to the JSC Analyses and Testing Laboratory (JATL) for failure analyses. The failure of the thermostat is believed to be induced by vibration because of the prior failure history of this type of thermostat. It has been determined that some APU fuel tubes, where the thermostats are mounted, produce a vibrational environment above which the thermostats are designed to withstand. CONCLUSION: Vibration is the most probable cause of the failure of the thermostat. CORRECTIVE_ACTION: Ground troubleshooting isolated the cause of the failed- off heater to the thermostat. The thermostat was replaced and verification testing was successfully completed. The thermostat was sent to JATL to determine the cause of the failure. This APU thermostat problem is being documented in CAR 61RF07-010. EFFECTS_ON_SUBSEQUENT_MISSIONS: None

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-61-V-06	Star Tracker
GNC-01	**GMT:**		**SPR** 61RF11	**UA**	**Manager:**
			IPR none	**PR**	x38167
					Engineer:

Title: -Y star tracker not acquiring stars (ORB)

Summary: DISCUSSION: During STS-61 on-orbit operations, the -Y star tracker, a solid state star tracker (SSST), failed to acquire navigation stars during star-of-opportunity mode for five hours between 340:20:00 and 341:01:00 G.m.t. At 341:01:18 G.m.t., the crew performed three self tests on the unit. The tracker failed all three because it did not acquire the test star. At 341:01:23 G.m.t., the crew power cycled the tracker and performed a fourth self test. The tracker passed the self test and functioned nominally for the remainder of the mission. The -Z star tracker, an image dissector tube (IDT) star tracker, was not affected.

The star tracker data are used to align the inertial measurement units (IMUs) in order to maintain attitude accuracy. In between the alignments, star tracker data are monitored on the ground during operations in the star-of- opportunity mode, and are used to verify star tracker function and IMU performance. If the SSST had not been recovered, flight rules require a calibrated crew optical alignment sight (COAS) or head-up display (HUD) as a backup to the remaining star tracker for IMU-attitude accuracy requirements. In this particular case, a calibration had not been performed for the cabin pressure being maintained, and the crew would have been required to perform this procedure had the SSST not been recovered. The time noted for the beginning of the anomalous behavior of the tracker coincides with the Orbiter passing through the South Atlantic anomaly (SAA), an area of high radiation. The high altitude flown on STS-61 resulted in increased radiation exposure when compared with flights at lower altitudes. When the vehicle entered the SAA on this orbit, other onboard radiation monitoring equipment registered increments in radiation upsets. Review of the radiation experienced during the time of the initial failure indicates three IBM 486 Thinkpad memory errors and four general purpose computer (GPC) memory errors. This is expected when the vehicle passes through the SAA at this altitude. The SSSTs are known to be more susceptible to radiation upsets than the IDT star trackers. Of the 11 components of the SSST susceptible to radiation-induced upsets, three were identified as candidates for causing this particular signature. They are the random access memory (RAM) used on the processor board, the processor itself, and the analog switches used on the processor board. No troubleshooting is planned. The SSST, serial number 2, will not be removed, nor will the light shade. There is one other SSST in the fleet. It is in the -Y slot on OV-102. All of the SSSTs are susceptible to this type of malfunction, but a power cycle recovers the tracker. CONCLUSION: Based on the indications available, the cause of the failure is radiation particles affecting either the RAM used on the processor board, the processor itself, or the analog switches used on the processor board. CORRECTIVE_ACTION: None. All SSSTs are known to be susceptible to this type of failure. EFFECTS_ON_SUBSEQUENT_MISSIONS: None. Should the problem recur on subsequent missions, a power cycle will restore the SSST to normal operation.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-61-V-07	EPD&C - Hardwar
dps-01	GMT:		SPR 61RF13	UA	Manager:
			IPR 59V-0007	PR	x31719
					Engineer:

Title: Aft Mission Timer Circuit Breaker (CB12) Popped (ORB)

Summary: DISCUSSION: The crew reported finding the aft mission timer circuit breaker (CB12 on panel O15) popped out after waking on flight day 3. A review of fuel cell 2 current data confirmed that a direct short from the power supply line to ground had not occurred; however, the 2 amp-per-bit resolution of the measurement was too coarse to determine whether a slight overcurrent condition may have existed that could have tripped the 3-amp circuit breaker. Normal load changes occurring through the crew sleep period also contributed to masking any possible indications of a slight overcurrent condition or identifying the time at which the circuit breaker tripped open. The circuit breaker was left open for the remainder of the flight.

The circuit breaker did not trip the first time it was closed and power was applied to the aft mission timer during postflight troubleshooting. The aft mission timer was successfully operated as often as power was available for a period of over one month. The breaker did not trip open during any of the postflight troubleshooting activities. Current supplied to the aft mission timer was monitored for two days using a 10 milli-ohm shunt resistor installed in series with the timer. Current through the shunt was monitored using a strip-chart recorder which measured a steady 0.12-amp current. The maximum specified load for the aft mission timer is 4 watts (0.14 amp). High-voltage potential (HI-POT) tests using 1500 Vdc were performed on the wiring between the circuit breaker and the aft mission timer to verify the integrity of the wiring insulation with nominal results. All de-mated connectors and receptacles were inspected revealing no discrepancies. A check of the mechanical force required to engage and disengage the circuit breaker was performed with nominal results. A 2.4-amp load (80 percent of the 3.0-amp circuit breaker trip rating) was applied to the circuit breaker for one hour. The 0.14-amp maximum current load from the aft mission timer is the only load connected to the circuit breaker. No anomalies were noted and the circuit breaker remained closed. Troubleshooting has produced nominal results and the cause of the anomaly is currently unexplained. A possible cause for the anomaly could be an intermittent problem within the aft mission timer that caused the circuit breaker to trip open due to slightly excessive current. If the anomaly were to recur or if a direct short between the power supply and ground were to occur, the circuit breaker will trip open to isolate the fault. Loss of the aft mission timer is not critical and does not jeopardize mission success. The aft mission timer has been removed and will be sent to the NASA Shuttle Logistics Depot (NSLD) for test, teardown, and evaluation (TT&E). CONCLUSION: The cause of the anomaly is currently unexplained but could be an intermittent problem within the aft mission timer that caused the circuit breaker to trip open due to slightly excessive current. CORRECTIVE_ACTION: The aft mission timer has been removed and will be sent to the NSLD for TT&E. Final corrective action will be documented in CAR 61RF13- 010. EFFECTS_ON_SUBSEQUENT_MISSIONS: If the fault is isolated and repaired during TT&E of the aft mission timer there should be no effect on subsequent missions. If the anomaly were to recur or if a direct short between the power supply and ground were to occur, the circuit breaker will trip open to isolate the fault. Loss of the aft mission timer is not critical and does not jeopardize mission success.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-61-V-08	C&T - Ku-band
INCO-06	GMT:		SPR 61RF08	UA	Manager:
			IPR 59V-0010	PR COMM-5-06-0077	x31719
					Engineer:

Title: Ku-Band Range Rate/Azimuth Indicator Units Digit Failed Off (ORB)

Summary: DISCUSSION: The crew reported that the units digit on the Ku-Band Range Rate/Azimuth indicator failed off while the Ku-Band antenna was being stowed at 339:02:50 G.m.t. (02:17:50 MET). The crew also reported that the failure light on the Range/Elevation and Range Rate/Azimuth digital display unit was illuminated.

Postflight troubleshooting isolated the fault to a problem within the Range/Elevation and Range Rate/Azimuth digital display unit. The display unit was removed and sent to the NASA Shuttle Logistics Depot (NSLD) for test, teardown and evaluation (TT&E). A spare display unit was installed and successfully retested. CONCLUSION: The problem was caused by a fault within the Range/Elevation and Range Rate/Azimuth digital display unit. CORRECTIVE_ACTION: The Range/Elevation and Range Rate/Azimuth digital display unit was removed and sent to the NSLD for TT&E. Final corrective action will be documented in CAR 61RF08-010. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-61-V-09	APU
MMACS-03	GMT:		SPR 61RF09	UA	Manager:
			IPR	PR APU-0103	x39047
					Engineer:

Title: APU 3 EGT 1 (V46T0342A) Erratic (ORB)

Summary: DISCUSSION: During entry, the auxiliary power unit (APU) 3 exhaust gas temperature (EGT) 1 measurement was erratic for 23 minutes of the 62 minute entry run. The data signature from EGT 1 tracked the EGT 2 signature before and after the period of erratic operation. The EGT sensor was removed from the APU and sent to Rockwell-Downey L & T laboratory for testing and failure analysis. Possible cause for the erratic operation of the EGT sensor is thought to be a loose connection in the wiring circuit internal to the sensor.

This EGT sensor is the first one of the new design to fail. The new design is installed on OV-102, OV-103, and OV-105. This EGT sensor has been on all five flights of OV-105. CONCLUSION: An intermittent connection inside the EGT sensor is thought to be the cause of the erratic EGT measurement. Intergranular cracks have been observed at the thermocouple joint. CORRECTIVE_ACTION: The EGT sensor was replaced and verification testing was successfully completed. The EGT sensor was sent to Rockwell-Downey for testing and failure analysis. The failure analysis is being documented in CAR 61RF09-010. EFFECTS_ON_SUBSEQUENT_MISSIONS: None

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET:	Problem	FIAR	IFA STS-61-V-10	OI - Recorders
INCO-04	GMT:		SPR None	UA	Manager:
			IPR 59V-0013	PR	x36908
					Engineer:

Title: MADS BITE (ORB)

Summary: DISCUSSION: The modular auxiliary data system (MADS) recorder built in test equipment (BITE) signal did not change to "GOOD" when the crew was requested to power up the recorder from the MADS RCDR PWR switch at approximately 345:04:30:00 G.m.t. The percent tape indication was at 100.4% (full-scale high), also indicating that the recorder had not received power. The BITE indication went "GOOD" and percent tape counter went to 77.1% when the uplink commands were sent to begin recording at 345:04:32:00 G.m.t. The recorder operated normally throughout the remainder of the mission.

The MADS RCDR PWR switch has 3 positions: "ON", "OFF" and "ENABLE". The "ON" position will apply power to the recorder regardless of uplink commands sent, thereby causing the BITE signal to change to "GOOD". The crew was requested to put the switch in the "ON" position. The "ENABLE" switch position does not directly apply power to the recorder, but will apply power and begin recording when two uplink commands are sent to power up the MADS pulse code modulation (PCM) unit or frequency division multiplexer (FDM). Until STS-53, the "ENABLE" position was the standard setting for this switch for the duration of the mission, without crew intervention. After STS-53, the prelaunch switch position was "ON", and the crew had been requested to cycle the switch "ON" and "OFF" as the recorder was needed. This change was implemented to eliminate the possibility of a single uplink command removing power from a running recorder, which was identified as a contributing factor in the breaking of the MADS recorder tape during STS-53 pre-launch. At the STS-61 crew debriefing, the crew indicated that they had initially placed the MADS RCDR PWR switch in the "ENABLE" position and later switched it to the "ON" position. These actions correspond with all data reviewed on the ground. As a result of a failure prior to STS-53, which broke the recorder tape, MCR 17821 was approved to add a new uplink command to control MADS recorder power. This change will supply a redundant power/control source and will not allow the removal of power from a running recorder with a single uplink command. This change has been implemented on OV-104 and OV-105, and will be installed OV-103 prior to STS-64 (OV-102 is not applicable). In addition to the MADS recorder changes, the ground operations control procedures have been modified along with the instrumentation and communication officer (INCO) control console. As a result of this modification, the MADS RCDR PWR switch will now be flown in the "ENABLE" position for the duration of future missions and will not require the crew involvement to control MADS power. CONCLUSION: The MADS recorder performed as configured. The BITE did not signal "GOOD" when expected because the crew initially placed the MADS RCDR PWR switch in the "ENABLE" position instead of "ON". Therefore, the BITE did not indicate "GOOD" until the uplink commands were sent. CORRECTIVE_ACTION: The MADS RCDR PWR switch will now be flown in the "ENABLE" position for the duration of future missions beginning with STS-59. EFFECTS_ON_SUBSEQUENT_MISSIONS: None

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-61-V-11	D&C - Lighting
EGIL	**GMT:**		**SPR** 61FR10	**UA**	**Manager:**
			IPR 59V-0009	**PR**	x38809
					Engineer:

Title: Broken Dogbone Retaining Angle (ORB)

Summary: DISCUSSION: During payload bay closure the flight crew reported that the aft starboard payload bay floodflight was failed

Ground testing at KSC was able to verify the failure. Visible signs of arcing were noted in the floodlight from the tripod assembly to the support ring. In addition, the FEA (FEA) ballast that drives the aft starboard floodlight was temporarily cross-strapped with the ballast that drives the forward port floodlight, causing the forward port light to fail. Therefore, it was determined that the ballast in FEA 1 that drives the aft starboard light had also failed. Both FEA and the aft starboard floodlight assembly will be removed and returned to the logistics depot for inspection and failure analysis. However, due to a shortage in FEA's, neither will be replaced until after STS-59. Therefore, STS-59 will be flown with one of two aft floodlights operative. This configuration meets the minimum equipment list requirements of 1 of 2 aft floodlights and has been approved by both the mission operations and payload community. On previous flight of OV-105, a failure in FEA 1 was the cause of the aft starboard floodlight not illuminating. As a result, FEA 1 was replace during vehicle processing. CONCLUSION: Both the floodlight electronics assembly and the floodlight failed CORRECTIVE_ACTION: Both the FEA and floodlight assembly will be removed and returned to the logistics depot for inspection and failure analysis when a spare FEA becomes available. EFFECTS_ON_SUBSEQUENT_MISSIONS: The aft starboard floodlight will be inoperative until a spare can be installed.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-61-V-12	Atmospheric Rev
EECOM-02	**GMT:**		**SPR** None	**UA**	**Manager:**
			IPR None	**PR**	
					Engineer:

Title: Small Cabin Air Leakage Through WCS (ORB)

Summary: DISCUSSION: During a waste control system (WCS) commode cycle on flight day 8 (FD8), the cabin pressure change rate (dP/dt) measured -0.040 psi/minute for approximately 2.5 minutes. Leak rates for nominal commode cycles are essentially zero. During a subsequent commode cycle on FD9, the cabin dP/dt measured -0.052 psi/minute. These cycles were 70 and 85 seconds longer, respectively, than nominal WCS/commode repressurizations. Anomalous commode cycles such as these are a concern since they lead to high cabin air leak rates. In both cases the leakage stopped when the crew stepped through the commode cycle procedure as per the WCS

Cue Card. Other than these two incidents, there were no other anomalous commode cycles during this flight.

Postflight inspection of the WCS control valve mechanism at the vendor revealed no hardware problems. The design of the commode control valve will allow leakage to occur while moving the commode control handle from the full vacuum to the repressurization position. Under normal operations, this leakage is minimal and undetected due to the relatively quick operation of the commode control handle. If, however, the handle is repositioned too slowly, higher leak rates may occur. This characteristic was confirmed by design evaluation and by testing of the commode control handle on three separate WCS units. CONCLUSION: The small leakage observed is consistent with slow operation of the WCS commode control handle, which results in an extended overboard leak to vacuum CORRECTIVE_ACTION: Crew training personnel have been advised that commode control handle operations should be continuous and should be performed as detailed on the WCS Cue Card. This will prevent reoccurrences of this problem. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-61-V-13	Hydraulics
None	**GMT:**		**SPR** 61RF12	**UA**	**Manager:**
			IPR 59V-0023	**PR**	
					Engineer:

Title: High Load on APU 3 During Postlanding Shutdown (ORB)

Summary: DISCUSSION: Postlanding and after the auxiliary power (APU)/hydraulic load test, hydraulic system 3 caused an unexplained increase in load on APU 3 and hydraulic return pressure spiking. These unusual signatures occurred during APU 1 shutdown. During that period, hydraulic switching valves were moving to respond to the loss of hydraulic pressure in system 1 (due to APU shutdown) and allow system 3 to supply the demand. The additional hydraulic load is evident in the APU 3 gas generator chamber pressure pulses.

To understand the unusual data signatures, a working group was established. The working group analyzed the available data. The data were reviewed and the working group found that during the time of the unusual signature, no commanding of the flight controls had occurred. However, the Space Shuttle main engine (SSME) 1 pitch thrust vector control (TVC) actuator had been commanded to its rain drain position of +10.0 degrees, which is 0.5 degrees from the mechanical hard stop of +10.5 degrees. The working group postulated that given the thermal gradient and the uncertainty in the position sensor of the actuator, the actuator could have been positioned against the hard stop. The position transducer's tolerance is nonlinear and is greatest at full extension and retraction. Operational Maintenance Requirements and Specification Document (OMRSD) requirement V79AT0.035 specifies a tolerance of +/- 1.12 degrees when commanded to 9.0 degrees. This positioning is important because vendor and flight control hydraulics laboratory testing found that if an actuator were placed against its mechanical hard stop causing the power valve to oscillate at ~50 Hz, flow demand could be increased significantly. The SSME TVC isolation valve had been opened approximately seven minutes prior to the event. At that time, all of the SSME TVC actuators experienced slight movement due to thermal gradients caused by the introduction of hot hydraulic fluid (over 200?F) to a relatively cool

actuator (~50?F). The mechanical feedback linkage inside the actuator remains cool while those parts of the actuator exposed to the hydraulic fluid expand. This results in a position error causing actuator retraction. A typical amount of drift is 0.5 degree. A test plan on the vehicle in the processing facility was developed to duplicate the Orbiter configuration whenever possible. The test plan included multiple configuration sequences that would help ascertain which, if any, actuator was the cause of the high flow rate and if it had also caused the high return pressures. The test was performed with ground support equipment (GSE) hydraulic power carts driving all three systems simulating the APU/main pumps at 54 GPM each versus an Orbiter system of 63 GPM per system; the reservoirs were empty and return pressures were regulated by GSE at 40-50 psia versus 100-110 psia; also, the hydraulic fluid temperatures were heated only to 120?F versus 200-210?F. The test confirmed that the vendor and flight control laboratory analysis of an actuator placed against its hard stop will cause the power valve to oscillate demanding a higher than standard flow rate. The flow rate observed during testing was almost identical to that of the postlanding shutdown. The working group concluded that the high demand on the system was caused by the SSME TVC 1 pitch actuator when it switched from system 1 to system 3 at APU 1 shutdown and the position of the actuator was against its hard stop as a result of thermal gradient and instrumentation error. The flight control community have also analyzed the potential impacts of a TVC actuator positioned at its hard stop during all flight phases and found the following (note that an actuator has never been commanded inflight to its hard stop in the program history): o Under simulated ascent conditions of a mismatched SRB thrust tail-off, a SSME TVC actuator could be commanded to its hard stop. o This would be no impact to flight because rates of other actuators are low during this period. o During entry SSME reposition for drag chute, the potential exists to drive a SSME actuator against its hard stop and have a reduced flow case for the elevons. o This scenario is not considered plausible because: o SSME TVC isolation valves are closed following engine reposition for drag chute (commands SSME TVC 1 pitch actuator to 9.7 degrees). o TVC isolation valve 3 would have to fail open (no history of isolation valve failures to close). o SSME TVC 1 pitch actuator position would have to shift 0.8 degree toward the hard stop (not expected, although this amount of shift is being evaluated). o The thermal gradient effect begins to dissipate after ~5 minutes. This is significant because the peak elevon flow demands occur during touchdown, which is 10 minutes after SSME repositioning. The recurrence of the postlanding high load can be avoided on future flights by modifying the postlanding SSME repositioning command to provide margin between the command limits and actuator hard stops. This change will require K-load modifications to the vehicle utility software. This change is currently under investigation. CONCLUSION: Testing confirmed that an actuator placed against its hard stop will cause the actuator power valve to oscillate, thus demanding a high rate. The high demand and high return pressure on hydraulic system 3 was caused by the SSME TVC 1 pitch actuator positioned against its mechanical hard stop due to the thermal gradient and instrumentation error. There are only two inflight scenarios where a SSME TVC actuator can cause excessive hydraulic demands. Each scenario requires an additional failure of a system. The most likely recurrence will follow the same scenario as STS-61 postlanding. However, a K-load software change can prevent future recurrence. This change is under investigation. CORRECTIVE_ACTION: Investigate K-load software change. EFFECTS_ON_SUBSEQUENT_MISSIONS: Additional load may occur on future postlanding APU shutdowns when the SSME's are place in the rain-drain position.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-61-V-14	TPS
None	**GMT:**		**SPR** KB2912	**UA**	**Manager:**
			IPR	**PR** STR-1238	x38809
					Engineer:

Title: Broken Dogbone Retaining Angle (ORB)

Summary: DISCUSSION: Postflight inspection of the OV-105 payload bay doors (PLBDs) revealed a titanium alignment clip (Figure 1) that was used to retain the dogbone seal between port door panels 1 and 2 was broken from the graphite epoxy (GR/E) support angle near the PLBD centerline. The alignment clip and GR/E support angle were held by a few fibers of the GR/E support angle. The dimensions of the section of GR/E support angle broken away were 1.25 inches long (approximately the length of the clip which was 1.19 inches) by 0.5 inches to the titanium alignment clip installing rivets (Figure 1). Further inspection of the GR/E angle revealed a delaminated area approximately 2.6 inches long which extended back to the radius of the GR/E angle.

The dogbone assembly provides an environmental seal, thermal barrier, and grounding continuity between door sections. The alignment clip is used to maintain position of the dogbone assembly in the expansion joint. The six pairs of retention clips are used to maintain the dogbone assembly's position for each expansion joint. The alignment clip and broken section of GR/E were returned to Rockwell-Downey laboratories for analysis. All materials and dimensions were verified to be per the drawings with no evidence of pre-existing cracks. Detailed evaluation of the hardware showed a single overload event had caused the failure of the GR/E angle. A stress analysis showed that a 270 lb compression force on the titanium alignment clip was required to produce the failure of the GR/E angle (Figure 3). There were witness marks where the dogbone had contacted the clip flange. All other clip installations on OV-105 were inspected, and no anomalous conditions were observed with the clips. However, many of the dogbone seals were not centered between the clips along the circumference of the PLBD's. Also friction/binding between the dogbone seal and the GR/E support angle was present. The most probable cause for this failure was a friction/binding condition which prohibited the normal motion of the dogbone subassembly within its cavity. The following is a description of the failure scenario. Initially the dogbone is canted within its cavity (Figure 2), but friction/binding is present which has been observed on previous occasions. With the payload bay doors open, the expansion of the joint pulls the dogbone off the shelf near the centerline, but the dogbone remains on the shelf towards the hingeline (Figure 3). This phenomenon could be a result of thermal effects on the orbiter structure and payload bay doors. A model is being developed to determine the mechanism of the dogbone seal movement. During door closure, the "Shoe-Horn" effect forces the dogbone onto the shelf and may not provide sufficient force to move the dogbone into position at the clip near the centerline. The action of the centerline gang of latches provides sufficient force to break the GR/E angle at the clip as latching is achieved. CONCLUSION: The STS-61 clip failure was caused by a single compression overload from dogbone contact during door closure. The most probable cause was a friction/binding condition which prohibited normal motion of the dogbone subassembly within its cavity. CORRECTIVE_ACTION: The damaged PLBD has been repaired on-site by Rockwell- Tulsa. The broken section of GR/E and the clip were sent to Rockwell-Downey for failure analysis. A design team is assembling and that team will address potential engineering changes and future inspections. A chit is being written to obtain data about the dogbone configuration throughout the fleet. This problem is being tracked under CAR KB2912-010 EFFECTS_ON_SUBSEQUENT_MISSIONS: None. Failure analyses and design assessments show that the worst case effect of clip/dogbone contact will result in a local clip failure, but PLBD closure can still be achieved. This type of failure does not result in the loss of the dogbone's environment seal, thermal barrier, and grounding continuity capabilities.