REVISED 5-7-87

FMEA NO. 2.3.8.1

CRITICALITY 2/2

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNIT TVC/WLA
DWG NO. 2294819-506, 508
2307068-503
SHEET 1 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. TVC A2 Camera Timing Logic 2294880-504 A4 Sync/Command Receiver 2294884-503 A6 Power On/Off, Input Voltage Preregulator, Output Voltage Regulators. 2294885-501 A7 DC-DC Converter, Primary Oscillator Driver, Secondary Rectifier/Filter. 2294886-503 A13 Master Oscillator. 2295527-1 WLA A3 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst Case: Loss of mission critical camera video.	DESIGN FEATURES The TVC/Lens Assembly is comprised of 16 electrical subassemblies; 13 subassemblies are RCA Astro designed and fabricated using standard printed-circuit board type of construction. The remaining three assemblies, high voltage power supply, oscillator, and stepper motors, are vendor supplied components which have been specified and purchased according to RCA Specification Control Drawings (SCDs) prepared by engineering and reliability assurance. Specifications per the SCD are prepared to establish the design, performance, test, qualification, and acceptance requirements for a procured piece of equipment. Parts, materials, processes, and design guidelines for the Shuttle CCTV program are specified in accordance with RCA 2295503. This document defines the program requirements for selection and control of EEE parts. To the maximum extent, and consistent with availability, all parts have been selected from military specifications at the JAN level, as a minimum. In addition to the overall selection criteria, a subset of general purpose preferred parts has been defined by this document and the RCA Government Systems Division Standard Parts List. In the case of the CMOS and TTL family of microcircuits, devices are screened and tested to the MIL-STD-883C equivalent and procured under the designations of HI-REL/3HQ and SMC 54LS from RCA-SSD and Texas Instruments Corp, respectively. Parts not included in the above documents have been used in the design only after a nonstandard item approval form (NSIAF) has been prepared, submitted to Reliability Assurance Engineering (RAE) and approved for use in the specific application(s) defined in the NSIAF by NASA-JSC. Worst-Case Circuit Analyses have been performed and documented for all circuit designs to demonstrate that sufficient operating margins exist for all operating conditions. The analysis was worst case-in that the value for each of the variable parameters was set to limits that will drive the output to a maximum (or minimum). A component application review and analysis was conducted to verify that the applied stress on each piece part by the temperature extremes identified with environmental qualification testing does not exceed the stress derating values identified in RCA 2295503. In addition, an objective examination of the design was performed through a PDR and CDR to verify that the TVC/Lens assembly met specification and contractual requirements.

FMEA NO. 2.3.8.1

CRITICALITY 2/2

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNIT TVC/WLA
DWG NO. 2294819-506, 508
2307088-503
SHEET 2 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. TVC A2 Camera Timing Logic 2294880-504 A4 Sync/Command Receiver 2294884-503 A6 Power On/Off. Input Voltage Preregulator. Output Voltage Regulators. 2294885-501 A7 DC-DC Converter. Primary Oscillator Driver. Secondary Rectifier/Filter. 2294886-503 A13 Master Oscillator. 2295527-1 WLA A3 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst Case: Loss of mission critical camera video.	DESIGN FEATURES (Continued) BARE BOARD DESIGN (A3, A4, A6, A7) The design of the associated A3, A4, A6, and A7 boards is constructed from laminated copper-clad epoxy glass sheets (NEMA G-10) Grade FR-4), PER MIL-P-55617A. Circuit connections are made through printed traces which run from point to point on the board surfaces. Every trace terminates at an annular ring. The annular ring surrounds the hole in which a component lead or terminal is located. This ring provides a footing for the solder, ensuring good mechanical and electrical performance. Its size and shape are governed by MIL-P-55640 as are trace widths, spacing and routing. These requirements are reiterated specifically in drawing notes to further assure compliance. Variations between the artwork master and the final product (due to irregularities of the etching process) are also controlled by drawing notes. This prevents making defective boards from good artwork. Holes which house no lead or terminal, but serve only to electrically interconnect the different board layers, contain stitch bars for mechanical support and increased reliability. The thru holes are drilled from a drill tape thus eliminating the possibility of human error and allowing tight control over hole and annular ring concentricity, an important reliability criterion. After drilling and etching, all copper cladding is tin-lead plated per MIL-STD-1495. This provides for easy and reliable soldering at the time of board assembly, even after periods of prolonged storage. BOARD ASSEMBLY DESIGN (A3, A4, A6, A7) All components are installed in a manner which assures maximum reliability. Component leads are pre-tinned, allowing total wetting of solder joints. All leads are formed to provide stress relief and the bodies of large components are staked. Special mounting and handling instructions are included in each drawing required after final assembly. The board is coated with urethane which protects against humidity and contamination. BOARD PLACEMENT (A2, A3, A4, A6) The A2, A3, A4, and A6 boards are secured in the electronics assembly by gold-plated beryllium copper card guides. Connections are made to the mother board with blind-mated connectors. Disengagement during launch is prevented by a cover which spans the board's free edge.

FMEA NO. 2.3.8.1

CRITICALITY 2/2

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNIT TVC/WLA
DWG NO. 2294819-506, 508
2307088-503
SHEET 3 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. TVC A2 Camera Timing Logic 2294880-504 A4 Sync/Command Receiver 2294884-503 A6 Power On/Off. Input Voltage Preregulator. Output Voltage Regulators. 2294885-501 A7 DC-DC Converter. Primary Oscillator Driver. Secondary Rectifier/Filter. 2294886-503 A13 Master Oscillator. 2295527-1 WLA A3 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst Case: Loss of mission critical camera video.	DESIGN FEATURES (Continued) BARE BOARD CONSTRUCTION (A2) The boards are of "welded wire" construction. At the bare board level this does not distinguish it from a normal PC board except that holes which will take weld pins generally are not connected to PC traces. Only those pins which bring power and ground potentials to the ICs are on PCs. An annular ring surrounds the hole in the board where each power and ground pin is located. These pins are then soldered to the trace like any other component lead. Aside from this feature, all design & construction techniques used in PC board layout apply. BOARD ASSEMBLY (A2) The drilled and etched board is populated with several hundred solderable or weldable pins. Power and ground pins, as well as connector pins, are soldered in place. Discreet components (resistors, diodes, capacitors) are attached to bifurcated terminals, where they are soldered. Flatpack ICs are welded, lead-by-lead, to the tops of the weld pins. After welding, extra lead material is trimmed away. Circuit connections are made using #30 AWG nickel weld wire. The wire is welded to the pin surfaces on the board backside. All wire welds are done using a machine which is tape driven, thus eliminating the possibility of miswiring due to operator error. All wiring & circuit performance is tested prior to box-level installation. After successful testing, components are staked as required by drawing notes and the assembly is coated with urethane. The board is inserted in the box on card-edge guides, in the same manner as the other PC boards. The A7-A low voltage power supply board is bolted in place at 6 points around its perimeter. Four of these mounting screws also pass through and tie down the smaller A7-B board. These two boards are mounted face-to-face, separated by the standoffs. Electrical interconnections are achieved by jumper wires between the two boards. The A7-A houses a 34-pin connector which brings in power and signals from outside the module. The A7 module includes these two boards as well as power transistor Q4. The module housing is bent aluminum sheet, comprised of two halves screwed together. The boards and Q4 are secured to the lower half, and wired together. Then the upper half is put in place. By mounting Q4 directly to the aluminum housing, good thermal performance is assured.

FMEA NO. 2.3.8.1

CRITICALITY 2/2

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNIT TVC/MLA
DWG NO. 2294819-506, 508
2307088-503
SHEET 4 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. TVC 2 Camera Timing Logic 2294880-504 4 Sync/Command Receiver 2294884-503 6 Power On/Off. Input Voltage Preregulator. Output Voltage Regulators. 2294885-501 12 DC-DC Converter. Primary Oscillator Driver. Secondary Rectifier/Filter. 2294886-503 13 Master Oscillator. 2295527-1 MLA 13 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst Case: Loss of mission critical camera video.	DESIGN FEATURES (Continued) The A13 assembly is a temperature compensated voltage controlled crystal oscillator (TCVCXO) that is purchased to a specification controlled drawing that establishes the requirements for performance, design, test, and qualification of the unit. The product assurance provisions of the document contain the identical requirements for electronic parts and materials as the Shuttle CCTV program and must receive the approval of RCA and NASA-JSC. Mechanical and electrical integrity of the assembly is confirmed by both analysis (design reviews) and test (qualification and acceptance). The general arrangement of the lens assembly is to provide an integrated housing, motor, and circuit board package which can accommodate various commercially available lenses. Emphasis is placed on accessibility of the lens, its drive components, and limit stops. Components within the lens assembly have been modularized, serving both the MLA, CLA, and HLA assemblies. The lens housing structure is a one-piece casting designed to minimize machining and provide a rugged dimensionally stable mounting for the optical components. The housing is in the form of a right angle. The vertical member interfaces with the front surface of the camera and the horizontal member supports the drive motors on the upper surface with the lens function circuit boards in a cavity on the underside. Lens Function Drive Train The iris, zoom, and focus drives are identical in concept; the only difference is the lower gear ratio in the iris train to provide the 2.8-second end-to-end travel capability necessary for the ALC operation. The table (on next page) shows the drive train parameters with overall torque margins for the three lens functions. The motor/gear heads are mounted on the lens housing rather than on the lens, to permit the desired lens interchangeability for the Shuttle mission with minimum impact on the actual lenses. Various types of motors were considered for this application, trading off size, power, weight, control-circuit complexity, command capability, and qualification status. The brushless and stepper-motor types fit the package and power requirements, the latter being preferred because of its simplicity, reliability, and space-qualified status. The selected stepper motor (a size-8, Alnico-9 pole-piece, permanent-magnet stepper) is mated with a spur train gearhead. Both units are manufactured by Monaco Motor Co. A 48-diametral-pitch (48-DP) spur gear on the gearhead output shaft meshes directly with the gears which are a part of the zoom, focus, and iris ring functions on the lens gear.

FMEA NO. 2.3.6.1

CRITICALITY 2/2

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNIT TVC/WLA
DWG NO. 2294819-506, 508
2307088-503
SHEET 5 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. TVC A2 Camera Timing Logic 2294880-504 A4 Sync/Command Receiver 2294884-503 A6 Power On/Off. Input Voltage Preregulator. Output Voltage Regulators. 2294885-501 A7 DC-DC Converter. Primary Oscillator Driver. Secondary Rectifier/Filter. 2294886-503 A13 Master Oscillator. 2295527-1 WLA A3 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst Case: Loss of mission critical camera video.	DESIGN FEATURES (Continued)

LENS DRIVE TRAIN PARAMETERS

Drive	Component	Travel (degrees)	Time End-to-End (seconds)	Input Torque (oz-in)	Ratio No. or Teeth	Efficiency (%)	Loss Torque (oz-in)	Net Torque (oz-in)
Zoom	Motor	150	6.6	-	-	-	-	0.27
	Gearhead			0.27	70:1	80	3.7	18.4
	Gearhead Output Gear			18.4	50	96	2.2	52.0
	Lens Gear				156		10.0	
							Torque Margin 5.2:1:	
Focus	Motor	262	7.5	-	-	-	-	0.27
	Gearhead			0.27	48:1	80	2.6	10.3
	Gearhead Output Gear			10.3	50	96	1.3	30.0
	Lens Gear				156		10.0	
							Torque Margin 3:1	
Iris	Motor	105	2.8	-	-	-	-	0.27
	Gearhead			0.27	48:1	80	2.6	10.3
	Gearhead Output Gear			10.3	50	96	1.3	30.0
	Lens Gear				156		5.0	
							Torque Margin 6:1	

FMEA NO. 2.3.8.1

CRITICALITY 2/2

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNIT TVC/WLA
OWG NO. 2294819-506, 508
2307088-503
SHEET 6 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. TVC A2 Camera Timing Logic 2294880-504 A4 Sync/Command Receiver 2294884-503 A6 Power On/Off. Input Voltage Preregulator. Output Voltage Regulators. 2294885-501 A7 DC-DC Converter. Primary Oscillator Driver. Secondary Rectifier/Filter. 2294886-503 A13 Master Oscillator. 2295527-1 WLA A3 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst Case: Loss of mission critical camera video.	ACCEPTANCE TEST The CCTV systems' WLA is subjected directly, without vibration isolators which might be used in their normal installation, to the following testing: • Vibration: 20-80Hz: 3 dB/Oct-rise from 0.01 G^2/Hz 80-350 Hz: 0.04 G^2/Hz 350-750 Hz: -3 dB/10 Oct-slope Test Duration: 1 Minute per Axis Test Level: 6.1 Grms • Thermal Vacuum: In a pressure of $1X10^{-5}$ Torr, the temperature shall be as follows: 125° F: Time to stablize equipment plus 1 hour 25° F: Time to stablize equipment plus 1 hour 125° F: Time to stablize equipment plus 1 hour The WLA may not have been subjected to the vacuum condition. For Acceptance Test Flow, See Table 1 located at the front of this book. OPERATIONAL TESTS In order to verify that CCTV components are operational, a test must verify the health of all the command related components from the PHS (A7A1) panel switch, through the RCU, through the sync lines to the Camera/PTU, to the Camera/PTU command decoder. The test must also verify the camera's ability to produce video, the VSU's ability to route video, and the monitor's ability to display video. A similar test would be performed to verify the MDM command path. Pre-Launch on Orbiter Test/In-Flight Test 1. Power CCTV System. 2. Via the PHS panel, select a monitor as destination and the camera under test as source. 3. Send "Camera Power On" command from PHS panel. 4. Select "External Sync" on monitor. 5. Observe video displayed on monitor. Note that if video on monitor is synchronized (i.e., stable raster) then this indicates that the camera is receiving composite sync from the RCU and that the camera is producing synchronized video. 6. Send Pan, Tilt, Focus, Zoom, ALC, and Gamma commands and visually (either via the monitor or direct observation) verify operation. 7. Select downlink as destination and camera under test as source. 8. Observe video routed to downlink. 9. Send "Camera Power Off" command via PHS panel. 10. Repeat Steps 3 through 9 except issue commands via the MDM command path.

FMEA NO. 2.3.8.1

CRITICALITY 2/2

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNIT TVC/WLA
DWG NO. 2294819-506, 508
2307088-503
SHEET 7 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. TVC A2 Camera Timing Logic 2294880-504 A4 Sync/Command Receiver 2294884-503 A6 Power On/Off. Input Voltage Preregulator. Output Voltage Regulators. 2294885-501 A7 DC-DC Converter. Primary Oscillator Driver. Secondary Rectifier/Filter. 2294886-503 A13 Master Oscillator. 2295527-1 WLA A3 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst Case: loss of mission critical camera video.	QA/ INSPECTION Procurement Control - The TVC/WLA EEE Parts and hardware items are procured from approved vendors and suppliers, which meet the requirements set forth in the CCTV contract and Quality Plan Work Statement (WS-2593176). Resident DCAS personnel review all procurement documents to establish the need for GSI on selected parts (PAI 517). Incoming Inspection and Storage - Incoming Quality inspections are made on all received materials and parts. Results are recorded by lot and retained in file by drawing and control numbers for future reference and traceability. All EEE parts are subjected to incoming acceptance tests as called for in PAI 315 - Incoming Inspection Test Instructions. Incoming flight parts are further processed in accordance with ACA 1846684 - Preconditioning and Acceptance Requirements for Electronic Parts, with the exception that DPA and PIND testing is not performed. Mechanical items are inspected per PAI 316 - Incoming Inspection Instructions for mechanical items, PAI 305 - Incoming Quality Control Inspection Instruction, and PAI 612 - Procedure for Processing Incoming or Purchased Parts Designated for Flight Use. Accepted items are delivered to Material Controlled Stores and retained under specified conditions until fabrication is required. Non-conforming materials are held for Material Review Board (MRB) disposition. (PAI 307, PAI IQC 531). Board Assembly & Test - Prior to the start of TVC board assembly, all items are verified to be correct by stock room personnel, as the items are accumulated to form a kit. The items are verified again by the operator who assembles the kit by checking against the as-built-parts-list (ABPL). DCAS Mandatory Inspection Points are designated for all printed circuit, wire wrap and welded wire boards, plus harness connectors for soldering wiring, crimping, solder splices and quality workmanship prior to coating of the component side of boards and sleeving of harnesses. TVC Boards Specific TVC board assembly and test instructions are provided in drawing notes, and applicable documents are called out in the fabrication Procedure and Record (FPR-2294819) and parts list PL2294819. These include shuttle TVC assembly notes 2593660, Process Standard RTV-566 2280881, Process Standard - Bonding Velcro Tape 2280889, Specification Soldering 2280749, Specification Name Plate Application 1960167, Specification - Crimping 2280800, Specification - Bonding and Staking 2280878, Specification - Urethane coating 2280877, Specification - locking compound 2026116, Specification Epoxy Adhesive 2010985, Specification - Marking 2280876, Specification - Workmanship 8030035, Specification Bonding and Staking 2280875.

REVISED 5-7-87

FMEA NO. 2.3.8.1 CRITICALITY 2/2	SHUTTLE CCTV CRITICAL ITEMS LIST	UNIT TVC/WLA DWG NO. 2294819-506, 508 2307088-503 SHEET 8 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. TVC A2 Camera Timing Logic 2294880-504 A4 Sync/Command Receiver 2294884-503 A6 Power On/Off. Input Voltage Preregulator. Output Voltage Regulators. 2294885-501 A7 DC-DC Converter. Primary Oscillator Driver. Secondary Rectifier/Filter. 2294886-503 A13 Master Oscillator. 2295527-1 WLA A3 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst Case: Loss of mission critical camera video.	QA/INSPECTION (Continued) TVC Assembly and Test An open box test is performed per TP-IT-2294819, and an Acceptance Test per TP-AT-2294819, including vibration and thermal vacuum. Torques are specified and witnessed, traceability numbers are recorded and calibrated tools are checked prior to use. RCA Quality and DCAS inspections are performed at the completion of specified FPR operations in accordance with PAI-204, PAI-205, PAI 206 and PAI 217. DCAS personnel witness TVC button-up and critical torquing. TVC/WLA Assembly and Test - After a TVC and an WLA have has been tested individually, they are mated and a final acceptance test is performed per TP-AT-2294819, including vibration and thermal vacuum environments. RCA and DCAS personnel monitor these tests and review the acceptance test data/results. These personnel also inspect for conformance after all repair, rework and retest. Preparation for Shipment - The TVC and WLA are separated prior to shipment after fabrication and testing is complete. Each is packaged according to CCTV Letter 8011 and 2280746, Process standard for Packaging and Handling guidelines. All related documentation including assembly drawings, Parts List, ABPL, Test Data, etc., is gathered and held in a documentation folder assigned specifically to each assembly. This folder is retained for reference. An EIOP is prepared for each assembly in accordance with the requirements of MS-2593176. RCA QC and DCAS personnel witness crating, packaging, packing, and marking, and review the EIOP for completeness and accuracy.

FMEA NO. 2.3.8.1

CRITICALITY 2/2

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNET IVC/WLA
DWG NO. 2294819-506, 508
2307088-503
SHEET 9 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. IVC A2 Camera Timing Logic 2294880-504 A4 Sync/Command Receiver 2294884-503 A6 Power On/Off. Input Voltage Preregulator. Output Voltage Regulators. 2294885-501 A7 DC-DC Converter. Primary Oscillator Driver. Secondary Rectifier/Filter. 2294886-503 A13 Master Oscillator. 2295527-1 WLA A3 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst case: Loss of mission critical camera video.	FAILURE HISTORY TDR - A1421 Log #0800 WLA S/N 010-501 TDR - Y9300 Log #0779 WLA S/N 011-501 Description: Acceptance Test Box Level Ambient Environment Delay pulse dissappears and output level goes to +10 Vdc. Cause: U4 causing slow fall time at input to U6. This slow fall time caused the one shot re-trigger. Corrective Action: ECN CCT 1093 was created to replace the CD4011 with a CD4093 Schmitt trigger 2 input NAND (U4). All previous delivered units were modified in accordance with ECN CCT 1093 and re-identified with new group numbers. TDR - W6852 Log #0959 WLA S/N 010-503 TDR - A2675 Log #0954 WLA S/N 010-503 Description: Flight Failure Spacecraft Level (STS - 11) Color Wheel stuck. Problem report PV2-860937. Cause: The failure was due to the presence of a micro-crack in the motor sleeve. Corrective Action: A review of the operational histories of other motors manufactured by the same supplier before and subsequent to the failed motor provides assurance that the probable failure cause was limited to this isolated case. No changes are being invoked on the vendor except additional inspection of the motor sleeve prior to bonding to the rotor hub.

REVISED 5-7-87

FMEA NO. 2.3.8.1

CRITICALITY 2/2

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNIT TVC/WLA
DWG NO. 2294819-506, 508
2307088-503
SHEET 10 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. TVC A2 Camera Timing Logic 2294880-504 A4 Sync/Command Receiver 2294884-503 A6 Power On/Off. Input Voltage Preregulator. Output Voltage Regulators. 2294885-501 A7 DC-DC Converter. Primary Oscillator Driver. Secondary Rectifier/Filter. 2294886-503 A13 Master Oscillator. 2295527-1 WLA A3 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst case: Loss of mission critical camera video.	FAILURE HISTORY TDR - 80802 Log #1098 WLA S/N 011-503 TVC S/N 027-506 NASA, ref. PV6-01537 Description: Flight Failure Spacecraft Level Color wheel sync problem observed during STS-41G mission. Cause: Anomaly could not be duplicated during extensive thermal-vacuum and Tenney chamber testing. Corrective Action: No specific repairs were performed on the WLS S/N 011. TVC (027) was modified per ECN CCT 1221 and were subject to flight acceptance retests. No evidence of an unlock condition was observed during these tests. NASA program office concurred in decision to discontinue additional testing.

FMEA NO. 2.3.8.1

CRITICALITY 2/2

SHUTTLE CCTV
CRITICAL ITEMS LIST

UNIT TVC/WLA
DWG NO. 2294819-506, 508
2307088-503
SHEET 11 OF 11

FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	RATIONALE FOR ACCEPTANCE
Filter wheel synchronous motor has stopped rotating. TVC A2 Camera Timing Logic 2294880-504 A4 Sync/Command Receiver 2294884-503 A6 Power On/Off. Input Voltage Preregulator. Output Voltage Regulators. 2294885-501 A7 DC-DC Converter. Primary Oscillator Driver. Secondary Rectifier/Filter. 2294886-503 A13 Master Oscillator. 2295527-1 WLA A3 Color Wheel Drive -Gear Train Failure -Motor Failure	Possible loss of video information due to filter wheel blanking bar stopping within lens FOV. Worst Case: Loss of mission critical camera video.	OPERATIONAL EFFECTS Loss of video. Possible loss of major mission objectives due to loss of RMS cameras or other required cameras. CREW ACTIONS If possible, continue RMS operations using alternative visual cues. CREW TRAINING Crew should be trained to use possible alternatives to CCTV. MISSION CONSTRAINT Where possible, procedures should be designed so they can be accomplished without CCTV.