FAILURE MODE EFFECTS ANALYSIS/CRITICAL ITEMS LIST

MEA NUMBER: 1.15.0 | ORIGINATOR: JSC/MM ASTRO | PROJECT: GFE

PART NAME: CARGO BAY
PART NUMBER: 3278890-506
LSC CONTROL NO:N/A
ZONE/LOCATION:N/A

LRU/ORU PART NUMBER: 3278890-506
LRU/ORU PART NAME: CTVC
DRAWING/REF DESIGNATOR:3278890
EFFECTIVITY/AFFECT STAGE:

QUANTITY: 1
SYSTEM: CCTV
SUBSYSTEM:

CRITICALITY:

CRITICAL ITEM?: Yes
CRITICALITY CATEGORY: 2/2

SUCCESS PATHS:
SUCCESS PATH REMAINING:

END ITEM NAME:
END ITEM FUNCTIONAL:
END ITEM CAPABILITY:

END ITEM FAILURE TOLERANCE:

REDUNDANCY SCREENS: (ORBITER/SPACE STATION)

A - Pass
B - Pass
C - Pass
D -

UNCTION:Camera will not respond to commands.
orst Case: Loss of mission critical video.

FAILURE MODE CODE:

FAILURE MODE: Loss of location code information.

CAUSE:
A1 Power Supply
A4 Com Dec/Tel Enc

FAILURE DETECTION:
REMAINING PATHS:

EFFECT/ MISSION PHASE:

CORRECTIVE ACTION:
None.

-FAILURE EFFECTS-

END ITEM/LRU/ORU/ASSEMBLY: Loss of camera output.

SUBSYSTEM/NEXT ASSEMBLY/INTERFACE: No video

SYSTEM/END ITEM/MISSION: Loss of mission critical video

CREW/VEHICLE : None.

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PART NUMBER: 3278890-S06	LRU/ORU PART NAME: CTVC	SYSTEM: CCTV
LSC CONTROL NO:N/A	DRAWING/REF DESIGNATOR:3278890	SUBSYSTEM:
ZONE/LOCATION:N/A	EFFECTIVITY/AFFECT STAGE:	

HAZARD INFORMATION:

HAZARD: YES___ NO_X__

HAZARD ORGANIZATION CODE:

HAZARD NUMBER:

TIME TO EFFECT:
TIME TO DETECT
TIME TO CORRECT:
FAILURE DETECTION/FLIGHT:

REMARKS:

-RATIONALE FOR ACCEPTABILITY-

(A) DESIGN:
The CTVC is comprised of 21 electrical subassemblies; 15 subassemblies are GE Astro Space designed and fabricated using standard printed circuit board type construction. The remaining six assemblies, 3 stepper motors, 1 brushless motor, ism/CCD, and Lens assembly are vendor supplies components, which have been specified and purchased according to GE pecification Control Drawing (SCDs) prepared by Engineering and Product Assurance. Specifications per the SCD are performance, test, qualification, and acceptance requirements for a procured piece of equipment. Parts, materials, processes, and design guidelines for the CTVC program are specified in accordance with GE 3267759. This document defines the program requirements.

MI-STD-975G will serve as the primary EEE parts selection document. If a suitable part cannot be found in MIL-STD-975G, equivalent EEE parts that meet the following criteria may be substituted.

Microcircuit s are at least Class B Level, MIL-M-38510 devices. All microcircuits are subjected to Particle Impact Noise Detection (PIND) testing per MIL-STD-883C (except for devices with plastic epory-type package).

Diodes and transistors are at least JANTXV in accordance with MIL-S-19500. All semi-conductors in cavity-type packages are subjected to PIND testing per MIL-STD-883C. Relays are procured to the highest military established reliability (MIL-ER) level as defined in MIL-R-39016. Relays are subject to PIND testing.

Switches are procured to at lease the second highest level of the appropriate MIL-ER specification. Switches are subjected to either PIND testing or X-ray analysis as appropriate, for particle detection.

Other discrete parts are procured to at least the second highest level of the appropriate MIL-ER specification.

Parts not included in the above documents have been used in the design only after a non-standard parts acceptance request (NSPAR) has been prepared, submitted to Reliability Assurance Engineering and approved for use in the specific application(s) defined in the NSPAR by NASA-JSC.

Worst case circuit analyses have been performed and documented for all circuit designs to demonstrate that sufficient perating 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 min). A component approach review and analysis

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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 GE 3267759.

In addition, an objective examination of the design was performed through a Preliminary Design Review and Critical Design Review to verify that the CTVC met specification and contractual requirements.

BARE BOARD DESIGN

All boards are constructed from laminated copper-clad epoxy glass sheets per MIL-P-13949 Type G Grade A. 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-S5640 as are trace widths, spacing and routing. These requirements are reiterated specifically in drawing notes to further assure compliance. Variation 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 through 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-ad plated per MIL-STD-1495. This provides for easy and reliable soldering at the time of board assembly, even after eriods of prolonged storage.

BOARD ASSEMBLY DESIGN

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 handing instructions are included in each drawing required after final assembly. The board is coated with urethane which protects against humidity and contamination.

(B) TEST: ACCEPTANCE

Each assembly is individually tested to a NASA approved Acceptance Test Procedure TP-AT-3278890. The Acceptance Test Flow is detailed in Table 1.

QUALIFICATION TEST

The qualification unit is identical to the flight unit configuration in every respect and is used solely for the purpose of qualification testing. The Qual unit must successfully complete acceptance testing prior to entering qualification testing. The Qual unit has passed testing in accordance with NASA approved test plan PN-C-3278890. The Qualification Test Flow is detailed in Table 2.

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.
3. Send "Camera Power On" command from the the PHS panel.

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4. Select "External Sync" on monitor.
5. Observe video displayed on monitor. Note that if video on monitor is synchronized (i.e., stable raster).
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.

(C) INSPECTION:

Procurement Control - The CTVC EEE Parts and hardware items are procured from approved vendors and suppliers, which meet the requirements set forth in the CTVC contract. Resident DPRO 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 GE 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). DPRO Mandatory Inspection Points are designed 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.

CTVC Boards

Specific CTVC board assembly and test instructions are provided in drawing notes, and applicable documents are called out in the Fabrication Procedure and Record (FPR-3278890) and parts list PL3278890. These include Process Standard RTV-566 2280881. Process Standard - Bonding Velcro Tape 2280889, Specification Soldering-Specification Crimping 2280800, Specification - Bonding and Staking 2220878, Specification - Marking 2280876,Specification - Workmanship 8030035, Specification Bonding and Staking 2280875, specification-Wave Solder 2280821, Specification-Printed Wire Board Staking 2280851, Specification-Reflow Soldering 2280754, Specification-Soldering Surface Mount Components 20005710.

CTVC Assembly and Test

An open box test is performed per TP-IT-3278890 and an Acceptance Test per TP-AT-3278890, including vibration and thermal vacuum. Torque's are specified and witnessed, traceability numbers are recorded and calibrated tools are checked prior to use. GE Quality and DPRO inspections are performed a the completion of specified FPR operations in accordance with PAI-204, PAI-205, and PAI-217. DPRO personnel witness CTVC button-up and critical torquing.

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The CTVC 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 EIDP is prepared for each assembly in accordance with the requirements of WS-2593176. GE QC and DPRO personnel witness crating, packaging, packing, and marking, and review the EIDP for completeness and accuracy.

TABLE 1. ACCEPTANCE TEST FLOW

1. ROOM AMBIENT PERFORMANCE TEST
   Test conducted per the requirements of NASA approved TP-AT-3278890.

2. ACCEPTANCE VIBRATION EXPOSURE
   20-80 Hz: 3 db/octave rise from 0.01 g2/Hz to 0.04 g2/Hz
   80-350 Hz:0.04 g2/Hz
   350-2000 Hz: 3 dB octave decreased to 0.006 g2/Hz
   Test Duration: 1 minute/axis, operating
   Test Level: 6.1 grms

3. POST-VIBRATION FUNCTIONAL CHECK
   Test conducted per the requirements of NASA approved TP-AT-3278890.

4. ACCEPTANCE THERMAL-VACUUM EXPOSURE
   1.5 cycles total from +115 deg F to +14 deg F.
   After stabilization, one hour minimum duration at each plateau. In-spec functional tests performed at each plateau.

5. POST-ENVIRONMENTAL PERFORMANCE TEST
   Room ambient performance testsconducted in accordance with NASA approved TP-AT-3278890.

TABLE 2. QUALIFICATION TEST FLOW

1. EMI
   Conduct tests run in accordance with the requirements of SL-E-0002B, including CS01, CS02, CS06, TT01, CE01, and CE03. Radiated tests run in accordance with SL-E0002B including RS02, RS03, and RE02 except that the test current for RS02 was 2 amps in lieu of 20 amps.

2. QUAL FOR ACCEPTANCE VIBRATION
   20-80 Hz: 2b/octave increasing to 0.067 g2/Hz
   80-350 Hz: 0.067/octave
   350-2000 Hz: 3db/octave decrease
   Test Level: 7.8 grms
   Test Duration: 5 minutes/axis operating

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3. FLIGHT QUALIFICATION VIBRATION

20-70 Hz: 8 dB/octave increasing to 0.4 g2/Hz
70-500 Hz: 0.4 g2/Hz
500-2000 Hz: 6db/octave decrease
Test Level: 18.1 grms
Test duration 48 minutes/axis non-operating

4. THERMAL-VACUUM

7.5 cycles total from +130 deg F to +9 deg F.
After stabilization, one hour minimum duration at each plateau.
In-spec functional tests performed at each plateau.

5. THERMAL SIMULATION

Worst case hot and cold mission environments simulated in vacuum. During hot case, in-spec operation is required for 6 of 14 consecutive hours. During cold case, in-spec operation is required for 14 consecutive hours

6. HUMIDITY

120 hours exposure to 85% RH including four 24 hour temperature cycles of +60 deg F to +125 deg F, non-operating.

(D) FAILURE HISTORY:
None.

(E) OPERATIONAL USE:
Loss of video. Possible loss of major mission objectives due to loss of RMS cameras or other required cameras.

(F) MAINTAINABILITY:

PREPARED BY: Bernie Erobrey	REVISION:
DATE: February 17, 1995	WAIVER NUMBER