Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	MET: Prelaunch	Problem	FIAR	IFA STS-31-V-01	APU
None	GMT: Prelaunch		SPR 31RF01	UA	Manager:
			IPR	PR APU-3-10-0208	
					Engineer:

Title: APU 1 Speed High During Start Sequence (ORB)

Summary: DISCUSSION: When auxiliary power unit (APU) 1 (serial number 305) was started during the STS-31 launch attempt on April 10, 1990, it ran at high speed (113 +/- 2 percent) with the speed select switch in the NORMAL speed (103+/-1 percent) position. Due to this anomaly, the launch countdown was held at T-4 minutes. APU 1 was switched to the high-speed mode by cockpit command approximately 30 seconds after APU 1 start and ran nominally at 113 +/- 2 percent for over 2 minutes. When normal speed was again selected with the cockpit switch, the APU continued to run at 113 +/- 2 percent. APU 1 was shutdown 5 minutes 13 seconds after APU 1 startup and the launch was scrubbed.

APU 1 and the APU 1 controller were removed and replaced on the pad and shipped to the vendor for analysis. Checks of the controller showed no anomalies. Failure analysis of the APU 1 gas generator valve module (GGVM) showed the pulse control valve (PCV) outlet seat was chipped, with a 0.04-inch x 0.144-inch x 0.075-inch fragment missing. This chipped area, almost a quarter of the outer sealing land, allowed fuel to leak past the PCV when the PCV was in the closed position. This leak caused the APU turbine speed to increase past the nominal 103 percent point. When the speed reached 113 percent, the shut off valve (SOV) speed control became effective and the SOV open/closed to maintain 113 +/- 2 percent speed. The PCV remained closed (and leaking) as long as the APU SPEED SELECT switch was in NORMAL. When the crew selected HIGH SPEED, the PCV correctly went full open and the SOV controlled speed nominally. When NORMAL speed was again selected, the PCV leak forced the SOV to maintain speed control at 113 +/- 2 percent. The PCV seat and poppet are both made of tungsten carbide. The GGVM was of medium age, having accumulated approximately 60,000 cycles. The PCVs have accumulated 7.4 million valve cycles throughout the GGVM/improved GGVM history with no similar failures. Analysis showed that the seat fracture was initiated at a single place. Although no foreign contamination has been found, the fracture was most probably initiated by a foreign particle causing a local overload in the seat material. CONCLUSION: APU 1 ran continuously in the high speed mode because a chipped portion of the pulse control valve seat allowed fuel to leak past the valve when it was in the closed position. The chip was most probably the result of a transient foreign particle causing localized stress on the seat. The shutoff valve operated as designed and controlled the APU at high speed. CORRECTIVE_ACTION: APU 1 and the APU 1 controller were removed and replaced before the STS-31 flight. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-31-V-02	APU, OMS
MMACS-05, MMACS-06, PROP-03	**GMT:**		**SPR** A) 31RF02; B) 31RF10; C) 31RF11; D) 31RF13	**UA**	**Manager:**
			IPR D) 41V0015	**PR** A) APU-3-10-0209; B) APU-3-10-0212; C) APU-3-11-02	**Engineer:**

Title: Operational Instrumentation Failures (ORB)

Summary: DISCUSSION: A. The auxiliary power unit (APU) 1 exhaust gas temperature (EGT) 2 (V46T0140A) failed to respond at APU activation during the first launch attempt. The sensor was removed and replaced and operated properly during flight. This is a criticality 3 measurement. This problem is closed.

B. The APU 1 EGT 1 (V46T0142A) failed off-scale low during entry. The sensor will be removed and replaced. This is a criticality 3 measurement. This problem is closed. C. The APU 3 EGT 2 (V46T0142A) failed off-scale low during entry. The sensor will be removed and replaced. This is a criticality 3 measurement. This problem is closed. D. The right orbital maneuvering system (OMS) fuel engine inlet pressure (V43P5646C) readings oscillated between 235-275 psia without a corresponding change in ullage pressure. This occurred approximately 5 minutes before landing and lasted 2-3 minutes. Troubleshooting will be conducted in the KSC Hypergolic Maintenance Facility (HMF) and the sensor will be replaced if it is failed. The sensor is a criticality 2R3 measurement. This anomaly is being tracked by IM31RF-13 and IPR 41V-0015. This problem is closed. CONCLUSION: See above. CORRECTIVE_ACTION: See above. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** 000:00:10	Problem	**FIAR**	**IFA** STS-31-V-03	OMS/RCS
PROP01, PROP-02	**GMT:** 114:12:44		**SPR** 29RF02; 31RF02; 31RF06	**UA**	**Manager:**
			IPR	**PR** LP04-07-0264	**Engineer:**

Title: RCS Jet L3A Failures (ORB)

Summary: DISCUSSION: A. Reaction control system (RCS) jet L3A failed to fire when it was commanded to fire for the first time following ascent, during the +X main propulsion system settling burn. Data analysis showed that the fuel valve opened but the oxidizer valve did not. The chamber pressure (Pc) reached a value of only 0.8 psia (nominal value during firing is 152 psia), indicating that no combustion took place. This low Pc caused a fail-off caution and warning indication, and the jet was deselected by redundancy management software.

B. Approximately seven hours later, L3A experienced an oxidizer leak. Its oxidizer injector temperature dropped from 90? F to about 21? F. The fuel temperature subsequently dropped to approximately 30? F because of the evaporative cooling in the region caused by the oxidizer leak. About 45 minutes after leak initiation, the Pc and the oxidizer and fuel injector temperatures began to cycle. This was apparently caused by frozen oxidizer plugging the throat, allowing liquid oxidizer to accumulate in the chamber, causing the pressure in the chamber to rise and the injector to warm up. Once the combination of the warming temperatures and building pressure was sufficient to dislodge the ice build-up, the collected oxidizer evaporated, causing the Pc and temperatures to drop again. This freeze/thaw cycle was repeated several times. The left RCS manifold 3 isolation valve was closed to isolate the leak approximately 2.5 hours after the leak started. At this time the oxidizer manifold pressure dropped from 252 psia to 40 psia in less than 10 seconds. Pc and injector temperatures continued to cycle until the frozen propellant blockage had completely melted. The injector temperatures then returned to nominal operating range. Postflight analysis of the thruster found that the source of leakage on the oxidizer injector valve was predominantly from the pilot stage. The accumulation of metallic nitrate was found at the pilot poppet Teflon seal, with the nitrate consistency ranging from viscous gelatinous, to crystalline. Metallic nitrates are formed by the chemical reaction of water with N2O4 forming nitric acid, which reacts with metals to form nitrates. Nitrates were found crushed between the sealing surfaces, indicating that the oxidizer pilot valve opened when the jet was commanded to fire. The gelatinous nitrate most probably blocked the flow of oxidizer from the pilot valve for the duration of the 295 millisecond pulse allowed by software, thus preventing the pressure bleed-off in the valve upper cavity (accomplished with pilot flow) required to hydraulically actuate the valve main stage. The closed main stage prevented oxidizer flow and produced the fail-off condition. When the pilot poppet reseated, it trapped some of the gelatinous nitrate in the sealing interface. Subsequent resolution/crystallization of this nitrate is believed to have created a leak path resulting in the oxidizer leak. The exact source of the contaminating nitrates is unknown. Possibilities include the propellant storage and delivery system, the injector valve, or a combination of the two. Additionally, iron/nitrates exist in very small quantities as contaminants in N2O4. CONCLUSION: The chemical reaction of N2O4 with water and metal formed a viscous gelatinous metallic nitrate which accumulated around the pilot valve poppet seat. When L3A was commanded to fire, the pilot valve most probably opened but the gelatinous nitrate prevented oxidizer flow from the valve for the short time the valve was open and caused the fail-off condition. A gradual state change of some of the nitrate from gelatinous to crystalline allowed oxidizer leakage past the pilot seat. CORRECTIVE_ACTION: The thruster was removed and replaced. An improved design of throat plugs (universal and evacuation throat plugs) will provide better capabilities to keep water and moist air out, and remove any water present in a thruster. A test program is progressing at White Sands with the objectives of: 1) better understanding the mechanics of nitrate formation; 2) developing nitrate flushing techniques for jet components; 3) investigating the possibility of a system-level nitrate flush technique; and 4) establishing long-term compatibility data on system materials. EFFECTS_ON_SUBSEQUENT_MISSIONS: None

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Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:**	Problem	**FIAR**	**IFA** STS-31-V-04	ECLSS
EECOM-01	**GMT:** 114:13:51		**SPR** 31RF04	**UA**	**Manager:**
			IPR 41V-0014	**PR** ECL 3-11-0671	
					Engineer:

Title: Supply Water Tank C Bellows Stuck (ORB)

Summary: DISCUSSION: Shortly after reaching orbit, it was noted that the supply water tank C quantity remained at 99.8 percent while tank D changed from 89.5 to 89.8

percent. Normally tanks C and D are filled to 93 to 96 percent in the OPF and when the Orbiter is placed into the vertical position, tank D will gravity fill tank C to approximately 100 percent. Within 30 minutes after launch, tanks C and D normally equalize to within 3-4 percent of each other.

Since the tank C quantity did not change, the bellows in tank C was determined to be stuck in the hard-fill position. Flash evaporator system (FES) B was activated in a successful attempt to drain some water from both tanks C and D, thereby providing an additional force on the tank C bellows and causing it to regain its freedom of motion. Soon after activation of FES B, the tank quantities equalized at 88.1 percent for tank D and 90.9 percent for tank C. At this point, FES B was deactivated and tanks C and D were returned to their nominal configuration. After the flight, tank C was pressurized with nitrogen gas to the hard-fill position and then the pressure was bled off slowly in an attempt to recreate the problem. This pressurization/depressurization cycle was performed 10 times. It was determined that the pressure required to extend the bellows increased when the tank reached the 96-percent point, and when decreasing the pressure, the tank remained at the full level until the internal pressure was at 0.35 psig. In each case, the tank freed itself with its own bellows pressure. A review of the acceptance test procedure (ATP) and previous flight data shows that this tank may be operating as delivered, and that the tank had never been in this exact configuration previously. Borescope inspection of the inside of tank C was not possible since removal of several water tanks would have been required to gain access to tank C. CONCLUSION: The supply water tank C stuck in the hard-filled position due to friction encountered above the 96-percent point. The cause of the bellows sticking could not be determined since visual inspection was not possible. CORRECTIVE_ACTION: While the vehicle is in the horizontal position, the tank C inlet and outlet valves will be closed. This will prevent tank C from being gravity filled to the hard-fill point when the Orbiter is taken to the vertical position. The inlet and outlet valves will be opened once the vehicle is on orbit to configure the system for normal operations. Tank C will be removed and replaced in the future when an opportunity arises to gain access to the tank on the Orbiter. EFFECTS_ON_SUBSEQUENT_MISSIONS: Supply water tank C inlet and outlet valves on OV-103 will remain closed during the launch phase of the mission, and opened once on orbit.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** 000:03:21	Problem	**FIAR**	**IFA** STS-31-V-05	HYD
MMACS-01	**GMT:** 114:15:55		**SPR** 31RF05	**UA**	**Manager:**
			IPR	**PR** TPS HYD-088	
					Engineer:

Title: No Post-Insertion Response from WSB 2 Vent Heater A (ORB)

Summary: DISCUSSION: During routine post-insertion activities, the A vent heaters of all three water spray boilers (WSB) were activated to melt any ice formed in the WSB vent areas. While the WSB 1 and 3 vent temperatures both rose above the minimum temperature transducer limit of 122? F within approximately 45 and 15 minutes, respectively, the WSB 2 vent temperature had not increased above 122? F approximately 1.5 hours after heater 2A activation. WSB vent heater 2A was deactivated and heater 2B activated. The temperature increased above 122? F in 12 minutes and cycled normally for the 2 hours that heater 2B was selected.

The WSB 2A heater was reactivated for entry. The vent temperature responded (above 122? F) after 35 minutes and displayed a normal duty cycle for 2 cycles. The third cycle was erratic, but the heater performed nominally for the remainder of the mission. An Orbiter thermal protection system (TPS) tile was found to be in physical contact with the nozzle during the postflight inspection. This condition most probably acted as a heat sink, causing the small 50-W heater to increase temperatures at a slower than normal rate. The vent temperature was probably nearing the 122? F level when the B heater was activated. It is believed that the B heater would have exhibited the same characteristics had it been enabled first. The tile was subsequently shaved to remove the nozzle contact. Following ascent, ice around the WSB vent nozzle must be overcome by the heaters in order to raise the temperatures. Prior to entry, there is no ice. For this reason, the A heater responded more rapidly when activated during the preentry period than it did following ascent. Although postflight testing of the WSB 2A heater system, wire harness, controller, and water supply valve revealed no component failures, one anomalous condition was observed during testing after the tile was shaved: after cutting off at a nominal 173? F, the heater cut on again at 168? F instead of the normal value of about 150? F. Additionally, during one cycle before the start of STS-31 ET loading, the heater was observed to cut off early at about 162? F. The cause of these abnormal cycles and the one erratic cycle during entry are not attributed to the tile contact with the nozzle and remain unexplained. The WSB 2A vent heater exhibited unusual duty cycles prior to the entry phase on the prior two flights of OV-103 (STS-29 and STS-33). Also, the WSB 2A heater for OV-104 showed similar abnormal entry responses and an abnormal on-orbit response during its previous two flights (STS-34 and STS-36). Ground troubleshooting of these anomalies revealed no discrepancies, although a check of nozzle to tile clearance was not performed prior to the STS-31 investigation. A recent check of the clearance on OV-104 revealed no problem. CONCLUSION: The WSB 2 vent temperatures controlled by heater A most probably increased at a less than normal rate after activation because a TPS tile was in contact with the nozzle, thus creating a heat-sink condition. When evaluating this condition during the mission, it was interpreted as an A heater system failure. The A heater system most probably functioned properly. The three anomalous cycles of the heater seen during flight and ground testing are unexplained. CORRECTIVE_ACTION: The tile contacting the WSB 2 vent nozzle was shaved until a proper clearance was obtained. The associated heater system, controller, wire harness, and water supply valve were tested and no failed components were identified. EFFECTS_ON_SUBSEQUENT_MISSIONS: The temperature response of the WSB 2 vent should be normal. However, erratic heater duty cycles may be experienced.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** 002:07:39	Problem	**FIAR**	**IFA** STS-31-V-06	FC/PRSD
EGIL-01	**GMT:** 116:20:13		**SPR** 31RF07	**UA**	**Manager:**
			IPR	**PR** FCP-3-11-0259	
					Engineer:

Title: Fuel Cell 2 Oxygen Flow Rate High During Purge (ORB)

Summary: DISCUSSION: During a fifth automatic purge sequence of fuel cell 2 at approximately 116:20:13 G.m.t., a high oxygen flow rate of 12.0 lb/hr (5.5 lb/hr nominal) was noted. The purge proceeded nominally for the first 90 seconds when the 7.3 lb/hr increase was noted. After 22 seconds at the high flow rate, purge flow returned to the nominal value for the remaining 8 seconds of the purge. The secondary cues of hydrogen flow and coolant pressure as well as data from earlier purges on this flight showing a similar but less severe oxygen flow-rate increase, verified that the high-flow condition had occurred. Purges of fuel cells 1 an 3 were normal during this same time period. As a result, purging of fuel cell 2 was discontinued for the remained of the mission. A small performance loss of about 0.5 V was noted after 66 hours of operation without a purge, but this loss did not impact mission operations.

After the flight, no further purges were performed on the fuel cell to maintain evidence of the cause of the problem, with the exception of one 10-minute flow-through purge to inert and safe the fuel cell at shutdown. After the Orbiter was returned to KSC, fuel cell 2 was removed and replaced with a new fuel cell. The regulator from the removed fuel cell was returned to the vendor for disassembly and inspection. The speculated cause of the problem at the time was contamination that was restricting the hydrogen flow coupled with a failure of the oxygen supply valve to close. However, disassembly of the regulator failed to show evidence of this, or any other failure mode. The regulator was then reassembled and remated to the fuel cell. The combination was run and purged 50 times over a period of several days in an unsuccessful effort to reproduce the problem. A complete overhaul of the regulator is underway. Straining has been found on the external surfaces at the oxygen regulator/stack interface fitting which indicates that an intermittent leak may have occurred, and this would explain the high purge flow anomaly. Leak checks performed at the vendor facility (receiving inspection) when the unit was received from KSC indicated no leakage at that time. CONCLUSION: The cause of the high oxygen purge flow is most likely the result of an intermittent leak between the regulator and the power section. Further failure analysis continues and will be tracked under the listed CAR. CORRECTIVE_ACTION: Fuel cell 2 was removed and replaced. The replaced fuel cell's purge capability was verified during the execution of Operations and Maintenance Instructions V5R01 and V1093. Even if the problem repeats, the failure is easily detectable and can be managed by ceasing purge activity on the affected fuel cell. Ceasing purges will cause a slight performance degradation over a period of time which, if necessary, can be minimized with load management or by saving the fuel cell for entry. The removed regulator is now undergoing a major overhaul. Once overhauled, the regulator will be returned to the flight inventory. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** 001:07:51	Problem	**FIAR** None	**IFA** STS-31-V-07	GFE
EVA-01	**GMT:** 115:20:25		**SPR** None	**UA**	**Manager:**
			IPR None.	**PR**	
					Engineer:

Title: EMU 2 "Power Restart" Messages (GFE) (GFE)

Summary: DISCUSSION: During extravehicular activity (EVA) preparation and depressurization, four separate "power restart" messages were annunciated by the extravehicular mobility unit (EMU) 2 caution and warning system. Receipt of these messages indicated that input power to the EMU had been interrupted. Had the messages occurred while the EMU was on internal power, contingency actions would have been required. Since the EMU was being powered externally by the airlock power supply (ALPS), receipt of the message was not a concern for continuation of the EVA preparations. In-flight troubleshooting, performed the day after the EVA attempt, failed to reproduce the problem. Potential causes of the "power restart" messages being annunciated while on external power were: a service and cooling umbilical (SCU) short or open circuit, an ALPS out-of-specification condition, radiation effects, electromagnetic interference (EMI), an EMU internal anomaly, or a voltage transient on the Orbiter bus supplying the ALPS. A SCU problem was ruled out both by the in-flight troubleshooting and analytically since an interruption in the voltage supplied to the EMU would have been detected by the ALPS sense lines and caused an ALPS shutdown. A survey of the ALPS output voltage and current data downlinked during the EVA preparations revealed no out-of-specification condition in the ALPS. The ALPS was also checked out after the flight per OMRSD requirement V76AX0.011 with no out-of-specification conditions noted.

Radiation effects were ruled out because the radiation levels experienced on STS-31 were within the military specifications under which the EMU electronic components were procured. EMI testing of the EMU conducted in January, 1989, did trigger "power restart" messages at a level of 3 V/M which was deemed acceptable. The likelihood of EMI causing this flight anomaly is not high, but cannot be completely ruled out. Postflight testing revealed no anomalies internal to the EMU. A transient on the Orbiter main A bus, which was powering the ALPS, did occur during the EVA preparation time frame when hydraulic circulation pump 1 was activated. However, this transient did not reduce input power to the ALPS below specification limits. No other significant transients were seen in the main A bus data. Since the exact times that the "power restart" messages were annunciated are not known, direct correlation of the messages to the circulation pump activation is not possible. CONCLUSION: The cause of the "power restart" messages cannot be definitely pinpointed. CORRECTIVE_ACTION: Fly as-is. Recurrence the "power restart" messages while on SCU power, with no corresponding transients in the ALPS, does not pose a threat to crew safety or mission success. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** 003:20:07	Problem	**FIAR**	**IFA** STS-31-V-08	APU
MMACS-03	**GMT:** 118:08:41		**SPR** 31RF08	**UA**	**Manager:**
			IPR	**PR** APU-3-11-0214	
					Engineer:

Title: APU 3 Gas Generator/Fuel Pump Heater System A Fail On (ORB)

Summary: DISCUSSION: Near the end of the flight control system check-out, at 118:08:41 G.m.t., the auxiliary power unit (APU) 3 (serial number 310) gas generator/fuel pump heater system A (consisting of 4 separate heaters) failed on. The fuel bypass line temperature (V46T0328A) increased from 105? F to 196? F (above the 180? F caution and warning limit), at which point the B system heaters were selected and the A heaters were turned off. The B heaters operated nominally for the remainder of the flight. The A heaters had been cycling erratically, but within acceptable limits since the A system thermostat (S37A) began controlling them around 115:00:30 G.m.t.

During the previous flight of OV-103 (STS-33), this same thermostat, along with the A thermostat on APU 1, displayed erratic behavior (Flight Problem STS-33-16). After STS-33, the APU 1 A thermostat was replaced; the APU 3 thermostat was not replaced since APU 3 was scheduled to be replaced after STS-31, and the B heater was available should the A heater fail. Erratic thermostat controlling was also observed on the B heater system of APU 2 on OV-104 during STS-34 (Flight Problem STS-34-10). Postflight failure analysis of the STS-34 thermostat revealed that it had experienced high vibration levels that resulted in excessive wear on the bimetallic disk component. A worn bimetallic disk produces erratic heater cycling. STS-31 thermostat S37A most probably failed-on because conductive were products from a worn bimetallic disk shorted the thermostat's electrical contacts. High vibration was experienced because the APU fuel bypass line heater thermostat is mounted on the APU reference line. Vibration instrumentation placed on the reference line on test APU's has shown that the line may experience vibrations with g-load amplitudes exceeding the thermostat design levels. CONCLUSION: The failed-on condition of the heaters was most probably caused by conductive contaminants creating a short within the controlling thermostat's electrical contacts. The contaminants were formed to wear particles from the thermostat's bimetallic disk element due to high-amplitude vibration of the thermostat. This thermostat is mounted on the APU reference line, which is known to experience high vibration levels. CORRECTIVE_ACTION: APU 3 and its thermostats were replaced due to normal turbine wheel life scheduling. The addition of a vibration dampening clamp to the reference line of each APU is in work. Workarounds for a potential thermostat failure that may occur on future missions before the dampening clamp can be added include switching to the back-up heater system, orienting the vehicle to maintain proper temperature, and/or manual control of the heaters. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** 004:00:57	Problem	**FIAR**	**IFA** STS-31-V-09	D&C - Lighting
EGIL-02	**GMT:** 118:13:31		**SPR** 31RF09	**UA**	**Manager:**
			IPR 41V-0016	**PR**	
					Engineer:

Title: Mid-starboard Payload Bay Floodlight Failed. (ORB)

Summary: DISCUSSION: The crew reported that when the mid-starboard payload bay floodlight was activated prior to payload bay door closure, it flickered and went out. The anomaly was confirmed by the observation of a rapid sequence of current spike on mid Main Bus C. The fluctuating current traces are normally indicative of a failed lamp; however, extensive troubleshooting at KSC failed to identify any problems with either the lamp, the floodlight electronics assembly (FEA), or the associated wiring and connectors.

Several floodlight anomalies have been experienced on recent flights, two of which could not be reproduced and remain unexplained (CAR's 36RF17 and 31RF09). Temperature sensing tape has now been applied to four of the OV-103 floodlights to obtain in-flight temperatures for evaluation. CONCLUSION: The cause of this anomaly is unknown. CORRECTIVE_ACTION: Final corrective action will be documented on CAR 31RF-09. EFFECTS_ON_SUBSEQUENT_MISSIONS: Specific requirements for individual floodlights are mission dependent. A recurrence of a failure of the mid-starboard floodlight would have no effect, but multiple failures may impact mission success.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** 001:18:12	Problem	**FIAR** None	**IFA** STS-31-V-10	TAGS
INCO-01, INCO-02, INCO-034	**GMT:** 116:06:46		**SPR** None	**UA**	**Manager:**
			IPR 41V-0006	**PR**	
					Engineer:

Title: Text and Graphic System Not Responding to Commands; Invalid Telemetry. (GFE)

Summary: DISCUSSION: At about 116:06:46 G.m.t., the text and graphics system (TAGS) hardcopier, while not in use, spontaneously began showing an invalid telemetry state (simultaneous indications for both JAM and EMPTY). While in this state, the hardcopier failed to respond to either uplink ADVANCE commands or message transmissions. Normal operation was restored by cycling the hardcopier power. Similar events occurred at about 118:04:01 G.m.t. and 119:00:34 G.m.t. However, on the second occurrence there was no invalid telemetry states displayed at the time that the system was discovered to be unresponsive. In both cases, normal operations were again restored by cycling hardcopier power. Postflight testing was performed on the system at KSC while the TAGS was still installed on the Orbiter in an attempt to duplicate the anomaly. The system was operated continuously for 38 hours with uplink ADVANCE commands transmitted at one-hour intervals. No anomalies of any type occurred.

CONCLUSION: No hardware failures occurred. The signatures of all three anomalies are consistent with what would be expected in the case of single event upsets induced by particle radiation in the TAGS microprocessor random access memory. Evidence of much higher-than-expected radiation levels on this flight points to single event upsets as the most likely cause of these anomalies. No hardware changes are recommended. Recurrence of such an event during any future high-altitude mission would be rare and easily corrected by cycling of TAGS hardcopier power. CORRECTIVE_ACTION: None required. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** 002:19:26	Problem	**FIAR**	**IFA** STS-31-V-11	APU
None	**GMT:** 117:08:00		**SPR** 31RF12	**UA**	**Manager:**
			IPR	**PR** APU-3-11-0213	

Engineer:

Title: APU 1 Gas Generator/Fuel Pump Heater A Thermostat Set Point Change (ORB)

Summary: DISCUSSION: At a mission elapsed time of 2 days 20 hours (117:08:00 G.m.t.), the auxiliary power unit (APU) 1 fuel bypass line temperature (V46T0128A) indicated a change of set-points in the controlling thermostat from a nominal 24? F band to an 8? F band. The APU 1 gas generator/fuel pump heater system A had been controlling temperatures nominally during the mission until this time. The thermostat continued to operate at the narrowed set-point band until the B heater system was selected approximately 24 hours later. The B system operated normally for the remainder of the mission.

There have been many documented problems with similar APU gas generator/fuel pump heater system thermostats on several prior missions. These failures have been attributed to the fact that the thermostats were mounted on the APU reference line. This line may experience high vibration levels which exceed the thermostat design level g-load amplitudes. These high vibration levels result in excessive wear on the bimetallic disk component of the thermostat. A worn bimetallic disk produces erratic heater cycling. This phenomenon has been seen on thermostats with low cumulative APU run time. Due to the fact that APU 1 (S/N 203) was a recently refurbished unit, placed on OV-103 after the high-speed failure of the original APU 1 (S/N 305) caused a launch scrub on the first STS-31 launch attempt, the anomalous A thermostat has accumulated approximately 1 hour of run time prior to the mission. Failure analysis on this thermostat at the vendor is pending. CONCLUSION: The set-point of the APU 1 gas generator/fuel pump A heater controlling thermostat most probably changed due to excessive wear of its bimetallic disk component caused by high-amplitude vibration of the thermostat due to its location on the APU reference line. A complete failure analysis is pending. CORRECTIVE_ACTION: The thermostat was removed and replaced. The addition of a vibration dampening clamp to the reference line is planned. Workarounds for a potential thermostat failure that may occur on future missions before the dampening clamp can be added include switching to the back-up heater system, orienting the vehicle to maintain proper temperature, and/or manual control of the heaters. EFFECTS_ON_SUBSEQUENT_MISSIONS: None

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Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** 003:19:56	Problem	**FIAR**	**IFA** STS-31-V-12	D&C - Panels
GNC-01	**GMT:** 118:08:30		**SPR** 31RF14	**UA**	**Manager:**
			IPR	**PR** DDC-3-11-0054	
					Engineer:

Title: Air Data Transducer Assembly (ADTA) 3 was not powered. (ORB)

Summary: DISCUSSION: Upon transition to OPS 8 at approximately 118:08:30 G.m.t., while preparing for the on-orbit flight control system (FCS) checkout, a "BCE STRG 3 ADTA" message occurred that indicated that ADTA 3 may have been unpowered. The crew reported that the circuit breaker (CB19 on Panel O16) was closed; however, switch scan data on the ground (V71S8300SX) indicated the circuit breaker was not closed.

This symptom is indicative of a known characteristic of these circuit breakers that are not hermetically sealed and are subject to contamination and contact oxidation. The breakers are designed to perform a self-cleaning contact wiping action upon closure. This is an accepted condition and existing Flight Rules and OMRSD requirements allow breakers to be cycled up to five times, if required, to clear the contacts of contamination. The crew was instructed to cycle the breaker five times. Toggling was noted while the breaker was being cycled, but at the end of five cycles the switch scan data still indicated that the circuit breaker was open. Due to sampling rate, data are inconclusive as to which cycles produced correct indications. The crew then cycled the breaker five more times after which the correct indication was observed. ADTA 3 functioned normally for the remainder of the flight. Based on the criticality of the ADTA's, and the fact that each is powered by a single source, the decision was made to remove and replace CB19 on Panel O16. Failure analysis results will be documented on CAR 31RF14. CONCLUSION: The failure was most likely caused by the known transient contamination condition. The fact that it did not completely clear within five cycles is consided to be an isolated incident. CORRECTIVE_ACTION: The suspect breaker has been removed and replaced. Final corrective action, if required, will be documented on CAR 31RF14. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** 004:06:51	Problem	**FIAR**	**IFA** STS-31-V-13	GN&C
GNC-02	**GMT:** 118:19:25		**SPR** 31RF16	**UA**	**Manager:**
			IPR None	**PR**	
					Engineer:

Title: Crew Optical Alignment Sight Line-of-Sight Shift (ORB)

Summary: DISCUSSION: The Crew Optical Alignment Sight (COAS), mounted in the +X position, was calibrated on flight day (FD) 4. On FD 5, the COAS was again calibrated in the +X position and this calibration revealed a line-of-sight (LOS) shift from the initial calibration of approximately 0.6 degrees in the horizontal axis. This problem is a repeat of OV-103 in-flight anomalies STS-29-15 and STS-33-12.

In an effort to resolve this anomaly, the following tests have been performed: a) a detailed inspection of both the primary and backup COAS and the +X adapter plate for OV-103; b) an alignment check of both COAS's and the adapter plate; c) a flatness verification of the interface plates on the COAS's, the adapter plate and panel O1; d) measurement of the diameter of the adapter plate guide pins and guide pin holes on panel O1; and e) a LOS repeatability test on OV-103 in the Orbiter Processing Facility. The LOS repeatability check included a check for hysteresis of the COAS and mount, and a verification that no parallax exists. Only one out-of-tolerance condition was found (the guide pin holes in panel O1 were smaller than the specification allows) and this condition was corrected prior to STS-31. In addition, a review of crew procedures and training was also conducted to determine if modifications are required to preclude the possibility of any procedural errors on future flights. CONCLUSION: Testing indicates both the primary and backup COAS's and the +X adapter plate are functioning as designed and are not the source of the errors experienced on the last three flights of OV-103. Two possible causes of this problem are procedural errors and/or unexplained structural deformation of the panel to which the COAS mounts. Although this problem has not been detected on OV-102 or OV-104, not enough data exists to completely rule out the possibility of a generic problem. CORRECTIVE_ACTION: The corrective action is to eliminate the possibility of procedural errors and perform on-orbit tests (with all three vehicles) to study the possibility of structural deformation. The Mission Operations Directorate Training Division is redesigning the COAS crew training curriculum to emphasize proper mounting and use of the COAS as well as suggested "flying" techniques available for centering the star in the reticle. In addition, more simulator time will be allotted for each crew person to master these techniques without the introduction of other anomalies. In conjunction with these training changes, the COAS crew procedures will be modified to preclude possible procedural errors. The on-orbit tests include the performance of multiple +X COAS calibrations in conjunction with DTO 785, Head Up Display (HUD) Backup to COAS, which is manifested on STS-38 (OV-104), STS-40 (OV-102) and STS-41 (OV-103). This test is designed to determine if the COAS +X LOS varies with the HUD LOS. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** Prelaunch	Problem	**FIAR**	**IFA** STS-31-V-14	MPS
None	**GMT:** Prelaunch		**SPR** KB1231	**UA**	**Manager:**
			IPR	**PR** MPS-3-10-0777	
					Engineer:

Title: Aft Compartment Helium Concetration High (ORB)

Summary: DISCUSSION: Prior to the first launch attempt of STS-31 on April 10, 1990, the concentration of helium in the aft compartment, resulting from the Orbiter/ET disconnect purge, was high. The concentration peaked at 12,000 ppm and eventually decreased to 8,000 ppm. No Launch Commit Criteria (LCC) violation was registered since the high reading occurred before the time the LCC limit of 10,000 ppm was active (T-2 hours to T-9 minutes).

An investigation that was performed following the launch scrub revealed a hairline crack in the 4-inch LH2 disconnect boot. This boot, which serves as a seal between the helium-purged ET/Orbiter umbilical plate-gap cavity and the Orbiter aft compartment, surrounds the 4-inch line interface with the umbilical cavity and is located on the Orbiter side of the ET/Orbiter interface. Room temperature vulcanizing (RTV) material was subsequently added to the boot and the boot was successfully leak-tested. Performance on launch day was satisfactory, with the helium concentration peaking at 9500 ppm and stabilizing near 6000 ppm. The 4-inch boot material, which is silicone rubber vulcanized to reinforcing fabric, appears to be susceptible to deterioration with age and exposure to cryogenic conditions. This boot has experienced one flight prior to this launch attempt. CONCLUSION: The high aft-compartment helium concentration was caused by a hairline crack in the 4-inch LH2 disconnect boot that allowed the Orbiter/ET disconnect helium purge flow to escape into the aft compartment. The hairline crack most probably resulted from boot material degradation. CORRECTIVE_ACTION: RTV was added to the leaking 4-inch LH2 boot as a temporary repair to limit leakage into the aft compartment. The leaking boot was removed and replaced after the flight. The necessity for a boot redesign is under evaluation. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** Postlanding	Problem	**FIAR**	**IFA** STS-31-V-15	TPS
None	**GMT:** Postlanding		**SPR** 31RF17	**UA**	**Manager:**

			IPR	**PR** STR-3-11-3204, -3205, TPS STR-3-11-462
				Engineer:

Title: Seal Material Missing from Elevon Flipper Door Trailing Edges (ORB)

Summary: DISCUSSION: During the STS-31 postflight inspection, seal material from the trailing edges of elevon flipper doors 5 and 6 was found in the upper elevon cove area. The retainer hardware on right-hand flipper doors 5, 6, 12, and 13 was found to be installed backwards. The door 5 and 6 cavity areas were inspected for thermal damage and the other two vehicles were inspected for similar installation problems. No evidence of thermal damage was found on OV-103; the retainers on OV-102 right-hand doors 5 and 6 and the retainer on OV-104 left-hand door 2 were also found to be installed backwards. The hardware on all three vehicles was brought back into drawing configuration and a sketch has been added to flipper-door-closure job cards V80-96001 through -96016 and V80-96101 through -96114 for better definition of the correct hardware installation.

CONCLUSION: The seals from the trailing edges of elevon flipper doors 5 and 6 came loose because of incorrect hardware installation. CORRECTIVE_ACTION: The door 5 and 6 cavity areas were inspected for evidence of thermal damage and none was found. All similar hardware on all three vehicles was inspected and brought back into drawing configuration, and a sketch was added to the applicable job cards to preclude a recurrence. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** Postlanding	Problem	**FIAR** B-FCE-023-F008	**IFA** STS-31-V-16	undefined
None	**GMT:** Postlanding		**SPR**	**UA**	**Manager:**
			IPR None	**PR**	
					Engineer:

Title: Gally Water Underdispense (GFE) (GFE)

Summary: DISCUSSION: During the postflight debriefing, the crew reported that the galley dispensed less cold water than the amount requested, with the underdispense becoming more noticeable towards the end of the mission. By flight day 5, the crew had to perform two 8 ounce dispense cycles to fill an 8 ounce drink container.

The galley was removed and shipped to JSC for troubleshooting. The underdispense problem could not be duplicated during troubleshooting. However, the cold water dispense solenoid valve was making an intermittent "buzzing" sound, and the water dispense rate did drop slightly when the "buzzing" was present. CONCLUSION: The cause of the galley underdispense can not be definitely pinpointed. The cold water dispense solenoid valve "buzzing" phenomenon may have been the cause or a contributor to the problem. If this problem recurs, rehydration of the crew food and drink containers would still be possible with no impact to crew safety or mission success. CORRECTIVE_ACTION: The cold water dispense solenoid valve was removed and replaced. Failure analysis will be performed on the removed solenoid. This galley unit (number 1004) was installed on OV-104 for the STS-38 mission. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** Postlanding	Problem	**FIAR** B-FCE-028-F005	**IFA** STS-31-V-17	GFE
None	**GMT:** Postlanding		**SPR**	**UA**	**Manager:**
			IPR None.	**PR**	
					Engineer:

Title: Five of Six Aft Fuselage Gas Sampler Bottles Leaked (GFE) (GFE)

Summary: DISCUSSION: Postflight inspection revealed that all six of the aft fuselage gas sampler bottles has successfully fired during ascent, however, five of the six had leaked air back into the bottle. One of the bottles developed a leak in the epoxy in the Torr seal around its vacuum gauge tube. All five of the leaking bottles developed leaks around the pyrotechnically actuated spool valve that opens and closes the bottles during ascent. When the spool valves were fired open the pyrotechnic device introduced debris into the cylinder in which the spool valve travels. When the spool valve was fired closed, it contacted the debris and scratched the cylinder wall, thereby ruining the seal for the bottle. The gas sampler bottles have a history of this type of failure.

CONCLUSION: The bottles leaked because the spool valve cylinder was scratched by debris from the valve-opening pyrotechnics. CORRECTIVE_ACTION: In the short term, fly as-is. If the problem recurs, neither crew safety or mission success will be affected. It is uncertain at this time why there appears to be a more frequent incidence of gas sample bottle leakage postflight. The pyrotechnic devices used are being modified to alleviate or reduce the mica closure disk, as this may be a contributing factor to postflight bottle leakage. Work is also being performed to determine if any changes in gas sample bottle preflight processing have occurred that may have contributed to this problem. Short term and long term solutions are being investigated. These include modification of the current pyrotechnic device, possible changes to gas sample bottle processing procedures, and a redesign of the gas sample valve/bottle. EFFECTS_ON_SUBSEQUENT_MISSIONS: None.

Tracking No	Time	Classification	Documentation		Subsystem
MER - 0	**MET:** Postlanding	Problem	**FIAR**	**IFA** STS-31-V-18	RMS
None	**GMT:** Postlanding		**SPR** None	**UA**	**Manager:**
			IPR	**PR** RMS-3-11-0016	
					Engineer:

Title: Remote Manipulator System (RMS) End Effector Snare Wires Out of Grooves (RMS)

Summary: DISCUSSION: The postflight inspection revealed that the remote manipulator system (RMS) end effector snare wires were 0.3-0.5 inch outside their grooves. The OMRSD limit is 0.25 inch. The OMRSD limit is under evaluation by the RMS community and an RCN will be submitted to establish a new limit after completion of the evaluation.

CONCLUSION: No problem. Fly as is.   CORRECTIVE_ACTION: The RCN change will establish realistic limits.   EFFECTS_ON_SUBSEQUENT_MISSIONS: None.