

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE
 NUMBER:05-1-FC6542 -X

SUBSYSTEM NAME: GUIDANCE, NAVIGATION, & CONTROL

REVISION: 0 04/11/94

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	:ATVC HONEYWELL INC	MC621-0043-6541

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
 ASCENT THRUST VECTOR CONTROLLER (ATVC), NO'S 1, 2, 3, 4

REFERENCE DESIGNATORS: 54V79A1
 55V79A2
 56V79A3
 56V79A21

QUANTITY OF LIKE ITEMS: 4
 FOUR

FUNCTION:
 PROVIDES ELECTRICAL OUTPUT DRIVE SIGNALS FOR ONE OF FOUR REDUNDANT CHANNELS OF THE SRB AND SSME TVC ACTUATORS. PROVIDES AUTONOMOUS MONITORING OF SECONDARY DELTA PRESSURE, EQUALIZATION, AND FAILURE ISOLATION COMMANDS FOR 10 TVC ACTUATORS.

FAILURE MODES EFFECTS ANALYSIS FMEA - CIL FAILURE MODE

NUMBER: 05-1-FC6542-02

REVISION#: 1 01/22/96

SUBSYSTEM NAME: GUIDANCE, NAVIGATION, & CONTROL

LRU: ATVC

ITEM NAME: ATVC

CRITICALITY OF THIS

FAILURE MODE: 1R2

FAILURE MODE:
ERRONEOUS OUTPUT

MISSION PHASE: LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:	102	COLUMBIA
	103	DISCOVERY
	104	ATLANTIS
	105	ENDEAVOUR

CAUSE:
PIECE-PART FAILURE, VIBRATION, MECHANICAL SHOCK, MISHANDLING,
CONTAMINATION, TEMPERATURE.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS
 B) FAIL
 C) PASS

PASS/FAIL RATIONALE:

A)

B)

FAILS SCREEN "B", BECAUSE SECONDARY DELTA PRESSURE (SDP) SIGNAL FAILURE
INSIDE THE ATVC (ABOVE EQUALIZATION DEADBAND AND BELOW BYPASS TRIP LEVEL)
COULD RESULT IN UNDETECTED HARDOVER CHANNEL

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

CASE 1: 1R2: PASS FAIL PASS

(ANY SINGLE FAILURE CAUSING A SECONDARY DELTA PRESSURE (SDP) SIGNAL TO
"FREEZE" ABOVE EQUALIZATION DEADBAND AND BELOW BYPASS TRIP LEVEL, COULD
RESULT IN AN UNBYPASSED HARDOVER OUTPUT FROM ONE OF FOUR ATVC'S):

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE
NUMBER: 05-1-FC5542-02**

NO EFFECT FOR UNBYPASSED HARDOVER OUTPUT FROM ONE OF FOUR ATVC'S. THIS UNDETECTED HARDOVER CONDITION RESULTS IN THREE CHANNELS AGAINST ONE HARDOVER CHANNEL FORCE FIGHT. FLIGHT CONTROL CAN MAINTAIN VEHICLE CONTROL WITH THIS CONDITION.

CASE 2: 1R3; PASS PASS PASS
(ANY OTHER FAILURE OTHER THAN THAT DEFINED IN CASE 1):

NO EFFECT FOR FIRST FAILURE, RESULTS IN LOSS OF ONE OF FOUR ATVC'S. REMAINING THREE CHANNELS ARE UTILIZED FOR FLIGHT CONTROL.

(B) INTERFACING SUBSYSTEM(S):

CASE 1: 1R2; PASS FAIL PASS
(ANY SINGLE FAILURE CAUSING A SECONDARY DELTA PRESSURE (SDP) SIGNAL TO "FREEZE" ABOVE EQUALIZATION DEADBAND AND BELOW BYPASS TRIP LEVEL, COULD RESULT IN AN UNBYPASSED HARDOVER OUTPUT FROM ONE OF FOUR ATVC'S):

NO EFFECT FOR UNBYPASSED HARDOVER OUTPUT FROM ONE OF FOUR ATVC'S. THIS UNDETECTED HARDOVER CONDITION RESULTS IN THREE CHANNELS AGAINST ONE HARDOVER CHANNEL FORCE FIGHT.

CASE 2: 1R3; PASS PASS PASS
(ANY OTHER FAILURE OTHER THAN THAT DEFINED IN CASE 1):

NO EFFECT FOR FIRST FAILURE, RESULTS IN LOSS OF ONE OF FOUR ATVC'S.

(C) MISSION:

CASE 1: 1R2; PASS FAIL PASS
(ANY SINGLE FAILURE CAUSING A SECONDARY DELTA PRESSURE (SDP) SIGNAL TO "FREEZE" ABOVE EQUALIZATION DEADBAND AND BELOW BYPASS TRIP LEVEL, COULD RESULT IN AN UNBYPASSED HARDOVER OUTPUT FROM ONE OF FOUR ATVC'S):

NO EFFECT.

CASE 2: 1R3; PASS PASS PASS
(ANY OTHER FAILURE OTHER THAN THAT DEFINED IN CASE 1):

NO EFFECT.

(D) CREW, VEHICLE, AND ELEMENT(S):

CASE 1: 1R2; PASS FAIL PASS
(ANY SINGLE FAILURE CAUSING A SECONDARY DELTA PRESSURE (SDP) SIGNAL TO "FREEZE" ABOVE EQUALIZATION DEADBAND AND BELOW BYPASS TRIP LEVEL, COULD RESULT IN AN UNBYPASSED HARDOVER OUTPUT FROM ONE OF FOUR ATVC'S):

NO EFFECT FOR THIS FAILURE, BECAUSE VEHICLE CONTROL CAN TOLERATE THREE CHANNELS AGAINST ONE HARDOVER CHANNEL FORCE FIGHT.

CASE 2: 1R3; PASS PASS PASS
(ANY OTHER FAILURE OTHER THAN THAT DEFINED IN CASE 1):

NO EFFECT FOR FIRST FAILURE, REMAINING 3 CHANNELS ARE UTILIZED FOR FLIGHT CONTROL.

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE
NUMBER: 05-1-FC6542-02

(E) FUNCTIONAL CRITICALITY EFFECTS:

CASE 1: 1R2; PASS FAIL PASS

(ANY SINGLE FAILURE CAUSING A SECONDARY DELTA PRESSURE (SDP) SIGNAL TO "FREEZE" ABOVE EQUALIZATION DEADBAND AND BELOW BYPASS TRIP LEVEL, COULD RESULT IN AN UNBYPASSED HARDOVER OUTPUT FROM ONE OF FOUR ATVC'S):

NO EFFECT FOR FIRST UNDETECTED FAILURE (SECONDARY PRESSURE SIGNAL FAIL BELOW FAILURE DETECTION THRESHOLD AND ABOVE EQUALIZATION DEADBAND). THIS FIRST FAILURE WOULD RESULT IN A TOLERABLE THREE CHANNELS AGAINST ONE CHANNEL FORCE FIGHT. A SECOND CHANNEL FAIL HARDOVER AFFECTING THE SAME ACTUATOR AND WITH THE SAME POLARITY AS THE FIRST FAILURE WOULD RESULT IN A TWO CHANNELS AGAINST TWO CHANNELS FORCE FIGHT. A TWO CHANNELS AGAINST TWO CHANNELS FORCE FIGHT COULD CAUSE LOSS OF VEHICLE CONTROL. CRITICALITY 1R BECAUSE LOSS OF THRUST VECTOR CONTROL DURING ASCENT MAY CAUSE LOSS OF VEHICLE.

CASE 2: 1R3; PASS PASS PASS

(ANY OTHER FAILURE OTHER THAN THAT DEFINED IN CASE 1):

NO EFFECT FOR FIRST FAILURE (DETECTABLE), BECAUSE REMAINING 3 CHANNELS ARE SUFFICIENT FOR FLIGHT CONTROL. SECOND FAILURE (UNDETECTED) COULD RESULT IN A TWO CHANNELS AGAINST ONE CHANNEL FORCE FIGHT. PRELIMINARY STUDY SUPPORTS ACCEPTABLE PERFORMANCE FOR TWO CHANNELS AGAINST ONE CHANNEL FORCE FIGHT. CRITICALITY 1R BECAUSE LOSS OF THRUST VECTOR CONTROL DURING ASCENT MAY CAUSE LOSS OF VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

ALL ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL (EEE) PIECE PARTS WHICH MAKE UP THE ATVC ARE CONTROLLED TO THE ORBITER PROJECT PARTS LIST (OPPL) REQUIREMENTS OF MF0004-400. PASSIVE EEE PARTS AND ELECTRICAL CONNECTORS ARE MILITARY QUALIFIED AND 100% SCREENED TO OPPL REQUIREMENTS. MICRO-CIRCUITS ARE QUALIFIED TO MIL-M-38510 AND SCREENED TO MIL-S-883, LEVEL B. CIRCUIT DESIGN LIMITS WORST CASE JUNCTION TEMPERATURES TO 95 DEGREES C AND ELECTRICAL STRESSES TO 50% OF RATED CAPABILITY FOR ALL PARTS. THE ATVC AS AN ASSEMBLY HAS A CERTIFIED LIFE OF 10,000 HOURS (100 MISSIONS) EQUIVALENT TO TEN YEARS.

THE ATVC IS DESIGNED AS A HERMETICALLY SEALED UNIT TO PREVENT OR ELIMINATE THE ENVIRONMENTAL EFFECTS OF RAIN, SAND, DUST, AS WELL AS MOISTURE. INTERNAL COMPONENTS ARE CONFORMAL COATED TO ELIMINATE THE ADVERSE EFFECTS OF MOISTURE, PRESSURE, AND/OR TEMPERATURE VARIATIONS IN ADDITION TO SHORT CIRCUIT PROTECTION. THE ATVC ALSO INCORPORATES A FAULT DETECTION CIRCUIT TO ISOLATE A FAILED DETECTED CHANNEL, THEREBY ELIMINATING ITS EFFECT ON THE SYSTEM.

(B) TEST:

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE
NUMBER: 05-1-FC6542-02**

ACCEPTANCE TESTING, WHICH INCLUDES ACCEPTANCE THERMAL TESTING (ATT) AND ACCEPTANCE VIBRATION TESTING (AVT), IS PERFORMED ON EACH UNIT. QUALIFICATION TESTING, INCLUDING VIBRATION, SHOCK, TEMPERATURE, HAS BEEN SUCCESSFULLY COMPLETED TO CERTIFY THE DESIGN. INTEGRATED/SUBSYSTEM VERIFICATION IS PERFORMED DURING TURNAROUND. FUNCTIONAL TESTING VERIFIES THE OUTPUT OF THE ATVC IS WITHIN SPEC FOR CONTROLLING THE MPS AND SRB.

(C) INSPECTION:

RECEIVING INSPECTION:
INCOMING MATERIAL IS VERIFIED BY RECEIVING INSPECTION.

CONTAMINATION CONTROL:

FINAL ASSEMBLY AND REWORK PERFORMED IN A CLEAN ROOM.

ASSEMBLY/INSTALLATION:

QUALITY PLANNING ENSURES ALL DRAWING AND PROCUREMENT REQUIREMENTS ARE PUT INTO IN-PROCESS WORK TICKETS. TORQUING VERIFICATION BY INSPECTION.

NONDESTRUCTIVE EVALUATION:

RADIOGRAPHIC ANALYSIS, ULTRASONIC TESTING, DYE PENETRANT AND MAGNETIC PARTICLE ANALYSIS VERIFIED BY INSPECTION

CRITICAL PROCESSES:

POTTING, BONDING, FUSION WELDING, SOLDERING AND MATERIAL CLEANING VERIFIED BY INSPECTION.

TESTING:

ENVIRONMENTAL ACCEPTANCE TESTING IS OBSERVED AND VERIFIED BY QUALITY CONTROL.

HANDLING/PACKAGING:

THE PACKING AND PACKAGING REQUIREMENTS ARE SATISFIED BY USE OF SPECIAL QUALIFIED CONTAINERS FOR IN-PLANT TRANSPORTATION AND SHIPPING. RETURNED AND ACCEPTED GOODS ARE STORED IN A BONDED AREA.

(D) FAILURE HISTORY:

CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:

PER STANDARD FCS CHANNEL MANAGEMENT (FLIGHT RULE 8-52), FAILED AND UNBYPASSED PORTS WILL BE ISOLATED WITH CREW ACTION TO TURN OFF THE AFFECTED FCS CHANNEL.

- APPROVALS -

EDITORIALLY APPROVED	: RI	: <u>Jim R 1/25/96</u>
EDITORIALLY APPROVED	: JSC	: <u>James J. 2-1-96</u>
TECHNICAL APPROVAL	: APPROVAL FORM	: 95-CIL-004,RI