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SATURN C-1 FAILURE EFFECT ANALYSIS

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SA-5 AND COMPLEX 37-B

FUNCTIONAL SYSTEMS INTEGRATION SECTION
PROPULSION AND VEHICLE ENGINEERING DIVISION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

SATURN C-1 FAILURE EFFECT ANALYSIS FOR SA-5 AND COMPLEX 37-B

FUNCTIONAL SYSTEMS INTEGRATION SECTION
PROPULSION AND VEHICLE ENGINEERING DIVISION

TABLE OF CONTENTS

	Section
INTRODUCTION	1.0
SATURN SYSTEM	2.0
S-I STAGE	3.0
Structure	3.1
Propulsion	3.2
S-I Staging	3.3
Telemetry and Instrumentation	3.4
Control and Guidance	3.5
Electrical	3.6
Command	3.7
Optical Tracking	3.8
Environmental Control (Preflight)	3.9
S-IV STAGE	4.0
Airframe	4.1
Propulsion	4.2
Propellant Utilization	4.3
Flight Control	4.4
Auxiliary Power Supply	4.5
Separation	4.6
Electrical	4.7
Instrumentation	4.8
INSTRUMENT UNIT	5.0
Structure	5.1
Environmental Control	5.2
Emergency Detection System	5.3
Telemetry and Instrumentation	5.4
Guidance and Control	5.5
Electrical	5.6
Tracking	5.7
PAYLOAD	6.0

TABLE OF CONTENTS (Concluded)

	Section
LAUNCH COMPLEX 37	7.0
S-I Support Equipment	7.1
S-IV Support Equipment	7.2
Instrument Unit Support Equipment	7.3
Electrical Support Equipment Integration	7.4
Vehicle Oriented Support Equipment	7.5

INTRODUCTION

1. Of prime importance in the design philosophy of the SATURN vehicle/launch complex is the fact that no single failure in a system should cause mission degradation or abort. Since strict adherence to this policy is not practical within the confines of a time and budget limited program, it is important to minimize vehicle loss probability. This dictates an analysis which is based on component reliabilities and single failure effect analysis.

2. The SATURN C-1 Failure Effect Analysis Committee, composed of members from the M-SAT and the various MSFC Divisions, was established to

a. Study failure effect analysis techniques.

b. Devise analysis procedures which would be compatible with MSFC operational procedures.

c. Perform failure effect analyses, through assistance from cognizant design personnel, for the S-I stage, S-IV stage, and the Instrument Unit of the SATURN SA-5 vehicle, and for the certain critical items of the Launch Complex. (The payload was not included as its design responsibility falls within the authority of Manned Spacecraft Center.)

d. Establish a permanent program as a follow-on effort to insure the effective accomplishment of failure effect analysis on vehicles subsequent to SA-5. (See M-P&VE-85, MSFC Space Vehicle Systems Failure Effect Analysis Integration Program Proposal, dated December 11, 1961, and M-SAT memo, Subject: Continuation of Failure Effect Analysis Studies on SATURN SA-5 and Subsequent Vehicles, dated January 22, 1962.)

3. Since the Committee was primarily a "study" group, considerable latitude was allowed in format (particularly concerning the block diagrams) of the various portions of the analysis presented. This enabled each committee member to display the systems under his cognizance in a manner which, he thought, would point out the failure effects most clearly. Consequently, some systems are analyzed by system "flow", while others are analyzed in a manner

similar to that performed in a logic study. However, an examination of the various formats reveals this fact; a systematic analysis of each system by one who is familiar with it will show the system weaknesses and the effect of the system failure on the vehicle. For this reason no attempt has been made to completely standardize the format in this presentation. This discrepancy will be resolved by the follow-on program.

4. An examination of the "Structures" portion of the presentation reveals that no written portion accompanies the block diagrams. An explanation for this can be stated briefly. During the initial phase of design, the structure undergoes an analysis, involving design and stress calculations, which can be classified as a single failure effect analysis. On the basis of this analysis, the structure is strengthened at points where possible failures will occur. For this reason, it can be stated that the complete structure has been designed to adequately withstand normal flight loading without a failure which will result in a vehicle loss.

5. In the presentation no attempt has been made to define the frequency of occurrence of the failure modes for each component. Therefore, the failure modes listed may be extremely remote, but for analysis purposes are included.

FAILURE EFFECT ANALYSIS

VEHICLE ORIENTED SUPPORT EQUIPMENT

ANALYSES AND DIAGRAMS FOR

G-1 THRU G-7 NOT AVAILABLE

FAILURE EFFECT ANALYSIS

ANALYSES AND DIAGRAMS ARE NOT AVAILABLE

FOR ELECTRICAL SUPPORT EQUIPMENT INTEGRATION G-EI

FAILURE EFFECT ANALYSIS

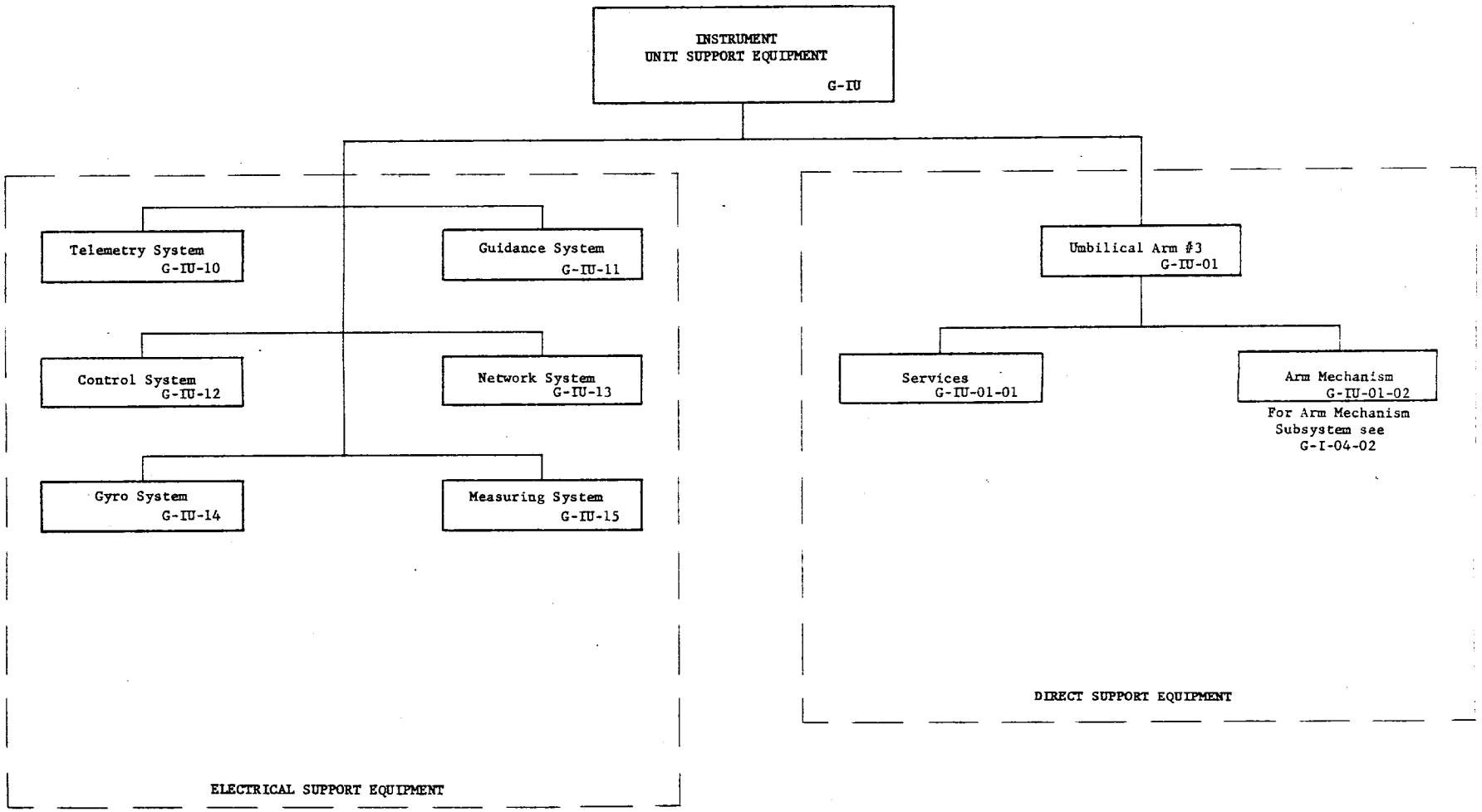
THE ANALYSIS AND DIAGRAM ARE NOT AVAILABLE
FOR THE SERVICES, 8-1-01-01.

FAILURE EFFECT ANALYSIS

ANALYSES AND DIAGRAMS ARE NOT AVAILABLE

FOR G-IU-10 THRU G-IU-15

FAILURE EFFECT ANALYSIS



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FAILURE EFFECT ANALYSIS

THE DIAGRAM AND ANALYSIS FOR THE SERVICES,
G-IV-01-01 ARE NOT AVAILABLE.

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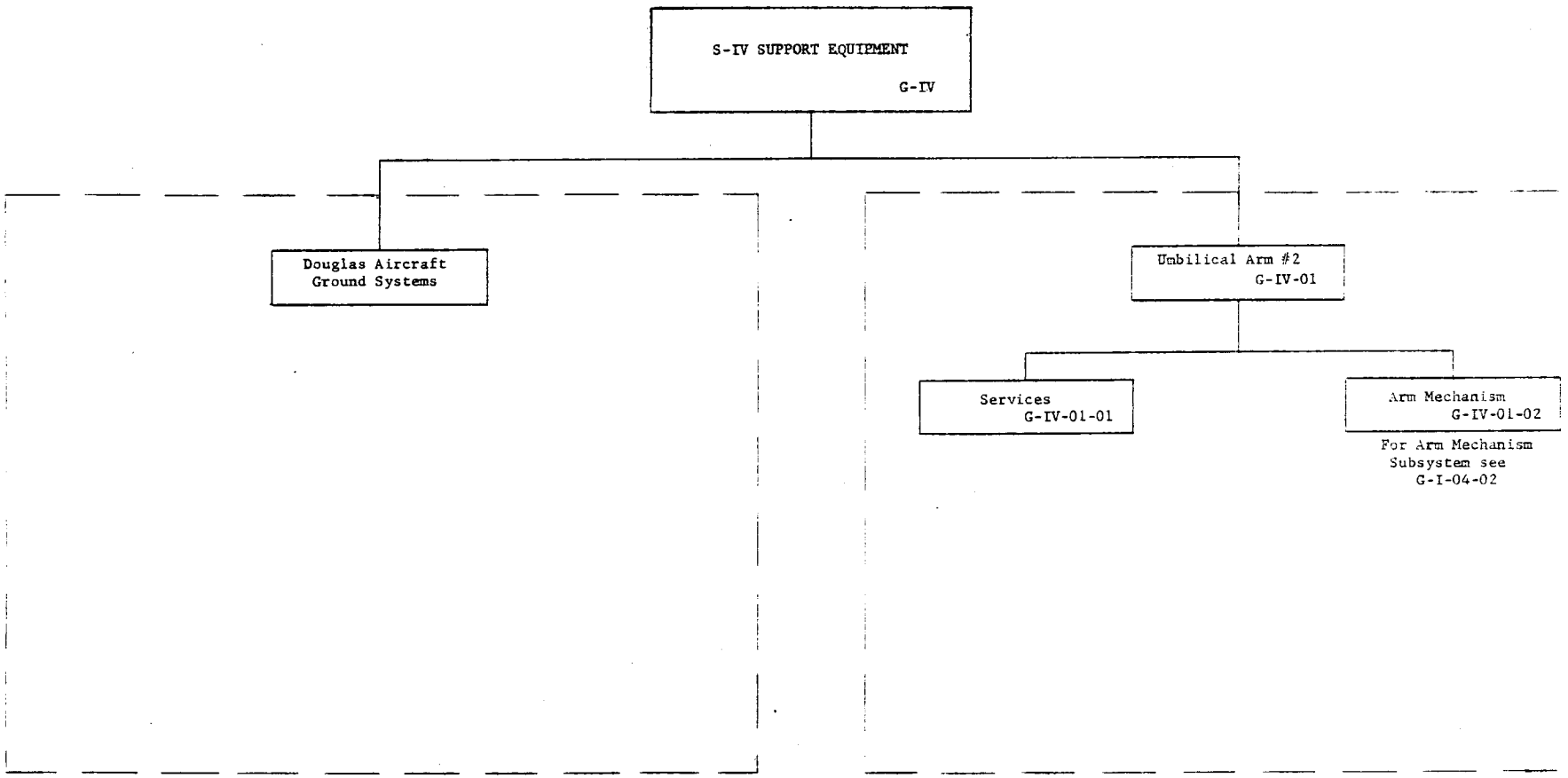
THE DIAGRAMS AND ANALYSES FOR THE DOUGLAS AIRCRAFT
GROUND SYSTEMS ARE NOT AVAILABLE.

FAILURE EFFECT ANALYSIS



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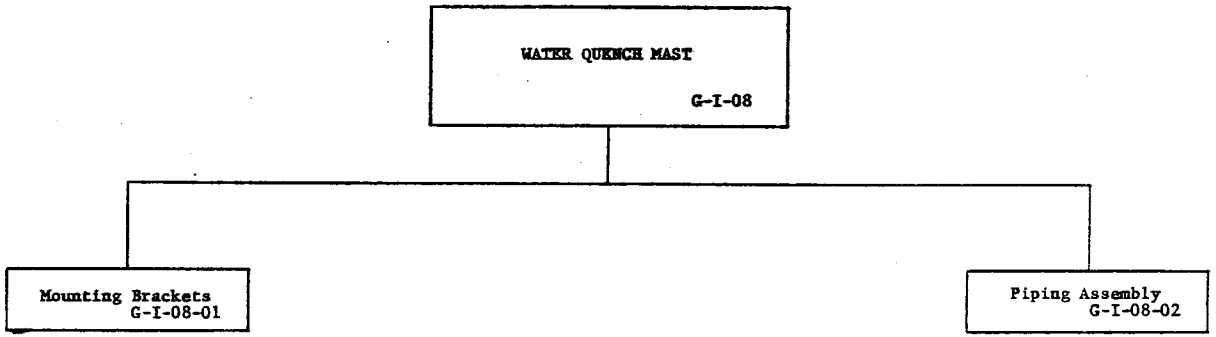
FAILURE EFFECT ANALYSIS

THE ANALYSIS IS NOT AVAILABLE FOR G-I-08

FAILURE EFFECT ANALYSIS



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FAILURE EFFECT ANALYSIS

FUEL FILL AND DRAIN MAST SUBSYSTEM

G-1-07

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
					Freeze closed	Possible loss of Subsystem Cause mast to be retracted at an excessive rate by not applying cushion pressure to bottom of Retract and Erecting Cylinder.	None If mast fails to retract upon command, it will be forced to retract by impact with the vehicle at lift-off.	
Check Valve G-I-07-15	*	10426693 (7323)		Allow application of pressure to the top of the Retract & Erecting Cylinder when the Solenoid Valve is energized (retract command) and prevent leakage of preload through vent of Solenoid Valve when de-energized.	Freeze open (leakage)	Possible loss of Subsystem Cause mast to be erected at excessive rate by allowing preload pressure on top of Retract and Erecting Cylinder to vent through Solenoid Valve.	None Malfunction determined prior to countdown.	
Solenoid Valve G-I-07-16	*	10425701 (7324)		When energized, apply pneumatic pressure to the top of the Retract and Erecting Cylinder thereby retract the mast.	Fail to energize	Loss of Subsystem Prevent automatic retraction of the fuel mast as the pneumatic pressure will not be applied to the top of the Retract and Erect Cylinder.	None If the mast fails to retract upon command, it will be forced to retract by impact with the vehicle at lift-off.	
					Energize erroneously	Loss of Subsystem Mast will attemp to retract but will be held mechanically to vehicle by coupling; however, leakage of fuel will result if the solenoid is erroneously energized during propellant transfer.	A. Delay in countdown. Spillage of fuel on the launch pedestal will force hold in countdown.	
Retract and Erecting Cylinder Orifice G-I-07-17	*	10425920 (7327)		Allow pneumatic preload pressure to be gradually applied to the top of Retract & Erecting Cylinder	Clog	Possible loss By preventing application of preload pressure to the top of the Retract and Erecting Cylinder and therefore allow shock loading of the mast upon erection command.	None Malfunction determined prior to countdown.	

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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
FUEL FILL AND DRAIN MAST SUBSYSTEM
G-I-07

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Check Valve G-I-07-11	*	10426693		Allow venting of pressure regulator to bottom of Retract and Erecting cylinder to cushion the retraction and to prevent venting through the pressure relief valve during mast erection	Freeze open (Leakage)	None Leakage through the check valve will result in a slower erection of the mast only.	None	
Pressure Relief Valve G-I-07-12		10426704 (7320)		Vent excessive pressure being applied to the bottom of the Retract and Erecting Circuit	None	None	None	
Coupling Vent Button Valve G-I-07-13	*	10426701 (7321)		Vent retract coupling and bottom of Retract and Erecting Cylinder thus allowing retract coupling to expand and mate with vehicle and permit retraction of mast upon application of pneumatic pressure to top of Retract and Erecting Cylinder.	Freeze open (Leakage)	Loss of Subsystem Prevent compression of retract coupling and erection of mast by not allowing pressure buildup in the retract coupling cylinder and the bottom of the retract and erecting cylinder.	None Malfunction determined prior to countdown.	
					Freeze closed	Probable Loss of Subsystem Prevent expansion of retract coupling and thereby allow leakage of fuel and prevent retraction.	A. Delay in countdown B. None If mast fails to retract upon command, it will be forced to retract by impact with the vehicle at lift-off of mast by maintaining pressure on the bottom of the Retract and Erecting Cylinder.	
Pressure Regulator G-I-07-14	*	10426705 (7322)		Regulate pressure applied to the bottom of the Retract and Erecting Cylinder to prevent retraction of the Fuel Mast at an excessive rate.	Freeze open	Possible Loss of Subsystem Cause mast to be erected at excessive rate by venting preload on Retract & Erecting Cylinder and cause retraction at inadequate rate of speed by applying an excessive cushion pressure to the bottom of the Retract & Erecting Cylinder.	None Malfunction determined prior to countdown.	
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FAILURE EFFECT ANALYSIS

FUEL FILL AND DRAIN MAST SUBSYSTEM

G-I-07

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Erecting Button Vent Valve G-I-07-07	*	10425920 (7314)		Allows venting top of retract and erecting cylinder to facilitate erecting the mast.	Freeze open	Possible Loss of Subsystem Prevent preloading of retract and erecting cylinder and allow shock loading of mast upon erection command.	None Malfunction determined prior to countdown	
					Freeze closed	Possible Loss of Subsystem Prevent venting of preload pressure on the retract and erecting cylinder thus preventing the erection of the mast.	None Malfunction determined prior to countdown	
Erecting Pressure Button Valve G-I-07-08	*	10425920 (7316)		Allows pressurizing bottom of retract and erecting cylinder to facilitate erecting the mast.	Freeze open (Leakage)	Possible Loss of Subsystem Prevent retraction of the mast by maintaining pressure on the bottom of the retract and erecting cylinder.	None If the mast fails to retract upon command it will be forced to retract by impace with the vehicle at lift-off.	
					Freeze closed	Possible Loss of Sub-System Prevent erecting of the mast by not allowing pneumatic pressure to be applied to the retract and erecting cylinder	None Malfunction determined prior to countdown.	
Retract Coupling Check Valve G-I-07-09	*	10426693 (7317)		Allows venting of retract coupling air cylinder and prevents pressurizing during mast retract.	Freeze open (Leakage)	Possible Loss of Subsystem Leakage past the check valve will allow compression of the retract coupling resulting in leakage of fuel.	A. Delay in countdown	
Retract and Erecting Cylinder Vent Check Valve G-I-07-10	*	10426693 (7318)		Allow venting of the retract and erecting cylinder during coupling vent command and prohibits pressurization of the cylinder during retract coupling command	Freeze open (leakage)	None Mast will start to erect on retract coupling command but will be checked by normal preload on cylinder before erection complete.	None Malfunction determined prior to countdown.	
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FAILURE EFFECT ANALYSIS
FUEL FILL AND DRAIN MAST SUBSYSTEM
G-I-07

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Retractable Coupling Assembly G-I-07-01	*	(7300)		Provide a positive seal between the coupling and the filling nozzle	Leakage	Loss of Subsystem Improper sealing will result in leakage of fuel on launch pedestal	A. Delay in launch	
Retractable Coupling Air Cylinder G-I-07-02	*	(7301) (7302)		Compress retractable coupling assembly when mast is erected or manually retracted using valve box controls	Leakage	Possible Loss of Sub-System When leakage is of sufficient capacity to prevent compression of retractable coupling assembly, misalignment of coupling will result.	None Malfunction determined prior to countdown	
Retracting and Erecting Cylinder G-I-07-03	*	10426944 (7303)		Connect and disconnect the mast to the vehicle by application of pneumatic pressure.	Leakage	Possible Loss of Sub-system When leakage is of sufficient capacity to prevent pressure build up the mast will not react upon command.	None If the mast fails to retract upon command it will be forced to retract by impact with the vehicle at lift-off.	
Mast Retract Button Valve G-I-07-04	*	10426701 (7311)		Depress Retract coupling and preload retracting and erecting assembly cylinder	Freeze open	Loss of Subsystem Depress retract coupling and allow leakage of fuel	A. Delay in countdown and present safety hazard.	
					Freeze closed	Loss of Subsystem Mast cannot be erected.	None Malfunction determined prior to countdown.	
Retract and Erecting Cylinder preload check valve G-I-07-05	*	10426693 (7312)		Allow preloading of retract and erecting cylinder and preventing venting during coupling vent.	Freeze open or closed	Possible Loss of Sub-system Preventing preloading of the retract and erecting cylinder will allow shock loading of the mast during erection and retraction.	None Malfunction determined prior to countdown.	
Orifice G-I-07-06	*	10426711 (7313)		Control the rate of erecting the fuel mast	Clog	Possible Loss of Sub-System Prevent venting of the pressure on the retract and erecting cylinder thus prevent erecting the mast.	None Malfunction determined prior to countdown	
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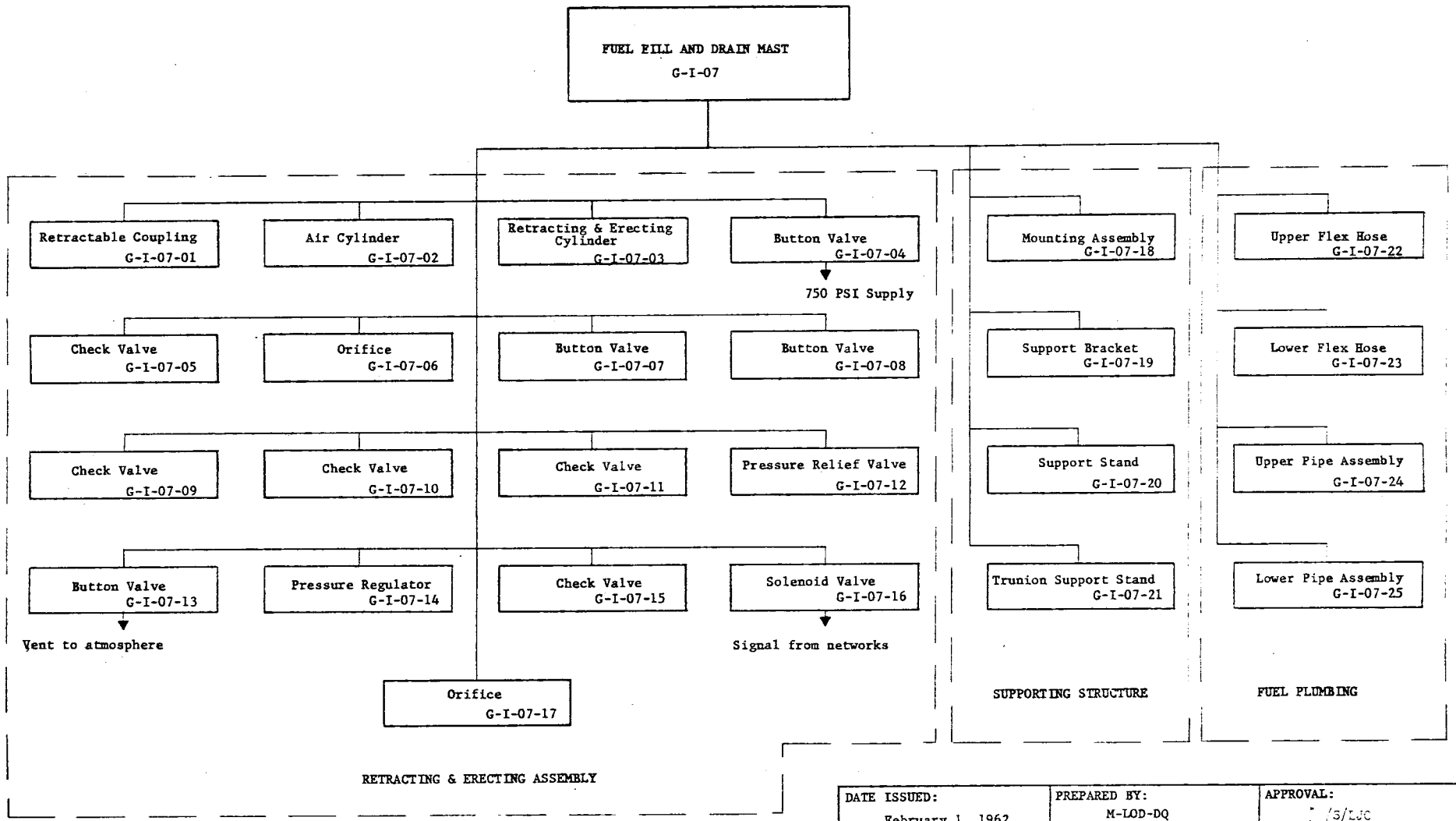
FAILURE EFFECT ANALYSIS



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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
LOX FILL & DRAIN MAST SUBSYSTEM
G-I-06

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Solenoid Valve G-I-06-16	*	10425701 (7224)		When energized, apply pneumatic pressure to the top of the Retract and Erecting Cylinder thereby retracting the mast.	Fail to energize	Loss of Subsystem Prevent automatic retraction of the LOX mast as the pneumatic pressure will not be applied to the top of Retract and Erecting Cylinder.	None If the mast does not retract upon command, it will be retracted by impact with the vehicle at lift-off.	
					Energize erroneously	Loss of Subsystem Mast will attempt to retract but will be held mechanically to vehicle by coupling; however, leakage of LOX will result if the solenoid is erroneously energized during propellant transfer.	A. Delay in countdown. Spillage of fuel on the launch pedestal will force hold in countdown.	
Retract & Erecting Cylinder Orifice G-I-06-17	*	10425920 (7227)		Allow pneumatic preload pressure to be gradually applied to top of Retract and Erecting Cylinder.	Clog	Possible loss of Subsystem By preventing application of preload pressure to top of Retract & Erecting Cylinder and therefore allow shock loading of the mast upon erect command.	None Malfunction determined prior to countdown.	
Check Valve G-I-06-15	*	10426693 (7223)		Allow application of pressure to top of Retract & Erecting Cylinder when the Solenoid Valve is energized (retract command) & prevent leakage of preload through vent of Solenoid Valve when de-energized.	Freeze open (Leakage)	Possible loss of Subsystem Cause mast to be erected at excessive rate by allowing preload pressure on top of Retract & Erecting Cylinder to vent through Solenoid Valve.	None Malfunction determined prior to countdown.	
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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
LOX FILL & DRAIN MAST SUBSYSTEM
G-I-06

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Coupling Vent Button Valve G-I-06-13	*	10426701 (7221)		Vent retract coupling and bottom of Retract & Erecting Cylinder thus allowing retract coupling to expand and mate with vehicle and permit retraction of mast upon application of pneumatic pressure to top of Retract and Erecting Cylinder.	Freeze open (Leakage)	Loss of Subsystem Prevent compression of retract coupling and erection of mast by not allowing pressure buildup in the retract coupling cylinders and the bottom of the retract & erecting cylinder.	None Malfunction determined prior to countdown.	
					Freeze closed	Probable loss of Subsystem Prevent expansion of retract coupling and thereby allow leakage of LOX and prevent retraction of mast by maintaining pressure on bottom of the retract and erecting cylinder.	A. Delay in countdown. B. None If mast fails to retract upon command, it will be forced to retract by impact with missile at lift-off.	
Pressure Regulator G-I-06-14	*	10426705 (7222)		Regulate pressure applied to the bottom of the Retract & Erecting Cylinder to prevent retraction of the LOX mast at an excessive rate.	Freeze open	Possible loss of Sub- Cause mast to be erected at excessive rate by venting preload on Retract & Erecting Cylinder and cause retraction at inadequate rate of speed by applying an excessive cushion pressure to the bottom of the Retract & Erecting Cylinder.	None Malfunction determined prior to countdown.	
					Freeze closed	Possible loss of Subsystem Cause mast to be retracted at an excessive rate by not applying cushion pressure to bottom of Retract & Erecting Cylinder.	None If mast fails to retract upon command, it will be forced to retract by impact with missile at lift-off.	
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P&VE Form #323 (January 1962)(OT)

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FAILURE EFFECT ANALYSIS
LOX FILL AND DRAIN MAST SUBSYSTEM
G-I-06

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Retract and Erecting Cylinder vent check valve. G-1-06-10	*	10426693 (7218)		Allow venting of the Retract and Erecting Cylinder during coupling vent command and prohibits pressurization of the cylinder dummy retract coupling operation	Freeze open (leakage)	None Mast will start to erect on Retract Coupling command but will be checked by normal preload on cylinder before erection complete.	None Malfunction determined prior to countdown.	
Check Valve G-I-06-11	*	10426693 (7219)		Allow venting of pressure regulator to bottom of Retract and Erecting cylinder to cushion the retraction and to prevent venting thru the pressure relief valve during mast erection.	Freeze open (leakage)	None Leakage thru the check valve will result in slower erection of the lox mast.	None	
Pressure Relief Valve G-I-06-12	*	10426704 (7220)		Vent excessive pressure being applied to the bottom of the Retract and Erecting Cylinder.			None	

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FAILURE EFFECT ANALYSIS
LOX FILL & DRAIN MAST SUBSYSTEM
G-I-06

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Orifice G-I-06-06	*	10426711 (7213)		Control the rate of erecting the LOX mast.	Clog	Possible loss of Subsystem Prevent venting of the pressure on the Retract and Erecting Cylinder will allow shock loading of the mast during erection and retraction.	None Malfunction determined prior to countdown.	
Erecting Button Vent Valve G-I-06-07	*	10425920 (7214)		Allows venting top of Retract and Erecting Cylinder to facilitate erecting the mast.	Freeze open	Possible loss of Subsystem Prevent preloading of Retract & Erecting Cylinder and allow shock loading of mast upon erection command.	None Malfunction determined prior to countdown.	
					Freeze closed	Possible loss of Subsystem Prevent venting of preload pressure on the Retract and Erecting Cylinder thus preventing the erection of the mast.	None Malfunction determined prior to countdown.	
Erecting Pressure Button Valve G-I-06-08	*	10425920 (7216)		Allows pressurizing bottom of Retract & Erecting Cylinder to facilitate erecting of the mast.	Freeze open (leakage)	Possible loss of Subsystem Prevent retraction of the mast by maintaining of pressure on the bottom of Retract & Erecting Cylinder.	None If the mast fails to retract upon command, it will be forced to retract by impact with the missile at lift-off.	
					Freeze closed	Possible loss of Subsystem Prevent erecting of the mast by not allowing pneumatic pressure to be applied to the Retract & Erecting Cylinder.	None Malfunction determined prior to countdown.	
Retract Coupling Check Valve G-I-06-09	*	10426693 (7217)		Allows venting of retract coupling air cylinder and prevents pressurizing during mast retract.	Freeze open (Leakage)	Possible loss of Subsystem Leakage past the check valve will allow compression of the retract coupling resulting in leakage of LOX.	A. Delay in countdown	
						Issue Date: Jan 31, 1962	Prepared by: M-ICD-DQ	Approval: /S/LJO

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FAILURE EFFECT ANALYSIS
LOX FILL & DRAIN MAST SUBSYSTEM
G-I-06

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Retractable Coupling Assembly G-I-06-01	*	(7200)		Provide a positive seal between the coupling and the filling nozzle.	Leakage	Loss of Subsystem Improper sealing will result in leakage of LOX on launch pedestal.	A. Delay in launching.	
Retractable Coupling Air Cylinder G-I-06-02	*	(7201) (7202)		Compress retractable coupling assembly when mast is erected or manually retracted using valve box controls.	Leakage	Possible loss of Subsystem When leakage is of sufficient capacity to prevent compression of retractable coupling assembly misalignment of coupling will result.	None Malfunction determined prior to countdown.	
Retracting & Erecting Cylinder G-I-06-03	*	10426689 (7203)		Connect and disconnect the mast to the vehicle by application of pneumatic pressure.	Leakage	Possible loss of Subsystem When leakage is of sufficient capacity to prevent pressure buildup, the mast will not react upon command.	None If the mast fails to retract upon command, it will be forced to retract by impact with the vehicle at lift-off.	
Mast Retract Button Valve G-I-06-04	*	10426701 (7211)		Depress retract coupling and preload retracting and erecting cylinder	Freeze open (leakage)	Loss of Subsystem Depress retract coupling and allow leakage of LOX.	A. Delay in launching.	
					Freeze closed Prior to connection with vehicle.	Possible loss of Subsystem Would prevent erection of mast and connection to vehicle.	A. Delay in launching.	
					Freeze closed After connection to vehicle.	None Once connection to vehicle is accomplished, valve is not required to open again.	None	
Retract and Erecting Cylinder Preload Check Valve G-I-06-05	*	10426693 (7212)		Allow preloading of retract and erecting cylinder and preventing venting during coupling vent.	Freeze open or closed	Possible loss of Subsystem Preventing preloading of Retract & Erecting Cylinder will allow shock loading of the mast during erection and retraction.	None Malfunction determined prior to countdown.	

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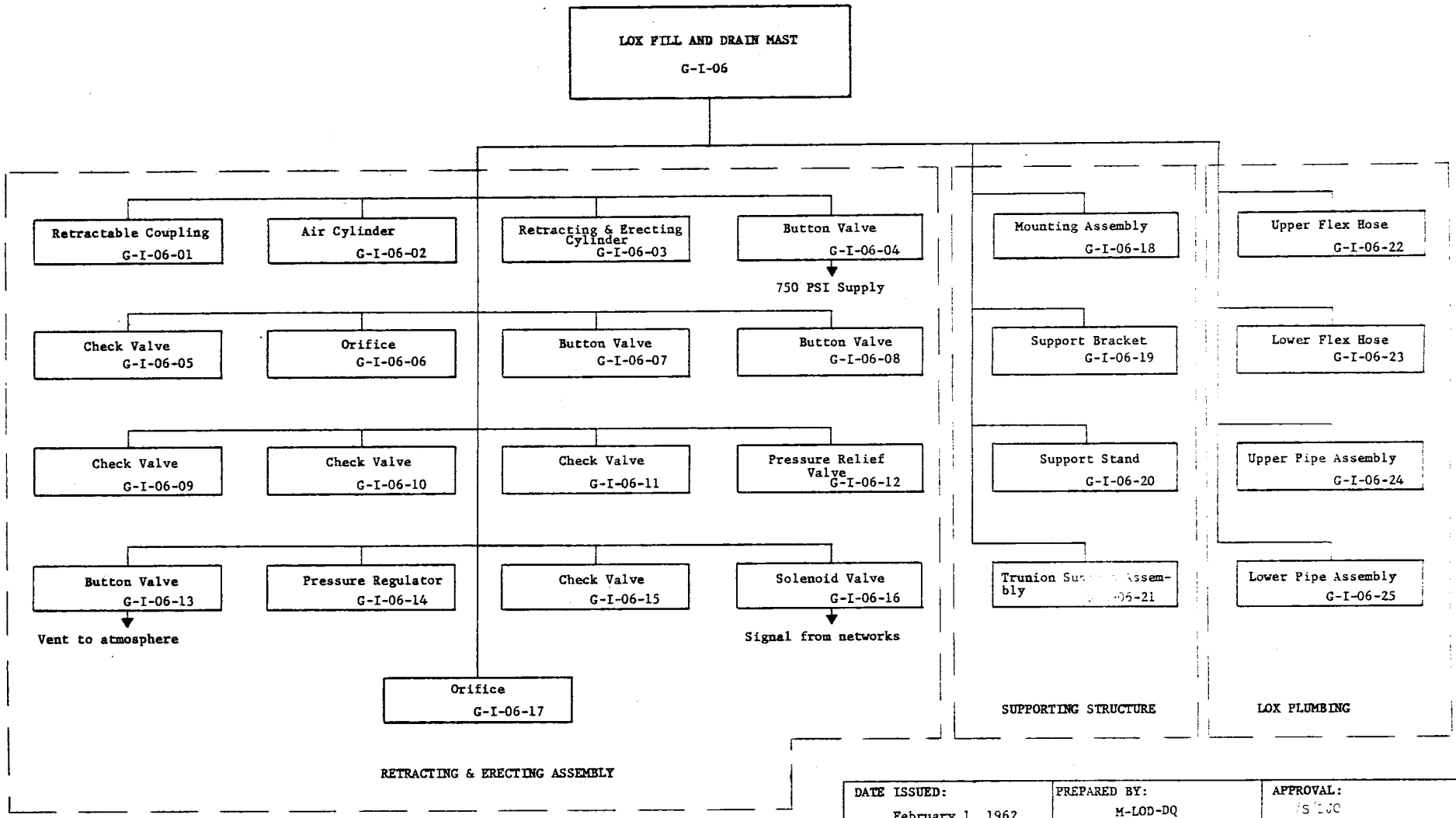
FAILURE EFFECT ANALYSIS



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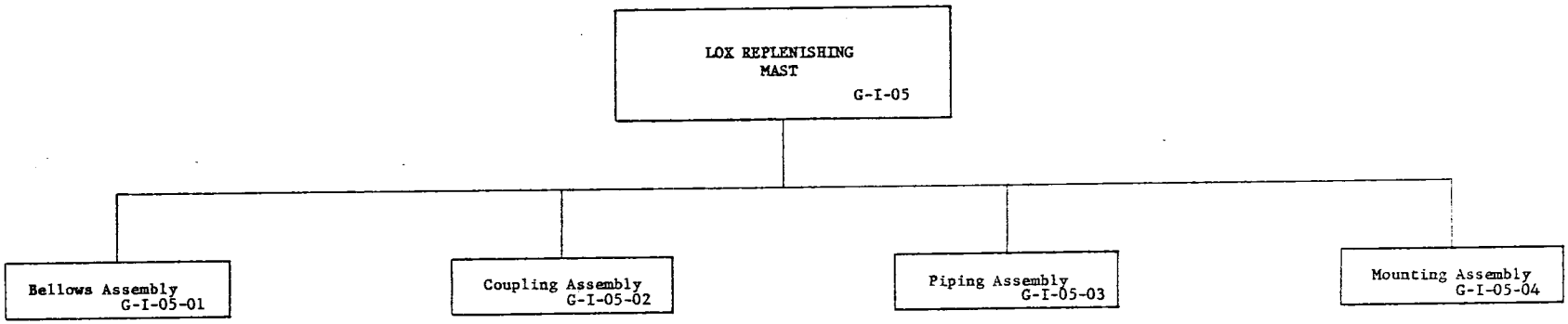
FAILURE EFFECT ANALYSIS

THE ANALYSIS FOR G-I-05-01 THRU G-I-05-04
IS NOT AVAILABLE

FAILURE EFFECT ANALYSIS



Issue Date: Feb 1, 1962	Prepared by: M-LOD-DQ	Approval: /S/LJC

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
UMBILICAL SWING ARM # 1 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Pressure Switch G-I-04-02-30	*			To indicate that sufficient pressure is available in the pneumatic accumulator	Indicate erroneously that insufficient pressure is available	A. Delay in countdown B. Delay in countdown	A. Delay in countdown B. Delay in countdown	A. Delay in countdown B. Delay in countdown
Regulator G-I-04-02-31	*			To maintain constant pressure in pneumatic accumulator	Leak	C. Loss	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Hand Valve G-I-04-02-32	*			To close off 3000 psi pneumatic supply line	Leak	C. Loss	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Pressure Switch G-I-04-02-33	*			To indicate that 750 psi pneumatic pressure is available to actuate the ball valves	Fail to indicate the pressure has dropped	C. Loss System failure would not be detected	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
					Indicate erroneously that insufficient pressure is available	A. Delay in countdown	A. Delay in countdown	A. Delay in countdown

Issue Date: Jan 31, 1962 | Prepared by: M-LCD-D2 | Approval: /S/LJC

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
UMBILICAL SWING ARM # 1 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Swing Arm Control Switch G-I-04-02-22	*			To actuate solenoid	Fail to open	C. Loss	C. Possible Loss Could cause structural damage to vehicle	C. Probable Loss
					Prematurely open	A. Loss B. Loss	A. Possible Loss B. Possible Loss Could cause loss of services to vehicle	A. Possible Loss B. Possible Loss
Hydraulic Accumulator G-1-04-02-23	*			Convert 3000 psi pneumatic pressure to 3000 psi hyd pressure	Leak	C. Possible Loss Could cause loss of hydraulic fluid	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Indicator Switch G-I-04-02-24	*			Indicates when accumulator is full of hydraulic fluid	Read full erroneously	C. Probable loss of subsystem	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
					Fail to read full when hydraulic system is full	None	None	None
Check Valve G-1-04-02-25	*			Prevent loss of hydraulic fluid through fill line	Leak	C. Possible Loss	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Filter G-I-04-02-26	*			To filter hydraulic fluid entering system	Possible contamination	C. Possible Loss of subsystem	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
					Clog up	None	None	None
Hand Valve G-I-04-02-27	*			To allow hydraulic system fill	Leak	C. Possible Loss Could cause loss of hydraulic fluid	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Gas Accumulator G-I-04-02-28	*			To allow pneumatic reservoir	Leak	C. Loss	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Gauge G-I-04-02-29	*			To indicate pneumatic pressure in gas accumulator	Fail to give correct reading	C. Possible Loss Could result in insufficient pressure to operate subsystem	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Pressure Switch G-I-04-02-30	*			To indicate that sufficient pressure is available in the pneumatic accumulator	Fail to indicate that pressure has dropped	C. Possible Loss Could result in insufficient pressure to operate subsystem	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss

Issue Date: Jan 31, 1962 Prepared by: A-LCD-DA Approval: /S/LJC

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
UMBILICAL SWING ARM #1 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Hand Valve G-I-04-02-16	*			Directs pressure for manual control	Leak	A. Possible Loss B. Possible Loss C. Possible Loss	A. Possible Loss B. Possible Loss C. Possible Loss	A. Possible Loss B. Possible Loss C. Possible Loss
Ball Valve G-I-04-02-17	*			To apply pressure to hydro pneumatic cylinder which disconnects quick release housing and to apply pressure to rotary hyd. cylinder	Fail to open on signal	C. Loss	C. Probable Loss Could cause structural damage to vehicle	C. Probable Loss Could cause structural damage to vehicle
					Prematurely open	A. Loss B. Loss	A. Possible Loss B. Possible Loss Could cause loss of services to vehicle	A. Possible Loss B. Possible Loss Could cause loss of services to vehicle
Swing Arm Locking Pin Assembly G-I-04-02-18	*			To lock swing arm in position prior to swinging	Prematurely unlock	A. Possible Loss B. Possible Loss	A. Possible Loss B. Possible Loss Could cause loss of services to vehicle	A. Possible Loss B. Possible Loss Could cause loss of services to vehicle
					Failure to unlock	C. Loss	C. Probable Loss Could cause damage to vehicle structure	C. Probable Loss
Check Valve G-I-04-02-19	*			To keep air out of the hydraulic system	Leak (getting air into system)	C. Possible Loss	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Ball Valve G-I-04-02-20	*			Releases Hyd pressure to lock pin, hydro-pneumatic cylinder and rotary hydraulic actuator	Fail to open	C. Loss	C. Possible Loss Could cause structural damage to vehicle	C. Probable Loss
					Prematurely open	A. Loss B. Loss	A. Possible Loss B. Possible Loss Could cause loss of services to vehicle	A. Possible Loss B. Possible Loss
Solenoid Valve G-I-04-02-21	*			Actuates the ball valve	Fail to open	C. Loss	C. Possible Loss Could cause structural damage to vehicle	C. Probable Loss
					Prematurely open	A. Loss B. Loss	A. Possible Loss B. Possible Loss Could cause loss of services to vehicle	A. Possible Loss B. Possible Loss

Issue Date: Jan 31, 1962 Prepared by: M-ICD-D4 Approval: /S/ICC

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
UMBILICAL SWING ARM #1 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Check Valve G-I-04-02-08	*			Direct flow to rotary hydraulic cylinder	Leak, therefore, draining rotary hydraulic actuator	C. Possible Loss	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Cam Operated Valve G-I-04-02-09	*			Breaks swing arm motion at end of swing	Premature closing	C. Possible Loss Could keep the swing arm from retracting	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
					Fail to close	C. Possible Loss Could cause structural damage to swing arm	C. None	C. None
Check Valve G-I-04-02-10	*			Restrict back flow from return line	Leakage	C. Possible Loss of Subsystem Allow contamination of rotary hydraulic cylinder	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Ball Valve G-I-04-02-11	*			Close return line for manual operation	Fail to close	None	None	None
					Close when should be open	C. Loss Would keep swing arm from retracting	C. Probable Loss Could cause structural damage to vehicle	C. Probable Loss
Check Valve G-I-04-02-12	*			Restrict back flow from return line	Leakage	C. Possible Loss Could impair operation subsystem by allowing contamination of ball valve	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Four-way Manual Valve G-I-04-02-13	*			To allow manual adjustment of swing arm	Leak	C. Possible Loss Could impair operation of subsystem by draining off hydraulic fluid	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
					Fail to operate, therefore, manual system inoperative	None	None	None
Orifice Bleed G-I-04-02-14	*			To facilitate manual operation	Fail to bleed	None	None	None
Push Button Valve G-I-04-02-15	*			To facilitate manual operation	Leak or failure to close	None	None	None

Issue Date: Jan 31, 1962 Prepared by: [illegible] Approval: /S/[illegible]

**Items marked thus (*) do not operate in flight

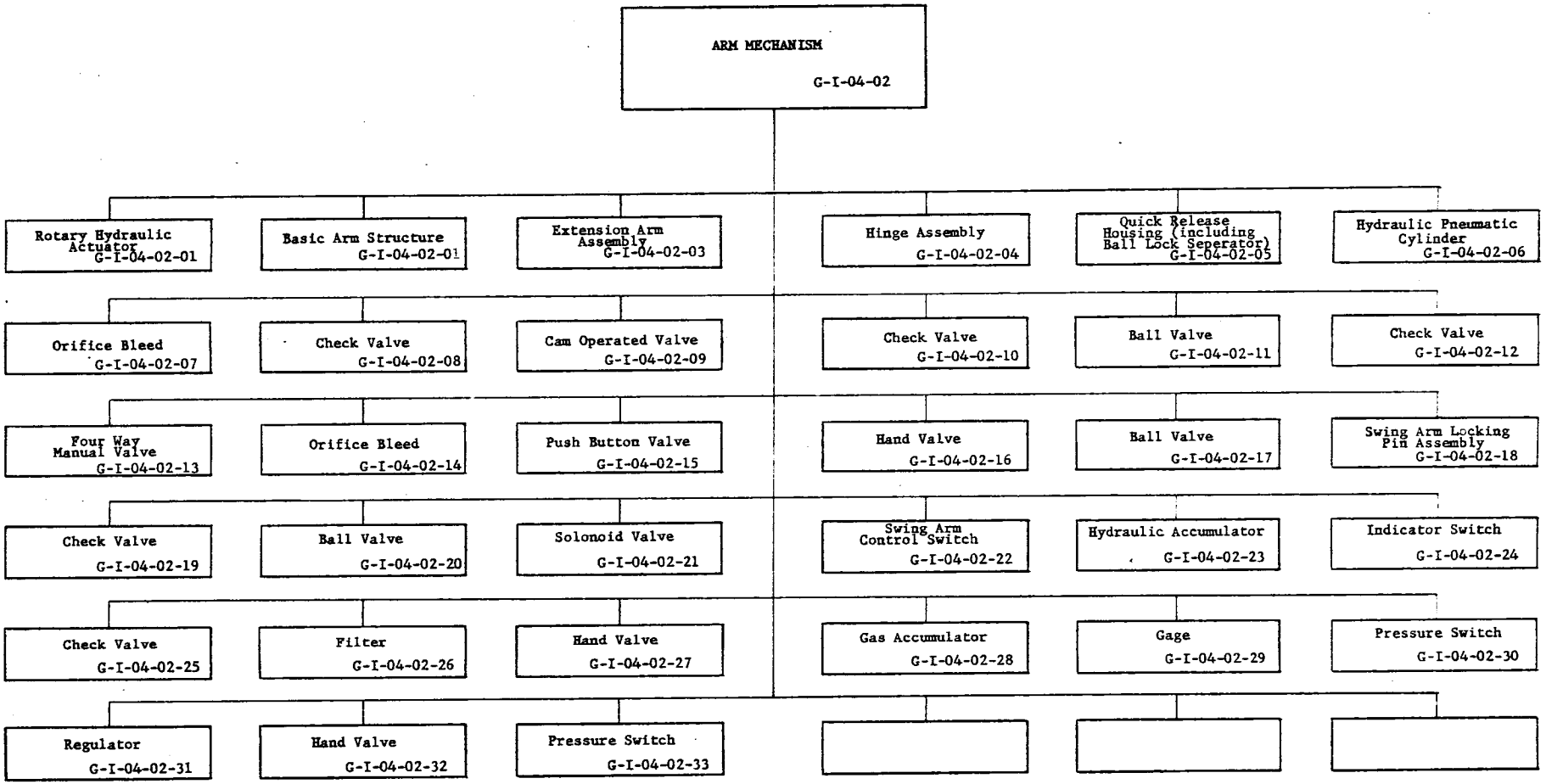
FAILURE EFFECT ANALYSIS
UMBILICAL SWING ARM #1 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Rotary Hydraulic Actuator G-I-04-02-01	*	B 10428419		Rotates swing arm to clear vehicle at liftoff	Fail to operate at lift-off	C. Loss	C. Probable Loss Could cause structural damage to vehicle	C. Probable loss
					Slow reaction due to hydraulic leakage	C. Possible Loss	C. Possible Loss Could cause structural damage to vehicle	C. Possible Loss
Basic Arm Structure G-I-04-02-02	*	10427276		To support service lines to vehicle	Structural Collapse	A. Loss B. Loss C. Loss	A. Possible Loss B. Possible Loss C. Possible Loss Could cause loss of services to vehicle	A. Possible Loss B. Possible Loss C. Possible Loss
Extension Arm Assembly G-I-04-02-03	*			To support service lines to vehicle	Structural Collapse	A. Loss B. Loss C. Loss	A. Possible Loss B. Possible Loss C. Possible Loss Could cause loss of services to vehicle	A. Possible Loss B. Possible Loss C. Possible Loss
Hinge Assembly G-I-04-02-04	*	J 10428380		Connects swing arm to umbilical tower and provides rotating axis for swing arm	Structural Collapse	A. Loss B. Loss C. Loss	A. Possible Loss B. Possible Loss C. Possible Loss Could cause loss of services to vehicle	A. Possible Loss B. Possible Loss C. Possible Loss
					Fail to allow the arm to rotate	C. Loss	C. Probable Loss Could cause damage to vehicle structure	C. Probable Loss
Quick Release Housing (Including Ball-Lock Separator) G-I-04-02-05	*			Disconnect service lines to S-I stage	Prematurely release	A. Loss B. Loss	A. Possible Loss B. Possible Loss Could cause loss of Services to vehicle	A. Possible Loss B. Possible Loss
					Fail to release	C. Loss	C. Possible Loss Could cause damage to vehicle structure	C. Possible Loss
Hydraulic - Pneumatic Cylinder G-I-04-02-06	*			Actuate quick release housing	Fail to function	C. Loss	C. Possible Loss Could cause damage to vehicle structure	C. Possible Loss
Orifice Bleed G-I-04-02-07	*			To bleed pneumatic side of hydro-pneu cylinder	Will not bleed pneumatic side of piston	C. Loss	C. Possible Loss Could cause damage to vehicle structure	C. Possible Loss

Issue Date: Jan 31, 1962 Prepared by: M-LOD-DQ Approval: /S/LOC

FAILURE EFFECT ANALYSIS



Issue Date: Feb 1, 1962	Prepared by: M-LOD-DQ	Approval: /S/LJO

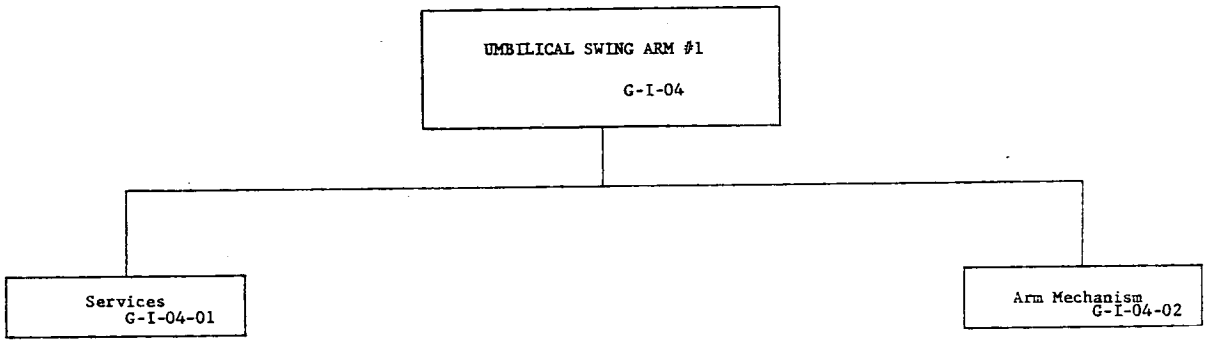
S&M Form #203-1 (August 1961)(OT)

FAILURE EFFECT ANALYSIS

ANALYSIS AND DIAGRAM NOT AVAILABLE

FOR G-I-04-01

FAILURE EFFECT ANALYSIS

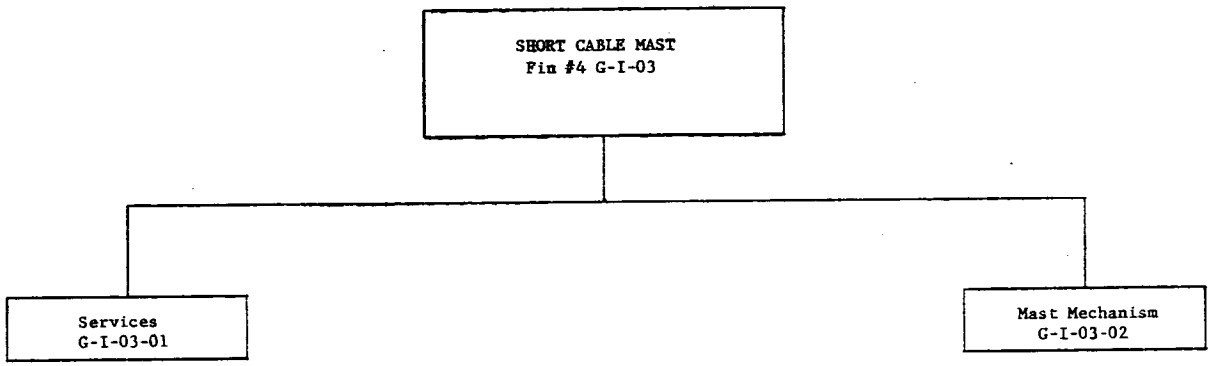


Issue Date: Feb 1, 1962	Prepared by: M-LOD-DQ	Approved: /S/LOC

FAILURE EFFECT ANALYSIS

ANALYSES AND DIAGRAMS ARE NOT AVAILABLE FOR G-1-13

FAILURE EFFECT ANALYSIS

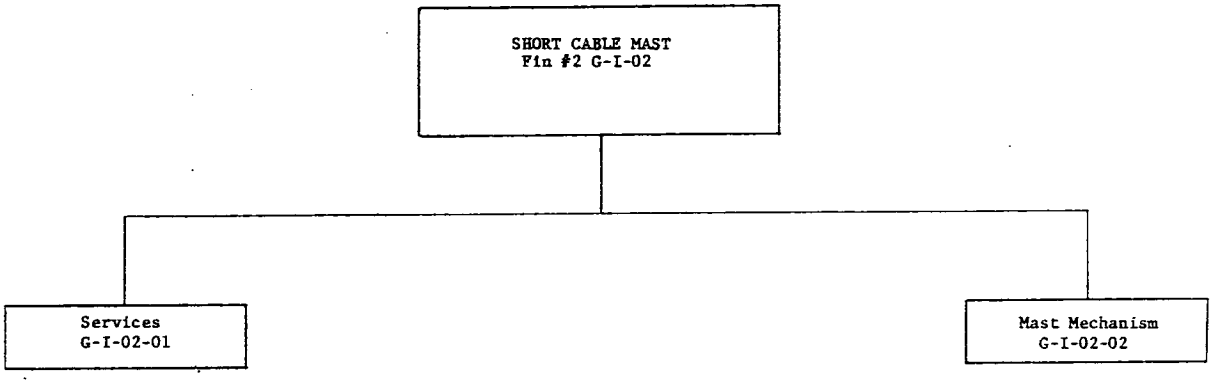


Issue Date: Feb 1, 1962	Prepared by: M-LOD-DQ	Approval: /S/LJC

FAILURE EFFECT ANALYSIS

ANALYSIS AND DIAGRAMS ARE NOT AVAILABLE FOR G-I-02

FAILURE EFFECT ANALYSIS



Issue Date: Jan 31, 1962	Prepared by: M-ICD-D2	Approval: /S/LJC

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
HOLD DOWN ARMS 1 - 8 SUBSYSTEM
G-I-01

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Structural Base Assembly G-I-01-12	*	75M-01825		To serve as a structural member which transmits the force of retaining the vehicle from the launch pedestal to the lower arm section.	Structure failure	Loss of Sub-system Structural failure will result in premature release of hold down arms.	A. Delay in Countdown B. Possible loss Uneven loading by remaining hold down arms may cause missile to tip over or cause excessive drift by vehicle at lift-off.	
						Issue Date: Jan 31, 1962	Prepared by: M-LOD-DQ	Approval: /S/LJO

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
HOLD DOWN ARMS 1 - 8 SUBSYSTEM
G-I-01

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Hand Valve G-I-01-08	*			To allow pneumatic isolation of hold down arms from high pressure source.	Leakage	None Redundant as solenoid valve will also isolate the hold down arms from the high pressure source.	None	
					Erroneously left closed	Loss of Subsystem Sufficient GN_2 at high pressure will not be available to affect release of hold down arms	Loss Possible Vehicle will be held down by arms that fail to release.	
Upper Arm Assembly G-I-01-09	*	75M-01821		To serve as a structural member which transmits the force of holding down the vehicle from the vehicle to the center arm assembly	Structurally fail	Loss of Subsystem Structural failure will result in premature release of hold down arms.	A. Delay in Countdown B. Possible loss Uneven loading by remaining hold down arms may cause missile to tip over or cause excessive drift of vehicle at lift-off.	
Lower Arm Assembly G-I-01-10	*	75M-01823		To serve as a structural member which transmits the force of retaining the vehicle from the center arm section to the base assembly.	Structural failure	Loss of Subsystem Structural failure will result in premature release of hold down arms.	A Delay in Countdown B. Possible loss Uneven loading by remaining hold down arms may cause missile to tip over or cause excessive drift by vehicle at lift-off	
Center Arm Assembly G-I-01-11	*	75M-01824		To serve as a structural member which transmits the force of retaining the vehicle from the upper arm assembly to the lower arm assembly.	Structural failure	Loss of Subsystem Structural failure will result in premature release of hold down arms.	A. Delay in Countdown B. Possible loss Uneven loading by remaining hold down arms may cause missile to tip over or cause excessive drift by vehicle at lift-off	
						Issue Date: Jan 31, 1962	Prepared by: M-LCD-DC	Approval: /S/LJO

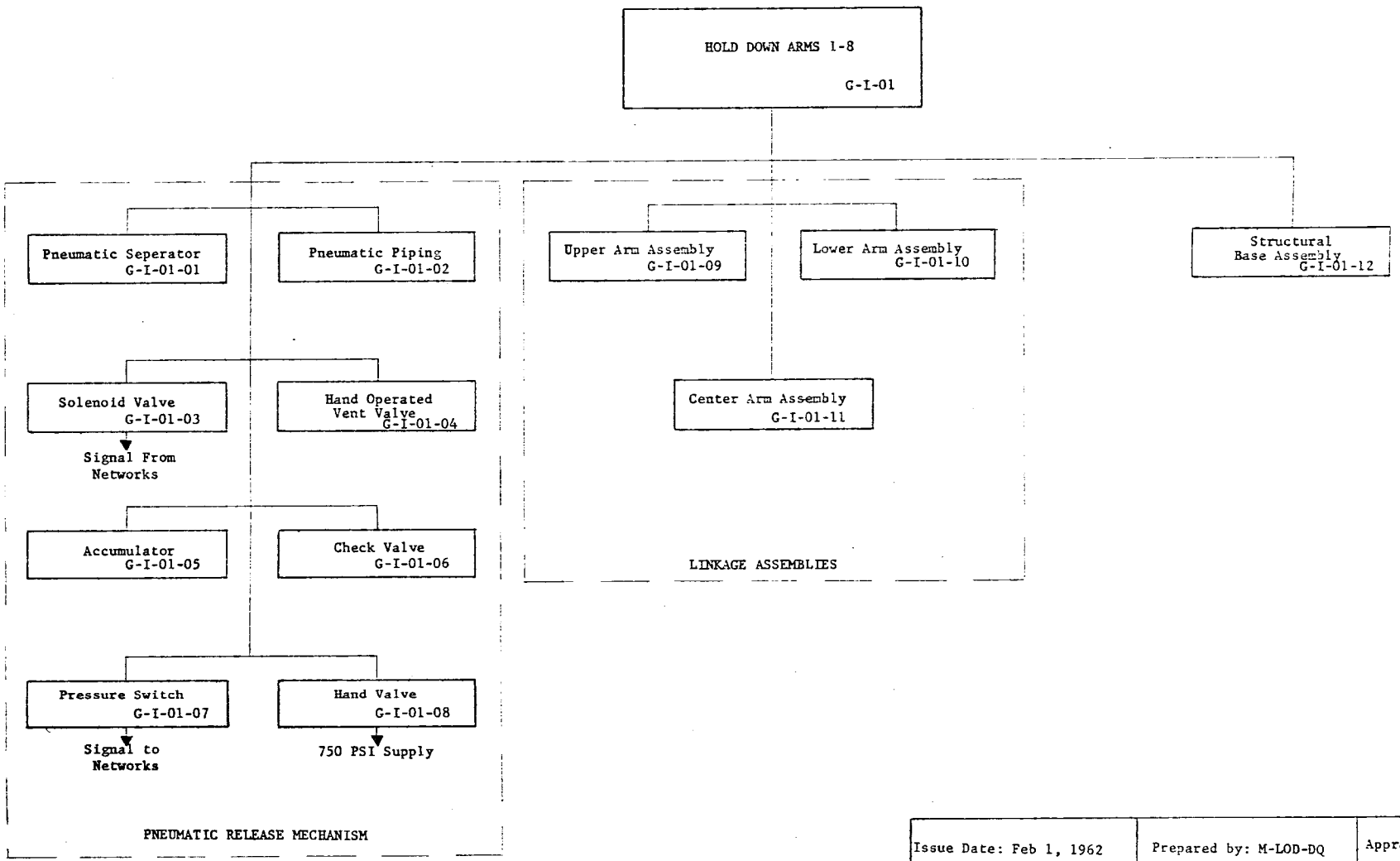
**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
HOLD DOWN ARMS 1 - 8 SUBSYSTEM
G-I-01

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Pneumatic Separator G-I-01-01	*	75M-01839		Release mechanism in releasing the missile from the launch pad.	Failure to release	Loss of Subsystem Hold down arm will not release vehicle.	B. Possible loss Vehicle hold down by arms that fail to release.	
					Premature release	Loss of Subsystem Hold down arm will release vehicle prematurely	A. None Delay in countdown. B. Probable loss Vehicle will not be held by arms that release.	
Pneumatic Piping Assembly G-I-01-02	*	75M-01863		Transmit pneumatic pressure from valve to pneumatic separator.	Rupture	Loss of Subsystem Hold down arm will not release.	B. Possible loss Vehicle hold down by arms that fail to release.	
Solenoid Operated Valve G-I-01-03	*			Opens pneumatically to application of electrical power to valve solenoid to allow pneumatic pressure to affect release of separator.	Failure to Open	Loss of Subsystem Hold down arms will not release the vehicle.	B. Possible loss Vehicle hold down by arms that fail to release.	
Hand Operated Vent Valve G-I-01-04	*			Provides vent for pneumatic pressure during manual operation.	Erroneously left open	Possible loss of Subsystem Release of hold down arms will be greatly retarded.	B. Possible loss Vehicle hold down by arms that fail to release.	
Accumulator G-I-01-05	*			To store 750 psi GN_2 to actuate pneumatic separator.	Rupture	Probable loss of Subsystem Hold down arms will not release if leakage is of sufficient capacity to cause loss of pressure.	A. Delay in Countdown Loss of pressure will be noted by indication from pressure switch. B. Possible loss Vehicle hold down by arms that fail to release.	
Pressure Switch G-I-01-07	*			To indicate automatic countdown circuits that sufficient pressure available to actuate the release of the hold down arms.	Fail to actuate	Loss of Subsystem Leak of pressure or faulty indication of switch will stop countdown.	A. Delay in Countdown Countdown held until discrepancy resolved.	
						Issue Date: Jan 31, 1962	Prepared by: M-LOD-DQ	Approval: /S/LJC

FAILURE EFFECT ANALYSIS



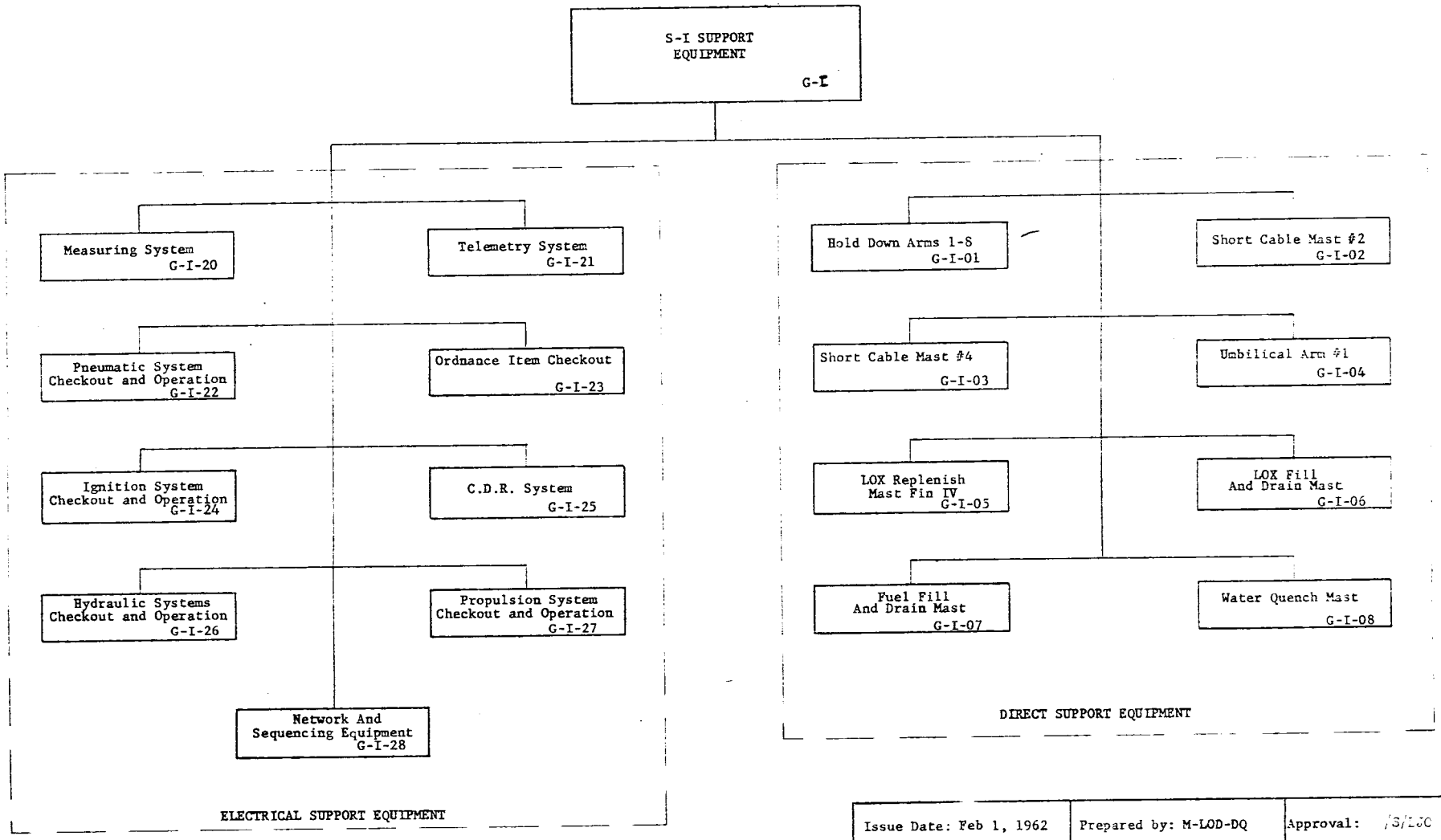
Issue Date: Feb 1, 1962	Prepared by: M-LOD-DQ	Approval:

FAILURE EFFECT ANALYSIS

ANALYSES AND DIAGRAMS ARE NOT AVAILABLE

FOR G-I-20 THRU G-I-28

FAILURE EFFECT ANALYSIS

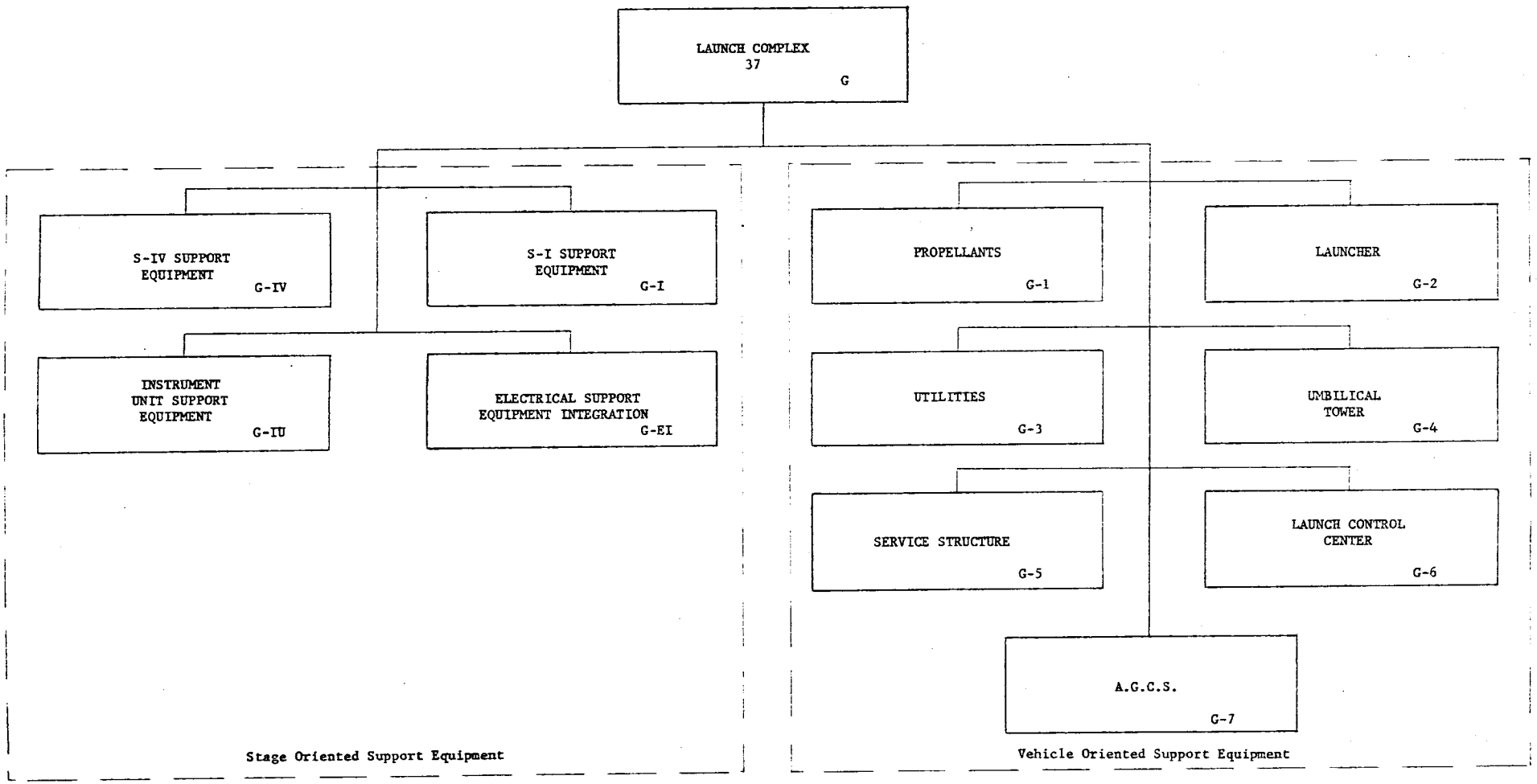


Issue Date: Feb 1, 1962	Prepared by: M-LOD-DQ	Approval: /S/LOC

S&M Form #203-1 (August 1961)(OT)

LAUNCH COMPLEX

FAILURE EFFECT ANALYSIS



Issue Date: Jan 31, 1962	Prepared by: M-LOD-DQ	Approval:

S&M Form #203-1 (August 1961)(OT)

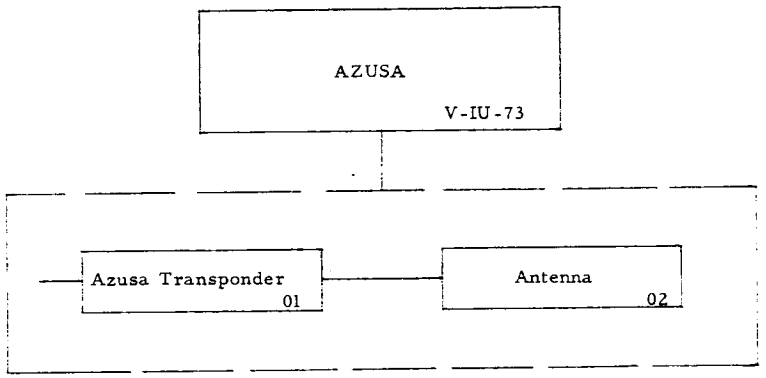
PAYLOAD

NOTE: This section is to be supplied by MSC if Apollo Boiler Plate Capsule is used on SA-5.

FAILURE EFFECT ANALYSIS

AZUSA V-IU-73 ANALYSIS NOT AVAILABLE

FAILURE EFFECT ANALYSIS

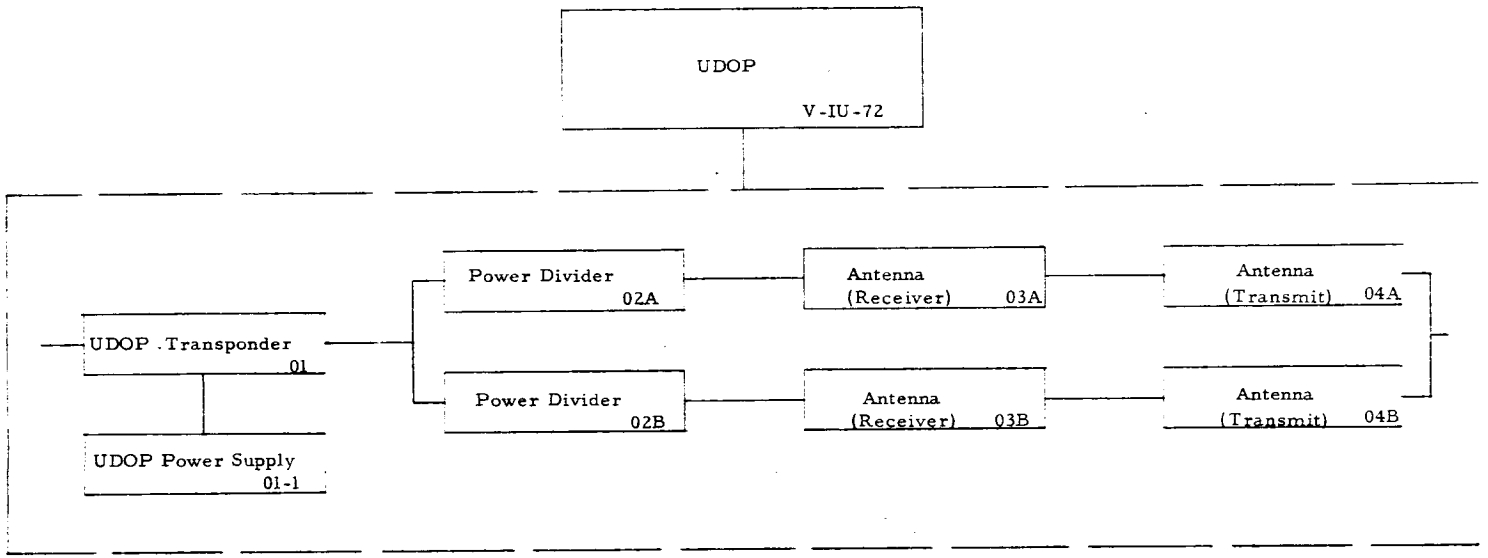


Issue Date: 1 Feb 62	Prepared by: M-ASTR-TSJ	Approval:

FAILURE EFFECT ANALYSIS

UDCP V-IU-72 ANALYSIS NOT AVAILABLE

FAILURE EFFECT ANALYSIS

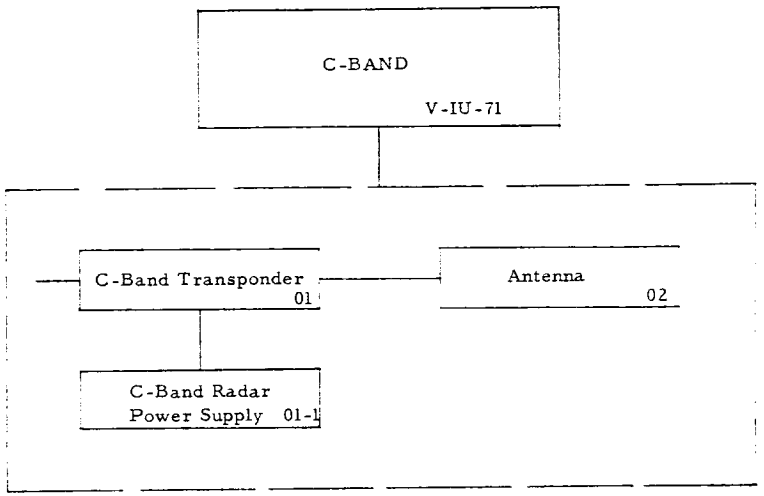


Issue Date: 1 Feb, 62	Prepared by: M-ASTER-TSJ	Approval:

FAILURE EFFECT ANALYSIS

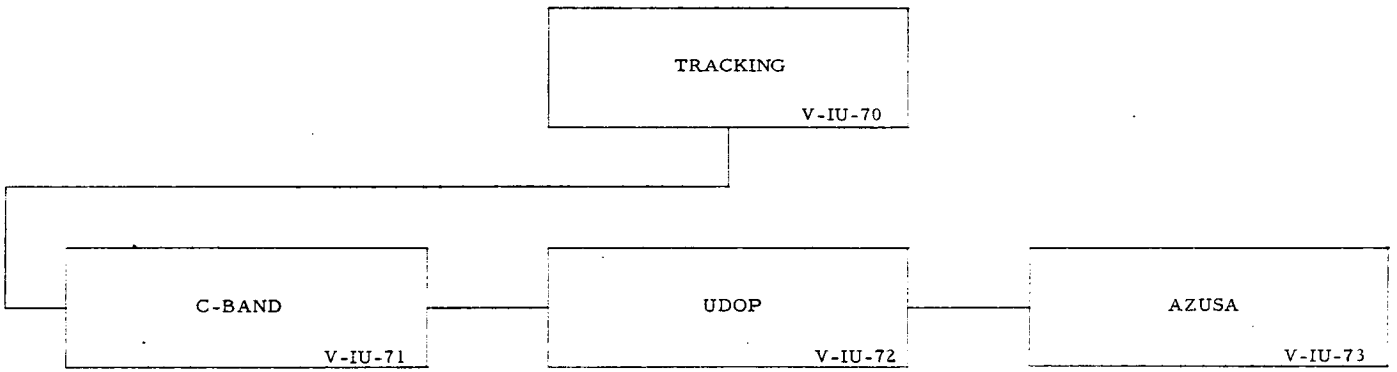
C-BAND V-IU-71 ANALYSIS NOT AVAILABLE

FAILURE EFFECT ANALYSIS



Issue Date: 1 Feb, 62	Prepared by: M-ASTR-TSJ	Approval:

FAILURE EFFECT ANALYSIS

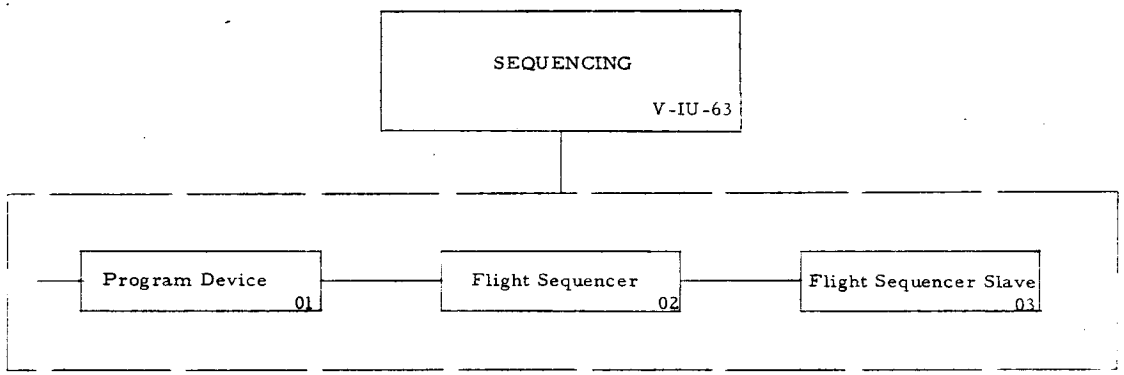


Issue Date: Jan 23, 62	Prepared By: M-ASTR-TSJ	Approval:

FAILURE EFFECT ANALYSIS

SEQUENCING V-IV-63 ANALYSIS NOT AVAILABLE

FAILURE EFFECT ANALYSIS

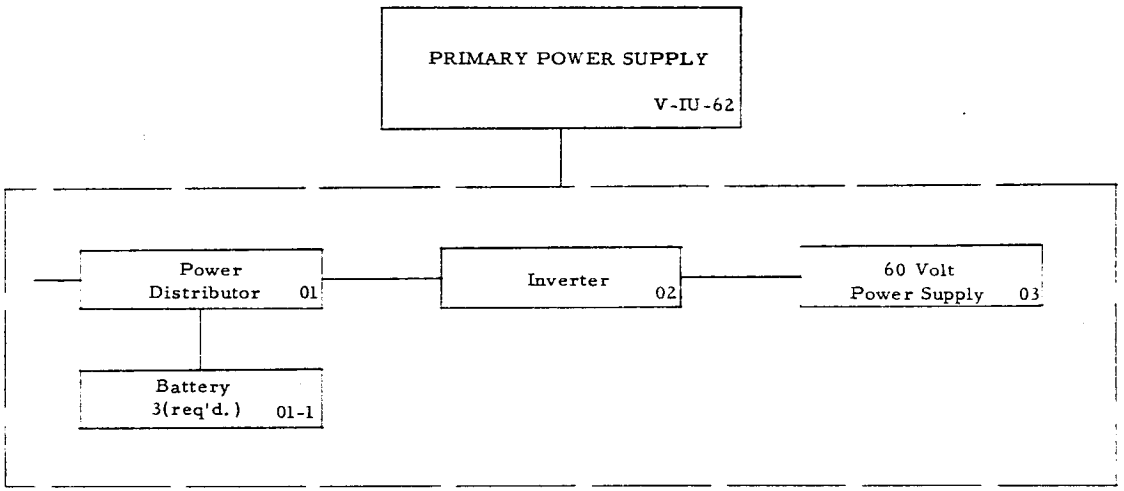


Issue Date: 1 Feb, 62	Prepared by: M-ASTR-TSJ	Approval:

FAILURE EFFECT ANALYSIS

PRIMARY POWER SUPPLY V-IU-62 ANALYSIS NOT AVAILABLE

FAILURE EFFECT ANALYSIS



Issue Date: 1 Feb, 62	Prepared by: M-ASTR-TSJ	Approval:

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
DISTRIBUTION SUBSYSTEM
V-IU-61

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Control Distributor V-IU-61-02		50M01070	802A1	Distributes power and signals among the following components: 60 volt power supply, flight sequencer, program device, control computer, payload, GSE, S-I stage, S-IV stage, power distributor, and measuring distributor.	1) Open or short circuit in wiring or relay failure.	Failure of circuitry associated with any component has the same effect as failure of the component. See individual components.	See individual components	See individual components.
Subsystem Wiring V-IU-61-01		N/A	N/A	Interconnects all electrical components in the instrument unit.	1) Open or short circuit	Failure of the wiring to any component has the same effect as failure of the component.	See individual components	See individual components.
						Issue Date: Jan. 15, 1962	Prepared by: M-ASTR-EA	Approval:

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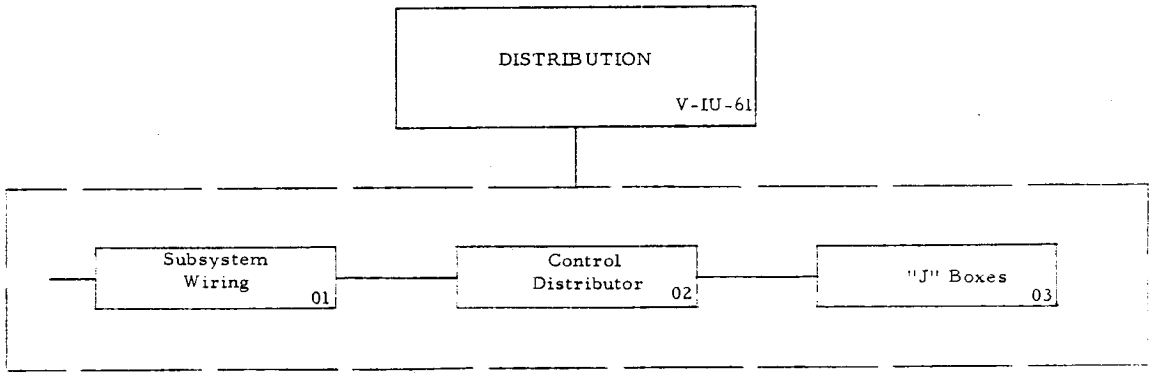
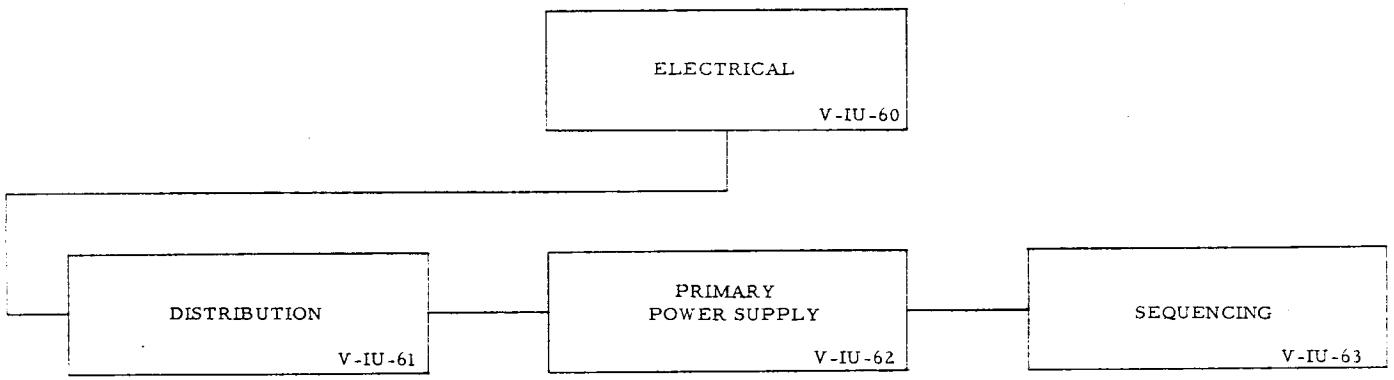
FAILURE EFFECT ANALYSIS



Issue Date: 1 Feb. 62	Prepared by: M-ASTR-TSJ	Approval:

FAILURE EFFECT ANALYSIS



Issue Date: 1 Feb, 62	Prepared by: M-ASTR-TSJ	Approval:

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
CONTROL COMPUTER SUBSYSTEM
V-IU-55

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Control Computer V-IU-55		50M30801	802A7	Receives control signals from ST-90S, control rate gyros and control accelerometers. Sums and shapes these signals, amplifies them and provides d.c. outputs to drive the control actuators. The computer's functions are related to flight time of the vehicle and is divided into S-1 stage powered flight (up to S-1/S-IV stage separation) and S-IV stage powered flight (up to S-IV/payload separation).	1) Loss of filter	POSSIBLE LOSS Dynamic gain incorrect	N/A	(A) Reschedule (B) Same as (A) (C) POSSIBLE LOSS System response improper.
					2) Loss of lead network	POSSIBLE LOSS Dynamic gain incorrect	N/A	(A) Reschedule (B) Same as (A) (C) POSSIBLE LOSS System gain improper
					3) Loss of control attenuator timer	POSSIBLE LOSS Attitude and angle of attack gains incorrect. Angle of attack gain program will not come in.	N/A	(A) Reschedule (B) None; not operational during this time. (C) POSSIBLE LOSS May loose attitude control.
					4) Loss of servo amplifier	POSSIBLE LOSS Some attitude and sensor signals will not pass to actuator package.	N/A	(A) Reschedule (B) Same as (A) (C) POSSIBLE LOSS Actuators driven by respective servo amplifier will be inoperative for control.
					5) Open or short circuit in computer internal wiring harness.	LOSS Due to loss of attitude information.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of control.
						Issue Date: 5 Feb, 62	Prepared by: M-ASTR-NA	Approval: [illegible]

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FAILURE EFFECT ANALYSIS

GUIDANCE SIGNAL PROCESSOR V-IU-54 ANALYSIS NOT AVAILABLE

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
ST 90S SERVO LOOP AMPLIFIER FOR SUBSYSTEM
V-IU-53

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-53 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Power Supply Relay 115 volts, 400 cps. V-IU-53-07			N/A	This relay is controlled from the stabilizer control panel in the blockhouse and is used to actuate the system. The relay is d.c. controlled and is locked in through the main distributor at power transfer.	1) Open or short circuit of control winding, loss of d.c. control voltage.	LOSS Loss of the ST-90S stabilized platform.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of attitude control.
Power Supply Relay, 28 vdc V-IU-53-08			N/A	This relay is controlled from the stabilizer control panel in the blockhouse and is used to actuate the system. The relay is d.c. controlled and is locked in through the main distributor at power transfer.	1) Open or short circuit of control winding. Loss of d.c. control voltage.	LOSS Loss of the ST-90S stabilized platform.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of attitude control.
						Issue Date: 1 Feb, 62	Prepared by: M-ASTR-G	Approval:

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FAILURE EFFECT ANALYSIS

ST 90S SERVO LOOP AMPLIFIER BOX SUBSYSTEM

V-IU-53

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-53 (contd'.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Command Voltage Demodulator (Pitch, Yaw and Roll) V-IU-53-03			N/A	Accepts an a.c. signal from the ST-90S attitude sensors which is a voltage analogue of vehicle angular deviation from the space fixed navigation coordinate system. This signal is amplified, demodulated and transmitted to the control computer to be used for attitude control of the vehicle.	1) Loss of input signal or a component failure within the C. V. D. M.	LOSS The servo loop amplifier looses the ability to control the attitude of the vehicle.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of attitude control.
Pitch Program Transmission V-IU-53-04			N/A	Accepts a voltage analogue of the predetermined pitch program (time vs angle). The pitch program transmission then unbalances the ST-90S pitch attitude sensor along the time vs angle pitch program which in turn causes the vehicle to fly along the predetermined pitch path.	1) Electrical or mechanical failure	LOSS The servo loop amplifier looses the ability to program the vehicle in pitch.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of pitch program the vehicle would fly vertically until burnout or destruction.
Transformer Gyro Power Supply V-IU-53-05			N/A	Supplies 26 volts 400 cps power to the gyro and accelerometer motor windings	1) Loss of voltage or frequency control of the primiary 400 cps power supply, loss of the power supply, open or short circuit in the transformer.	LOSS Loss of the inertially space fixed navigation coordinate system.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of attitude control.
Transformer Pendulum Excitation V-IU-53-06	*		N/A	Supplies 4 volts 400 cps excitation to the air bearing pendulums.	1). Loss of power supply, short or open circuit.	Loss of the ST-90S ability to remain earth fixed until liftoff.	N/A	(A) Delay or Reschedule (B) Not operating during this time. (C) Same as (B)
						Issue Date: 1 Feb, 62	Prepared by: M-ASTR-G	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS

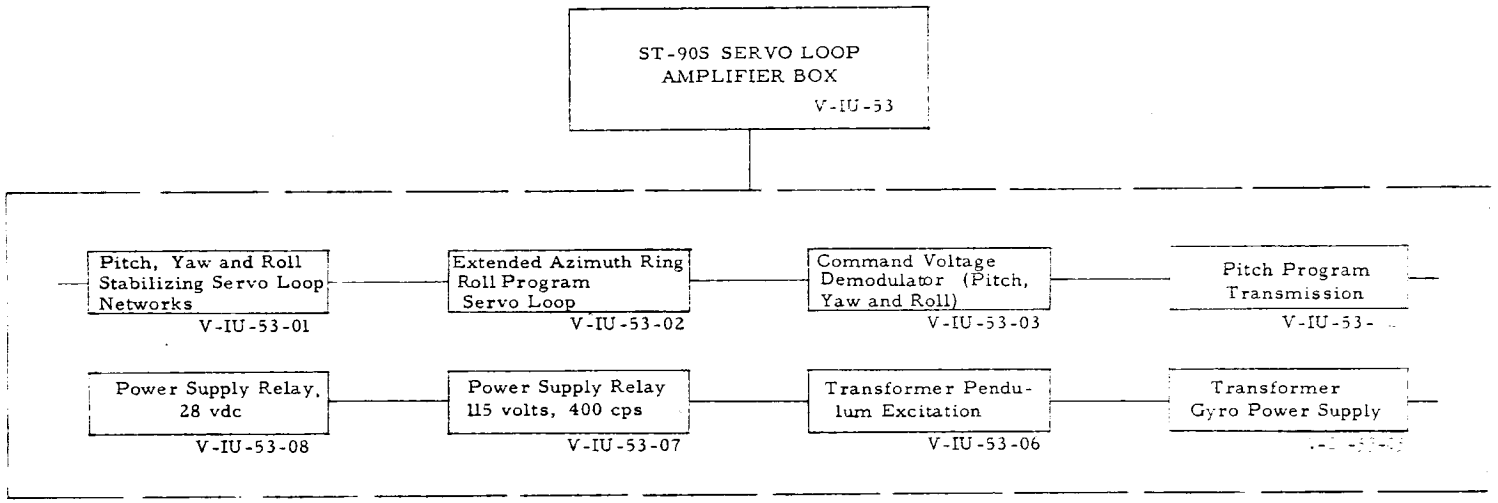
ST 90S SERVO LOOP AMPLIFIER BOX SUBSYSTEM

V-IU-53

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
ST-90S Servo Loop Amplifier Box V-IU-53		8970199	802A31	Contains the associated electronics for the ST-90S DETAILS BELOW				
Pitch, Yaw, and Roll Stabilizing Servo Loop Networks V-IU-53-01			N/A	Accepts the stabilizing gyro generated signals caused by external disturbing torques and generates the correct phase sensitive voltage and power which drives the appropriate servo motor which nullifys the disturbing torque and holds the navigation coordinate system space fixed.	1) Malfunction in the preamplifier, phase lead network, demodulator, modulator, or the power amplifier.	LOSS Any of the failures mentioned will cause a loss of the servo loop amplifier's ability to maintain the inertially space fixed navigation coordinate system.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of attitude control.
Extended Azimuth Ring Roll Program Servo Loop V-IU-53-02			N/A	This servo loop receives a signal from the roll program resolver which is a voltage analogue of the sine of the angular difference between the ST-90S azimuth and the vehicle azimuth at liftoff. This signal through the servo loop drives the extended azimuth ring of the ST-90S back into coincidence with the vehicle coordinate system. As the ring is rotated a phi roll signal is generated on the ST-90S which causes the control system to rotate the vehicle coordinate system into coincidence with the navigation coordinate system.	1) Loss of resolver input to the servo loop, or a component failure in the servo loop.	LOSS Any of the failures mentioned will cause a loss of the servo loop amplifier's ability to initiate or complete a roll program after liftoff.	N/A	(A) Reschedule (B) Same as (A) (C) POSSIBLE LOSS Due to incorrect attitude after the pitch program. If the pitch program is initiated before the roll program has been completed the vehicle will assume an angle of attack in yaw which would be a function of the pitch program angle and incomplete roll program angle.
						Issue Date: 1 Feb, 62	Prepared by: M-ASTR-G	Approval:

FAILURE EFFECT ANALYSIS



Issue Date: 1 Feb, 62	Prepared by: M-ASTR-TSJ	Approval:

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
ST 90S STABILIZED PLATFORM SUBSYSTEM
V-IU-52

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-52 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Roll Microsyn V-IU-52-23			N/A	Generates an error signal which is a voltage analogue of the angular difference between the vehicle roll attitude and the navigation coordinate system.	1). Electrical open or short circuit or mechanical failure.	LOSS Loss of ST-90S ability to control vehicle roll attitude	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of roll attitude control.
X-Y Gyro Pickoff Resolver V-IU-52-24			N/A	Receives the X and Y gyro pickoff signals and resolves and reroutes the composit signal to the correct roll or yaw servo loop network as the vehicle changes attitude due to the pitch program.	1). Electrical open or short circuit or mechanical failure.	LOSS Loss of the ST-90S inertially fixed navigation coordinate system.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of attitude control.
5 KC Oscillator Power Supply V-IU-52-25			N/A	Supplies excitation to the stabilizing gyros pickoff. Supplies the keying voltage for the accelerometer and stabilizing gyro servo networks.	1). D.C. power or a component part failure of the oscillator	LOSS The ST-90S looses the inertial space fixed navigation coordinate reference.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of attitude control.
Cover Heaters V-IU-52-26	*		N/A	This heater supplies auxiliary heat for rapid temperature conditioning of the ST-90S at start of countdown.	1). Electrical failure.	Slight delay in temperature conditioning of the ST-90S.	N/A	(A) Delay (B) Same as (A) (C) None; not used after liftoff.
						Issue Date: Jan 26, 62	Prepared by: M-ASTR-G	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
ST-90S STABILIZED PLATFORM SUBSYSTEM
V-IU-52

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-52 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Pitch and Yaw Pendulum Preamplifiers V-IU-52-18	*		N/A	Amplifies the low level pendulum signals for transmission to the ST-90S alignment panels in the utility room of the launch complex.	1) Electrical open or short circuit or loss of a component part.	Loss of the ST-90S ability to hold on earth fixed position.	N/A	(A) Delay or Reschedule (B) No function after final leveling (C) Same as (B)
Azimuth Pickoff V-IU-52-19	*			Generates an a.c. voltage analogue of angular difference between the azimuth of the vehicle and the azimuth of the ST-90S.	1) Electrical open or short circuit. Loss of excitation.	Loss of the ST-90S ability to hold a constant fixed azimuth.	N/A	(A) Delay or Reschedule (B) No function after final leveling. (C) Same as (B)
Azimuth Pickoff Preamplifier V-IU-52-20	*		N/A	Amplifies the low level azimuth pickoff signal for transmission to the ST-90S alignment panels in the utility room of the launch complex.	1) Electrical open or short circuit. Loss of a component part.	Loss of the ST-90S ability to hold a constant fixed azimuth.	N/A	(A) Delay or Reschedule (B) No function after final leveling. (C) Same as (B)
Pitch Control Transformer V-IU-52-21			N/A	Generates an error signal which is a voltage analogue of the angular difference between the vehicle pitch attitude and the navigation coordinate system.	1) Electrical open or short circuit or mechanical failure.	LOSS Loss of ST-90S ability to control vehicle pitch attitude.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of pitch attitude control.
Yaw Microsyn V-IU-52-22			N/A	Generates an error signal which is a voltage analogue of the angular difference between the vehicle yaw attitude and the navigation coordinate system.	1) Electrical open or short circuit or mechanical failure.	LOSS Loss of ST-90S ability to control vehicle yaw attitude.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of yaw attitude control.
						Issue Date: Jan. 26, 62	Prepared by: M-ASTR-G	Approval: [illegible]

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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
ST 90S STABILIZED PLATFORM SUBSYSTEM
V-IU-52

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-52 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Air Bearing Air Distributor (cont'd.) V-IU-52-16			N/A		3) Failure of output connection to the slant range or slant altitude accelerometer.	Loss of ST-90S ability to determine velocity displacement guidance parameters for slant range and slant altitude.	N/A	(A) Delay or Reschedule (B) Same as (A) (C) POSSIBLE LOSS Not used for S-1 stage flight. For S-IV stage flight the accelerometers would spin about their precession axis creating gross errors in slant range and slant altitude.
					4) Failure of output connection to cross range accelerometer.	LOSS Loss of the ST-90S ability to determine velocity-displacement in cross range.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS If the S-1 stage flies a null cross range accelerometer output - Loss of air causes the accelerometer to spin and this would call for exaggerated correction in attitude.
					5) Failure of output connection to pendulums	Loss of earth fixed leveling of the ST-90S	N/A	(A) Delay or Reschedule (B) No function after final leveling (C) Same as (B)
Pitch and Yaw Pendulum V-IU-52-17	*		N/A	The pendulums are gravity plumbing sensors and generate a. c. voltage analogue of angular deviation from the gravity plum line to the ST-90S coordinate system.	1) Electrical or mechanical failure.	Loss of the ST-90S ability to hold on earth fixed position.	N/A	(A) Delay or Reschedule (B) No function after final leveling (C) Same as (B)
						Issue Date: Jan 26, 62	Prepared by: M-ASTR-G	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
ST 90S SLANT ALTITUDE ACCELEROMETER SUBSYSTEM
V-IU-52

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-52 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Slant Altitude Accelerometer V-IU-52-13			N/A	Measures slant altitude acceleration of the vehicle and generates an a.c. output that is the voltage analogue of vehicle velocity along the slant altitude navigation coordinate.	1) Electrical or mechanical failure to the gyro or any of its associated electronics.	Loss of ST-90S furnished guidance parameter slant altitude displacement.	N/A	(A) Delay or Reschedule (B) Same as (A) (C) POSSIBLE LOSS Slant altitude not a guidance parameter for the S-1 stage flight. For the S-IV stage flight the guidance system looses the ability to determine slant altitude displacement.
Slant Altitude Accelerometer Servo Loop V-IU-52-14			N/A	Accept the accelerometer servo pickoff signal which is a voltage analogue of the retarding friction of the accelerometer precession axis and generates a voltage analogue equal to the counter torque necessary to cancel these frictions.	1) Loss of a.c. or d.c. power supply or any electrical or mechanical component failure or air supply malfunction.	Loss of ST-90S furnished guidance parameter slant altitude displacement.	N/A	(A) Delay or Reschedule (B) Same as (A) (C) POSSIBLE LOSS The guidance system looses the ability to determine slant altitude displacement.
Air Bearing Air Distributor V-IU-52-15			N/A	Receives the main external air supply and distributes this air to all the air bearing components on the ST-90S.	1) Mechanical (Failure of input connection)	LOSS Loss of ST-90S guidance parameters; attitude control, velocity and displacement	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of attitude control.
					2) Failure of output connection to any stabilizing gyro.	LOSS Loss of ST-90S guidance parameters; attitude control, velocity and displacement	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of attitude control.
						Issue Date: Jan. 26, 62	Prepared by: M-ASTR-C	Approval: [illegible]

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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
ST 90S STABILIZED PLATFORM SUBSYSTEM
V-IU-52

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-52 (con'td.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Cross Range Accelerometer V-IU-52-11			N/A	Measures the cross range acceleration of the vehicle and generates an a.c. output that is the voltage analogue of vehicle velocity along the cross range navigation coordinate.	1) Electrical or mechanical failure to the gyro or any of its associated electronics.	Loss of ST-90S furnished guidance parameter cross range displacement.	N/A	(A) Delay or Reschedule (B) Same as (A) (C) POSSIBLE LOSS The S-1 stage flight will probably fly a null cross range accelerometer output. The failure of the accelerometer will have no effect on proper functioning of this stage. For the S-IV flight, failure of the cross range accelerometer would cause a lateral displacement of the pitch plane of the navigation coordinate system. However, some missions could be completed with this error.
Cross Range Accelerometer Servo Loop V-IU-52-12			N/A	Accept the accelerometer servo pickoff signal which is a voltage analogue of the retarding friction of the accelerometer precession axis and generates a voltage analogue equal to the counter torque necessary to cancel these frictions.	1) Loss of a.c. or d.c. power supply or any electrical or mechanical component failure or air supply malfunction.	Loss of ST-90S furnished guidance parameter cross range displacement.	N/A	(A) Delay or Reschedule (B) Same as (A) (C) POSSIBLE LOSS Failure of the cross range accelerometer would cause a lateral displacement of the pitch plane of the navigation coordinate system during the S-IV stage flight.
						Issue Date: Jan 26, 62	Prepared by: M-ASTR-G	Approval: C.B. Jones

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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
ST 90S STABILIZED PLATFORM **SUBSYSTEM**
V-20-54

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-52 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Slant Range Accelerometer V-IU-52-09			N/A	Measures the slant range acceleration of the vehicle and generates an a.c. output that is the voltage analogue of vehicle velocity along the slant range navigation coordinate.	1) Electrical or Mechanical failure to the gyro or any of its associated electronics.	Loss of the ST-90S furnished guidance parameter slant range displacement.	N/A	(A) Delay or Reschedule (B) Same as (A) (C) None; Cutoff of the S-1 and S-IV stages is not based on ST-90S slant range displacement. Cutoff of S-1 stage is by liquid level sensing and a timer. If velocity cutoff is required on the S-IV stage the signal will come from the ST-124.
Slant Range Accelerometer Servo Loop V-IU-52-10			N/A	Accepts the accelerometer servo pickoff signal which is a voltage analogue of the retarding friction of the accelerometer precession axis and generates a voltage analogue equal to the counter torque necessary to cancel these frictions.	1) Loss of a.c. or d.c. power supply or any electrical or mechanical component failure or malfunction of the air supply.	Loss of the ST-90S furnished guidance parameter slant range displacement.	N/A	(A) Delay or Reschedule (B) Same as (A) (C) None; Slant range displacement will not be a S-1 stage guidance parameter. For the S-IV stage the guidance system looses the ability to determine slant range displacement.
						Issue Date: Jan 26, 62	Prepared by: M-ASTR-G	Approval: [illegible]

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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
ST 90S STABILIZED PLATFORM SUBSYSTEM
V-IU-52

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-52 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
X, Y, and Z Stabilizing Gyros V-IU-52-07			N/A	Inertial reference for vehicle navigation coordinate system.	1) Electrical (Internal electrical open or short in any gyro)	LOSS The loss of any one of the three gyros causes a complete loss of the ST-90S generated navigation coordinate system	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of vehicle attitude control
				Generates analogue signals proportional to external disturbing torques which in turn drives the stabilizing servo loops.	1) Loss of gyro pickoff excitation. (Electrical open or short circuit of pickoff)	LOSS The loss of any one of the stabilizing gyro servo loops causes a complete loss of the ST-90S generated navigation coordinate system	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of vehicle attitude control.
	*			Maintains the navigation coordinate system at a fixed earth reference by procession of the gyros up until liftoff of the vehicle.	1) Loss of gyro torquer excitation. (Electrical open or short circuit of gyro torquer).	LOSS The loss of any ST-90S alignment servo loop will cause the coordinate system to change orientation at the earth rate of rotation appearing in the axis affected.	N/A	(A) Delay or rescheduled (B) Same as (A) (C) None Not used after liftoff.
X, Y, and Z Servo Motors V-IU-52-08			N/A	Receives an a.c. signal from the servo loop network which is a voltage analogue of any disturbing torque appearing in the stabilized platform coordinate system and generates a counter torque equal and opposite to the disturbing torque.	1) Electrical open or short circuit or mechanical failure.	LOSS The ST-90S loses its ability to counteract external disturbing torques through its servo loops.	N/A	(A) Reschedule (B) Same as (A) (C) LOSS Due to loss of vehicle attitude control.
						Issue Date: Jan 26, 62	Prepared by: M-ASTR-G	Approval: [illegible]

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FAILURE EFFECT ANALYSIS

ST 90S STABILIZED PLATFORM SUBSYSTEM

V-IU-52

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-52 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Extended Azimuth Ring Optical Dividing Head. V-IU-52-05	*		N/A	This is the readout of the angle turned, by the ST-90S, from the base line reference azimuth to the desired firing azimuth.	1) Electrical or Mechanical failure	Loss of azimuth laying capability for the ST-90S	N/A	(A) Delay or Reschedule (B) None (C) None
Extended Azimuth Ring Roll Resolver V-IU-52-06			N/A	This resolver stores the voltage analogue of the angular difference between the vehicle pitch-yaw coordinate axis and the ST-90S Z-X coordinate axis. This This stored angle then becomes the roll program. After initiation of the roll program this resolver is driven mechanically to zero by the extended azimuth ring and the ST-90S generates a roll phi which rotates the vehicle until the roll resolver is at zero and the vehicle coordinate axis coincides with the navigation coordinate axis.	1) Electrical or mechanical failure	LOSS Loss of roll program capability	N/A	(A) Reschedule (B) Same as (A) (C) POSSIBLE LOSS An error would exist between the vehicle coordinate system and the navigation coordinate system. A possible effect would be breakup of the vehicle.
						Issue Date: Jan, 26, 62	Prepared by: M-ASTR-G	Approval: [illegible]

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FAILURE EFFECT ANALYSIS
ST 90S STABILIZED PLATFORM SUBSYSTEM
V-IU-52

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-IU-52 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Temperature Control Ambient Air-Gimbal Mass V-IU-52-03	*		N/A	Ambient air is a backup protection to gimbal mass temperature. These devices control the rapid temperature conditioning of the stabilized platform and indicate when a stablized temperature has been achieved.	1) Ambient air sensor open circuit.	None	N/A	None
					2) Ambient air sensor short circuit	Delay in temperature conditioning of the ST-90S.	N/A	(A) Possible Delay (B) None (C) None
					3) Gimbal mass sensor open circuit.	None	N/A	None
					4) Gimbal mass sensor short circuit.	Delay in temperature conditioning of the ST-90S	N/A	(A) Possible Delay (B) None (C) None
					5) Both sensors open circuit.	Overheating of the ST-90S	N/A	(A) Delay (B) None (C) None
					6) Both sensors short circuit.	Delay in temperature conditioning of the ST-90S	N/A	(A) Possible Delay (B) None (C) None
Extended Azimuth Ring V-IU-52-04				The extended azimuth ring and its associated electronics gives the guidance system the capability of programming the vehicle in roll, after liftoff, to the preset azimuth of the navigation coordinate system.	1) Mechanical or electrical failure	LOSS Loss of roll program capability after liftoff.	N/A	(A) Reschedule (B) Same as (A) (C) POSSIBLE LOSS An error would exist between the vehicle coordinate system and the navigation coordinate systems and as the pitch program was initiated the vehicle would assume an angle of attack in yaw. A possible effect would be a breakup of the vehicle.
					2) Azimuth laying malfunction	Loss of azimuth laying capability of ST-90S	N/A	(A) Delay or Reschedule (B) None; No function after final azimuth laying. (C) Same as (B)
						Issue Date: Jan 26, 62	Prepared by: M-ASTR-G	Approval: [signature]

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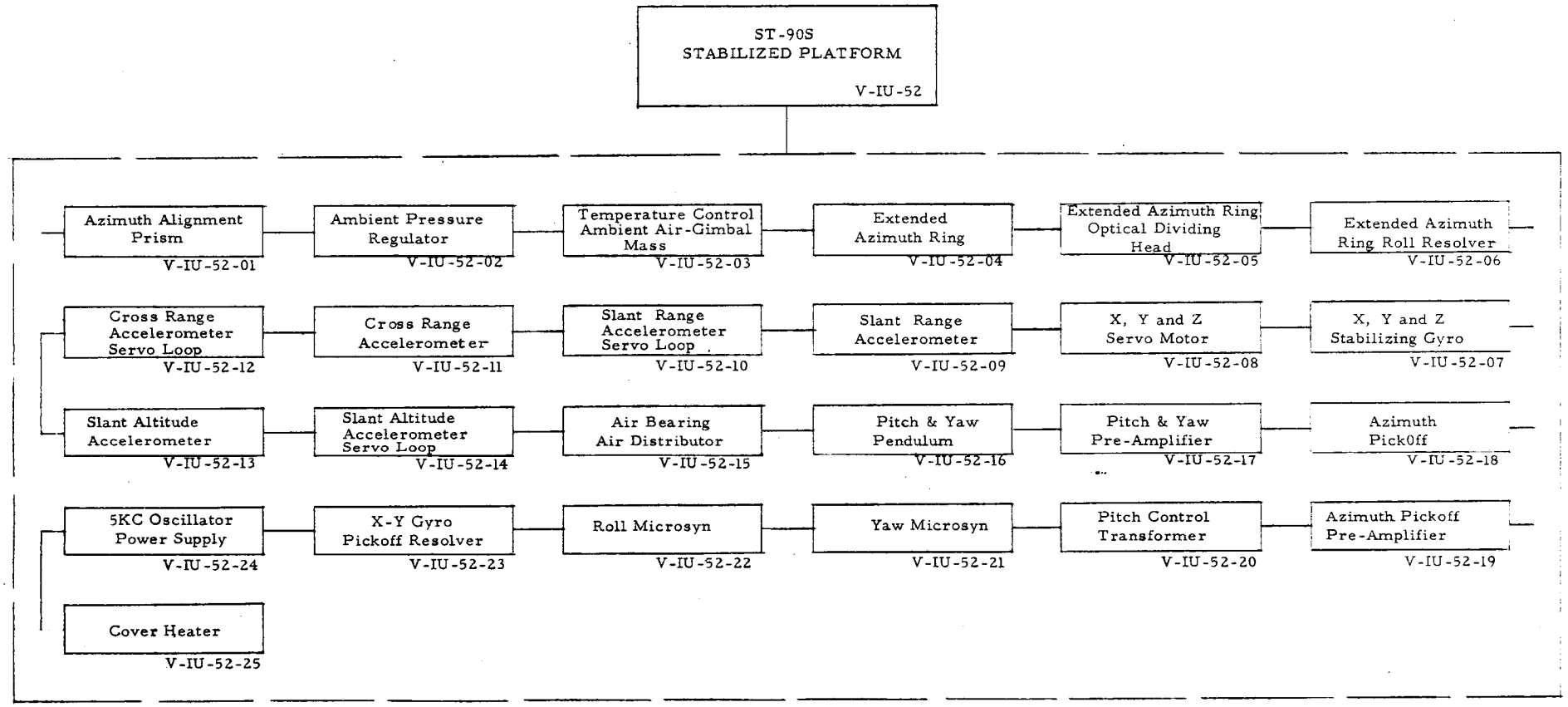
FAILURE EFFECT ANALYSIS
ST 90S STABILIZED PLATFORM SUBSYSTEM
V-IU-52

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
ST-90S Gyro Stabilized Platform V-IU-52		50M21173	802A30	Originates the attitude and velocity signals. Serves as autopilot for vehicle attitude and for inertial reference for acceleration sensors. Fixes a point of reference of the navigation coordinate system at liftoff.	1) Loss of attitude signals.	LOSS Loss of entire guidance and navigation function.	N/A	(A)Reschedule (B)Same as (A) (C)LOSS Due to loss of vehicle attitude control.
					2) Loss of velocity and displacement signals.	None; Velocity and displacement signals are used for telemetering only.	N/A	(A)Delay (B)Same as (A) (C)None; Cutoff of S-1 stage is by liquid level sensing and a timer. If velocity cutoff is required on the S-IV stage the signal will come from the ST-124.
Azimuth Aiming Prism. V-IU-52-01	*		N/A	The prism is a reference surface that is used to optically position the navigation coordinate system to a ground reference azimuth.	1) Mechanical damage to the prism or its alignment to the platform.	POSSIBLE LOSS No means would be available to accurately lay the stabilized platform on the desired firing azimuth.	N/A	(A)Delay or Reschedule (B)None: No function after final azimuth laying (C)Same as (B)
Ambient Pressure Regulator V-IU-52-02			N/A	Controls the ambient pressure of the stabilizing gyros and accelerometers at 14.7 ±3 psia	1) Fails to regulate within tolerance. Pressure rises above 18 psia.	None; slight loss of accuracy.	N/A	(A)Delay (B)Same as (A) (C)None; attitude signals not affected. Slight deviation from mission trajectory.
					2) Pressure rises above 22 psia	POSSIBLE LOSS Loss of accuracy due to higher drift rate of gyros	N/A	(A)Delay or Reschedule (B)Same as (A) (C) None; attitude signals not affected. Some deviation from mission trajectory.
					3) Pressure drops below approx. 6 psia.	PROBABLE LOSS Due to touching of the gyro air bearings	N/A	(A)Reschedule (B)Same as (A) (C) LOSS Due to loss of attitude control.
						Issue Date: Jan 26, 62	Prepared by: M-ASTR-G	Approval:

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



Issue Date: 1 Feb, 62	Prepared by: M-ASTR-TSJ	Approval:

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

AIR BEARING GN_2 SUPPLY SUBSYSTEM

V-IU-51

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Plumbing V-IU-14 (Includes Tubing, connections and external leakage from other pneumatic components)				a. Conducts GN_2 from inlet coupling to check valve	Gross Leakage or Rupture	LOSS OF SUBSYSTEM could not fill GN_2 sphere	(A) Launch Delay or Reschedule (B & C) None: Failure Mode not applicable (this plumbing is required only during the GN_2 fill operation)	(A) Launch Delay or Reschedule (B & C) None: Failure Mode not applicable.
				b. Conducts GN_2 from check valve to regulator	Gross Leakage or Rupture	LOSS OF SUBSYSTEM Premature depletion of Air Bearing GN_2	(A & B) Launch Delay or Reschedule (C) LOSS of ST-90S due to excessive Gyro Bearing Friction	(A & B) Launch Delay or Reschedule (C) LOSS OF VEHICLE through guidance error.
				c. Conducts GN_2 from Regulator to ST-90 S	Gross Leakage or Rupture	LOSS OF SUBSYSTEM Premature depletion of Air Bearing GN_2 and Insufficient GN_2 pressure to Gyro Bearings.	(A & B) Launch Delay or Reschedule (C) LOSS of ST-90s due to excessive Gyro Bearing Friction.	(A & B) Launch Delay or Reschedule (C) LOSS OF VEHICLE through guidance error.
Heater V-IU-51-12		Part of 20M30064		Heats GN_2 before it goes to Gyro Bearings	1. Open or Short circuit	PROBABLE LOSS OF SUBSYSTEM Air bearing GN_2 temperature too low.	(A & B) Launch Delay or Reschedule (C) PROBABLE LOSS of ST-90 accuracy	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE through guidance error.
Filter V-IU-51-13		Part of 20M30064		Removes particle impurities from GN_2 going to Gyro Bearings	1. Implosion of Filter Element.	LOSS OF SUBSYSTEM Filter Element Particles could damage Gyro Bearings.	(A & B) Launch Reschedule if condition is detected. (C) PROBABLE LOSS of ST-90S accuracy.	(A & B) Launch Reschedule if condition is detected. (C) PROBABLE LOSS OF VEHICLE through guidance error.
						Issue Date: Feb. 1-, 1962	Prepared by: M-P&VE-EF	Approval [illegible]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
AIR BEARING GN_2 SUPPLY SUBSYSTEM
V-IU-51

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Low Pressure OK Switch V-IU-51-08	*	20M30159			1. Actuates at a pressure higher than 1200 psi.	POSSIBLE LOSS OF SUBSYSTEM Too much pressure on Gyro Bearings.	(A) Possible Launch Delay or Reschedule due to Gyro Drift (B & C) None: Failure Mode not applicable	(A) Possible Launch Delay or Reschedule due to Gyro Drift (B & C) None: Failure Mode not applicable
				Provides signals to open V-IU-51-09 solenoid valve and to shut down the ST-90s whenever GN_2 sphere pressure drops below 1200 psi. These functions are performed only during ST-90S stand-by operation.	1. Failure to Actuate or Actuation at a pressure less than 1200 psi.	LOSS OF SUBSYSTEM Insufficient pressure to Gyro bearings when GN_2 sphere drops below 1200 psi.	(A) Launch Delay or Reschedule (B & C) None: Failure Mode not applicable	(A) Launch Delay or Reschedule (B & C) None: Failure Mode not applicable.
					2. Failure to Deactuate	LOSS OF SUBSYSTEM Could not restart ST-90S	(A) Launch Delay or Reschedule (B & C) None: Failure Mode not applicable	(A) Launch Delay or Reschedule (B & C) None: Failure Mode not applicable
Thermostat V-IU-51-10		Part of 20M30064		Provides signal to apply power to heater whenever GN_2 temperature drops too low.	1. Failure to "Make" Circuit when required	PROBABLE LOSS OF SUBSYSTEM Air bearing GN_2 temperature too low.	(A & B) Launch Delay or Reschedule if condition is detected (C) PROBABLE LOSS of ST-90S accuracy	(A & B) Launch Delay or Reschedule if condition is detected. (C) POSSIBLE LOSS OF VEHICLE through guidance error.
					2. Failure to "Break" Circuit when required	PROBABLE LOSS OF SUBSYSTEM Air Bearing GN_2 temperature too high.	(A & B) Launch Delay or Reschedule if condition is detected. (C) PROBABLE LOSS of ST-90S accuracy	(A & B) Launch Delay or Reschedule if condition is detected. (C) POSSIBLE LOSS OF VEHICLE through guidance error.
Relay V-IU-51-11		Part of 20M30064		Provides switching for power to Heater V-IU-51-12	1. Failure to "Make" Circuit when required	Same as for Thermostat V-IU-51-10		
					2. Failure to "Break" Circuit when required.	Same as for Thermostat V-IU-51-10		
						Issue Date: Feb. 14, 1962	Prepared by: M-P&VE-EF	Approval R.T. Gilbert

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
AIR BEARING GN_2 SUPPLY SUBSYSTEM
V-IU-51

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Calibration Valve V-IU-51-06	*			Provides a means to isolate the high & low pressure OK switches for checkout purposes only. Valve is not used during countdown or flight.	1. Failure to Open or Close	None: This valve is only used for system checkout.	(A, B & C) None: Failure mode not applicable.	(A, B & C) None: Failure mode not applicable.
Regulator V-IU-51-07		Part of 20M30064		Reduces the GN_2 pressure from the storage tank pressure down to that required for the air bearings.	1. Regulates lower than "setting"	LOSS OF SUBSYSTEM Insufficient GN_2 pressure to gyro bearings	(A & B) Launch Delay or Reschedule (C) LOSS of ST-90 due to excessive gyro friction	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE through guidance error.
					2. Failure to Open or Remain Open	LOSS OF SUBSYSTEM No GN_2 pressure to gyro bearings	(A & B) Launch Reschedule (C) LOSS of ST-90 Due to gyro bearing seizure	(A & B) Launch Reschedule (C) LOSS OF VEHICLE through guidance error.
					3. Regulates Higher than "setting"	LOSS OF SUBSYSTEM Too much GN_2 pressure to Gyro Bearings	(A & B) Launch Delay or Reschedule (C) LOSS of ST-90 due to premature depletion of GN_2	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE through guidance error.
Solenoid Valve V-IU-51-09	*	Part of 20M30064		Provides bypass around regulator and is actuated when the supply pressure drops below 1200 psi. Operates only during ST-90, standby operation	1. Failure to Open or Remain Open	LOSS OF SUBSYSTEM Insufficient GN_2 pressure to Gyro Bearings.	(A) Launch Delay or Reschedule (B & C) None: Failure mode not applicable	(A) Launch Delay or Reschedule (B & C) None: Failure mode not applicable
					2. Failure to Close or Remain Closed (Includes excessive Internal Leakage)	LOSS OF SUBSYSTEM Too much pressure applied to Gyro Bearings.	(A & B) Launch Delay or Reschedule (C) LOSS of ST-90 due to premature depletion of GN_2	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE through guidance error
						Issue Date: Feb. 14, 1962	Prepared by: M-PAME-EF	Approval

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

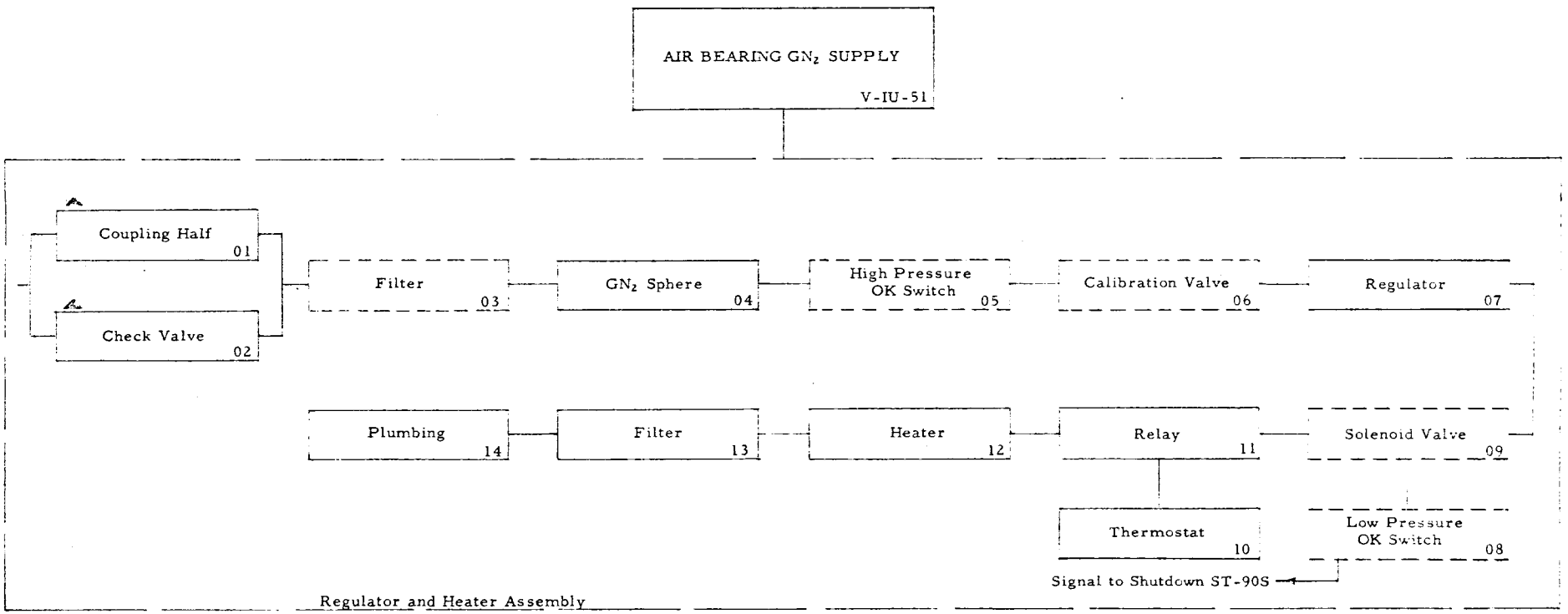
FAILURE EFFECT ANALYSIS
AIR BEARING GN_2 SUPPLY SUBSYSTEM
V-IU-51

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Coupling Half V-IU-51-01		20M30139	N/A	Provides Self-sealing connection to ground GN_2 supply. Provides Redundancy for V-IU-51-02 check valve failure to close.	1. Failure to Open	LOSS OF SUBSYSTEM could not flow GN_2 onto vehicle.	(A) Delay in Launch (B & C) Failure Mode not applicable	(A) Delay in Launch (B & C) Failure Mode not applicable
					2. Failure to Close	None: Redundancy provided	(A, B & C) None: Redundancy Provided	(A, B & C) None: Redundancy Provided
Check Valve V-IU-51-02		20M30124	N/A	Prevents Reverse flow of GN_2 from storage. Sphere V-IU-51-04. Coupling half, V-IU-51-01 Provides Redundancy for Failure to close only	1. Failure to Open	LOSS OF SUBSYSTEM Could not flow GN_2 into Storage Sphere	(A) Delay in Launch (B & C) Failure Mode not applicable	(A) Delay in Launch (B & C) Failure Mode not applicable
					2. Failure to Close	None: Redundancy Provided	(A, B & C) Redundancy provided	(A, B & C) Redundancy provided
Filter V-IU-51-03	*	20M30127	N/A	Removes Particle impurities from GN_2	1. Implosion of Filter	POSSIBLE LOSS OF SUBSYSTEM Regulator could be jammed by filter particles.	(A & B) Launch Reschedule or Delay (C) POSSIBLE LOSS of ST-90S due to excessive GN_2 pressure to gyro bearings.	(A & B) Launch Reschedule or Delay (C) PROBABLE LOSS OF VEHICLE through guidance error.
GN_2 Sphere V-IU-51-04		20M00846	N/A	Stores GN_2 for operation of gyro bearings.	1. Rupture or Gross Leakage	LOSS OF SUBSYSTEM Insufficient GN_2 to operate gyro bearings.	(A & B) Launch Reschedule or Delay (C) LOSS of ST-90S due to excessive gyro bearing friction	(A & B) Launch Reschedule or Delay (C) PROBABLE LOSS OF VEHICLE through guidanc error.
High Pressure OK Switch V-IU-51-05	*	20M30130	801A9	Monitors storage sphere pressure. High pressure OK signal must be obtained prior to start of automatic sequence	1. Failure to Actuate	LOSS OF SUBSYSTEM Could not initiate automatic sequence due to erroneous indication	(A) Launch Reschedule or Delay (B & C) Failure Mode not applicable	(A) Launch Reschedule or Delay (B & C) Failure Mode not applicable
					2. Premature operation (Sphere pressure less than 3000 psi)	POSSIBLE LOSS OF SUBSYSTEM Insufficient air bearing GN_2 to complete flight	(A & B) None (C) POSSIBLE LOSS of ST-90S due to excessive gyro bearing friction	(A & B) None (C) POSSIBLE LOSS OF VEHICLE through guidance error (near end of powered flight)
					3. Failure to Deactuate	LOSS OF SUBSYSTEM False indication of GN_2 pressure	(A & B) Launch Delay if detected (C) None: Failure Mode not applicable	(A & B) Launch Delay if detected. (C) None: Failure mode not applicable
						Issue Date: Feb. 14, 1962	Prepared by: M-P&VE-EF	Approval

S&M Form #203 (August 1961)(OT)

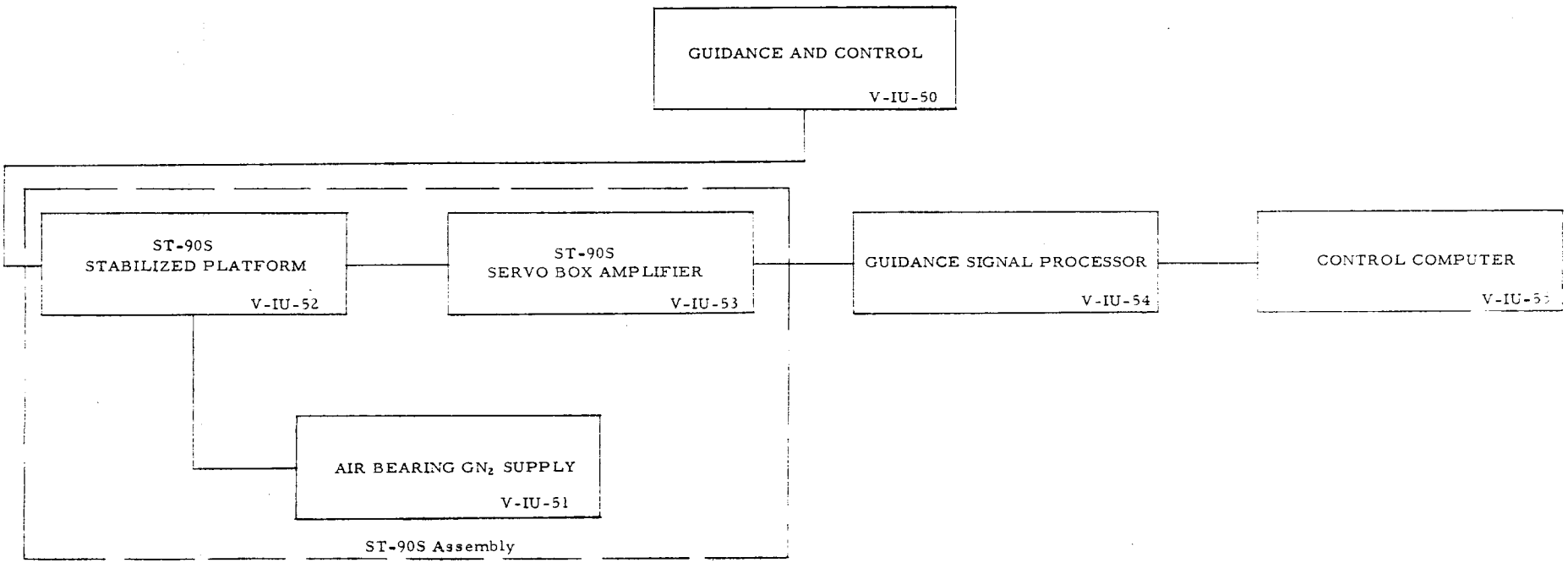
FAILURE EFFECT ANALYSIS



Redundant for failure to close only.

Issue Date: Jan 23, 62	Prepared by: M-P&VE-EF	Approval:

FAILURE EFFECT ANALYSIS



Issue Date: Jan 23, 1962	Prepared By: M-ASTR-TSJ	Approval:

FAILURE EFFECT ANALYSIS

TELEMETRY AND INSTRUMENTATION V-201-A3 DIAGRAM AND ANALYSIS NOT AVAILABLE.

FAILURE EFFECT ANALYSIS

EMERGENCY DETECTION SYSTEM V-10-30 DIAGRAM AND ANALYSIS NOT AVAILABLE

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
[illegible] V-IU-24 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Vent Valve V-IU-24-03	*	20M40072		Vents LN_2 cooler tank to atmosphere during filling	(1) Failure to open during filling	None: Redundancy provided by relief valve V-IU-24-02	(A, B) None: Redundancy provided (C) None: Valve remains closed during flight	(A, B) None: Redundancy provided (C) None: Valve remains closed during flight
					(2) Failure to Close or remain closed	PARTIAL LOSS OF SUBSYSTEM LN_2 boil-off to atmosphere requiring more frequent filling during preflight and early depletion of LN_2 during flight	(A, B) None: Preflight filling and cooling would be adequate even though vent valve is stuck open (C) POSSIBLE LOSS OF OTHER SYSTEMS Due to heat build-up in instrument compartment	(A, B) Launch delay or reschedule (C) POSSIBLE LOSS OF VEHICLE through guidance error.
[illegible] V-IU-24-04				Permits flow of LN_2 to cooler tank and GN_2 to vent and instrument compartment ducting	Leakage	PARTIAL LOSS OF SUBSYSTEM Due to early depletion of LN_2 during flight	(A, B) None: (C) POSSIBLE LOSS OF OTHER SYSTEMS due to heat build-up in Instrument Unit.	(A, B) Launch delay (C) POSSIBLE LOSS OF VEHICLE through guidance error.
						Issue Date: 19 Jan 62	Prepared by: M-P&VE-EF	Approval: [illegible]

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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

LN_2 FILL V-IU-24 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Relief Valve V-IU-24-02		20M40073		Relieves excess pressure in LN_2 cooler during fill operations (opens at 35 psig pressure)	(1) Failure to open	POSSIBLE LOSS OF SUBSYSTEM Due to excessive pressure in LN_2 cooler possibly causing leakage of GN_2 to atmosphere and decrease of cooling capability	(A, B) None: Cooling is provided directly from ground source until T-185 seconds. Time would not allow serious heat built-up before lift-off (C) POSSIBLE LOSS of other Systems in Instrument Unit	(A, B) None (C) POSSIBLE LOSS VEHICLE through guidance error.
					(2) Leakage (Failure to reseat)	PARTIAL LOSS OF SUBSYSTEM LN_2 boil-off to atmosphere requiring more frequent filling during preflight and causing partial loss of cooling capability during flight	(A, B) None: Filling Capacity is adequate to insure full cooler tank at lift-off (C) POSSIBLE LOSS OF OTHER SYSTEMS Caused by premature loss of LN_2 which results in Instrument Compartment overheating.	(A) Launch delay (B) Launch delay (C) POSSIBLE LOSS OF VEHICLE Time from failure to vehicle loss greater than 100 seconds
						Issue Date: 19 Jan 62	Prepared by: M-P&VE-EF	Approval: [illegible]

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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

[illegible] SUBSYSTEM

V-IU-24

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Check Valve V-IU-24-01		20M40166		Closes to prevent reverse flow of LN_2 from cooler.	Leakage (Failure to reseat during fill cycling or at lift-off.	LOSS OF SUBSYSTEM LN_2 would be lost from cooler immediately after separation of fill line resulting in loss of practically all cooling capacity.	(A, B) None; Three-way valve in fill line prevents LN_2 loss during preflight. (C) PROBABLE LOSS OF OTHER SYSTEMS Due to overheating of instrument compartment and damage to components.	(A, B) None; Failure would not be detected (C) PROBABLE LOSS OF VEHICLE Time of loss would depend on heat load in instrument compartment.
LN_2 Cooler V-IU-21-04		20M40010		Contains LN_2 to provide instrument compartment cooling capability after cutoff of ground cooling. Two upper and one lower level thermistors inside the cooler provide signals for filling operation. Lower thermistor-initiates refill command and opens vent valve. Upper thermistors-stop filling operation and closes vent valve.	(1) Failure of lower thermistor to transmit signal	LOSS OF SUBSYSTEM Cooler tank will not be adequately filled.	(A, B) None; Ground cooling is adequate until lift-off. If not detected prior to lift-off possible guidance error in flight due to insufficient cooling. (C) None; Failure mode not applicable.	(A, B) Launch delay or reschedule if detected (C) None; Failure mode not applicable
					(2) Failure of upper thermistors to transmit signal	None: Redundancy provided	(A, B) None: Redundancy provided (C) None: Failure mode not applicable	(A, B) None: Redundancy provided (C) None: Failure mode not applicable
					(3) Leakage	This failure mode considered under cooling subsystem, V-IU-21		

Issue Date: Jan 19, 1962 | Prepared by: M-P&VE-EF | Approval: [illegible]

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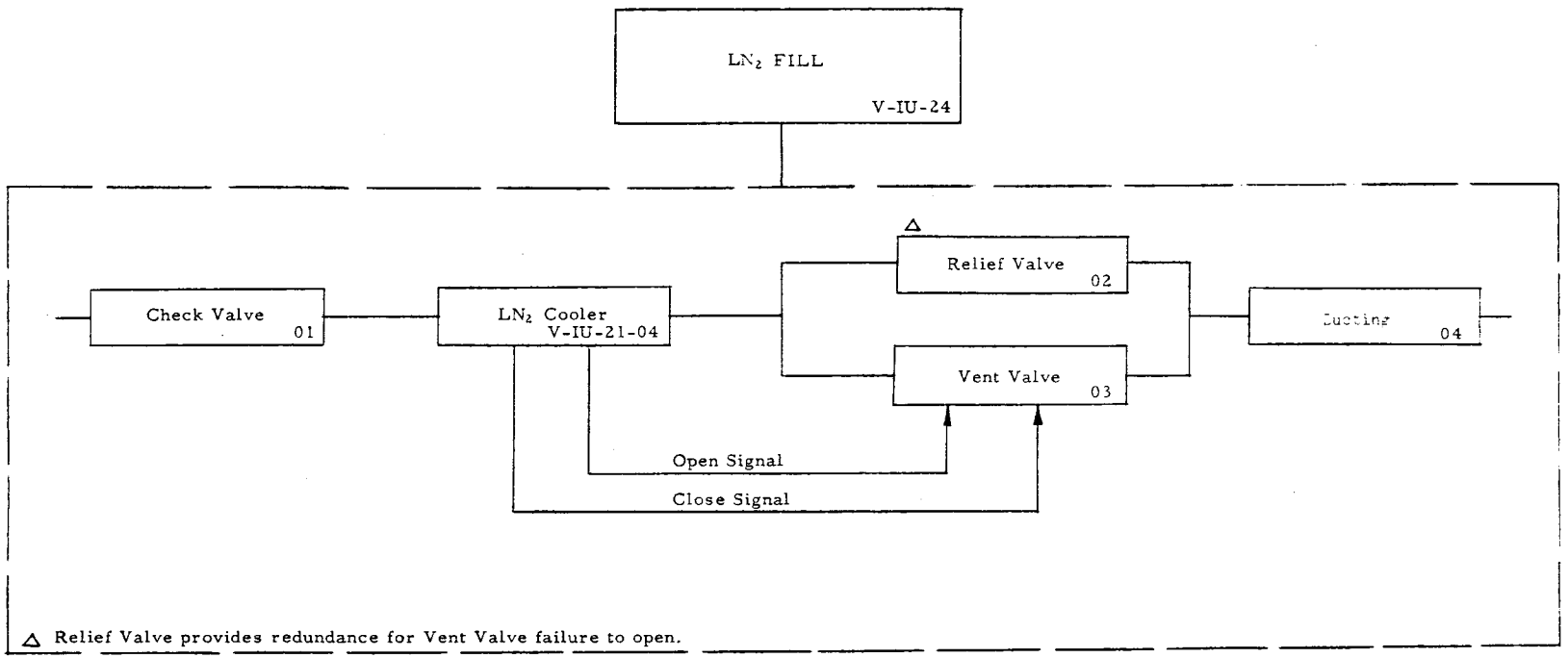
FAILURE EFFECT ANALYSIS



Issue Date: Jan 19, 1962	Prepared by: M-P&VE-EF	Approval: J.T. Gillard

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

COOLING DISTRIBUTION V-IU-23 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Ducting V-IU-23-08 (Tube III T/M Area)				This ducting delivers cooling air to the telemetry area from the LN_2 cooler.	Leakage (Excessive) Small leakage has no effect	PARTIAL LOSS OF SUBSYSTEM Cooling to the telemetry equipment will be reduced or lost	(A & B) POSSIBLE LOSS of T/M due to excessive heat (C) POSSIBLE LOSS of telemetry equipment due to excessive heat	(A) Launch Delay or Reschedule (B) Launch Delay or Reschedule (C) None
60 CFM Blower V-IU-23-04 (Tube IV Azusa Area)		20M40008		This blower draws cooling air into the azusa area.	Failure to Operate at Specified RPM	PARTIAL LOSS OF SUBSYSTEM Cooling to the area will be lost	(A & B) Excessive heating in the azusa area (C) POSSIBLE LOSS of azusa transponder	(A & B) Launch Delay or Reschedule. (Providing temperature in this area is monitored) (C) None
Ducting V-IU-[illegible]-10 (Tube IV Azusa Area)				This ducting delivers cooling air to the azusa area from the LN_2 cooler	Leakage (Excessive) Small leakage has no effect	PARTIAL LOSS OF SUBSYSTEM Cooling to the azusa area will be lost	(A, B & C) POSSIBLE LOSS of azusa transponder due to overheating	(A) Launch Delay or Reschedule (B) Launch Delay or Reschedule (C) None. Some Tracking Capabilities Lost

Issue Date: 19 Jan 62 | Prepared by: M-P&VE-EF | Approval: JT Gilbert

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

COOLING DISTRIBUTION V-IU-23 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Butterfly Valve, 2" V-IU-23-05 (Tube II St-124 Area)		20M40007		Modulates to Control the flow of cooling air or GN_2 to the ST-124 Passenger Guidance System	1. Failure to Close	LOSS OF PORTION OF SUBSYSYSTEM Too much cooling supplied to ST-124 Area	(A, B & C) POSSIBLE LOSS of ST-124 System	(A & B) Launch Delay or Reschedule (C) None
					2. Failure to Open	LOSS OF PORTION OF SUBSYSTEM Insufficient Cooling Supplied to ST-124 Area	(A, B & C) POSSIBLE LOSS of ST-124 System	(A & B) Launch Delay or Reschedule (C) None
Temperature Control Assembly and Probes V-IU-23-05-1 (Tube II ST-124 Area)		20M40061		Senses Temperatures in ST-124 Area and provides Signal for Modulation of the 2" Butterfly Valve	1. Failure to Supply Closing Signal at Correct Time	LOSS OF PORTION OF SUBSYSTEM Too much Cooling Supplied to ST-124 Area	(A, B & C) POSSIBLE LOSS of ST-124 System	(A & B) Launch Delay or Reschedule (C) None
					2. Failure to Supply Opening Signal at Correct Time	LOSS OF PORTION OF SUBSYSTEM Insufficient Cooling Supplied to ST-124 Area	(A, B & C) POSSIBLE LOSS of ST-124 System	(A & B) Launch Delay or Reschedule (C) None
Blower, 60 CFM V-IU-23-06 (Tube II ST-124 Area)		20M40008		Circulates Cooling Air or GN_2 to Bottom of ST-124	1. Failure to Operate or Attain Sufficient RPM	PROBABLE LOSS OF PORTION OF SUB-SYSTEM Insufficient Cooling Supplied to Bottom of ST-124	(A, B & C) POSSIBLE LOSS of ST-124 System	(A & B) Launch Delay or Reschedule (C) None
					2. Overspeed of Blower	None	(A, B & C) None	(A, B & C) None
Ducting V-IU-23-07 (Tube II ST-124 Area)				Conducts GN_2 or Air to ST-124 Area in Tube II	1. Leakage (Small Amount)	None	(A, B & C) None	(A, B & C) None
					2. Gross Leakage or Rupture	PROBABLE LOSS OF PORTION OF SUB-SYSTEM Insufficient Cooling Supplied to ST-124 Area	(A, B & C) POSSIBLE LOSS of ST-124 System	(A & B) Launch Delay or Reschedule (C) None
						Issue Date: 19 Jan 62	Prepared: M-P&VE-EF	Approval: LT Gillody

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
COOLING DISTRIBUTION V-IU-23 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Temperature Control Assembly and Probes V-IU-23-02-1 (Tube I ST-90 Area)		20M40061		Senses Temperatures in ST-90 Area and provides Signal for Modulation of the 2" Butterfly Valve	(1) Failure to Supply Closing Signal at Correct Time	LOSS OF PORTION OF SUBSYSTEM Too much Cooling Supplied to ST-90 Area.	(A, B & C) POSSIBLE LOSS of ST-90 System	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE Through Guidance Error (Self Destruct or Destruct by RSO)
					(2) Failure to Supply Opening Signal at Correct Time	LOSS OF PORTION OF SUBSYSTEM Insufficient Cooling Supplied to ST-90 Area	(A, B & C) POSSIBLE LOSS of ST-90 System	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE Through Guidance Error (Self Destruct or Destruct by RSO)
Blower, 60 CFM V-IU-23-03 (Tube I ST-90 Area)		20M40008		Circulates Cooling Air or GN_2 to Bottom of ST-90	(1) Failure to Operate or Attain Sufficient RPM	PROBABLE LOSS OF PORTION OF SUB-SYSTEM Insufficient Cooling Supplied to Bottom of ST-90	(A, B & C) POSSIBLE LOSS of ST-90 System	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE Through Guidance Error (Self Destruct or Destruct by RSO)
					(2) Overspeed of Blower	None	(A, B & C) None	(A, B & C) None
Ducting V-IU-23-04 (Tube I ST-90 Area)				Conducts GN_2 or Air to ST-90 Area in Tube I	(1) Leakage (Small Amount)	None	(A, B & C) None	(A, B & C) None
					(2) Gross Leakage or Rupture	PROBABLE LOSS OF PORTION OF SUB-SYSTEM Insufficient Cooling Supplied to ST-90 Area	(A, B & C) POSSIBLE LOSS of ST-90 System	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE Through Guidance Error (Self Destruct or Destruct by RSO)
						Issue Date: 19 Jan 62	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

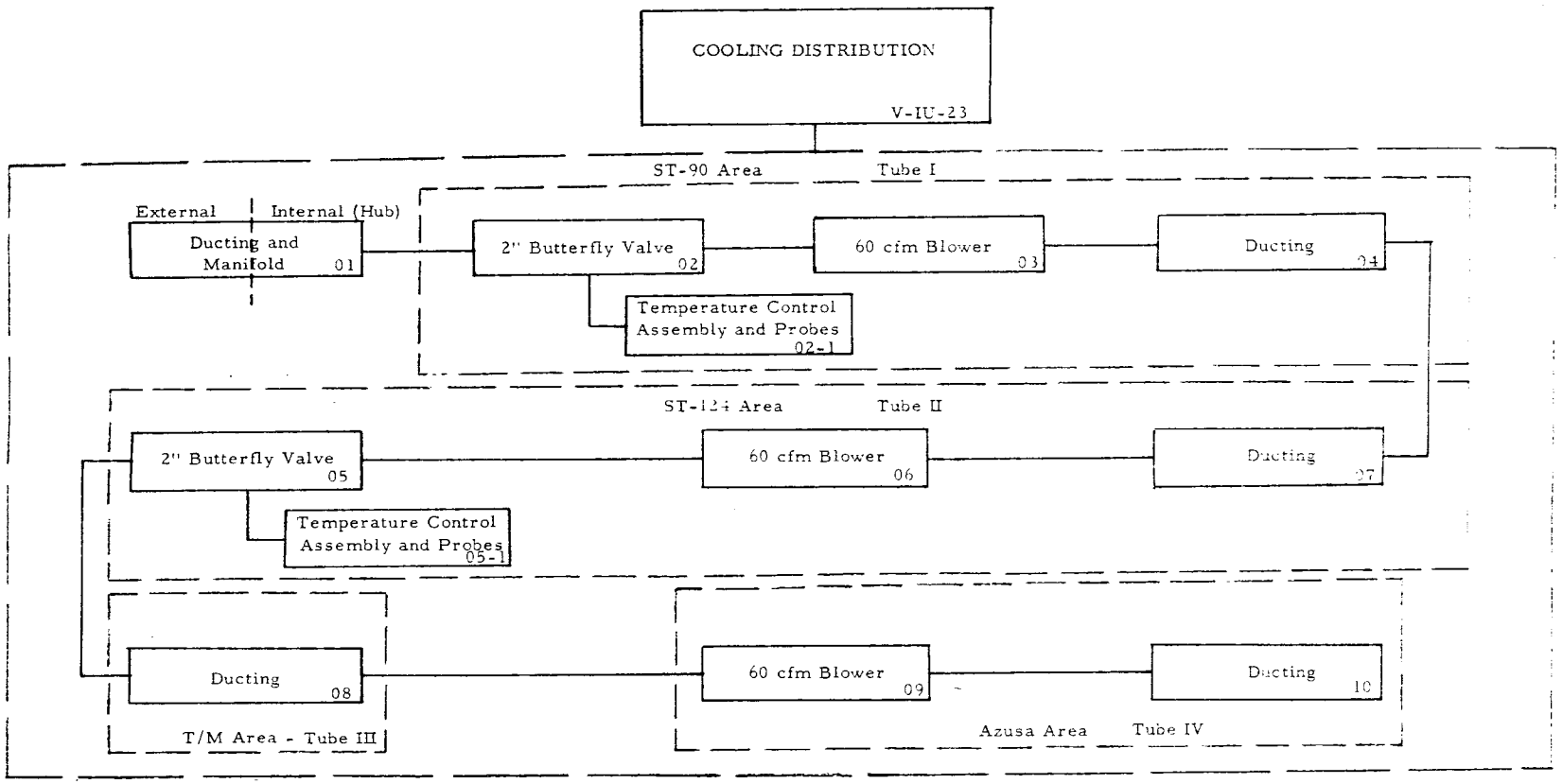
FAILURE EFFECT ANALYSIS
COOLING DISTRIBUTION V-IU-23 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Ducting and Manifold (External) V-IU-23-01				Carries Air or GN_2 from the Precooling Check Valve to the Hub of the Instrument Unit	(1) Leakage (Small Amount)	None	(A, B, & C) None	(A, B & C) None
					(2) Rupture or Gross Leakage	PROBABLE LOSS OF SUBSYSTEM insufficient cooling & internal pressure in Instrumemt Unit	(A, B & C) POSSIBLE LOSS of Other Systems in Instrument Unit	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE through Guidance Error (Self Destruct or Destruct by RSO)
Ducting and Manifold (Internal) V-IU-23-01				Carries Air or GN_2 from Wall of the Hub to Tubes I thru IV	(1) Leakage (Small Amount)	None	(A, B & C) None	(A, B & C) None
					(2) Rupture or Gross Leakage	POSSIBLE LOSS OF SUBSYSTEM Insufficient Cooling may Result in one or more of the Instrument Unit Tubes	(A, B & C) POSSIBLE LOSS of Other Systems in the Instrument Unit	(A & B) Launch Delay or Reschedule if Detected (C) POSSIBLE LOSS OF VEHICLE through Guidance Error (Self Destruct or Destruct by RSO)
Butterfly Valve, 2" V-IU-23-02 (Tube I ST-90 Area)		20M40007		Modulates to Control the Flow of Cooling Air or GN_2 to the ST-90 Guidance System	(1) Failure to Close	LOSS OF PORTION OF SUBSYSTEM Too much Cooling Air or GN_2 Supplied to ST-90 Area	(A, B & C) POSSIBLE LOSS of ST-90 System	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE Through Guidance Error (Self Destruct or Destruct by RSO)
					(2) Failure to Open	LOSS OF PORTION OF SUBSYSTEM Insufficient Cooling Air or GN_2 Supplied to ST-90 Area	(A, B & C) POSSIBLE LOSS of ST-90 System	(A & B) Launch Delay or Reschedule (C) POSSIBLE LOSS OF VEHICLE Through Guidance Error (Self Destruct or Destruct by RSO)
						Issue Date: 19 Jan 62	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



Issue Date: Jan 19, 1962	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203-1 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PRESSURE CONTROL SUBSYSTEM
V-IU-22

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Precooling Check Valve V-IU-22-03		20M40000		This valve connects to the ground cooling system and opens to allow air/GN_2 to enter the instrument compartment for preflight cooling. It closes at T-185 seconds to prevent GN_2 from leaving the instrument compartment through the ducting.	Leakage	PARTIAL LOSS OF SUBSYSTEM The pressure control capabilities of the system will be lost.	(A) None (B) None, Instrument Compartment Pressure will be within accepted limits (10-17 psia). (C) POSSIBLE LOSS of ST-90 and batteries. The ST-90 required a minimum of 10 psia to function properly and the batteries do not function below 5 psia.	(A) None (B) None (C) POSSIBLE LOSS Dependent upon the leakage rate.
					Failure to Close or remain closed.	LOSS OF SUBSYSTEM Pressure will fall below required limits.	(A) None (B) None, Instrument Compartment Pressure will be within accepted limits (10-17 psia). (C) LOSS of ST-90 and batteries as pressure will drop below the required limits.	(A) None (B) None (C) LOSS OF VEHICLE caused by loss of ST-90 and batteries. Time for failure is greater than T + 50 seconds.
Ducting V-IU-22-04				All Instrument Compartment Seals.	Excessive leakage.	PARTIAL LOSS OF SUBSYSTEM Pressure control capabilities are reduced.	(A) None (B) None, Instrument Compartment Pressure will be within accepted limits (10-17 psia).	(A) None (B) None (C) POSSIBLE LOSS dependent upon leakage rate.
						Issue Date: Jan 19, 1962	Prepared by: M-P&VE-EF	Approval: J. T. Gilbody

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PRESSURE CONTROL V-IU-22 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Pressure Switch V-IU-22-02-1		Not Available		This switch actuates the solenoid vent valve to maintain instrument compartment pressure. The switch controls the instrument compartment pressure only after LN_2 cooler starts operation.	Actuates out of specification.	LOSS OF SUBSYSTEM Instrument Compartment Pressure out of spec.	(A) None. Switch not operative at this time. (B) POSSIBLE LOSS of guidance due to excessive pressure in the instrument compartment. (C) LOSS of ST-90 Instrument compartment pressure out of spec.	(A) None. (B) Launch delay or reschedule if this malfunction can be detected. (C) LOSS OF VEHICLE caused by erratic behavio of the ST-90 necessitating destruct.
					Fails to Close Circuit	LOSS OF SUBSYSTEM Instrument compartment pressure will be excessive.	(A) None. (B) POSSIBLE LOSS of ST-90 due to excessive pressure. (C) LOSS of ST-90 caused by excessive back pressure on the air bearings.	(A) None (B) Launch Delay or Reschedule if this condition is detected. (C) LOSS OF VEHICLE Excessive pressure would cause erratic behavior of the gyros and possibly a structural failure of the compartment. Time for failure >T + 50 Seconds.
					Fails to Open Circuit	LOSS OF SUBSYSTEM Instrument compartment pressure will be lost.	(A, B) None: Instrument Unit pressure requirements are 10-17 psia. (C) PROBABLE LOSS of ST-90 and batteries because of a lack of pressure.	(A) None (B) Launch Delay or Reschedule if the condition can be detected. (C) LOSS OF VEHICLE The ST-90 operates erratically at pressure below 10 psia and the batteries fail to operate below 5 psia. Time for failure is greater than T + 100 sec.
						Issue Date: 19 Jan 62	Prepared by: M-P&VE-EF	Approval: W. T. Gillooly

**Items marked thus (*) do not operate in flight

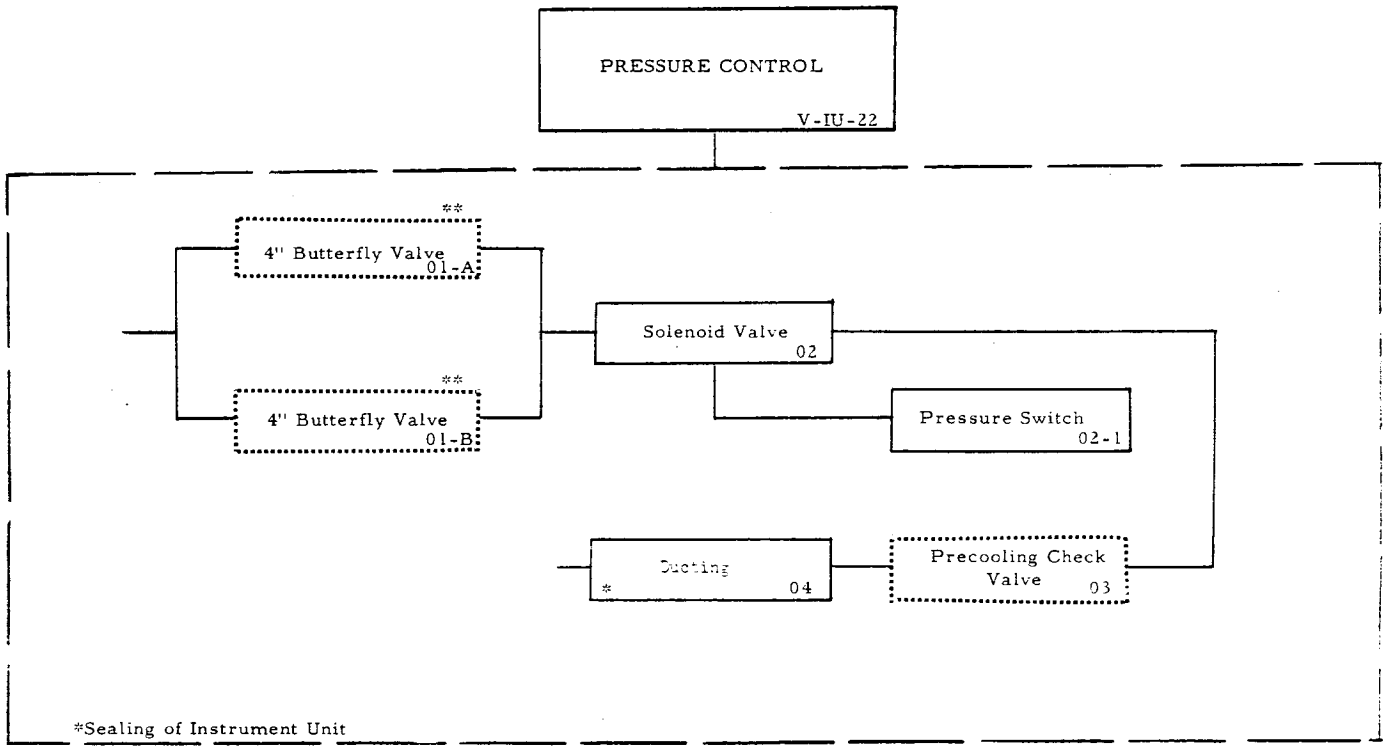
FAILURE EFFECT ANALYSIS
PRESSURE CONTROL V-IU-22 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Valve, Butterfly 4" (2) V-IU-22-01A -01B	*	20M40002		These valves are open during preflight cooling to prevent over pressurization of the instrument unit.	Failure to open or failure to remain in the open position.	None; redundancy provided.	(A, B & C) None	(A, B & C) None
					Failure to close or failure to remain closed.	LOSS OF SUBSYSTEM Instrument Compartment pressure will drop below required limit.	(A) None (B) None. Pressure will remain within spec until after lift-off. (C) LOSS of guidance The guidance system requires a pressure of 10-17 psia to properly operate. LOSS of batteries. These batteries need a minimum pressure of 5 psia	(A) None (B) Launch Delay or Reschedule if this condition can be discovered. (C) LOSS· Erratic performance of the gyros is caused by a low air bearing back pressure causing erratic vehicle guidance. The time for this failure T + 10 sec.
Valve, Solenoid V-IU-22-02		Not available		This valve is actuated and deactuated by a pressure switch to vent instrument compartment pressure and maintain proper compartment pressure. 10-17 psia	Failure to Open	LOSS OF SUBSYSTEM Compartment pressure control is lost.	(A) None (B) POSSIBLE LOSS of ST-90 due to excessive backpressure. (C) LOSS of ST-90 caused by excessive backpressure on the air bearings.	(A) None (B) Launch Delay or Reschedule. If this condition can be discovered (C) LOSS OF VEHICLE The erratic guidance of the vehicle would necessitate its destruction
					Failure to Close	LOSS OF SUBSYSTEM The instrument compartment pressure will go below the required limits	(A) None (B) None (C) LOSS of ST-90 and batteries. ST-90 requires 10 psia to operate and the batteries require 5 psia to function.	(A) None (B) Launch Delay or Reschedule if the condition is discovered. (C) LOSS OF VEHICLE Erratic guidance will necessitate destruction of the vehicle. This loss should not occur before T + 100 sec.
						Issue Date: 19 Jan 62	Prepared by: M-P&VE-EF	Approval: J T Gilbody

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



**Redundant in failure to open.

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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
COOLING V-IU-21 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
LN_2 Cooler V-IU-21-04		20M40010		Heat Exchanger. - A portion of the compartment GN_2 is circulated through the cooler to absorb heat produced by the electrical components.	(1) Leakage from LN_2 chamber, (internal or external)	POSSIBLE LOSS OF SUB-SYSTEM Premature depletion of LN_2 supply.	(A & B) NONE: LN_2 cooler is topped until T-35 sec. (C) POSSIBLE LOSS of other systems in Instrument Unit	(A & B) Launch Delay or Reschedule if detected (C) POSSIBLE LOSS OF VEHICLE Through guidance error (Self destruct or Destruct by RSO)
					OTHER FAILURE MODES	ARE ANALYZED UNDER LN_2	FILL V-IU-24	
Ducting V-IU-21-05				Carries GN_2 from blower to Iris Valve to LN_2 cooler to Distribution Manifold and from Iris Valve to 4" Butterfly Valve to Distribution Manifold	(1) Leakage (Small amount) (2) Gross leakage or rupture	NONE	(A, B & C) NONE	(A, B & C) NONE
						PROBABLE LOSS OF SUB-SYSTEM Insufficient cooling and pressure supplied to Instrument Unit	(A, B & C) POSSIBLE LOSS of other systems in Instrument Unit due to short circuited cooling air.	(A & B) Launch Delay or Reschedule if detected (C) POSSIBLE LOSS OF VEHICLE Through guidance error (Self destruct or Destruct by RSO)
Temperature Sensor (Preflight A/C Control)	*			Senses temperature of air or GN_2 being exhausted from the Instrument Unit during operation of the central (preflight) A/C system. It controls the re-heater in the central A/C supply to the Instrument Unit	(1) Inaccurate or erratic signal sent to central A/C system	PROBABLE LOSS OF SUB-SYSTEM Insufficient or too much cooling provided by the central A/C system	(A) POSSIBLE LOSS of other systems in the Instrument Unit (B & C) NONE: Failure mode not applicable	(A) Launch Delay or Reschedule (B & C) NONE: Failure mode not applicable
						Issue Date: 19 Jan 62	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
COOLING V-IU-21 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Iris Valve V-IU-21-02 (continued)							(B & C) POSSIBLE LOSS of other systems in the Instrument Unit	
					(3) Seizure of Valve in intermediate position	PROBABLE LOSS OF SUB-SYSTEM Could not modulate GN_2 sent through LN_2 cooler and Bypass Line. Insufficient or too much cooling could result.	(A & B) None: Temperature of the Instrument Unit should remain within specifications from T-185 seconds when the onboard cooler begins operation until flight. (C) POSSIBLE LOSS of other systems in the Instrument Unit.	(A & B) Launch Delay or Reschedule if detected (C) POSSIBLE LOSS OF VEHICLE Through guidance error (Self destruct or Destruct by RSO)
Thermostatic Control (Iris Valve) V-IU-21-03		20M40039		Senses temperature in Manifold Duct and sends modulating pulses to Iris Valve to control the amount of air going through the LN_2 cooler or the Bypass Line.	(1) Failure to provide opening pulse to Iris Valve when temperature is above setting.	LOSS OF SUBSYSTEM Insufficient cooling provided by LN_2 cooler	(A & B) NONE: Cooling is provided by central system until T-185 sec. Excessive temperature buildup is not expected between T-185 and Lift-Off. (C) POSSIBLE LOSS of other systems in the Instrument Unit.	(A & B) Launch Delay or Reschedule if detected (C) POSSIBLE LOSS OF VEHICLE Through guidance error (Self destruct or Destruct by RSO)
					(2) Failure to provide closing pulse to Iris Valve when temperature is below setting	LOSS OF SUBSYSTEM Too much cooling provided by LN_2 cooler.	(A & B) NONE: Component is not in operation until T-185 sec. Excessive temperature drop is not expected between T-185 and Lift-Off. (C) POSSIBLE LOSS of other systems in the Instrument Unit.	(A & B) Launch Delay or Reschedule if Detected (C) POSSIBLE LOSS OF VEHICLE Through guidance error (Self destruct or Destruct by RSO)
						Issue Date: 19 Jan 62	Prepared by: M-PLVE-EF	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
COOLING V-IU-21 SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Blower, 250 CFM V-IU-21-01		20M40088		Circulates compartment GN_2 through LN_2 cooler and/or through the LN_2 cooler Bypass Line.	(1) Failure to operate or attain sufficient RPM.	LOSS OF SUBSYSTEM Insufficient cooling supplied to instrument unit.	(A) NONE; Cooling provided by central system until T-185 sec. (B) NONE; Excessive temperature buildup is not expected between T-185 & LIFT-OFF . (C) Possible loss of other systems in instrument unit.	(A) Launch Delay or Reschedule (B) Launch Delay or Reschedule (C) Possible Loss of Vehicle Through guidance error. (Self destruct or Destruct by RSO)
					(2) Overspeed of blower	NONE: Adjustment for increased cooling will be made by Iris Valve.	(A, B &C) NONE	(A, B & C) NONE
Iris Valve V-IU-21-02		20M40009		Controls the amounts of GN_2 sent through the LN_2 cooler & through the Bypass Duct	(1) Seizure of valve in LN_2 cooler line closed position. (Bypass line open)	LOSS OF SUBSYSTEM Insufficient cooling provided by LN_2 cooler. Some cooling would be derived from LN_2 boiloff	(A & B) NONE: Cooling provided by central system until T-185 sec. Excessive temperature buildup is not expected between T-185 & LIFT-OFF. (C) Possible Loss of other systems in instrument	(A & B) Launch Delay or Reschedule Detected through abnormal operation of LN_2 cooler. (C) POSSIBLE LOSS OF VEHICLE Through guidance error (Self Destruct or Destruct by RSO)
					(2) Seizure of valve in Bypass Line closed position. (LN_2 cooler line open)	LOSS OF SUBSYSTEM Too much cooling provided by LN_2 cooler during flight. Also reverse flow of air or GN_2 through the LN_2 cooler is possible resulting in too much preflight cooling.	(A) Possible loss of other subsystems in instrument unit. Reverse flow of GN_2 through LN_2 cooler would cause abnormally low temperature around V-IU-21-06 preflight A/C temperature probe.	(A & B) Launch Delay or Reschedule if Detected (C) POSSIBLE LOSS OF VEHICLE Through guidance error (Self Destruct or Destruct by RSO)
						Issue Date: 19 Jan 62	Prepared by: M-P&VE-EF	Approval: J. T. Gilbody

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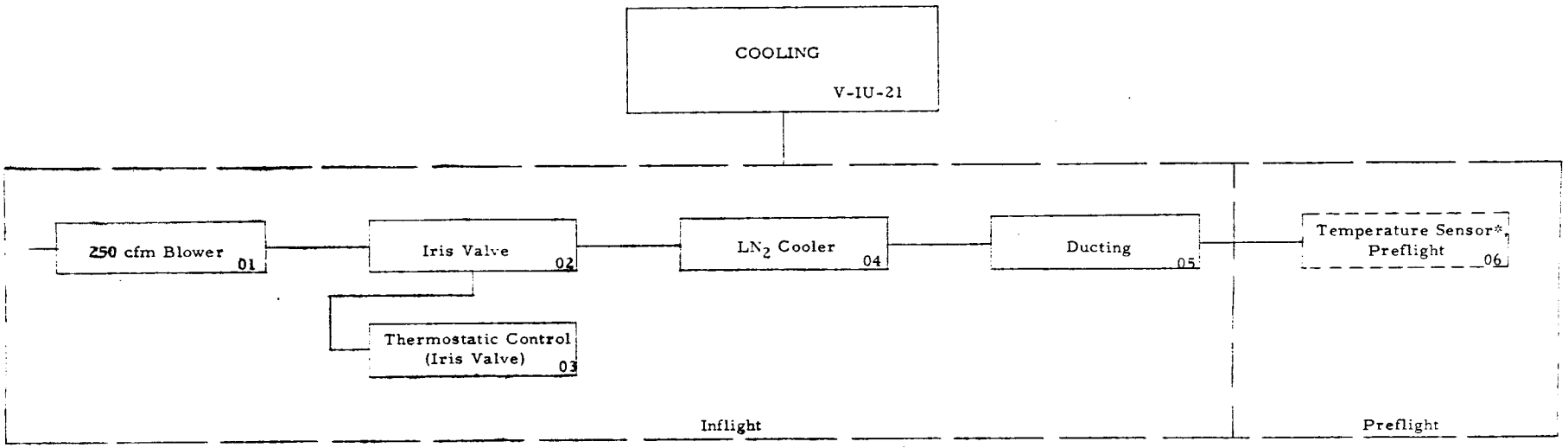
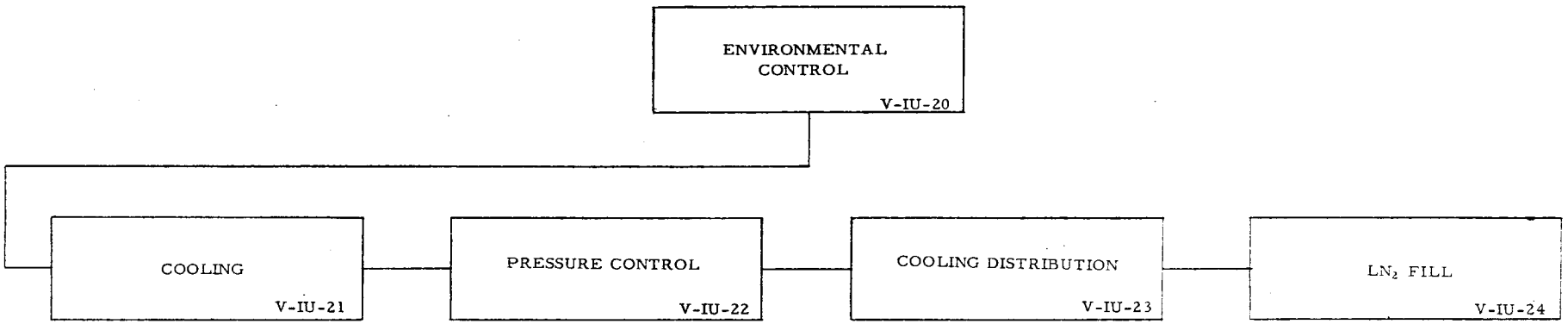
FAILURE EFFECT ANALYSIS



*Preflight Cooling System (GSE) is Functionally Dependent on V-IU-21-06

Issue Date: 19 Jan 62	Prepared by: M-P&VE-EF	Approval:

FAILURE EFFECT ANALYSIS



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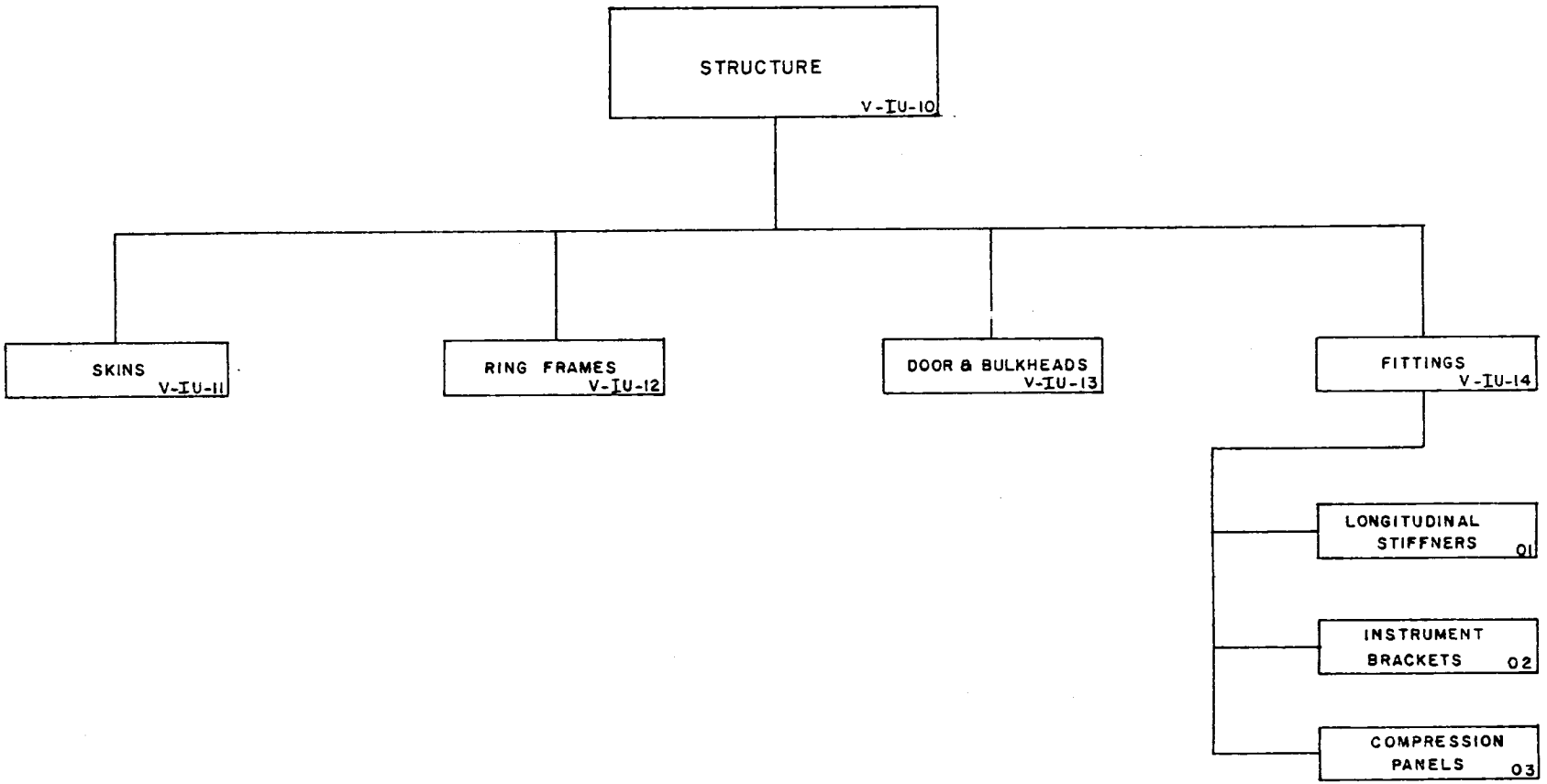
FAILURE EFFECT ANALYSIS



ISSUE DATE:	PREPARED BY:	APPROVAL:
November 3, 1961	M-P&VE-S	

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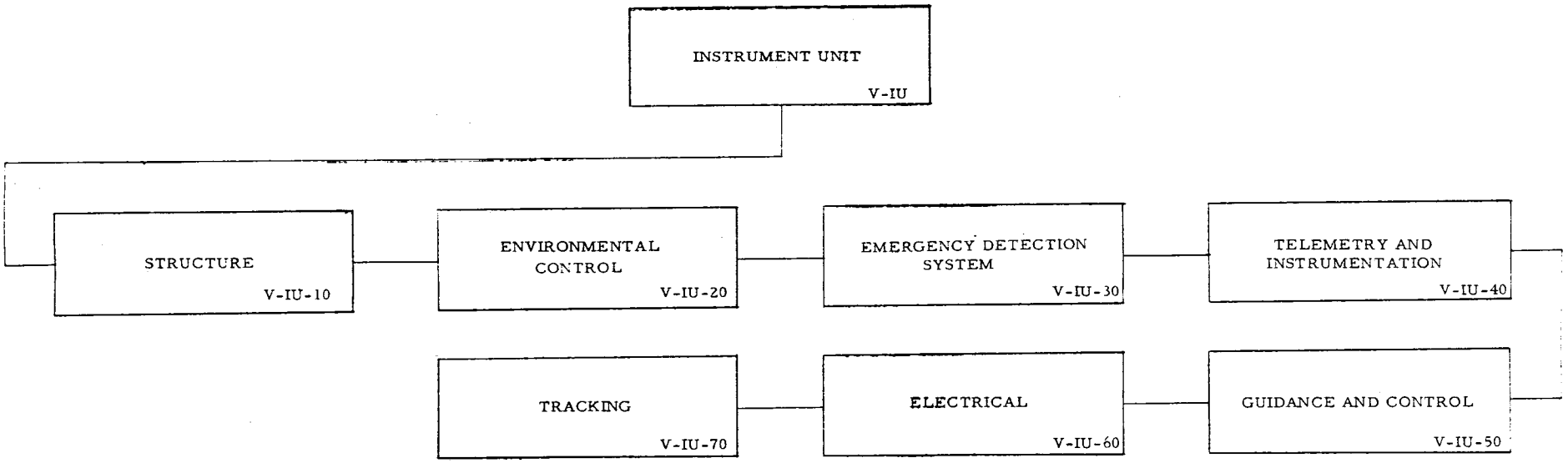
INSTRUMENT UNIT

FAILURE EFFECT ANALYSIS



Issue Date: Jan 19, 1962	Prepared by: M-P&VE-EF	Approval:

S&M Form #203-1 (August 1961)(OT)

**TEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

RANGE SAFETY SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	SEE ▲ NOTE ON M/M DIAGRAM FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	SEE ▲ NOTE ON M/M DIAGRAM FAILURE EFFECT ON S-IV STAGE
Aft Interface Separation Block (2)		4884325	1) Transmits explosive shock wave across S-IV aft interface (Either to or from S-I stage destruct system.)	1) Failure to transmit the explosive shock wave.	None; redundancy provided. Either block, of two, can transmit shock wave.	

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

RANGE SAFETY SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	SEE ⚠ NOTE ON M/M DIAGRAM FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	SEE ⚠ NOTE ON M/M DIAGRAM FAILURE EFFECT ON S-IV STAGE
Detonating Cord (2) (To LH_2 tank.)			1) Provides explosive train from S. & A. Device to linear shaped charge at LH_2 tank.	1) Failure to ignite when explosive shock wave is received.	None; redundancy provided.	
Shaped Charge (2) (At LH_2 tank.)			1) Ruptures tank, by explosion.	1) Failure to explode when explosive shock wave is received.	None; redundancy provided. Either one of two charges can rupture LH_2 tank.	
			2) Ignites detonating cord leading to single shaped charge at LOX tank.	1) Failure to ignite cord when explosive shock wave is received.	None; redundancy provided. Explosion of either one of the LH_2 tank charges can ignite both detonating cords.	
			3) Ignites detonating cord leading to aft interface connectors.	1) Failure to ignite cord when explosive shock wave is received.	None; redundancy provided. Explosion of either one of the LH_2 tank charges can ignite the cord.	
Detonating Cord (2) (To LOX tank.)			1) Provides explosive train to one end of single linear shaped charge at LOX tank.	1) Failure to ignite when explosive shock wave is received.	None; redundancy provided. Either cord, of two, can ignite the tank charge.	
Shaped Charge (At LOX tank.)			1) Ruptures tank, by explosion.	1) Failure to explode when explosive shock wave is received.	The degradation resulting from failure to rupture LOX tank by explosion of shaped charge will probably be offset by LOX tank rupture when LH_2 tank is blown apart.	
Detonating Cord (To aft interface separation blocks.)			1) Provides explosive train to aft interface for initiating S-I stage destruction from S-IV.	1) Failure to ignite when explosive shock wave is received.	Degradation to the extent of loss of the required capability for initiating destruction of S-I stage from S-IV.	
			2) Provides explosive train from aft interface for initiating S-IV stage destruction from S-I.	1) Failure to ignite when explosive shock wave is received.	Degradation to the extent of loss of the required capability for initiating destruction of S-IV stage from S-I.	

**TEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

RANGE SAFETY SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	SEE ▲ NOTE ON M/M DIAGRAM FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	SEE ▲ NOTE ON M/M DIAGRAM FAILURE EFFECT ON S-IV STAGE
EBW Detonator (2)		7865742	1) Ignites detonating cord leading to shaped charges at LH_2 tank. (Either one of two detonators can cause ignition in both cords.)	1) Failure to ignite cord when firing voltage is received.	None, redundancy provided. Either detonator can ignite both detonating cords.	
Safe & Arm Device			1) Provides mechanical interruption of explosive trains by placing a metal barrier between cords and detonators. (This device has reversible electro-mechanical capability. Ground operation causes device to move from "Safe" to "Arm" position approx. 10 seconds before lift-off.)	1) Failure to operate to, and maintain, arm position when required. (Due to lack of signal, open or short circuit, or damaged part.)	LOSS OF SUBSYSTEM The S. & A. Device is redundant for explosive trains, but is not redundant for electro-mechanical operation.	A) Scrub. B) Loss of capability for initiating destruction from S-IV stage. Initiation can be from S-I stage, if such stage is still attached.
			2) Provides operation signal circuit from umbilical to electro-mechanical actuator of the safe and arm device.	1) Failure due to open circuit.	LOSS OF SUBSYSTEM S. and A. device cannot be switched to arm position.	A) Scrub. B) None; device is switched to arm prior to flight.
				2) Failure due to short circuit to ground, or to adjacent power source.	POSSIBLE LOSS OF SUBSYSTEM Possible failure to ground could prevent switching S. and A. device. Possible failure to power source during flight could cause the safe and arm device to switch back to safe position.	A) Possible scrub. (Provided purge is adequate against short-circuit fire.) B) Possible loss of capability for initiating S-IV destruction. (Initiation can be from S-I stage if such stage is still attached.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS
RANGE SAFETY SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	SEE ▲ NOTE ON M/M DIAGRAM FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	SEE ▲ NOTE ON M/M DIAGRAM FAILURE EFFECT ON S-IV STAGE
C. D. Controller (cont'd)			3) Receives "Destruct" command, & triggers an associated exploding-bridgewire (EBW) firing unit.	1) Sending of trigger pulse without receipt of destruct signal. a) Sending of trigger pulse prior to arming S. & A. device.	None; redundancy provided. The failure causes firing of one detonator. Firing the remaining detonator can cause ignition of both detonating cords.	A) Delay in launching or scrub. B) None; device is armed prior to launch.
				b) Sending of trigger pulse after arming S. & A. device.	LOSS OF SUBSYSTEM Subsequent ignition of associated explosive train is assumed to happen	A) LOSS OF S-IV STAGE S. & A. Device is armed for approx. last 10 sec. of count-down. B) LOSS OF S-IV STAGE
				2) Failure to operate when destruct signal is received.	None; redundancy provided.	A) None; not required to operate prior to launch. B) None; redundancy provided.
Exploding Bridgewire (EBW) Firing Unit. (2)		7865719	1) Explodes associated EBW Detonator, upon receipt of trigger operating signal. (Unit is charged prior to lift-off and sends discharge thru bridgewire of detonator when triggered.)	1) Exploding detonator without receipt of destruct signal. a) Operation before safe & arm device is in arm position.	None; redundancy provided. The failure causes firing of one detonator. The other detonator can cause ignition of both detonating cords.	A) Delay in launching or scrub. B) None; S. & A. device is armed for approx. 10 seconds prior to flight.
				b) Operation after safe & arm device is in arm position. (After approx. T-10 seconds)	LOSS OF SUBSYSTEM Subsequent ignition of associated explosive train is assumed to happen.	A) LOSS OF S-IV STAGE S. & A. device is armed for approx. last 10 seconds of count-down. B) LOSS OF S-IV STAGE
				2) Failure to explode detonator when destruct signal is received.	None, redundancy provided.	A) None; not operational prior to launch. B) None; redundancy provided.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

RANGE SAFETY SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	SEE ▲ NOTE ON M/M DIAGRAM FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	SEE ▲ NOTE ON M/M DIAGRAM FAILURE EFFECT ON S-IV STAGE
Command Destruct Controller (2)			1) Transfers electric load of one command destruct receiver set from ground power supply circuit to a vehicle battery supply circuit, when required.	1) Failure while switch is in the external position, due to open or short circuit, or to damaged part.	None; redundancy provided.	A) Delay in launching or scrub. B) None; external position not used after launch.
				2) Failure to transfer when required. (At T-4 Minutes)	None; redundancy provided.	A) Scrub. B) None; transfer occurs prior to launch.
				3) Failure while switch is in the internal position due to open or short circuit, or to damaged part.	None; redundancy provided.	A) Delay in launching or scrub. B) None; redundancy provided.
			2) Upon receipt of "Arm" signal by receiver the arm relay is operated. (Closure of the arm relay causes engine cutoff, enables the destruct relay circuit, and enables the time delay relay circuit. Closure of the time delay relay circuit, by use of either a shorting bar or timer module, enables the EBW trigger circuit. NOTE: Complete arming of the R.S. Subsystem requires both the arm operation of receiver and the arm position of the Safe & Arm Device.	1) Operation of arm relay without receipt of arm signal from range safety officer.	None. Subsystem effectiveness not impaired.	A) Delay in launching or scrub. B) LOSS OF S-IV STAGE Operation of controller arming circuit causes cut-off of all S-IV engines.
				2) Failure to arm when arm signal is received.	None, redundancy provided.	A) Delay in launching or scrub. B) None; redundancy provided.
				3) Failure to maintain arm condition, due to open or short circuit, or damaged part.	None, redundancy provided.	A) Delay in launching or scrub. B) None; redundancy provided.

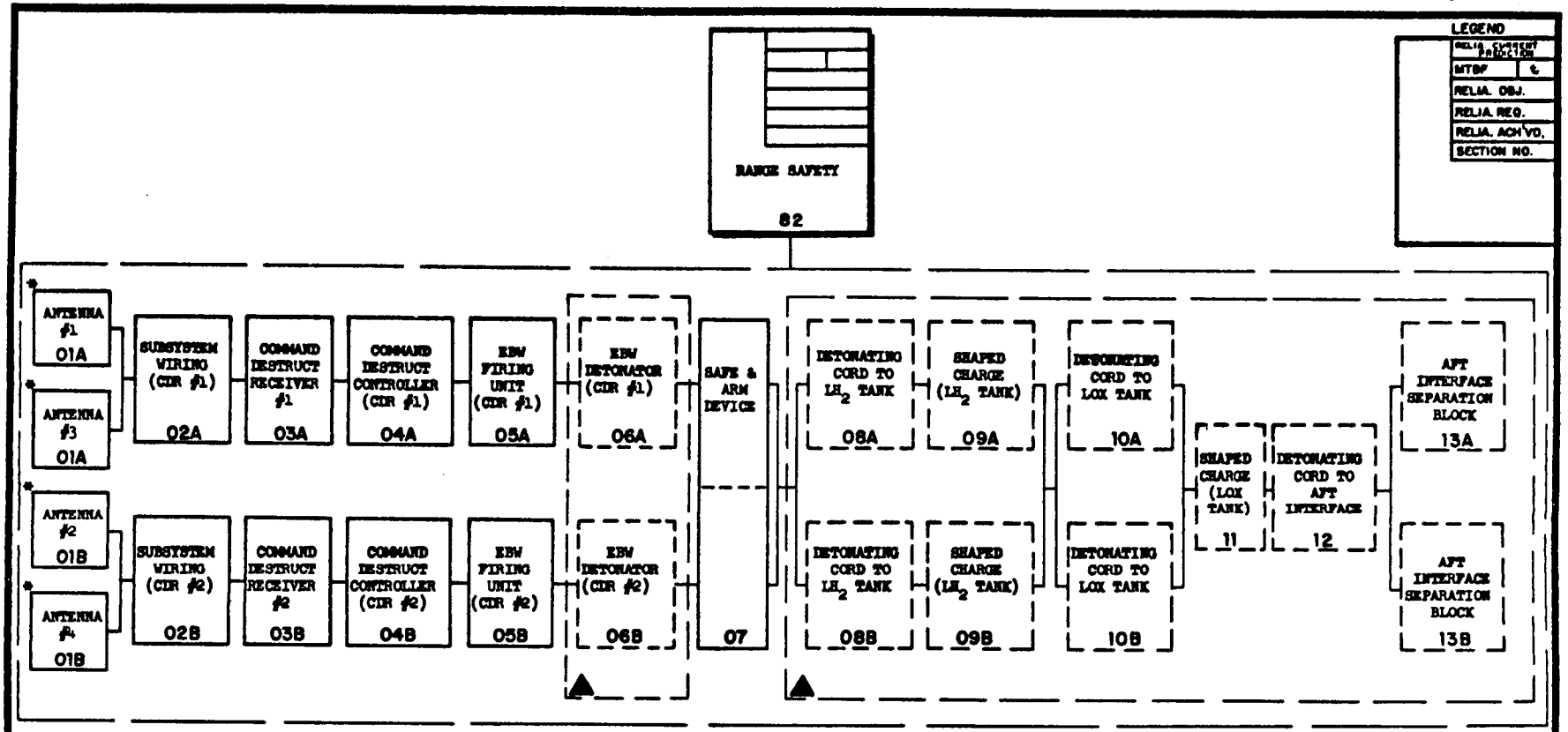
**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

RANGE SAFETY SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	SEE NOTE ▲ ON M/M DIAGRAM FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	SEE ▲ NOTE ON M/M DIAGRAM FAILURE EFFECT ON S-IV STAGE
Antenna (2 Pairs)		5883595 5883596	1) Receives command signals originated by range safety (RS) officer.	1) Failure due to open or short circuit, or damaged part.	None; redundancy provided. Each antenna pair, such as #1 & #3 or #2 and #4, together with associated Command Destruct Receiver (CDR), is physically redundant with other pair and its associated CDR. Patternwise the antenna pairs are designed to be complementary, i.e., the weak-signal area of one pair is the strong-signal area of the other pair for any vehicle attitude.	A) Delay in launching or scrub. B) None; redundancy provided
Subsystem Wiring (2)			1) Provides electrical connection between all associated units from a given pair of antennas to respective EBW detonator.	1) Failure to maintain connections between parts.	None; redundancy provided.	A) Delay in launching or scrub. B) None; redundancy provided
				2) Short circuit in wiring.	None; redundancy provided.	A) Possible scrub. (Provided purge is adequate against short-circuit fire.) B) None; redundancy provided
Command Destruct Receiver (CDR) (2)			1) Operates required controller relays on receipt of command signals. (Ground operations require receivers to be "on" approx. 1½ hours prior to lift-off.)	1) "On" prematurely. (Sooner than required.)	None. Capabilities of subsystem not affected.	A) Delay in launching or scrub. B) None; receiver is on prior to flight.
				2) Failure to turn on and remain on, due to failure of circuit or part.	None; redundancy provided.	A) Delay in launching or scrub. B) None; redundancy provided



*Antenna pair (#1 & #3, or #2 & #4) and the associated Command Destruct Receiver (CDR) is physically redundant with other pair and its associated CDR. Patternwise the antenna pairs are designed to be complementary, i.e., the weak-signal area of one pair is the strong-signal area of the other pair for any vehicle attitude.

▲ Denotes components which do not operate unless some failure has caused: a) Range Safety Officer to activate the destruct command signal, or b) detonation of the explosive train without receipt of destruct signal. Accordingly, any failure of any of these components is considered a "double" failure insofar as the S-IV stage is concerned. The effect of these latter failures is included in the attached failure effect analysis only to the exten that they affect subsystem reliability. Their effect on the S-IV stage is not included in the analysis.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

TELEMETRY SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Subsystem Wiring (Cont)				2) Short Circuit in wiring.	POSSIBLE LOSS OF SUBSYSTEM	A) Delay in launching. (Provided purge is adequate) B) POSSIBLE LOSS OF S-IV STAGE (Short circuit and fire could occur in an area containing oxygen-rich atmosphere.)
Antenna (4)		5883605 5883606	1) Transmits all outgoing telemetry signals from S-IV stage.	Failure due to open or short circuit, or damaged part.	POSSIBLE LOSS OF SUBSYSTEM (Single failure may or may not constitute subsystem failure, i.e., system degradation from single failure may still permit transmission of useable (reducible) information.	A) Delay in launching. B) Possible loss of all telemetry data.
Directional Coupler		7883956	1) Provides incident and reflected power levels from which the Standing Wave Ratio of one antenna is determined.	Failure due to open or short circuit, or damaged part.	POSSIBLE LOSS OF SUBSYSTEM (Failure of directional coupler could cause loss of associated antenna and, under unfavorable circumstances of the worst kind possible, could cause loss of all reception by ground stations.)	A) Delay in launching B) Possible loss of all telemetry data.

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A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS
TELEMETRY SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Subcarrier Oscillators (9) (Telemetry Set #2)		7869834	1) Converts multicoder PDM output signals into varying frequencies for output to wideband amplifier.	Failure due to open or short circuit, or damaged part.	Possible loss of all of group D, & E input signals.	A) Delay in launching. B) Possible loss of all telemetry from set #2. (Information from group D & E transducers.)
Wideband Amplifier (Telemetry Set #2.)		7869830	1) Converts input signals from subcarrier oscillators into voltages of required amplification for modulation of transmitter set #2.	Failure due to open or short circuit, or damaged part.	Possible loss of all of group D, & E input signals.	A) Delay in launching. B) Possible loss of all telemetry monitoring from set #2. (Information from group D & E transducers.)
Transmitter Set #2		7869831	1) Transmits all telemetry signals from group D, & E transducer inputs.	Failure due to open or short circuit, or damaged part.	Possible loss of all of group D & E input signals.	A) Possible delay in launching. B) Possible loss of all telemetry monitoring from set #2. (Information from group D & E transducers.)
Triplexer		7883543	1) Integrates all signals from telemetry sets 1, 2 & 3, for transmission from vehicle.	Failure due to open or short circuit, or damaged part.	POSSIBLE LOSS OF SUBSYSTEM (Open or short circuit in output of triplexer could cause loss of all telemetry output.)	A) Delay in launching. B) Possible loss of all telemetry data. (Loss of all learning capability.)
Power Divider			1) Distributes telemetry signals equally among four antennas.	Failure due to open or short circuit, or damaged part.	POSSIBLE LOSS OF SUBSYSTEM (Open or short circuit in input of power divider could cause loss of all telemetry output.)	A) Delay in launching. B) Possible loss of all telemetry data.
Subsystem Wiring			1) Connects, electrically all components of telemetry subsystem. (Includes telemetry power supply wiring from the internal-external switch, M/M code 51-05.)	1) Failure to maintain connections between parts.	POSSIBLE LOSS OF SUBSYSTEM	A) Delay in launching. B) Possible loss of all telemetry data.

**TITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

TELEMETRY SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Group D Transducers (Only Those Signals Going Through 90 x 10 Multi-coder of Set #2.)		Ref: DSV-4 Section List	1) Provides input signals to subsystem from vehicle. (For monitoring of a performance, or a condition)	Failure to send input due to open or short circuit, or damaged part.	Loss of single input (from failed transducer) into subsystem.	A) Possible delay in launching. B) Loss of some monitoring capability.
Group E Transducers (Only Those Signals Routed Directly to Set #2. Oscillators.)		Ref: DSV-4 Section List	1) Provides input signals to subsystem from vehicle. (For monitoring of a performance, or a condition)	Failure to send input due to open or short circuit, or damaged part.	Loss of single input (from failed transducer) into subsystem.	A) Possible delay in launching. B) Loss of some mointoring capability.
Interconnect Bracket, Set #2. (Wiring Junction)			1) Provides junction and routing point for connecting wiring from group D.transducers to multicoder of set #2. Signals from group E are interconnected directly to oscillators.	Failure to maintain the required connections due to open or short circuit or damaged part.	Loss of some of the inputs to subsystem from group D & E transducers.	A) Delay in launching. B) Loss of some monitoring capability.
90 x 10 Multicoder, Set #2. (Commutator - Keyer)		7869832	1) Sequences inputs from group D transducers and selects telemetry samples from each in turn. 2) Converts input signals into pulse-duration modulated (PDM) type signals.	Failure due to open or short circuit or damaged part.	Possible loss of group D, inputs into subsystem.	A). Delay in launching. B) Possible loss of all telemetry from group D transducers.

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A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS
TELEMETRY SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Subcarrier Oscillators (10 (Telemetry Set #1)		7869834	1) Converts multicoder PDM output signals into varying frequencies for output to wideband amplifier.	Failure due to open or short circuit, or damaged part.	Possible loss of all of group A, and part of group B, input signals.	A) Delay in launching. B) Possible loss of all telemetry monitoring from set #1. (Information from group A, and part of group B, transducers.)
Subcarrier Oscillators (Telemetry Set #3)		7869834	1) Converts multicoder PDM output signals into varying frequencies for output to wideband amplifier.	Failure due to open or short circuit, or damaged part.	Possible loss of all of group C, and part of group B, input signals.	A) Delay in launching. B) Possible loss of all telemetry monitoring from set #3. (Information from group C, and Part of group B, transducers.)
Wideband Amplifier (Telemetry Set #1.)		7869830	1) Converts input signals from subcarrier oscillators into voltages of required amplification for modulation of transmitter set #1.	Failure due to open or short circuit, or damaged part.	Possible loss of all of group A, and part of group B, input signals.	A) Delay in launching. B) Possible loss of all telemetry monitoring from set #1. (Information from group A, and part of group B, transducers.)
Wideband Amplifier (Telemetry Set #3)		7869830	1) Converts input signals from subcarrier oscillators into voltage of required amplification for modulation of transmitter set #3.	Failure due to open or short circuit, or damaged part.	Possible loss of all of group C, and part of group B, input signals.	A) Delay in launching. B) Possible loss of all telemetry monitoring from set No. 3, (Information from group C, and part of group B, transducers.)
Transmitter Set #1.		7869831	1) Transmits all telemetry signals from group A, and part of group B, transducer inputs.	Failure due to open or short circuits, or damaged part.	Possible loss of all of group A, and part of group B, inputs.	A) Delay in launching. B) Possible loss of all telemetry monitoring from set #1. (Information from groupA, and part of group B, transducers.)
Transmitter Set #3.		7869831	1) Transmits all telemetry signals from group C, and part of group B, transducer inputs.	Failure due to open or short circuit, or damaged part.	Possible loss of all of group C, and part of group B, input signals.	A) Delay in launching. B) Possible loss of all telemetry monitoring from set #3. (Information from group C, and part of group B, transducers.)

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

TELEMETRY SUBSYSTEM

ITEM	*	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Group C Transducers (Only Those Signals Going Through 45 x 2½ Multicoder)		Ref: DSV-4 Section List	1) Provides input signals to subsystem from vehicle. (For monitoring of a performance, or a condition)	Failure to send input due to open or short circuit, or damaged part.	Loss of single input (from failed transducer) into subsystem.	A) Possible delay in launching. B) Loss of some monitoring capability.
Interconnect Bracket, Sets #1 & 3 (Wiring Junction)			1) Provides junction and routing point for connecting wiring from group A & C transducers to two multicoders. Signals from group B are interconnected directly to oscillators.	Failure to maintain the required connections due to open or short circuit, or damaged part.	Loss of some of the inputs to subsystem from group A, B, and C transducers.	A) Delay in launching. B) Loss of some monitoring capability.
90 x 10 Multicoder, Set #1 (Commutator - Keyer)		7869832	1) Sequences 86 inputs from group A transducers and selects telemetry samples from each, in turn. 2) Converts input signals into pulse-duration modulated (PDM) type signals.	Failure due to open or short circuit, or damaged part.	Possible loss of group A inputs into subsystem.	A) Delay in launching. B) Possible loss of all telemetry from group A transducers.
45 x 2½ Multicoder (Commutator, Amplifier, and Keyer.)		7869833	1) Sequences 41 inputs from group C transducers and selects telemetry sample from each, in turn. 2) Amplifies low-level signals to level necessary for proper operation of oscillators. 3) Converts input signals into pulse-duration modulated (PDM) type signals.	Failure due to open or short circuit, or damaged part.	Possible loss of group C inputs into subsystem.	A) Delay in launching. B) Possible loss of all telemetry from group C transducers.

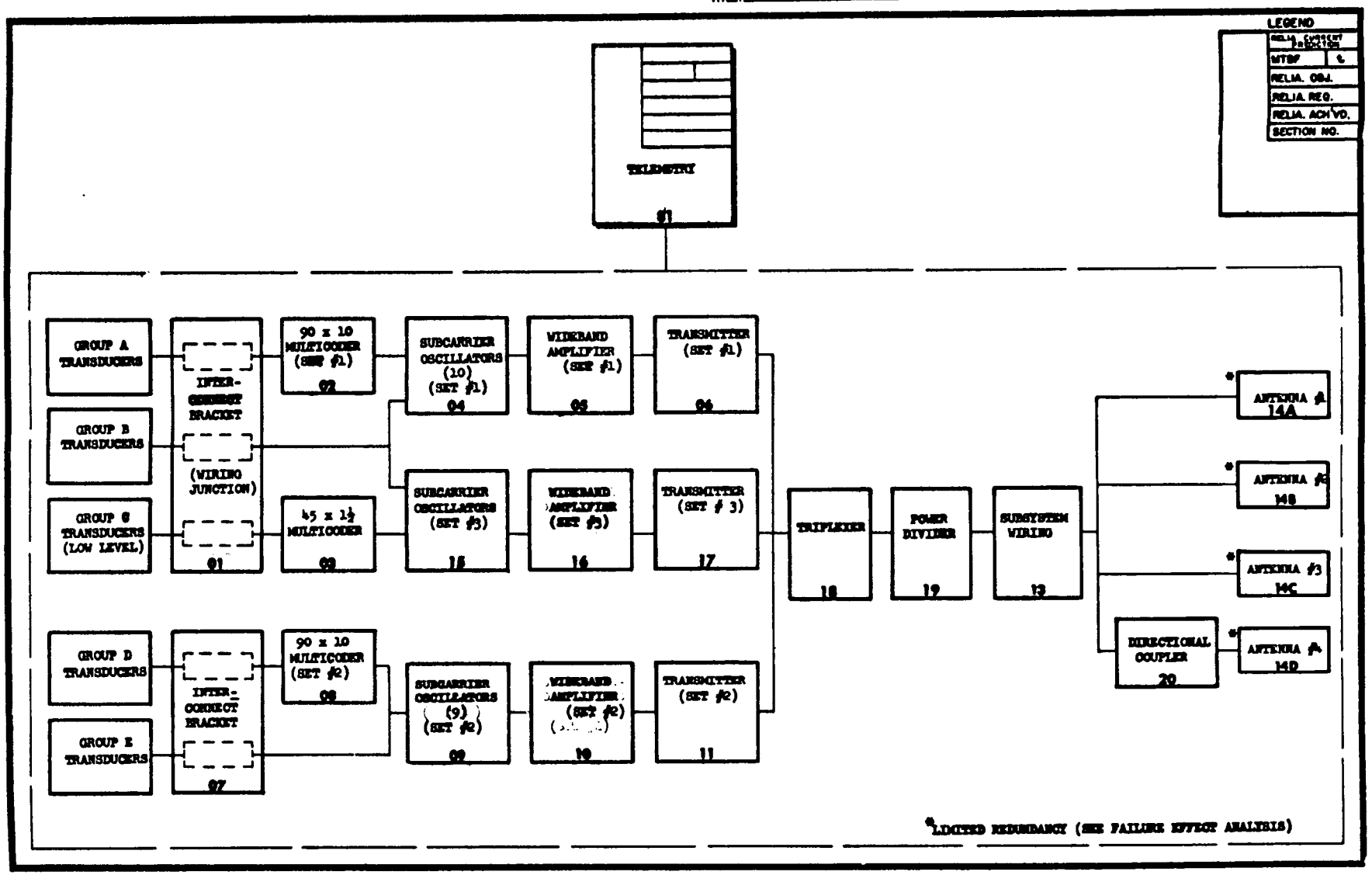
**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

TELEMETRY SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Group A Transducers (Only These Signals Going Through 90 x 10 Multi-coder of Set #1)		Ref: DSV-4 Section List	1) Provides input signals to subsystem from vehicle. (For monitoring of a performance, or a condition)	Failure to send input due to open or short circuit, or damaged part.	Loss of single input (from failed transducer) into subsystem.	A) Possible delay in launching. B) Loss of some monitoring capability.
Group B Transducers (Only Those Signals Routed Directly to Oscillators of Set #1 or Set #3)		Ref: DSV-4 Section List	1) Provides input signals to subsystem from vehicle. (For monitoring of a performance, or a condition.)	Failure to send input due to open or short circuit, or damaged part.	Loss of single input (from failed transducer) into subsystem.	A) Possible delay in launching. B) Loss of some monitoring capability.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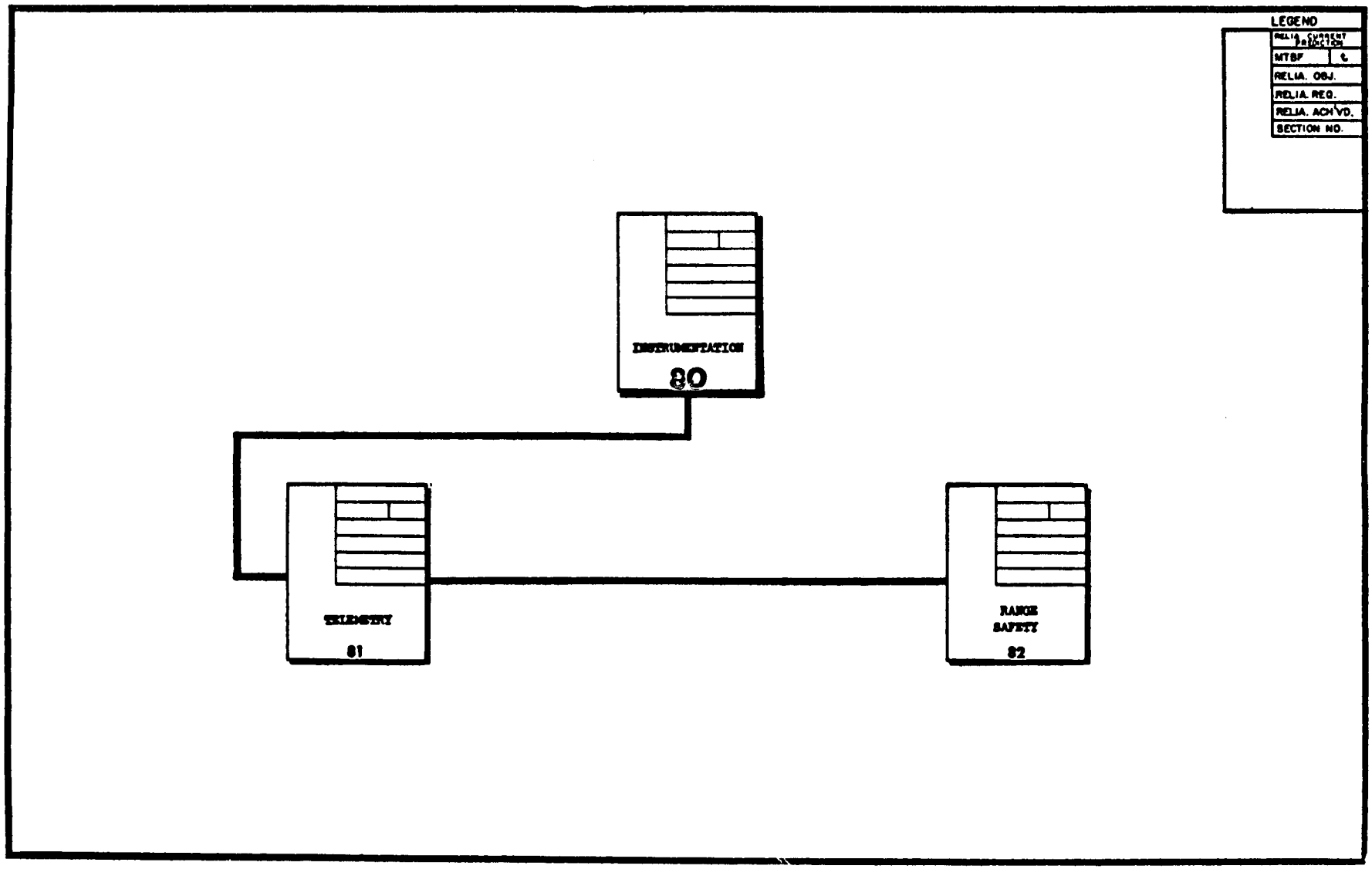
TELEMETRY
01
GROUP A TRANSDUCERS
GROUP B TRANSDUCERS
GROUP C TRANSDUCERS (LOW LEVEL)
INTER-CONNECT BRACKET
(WIRING JUNCTION)
01
90 x 10 MULTICODER (SET #1)
02
45 x 1½ MULTICODER
03
SUBCARRIER OSCILLATORS (10) (SET #1)
04
SUBCARRIER OSCILLATORS (SET #3)
15
WIDEBAND AMPLIFIER (SET #1)
05
WIDEBAND AMPLIFIER (SET #3)
16
TRANSMITTER (SET #1)
06
TRANSMITTER (SET # 3)
17
TRIPLEXER
18
POWER DIVIDER
19
SUBSYSTEM WIRING
13
ANTENNA #1
14A
ANTENNA #2
14B
ANTENNA #3
14C
ANTENNA #4
14D
DIRECTIONAL COUPLER
20
GROUP D TRANSDUCERS
GROUP E TRANSDUCERS
INTER-CONNECT BRACKET
07
90 x 10 MULTICODER (SET #2)
08
SUBCARRIER OSCILLATORS (9) (SET #2)
09
WIDEBAND AMPLIFIER (SET #2)
10
TRANSMITTER (SET #2)
11
*LIMITED REDUNDANCY (SEE FAILURE EFFECT ANALYSIS)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SECTION NO.
INSTRUMENTATION
80
TELEMETRY
81
RANGE SAFETY
82

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

S-IV SEQUENCING SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Engine-Out Pressure Switch (Two switches are associated with each engine.) (continued)			B) The second time interval is the period covering approximately 90% of flight time after the engine start. During this second period, fallback to pressure-off position by both switches of a given engine results in sequencer operation to cause single-engine cutoff as follows: 1) Closure of the prestart and the start solenoid valves of the associated engine. 2) Isolation of respective sensor circuit with respect to all-engine cutoff circuit. C) The third time interval is approximately the last 10% of S-IV flight and extends from the moment sequencer receives the all-engine-cutoff arming signal to the end of flight. During this third period, fallback to pressure-off position by both switches of a given engine results in sequencer operation to close propellant valves to all engines. (In the event of each single-engine cutoff, and of all engine cutoff, sequencer sends signal to guidance and control package.)	2) Operation failure on fallback (Single switch fails to operate to the pressure-off position when the operating pressure in associated engine drops below normal value.) a) Failure during second time period. (All-engine-cutoff is not armed.)	PARTIAL LOSS OF SUBSYSTEM Loss of single-engine cutoff capability with respect to the engine associated with failed switch. Balance of subsystem capabilities not affected.	A) None; not operational prior to launch. B) None for single failure. The loss of single-engine cutoff capability for a failed engine results in propellant valves remaining open in that engine. Explosion of unburned propellant possibly could result.
				b) Failure during third time period. (All-engine-cutoff is armed.)	PARTIAL LOSS OF SUBSYSTEM Loss of capability for an all-engine-cutoff based on stopped engine. All-engine-cutoff will occur upon stoppage of "next engine" of those still operating.	A) None; not operational prior to launch. B) This single failure is significant only if the associated engine is also the first one, of six, to stop. In such case, during the time between first and second engine stoppage unburned propellant from open valves in first engine possibly could cause explosion.
				3) Premature operation. (Single switch returns to pressure-off position while engine is operating satisfactorily, in any time period	None for single failure. Each switch of a given engine is redundant for subsystem engine-cutoff success, i. e. the sequencer cannot cause false cutoff of single engine, or of all engines, due to premature-operation-failure of single switch.	A) None; not operational prior to launch. B) None; redundancy provided. Both switches of a given engine must go to pressure-off position to cause single engine cutoff or to cause all-engine cutoff.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

S-IV SEQUENCING SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
S-IV Sequencer (continued)				b) Failure to operate on signal for all-engine cutoff. Signal may come from: 1) Guidance computer. 2) As a result of S-IV stage fuel depletion. 3) Range safety requirements.	PARTIAL LOSS OF SUBSYSTEM Loss of capability to cutoff all engines leaves balance of sequencer unaffected.	A) None; not operational prior to launch. B) POSSIBLE LOSS OF S-IV STAGE 1) Failure to operate on signal from guidance could cause loss of critical mission. 2) POSSIBLE LOSS OF S-IV STAGE Failure to operate on in-stage all-engine-cutoff signal could cause loss of mission. 3) Loss of required capability for cut off of all engines by range safety officer.
Engine-Out Pressure Switch (Two switches are associated with each engine.)			1) Each switch functions individually as a sensor of below-normal operating pressure in the associated engine. Note: A) In this analysis S-IV flight time is separated into three intervals. In the first, a period of three seconds after engine-start signal, the switch sensor circuits to sequencer are open (inoperative) to allow engine operating pressure to build up.	1) Operation Failure on pickup. (Single switch fails to operate to the pressure-on position as the operating pressure in associated engine reaches normal value) a) Failure during second time period. (All-engine-cutoff is not armed.)	None; redundancy provided. The associated engine will start and operate satisfactorily, and single-engine cutoff of this engine can occur with fallback of the respective other pressure switch.	A) None; not operation prior to launch. B) None; redundancy provided.
				b) Failure during third time period. (All-engine-cutoff is armed)	None; redundancy provided. The associated engine can continue operation, and all-engine cutoff can occur with fallback of respective other switch.	A) None; not operational prior to launch. B) None; redundancy provided.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS
S-IV SEQUENCING SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
S-IV Sequencer (continued)				(Operation failure, sequencer function 1), cont'd.)		5. LOSS OF S-IV STAGE Due to loss of signal to both helium heater igniters. 6. Loss of signal to both retro rocket EBW firing units possibly could cause mission failure. 7. Loss of signal for all ullage rocket ejection could cause loss of critical mission due to unejected weight.
			2) Controls engine cutoff circuitry. (Closes propellant valves for single engine stoppage, or for all-engine cutoff.	1) Premature Operation a) Single failure causing one-engine cutoff sooner than required.	PARTIAL LOSS OF SUBSYSTEM Expenditure of one-engine cut-off capability, as indicated, leaves the balance of sequencer capabilities unaffected.	A) None; not operational prior to launch. B) LOSS OF ONE ENGINE
				b) Single failure causing all-engine cutoff sooner than required.	PARTIAL LOSS OF SUBSYSTEM Expenditure of all-engine cut-off capability, as indicated, leaves the balance of sequencer capabilities unaffected	A) None; not operational prior to launch. B) LOSS OF S-IV STAGE Premature arming of all-engine-cutoff circuit occurring ahead of engine-start signal would prevent any start of S-IV engines. Premature operation of the all-engine-cutoff relay would stop all engines.
				2) Failure to operate when required. a) Failure to operate on signal for single engine cutoff, (Signal originates when both pressure switches of a given engine fall back to pressure-off position.)	PARTIAL LOSS OF SUBSYSTEM Loss of capability to operate single-engine cutoff leaves balance of sequencer unaffected.	A) None; not operational prior to launch. B) The engine failure plus sequencer failure to close respective propellant valves, possibly could cause explosion of unburned propellant.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

S-IV SEQUENCING SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
S-IV Sequencer (continued)				(Premature operation failure, sequencer funct. 1), cont'd.)		4. LOSS OF S-IV STAGE Due to premature operation of all four ullage rockets and premature explosion of all stage-separation explosive nuts. 5. Premature operation of both retro rockets possibly could cause mission failure.
				2) Operation Failure (A single failure in sequencer which results in failure to send, maintain, or to stop, one or more required output signals.)	PARTIAL LOSS OF SUBSYSTEM Output signal is not in normal sequence.	A) None; not operational prior to launch. B) For any given component, the effect of failure to operate when required, and of failure to stop operating when required, is identical to the effect described for similar type of failure in the failure effect analysis of that component, except: 1. LOSS OF S-IV STAGE Due to loss of signal to all prestart solenoid valves. 2. LOSS OF S-IV STAGE Due to loss of signal to all start solenoid valves. 3. LOSS OF S-IV STAGE Due to loss of signal to all engine ignition exciters. 4. LOSS OF S-IV STAGE Due to loss of trigger signal to all EBW firing units of explosive nuts, and of ullage rockets.

**TITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

S-IV SEQUENCING SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Aft Interface Connector (Includes wiring between connector and sequencer.)			1) Provides electrical connection across aft interface for all circuits between sequencer and S-I Stage. (Includes the wiring between S-IV half of connector and the sequencer unit.)	1) Failure due to open or short circuit, or damaged part.	POSSIBLE LOSS OF SUBSYSTEM The significance of any single failure is dependent on when and where, i. e. what time in flight, and where in S-IV vehicle, the circuit failure occurs.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE Single failure during first 100 seconds of S-I flight could cause no prestart signal from S-I to sequencer. Resultant lack of sequencer output signal for engine cooldown would cause loss of stage.
S-IV Sequencer			1) On receipt of signals from S-I stage, or from guidance and control computer, sequences all normal in-flight functions of S-IV stage. (With the exception of engine cutoff functions, which are analyzed below.) NOTE: By design, the essential parts of the sequencer assembly consist of power bus circuits, signal circuits for inputs to the sequencer, associated relays, and signal circuits for sequencer outputs. The terms "on", "off", and "running", are not applicable to the sequencer unit in connection with operating time or cycle inasmuch as bus circuits could be energized ("on") and no operation would occur.	1) Premature operation. (Any output signal earlier than required for normal flight, due to short circuit or damaged part in sequencer.)	PARTIAL LOSS OF SUBSYSTEM Output signal is not in normal sequence.	A) POSSIBLE LOSS OF S-IV STAGE (Example: Premature firing of ullage rockets creates explosion hazard due to proximity to explosive atmosphere.) B) The effect of a premature actuating signal to a given component is identical to the effect described under "premature operation" failure in the failure effect analysis of that component, except: 1. POSSIBLE LOSS OF S-IV STAGE Due to premature operation of all six prestart solenoid valves. 2. LOSS OF S-IV STAGE Due to premature operation of all six start solenoid valves 3. LOSS OF S-IV STAGE Due to premature operation of all six engine ignition exciters.

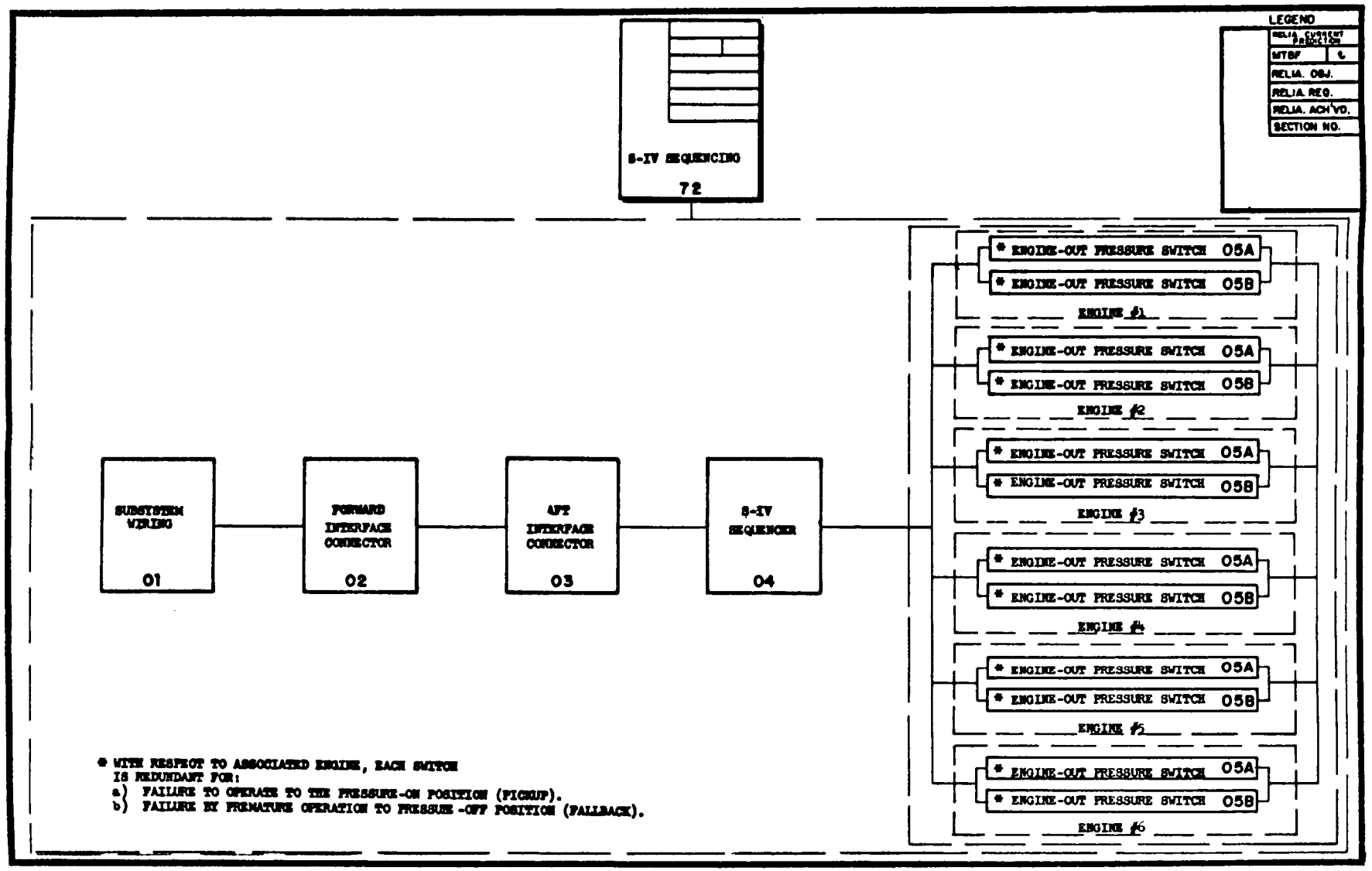
**TEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

S-IV SEQUENCING SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Subsystem Wiring			1) Connects, electrically, between sequencer and all S-IV components wired to sequencer, with the exception of the fore and aft interface connectors.	1) Open circuit in wiring.	POSSIBLE LOSS OF SUBSYSTEM The significance of any single failure is dependent on when and where, i. e. what time in flight, and where in S-IV vehicle, the circuit failure occurs.	A) Delay in launching or scrub. B) The effect of an "open" in actuating circuit of a given component is identical to the effect described under "failure-to-operate" in the failure effect analysis of that component.
				2) Short circuit in wiring. (Short to ground, or between wires.)	POSSIBLE LOSS OF SUBSYSTEM The significance of any single failure is dependent on when and where, i. e. what time in flight, and where in S-IV vehicle, the circuit failure occurs.	A) Delay in launching or scrub. (Provided purge is adequate against short-circuit fire.) B) POSSIBLE LOSS OF S-IV STAGE Short circuit could cause critical loss of electric power, cause fire in an area containing oxygen-rich atmosphere, or cause out-of-sequence operation of some component.
Forward Interface Connector (Includes Wiring Between Connector and Sequencer.)			1) Provides electrical connection across forward interface for all circuits between sequencer and guidance & control package. (Includes wiring between the S-IV half of connector and the sequencer unit.)	1) Failure due to open or short circuit, or damaged part.	POSSIBLE LOSS OF SUBSYSTEM The significance of any single failure is dependent on when and where, i. e. what time in flight, and where in S-IV vehicle, the circuit failure occurs.	A) Delay in launching or scrub B) PROBABLE LOSS OF S-IV STAGE Due to interruption of G. & C. computer control circuits to sequencer.



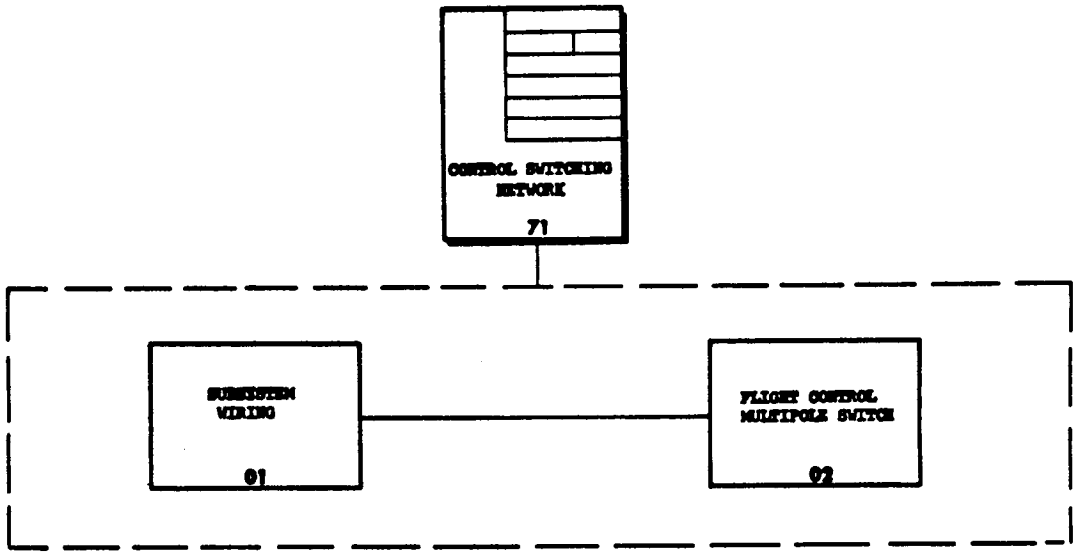
* WITH RESPECT TO ASSOCIATED ENGINE, EACH SWITCH IS REDUNDANT FOR:
a) FAILURE TO OPERATE TO THE PRESSURE-ON POSITION (PICKUP).
b) FAILURE BY PREMATURE OPERATION TO PRESSURE-OFF POSITION (FALLBACK).

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

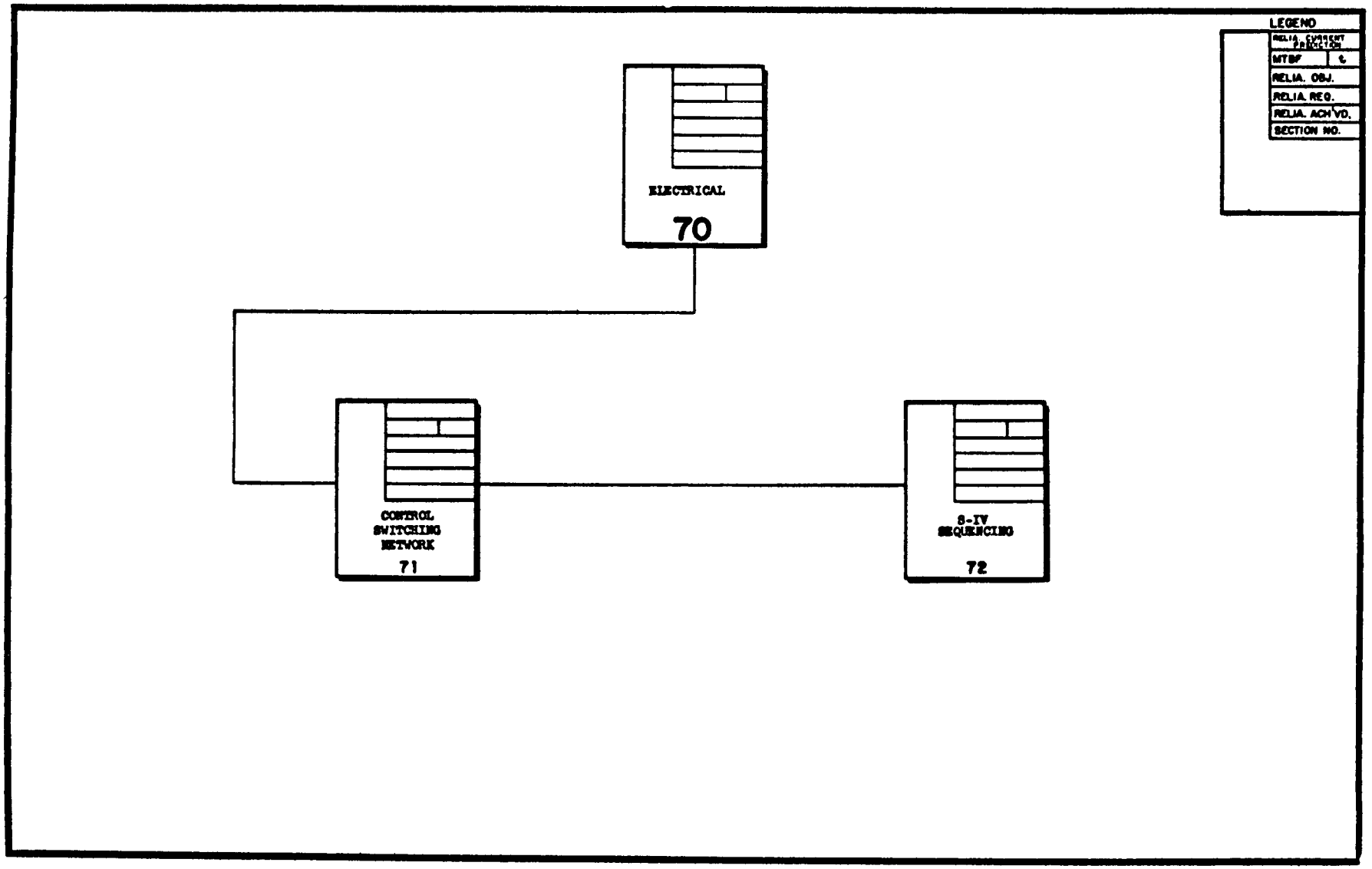
A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS
CONTROL SWITCHING NETWORK SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Subsystem Wiring (Includes S-IV half of electrical connectors at fore and aft interfaces, all subsystem wiring between them and flight control multipole switch and all subsystem wiring from switch to S-IV components.)			1) Provides control circuits from guidance and control computer through the S-IV stage, for S-I stage engine position control.	1) Open or short circuit.	POSSIBLE LOSS OF SUBSYSTEM (Significance of the failure effect depends on time and location of occurrence. A single short circuit, with resultant fire, possibly could affect numerous adjacent circuits.)	A) Delay in launching, or scrub. B) POSSIBLE LOSS OF S-IV STAGE (Due to possible loss of control of S-I engines.)
			2) After transfer is made, provides control circuits from computer to S-IV stage engine position control.	1) Open or short circuit.	POSSIBLE LOSS OF SUBSYSTEM (Significance of the failure effect depends on time and location of occurrence. A single short circuit, with resultant fire, possibly could affect numerous adjacent circuits.)	A) Delay in launching, or scrub. B) POSSIBLE LOSS OF S-IV STAGE (Due to possible loss of control of S-IV engines.)
Flight Control Multipole Switch (For flight control circuits governing engine positions, together with associated feedback transducer and telemetry circuits. The switch has reversible break-before-make type operation.)		7866039	1) Connects control circuits from G&C computer with circuits leading via S-IV aft interface, to S-I engine position control units.	1) Premature operation. (Transfer from S-I to S-IV earlier than required.)	LOSS OF SUBSYSTEM (Circuits to S-I interrupted.)	A) Delay in launching, or scrub. B) POSSIBLE LOSS OF S-IV STAGE (Due to no control circuits to S-I engines.)
			2) When required, transfers the connection of these control circuits to circuits leading to S-IV engine position control units.	2) Failure to operate (transfer, S-I to S-IV) when required.	LOSS OF SUBSYSTEM (Circuits for S-IV engines not established.)	A) Delay in launching, or scrub. B) LOSS OF S-IV STAGE (Due to no control circuits to S-IV engines.)
				3) Failure to maintain connection to S-I or S-IV wiring due open or short circuit, or damaged part, in the the switch.	POSSIBLE LOSS OF SUBSYSTEM (Significance of the failure effect depends on time and location of occurrence. A single mechanical failure could affect numerous circuits.)	A) Delay in launching, or scrub. B) POSSIBLE LOSS OF S-IV STAGE (Mechanical failure could cause loss of all S-I or S-IV engine control.)



LEGEND	
RELIA. CURRENT PREDICTION	
MTBF	ℓ
RELIA. OBJ.	
RELIA. REQ.	
RELIA. ACH'VD.	
SECTION NO.	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MTBF
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RELIA. OBJ.
RELIA. REQ.
RELIA. ACH'VD.
SECTION NO.
ELECTRICAL
70
CONTROL SWITCHING NETWORK
71
S-IV SEQUENCING
72

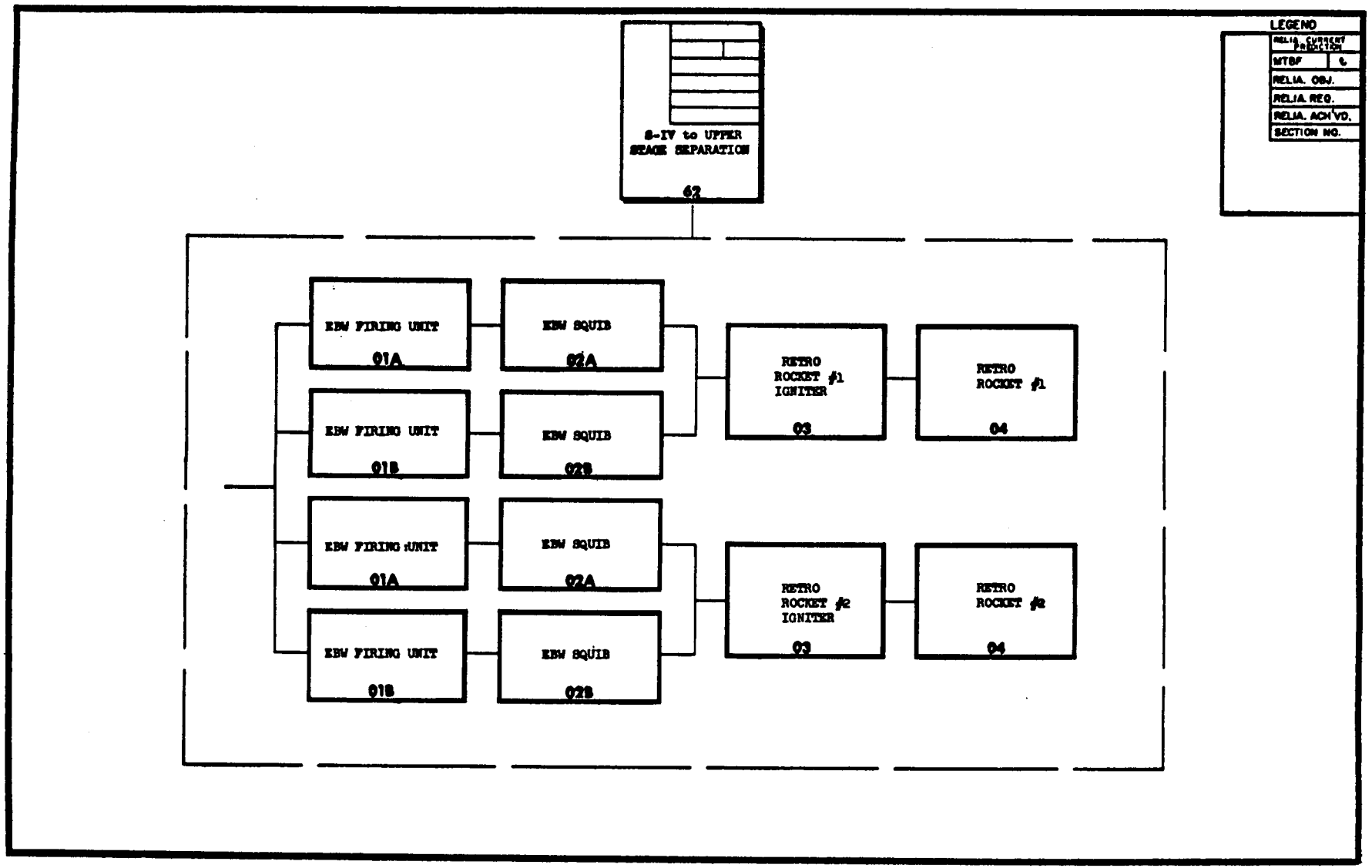
**TEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

S-IV TO UPPER STAGE SEPARATION SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
EBW Firing Unit (4) (For Retro Rocket Ignition.)		7865719	Explodes bridge wire in an associated EBW squib upon receipt of electrical signal.	1) Failure to explode bridge wire.	None; two EBW units are provided for each retro rocket. (Either unit can cause rocket ignition.)	A) None; not operational prior to launch. B) None; redundancy provided.
				2) Premature explosion of wire. (Subsequent ignition of associated explosive train with consequent firing of one rocket is assumed to happen.)	None; redundancy provided. (Satisfactory separation may be secured with one retro rocket.)	A) POSSIBLE LOSS OF S-IV STAGE (Creates explosion hazard due to proximity to explosive atmosphere.) B) None; stage rotation and drift due to single premature retro rocket ignition is not sufficient at any time to cause loss of vehicle control, or to cause collision during stage separation.
EBW Squib (4) (For Retro Rocket Ignition.)			Activates ullage rocket igniter.	1) Failure to start igniter.	None; two squibs are provided for each rocket. (Either one can start the rocket igniter.	A) None; not operational prior to launch. B) None; redundancy provided.
Retro Rocket Igniter (2)			Starts rocket motor.	1) Failure to start motor.	None; two rockets each with an individual igniter are provided. (Starting and operating one rocket will secure a satisfactory separation.)	A) None; not operational prior to launch. B) None; redundancy provided.
Retro Rocket (2)		7851872	Gives backward thrust to DSV4 vehicle at start of S-IV from upper stage separation.	1) Failure to provide thrust.	None; two rockets provided. (Operation of one retro rocket will secure a satisfactory separation.)	A) None; not operational prior to launch. B) None; redundancy provided.
				2) Rocket burst. (As a result of excessive internal pressure.)	None; subsystem can still function.	A) None; not operational prior to launch. B) None; stage function ceases at separation.


LEGEND
RELIA. CURRENT PRODUCTION
MTBF
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RELIA. OBJ.
RELIA. REQ.
RELIA. ACH'VD.
SECTION NO.
S-IV to UPPER STAGE SEPARATION
62
EBW FIRING UNIT
01A
EBW SQUIB
02A
EBW FIRING UNIT
01B
EBW SQUIB
02B
EBW FIRING UNIT
01A
EBW SQUIB
02A
EBW FIRING UNIT
01B
EBW SQUIB
02B
RETRO ROCKET #1 IGNITER
03
RETRO ROCKET #1
04
RETRO ROCKET #2 IGNITER
03
RETRO ROCKET #2
04

**TITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

S-I TO S-IV STAGE SEPARATION SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Confined Detonation Fuse (CDF) (For Ullage Rocket Ejection Explosive Nuts. Two Fuses Attach to Each Nut.)			Ignites explosive charge in explosive nuts.	1) Failure to ignite charge.	None; fuse trains are redundant. (Each of eight nuts can be exploded by either one of two CDF trains.)	A) None; not operational prior to launch. B) None; redundancy provided.
Explosive Nut (8) (Ullage Rocket Attachment)		7057734-1	Releases tension bolt by explosive breaking of nut in rocket-to-vehicle fastening. (Thus allowing rocket assembly to be ejected.)	1) Failure to explode and release bolt. (Nut must break to release bolt, and all eight nuts must break to eject all four rockets.)	None; each nut is considered redundant because each contains two explosive charges, either of which can break nut. (A separate fuse train is provided to each charge in a given nut.)	A) None; not operational prior to launch. B) None; redundancy provided.
Ullage Rocket Ejection (4) Device (Coiled Spring)			Imparts lateral velocity to rocket assembly, when required. (A compressed coil spring gives lateral thrust upon explosion of rocket attach nuts.)	1) Failure to eject rocket.	LOSS OF SUBSYSTEM	A) None; not operational prior to launch. B) Degradation of critical mission. (Due to approximate 40 lb. weight of unejected rocket assembly.)
				2) Failure to impart required lateral thrust. (Due to "weak" spring, bent or broken parts, etc.)	LOSS OF SUBSYSTEM	A) None; not operational prior to launch. B) POSSIBLE LOSS OF S-IV STAGE (With the most extreme case of unfavorable manouvering circumstances, a "soft-ejected" rocket could strike and damage engine assembly.)

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B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

S-I TO S-IV STAGE SEPARATION SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Ullage Rocket (4)		7051868	Gives foward thrust to DSV4 vehicle at start of separation from aft staging.	1) Failure to provide thrust.	None; of four rockets provided in subsystem, firing of a minimum of three will secure satisfactory separation.	A) None; not operational prior to launch. B) None; redundancy provided.
				2) Rocket burst. (As a result of excessive internal pressure.)	None; subsystem can still function.	A) None; not operational prior to launch. B) PROBABLE LOSS OF S-IV STAGE (Rocket burst could cause structural failure.)
EBW Firing Unit (2) (For Ullage Rocket Ejection)		7365719	Explodes bridge wire in an associated detonator upon receipt of electrical signal.	1) Failure to explode bridge wire.	None; two EBW firing units are provided in subsystem. (Either one can cause ejection of all four rockets.)	A) None; not operational prior to launch. B) None; redundancy provided.
				2) Premature explosion of wire. (Subsequent ignition of associated explosive train and consequent ejection of all ullage rockets is assumed to happen.)	LOSS OF SUBSYSTEM	A) POSSIBLE LOSS OF S-IV STAGE (Creates explosion hazard due to proximity to explosive atmosphere.) B) PROBABLE LOSS OF S-IV STAGE (Loss of required ullage rocket thrust due to premature ejection could "starve" fuel pumps at start of S-IV engines.)
EBW Detonator (2) (For Ullage Rocket Ejection)		7865742	Ignites explosive fuses which lead to explosive nuts on ullage rocket attach bolts.	1) Failure to ignite fuse.	None; two detonators are provided in subsystem and either one can cause explosion of all eight nuts.	A) None; not operational prior to launch. B) None; redundancy provided

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

S-I TO S-IV STAGE SEPARATION SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
EBW Detonator (2) (For Stage Separation Explosive Nuts)		7865742	Ignites explosive fuse which leads to explosive nuts on S-IV to S-IV aft interstage attach bolts. (Exploding the nuts allows separation.)	1) Failure to ignite fuse.	None; two detonators in subsystem are redundant. (Either detonator will ignite both fuses.)	A) None; not operational prior to launch. B) None; redundancy provided.
Confined Detonating Fuse (2) (CDF) (For Stage Separation Explosive Nuts)			Ignites explosive charge in explosive nuts.	1) Failure to ignite charge.	None; two fuse trains in subsystem are redundant. (Either fuse will ignite one charge in each of four nuts.)	A) None; not operational prior to launch. B) None; redundancy provided.
Explosive Nut (4) (S-IV to S-IV aft interstage attachment)		7857734-501	Releases tension bolt, by explosive breaking of nut, in S-IV to S-IV aft interstage bolted attachment. (Release of four bolts permits separation.)	1) Failure to explode and release bolt. (Nut must break to release bolt.)	None; each nut is considered redundant because each contains two explosive charges, either of which can break nut. (A separate fuse train is provided to each charge in a given nut.)	A) None; not operational prior to launch. B) None; redundancy provided.
EBW Firing Unit (8) (For Ullage Rocket Ignition.)		7865719	Explodes bridge wire in an associated EBW squib upon receipt of electrical signal.	1) Failure to explode bridge wire.	None; redundant sets (or pairs) of firing unit and squib components are provided for each rocket. (Either set will ignite rocket.)	A) None; not operational prior to launch. B) None; redundancy provided.
				2) Premature explosion of wire. (Subsequent firing of associated explosive train is assumed to happen.)	None for single failure. (Proper operation of three rockets out of a total of four will secure satisfactory separation.)	A) POSSIBLE LOSS OF S-IV TWO (Creates explosion hazard due to proximity to explosive atmosphere.) B) None; side thrust considered negligible.
EBW Squib (8) (For Ullage Rocket Ignition)			Activates ullage rocket igniter.	1) Failure to start igniter, and ignite rocket motor.	None; two squibs are provided for each rocket. (Either squib can start the rocket igniter.)	A) None; not operational prior to launch. B) None; redundancy provided.
Ullage Rocket Igniter (4)			Starts rocket motor.	1) Failure to start motor.	None; of four rocket motors provided, a minimum of three will secure satisfactory separation.	A) None; not operational prior to launch. B) None; redundancy provided.

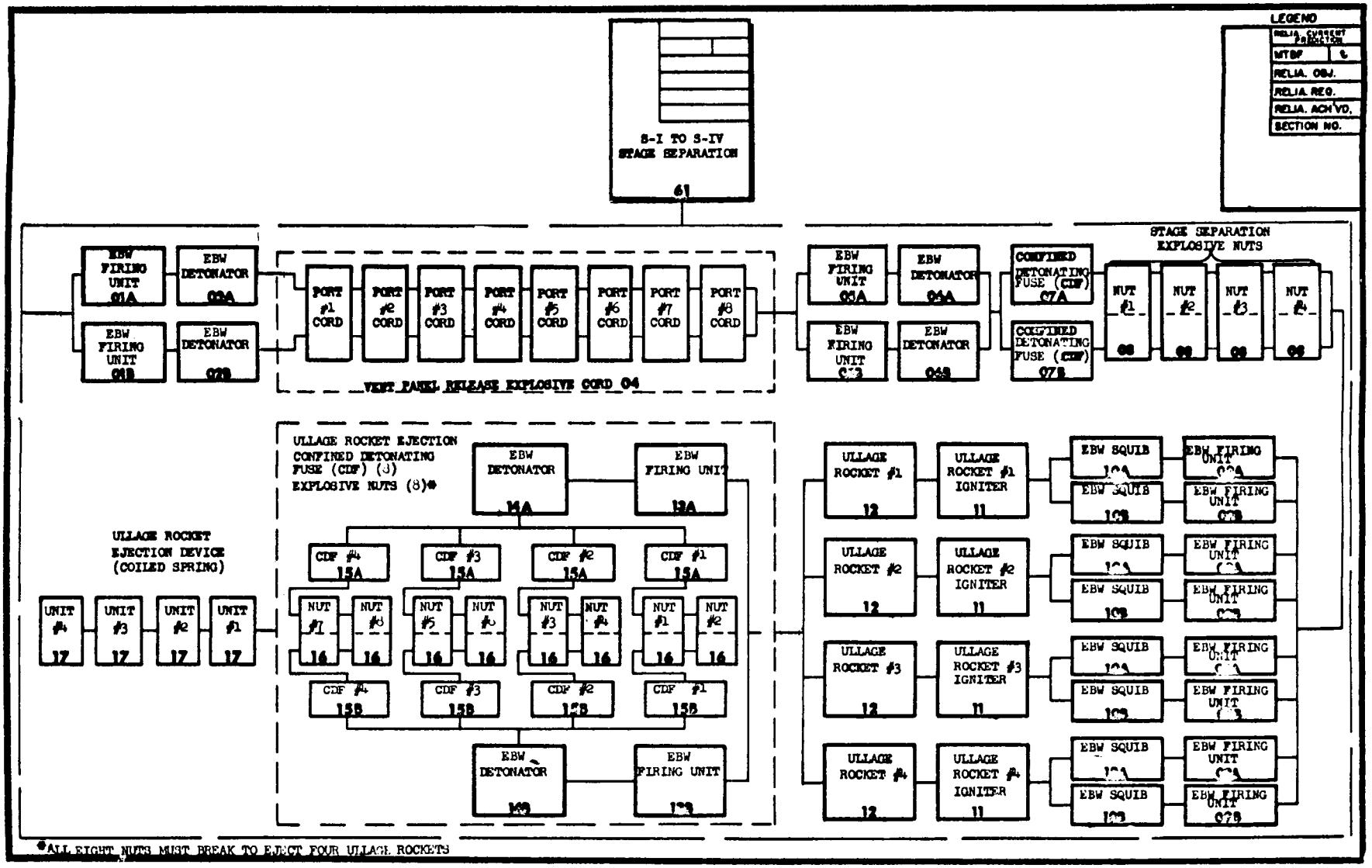
**TEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

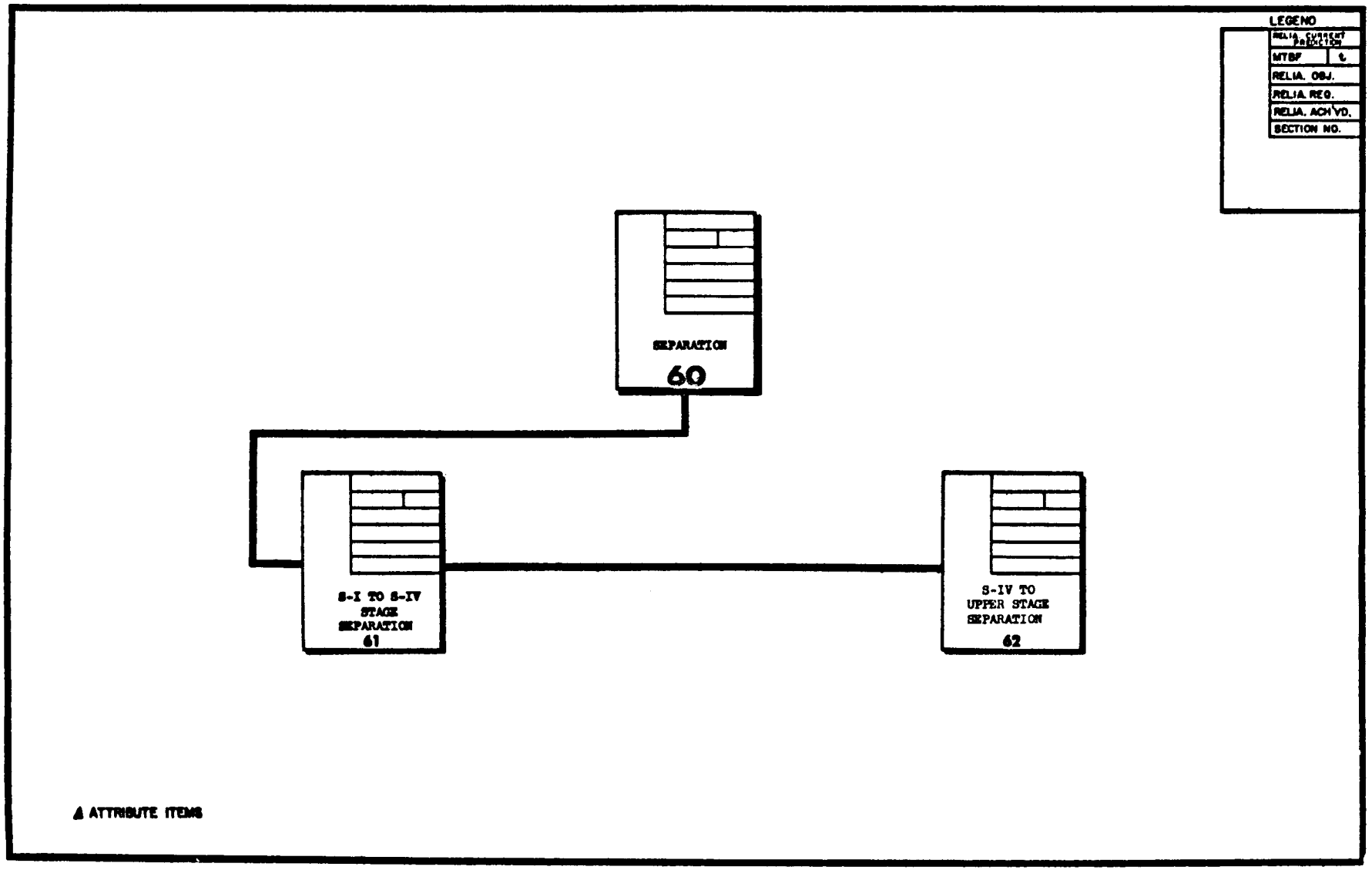
RELIABILITY FAILURE EFFECT ANALYSIS

S-I TO S-IV STAGE SEPARATION SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
EBW Firing Unit (2) (For Vent-Panel Release)		7865719	Explodes bridge wire in an associated detonator upon receipt of electrical signal. (All EBW units in subsystem are fully charged approximately six minutes prior to lift-off.)	1) Failure to explode bridge wire.	None; two EBW units in subsystem are redundant. (Each unit can explode one detonator wire and cause removal of all fairings.)	A) None; not operational prior to launch. B) None; redundancy provided.
				2) Premature explosion of wire. (Subsequent ignition of associated explosive train is assumed to happen.)	None. (Premature explosion will remove fabric panels prematurely - separation not affected.)	A) POSSIBLE LOSS OF S-IV STAGE (Creates explosion hazard due to proximity to explosive atmosphere.) B) POSSIBLE LOSS OF S-IV STAGE (Possible damage in engine section due to aero buffeting.)
EBW Detonator (2) (For Vent-Panel Release)		7865742	Ignites explosive cord which leads to vent panels and which also cuts free the fabric panels at each vent port, in turn.	1) Failure to ignite cord.	None; two detonators in subsystem are redundant. (Each can ignite opposite ends of the explosive cord train.)	A) None; not operational prior to launch. B) None; redundancy provided.
Vent Panel Release Explosive Cord		4882928	Removes panels (covers) from ports by explosive cutting of fabric panels.	1) Failure to explode.	None; redundancy provided. (Explosive shock progresses from both ends of continuous explosive train.)	A) None not operational prior to launch. B) None; redundancy provided.
EBW Firing Unit (2) (For Stage Separation Explosive Nuts.)		7865719	Explodes bridge wire in an associated detonator, upon receipt of electrical signal.	1) Failure to explode bridge wire.	None; two EBW units in subsystem are redundant. (Each unit will explode one detonator wire.)	A) None; not operational prior to launch. B) None; redundancy provided.
				2) Premature explosion of wire. (Subsequent ignition of associated explosive train is assumed to happen.)	LOSS OF SUBSYSTEM (S-IV to S-IV Aft interstage structure becomes unbolted prior to proper time of separation.)	A) POSSIBLE LOSS OF S-IV STAGE (Creates explosion hazard due to proximity to explosive atmosphere.) B) POSSIBLE LOSS OF S-IV STAGE (Mechanical and electrical connection at interface could separate prior to required time.)



*ALL EIGHT NUTS MUST BREAK TO EJECT FOUR ULLAGE ROCKETS


LEGEND
RELIA. CURRENT PREDICTION
MTBF
RELIA. OBJ.
RELIA. REQ.
RELIA. ACH'VD.
SECTION NO.
SEPARATION
60
S-I TO S-IV
STAGE
SEPARATION
61
S-IV TO
UPPER STAGE
SEPARATION
62
▲ ATTRIBUTE ITEMS

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

HELIUM HEATER SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Ignition Exciter		7871525	Releases upon command a capacity discharge to the spark igniter.	1) Failure to operate (failure of hermetic seal or internal electrical failure).	None; redundancy provided.	A) None; not operational prior to launch. B) None; redundancy provided.
Spark Igniter			Provides sparks for helium heater ignition.	1) Failure to spark.	None; redundancy provided.	A) None; not operational prior to launch. B) None; redundancy provided.
Propellant Pre-Heat Heat Exchanger			Provides heat exchange between incoming propellant and combustion products in helium heater.	1) Coil burn-through at hot spot.	LOSS OF SUBSYSTEM Off mixture ratio will either cease combustion or cause heat failure of helium heater.	A) None; not operational prior to launch. B) PROBABLE LOSS OF S-IV STAGE
Propellant Injectors			Atomizes and mixes the fuel and oxidizer to provide the correct conditions for ignition and combustion.	1) None		
Combustion Chamber Assembly			Provides chamber where combustion or burning of propellants occurs to form gaseous reaction products.	1) Structural failure due to hot spot.	LOSS OF SUBSYSTEM Escaping products of combustion will preclude effective oxidizer tank pressurization and flames from combustion chamber may cause failure of sensitive equipment.	A) None; not operational prior to launch. B) PROBABLE LOSS OF S-IV STAGE

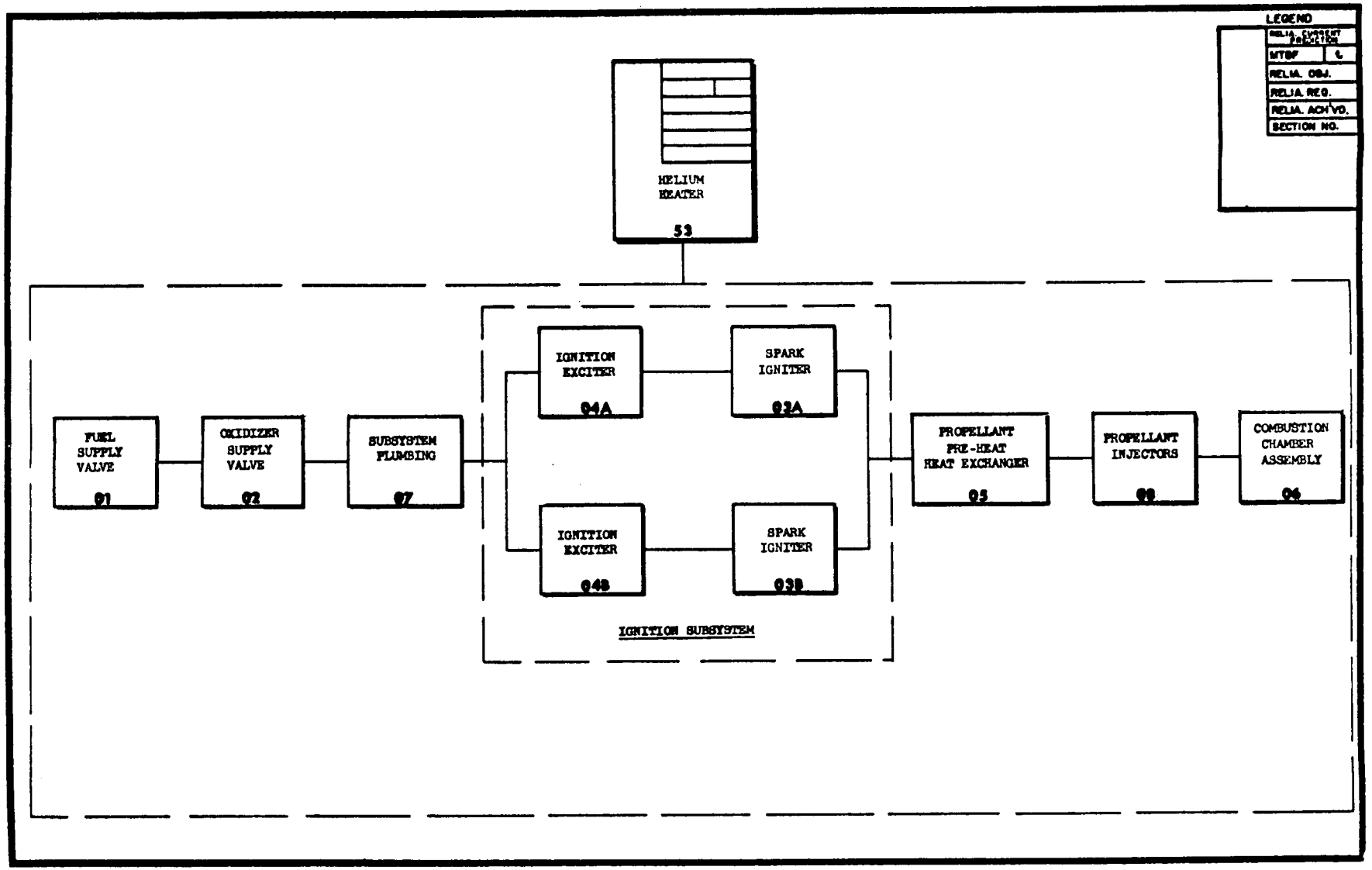
**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

HELIUM HEATER SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Fuel Supply Valve		7851767-1	Seals off fuel supply from helium heater; opens at S-IV engine start to allow fuel flow to helium heater injector.	1) Failure to open (stuck in closed position).	LOSS OF SUBSYSTEM Gaseous oxygen by itself will not support the required combustion.	A) None; not operational prior to launch. B) LOSS OF S-IV STAGE Loss of helium heater precludes effective oxidizer pressurization - engine pump cavitation will result.
				2) Failure to close at cut-off.	None; fuel rich mixture will cease combustion.	A) None; not operational prior to launch. B) None; stage function ceases at cut-off.
Oxidizer Supply Valve		7851767-1	Seals off oxidizer supply from helium heater; opens at S-IV engine start to allow oxidizer flow to helium heater injector.	1) Failure to open (stuck in closed position).	LOSS OF SUBSYSTEM Gaseous hydrogen by itself will not support the required combustion.	A) None; not operational prior to launch. B) LOSS OF S-IV STAGE Loss of helium heater precludes effective oxidizer pressurization - engine pump cavitation will result.
				2) Failure to close at cut-off.	Liquid oxygen rich cut-off may cause damage to internal parts of helium heater.	A) None; not operational prior to launch. B) None; stage function ceases at cut-off.
Subsystem Plumbing				1) External leakage of fuel.	POSSIBLE LOSS OF SUBSYSTEM Oxidizer rich combustion may cause failure of helium heater due to excessive flame temperature.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE
				2) External leakage of oxidizer	POSSIBLE LOSS OF SUBSYSTEM Fuel rich mixture may cease combustion in helium heater.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE


LEGEND
RELIA. CURRENT PREDICTION
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RELIA. OBJ.
RELIA. REQ.
RELIA. ACHVD.
SECTION NO.
HELIUM HEATER
53
FUEL SUPPLY VALVE
01
OXIDIZER SUPPLY VALVE
02
SUBSYSTEM PLUMBING
07
IGNITION EXCITER
04A
SPARK IGNITER
03A
IGNITION EXCITER
04B
SPARK IGNITER
03B
IGNITION SUBSYSTEM
PROPELLANT PRE-HEAT HEAT EXCHANGER
05
PROPELLANT INJECTORS
08
COMBUSTION CHAMBER ASSEMBLY
06

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS
HYDRAULIC POWER SUPPLY SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FOR ONE ENGINE ONLY FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Motor Driven Auxiliary Hydraulic Pump	*	7865752	Provides high pressure hydraulic fluid for ground checkout of flight control subsystem.	1) Electrical failure. 2) Mechanical failure. 3) Excessive internal leakage.	Loss of ground operation hydraulic power supply. LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) None; not operational in flight.
Hydraulic Pump Cutoff Thermal Switch	*	7866147	Protects hydraulic power supply and flight control subsystems from excessive hydraulic oil temperature during ground operation.	1) Failure to open at excessive temperature.	Possible damage to other components in subsystem. POSSIBLE LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) None; not operational in flight.
				2) Failure to close with decreasing temperature or to remain closed at normal temperature.	LOSS OF SUBSYSTEM	
Auxiliary Pump Outlet Filter	*	7865750	Filters hydraulic fluid during ground operation of subsystem.	Implosion of element.	Possible damage to downstream components by particles from failed element. POSSIBLE LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) None; not operational in flight.
Auxiliary Pump Inlet Filter	*	7865750				
Auxiliary Pump Case Drain Filter	*	7865753	Filters hydraulic fluid flowing from auxiliary pump case drain.			
Engine Driven Pump Check Valve	*	7865751	Prevents reverse flow through engine driven pump during ground operation of subsystem.	Internal leakage (failure to reseat).	Loss of ground operation hydraulic power supply. LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) None; not operational in flight.
Engine Driven Hydraulic Pump		7865733	Provides high pressure hydraulic fluid during flight.	1) Broken spline. 2) Internal Failure.	LOSS OF SUBSYSTEM	A) None; not operational prior to launch. B) None; S-IV Stage is capable of mission completion with complete loss of one engine hydraulic power supply/flight control.
Primary High Pressure Filter		7865750	Filters hydraulic fluid during flight.	Implosion of element.	Possible damage to downstream components by particles from failed element. POSSIBLE LOSS OF SUBSYSTEM	A) None; not operational prior to launch. B) None; S-IV Stage is capable of mission completion with complete loss of one engine hydraulic power supply/flight control.
Engine Driven Pump Case Drain Filter		7865753	Filters hydraulic fluid flowing from engine driven pump case drain.			

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

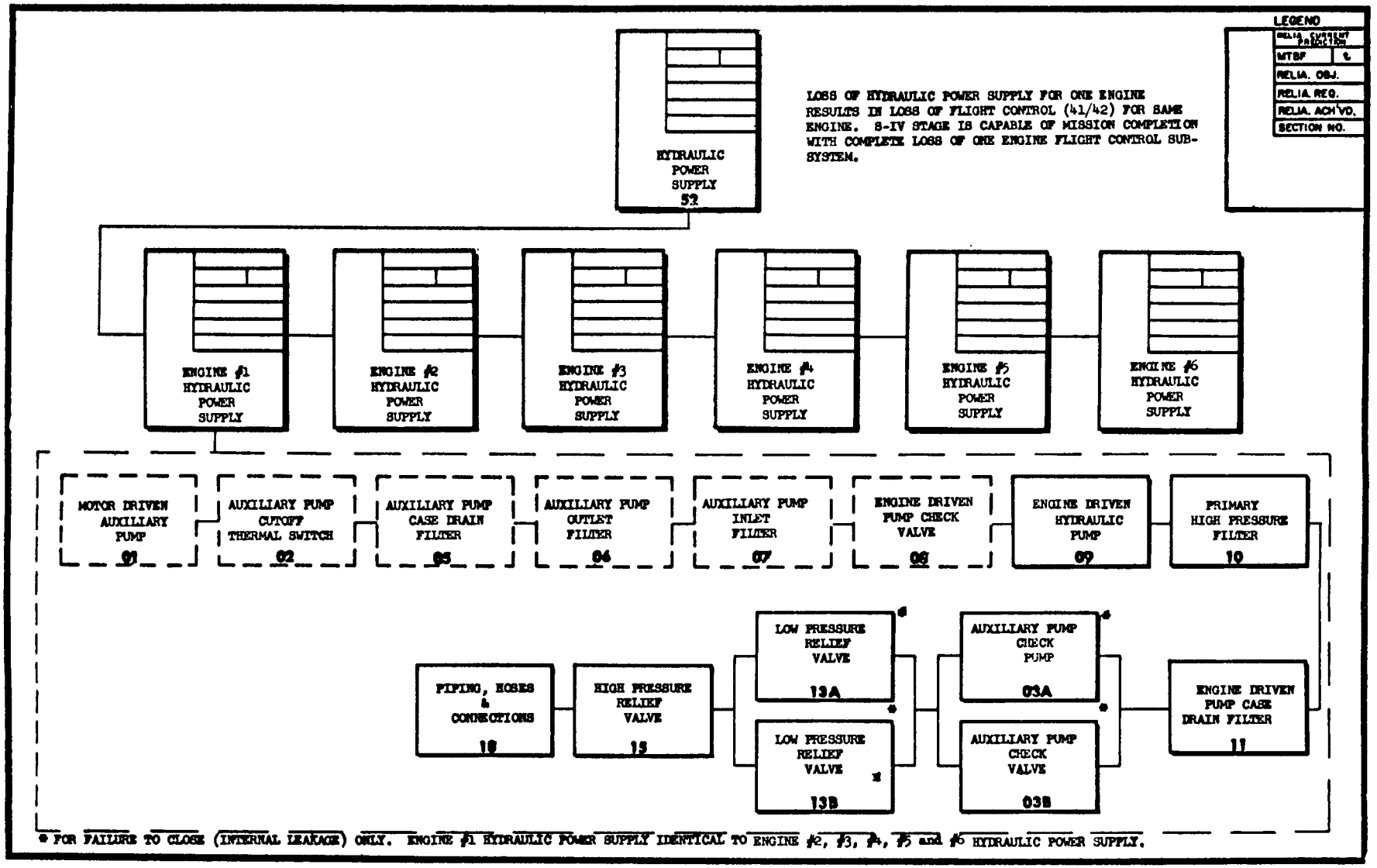
A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

HYDRAULIC POWER SUPPLY SUBSYSTEM

FOR ONE ENGINE ONLY

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Auxiliary Pump Check Valve		7865751	Prevents reverse flow of high pressure hydraulic fluid through auxiliary pump during flight.	Internal leakage (failure to reseat).	None; two auxiliary pump check valves are physically in series and are redundant for failure noted.	A) None; not operational prior to launch. B) None; redundancy provided.
Low Pressure Relief Valve		7865754	Controls maximum pressure in hydraulic fluid return lines.	Internal leakage (failure to reseat).	None; two relief valves are physically in series and are redundant for failure noted.	A) None; redundancy provided. B) None; redundancy provided.
High Pressure Relief Valve		1A000659 L	Controls maximum hydraulic fluid pressure supplied to flight control subsystem.	Internal leakage (failure to reseat).	LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) None; S-IV Stage is capable of mission completion with complete loss of one engine hydraulic power supply/ flight control.
Piping, Hoses, and Connections		5865941 (Ref.) 7871262 (Ref.)		Leakage or burst.	LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) None; S-IV Stage is capable of mission completion with complete loss of one engine hydraulic power supply/ flight control.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RELIA. CURRENT PREDICTION
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RELIA. OBJ.
RELIA. REQ.
RELIA. ACH'VD.
SECTION NO.
HYDRAULIC POWER SUPPLY 52
LOSS OF HYDRAULIC POWER SUPPLY FOR ONE ENGINE RESULTS IN LOSS OF FLIGHT CONTROL (41/42) FOR SAME ENGINE. S-IV STAGE IS CAPABLE OF MISSION COMPLETION WITH COMPLETE LOSS OF ONE ENGINE FLIGHT CONTROL SUB-SYSTEM.
ENGINE #1 HYDRAULIC POWER SUPPLY
ENGINE #2 HYDRAULIC POWER SUPPLY
ENGINE #3 HYDRAULIC POWER SUPPLY
ENGINE #4 HYDRAULIC POWER SUPPLY
ENGINE #5 HYDRAULIC POWER SUPPLY
ENGINE #6 HYDRAULIC POWER SUPPLY
MOTOR DRIVEN AUXILIARY PUMP 01
AUXILIARY PUMP CUTOFF THERMAL SWITCH 02
AUXILIARY PUMP CASE DRAIN FILTER 05
AUXILIARY PUMP OUTLET FILTER 06
AUXILIARY PUMP INLET FILTER 07
ENGINE DRIVEN PUMP CHECK VALVE 08
ENGINE DRIVEN HYDRAULIC PUMP 09
PRIMARY HIGH PRESSURE FILTER 10
PIPING, HOSES & CONNECTIONS 18
HIGH PRESSURE RELIEF VALVE 15
LOW PRESSURE RELIEF VALVE 13A
LOW PRESSURE RELIEF VALVE 13B
AUXILIARY PUMP CHECK PUMP 03A
AUXILIARY PUMP CHECK VALVE 03B
ENGINE DRIVEN PUMP CASE DRAIN FILTER 11
* FOR FAILURE TO CLOSE (INTERNAL LEAKAGE) ONLY. ENGINE #1 HYDRAULIC POWER SUPPLY IDENTICAL TO ENGINE #2, #3, #4, #5 and #6 HYDRAULIC POWER SUPPLY.

TITLE: RELIABILITY FAILURE EFFECT ANALYSIS

ELECTRICAL POWER SUPPLY SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

TITLE: ITEMS MARKED THUS (•) DO NOT OPERATE IN FLIGHT

ITEM	••	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
#1 Battery (continued)			2) Provides vehicle battery power to one command destruct receiver (CDR) of the range safety subsystem, M/M code 82.	1) Internal failure	PARTIAL LOSS OF SUBSYSTEM Loss of power to one CDR set.	A) Delay in launching or scrub. B) None; redundancy provided. Either one of two CDR sets can cause destruction of the S-IV stage.
#2 Battery (15AH capacity - for transient loads.)		7864237	1) Provides vehicle battery power for all S-IV electrical loads, other than the electrical power provided by vehicle batteries #1, and #3.	1) Internal failure	PARTIAL LOSS OF SUBSYSTEM Loss of power to the bulk of S-IV vehicle control components.	A) Delay in launching or scrub. B) LOSS OF S-IV STAGE Due to loss of all sequencing, M/M code 72, or to loss of all flight control, M/M code 40.
#3 Battery (15AH capacity - for telemetry subsystem)		7864237	1) Provides vehicle battery power for all electrical loads of telemetry subsystem, M/M code 81.	1) Internal failure	PARTIAL LOSS OF SUBSYSTEM Loss of all S-IV vehicle power to telemetry subsystem.	A) Delay in launching or scrub. B) Loss of all telemetry monitoring capability.
Subsystem Wiring Harness. (In-flight power distribution for S-IV vehicle.)			1) Provides electrical connection between all components of subsystem as required. Includes power supply connections to propellant utilization subsystem, to respective associated controllers in range safety subsystem, and power supply wiring to EBW firing units.	1) Failure due to open or short circuit.	PARTIAL LOSS OF SUBSYSTEM Loss of power to component normally supplied fy failed circuit.	A) Delay in launching or scrub. (Provided purge is adequate against short-circuit fire) B) POSSIBLE LOSS OF S-IV STAGE Open circuit could cause loss of all flight control. Short circuit could cause fire in an area containing oxygen-rich atmosphere.

*ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

ELECTRICAL POWER SUPPLY SUBSYSTEM

ITEM	*	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Inverter-Converter (115v, 400 cycle, power output)		5866456	1) Provides power for propellant utilization (PU) subsystem. (M/M code 30)	1) Failure to provide power, due open or short circuit or to damaged part.	PARTIAL LOSS OF SUBSYSTEM Loss of 115v power for PU subsystem.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE Loss of PU subsystem. Loss of fuel pressurization step-pressure may cause fuel pumps to cavitate and result in loss of engines.
Internal-External Switch (For telemetry subsystem, M/M code 81)			1) Transfers telemetry subsystem electric loads from ground power supply circuit to a supply circuit from #3 battery in S-IV vehicle.	1) Failure while switch is in external position, due to open or short circuit, or to damaged part.	PARTIAL LOSS OF SUBSYSTEM Loss of ground power for telemetry.	A) Delay in launching or scrub. B) None; external position is not used after launch.
				2) Failure to transfer when required. (At T-2 minutes.)	PARTIAL LOSS OF SUBSYSTEM Loss of vehicle battery to telemetry for final checkout and flight.	A) Delay in launching or scrub. B) None; transfer is made prior to launch.
				3) Failure while switch is in the internal position due to open or short circuit, or to damaged part.	PARTIAL LOSS OF SUBSYSTEM Loss of vehicle battery to telemetry.	A) Delay in launching or scrub. B) Loss of all telemetry monitoring capability.
#1 Battery (5AH capacity - for steady loads.)		7864238	1) Provides vehicle battery power to propellant utilization (PU) subsystem, (Power is supplied direct, and also via the inverter-converter unit.)	1) Internal failure.	PARTIAL LOSS OF SUBSYSTEM Loss of all battery power supply to PU subsystem.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE Loss of PU subsystem. Loss of fuel pressurization step-pressure may cause fuel pumps to cavitate and result in loss of engines.

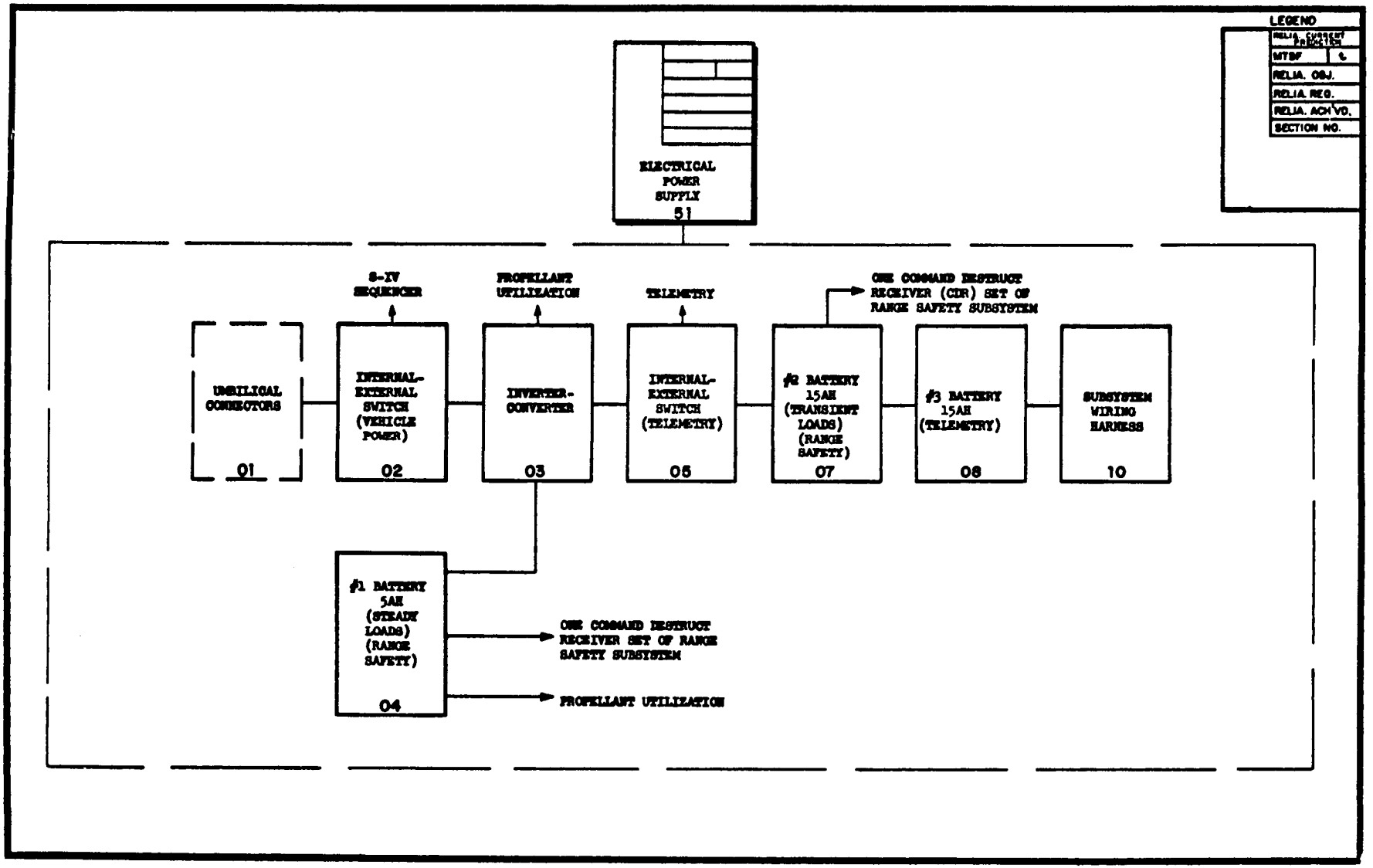
**TEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

ELECTRICAL POWER SUPPLY SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Umbilical Connector (7) Part Number: J1 - QWL-82-107340-56S J2 - " " " - 98 J3 - " " " -56H J4 - " " " -68S J5 - " " " -56J J6 - " " " -56L J7 - " " " -56N			1) Provides connection of 28V DC ground power for all vehicle useage (checkout, countdown) prior to the time when use of vehicle batteries is required.(final calibration and flight).	1) Failure to supply ground power due to open or short circuit, or to damaged part.	PARTIAL LOSS OF SUBSYSTEM Loss of ground power to component normally supplied by failed circuit.	A) Delay in launching or scrub. B) None; not operational in flight.
Internal-External Switch (For Vehicle Power)			1) Transfers vehicle electric loads from ground power supply circuits to circuits from #1 and #2 batteries, respectively. (Expected time of transfer is three minutes before lifteff.)	1) Failure while switch is in the external position, due to open or short circuit, or to damaged part.	PARTIAL LOSS OF SUBSYSTEM Loss of ground power to affected circuit.	A) Delay in launching or scrub. B) None; external position is not used after launch.
				2) Failure to transfer when required. (At approx. T-3 minutes.)	PARTIAL LOSS OF SUBSYSTEM Loss of power from both batteries.	A) Delay in launching or scrub. B) None; transfer is made prior to launch.
				3) Failure while switch is in the internal position, due to open or short circuit, or to damaged part.	PARTIAL LOSS OF SUBSYSTEM 1) Due to loss of #1 battery power. 2) Due to loss of #2 battery power.	A) Delay in launching or scrub. B) 1) POSSIBLE LOSS OF S-IV STAGE Loss of #1 battery (5AH) causes loss of vehical power to propellant utilization subsystem. 2) LOSS OF S-IV STAGE Loss of #2 battery, (15AH) causes loss of all flight control.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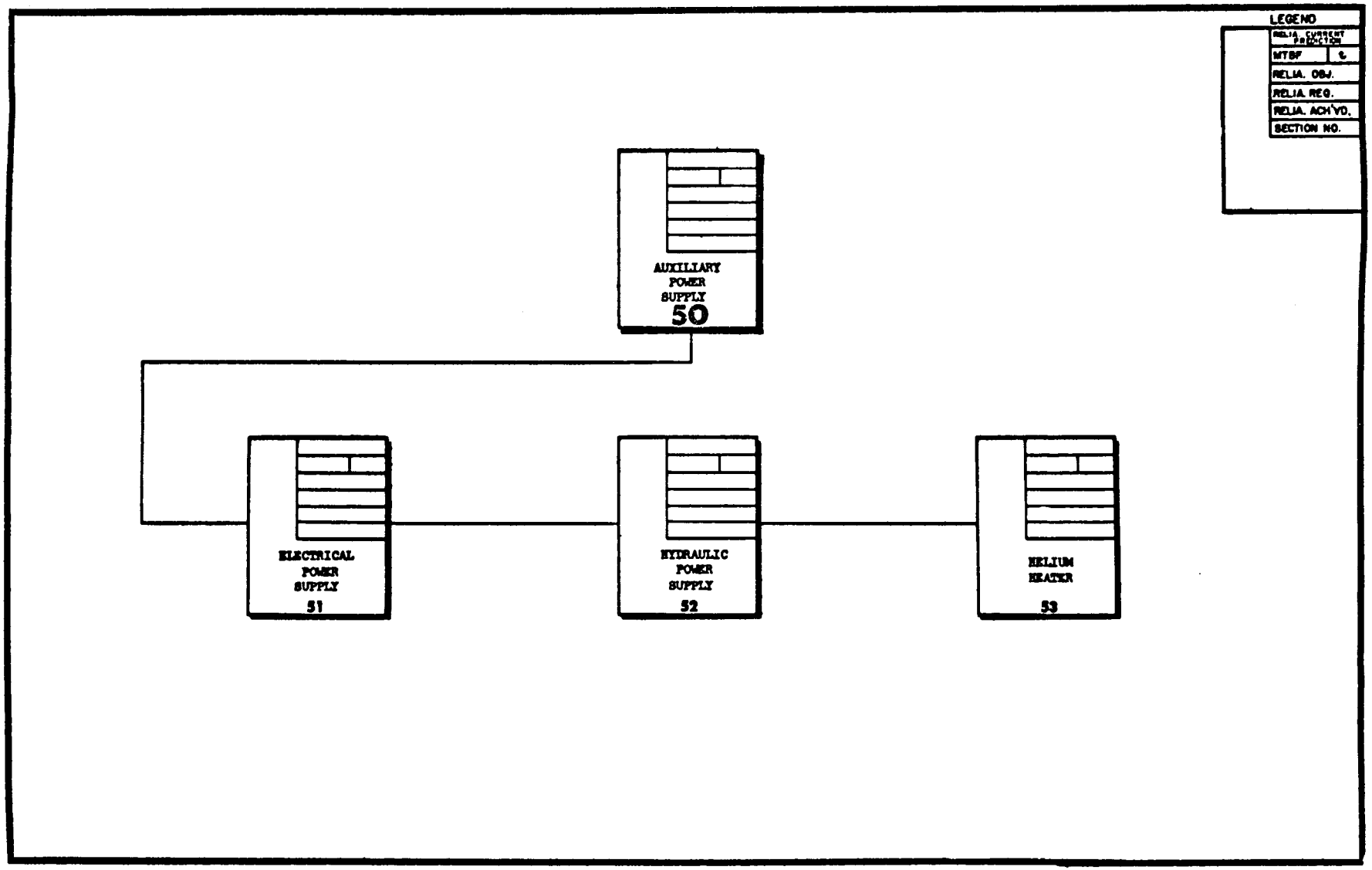
SECTION NO.
ELECTRICAL POWER SUPPLY 51
S-IV SEQUENCER
PROPELLANT UTILIZATION
TELEMETRY
ONE COMMAND DESTRUCT RECEIVER (CDR) SET OF RANGE SAFETY SUBSYSTEM
UMBILICAL CONNECTORS 01
INTERNAL-EXTERNAL SWITCH (VEHICLE POWER) 02
INVERTER-CONVERTER 03
INTERNAL-EXTERNAL SWITCH (TELEMETRY) 05
#2 BATTERY 15AH (TRANSIENT LOADS) (RANGE SAFETY) 07
#3 BATTERY 15AH (TELEMETRY) 08
SUBSYSTEM WIRING HARNESS 10
#1 BATTERY 5AH (STEADY LOADS) (RANGE SAFETY) 04
ONE COMMAND DESTRUCT RECEIVER SET OF RANGE SAFETY SUBSYSTEM
PROPELLANT UTILIZATION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RELIA. ACH'VD.
SECTION NO.
AUXILIARY POWER SUPPLY
50
ELECTRICAL POWER SUPPLY
51
HYDRAULIC POWER SUPPLY
52
HELIUM HEATER
53

15

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

YAW CONTROL SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Piping and Connections		7871262 (ref.) 5863925 (ref.)		Leakage or burst.	LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) None; S-IV Stage is capable of mission completion with complete loss of one engine flight control subsystem.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

YAW CONTROL SUBSYSTEM

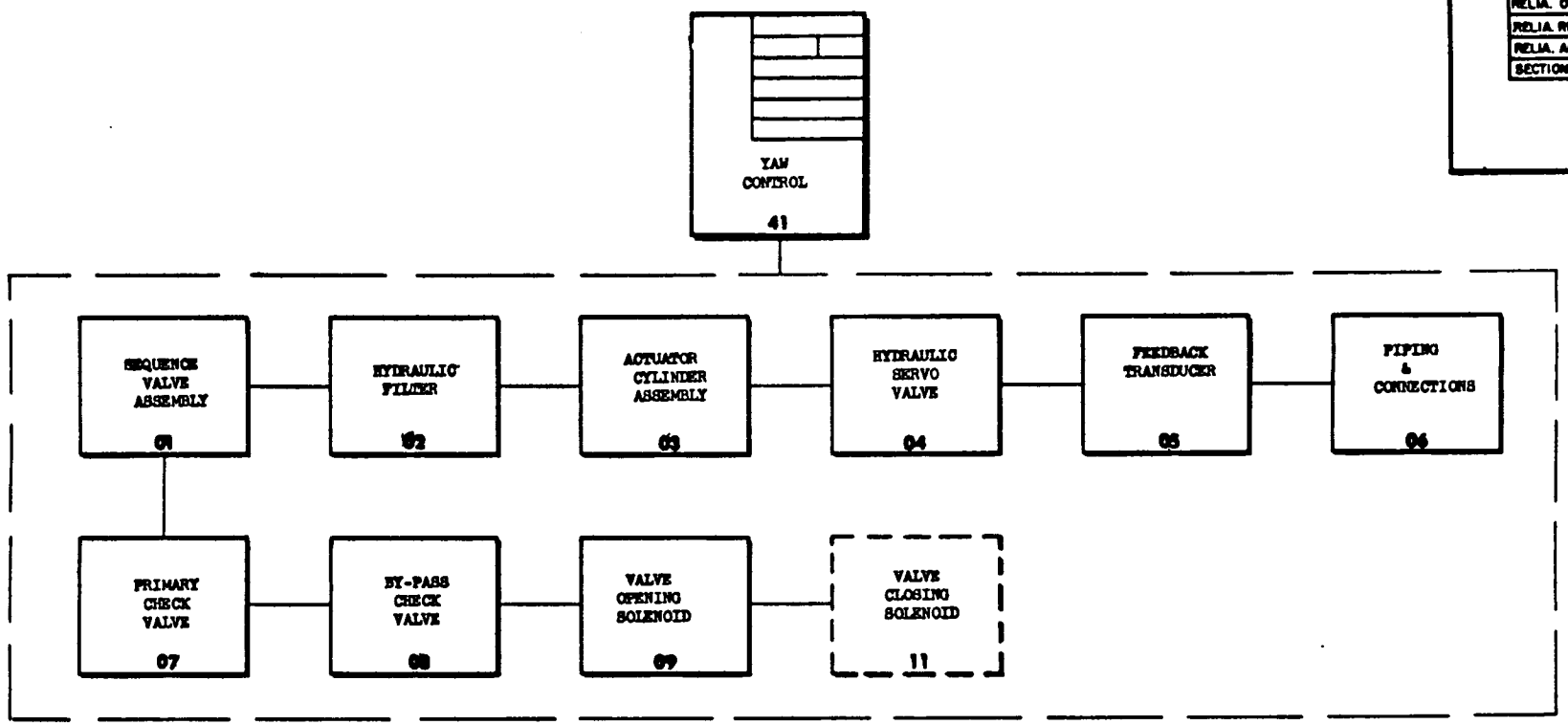
ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Actuator Cylinder Assembly		5863926	Provides GN_2 charged high pressure hydraulic fluid storage (accumulator) and low pressure hydraulic fluid storage (reservoir). Assembly also contains a linear hydraulic actuating cylinder for engine directional control.	Principal mode of failure is leakage past "O" ring seals in the following areas (1-5).		1), 2), 3), 4), and 5), A) Delay in launching or scrub. B) None; S-IV Stage is capable of mission completion with complete loss of one engine flight control subsystem.
				1) High pressure hydraulic fluid to atmosphere.	1) Lose accumulator precharge and dump hydraulic fluid in accumulator overboard. LOSS OF SUBSYSTEM	
				2) Low pressure hydraulic fluid to atmosphere.	2) Fluid stored in reservoir will be lost overboard. LOSS OF SUBSYSTEM	
				3) GN_2 to high pressure accumulator.	3) Permit slug of air in high pressure system causing erratic action or slow response. POSSIBLE LOSS OF SUBSYSTEM	
				4) Leak past end seals of actuating cylinder piston.	4) POSSIBLE LOSS OF SUBSYSTEM	
				5) Internal leak in actuating cylinder.	5) POSSIBLE LOSS OF SUBSYSTEM	
Servo Valve		7865889	Controls flow of hydraulic fluid to actuating cylinder upon receipt of signal from guidance control.	1) Electrical failure. 2) Mechanical failure.	LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) None; S-IV Stage is capable of mission completion with complete loss of one engine flight control subsystem.
Feedback Transducer		7863921	Signals actuator position to guidance subsystem	1) Electrical short. 2) Mechanical binding.	Actuator will hunt for location. Partial loss of control.	A) Delay in launching or scrub. B) None; S-IV Stage is capable of mission completion with complete loss of one engine flight control subsystem.
				3) Open electrical circuit.	Actuator will go to "hard over" position. LOSS OF SUBSYSTEM	

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

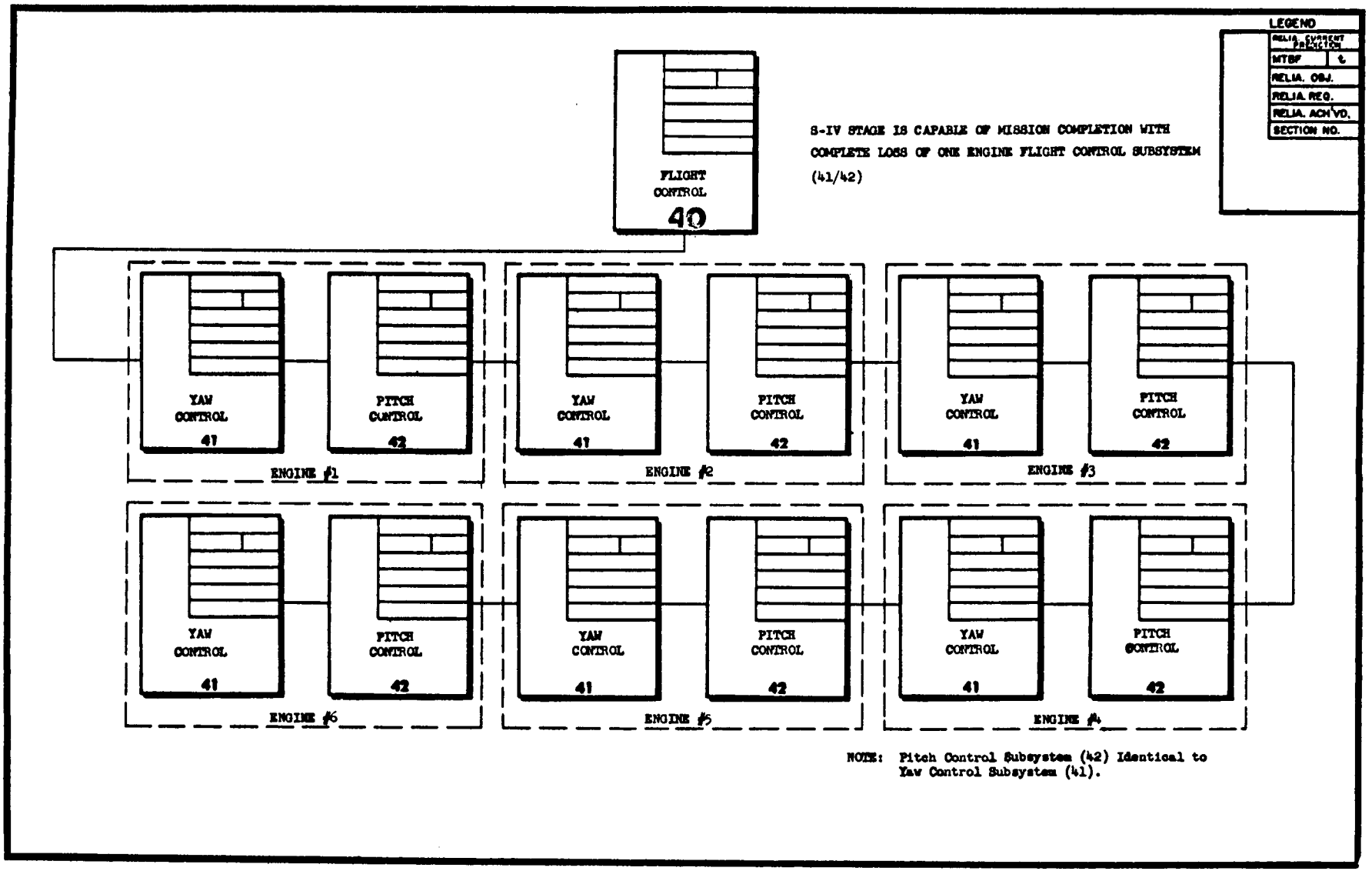
A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS
YAW CONTROL SUBSYSTEM

	ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
	Sequence Valve Assembly		5866263	Controls flow of hydraulic fluid from charged accumulator section of the actuator cylinder assembly.	1) Leakage between ball valve and seat permitting fluid in accumulator to flow to reservoir.	1) Loss of accumulator charge. LOSS OF SUBSYSTEM	1A) Delay in launching or scrub. 1B) None; hydraulic power will be supplied by hydraulic power supply subsystem. Failure can occur only prior to separation.
					2) Component failure as detailed below.		
SEQUENCE VALVE ASSEMBLY	Primary Check Valve		7871387-1	Opens to permit high pressure hydraulic fluid to flow from hydraulic power supply subsystem to accumulator. Closes to prevent discharge of accumulator when hydraulic power supply subsystem is not operating.	Internal leakage (failure to reseat).	Loss of accumulator charge. LOSS OF SUBSYSTEM	A) Delay in launch or scrub. B) None; hydraulic power will be supplied by hydraulic power supply subsystem. Failure can occur only prior to separation.
	By-pass Check Valve		7871387-501	Opens to permit high pressure fluid from hydraulic power supply subsystem to open sequence valve in event of solenoid failure. Closes to prevent loss of fluid in event of upstream component failure.	Internal leakage (failure to reseat).	None; not required unless prior failure of subsystem component.	A) None; not required unless prior failure of subsystem component. B) None; not required unless prior failure of subsystem component.
	Valve Opening Solenoid		3871345	Opens sequence valve to permit hydraulic fluid to flow from charged accumulator to servo valve.	Electrical failure.	None; high pressure fluid from hydraulic power supply subsystem will open sequence valve.	A) Delay in launching or scrub. B) None; high pressure fluid from hydraulic power supply subsystem will open sequence valve.
	Valve Closing Solenoid	*	3871345	Closes sequence valve.	Electrical failure.	Unable to close sequence valve. LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) None; not operational in flight.
	Hydraulic Filter		7865753	Filters high pressure hydraulic fluid to servo valve.	Implosion of element.	Particles may jam servo valve. POSSIBLE LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) None; S-IV Stage is capable of mission completion with complete loss of one engine flight control subsystem.



NOTE: Pitch Control Subsystem (42) Identical to Yaw Control Subsystem (41)



NOTE: Pitch Control Subsystem (42) Identical to Yaw Control Subsystem (41).

**TITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

Note: Loss of propellant utilization will result in loss of burning time due to premature depletion of one propellant or excess residual propellant at engine cutoff.

RELIABILITY FAILURE EFFECT ANALYSIS

PROPELLANT UTILIZATION SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

	ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
VALVE ACTUATOR ASSEMBLY 5680796	Servo Motor-Gear Box (Six Required)			Repositions propellant utilization valve upon receipt of signal from amplifier.	Electrical or mechanical failure.	Propellant utilization valve of affected engine will remain in position at time of failure. LOSS OF ONE ENGINE PROPELLANT UTILIZATION SUBSYSTEM	A) Delay in launching or scrub. B) Loss of one engine propellant utilization subsystem.
	Feedback Transducer (Six Required)			Signals propellant utilization valve position to electronics assembly.	1) Electrical short.	Propellant utilization valve will hunt for position. Degradation of one engine propellant utilization subsystem.	A) Delay in launching or scrub. B) Slight degradation of one engine propellant utilization subsystem.
					2) Open electrical circuit.	Propellant utilization valve will move "hard over." LOSS OF ONE ENGINE PROPELLANT UTILIZATION SUBSYSTEM	A) Delay in launching or scrub. B) Loss of one engine propellant utilization subsystem.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

Note: Loss of propellant utilization will result in loss of burning time due to premature depletion of one propellant or excess residual propellant at engine cutoff.

RELIABILITY FAILURE EFFECT ANALYSIS

PROPELLANT UTILIZATION SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

	ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
ELECTRONICS ASSEMBLY	Oxidizer Servo Balanced Bridge			Generates AC outputs which are voltage analogs of the sensor capacitance added by the oxidizer. The unit contains switches for fuel depletion and fuel step pressurization signals to the sequencer and a potentiometer for varying the gain of the summing and shaping network.	1) Electrical short or open circuit. 2) Electrical or mechanical failure of servo motor.	Propellant utilization valves will go to "hard over" position. Fuel depletion and/or fuel step pressure signals may be lost or premature. LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE Loss of fuel pressurization step pressure may cause fuel pumps to cavitate and result in loss of engines. Premature fuel depletion signal will permit premature cutoff of all engines in event of one engine failure. Loss of P.U.
	Fuel Servo Balanced Bridge			Generates AC outputs which are voltage analogs of the sensor capacitance added by the fuel.	1) Electrical short or open circuit. 2) Electrical or mechanical failure of servo motor.	Propellant utilization valves will go to "hard over" position. LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) Loss of propellant utilization.
	Summing Amplifier Shaping Network Output Amplifier (Summing and Shaping Network)			Creates the system error signal by summing the outputs of the fuel and oxidizer bridges.	1) Electrical failure resulting in loss of signal.	Propellant utilization valves will assume nominal position. LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) Loss of propellant utilization.
					2) Electrical short or open circuit.	Propellant utilization valves may go to "hard over" position or will remain in position at time of failure. LOSS OF SUBSYSTEM	
	Actuator Servo Amplifier (Six Required)			Amplifies output signal from summing and shaping network and supplies amplified signal to valve actuator servo motor.	1) Electrical failure resulting in loss of signal.	Propellant utilization valve of affected engine will assume nominal position. LOSS OF ONE ENGINE PROPELLANT UTILIZATION SUBSYSTEM	A) Delay in launching or scrub. B) Loss of one engine propellant utilization subsystem.
					2) Electrical short or open circuit.	Propellant utilization valve of affected engine may go to "hard over" position or will remain in position at time of failure. LOSS OF ONE ENGINE PROPELLANT UTILIZATION SUBSYSTEM	

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

Note: Loss of propellant utilization will result in loss of burning time due to premature depletion of one propellant or excess residual propellant at engine cutoff.

RELIABILITY FAILURE EFFECT ANALYSIS

PROPELLANT UTILIZATION SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Fuel Mass Sensor		7866357	Provides capacitance signal to electronics assembly proportional to mass of fuel in tank.	1) Open electrical circuit.	Propellant utilization valves will move to stops in fuel lean mixture position. LOSS OF SUBSYSTEM	A) Scrub B) Loss of propellant utilization.
				2) Short electrical circuit.	Propellant utilization valves will move to stops in fuel rich mixture position. LOSS OF SUBSYSTEM	
Oxidizer Mass Sensor		7866356	Provides capacitance signal to electronics assembly proportional to mass of oxidizer in tank.	1) Short electrical circuit.	Propellant utilization valves will move to stops in fuel lean mixture position. Fuel depletion and fuel pressurization step pressure switches will be inoperative. LOSS OF SUBSYSTEM	A) Scrub B) POSSIBLE LOSS OF S-IV STAGE Loss of fuel pressurization step pressure may cause fuel pumps to cavitate and result in loss of engines. Loss of P.U. Possible loss of fuel depletion signal to sequencer.
				2) Open electrical circuit.	Propellant utilization valves will move to stops in fuel rich mixture position. Fuel depletion and fuel pressurization step pressure signals will be sent to sequencer at time of failure. LOSS OF SUBSYSTEM	A) Scrub B) Loss of propellant utilization. Premature fuel depletion signal will permit premature cutoff of all engines in event of one engine failure. Premature fuel step pressurization signal may result in decreased burning time.
Subsystem Wiring				1) Open or short circuit between sensor and electronic assembly.	Same as open or short circuit in affected sensor. LOSS OF SUBSYSTEM	A) Delay in launching or scrub. B) Same as open or short circuit in affected sensor.
				2) Open or short circuit between electronic assembly and valve actuator assembly.	LOSS OF ONE ENGINE PROPELLANT UTILIZATION SUBSYSTEM	A) Delay in launching or scrub. B) Loss of one engine propellant utilization subsystem.

DOUGLAS AIRCRAFT COMPANY, INC.

PREPARED BY: _____
CHECKED BY: _____
DATE: 5-15-61
TITLE: _____
_____ DIVISION

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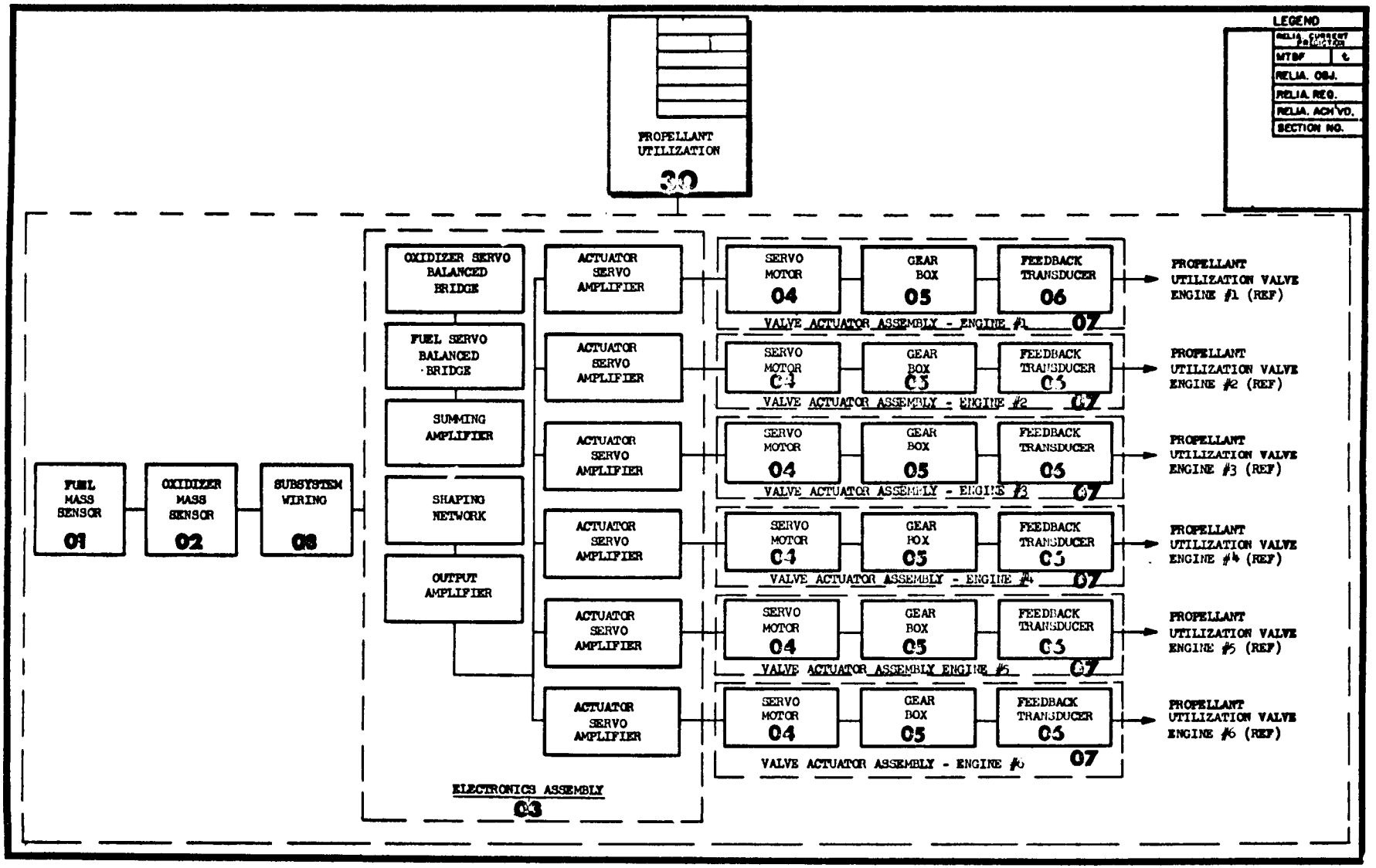

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

YLR 115 P & W ENGINES SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FOR ONE ENGINE ONLY FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Ignition Exciter			Releases upon command a capacity discharge to the high voltage spark igniter and furnishes a minimum of 20 sparks per second	1) Failure to operate (failure of hermetic seal or internal electrical failure)	PROBABLE LOSS OF SUBSYSTEM Accumulation of unburned propellants in thrust chamber creates explosion hazard due to delayed light-off by operating engines.	A) None; not operational prior to launch B) PROBABLE LOSS OF S-IV STAGE
High Tension Lead			Transmits the capacity discharge from the exciter to the high voltage spark igniter.	1) Failure to operate (open circuit)	PROBABLE LOSS OF SUBSYSTEM Accumulation of unburned propellants in thrust chamber creates explosion hazard due to delayed light-off by operating engines.	A) None; not operation prior to launch B) PROBABLE LOSS OF S-IV STAGE
Spark Igniter			Furnishes a minimum of 20 sparks per second for engine ignition	1) Failure to spark	PROBABLE LOSS OF SUBSYSTEM Accumulation of unburned propellants in thrust chamber creates explosion hazard due to delayed light-off by operating engines.	A) None; not operational prior to launch B) PROBABLE LOSS OF S-IV STAGE
Propellant Injector			Atomizes and mixes the fuel and oxidizer to provide the correct conditions for ignition and efficient combustion.	1) Structural failure	LOSS OF SUBSYSTEM	A) None; not operational prior to launch B) PROBABLE LOSS OF S-IV STAGE
Thrust Chamber			Provides chamber where combustion or burning of propellants occurs at high pressure to form gaseous reaction products	1) Structural failure	LOSS OF SUBSYSTEM	A) None; not operational prior to launch B) PROBABLE LOSS OF S-IV STAGE

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)

B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

YLR 115 P & W ENGINES SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FOR ONE ENGINE ONLY FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
1) Fuel Pump 2) Oxidizer Pump 3) Gear Box 4) Turbine			Pressurizes the propellants by means of pumps which are driven by the turbine.	1) Structural failure	LOSS OF SUBSYSTEM	A) None; not operational prior to launch B) LOSS OF ONE ENGINE
Overboard Vent Relief Valve			Maintains a positive pressure of 16 to 20 psia of gaseous hydrogen within the gearbox	1) Internal leakage or failure to reseat.	POSSIBLE LOSS OF SUBSYSTEM Loss of positive pressure and cooling atmosphere in gearbox may cause seizure of bearings due to overheating.	A) None; not operational prior to launch B) POSSIBLE LOSS OF ONE ENGINE
Propellant Utilization and Mixture Ratio Adjustment Valve			Controls oxidizer flow rate during prestart cycle for cooldown and during engine operation for proper mixture ratio.	1) Failure to respond to servo input	Loss of propellant utilization	A) None; not operational prior to launch B) Loss of one engine propellant utilization
Thrust Control Valve			Functions to increase or decrease the turbine bypass fuel flow by changing the position of the bypass valve in response to combustion chamber pressure.	1) Failure to respond to chamber pressure	Subsystem will operate off trim mixture ratio.	A) None; not operational prior to launch B) None; engine will operate off trim mixture ratio, but effect is corrected by flight control, guidance and propellant utilization subsystems.
Plumbing				1) External leakage of propellant	POSSIBLE LOSS OF SUBSYSTEM Severe loss of system pressure may cause engine shut-down.	A) None; not operational prior to launch B) POSSIBLE LOSS OF S-IV STAGE Temperature shock from escaping propellants may cause damage to sensitive equipment.
				2) External leakage of helium (control gas)	POSSIBLE LOSS OF SUBSYSTEM Severe loss of system pressure may cause engine shut-down.	A) None; not operational prior to launch B) POSSIBLE LOSS OF S-IV STAGE Continuous loss of engine control gas on operating engine may deplete central helium supply.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

YLR 115 P & W ENGINES SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FOR ONE ENGINE ONLY FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Oxidizer Inlet Shutoff Valve, N. C. (cont'd)				3) Failure to close at cut-off	Liquid oxygen high cut-off	A) None; not operational prior to launch B) None; stage function ceases at cut-off
Fuel Inlet Shutoff Valve, N. C.			Seals off fuel supply from pump assembly; opens at initiation of prestart cooldown period.	1) Failure to open or failure to stay open during operation	LOSS OF SUBSYSTEM	A) None; not operational prior to launch B) LOSS OF ONE ENGINE
				2) Internal leakage	Premature cooldown (gaseous hydrogen dumped overboard)	A) Scrub B) Possible loss of burning time
				3) Failure to close at cut-off	None; main fuel shut-off valve stops fuel flow to thrust chamber injector; however, there is a possibility of dynamic disturbance of engine and associated plumbing since turbine continues to operate.	A) None; not operational prior to launch B) None; stage function ceases at cut-off; however, pressure transients in engine could affect S-IV to S-V stage separation.
Fuel Pump Interstage Cooldown Valve, N.O.			Allows fuel flow for cooling the pump and gear-box bearings to the desired operating temperature during the prestart cycle; closes during engine start.	1) Failure to respond to helium control gas or fuel pressure (stuck in open or half-way closed position).	LOSS OF SUBSYSTEM Turbine will not start because fuel is dumped overboard through cooldown valve.	A) None; not operational prior to launch B) LOSS OF ONE ENGINE
Fuel Pump Discharge Cooldown Valve, N.O.			Allows fuel flow for cooling thrust chamber and turbine to the desired operating temperature during the prestart cycle; closes during engine start.	1) Failure to respond to helium control gas or fuel pressure (stuck in open or half-way closed position).	LOSS OF SUBSYSTEM Turbine will not start because fuel is dumped overboard through cooldown valve.	A) None; not operational prior to launch B) LOSS OF ONE ENGINE
Main Fuel Shutoff Valve, N. C.			Opens at engine start and allows fuel flow to thrust chamber injectors; spring expands and closes valve gate upon removal of helium pressure signal.	1) Failure to open or failure to stay open during operation.	LOSS OF SUBSYSTEM	A) None; not operational prior to launch B) LOSS OF ONE ENGINE
				2) Failure to close at cut-off	Slow cut-off	A) None; not operational prior to launch B) None; stage function ceases at cut-off; however, tail-off thrust could affect S-IV to S-V stage separation.

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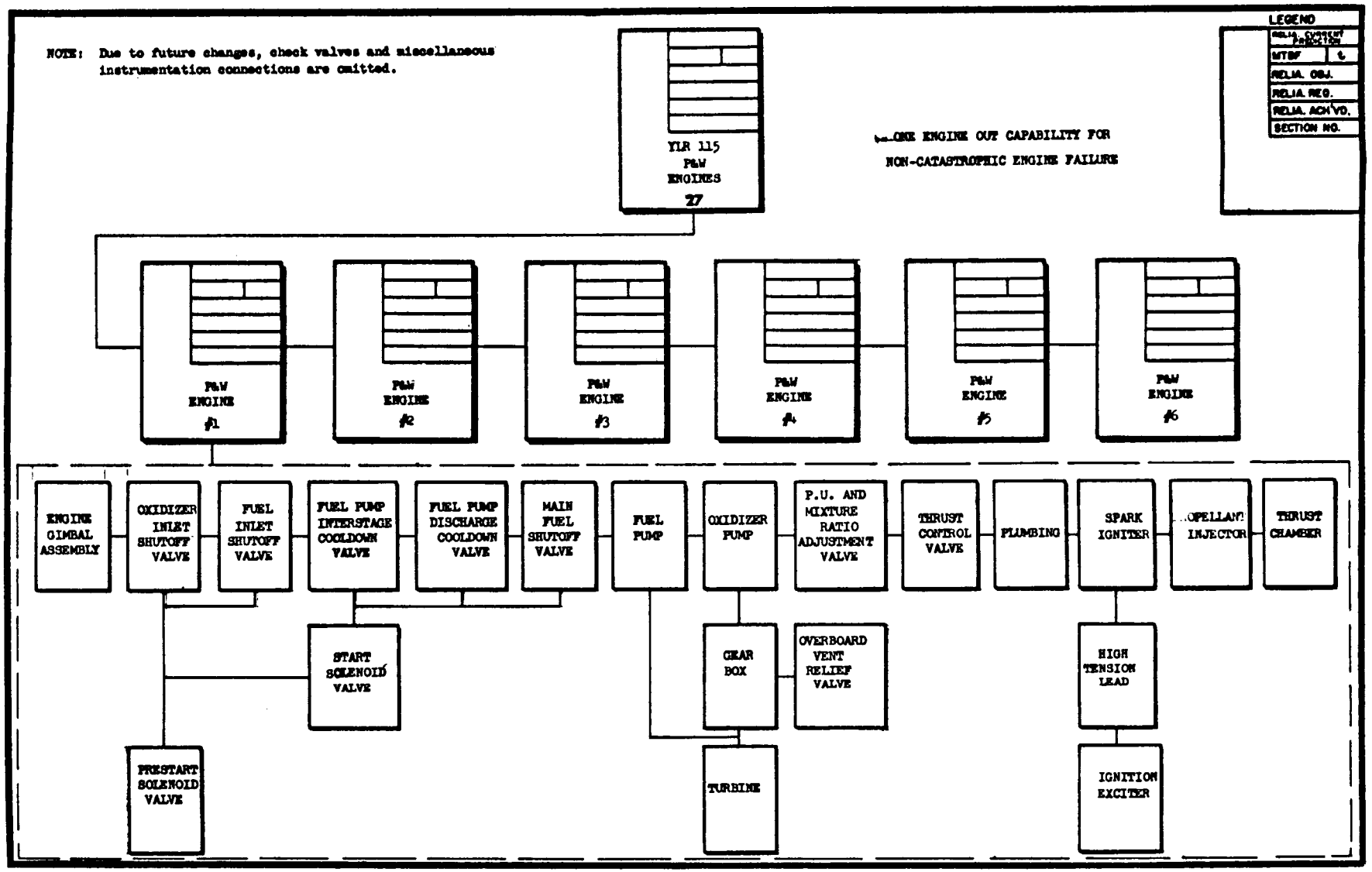
A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

YLR 115 P & W ENGINES SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FOR ONE ENGINE ONLY FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Engine Gimbal Assembly			Provides mount for engine to thrust structure and permits gimballing of engine in square vectoring range.	1) Structural failure	PROBABLE LOSS OF SUBSYSTEM Marginal attachment may cause failure of propellant feed system due to excessive vibration in flight.	A) Scrub B) PROBABLE LOSS OF S-IV STAGE
				2) "Frozen" pintle joint	None; engine operation unaffected by "frozen" pintle joint.	A) Scrub B) None; effect of loss of one engine control will be corrected by remaining five engine flight control subsystems.
Pre-start Solenoid Valve, N. C.			Controls the pre-start cycle of engine operation by porting helium supply pressure through the valve to the propellant inlet shutoff valves.	1) Failure to open or failure to stay open during operation.	LOSS OF SUBSYSTEM	A) None; not operational prior to launch. B) LOSS OF ONE ENGINE
				2) Failure to close at cut-off.	Liquid oxygen rich cut-off.	A) None; not operational prior to launch. B) None; stage function ceases at cut-off.
Start Solenoid Valve, N.C.			Controls the start cycle of engine operation by porting helium supply pressure through the valve to the fuel cooldown valves and main shutoff valve.	1) Failure to open or failure to stay open during operation.	LOSS OF SUBSYSTEM	A) None; not operational prior to launch. B) LOSS OF ONE ENGINE
				2) Failure to close at cut-off.	Slow cut-off	A) None; not operational prior to launch. B) None; stage function ceases at cut-off; however, tail-off thrust could affect S-IV to S-V stage separation.
Oxidizer Inlet Shutoff Valve, N.C.			Seals off oxidizer supply from pump assembly; opens at initiation of prestart cooldown period.	1) Failure to open or failure to stay open during operation	LOSS OF SUBSYSTEM	A) None; not operational prior to launch. B) LOSS OF ONE ENGINE
				2) Internal leakage	Premature cooldown (also excessive gaseous oxygen in interstage)	A) Scrub B) Possible loss of burning time


NOTE: Due to future changes, check valves and miscellaneous instrumentation connections are omitted.
LEGEND
RELIA. CURRENT PREDICTION
MTBF
RELIA. OBJ.
RELIA. REQ.
RELIA. ACH'VD.
SECTION NO.
YLR 115 P&W ENGINES 27
ONE ENGINE OUT CAPABILITY FOR NON-CATASTROPHIC ENGINE FAILURE
P&W ENGINE #1
P&W ENGINE #2
P&W ENGINE #3
P&W ENGINE #4
P&W ENGINE #5
P&W ENGINE #6
ENGINE GIMBAL ASSEMBLY
OXIDIZER INLET SHUTOFF VALVE
FUEL INLET SHUTOFF VALVE
FUEL PUMP INTERSTAGE COOLDOWN VALVE
FUEL PUMP DISCHARGE COOLDOWN VALVE
MAIN FUEL SHUTOFF VALVE
FUEL PUMP
OXIDIZER PUMP
P.U. AND MIXTURE RATIO ADJUSTMENT VALVE
THRUST CONTROL VALVE
PLUMBING
SPARK IGNITER
PROPELLANT INJECTOR
THRUST CHAMBER
START SOLENOID VALVE
GEAR BOX
OVERBOARD VENT RELIEF VALVE
HIGH TENSION LEAD
PRESTART SOLENOID VALVE
TURBINE
IGNITION EXCITER

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

OXIDIZER PRESSURIZATION SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Pressure Switch		7851847-1	Activates whenever internal tank pressure exceeds 47 ± 1 psia and deactivates whenever pressure drops below 45 ± 8 psia. "Makes and breaks circuit" for solenoid shut-off valve during launch countdown and for the by-pass control solenoid valve during flight.	1) Failure to "make circuit" (activate).	A) None; oxidizer tank ullage pressure may be controlled by ground support equipment during pre-pressurization. B) None; the excess of pressurizing gas will be dumped overboard by vent and relief valves in oxidizer tank.	A) Delay in launching or scrub. B) None; cold helium supply will be adequate to complete mission because of choked gas flow through orifice.
				2) Failure to "break circuit" (deactivate).	A) LOSS OF SUBSYSTEM Solenoid shut-off valve will remain closed precluding oxidizer tank pre-pressurization. B) POSSIBLE LOSS OF SUBSYSTEM Low oxidizer tank ullage pressure may cause pump cavitation and engine shutdown.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE
Subsystem Plumbing		3851849-1		1) Leakage at connection.	POSSIBLE LOSS OF SUBSYSTEM Continuous loss of pressurizing gas may deplete cold helium supply prior to mission completion.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE
Vent and Relief Valve (2)		7851777-1	Vents oxidizer tank upon command during launch countdown; opens at maximum pressureof 50 psia, closes at minimum of 47 psia to relieve tank ullage pressure, except when "boost close" is applied during launch countdown.	1) Failure to open.	None; redundancy provided.	A) Delay in launching or scrub. B) None; redundancy provided.
				2) Failure to close.	LOSS OF SUBSYSTEM Open vent and relief valve will preclude oxidizer tank pre-pressurization during launch countdown and cause loss of pressurization gas during flight.	A) Delay in launching or scrub. B) LOSS OF S-IV STAGE

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)

B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

OXIDIZER PRESSURIZATION SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Pressure Switch		7871397-1	Activates whenever pressure downstream of solenoid shut off valve exceeds 320 ± 10 psia; deactivates at 115 ± 15 psia. Provides back-up in case upstream pressure regulator fails open.	1) Failure to "make circuit" (activate).	LOSS OF SUBSYSTEM Cold helium supply will discharge through failed upstream pressure regulator and downstream heat exchanger into oxidizer tank.	A) None; not operational prior to launch. B) None; pressure switch not operational in flight unless pressure regulator fails. Double failure required for probable S-IV stage loss.
				2) Failure to "break circuit" (deactivate).	LOSS OF SUBSYSTEM Closed solenoid shut-off valve will preclude oxidizer tank pressurization.	A) None; not operational prior to launch. B) None; pressure switch not operational in flight unless pressure regulator fails. Double failure required for S-IV stage loss.
Heat Exchanger			Provides heat exchange between the incoming cold helium and combustion products in helium heater during S-IV stage flight to raise the temperature of the oxidizer tank pressurization gas.	1) Coil burn-through at hot spot.	LOSS OF SUBSYSTEM Cold helium supply will discharge through failed heat exchanger coil. Escaping cold helium gas may also cease helium heater combustion.	A) None; not operational prior to launch. B) PROBABLE LOSS OF S-IV STAGE
By-Pass Control Solenoid Valve, N.O.		7851845-1	Controls amount of cold helium supply to heat exchanger. Closes when internal oxidizer tank pressure exceeds 47 ± 1 psia and remains open whenever pressure drops below 45 ± 5 psia.	1) Failure to stay closed when energized.	None; the excess of pressurizing gas will be dumped overboard by vent and relief valves in oxidizer tank.	A) None; not operational prior to launch. B) None; cold helium supply will be adequate to complete mission because of choked gas flow through orifice.
				2) Failure to open when de-energized.	POSSIBLE LOSS OF SUBSYSTEM Low oxidizer tank ullage pressure may cause pump cavitation and engine shut-down.	A) None; not operational prior to launch. B) POSSIBLE LOSS OF S-IV STAGE

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A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS
OXIDIZER PRESSURIZATION SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Check Valve (Installed in Pressure Regulator By-Pass Line)		7851843-1	Opens to permit high pressure cold helium to flow from ground supply to gas spheres. Closes to prevent by-pass of pressure regulator.	1) Internal leakage.	None; normally open solenoid shut-off valve will close if leakage becomes excessive and downstream pressure exceeds pressure switch setting.	A) Delay in launching or scrub. B) None; solenoid valve will prevent subsystem over-pressurization.
Check Valve (Adjacent to Disconnect)		7851843-1	Opens to permit cold helium fill and oxidizer tank pre-pressurization. Closes to prevent loss of pressurizing gas.	1) Internal leakage	None; upstream disconnect prevents loss of pressurizing gas.	A) None; redundancy provided. B) None; redundancy provided.
Disconnect		7851844-501	Engages with ground half to permit cold helium fill or oxidizer tank pre-pressurization. Closes at disconnect.	1) Internal leakage. 2) Failure to close at disconnect.	None; downstream check valve prevents loss of pressurizing gas.	A) None; redundancy provided. B) None; redundancy provided.
Pressure Regulator		7851841-1	Regulates cold gaseous helium from 3100 psig to 400 psig inlet pressure to 250 ± 25 psig outlet pressure during S-IV stage flight. Goes to fully open position at 400 psig inlet pressure.	1) Failure to open (stuck in closed position).	LOSS OF SUBSYSTEM: Failure to unlock at start of S-IV stage flight will preclude oxidizer tank pressurization	A) None; not operational prior to launch. B) LOSS OF S-IV STAGE
				2) Failure to close.	None; downstream solenoid shut-off valve will close if pressure becomes excessive.	A) None; not operational prior to launch. B) None; redundancy provided.
Solenoid Shut-Off Valve, N.O. (Installed Downstream of Pressure Regulator)		7851845-1	Remains in closed (energized) position during cold helium fill and S-I stage flight. Opens at start of S-IV stage flight and shuts-off helium supply whenever downstream pressure exceeds pressure switch setting.	1) Failure to stay closed when energized.	LOSS OF SUBSYSTEM Cold helium supply will discharge from upstream regulator (or fill system during filling) and heat exchanger into oxidizer tank.	A) Scrub B) PROBABLE LOSS OF S-IV STAGE Loss of cold helium during S-I stage flight may deplete gas supply.
				2) Failure to open when de-energized.	LOSS OF SUBSYSTEM Closed solenoid shut-off valve will preclude oxidizer tank pressurization.	A) Scrub B) LOSS OF S-IV STAGE Failure to open at start of S-IV flight will preclude oxidizer tank pressurization.

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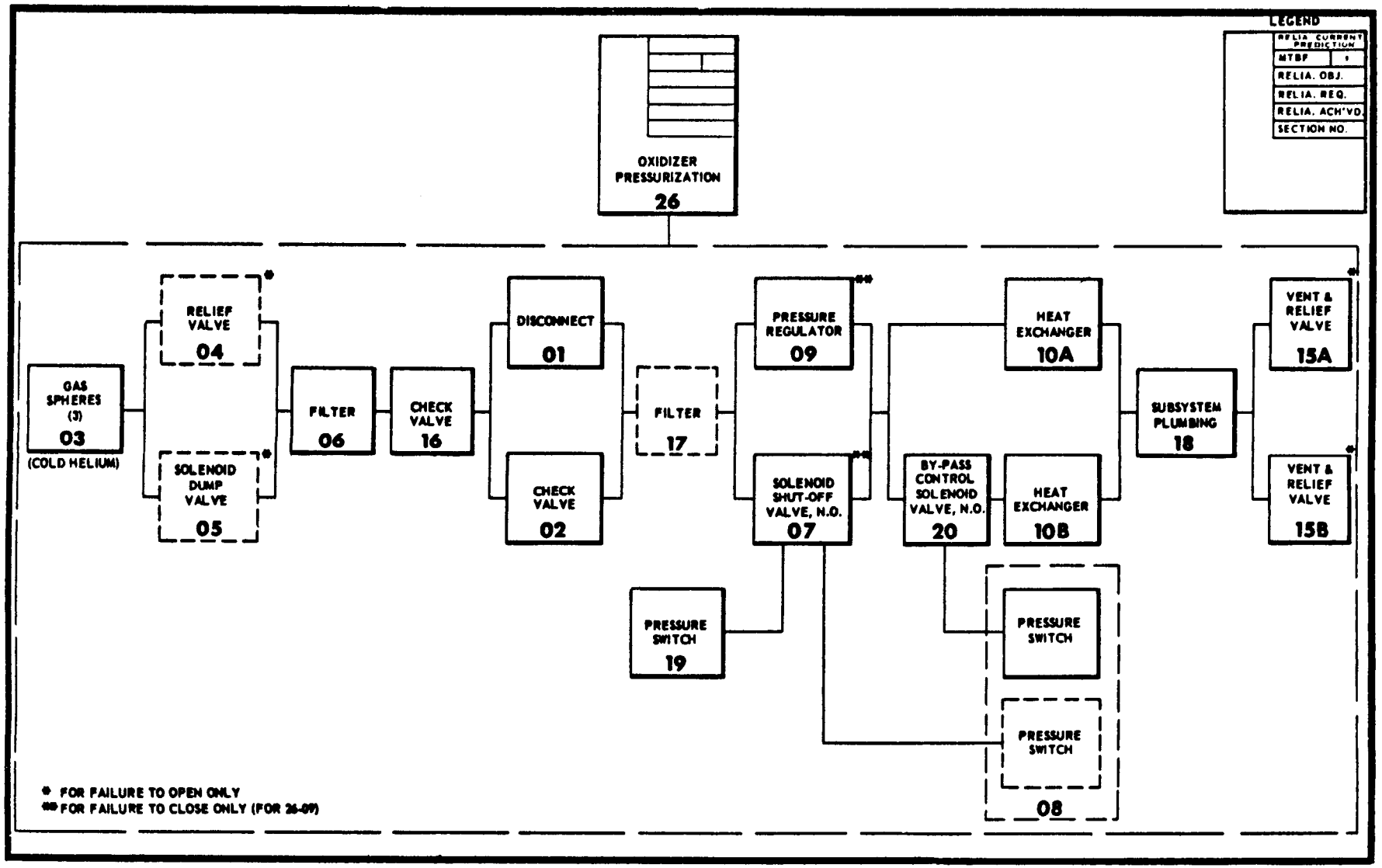
A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

OXIDIZER PRESSURIZATION SUBSYSTEM

ITEM	*	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Gas Spheres (3) (Cold Helium)		7851834-1	Provides storage for high pressure gaseous helium (3200 psig maximum). Gas spheres are submerged in liquid hydrogen.	1) External leak at connection.	POSSIBLE LOSS OF SUBSYSTEM Continuous loss of pressurizing gas may deplete cold helium supply prior to mission completion.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE
Relief Valve	*	7851842-1	Relieves cold helium supply pressure in excess of 3250 ± 100 psig.	1) Internal leakage (leakage overboard).	POSSIBLE LOSS OF SUBSYSTEM Continuous loss of pressurizing gas may deplete cold helium supply prior to mission completion.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE
				2) Failure to open.	None; redundant solenoid valve can be used to dump pressure.	A) None; redundancy provided. B) None; not operational in flight.
Solenoid Dump Valve, N.C.	*	7851845-501	Dumps cold helium supply when activated.	1) Internal leakage (leakage overboard).	POSSIBLE LOSS OF SUBSYSTEM Continuous loss of pressurizing gas may deplete cold helium supply prior to mission completion.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE
				2) Failure to open.	None; relief valve will relieve pressure in excess of 3250 ± 100 psig, and oxidizer tank vent valves can be used to dump the cold helium supply.	A) Delay in launching. B) None; not operational in flight.
Filter (Installed Between Gas Spheres and Pressure Regulator)		7851840-1	Filters cold helium supply during flight.	1) Implosion of element.	POSSIBLE LOSS OF SUBSYSTEM Filter particles will damage or affect the operation of all downstream components.	A) None; not operational prior to launch. B) POSSIBLE LOSS OF S-IV STAGE
Filter (Installed in Oxidizer Tank Pre-Pressurization Line)	*	7851840-1	Filters helium pre-pressurizing gas during launch countdown.	1) Implosion of element.	POSSIBLE LOSS OF SUBSYSTEM Filter particles will damage or affect the operation of all downstream components	A) Scrub B) None; not operational in flight.


LEGEND
RELIA. CURRENT PREDICTION
MTBF
RELIA. OBJ.
RELIA. REQ.
RELIA. ACH'VD.
SECTION NO.
OXIDIZER PRESSURIZATION 26
GAS SPHERES (3) 03
(COLD HELIUM)
RELIEF VALVE 04
SOLENOID DUMP VALVE 05
FILTER 06
CHECK VALVE 16
DISCONNECT 01
CHECK VALVE 02
FILTER 17
PRESSURE REGULATOR 09
SOLENOID SHUT-OFF VALVE, N.O. 07
PRESSURE SWITCH 19
HEAT EXCHANGER 10A
BY-PASS CONTROL SOLENOID VALVE, N.O. 20
HEAT EXCHANGER 10B
PRESSURE SWITCH
PRESSURE SWITCH
08
SUBSYSTEM PLUMBING 18
VENT & RELIEF VALVE 15A
VENT & RELIEF VALVE 15B
* FOR FAILURE TO OPEN ONLY
** FOR FAILURE TO CLOSE ONLY (FOR 26-09)

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS
FUEL PRESSURIZATION SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Check Valve		7851859-1	Opens to permit fuel tank pre-pressurization. Closes to prevent loss of pressurizing gas.	1) Internal leakage	None; upstream disconnect prevents loss of fuel pressurization gas.	A) None; redundancy provided B) None; redundancy provided
Subsystem Plumbing				1) Leakage at connection	POSSIBLE LOSS OF SUBSYSTEM Continuous loss of pressurizing gas during S-IV stage flight may preclude effective fuel pressurization.	A) Delay in launching or scrub B) POSSIBLE LOSS OF S-IV STAGE
Vent and Relief Valve (2)		7851795-1	Vents fuel tank upon command during launch countdown; opens at maximum pressure of 44 psia, closes at minimum of 41 psia to relieve tank ullage pressure, except when "boost close" is applied during launch countdown.	1) Failure to open	None; redundancy provided	A) Delay in launching or scrub B) None; redundancy provided
				2) Failure to close	LOSS OF SUBSYSTEM Open vent and relief valve will preclude fuel tank pre-pressurization during launch countdown and cause loss of pressurization gas during flight.	A) Delay in launching B) POSSIBLE LOSS OF S-IV STAGE Since vent and relief valves may operate near the end of S-IV stage flight, engine pumps may cavitate prior to S-IV stage cut-off due to low ullage pressure.

*ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS

FUEL PRESSURIZATION SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	*	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
By-Pass Solenoid Valve, N.C. (Cont.)		7851858-1	Opens by-pass whenever fuel tank pressure decays below pressure switch setting to allow more gaseous hydrogen for fuel pressurization.	2) Failure to close	LOSS OF SUBSYSTEM Subsystem will provide more than the required amount of hydrogen bleed gas, however, the ullage pressure will stabilize at approximately 34 psia.	A) Delay in launching or scrub B) POSSIBLE LOSS OF S-IV STAGE Engine pumps may cavitate prior to S-IV stage cut-off due to higher temperature rise of liquid hydrogen upper layers.
Pressure Switch		7851860-1	Deactivates whenever fuel tank ullage pressure drops below $30 \pm^{1}_{6}$ psia to "make circuit" for normally closed by-pass solenoid valve; activates at 32 ±1 psia to "break circuit."	1) Failure to deactivate - "make circuit"	LOSS OF SUBSYSTEM Subsystem will not provide the required amount of hydrogen bleed gas, however, the ullage pressure will stabilize at approximately 26 psia.	A) Delay in launching or scrub B) POSSIBLE LOSS OF S-IV STAGE Engine pumps may cavitate prior to S-IV stage cut-off due to low ullage pressure.
				2) Failure to activate - "break circuit"	LOSS OF SUBSYSTEM Subsystem will provide more than the required amount of hydrogen bleed gas, however, the ullage pressure will stabilize at approximately 34 psia.	A) Delay in launching or scrub B) POSSIBLE LOSS OF S-IV STAGE Engines pumps may cavitate prior to S-IV stage cut-off due to higher temperature rise of liquid hydrogen upper layers.
Disconnect		7851861-1	Engages with ground half to permit fuel tank pre-pressurization. Closes at disconnect.	1) Internal leakage 2) Failure to close at disconnect	None; downstream check valve prevents loss of fuel pressurization gas.	A) None; redundancy provided B) None; redundancy provided

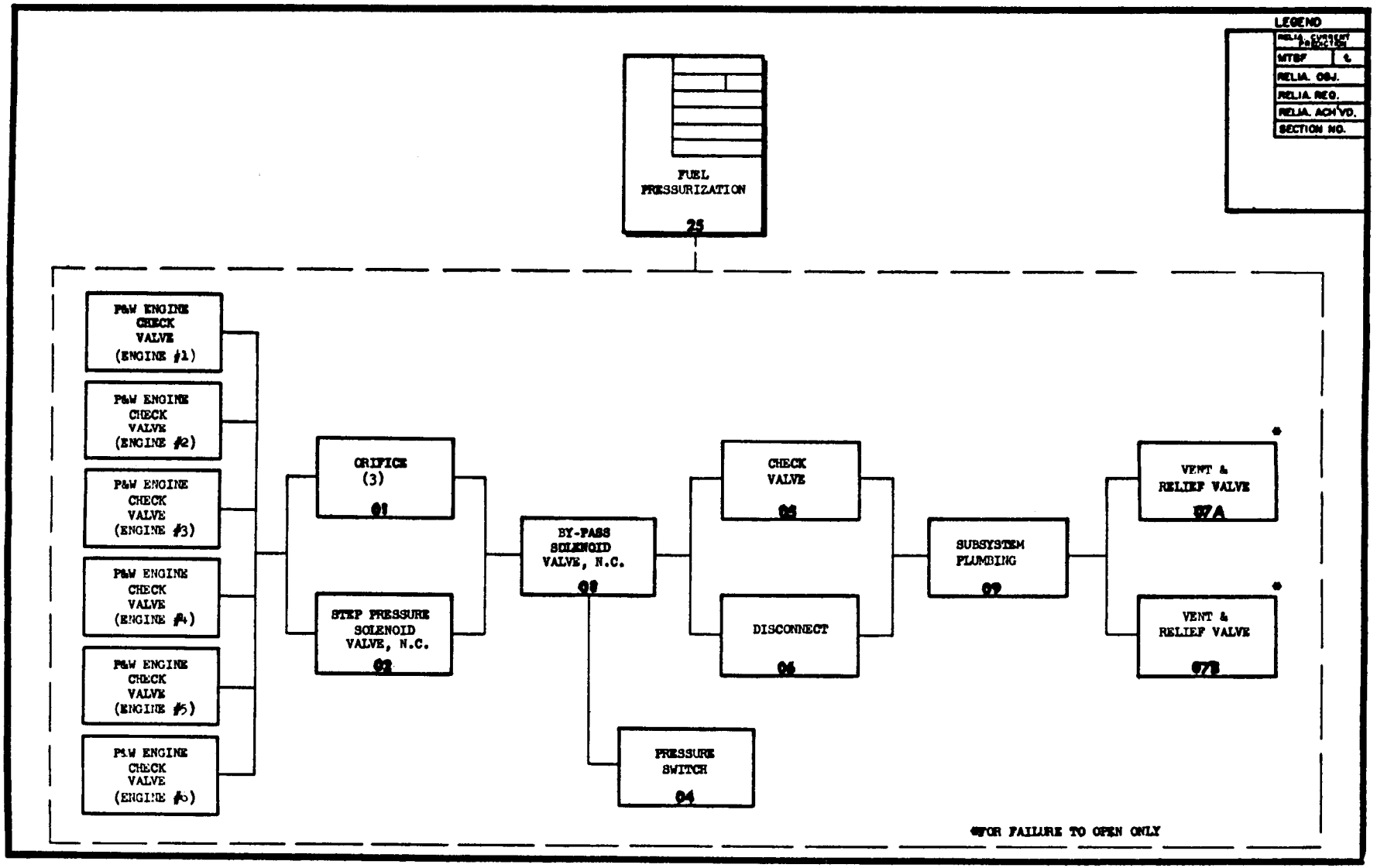
**TITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

FUEL PRESSURIZATION SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Check Valve (6) P&W Engines		P&W Item	Opens to permit gaseous hydrogen flow during S-IV stage flight for fuel pressurization. Closes to prevent loss of pressurizing gas.	1) Failure to open (frozen shut due to moisture)	None; remaining five engine bleed systems provide sufficient pressurizing gas.	A) Scrub; moisture in engine bleed system could also affect other components. B) None; remaining five engine bleed systems provide sufficient pressurizing gas.
				2) Internal leakage (excessive)	None; amount of pressurizing gas lost due to check valve leakage is negligible.	A) Delay in launching or scrub B) None; tolerable decay in ullage pressure during S-1 stage flight.
Step Pressure Solenoid Valve, N.C.		7851858-1	Opens at signal from P.U. electronics assembly to permit additional gaseous hydrogen for fuel pressurization.	1) Failure to open	LOSS OF SUBSYSTEM Closed solenoid valve will preclude required fuel pressurization step pressure.	A) Delay in launching or scrub B) POSSIBLE LOSS OF S-IV STAGE Engine pumps may cavitate prior to S-IV stage cut-off due to low ullage pressure.
Orifice (3)			Controls flow of gaseous hydrogen for fuel pressurization.	None		
By-Pass Solenoid Valve, N.C.		7851858-1	Opens by-pass whenever fuel tank pressure decays below pressure switch setting to allow more gaseous hydrogen for fuel pressurization.	1) Failure to open	LOSS OF SUBSYSTEM Subsystem will not provide the required amount of hydrogen bleed gas, however, the ullage pressure will stabilize at approximately 20 psia.	A) Delay in launching or scrub B) POSSIBLE LOSS OF S-IV STAGE Engine pumps may cavitate prior to S-IV stage cut-off due to low ullage pressure.


LEGEND
RELIA. CURRENT PREDICTION
MTBF
%
RELIA. OBJ.
RELIA. REQ.
RELIA. ACH'VD.
SECTION NO.
FUEL PRESSURIZATION
25
P&W ENGINE CHECK VALVE (ENGINE #1)
P&W ENGINE CHECK VALVE (ENGINE #2)
P&W ENGINE CHECK VALVE (ENGINE #3)
P&W ENGINE CHECK VALVE (ENGINE #4)
P&W ENGINE CHECK VALVE (ENGINE #5)
P&W ENGINE CHECK VALVE (ENGINE #6)
ORIFICE (3)
01
STEP PRESSURE SOLENOID VALVE, N.C.
02
BY-PASS SOLENOID VALVE, N.C.
03
PRESSURE SWITCH
04
CHECK VALVE
05
DISCONNECT
06
SUBSYSTEM PLUMBING
09
VENT & RELIEF VALVE
07A
VENT & RELIEF VALVE
07B
*FOR FAILURE TO OPEN ONLY

**TEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS
VENT VALVE CONTROL SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Subsystem Plumbing (Includes all ambient helium lines from helium heater propellant supply valves to fill line shut-off valves and to vent valve control solenoid valves.)				1) Leakage at connection.	POSSIBLE LOSS OF SUBSYSTEM Continuous loss of engine control gas may deplete ambient helium supply prior to mission completion.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

RELIABILITY FAILURE EFFECT ANALYSIS
VENT VALVE CONTROL SUBSYSTEM

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

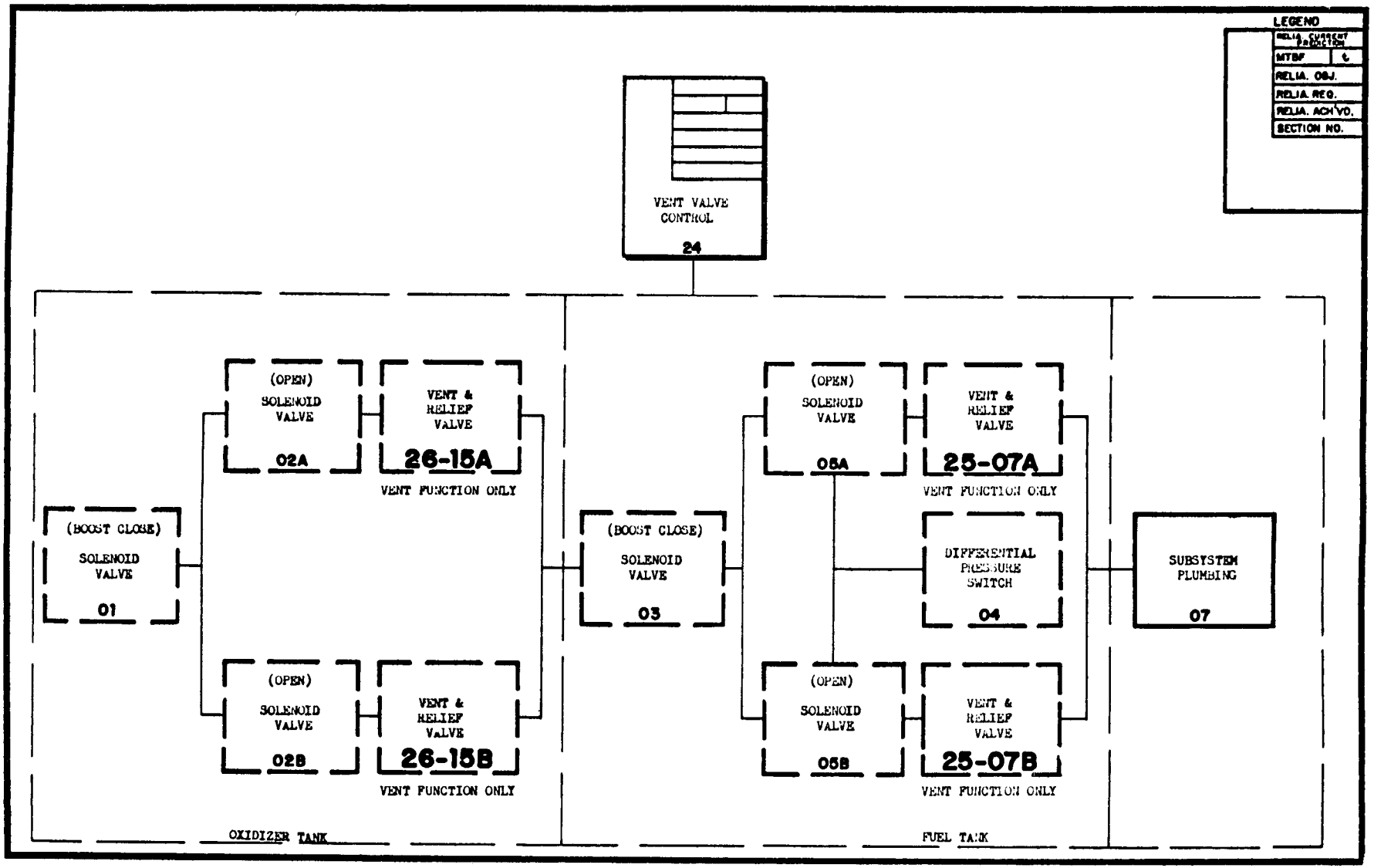
	ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
FUEL TANK	Solenoid Valve, N.C. (Boost Close) Cont.	*	7851827-1	Opens upon command to provide "boost close" actuation pressure for fuel tank vent and relief valves; closes before lift-off. Used only as back-up in case the vent valves do not close when "open" pressure is removed.	2) Failure to re-seat.	LOSS OF SUBSYSTEM Loss of engine control gas through actuation piston of vent valves (8 scfm max. per valve). Vent and relief valves will also relieve at higher than set pressure.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE Possible loss of burning time due to excessive ullage pressure in fuel tank; total gas loss through actuation piston during flight may be excessive considering leakage through both vent valves.
	Solenoid Valve, N.C. (Open) 2 Required	*	7851827-1	Opens upon command to provide "open" actuation pressure for single fuel tank vent and relief valve; closes before lift-off.	1) Failure to open.	Loss of one vent and relief valve control - propellant loading rate may be affected.	A) Delay in launching. B) None; not operational in flight.
					2) Failure to re-seat.	LOSS OF SUBSYSTEM Vent and relief valve will stay open preventing pressurization.	A) Delay in launching or scrub. B) None; not operational in flight.
	Differential Pressure Switch	*	7851831-1	Activates whenever the fuel tank port pressure (port #2) exceeds the oxidizer tank port pressure (port #1) by 1.0 ± 1.0 psi to "make circuit" for the fuel tank vent valve control solenoid valves; deactivates whenever port #1 pressure exceeds port #2 pressure by 1.0 ± 1.0 psi.	1) Failure to actuate.	LOSS OF SUBSYSTEM Subsystem will have lost the automatic capability to react to reverse common bulkhead pressure exceeding 1.0 ± 1.0 psi.	A) POSSIBLE LOSS OF S-IV STAGE Failure in ground pre-pressurization could cause excessive fuel tank pressure (single failure on vehicle). B) None; not operational in flight.
					2) Failure to deactivate	None; fuel tank vent valves can be closed by deactivating pressure switch.	A) Delay in launching B) None not operational in flight.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS
VENT VALVE CONTROL SUBSYSTEM

	ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
OXIDIZER TANK	Solenoid Valve, N.C. (Boost Close)	*	7851827-1	Opens upon command to provide "boost close" actuation pressure for oxidizer tank vent and relief valves. Closes before lift-off. Used only as back-up in case the vent valves do not close when "open" pressure is removed.	1) Failure to open.	None; vent and relief valves close prior to boost close application.	A) None; redundancy provided. B) None; not operational in flight.
					2) Failure to re-seat.	LOSS OF SUBSYSTEM Loss of engine control gas through actuation piston of vent valves (8 scfm max. per valve). Vent and relief valves will also relieve at higher than set pressure.	A) Delay in launching or scrub. B) POSSIBLE LOSS OF S-IV STAGE By-pass control solenoid valve and pressure switch will preclude oxidizer tank overpressurization, however, total gas loss through actuation piston during flight may be excessive considering leakage through both vent valves.
	Solenoid Valve, N.C. (Open) 2 Required	*	7851827-1	Opens upon command to provide "open" actuation pressure for single oxidizer tank vent and relief valve; closes before lift-off.	1) Failure to open.	Loss of one vent and relief valve control - propellant loading rate may be affected.	A) Delay in launching. B) None; not operational in flight.
					2) Failure to re-seat	LOSS OF SUBSYSTEM Vent and relief valve will stay open preventing pressurization.	A) Delay in launching or scrub. B) None; not operational in flight.
FUEL TANK	Solenoid Valve, N.C. (Boost Close)	*	7851827-1	Opens upon command to provide "boost close" actuation pressure for fuel tank vent and relief valves; closes before lift-off. Used only as back-up in case the vent valves do not close when "open" pressure is removed.	1) Failure to open.	None; vent and relief valves close prior to boost close application.	A) None; redundancy provided. B) None; not operational in flight.


LEGEND
RELIA. CURRENT PREDICTION
MTBF
RELIA. OBJ.
RELIA. REQ.
RELIA. ACHVD.
SECTION NO.
VENT VALVE CONTROL
24
(BOOST CLOSE)
SOLENOID VALVE
01
(OPEN)
SOLENOID VALVE
02A
VENT & RELIEF VALVE
26-15A
VENT FUNCTION ONLY
(OPEN)
SOLENOID VALVE
02B
VENT & RELIEF VALVE
26-15B
VENT FUNCTION ONLY
OXIDIZER TANK
(BOOST CLOSE)
SOLENOID VALVE
03
(OPEN)
SOLENOID VALVE
05A
VENT & RELIEF VALVE
25-07A
VENT FUNCTION ONLY
DIFFERENTIAL PRESSURE SWITCH
04
(OPEN)
SOLENOID VALVE
05B
VENT & RELIEF VALVE
25-07B
VENT FUNCTION ONLY
FUEL TANK
SUBSYSTEM PLUMBING
07

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

ENGINE CONTROL SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Subsystem Plumbing (Includes all ambient helium lines from gas sphere to P&W engine connection.)				1) Leakage at connection	POSSIBLE LOSS OF SUBSYSTEM Continuous loss of engine control gas may deplete ambient helium supply prior to mission completion	A) Delay in launching or scrub B) POSSIBLE LOSS OF S-IV STAGE
Pressure Regulator		7851821-1	Regulates ambient helium from 3100 psig to 600 psig inlet pressure to 450 ± 25 psig outlet pressure during flight. Goes to fully open position at 600 psig inlet pressure.	1) Failure to open (stuck in closed position)	LOSS OF SUBSYSTEM Closed regulator will preclude engine control - valve actuation	A) Scrub. B) LOSS OF S-IV STAGE
				2) Failure to close or regulate (regulator in fully open position).	None; downstream solenoid shut-off valve will close if pressure becomes excessive.	A) Scrub B) None; redundancy provided
Solenoid Shut-off Valve, N.O.		7851826-1	Shuts-off ambient helium supply whenever downstream pressure exceeds pressure switch setting. Operates only when upstream regulator fails to close or regulate (fully open).	1) Failure to stay closed when energized (Second failure of subsystem)	LOSS OF SUBSYSTEM Operation of all downstream components will be affected due to excessive pressure. (Second failure analysis)	A) Delay in launching or scrub B) None; solenoid shut-off valve not operational unless pressure regulator fails. Double failure required for probable S-IV stage loss.
				2) Failure to open when de-energized (Second failure of subsystem)	LOSS OF SUBSYSTEM Closed solenoid shut-off valve will preclude engine control - valve actuation. (Second failure analysis)	A) Delay in launching or scrub B) None; solenoid shut-off valve not operational unless pressure regulator fails. Double failure required for S-IV stage loss.
Pressure Switch		7851830-1	Activates whenever pressure downstream of solenoid shut-off valve exceeds 550 ± 8 psia; deactivates at 510 ± $^{11}_{10}$ psia; provides back-up in case upstream regulator fails open.	1) Failure to "make circuit" (activate) (Second failure of subsystem)	LOSS OF SUBSYSTEM Operation of all downstream components will be affected due to excessive pressure. (Second failure analysis)	A) None; not operational prior to launch B) None; pressure switch not operational unless pressure regulator fails. Double failure required for probable S-IV stage loss.
				2) Failure to "break circuit" (deactivate) (Second failure of subsystem)	LOSS OF SUBSYSTEM Closed solenoid shut-off valve will preclude engine control - valve actuation. (Second failure analysis)	A) None; not operational prior to launch B) None; pressure switch not operational unless pressure regulator fails. Double failure required for S-IV stage loss.

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

ENGINE CONTROL SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Disconnect		7851823-1	Engages with ground half to permit ambient helium fill. Closes at disconnect	1) Internal leakage 2) Failure to close at disconnect	None; downstream check valve prevents loss of engine control gas.	A) None; redundancy provided B) None; redundancy provided
Check Valve		7851822-1	Opens to permit ambient helium fill. Closes to prevent loss of engine control gas.	1) Internal leakage.	None; upstream disconnect prevents loss of engine control gas.	A) None; redundancy provided B) None; redundancy provided
Gas Sphere		7851820-1	Provides storage for high pressure gaseous helium (3200 psig maximum)	1) External leak at connection.	POSSIBLE LOSS OF SUBSYSTEM Continuous loss of ambient helium may deplete gas supply prior to mission completion.	A) Delay in launching or scrub B) POSSIBLE LOSS OF S-IV STAGE
Relief Valve	*	7851824-1	Relieves ambient helium supply in excess of 3250 ± 100 psig.	1) Internal leakage (leakage overboard)	POSSIBLE LOSS OF SUBSYSTEM Continuous loss of ambient helium may deplete gas supply prior to mission completion.	A) Delay in launching or scrub B) POSSIBLE LOSS OF S-IV STAGE
				2) Failure to open	None; redundant solenoid valve can be used to dump pressure.	A) None; redundancy provided B) None; not operational in flight.
Solenoid Dump Valve	*	7851825-1	Dumps ambient helium supply when activated	1) Internal leakage (leakage overboard)	POSSIBLE LOSS OF SUBSYSTEM Continuous loss of ambient helium may deplete gas supply prior to mission completion	A) Delay in launching or scrub B) POSSIBLE LOSS OF S-IV STAGE
				2) Failure to open	None; relief valve will relieve pressure in excess of 3250 ± 100 psig and ambient helium gas supply may be dumped through actuation piston of vent and relief valves when in boost close position.	A) Delay in launching B) None; not operational in flight
Filter		7851829-1	Filters ambient helium supply	1) Implosion of element	POSSIBLE LOSS OF SUBSYSTEM Filter particles will damage or affect the operation of all downstream components	A) Scrub B) POSSIBLE LOSS OF S-IV STAGE

DOUGLAS AIRCRAFT COMPANY, INC.

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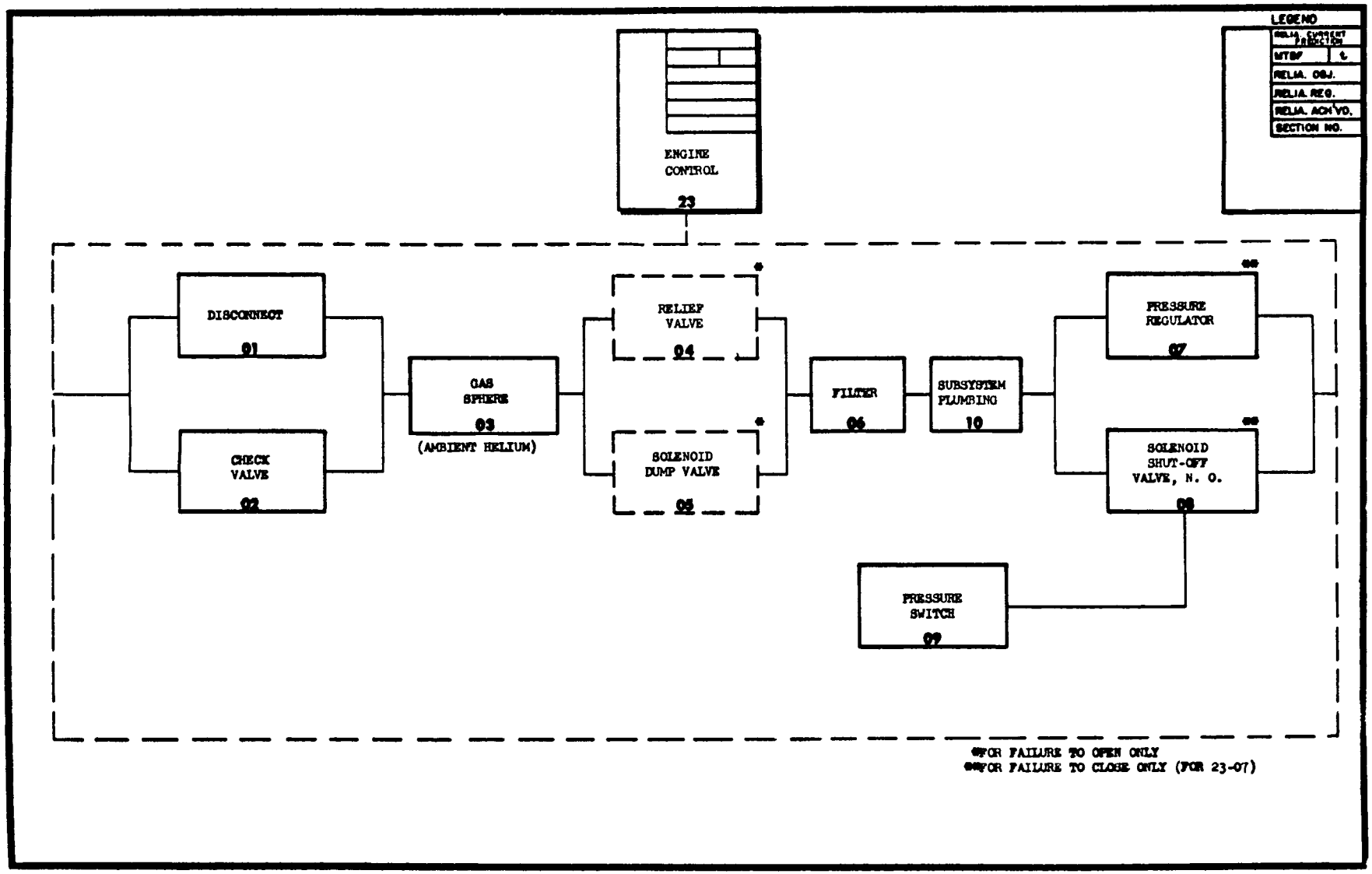


*FOR FAILURE TO OPEN ONLY
**FOR FAILURE TO CLOSE ONLY (FOR 23-07)

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

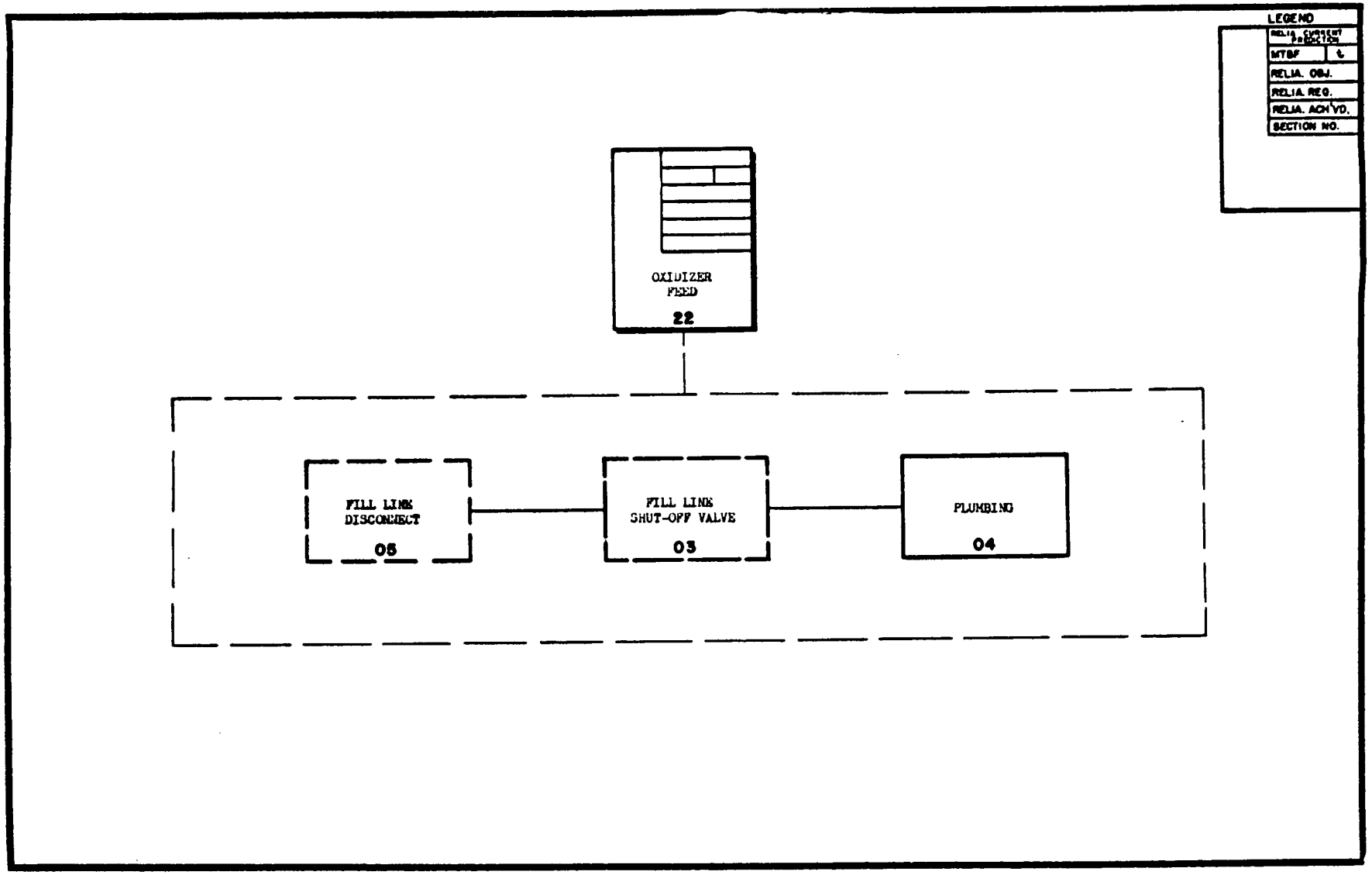
NOTE:
Leakage is considered a failure if it is in excess of the allowable rate.

A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

RELIABILITY FAILURE EFFECT ANALYSIS

OXIDIZER FEED SUBSYSTEM

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Fill Line Disconnect (Open Type)	*	7851786-1	Connects and locks with ground half (-501) to allow liquid oxygen to flow to oxidizer tank; disconnects at lift-off.	1) Failure to engage with ground half.	LOSS OF SUBSYSTEM Propellant loading will not be possible.	A) Delay in launching or scrub. B) None; not operational in flight.
Fill Line Shut-off Valve	*	7851806-2	Opens pneumatically upon application of electrical power to valve's solenoid to allow liquid oxygen to flow to oxidizer tank; closes before lift-off when electrical power is removed.	1) Failure to open.	LOSS OF SUBSYSTEM Propellant loading will not be possible.	A) Scrub B) None; not operational in flight.
				2) Failure to close prior to lift-off.	LOSS OF SUBSYSTEM Open shut-off valve will preclude launch of vehicle.	A) Scrub B) None; not operational in flight.
				3) Loss of electrical continuity on solenoid during filling.	LOSS OF SUBSYSTEM Propellant loading will be interrupted because shut-off valve will close.	A) Delay in launching or scrub. B) None; not operational in flight.
				4) Leakage past lip seal during S-I and S-IV Stage flight.	None; gaseous oxygen by itself will not create an explosion hazard due to lack of combustibles.	A) None; fill line disconnect remains engaged until first motion of vehicle. B) None; gaseous oxygen by itself will not create an explosion hazard due to lack of combustibles.
Plumbing		7851781 5851784		1) Leakage at connection.	POSSIBLE LOSS OF SUBSYSTEM Severe loss of system pressure may cause engine shut-down.	A) Delay in launching or scrub. (Purging provided.) B) POSSIBLE LOSS OF S-IV STAGE Temperature shock from escaping oxidizer may cause damage to sensitive equipment.


LEGEND
RELIA. CURRENT PREDICTION
MTBF
RELIA. OBJ.
RELIA. REQ.
RELIA. ACH'VD.
SECTION NO.
OXIDIZER FEED
22
FILL LINE DISCONNECT
05
FILL LINE SHUT-OFF VALVE
03
PLUMBING
04

**ITEMS MARKED THUS (*) DO NOT OPERATE IN FLIGHT

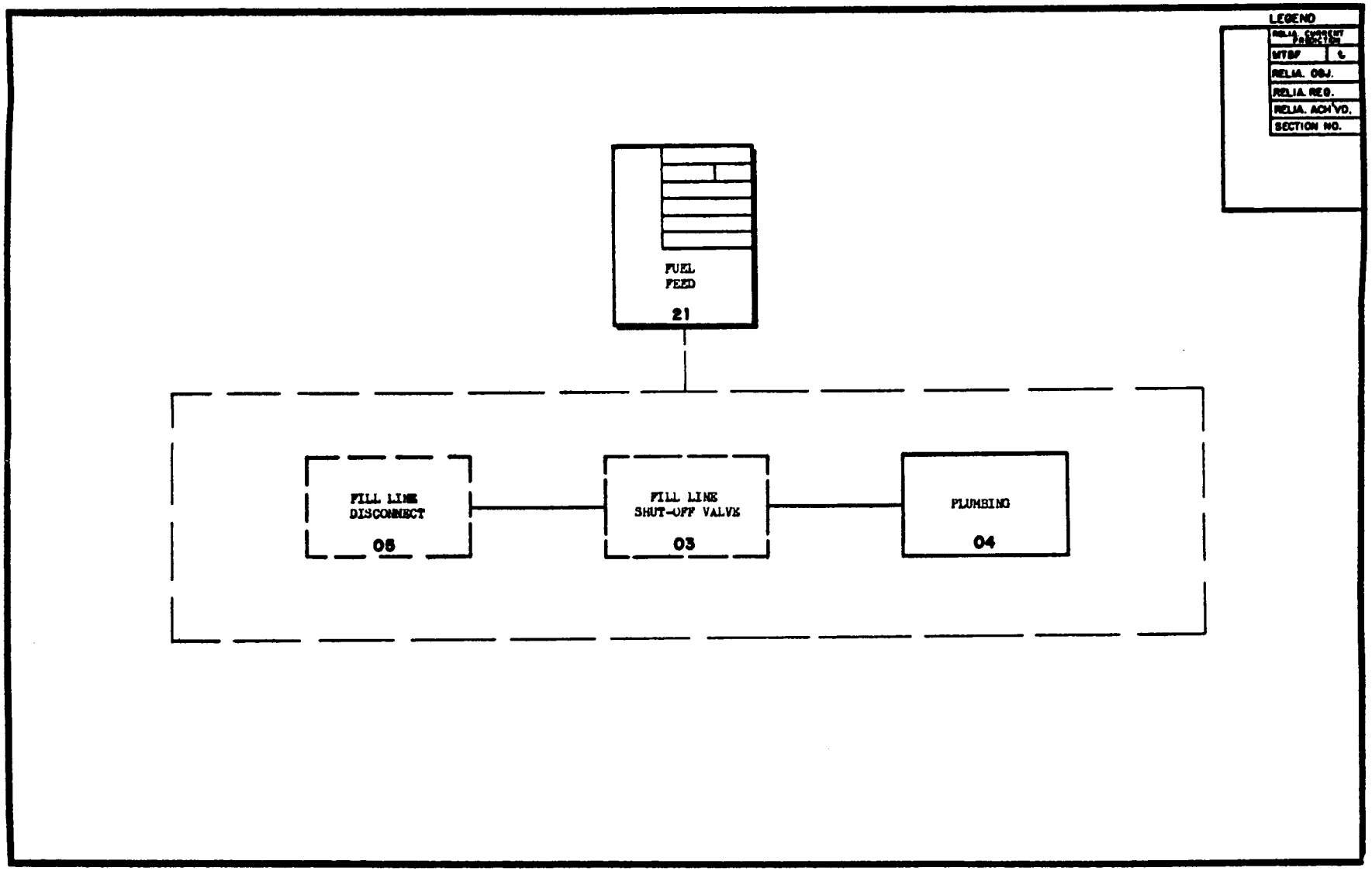
NOTE:
Leakage is considered a failure if it is in excess of the allowable rate.

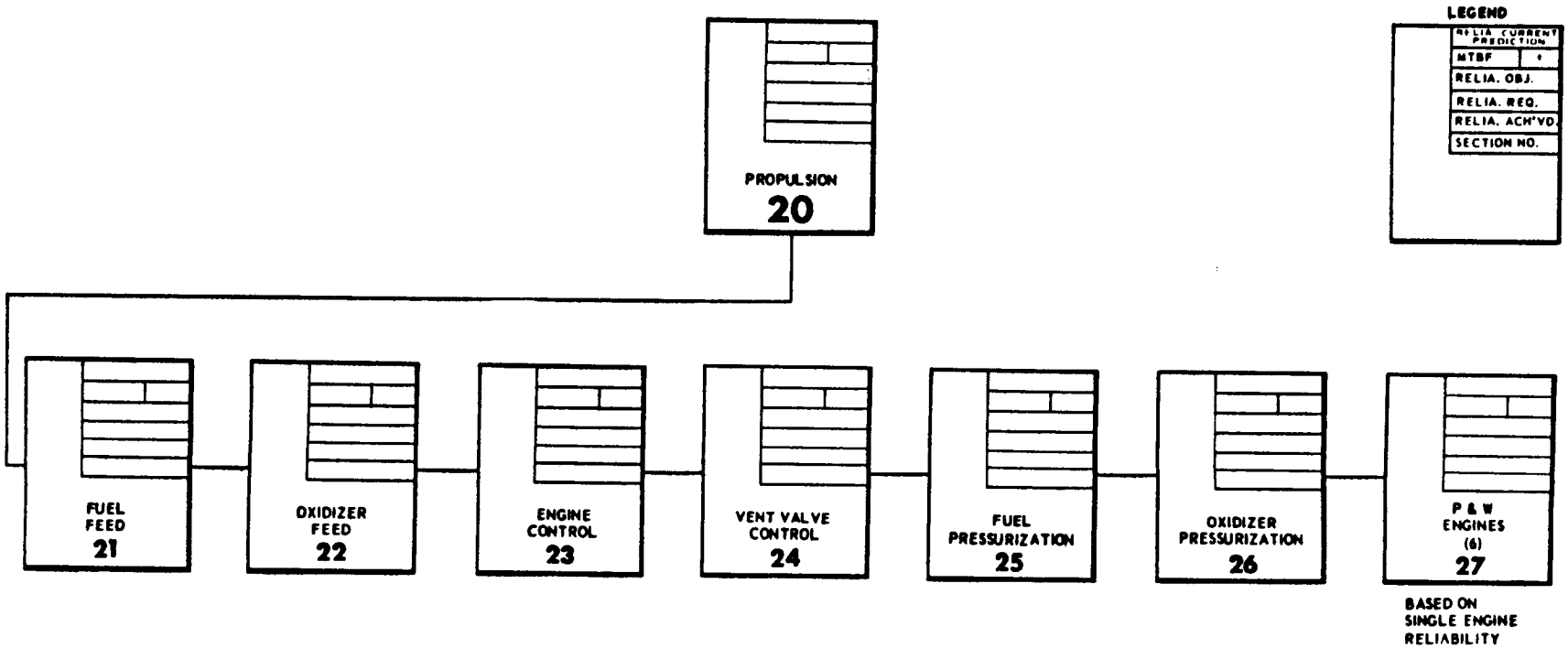
RELIABILITY FAILURE EFFECT ANALYSIS

FUEL FEED SUBSYSTEM

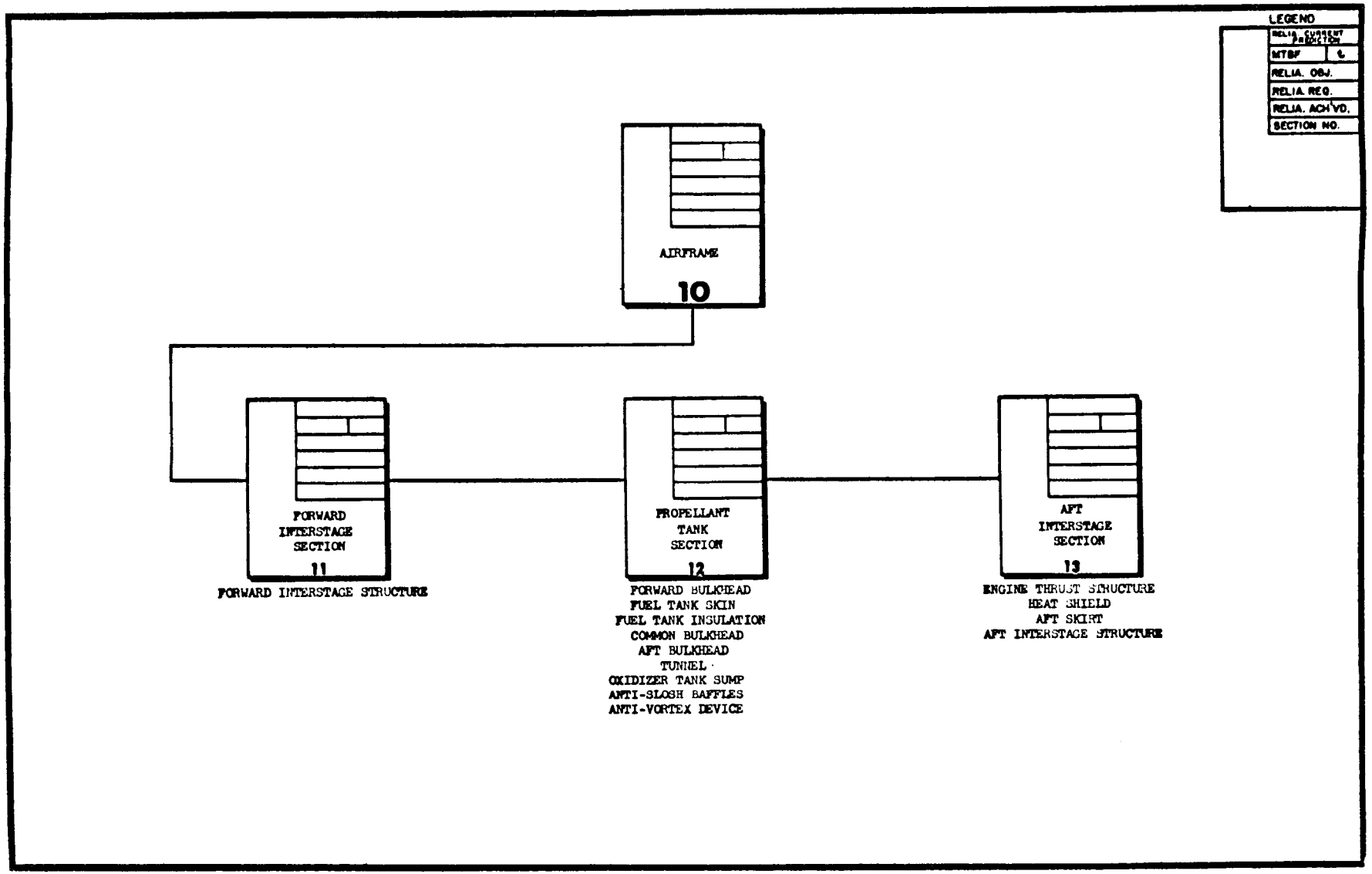
A) LAUNCH COUNTDOWN (T MINUS TIME)
B) FLIGHT (T PLUS TIME)

ITEM	**	PART NUMBER	FUNCTION	FAILURE TYPE	FAILURE EFFECT ON SUBSYSTEM PERFORMANCE	FAILURE EFFECT ON S-IV STAGE
Fill Line Disconnect (Open Type)	*	7851805-1	Connects and locks with ground half (-501) to allow liquid hydrogen to flow to fuel tank; disconnects at lift-off.	2) Failure to engage with ground half.	LOSS OF SUBSYSTEM Propellant loading will not be possible.	A) Delay in launching or scrub. B) None; not operational in flight.
Fill Line Shut-off Valve	*	7851806-501	Opens pneumatically upon application of electrical power to valve's solenoid to allow liquid hydrogen to flow to fuel tank; closes before lift-off when electrical power is removed.	1) Failure to open.	LOSS OF SUBSYSTEM Propellant loading will not be possible.	A) Scrub B) None; not operational in flight.
				2) Failure to close prior to lift-off.	LOSS OF SUBSYSTEM Open shut-off valve will preclude launch of vehicle.	A) Scrub B) None; not operational in flight.
				3) Loss of electrical continuity on solenoid during filling.	LOSS OF SUBSYSTEM Propellant loading will be interrupted because shut-off valve will close.	A) Delay in launching or scrub. B) None; not operational in flight.
				4) Leakage past lip seal during S-I and S-IV Stage Flight.	POSSIBLE LOSS OF SUBSYSTEM	A) None; fill line disconnect remains engaged until first motion of vehicle. B) POSSIBLE LOSS OF S-IV STAGE Due to deflagration hazard of gaseous hydrogen vapor at very low energy levels (in atmosphere).
Plumbing		7851800 5862614 5871393		1) Leakage at connection.	POSSIBLE LOSS OF SUBSYSTEM Severe loss of system pressure may cause engine shut-down.	A) Delay in launching or scrub. (Purging provided.) B) POSSIBLE LOSS OF S-IV STAGE Escaping fuel will create an explosion hazard in engine section, in addition temperature shock may cause damage to sensitive equipment.

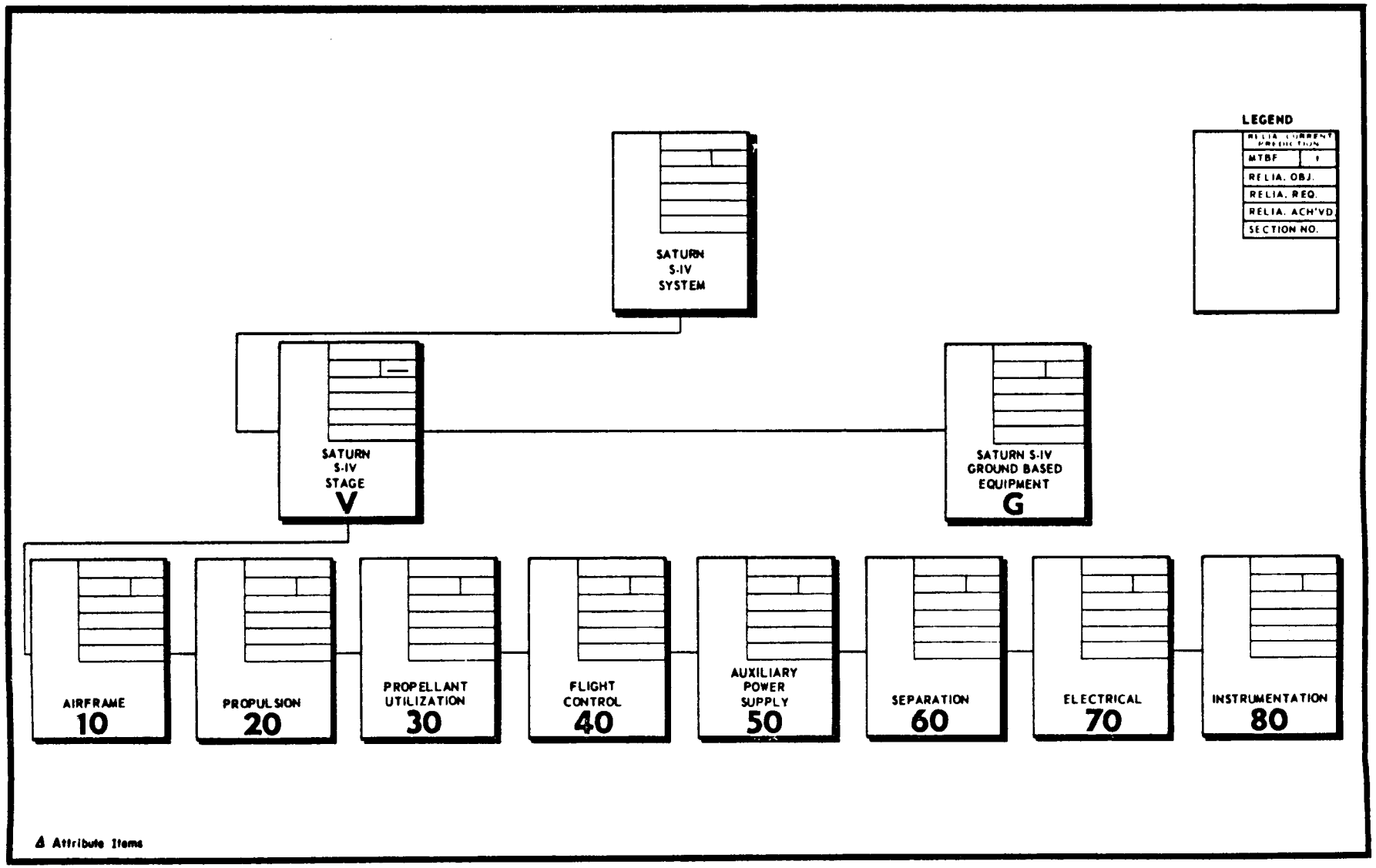

LEGEND
RELIA. CURRENT PREDICTION
MTBF
RELIA. OBJ.
RELIA. REQ.
RELIA. ACH'VD.
SECTION NO.
FUEL FEED
21
FILL LINE DISCONNECT
05
FILL LINE SHUT-OFF VALVE
03
PLUMBING
04



NOTE: ONE ENGINE OUT CAPABILITY FOR NON-CATASTROPHIC ENGINE FAILURE


LEGEND
RELIA. CURRENT PREDICTION
MTBF
RELIA. OBJ.
RELIA. REQ.
RELIA. ACH'VD.
SECTION NO.
AIRFRAME
10
FORWARD INTERSTAGE SECTION
11
FORWARD INTERSTAGE STRUCTURE
PROPELLANT TANK SECTION
12
FORWARD BULKHEAD
FUEL TANK SKIN
FUEL TANK INSULATION
COMMON BULKHEAD
AFT BULKHEAD
TUNNEL
OXIDIZER TANK SUMP
ANTI-SLOSH BAFFLES
ANTI-VORTEX DEVICE
AFT INTERSTAGE SECTION
13
ENGINE THRUST STRUCTURE
HEAT SHIELD
AFT SKIRT
AFT INTERSTAGE STRUCTURE

S-IV STAGE



Δ Attribute Items

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

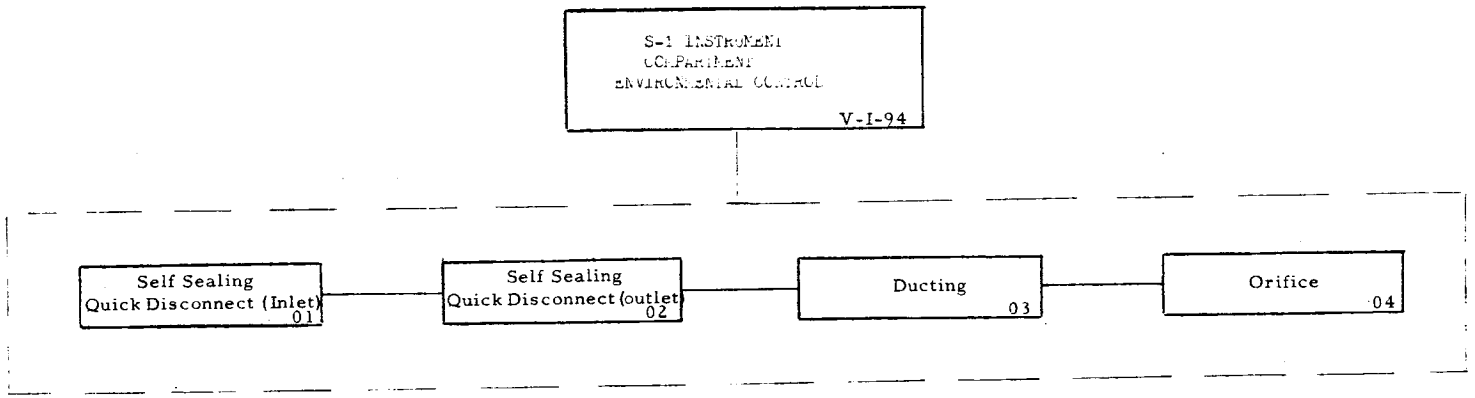
S-1 INST. COMPARTMENTS ENVIRONMENTAL CONTROL SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
Quick Disconnet (Inlet) V-1--94-01		Not available		Engages with ground half to permit flow of GN_2 to missile ducting. Closes at lift-off to prevent loss of pressure from instrument compartments. The GN_2 provides temperature control prior to lift-off and pressurization for flight.	Failure to close at disconnect (lift-off).	Loss of Subsystem Instrument compartment pressure would drop immediately.	A, B Failure mode not applicable until lift-off. C Possible Loss of Stage Absence of pressure inside the instrument compartment could allow hydrogen to enter causing explosive hazard.	A, B Failure mode not applicable until lift-off. C Possible Loss of Vehicle Explosive hazard could exist any time during flight.
Quick Disconnect (Outlet) V-1-94-02		Not available		Engages with ground half to permit exhaust of GN_2 from instrument compartments. Closes at lift-off to prevent loss of pressure from instrument compartments.	Failure to close at disconnect (lift-off).	Loss of Subsystem Instrument compartment pressure would drop immediately.	A, B Failure mode not applicable until lift-off. C Possible Loss of Stage "Effect same as that for	A, B Failure mode not not applicable until lift-off. C Possible Loss of Stage Inlet Quick Disconnect"
Ducting V-1-94-03		Not available		Divides equally and directs the GN_2 to the two instrument compartments.	Excessive leakage or rupture.	Partial Loss of Subsystem Loss of instrument compartment pressure	A Failure mode not applicable. B C Possible Loss of Stage Loss of instrument compartment pressure and resulting explosion hazard.	A Failure mode not applicable. B C Possible Loss of Vehicle Failure late in flight would decrease chance of loss.
Orifice V-1-94-04		Not available		Provides constant bleed from instrument compartments.	No failure modes applicable.			
						Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203-1 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
WATER QUENCH SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Self Sealing Quick Disconnect V-I-91-01		10490874 4 required		Engages with ground half to permit flow of water to engine compartments for water quench. Also permits flow of GN_2 or air to eng. compartments for purge or GN_2 deluge.	External leakage under hydraulic pressure.	Partial Loss of Subsystem Subsystem is designed to provide partial redundancy; however, excessive leakage would reduce the fire extinguishing capabilities.	A, B. None; subsystem is not operational unless another failure occurs causing a fire. Double failure required for stage loss. C. Failure mode not applicable.	A, B. Same as S-I stage C Failure mode not applicable.
Ducting (to all engine compartments) V-I-91-02				Distributes water to all engine compartments for water quench.	Failure during water quench due to hydraulic pressure surge.	Partial Loss of Subsystem Fire extinguishing capability would be greatly reduced.	A, B. None; double failure required for stage loss. C Failure mode not applicable	A, B. Same as S-I stage C Failure mode not applicable
						Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval: [illegible]

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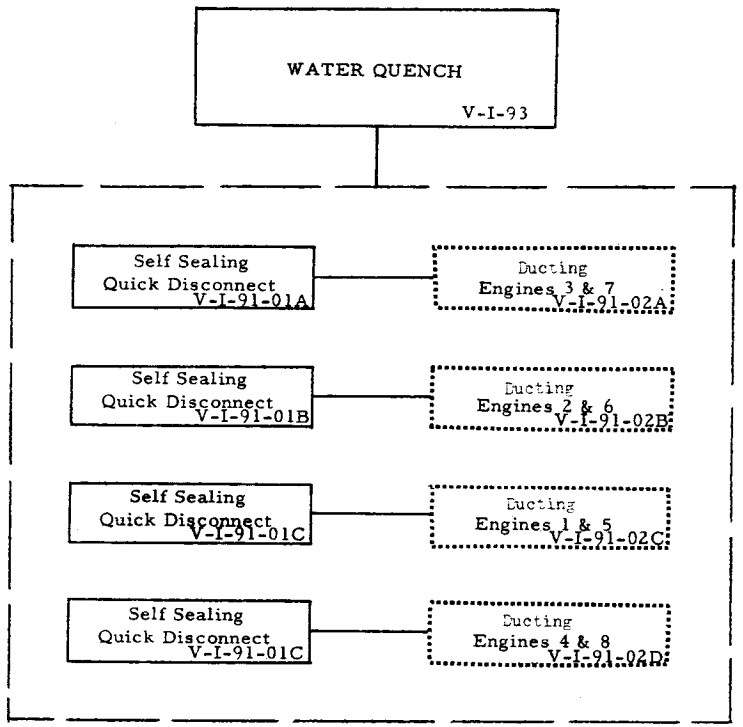
FAILURE EFFECT ANALYSIS



Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval:

S&M Form #203-1 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

Boattail GN_2 DELUGE PURGE SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Self Sealing Quick Disconnect V-I-91-01		10490874 (4 required) 10414315 (1 required)		(10490874) Engages with ground half to permit flow of GN_2 to engine compartments for deluge purge. Also permits flow during normal purge and water quench (10414315) Engages with ground half to permit flow of GN_2 to center lox tank skirt area for deluge purge and flow during normal purge. All quick disconnects close at disconnect to prevent entrance of hot gas during flight.	(1) Leakage at disconnect mating surfaces.	Partial Loss of Subsystem Subsystem is designed to give partial redundancy; however, excessive leakage would reduce the fire extinguishing capabilities.	A, B. None; double failure required for stage loss. C Failure mode not applicable	A, B. Same as S-I stage C Failure mode not applicable
					(2) Failure to close at disconnect	Failure mode analyzed under "boattail air and normal GN_2 purge" subsystem (V-I-91-01)		
DUCTING (to all engine compartments and center lox tank skirt area) V-I-91-02	*		C	Carries and distributes GN_2 to engine compartments and center lox tank skirt area.	No failure modes applicable.			
						Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

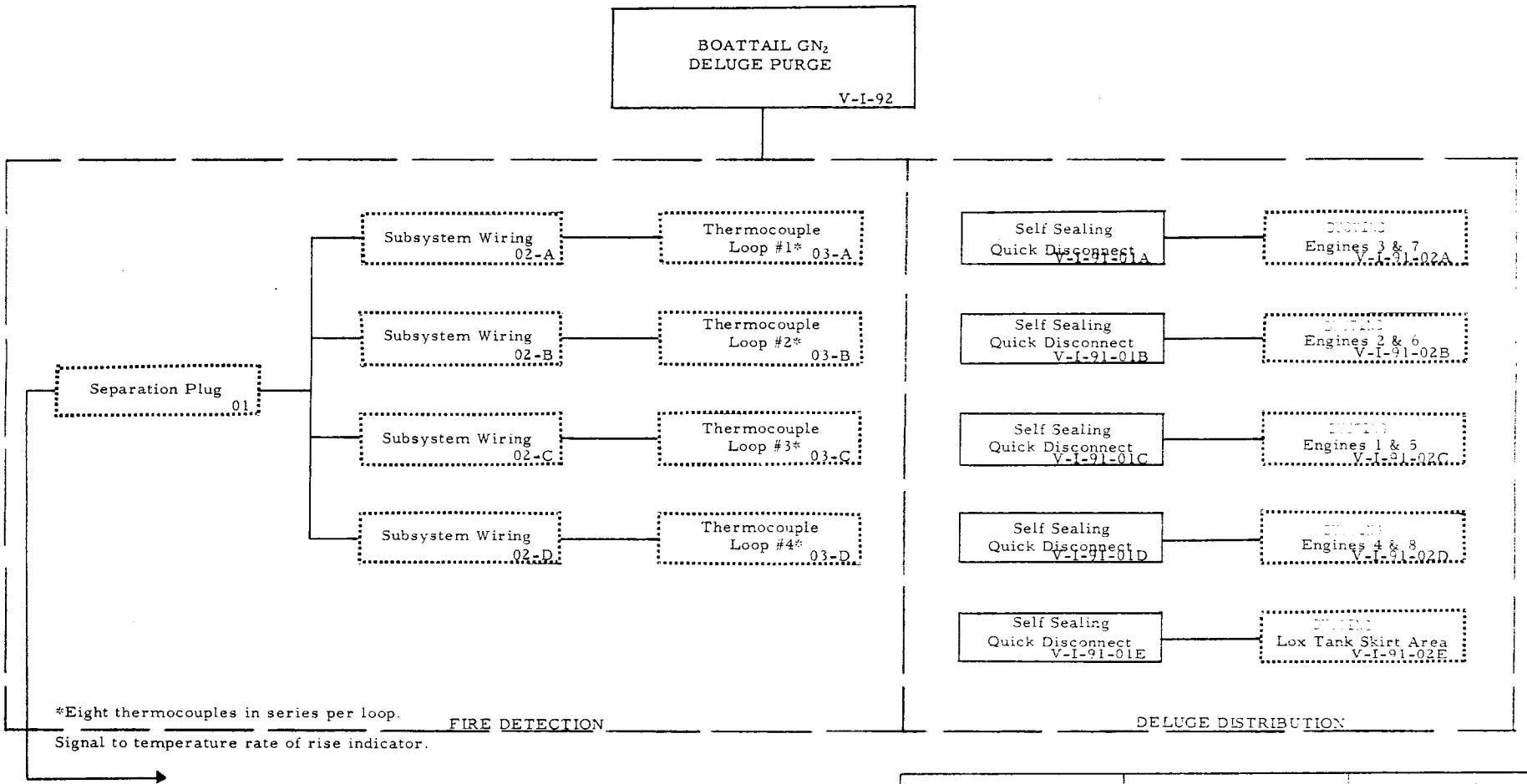
Boattail GN_2 DELUGE PURGE SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Separation Plug V-I-92-01	*	Cannon SPL 3100, E40 (2012-27)S	9W17-J1	Connects vehicle signal source to ground control and monitoring circuit.	Failure due to open or short circuit causing loss of one or more thermocouple loops.	Partial Loss of Subsystem Loss of one or more thermocouple loops would reduce subsystem performance to a degree that early fire detection might not be accomplished.	A, B. None; subsystem is not operational unless another failure occurs causing a fire. Double failure required for stage loss. C None; not operational during flight.	A, B. Same as S-I stage C None; not operational during flight.
Subsystem Wiring V-I-92-02	*		9W17	Transmits signal from all thermocouple loops to separation plug.	Failure due to open or short circuit causing loss of one or more thermocouple loops.	Partial Loss of Subsystem "Effects same as that for Separation Plug"	A, B. None; double failure required for stage loss. C None; not operational during flight.	A, B. Same as S-I stage C None; not operational during flight.
Thermocouple Loop (4 loops required) 8 thermocouples connected in series per loop V-I-92-03	*	10420625	1A469-72 2A467-70 3A467-72 4A466-69 5A451-54 6A446-49 7A454-57 8A450-53	Senses temperature in the engine compartments and relays this information to the rate of rise indicator. When the rate of rise is above a specified limit, the GN_2 deluge purge is automatically actuated.	Open or short circuit in one thermocouple loop causing partial or complete loss of one thermocouple loop.	Partial Loss of Subsystem "Effects are somewhat less severe than that for Separation Plug"	A, B. None; double failure required for stage loss. C None; not operational during flight	A, B. Same as S-I stage C None; not operational during flight
						Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



*Eight thermocouples in series per loop.

Signal to temperature rate of rise indicator.

Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval:

S&M Form #203-1 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

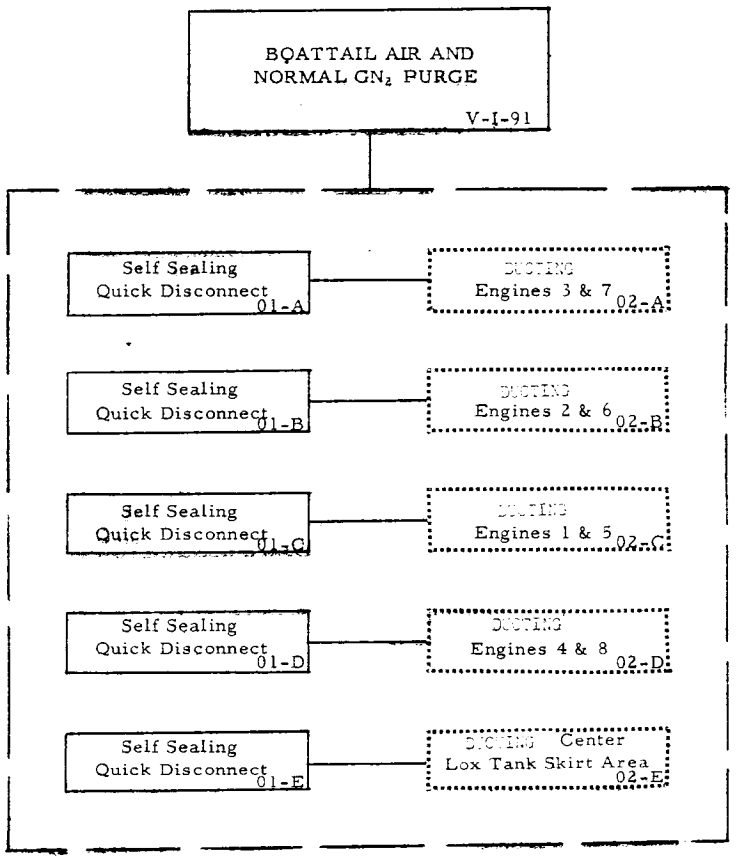
BOATTAIL AIR AND NORMAL GN_2 PURGE SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Quick Disconnect V-1-91-01		10490874 (4 required) 10414315 (1 required)		10490874 - Engages with ground half to permit flow of air, or GN_2 to engine compartments for purging; permits flow of GN_2 or water fire extinguishing. 10414315 - Engages with ground half to permit flow of air or GN_2 to center lox tank skirt for purging or fire extinguishing. All quick disconnects close at disconnect to prevent carry-through of hot gases into engine compartments during flight.	(1) Leakage at disconnect mating surfaces	None; partial redundancy would provide adequate boattail conditioning	A, B Possible launch delay Correction would be required due to subsequent function (fire extinguishing) under more severe conditions C Failure mode not applicable	A, B Possible launch delay C Failure mode not applicable
					(2) Failure to close at disconnect	None; subsystem function ceases at lift-off	A, B Failure mode not applicable C <u>Possible Loss of Stage</u> May have hot gases carry through into engine compartment at high altitude causing damage to components	A, B Failure mode not applicable C <u>Possible Loss of Vehicle</u> Time from component failure to loss of vehicle > 10 seconds
DUCTING V-I-91-02				Distributes air and GN_2 to engine compartments and center lox tank skirt.	No failure modes applicable			
						Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

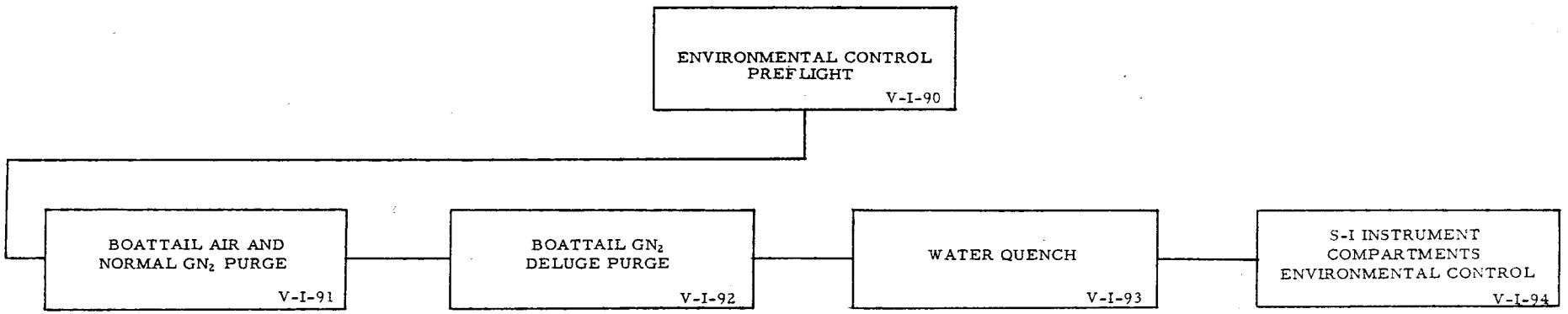
FAILURE EFFECT ANALYSIS



Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval:

S&M Form #203-1 (August 1961)(OT)

FAILURE EFFECT ANALYSIS

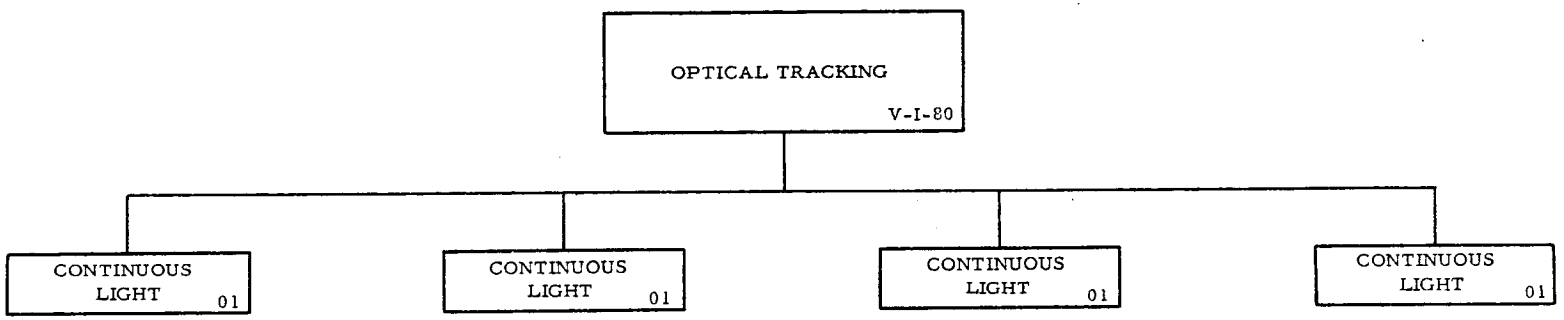


Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval:

FAILURE EFFECT ANALYSIS

OPTICAL TRACKING V-I-80 ANALYSIS NOT AVAILABLE

FAILURE EFFECT ANALYSIS

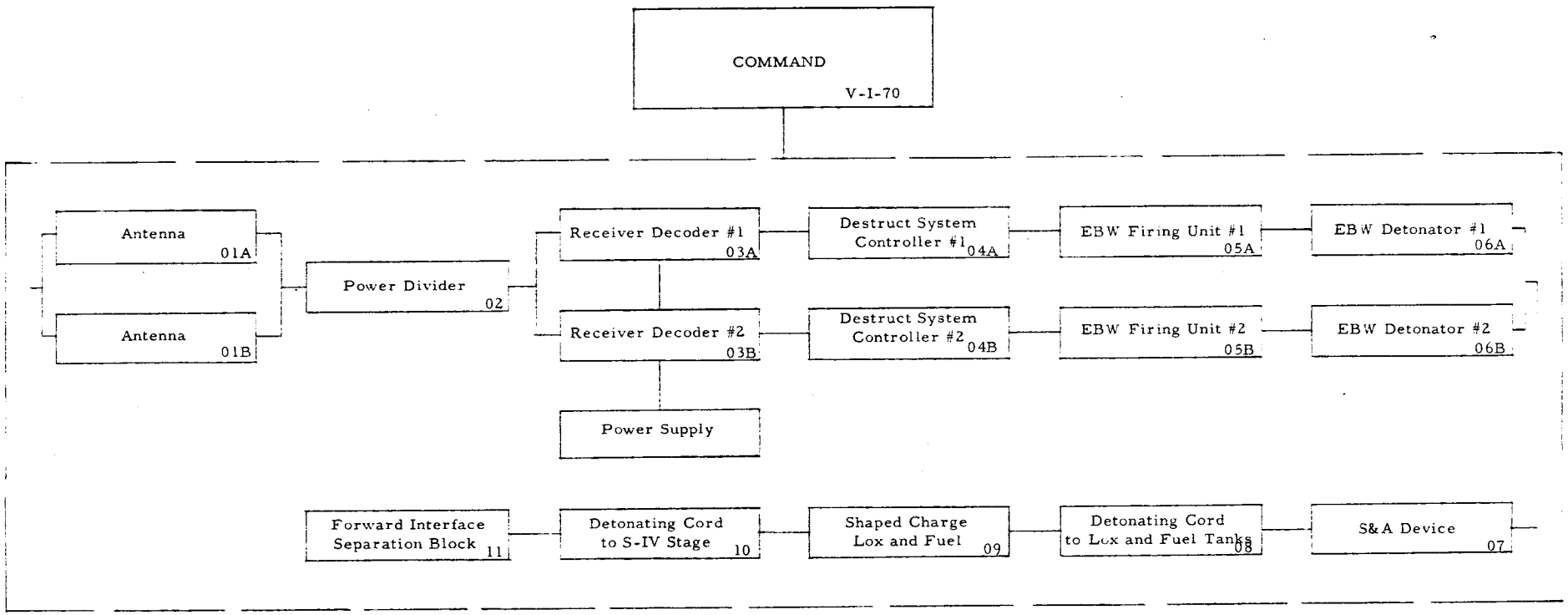


Issue Date: Jan 23, 1962	Prepared by: M-G&C-TSJ	Approval:

FAILURE EFFECT ANALYSIS

CONTRAIL 7-1-70 ANALYSIS NOT AVAILABLE

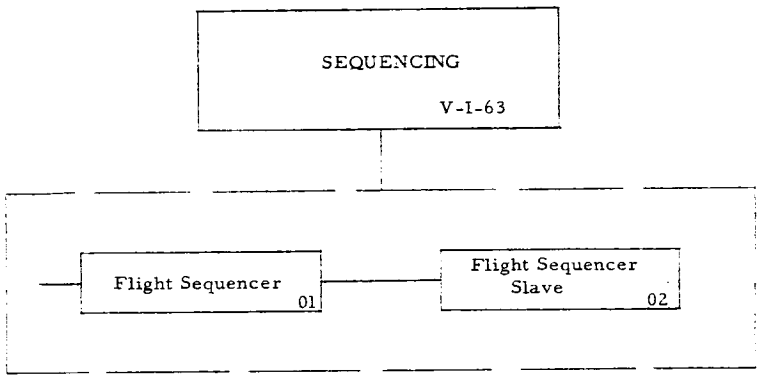
FAILURE EFFECT ANALYSIS



Issue Date:	Prepared by:	Approval:
Jan 23, 1962	M-P&VE-EF	

S&M Form #203-1 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



SEQUENCING V-I-63 ANALYSIS NOT AVAILABLE

Issue Date: 1 Feb, 62	Prepared by: M-ASTR-TSJ	Approval:

**Items marked thus (*) do not operate in flight

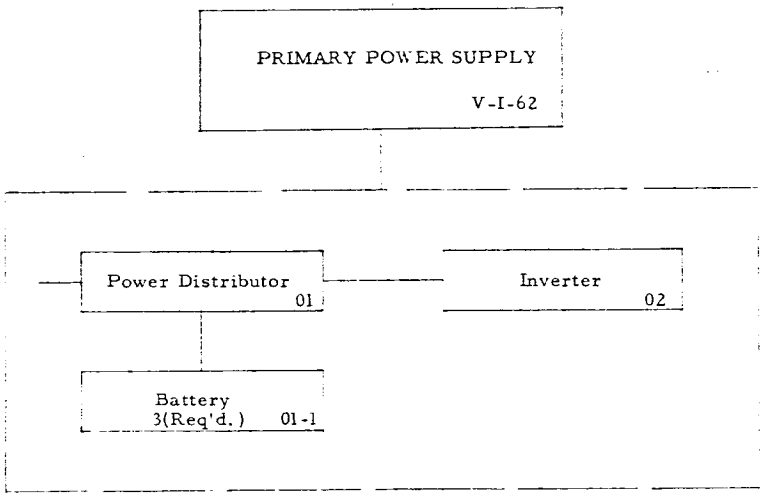
FAILURE EFFECT ANALYSIS
PRIMARY POWER SUPPLY SUBSYSTEM
V-I-62

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Power Distributor V-I-62-01		50M01138	12A25	Transfer Power from ground support equipment to vehicle batteries for distribution throughout S-I stage.	1. Loss of +1D11 bus (+28V) (Open or short)	LOSS Loss of electrical power to critical components.	(A,B) Delay or reschedule (C) LOSS Due to loss of control and thrust.	(A,B) Delay or reschedule (C) LOSS Due to loss of control and thrust.
					2. Loss of +1D21 bus (Open or short)	LOSS Loss of electrical power to critical components.	(A,B) Delay (C) LOSS Due to loss of control.	(A,B) Delay (C) LOSS Due to loss of control.
Propulsion System Distributor V-I-61-04		10420011	9A1	Distribute electrical power to engines for control, sequencing (such as cutoff) and monitoring.	Loss of +1D11 or +1D21 (28V) (Open or short)	LOSS Loss of engine functions	(A) Delay (B) Delay & possible damage due to heat. (C) LOSS (Cutoff of engines)	(A,B) Delay (C) LOSS (Cutoff of engines)
						Issue Date: Jan 30, 62	Prepared by: M-ASTR-EA	Approval:

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



Issue Date: 1 Feb, 62	Prepared by: M-ASTR-TSJ	Approval:

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
DISTRIBUTION SUBSYSTEM
V-I-61

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Main Distributor V-I-61-02		50M00901	12A1	Distribute electrical power for sequencing, monitoring, and control.	1. Loss of +1D11 bus (+28V) or +1D21 (+28V). (Open or short)	LOSS (Including all sequencing functions performed in S-I stage and S-I to S-IV stage.	(A,B) Delay or Reschedule (C) LOSS No control.	(A,B) Delay or Reschedule (C) LOSS No control.
Heater Power Distributor V-I-61-05		10420010	9A2	Distribute AC power for heaters used prior to flight.	1. Loss of AC power (Open or short)	None Power furnished from ground support equipment.	(A,B) Delay or Reschedule (Possible rupture of tank) (C) None Inactive during flight.	(A,B) Delay or Reschedule (Possible rupture of tank) (C) None Inactive during flight.

Issue Date: Jan. 30, 62 | Prepared by: M-ASTR-EA | Approval:

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

DISTRIBUTION SUBSYSTEM

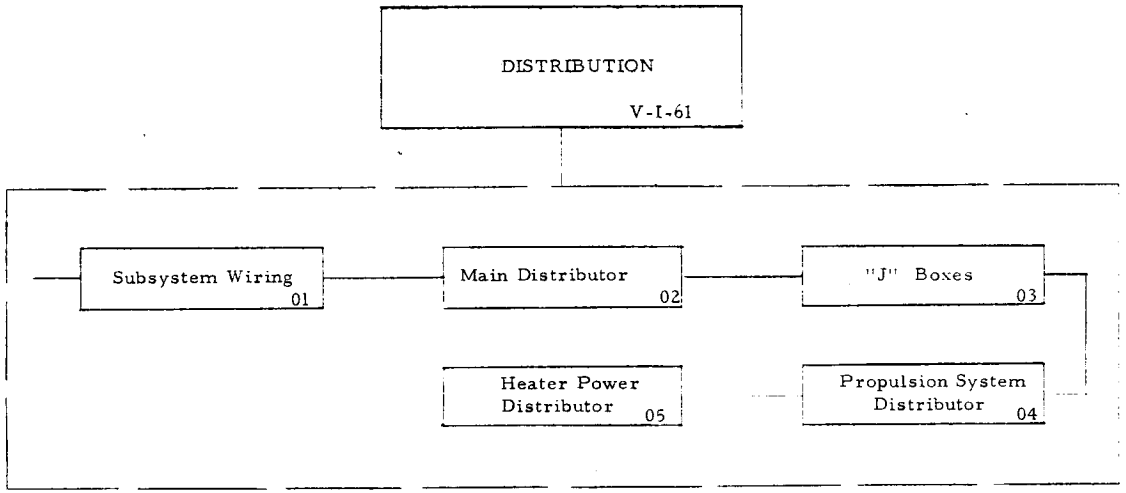
V-I-61

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Sub-systems Wiring V-I-61-01		N/A	N/A	Connects, electrically, all components used in measuring, monitoring, guidance, control, and sequencing.	1. Open or short circuit (Damaged cable).	Failure of the wiring to any component has the same effect as failure of the component. Extent of loss depends upon location and time of failure.	See individual component.	See individual component.
"J" Boxes (13 req.) V-I-61-03		N/A	9A71 9A72 9A73 9A74 9A75 9A76 9A77 9A78 9A79 10A29 11A63 11A64 11A65	Furnish power requirements for certain measurements.	Loss of bus voltage by open or short circuit.	Partial Loss Same effect as failure of the component.	(A,B) Delay (C) Loss of telemetry data on measurements concerned.	(A,B) Delay (C) Loss of telemetry data on measurements concerned.
						Issue Date: Jan 30, 62	Prepared by: M-ASTR-EA	Approval:

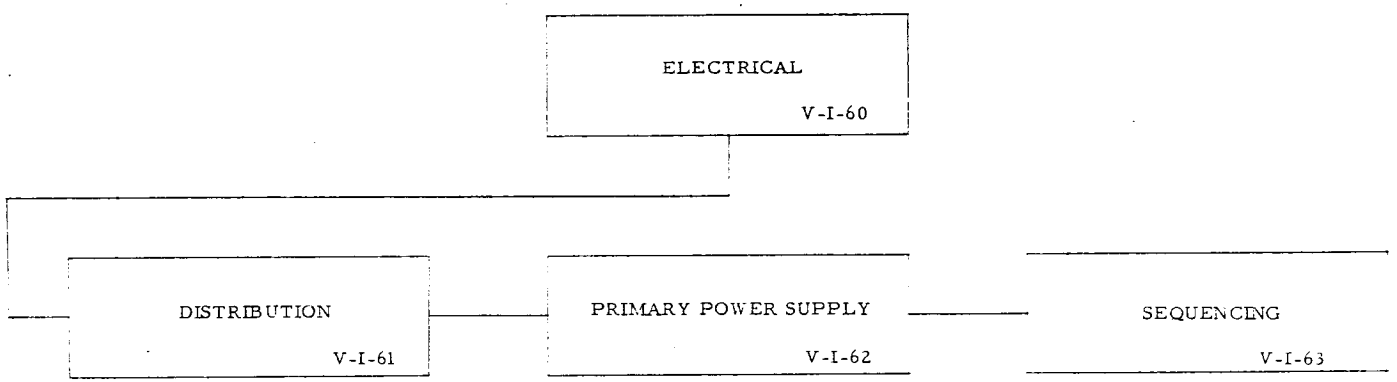
S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



Issue Date: 1 Feb, 62	Prepared by: M-ASTR-TSJ	Approval:

FAILURE EFFECT ANALYSIS



Issue Date: 1 Feb, 62	Prepared by: M-ASTR-TSJ	Approval:

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PITCH CONTROL ACCELEROMETER SUBSYSTEM
V-I-55

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Pitch Control Accelerometer V-I-54		10422024	11A433	Measures lateral acceleration of the vehicle. Furnishes this information to the control system to reduce structural loading & control deflection of the vehicle. Sensor is linear type accelerometer, having spring loaded mass and is fluid damped. Pick-off is inductive type.	1) Electrical (Internal electrical open or short)	LOSS Result is loss of accelerometer output signal	A) Reschedule; accelerometer must be replaced B) Same as (A) (Monitored) C) LOSS Interruption of accelerometer information resulting in loss of vehicle control.	A) Reschedule; accelerometer must be replaced B) Same as (A) (Monitored) C) LOSS (Up to S-I/S-IV separation) Interruption of accelerometer information resulting in loss of vehicle control.
					2) Mechanical (Internal mechanical binding)	LOSS Result is loss of accelerometer output signal	A) Reschedule; accelerometer must be replaced B) Same as (A) (Monitored) C) LOSS Interruption of accelerometer information resulting in loss of vehicle control.	A) Reschedule; accelerometer must be replaced B) Same as (A) (Monitored) C) LOSS (Up to S-I/S-IV separation) Interruption of accelerometer information resulting in loss of vehicle control.
	*				3) Force coil malfunction	LOSS Not able to properly check out the pitch control accelerometer	A) Reschedule; extent of damage unknown Must replace accelerometer B) Same as (A) C) Not active	A) Reschedule; extent of damage unknown. Must replace accelerometer. B) Same as (A) C) Not active
						Issue Date: Jan. 10, 1962	Prepared by: M-ASTR-NA	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
YAW CONTROL ACCELEROMETER SUBSYSTEM
V-I-55

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Yaw Control Accelerometer V-I-55		10422025	11A434	Measures lateral acceleration of the vehicle. Furnishes this information to the control system to reduce structural loading & control deflection of the vehicle. Sensor is linear type accelerometer, having spring loaded mass and is fluid damped. Pick-off is inductive type.	1) Electrical (Internal electrical open or short)	LOSS Result is loss of accelerometer output signal	A) Reschedule; accelerometer must be replaced B) Same as (A) (Monitored) C) LOSS Interruption of accelerometer information resulting in loss of vehicle control.	A) Reschedule; accelerometer must be replaced B) Same as (A) (Monitored) C) LOSS (Up to S-1/S-IV separation) Interruption of accelerometer information resulting in loss of vehicle control.
					2) Mechanical (Internal mechanical binding)	LOSS Result is loss of accelerometer output signal	A) Reschedule; accelerometer must be replaced B) Same as (A) (Monitored) C) LOSS Interruption of accelerometer information resulting in loss of vehicle control.	A) Reschedule; accelerometer must be replaced B) Same as (A) (Monitored) C) LOSS (Up to S-1/IV separation) Interruption of accelerometer information resulting in loss of vehicle control.
	*				3) Force coil malfunction	LOSS Not able to properly check out the yaw control accelerometer	A) Reschedule; extent of damage unknown Must replace accelerometer B) Same as (A) C) Not active	A) Reschedule; extent of damage unknown. Must replace accelerometer. B) Same as (A) C) Not active
						Issue Date: Jan 10, 1962	Prepared by: M-ASTR-NA	Approval:

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS

PITCH AND YAW CONTROL RATE GYRO PACKAGE SUBSYSTEM

V-I-53

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Pitch and Yaw Control Rate Gyro Package V-I-53		104 22022	12A29	Senses rate of angular movement of vehicle in pitch and yaw planes. Gives rate stabilization to the vehicle control system. Each gyro is a single degree of freedom type, with spring restrained gimbal and angular variable differential transformer pick-off. The gyro is fluid damped.	1) Electrical (Internal electrical open or short in either gyro)	LOSS Result is loss of rate output signal in effected gyro.	A) Reschedule; gyro pkg. must be replaced. B) Same as (A) (Monitored) C) LOSS Interruption of rate information to the vehicle control system resulting in loss of control.	A) Reschedule; gyro pkg. must be replaced. B) Same as (A) (Monitored) C) LOSS (Up to S-1/S-IV separation) Interruption of rate information to the vehicle control system resulting in loss control.
					2) Mechanical (Internal mechanical binding in either gyro)	LOSS Result is loss of rate output signal in effected gyro.	A) Reschedule; gyro pkg. must be replaced. B) Same as (A) (Monitored) C) LOSS Interruption of rate information to the vehicle control system resulting in loss of control.	A) Reschedule; gyro pkg. must be replaced. B) Same as (A) (Monitored) C) LOSS (Up to S-1/S-IV separation) Interruption of rate information to the vehicle control system resulting in loss of control.
	*				3) Torquer coil malfunction. (electrical open or short in either gyro torquer coil)	LOSS Not able to properly check out the effected control rate gyro	A) Reschedule; Extent of damage unknown. Must replace gyro package. B) Same as (A) C) Not active	A) Reschedule; Extent of damage unknown. Must replace gyro package. B) Same as (A) C) Not active
	*				4) Wheel speed malfunction. (electrical open or short or mechanical binding in either gyro wheel speed device)	LOSS Not able to properly check out the effected control rate gyro	A) Reschedule; Extent of damage unknown. Must replace gyro package. B) Same as (A) C) Not active	A) Reschedule; Extent of damage unknown. Must replace gyro package. B) Same as (A) C) Not active
						Issue Date: Jan 10, 62	Prepared by: M-ASTR-NA	Approval:

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
[illegible] SUBSYSTEM
V-I-51

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-I-51 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on Instrument Unit	Failure Effect on C-1 Vehicle
					10) Electrical open or short in actuator differential pressure transducer. (Function of transducer: Measuring component used to indicate difference in pressure on the actuator piston sides).	None; Loss of measurement.	(A) Delay (B) Same as (A) (C) None; Loss of telemetered measurement.	(A) Delay (B) Same as (A) (C) None; Loss of telemetered measurement.
					11) Leakage of hydraulic fluid and loss of system pressure in actuator differential pressure transducer. (Function of transducer: Measuring component used to indicate difference in pressure on the actuator piston sides).	PARTIAL LOSS Leakage of high pressure hydraulic fluid.	(A) Delay or Reschedule (B) Same as (A) (C) None; S-1 stage has capability of operating with one engine out of control.	(A) Delay or Reschedule (B) Same as (A) (C) None; C-1 vehicle will function with one S-1 stage engine out of control.
						Issue Date: 7 Feb. 62	Prepared by: M-ASTR-NF	Approval:

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
CONTROL ACTUATORS PITCH AND YAW SUBSYSTEM
V-I-51

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item V-I-51 (cont'd.)	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
					6) Leakage or mechanical binding of actuator cylinder assembly. (Function of cylinder: Double acting hydraulic cylinder).	PARTIAL LOSS Actuator will not function properly.	(A) Reschedule (B) Same as (A) (If detected) (C) None; S-1 stage has capability of operating with one engine out of control.	(A) Reschedule (B) Same as (A) (If detected) (C) None; C-1 vehicle will function with one S-1 stage engine out of control.
					7) Leakage or a broken bleed valve: Two per actuator. (Function of valve: Allows removal of air from the hydraulic system).	PARTIAL LOSS Loss of system fluid and pressure.	(A) Reschedule (B) Same as (A) (C) None; S-1 stage has capability of operating with one engine out of control.	(A) Reschedule (B) Same as (A) (C) None; C-1 vehicle will function with one S-1 stage engine out of control.
					8) Failure of actuator cylinder by-pass valve to seat properly. (Function of valve: Provides for manual positioning of hydraulic cylinder for calibration purposes)	PARTIAL LOSS Actuator will operate at a lower than normal piston velocity.	(A) Delay or Reschedule (B) Same as (A) (If detected) (C) None; S-1 stage has capability of operating with one engine out of control.	(A) Delay or Reschedule (B) Same as (A) (If detected) (C) None; C-1 vehicle will function with one S-1 stage engine out of control.
					9) Failure of prefiltration valve to seat properly. (Function of valve: Allows fluid flow through tubing system without going through the servo valve).	PARTIAL LOSS Actuator would not function or would operate at a lower than normal piston velocity.	(A) Reschedule (B) Same as (A) (If detected) (C) None; S-1 Stage has capability of operating with one engine out of control.	(A) Reschedule (B) Same as (A) (If detected) (C) None; C-1 vehicle will function with one S-1 stage engine out of control.
						Issue Date: 7 Feb. 62	Prepared by: M-ASTR-NF	Approval:

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

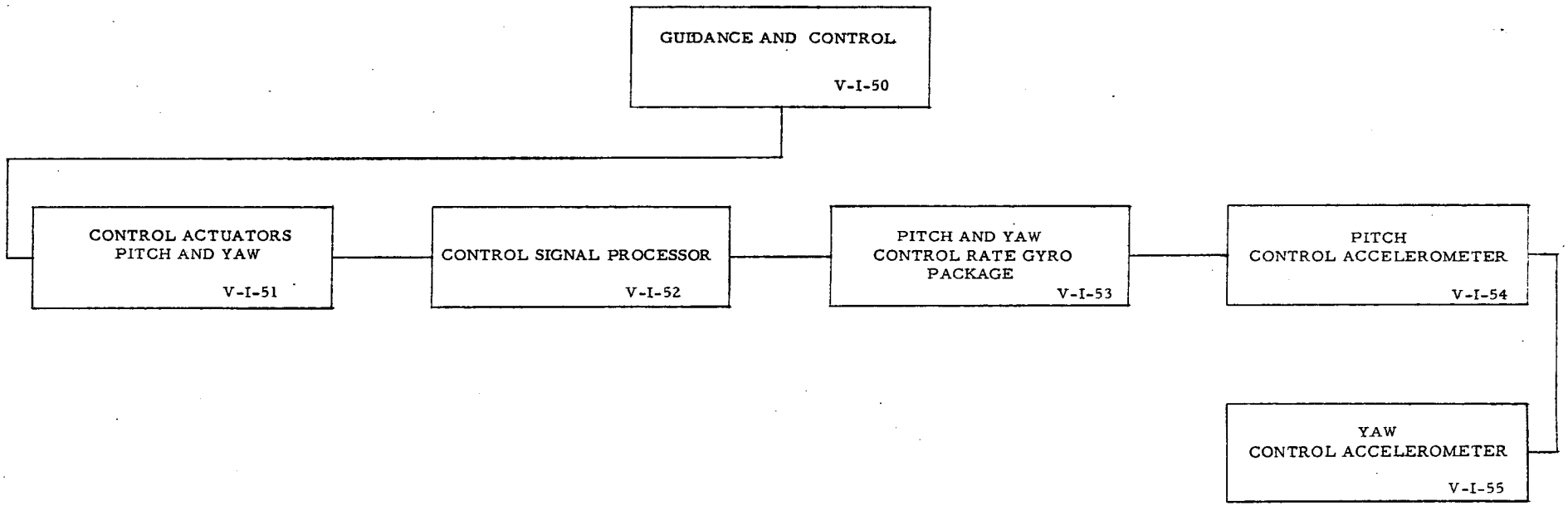
FAILURE EFFECT ANALYSIS
CONTROL ACTUATORS PITCH AND YAW SUBSYSTEM
V-1-51

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Control Actuators (4 pitch; 4 yaw required) V-1-51		J50M01149	1A14 2A14 3A14 4A14 1A12 2A12 3A12 4A12	The hydraulic actuators control the vehicle by engine positioning from liftoff to S-1/S-IV separation. This controls a thrust vector direction in the pitch, yaw, and roll axes in accord with electrical signals from the control computer. Each engine has one pitch and one yaw actuator and an independent hydraulic system.	1) Failure of an actuator electrical or mechanical subcomponent or hydraulic fluid leakage during operation.	PARTIAL LOSS Subsystem will be degraded due to inability of actuator to function properly.	(A) Reschedule (B) Same as (A) (C) None; S-1 Stage has capability of operating with one engine out of control.	(A) Reschedule (B) Same as (A) (C) None; C-1 vehicle will function with one S-1 stage engine out of control.
					2) Electrical open or short circuit of feedback transducer. (Function of transducer: Signals actuator position to flight control computer)	PARTIAL LOSS Actuator position (engine thrust vector) undefined.	(A) Delay (B) Same as (A) (C) None; S-1 stage has capability of operating with one engine out of control.	(A) Delay (B) Same as (A) (C) None; C-1 vehicle will function with one S-1 stage engine out of control.
					3) Electrical or mechanical failure of hydraulic servo valve. (Function of valve: controls flow of fluid to actuator upon a signal from the flight control computer)	PARTIAL LOSS Actuator position (engine thrust vector) undefined.	(A) Reschedule (B) Same as (A) (C) None; S-1 stage has capability of operating with one engine out of control.	(A) Reschedule (B) Same as (A) (C) None; C-1 vehicle will function with one S-1 stage engine out of control.
					4) Leakage or a break in the hydraulic piping and connections. (Function of piping: Provides connections between associated hydraulic components that make up the actuator).	PARTIAL LOSS Loss of hydraulic fluid and pressure.	(A) Reschedule (B) Same as (A) (C) None: S-1 stage has capability of operating with one engine out of control.	(A) Reschedule (B) Same as (A) (C) None; C-1 vehicle will function with one S-1 stage engine out of control.
					5) Collapse of element in hydraulic filter. (Function of filter: Filters all high pressure fluid going to servo valve).	PARTIAL LOSS Particles may jam servo valve.	(A) Reschedule (B) Same as (A) (If detected) (C) None; S-1 stage has capability of operating with one engine out of control.	(A) Reschedule (B) Same as (A) (If detected) (C) None: C-1 vehicle will function with one S-1 stage engine out of control.
						Issue Date: 7 Feb. 62	Prepared by: M-ASTR-NF	Approval:

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



CONTROL SIGNAL PROCESSOR V-I-52 ANALYSIS NOT AVAILABLE

Issue Date: Jan 23, 1962	Prepared By: M-ASTR-TSJ	Approval: CBJ

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
MEASURING DISTRIBUTION SUBSYSTEM
V-I-1

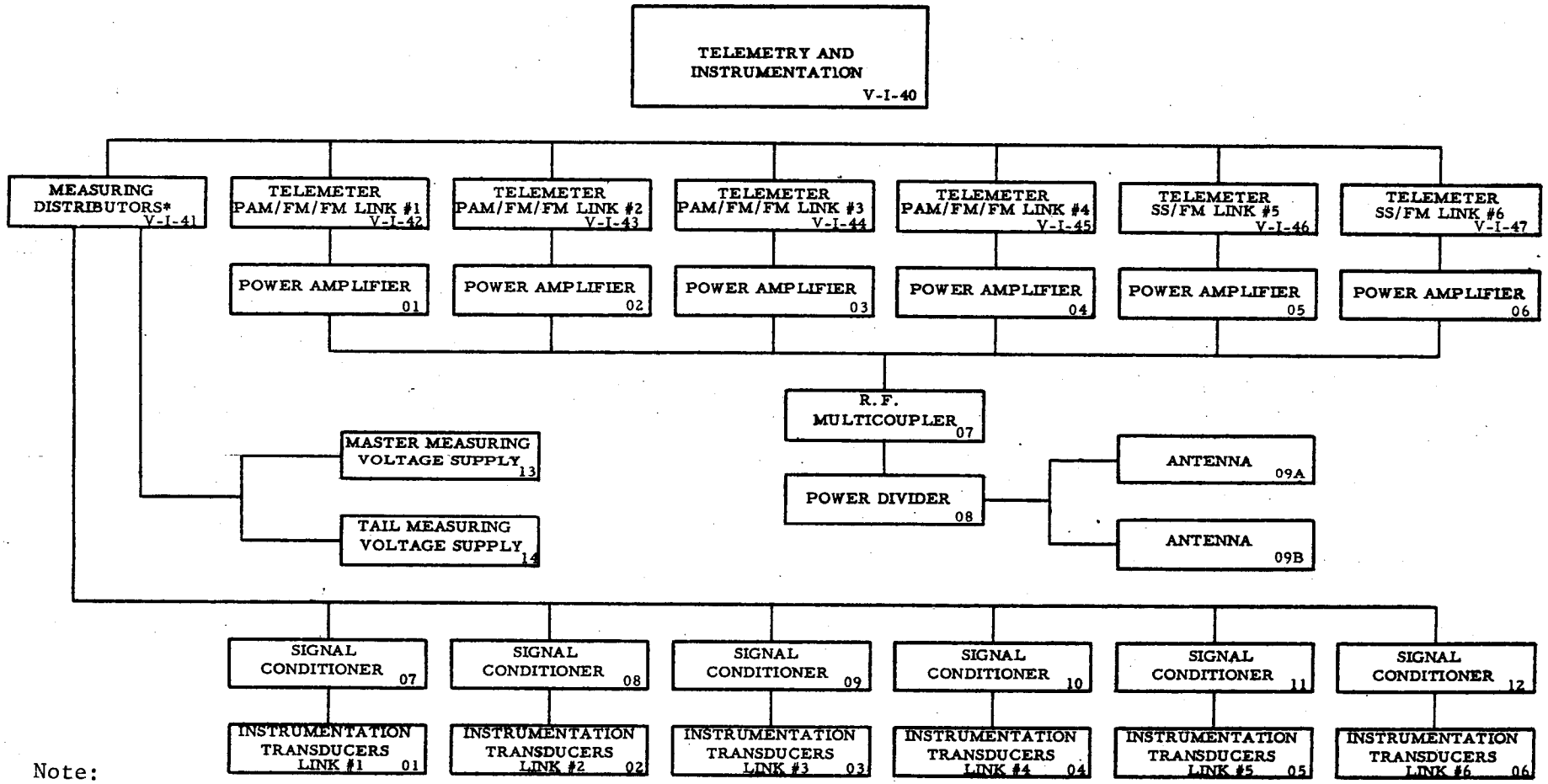
(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Measuring Distributor (5 req.) V-I-41		50M01139 10420007 10420008 10420009 10420013	12AZ6 9A3 9A4 9A5 9A6	Distribute power as required for measurements and telemeter links and necessary switching.	1. Loss of +1D11 or +1D21 bus, + 28V. (Open or short)	Loss of telemeters on this bus.	(A,B) Delay or Reschedule (C) None; Only flight measurements effected	(A,B) Delay or Reschedule (C) None; Only flight measurements effected
					2. Loss of +1D69 bus, +5V (Open or short)	Loss of all data from transducers, depending on master measuring supplies.	(A,B) Delay (C) Loss of measurements connected to master measuring supply.	(A,B) Delay (C) Loss of measurements connected to master measuring supply.
					3. Loss of +1D81 or +1D82 or +1D83 or +1D84, or +1D85, or +1D86, or +1D87 or +1D88 (+5V bus). (Open or short)	Loss of data from transducers in particular engine.	(A,B) Delay (C) Loss of particular engine measurements requiring 5 volts D.C.	(A,B) Delay (C) Loss of particular engine measurements requiring 5 volts D.C.
					4. Loss of 3 phase, 115 volt A.C. 400 cps.	Loss of data from transducers, depending on 400 cps.	(A,B) Delay (C) Loss of particular measurements requiring 400 cps.	(A,B) Delay (C) Loss of particular measurements requiring 400 cps.

Issue Date: Jan 30, 62 | Prepared by: M-ASTR-EA | Approval: [illegible]

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



Note:
Only measuring distributor analysis V-I-41 available.

*Four required.

Issue Date: Sept 20, 1961	Prepared by: M-ASTR-TCT	Approval: CBF

S&M Form #203-1 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
S-I STAGING SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Retro Rocket Igniter (4) V-I-30-03				Starts rocket motor	1) Failure to start motor	None; four rockets each with an individual igniter are provided. (Starting and operating three rockets will secure a satisfactory separation.)	(A) None; not operational prior to launch (B) Same as above (C) None; redundancy provided	(A) None; not operational prior to launch (B) Same as above (C) None; redundancy provided
Retro Rocket (4) V-I-30-04			11A32 11A33 11A34 11A35	Gives backward thrust to S-I stage at start of S-I from upper stage separation	1) Failure to provide thrust	None; four rockets provided. (Operation of three retro rockets will secure a satisfactory separation.)	(A) None; not operational prior to launch (B) Same as above (C) None; redundancy provided	(A) None; not operational prior to launch (B) Same as above (C) None; redundancy provided
					2) Rocket burst. (As a result of excessive internal pressure.)	None; subsystem can still function.	(A) None; not operational prior to launch (B) Same as above (C) None; stage function ceases at separation	(A) None; not operational prior to launch (B) Same as above (C) Probable loss of C-1 Vehicle (Fragmentation of retro rocket may cause damage to components in aft interstage of upper stage and H_2 chill-down ducts)
						Issue Date: Jan 23, 1962	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

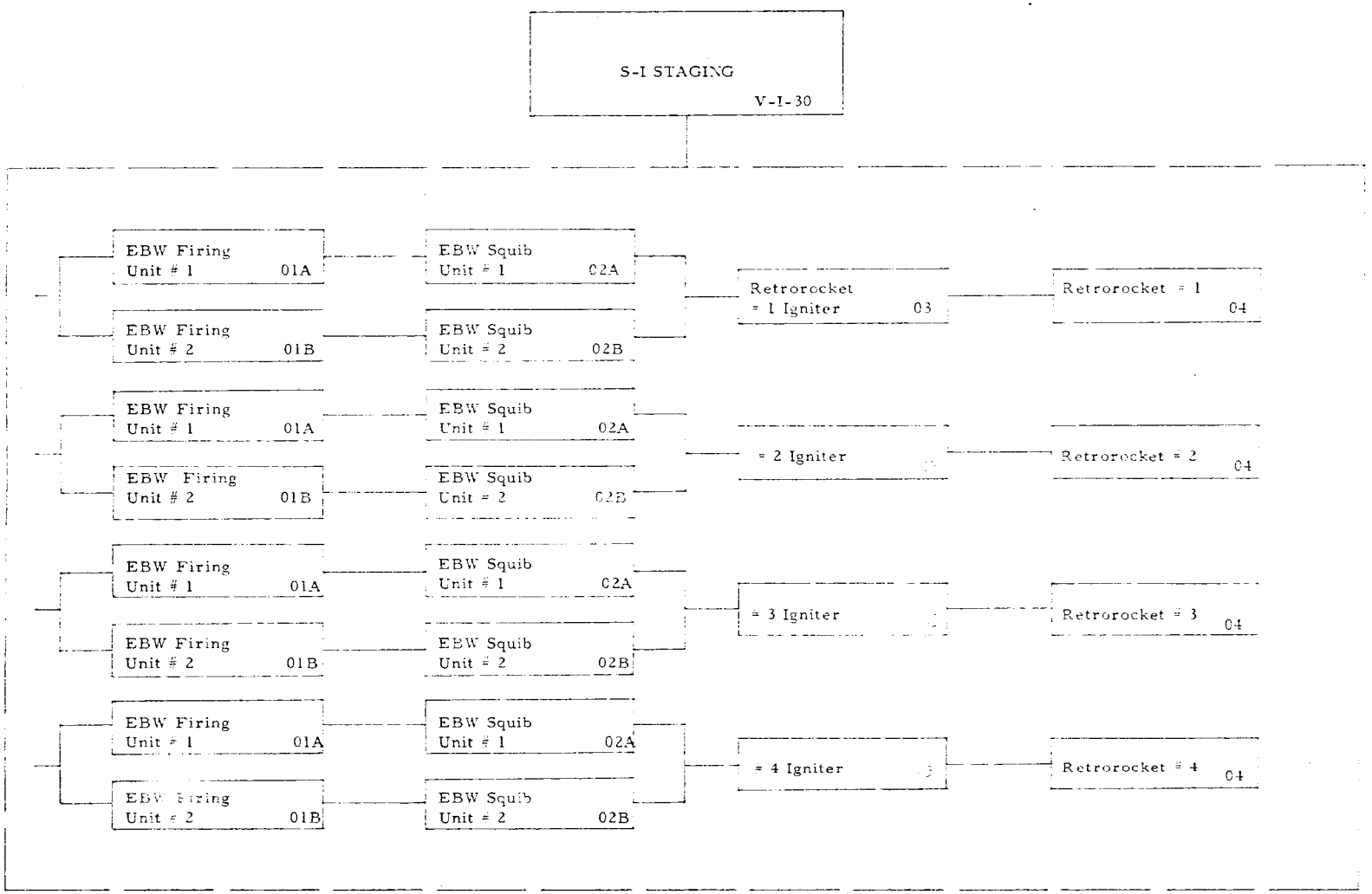
FAILURE EFFECT ANALYSIS
S-I STAGING SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
EBW Firing Unit (8) (For Retro Rocket Ignition.) V-I-30-01-A & B			11A44 11A25 11A26 11A27 11A28 11A29 11A30 11A31	Explodes bridge wire in an associated EBW squib upon receipt of electrical signal	1) Failure to explode bridge wire	None; two EBW units are provided for each retro rocket. (Either unit can cause rocket ignition.)	(A) None; not operational prior to launch (B) Same as above (C) None; redundancy provided	(A) None; not operational prior to launch (B) Same as above (C) None; redundancy provided
					2) Premature explosion of wire. (Subsequent ignition of associated explosive train with consequent firing of one rocket is assumed to happen.)	None; redundancy provided. (Satisfactory separation may be secured with three retro rockets within the expected angles of attack)	(A) Possible Loss of S-I Stage (Creates explosion hazard due to proximity to explosive atmosphere) (B) Same as above (C) None; stage rotation and drift due to single premature retro rocket ignition is not sufficient at any time to cause loss of stage control, or to cause collision during stage separation	(A) Possible Loss of C-1 Vehicle (Creates explosion hazard due to proximity to explosive atmosphere (B) Same as above (C) None; vehicle rotation and drift due to single premature retro rocket ignition is not sufficient at any time to cause loss of vehicle control, or to cause collision during stage separation
EBW Squib (8) (For Retro Rocket Ignition) V-I-30-02-A & B				Activates ullage rocket igniter	1) Failure to start igniter	None; two squibs are provided for each rocket. (Either one can start the rocket igniter.)	(A) None; not operational prior to launch (B) Same as above (C) None; redundancy provided	(A) None; not operational prior to launch (B) Same as above (C) None; redundancy provided
						Issue Date: Jan 23, 1962	Prepared by: M-P&VE-EF	Approval: [illegible]

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



Issue Date:	Prepared By:	Approval:
Jan 23, 1962	M-P&VE-EF	

S&M Form #203-1 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

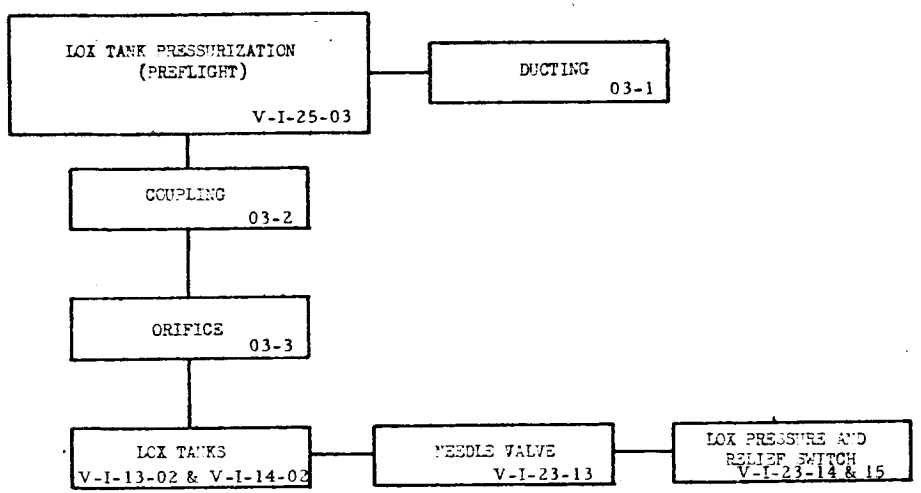
FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Slosh Measuring (V-I-25-01)				Measures slosh in fuel and LOX tanks.	Failures will not affect propulsion sub-system.	None.	None.	None.
Storage Bottle (V-I-25-01-5)				Container for helium used in slosh measuring.	Rupture.	(A) None. (B) None. (C) None.	(A) PROBABLE LOSS due to damage from rupture. (B) PROBABLE LOSS due to damage from rupture. (C) PROBABLE LOSS due to damage from rupture.	(A) PROBABLE LOSS due to damaged from rupture. (B) PROBABLE LOSS due to damaged from rupture. (C) PROBABLE LOSS due to damage from rupture.
Ducting (V-I-25-02-1)	*	NA	NA	Ducts helium from the ground supply to the LOX pump inlet of each engine for LOX bubbling.	Leakage.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Coupling (V-I-25-02-2)	*	20M30141	NA	Coupling for connecting ground supply to vehicle system.	Leakage.	(A) None (to be corrected) (B) Slight loss of helium. (C) Slight loss of gaseous oxygen.	(A) NA. (B) None. (C) None.	(A) NA. (B) None. (C) None.
Orifice (8 reqd) (V-I-25-02-3)	*	20M30199	NA	Controls helium flow rate to the particular suction line.	Clogged.	(A) None (to be corrected) (B) LOX exceeds red line value (delay). (C) NA.	(A) Delay. (B) Delay. (C) NA.	(A) Possible delay. (B) Delay. (C) NA.
Coupling (4 reqd) (V-I-25-02-4)		NA	NA	Prevents torsion on flex hoses during engine gimbaling.	Failure during operation Leakage.	(A) None (to be corrected) (B) Slight loss of helium (C) Slight loss of GOX.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Ducting (V-I-25-03-1)	*	NA	NA	Ducts helium from the ground supply to the LOX tank system for initial LOX tank pressurization.	Rupture.	(A) None (to be corrected) (B) No LOX tank pressurization. (C) Loss of gaseous oxygen.	(A) Delay. (B) Delay. (C) Possible fire hazard.	(A) Possible delay. (B) Delay. (C) Possible abortion.
Coupling (V-I-25-03-2)	*	20M30165	NA	Coupling use for connecting ground supply.	Failure during operation Leakage.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Orifice (V-I-25-03-3)	*	20M30187	NA	Controls helium flow into LOX pressurization manifold.	Partially plugged.	(A) None (to be corrected) (B) Extended LOX tank pressurization time (LOX temp. red line) (C) None.	(A) Delay. (B) Delay. (C) None.	(A) Possible delay. (B) Delay (C) None.

Issue Date: [illegible] 1962 | Prepared By: M-P&VE-PL | Approved: [illegible]

FAILURE EFFECT ANALYSIS



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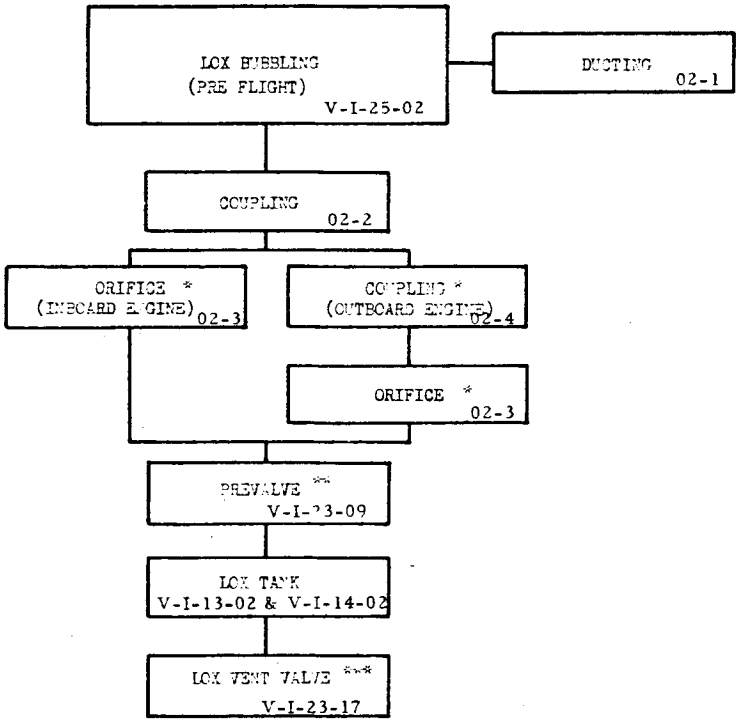
SEP 28 1961	M-P & VE-P	

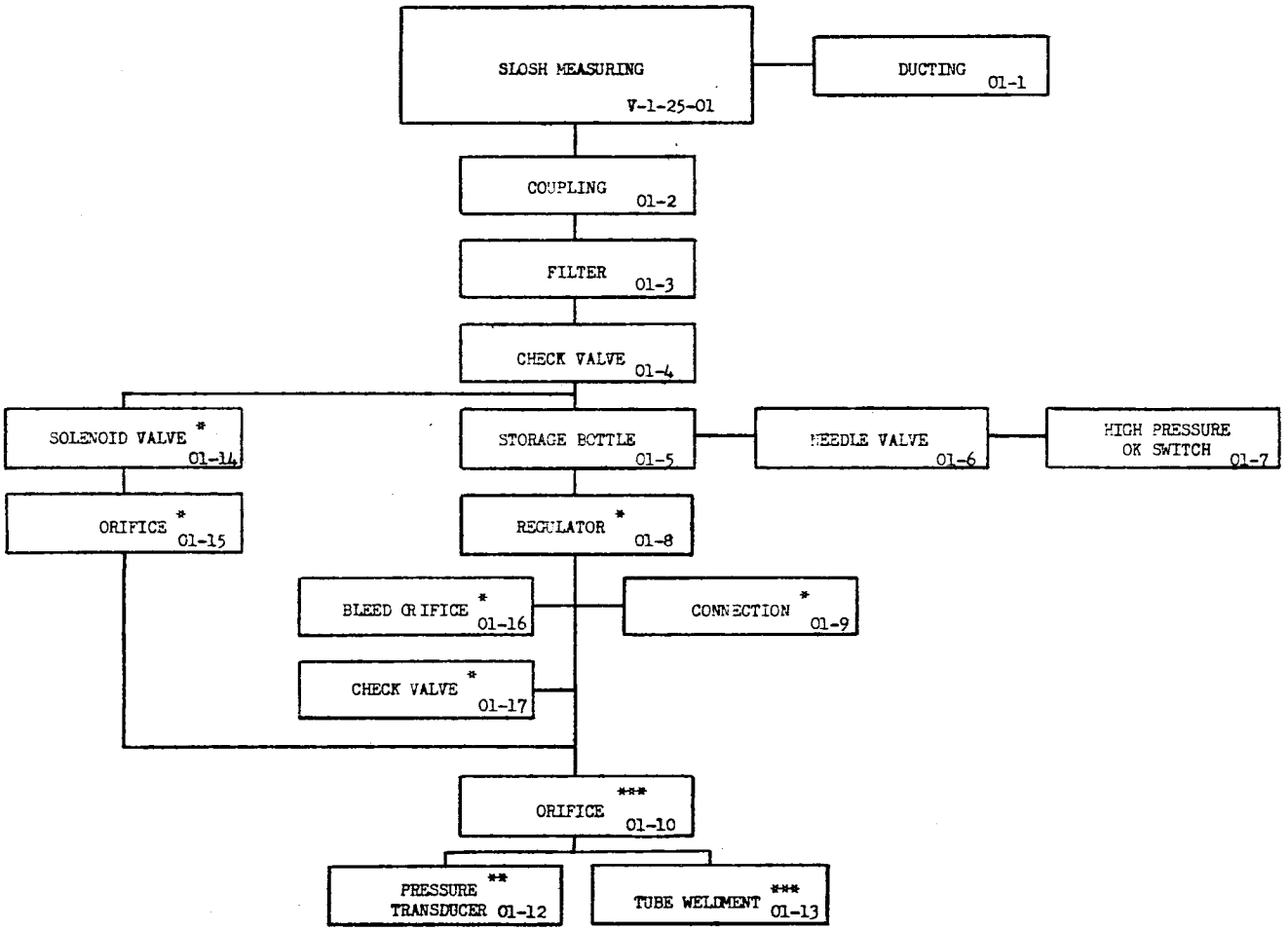
FAILURE EFFECT ANALYSIS



* FOUR (4) REQUIRED
** EIGHT (8) REQUIRED
*** THREE (3) REQUIRED

ISSUE DATE:	PREPARED BY:	APPROVAL:
SEP 18 1981	M-P&VE-P	

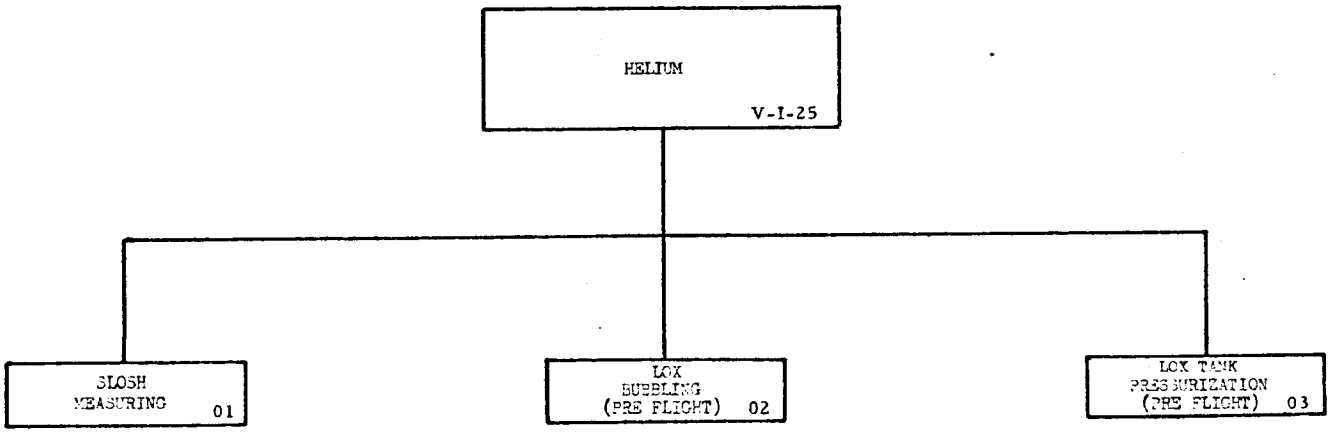
FAILURE EFFECT ANALYSIS



* TWO (2) REQUIRED
** SIX (6) REQUIRED
*** TWELVE (12) REQUIRED

ISSUE DATE:	PREPARED BY:	APPROVAL:
SEPT 28, 1961	M-P & VE-P	

FAILURE EFFECT ANALYSIS



ISSUE DATE:	PREPARED BY:	APPROVAL:
SEP 28 [illegible]	M-P & VE-P	

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Ducting (V-I-24-04-1)	*	NA	NA	Lines bubbling nitrogen into the suction lines to prevent fuel temp. stratification tanks & suction lines.	Failure during operation Leakage or rupture.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
Coupling (V-I-24-04-2)	*	20M30139	NA	Used to connect ground supply for fuel bubbling.	Failure during operation leakage or rupture.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
Filter (V-I-24-04-3)	*	20M30176	NA	Filters GN_2 supply entering stabilized platform.	Failure during operation Clogged.	(A) Slow or halt bubbling process. (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Burst.	(A) Congest or halt flow. (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Orifice (8 reqd) (V-I-24-04-4)	*	20M30198	NA	Controls GN_2 flow to fuel fuel suction lines.	Restricted flow.	(A) Slow bubbling process. (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Check Valve (8 reqd) (V-I-24-04-5)	*	20M30175	NA	Eliminates reverse flow thru bubbling ducting during flight.	Failure during operations Fail open.	(A) None. (B) None. (C) None redundancy provided.	(A) None. (B) None. (C) None redundancy provided.	(A) None. (B) None. (C) None redundancy provided.
					Fail closed.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.

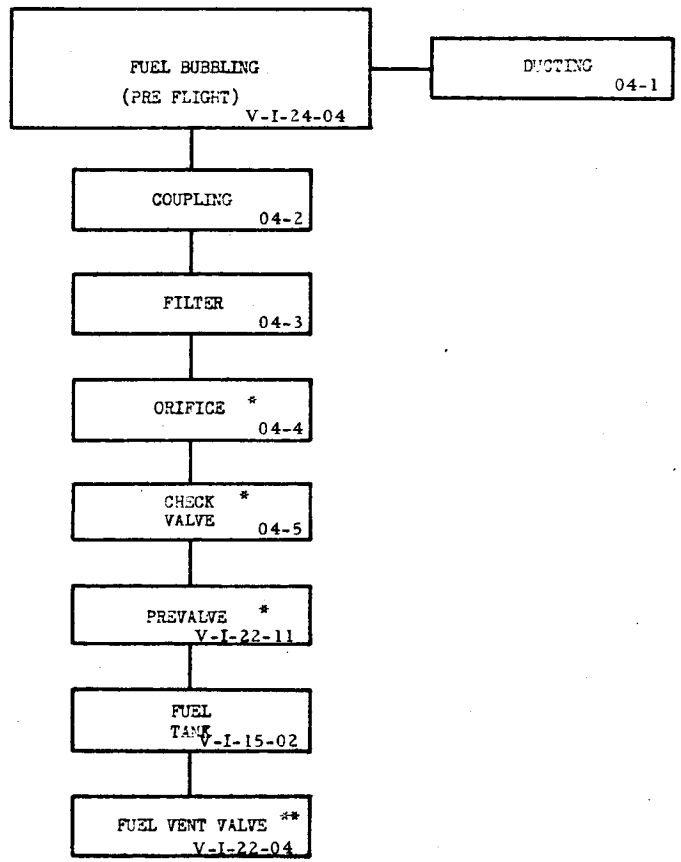
Issue Date: JAN 25 1962

Prepared By: M-P&VE-PL

Approved:

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



* EIGHT (8) REQUIRED

** TWO (2) REQUIRED

ISSUE DATE:	PREPARED BY:	APPROVED:
SEP 23 1981	M-P&VE-P	

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Check Valve (V-I-24-03-8)				Prevents the flow of fuel into purge line after purging operation.	Fail closed.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Fail open.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
Coupling (V-I-24-03-9)				Disconnect coupling used for connecting ground supply GG LOX injector purge.	Fails during operation.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Check Valves (V-I-24-03-10)				Prevents the loss of GG pressure during bootstrap operation.	Fail closed.	(A) None (to be corrected) (B) Possible loss of engine - shutdown. (C) None.	(A) Delay. (B) Possible loss of engine - shutdown. (C) None.	(A) Possible delay. (B) Reschedule. (C) None.
					Fail open.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
Coupling (V-I-24-03-11)				Disconnect coupling used for connecting ground supply LOX dome purge.	Fails during operation.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Check Valve (V-I-24-03-12)				Prevents bleed from Heat Exchanger LOX flow.	Fail closed.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Fail open.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
LOX Dome (V-I-24-03-13)				LOX inlet to thrust chamber.	Contamination.	(A) None. (B) Possible loss of an engine. (C) Possible loss.	(A) None. (B) Possible shutdown. (C) Reduced performance.	(A) None. (B) Possible reschedule. (C) Reduced performance.
Coupling (V-I-24-03-14)				Disconnect coupling. Used for connecting ground supply TC fuel injector.	Failure during operation.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
						Issue Date: JAN 25 1961	Prepared By: M-P&VE-PL	Approved:

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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Ducting (V-I-24-03-1)				All ducting used in carrying purging media.	Small leakage	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Rupture.	(A) None (to be corrected) (B) Possible loss. (C) Possible loss.	(A) Delay. (B) Possible shutdown. (C) POSSIBLE LOSS, gearbox explosion.	(A) Possible delay. (B) Possible delay. (C) POSSIBLE LOSS, gearbox explosion.
Orifice (V-I-24-03-2)				Controls GN_2 flow to LOX pump seal cavity.	Restricted flow.	(A) Conjest or halt flow. (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Delay. (B) None. (C) None.
Check Valve (V-I-24-03-3)				Shuts off GN_2 after engine starts (thrust chamber fuel injector purge).	Failure during operation Fail open.	(A) None. (B) None redundancy provided. (C) None redundancy provided.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
					Fail closed.	(A) None redundancy provided. (B) None. (C) None.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
LOX Seal Drain (V-I-24-03-4)				Drain for LOX Pump seal purge.	None	None	None	None
Orifice (V-I-24-03-5)				Controls GN_2 flow to gearbox.	Restricted flow.	(A) Conjest or halt flow. (B) None. (C) Possible loss of engine.	(A) Delay. (B) None. (C) Possible loss of an engine.	(A) Delay. (B) None. (C) Reduced performance.
Check Valve (V-I-24-03-6)				Prevents reverse flow from gearbox into purge lines.	Failure during operation. Fail open.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
					Fail closed.	(A) None (to be corrected) (B) None. (C) Possible loss of an engine.	(A) Delay. (B) None. (C) POSSIBLE LOSS, gearbox explosion.	(A) Delay (possible) (B) None. (C) POSSIBLE LOSS, gearbox explosion.
Coupling (V-I-24-03-7)				Disconnect coupling for purge. (igniter fuel purge)	Fails during operation.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved:

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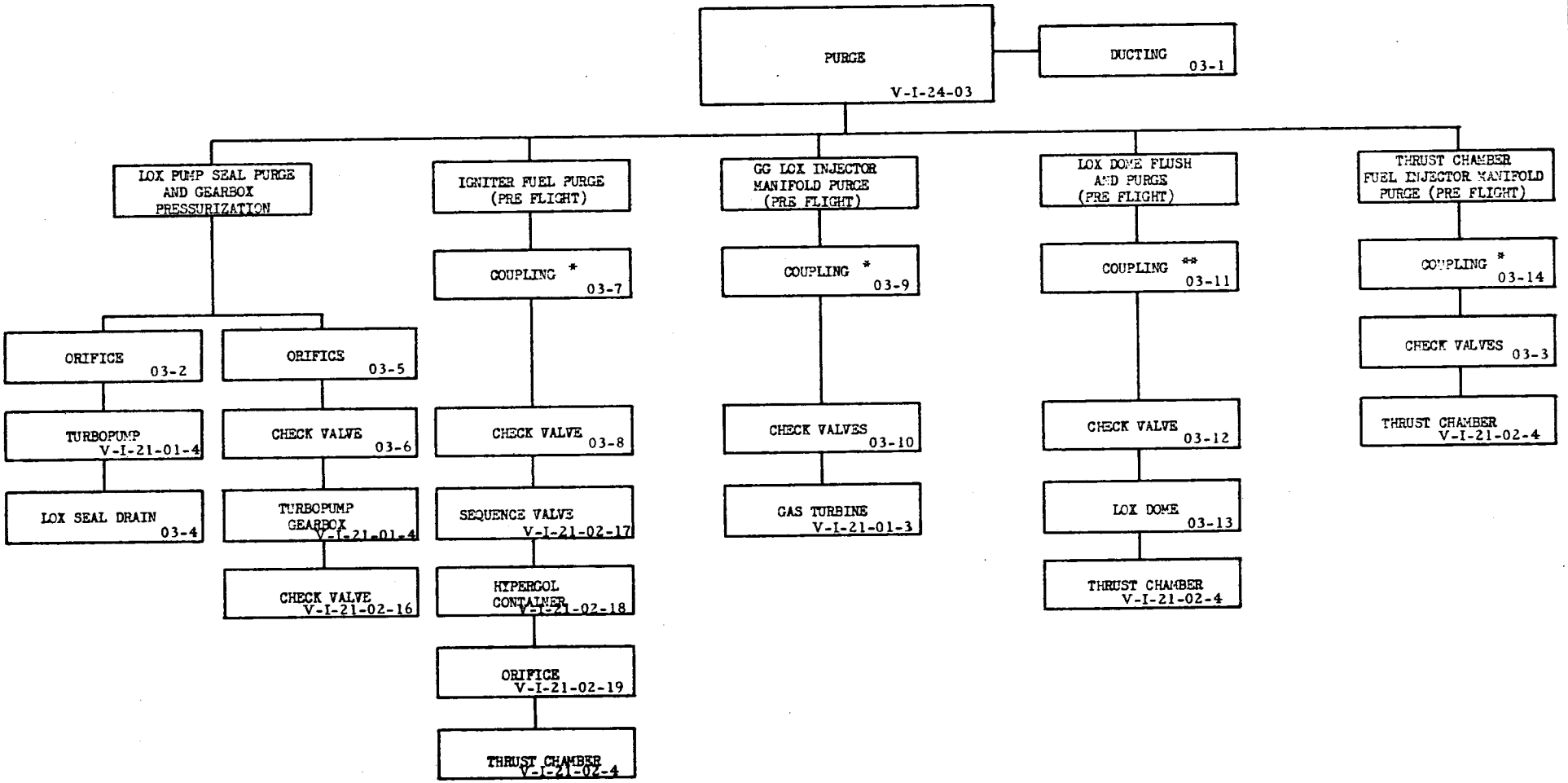
FAILURE EFFECT ANALYSIS



EIGHT (8) REQUIRED EXCEPT WERE NOTED
* ONE (1) REQUIRED
** TWO (2) REQUIRED

ISSUE DATE:	PREPARED BY:	APPROVED:
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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Needle Valve (V-I-24-02-6)			NA	Used to check the calibration of high pressure switch.	Failure to operate at prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
					Failure to cease operation at prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
High Pressure OK Switch (V-I-24-02-7)		20M30130	11A51	Monitors pressure in containers.	Fails to actuate.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Probable delay. (B) NA. (C) NA.
Filters (3 reqd) (V-I-24-02-8)		20M30129	NA	Filters GN_2 after it leaves the high pressure containers.	Failure during operation Clogged.	(A) None (to be corrected) (B) None. (C) Possible pressure decay	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None (C) None.
					Burst	(A) None (to be corrected) (B) None. (C) Possible pressure decay	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Pressurization Valves (3 reqd) (V-I-24-02-9)		20M30171	11A47 11A48 11A49	Controls pressurization of container ullage area on command of pressure switch	Fail open.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Fail closed	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Needle Valve (V-I-24-02-10)			NA	Used to check the calibration on high pressure switch.	Failure to operate at prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
					Failure to cease operation at prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
Pressure Switch (V-I-24-02-11)		20M30184	11A50	Controls tank pressure and operates the pressurizations valves.	Fails to actuate.	(A) None (to be corrected) (B) Not detected. (C) Probable pressure decay.	(A) Delay. (B) None. (C) POSSIBLE LOSS, no fuel tank pressure.	(A) Probable delay. (B) None. (C) POSSIBLE LOSS, no fuel tank pressure.
					Fails to deactuate	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Orifice (3 reqd) (V-I-24-02-12)		20M30197	NA	Controls GN_2 flow for pressurization.	None	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
						Issue Date: JAN 2 9 1962	Prepared By: M-P&VE-PL	Approved:

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

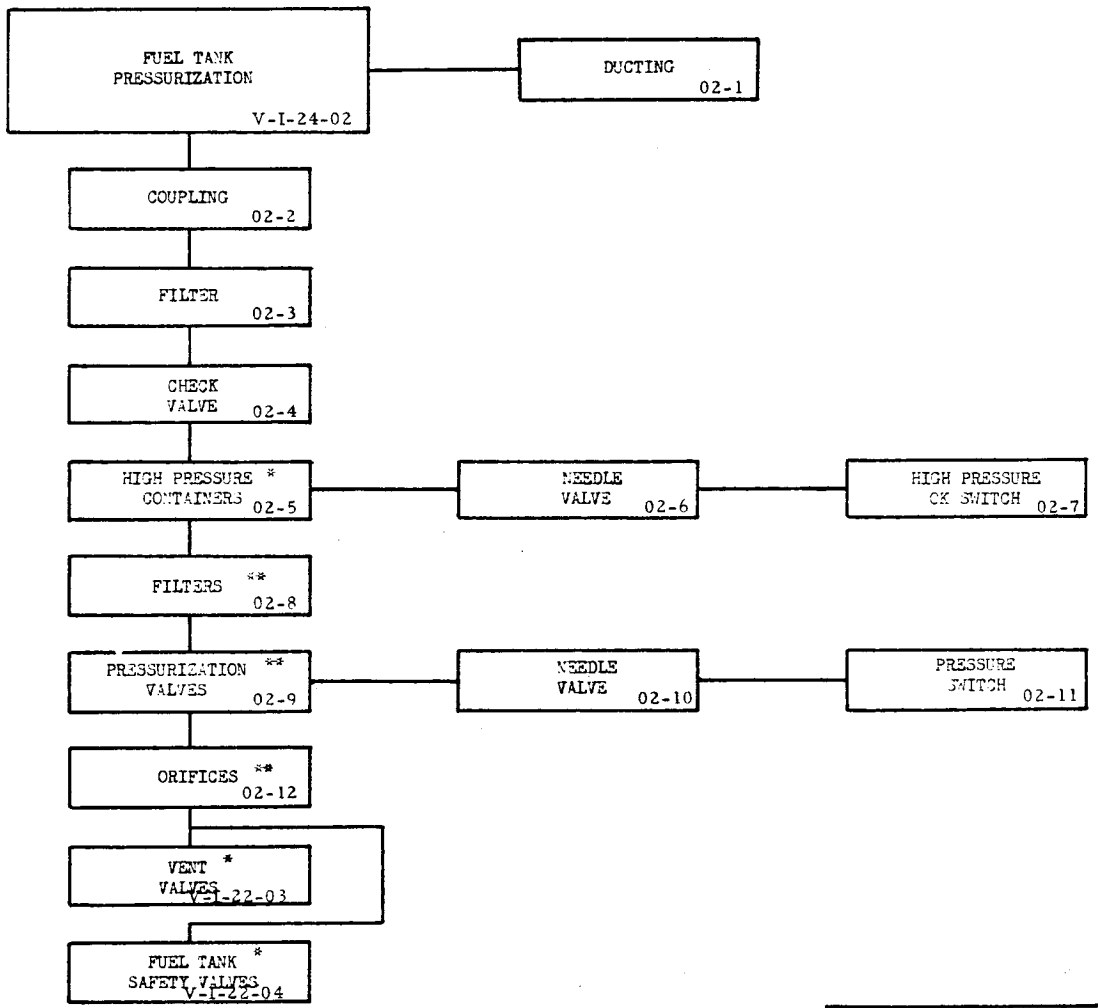
FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Ducting (V-I-24-02-1)		NA	NA	Ducting used in connection with fuel tank pressurization.	Small leakage.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Rupture	(A) None (to be corrected) (B) Loss (shutdown) (C) Loss (shutdown)	(A) Delay. (B) Shutdown. (C) Premature cut-off.	(A) Possible delay. (B) Reschedule. (C) Reduced performance.
Coupling (V-I-24-02-2)	*	20M30133	NA	Connects ground supply with vehicle system.	Failure during operation.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
Filter (V-I-24-02-3)	*	20M30129	NA	Filters GN_2 ground supply to high pressure spheres.	Failure during operation. Clogged	(A) Slow or halt fill process. (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Burst	(A) Conjest or halt flow. (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Check Valve (V-I-24-02-4)		20M30132	NA	Prevents venting of high pressure GN_2 used for fuel tank pressurization.	Fail open.	(A) None (to be corrected) (B) None (redundancy provided). (C) None (redundancy provided)	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Fail closed.	(A) Halt fill procedure. (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
High Pressure Containers (2 reqd) (V-I-24-02-5)		20M00414	NA	Storage high pressure GN_2.	Leakage at fittings.	(A) None (to be corrected) (B) Possible tank pressure decay. (C) Possible tank pressure decay.	(A) Delay. (B) Possible reduced performance. (C) Possible reduced performance.	(A) Possible delay. (B) Possible reduced performance. (C) Possible reduced performance.
					Rupture.	(A, B & C) Tremendous explosion would result due to sudden expansion of high pressure gas.	(A) LOSS, explosion. (B) LOSS, explosion. (C) LOSS, explosion.	(A) LOSS, explosion. (B) LOSS, explosion. (C) LOSS, explosion.
						Issue Date:	Prepared By: M-P&VE-PL	Approved:

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



* TWO (2) REQUIRED
** THREE (3) REQUIRED

ISSUE DATE:	PREPARED BY:	APPROVED:
SEP 23 1966	M-P & VE-P	

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Control Valve (LOX Relief) (V-I-24-01-22)		20M30172	11A53	Supplies control pressure to LOX relief valve No. 2 on signal from pressure switch.	Fail closed.	(A) NA. (B) NA. (C) None (redundancy provided)	(A) NA. (B) NA. (C) None (redundancy provided).	(A) NA. (B) NA. (C) None.
					Fail open.	(A) NA. (B) LOX tank pressurization not obtained. (C) None.	(A) NA. (B) Delay. (C) None.	(A) NA. (B) Delay. (C) None.
Control Valve (LOX Vent and LOX Relief) (V-I-24-01-23)		20M30172	11A55	Supplies control pressure to LOX relief valve No. 1 and LOX vent valve on signal from press switch.	Fail closed.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Fail open.	(A) NA. (B) LOX tank pressurization not obtained. (C) Possible loss.	(A) NA. (B) Delay. (C) POSSIBLE LOSS, loss of LOX tank pressure.	(A) NA. (B) Delay. (C) POSSIBLE LOSS, loss of LOX tank pressure.
Control Valve (LOX Replenshing) (V-I-24-01-24)		20M30128	9A17	Closes LOX replenishing valve.	Fail closed.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) Delay. (C) None.	(A) Possible delay. (B) Delay. (C) None.
					Fail open.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Control Valve (Engine Pre-Valve) (8 reqd.) (V-I-24-01-25)			9A25 9A28 9A31 9A34 9A37 9A40 9A43 9A46	Supplies controls pressure to engine pre-valves.	Fail closed.	(A) None (to be corrected) (B) Loss of one engine. (C) Loss of one engine.	(A) Delay. (B) Shutdown. (C) Reduced performance.	(A) Possible delay. (B) Reschedule. (C) Reduced performance.
					Fail open.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Orifice (8 reqd.) (V-I-24-01-26)				Controls bleed back on control valve for engine pre-valve to insure a fuel rich cut-off.	Clogged.	(A) NA. (B) NA. (C) NA.	(A) NA. (B) NA. (C) NA.	(A) NA. (B) NA. (C) NA.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved: [signature]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Relief Valve (V-I-24-01-13)		20M30137	NA	Vents control pressure in excess of 950 psi	Fail open.	(A) None (to be corrected) (B) Probable loss. (C) Probable loss.	(A) Delay. (B&C) PROBABLE LOSS, no control pressure.	(A) Possible delay. (B&C) PROBABLE LOSS, no control pressure.
					Fail closed.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Hand Valve (V-I-24-01-14)	*		NA	Allows gear box pressurization and LOX seal purge.	Failure to operate at prescribed time.	(A) None(to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
					Failure to cease operation at prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
Orifice (V-I-24-01-15)		20M30163	NA	Controls flow of GN_2 used for gear box pressurization and LOX seal purge.	Clogged.	(A) None (to be corrected) (B) Possible loss. (C) Possible loss.	(A) Delay. (B&C) POSSIBLE LOSS, gearbox explosion.	(A) Possible delay. (B&C) POSSIBLE LOSS, gearbox explosion.
Solenoid Valve (V-I-24-01-17)		20M30160	9A9	Control GN_2 supply to calorimeter.	Fail open.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
					Fail closed.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
Calorimeter (2 reqd) (V-I-24-01-19)		NA	NA			(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
Needle Valve (V-I-24-01-20)			NA	During checkout the measuring source is shut-off by the hand valve and test pressure is applied from the ground	Failure to operate at prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
					Failure to cease operation at prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
750 Psi OK Pressure Switch (V-I-24-01-21)		20M30135	9A53	Gives OK signal on control pressure prior to firing command.	Failure to operate at the prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved:

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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Needle Valve (V-I-24-01-8)	*		NA	Pre-launch check out of pressure switch.	Failure to operate at required time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
					Failure to cease operation at prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
High Pressure OK Switch. (V-I-24-01-9)	*	20M30130	9A52	Indicates that spheres are at required pressure.	Pre-mature operation of component.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Failure to operate at the prescribed time.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Failure to cease operation at prescribed time.	(A) None (to be corrected) (B) NA. (C) None.	(A) Delay. (B) NA. (C) None.	(A) Possible delay. (B) NA. (C) None.
Filter (V-I-24-01-10)		20M30127	NA	Filters on board GN_2 supply before entrance into various control devices.	Failure during operation. Burst	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Regulator (V-I-24-01-11)		20M30134	NA	Provides correct flow and pressure to control devices.	Regulates "High" (relief valve @ 950)	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Regulates "Low" (below 500).	(A) None (to be corrected) (B) Possible loss. (C) Possible loss.	(A) Delay. (B&C) POSSIBLE LOSS, prevalves will close.	(A) Possible delay. (B&C) POSSIBLE LOSS, prevalves will close.
Manifold (V-I-24-01-12)			NA	Provides connections for various controls.	Leakage.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved:

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**Items marked thus (*) do not operate in flight

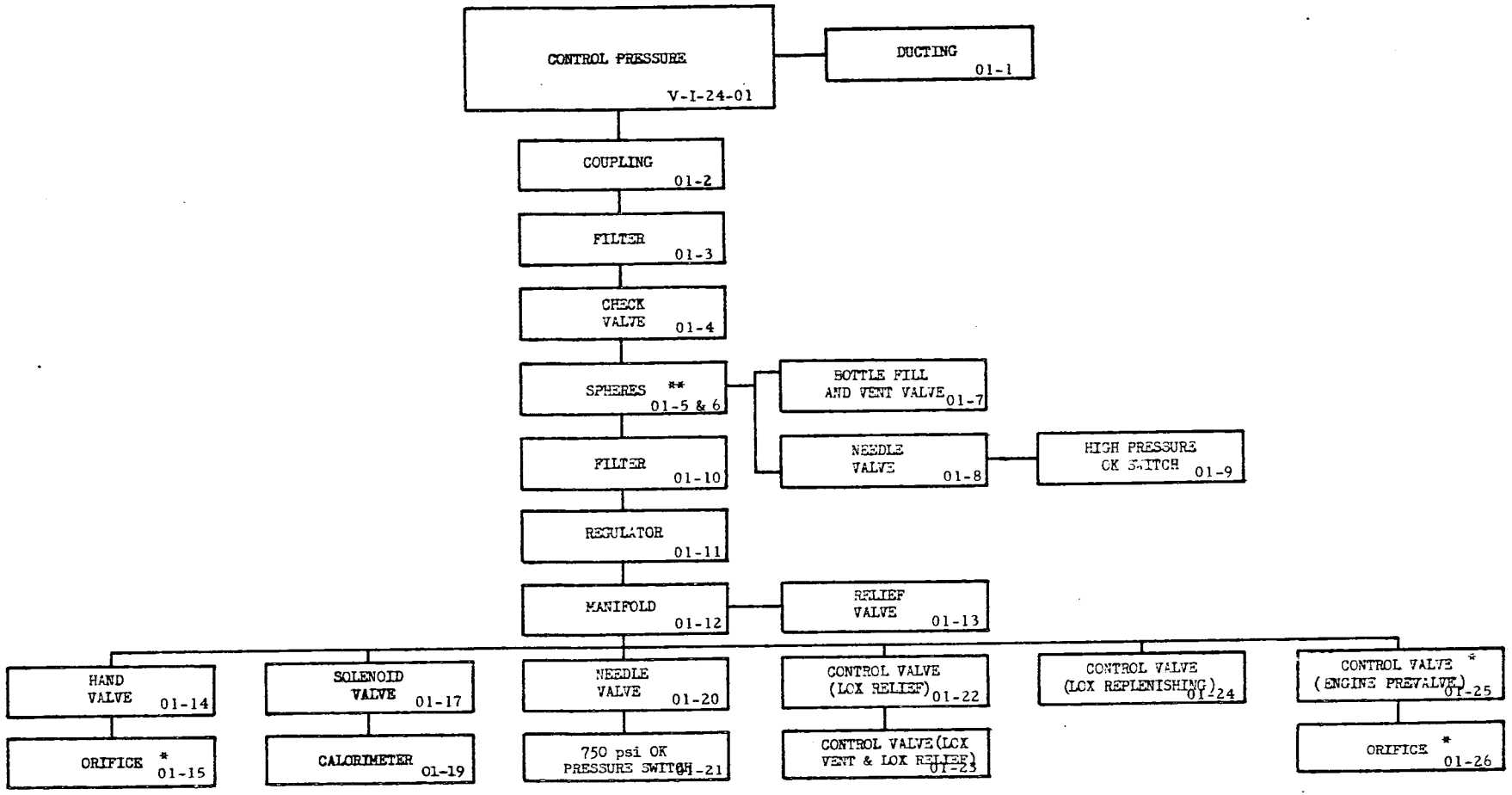
FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Ducting (V-I-24-01-1)		NA	NA	GN_2 Ducting for control pressure.	Small leakage	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Rupture	(A) None (to be corrected) (B) Shut-down. (C) Loss of one to eight engines.	(A) Delay. (B) Shut-down. (C) PROBABLE LOSS, loss of control pressure.	(A) Possible delay. (B) Reschedule. (C) PROBABLE LOSS, loss of control pressure.
Coupling (V-I-24-01-2)	*	20M30140	NA	Disconnect Coupling for ground connection.	Leakage.	(A) None(to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Filter (V-I-24-01-3)	*	20M30127	NA	Filters control pressure GN_2 ground supply entering vehicle.	Failure during operation.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Check Valve (V-I-24-01-4)	*	20M30124	NA	Prevent reverse flow of GN_2 supply to Overboard.	Fail open.	(A) None (to be corrected) (B) None redundancy provided. (C) None redundancy provided.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Fail closed.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Spheres (2 reqd) (V-I-24-01-5)			NA	Containers for GN_2 control pressure supply.	Rupture.	(A) Loss. (B) Loss. (C) Loss.	(A) LOSS, explosion. (B) LOSS, explosion. (C) LOSS, explosion.	(A) LOSS, explosion . (B) LOSS, explosion. (C) LOSS, explosion.
Bottle Fill and Vent Valve (V-I-24-01-7)		20M30131	9A51	Used in filling and venting of 750 psi pressure supply sphere.	Fail open.	(A) None (to be corrected) (B) None. (C) Possible loss.	(A) Delay. (B) None. (C) POSSIBLE LOSS, loss of control pressure.	(A) Possible delay. (B) None. (C) POSSIBLE LOSS, loss of control pressure.
					Fail closed.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved:

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS

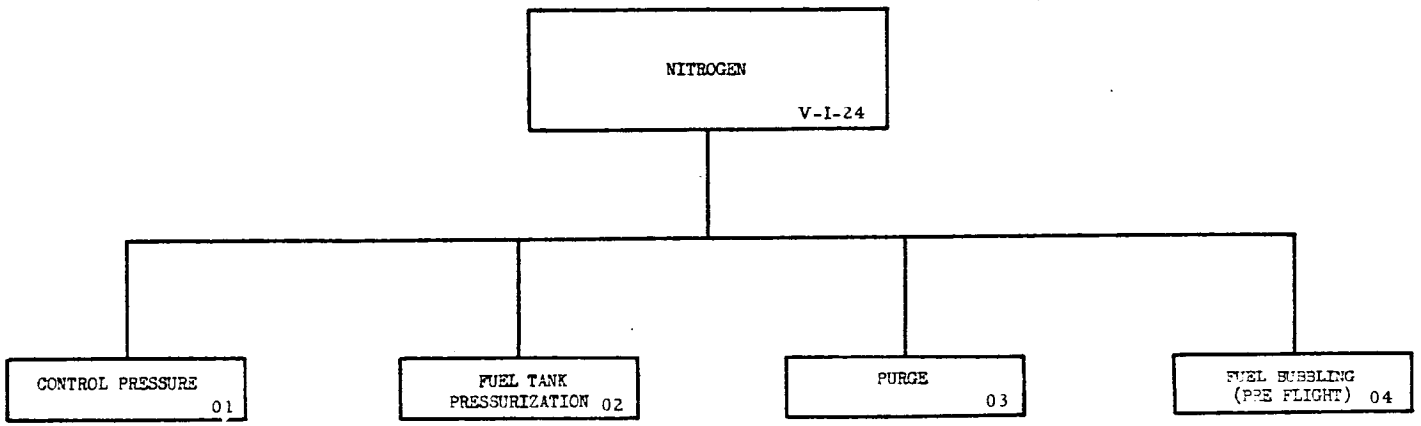


* EIGHT (8) REQUIRED

** TWO (2) REQUIRED

ISSUE DATE:	PREPARED BY:	APPROVED:
SEP 28 361	M-P & YE-P	

FAILURE EFFECT ANALYSIS



ISSUE DATE:	PREPARED BY:	APPROVAL:
SEP 28 1961	M-P&VE-P	

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Emergency Switch (V-I-23-15)		20M30186	11A57	Controls LOX tank pressure by opening LOX tank vent valve and LOX tank relief valve if pressure exceeds 65 psia (redundancy if 60 psia switch does not function properly)	Failure to actuate.	(A) NA. (B) None, (second malfunction. (C) None, (Second malfunction)	(A) NA. (B) Mech. setting of two (2) relief valves (61 psig) will relief tank pressure. (Second redundancy). (C) Mech. setting of two (2) relief valves (61 psig) will relief tank pressure. (Second redundancy.	(A) NA. (B) None. (C) None.
LOX Relief Valve (2 required) (V-I-23-16)		20M30121	11A54 11A52	Vents LOX tanks of excess pressure. Actuated by electrical pressure switch or if necessary mechanical by spring.	Fail closed.	(A) None (to be corrected) (B) None. (C) Increased ullage pressure.	(A) Delay. (B) None. (C) Reduced performance.	(A) Possible delay. (B) None. (C) Reduced performance.
					Fail open.	(A) None (to be corrected) (B) Decay in LOX tank pressure. (C) Decay in LOX tank pressure.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
Lox Vent Valve (V-I-23-17)		20M30122	11A56	Vents LOX tank of excess pressure. Actuated by electrical pressure switch	Fail closed.	(A) None (to be corrected) (B) None. (C) Increased ullage pressure.	(A) Delay. (B) None. (C) Reduced performance.	(A) Possible delay. (B) None. (C) Reduced performance
					Fail open.	(A) None (to be corrected) (B) Decay in LOX tank pressure. (C) Decay in LOX tank pressure.	(A) Delay. (B) Shutdown. (C) POSSIBLE LOSS if failure occurs during first 10 seconds of flight.	(A) Possible Delay. (B) Reschedule. (C) POSSIBLE LOSS due to loss of tank pressure.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved: [illegible]

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
LOX Prevalve (V-I-23-09)		20M30042	9A27 9A30 9A33 9A36 9A39 9A42 9A45 9A48	Allows cutoff of LOX flow to the engine compartment in case of malfunction (requirement for "Engine Out" capibility).	Failure to open at prescribed time.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Failure during operation (closes prematurely).	(A) None (to be corrected) (B) Loss of an engine (C) Loss of an engine.	(A) Delay. (B) Shutdown. (C) Reduced performance.	(A) Possible delay. (B) Reschedule. (C) Reduced performance.
Suction Lines (V-I-23-10)		NA	NA	Ducts LOX from the tanks to the pump inlet absorbs vibration, surges thermal and shock displacement.	Rupture	(A) NA. (B) Loss of an engine. (C) Loss of an engine.	(A) NA. (B) Shutdown. (C) PROBABLE LOSS, due to fire hazard).	(A) NA. (B) Reschedule. (C) PROBABLE LOSS, due to fire hazard.
Check Valves (V-I-23-11)		20M30046	NA	Prevents loss of LOX tank pressure in case of engine or heat exchanger malfunction.	Fail closed.	(A) None. (B) Possible loss of engine. (C) Possible loss of engine.	(A) None. (B) Shutdown. (C) Reduced performance.	(A) None. (B) Reschedule. (C) Reduced performance.
					Fail open.	(A) NA. (B) None. (C) None.	(A) NA. (B) None. (C) None.	(A) NA. (B) None. (C) None.
Orifice (V-I-23-12)		20M30142	NA	Controls flow of GOX used in pressurization.	Orifice size makes clogging improbable	None.	None.	None.
Needle Valve (V-I-23-13)	*		NA	During checkout the measuring source is shut-off by the hand valve and test pressure is supplied from the ground.	Failure to operate at the prescribed time.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Failure to cease operation at prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.
Low Pressure and Relief Switch. (V-I-23-14)		20M30185	11A59	Controls LOX tanks pressure(60 psia) during initial pressurization and controls relief valve during flight.	Failure to actuate.	(A) NA. (B) Increase ullage pressure. (C) Increase ullage pressure.	(A) NA. (B) Stops automatic sequence if actuation does not occur. (C) Reduced performance.	(A) NA. (B) Possible delay. (C) Reduced performance.
					Failure to deactuate.	(A) NA. (B) Over pressurization. (C) Possible pressure decay.	(A) NA. (B) Initiates emergency vent. (C) None.	(A) NA. (B) None. (C) None.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved:

S&M Form #203 (August 1961)(OT)

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
LOX Replenishing Valve (V-I-23-05)	*	20M30045	9A18	Allows to maintain proper LOX level by replenishing LOX at a limited flowrate to the LOX tanks during standby.	Failure to open at prescribed time.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Failure to close at prescribed time.	(A) None (to be corrected) (B) None. (C) None.	(A) Position indicator will stop sequence. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Leakage during flight (Partially open valve).	(A) NA. (B) Not detectable. (C) LOX drains in limited amount from vehicle.	(A) NA. (B) Possible fire hazard at base plate. (C) Possible fire hazard at base plate.	(A) NA. (B) Possible fire hazard at base plate. (C) Possible fire hazard at base plate.
Slip Coupling (V-I-23-06)	*	20M30050	NA	Disconnect coupling for LOX replenishing.	Failure during operation failure would not affect mission malfunction of coupling would be detected during LOX replenishing.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
LOX Fill Valve (C-I-23-07)	*	20M30042	9A20	Allows main LOX tanking process, prevents draining of LOX tanks during flight. Valve is opened by ground control pressure and spring closed.	Failure to open at prescribed time. Failure would not affect mission. Malfunction of valve would be detected during filling operation.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Failure to close at prescribed time.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Leakage during flight (Partially open valve)	(A) NA. (B) Not detectable. (C) LOX drains in limited amount from vehicle.	(A) NA. (B) Possible fire hazard at base plate. (C) Possible fire hazard at base plate	(A) NA. (B) Possible fire hazard at base plate. (C) Possible fire hazard at base plate.
Pressure Switch (V-I-23-08)		20M30144	9A21	Used to cut off LOX tanking if computer fails to operate properly.	Failure to operate at prescribed time.	(A) LOX over flow thru vent valves. (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
						Issue Date: JAN 2 5 1962	Prepared By: M-P&VE-PL	Approved:

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**Items marked thus (*) do not operate in flight

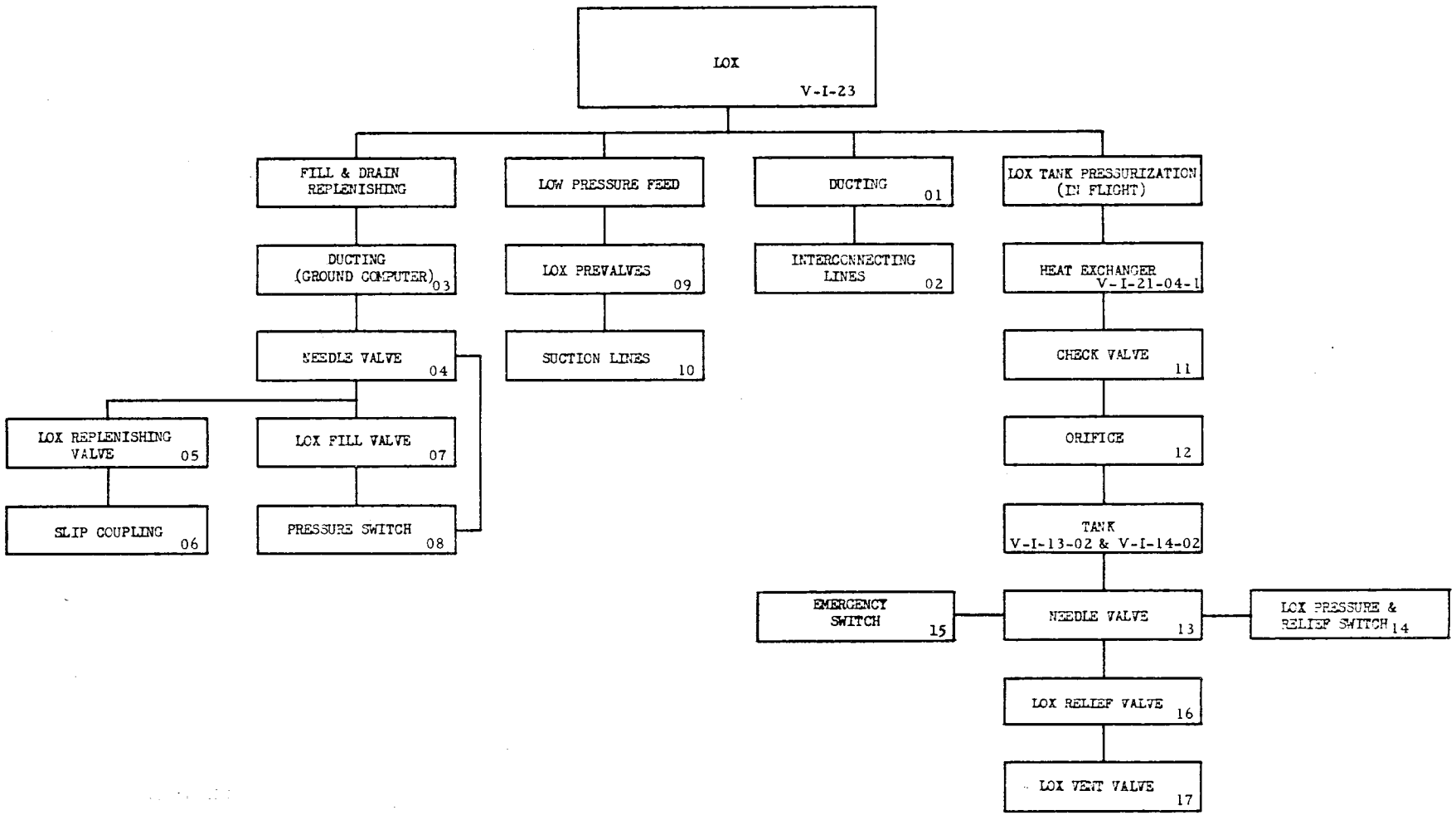
FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Ducting (V-I-23-01)		NA	NA	All Ducting associated with the flow of liquid LOX.	Both large and small ducting exhibit the same type of failure mode but the time between failure and effect depends on size and location of the ducting.	(A) Small leakage none. (B) Small leakage none. (C) Small leakage none.	(A) Delay (B) POSSIBLE LOSS due to fire hazard. (C) POSSIBLE LOSS due to fire hazard.	(A) Possible delay. (B) POSSIBLE LOSS due to fire hazard. (C) POSSIBLE LOSS due to fire hazard.
						(A) Rupture none. (B) Rupture possible loss. (C) Rupture possible loss.	(A) Delay. (B) POSSIBLE LOSS due to fire hazard. (C) POSSIBLE LOSS due to fire hazard.	(A) Reschedule. (B) POSSIBLE LOSS due to fire hazard. (C) POSSIBLE LOSS due to fire hazard.
				All ducting associated with the flow of the pressurizing medium.	Both large and small ducting exhibit the same type of failure mode but the time between failure and effect depends on size and location of the ducting.	(A) Small leakage none. (B) Small leakage none. (C) Small leakage none.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
						(A) Rupture none (to be corrected. (B) Rupture possible loss. (C) Rupture possible loss.	(A) Delay. (B) POSSIBLE LOSS, fire. (C) POSSIBLE LOSS, fire.	(A) Reschedule. (B) POSSIBLE LOSS, fire. (C) POSSIBLE LOSS, fire.
Interconnecting Lines (V-I-23-02)			NA	Lines connecting center LOX tank with outer tanks.	Small leakage	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Rupture	(A) None (to be corrected) (B) Possible loss. (C) Possible loss.	(A) Delay. (B) Shutdown. (C) POSSIBLE LOSS, fire.	(A) Possible delay. (B) Reschedule. (C) POSSIBLE LOSS, fire.
Ducting (Ground Computer) (V-I-23-03)	*	NA	NA	Ducting running to ground computer which controls fluid level in tanks.	Failure during operation Rupture	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
Needle Valve (V-I-23-04)	*		NA	During checkout the measuring source is shut-off by the hand valve and a test pressure ia applied from the ground.	Failure to operate at the prescribed time.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Failure to be re-opened after calibration check.	(A) None (B) None. (C) NA.	(A) None. (B) None. (C) NA.	(A) None. (B) None. (C) NA.
						Issue Date: JAN [illegible]	Prepared By: M-P&VE-PL	Approved: [illegible]

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Ducting (Ground Computer) (V-1-22-05)			NA	Ducting running to ground computer which controls fluid level in tanks.	Failure during operation Rupture.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
Needle Valve (V-1-22-06)	*		NA	Used to calibrate pressure switch.	Failure to operate at the prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.
					Failure to cease operation at prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
Pressure Switch (V-I-22-07)	*	20M30154	9A24	Used to cut fuel off if computer fails to cut it off.	Failure to operate at the prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
Fuel Fill and Drain Valve (V-I-22-10)		20M30043	NA	Shut-off valve for filling and draining containers.	Failure to cease operation at the prescribed time.	(A) None (to be corrected) (B) NA. (C) NA.	(A) Delay. (B) NA. (C) NA.	(A) Possible delay. (B) NA. (C) NA.
					Failure to open at prescribed time.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Leakage during flight (Partially open valve)	(A) NA. (B) Not detectiable. (C) LOX drains in limited amount from vehicle.	(A) NA. (B) Possible fire hazard at base plate. (C) Possible fire hazard at base plate.	(A) NA. (B) Possible fire hazard at base plate. (C) Possible fire hazard at base plate.
Fuel Prevalves (8 reqd.) (V-I-22-11)		20M30043	9A26 9A29 9A32 9A35 9A38 9A41 9A44 9A47 9A63	Allows cutoff of fuel flow to the engine compartment in case of malfunction (requirement for "Engine Out" capibility).	Failure to operate at the prescribed time.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Delay. (B) None. (C) None.
					Failure during operation (closes prematurely)	(A) None. (B) Loss of an engine. (C) Loss of an engine.	(A) Delay. (B) Shutdown. (C) Reduced performance.	(A) Possible delay. (B) Shutdown. (C) Reduced performance.
Suction Line O/B (4 reqd) Suction Line 1/B (4 reqd) (V-1-22-12)		20M00042 20M00043	NA	Ducts fuel from pre-valve (container sump) to pump inlet on engine.	Failure during operation Rupture.	(A) NA. Fuel would drain into hot gas area. Thrust OK switch will initiate cutoff on the effected engine and close pre-valve possible fire hazard.	(A) NA. (B) No thrust commit stage will shutdown possible fire hazard. (C) Engine out capability possible fire hazard.	(A) NA. (B) Reschedule possible fire hazard. (C) POSSIBLE LOSS fire hazard.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved: [illegible]

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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Ducting (V-I-22-01)		NA	NA	All ducting associated with the flow of fuel.	Both large and small ducting exhibit the same type of failure mode but the time between failure and effect depends on size and location of the ducting.	(A) Small leakage none. (B&C) Small leakage none.	(A) Delay. (B&C) POSSIBLE LOSS, due to fire hazard.	(A) Possible delay. (B&C) POSSIBLE LOSS, due to fire hazard.
						(A) Rupture none. (B) Rupture possible loss. (C) Rupture possible loss.	(A) Delay. (B) POSSIBLE LOSS, due to fire hazard. (C) POSSIBLE LOSS, due to fire hazard.	(A) Reschedule. (B) POSSIBLE LOSS, due to fire hazard. (C) POSSIBLE LOSS, due to fire hazard.
				All ducting associated with the flow of the pressurizing medium.	Both large and small ducting exhibit the same type of failure mode but the time between failure and effect depends on size and location of the ducting.	(A) Small leakage none. (B) Small leakage none. (C) Small leakage none.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
						(A) Rupture none (to be corrected) (B) Rupture possible loss. (C) Rupture possible loss.	(A) Delay. (B) POSSIBLE LOSS, fire. (C) POSSIBLE LOSS, fire.	(A) Reschedule. (B) POSSIBLE LOSS, fire. (C) POSSIBLE LOSS, fire.
Fuel Inter-Connect Line (V-I-22-02)		20M00009	NA	Lines connecting tanks.	Failure during operation Rupture would allow fuel to drain into the AFT section.	(A) None. (B) Emergency cut-off. Fire hazard. (C) Loss of propellant Fire hazard.	(A) Emergency drain, replace duct. Decontaminate vehicle. (B) Emergency cut-off. (C) Premature cutoff fire hazard.	(A) Reschedule. (B) POSSIBLE LOSS, fire hazard. (C) POSSIBLE LOSS, fire hazard.
Vent Valve (2 reqd) (V-I-22-03)		20M30000	11A45 11A46	Relief valve for tank pressure control. Mech. setting ≈ 19.5 psig (tank pressure is controlled by switch V-I-24-02-11)	Fails closed, increase tank pressure to safety valve setting caused by switch failure.	(A) None (to be corrected). (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
					Fails open, prior to 50-60 sec drop tank pressure below specified, after 60 sec no effect.	(A) None (to be corrected) (B) Loss. (C) Possible loss.	(A) Delay. (B) Shutdown. (C) POSSIBLE LOSS, loss of pressurization.	(A) Possible delay. (B) Reschedule. (C) POSSIBLE LOSS, loss of pressurization.
Safety Valve (2 reqd) (V-I-22-04)		20M30020	NA	Redundant safety valve for tank pressure control. Mech. setting at 23psig	Fails closed.	(A) None (to be corrected) (B) None. (C) None.	(A) Delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.

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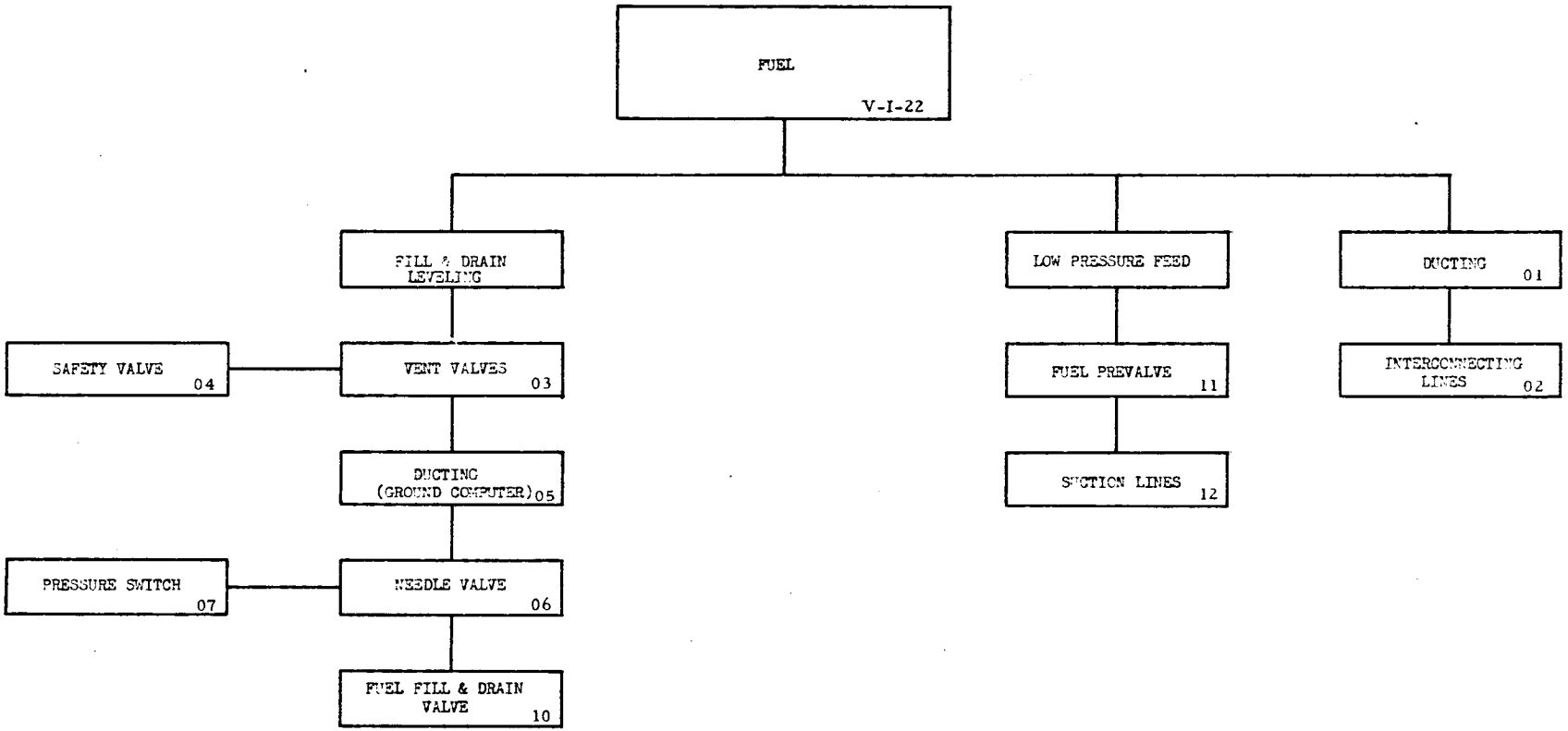
FAILURE EFFECT ANALYSIS



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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Fluid Thermal Switch (V-I-21-05-16)		20M85016	1A10 2A10 3A10 4A10	Indicates if fluid temperature exceeds 200 ± 10 deg. F.	Premature operation.	(A) Temporary loss of one hydraulic system. (B) Possible loss of one hydraulic system. (C) N.A.	(A) Delay. (B) Possible delay. (C) N.A.	(A) Delay. (B) Possible delay. (C) N.A.
					Failure to operate at the prescribed time.	(A) Possible loss of one hydraulic system due to high temp. operation (B) Possible loss of one hydraulic system due to high temp. operation (C) N.A.	(A) Possible delay. (B) Possible loss of one engine control. (C) N.A.	(A) Reschedule. (B) Possible reduced performance. (C) N.A.
Pressure Transducer (V-I-21-05-17)		10480614	1A426 2A425 3A426 4A425	Indicates pressure in reservoir.	Failure during operation 1. Electrical failure.	(A) None, measurement only (B) None, measurement only (C) None, measurement only	(A) None. (B) None. (C) None.	(A) None. (B) None. (C) None.
					2. Rupture	(A) Loss of one hydraulic system. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) Delay. (B) Loss of one engine control. (C) Loss of one engine control.	(A) Delay. (B) Reduced performance. (C) Reduced performance.
Potentiometer (V-I-21-05-18)		18427	N/A	Indicates fluid level in reservoir.	Failure during operation.	(A) None. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.	(A) Possible delay. (B) None. (C) None.
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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Reservoir (V-I-21-05-14)		20M85062	N/A	Receives return fluid from the actuators and supplies inlet fluid to the pump. Provides volume for thermal expansion of fluid.	Failure during operation 1. Rupture	(A) Loss of one hydraulic system. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) Delay. (B) Loss of one engine control. (C) Loss of one engine control.	(A) Reschedule. (B) Reduced performance. (C) Reduced performance.
					2. Fluid leakage.	(A) Probable loss of one hydraulic system. (B) Probable loss of one hydraulic system. (C) Probable loss of one hydraulic system.	(A) Delay. (B) Probable loss of one engine control. (C) Probable loss of one engine control.	(A) Delay. (B) Probable reduced performance. (C) Probable reduced performance.
Low Pressure Relief Valve (V-I-21-05-15)		10480760	N/A	Relieves if low pressure exceeds 100 ± 10 PSIG.	Premature operation.	(A) Temporary loss of one hydraulic system. (B) Possible loss of one hydraulic system. (C) Possible loss of one hydraulic system.	(A) Delay. (B) Possible loss of one engine control. (C) Possible loss of one engine control.	(A) Delay. (B) Possible reduced performance. (C) Possible reduced performance.
					Failure to operate at the prescribed time.	(A) Temporary loss of one hydraulic system. (B) Possible loss of one hydraulic system. (C) Possible loss of one hydraulic system.	(A) Delay. (B) Possible loss of one engine control. (C) Possible loss of one engine control.	(A) Delay. (B) Possible reduced performance. (C) Possible reduced performance.
					Failure to cease operation at the prescribed time.	(A) Temporary loss of one hydraulic system. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) Delay. (B) Possible loss of one engine control. (C) Possible loss of one engine control.	(A) Delay. (B) Possible reduced performance. (C) Possible reduced performance.
					Failure during operation (Rupture)	(A) Temporary loss of one hydraulic system. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) Delay. (B) Loss of one engine control. (C) Loss of one engine control.	(A) Delay. (B) Reduced performance. (C) Reduced performance.
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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Accumulator (V-I-21-05-12)		20M850 62	N/A	Receives and stores high pressure fluid from the pump. Damps out pressure surges.	Failure during operation 1. Rupture.	(A) Loss of one hydraulic system. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) Delay. (B) Loss of one engine control. (C) Loss of one engine control.	(A) Reschedule. (B) Reduced performance. (C) Reduced performance.
					2. Fluid leakage.	(A) Probable loss of one hydraulic system. (B) Probable loss of one hydraulic system. (C) Probable loss of one hydraulic system.	(A) Delay. (B) Probable loss of one engine control. (C) Probable loss of one engine control.	(A) Delay. (B) Reduced performance. (C) Reduced performance.
High Pressure Relief Valve (V-I-21-05-13)		10480869	N/A	Relieves if pressure in accumulator exceeds 3800 ± 100 psig.	Premature operation (Relieves at lower pressure)	(A) Probable temporary loss of one hydraulic system. (B) Possible loss of one hydraulic system. (C) Possible loss of one hydraulic system.	(A) Delay. (B) Possible loss of one engine control. (C) Possible loss of one engine control.	(A) Delay. (B) Reduced performance. (C) Reduced performance.
					Failure to operate at the prescribed time.	(A) Probable temporary loss of one hydraulic system. (B) Possible loss of one hydraulic system. (C) Possible loss of one hydraulic system.	(A) Delay. (B) Possible loss of one engine control. (C) Possible loss of one engine control.	(A) Delay. (B) Reduced performance. (C) Reduced performance.
					Failure to cease operation at the prescribed time. (Jammed open)	(A) Temporary loss of one hydraulic system. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) Delay. (B) Loss of one engine control. (C) Loss of one engine control.	(A) Delay. (B) Reduced performance. (C) Reduced performance.
					Failure during operation (Rupture)	(A) Temporary loss of one hydraulic system. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) Delay. (B) Loss of one engine control. (C) Loss of one engine control.	(A) Delay. (B) Reduced performance. (C) Reduced performance.
						Issue Date: JAN 2 5 1962	Prepared By: M-P&VE-PL	Approved:

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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Motor Thermal Switch (V-I-21-05-9)	*		N/A	Indicates if motor temperature exceeds 325 ± 18°F.	Premature operation.	(A) Temporary loss of checkout of one hydraulic system. (B) N.A. (C) N.A.	(A) Delay. (B) N.A. (C) N.A.	(A) Possible reschedule. (B) N.A. (C) N.A.
					Failure to operate at the prescribed time.	(A) Possible burn-out of motor. (B) N.A. (C) N.A.	(A) Delay. (B) N.A. (C) N.A.	(A) Reschedule. (B) N.A. (C) N.A.
Filter Element (V-I-21-05-10)		10480613	N/A	Removes contamination from hydraulic fluid.	Failure during operation 1. External leakage.	(A) Loss of hydraulic pressure. (B) Loss of hydraulic pressure. (C) Loss of hydraulic pressure.	(A) Delay. (B) Loss of one engine control. (C) Loss of one engine control.	(A) Reschedule. (B) Reduced performance. (C) Reduced performance.
					2. Clogging of element.	(A) None differential pressure indicator shows malfunction. (B) None differential pressure indicator shows malfunction. (C) Possible loss of one hydraulic system.	(A) Delay. (B) Delay. (C) Possible loss of one engine control.	(A) Reschedule. (B) Reschedule. (C) Reduced performance
Differential Pressure Indicator (V-I-21-05-11)		10480612	N/A	Indicates if differential pressure across filter element exceeds 80 ± 10 psig.	Premature operation.	(A) Delay. (B) Delay. (C) N.A.	(A) Delay. (B) Delay. (C) N.A.	(A) Delay. (B) Possible reschedule. (C) N.A.
					Failure to operate at the prescribed time.	(A) Possible loss of one hydraulic system for checkout. (B) Possible loss of hydraulic pressure. (C) N.A.	(A) Delay. (B) Possible loss of one engine control. (C) N.A.	(A) Reschedule. (B) Reduced performance. (C) N.A.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved: [illegible]

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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Auxiliary Hydraulic Pump (V-I-21-05-7)	*	20M85064	N/A	Provides high pressure fluid for gimbaling check-out.	Failure to operate at prescribed time.	(A) Loss of check-out capability for one engine. (B) Loss of initial hydraulic pressure. (C) N.A.	(A) Delay. (B) None. (C) N.A.	(A) Reschedule. (B) None. (C) N.A.
					Failure during operation 1. Internal malfunction.	(A) Loss of check-out capability for one engine. (B) Loss of initial hydraulic pressure. (C) N.A.	(A) Delay. (B) None. (C) N.A.	(A) Reschedule. (B) None. (C) N.A.
					2. External rupture.	(A) Loss of check-out capability for one engine. (B) Loss of one hydraulic system. (C) N.A.	(A) Delay. (B) Loss of one engine control. (C) N.A.	(A) Reschedule. (B) Reduced performance. (C) N.A.
Check Valve -Auxiliary Pump. (V-I-21-05-8)		10480615-1	N/A	Prevents reverse flow to pump.	Failure to operate at the prescribed time (does not prevent reverse flow).	(A) N.A. (B) None. (C) None.	(A) N.A. (B) None. (C) None.	(A) N.A. (B) None. (C) None.
					Failure during operation 1. Rupture	(A) Loss of checkout of one hydraulic system. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) Delay. (B) Loss of one engine control. (C) Loss of one engine control.	(A) Reschedule. (B) Reduced performance. (C) Reduced performance vehicle controlled by 3 engines.
					2. Jammed closed.	(A) Loss of checkout of one hydraulic system. (B) Loss of initial press. on one hydraulic system. (C) N.A.	(A) Delay. (B) None. (C) N.A.	(A) Reschedule. (B) None. (C) N.A.
						Issue Date: JAN 25	Prepared By: M-P&VE-PL	Approved:

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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Check Valve (Main Pump) (V-I-21-05-4)		10480615-2	N/A	Prevents reverse flow to pump.	Failure to operate at the prescribed time (does not prevent reverse flow).	(A) Possible loss of one hydraulic system. (B) N.A. (C) N.A.	(A) Delay. (B) N.A. (C) N.A.	(A) Reschedule. (B) N.A. (C) N.A.
					Failure during operation. 1. Rupture	(A) Loss of one hydraulic system. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) Delay. (B) One engine without control. (C) One engine without control.	(A) Reschedule. (B) Reduced performance. (C) Reduced performance.
					2. Jammed open.	(A) Possible loss due to main pump damage. (B) None. (C) None.	(A) Possible one engine without control. (B) None. (C) None.	(A) Possible reduced performance. (B) None. (C) None.
Quick Disconnect Nipples (V-I-21-05-5)	*	10415554	N/A	Provide connections for filling and purging system	Failure to operate at the prescribed time (during filling).	(A) Delay. (B) N.A. (C) N.A.	(A) Delay. (B) N.A. (C) N.A.	(A) Delay. (B) N.A. (C) N.A.
Low Pressure Purging Return Nipple (V-I-21-05-6)	*	10415555	N/A	Used to drain system.	Failure during operation.	(A) Delay. (B) N.A. (C) N.A.	(A) Delay. (B) N.A. (C) N.A.	(A) Delay. (B) N.A. (C) N.A.
					Leak (Failed to stay closed)	(A) Delay. (B) Possible loss of one hydraulic system. (C) Possible loss of one hydraulic system.	(A) Delay. (B) Shutdown. (C) Possible loss of one engine control.	(A) Delay (B) Reschedule. (C) Possible reduced performance.
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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Servo Actuators (V-I-51) (V-I-52)		N/A	1A12 2A12 3A12 4A12	Provide forces for Engine movement in response to input signals.	Premature operation or failure to cease operation at prescribed time.	(A) Temporary loss of engine control. (B) Temporary loss of engine control. (C) Loss of control of one Outboard engine.	(A) Possible delay. (B) Delay. (C) Reduced performance. (3 engines left for control)	(A) Possible delay. (B) Reschedule. (C) Reduced performance. (3 engines left for control)
					Failure to operate at the prescribed time.	(A) Temporary loss of engine control. (B) Temporary loss of engine control. (C) Loss of control of one Outboard engine.	(A) Possible delay. (B) Delay. (C) Reduced performance. (3 engines left for control)	(A) Possible delay. (B) Reschedule. (C) Reduced performance. (3 engines left for control)
					Failure during operation.	(A) Temporary loss of engine control. (B) Temporary loss of engine control. (C) Loss of control of one Outboard engine.	(A) Possible delay. (B) Delay. (C) Reduced performance. (3 engines left for control)	(A) Possible delay. (B) Reschedule. (C) Reduced performance. (3 engines left for control)
Ducting (V-I-21-05-1)				Provides passage for hydraulic fluid.	Failure during operation.	(A) N.A. (B) Loss of control of one engine. (C) Loss of control of one engine.	(A) N.A. (B) Shutdown. (C) Reduced performance.	(A) N.A. (B) Reschedule. (C) Reduced performance vehicle controlled by 3 engines.
Main Hydraulic Pump (V-I-21-05-2)		20M85035	N/A	Provides high pressure fluid to actuators for engine gimbaling during flight.	Failure to operate at the prescribed time.	(A) N.A. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) N.A. (B) One engine without control. (C) One engine without control.	(A) N.A. (B) Reduced performance. (C) Reduced performance vehicle controlled by 3 engines.
					Failure during operation (assuming loss of flow and pressure).	(A) N.A. (B) Loss of one hydraulic system. (C) Loss of one hydraulic system.	(A) N.A. (B) One engine without control. (C) One engine without control.	(A) N.A. (B) Reduced performance. (C) Reduced performance vehicle controlled by 3 engines.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved:

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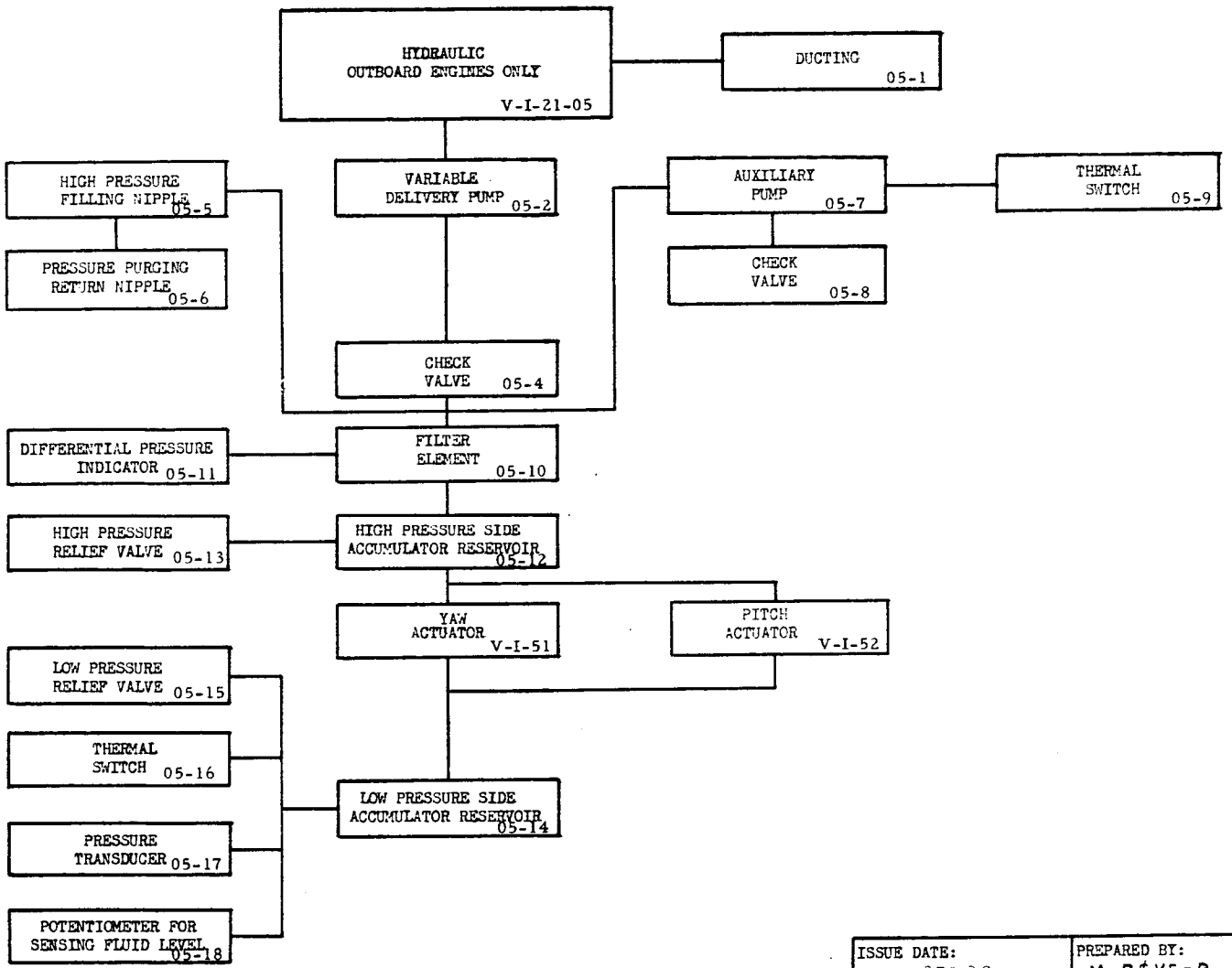
FAILURE EFFECT ANALYSIS



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SEP 28 '85	M-P&VE-P	

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Heat Exchanger (Inboard and Outboard) (V-I-21-04-1)		10438000	N/A	Converts LOX to GOX for LOX Tank pressurization.	Failure during operation 1. Leak	(A) N.A. (B) Reduced performance of LOX pressurization. (C) Reduced performance of LOX pressurization.	(A) N.A. (B) Possible reduced performance. (C) Possible reduced performance.	(A) N.A. (B) Possible reduced performance. (C) Possible reduced performance.
					2. Rupture	(A) N.A. (B) Reduced performance of LOX pressurization and possible fire hazard. (C) Reduced performance of LOX pressurization and possible fire hazard.	(A) N.A. (B) Possible shutdown. (C) Reduced performance and POSSIBLE LOSS, fire hazard.	(A) N.A. (B) Possible reschedule. (C) Reduced performance and POSSIBLE LOSS, fire hazard.
Ducting (V-I-21-04-2)		306168	N/A	Directs turbine exhaust gases to Heat Exchanger.	Failure during operation Leak	(A) N.A. (B) Fire hazard. (C) Fire hazard.	(A) N.A. (B) Fire detection cut-off. (C) POSSIBLE LOSS, fire damage to associated hardware.	(A) N.A. (B) Reschedule. (C) POSSIBLE LOSS, tail fire in S-1 stage.
Aspirator (V-I-21-04-3)		202000	N/A	Expells turbine exhaust gases via thrust chamber.	Failure during operation Leak.	(A) N.A. (B) Possible fire hazard. (C) Possible fire hazard.	(A) N.A. (B) Possible fire hazard. (C) Possible fire hazard.	(A) N.A. (B) Possible fire hazard. (C) Possible fire hazard.
Ducting to Atmosphere (V-I-21-06-1)			N/A		Failure during operation Leak	(A) N.A. (B) Fire hazard. (C) Fire hazard.	(A) N.A. (B) Fire detection cut-off. (C) POSSIBLE LOSS, fire damage to associated hardware.	(A) N.A. (B) Reschedule. (C) POSSIBLE LOSS, tail fire in S-I stage.
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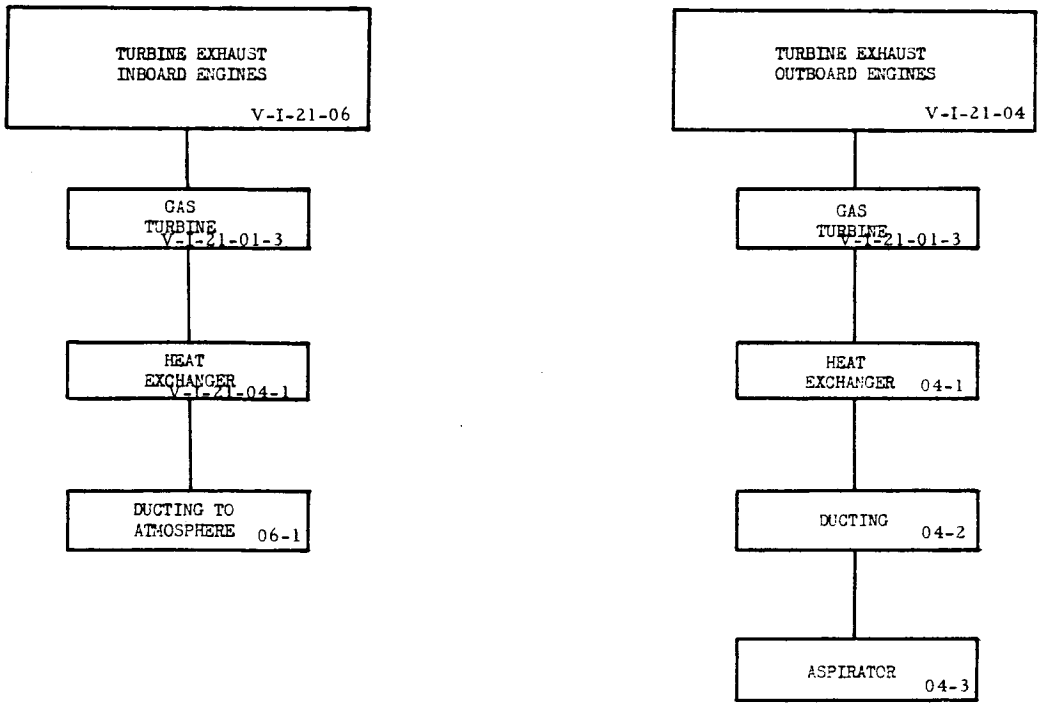
FAILURE EFFECT ANALYSIS



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**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Continued Check Valve (V-1-21-03-5)					Failure during operation. Fail closed	(A) N.A. (B) Reduces performance of LOX pressurization. (C) Reduces performance of LOX pressurization.	(A) N.A. (B) Possible shutdown. (C) Reduced performance.	(A) N.A. (B) Possible dealy. (C) Reduced performance.
Orifice (V-I-21-03-7)		10438376	N/A	Meters LOX flow to Heat Exchanger.	Failure during operation partially plugged.	(A) None redundancy provided. (B) None redundancy provided. (C) None redundancy provided.	(A) None redundancy provided. (B) None redundancy provided. (C) None redundancy provided.	(A) None redundancy provided. (B) None redundancy provided. (C) None redundancy provided.
Orifice (LOX Gas Generator) (V-I-21-03-9)		600929-5	N/A	Regulate LOX flow to gas generator.	Failure during operation partially plugged.	(A) N.A. (B) Loss of one engine. (C) Loss of one engine.	(A) N.A. (B) Shutdown. (C) Reduced performance.	(A) N.A. (B) Reschedule (C) Reduced performance.

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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Ducting (V-I-21-03-1)				Provides passage for high pressure LOX.	Failure during operation 1. Leak	(A) None for small leakage (B) None for small leakage (C) Performance shift in G.G. system	(A) Possible delay (B) None for small leakage (C) Reduced performance	(A) Possible delay (B) None for small leakage (C) Reduced perforance
					2. Rupture	(A) Delay. (B) Engine cut-off. (no thrust O.K.) (C) Engine cut-off by thrust O.K. switch.	(A) Delay. (B) Shutdown. (C) Reduced performance.	(A) Delay. (B) Reschedule. (C) Reduced performance.
Orifice (V-I-21-03-2)		402510	N/A	Meters propellant to thrust chamber.	Partially plugged.	(A) N.A. (B) Reduced performance. (C) Reduced performance.	(A) N.A. (B) Reduced performance. (C) Reduced performance.	(A) N.A. (B) Reduced performance. (C) Reduced performance.
Main LOX Valve (MLV) (V-I-21-03-4)		403835	1A4 2A4 3A4 4A4 5A4 6A4 7A4 8A4	Admits LOX to thrust chamber and gas generator.	Failure to operate at prescribed time.	(A) N.A. (B) No engine ignition no thrust commit. (C) N.A.	(A) N.A. (B) Shutdown. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
					Failure to cease operation at prescribed time.	(A) N.A. (B)&(C) Engine will be cut off by pre-valve closing.	(A) N.A. (B) Shutdown. (C) Reduced flight performance.	(A) N.A. (B) Reschedule. (C) Reduced flight performance.
					Leakage, external	(A) None for small leakage (B) None for small leakage (C) None for small leakage	(A) None for small leakage (B) None for small leakage (C) None for small leakage	(A) None for small leakage (B) None for small leakage (C) None for small leakage
					Failure during operation.	(A) N.A. (B) Loss of an engine. (C) Loss of an engine.	(A) N.A. (B) Shutdown. (C) Reduced performance.	(A) N.A. (B) Reschedule. (C) Reduced performance.
Check Valve (V-I-21-03-5)		NA5-26032-T2	N/A	Prevents back flow of LOX from heat exchanger to combustion chamber at cut off.	Failure to operate at prescribed time.	(A) N.A. (B) Severe engine chugging possible hardware damage (C) Severe engine chugging possible hardware damage	(A) N.A. (B) Shutdown (C) Abnormal thrust decay	(A) N.A. (B) Reschedule (C) Abnormal thrust decay

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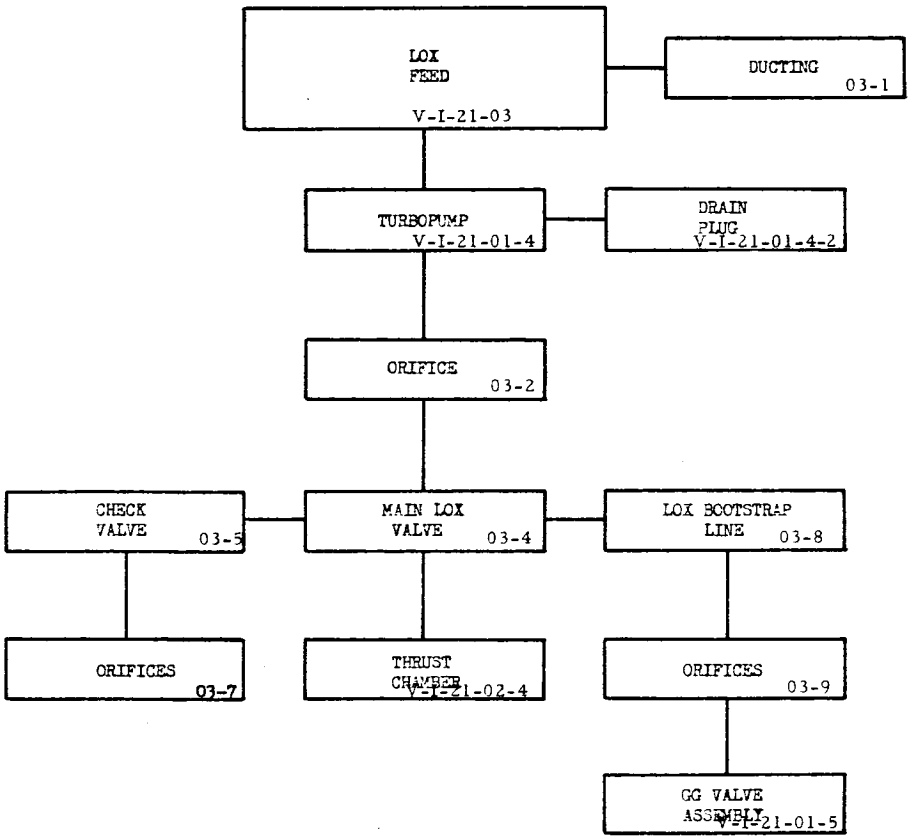
FAILURE EFFECT ANALYSIS



ISSUE DATE: SEP 23 1961	PREPARED BY: M-P&VE-P	APPROVED:

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Drain Plug (V-I-21-02-23) 8 required.	*	AN 814-46	N/A	Drain for main fuel valve.	Failure during operation 1. Leak	(A) N.A. (B) Possible fire hazard. (C) Possible fire hazard.	(A) N.A. (B) Possible fire detection cut-off. (C) Possible fire hazard.	(A) N.A. (B) Possible reschedule. (C) Possible fire hazard.
Drain Plug (V-I-21-02-24) 32 required.	*	NS 48143	N/A	Drain for fuel jacket.	Failure during operation. 1. Leak	(A) N.A. (B) None for small leakage (C) None for small leakage	(A) N.A. (B) None for small leakage (C) None for small leakage	(A) N.A. (B) None for small leakage (C) None for small leakage

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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Orifice (V-I-21-02-19)		NA5-26563	N/A	Controls flow of hypergol and igniter fuel to thrust chamber.	Failure during operation (plugged up)	(A) N.A. (B) Loss of one engine (no thrust chamber ignition) (C) N.A.	(A) N.A. (B) Shutdown. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
Ignition Monitor Valve (V-I-21-02-20)		554838	N/A	Provides a fail safe start senses combustion pressure and then allows high pressure control fuel to open MFV.	Failure to operate at prescribed time.	(A) N.A. (B) Loss of one engine MFV does not open. (C) N.A.	(A) N.A. (B) Shutdown. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
					Failure during operation	(A) N.A. (B) Loss of engine. (C) Loss of engine.	(A) N.A. (B) Shutdown. (C) Reduced performance.	(A) N.A. (B) Reschedule. (C) Reduced performance.
					Leak severe	(A) None (to be corrected during checkout) (B) Possible loss of engine (C) Possible loss of engine possible fire hazard.	(A) None. (B) Possible shutdown. (C) Possible reduced performance, possible fire hazard.	(A) None. (B) Possible reschedule. (C) Possible reduced performance, possible fire hazard.
Orifice (V-I-21-02-21)		305189	N/A	Controls opening and closing time of MLV.	Failure during operation.	(A) N.A. (B) Possible loss of one engine. (C) N.A.	(A) N.A. (B) Shutdown. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
Main LOX Valve Control (Part of MLV) (V-I-21-02-22) 8 required.		403835	1A4 2A4 3A4 5A4 6A4 7A4 8A4	Opens and closes MLV using high pressure fuel as the medium.	Failure to operate at the prescribed time.	(A) N.A. (B) Loss of engine no MLV opening. (C) N.A.	(A) N.A. (B) Shutdown. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
					Failure to cease operation at prescribed time.	(A) N.A. (B) N.A. (C) Cut-off initiated by prevalve.	(A) N.A. (B) N.A. (C) Cut-off not as predicted.	(A) N.A. (B) N.A. (C) Performance effected.
					Failure during operation.	(A) N.A. (B) Loss of engine. (C) Loss of engine.	(A) N.A. (B) Shutdown. (C) Reduced performance.	(A) N.A. (B) Reschedule. (C) Reschedule.
					Leak, external.	(A) None to be corrected. (B) Possible loss of control pressure and eng. (C) Possible loss of eng.	(A) Possible delay. (B) Possible shutdown, possible fire hazard. (C) Reduced performance.	(A) Possible delay. (B) Possible reschedule possible fire hazard. (C) Reduced performance.
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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Continued Filter (FABU to turbopump Gearbox) (V-I-21-02-15)					Leakage, external	(A) None (to be corrected) (B) None, for small leak. (C) None, for small leak.	(A) None (B) Possible fire hazard. (C) Possible fire hazard.	(A) None (B) Possible fire hazard. (C) Possible fire hazard.
Check Valve (Lube Drain) (V-I-21-02-16)		554359	N/A	Allows pressurization of gearbox	Failure during operation Fail open	(A) None (B) None (C) Loss of gearbox pressure.	(A) Delay (B) None (C) Possible loss of one engine.	(A) Delay (B) None (C) Reduced performance.
					Fail closed	(A) Over press. of gearbox (B) None (C) Probable loss of engine	(A) Delay (B) None (C) Reduced performance.	(A) Delay (B) None (C) Reduced performance.
Sequence Valve (V-I-21-02-17)		401340	1A5 2A5 3A5 4A5 5A5 6A5 7A5 8A5	Allows high pressure control fuel to pass to IMV and hypergol container.	Failure to operate at the prescribed time.	(A) N.A. (B) No engine sequence no ignition. (C) N.A.	(A) N.A. (B) Shutdown. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
					Failure during operation.	(A) N.A. (B) Loss of engine. (C) Loss of engine.	(A) N.A. (B) Shutdown. (C) Reduced performance.	(A) N.A. (B) Reschedule. (C) Reduced performance.
					Leak, external	(A) None (to be corrected) (B) Possible fire hazard. (C) Possible fire hazard.	(A) None. (B) Possible shutdown. (Fire detection devices) (C) Possible fire hazard.	(A) None. (B) Reschedule. (C) Possible fire hazard.
Hypergol Container (V-I-21-02-18)	*	600833	1A7 2A7 3A7 4A7 5A7 6A7 7A7 8A7	High pressure fuel burst diaphrams and hypergol (tea) and igniter fuel flows to thrust chamber through this container.	Failure of hypergol to operate at the prescribed time.	(A) N.A. (B) Loss of one engine no ignition. (C) N.A.	(A) N.A. (B) Shutdown. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
					Failure of container during operation.	(A) N.A. (B) Loss of an engine. (C) Possible loss of engine	(A) N.A. (B) Shutdown. (C) Reduced performance	(A) N.A. (B) Reschedule. (C) Reduced performance
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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Continued Conax Valve (V-I-21-02-11)					Leak, external. severe	(A) None (to be corrected) (B) Engine control pressure lost, fire hazard. (C) Engine control pressure lost, fire hazard.	(A) None. (B) Shutdown. (C) Reduced performance and possible fire hazard.	(A) None (B) Reschedule. (C) Reduced performance and possible fire hazard.
Coupling Half (V-I-21-02-12)	*	340234	N/A	Allows for fuel drainage upstream of the fuel additive blender unit.	Failure to close after operation, leakage.	(A) None (to be corrected) (B) Possible loss of an engine and possible fire hazard. (C) Possible loss of an engine and possible fire hazard.	(A) Possible delay. (B) Shutdown. (C) Reduced performance POSSIBLE LOSS, fire hazard.	(A) Possible delay. (B) Reschedule. (C) Reduced performance POSSIBLE LOSS, fire hazard.
Fuel Additive Blender Unit (V-I-21-02-13)		454075	1A3 2A3 3A3 4A3 5A3 6A3 7A3 8A3	Mixes high pressure fuel and oronite and furnishes this lubricant to the turbopump gearcase.	Temperature above or below Red line value.	(A) None, environment requirement must be met. (B) N.A. (C) N.A.	(A) Delay. (B) N.A. (C) N.A.	(A) Delay. (B) N.A. (C) N.A.
					Failure to operate at prescribed time.	(A) N.A. (B) N.A. (C) Loss of one engine	(A) N.A. (B) N.A. (C) Reduced performance	(A) N.A. (B) N.A. (C) Reduced performance
					Failure during operation.	(A) N.A. (B) None engine. (C) Possible loss of one engine.	(A) N.A. (B) None (C) Reduced performance.	(A) N.A. (B) None (C) Reduced performance.
Coupling Half (FABU) (V-I-21-02-14)	*	340234-8	N/A	Fill FABU	Failure during operation. Leak, external	(A) N.A. (B) None (C) Possible gear or bearing failure	(A) N.A. (B) None (C) POSSIBLE LOSS, explosion hazard.	(A) N.A. (B) None (C) POSSIBLE LOSS, explosion hazard.
Filter (FABU to turbopump Gearbox) (V-I-21-02-15)		NA5-26278	N/A	Filter lubricant to turbopump gearcase.	Failure during operation.	(A) N.A. (B) None (C) Reduced lubrication hot gearbox, loss of an engine.	(A) N.A. (B) None (C) POSSIBLE LOSS, explosion hazard.	(A) N.A. (B) None (C) POSSIBLE LOSS, explosion hazard.

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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Coupling Half (V-I-21-02-8)	*	340206-8	N/A	Used to pre-fill thrust chamber.	Leak	(A) None (to be corrected) (B) Loss of an engine and fire hazard. (C) Loss of an engine and fire hazard.	(A) Possible delay. (B) Shutdown, thrust OK switch or fire detection device. (C) Reduced performance POSSIBLE LOSS, due to fire hazard.	(A) Possible delay. (B) Reschedule. (C) Reduced performance POSSIBLE LOSS, due to fire hazard.
Hand Valve (Thrust OK) (V-I-21-02-9)	*	10414076	N/A	Calibration and checkout of thrust OK switch prior to firing.	Left in closed position after check.	(A) None (to be corrected) (B) No thrust commit. (C) N.A.	(A) Possible delay. (B) Shutdown. (C) N.A.	(A) Possible delay. (B) Reschedule. (C) N.A.
Thrust OK Pressure Switch (V-I-21-02-10)		20M50242	1A11 2A11 3A11 4A11 5A11 6A11 7A11 8A11	Monitor fuel pump outlet pressure during mainstage and give cut-off signal when pressure drops below a given value.	Failure to operate at prescribed time (Thrust OK)	(A) N.A. (B) Thrust commit will not occur. (C) N.A.	(A) N.A. (B) Shutdown. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
					Fail to signal Pc decay.	(A) N.A. (B) Possible loss of one engine and explosion hazard. (C) Possible loss of one engine and explosion hazard.	(A) N.A. (B) POSSIBLE LOSS, due to malfunctioning engine exploding. (C) POSSIBLE LOSS, due to malfunctioning engine exploding.	(A) N.A. (B) POSSIBLE LOSS, due to malfunctioning engine exploding. (C) POSSIBLE LOSS, due to malfunctioning engine exploding.
					Failure during operation Leak	(A) N.A. (B) Engine shutoff. (C) Engine shutoff possible fire hazard.	(A) N.A. (B) Shutdown. (C) Reduced performance possible fire hazard	(A) N.A. (B) Reschedule. (C) Reduced performance possible fire hazard.
Conax Valve (V-I-21-02-11)		NA5-26594	1A8 2A8 3A8 4A8 5A8	Admits high pressure fuel to closing side of MLV upon actuation.	Premature operation	(A) None, replace valve. (B) No engine ignition. (C) Loss of an engine.	(A) Delay. (B) Shutdown. (C) Reduced performance due to one engine out.	(A) Delay. (B) Reschedule. (C) Reduced performance due to one engine out.
					Failure to operate at prescribed time.	(A) N.A. (B) Delayed emergency shutdown. (C) Delayed flight cut-off	(A) N.A. (B) Shutdown. (C) Engine cut-off by pre-valves.	(A) N.A. (B) Reschedule. (C) Reduced flight performance.
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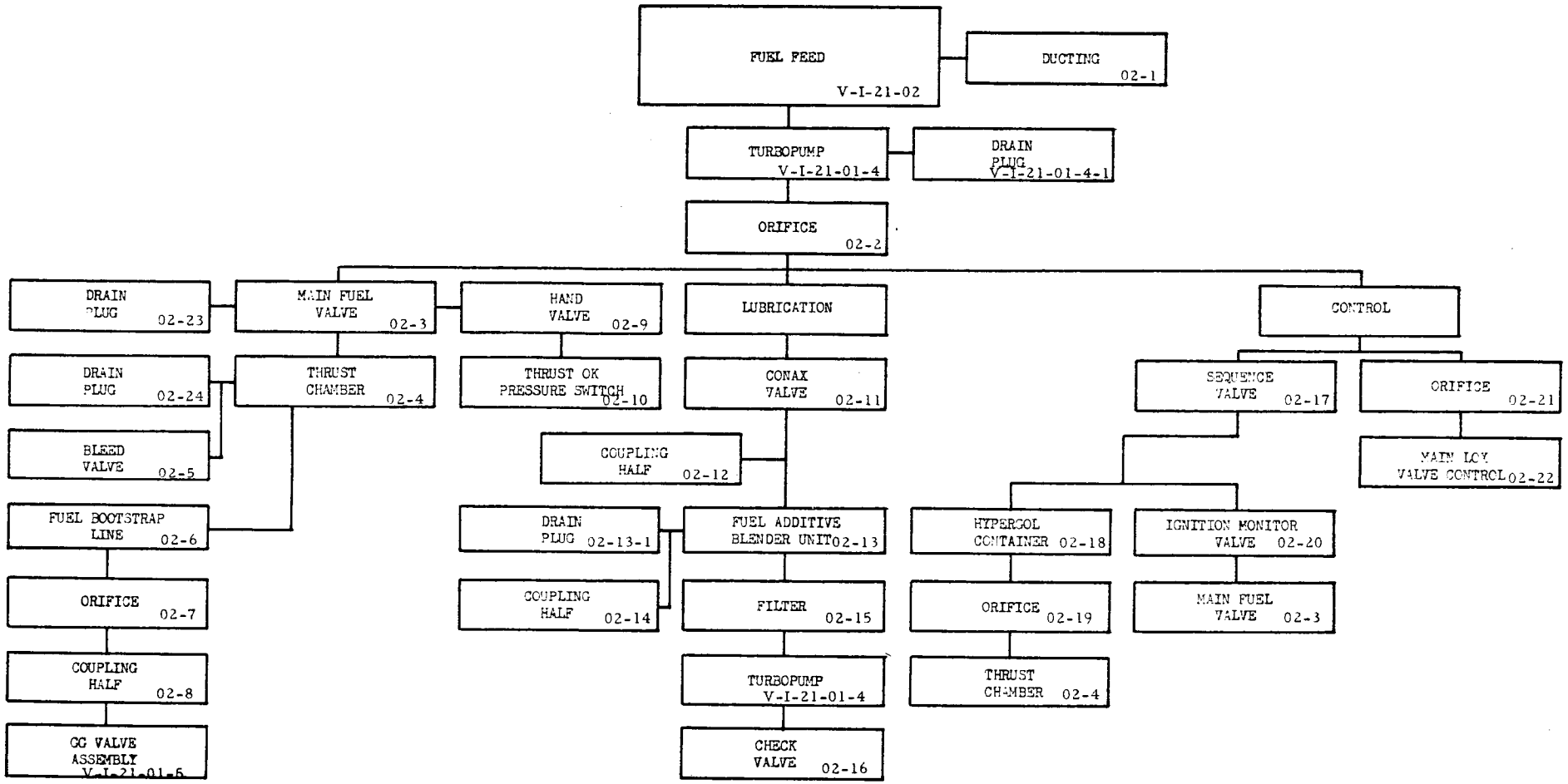
FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Ducting (V-I-21-02-1)				Provides passage for high pressure fuel.	Failure during operation 1. Leak	(A) N.A. (B) None for small leak. (C) None for small leak	(A) N.A. (B) Possible fire hazard. (C) Possible fire hazard.	(A) N.A. (B) Possible fire hazard. (C) Possible fire hazard.
					2. Rupture	(A) N.A. (B) Engine shutdown. (C) Engine shutdown.	(A) N.A. (B) Shutdown, possible fire hazard. (C) Reduced performance, possible fire hazard.	(A) N.A. (B) Reschedule, possible fire hazard. (C) POSSIBLE LOSS, due to fire hazard.
Orifice (V-I-21-02-2)		401883-3	N/A	Meters propellant to thrust chamber.	Partially plugged.	(A) N.A. (B) Reduced performance. (C) Reduced performance.	(A) N.A. (B) Reduced performance. (C) Reduced performance.	(A) N.A. (B) Reduced performance. (C) Reduced performance.
Main Fuel Valve (MFV) (V-I-21 -02-3)		405224	1A19 2A19 3A19 4A19 5A19 6A19 7A19 8A19	Admits high pressure fuel to thrust chamber and gas generator.	Failure to operate at the prescribed time.	(A) N.A. (B) Loss of an engine. (C) N.A.	(A) N.A. (B) Shutdown. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
					Failure during operation 1. Leak, external	(A) N.A. (B) Fire hazard. (C) Fire hazard.	(A) N.A. (B) Possible fire detection cut-off. (C) POSSIBLE LOSS, fire.	(A) N.A. (B) Possible reschedule. (C) POSSIBLE LOSS, fire.
					2. Close premature	(A) N.A. (B) Loss of an engine. Hardware damage (C) Loss of an engine.	(A) N.A. (B) Shutdown. (C) Reduced performance, fuel depletion possible fire hazard.	(A) N.A. (B) Reschedule, possible fire hazard. (C) Reduced performance and possible fire hazard.
Thrust Chamber (V-I-21-02-4)		201994	N/A	Main combustion chamber.	Failure during operation.	(A) N.A. (B) Loss of an engine. (C) Loss of an engine.	(A) N.A. (B) Shutdown. (C) Reduced performance.	(A) N.A. (B) Reschedule. (C) Reduced performance.
Bleed Valve (V-I-21-02-5)	*	553920	N/A	Bleed air from chamber during pre-fill operation.	Leak, external caused by improper closing.	(A) N.A. (B) Fire hazard. (C) Fire hazard.	(A) N.A. (B) Possible shutdown. (C) Reduced performance.	(A) N.A. (B) Possible reschedule. (C) Reduced performance.
Orifice (V-I-21-02-7)		402520	N/A	Regulates fuel flow to gas generator.	Partially plugged	(A) N.A. (B) Loss of an engine. (C) Loss of an engine.	(A) N.A. (B) Shutdown, no thrust commit. (C) Reduced performance.	(A) N.A. (B) Reschedule. (C) Reduced performance.
						Issue Date: JAN 2 5 1962	Prepared By: M-P&VE-PL	Approved:

S&M Form #203 (August 1961)(OT)

FAILURE EFFECT ANALYSIS



ISSUE DATE:	PREPARED BY:	APPROVED:
SEP 29 [illegible]	M-P & VE-P	

**Items marked thus (*) do not operate in flight

FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Fuel Pump Volute Drain Plug. (V-I-21-01-4-1)		AN-814	N/A	Covers drain hole.	Failure during operation 1. Leak, external	(A) N.A. (B) Fire Hazard. (C) Fire Hazard.	(A) N.A. (B) Fire Detection cut-off (C) POSSIBLE LOSS, fire.	(A) N.A. (B) Reschedule. (C) POSSIBLE LOSS, fire.
LOX Pump Drain Plug. (V-I-21-01-4-2)		AN-814	N/A	Covers Drain Hole.	Failure during operation 1. Leak, external	(A) N.A. (B) None for small leakage (C) None for small leakage	(A) N.A. (B) None for small leakage (C) None for small leakage	(A) N.A. (B) None for small leakage (C) None for small leakage
Gas Generator Valve Assembly (Yoke Valve) (V-I-21-01-5)		307675	N/A	Controls the supply of propellants to gas generator combustion chamber	Failure to operate at prescribed time. 1. Excessive fuel lead	(A) NA (B) Hardware damage loss of an engine. (C) NA	(A) NA (B) Shutdown by thrust OK Switch possible fire caused by cracked GG (C) NA	(A) NA (B) Reschedule (C) NA
					2. Excessive LOX lead	(A) NA (B) Turbine blades erode loss of an engine (C) NA	(A) NA (B) Shut down by thrust OK switch (C) NA	(A) NA (B) Reschedule (C) NA
					3. Valve does not open fully.	(A) NA (B) Engine cut-off due to low performance. (C) NA	(A) NA (B) Shutdown (C) NA	(A) NA (B) Reschedule (C) NA
					Failure during operation 1. Leak (External)	(A) NA (B) Fire Hazard (C) Fire Hazard	(A) NA (B) Fire detection cutoff (C) POSSIBLE LOSS, Fire	(A) NA (B) Reschedule (C) POSSIBLE LOSS, Fire
					2. Close Premature	(A) NA (B) Loss of an engine (C) Loss of an engine	(A) NA (B) Shutdown, by thrust OK switch (C) Reduced performance	(A) NA (B) Reschedule (C) Reduced performance
					3. Bootstrap line break	(A) NA (B) Engine cut-off possible hardware damage (C) Loss of one engine	(A) NA (B) Shutdown (C) Reduced performance	(A) NA (B) Reschedule (C) Reduced performance

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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Turbopump (V-I-21-01-4) (Fuel Pump)		454105	1A1 2A1 3A1 4A1 5A1 6A1 7A1 8A1	Supplies high pressure fuel to the thrust chamber gas generator, and control system.	Failure during operation 1. Leak, external.	(A) N.A. (B) Possible loss of an engine. (C) Possible loss of an engine.	(A) N.A. (B) Shutdown, thrust OK switch. (C) Shutdown, thrust OK switch.	(A) N.A. (B) Reschedule. (C) Reduced performance possible fire hazard.
					2. Rupture	(A) N.A. (B) Loss of an engine. (C) Loss of an engine.	(A) N.A. (B) Shutdown possible loss of other engines due to rupture. (C) Reduced performance. Possible loss of other engines due to rupture.	(A) N.A. (B) Reschedule. (C) POSSIBLE LOSS, fire hazard.
(Gearbox)				Transmits power from turbine to pumps.	Failure during operation 1. Leak, external.	(A) N.A. (B) None for small leakage. (C) None for small leakage.	(A) N.A. (B) None for small leakage. (C) None for small leakage.	(A) N.A. (B) None for small leakage. (C) None for small leakage.
					2. Gear Break ; bearing failure ; failure of quill shaft	(A) N.A. (B) Loss of an engine. (C) Loss of an engine.	(A) N.A. (B) Shutdown. (C) Reduced performance.	(A) N.A. (B) Reschedule. (C) Reduced performance.
(LOX Pump)				Provides high pressure LOX to the thrust chamber, gas generator and Heat Exchanger.	Failure during operation 1. Leak	(A) N.A. (B) None for small leakage. (C) None for small leakage.	(A) N.A. (B) None for small leakage (C) None for small leakage	(A) N.A. (B) None for small leakage. (C) None for small leakage.
					2. Rupture	(A) N.A. (B) Loss of an engine. (C) Loss of an engine.	(A) N.A. (B) Shutdown. (C) Reduced Performance.	(A) N.A. (B) Reschedule. (C) Reduced Performance.
					3. Contamination of LOX side and internal seal leak.	(A) None (to be corrected) (B) Possible loss of one engine (C) Possible loss of one engine	(A) Delay engine must be cleaned. (B) PROBABLE LOSS, explosion. (C) PROBABLE LOSS, explosion.	(A) Delay engine must be cleaned. (B) PROBABLE LOSS, explosion. (C) PROBABLE LOSS, explosion.
						Issue Date: [illegible] 1962	Prepared By: M-P&VE-PL	Approved: [illegible]

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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Combustor Assembly (Conisphere) (V-I-21-01-2)		307350	N/A	Delivers combustion gases for turbine drive.	Failure during operation 1. Leak (Small)	(A) N.A. (B) Possible loss of one engine. (C) Hot gas may damage associated hardware.	(A) N.A. (B) Possible fire detection cut-off. (C) POSSIBLE LOSS, hot gas leakage affecting vital parts.	(a) N.A. (B) Possible reschedule. (C) POSSIBLE LOSS, hot gas leakage affecting vital parts.
					2. Rupture	(A) N.A. (B) Hardware damage, loss of engine. (C) Loss of an engine and fire in engine compartment.	(A) N.A. (B) Shutdown. POSSIBLE LOSS, due to rupture. (C) Reduced performance PROBABLE LOSS, due to fire hazard.	(A) N.A. (B) Reschedule, POSSIBLE LOSS, due to rupture. (C) Reduced performance PROBABLE LOSS, due to fire in engine compartment.
Gas Turbine (Part of Turbopump) (V-I-21-01-3)		454100	N/A	Furnishes power to LOX and fuel pumps; drives hydraulic pump.	Failure during operation 1. Leak (Small)	(A) N.A. (B) Fire detection cut-off (C) Loss of an engine.	(A) N.A. (B) Shutdown, reschedule. (C) POSSIBLE LOSS, fire.	(A) N.A. (B) Reschedule. (C) POSSIBLE LOSS, fire.
					2. Rupture (and/or parts breakage)	(A) N.A. (B) Hardware damage, loss of engine. (C) Loss of engine, system effected depending on amount of damage.	(A) N.A. (B) Shutdown POSSIBLE LOSS, due to rupture or parts breaking apart. (C) Reduced performance POSSIBLE LOSS, due to rupture or parts breaking apart.	(A) N.A. (B) Reschedule, POSSIBLE LOSS, due to rupture or parts breaking apart. (C) Reduced performance POSSIBLE LOSS, due to rupture or parts breaking apart.
						Issue Date: JAN 2 5 1962	Prepared By: M-P&VE-PL	Approved: [illegible]

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FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
500V Initiator (Turbine Spinner) 16 required. (V-I-21-01-1-1)	(*)	NA5-26737	N/A	Ignites Turbine Spinner	Premature operation	(A) One engine starts. (B) N.A. (C) N.A.	(A) Engine must be cleaned and SPGG replaced. (B) N.A. (C) N.A.	(A) Reschedule (B) N.A. (C) N.A.
					Failure to operate at prescribed time.	(A) N.A. (B) None redundancy provided. (C) N.A.	(A) N.A. (B) None redundancy provided. (C) N.A.	(A) N.A. (B) None redundancy provided. (C) N.A.
					Failure after operation. (Leakage)	(A) N.A. (B) Fire detection cut-off (C) Hot gas may damage assiciated hardware.	(A) N.A. (B) Fire dectection cut-off (C) POSSIBLE LOSS due to hot gas leakage affecting vital hardware.	(A) N.A. (B) Reschedule. (C) POSSIBLE LOSS due to hot gas leakage affecting vital hardware.
Gas Generator Igniter (16 required). (V-I-21-01-1-2)	(*)	651139	N/A	Supports Combustion in conisphere at ignition.	Premature operation.	(A) None Igniter must be replaced. (B) N.A. (C) N.A.	(A) Delay while Igniter is replaced. (B) N.A. (C) N.A.	(A) Delay while Igniter is replaced. (B) N.A. (C) N.A.
					Failure to operate at prescribed time and failure during operation.	(A) N.A. (B) None redundancy provided. (C) N.A.	(A) N.A. (B) None redundancy provided. (C) N.A.	(A) N.A. (B) None redundancy provided. (C) N.A.
					Failure after operation. (Leakage).	(A) N.A. (B) Fire detection cut-off (C) Hot gas may damage associated hardware.	(A) N.A. (B) Fire detection cut-off (C) POSSIBLE LOSS due to hot gas leakage.	(A) N.A. (B) Reschedule (C) POSSIBLE LOSS due to hot gas leakage.
						Issue Date: JAN 5 1962	Prepared By: M-P&VE-PL	Approved:

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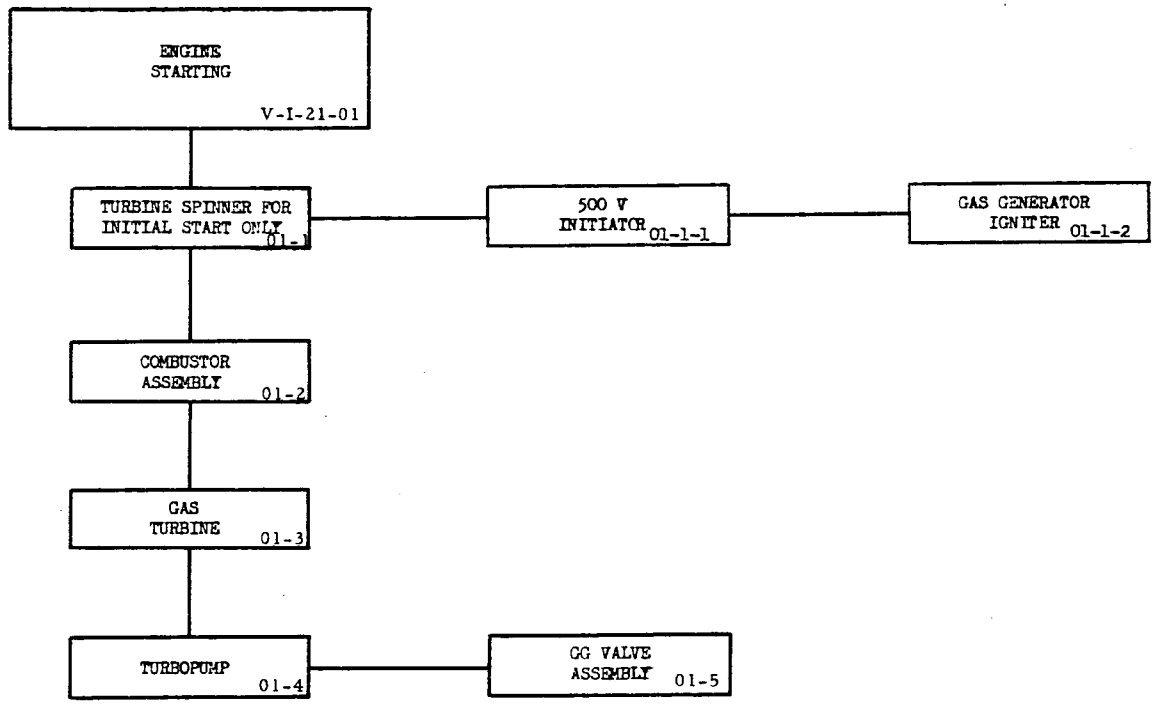
FAILURE EFFECT ANALYSIS
PROPULSION (V-I-20) SUBSYSTEM

(A) Launch condition
(B) Firing command to lift-off
(C) Flight

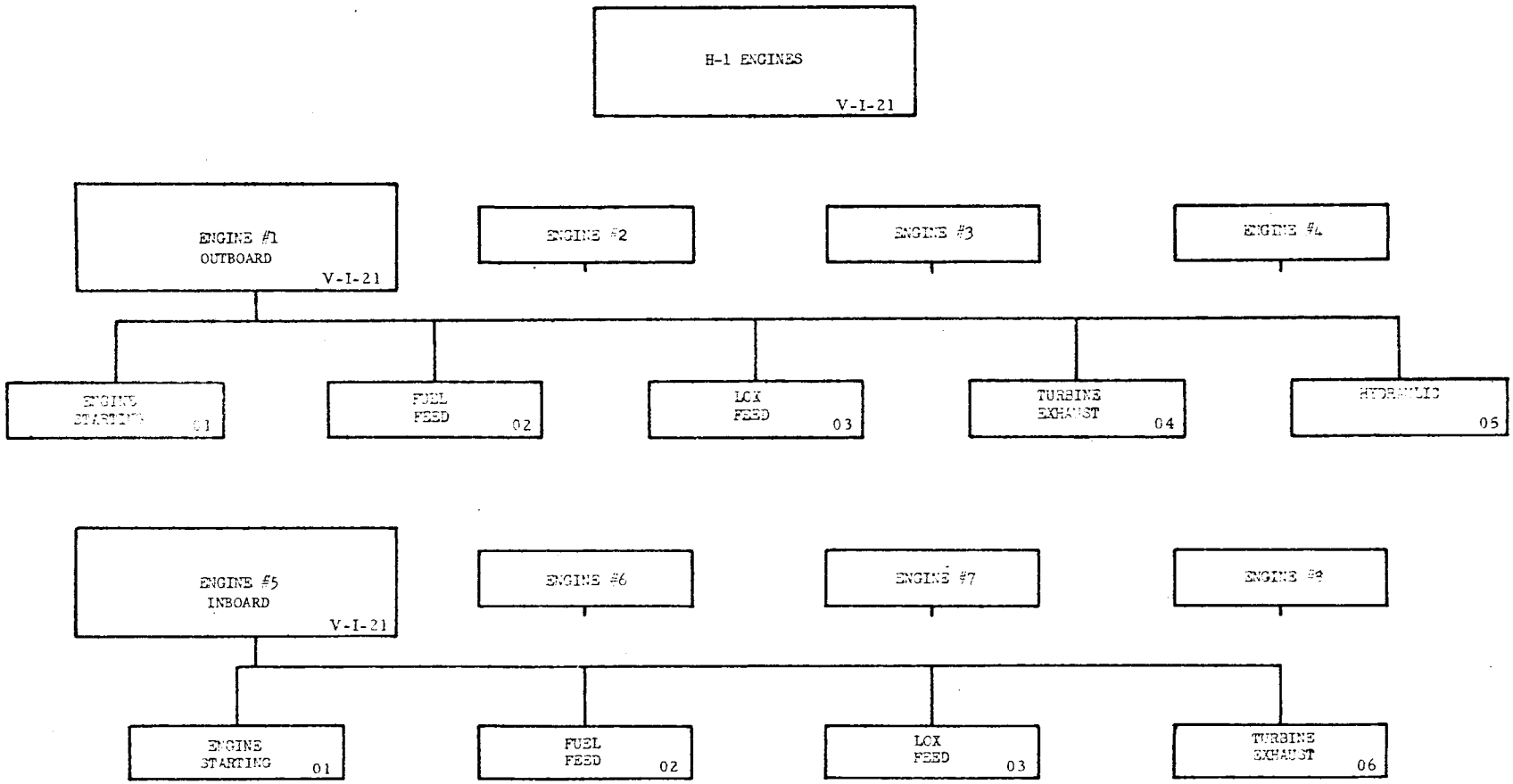
Item	**	Drawing Number	Elect. Ref Desig	Function	Failure Type	Failure Effect on Subsystem Performance	Failure Effect on S-I Stage	Failure Effect on C-1 Vehicle
Solid Propellant Gas Generator (Type A-2 Turbine Spinner) 8 required (V-I-21-01-1)	(*)	651240	1A6 2A6 3A6 4A6 5A6 6A6 7A6 8A6	Starts H-1 Enging by spinning up turbine and igniting liquid gas generator.	Premature operation	(A) One engine starts premature. (B) N.A. (C) N.A.	(A) Engine must be cleaned and SPGG replaced. (B) N.A. (C) N.A.	(A) Reschedule (B) N.A. (C) N.A.
					Failure of component to operate at the prescribed time.	(A) N.A. (B) Loss of an engine. (C) N.A.	(A) N.A. (B) Shutdown all engines. must be cleaned and SPGG replaced. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
					Failure of a component during operation. (Short burning time).	(A) N.A. (B) No bootstrap loss of an engine. (C) N.A.	(A) N.A. (B) Shutdown all engines must be cleaned and SPGG replaced. (C) N.A.	(A) N.A. (B) Reschedule. (C) N.A.
					Failure of a component after operation. (Cracked Housing).	(A) N.A. (B) Fire detection cut-off. (C) Possible loss of an engine depending on amount of damage.	(A) N.A. (B) Fire detection cut-off. (C) POSSIBLE LOSS due to hot gas leakage affecting vital hardware.	(A) N.A. (B) Reschedule. (C) POSSIBLE LOSS due to hot gas leakage affecting vital hardware.
						Issue Date: JAN 25 1962	Prepared By: M-P&VE-PL	Approved:

FAILURE EFFECT ANALYSIS



ISSUE DATE:	PREPARED BY:	APPROVED:
SEP 28 '86	M-P & VE-P	

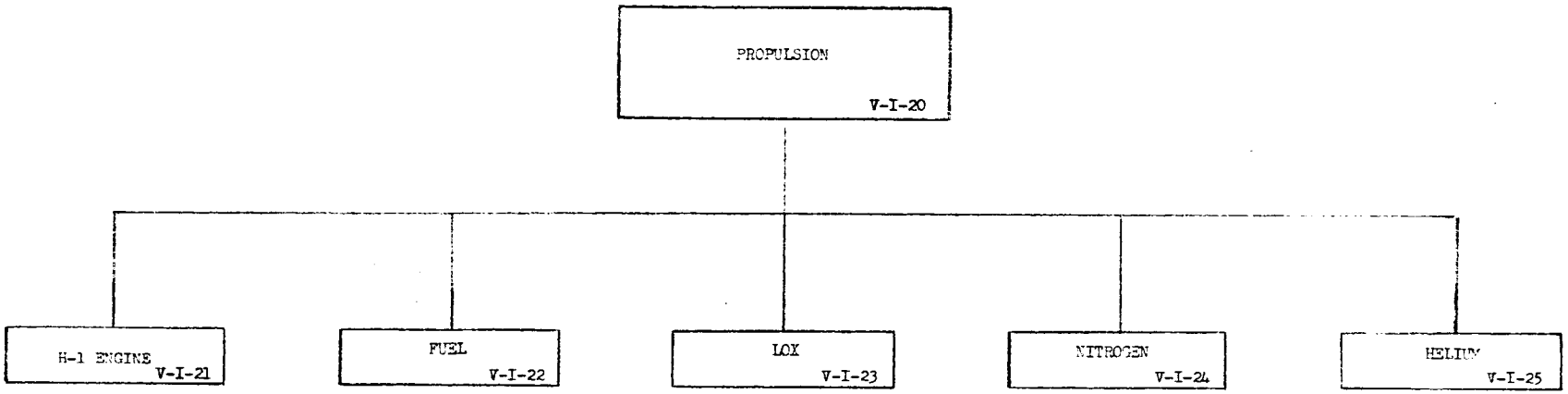
FAILURE EFFECT ANALYSIS



SYSTEM TYPICAL FOR ENGINES INDICATED

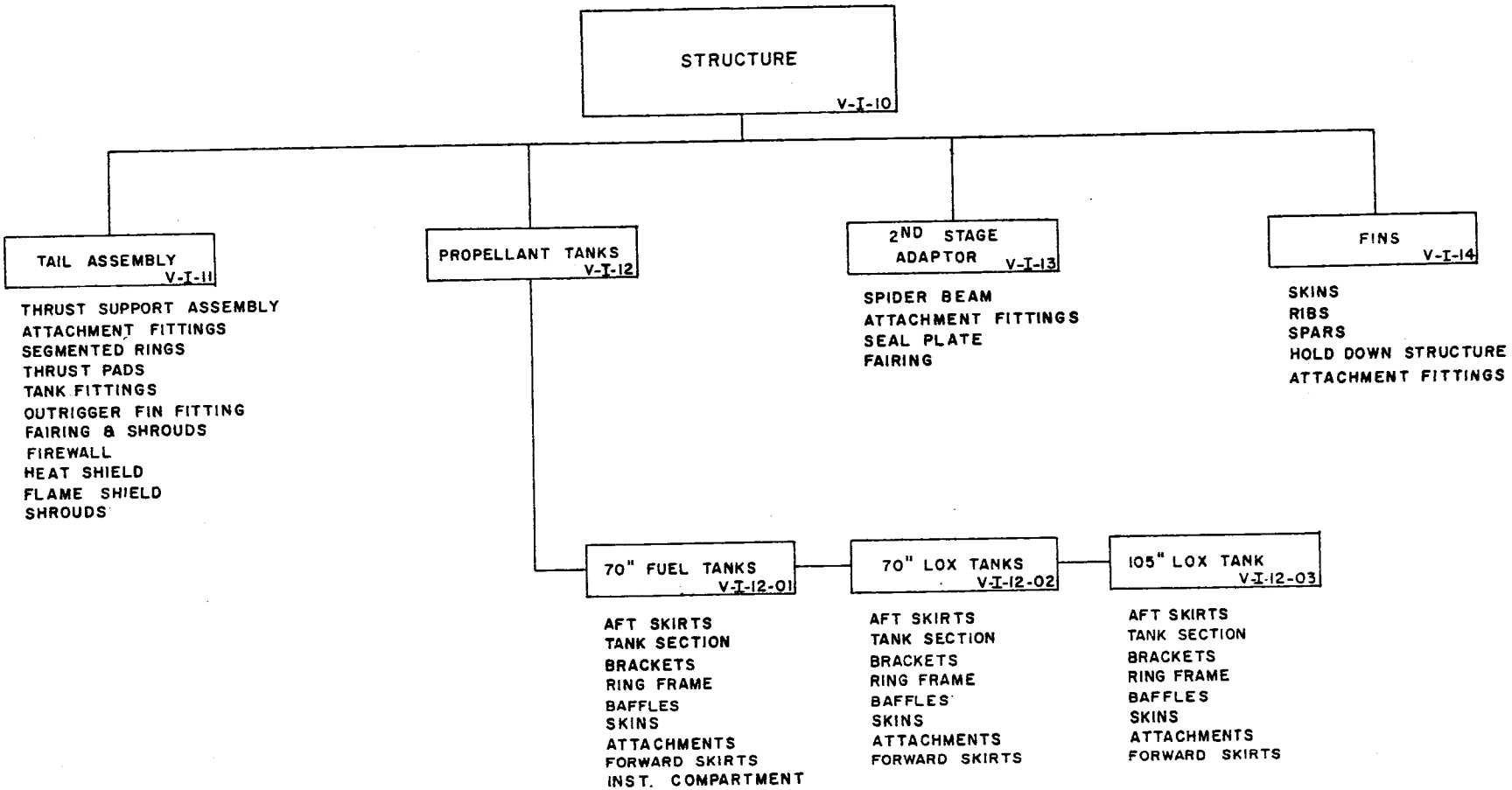
ISSUE DATE:	PREPARED BY:	APPROVAL:
SEP 28 1961	M-P & VE-P	

FAILURE EFFECT ANALYSIS



ISSUE DATE:	PREPARED BY:	APPROVED:
SEPT 28, 1961	M-P & VE-P	

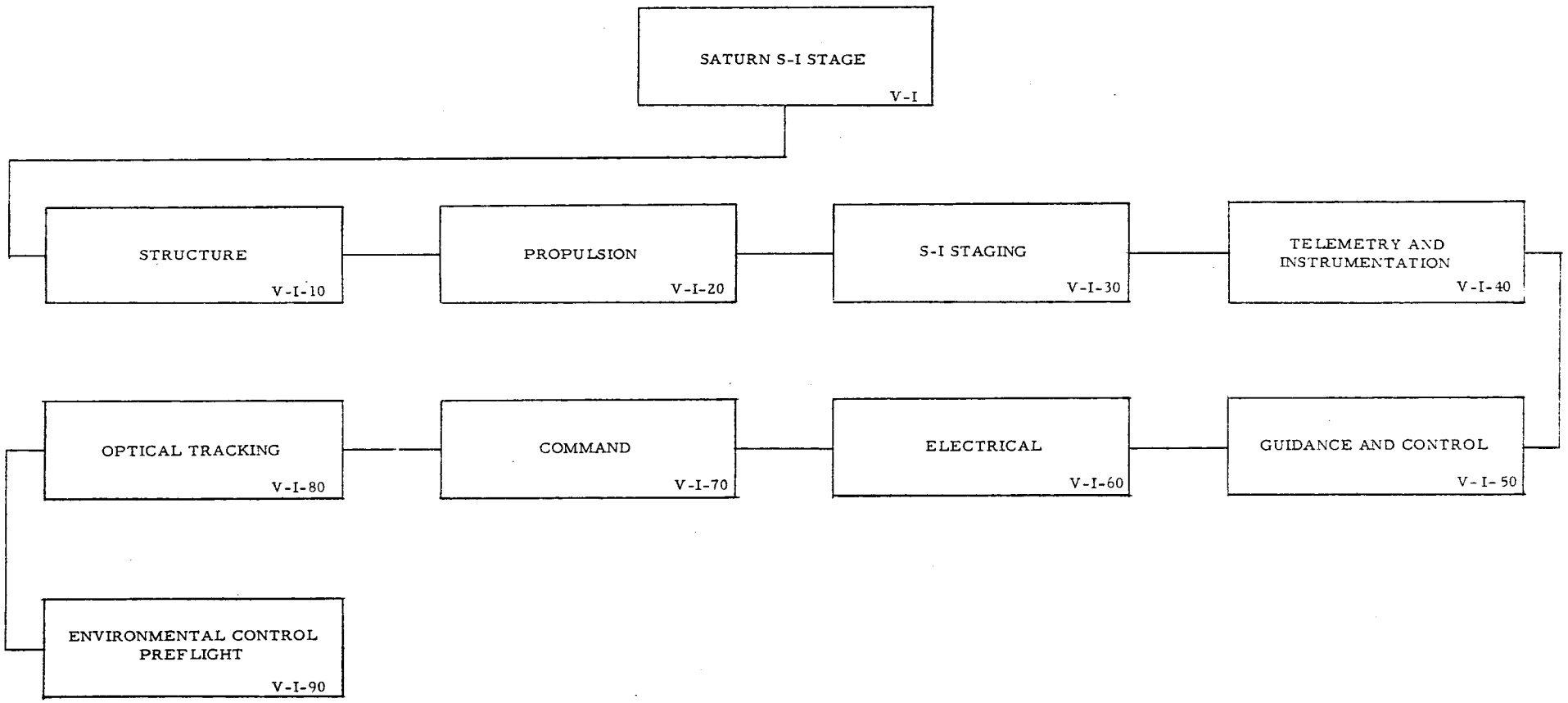
FAILURE EFFECT ANALYSIS



ISSUE DATE:	PREPARED BY:	APPROVAL:
January 5, 1962	M-P&VE-S	[illegible]

S&M Form #203-1 (August 1961)(OT)

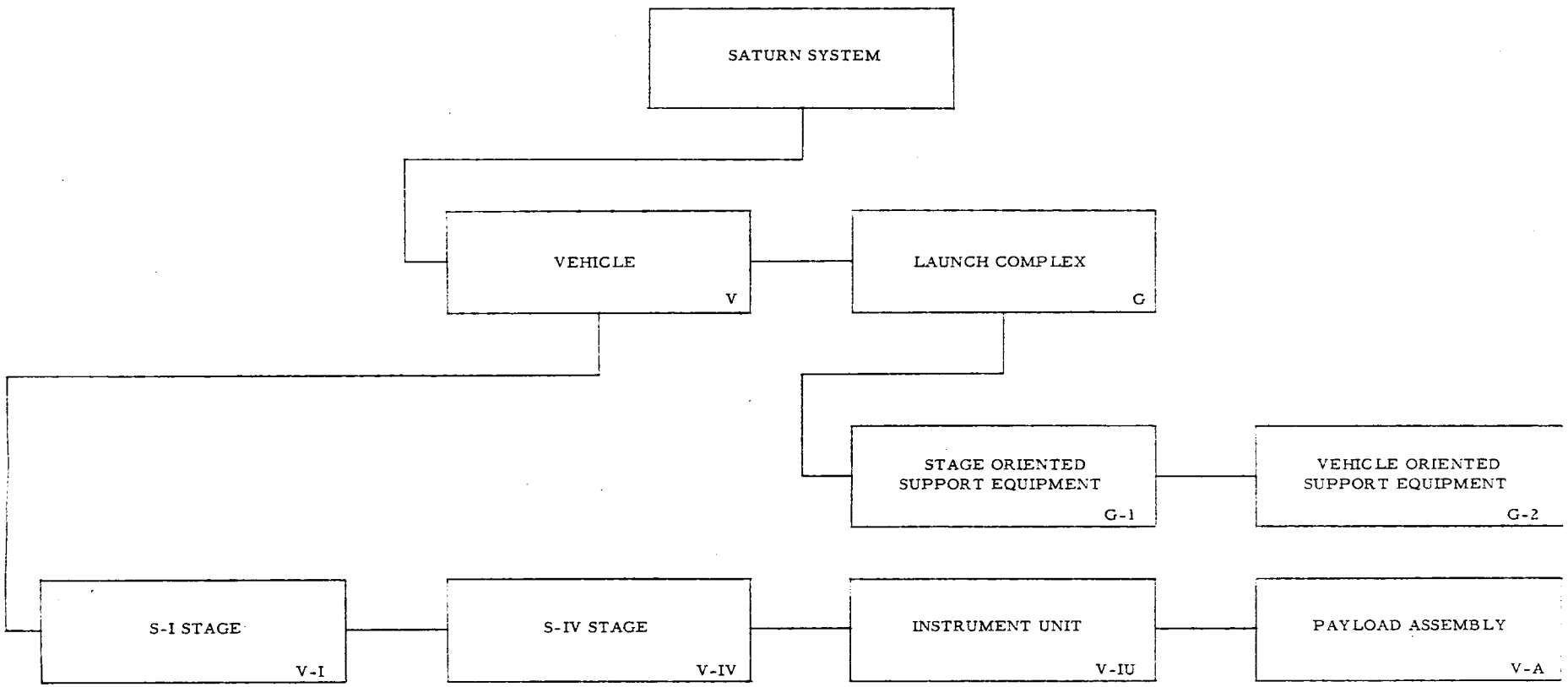
FAILURE EFFECT ANALYSIS



Issue Date: Nov 27, 1961	Prepared by: M-P&VE-EF	Approval:

SATURN SYSTEM

FAILURE EFFECT ANALYSIS



Issue Date: Jan 23, 1962	Prepared by: M-P&VE-EF	Approval: J.T. Gillard

S&M Form #203-1 (August 1961)(OT)

APPLICATION		PART No.	MF	REVISIONS			
NEXT ASSY	USED ON			SYM	DESCRIPTION	DATE	APPROVAL

NOTES:

1. Section 4, consisting of 81 pages, is Douglas Aircraft Company Drawing Number 7859475, Change Letter B. Douglas coding has been retained throughout this section.

2. Drawing 10M030061 consists of 290 pages.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING Feb. 14, 1962	SATURN C-1 FAILURE EFFECT ANALYSIS FOR SA-5 AND COMPLEX 37-B	GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
MATERIAL	DRAFTSMAN / CHECKER		
	TRACER / CHECKER		
HEAT TREATMENT	ENGINEER / ENGINEER		
	SUBMITTED 2-21-62 W. A. Schmitz		
FINAL PROTECTIVE FINISH	APPROVED	SCALE / DWG SIZE A	10M030061
		UNIT WT	SHEET OF