F/u BS-1331-50-3 (1)

SAFSL EXHIBIT 34003
DATE: 18 October 1968

DOCUMENT CONTROL
BIN: BIF-055-1316-126-2-68 PAGES 198
COPY NO. 4 OF 10 COPIES

MISSION DEVELOPMENT SIMULATOR PERFORMANCE DESIGN REQUIREMENTS

For The
MANNED ORBITING LABORATORY (MOL) SYSTEM

DEPARTMENT OF THE AIR FORCE
MANNED ORBITING LABORATORY SYSTEM PROGRAM OFFICE (USAF)
AF UNIT POST OFFICE
LOS ANGELES, CALIFORNIA 90045

NOV 5 - 1968

1331-52
~~1316-136~~
1270-212

SPECIFICATION NO.

END ITEM CONFIGURATION CHART

SPECIFICATION ISSUE & DATE	ECP'S	PRODUCTION EFFECTIVITY (SERIAL NUMBER)

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

TABLE OF CONTENTS (Cont)

LIST OF ILLUSTRATIONS

SAFSL EXHIBIT 34003
DATE: 21 October 1968

PERFORMANCE DESIGN REQUIREMENTS
MISSION DEVELOPMENT SIMULATOR

Basic Approved By: ____________________
Manager, Program Management Section
MOL Program
General Electric Company

Date: ____________________

Basic Approved By: ____________________
MOL System Program Office

Date: ____________________

SECTION 1

SCOPE

SECTION 1

SCOPE

This specification establishes the requirements for performance, design, and test of one mission design series of equipment identified as the Mission Development Simulator, hereinafter referred to as the MDS.

SECTION 2

APPLICABLE DOCUMENTS

SECTION 2

APPLICABLE DOCUMENTS

The following documents of exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between documents referenced below and the contents of Sections 3 and 4 of this specification, the detail requirements of Sections 3 and 4 shall be considered as superseding requirements. Any conflict between a document listed in this section and a lower tier referenced document shall be resolved in favor of the listed document. In the event of conflicts between this specification and other specifications for the MDS, this specification shall be considered as the superseding document.

SYSTEM PROGRAM DOCUMENTS

Document Number	Date	Title
TR 00557, Issue No. 1	9 Sept. 1967	Douglas Part I, Spec for PSCS and LPSS Software.
CG 807A	15 August 1968	MMSE Computer Programs, CEI MOK 807A.
CEI MOK 802A	30 Nov. 1967	On-Board Computer Program (Operational).
CP1460AI	15 August 1968	MMSE System CEI Requirements.
CEI MOK 804A	5 Dec. 1967	Command and Control Program (STC).
MIL-H-27894A	9 Jan. 1963	Human Engineering Requirements for Aerospace Systems.
MIL-STD-454A (Req. 1, 3 and 5)	5 Jan. 1965	Military Standard, General Requirements for Electronic Equipment.

Document Number		
MIL-S-38130A (Guide)	6 June 1966	System Safety Engineering
MIL-C-45662A	- - -	Calibration of System Requirements
DN-50249-192-1	21 June 1968	Product Assurance Plan for MDS Program, Revision D
MJS-1300-001	21 June 1968	106 Quality Program Requirements, Revision A
SS-MOL-1B (Section 3. 1. 1. 10. 3. 3)	29 April 1968	System Performance/Design Requirements
MIL-T-27474 (as amended by Section 10 herein)	22 Aug. 1960	Training Equipment, Ground, General Requirement for
SAFSL Exhibit 34121		Government Furnished Property

SECTION 3

REQUIREMENTS

SECTION 3

REQUIREMENTS

3.1 PERFORMANCE

The Mission Development Simulator (MDS) shall be capable of performance specified in this section.

3.1.1 FUNCTIONAL CHARACTERISTICS

The MDS will provide a simulation system for development and checkout of Mission Payload System Segment (MPSS) related MOL hardware/software, and development of procedures to be used in the operations of the MPSS. Crew related mission payload functions, as defined in this document, will be exercised via a display/control crew interface. Orbital parameters representing the operational mission profiles will be utilized. The capability to simulate representative subsystem malfunctions and contingency modes will be provided.

The MDS will be used for the following purposes:

a. Develop the mission payload operations procedures required to meet MOL objectives.

b. Provide engineering data on crew/AVE hardware and software interfaces.

c. Provide quantitive data on man's performance with the simulated MOL System.

d. Develop and validate AVE Software.

e. Contribute to the development of the MMSE.

f. Provide Flight Crew training.

g. Validate and refine operational time-lines, contingency plans, and backup operating modes.

The basic program requirements for the MDS are specified in SS-MOL-1B, paragraph 3.1.1.10.3.3.

3.1.1.1 Primary Performance Characteristics

MDS design shall be based on a mutually agreed upon AVE baseline established on the following dates: Phase "O" - - - - - - - - 1 May 1968

(except for SLM panels 2C and 2D, which are 30 June 1968

Phase 3 - - - - - - - - - 21 December 1968

EK Hardware - - - - - 30 June 1968

To meet the requirement of paragraph 3.1.1, that the MDS aid in developing the MMSE, it is a general requirement that MDS system and subsystem design requirements will conform to the maximum extent practical to the requirements of the MMSE CEI Spec. CP1460AI. Common design of MDS and MMSE components and programs will be performed wherever practical.

3.1.1.1.1 Communication, Command and Instrumentation

The system performance requirements shall be:

a. Command Processing.

b. Sense critical MPSS operating conditions or events and provide signals for telemetry and/or alarm indication.

c. Provide all functions of the Data Computation Subsystem Group (DCSG) and its interfaces with the MPSS and LMSS simulated hardware, including the Computer Subsystem Controller, Laboratory Data Adapter, Mission Data Adapter, Airborne Digital Computer (ADC), the Printer, Keyboard Display Unit, and the Auxiliary Memory Unit.

3.1.1.1.1.1 Command Processing

The data associated with the uplink portion of the Command Subsystem (receivers, encripters, Laboratory Data Adapter Unit (LDAU) and Laboratory Decoder) will be provided. The specific hardware implementation will not be included. The simulation will accept and transmit command data messages generated by the MOL Command Generation Programs. In addition, the simulated LDAU will present command data messages to the Airborne Digital Computer (ADC) in the actual format. The simulation shall not decript messages but will separate real-time LM commands from stored commands and store them. The MPSS real time commands shall be separated in the ADC for execution via the simulated MDAU or internal in the ADC. Only malfunctions associated with the ADC data interface and MDAU will be simulated. Switching to redundant devices will be simulated. Printer messages from the Command Data Message shall be provided to the crew.

3.1.1.1.1.2 Instrumentation

Monitor and alarm signals shall propagate through the system to drive the affected simulated MPSS controls and displays. The master warning and caution visual indications and aural alarms shall be provided. Warning functions and caution functions associated with the MPSS will be simulated. Redundant channels will not be simulated. MAS malfunctions will not be simulated. Where data is not available in the various math models or is not precomputed, a constant value for the TLM points will be provided. Of the 128 by 256 matrix, a 61 by 256 word matrix associated with the MPSS will be provided. The data will be provided in engineering units in the case of real-time telemetry. The crew shall have the capability to monitor the present reading on TBD 7 MPSS telemetry point.

3.1.1.1.2 Electrical Power and Signal Distribution

Controls and displays associated with the electrical power and signal distribution system shall be dynamically driven. The following capabilities shall be provided:

a. React to power switching commands.

b. Compute power bus loads based on MPSS component utilization.

c. Compute circuit breaker trip signals.

d. Simulate prime power source.

e. Compute bus voltages based on system loads, source voltages, and effect of power conditioners.

f. Propagate short circuits, and open circuits through the MPSS portion of the power system.

3.1.1.1.3 LMSS Interface

The following LMSS functions required for MPSS operation shall be simulated:

a. Attitude Control and Translation System.

b. Timing Subsystem:

   1. GMT Clock

   2. Event Timers

   3. Mission Time

c. Data Computation Subsystem Group.

d. Command Subsystem.

e. Monitor and Alarm Subsystem.

f. Data Acquisition Subsystem Group

Malfunctions shall not be included in the simulation of the above subsystems except as identified below.

3.1.1.1.3.1 Attitude Control and Translation System

A simulation of all ACTS/SCE controls and displays shall be provided except for the translation thruster controls, emergency direct mode controls, and the gyro and horizon sensor power controls. The hardware will be simulated to the fidelity necessary to drive the displays and to give realistic vehicle rate data to the On-Board Computer and realistic Jet Firing torques. The systems shall react to Main Optics Mirror slews. Dead-band characteristics will be simulated. Certain ACTS malfunctions such as thruster failure will be simulated.

3.1.1.1.3.2 Timing Subsystem

The Timing Subsystem consists of four clocks: Vehicle Clock (1), Event Timers (2), and a Greenwich Mean Timer (1). These simulated timers shall be synchronized within the tolerance of the time synchronism of the vehicle timers.

3.1.1.1.3.3 Data Computation Subsystem Group

Refer to paragraph 3.1.1.1.1

3.1.1.1.3.4 Command Subsystem

Refer to paragraph 3.1.1.1.1

3.1.1.1.3.5 Monitor and Alarm Subsystem

Refer to paragraph 3.1.1.1.1

3.1.1.1.3.6 Data Acquisition Subsystem Group

Refer to paragraph 3.1.1.1.1

3.1.1.1.4 Control and Display Subsystem

Controls and displays for MPSS and LMSS functions provided shall be:

1. Reconnaissance Subsystem.
2. Electrical Power and Signal Distribution Subsystem.
3. Command and Control Subsystem.
4. Navigation and Control.
5. Film Processing.
6. Master Control Unit Switches.
7. Keyboard Display Unit.

8. Vehicle Printer.

9. Camera, film status, focus, and alignment.

10. Primary Film Handling.

11. Secondary Film Handling.

12. Monitor and Alarm.

13. ACTS/SCE.

14. Structure and Thermal Control.

3.1.1.1.5 Navigation and Control

3.1.1.1.5.1 Star Tracker

Interface signals from Star Trackers 1 and 2 to the On-Board Computer will be simulated for slew, acquisition, tracking, and search modes. Tracker mode displays will be activated as required when in these modes. Misalignment and bias errors associated with nominal dynamic operation of the Star Tracker will be simulated. Capability to simulate catastrophic Star Tracker failures and output gimbal angle malfunctions will be included. Either or both Star Trackers can be completely failed. All displays and controls related to Star Tracker alignment will be active.

3.1.1.1.5.2 Low-g Accelerometer

Low-g Accelerometer errors, consisting of bias errors and random errors, will be simulated by Script inputs. The magnitude of the bias errors will be limited according to stimulus material constraints. However, when stimulus material is not being used, the errors may be increased in magnitude for software checkout. All controls and displays will be active. Both the airborne and TLM modes will be commandable.

All malfunctions to be simulated will generate system pointing errors.

3.1.1.1.5.3 Image Velocity Sensor (IVS)

Interface signals between the IVS and MDAU shall be simulated. IVS errors to be simulated include random errors and bias errors. Saturation will be simulated in the event of clouds (when prescripted), in which case the saturate light will be turned on and the IVS output will limit. Nominal IVS rate-nulling will be simulated in the range of $\pm$ 540 μ rad/sec.

3.1.1.1.5.4 Control Stick

Control stick effects are discussed in paragraph 3.1.1.1.7.1.6.4.

3.1.1.1.6 Structure and Thermal Control

The Structural Thermal Control Subsystem consists of the following:

a. Thermal Door.

b. Environmental Door.

c. Temperature Display and Controls.

3.1.1.1.6.1 Thermal Door

All displays and controls associated with the Thermal Door shall be active including the manual Hand Crank. Commanded door motion shall be simulated by a constant velocity drive. In the case of the Hand Crank, the door will be either fully open or fully closed. The Eyepiece Display in all modes shall indicate either a fully opened or fully closed door, and may be failed in either position.

3.1.1.1.6.2 Environmental Door

The ATS Environmental Door shall be simulated by blanking or unblanking the ATS eyepiece. Backup controls located on the front panels will be simulated.

3.1.1.1.6.3 Temperature Display and Controls

The displays and controls associated with the MPSS Subsystem shall be simulated. The temperature displays shall vary as a function of Beta angle, heater operations including failures, thermostat failures, component usage, and thermal door position.

3.1.1.1.7 Acquisition Subsystem

The MDS shall provide a simulation of the operator interface with the Acquisition Subsystem. This AVE subsystem consists of two steerable telescopes (ATS) and associated controls and displays. A dynamic simulation of the ground scene, as viewed through the simulated telescopes, is also required. The following paragraphs describe the primary performance characteristics of this simulation. See also paragraph 3.1.1.2.5 for the secondary performance characteristics of the stimulus subsystem of which the acquisition equipment is a part.

3.1.1.1.7.1 AVE ATS Hardware Parameters

3.1.1.1.7.1.1 Magnification and Real Field-of-View

The MDS shall provide magnification equivalent to 15.88X ± 5 percent to 31.76X ± 5 percent, and 63.5X ± 5 percent to 127X ± 5 percent and shall follow operator commands and reach any commanded value within 0.5 second. The step from 31.76X ± 5 percent to 63.5X ± 5 percent shall occur in 1.0 second or less. See paragraph 3.1.1.1.7.1.5 for a discussion of presentation rates. The real field-of-view shall be 3.78 degrees ± 5 percent at 15.88X ± 5 percent, and 0.945 degree ± 5 percent at 63.5X ± 5 percent. The field varies inversely with zoom to the higher powers in each range.

3.1.1.1.7.1.2 Eyepiece Properties

The initial MDS configuration shall include a supplemental eyepiece. The final MDS configuration shall include an AVE Eyepiece Assembly.

3.1.1.1.7.1.2.1 Peripheral Display

With the supplemental eyepiece, MDS shall provide an eyepiece Peripheral display which has sufficient flexibility to simulate a wide variety of potential AVE configurations. The system shall have the capability of displaying up to 45 lights which may be arrayed anywhere in the field-of-view. The area of the field-of-view from the peripheral location to the edge will be obscured. The lights will have the capability of being switched on singly or in any combination or sequence. The color of each source shall be variable by insertion of a colored filter over the light. The brightness of the display shall be variable over a 50:1 ± 5 percent range, controlled by the operators up to 500 foot lamberts. The display shall appear to focus at the reticle plane across the entire format. For baseline configuration see paragraph 3.3.2.

With the AVE Eyepiece Assembly, the peripheral display will be an integral part of the hardware.

3.1.1.1.7.1.2.2 Reticle

An illuminated reticle shall be employed with the supplemental eyepiece. Its brightness shall be manually controllable over a 50:1 ± 5 percent range up to 500 foot lamberts. The center of the ground scene image shall appear to grow and contract with the ground scene. The reticle configuration shall have the capability to substitute new patterns.

3.1.1.1.7.1.2.3 Other Characteristics

The supplemental ATS eyepiece in the MDS shall have an external appearance similar to that of the AVE. It shall have a 60 ± 1 degree apparent field-of-view. At nadir the exit pupil shall be approximately circular with a 4mm diameter ± 0.2mm at 15.88X and 63.5X, varying inversely with magnification to 2mm ± 0.1mm at 31.76X and 127X. Eye relief shall be such that the near range is acceptable to the eye and the far range is acceptable with respect to the tasks to be performed outside the ATS. Manual focus adjustment of ± 3 diopters shall be provided. Head restraints shall be like those used in the AVE with slight modification to accommodate the simulation eye relief.

3.1.1.1.7.1.3 Output Image Quality

A. Resolution - Using a standard white on black bar chart of 2:1 contrast as an input, the device when simulating 127X at nadir from orbit shall provide at least 30 LP/mm for 32K scale stimulus and 67 LP/mm for 72K scale stimulus. This performance shall be provided on axis as viewed through the supplemental eyepiece or the AVE eyepiece by the unaided eye, with optical drives operating, the target centered in the F. O. V. and scene drifts nulled by the computer. The resolution variation from the center to the edge of the apparent field shall not vary by more than a factor of 2 from the on axis performance.

The resolution under the above conditions shall not degrade by more than a factor of 2 from the performance at a simulated 127X where the device is configured to simulate a magnification of 63.5X.

B. Field Curvature - The curvature of the apparent field from center to edge under static conditions at 1:1 anamorph setting using the supplemental eyepiece shall be 3.0 diopters ±0.5 diopters.

3.1.1.1.7.1.4 Light Transmission

3.1.1.1.7.1.4.1 Optical Transmission of ATS

The MDS shall deliver an overall light level to the observer which accounts for the light transmission characteristics of the ATS. Transmission is constant as a function of zoom (± 10 percent). The intensity of the image at 5 degrees from the edge shall not be less than 50 percent of the on-axis intensity. No simulation of the vignetting phenomenon is required.

3.1.1.1.7.1.4.2 Manual Filter Wheel

Manual insertion of fixed filters into the ATS optical path shall be simulated. Three neutral density filters having transmittances of 1, 0.5, and 0.25 shall be simulated with the capability to readily change their values. No simulation of color filters is required.

3.1.1.1.7.1.4.3 Other Obscurations

Simulation of other obscurations, due to the Sun shutter and environmental shroud, shall only be accomplished in a fully obscured or completely unobscured fashion. Total obscuration of the scene shall occur in less than 0.5 second when simulating Sun shutter closure, and in 10 ± 1 second when simulating the environmental shroud. The same response times apply for unblanking.

3.1.1.1.7.1.5 Target Loading and Coordination

All functions associated with the target selection logic shall be available for exercising by the operator. Appropriate action in terms of the particular targets which appear in the ATS, and the rate and duration at which they appear, shall be accurately represented in the ATS. Presentation rates of up to one HPA target per second shall be possible. A group of five consecutive targets may be rejected with the sixth target in view within three seconds of the reject. This assumes a group consists of six targets in one ATS, and the operator is viewing the first one at the time of reject. Switching between HPA and LPA and vice versa shall occur within one second. See paragraph 3.1.1.2.5, Secondary Performance Characteristics.

3.1.1.1.7.1.6 Scene Dynamics

TBD 3

NOTE

The requirements noted by " ∇ " replace the requirements of the draft copy of this specification, dated 5 April 1968. GE does not concur that the requirements noted " ∇ " can be met with current design until completion of a study due 1 July 1968. (See AF TWX No. [redacted]0990, 14 May 1968 for details of AF/GE understanding.)

∇ 3.1.1.1.7.1.6.1 Line of Sight Dynamics

The MDS shall accurately model the dynamic performance of the ATS pointing equipment. The effect of this model shall be to give real world appearance to the simulated ATS scene. This model will provide an accurate representation of slew time and the settling of the gimbals at the end of slew. Rates and accelerations within the following limits and to the accuracies shown, shall be represented by this model:

Tracking Rate - - - - - - - - -	$\pm 0.5 \pm 0.001$ deg/sec roll $\pm 4.0 \pm 0.001$ deg/sec pitch
Tracking Acceleration - - - - -	± 114 deg/sec^2 (accuracy consistent with rate error)
Slew Rate - - - - - - - - - -	$\pm 45 \pm 0.01$ deg/sec
Slew Acceleration- - - - - - -	± 114 deg/sec^2 (accuracy consistent with slew rate error)

Tracking precision shall be consistent with the requirement specified in paragraph 3.1.1.1.7.1.6.3.

V 3.1.1.1.7.1.6.2 Line-of-Sight Perturbations

The MDS shall perturb the visual presentation of the ground scene to simulate the position and motion of the line-of-sight (LOS) during tracking. The following errors to the LOS, which are essentially static or producing low rates, shall be simulated:

a. Attitude measurement errors.

b. Servo bias errors, mirror rate measurement errors.

c. Ephemeris errors (intrack, crosstrack, altitude).

d. Target location errors (longitude, latitude, altitude).

e. Misalignment errors.

These perturbations shall generally be distributed in the same statistical fashion as the corresponding AVE errors. The simulator shall have the capability to represent the total AVE 2 σ pointing error, consistent with the stimulus format size and scale factors (paragraph 3.1.1.2.5).

The MDS shall perturb the visual presentation to simulate the response of the line-of-sight to the following vehicle structural disturbances which are of an oscillatory nature:

a. Bearing noise.

b. Main mirror slew and settling.

c. ACTS jet firing.

The above disturbances shall be coordinated in time with the actual events which produce them. These disturbances will be simulated with a resolution equivalent to two arc minutes per axis apparent at a command rate of 100 commands/sec.

NOTE

Resolution is defined as the smallest servo output which can be achieved by varying the input.

∇ 3.1.1.1.7.1.6.3 Overall Line-of-Sight Position Accuracy

The MDS shall have the capability to determine, at any instant of time, the position of the line-of-sight relative to the target to an accuracy equivalent to $\pm$ 0.025 inches at the plane of the stimulus material. This represents total system error including servo, computational, stimulus registration, and location of the target on the stimulus material. The overall line-of-sight position precision shall be better than two arc minutes per axis apparent. The purpose of this requirement is to ensure smooth low apparent rate performance.

∇ 3.1.1.1.7.1.6.4 Stick Effects

The MDS shall have the capability to change the transfer function between control stick motions and the resultant line-of-sight motion. The limiting values of stick commands are:

LOS rate - - - - - - - - - -	max. 0.5 deg/sec each axis, with a positive resolution better than two arc minutes per axis apparent.
LOS acceleration - - - - - - -	0 to 6 deg/sec^2 each axis.

The purpose of the command resolution requirement is to allow smooth low-rate stick commands.

In addition, it shall be possible to reverse the polarity of the controller, independently on each axis. This change shall be initiated manually during a normal turn-around cycle.

3.1.1.1.7.1.6.5 Image Derotation

The MDS shall simulate the AVE derotation prism by erecting the in-track line at the end of each slew. In addition the capability shall be provided to orient the image in any direction. The image shall be rotated during track only to simulate vehicle motion.

3.1.1.1.7.2 Earth Phenomena

3.1.1.1.7.2.1 Lighting

3.1.1.1.7.2.1.1 General

The light levels (scene and haze) shall be controlled to a tolerance of $\pm$ 10 percent. The color temperature of both sources shall be fixed at some value in the range of 3000 to 6000°K. As intensity varies, the color temperature shall not vary more than $\pm$ 25 mireds in absolute value.

3.1.1.1.7.2.1.2 Scene Lighting

The ground scene brightness shall be variable over the range of 50:1 to 500 foot lamberts (open gate) as seen by the operator. This brightness range accounts for the ATS light transmission per paragraph 3.1.1.1.7.1.4. Basic scene illumination shall vary from target as a function of Sun position. The basic scene illumination shall vary due to target latitude, season, and local time.

3.1.1.1.7.2.1.3 Haze

The haze brightness (atmospheric luminance) shall be variable over a 50:1 range up to 500 foot lamberts as seen by the operator. This brightness range accounts for the ATS light transmission per paragraph 3.1.1.1.7.1.4. The haze illumination for any target will be constant. Haze brightness shall be coordinated with scene brightness to give the proper appearance of the overall scene as seen from orbit.

3.1.1.1.7.2.2 Ground Scene Special Effects

The following characteristics of the ground scene shall be represented by the stimulus material:

a. Cloud cover.

b. Cloud shadows.

c. Shadows of objects on the ground.

d. Specular reflectance.

3.1.1.1.7.2.3 Initial Target Location

When first presented in the ATS eyepiece, a target shall appear to fall anywhere within the following envelope:

In-track	45 degrees forward to 40 degrees aft
Cross-track	45 degrees left to 45 degrees right
Altitude	75 to 85 nm

The appearance of the target scene in the simulator shall have geometry presentation based upon the original geometry of the stimulus within the following envelope limitations: initial in-track positions beyond the above limits shall be possible (up to 60 degrees forward) for selected stimulus scales (see Secondary Performance Characteristics, paragraph 3.1.1.2.5). Cross-track position shall be a property of the stimulus material with the simulator providing the capability for $\pm$ 10 degree distortion cross-track beyond the obliquity of the input material. Altitudes beyond the range stated above shall be possible if proper stimulus material is provided with scale factor proportional to the required altitude (see Secondary Performance Characteristics paragraph 3.1.1.2.5).

3.1.1.1.7.2.4 Dynamic Target Location

The MDS shall provide the capability to simulate the apparent motion of the target, in real-time, from its initial in-track position to 40 degrees aft. This motion shall appear as dynamic perspective and slant range. Each payload pass shall be simulated at either constant altitude or at a variable altitude within the limits set forth in paragraph 3.1.1.1.7.2.3. The in-track line on the ground scene shall have fixed orientation throughout the target pass except during simulated attitude excursion. This orientation shall be determined by the script depending on status of ATS derotation prism, orbit inclination, and target latitude.

3.1.1.1.7.2.5 Scan Area

The MDS shall allow excursions of the line-of-sight from perfect pointing at the target which are limited only by stimulus material format and scale, and the response of the ATS drive system (see Secondary Performance Characteristics, paragraph 3.1.1.2.5).

3.1.1.1.7.2.6 Scene Streaming

A simulation of rapid image streaming which occurs during slew or periods when the gimbals are stationary (as during a power failure) is not required, i.e., a real blurred image need not appear. However, during such periods the ground scene shall be blocked from view and the field-of-view illuminated to an intensity comparable to the scene intensity.

3.1.1.1.7.3 Associated Controls and Displays

Controls and displays used in conjunction with the ATS shall be active and simulate the same functions as in the AVE.

3.1.1.1.7.4 Control Stick and Magnification Control During Freeze

It shall be possible, at the option of the SCC operator, for the crewmen to scan the stimulus area and change magnification during the freeze mode. The response of the stick controller shall enable scanning of the stimulus area but need not comply with paragraph 3.1.1.1.7.1.6.4.

3.1.1.1.8 Main Optics (MO)

The MDS shall provide a simulation of the operator interface with the Main Optics. This interface consists of two Eyepiece Assemblies, known as the Visual Optics through which the crewmen view the image formed by the Primary Mirror, and associated controls and displays. Also included as part of this subsystem are equipment, controls and displays for aligning the photographic system and the Visual Optics. A simulation of the ground scene as viewed through these eyepieces is also required. The following paragraphs describe the primary performance characteristics of this simulation (see also paragraph 3.1.1.2.5 for the secondary performance characteristics of the Stimulus Subsystem of which the Main Optics equipment is a part).

3.1.1.1.8.1 AVE Visual Optics Hardware Parameters

3.1.1.1.8.1.1 Magnification and Real Field-of-View

The MDS shall provide step magnifications equivalent to 125X, 250X, 500X and 1000X. The total range shall be covered using a combination of two ranges (namely: 125X, 250X, 500X; or 250X, 500X, 1000X) each range having its own characteristic stimulus scale. The time between consecutive magnification steps shall be 0.35 $\pm$0.015 second where no slide change is required. If a slide change is required, the time for a magnification step change shall be no greater than 1 second. The real field-of-view is 0.32 degree at 125X and varies inversely with magnification to 1000X.

3.1.1.1.8.1.2 Eyepiece Properties

3.1.1.1.8.1.2.1 Peripheral Display

The MDS shall provide an eyepiece peripheral display consistent with the AVE baseline on the freeze date specified in paragraph 3.1.1.1. The display shall appear to be in focus at the reticle plane across the entire format.

3.1.1.1.8.1.2.2 Reticle

An illuminated reticle shall be employed. Its brightness shall be manually controllable over a 50:1 range up to 10 foot lamberts. The center of the ground scene image shall be coplanar with the reticle. As the magnification controller is exercised, the reticle shall appear to grow and contract in discrete steps with the ground scene. Flexibility is required in the configuration of the reticle, in the form of a capability to substitute a new pattern.

3.1.1.1.8.1.2.3 Other Characteristics

The VO eyepiece in the MDS shall have the same appearance as that of the AVE. It shall have 40 degrees $\pm$ 1 degree apparent field-of-view. The exit pupil shall be circular with a 6.4 $\pm$ 0.3mm diameter at 125X and 250X, a 3.5mm $\pm$ 0.2mm diameter at 500X, and a 1.75mm $\pm$ 0.1mm diameter at 1000X. Eye relief shall be such that the near range is acceptable to the eye and the far range is acceptable with respect to the tasks to be performed outside the VO. Manual focus adjustment of $\pm$ 3 diopters shall be provided. Head restraints shall be provided with modifications to accommodate the simulation eye relief. The central obscuration produced by the Newtonian Fold shall not be simulated.

3.1.1.1.8.1.3 Output Image Quality

A. Resolution - Using a standard white on black bar chart of 2:1 contrast as an input, the device when simulating 500X at nadir from orbit shall provide at least 67 LP/mm for 18.5K scale stimulus. This performance shall be provided on axis as viewed through the eyepiece by the unaided eye, with optical drives operating, the target centered in the FOV and scene drifts nulled by the computer. The resolution variation from the center to the edge of the apparent field shall not vary by more than a factor of 2 from the on axis performance.

The resolution under the above conditions shall not degrade by more than a factor of 2 from the performance at a simulated 500X where the device is configured to simulate a magnification of 250X.

B. Field Curvature - The curvature of the apparent field from center to edge under static conditions using the eyepiece shall be no greater than 3.5 diopters.

3.1.1.1.8.1.4 Light Transmission

The MDS shall deliver an overall light level to the observer which accounts for the light transmission characteristics of the VO. Overall VO transmission varies inversely as a function of magnification. The transmissions at Bay 2 shall be 80 percent of those at Bay 8. The intensity of the image at five degrees from the edge shall not be less than 50 percent of the on-axis intensity. No simulation of vignetting is required.

3.1.1.1.8.1.4.1 Light Path Switching

The ground scene image is never directed to both eyepieces simultaneously. At least one eyepiece is blanked at all times; the active one having been selected by the operator. The light level in the active eyepiece is dependent on the way the input light is divided between the active eyepiece and the Image Velocity Sensor. This division is under operator control and is such that the transmittance of the active eyepiece can be 0, 50, or 100 percent of the available light.

3.1.1.1.8.1.4.2 Other Obscurations

Simulation of obscurations due to Thermal Door shall be accomplished in a fully obscured or completely unobscured fashion. Total obscuration or unblanking of the scene shall occur in 4.5 ± 1 second when the door is being opened or closed by automatic or manual override devices. When the hand-crank is used the response shall be keyed to the crank travel.

3.1.1.1.8.1.5 Target Coordination and Loading

The targets selected by the voting logic shall appear in the Visual Optics, provided that stimulus material is available and these targets have been prescripted. The targets shall appear at a time corresponding to the end of slew and remain in view until the commencement of slew to the next target. Capability shall be provided to present in the eyepiece certain prescripted targets in coordination with the ground mission planning function at STC provided stimulus material is available.

3.1.1.1.8.1.6 Scene Dynamics

TBD 3

NOTE

The requirements noted by " ∇ " replace the requirements of the draft copy of this specification, dated 5 April 1968. GE does not concur that the requirements noted " ∇ " can be met with current design until completion of a study due 1 July 1968. (See AF TWX No. [redacted] 0990, 14 May 1968 for details of AF/GE understanding.)

∇ 3.1.1.1.8.1.6.1 Line-of-Sight Dynamics

The MDS shall accurately model the dynamic performance of the VO pointing equipment. This model will provide a representation of slew time and the settling of the gimbals at the end of slew. Rates and accelerations within the following limits and to the accuracies shown, shall be represented by this model:

Tracking rate	$\pm 0.5 \pm 0.001$ deg/sec roll $\pm 3.4 \pm 0.001$ deg/sec pitch
Tracking acceleration	± 6.3 deg/sec^2 (accuracy consistent with rate error)
Slew rate	$\pm 15 \pm 0.01$ deg/sec
Slew acceleration	± 6.3 deg/sec^2 (accuracy consistent with slew rate error)

The model shall reflect the AVE characteristics without regard to stimulus characteristics. Tracking precision shall be consistent with the requirements specified in paragraph 3.1.1.1.8.1.6.3.

V 3.1.1.1.8.1.6.2 Line-of-Sight Perturbations

The MDS shall perturb the visual presentation of the ground scene to simulate the position and motions of the line-of-sight during tracking. The following errors to the LOS, which are essentially static or producing low rates, shall be selected:

a. Attitude measurement errors.

b. Servo bias errors.

c. Ephemeris errors (cross-track, in-track, altitude.)

d. Mirror rate measurement errors.

e. Target location errors (longitude, latitude, altitude).

f. Misalignment errors.

These perturbations shall generally be distributed in the same statistical fashion as the corresponding AVE errors. The simulator shall have the capability to represent 95.45 percent of all the pointing errors consistent with the stimulus format size and scale factors (paragraph 3.1.1.2.5). In addition, the MDS shall, in those modes where the AVE computer does so, transfer operator pointing corrections made in the ATS to the Visual Optics.

The MDS shall perturb the visual presentation to simulate the response of the line-of-sight to the following v;ehicle structural disturbances which are of an oscillatory nature:

a. Bearing noise.

b. Main mirror slew, and settling.

c. ACTS jet firing.

The above disturbances shall be coordinated in time with the actual events which produce them. These disturbances will be simulated with a resolution equivalent to two arc minutes per axis apparent.

Resolution - - - - - - - - - 1.8 μ rad LOS

Command Rate - - - - - - - - 100 commands/sec

NOTE

Resolution is defined as the smallest servo output which can be achieved by varying the input.

∇ 3.1.1.1.8.1.6.3 Overall Line-of-Sight Position Accuracy

The MDS shall have the capability to determine, at any instant of time, the position of the line-of-sight relative to the target to an accuracy equivalent to 0.06 inches at the plane of the stimulus material. This represents total system error including servo, computational, stimulus registration, and location of the target on the stimulus material. The overall line-of-sight position precision shall be better than two arc minutes per axis apparent. The purpose of this requirement is to ensure smooth low apparent rate performance.

∇ 3.1.1.1.8.1.6.4 Stick Effects

The MMSE shall have the capability of changing the transfer function between control stick motions and the resultant line-of-sight motion. The limiting values of stick commands are:

LOS rate - - - - - - - - - - max. 0.5 deg/sec each axis, with a position resolution better than two arc minutes per axis apparent.

LOS acceleration - - - - - - - 0 to 6.3 deg/sec^2 each axis

The purpose of the command resolution requirement is to allow smooth low rate stick commands. In addition, it shall be possible to reverse the polarity of the controller independently on each axis. The change shall be initiated manually during a normal stimulus turn around cycle.

3.1.1.1.8.1.6.5 Image Derotation

The MDS shall simulate the AVE derotation prism by erecting the in-track line at the end of each slew. In addition the capability shall be provided to orient the image in any direction. The image shall be rotated during rack only to simulate vehicle motions.

3.1.1.1.8.2 Earth Phenomena

3.1.1.1.8.2.1 Lighting

3.1.1.1.8.2.1.1 General

The light levels (scene and haze) shall be controlled to a tolerance of ±10 percent. The color temperature of both sources shall be fixed at some value in the range of 3000 to 6000°K. As intensity varies, the color temperature shall not vary by more than ± 25 mireds.

3.1.1.1.8.2.1.2 Scene Lighting

The ground scene brightness shall be variable over a 50:1 range up to 20 foot-lamberts open gate as seen by the operator. This brightness range accounts for the VO light transmission per paragraph 3.1.1.1.8.1.4. Basic scene illumination shall vary from target to target as a function of atmospheric composition and Sun position. The basic scene illumination shall vary due to target latitude, season and local time.

3.1.1.1.8.2.1.3 Haze

The haze brightness (atmospheric lumaninice) shall be variable over a 50:1 range up to 10 foot-lamberts as seen by the operator. This brightness range accounts for the VO light transmission per paragraph 3.1.1.1.8.1.4. The haze illumination for any target shall be constant. Haze brightness shall be coordinated with scene brightness.

3.1.1.1.8.2.2 Ground Scene Special Effects

The following characteristics of the ground scene shall be represented by the stimulus material:

a. Cloud cover.

b. Cloud shadows.

c. Shadows of objects on the ground.

d. Specular reflectance.

Main optics stimulus material containing clouds may be used in certain prescripted cases to simulate IVS saturation due to lock-on to clouds.

3.1.1.1.8.2.3 Target Location Relative to Vehicle

The Visual Optics target shall be anywhere within the following envelope:

In-track - - - - - - - - - -	30 degrees forward to 40 degrees aft
Cross-track - - - - - - - - -	40 degrees left to 40 degrees right
Altitude - - - - - - - - - -	75-85 nm

The persepective and slant range associated with the above envelope are considered to be properties of the stimulus material and the MDS will have no capability for altering them. Altitudes beyond the range stated above shall be possible if proper stimulus material is provided with scale factor proportional to the required altitude (see Secondary Performance Characteristics, paragraph 3.1.1.2.5). The in-track line on the ground scene will be properly oriented for each target and fixed in time. This orientation shall be determined by the script depending on the status of the VO derotation prism, orbit inclination, and target latitude.

3.1.1.1.8.2.4 Scan Area

The MDS shall allow excursions of the line-of-sight from perfect pointing at the target which are limited only by stimulus material format and scale (see Secondary Performance Characteristics, paragraph 3.1.1.2.5).

3.1.1.1.8.2.5 Scene Streaming

A simulation of rapid image streaming which occurs during slew or periods when the gimbals are stationary (as during a power failure) is not required, i.e., a real, blurred image need not appear. However, during such periods the ground scene shall be blocked from view and the field-of-view illuminated to an intensity comparable to the scene intensity.

3.1.1.1.8.3 Main Optics Alignment

The MDS shall provide the capability to simulate the verification and improvement of the Main Optics alignment. The simulation of the three optical alignment modes of manual, automatic, and remote will be provided. Simulation of the alignment grids insertion into the eyepiece will be performed with the thermal door closed.

3.1.1.1.8.4 Associated Controls and Displays

Controls and displays used in conjunction with the VO shall be active and simulate the same functions as in the AVE. The following controls and displays are required:

a. Magnification Control Stick.

b. Control Stock.

c. Manual Overrides:

   1. Thermal Door
   2. Derotation Prism
   3. Power Changer (Turret)

d. Power On/Off Switches.

e. Event Indicators.

f. Focus and Alignment Controls and Displays.

3.1.1.1.8.5 Control Stick and Magnification Control During Freeze

It shall be possible, at the option of the SCC operator, for the crewmen to scan the stimulus area and change magnification during the freeze mode. The response of the stick controller shall enable scanning of the stimulus area but need not comply with the requirements of paragraph 3.1.1.1.8.1.6.4.

3.1.1.1.9 Cue Subsystem

The Cue Subsystem will be presented by rear projection display. Four operating modes shall be simulated in the rear projection display. In the manual mode the ability to advance, backup, or random access shall be provided. Consecutive cues can be accessed in one second. Any one cue in the file shall be accessible in four seconds. The auto-prepass mode shall provide a manually controlled dwell time. The auto-during pass mode shall provide a computer controlled dwell time. The minimum and maximum time to view the cue will be as programmed in the auto-during pass mode with no limit in the auto-prepass mode. Upon command, an accessed slide image shall be insertedinto or removed from the eyepiece in 0.4 $\pm$ 0.1 second.

3.1.1.1.10 Photographic Section

A simulation of the film processor, primary and secondary camera assemblies, primary film handling equipment and the controls and displays for focus, alignment, correction, VO, and film handling shall be included in the MDS. In addition, controls and displays associated with the photographic equipment and located on the operating panels shall be dynamically driven to indicate nominal and non-nominal operation of the photographic equipment. Eyepiece display simulation of VO "reticle" focus control will not be provided. Primary and secondary camera controls and displays, which are under ADC control in the AVE, shall be interfaced with the simulator ADC. Data handling of such items as edge data, frame count, camera commands and camera responses shall be simulated.

The simulation equipment for this subsystem shall provide the capability to develop operational tasks that are to be performed with this equipment on orbit. Sensors and interlocks shall be provided and interface with the Simulation Computer Subsystem. The manual tasks associated with film processing shall be provided, however, actual film processing is not required. Provision for a later addition of a film viewer will be considered in the design.

An AVE complement of simulated DRC's, cassettes, and tools associated with photographic equipment shall be provided. Design of these devices shall allow accomplishment of all manual tasks associated with them. Storage space shall be provided which simulates the AVE interface.

3.1.1.2 Secondary Performance Characteristics

The MDS shall be divided into subsystems as described herein:

a. Hardware

1. Simulated Laboratory Module Subsystem.
2. Simulator Control Subsystem.
3. Simulation Computer Subsystem.
4. Interface Subsystem.
5. Stimulus Subsystem.

b. Software

1. Executive.
2. Real World Tracking.
3. Simulation Data Generator.
4. Hardware Simulation.

5. Stimulus and Display Drive.

6. Non-Real Time Functions.

7. On-Board Computer Programs.

3.1.1.2.1 Simulated Laboratory Module (SLM)

The SLM shall provide an environment within the SLM like the AVE from the bottom of the curved floor to the top of the "B" panel. Simulation of controls requiring access behind the operating panels will not be provided. To ensure environmental similarity, the SLM shall be designed to provide the following:

a. Ambient Light Level - The cabin level shall be variable from 0 to 50 foot candles.

b. Temperature - The temperature shall be maintained between 60 and 75^{o}F. Control of the cabin temperature shall be accomplished from within the cabin.

c. Panel Lighting - Functional simulation of AVE EL panel lighting is required on all active panels.

d. Seat Restraints - Seat restraints will be designed for one-g operation. The seat reference point will be the same as the AVE.

e. Noise Level - The noise level shall be equivalent to that in the EDS.

f. Communications - Voice communications shall be provided between the SLM and the SCC. Communications will be a standard intercom with no AVE controls and displays simulated. A recorder will be provided during MPSS operation to record crew comments.

The prime film handling equipment, normally located above Console No. 1, shall be located external to the SLM. Simulation of storage locations above the top of the "B" panel will be accomplished externally to the SLM.

3.1.1.2.2 Simulation Control Console

The SCC shall provide simulator control and performance monitoring as well as features which are necessary for the operation and control of the MDS as defined herein.

Provisions shall be made to monitor the images presented to the operators through the eyepieces. An optical pick-off of each eyepiece display shall be used to drive TV monitors mounted at the SCC.

Controls shall be provided to record experimental data.

An alphanumeric keyboard and display system shall be provided for inserting new data or modifying old data in the computer. This display system shall enable the operator to modify the script as desired during system operation, and to call up and monitor data in a pre-defined format.

The SCC shall have controls and displays for applying power to the subsystems making up the MDS with the exception of the computer subsystem. In addition to the subsystem control and monitoring facilities at the SCC, the Control Console shall have the necessary controls and displays to exercise the simulator to determine its operability. Additional controls shall be provided to allow initialization, start, stop, freeze, resume, checkpoint, recycle, inhibit, single step, and single cycle control of the computer.

3.1.1.2.3 Simulation Computer Subsystem

The complex shall consist of all computational elements, memory data channels, input/output controllers, operating consoles, and peripheral devices required for the simulation function.

The MDS computer program shall be designed for operation within the capability of the MDS computer. As a design objective, the MDS computer program shall be limited to a utilization of 80 percent of its operational time and core storage capability of the MDS digital simulator computers (IBM 360/44 and SDS 930) as follows:

a. The overall operational time utilization should be equal to or less than average of 0.8 seconds per second over any mission time line segment during which the On-Board Computer program mode remains unchanged.

b. The peak operational time utilization used for demand operations (i.e., excluding non-demand overhead operations) should be equal to or less than 80 milliseconds for any of the real-time operational prime 100-millisecond time frames.

c. The total core utilization should be equal to or less than 80 percent of the MDS computer full core complement of 49,152 words.

d. Any one digital simulation computer shall have a core utilization of not more than 90 percent of its full core complement.

e. The analog computer shall be loaded to not more than 80 percent of its operational amplifier and input/output capability.

3.1.1.2.3.1 Simulation Control

The Simulation Computer Subsystem shall provide the capability to control and coordinate the operation of the various subsystems as defined by the operating mode.

3.1.1.2.3.2 Data Computation

The Simulation Computer Subsystem shall provide for all analog and digital data computation requirements.

3.1.1.2.3.3 Data Transfer

The Simulation Computer Subsystem shall provide the capability to transfer data to the Interface Subsystem at a rate which will enable the various components to operate within their specified tolerances.

3.1.1.2.3.4 Data Recording and Display

The Simulation Computer Subsystem shall provide for the on-line recording of data, in pre-defined formats, for each software iteration for post-simulation processing and analysis. It shall also provide for the on-line display of data in pre-defined formats.

3.1.1.2.3.5 Malfunctions

The Computer Subsystem shall provide the capability to simulate malfunctions of the various components by means of status changes and parameter values. Programmed malfunctions shall be selected from a library by a pre-defined script statement in real-time as commanded from the SCC.

3.1.1.2.3.6 AVE Software Development

The Computer Subsystem shall include an IBM 360/44G computer, which is used as a functional prototype of the AVE computer, for the purpose of ADC software development.

3.1.1.2.3.7 Data Computation Subsystem Group (DCSG) Simulation

The AVE Data Computation Subsystem Group will be simulated by the inclusion of DCSG components in the simulator, or by simulation computer software as indicated in the subparagraphs below.

3.1.1.2.3.7.1 Airborne Digital Computer

An engineering prototype of the Airborne Digital Computer (ADC) shall be included in the simulator. It shall contain only on-board software. The on-board software will be presented with an input/output and signal characteristic interface identical to that which it will encounter in the vehicle.

3.1.1.2.3.7.2 KDU and Printer

The simulator shall include prototypes of the DCSG KDU and Printer. These two components will be physically located in the SLM.

3.1.1.2.3.7.3 Auxiliary Memory Unit

The Auxiliary Memory Unit (AMU) shall be simulated with a magnetic tape unit of the simulation computer and with software. Data content will be identical to AVE AMU data. The simulation computer AMU software will provide AMU data to the ADC in AVE format.

3.1.1.2.3.7.4 LDAU and Computer Subsystem Controller

The LDAU and Computer Subsystem Controller (CSC) shall be simulated with simulation computer software.

3.1.1.2.3.8 MDAU

The MDAU shall be simulated with simulation computer software and the ADCAS.

3.1.1.2.4 Interface Subsystem

The Interface equipment shall consist of the Digital Interface Unit, 930/360 Adapter, Printer and Keyboard Adapter (PAKA) and Airborne Digital Computer Adapter Simulator (ADCAS).

3.1.1.2.4.1 Digital Interface Unit

The Digital Interface Unit (DIU) will provide input/output signal routing from the SDS 930 digital computer to other simulator subsystems.

The DIU shall also provide the necessary timing and control necessary to pass data between the Simulation Computer Subsystem, Simulation Control Console, and the Simulated Laboratory Module. As a design goal the DIU shall have a 20 percent growth and spare capability. The spare interface equipment will be provided such that the capability can be enlarged by the addition of logic cards into prewired classes.

3.1.1.2.4.2 930/360 Adapter

The 930/360 Adapter will provide the interface between the hybrid (930/2200) system and the IBM 360/44 computer system.

3.1.1.2.4.3 PAKA

The PAKA will provide the interface with the AVE Printer and KDU in the SLM and the 360/44.

3.1.1.2.4.4 ADCAS

The ADCAS will provide the interface between the 360/44 and the Airborne Digital Computer (ADC). The ADCAS interface with the ADC will be functionally identical to the interfaces provided to the ADC by the LDAU, MDAU, Printers, KDU, and the CSC in the AVE. The interface between the Beckman 2200 analog computer and the Stimulus Subsystem will be provided by the Power Conditioning Equipment.

3.1.1.2.5 Stimulus Subsystem

The Stimulus Subsystem shall consist of the Acquisition Eyepieces, the Visual Optics Eyepieces, and the Cue displays, including the equipment necessary to provide the images on these displays. To develop the optical capabilities of the stimulus subsystem an optical bench test shall be performed. The following secondary performance capabilities are required of this subsystem.

3.1.1.2.5.1 General

All elements of the Stimulus Subsystem shall be designed to allow a turn around time of 10 minutes or less for rerunning the same active reconnaissance pass and 30 minutes for initializing a full new target load.

All optical systems shall be designed primarily to present black and white imagery. The presentation of color imagery is a secondary objective. All optical trade-offs shall be made in favor of optimizing performance with black and white stimulus material.

3.1.1.2.5.2 Acquisition Displays

The MDS shall be designed to present a total of up to 70 slides in each slide changer. The capability for presenting more than one target per slide will be provided. These slides will be allocated between LPA and HPA by the script. The ability to switch from L... to HPA and vice versa in the required time will be dependent on the way the slide positions are allocated by the script, and the availability of sufficient duplicate stimulus material. The scale factor of these slides will have any value within the following two ranges:

LPA	HPA	
128,000:1 to 160,000:1	32,000:1 to 40,000:1	Scale Range A
286,000:1 to 364,000:1	71,500:1 to 91,000:1	Scale Range B

For any one simulated target pass only one scale range is applicable. The capability to change scale ranges within 10 minutes shall be provided. These scale factors correspond to simulations of nominal (75-85 nm) altitudes per paragraph 3.1.1.1.7.2.3. The MDS shall allow the line-of-sight to be scanned over very nearly the entire surface of the slide ($\pm$4.06 inches in two orthogonal directions).

The mechanism for changing 9 in. x 9 in. target slides shall have the capability of operating either of the two elevators independently and in either direction and of bringing any one of four slides into view in one second or less. Speeds for reverse operation shall be the same as for forward operation. In addition, it shall have the capability to skip up to five slides and present the sixth for viewing in three seconds or less. An automatic restacking capability shall be provided.

The MDS design will be performed in such a way as to allow an actual AVE Acquisition Eyepiece Assembly to be retrofitted to the display. All optical trade-offs shall be made in favor of the AVE eyepiece rather than the supplemental eyepiece to be supplied initially. The design of the MDS will be such that it will allow the AVE eyepiece to exhibit its normal functional characteristics as defined in paragraph 3.1.1.1.7.

3.1.1.2.5.3 Visual Optics Displays

he MDS shall be designed to present a total of up to 70 main optics slides. The MDS shall allow the line-of-sight to be scanned over the surface of the frame up to $\pm$4.06 inches in two orthogonal directions.

The mechanism for changing 9 in. x 9 in. frames shall have the capability of operating either of the two elevators independently and in either direction and of bringing any one of four slides into view in one second or less. In addition, it shall have the capability to skip up to five slides forward or backward in two seconds. An automatic restacking capability shall be provided.

3.1.1.2.5.4 Cue Displays

The MDS cue system simulation shall provide the capability to present one cue per acquisition target in the "during pass" mode, and one cue of different content per acquisition target in the pre-pass briefing mode. Cues shall have a 35 mm super slide format.

3.1.1.2.6 Simulation Executive Function

In addition to the simulation software requirements specified in paragraphs 3.1.1.2.6 through 3.1.1.2.12, the MDS shall be designed to provide an essentially realistic software development and validation environment for the ADC computer programs (CEI MOK 802A).

The Simulation Execution Function consists of one module, the Simulation Executive. This module performs the following functions:

1. Responds to operational mode controls.
2. Determines and controls sequence of real time modules.
3. Insures time simulation of all simulator functions.
4. Senses and responds to simulator equipment failures.
5. Controls transfer of data between the various simulation computers and the simulation hardware.
6. Controls operation, mode of the analog computer.

3.1.1.2.7 Real World Tracking Function

This function block computes the reference tracking data; i.e., the tracking is based on simulated perfect knowledge of the vehicle, star and target position and velocity as well as perfect knowledge of vehicle attitude and rate of change of attitude. The output of this function is the line-of-sight vector to two stars and to three ground targets (one on each Acquisition and Tracking Scope and one for the Main Optics). The Attitude Control and Translation System (ACTS) is also simulated in this function block. This function block consists of the following modules:

a. Mission Data Error Correction Adder.
b. Ephemeris and Error Adder.
c. Sun Angle Generator.
d. Reference Line of Sight Generator.

3.1.1.2.8 Simulation Data Generation Function

This function block provides the simulation with real time, on line, data management capability. The block inputs script statements and interprets the required function.

Command Data Messages and reference tracking data are inputted through this function. This function extracts all necessary data to drive the reference tracking function from the Command Data Message. All communication with the ADC is handled in this function block, including data from the Auxiliary Memory Unit. This function will respond to and drive all Controls and displays associated with the Computer Group. This block consists of:

a. Mission Data Adapter Unit Simulator.
b. Laboratory Decoder Simulator.
c. Bulk Data Handling.
d. Script Interpreter.
e. Laboratory Data Adapter Unit Simulator.

3.1.1.2.9 Hardware Simulation

This block is composed of modules which simulate the responses of various drives and sensors which are part of the MPSS. These consist of the gimbal drive responses for the Main Optics, Star Tracker and Acquisition and Tracking Scope, the derotation prism responses, and the camera responses. The IVS sensor outputs and the film processor are also simulated. Both nominal and non-nominal responses must be included. The dynamic responses in the prism system are modeled and thermal responses in this block. The Telemetry and Monitor and Alarm Subsystems are simulated to the extent they reflect the MPSS. All displays and controls associated with the simulated hardware will be interfaced with this function block. This block consists of the following modules:

a. Drive Control Response and Position Simulation.
b. Payload Simulator and Hardware Controller.
c. Electrical Power and Signal Distribution Module.
d. Mission Module Environmental Simulator.
e. Mission Module Variable Alignment Simulator.
f. Image Velocity Sensor Simulator.
g. Derotation Simulator.
h. Star Tracker Simulator.
i. Telemetry/Monitor and Alarm Simulator.
j. Film Processor Simulator.
k. Attitude Reference Generator and ACTS Simulator.

3.1.1.2.10 Stimulus Control Function

This function block contains the simulation modules which generate the simulation hardware drive signals. In addition, all data received from the simulation hardware is received, formatted and distributed by this function block. The drive signals are compensated, formatted and transmitted by this block. This block consists of the following modules:

a. Tracking Simulation Controller
b. Display Position Drive.

c. Performance Data Collection.

d. Input.

e. Output.

3.1.1.2.11 Non-Real Time Functions

The non-real time functions either prepare data for use in the simulation or analyze performance data collected during a real time simulation run. The presimulation functions include Editing and Formating Command Data Messages, preprocessing the script, generating ephemerides (including errors), generating target locations errors and generating stellar vectors. In addition, a hardware checking capability will be provided. This block consists of the following modules:

a. Command Message Editor.

b. Script Preprocessor.

c. Presimulation Data Generator.

d. Post Operation Data Reduction and Evaluation.

e. Program Library Generate/Update.

f. Simulation Check.

g. Data Base Present/Update.

3.1.1.2.12 On-Board Computer Programs

Provisions shall be made to operate the MDS with all On-Board Computer Programs contained in CEI-MOK-802A and G. F. P. Software as specified in SAFSL Exhibit 34121. These programs will be unmodified for simulator operation. All simulated malfunctions associated with the ADC software will be incorporated in the MDAU or LDAU simulation. The on-board programs execute all stored commands and real time commands associated with the ADC or MPSS. These programs provide the drive command to the Main Optics, Acquisition and Tracking Scope, Camera, Star Tracker and simulated Visual Display Projector as well as various console controls and displays. In addition the computer collects data to enable the ground to access the reconnaissance value of each target photograph.

3.1.2 OPERABILITY

3.1.2.1 Reliability

The MDS shall be designed to give an availability of 80 percent based on single shift operation, scheduled preventive maintenance and a MTBF of 27.6 hours. The 27.6 hours MTBF figure will be verified by an analysis based on the assumption that the:

1. IBM 360/44 has a MTBF of 87 hours
2. SDS 930 has a MTBF of 1500 hours
3. Beckman 2200 has a MTBF of 1000 hours
4. ADC has a MTBF of 1512 hours
5. ADCAS has an MTBF of at least 400 hours
6. PAKA has an MTBF of at least 400 hours

3.1.2.2 Maintainability

Each assembly and subassembly forming a part of this equipment shall be designed to permit access to its interior. Such access shall be to an extent that will enable circuit checking and removal and replacement of parts. All covers, hinged access doors or removal panels that must be opened for inspection or maintenance purposes shall be secured by readily removable screws or quick-release mechanisms. The maintainability provisions of paragraph 3.5.1, MIL-T-27474, as amended, apply.

3.1.2.2.1 Maintenance and Repair

Maintenance and repair cycles shall be consistent with the operating requirements specified in paragraph 3.1.2.1. Hardware and component spares shall be provided.

A. Documentation - A Maintenance Description Document and an Operations Description Document shall detail the concepts to be followed in operation and maintenance of the system after delivery. These plans will be implemented through detailed standard operating procedures to be published separately by the contractor.

B. Software Program Support - A series of software system checkout and diagnostic programs shall provide a quick health check of the simulator and assist in fault isolation as follows:

1. Internal check of 360 operation (vendor diagnostics)
2. Check of 360 peripheral equipment (vendor diagnostics)
3. Check of ADC/ADCAS/360 interface (vendor diagnostics plus I/O tester capable of fault isolation as provided by IBM as part of maintenance contract).
4. Check of 360/PAKA/Printer and Keyboard (vendor diagnostics plus I/O tester capable to the card level as provided by IBM as part of maintenance contract).
5. Check of 930 internal and peripheral (vendor diagnostics).
6. Check of 360/930 interface (diagnostic software capable of fault isolation to the I/O bit level).
7. Check of 2200 (Maintenance patch panel with manual proc. capable of fault isolation to the amplifier level).
8. Check of 930/2200/Hybrid system (vendor diagnostics).

C. Trouble Shooting Procedures - Necessary trouble shooting procedures that will permit tracing the flow and interruption of data through sequential list points in the system will be provided. This procedure is to be implemented by a standard card listing which will identify correct signal levels at access points in the circuit. The trouble shooting procedure will detail the steps required to isolate a fault to the logic card level. Special test equipment will be provided to isolate logic card failures to the piece-part level.

D. Preventive Maintenance Routines - A system of preventive maintenance routines and the frequency of accomplishing each routine shall be established.

E. Software Pre-Simulation Automation Programs - Pre-simulation software programs shall be included to assist in automatic generation of simulation input data to conform to a designated sequence-of-events in a given simulation exercise.

3.1.2.2.1.1 Power Interrupt Protection

The MDS shall include self-protective devices to prevent damage in the event of power surges, failures, or interrupts. The protective devices and checkout routines shall be designed so that operations which were in progress may be resumed within two hours after the abnormal power condition is rectified.

3.1.2.2.2 Service and Access

The simulated Laboratory Module shall be constructed with removable exterior panels to provide access to the rear of the consoles. The console instrument panels in the Simulated Laboratory Module and in the Simulator Control Consoles shall be easily removable or hinged to console structure. Quick disconnect electrical connectors shall be used to facilitate component removal for test and repair. The MDS shall conform to the Service and Access provisions of paragraph 3.5.1, MIL-T-27474, as amended.

3.1.2.3 Useful Life

The MDS shall be designed for a useful life in excess of 8000 operating hours over a period of three calendar years of intermittent operation when supported by scheduled and periodic maintenance. Parts and equipment having characteristics of degradation with life shall be identified.

3.1.2.4 Environmental

The MDS shall be designed for operation in an enclosed laboratory environment specified to have filtered air, operating temperature of $72^{o}F \pm 5^{o}$ and humidity of 45 percent ± 5 percent. Its design operating environment temperature shall be 60 to $77^{o}F$.

3.1.2.5 Transportability

There are no transportability design requirements for the MDS. However, the design of components common to MMSE shall meet the transportability requirements of CEI 1400 BI.

3.1.2.6 Human Performance

The design of the system shall be such that all aspects of human performance are considered to achieve an optimum man-machine relationship. Appropriate task analyses and design criteria shall be generated in accordance with MIL-H-27894A.

3.1.2.7 Safety

3.1.2.7.1 Flight Safety

Not applicable.

3.1.2.7.2 Ground Safety

Not applicable.

3.1.2.7.3 Nuclear Safety

Not applicable.

3.1.2.7.4 Personnel Safety

a. The MDS shall be designed to assure safe operation to using personnel during training periods as well as during maintenance operations in accordance with MIL-STD-454, Requirement 1. All Class IV hazards shall be eliminated and Class III hazards minimized and controlled in accordance with MIL-S-38130.

b. Personnel contact with potential electrical and mechanical hazards shall be eliminated by safety devices such as covers, shields, guards, warning labels, or interlocks in accordance with MIL-T-27474 paragraph 3.4.4.1, revised.

c. Additional personnel safety requirements shall comply with the requirements of MIL-STD-803, paragraph 13.

d. Materials which will support combustion or which are capable of causing an explosion shall not be used as specified in MIL-STD-454, Requirement 3.

e. The MDS shall comply with the safety requirements of paragraphs 3.4.4 and 3.4.4.1 of MIL-T-27474, as amended.

3.1.2.7.5 Explosive and/or Ordnance Safety

Not applicable.

3.1.2.8 Ease of Operations

The MDS shall be designed for ease of operations. Operational requirements will be further specified in SAFSL Exhibit 34004, which will amplify the following typical items:

a. Scripting aids, such as check lists and scripting programs, shall be provided.

b. Target indexing and weighing, command generations and verifications, and ephemeris generation shall be simplified and automated to the extent practical.

c. The performance data routine shall be capable of displaying, printing, or storing on tape any of the parameters in the data base as defined in a predetermined parameters immediately after a data run. It shall be capable of printing out any parameter in the data base within 15 minutes after a run as defined in a predetermined format. The data shall be in predetermined formats (engineering units, octal, PFS, etc.) with alpha-numeric designators. It should be capable of accepting changes to the display formats at any time before a run.

3.1.3 DATA BASE REQUIREMENTS

The simulation data base shall provide the data interface for all modules within the simulation programs. It shall contain the following types of data:

3.1.3.1 All parameters used to mechanize the software representation of the system.

3.1.3.2 Malfunction and error parameters, system Status Flags and Flow Flags

3.1.3.3 Constants common to several programs.

3.1.3.4 Simulation Data Mode format definitions.

3.1.3.5 Predefined operator messages.

3.1.3.6 Simulation Display Mode format definitions.

3.2 SYSTEM DEFINITION

3.2.1 INTERFACE REQUIREMENTS

3.2.1.1 Schematic Arrangement/Interface Block Diagram

The block diagram shown in Figure 3-1 shows the subsystem interfaces.

3.2.1.2 Detailed Interface Definition

Not applicable.

3.2.1.3 Facilities

Facilities provided for the MDS equipment shall include the following:

a. AC power.

b. Air conditioning.

c. Raised floor for cables.

d. Maintenance area.

e. Storage area for spare parts.

f. Storage area for stimulus material.

3.2.2 COMPONENT IDENTIFICATION

The following subparagraphs identify the components of the system.

3.2.2.1 Government Furnished Property

G.F.P. is specified in SAFSL Exhibit 34121.

3.2.2.2 Engineering Critical Component List

Not applicable.

3.2.2.3 Logistic Critical Component List

Not applicable.

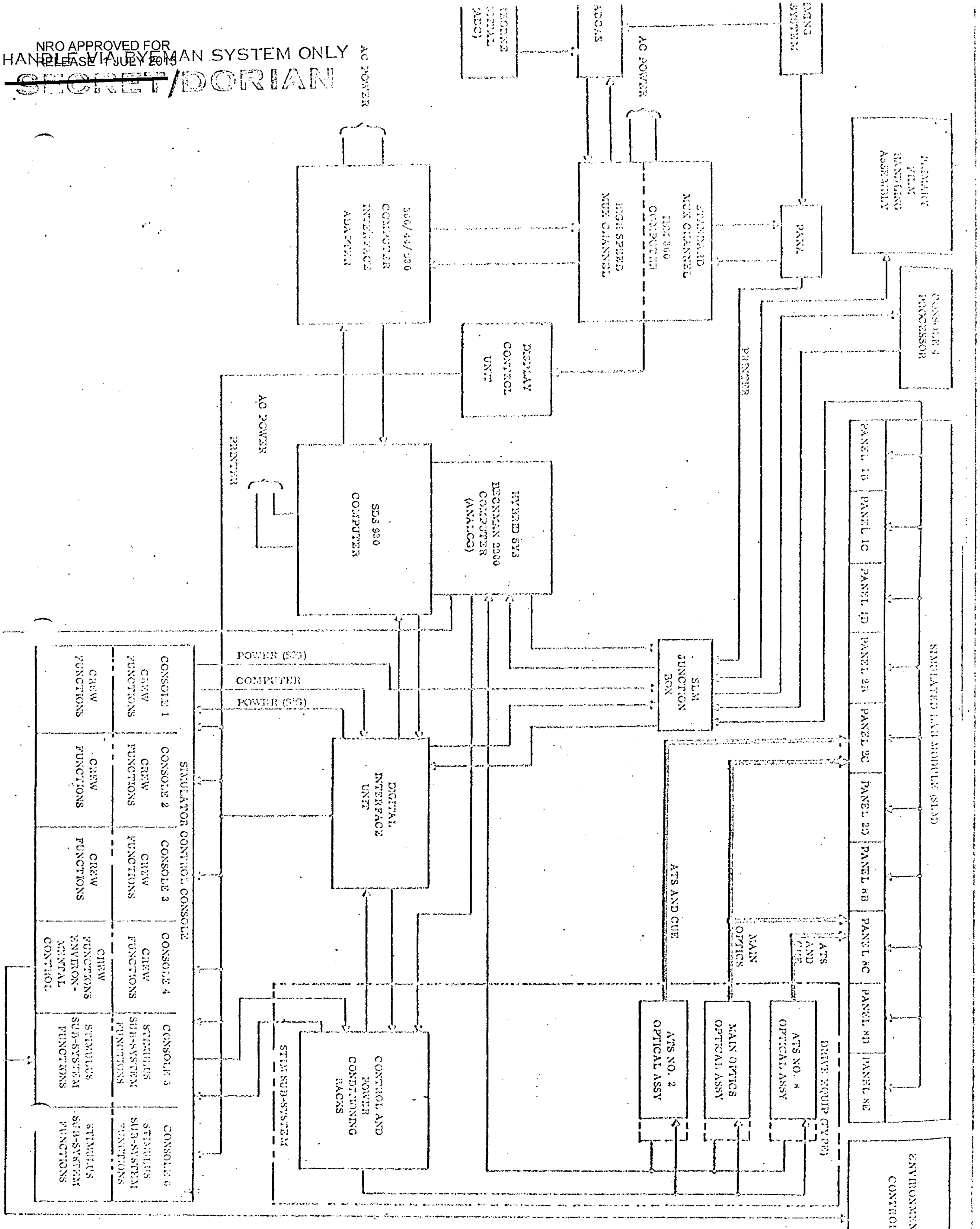

FIGURE 3-1. MDS SUBSYSTEM INTERFACE

3.3 HARDWARE DESIGN AND CONSTRUCTION

3.3.1 GENERAL

The MDS shall provide simulation of all mission related functions to support the performance requirements set forth in paragraph 3.1. In addition, the design will conform to the maximum practical extent the requirements of the MMSE CEI MOL 900AI. Commonality of subsystem components will be required wherever practical. The equipment will be designed to accommodate periodic inspections, complete optical and mechanical calibrations, and daily checkout operations.

The MDS shall have the five following subsystems:

1. Simulated Laboratory Module
2. Simulation Control Console
3. Computer Subsystem
4. Interface Subsystem
5. Stimulus Subsystem

The subsystems, with the exception of the Computer Subsystem, the ADCAS, PAKA and 360/930 Adapter of the Interface Subsystem, and the Slide Viewer System of the stimulus subsystem shall be designed and fabricated in accordance with MIL-T-27474 as amended.

3.3.2 STIMULUS SUBSYSTEM

3.3.2.1 Acquisition

3.3.2.1.1 General Description

This section of the specification delineates the performance requirements for the Slide Viewing Subsystem (SVS).

The equipment will consist of the source holding and selection system, an optical processing and relaying system, and the electrical driving system.

3.3.2.1.2 Source Holding and Selecting System

The source material is 9 in. x 9 in. diapositive film plates. Two holder and changer systems are required on the bay No. 2 ATS and one on the bay No. 8 ATS. The bay No. 8 ATS shall have the capability to incorporate the second holder/changer. Each holder must hold 70 9 in. x 9 in. diapositives. Each changer system must be able to change to next slide within one second. Furthermore, the changers must be so designed as to be commanded to any diapositive, forward or reverse of the present position, and to operate the two elevators independently. The time response for access to five positions will be within two seconds. The changer design shall provide the capability to recall the preceding slide within one second if it has not been rejected. An automatic restacking capability shall be provided:

Table 3-1. Source Holding and Selecting System Requirements

Holder/Changers	3 required
Capacity (ea)	70 9 in. x 9 in. diapositives
Change Speed	1 sec adjacent sides 2 sec 5 adjacent indexes
Direction	Forward or reverse

3.3.2.1.3 Optical Processing and Relaying System

The Optical Processing and Relaying System in the SVS shall perform various optical functions on an input image and transmit this processed image to an eyepiece. The purpose of this system is to optically process an input image by dynamic change of image perspective, dynamic change in image orientation and dynamic optics center selection.

3.3.2.1.3.1 Image Intensity

The image intensity shall have a variable light level range of 50:1 with the upper level at 500 foot lamberts when the system is evaluated without diapositives in the chain. The color balance of the light shall be between 3000 and 6000^{o}K.

3.3.2.1.3.2 Image Size

The angular magnification of the objective shall be by a continuous zoom technique. The range of change is 7.2:1. This magnification change shall be presented in an exit pupil so that the field presented will subtend an apparent 60 degrees ± 1 degree field of view. Further, when the image is at the lowest magnification the exit pupil shall be 4 mm and as the magnification increases the exit pupil will decrease to 2 mm.

3.3.2.1.3.3 Image Perspective

Anamorphic optics will provide image perspective by distorting an input to simulate various slant angles of view. The amount of image perspective provided will be determined by the initial stimulus geometry and scale. For all stimulus provided, it shall be possible to simulate stereo angles from +45 to -40 degrees, and to change stimulus roll angle by at least ± 10 degrees. These conditions shall be met if the target original stereo angle is 15 degrees or less.

3.3.2.1.3.4 Optical Center Selection

The center of the optical axis with respect to the diapositive shall be continuously variable to at least ± 4 inches in two orthogonal directions.

3.3.2.1.4 Electrical Drive System

This section discusses the response characteristics required for the various optical components to meet the dynamic time and accuracy specification.

3.3.2.1.4.1 Brightness Control

A filter modulator drive will cause a brightness change of 16 percent within 1 second. The drive must be real-time to simulate brightness change caused by Sun angle, slant angle and ranging.

A fast response capability will also be available to set the filter modulator to any command position within the brightness range within one second.

Control accuracy shall be within ± 10 percent of a commanded foot lambert setting.

3.3.2.1.4.2 Magnification Control

The spherical zoom control will cause magnification change to be continuous over the operating range and will simulate the 2:1 magnification change within 0.5 second.

3.3.2.1.4.3 Anamorphic Control

The dynamic perspective change shall be provided by an anamorphic lens assembly. The anamorphic azimuth shall be continuously varied on command from 0 to 360 degrees within one second and to an accuracy of ± 15 arc minutes.

3.3.2.1.4.4 Image Rotation

The image rotation shall be continuously varied on command from 0 to 360 degrees within one second and to an accuracy of ± 30 arc minutes.

∇ 3.3.2.1.4.5 Position Selection

The drive to place the diapositives on an optics scanner to a selected portion of the objective shall have the following performance characteristics:

a. The center of the optics chain shall have a position accuracy of ± 0.00590 inch with a repentability of position to ± 0.00040 inch.

b. The minimum position change is 0.00040 inch.

c. Position change shall be capable of position change at a rate from 0 to 4.61 inches per second. Simultaneously, positioning commands will contain accelerations from 0 to 38 inches per second square.

d. Overall system position precision shall meet the requirements specified in paragraph 3.1.1.1.8.1.6.3.

3.3.2.1.4.6 Acquisition Peripheral Display

The initial configuration is described below:

a. All lights will be displayed against a dark background in the outer three degrees in the periphery of a 60 degree field of view.

b. All lights will subtend one-half degree in the field of view (FOV).

c. All lights will have the capability of being switched on singly in any combination or sequence.

d. There will be a total of 35 lights in the wipeout.

1. Twenty-five lights equally spaced within a 120 degree arc in the left hand FOV 60 degrees above and 60 degrees below the horizontal centerline.

2. Two groups of five lights each in the right half of the FOV.

(a) One group of lights equally spaced and centered in a 30 degree arc centered in the upper right quadrant.

(b) The second group of lights also equally spaced and centered in a 30 degree arc centered in the lower right quadrant.

e. The ability to provide a means for color lighting will be provided.

3.3.2.2 Main Optics

3.3.2.2.1 General Description

This portion of the specification delineates the performance requirements for a version of the SVS described in paragraph 3.3.2.1. The configuration of the unit to be used for Main Optics simulation is described herein.

3.3.2.2.2 Source Holding and Selecting System

The source material is 9 in. x 9 in. diapositive film plates. One holder and changer system is required and must hold 70 9 in. x 9 in. diapositives. The changer system must be able to change to the next slide within one sec. Furthermore, the changer must be so designed as to be commanded to any diapositive, forward or reverse of the present position, and to operate the two elevators independently. The time response for access to five positions will be within two seconds. The system shall have the capability of operating in either a forward or reverse mode with equal speeds.

3.3.2.2.3 Optical Processing and Relaying System

The optical processing and relaying system in the SVS shall perform various optical functions on an input image and transmit this processed image to an eyepiece. The purpose of this system is to optically process an image by change of image intensity, change of image size, change in image orientation, and optics center selection.

3.3.2.2.3.1 Image Intensity

The image intensity shall have a variable light level range of 50:1 with the upper level at 20 foot lamberts when the system is evaluated without a diapositive in the chain. The color balance of the light shall be between 3000 and 6000° K, remaining constant ± 25 mireds with changing intensity.

3.3.2.2.3.2 Image Size

The angular magnification of the objective shall be a continuous zoom technique. The range of change available is 7.2:1. Two ranges of stimulus material can be used to cover the full magnification range, the required scale ranges are shown below:

Mag Range	Stimulus Scale Range
125X, 250X, 500X	10240:1 to 18500:1
250X, 500X, 1000X	5120:1 to 9250:1

This magnification change shall be presented in an exit pupil so that the field presented will subtend an apparent 40 degrees ± 1 degree field of view. Further, when the image magnified the exit pupil dimension will decrease as described below:

Magnification	Exit Pupil
125X	6.4mm
250X	6.4mm
500X	3.5mm
1000X	1.75mm

3.3.2.2.3.3 Image Perspective

Image perspective shall be static.

3.3.2.2.3.4 Optical Center Selection

The center of the optical axis as to its orientation to the diapositives shall be continuously variable in two orthogonal directions to at least ± 4.06 inches from the center of the diapositive objective.

3.3.2.2.4 Electrical Drive System

This portion discusses the response characteristics required for the various optical components to meet the dynamic time and accuracy specification.

3.3.2.2.4.1 Brightness Control

A filter modulator drive will cause a brightness change of 16 percent within one second. The drive must be real-time to simulate brightness change caused by Sun angle, slant angle and ranging.

A fast response capability will also be available to set the filter modulator to any commane position within the brightness range within one second.

Control accuracy shall be within ± 10 percent of a commanded foot lambert setting.

3.3.2.2.4.2 Magnification Control

The spherical zoom control will simulate AVE magnification step change over the operating range.

3.3.2.2.4.3 Image Rotation

The image rotation shall be continuously varied on command from 0 to 360 optical degrees within one second and to an accuracy of ± 30 arc minutes.

Δ 3.3.2.2.4.4 Position Selection

The drive to place the diapositives on an optics scanner to a selected portion of the objective shall have the following performance characteristics:

a. The center of the optics chain shall have a position accuracy of ± 0.000590 inches with a repetability of position to ± 0.00040 inch.

b. The minimum position change is 0.0004 inch.

c. The optical center shall be capable of position change at a rate from 0 to 4.61 inches per second. Simultaneously, positioning commands will contain accelerations from 0 to 38 inches per second square.

3.3.2.2.5 Main Optics Alignment

The simulation of optical alignment will be accomplished by inserting the alignment grid patterns into the Stimulus Subsystem on 9 in. x 9 in. diapositives. Simulation of tilt and decenter corrections will be provided using the simulator X-Y positioner. The vehicle control stick will be inhibited during this exercise.

3.3.2.2.6 Main Optics Timer Wipeout

The initial configuration is as follows:

a. Eyepiece will subtend a 40 degree apparent field of view.

b. The peripheral display will consist of 35 lights remotely controlled.

c. Each light will subtend one-half degree in the FOV.

d. All lights will be displayed against a dark background in the outer three degrees in the periphery of the FOV.

e. All lights will be as near white as possible in color, but no correction for color temperature will be necessary.

f. There is a requirement for changing the light colors for coding purposes.

g. The lights will be located as follows:

1. 32 lights at the bottom of the FOV

(a). One light in the bottom center or zero position

(b). 13 lights placed at four degree intervals from zero to 52 degrees to the left of center light

(c). 18 lights placed at four degree intervals from zero to 72 degrees to the right of center light

2. Three lights equally spaced in the upper right quadrant at 10^{o}, 42^{o}, 75^{o} points.

h. The wipeout display will be neither magnified nor totaled in the eyepiece.

3.3.2.3 <u>Cue Presentation</u>

A rear screen cue presentation will be driven at each console. A maximum of 80 cues will be required for each console cue system.

3.3.3 SIMULATED LABORATORY MODULE

The simulated Laboratory Module shall contain all operating consoles associated with the MPSS and certain LMSS devices. Non-operating panels will be blank. Operating panels shall be designed to reflect the configuration of the AVE panel as of the date specified below. All operating components shall be flush mounted on the panels. Recessed controls will be simulated by flush mounted controls with attached quards. They will be designed to provide a comfortable feel to the crewman. All controls shall be designed for maximum flexibility and ease of change.

The SCC shall consist of an assembly of consoles designed for seated operation.

Each console shall consist of an upper panel which slopes downward 20 degrees toward the operator, and a lower panel which slopes 20 degrees upward toward the operator. The upper panel shall be designated GXA and the lower panel GXB. A writing surface shall be provided with each console which can be lifted for access to a storage tray. The panels shall be fastened to chassis slides, and may be maintained at the console by sliding them forward.

3.3.4.2 Controls and Displays

Functional controls and displays in the SLM shall be monitored on the SCC, however, the following items need not be monitored:

a. Audio Volume Controls.

b. Focus and Intensity Controls.

Displays on the SCC used to monitor controls and displays in the SLM shall be grouped according to the arrangements which represent, where practical, the layout of their counterparts in the SLM.

Legends used on the SLM panels to group together related control/display devices, identify device functions and identify control positions, shall be repeated on the SCC, either on the panel or, where appropriate, on the legend face of the related display. Legends on status displays in the SLM shall be repeated on the legend faces of the related displays on the SCC.

3.3.4.2.1 Toggle Switch Monitoring

Toggle switches, except as noted in paragraph 3.3.4.2.1 e.3 shall be represented on the SCC by legend indicators with white diffusers, functionally grouped to represent AVE subsystems. The lights representing a switch shall be grouped together in a vertical

Simulation of the monitor and alarm aural tones shall be provided by two separate tones; one for warning and one for caution.

An intercom communication system will be provided between the SLM and the SCC.

The following panels shall be provided as part of the SLM and shall reflect the AVE design as of the date indicated:

AVE Dwg. No.	Dated
Panel 2C 711-03063	2 July 1968
Panel 2D 711-03064	2 July 1968

The primary film handling equipment located above the "B" panels will be located outside the SLM. The area provided for storage of the secondary cassettes will be in bay 6 in the Simulator to avoid the SLM access door. The other photographic equipment will be located in the SLM in the same location it has in the Laboratory Module.

The bath tub depth will be simulated down to the camera interface with the Ross Plane.

3.3.4 Simulation Control Console (SCC)

3.3.4.1 General

The functions of the SCC are to provide the capability to control and monitor the MDS. The SCC shall include the following:

a. Controls and Displays for simulated operations.

b. Displays of status for SLM controls and displays.

c. Simulation equipment status displays.

d. Controls for recording of simulation test data.

e. Display for monitoring test data.

column, each light representing a single position of the switch. Legends on the SLM panels identifying switch positions shall be repeated on the associated lights on the SCC. Each display shall conform to Case 1, 2, or 3 illustrated in Figure 3-2, depending on the type and function of the switch being monitored. The following criteria shall govern the selection of the display to be used:

a. In general, maintained toggle switch positions marked OFF, NORMAL, and CLOSED shall not be shown by lights. These missing positions shall be shown by black bordered, rectangular areas containing the appropriate legends as shown in Figure 3-2, Case 1. The background within the rectangles shall be the standard grey panel color.

b. The center null position of momentary switches shall be shown by means of black bordered rectangular area with a white background containing, where applicable, the appropriate legend as shown in Figure 3-2, Case 3.

c. Switches not applicable to either a. or b. above shall be represented on the SCC as shown in Figure 3-2, Case 2, with all positions shown by lights.

d. Except as noted in 3.3.4.2. e, the indicator light representing a toggle switch position shall illuminate white upon receipt of a signal, indicating that the switch contacts are closed. Upon removal of this signal, the indicator light shall extinguish.

e. In cases where toggle switches have momentary positions whose actuation normally causes the related function to be latched in, these momentary positions shall be represented on the SCC by means of illuminated, pushbutton indicators with momentary switches attached. Two lamps in each indicator shall be fitted with blue boots. The display shall function as follows:

   1. Upon receipt of a signal indicating the closure of the momentary contacts of the switch being monitored, the white and blue lamps in the associated light on the SCC shall illuminate.

   2. Upon removal of this signal the white lamps shall extinguish, the blue lamps remaining on.

   3. The light shall continue to display the blue color until cancelled by one of the following methods:

(a) Manually by the Instructor/Operator depressing the face of the light.

(b) Automatically upon receipt of a signal indicating that the switch being monitored has been moved to other positions.

3.3.4.2.2 Pushbutton Switch Monitoring

Pushbutton switches in the SLM which do not contain integral status lights shall be represented on the SCC by legend indicators with black bezels and black lens holders as shown in Figure 3-2, Case 4. The lights shall contain white diffusers and black legends identifying the switch function. The displays shall function as follows:

a. Lights on the SCC monitoring pushbutton switches whose functions are active only during switch contact closure shall illuminate white upon receipt of a signal indicating closure of the contacts and shall extinguish 0.75 ±.20 second after removal of this signal.

b. Lights on the SCC monitoring pushbutton switches whose functions are latched in upon switch contact closure shall be illuminated pushbutton types fitted with momentary switches. Two lamps in each indicator shall be fitted with blue boots. The display shall function as follows:

1. Upon receipt of a signal indicating closure of the contacts of the switch being monitored, the white and blue lamps in the associated light on the SCC shall illuminate.

2. Upon removal of this signal the white lamps shall extinguish and the blue lamps shall remain on.

3. The light on the SCC shall continue to display the blue color until cancelled manually by the Instructor/Operator depressing the face of the light.

Those pushbutton switches in the SLM which contain integral status lights shall be represented on the SCC by means of a pair of indicator lights, mounted one above the other, as shown in Figure 3-2, Case 5. Both lights shall have black bezels and black lens holders. The button indicator shall function as described in a. and b. above. The upper indicator shall operate in parallel with the associated status light of the switch being monitored.

3.3.4.2.3 Status Light Monitoring

Status lights in the SLM shall be functionally duplicated on the SCC by means of legend indicators. The indicators shall contain white diffusers. The white diffuser plate shall be visible through the clear areas. The legends on these lights shall match those of the related lights in the SLM.

3.3.4.2.4 Rotary Switch Monitoring

The position of rotary switches in the SLM shall be displayed on the SCC by means of round indicator lights; one for each switch position including OFF. The lights shall be arranged in a circular pattern corresponding to the arrangement of the panel legends used in the SLM to identify the switch positions. Similar legends on the SCC panel shall identify each light. A switch position shall be provided for the purpose of making a lamp test for the indicator lights.

3.3.4.2.5 Thumbwheel Switch Monitoring

The position of thumbwheel switches in the SLM shall be displayed on the SCC by means of digital type readout.

3.3.4.2.6 Data Computation Subsystem Group (DCSG) Monitoring

The alph-numeric readouts pertaining to the DCSG can be displayed at the SCC on the face of the CRT. The outputs of the DCSG Line Printer in the SLM can be displayed on the CRT. All other controls and displays associated with the DCSG shall be monitored at the SCC as outlined in the other applicable sub-paragraphs of 3.3.4.2.

3.3.4.2.7 Analog Displays

Analog type meters in the SLM shall be represented on the SCC by similar meters.

Where rotary switches are used in the SLM to select analog functions for display on a common meter (meter time-sharing), the switch positions shall be represented on the SCC as described in paragraph 3.3.4.2.4 with the addition of a dummy rotary switch at the center of the light pattern.

3.3.4.2.8 Circuit Protection Device Monitoring

The status of circuit protection devices shall be displayed on the SCC by means of a horizontally split legend plate.

3.3.4.2.9 Character Displays

Character displays in the SLM shall be functionally duplicated at the SCC.

3.3.4.2.10 CRT Display Unit and Keyboard

The CRT Display Unit and Keyboard of the SCC shall be peripheral devices of the IBM 360/44 computer system. Required features and components are listed in paragraph 3.3.6. The Display Unit shall be capable of continuous data displays on the CRT by the 360/44 with a simultaneous display of operator keyboard inputs. The CRT shall be capable of displaying a minimum of 1024 characters on 32 lines. The top thirty-one lines will be used for 360/44 data display, and the thirty-second (last) line for displaying keyboard inputs. The Keyboard shall contain, as a minimum, a complete set of alphabetic characters and decimal numerals, and the special characters found on standard typewriter keyboards.

3.3.4.2.11 Simulation and Mode Controls

The SCC shall provide the controls necessary to establish the mode of operation of a training exercise. Computer controls shall include the following:

a. Start

b. Freeze

c. Resume

d. Checkpoint

e. Recycle

f. Stop

g.. Inhibit

h. Single Step

i. Single Cycle

3.3.5 INTERFACE SUBSYSTEM

The Interface Subsystem shall include the DIU, ADCAS, PAKA, 360/930 Adapter, and power conversion and distribution.

3.3.5.1 Digital Interface Unit

The DIU shall be of modular construction and shall be designed to provide flexibility by means of addressable input and output registers and signal patching.

TOGGLE SWITCH MONITORING

Case 1	OFF, CLOSED, and NORMAL positions shown by black bordered rectangular area with grey background. Indicators to have silver bezels and white lens holders.
Case 2	All active switch positions shown by lights.
Case 3	Three position momentary switch, center null position shown by black bordered rectangular area with white background.

PUSHBUTTON SWITCH MONITORING

Case 4	Pushbutton switch without integral status light shown by light with black bezel and black lens holder.
Case 5	Pushbutton switch with integral status light shown by two lights with black bezels and black lens holders.

Figure 3-2. Toggle and Pushbutton Switch Monitoring

3.3.5.1.1 Functional Characteristics

The DIU shall interface and provide for data transfer in either direction between the SDS 930 digital computer and the SCC, the SLM, and the Stimulus Subsystem. The DIU shall provide patching of digital signals, and signal conditioning required to ensure correct interfaces between subsystems.

3.3.5.1.2 Performance Characteristics

The DIU shall interface with the SDS 930 and the other simulator subsystems.

3.3.5.1.2.1 Data Transfer

Digital data shall be transferred between the DIU and the SDS 930 in 24-bit words at a rate commanded by the SDS 930.

Data from the SCC, the SLM and the Stimulus Subsystem to the DIU arereceived on a random basis as discrete inputs and stored in the input registers for later transfer to the computer as commanded by the SDS 930. Data to the SCC, the SLM and the Stimulus Subsystem are transferred at the same rate as the SDS 930 to DIU data rate.

3.3.5.1.2.2 Decode Matrix

Register addresses received from the computer are decoded by a matrix within the DIU. A total of 127 addresses are available. The instruction word shall be decoded in a matrix which enables selection of the addressed output or input register.

3.3.5.1.2.3 Output Register

The output registers store the digital data received from the SDS 930. Each register contains 24-bits and may be used for storing any of the data transferred by selecting the appropriate address.

The DIU shall initially have 48 output registers. The total capability of the DIU is 54 output registers.

3.3.5.1.2.4 Input Registers

The DIU shall deliver data to the SDS 930 through the input registers. These registers are sampled by the computer on a predetermined basis. All registers may be reset by computer command. The DIU shall have 30 addressable input registers of 24-bits each.

3.3.5.2 Airborne Digital Computer Adapter Simulator (ADCAS)

The ADCAS shall have the capability to transfer data between the Data Computation Subsystem Group (DCSG), Airborne Digital Computer (ADC), and an IBM 360/44 digital computer for the purpose of loading the ADC and operating the ADC during "real-time" simulations.

3.3.5.2.1 Performance Characteristics

The ADCAS shall interface with the ADC and the IBM 360/44.

3.3.5.2.1.1 Data Transfer

The ADCAS shall provide the necessary control, buffering, signal conditioning, and power supplies to permit data transfer between the two digital computers. The data transfer shall be as described in paragraphs 3.3.5.2.1.1.1 and 3.3.5.2.1.1.2.

3.3.5.2.1.1.1 ADC to IBM 360/44

Transfer of data from the ADC to the IBM 360/44 shall be under the control of the ADC executive program with the Input/Output (I/O) routines residing in the ADC.

3.3.5.2.1.1.2 IBM 360/44 to ADC

The transfer of data from the IBM 360/44 to the ADC shall be controlled by programs in the IBM 360/44.

3.3.5.2.1.2 Operational Modes

The ADCAS shall operate in the burst and multiplex modes.

3.3.5.2.1.3 Interrupts

The ADCAS shall be capable of accepting data from the IBM 360/44 to generate six priority and six external interrupts to the ADC. Provisions shall be made on the ADCAS for connecting to one set of external and one set of priority interrupts lines on the ADC.

3.3.5.2.1.4 IBM 360/44 Interface

The ADCAS shall be connected to the IBM 360/44 by means of the standard IBM 360/44 I/O interface.

3.3.5.2.1.5 ADC Interface

The ADCAS shall connect to the ADC through standard DCSG interface without modification. The ADCAS shall present an interface to the ADC indistinguishable from the interface presented by the DCSG.

3.3.5.2.1.6 ADC Software

Only on board programs shall reside on the ADC.

3.3.5.2.1.7 IBM 360/44 Subchannels

One control position on each of two subchannels of the IBM 360/44 High Speed Multiplexer channel shall be utilized. Other control units may occupy the two remaining control unit positions; however, ADCAS shall have exclusive use of both subchannels during real-time system operation.

3.3.5.2.1.8 Electrical Power

Electrical power shall be provided from a facility power source.

3.3.5.2.1.9 Timing Signals

The ADCAS shall provide the timing interface required for operation of the ADC software. Timing signals, consisting of 1, 10, 100, and 1,000 pulses per second (pps) signals, shall be provided to ADCAS by the DIU. This timing shall be addressable by the ADC software. In addition, the ADCAS shall provide to the IBM 360/44, the capability of inhibiting or restoring the timing.

3.3.5.2.1.10 DCSG Controls and Displays

The ADCAS shall provide the interface for the DCSG controls and displays. The following control data shall be routed via the ADCAS from the IBM 360/44 to the ADC:

a. ADC ON/OFF (power)
b. Core Dump
c. Stop
d. Compute
e. Load PSW
f. Load Memory

The following indicator data shall be routed via the ADCAS from the ADC to the IBM 360/44:

a. ADC Malfunction
b. Manual Mode (Stop)
c. Compute
d. LDA Malfunction
e. Load Memory
f. ADC Power ON/OFF
g. Core Dump

The operation of the remainder of the DCSG controls and displays shall be handled entirely by the IBM 360/44. Simulation of redundant DCSG components will be provided by simulation software. The ADCAS shall provide sufficient termination for the remainder of the controls and displays to assure proper operation of the ADC.

3.3.5.2.1.11 ADC Initial Selection Sequence

The ADCAS shall provide the capability of completing the ADC initiated Initial Selection Sequence within the ADC 99 micro-second time out constraint. The ADCAS shal provide zero status for each DCSG device address to complete the ADC Initial Selection Sequence.

3.3.5.2.1.12 Simulated Malfunctions

The ADCAS shall provide the capability to the IBM 360/44 to allow simulated malfunctions of DCSG and Mission Data Adapter (MDA) units and interfaces. The IBM 360/44 shall provide, and keep current, malfunction information to the ADCAS via the standard I/O interface. The ADCAS shall store the malfunction information and perform the malfunction in response to the ADC during an Initial Selection Sequence. No more than four device or control unit malfunctions shall be handled at any one time. The malfunction required shall include, but not be limited to the following:

a. Unit diagnosed malfunctions:

   1. Unit check

   2. Unit exception

b. Non-diagnosed malfunctions:

   1. Address recognition

3.3.5.3 Printer and Keyboard Display Unit Adapter

3.3.5.3.1 General Characteristics

PAKA shall interface with one or two Block I Printers, Keyboard and Display Unit (KDU), and an IBM 360/44. PAKA shall provide the necessary controls, signal conditioning, error detection, and power to permit operation of the printer(s) and KDU. Data transfer shall be under program control of the IBM 360/44. The devices will be presented with an operational interface by PAKA including Master Control Console (MCC) signals associated with the Printers and KDU.

3.3.5.3.2 Interfaces

The PAKA shall interface with the 360/44 via a standard 360/44 multiplexer channel. PAKA shall appear to the 360/44 as a standard control unit utilzing four subchannels (four device addresses for the two Printers, Keyboard Assembly and Display Assembly). PAKA shall connect to the Printers and KDU through their standard DCSG interfaces without modification. Status, sense command, and control information will be provided for each device.

3.3.5.3.3 Malfunctions

Simulated malfunctions of the Printers and KDU shall be performed by the 360/44 and ADCAS (responses to the ADC).

3.3.5.3.4 Electrical Power

PAKA shall be provided with 28 vdc and 208 v rms power from a facility power source. It will, in turn, provide the KDU and Printer with their required 28 vdc operating power. The +5 vdc lamp test power and two 0-115v, 400 Hz electroluminescence power sources required by the KDU shall be provided directly from the Crew Station.

3.3.5.4 360/930 Adapter

3.3.5.4.1 Functional Characteristics

The 360/930 Adapter shall operate and interface with the IBM 360/44 and SDS 930 central processors. It shall be capable of responding to initial selections from the IBM 360/44 computer and of transferring data in either direction.

3.3.5.4.2 Performance Characteristics

The adapter shall provide the necessary control buffering and signal conditioning to permit either computer to transfer data to the other.

3.3.5.4.2.1 Data Transfer

The data transfer shall be controlled by the 360/44 computer. To ensure the specified data transfer rate and provide minimal data transfer initiation times, the data shall be transferred in block each iteration. The two computers will operate synchronously. The simulation control interrupts shall be addressed to the 360/44 through the 930 computer.

3.3.5.5 Junction Box

A system Junction Box shall be designed to provide patching flexibility of digital signals. The Junction Box shall be designed to patch any output register bit to any signal load (up to 45 output registers) and any signal source to any input register bit (up to 30 input registers).

The Junction Box shall be designed to allow patching of any signal for recording purposes.

3.3.6 COMPUTER SUBSYSTEM

The MDS Computer Subsystem shall consist of the Simulation Computer and its associated peripheral equipment, and exchange hardware DCSG components.

3.3.6.1 Simulation Computer

The Simulation Computer shall consist of an IBM System 360/Model 44 commercial computer system, and an SDS 930/Beckman 2200 commercial hybrid computer system as described in paragraph 3.3.6.1.1 and 3.3.6.1.2.

3.3.6.1.1 IBM 360/44

The IBM 360/44 of the Simulation Computer shall consist of the following components:

P/N	Name	Quantity
2044G	Processing Unit, Model G	1
4427	Floating Point Arithmetic	1
4583	High Speed General Registers	1
4455	High Resolution Timer	1
6415	2nd Internal Disk	1
2315	Disk Cartridge	3
7531	Store and Fetch Protection	1
7532	Store and Fetch Protection	1
7533	Store and Fetch Protection	1
5248	Multiplexer Channel	1
4598	High Speed Multiplexer Channel	1
4560	High Speed Multiplexer Subchannel, Add'l	1
4599	High Speed Multiplexer Channel	1
4565	High Speed Multiplexer Subchannel, Add'l	1
2803-1	Magnetic Tape Controller	1
2401-3	Magnetic Tape Unit (9 track)	3
2401-3	Magnetic Tape Unit (7 track)	1
7125	Seven Track Compatibility	1
2821-1	Control Unit	1
2540-1	Card Read Punch	1

P/N	Name	Quantity
1403-2	Printer	1
1052-7	Printer Keyboard	1
2841-1	Storage Control	1
2311-1	Disk Storage Drive	1
1316-1	Disk Pack	3
1990	Column Binary Feature	1
3228	Data Conversion	1

The 360/44 will also contain the following 360-compatible SANDERS Associates display system:

Model No. Feature Code	Name	Quantity
722A-3	Keyboard	1
708B-1H	Display Unit	1
MQR 091	Split Screen Features	1
701B-1	Control Unit	1
FC1703	Edit Module	1
FC1705	Memory Module	1
FC1712	I/O Module	1
713D-1	Equipment Rack	1
731 Mod O	Display Communications Buffer	1
FC1731	Transmission Control Module	1

3.3.6.1.2 SDS 930/Beckman 2200

The SDS 930/Beckman 2200 hybrid computer (provided by GE) of the Simulation Computer System shall consist of the following components:

Model No.		Quantity
930	General Purpose Digital Computer	1
92160	16,384 words Core Memory (24-bit words)	1
93220	Additional Time-Multiplexed Comm. Channel	1
91210	Memory Interlace Control Unit (one for each TMCC)	2
93280	Interrupt Control System	1
93290	Priority Interrupt (two levels)	7
9152	Card Reader and Coupler 400 CPM	1
9372	Unbuffered Line Printer 140-600 LPM	1
92481	Magnetic Tape Control Unit	1
92461	Magnetic Tape Transport	3
9234	Keyboard/Printer and Coupler	1
9239	Keyboard Printer	1
9230	Photoelectric Paper-Tape Reader	1
9134	Paper Tape Spooler	1

Beckman 2200 Analog Configuration

Quantity	Name
72	Integrator Summer Simplifiers
48	Summing Amplifiers
1	Interative Controller
40	Quarter-Square Multipliers
5	Positional Resolvers
32	Dual Feedback Limiters
200	Servo Set Pots
24	3-Terminal Pots
24	Electronic-Capacitors
24	Electronic Switches
32	Form "C" Function Relays

Quantity	Name
20	Eleven Segment Diode Function Generators
1	Patchable Logic Counter
4	Preset Decade Counters
200	Trunk Lines
1	Control Interface
1	Noise Generator (Md. 52.5)

Hybrid Interface

1	Parallel Input/Output Units with: 40 sample and hold A/D units 40 Registers (double buffered) with D/A units

3.3.6.1.3 DCSG Components

The DCSG components of the computer Subsystem shall consist of the exchange hardware Airborne Digital Computer (ADC), Keyboard and Display Unit (KDU) and Printer (PR) listed in paragraph 3.2.2.4. The ADC shall interface the MDS via the ADCAS of the Interface Subsystem. It shall interface with the KDU and PR via the ADCAS, 360/44, and the PAKA of the Interface Subsystem. The KDU and PR are physically located in the SLM.

3.3.7 FACILITIES

GE will provide a facility which will have sufficient floor space, air conditioning, power and communication required by the MDS.

3.4 SIMULATION SOFTWARE DESIGN

3.4.1 OPERATIONAL REQUIREMENTS

The computer program system for the MDS will be designed to be a self-contained package capable of complete support of MDS operations. Figure 3-3 shows the relationships between the function blocks in the system, and Figure 3-4 shows the software module relationships. The flow charts included within this specification are intended to indicate functional flow and shall not be construed as constraining the design of the subsystems. Two categories of programs are defined:

a. Non-real time programs shall be used for:

   1. Script, ephemeris, and command data message preparation.

   2. Post-simulation analysis.

   3. Simulation check and calibration.

   4. Program library and data base servicing.

   5. Diagnostic software shall be provided to meet the requirements of paragraph 3.1.2.2.

b. Real time programs shall be capable of actual simulator operation. They shall provide four distinct capabilities:

   1. Creation of an operational environment for the Airborne Digital Computer (ADC). The ADC software for the simulator will be the operational software; there will not be special simulation software developed for the ADC. Software required to re-initialize the ADC software for non-flight (simulation unique) operations such as "Freeze", "Skip" and "Re-cycle" shall be accomplished by means of simulation software.

   2. Simulation of those subsystems which interface with the simulated AVE controls and displays

   3. Creation of drive signals for the Stimulus, Simulation Control Console, and Interface Subsystems of the simulator; and gathering output data from these subsystems.

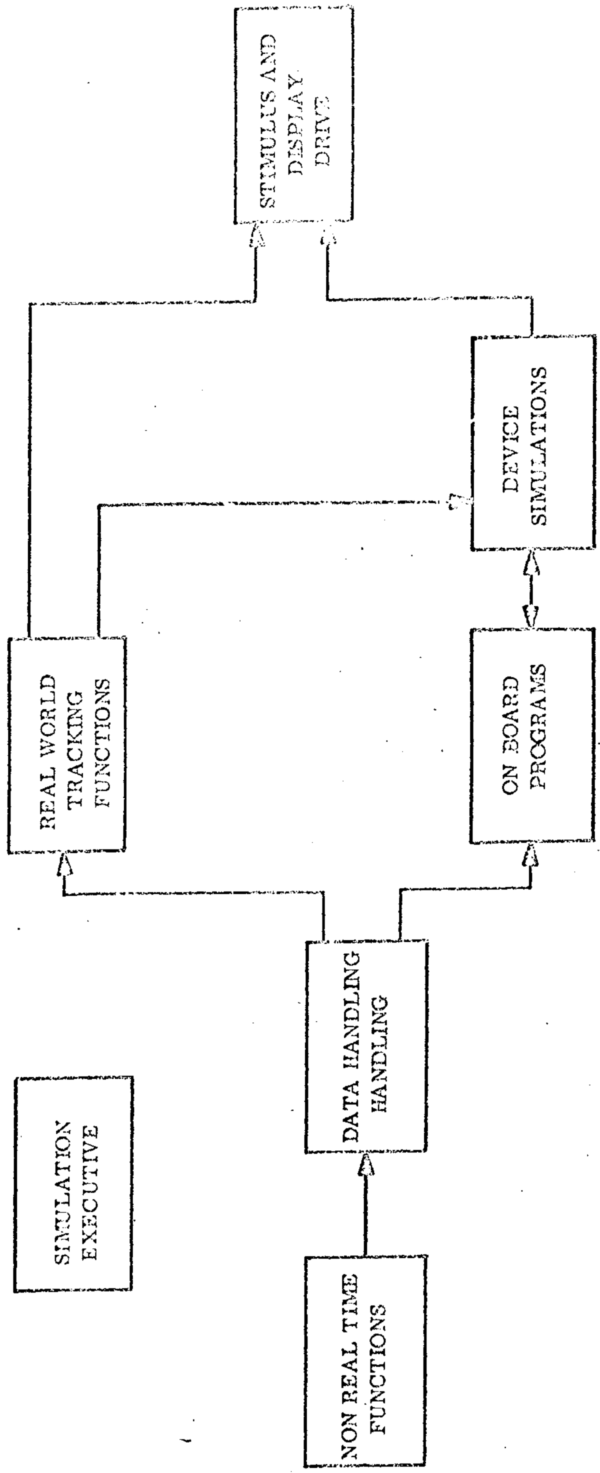

Figure 3-3. Relationships Between Function Blocks

4. Control of the simulation and data transfer between the various hardware and software system components.

The software shall be designed for consistency among the following:

a. The Command Messages to be used.

b. The simulation data generated by the Pre-simulation Date Generation Module.

c. The Stimulus Material to be used.

d. The requirements and goals of the simulation.

e. The Script.

f. The evaluation of the simulation which must be made after its completion.

Checkout philosophy for the system will include the active Operator participation to verify and report equipment status in the SLM and SCC.

The simulation software takes into account the five major sources to image pointing and velocity error.

1. Ephemeris uncertainties.
2. Target location uncertainties.
3. Attitude measurement uncertainties.
4. System misaligmments.
5. Drive system inaccuracies.

A combination of the above shall not initially drive the line-of-sight off the stimulus material.

Simulation of the payload operations is accomplished via two parallel computations. The Airborne Digital Computer computations of gimbal drive position and rates are based on the following:

a. Ephemeris from the command message.

b. Target locations from the command message.

c. Vehicle attitude as measured using the simulated Star Tracker.

d. System alignments as measured during test.

Reference computations in the simulation computer are based on:

a. Reference ephemeris obtained by correcting the ephemeris in the command message (Reference Ephemeris Generator)*

b. Reference target locations obtained by correcting the locations specified by the command message (Reference Target Generator)*

c. Reference attitude as simulated by the Attitude Reference Generator and ACTS Simulator*.

d. Reference system alignments computed by the Mission Module Variable Alignment Simulation*

The result of these reference computations is the line-of-sight vector from the Tracking Mirror in the vehicle to the reference target (Reference LOS Generator)*.

The ADC gimbal drive rate data feeds a simulation of the main optics drive or acquisition scope drive systems (Drive Control Response and Position Simulator)*. The output of this simulation are the actual Tracking Mirror gimbal rates and angles corresponding to the actual aim point.

*Software System Module Components

The reference line-of-sight vector (pointing to the reference target) and the actual Tracking Mirror gimbal angles (corresponding to the actual aim point) are then transformed to the proper drive signals for the Stimulus Subsystem (Display Position Driver)*.

In addition to the program modules mentioned above, there are other functions required for the tracking simulation. The Tracking Simulation Controller* provides sequencing, control, and general management of the entire tracking simulation. It reacts to man's actions and the command message data to determine the targets being tracked, slew times, cue requirements, etc. It controls the projectors, haze generators, etc., of the stimulus subsystems, and in general performs the housekeeping functions for the tracking simulation.

A Sun Angle Generator* and a Mission Module Environment Simulator* are provided to generate system temperatures and the current Sun Angle.

The Star Tracker input to the ADC is obtained from the Star Tracker Simulation* which bases its computations on reference attitude data, reference alignment data, a star vector, and commands from the ADC.

The TLM/MAS Simulator generates the MPSS portion of the Telemetry Master Frame Data Matrix in engineering units whenever the real-time telemetry is operating, and generates the Monitor and Alarm status associated with the MPSS.

The Derotation Simulation Module simulates the rotation of the image in the AVE image plane.

The Image Velocity Sensor Simulator facilities simulation of image motion attributable to errors in tracking rates of the Main Optics tracking mirror.

---

*Software System Module Components

The MDAU* and LDAU Simulation Modules* provide the interface for all data to and from the ADC. Command decoder and clock comparator functions are provided, as well as interface handling for AVE line printers, simulated auxiliary memory unit, uplink messages, etc. Since the ADC will not contain any simulation software, the MDAU and LDAU simulators must also provide the necessary interrupt signaling to the ADC and must respond to interrupts generated in the interface hardware by data eminating from the ADC.

The Laboratory Decoder Module* decodes those commands which the MDS requires for proper functioning.

Certain systems in the AVE are simulated only to the extend necessary to provide life like displays and reactions to the astronauts. The Payload Simulation and Hardware Control Module* performs this function for the film handling, Main Optics, and Acquisition Scope systems. The Film Processor Simulation* handles displays associated with the film processing. Electrical power displays and switching are handled by the Electrical Power and Signal Distribution Module*. Thermal monitoring handled by the Mission Module Environmental Simulator*.

Control over the program modules is maintained by the Simulation Executive module. It sets the basic sequencing and cycle time and contains subfunctions responsible for I/O to peripherals, interrupt handling, and program loading.

User control of the simulation is accomplished by script input, either on-line or via predetermined script sequences. The interpretation of these script statements is accomplished by the Script Interpreter*. Collection of the results of the simulation for off-line processing and on-line display generation is performed by the Simulation Performance Data Collection Module*. Initialization of the MDS at selected times is handled by the Bulk Data Handling Module*.

*Software System Module Components

The handling of the various hardware interfaces is performed by the Input and Output* modules.

An information and control flow chart is included as Figure 3-4.

3.4.1.1 MDS Executive

This module will perform the following functions:

a. Interpret interrupts from the real time clock

b. Interpret interrupts from the Simulation Control Console.

c. Control the mode of the Simulator based on Simulator Control Console SCC interrupts, and mode changes generated by real time simulation modules.

d. Control the initialization (and shut down) of all simulation hardware and computer data bases prior to (and at the termination of) a real time run.

e. Provide timing and synchronization of simulation hardware and software.

f. Control sequencing of the real time simulation modules.

g. Control the following data interfaces:

   1. Simulation Hardware to Simulation Software.

   2. Simulation Software to the AVE Computer.

3.4.1.1.1 Source and Type of Inputs

a. Hardware interrupts shall be received from the Simulation Control console and the real-time clock.

b. Stimulus subsystem hardware status and malfunction indicators shall be received from the Stimulus Subsystem through the Input Module.

*Software System Module Components

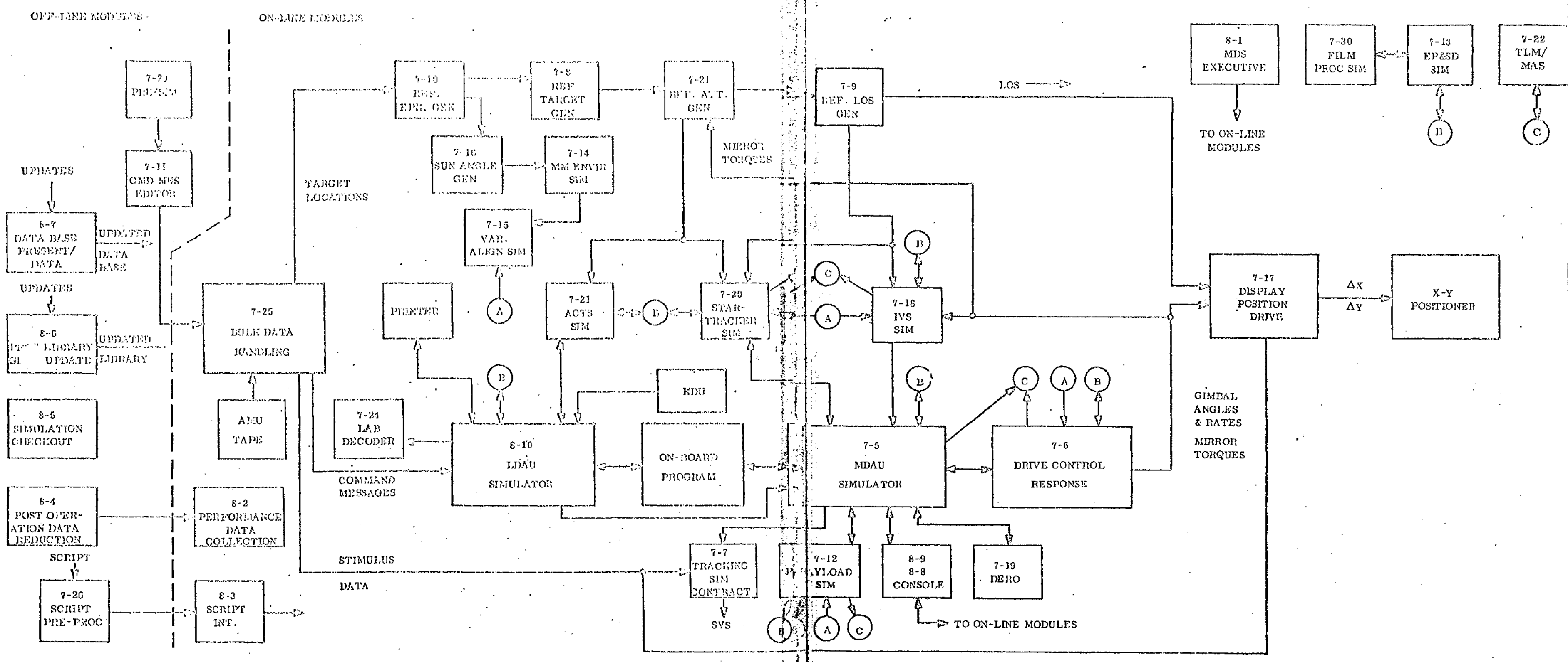

Figure 3-4. MDS Simulation Block Diagram

~~SECRET~~/DORIAN
HANDLE VIA BYEMAN SYSTEM ONLY

c. Hardware status shall be received from the Tracking Simulation Controller module and the Bulk Data Handling Module.

d. Simulated Laboratory Module inputs shall be received from the Keyboard Display Unit via the PAKA.

e. Data transfer request interrupts shall be received from the ADC via ADCAS.

3.4.1.1.2 Destination and Type of Outputs

a. Operational status of non-stimulus simulation devices controllable in the Simulated Laboratory Module shall be sent to the output module.

b. Operational mode of the Simulator shall be sent to the Simulation Control Console via the output module.

c. Vehicle elapsed time, Simulation Time, and Reference time as required, shall be sent to the Ephemeris Generate and Payload Controller modules of the ADC via ADCAS to the Tracking Simulation Controller, the Reference Target Generator, the Reference Ephemeris Generator, the Bulk Data Handling, the Mission Module Variable Alignment Simulator,. and the Script Interpreter Module.

d. Printer messages shall be sent to the Simulated Laboratory Module.

e. Cathode Ray Tube display data shall be sent to the Simulation Control Console.

3.4.1.1.3 Information Processing

The MDS Executive shall use the following routines in the IBM 360/44:

a. The Timer routine will update all simulation times once every 0.1 seconds during real time operation.

b. The Malfunction routine will check for simulator hardware failures.

c. The Sequencer routine will control the sequencing of the real-time (math model) modules.

d. The New Cycle routine will take appropriate action on mode change requests.

e. The Interrupt Handling routine will determine the type of interrupt and transfer control to the appropriate routine.

f. The Mode Interrupt routine will validate mode changes and transfer control to valid "new mode" routines.

g. The Simulation Mode routines will set up the simulation software for the various modes of operation.

h. The executive will handle all data transfer into and out of the IBM 360/44 computer.

3.4.1.2 Performance Data Collection Module

This module shall perform the following functions:

a. Record each set of monitored data base variables on the Simulation Performance Data File with the current monitor mode for each iteration.

b. Update the Cathode Ray Tube (CRT) display with new message pages on request, and with data page variables of specified accuracy.

3.4.1.2.1 Source and Type of Inputs

a. Monitor modes and dispaly modes shall be received from the Script Interpreter (paragraph 3.4.1.3).

b. Variable values shall be received from the IBM 360/44 or the SDS 930 data base.

c. Calibration limits for display variables shall be received from the Disc Storage device of the 360/44.

d. Format for data display shall be received from the Disc Storage device.

e. Format for each monitored variable specifying the location within the Data Base the the byte count of the variable shall be received from the Disc Stroage Device.

3.4.1.2.2 Destination and Type of Outputs

a. This module shall output raw data on the Simulation Performance Data File of the IBM 360/44.

b. This module will output predetermined messages and limit checked data base variables in predefined formats on the Cathode Ray Tube.

3.4.1.2.3 Information Processing

Figure 3-5 depicts the information flow within the Module. As shown in Figure 3-5, the requested data is monitored, page formated, and then displayed on the CRT.

The monitored variables are raw data values found within the data base and defined by location and length. When monitoring variables, a file test is made to determine if the start of a new file is necessary. If it is, the simulation data file header information is constructed from parameters contained in the data base.

The data for the display will be in two forms. The first is a data page consisting of variables, the second is a message page. When processing a data page, each value is checked for a specified variance from its previous value. If this variance exists, the new variable is calibrated, limit checked, and then replaces the old value on the CRT. A requested message page is displayed on the CRT. If a new page is desired, the Script Interpreter Module alerts this module which then searches the disk storage device for the requested page.

3.4.1.3 Script Interpreter

This module shall perform the following functions:

a. Execute preprocessed and real-time script statements during a simulation run.

b. Maintain and update a chronological script statement list.

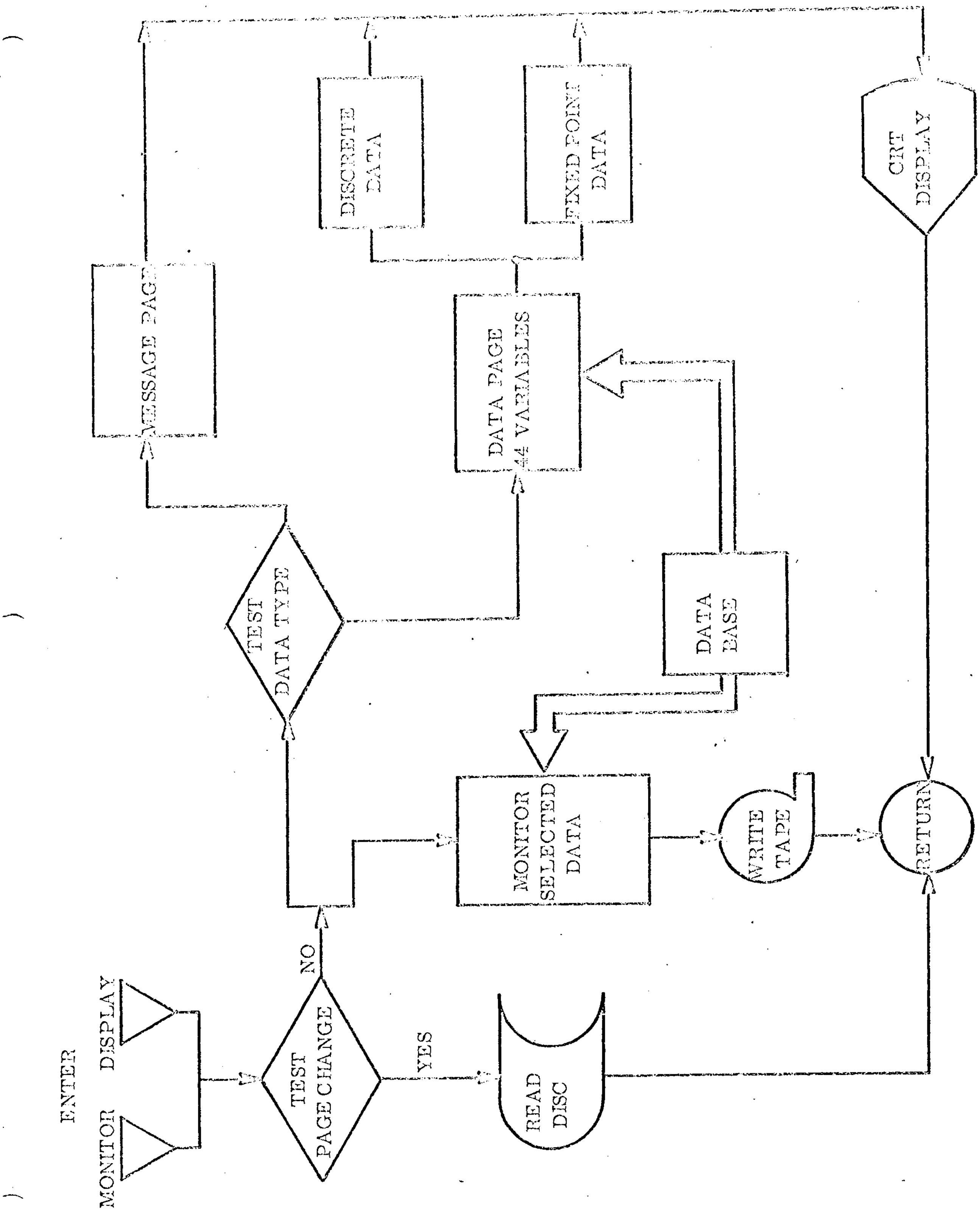

Figure 3-5. Performance Data Collection Module

NOTE

The script operators are listed in paragraph 3.4.1.12.

3.4.1.3.1 Source and Type of Inputs

a. Preprocessed script statements shall be reviewed from the preprocessor module.

b. Real-time script statements shall be received from the SCC switches and keyboard.

c. The Vehicle Elapsed Time, Simulation Time, and Reference Time shall be received from the Executive Module.

3.4.1.3.2 Destination and Type of Outputs

Modified Data Base values (per script request) shall be sent to other programs in the system.

3.4.1.3.3 Information Processing

When called by the executive routine, this module checks the chronological script statement list for script statements which are to be executed in the current cycle. If a statement to be executed is located, its operation code is used to transfer control to the correct translation subroutine. The translation subroutine uses the remaining portions of the preprocessed script statement to generate modifications to the Simulation Data Base.

Executed script statements will be flagged on the chronological script statement list and new statements will be added at certain times during a run. The proper statements shall be brought into core in time to ensure their execution. The script preprocessor will do some of this logic off-line (see Figure 3-6).

The script translator subroutine action is summarized as follows:

<u>ENTER</u> - Will place the value of the arguments into the data base.

<u>GO TO</u> - Will cause an unconditional brance in the script.

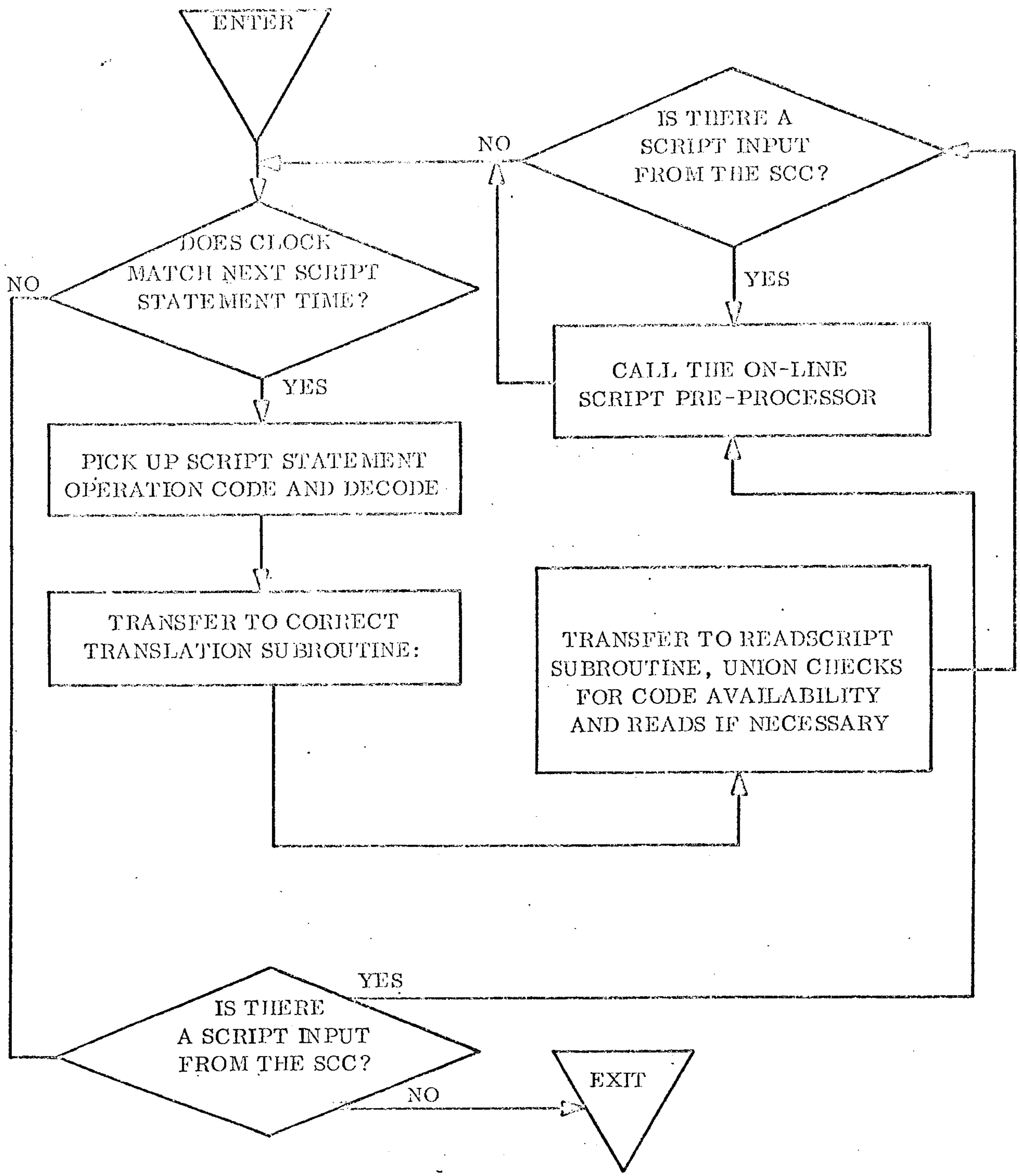

Figure 3-6. Script Interpreter

IF - Will compare the value of the variable in the data base with the script specified argument and will modify the chronological script statement list pointer if the comparison is true. If the comparison is false, the next sequential script statement will be executed.

FREEZE - Will change the simulation mode to FREEZE mode and will modify the data base to indicate which, if any, message will be displayed.

DISPLAY - Will change the date base to indicate the requested display mode and device.

CHECKPOINT - Will change the data base to indicate that a "checkpoint" has been requested.

RECYCLE - Will reset the data base with the information contained under the desired checkpoint "name".

SKIP - Will modify simulation machine time as indicated and shall estimate and update all time dependent variables.

MONITOR - Will change the data base to indicate the desired monitor mode.

DISPATCH - Will change the data base to indicate that a Command Message is to be processed and record the message name.

STOP - A final "snapshot" of pertinent information will be prepared for recording. A flag will be set which indicates to the executive the termination of the script exercise.

INSERT - Will place the malfunctioned values into the specified data base locations and at the same time; will save the values being replaced.

REMOVE - Will reset to nominal values those data base locations which were perturbed by a previous INSERT operator.

TURN ON/OFF - Will set the specified data base locations (bilevel data) to 0 or 1, depending on whether the ON or the OFF option is used.

APPLY - Will set the specified data base locations (analog data) to the specified values.

INHIBIT – Will flag the specified script statements to indicate to the interpreter that they will not be executed. INHIBIT is an on-line input only.

Real time script inputs, if any, will be handled by calling the on-line portion of the script preprocessor which will process and merge the statements. Real-time script statements will come either from the SCC keyboard or the Simulator Control Panel Switches.

3.4.1.4 Post-Operation Data Reduction and Evaluation

This module shall process and evaluate data from a simulation exercise.

3.4.1.4.1 Source and Type of Inputs

a. Raw data tape generated on-line shall be received from the Performance Data Collection module.

b. Calibration reference curves, output format, and Executive control options shall be received from the off-line calibration software tape.

c. Formated data tape shall be generated from the raw data tape and the calibration software tape.

d. On-line changes or modifications to the functionalized data shall be received from optional card input.

3.4.1.4.2 Destination and Type of Outputs

a. A formated magnetic tape shall be produced for further processing by this module.

b. A high speed printer listing of the reduced data shall be produced in the requested formats.

c. A finalized magnetic tape of the reduced data shall be produced for subsequent manual analysis.

3.4.1.4.3 Information Processing

This module shall:

a. Calibrate raw data input and produce a functional formated tape.

b. Process the functional formated tape referenced in a. above.

The subroutine programs executed during the run shall generate output identified by numbers written on the raw data output tape.

The elements of this module shall be:

a. Data List - Will produce a list of functions with time notation and script statement correlation.

b. Event - Will identify the time of occurrence of a particualr function(s).

c. Interval Mean and Standard Deviation - Will compute a mean and standard deviation of a function(s) over an interval of time, or over a number of samples.

d. Summary Mean and Standard Deviation - Will compute a mean and standard deviation of a function(s) over the entire quantity of information.

e. Limit - Will flag the data when specified time limits are exceeded.

f. Print Routine - Will generate the final results on a high speed printer (see Figure 3.4.1.4.3-1.)

3.4.1.5 Simulation Check

This module shall consist of a software program which will determine the operational readiness of the MDS hardware prior to a Simulation run as follows:

a. Will check proper operation of the Digital Interface Unit.

b. Will check proper operation of the Stimulus Subsystem.

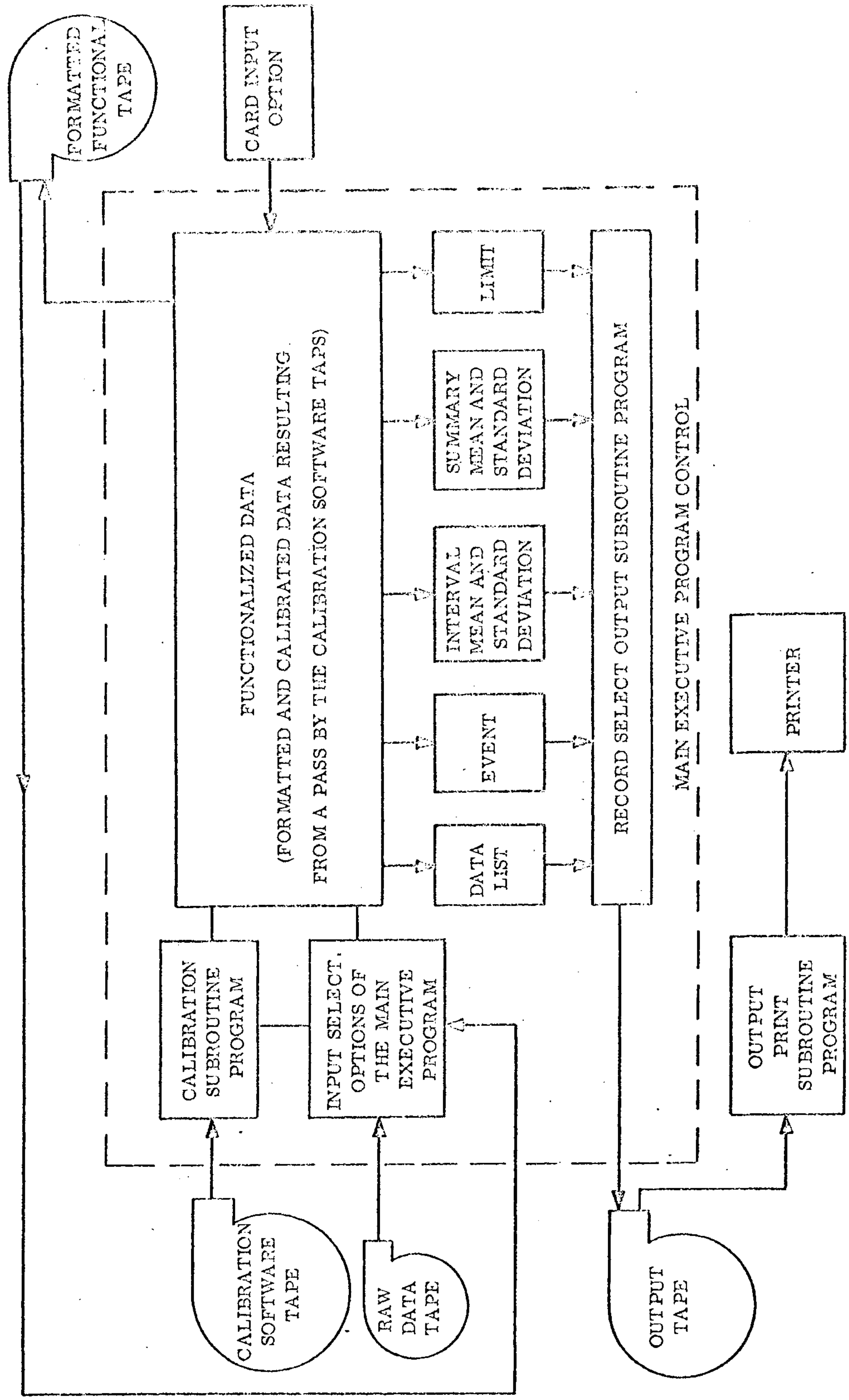

Figure 3-7. Post-Operation Data Reduction and Evaluation

c. Will check panel control functions of the Simulated Laboratory Module.

d. Will check Simulation Control Console interrupts.

e. Will check proper operation of all panel lamps.

NOTE

Computer diagnostics shall not be included in this checkout procedure.

3.4.1.5.1 Source and Type of Inputs

a. Interrupt signals will be received from the Simulation Control Console.

b. Input data will be received from the Simulated Laboratory Module and the Stimulus Subsystem via the Digital Interface Unit.

3.4.1.5.2 Destination and Type of Outputs

a. Packed digital data will be output to the Digital Interface Unit.

b. Servo drive voltage functions will be output to the hardware via the Beckman 2200 Analog Computer.

c. Packed digital data will be output to the Stimulus Subsystem.

3.4.1.5.3 Information Processing

The MDS hardware will be checked out as specified in paragraph 3.4.1.5 and as indicated in the Simulation Check flow chart (Figure 3-8).

3.4.1.6 Program Library Generator/Update Program

This off-line module shall add or delete programs from the library and update the library directory accordingly.

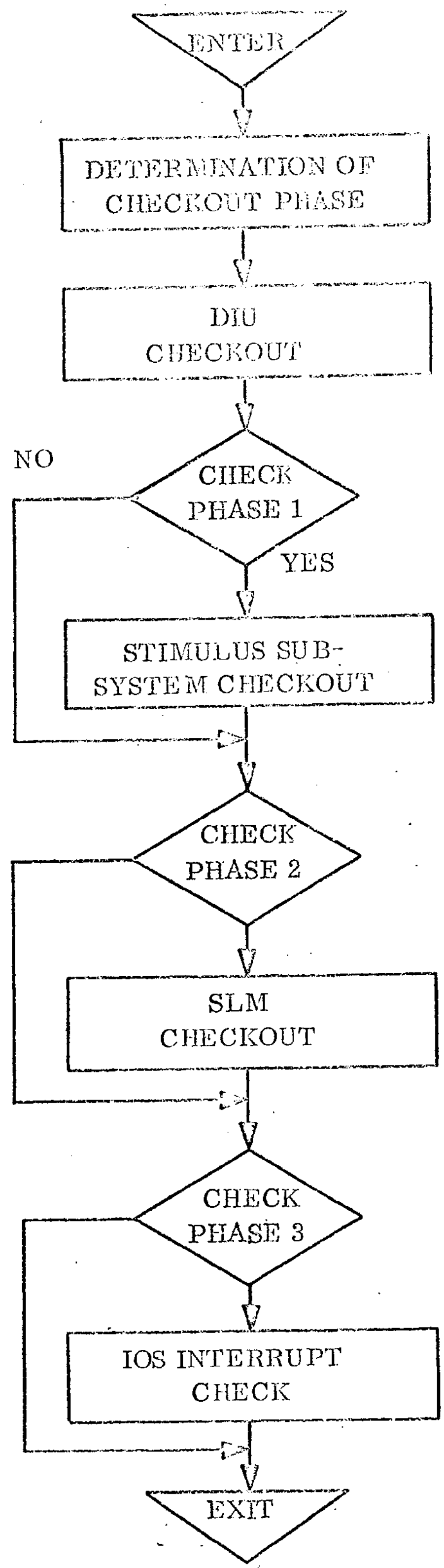

Figure 3-8. Simulation Check

3.4.1.6.1 Source and Type of Inputs

The following inputs shall be received from either punched cards or magnetic tape:

a. The programs to be added to the library.

b. The current library file.

c. The library director.

3.4.1.6.2 Destination and Type of Outputs

a. The program to be added shall be placed in the library.

b. The location and the name of the program to be added to the library shall be placed in the directory.

3.4.1.6.3 Information Processing

The programs received for addition to the library shall be put in absolute form before being added to the library.

Programs to be deleted shall be deleted from the library prior to condensing the library.

The library directory shall be updated after each addition or deletion from the library (see Figure 3-9).

3.4.1.7 Data Base Present/Update Program

This off-line utility program shall provide capability for displaying, updating, or generating any part or all of the simulation data base.

3.4.1.7.1 Source and Type of Inputs

A requirement specification shall be inputted via a data card which will define the program function as display, delete, update, or generate.

3.4.1.7.2 Destination and Type of Outputs

a. Requested data shall be displayed on an output device.

b. Updated values shall be sent to the data base.

c. Newly generated values shall be sent to the data base.

3.4.1.7.3 Information Processing

This module shall use the data base directory to determine the appropriate type and scale of modified data and to locate/update/delete/generate data base items (see Figure 3-10).

3.4.1.8 Input Module

This module, resident in the SDS 930, shall provide data to the Simulation data base from the SCC, the SLM and the Stimulus Subsystem via the DIU or the analog interface.

3.4.1.8.1 Source and Type of Inputs

a. Discrete and/or variable packed input words shall be received from the SLM Panels and the Stimulus Subsystem hardware via the Digital Interface Unit (DIU).

b. Digital input words (converted from analog signals) shall be received from the Crew Station panels and the Stimulus Subsystem via the Beckman 2200 analog computer.

3.4.1.8.2 Destination and Type of Outputs

a. Packed digital words shall be sent to the IBM 360/44 via the ADCAS.

b. Unpacked digital data shall be stored in the 930 data base.

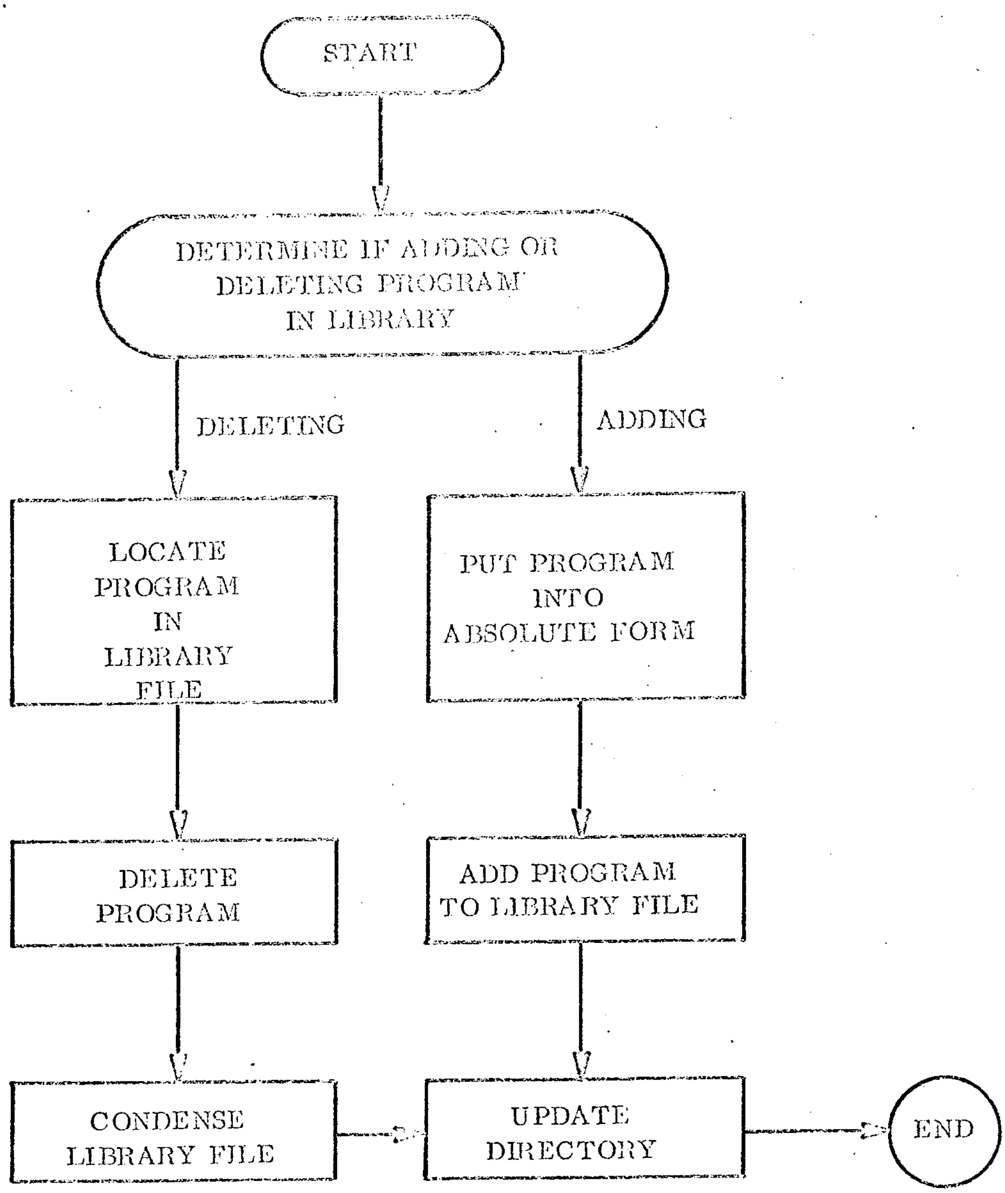

Figure 3-9. Program Library Generate/Update Program

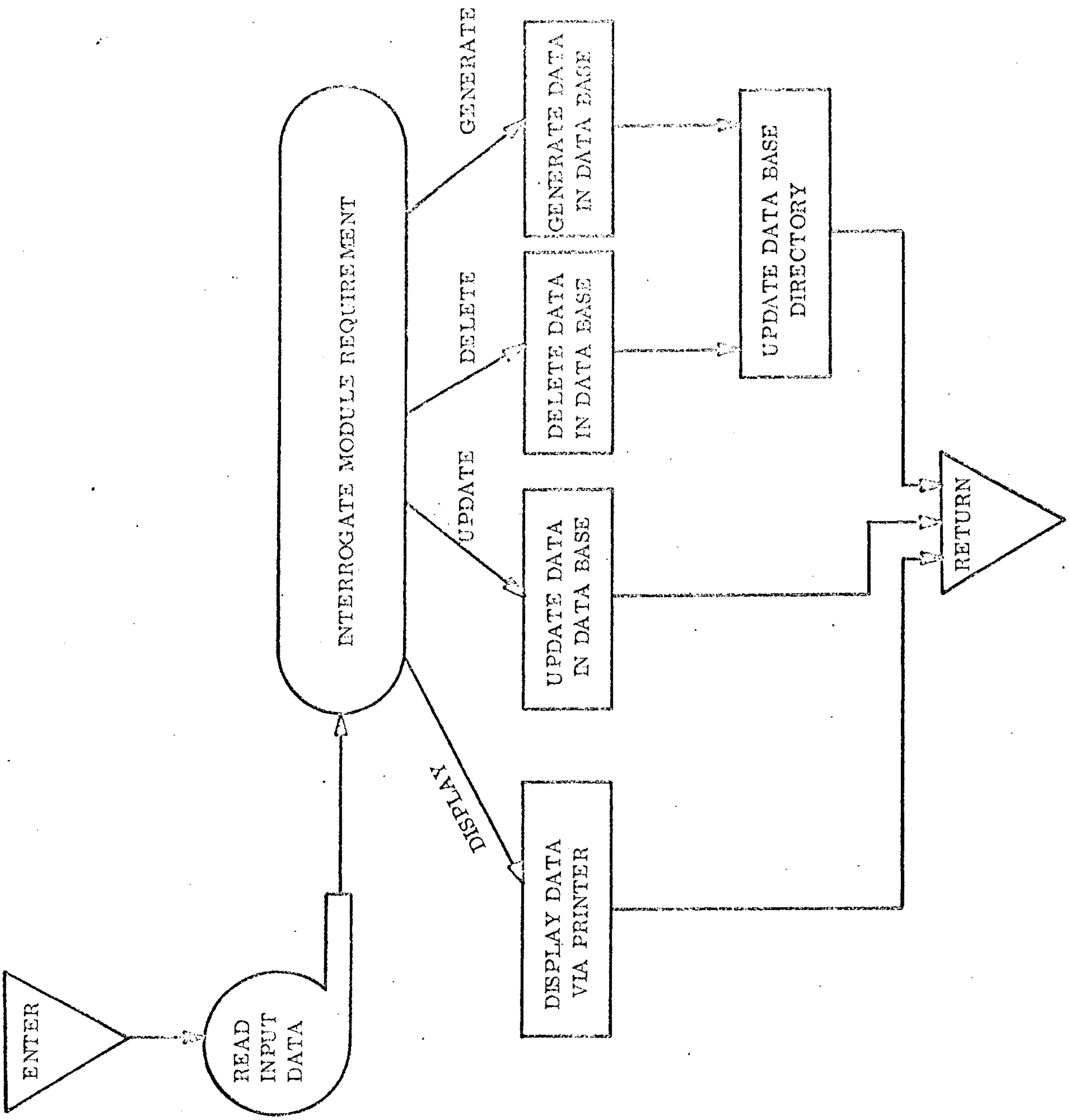

Figure 3-10. Data Base Present/Update

3.4.1.8.3 Information Processing

The Module shall unpack the registers and reformat the data (received from the DIU and the analog computer) for storage in the 930 data base and for output to the IBM 360/44 via the 930/360 adapter (see Figure 3-11).

3.4.1.9 Output Module

This module, resident in the SDS 930, shall transfer data from the data base to the Simulation Control Console, the Simulated Lab Module, and the Stimulus Subsystem via the DIU or the Beckman analog computer.

3.4.1.9.1 Source and Type of Inputs

a. Discrete and/or variable data shall be received from the IBM 360/44 via the 930/360 adapter.

b. Unpacked digital data received from the 930 data base.

3.4.1.9.2 Destination and Type of Outputs

a. The reformatted data described in paragraph 3.4.1.9.1 shall be sent to the Simulation Control Console, the SLM panels, and the Stimulus Subsystem hardware via the Digital Interface Unit.

b. Digital words shall be sent to the Beckman analog computer. The Digital to Analog converters located in the Beckman computer will convert the digital words to analog data and transmit the analog data to the external equipment.

3.4.1.9.3 Information Processing

This module shall reformat the input data described in paragraph 3.4.1.9.1 and send it to the Simulation Control Console, the Simulated Laboratory Module and the Stimulus Subsystem via the Digital Interface Unit and the Beckman 2200 Analog Computer (see Figure 3-12).

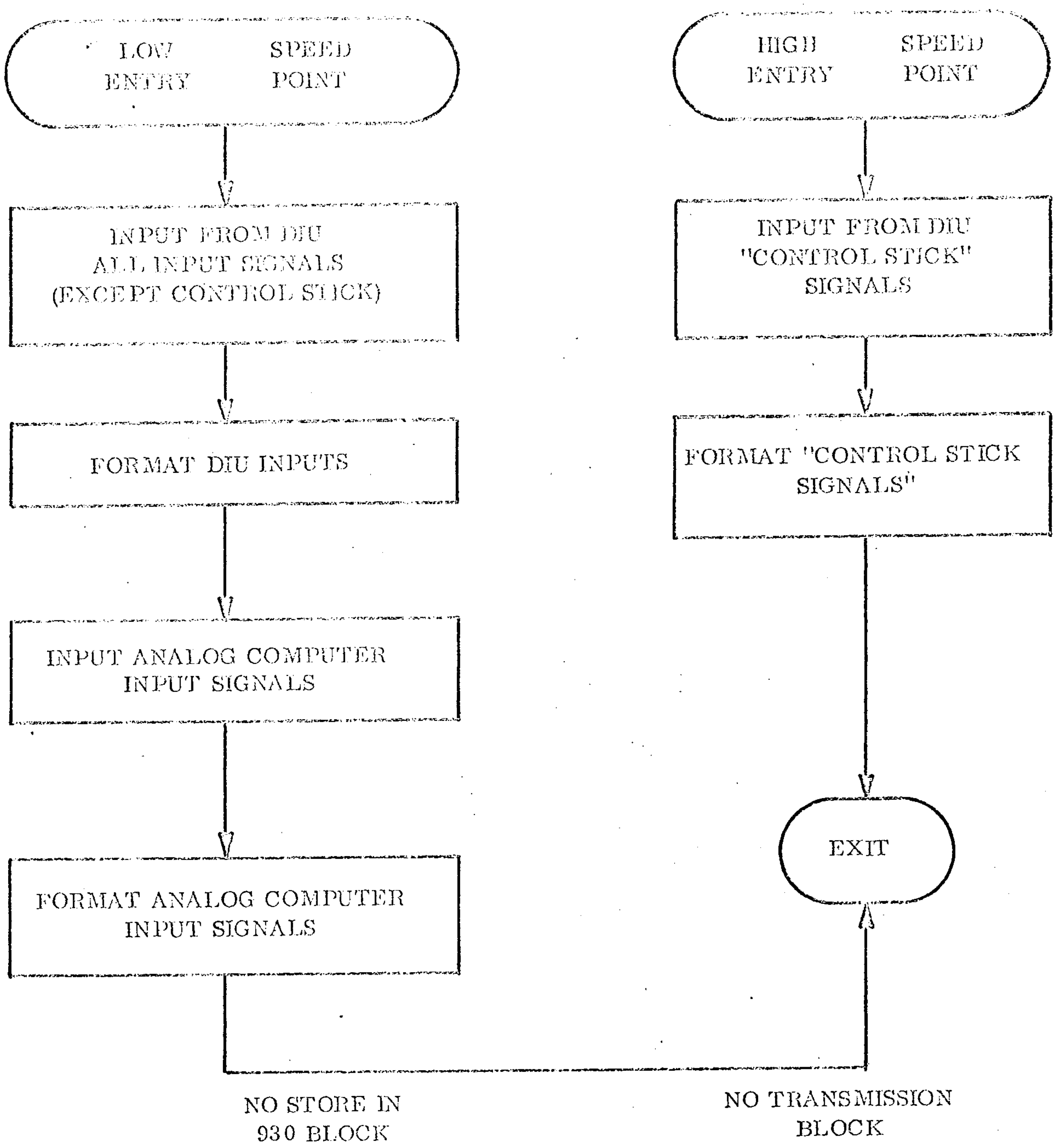

Figure 3-11. Input

3.4.1.10 Laboratory Data Adapter Unit (LDAU) Simulator

The LDAU Simulator shall be designed to be functionally identical with the LDAU for the functions described below.

a. Inhibit LDAU functions upon receipt of a power-off command from the computer Subsystem Controller.

b. Recognize addresses of both LDAU's.

c. Decode device addresses.

d. Decode device commands.

e. Generate device status information.

f. Provide simulated vehicle clock.

g. Simulate all internal and external controllers, adapters, and devices.

h. Accept and process uplink command data messages.

i. Simulation of Computer Subsystem Controller.

j. Provide ADC core dump and printout.

3.4.1.10.1 Source and Type of Inputs

a. Power switching commands from Stored Command Event Timer (SCET) and ADC.

b. Power commands from crew consoles.

c. Device addresses from the ADC via the ADCAS.

d. Device commands from the ADC via the ADCAS.

e. Device data bytes from the ADC via the ADCAS.

f. Target location data and stored ADC programs from the Auxiliary Memory Unit (AMU) from the Bulk Data Handling Module.

g. Command data messages from the Bulk Data Handling Module.

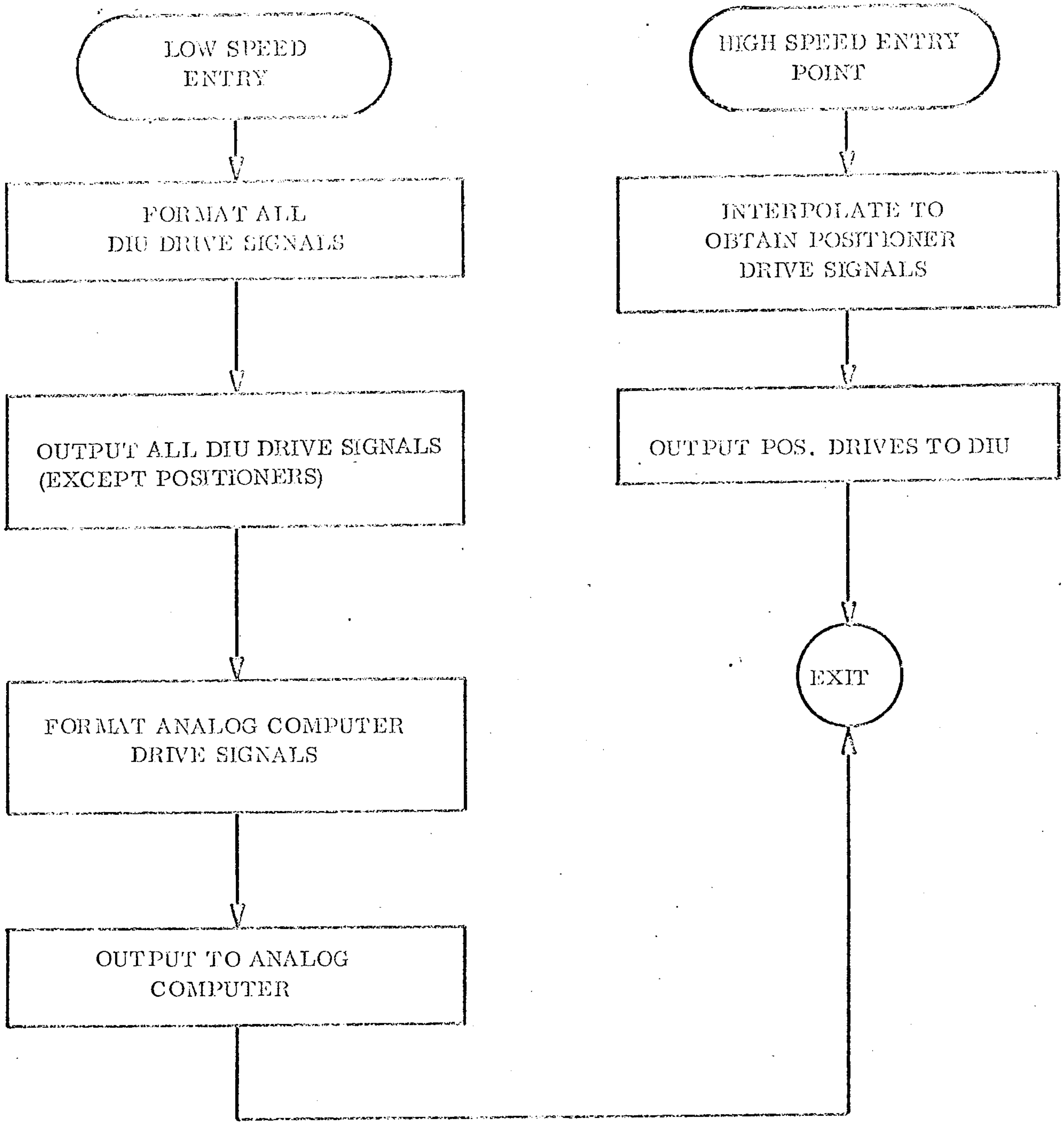

Figure 3-12. Output

h. Decode commands shall be received from the Laboratory Decoder Module.

3.4.1.10.2 Destination and Type of Outputs

a. Device status bytes to the ADC via the ADCAS.

b. Interrupts to the ADC via the ADCAS.

c. Telemetry data to the TLM/MAS simulation module.

d. Data to the printers.

e. Commands to the Laboratory Decoder simulation module.

f. Command message blocks to the ADC via the ADCAS.

g. Data to the ACTS simulation module.

h. Target location data and stored ADC programs to the ADC via the ADCAS.

i. Power ON/OFF flags to components of the Computer Subsystem Group and the MDAU.

j. AMU data requests to the Bulk Data Handling Module.

3.4.1.10.3 Information Processing

The LDAU simulation module will service certain I/O requests generated by the ADC, route device data to and from the ADC via the ADCAS, and from the interface between the ADC and several devices.

3.4.1.10.3.1 AMU-LDAU-ADC Interface

A tape drive on the IBM 360/44 will serve as the simulating device for the Auxiliary Memory Unit.

The ADC generates requests for AMU data and programs which are sent to the LDAU simulator. The LDAU will acquire the data and programs from the data base and route it to the ADC for processing. The Bulk Data Handling Module will actually read the AMU tape, properly format the data and place it in the data base. This process will be performed in anticipation of ADC requests for AMU data in order not to incur excessive time delays in responding to ADC data requests.

3.4.1.10.3.2 CSG-TSG-ADC Interface

Vehicle time update commands will be simulated by calling the LDAU module when the update function is to be performed. Either data base parameters involved in the computation of simulated vehicle time will be modified or a time register continually updated by the simulation executive program will be altered.

3.4.1.10.3.3 ADC-LDAU-ACTS Interface

Based on an ADC request for ACTS data, the LDAU simulator will supply the necessary data by referencing parameters stored in the data base by the ACTS simulation module.

The ADC will also send an ACTS Inhibit signal to the LDAU via the ADCAS.

The LDAU simulator will place an ACTS Inhibit Flag in the simulation data base for subsequent use by the ACTS simulation module.

Real-time commands to the ACTS are decoded in the Laboratory Command Decoder simulation module.

3.4.1.10.3.4 Uplink Message Processing

Command Data Messages are entered into the simulator by means of the Command Message Tape. This tape is generated off-line by the Command Message Editor Module. The message blocks are read into the LDAU simulation module which scans them and routes real-time commands to the Laboratory-Decoder module.

Printer data for immediate printing will be routed to the printer via the PAKA. Stored Program Commands (SPC), computer data, and printer data for later printing will be sent to the ADC via the ADCAS. For each block it receives, the ADC will send an Accept/Reject signal to the LDAU which will route the signal to the TLM/MAS module.

3.4.1.10.3.5 ADC-LDAU-Printer Interface

When the ADC requests printer service the LDAU will accept the request and ensure that the printer power flag is "ON" and that the printer has been enabled. The printer data is then accepted by the LDAU input buffer and transferred to the printer via the PAKA.

3.4.1.10.3.6 Computer Subsystem Controller (CSC)

The LDAU module will be responsible for the simulation of the CSC. Power ON/OFF and switching commands will be received from the ADC, stored command Execute Timer, the crew consoles, and the LDAU itself. These commands will determine the power status of each device in the Computer Subsystem Group. The appropriate power status flags will then be set in the data base for use by the Electrical Power and Signal Distribution Module.

3.4.1.11 MMSE Program Functions

The following functions are specified in the Part I CEI Specification for the Mission Module Simulation Equipment Programs CEI MOK807A, and they form a part of that end item. However, since they will be used in the MDS Program System, a short description of each module is included here for information purposes.

3.4.1.11.1 Reference Ephemeris Generator

Provides reference vehicle position and rate for any input time.

3.4.1.11.2 Attitude Reference Generator and ACTS Simulator

Provides reference vehicle attitude and the attitude as measured by the DACO ACTS System. The module shall be expanded to include the SCE control/display interface.

3.4.1.11.3 Star Tracker Simulator

Simulates the output of the Star Tracker for input to the ADC.

3.4.1.11.4 Electrical Power and Signal Distribution

Provides for realistic operation of the SLM electrical displays and controls.

3.4.1.11.5 Mission Module Environmental Simulator

Provide for the simulation of thermal parameters in MPSS.

3.4.1.11.6 Sun Angle Generator

Calculates Sun-vehicle unit vector.

3.4.1.11.7 Pre-Simulation Data Generator

Provides both the reference and the command ephemerides, and command star vectors.

3.4.1.11.8 Script Preprocessor

Converts user oriented script statements to a more machine compatible form.

3.4.1.11.9 MDAU Simulator

Provides the interface handling for all data between the ADC and the mission oriented portion of the simulation.

3.4.1.11.10 Drive Control Response and Position Simulator

Simulates the dynamics of the main optics and the ATS's under drives from the ADC.

3.4.1.11.11 Tracking Simulation Controller

Provides sequencing and control for the acquisition and tracking simulation.

3.4.1.11.12 Reference Target Generator

Produces reference target location based on location used in ADC.

3.4.1.11.13 Reference LOS Generator

Produces the reference line-of-sight position and velocity vectors for the main optics and the ATS's.

3.4.1.11.14 Payload Simulator and Hardware Controls

Provides for simulated reaction of the apyload to commands, etc.

3.4.1.11.15 Mission Module Variable Alignment Simulator

Provides for injecting alignment effects in the tracking simulation.

3.4.1.11.16 Display Position Driver

Provides error drives to the Stimulus Subsystem.

3.4.1.11.17 IVS Simulator

Provides for insertion of IVS capability.

3.4.1.11.18 Derotation Simulation

Provides the drive for the derotation devices in the main optics and ATS'sπ

3.4.1.11.19 Bulk Data Handling

Provides for distribution of ephemeris, target, and star data within the simulation.

3.4.1.11.20 Film Processor

Provides the drive signals and recording capability for the film processor.

3.4.1.11.21 TLM/MAS

Provides a simulation of the Telemetry and Monitor an Alarm Subsystem.

3.4.1.11.22 Laboratory Decoder

Provides a simulation of the DACO Laboratory Decoder.

3.4.1.11.23 Command Message Editor

Provides for the generation and editing of Command Messages to be used in the MDS.

3.4.1.11.24 Stimulus Data Generator

Generates an unoptimized target list which meets vehicle and POSC constraints.

3.4.1.12 Training Language Requirements

3.4.1.12.1 Macro

This Operator shall provide a means to generate a desired sequence of Training Language Script statements many times in a script program. The macro-definition shall be written only once, and a single statement (EXECUTE) will be written each time the user wants to generate the desired sequence of statements. Every macro-definition shall consist of the following:

> MACRO macro name & dummy name 1, & dummy name 2, etc.,
>
> Any legitimate statements (excluding MACRO and EXECUTE) using the dummy names enclosed between commas (shown above) and other legitimate labels, operators, variable names, numbers, or delta times from the first statement.
>
> MEND
>
> All dummy names appear at least once somewhere in the imperative statements enclosed within the MACRO, MEND delimiters.

Following the header statement will be one or more script statements (excluding MACRO) forming a model to be generated by the Preprocessor upon each occurrence of the macro's EXECUTE statement. The optional use of the variable symbol "& dummy name" shall vary the format of the generated statements.

The variable symbol "& dummy name" shall optionally appear following the name of the macro. Each "& dummy name" shall consist of a maximum of eight characters with the character being an ampersand. The remaining characters shall consist of A through Z and 0 through 9. No embedded blanks shall be permitted. Each variable symbol shall be separated by a comma. The model script statements shall have the option of using "& dummy name" in order to assign different values to a name, number, or argument. Variable symbols used as part of the model sequence shall be defined by the arguments of the EXECUTE statement.

3.4.1.12.2 Execute

This operator allows a series of statements, previously defined in a MACRO declaration, to be inserted into the script. The dummy names in the MACRO declaration must agree in number with the arguments contained in the EXECUTE statement. Furthermore, the type of argument (i.e., number, name, time, operator, label) must be consistent with the use of the dummy name in the statements contained in the MACRO declaration. The arguments in the EXECUTE statement are mapped onto the dummy names in the MACRO statement in the order in which they occur between commas in both statements. The form is:

Label <u>EXECUTE macro name</u> argument 1, argument 2, ...

The macro name used must have previously occurred in a MACRO statement.

3.4.1.12.3 GO TO

The form is: label <u>GO TO label</u>. This operator is an unconditional transfer and will direct the execution sequence to the statement defined by the given <u>label</u>. The label shall exist on a script statement occurring later in time in the script sequence than the GO TO statement.

3.4.1.12.4 IF

This operator shall specify a conditional transfer to a specific statement of the script program. Transfer shall be dependent upon the conditions specified as follows: if conditions of the statement are met the transfer shall be made; if the condition fails the next sequential statement shall be executed. The IF statement shall test the state of a specified data base bilevel or variable value. The form for bilevel tests shall be:

label IF bilevel device name IS ON / OFF GO TO label

The form for the analog test shall be:

label IF variable name is LT / EQ / GT number GO TO label

LT means "less than", EQ means "equal to", and GT means "greater than". The label following GO TO must appear on a training statement occurring later in time in the script sequence. (The frequency of occurrence and the placement of "GO TO" and "IF" statements within a script program will be severly limited for MMSE due to core and timing restrictions).

3.4.1.12.5 Enter

This operator establishes a value in the specified data base parameter.

label ENTER data base name 1 = argument 1, data base name 2 = argument 2, ...

3.4.1.12.6 Freeze

This operator shall halt all time, resulting in a cessation of math model iteration. Input/Output processing, keyboard inputs, displays and recording of simulation results shall remain active.

An optional message shall be output on the IOS keyboard CRT if included as part of the script statement. The form shall be:

label FREEZE & message &

3.4.1.12.7 Checkpoint

This operator causes the executive to establish a complete record (snapshot) of the status of the simulation at this instant. This allows the operator to reset the simulation to this point if it is desired to re-initiate operation at this point sometime later in the session. The form is:

label CHECKPOINT name

where name is the checkpoint identifier.

3.4.1.12.8 Recycle

This operator shall reset the simulation system back to some previous script checkpoint. The simulation shall automatically go into the FREEZE mode of operation upon execution of RECYCLE. The form shall be:

label RECYCLE checkpoint name

The checkpoint name shall correspond to the identifier given by a previous checkpoint statement.

3.4.1.12.9 Display

This operator causes the display subsystem to display the current values in the display mode format, variable name, or literal string on the specified peripheral device. The displays values are updated as indicated in the display mode format until another DISPLAY statement is executed.

The form is:

label DISPLAY ON peripheral name <u>format name</u> / <u>variable name</u> / <u>& literal string &</u>

3.4.1.12.10 Insert

This operator causes a malfunction condition to be inserted into the simulation. The form is:

label INSERT malfunction name, argument name 1 <u>(X percentage),</u> / <u>(= number)</u>

argument name N (X percentage) / (= number)

Each argument name shall be followed by "X percentage" or " = number". The "X" specifies replacement of the nominal value by the product of the nominal value and the specified percentage. The "=" specifies replacement of the nominal value by the specified number. The percentage shall be written in decimal fixed point.

The "malfunction name" is a pre-defined block of storage, containing the mnemonics for all possible arguments ever to be associated with this malfunction.

3.4.1.12.11 Remove

This operator shall remove a malfunction condition from the simulation. The form shall be:

label <u>REMOVE</u> <u>malfunction name</u>

The malfunction name shall appear in a previous INSERT statement. All inserted values will be restored to nominal.

3.4.1.12.12 Skip

This statement shall advance the simulator clock the prescribed time. The expendables maintained in the system shall be updated to include operation during the skipped period. The simulation is implicitly frozen by the interpretation of this operator. The forms shall be:

label SKIP hhh HRS mm MIN ss SEC

and

label SKIP o ORBITS

hhh = 0-999, mm = 0-59, ss = 0-59, 0 + .1-9.0

Skips can only be applied between non-payload periods of operation.

3.4.1.12.13 Monitor

This operator causes simulation data points to be monitored and recorded for historical purposes in accordance with the simulator data mode definitions. The forms are:

label MONITOR data mode name

label MONITOR O

The second form causes all monitoring to cease.

3.4.1.12.14 Dispatch

This operator shall call for transmittal of Command Data Messages (CDM) through the simulation system. The form shall be:

label DISPATCH (& message)
(message name)

The form of the operand shall determine the type of message to be dispatched. If "& message" is used, the operand shall consist of a EBCDIC message to be output on the Simulated Laboratory Module (SLM) teleprinter. The ampersand must be present to distinguish the operand as an EBCDIC message. If the operand is of the form "message name", a vehicle command shall be transmitted through the simulation system.

3.4.1.12.15 Turn On/Off

This operator shall stimulate a bilevel device. The state of the device shall be selected by use of the words ON or OFF. The form shall be:

label TURN ON / OFF device name 1, device name 2, ... , device name n

3.4.1.12.16 Apply

This operator shall apply an analog value to a specified device. The form shall be:

label APPLY analog number AMPS / VOLTS / PSI / OTHER TO device name

Other applies to any engineering description.

3.4.1.12.17 Ident

This operator is the first statement of a training program and performs the following functions:

a. Identifies the script program.

b. The control filed identifies the time reference to be used with all script statements within the program.

c. If vehicle time is specified by the control field then the time field must contain the elapsed time from launch to the start of simulation.

3.4.1.12.18 Stop

This input will cause the termination of the simulation operation underway. Included in the termination will be a final snapshot of the simulator, the termination of training script interpretation and clearing of flags and buffers relating to that operation, the clearing of training results, records to clearly indicate the termination point and condition, and the general termination of all simulator functions relating to the operation in progress. The STOP input must be used to clear one training script program before a second can be called in for execution. The form is:

label STOP & message &

The IOS annunciator FREEZE switch must be depressed before the IOS annunciator STOP switch is depressed. However, a FREEZE operator is not required to preceed a STOP operator is predefined scripts.

3.4.1.12.19 End

This operator shall be the final statement of a script program and shall notify the Training Language Script Preprocessor that all script statements pertaining to one source program have been processed. The form shall be:

END

3.4.1.12.20 Inhibit

This operator is an exclusive real-time keyboard input which is used to operate upon source statements of the Training Language. It specifies object statements to be removed from the execution sequence or specifies object statements to be NOPED. The form of the input is:

INHIBIT sequence number

3.4.1.13 Allowable Input Modes

All operators defined in this specification (except INHIBIT) may be used in the script to be processed by the non-real time script preprocessor.

All operators defined in this specification except MACRO, EXECUTE, DEFINE, END, and IDENT may be inserted into the script in real time via the Simulator Control Console (SCC) keyboard.

The capability also exists to execute the Training Language operators FREEZE, CHECK-POINT, RECYCLE, INHIBIT, and STOP in real time via the annunciator switches on the SCC.

3.4.2 DESIGN REQUIREMENTS

3.4.2.1 Programming Languages

Program modules shall be coded in either Fortran IV or Assembly language, depending on the particular situation. The program loader will allow mixing of Fortran and Assembly coded subroutines. However, in either case, sufficient comments will be included in the code to allow personnel other than the original programmer to work on the program.

3.4.2.2 Planning for Program Checkout

Initial coding of the programs for this system will provide readily identifiable output statements for outputting intermediate results of lengthy logical or mathematical computations. These outputs shall be available by input option. The implementing statements shall be removed after checkout.

3.4.2.3 Subsystem Simulation Implementation Concepts

In order to accommodate changes in the AVE subsystems being simulated, to accommodate expected errors in these systems, and to provide for useful malfunctions in these subsystems, the following implementation concepts shall be incorporated into the designs:

a. All parameters which are used to mechanize the software representation of a subsystem shall be placed in the data base.

b. Malfunction and error parameters and flags shall be in the data base.

3.4.2.4 Growth Capabilities

Program functions shall be designed, to allow the MDS Software System to change and grow as the MOL design of the Payload System progresses. The system shall provide for convenient insertion of meaningful new malfunction modes as they are defined. Since the MDS is a development "vehicle" for concepts in the MMSE, it shall be designed to incorporate "try out" features.

SECTION 4

QUALITY ASSURANCE PROVISIONS

SECTION 4

QUALITY ASSURANCE PROVISIONS

Quality Assurance provisions for the MDS shall be as defined in Product Assurance Plan for 106 (MDS) Program, Revision D, dated 21 June 1968 (DIN-50249-192-1), and 106 Quality Program Requirements, Revision A, dated 21 June 1968.

4.1 SUBSYSTEM LEVEL

This paragraph defines the method by which subsystem level hardware and software performance requirements as specified in Section 3 will be verified. Software will be verified by the following methods:

a. Inspection - Includes visual inspection of program listings, program flow charts, and hardware.

b. Preliminary CPC Analysis - Includes analysis of detailed design flow charts, program listings, and listings of punched card input to program tests on the subroutine tests with the predicted results from these tests.

c. Demonstration Tests - Include generation of input data to cover the complete range of expected operating conditions, observation by means of program execution, and verification of the correspondence of program performance with design requirements by observation of equipment response and examination of on-line and off-line hard copy output.

d. Post-test Analysis - Includes analysis of program execution times, comparison of selective memory dumps of data base areas with program input/output design specifications, and comparison of recorded equipment response with predetermined responses predicted from test input.

4.1.1 SUBSYSTEM TEST

4.1.1.1 Engineering Test and Evaluation

Not applicable.

4.1.1.2 Preliminary Qualification Tests

This portion describes requirements for validation of the subsystem and program component performance of the MDS software. The following requirements of Section 3 shall be verified as indicated.

4.1.1.3 Formal Qualification Tests

Not applicable.

4.1.1.4 Reliability Test and Analyses

Not applicable.

4.1.1.5 Engineering Critical Component Qualification

Not applicable.

4.1.1.6 Design Verification

4.1.1.6.1 Inspection

The following requirements of Section 3 shall be verified by inspection of the hardware:

Paragraph	
3.1.1.1	Primary performance Characteristics (Verification of AVE baseline freeze only)
3.1.1.1.1.2	Instrumentation
3.1.1.1.4	Control and Display Subsystem
3.1.1.1.7.2.2	Not applicable (GFE)
3.1.1.1.8.2.2	Not applicable (GFE)
3.1.1.1.10	Photographic Section
3.1.1.2.1	Simulated Laboratory Module
3.1.1.2.2	Simulation Control Console
3.1.1.2.3	Simulation Computer Subsystem

Paragraph	
3.1.1.2.4	Interface Subsystem
3.1.1.2.5	Stimulus Subsystem
3.1.2.2	Maintainability
3.1.2.2.2	Service and Access
3.1.3	Data Base Requirements
3.2.1	Interface Requirements
3.3.2	Stimulus Subsystem
3.3.3	Simulated Laboratory Module
3.3.4	Simulation Control Console
3.3.5	Interface Subsystem
3.3.6	Computer Subsystem
3.3.7	Facilities
3.4.2.1	Programming Languages
3.4.2.2	Planning for Program Checkout
3.4.2.3	Subsystem Simulation Implementation Concepts
3.4.2.4	Growth Capabilities

4.1.1.6.2 Analyses

The following requirements of Section 3 shall be verified by review of analyses, analytical data and available test data:

Paragraph	
3.1.2.1	Reliability

The MDS capability of meeting the availability requirement of paragraph 3.1.2.1 shall be verified by an analytical demonstration that combines the MDS reliability analyses with a maintainability analysis of the system elements. This relationship is:

$$\text{Availability} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}.$$

The reliability analysis shall include review and comparison of analytical data, results of failure mode and effects analysis, component test data, and component historical data to develop a Reliability Figure of Merit (mean-time between failures).

The down time (mean-time to repair) shall be based upon an analysis of typical maintenance tasks from fault detection through system revalidation.

Paragraph	
3.1.2.4	Environmental

The requirements of paragraph 3.1.2.4 shall be verified by review of analyses, analytical data and available test data.

Paragraph	
3.1.2.6	Human Performance

Requirements of paragraph 3.1.2.6 shall be verified in accordance with Section 4 of MIL-H-27894.

Paragraph	
3.1.2.7	Safety

Compliance with the safety requirements of paragraph 3.1.2.7 shall be verified by a hazard analysis, and hazard modes and effects analysis of the MDS functions and procedures.

4.1.1.6.2.1 The following paragraphs will be tested by preliminary analysis:

Paragraph	
3.4.1.4	Post-Operation Data Reduction and Evaluation
3.4.1.4.1	Source and Type of Inputs

Paragraph	
3.4.1.5	Simulation Check
3.4.1.5.1	Source and Type of Inputs
3.4.1.6	Program Library Generate/Update Program
3.4.1.6.1	Source and Type of Inputs
3.4.1.7	Data Base Present/Update Program
3.4.1.7.1	Source and Type of Inputs

4.1.1.6.2.2 The following sections will be tested by Post-Test analysis:

3.4.1.2.1	Source and Type of Inputs
3.4.1.2.2	Destination and Type of Outputs
3.4.1.3.1	Source and Type of Inputs
3.4.1.3.2	Destination and Type of Outputs
3.4.1.4.2	Destination and Type of Outputs
3.4.1.5.2	Destination and Type of Outputs
3.4.1.6.2	Destination and Type of Outputs
3.4.1.7.2	Destination and Type of Outputs
3.4.1.8.1	Source and Type of Inputs
3.4.1.9.1	Source and Type of Inputs
3.4.1.10.2	Destination and Type of Outputs

4.1.1.6.3 Demonstration

Not applicable.

4.1.1.6.4 Test

4.1.1.6.4.1 Tests Types shall be of the following categories:

a. Major Subcontractor Component Tests

b. Major Subcontractor Subsystem Tests

c. Subcontractor Tests

4.1.1.6.4.2 The following requirements of Section 3 shall be verified by component or subsystem test:

Paragraph	
3.1.1.1.7	Acquisition Subsystem
	(only the following subparagraphs)
3.1.1.1.7.1.1	Magnification and Real Field of View
3.1.1.1.7.1.2	Eyepiece Properties
3.1.1.1.7.1.3	Output Image Quality
3.1.1.1.7.1.4	Light Transmission
3.1.1.1.7.1.5	Target Loading and Coordination
3.1.1.1.7.2.1	Lighting
3.1.1.1.7.2.5	Scan Area
3.1.1.1.8	Main Optics
	(only the following subparagraphs)
3.1.1.1.8.1.2	Eyepiece Properties
3.1.1.1.8.1.3	Output Image Quality
3.1.1.1.8.1.4	Light Transmission
3.1.1.1.8.2.1	Lighting
3.1.1.1.8.2.4	Scan Area
3.1.1.2.1	Simulated Laboratory Module
3.3.2	Stimulus Subsystem

4.2 SYSTEM TESTS

This test shall be defined as an integrated system test of the MDS. The following requirements of Section 3 shall be verified by system test:

Paragraph	
3.1.1	Not applicable
3.1.1.1.1	Communication Command and Instrumentation
3.1.1.1.2	Electrical Power and Signal Distribution
3.1.1.1.3	LMSS Interface
3.1.1.1.4	Control and Display Subsystem
3.1.1.1.5	Navigation and Control
3.1.1.1.6	Structure and Thermal Control
3.1.1.1.7	Acquisition Subsystem
(only the following subparagraphs)	
3.1.1.1.7.1.1	Magnification and Real Field of View
3.1.1.1.7.1.2	Eyepiece Properties
3.1.1.1.7.1.3	Output Image Quality
3.1.1.1.7.1.4	Light Transmission
3.1.1.1.7.1.5	Target Loading and Coordination
3.1.1.1.7.1.6	Scene Dynamics
3.1.1.1.7.2.1.1	General
3.1.1.1.7.2.1.2	Scene Lighting
3.1.1.1.7.2.1.3	Haze
3.1.1.1.7.2.2	Ground Scene Special Effects
3.1.1.1.7.2.3	Initial Target Location
3.1.1.1.7.2.4	Dynamic Target Location
3.1.1.1.7.2.5	Scan Area
3.1.1.1.7.2.6	Scene Streaming
3.1.1.1.7.3	Associated Controls and Displays
3.1.1.1.7.4	Control Stick and Magnification Control During Freeze

Paragraph	
3.1.1.1.8	Main Optics
	(only the following subparagraphs)
3.1.1.1.8.1.1	Magnification and Real Field of View
3.1.1.1.8.1.2	Eyepiece Properties
3.1.1.1.8.1.3	Output Image Quality
3.1.1.1.8.1.4	Light Transmission
3.1.1.1.8.1.5	Target Landing and Coordination
3.1.1.1.8.1.6	Scene Dynamics
3.1.1.1.8.2.1.1	General
3.1.1.1.8.2.1.2	Scene Lighting
3.1.1.1.8.2.1.3	Haze
3.1.1.1.8.2.3	Target Location Relative to Vehicle
3.1.1.1.8.2.4	Scan Area
3.1.1.1.8.2.5	Scene Streaming
3.1.1.1.8.3	Main Optics Alignment
3.1.1.1.8.4	Associated Controls and Displays
3.1.1.1.8.5	Control Stick and Magnification Control During Freeze
3.1.1.1.9	Cue Subsystem
3.1.1.1.10	Photographic Section
3.1.1.2.2	Simulation Control Console
3.1.1.2.3	Simulation Computer Subsystem
3.1.1.2.4	Interface Subsystem
3.1.1.2.5	Stimulus Subsystem
3.1.1.2.6	Simulation Executive Function
3.1.1.2.7	Real World Tracking Function
3.1.1.2.8	Simulation Data Generation Function
3.1.1.2.9	Hardware Simulation
3.1.1.2.10	Stimulus Control Function
3.1.1.2.11	Non-Real Time Functions

Paragraph	
3.1.1.2.12	On-Board Computer Programs
3.1.2.4	Environmental
3.1.3	Data Base Requirements
3.3.2	Stimulus Subsystem
3.3.4.2	Controls and Displays
3.3.5	Interface Subsystem
3.4	Simulation Software Design
3.4.1	Operational Requirements
3.4.1.1	MDS Executive
3.4.1.1.1	Source and Type of Inputs
3.4.1.1.2	Destination and Type of Outputs
3.4.1.1.3	Information Processing
3.4.1.2	Performance Data Collection Module
3.4.1.3	Script Interpreter
3.4.1.8	Input Module
3.4.1.9	Output Module
3.4.1.10	LDAU Simulator

4.3 QUALITY SYSTEMS

4.3.1 DRAWINGS AND SPECIFICATIONS

A formal review board is not required on the MDS. However, all GE design specifications will be reviewed and approved by Product Assurance.

4.3.2 VISUAL AND MECHANICAL IN-PROCESS INSPECTION

GE fabricated parts shall be visually and mechanically inspected to determine that the materials, finish, design, workmanship, construction, dimensions, and markings conform to the applicable drawings and to the requirements of the applicable specifications.

4.3.3 ASSEMBLY INSPECTION

Each GE subsystem assembly shall be visually and mechanically inspected to ensure conformance to the applicable drawings.

4.3.4 NON-CONFORMING MATERIAL

Non-conforming Material shall be handled according to MIL-T-27474, paragraph 6.5.

4.3.5 SUPPLIER ACTIVITY

In cases where GE work statements and/or specifications require component acceptance tests to be the responsibility of the Supplier, Product Assurance will define and issue Supplier quality assurance requirements and review and approve the Supplier's test plan. If the acceptance tests are conducted at the Supplier's facility, their performance shall be subject to direct surveillance by GE Product Assurance representatives.

4.3.6 TEST CONDITIONS

4.3.6.1 Measurements and Calibration

All measurements shall be made with instruments whose accuracy has been verified and which are calibrated periodically. All test instruments shall be calibrated per a plan prepared in accordance with specification MIL-C-45662A. (Calibration of System Requirements).

4.3.6.2 Ambient Test Conditions

Unless otherwise specified, all measurements and tests shall be made at ambient conditions.

4.3.7 PRODUCT ASSURANCE DOCUMENTATION

4.3.7.1 Product Assurance Plan

Product Assurance Plan for (MDS) Program, Revision C, dated April 24, 1968 (DIN-50249-22-1), describes the Quality Program to be undertaken on the MDS Program. The quality system delineated in this plan shall be applicable through design, procurements, manufacture, test and acceptance phase of the program. Quality provisions for the operations phases of the MDS shall be defined in the SAFSL Exhibit 34004 Development Simulator Operation Plan.

4.3.7.2 Log Book

General Electric will compile a Customer Logbook containing information such as the defined configuration, the verified "as built" configuration, and system test data sheets. The Customer Logbook will provide the objective evidence of system performance acceptability and will be used as a basis for Customer acceptance of the MDS. The logbook will be given to the Customer at the time of acceptance of the MDS.

4.3.7.3 System Acceptance Test Procedure

The System Test Procedure will be submitted to the Customer for review 60 days prior to the start of the System Acceptance Test. Any changes to the test procedure during the System Acceptance Test will be documented and become part of the Customer logbook. A formal revision to the test procedure will be made at the completion of the test.

4.3.7.4 System Acceptance Test Report

General Electric will prepare and submit to the Customer a System Acceptance Test Report within 30 days after the completion of the System Acceptance Test.

4.3.8 SYSTEM TESTING

General Electric will conduct the System Acceptance Test and ensure all system test data is incorporated into the Log Book.

General Electric will conduct or witness the System Tests for Phase II and III and ensure all system test data is incorporated into the Log Book.

SECTION 5

PREPARATION FOR DELIVERY

SECTION 5

PREPARATION FOR DELIVERY

Not Applicable.

SECTION 6

NOTES

SECTION 6

NOTES

6.1 GLOSSARY

NUMERICAL

4π	–	IBM Computer = ADC
360/44	–	IBM Series 360 Model 44 Computer
360/65	–	IBM Series 360 Model 65 Computer
930	–	SDS 930 Computer
2200	–	Beckman Analog Computer

A

ACTS	–	Attitude Control & Translation Subsystem
ADC	–	Airborne Digital Computer (IBM 4 II)
ADCAS	–	ADC Adapter Subsystem
AMU	–	Auxiliary Memory Unit
ATS	–	Acquisition & Tracking Scopes
AVE	–	Aerospace Vehicle Equipment

B

BTIP	–	Basic Timing Interrupt Processing

C

CDM	–	Command Data Message
CEU	–	Control Electronics Unit
CPC	–	Computer Program Component
CSC	–	Computer Subsystem Controller
CSG	–	Command Subsystem Group

D

DACO	–	Douglas Aircraft Company – DAC
DCSG	–	Data Computation Subsystem Group
DDM	–	Digital Data Multiplexor
DIU	–	Digital Interface Unit

DRC	–	Data Recovery Capsule
	E	
EDS	–	Elemental Development Simulator
E-K or EK	–	Eastman-Kodak Co.
EPSD	–	Electrical Power & Signal Distribution = EPSD
	F	
FOV	–	Field of View
	G	
GMT	–	Greenwich Mean Time
	H	
HPA	–	High Power Acquisition
	I	
IMC	–	Image Motion Compensation
IMD	–	Image Motion Detector
IOS	–	Instructor/Operator Station
ISU	–	Interface Switching Unit
IVS	–	Image Velocity Sensor
	K	
KDU	–	Keyboard & Display Unit
	L	
LDAU	–	Lab Data Adapter Unit
LGA	–	Low-g Accelerometer
LMSE	–	Lab Module Simulation Equipment
LMSEC	–	Lab Module Simulation Equipment Computer
LOS	–	Line of Sight
LPA	–	Low Power Acquisition
LPSS	–	Laboratory Programming Support System
LVSS	–	Lab Vehicle Systems Segment

M

MAS	–	Monitor & Alarm System
MCC	–	Mission Control Center
		Master Control Console
MCU	–	Master Control Unit
MDAU	–	Mission Data Adapter Unit
MDS	–	Mission Development Simulator
MM	–	Mission Module
MMSE	–	Mission Module Simulation Equipment
MO	–	Main Optics
MOL	–	Manned Orbiting Laboratory
MPSS	–	Mission Payload System Segment

P

PAKA	–	Printer and Keyboard Adapter
PIP	–	Power Up Interrupt Processing
POSC	–	Payload Operation Sequencing & Control
PSCS	–	Program Support Computer System

R

RCU	–	Response Conditioning Unit
RT	–	Real-Time
RTC	–	Real-Time Command

S

SCC	–	Simulation Control Console
SCET	–	Stored Command Execute Timer
SCF	–	Satellite Control Facility (Sunnyvale)
SCS	–	Simulator Control Subsystem
SCSU	–	Signal Conditioning & Switching Unit
SCU	–	Signal Conditioning Unit
SDB	–	Simulation Data Base
SDS	–	Scientific Data Systems, Inc.

SLM	-	Simulated Lab Module
SPC	-	Stored Program Command
SPDR	-	System Performance/Design Requirements
S/S	-	Stimulus Subsystem (Projectors)
STC	-	VFSTC
		Satellite Test Center (Sunnyvale)

T

TLM	-	Telemetry (also TM)

V

VO	-	Visual Optics

6.2 MDS PHASING

6.2.1 MDS MODULE MATRIX

Paragraph Number	Title	On-Line	Off-Line	Planned Computer Allocation	Planned Phase Incorporation 0	1	2	3
MDS Modules								
3.4.1.1	MDS Executive	X		360/930	P	P	X	X
2	Performance Data Collection	X		360/930	P	P	X	X
3	Script Interpreter	X		360	P	P	X	X
4	Post Operation Data Reduction		X	360	-	-	X	X
5	Simulation Check		X	360/930/ 2200	P	-	-	X
6	Program Library Generate/ Update		X	360	-	-	P	X
7	Data Base Present/Update		X	360	-	-	P	X
8	Input	X		930/2200	P	-	P	X
9	Output	X		930/2200	P	-	P	X
10	Laboratory Data Adapter Unit (LDAU) Simulator	X		360	-	P	X	X
MMSE Modules Supporting MDS Operation								
3.1 2.5*	Mission Data Adapter Unit (MDAU) Simulator	X		360	-	P	X	X
6	Drive Control Response and Position Simulator	X		930/2200	X	-	X	X
7	Tracking Simulation Controller	X		930	X	-	X	X
8	Reference Target Generator	X		360	X	-	X	X
9	Reference Line of Sight (LOS) Generator	X		360	X	-	X	X
10	Reference Ephemeris Generator	X		360	X	-	X	X
11	Command Message Editor (CME)		X	360	-	P	X	X
12	Payload Simulator and Hardware Controls	X		930	-	-	X	X
13	Electrical Power and Signal Distribution	X		930	-	-	X	X

MDSE Modules Supporting MDS Operation

Paragraph Number	Title	On-Line	Off-Line	Computer Allocation	Planned Phase Incorporation 0	1	2	3
3.1.2.14	MM Environmental Simulator	X		930	-	-	X	X
15	MM Variable Alignment	X		360	-	-	X	X
16*	Sun Angle Generator	X		930	-	-	P	X
17	Display Position Drive	X		930	X	-	P	X
18	IVS Simulator	X		360	P	-	X	X
19	Derotation	X		360	X	-	X	X
20	Star Tracker Simulator	X		360	-	-	X	X
21	Attitude Reference Generator and ACTS Simulator	X		930/2200**	P	-	X	X
22	TLM/MAS Simulation	X		360	-	-	X	X
24	Laboratory Decoder Simulator	X		360	-	-	X	X
25	Bulk Data Handling	X		360	P	P	X	X
26	Script Pre-Processor		X	360	P	P	X	X
29	Pre-Simulation Data Generator		X	360	P	P	X	X
30	Film Processor Simulation	X		930	-	-	X	X
31	Simulation Data Generation		X	360	-	-	-	X

*Refer to CG 807, MMSE Computer Programs, CEI MOK 807A

**360 in Phase I MDS

NOTE: P Represents preliminary incorporation

X Represents complete incorporation

6.2.2 ON-BOARD COMPUTER FUNCTION MATRIX

Paragraph Number*	On-Board Computer Functions	Planned 360/44 Allocation	Planned ADC Prototype Allocation	
		Phase 1	Phase 2	Phase 3
2-1	Uplink Message Handling		X	X
2-2	Command Execution		X	X
2-3	Data Distribution		X	X
2-4	Payload Operation, Sequence & Control	P	X	X
2-5	Main Camera Parameter Generator			X
2-6	Drive Generation	X	X	X
2-7	Drive Correction	P	P	X
2-9	Initial Positioning		X	X
2-10	Ephemeris Generate	X	X	X
2-11	Vehicle Attitude Determination		X	X
2-12	Position Learning		P	X
2-19	System Readiness			X
2-13	Payload Prepass Setup		X	X
2-14	Geoposition Display			X
2-15	Extrapolate		X	X
2-16	Drag Processor			X
2-20	External Interrupt Processing		X	X
2-18	Basic Timing Cycle Interrupt Processing		X	X
2-17	Experiment Interrupt Processing			X
2-21	Payload Mode Control	P	X	X
2-22	Cue Present		X	X
2-25	Decoupling Matrix			X
2-23	Boresight Alignment			X
2-24	Power Interrupt Recovery			
2-26	MDAU Error Routine		X	X
2-27	Device Routines		X	X

*Refer to CEI MOK 802A, 30 November 1967, On-Board Computer Program (Operational)

NOTE: P Represents preliminary incorporation X Represents complete incorporation

6.2.3 HARDWARE COMPLEMENT

PHASE 0	PHASE 1	PHASE 2	PHASE 3
930/2200 Hybrid Computer (106)	360/44 Digital Computer (111)	360/44 Digital Computer (111)	Complete 106 hardware complement
360/44 Digital Computer (106)	ADC--Engr. Prototype (106)	930/2200 Hybrid Computer (111)	
930/360 Adapter Unit (106)	ADCAS (106)	930/360 Adapter Unit (111)	
DIU & Junction Box (106)	PAKA (106)	DIU & Junction Box (111)	
SLM with panels 2C & 2D (106)	AVE KDU, Printer (106)	ADC (106/111)	
SCC with CRT & Keyboard (106)	IOS CRT & Key-board (111)	ADCAS (106/111)	
1-SVS Subsystem (106)		PAKA (106/111)	
		IOS CRT & Key-board (111)	
		AVE KDU, Printer (106/111)	
		Test Panel (Ø 2)	

6.3 TRAINING LANGUAGE DEFINITION

6.3.1 GENERAL

6.3.1.1 Purpose

The primary purpose of the Training Language Script is to provide a control capability for the Mission Development Simulator.

6.3.1.2 Function

The Training Language Script shall consist of a set of source statements termed operators. Each operator shall be given a specific function specified by the operator and its arguments (script statements). Properly selected combinations of statements shall combine to perform simulator tasks of MOL Mission Simulator Pilot training. The script statements as a source program shall be processed by the Training Language Preprocessors.

6.3.1.3 Physical

The Training Language Script shall have an English language oriented syntax.

The script statements shall be written on a Training Language Script Coding Form and key-punched onto 80 column tabulator cards.

6.3.1.3.1 Script Generation

a. Write the program in MOL training language in accordance with paragraph 3.4.1.12.

b. Keypunch the program on tabulator cards.

c. Insert the tabulator cards in the off-line Script Preprocessor which will generate a tape for operation of the on-line Script Interpreter module.

6.3.1.3.2 Real-Time Script Statement Insertion

On-line training language statements which comply with paragraph 3.4.1.12 are inputted by the Simulation Control Console keyboard. Those with no time tag will be executed immediately while those with a time tag will be executed at the specified time.

6.3.2 TRAINING LANGUAGE SCRIPT FUNCTIONS

The Training Language Script shall provide the following functions for simulation control:

a. Provide the capability to define macro type groups of statements for insertion as open subroutines in the script.

b. Provide the means to establish values to data base parameters.

c. Provide conditional and unconditional branching in the script.

d. Provide script halt points from which sequencing can be continued following a pause.

e. Provide checkpoints (simulator status snapshot) in the script to which script sequencing can be recycled if desired.

f. Provide the means to initiate and terminate malfunctions.

g. Provide the capability to advance the simulation clock.

h. Provide the capability to select data base parameters to be recorded.

i. Provide the capability to command transfer of Simulation Command Data Messages to the simulated vehicle.

j. Provide the capability to print script messages.

k. Provide the capability to display a predefined format.

l. Request the display of text messages to the training operators.

6.3.3 STANDARDS

6.3.3.1 Character Set

Following characters are permitted:

a. Letters: ABCDEFGHIJKLMNOPQRSTUVWXYZ.

b. Digits: 0123456789.

c. Special Characters: */=",.&+-

d. Space.

The special characters are assigned explicit meanings in the following paragraphs.

6.3.3.2 Notation

The following notational conventions are used throughout this specification.

6.3.3.2.1 Upper Case Letters

Underlined are words which must be present in the source program.

6.3.3.2.2 Upper Case Letters

Not underlined are words which may be used at the discretion of the user.

6.3.3.2.3 Lower Case Letter String

Underlined specifies the syntactic location and type of term to be supplied by the user.

6.3.3.2.4 Lower Case Letter String

Not underlined specifies the syntactic location and type of term which may be supplied at the user's option.

6.3.3.2.5 Special Characters

These must be present in the source program where indicated.

6.3.3.2.6 Braces

Braces are used to enclose a set of words or terms of which any one may apply; i.e., $\left\{\begin{matrix} \text{GT} \\ \text{EQ} \\ \text{LT} \end{matrix}\right\}$ signified GT or EQ or LT must be selected.

6.3.3.2.7 Brackets

Brackets are used to enclose members of the character set whenever they are named in text; i.e., "The period [.] is used as a name-part connector."

6.3.3.3 Definitions

6.3.3.3.1 Name

A name is a string containing any of the basic characters A through Z, 0 through 9, and space. The string must begin with one of the characters A through Z. The special characters are not to be used in forming a name. Maximum name length is 36 characters.

6.3.3.3.2 Label

A label, defined only in the label field, is a string four characters in length, containing any of the following: A through Z and 0 through 9 and space.

6.3.3.3.3 Number

A number shall be specified in three forms: (1) hexidecimal, (2) decimal, and (3) decimal floating point constant.

6.3.3.3.3.1 Hexidecimal

A hexidecimal number shall consist only of the numerals 0 through 9 and the alphabetic characters A through F. The use of a decimal point shall not be allowed.

6.3.3.3.3.2 Decimal

A decimal number shall consist of the numerals 0 through 9 and the special character +, -, and . . Each decimal number shall contain a decimal point. . The number shall be specified as positive + or negative - by use of the proper sign. Absence of a sign shall designate the number as positive. The number shall not contain embedded commas or blanks.

6.3.3.3.3.3 Decimal Floating Point

The decimal floating point number shall consist of the decimal digits 0 through 9. The number may be signed positive + or negative - . If unsigned, the number shall be assumed positive. The number shall be followed by a decimal exponent written as the letter E followed by a signed or unsigned one - or two-digit integer constant. The range (R) covered by the floating point number shall be $5.5 . 10^{-79}$ R $7.2 . 10^{75}$. The number shall consist of 1 through 7 significant decimal digits.

Examples:

7.0E+0	(i.e., $7.0 \times 10^{0} - 7.0$)
19761.25E+1	(i.e., $19761.25 \times 10^{1} = 197612.5$)
7.E3	
7.0E3	(i.e., $7.0 \times 10^{3} = 7000.0$)
7.0E03	
7.0E+03	
7.0E-03	(i.e., $7.0 \times 10^{-3} = 0.007$)

6.3.3.3.4 Argument

All names and numbers are arguments.

6.3.3.4 Card Format

The format in which the training language statements are written (and punched on 80 column cards) is as follows (see Figure 6-1):

	ID	CONTROL		TIME		LABEL		STATEMENT	CON-TIN-UA-TION	SEQUENCE
CARD COLUMNS	1	2	3	4 ______ 13	14	15 ______ 18	19	20 ______ 72	73	74 ______ 80

Figure 6-1. Training Language Coding Form

6.3.3.4.1 Control Character Field

Column 2 of the coding form shall contain one of the optical control characters. The permissable control characters shall be the following:

Character	Definition
*	An asterisk shall denote a comments card which will be printed on the program listing. The columns 3 through 72 shall be available for comments.
T	Time since T_o, where T_o is a reference time T and is advanced with system time. Ident. card only.
V	Indicates the script statement is referenced to Vehicle, Time, Ident. card only.

6.3.3.4.2 Time Field (Card Columns 4 through 13)

The time field references vehicle time, or time since T_o. Vehicle time and time since T_o are written as DD/SSSSS.S. When this field is used it essentially says "wait until the clock reaches the time designated in the time field before executing this statement." All operators must have time field entries except the IDENT, END, and MACRO operators. A blank time field means use time from previous statement.

6.3.3.4.3 Label Field (Card Columns 15 through 18)

The label field is used to tag statement for control sequencing purposes. The label field is optional. If used, it is exactly four characters in length including trailing blanks.

6.3.3.4.4 Statement Field (Card Columns 20 through 72)

The procedural statements are written in this field. Comments may be inserted in the statement field on any card merely by inserting the text of the comment between quotation marks ("text"). Comments shall not extend onto continuation cards.

6.3.3.4.5 Continuation Field (Card Column 73)

Any character in this field indicates that the statement field is to be continued on the next card using card columns 20-72.

6.3.3.4.6 Identifier/Sequence Field (Card Columns 74-80)

Letters or numbers are included in this field to allow the completed punched card program decks to be sequenced. This field is not processed by any simulator programs.

6.3.3.4.7 Module Ident. Field

This field is not processed by any simulator program.

SECTION 10

APPENDIX

SECTION 10

APPENDIX

10.1 WORKMANSHIP AND DESIGN PRACTICES

The provisions of MIL-T-27474 "Training Equipment, Ground, General Requirement for" dated 22 August 1960, as amended by the clarification and deviations contained within this Section shall apply to the equipment of this document.

Paragraph	Deviation/Clarification
2.1	A. Delete MIL-S-6872 and replace with MIL-STD-454, Section 5. Reason: MIL-S-6872A has been canceled for AF use (ref. MIL-S-6872A, Amend. 1, dated 12/14/65) and replaced by MIL-STD-454.
	B. Add MIL-W-81044, Wire, Electrical, Crosslinked Polyalkene Insulated Copper. Reason: MIL-W-81044 wiring requirements will be used in conjunction with MIL W-16878.
	C. Delete MIL-P-26441 and replace with MIL-P-55110A. Reason: MIL-P-55110A supersedes MIL-P-26441.
	D. Change ANA Bulletin 143 to read MIL-STD-143. Reason: to reflect proper identification.
	E. Delete MIL S-3644. Reason: previously waived (refer to paragraph 3.4.10.3).
	F. Delete MIL-E-4682. Reason: previously waived (refer to paragraph 3.6.1).

Paragraph	Deviation/Clarification
	G. Delete MIL-T-9107. Reason: previously waived (refer to paragraph 4.6.2).
	H. Delete MIL-R-25717. Reason: previously waived (refer to paragraph 3.4.3).
	I. Delete MIL-P-27259. Reason: previously waived (refer to paragraph 3.7).
	J. Delete MIL-STD-681. Reason: previously deviated from to allow use of GE Standard (refer to paragraph 3.15.2.2).
	K. Delete MIL-STD-803 and replace with MIL-H-27894, dated 9 January 1963. Reason: refer to deviation to paragraph 3.4.2.
	L. Delete TT-E-489, TT-P-636, TT-S-176, and MIL-P-8585. Reason: these specifications not pertinent. Epoxy to be used in lieu of materials specified (refer to devia tion to paragraphs 3.14.1 and 3.14.2).
	M. Delete MIL-STD-130. Reason: previously waived (refer to paragraph 3.17).
	N. Delete MIL-T-7928 "Terminal Lug and Splice, Crimp Style, Copper".
3.2.1	Delete.
3.2.2	Delete.
3.2.3	Delete.

Paragraph	Deviation/Clarification
3.3.1	Delete. Reason: previously waived.
3.3.5	Add to last sentence: "over the total range of required operating temperatures." Reason: clarification of the term "temperature resistant." At elevated temperatures virtually no materials are temperature resistant. (Refer to paragraph 3.3.5.1).
3.3.5.1	Change to read: "Flame resistant materials shall be used where practical in the design of the Simulated Laboratory Module (SLM) only. When used they shall: a. Be rated as self extinguishable in air when tested to the applicable ASTM material specification; or, b. Meet the combustion rate requirements imposed for similar application in the MOL AVE (refer to GE specifications DR 1111 and DR 1115); or, c. Meet the requirements of MIL-STD-454A, Requirement 3. These requirements shall not be imposed on catalog purchased hardware." Reason: Clarification of the requirement "no toxic fumes will be liberated." All metallic and hydrocarbon combustion products are toxic to some degree.
3.4.1	Delete "It shall be possible for the student to perform all functions and observe all phenomena normally encountered when using the operational equipment or system." Replace with: "It shall be possible for the student to perform functions as specified in the approved Experiment Plan." Reason: many functions or phenomena cannot be simulated (e.g., zero-g). The credibility of the simulation is subject to individual approval by the customer at the time of approval of the Experiment

Paragraph	Deviation/Clarification
3.4.2	Delete MIL-STD-803 and replace with MIL-H-27894, paragraph 3.8. Reason: since simulators are closely related to AVE, the human factors requirements of the AVE are more appropriate. The identification of human factors items, as specified in paragraph 3.8 of MIL-H-27894, is accomplished in Experiment Plans. Resolution of such factors are subject to MOL/SPO approval at the time of approval of the Experiment Plan. In addition, all modifications required to resolve human factors problems require approval.
3.4.2.1.1	Delete.
3.4.2.1.2	Delete.
3.4.2.1.3	Delete.
3.4.2.1.4	Delete.
3.4.3	Delete. Reason: previously waived.
3.4.4.1	Delete "Cabinets and inclosed racks having access doors or removable panels for maintenance purposes shall have protective interlocks to eliminate the hazardous potentials." Replace with: "Cabinets and enclosed racks having access doors or removable panels for maintenance purposes shall have warning labels affixed to or adjacent to such openings to indicate the hazardous potentials. Such warnings shall indicate 'remove power before opening' when applicable." Reason: SCC Panel 2A, if interlocked, would shut down entire system. In addition, there are maintenance considerations which require power.

Paragraph	Deviation/Clarification
3.4.5.1	A. Change first sentence to read: "The training equipment shall be required to operate on commercial power as supplied by the Philadelphia Electric Company." Reason: clarification of requirement. Philadelphia Electric Company supplies ±10V; this tolerance more stringent than present specification requirement. B. Delete "Batteries shall not be used as a part of, or in connection with, the power supply equipment." Reason: batteries will be used for emergency light in the event of power failure. This is a safety consideration.
3.4.5.2	Delete. Reason: GE will use single phase motors in 106.
3.4.5.4	Clarify: "Lamp indicators shall be used so that fuse failures are visually indicated." To be deleted when applied to commercial equipment. Reason: requirement is not an industry-wide standard commercial practice. GE will comply on non-commercial equipment.
3.4.9.2	Delete.
3.4.10.3	Delete.
3.4.10.4	Delete. Reason: previously waived.

Paragraph	Deviation/Clarification
3.4.10.5	Add the following: "In cases where the training equipment is to simulate operational equipment, the controls and indicators that contribute to the training objective shall be of similiar layout as the operational equipment." Reason: to provide for developing and evaluating AVE designs and training.
3.4.10.6	A. Delete requirement for existing commercial equipment only. Reason: previously waived.
	B. Add the following: "In cases where the training equipment is to simulate operational equipment, the controlled characteristics shall be similar to the operational equipment." Reason: to provide for developing and evaluating AVE designs and training.
3.4.10.7	Delete requirement for existing commercial equipment only. Reason: previously waived.
3.4.13	Change to read: "Running time meters shall be installed to indicate accrued operating time on assemblies classified as limited life equipment." Reason: the total system operating time (power on time: does not necessarily reflect the on-time for all assemblies. The accrued time of specific assemblies is more important from reliability and cost-effectiveness standpoints.
3.5.1.6	Delete and replace with the following: "Test points shall be incorporated in power conditioning equipment for maintenance purposes. Other equipment shall be designed for easy access to test points."

Paragraph	Deviation/Clarification
	Reason: complexity and density of equipment makes installation of all test points accessible from the outside impractical.
3.5.1.9	Delete second sentence and replace with the following: "When a need for special tools and test equipment exists, these tools shall be kept in the same area as the training equipment and shall be made available for use during maintenance and repair." Reason: the objectives of the original requirement will be met. However, as a matter of access and working space around the simulator, it is more practical not to securely attach the tool kit to the simulator.
3.5.2.6.1	Delete requirement for existing commercial equipment only.
3.5.2.1.6	Delete requirement for existing commercial equipment only. Reason: previously waived.
3.5.2.1	A. Change second sentence to read: "MIL-W-16878 or MIL-W-81044." Reason: same as deviation in paragraph 2.1.
	B. Delete MIL P-26441 and replace with the following: "MIL-P-55110A, except paragraphs 3.7 through 3.14 and paragraphs relating to pre-production testing. The inspection tests shall be limited to visual and dimensional examination as specified in paragraph 4.8.1. (Table III, Group A tests only.)" Reason: MIL-P-55110A supersedes MIL P-26441. Paragraphs 3.7 through 3.14 apply to pre-production testing of the wiring boards. The wiring board material used in the simulator is purchased as Plastic Sheet, Laminated Copper Clad per MIL-P-13949 Type FL. (MIL P-13949 is a first-tier applicable

Paragraph	Deviation/Clarification
	specification of MIL P-55110A.) The wiring board material goes through no process subsequent to receipt that would degrade or affect the essential properties (e.g., insulation, moisture resistance, adhesion, etc.). The pre-production testing specified in MIL P-55110A is considered to be redundant with the testing required under the purchase specification MIL-P-13949.
	C. Change reference in MIL-P-55110A to "MIL-STD-275, except paragraph 5.2.1.1." Reason: paragraph 5.2.1.1 states that "the terminal areas shall completely surround and abut on the mounting holes." In the case of mounting transistors on the printed wiring board, the drilled holes for the transistor leads breaks through the edge of the terminal area (e.g., 2N3908 transistors on the 2" X 2" DIU boards). This condition does not affect the functionality of the assembly nor does it represent a degradation in performance or reliability in this application. The fabrication permitted by deleting the requirement is in common use in commercial equipment.
3.5.2.4	Delete requirement for existing commercial equipment only.
3.5.2.6	A. Delete requirement for existing commercial equipment only. Reason: previously waived.
	B. Delete 10 percent requirement. Reason: spares are available. However, design changes have utilized some original spares such that the 10 percent capability does not presently exist.

Paragraph	Deviation/Clarification
3.5.2.7	Delete requirement for existing commercial equipment only.
3.5.2.8	Delete requirement for existing commercial equipment only.

Delete reference to MIL-T-7928

Reason: MIL-T-7928 specifies the use of MS type terminals. In addition, it specifies the maximum allowable voltage drop for the connection and specifies tensile (pull test) requirements.

Commercial equipment does not conform to the MIL-T-7928 requirements.

The General Electric method is to control the fabrication by Process Control Instructions. The instructions specify the specific crimping tool to be used, the contact size to be used for a given wire size, and the tensile test requirements. The tensile test requirements in the Process Control Instructions meet or exceed the MIL-T-7928 requirements. Recent representative tests of contacts fabricated for 106 indicate that the crimp joints fabricated met the voltage drop tests and withstood, far in excess, the minimum tensile test requirements, with some joints having failed at loads slightly below the rated strength of the wire. This deviation is requested as a matter of standardization, since the current practices are well controlled and result in products which meet or exceed the MIL specification requirements.

3.5.2.9	Delete requirement for existing commercial equipment only. Reason: previously waived.
3.5.2.10	Delete.
3.5.2.10.1	Delete. Reason: previously waived.

Paragraph	Deviation/Clarification
3.5.2.10.2	Delete reference to Table I. Reason: in general, 10 percent spares have been designed into cables. For point-to-point wiring practices, this ratio is considered adequate.
3.5.2.10.4	Delete. Reason: previously waived.
3.5.2.12a	Change from: "at least two times" to "once." Reason: due to compact packaging required within the DIU, and to eliminate interference which extra slack might induce, good design practice dictates reduction of slack to the extent that only one repair capability exists.
3.5.3	A. Delete requirement for existing commercial equipment only. Reason: previously waived. B. Delete MIL-S-6872 and replace with MIL-STD-454, Section 5. Reason: to reflect cancellation of MIL-S-6872A and impose its replacement.
3.5.3.1	Delete requirement for existing commercial equipment only. Reason: previously waived.
3.5.3.3	Delete the following: "In no case where flexible wires are used shall electrical connections be made solely by clamping wires between metal parts. Such a connection shall be soldered or soldering lugs may be used in lieu thereof." Replace with: "In no case where flexible wires are used shall electrical connections be made solely by clamping wires between metal parts unless specific applications employing solderless termination techniques have been approved for use by the contractor and are referenced on the assembly drawings."

Paragraph	Deviation/Clarification
	Reason: new solderless termination techniques for high density packaging have been developed and are being used throughout the industry.
3.5.3.5	Delete. Reason: provisions of paragraph 3.5.3.3 shall apply.
3.6.1	Delete. Reason: previously waived.
3.6.5	Delete requirement for self-wiping contacts. Reason: relays conform to dust proof requirements. In addition, equipment will be used in controlled environment.
3.6.6	Change to read: "All servos shall be designed to be driven in either direction to aid in maintenance procedures, or for determination of performance. Protection against overdriving servos shall be provided." Reason: the equipment is designed to provide test signals to the servos via potentiometers to check performance of servos. The servos are protected against overdrive; however, switches for locking are unnecessary due to the test drive capability and could interfere with experiment operations if included. Since locks are unnecessary, the indicator requirements do not apply.
3.7	Delete. Reason: previously waived.
3.8	Delete requirement for commercial equipment. Reason: GE-designed equipment will comply with requirement. However, not all commercial equipment is designed to comply with MIL-D-70327 interchangeability requirements.

Paragraph	Deviation/Clarification
3.10	GE Acceptance test will be sole criteria. Reason: previous deviation approved.
3.11	Delete. Reason: previously waived.
3.13	A. Deviation: FED-STD-595, No. 25109, Blue shall be used on exterior of consoles, storage cabinets and equipment racks, and simulator support structures. Reason: to obtain greater contrast and color harmony (special MOL shades) for human factors purposes. The contrast between the darker exterior and the lighter control panels accents the control section panels. (NOTE: epoxy paint usage is covered under paragraph 3.14.1 deviation.) B. Deviation: Pale Aqua Blue, Color No. 17ca and Celadon Green, Color No. 24ge shall be used on the interior of consoles, storage cabinets and equipment racks. Reason: in addition to contrast and human factors color harmony, these colors will increase the reflectivity of interior surfaces while performing work within racks and cabinets.
3.14.1	A. Waive for existing commercial equipment only. Reason: previously waived. B. Add: "The optional use of epoxy paints shall be allowed." Reason: a study was made by General Electric to determine the best method of marking the control consoles. A GE VFSTC Division facility has been set-up and is available with special

Paragraph	Deviation/Clarification
arrangements to do this work professionally. Concurrent with these developments S&T considered the developments at Pittsfield Ordnance in introducing a similar improvement on Polaris Fire Control Equipment. As at GE X-Ray Department the best silk screen ink (paint) was sought. It was concluded that Wornow Epoxy Inks (paint) is highly resistant to abrasion and is most suitable for this application. Preferred application of the lettering is on a background of the same material previously cured. In addition, because of the extended checkout and usage of the equipment in a show case manner, high resistance of the degrading appearance of scuffs, scratches, nicks, etc., is most desirable. The epoxy paint fills these requirements significantly better than alkyd base paints.

These epoxy paints conform with:

O.D. 14301 (Bu Ord) Part.No. and Inspection Base Marking (Permanent Ink).

O.S. 1173 (Bu Weps) Paint, catalyzed, plastic base.

O.S. 7446B (Bu Ord) Marking ink, silk screen, permanent.

MIL-E-5272A, Procedure 1 fungus resistance.

MIL-E-8261, Fungus Resistance.

GE MSD specs are available for proper control of both painting and silk screen application of this material. Proper application of this material is upon a clean ferrous surface or an alodined aluminum surface. Its coverage is considered excellent.

3.14.2 Delete and replace with: "The provisions of paragraph 3.14.1 shall apply."

Reason: for consistency.

3.14.3 Delete.

Paragraph	Deviation/Clarification
3.14.3.1	Delete.
3.14.3.2	Delete.
3.14.3.3	Delete. Reason: previously waived.
3.14.4	Add the following: "The provisions of this paragraph shall not apply in cases where the painting or plating of precision close tolerance surfaces shall interfere with the functioning of the equipment." Reason: there are isolated instances of precision design requirements that preclude the use of paint or plating on surfaces. Such uses shall be inspected frequently for oxidation.
3.15.2.1	Delete. Reason: previously waived.
3.15.2.2	Per standard GE shop practice. Reason: previous deviation approved.
3.15.2.3	Deviation: The provisions of this paragraph shall not apply to the identification of parts within purchased commercial equipment or to high density assemblies (e.g., miniaturized printed wiring boards) where such identification is impractical. Reason: it is not industry-wide standard commercial practice to identify parts in accordance with the provisions of this paragraph. General Electric will comply with the provisions of this paragraph except in cases of where high packaging densities or where advances in the state-of-the-art in miniaturization makes it impractical.

Paragraph	Deviation/Clarification
3.15.2.3.1	Electronic and electrical symbols shall be in accordance with MIL-STD-15. Reason: to standardize method.
3.15.2.3.2	A. The requirements of this paragraph are waived for commercial equipments. B. Electronic and electrical symbols shall be in accordance with the provisions of MIL-STD-15. Reason: same as reasons for deviations to paragraphs 3.15.2.3 and 3.15.2.3.1.
3.15.2.4.1	Per standard GE drafting practice.
3.17	Per standard GE drafting practice. Reason: previous deviation approved.
4.3.1	Per GE acceptance test plan.
4.5.3	Per GE acceptance test plan. Reason: previous deviation approved.
4.5.4	Delete.
4.5.4.1	Delete.
4.5.4.2	Delete.
4.5.4.2.1	Delete.

Paragraph	Deviation/Clarification
4.5.5	Delete. Reason: previously waived.
4.6	Not applicable.
4.6.1	Not applicable.
4.6.2	Not applicable.
4.6.2.1	Not applicable.
4.6.3	Not applicable.
4.6.4	Not applicable.
5.0	Not applicable.
5.1	Not applicable.
6.0	Not applicable.
6.1	Not applicable. Reason: previously waived.
6.2c	Delete. Reason: previously waived.
6.2f	Change 90 days to 30 days. Reason: previous deviation approved.