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52

DEVELOPMENT OF A TEST AND FLIGHT ENGINEERING ORIENTED LANGUAGE

PHASE II PRESENTATION

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16. Abstract This booklet contains the material used during the oral presentation to describe the work done in Phase II of the development of a Test and Flight Engineer Oriented Computer language. The Phase II report performs an analysis of the Space Shuttle system and details those requirements which impact on the development of a test and flight engineer language. In the report the necessary resulting language characteristics are analyzed and reasons are given as to why they are necessary in the proposed test oriented language. The Phase II report is published as Martin Marietta document MCR-70-365.			
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INTRODUCTION

MARTIN MARIETTA

DENVER DIVISION

DEVELOPMENT OF A TEST AND
FLIGHT ENGINEER ORIENTED LANGUAGE
for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
KENNEDY SPACE CENTER, FLORIDA
CONTRACT NAS10-7308
PHASE II ORAL PRESENTATION
15 OCTOBER 1970

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MARTIN MARIETTA

DENVER DIVISION

WILLIAM F. KAMSLER - PROGRAM MANAGER

C. WILLIAM CASE

J. GYURE

EDMUND L. KINNEY

STUDY PHASES

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PHASE I

REVIEW THE PAST AND CURRENT DEVELOPMENT
EFFORT RELATED TO SPACE VEHICLE AUTOMATIC
CHECKOUT LANGUAGE

PHASE II

DEVELOP THE NEEDED CHARACTERISTICS FOR A
SPACE SHUTTLE AND FLIGHT ENGINEER ORIENTED
LANGUAGE

PHASE III

PRODUCE A LIST OF LANGUAGE REQUIREMENTS
(A SPECIFICATION) FOR THE BASIC DESIGN OF
THE LANGUAGE

PHASE II TASKS

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ANALYZE THE SPACE SHUTTLE SYSTEM AND DETAIL THOSE REQUIREMENTS

WHICH IMPACT ON THE DEVELOPMENT OF THE TEST AND FLIGHT

ENGINEER LANGUAGE

INVESTIGATE LANGUAGE FEATURES AND DETERMINE WHAT CHARACTERISTICS

ARE NECESSARY IN THE PROPOSED TEST ORIENTED LANGUAGE

GROUND RULES

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THE FOLLOWING GROUND RULES APPLY TO SPACE SHUTTLE

TWO STAGE REUSEABLE VEHICLE

MAXIMUM ONBOARD AUTONOMY

VEHICLE CAPABILITY OF 100 MISSION CYCLES

HIGH LAUNCH RATE (25 TO 75 PER YEAR)

SELF-SUSTAINING ORBITAL LIFETIME OF 7 DAYS

14 DAY GROUND TURN-AROUND TIME

NO INFLIGHT MAINTENANCE

MECHANICAL SUBSYSTEMS SHALL FAIL OPERATIONAL, THEN FAIL SAFE

ELECTRONIC SUBSYSTEMS SHALL FAIL OPERATIONAL, FAIL
OPERATIONAL, THEN FAIL SAFE

AIRLINE TYPE OPERATIONS; TWO MAN CREW WITH ONE MAN CAPABILITY

RETEST REQUIREMENTS INVOLVE ONLY THE REPLACED LRU

TECHNOLOGY BASELINE 1972

BOOSTER INTEGRATED AVIONICS SYSTEM BASELINE CONFIGURATION

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GUIDANCE & NAVIGATION SENSORS
INERTIAL MEAS UNIT
NAVIGATION BASE ASSEMBLY
AIR DATA SENSORS

COMMUNICATIONS AND RADIO NAV AIDS
DME
MARKER BEACON
VOR/LOCALIZER
GLIDE SLOPE
ATC TRANSPONDER
RECOVERY BEACON
GSE INTERFACE
UHF RADIO
INTERCOM
RADAR ALTIMETER

FLT. CONT.ELECT.
ACS/OMS CONTROL
JET ENGINE CONTROL
ELEVON
RUDDER
MAIN ENGINE
RATE GYRO PKG
ENGINE DEPLOY

DATA MANAGEMENT
CENTRAL COMPUTER
MASS MEMORY
HARDWARE EXEC.
MAINT. RECORDER
FLIGHT RECORDER
GSE INTERFACE

- GUIDANCE, NAVIGATION, ONBOARD CHECKOUT, CONFIGURATION SEQUENCE AND CONTROL FLIGHT CONTROL, FUNCTIONALLY INTEGRATED

- QUAD REDUNDANCY FOR CRITICAL BOXES

- AUTONOMOUS, AUTOMATIC OPERATION WITH CREW OVERRIDE, EXCEPT LANDING

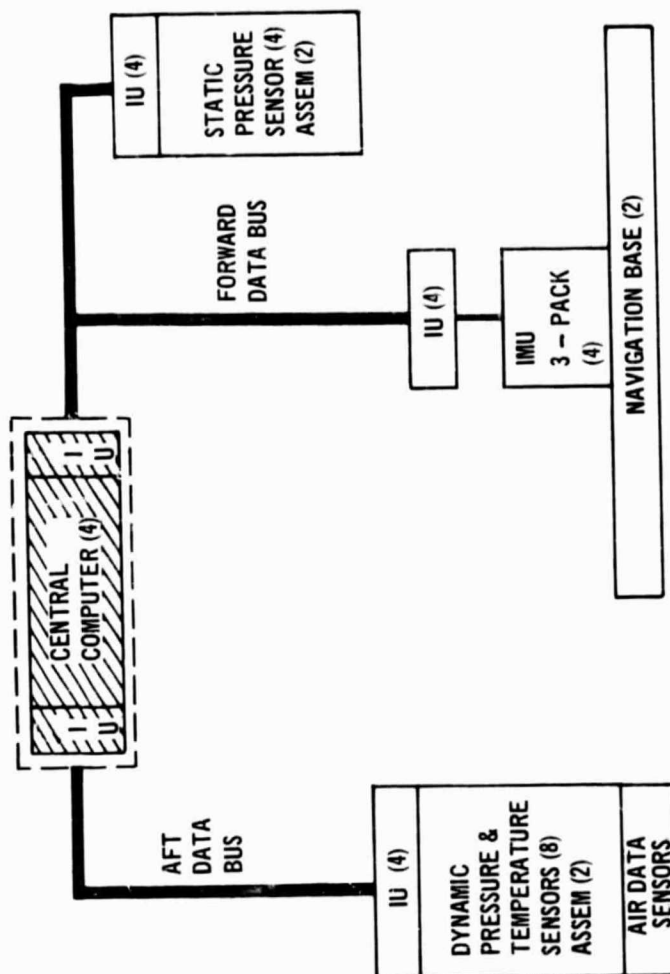
DISPLAYS & CONTROLS
DISPLAY PROCESSOR
PRI FLT CONT. DISP
SYSTEM MONITOR DISPLAY
ALPHA/NUM DISPLAY
CENTRAL DATA DISPLAY
THROTTLE
YOKE
RETICLE PROJ
ATTITUDE HAND CONT.
RUDDER/BRAKE
MODE SWITCH PANEL
KEYBOARD PANEL
MICROVIEWER ASSEM.

CONFIGURATION SEQUENCE AND CONTROL
LANDING
ECLS
POWER
SEPARATION
FIRE PROTECTION
LIGHTING
PROPELLANTS & PRESSURIZATION
INGRESS/EGRESS HATCH

BOOSTER GUIDANCE AND NAVIGATION SENSORS SUBSYSTEM

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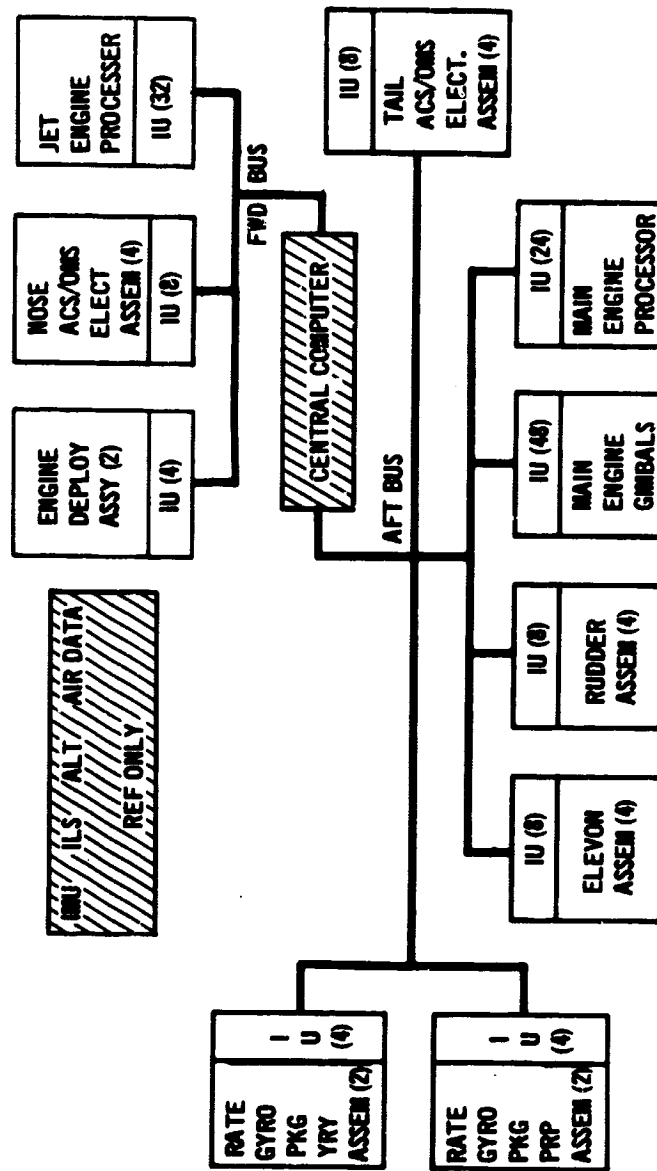
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BOOSTER FLIGHT CONTROL ELECTRONICS

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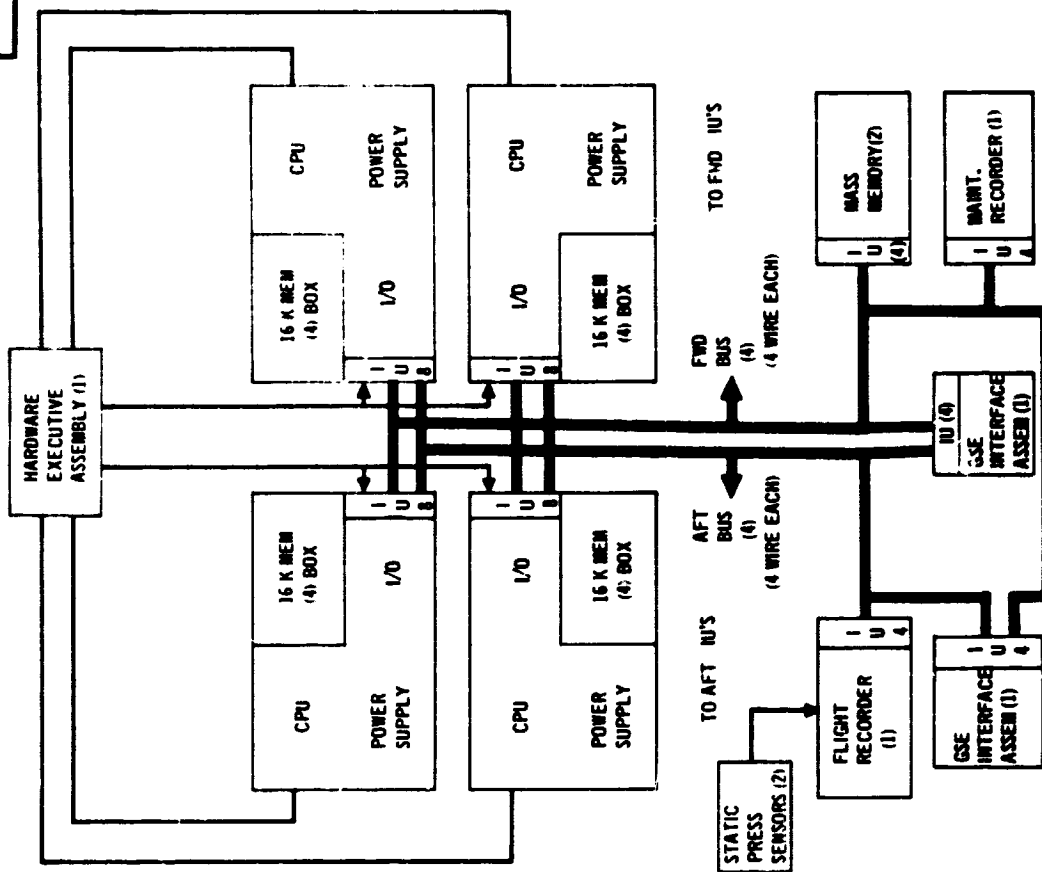
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BOOSTER DATA MANAGEMENT SUBSYSTEM

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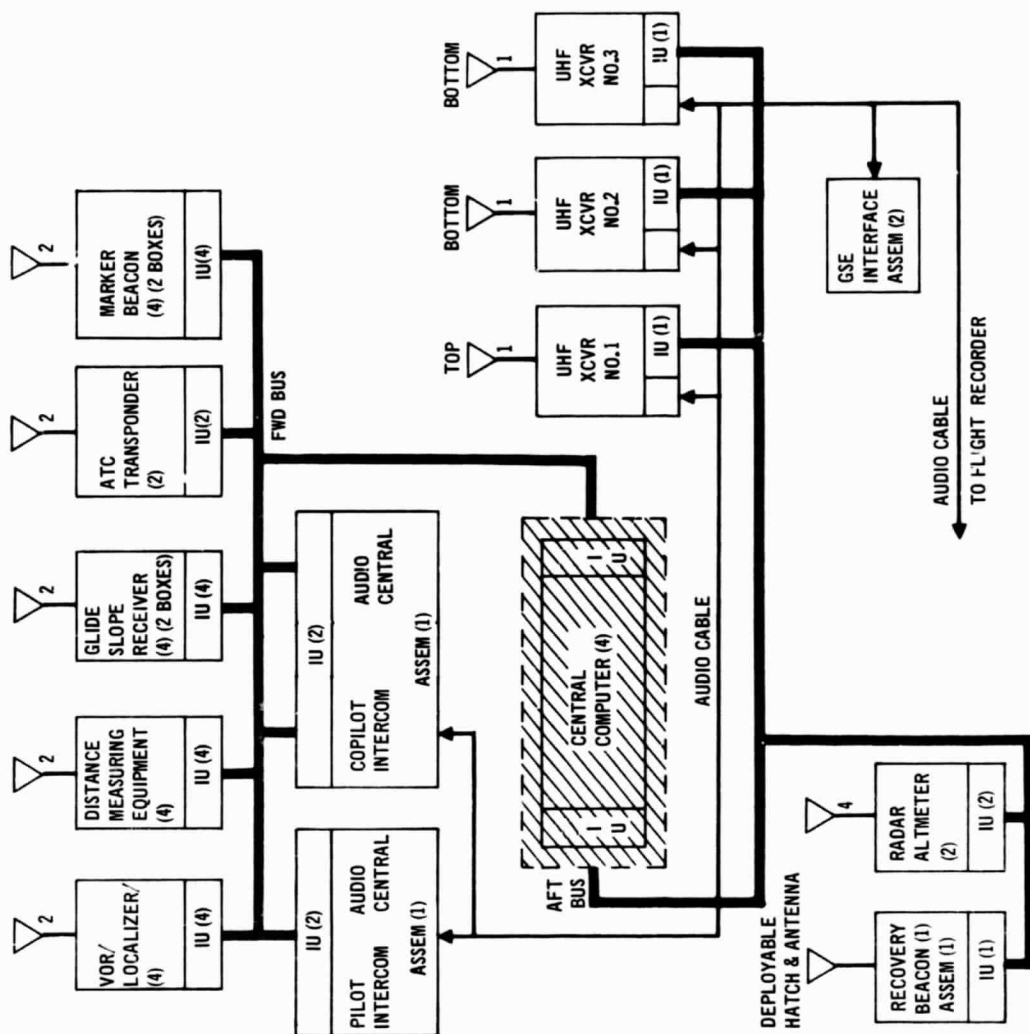
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BOOSTER COMMUNICATIONS AND NAVAIDS SUBSYSTEM

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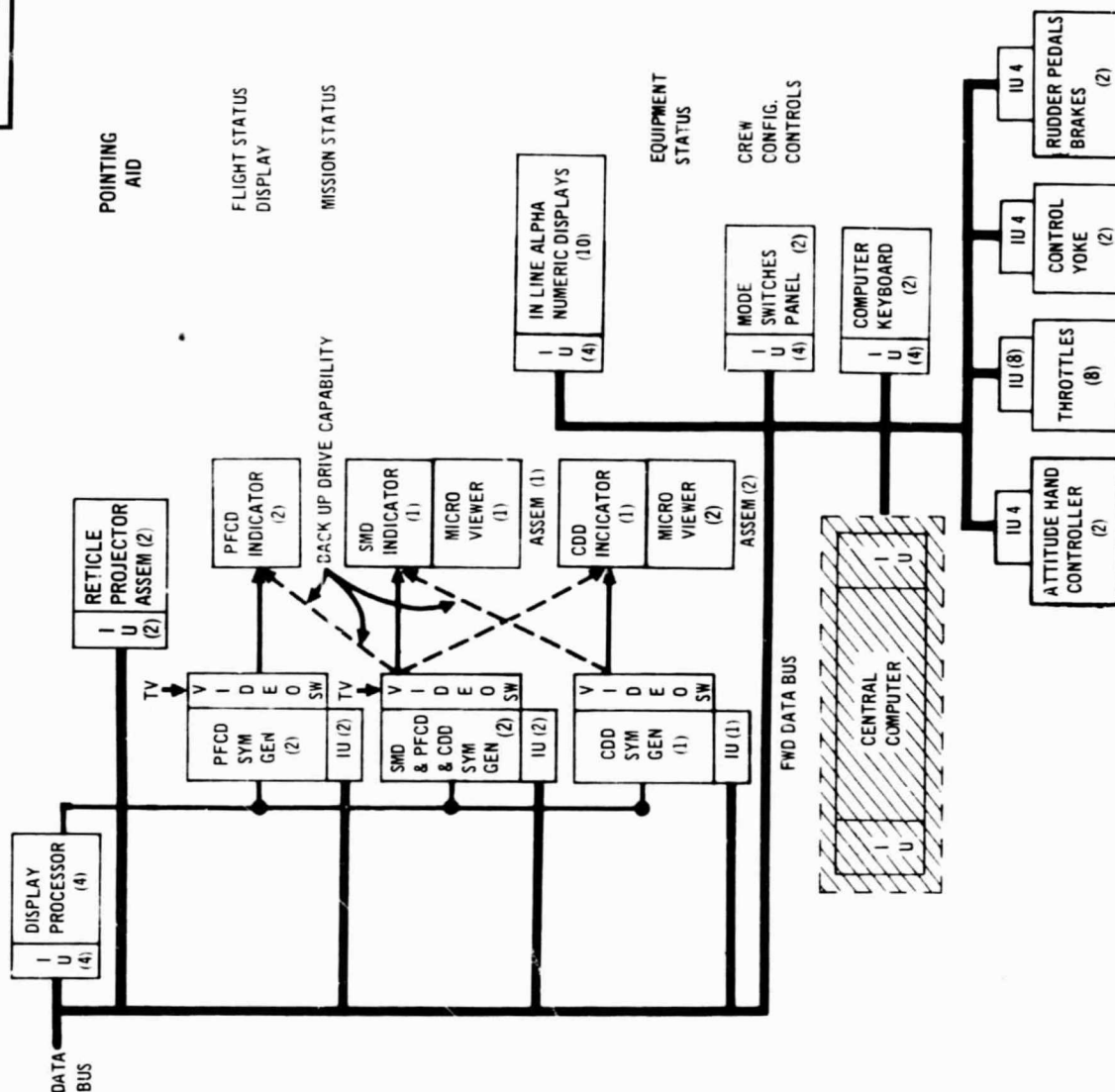
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BOOSTER CONTROLS AND DISPLAYS SUBSYSTEM

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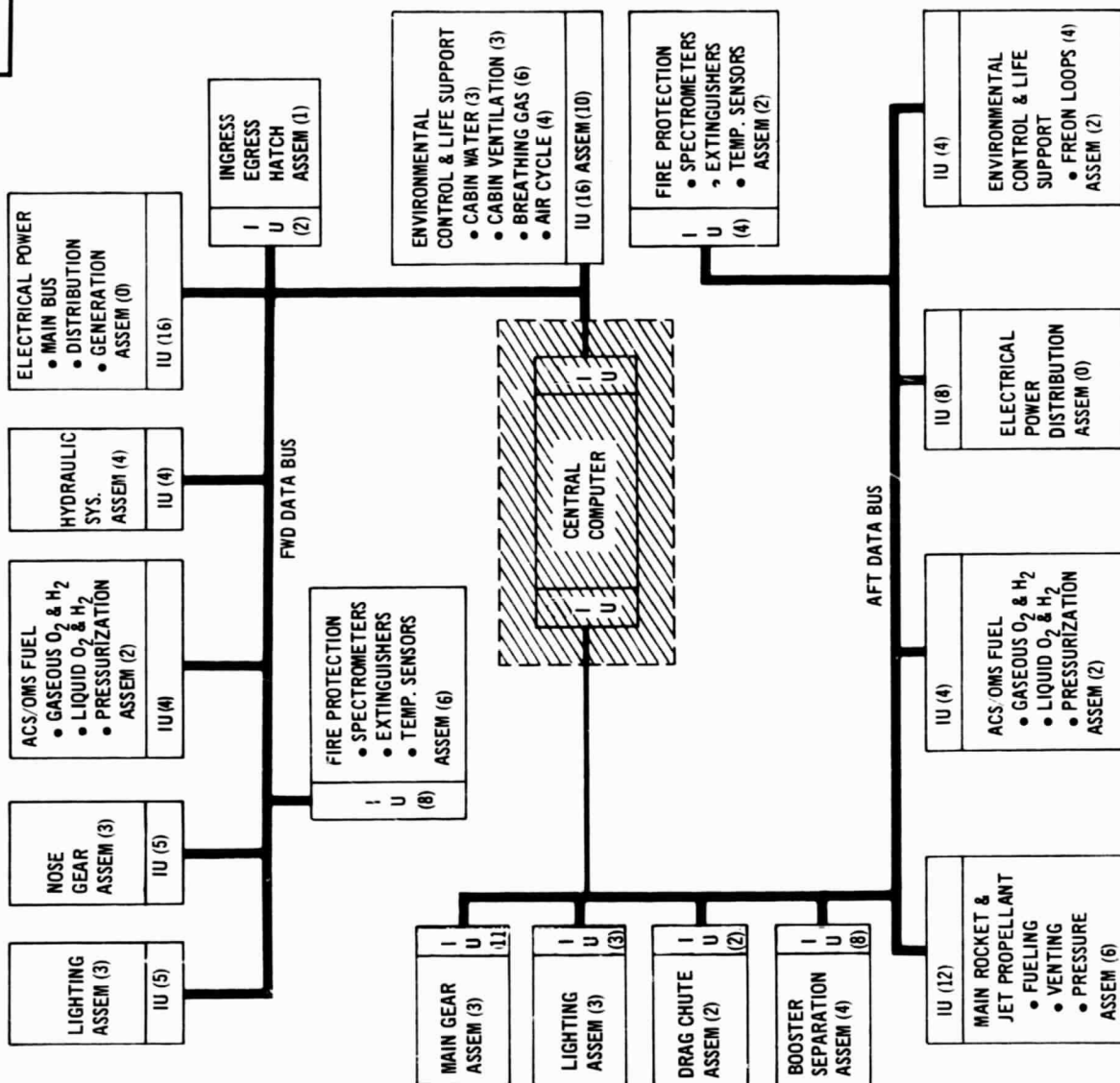
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BOOSTER CONFIGURATION AND SEQUENCE CONTROL SUBSYSTEM

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ORBITER INTEGRATED AVIONICS SYSTEM BASELINE - CONFIGURATION

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FLT CONT. ELECT
ACS/DMS CONTROL
JET ENGINE CONTROL
RATE GYRO PKG
AILERON
WING FOLD
ELEVATOR
FLAP
RUDDER
MAIN ENGINE

GUIDANCE & NAVIGATION
INERTIAL MEAS. UNIT
LASER/STAR TRACKER
HORIZON SCANNER
TRAINABLE TV
CCTV
NAVIGATION BASE ASSEM.
AIR DATA SENSORS
REND. RADAR*INTERFACE

*RENDEZVOUS RADAR ITSELF
PART OF PAYLOAD WHEN
REQUIRED

DATA MANAGEMENT
CENT. COMPUTER
MASS MEMORY
HARDWARE EXEC.
MAINT. RECORDER
FLT. RECORDER
PRINTER
GSE INTERFACE

DISPLAYS AND CONTROLS
DISPLAY PROCESSOR
PRI FLT CONT DISPLAY
SYSTEM MONITOR DISPLAY
ALPHA/NUM. DISPLAY
CENTRAL DATA DISPLAY
THROTTLE
YOKE
TRANSLATE HAND CONT.
ATTITUDE HAND CONT.
SENS. POINT CONTROL
RUDDER/BRAKE
MODE SWITCH PANEL
KEYBOARD PANEL
MICROVIEWER ASSEM.
RETICLE PROJECTOR

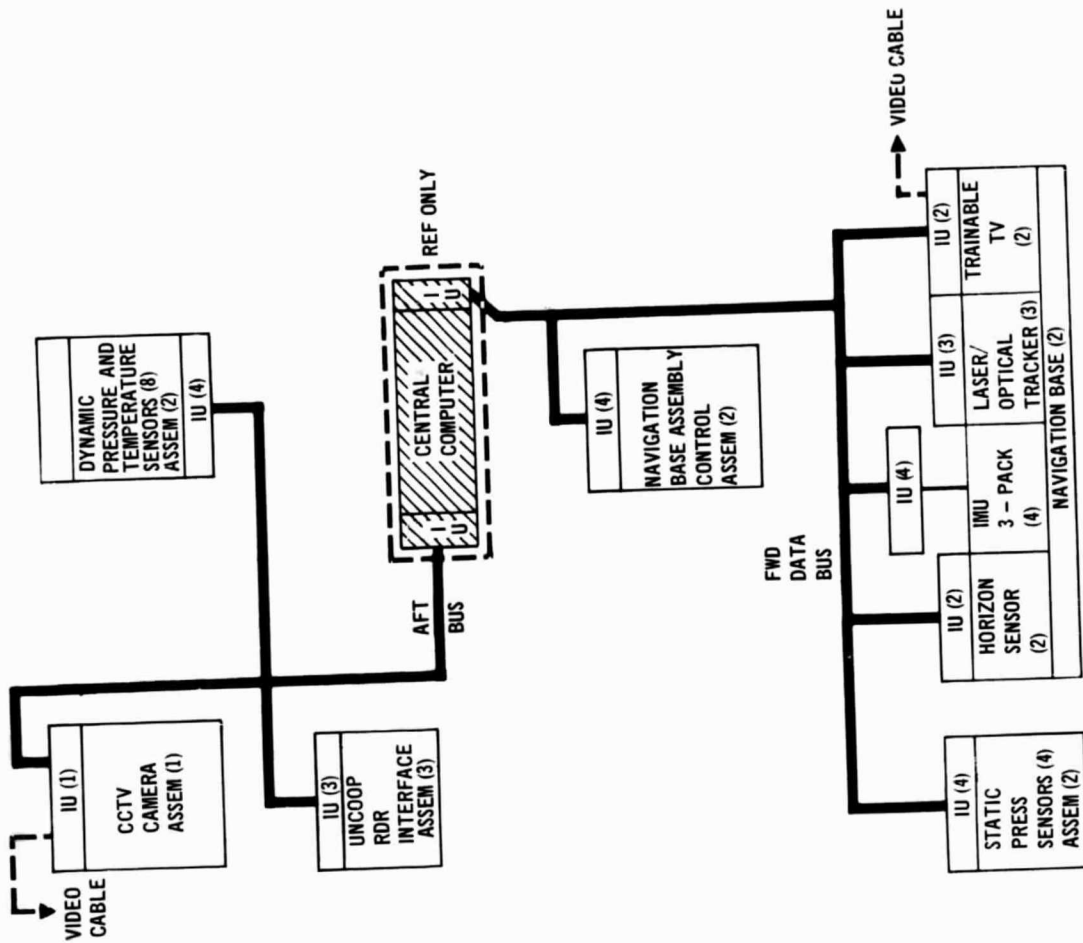
COMMUNICATIONS & NAVAIDS
TRANSIT RECEIVER
DME
MARKER BEACON
VOR/LOCALIZER
GLIDE SCOPE REC.
ATC TRANSPONDER
RECOVERY BEACON
SHF RADIO
UHF RADIO
INTERCOM
SHF DISH ASSEMBLY
GSE INTERFACE
SPACE STATION INTERFACE
RADAR ALTIMETER
DIPLEXERS

CONFIGURATION SEQUENCE AND CONTROL
LANDING
ECLS
POWER
DOCKING LATCH
PAYLOAD DOORS
FIRE PROTECTION
LIGHTING
PROPELLANT & PRESSURIZATION
HATCHES

- GUIDANCE, NAVIGATION
ON BOARD CHECKOUT,
CONFIGURATION SEQUENCE,
& CONTROL, FLIGHT CONTROL
FUNCTIONALLY INTEGRATED
- QUAD REDUNDANCY FOR
CRITICAL BOXES
- AUTONOMOUS, AUTOMATIC
OPERATION WITH CREW
OVERRIDE, EXCEPT
LANDING

ORBITER GUIDANCE AND NAVIGATION SUBSYSTEM

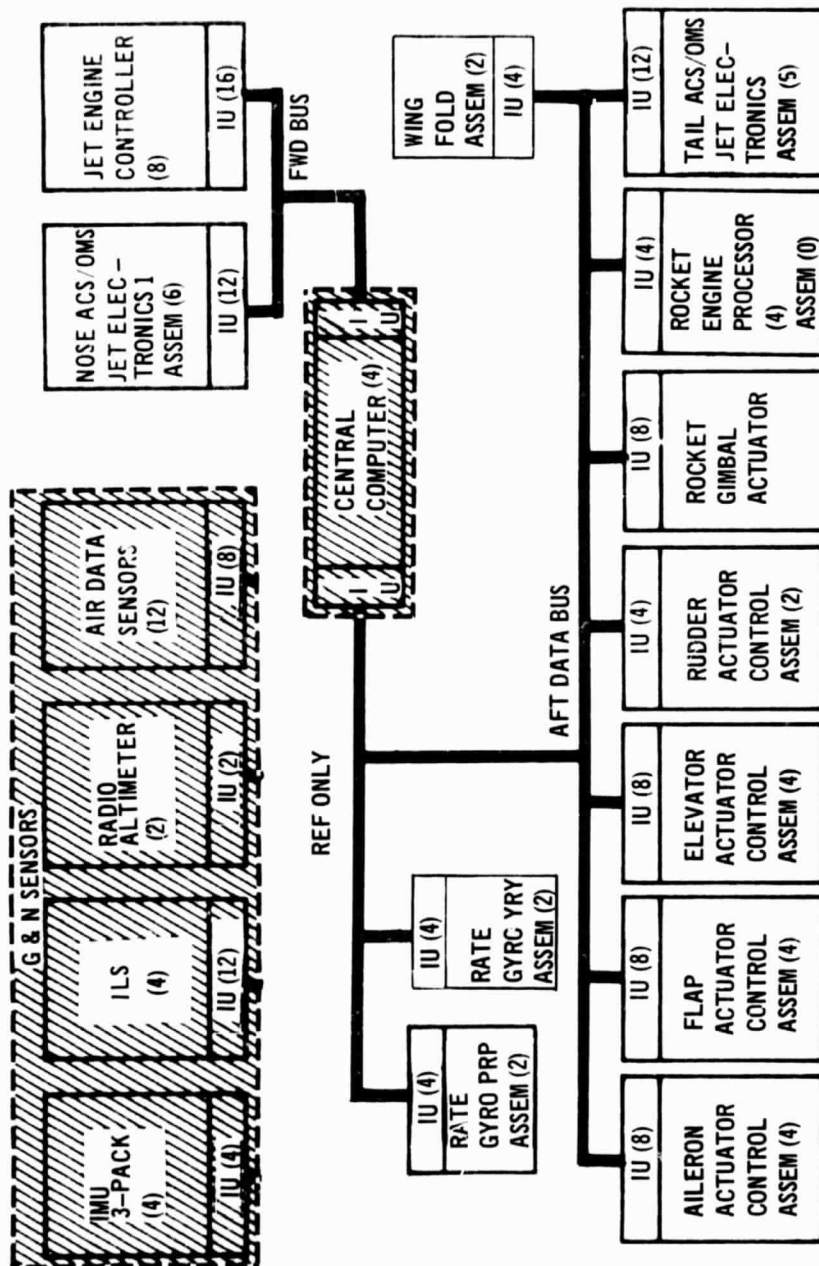
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ORBITER FLIGHT CONTROL ELECTRONICS

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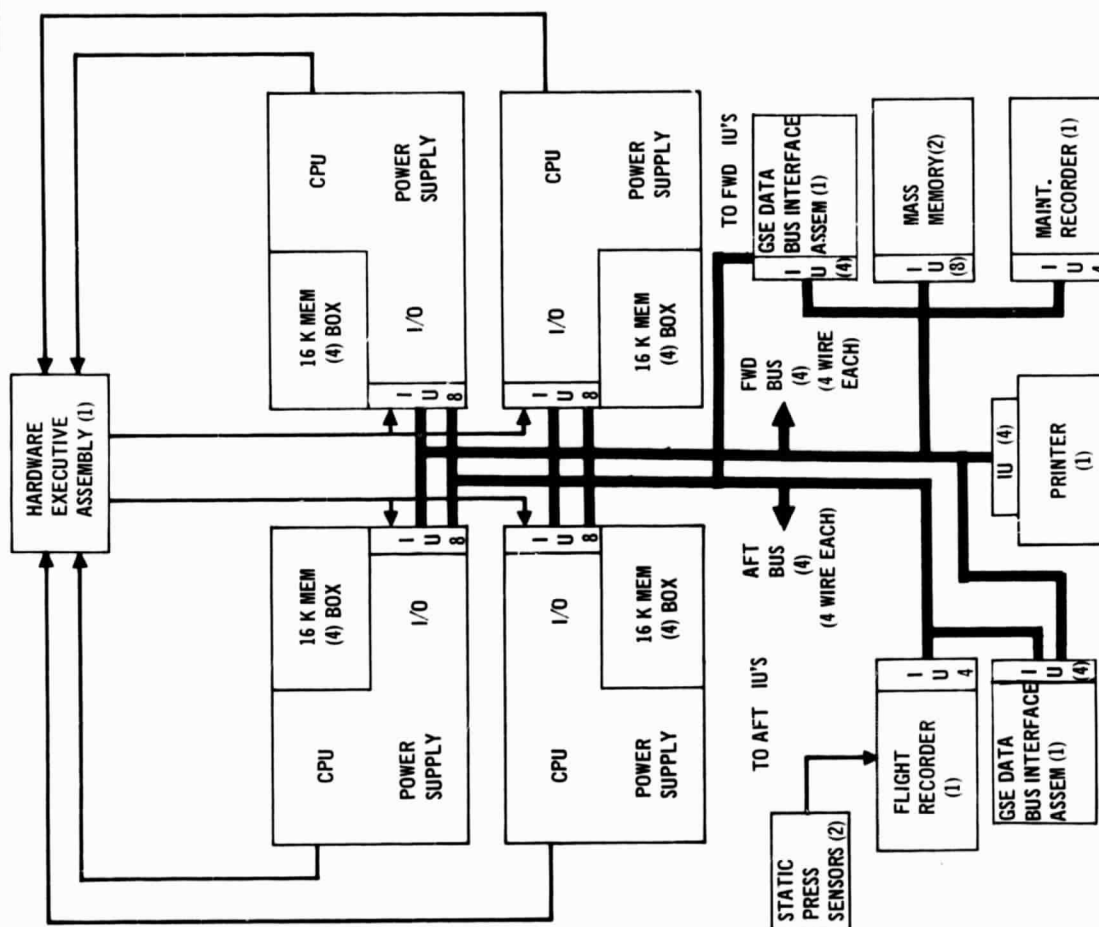
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ORBITER DATA MANAGEMENT SUBSYSTEM

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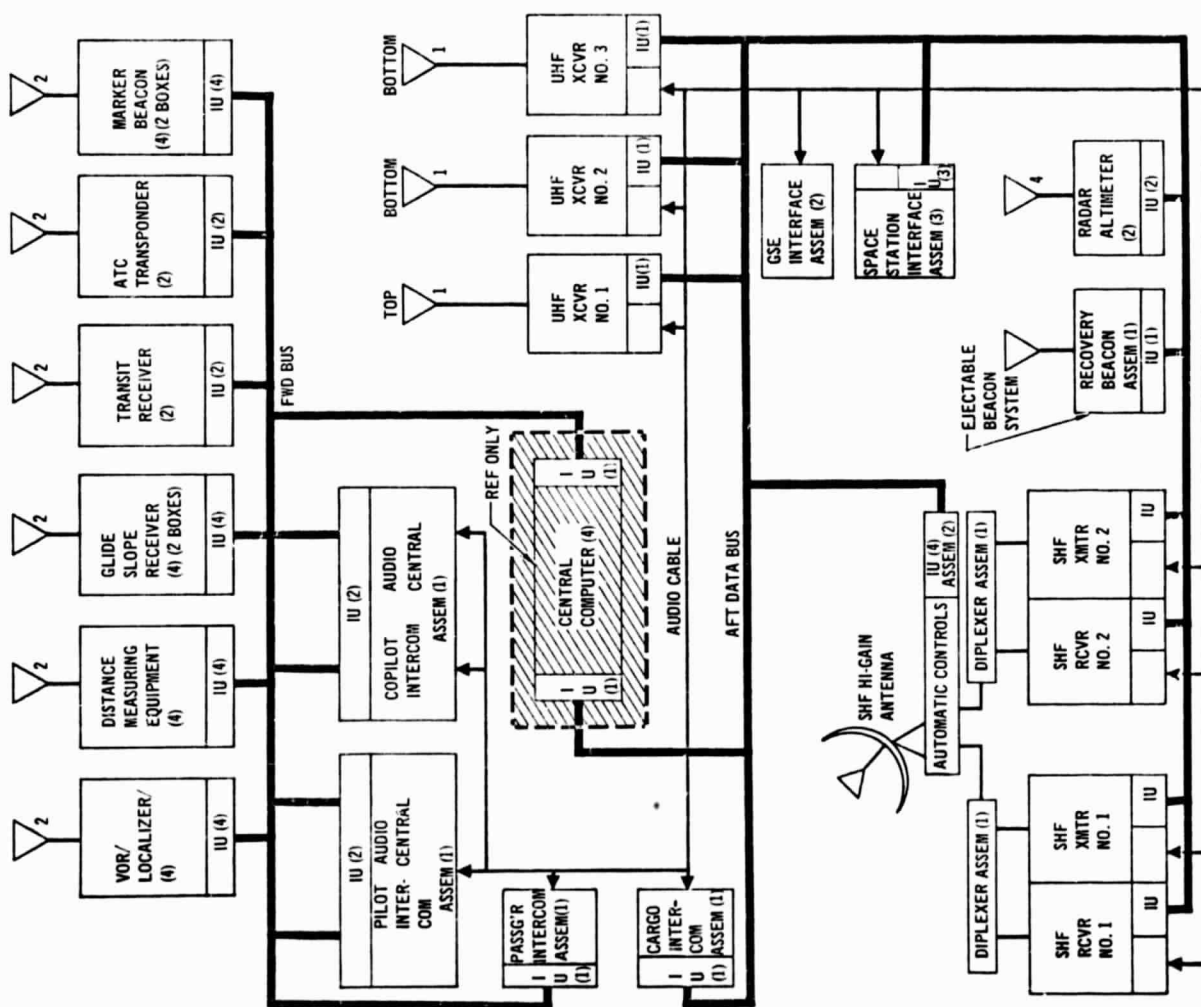
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ORBITER COMMUNICATION AND NAVAIDS

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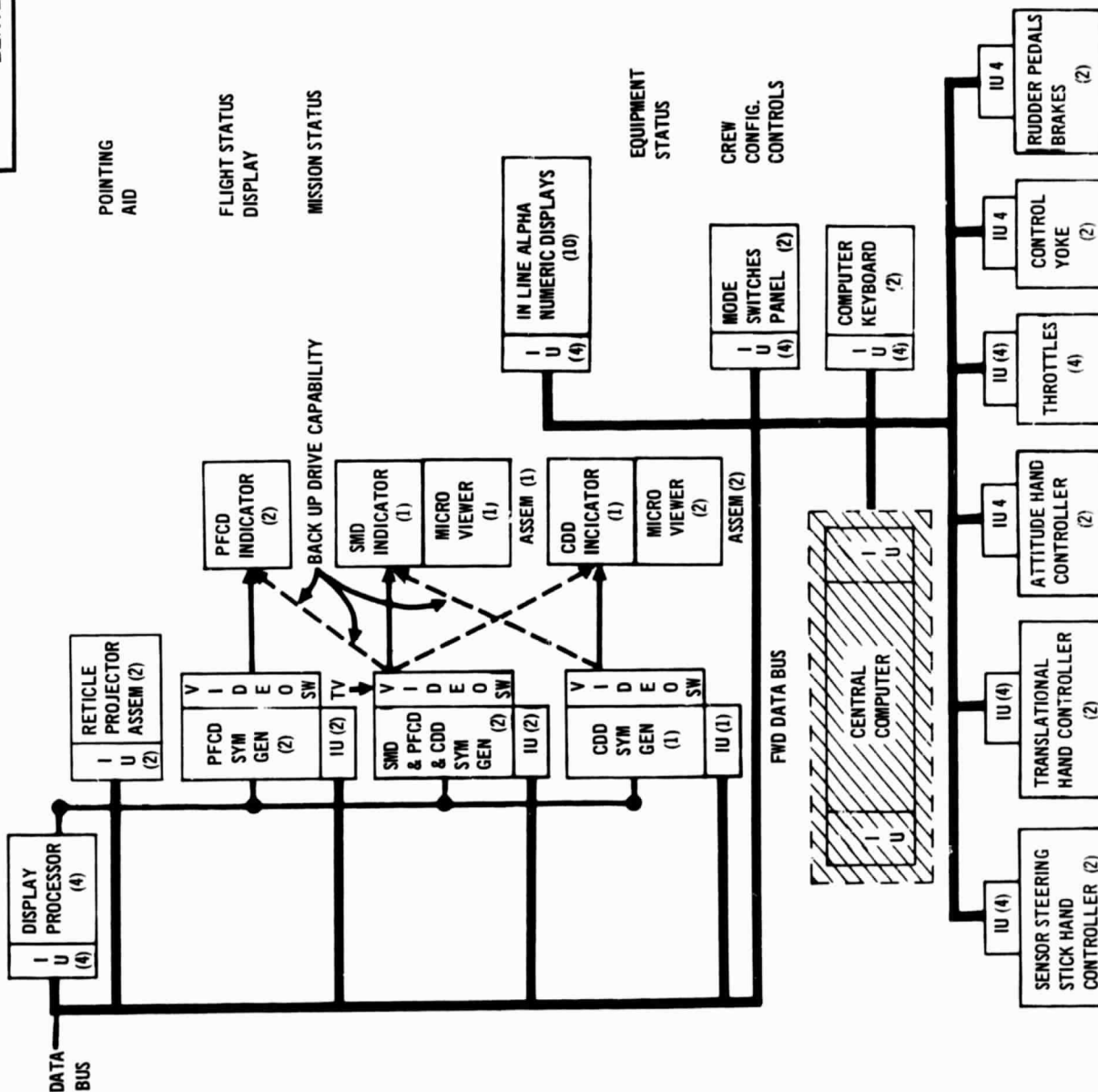
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ORBITER CONTROLS AND DISPLAYS SUBSYSTEM

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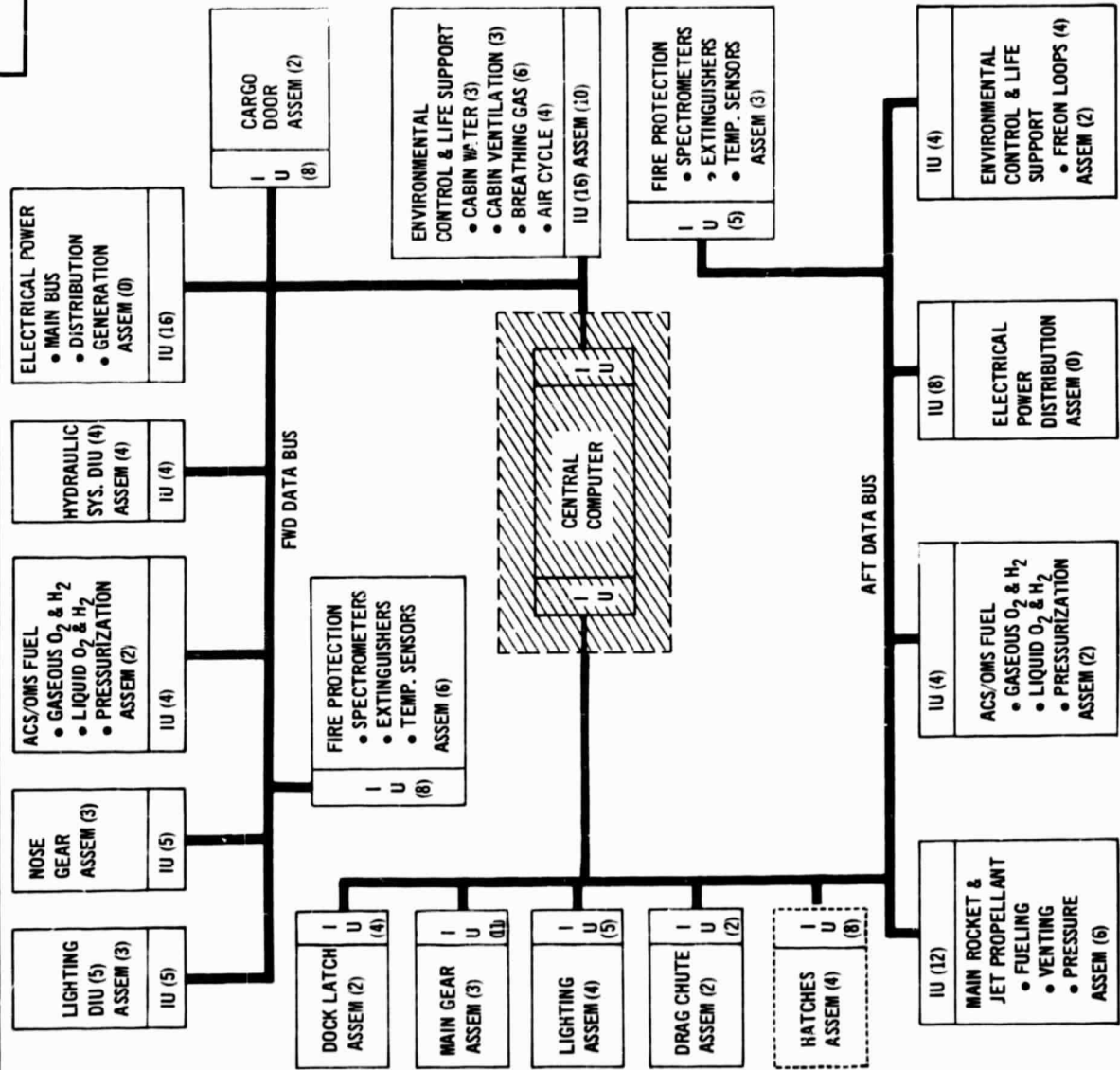
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ORBITER CONFIGURATION AND SEQUENCE CONTROL SUBSYSTEM

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THE LANGUAGE ENVIRONMENTS

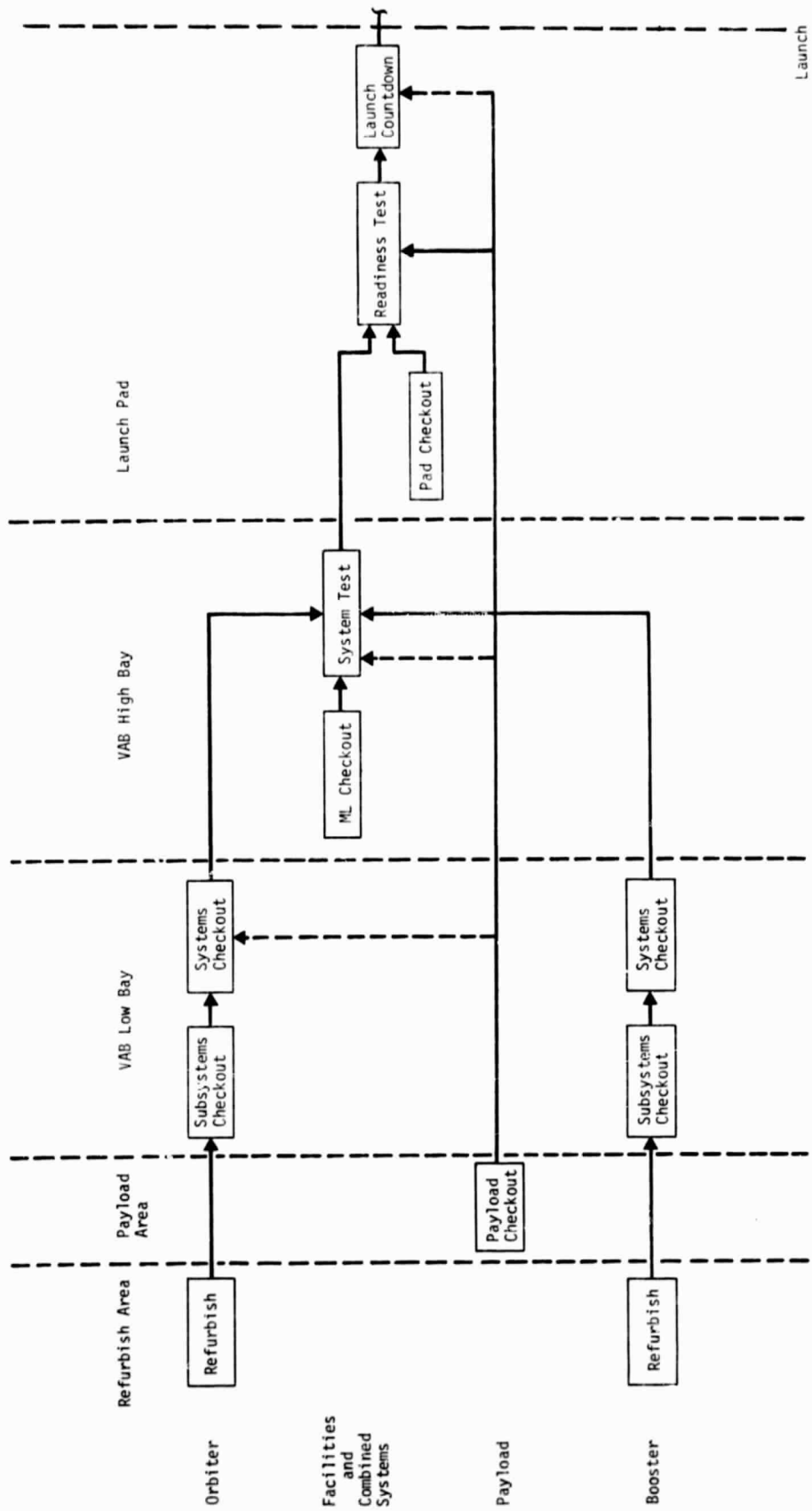
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- THE FLIGHT VEHICLES
- THE TEST AND CONTROL ACTIVITIES
- THE GROUND SUPPORT SYSTEMS
- THE LANGUAGE USERS

SHUTTLE TEST ACTIVITY FLOW - REFURBISH TO LAUNCH

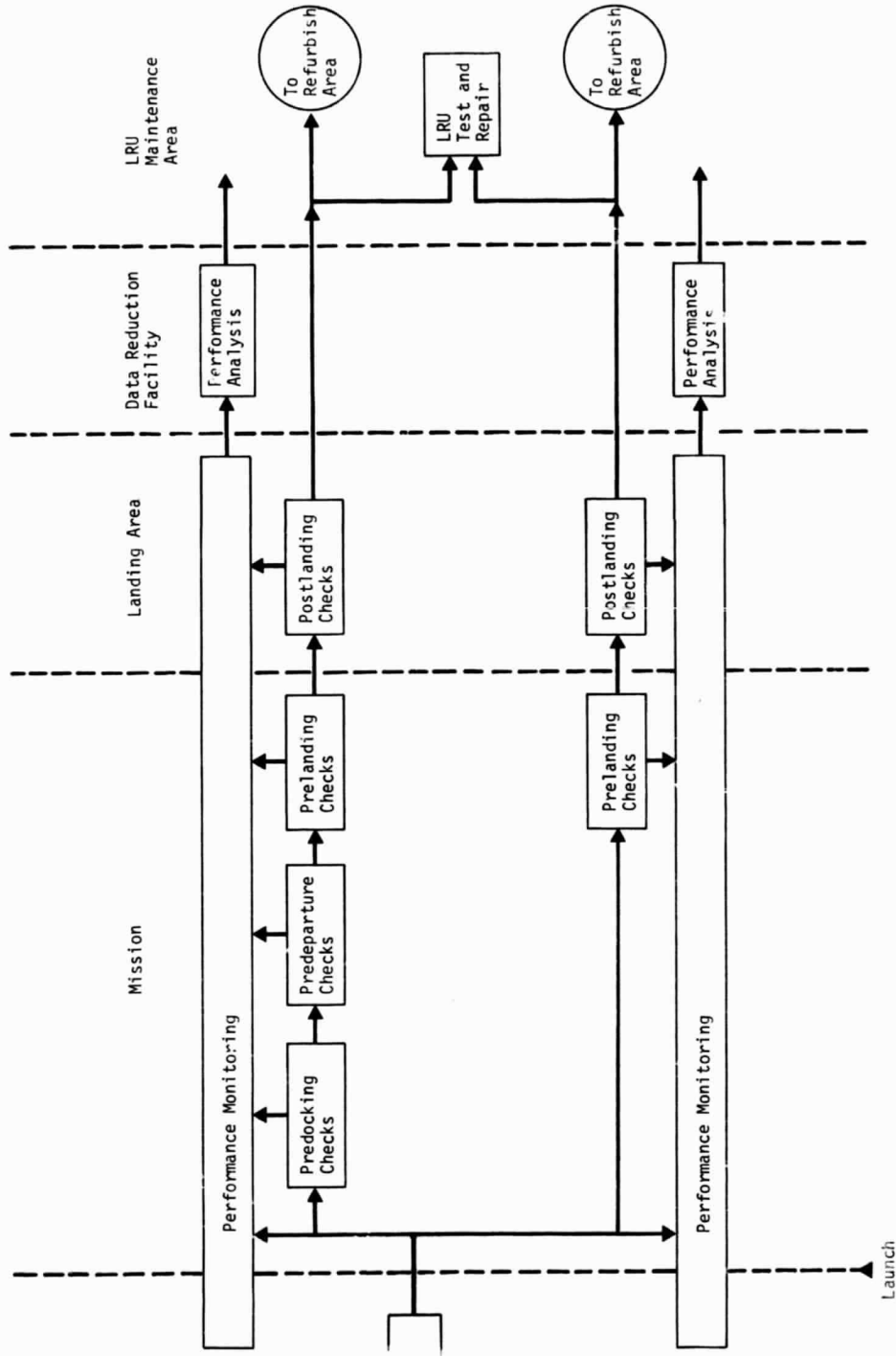
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SHUTTLE TEST ACTIVITY FLOW - LAUNCH TO REFURBISH

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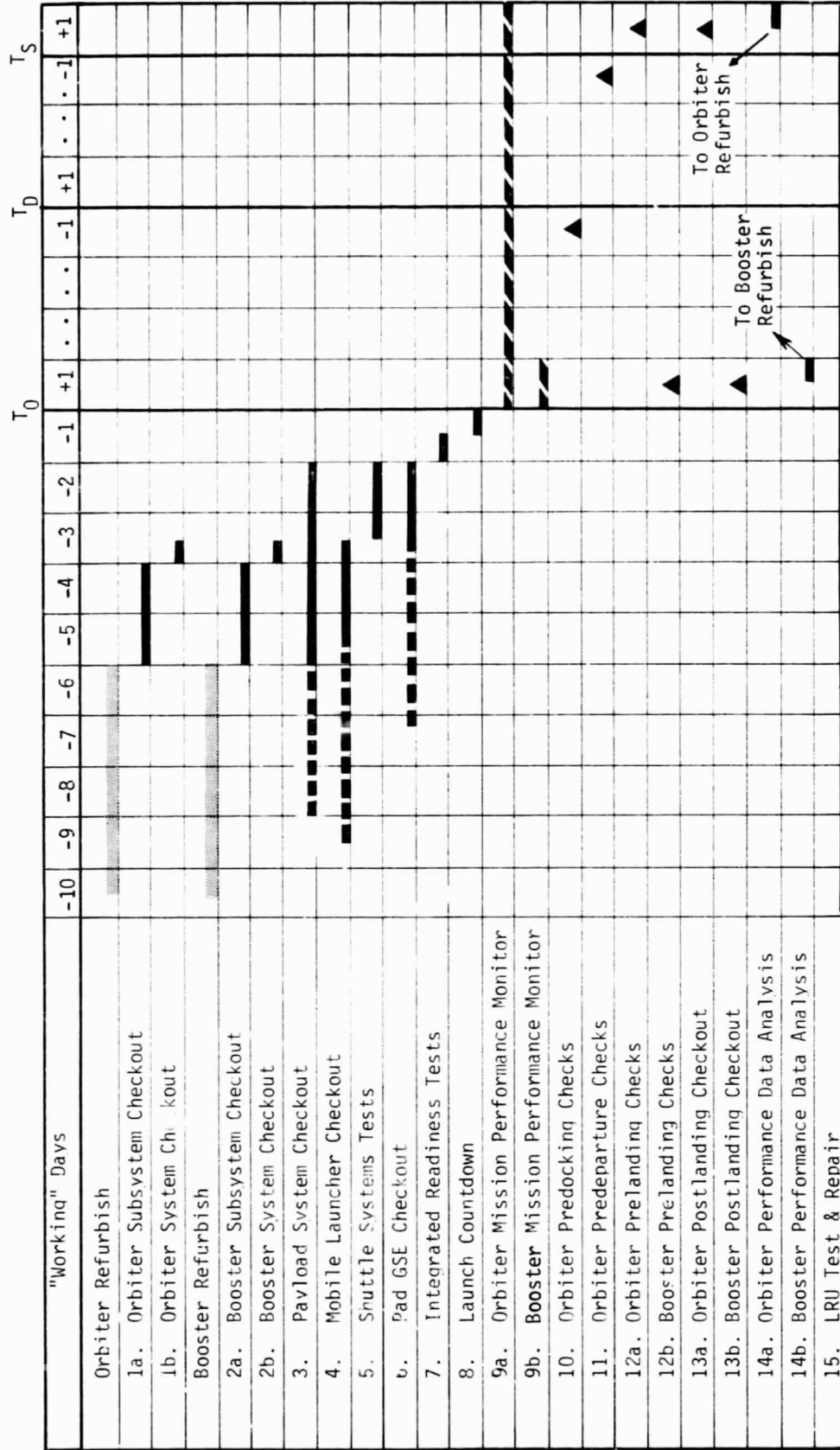
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TEST ACTIVITIES SCHEDULE

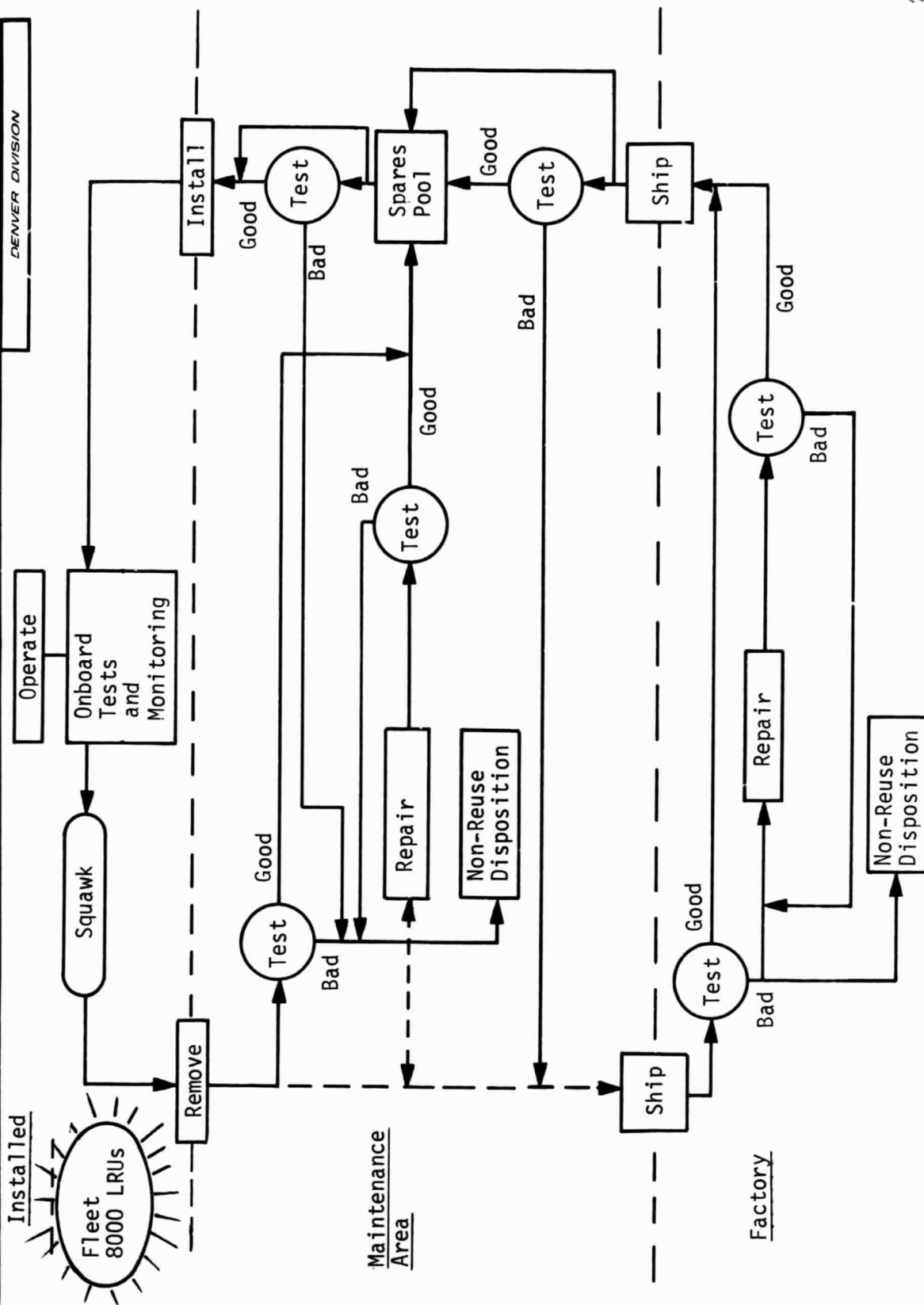
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LRU MAINTENANCE FLOW

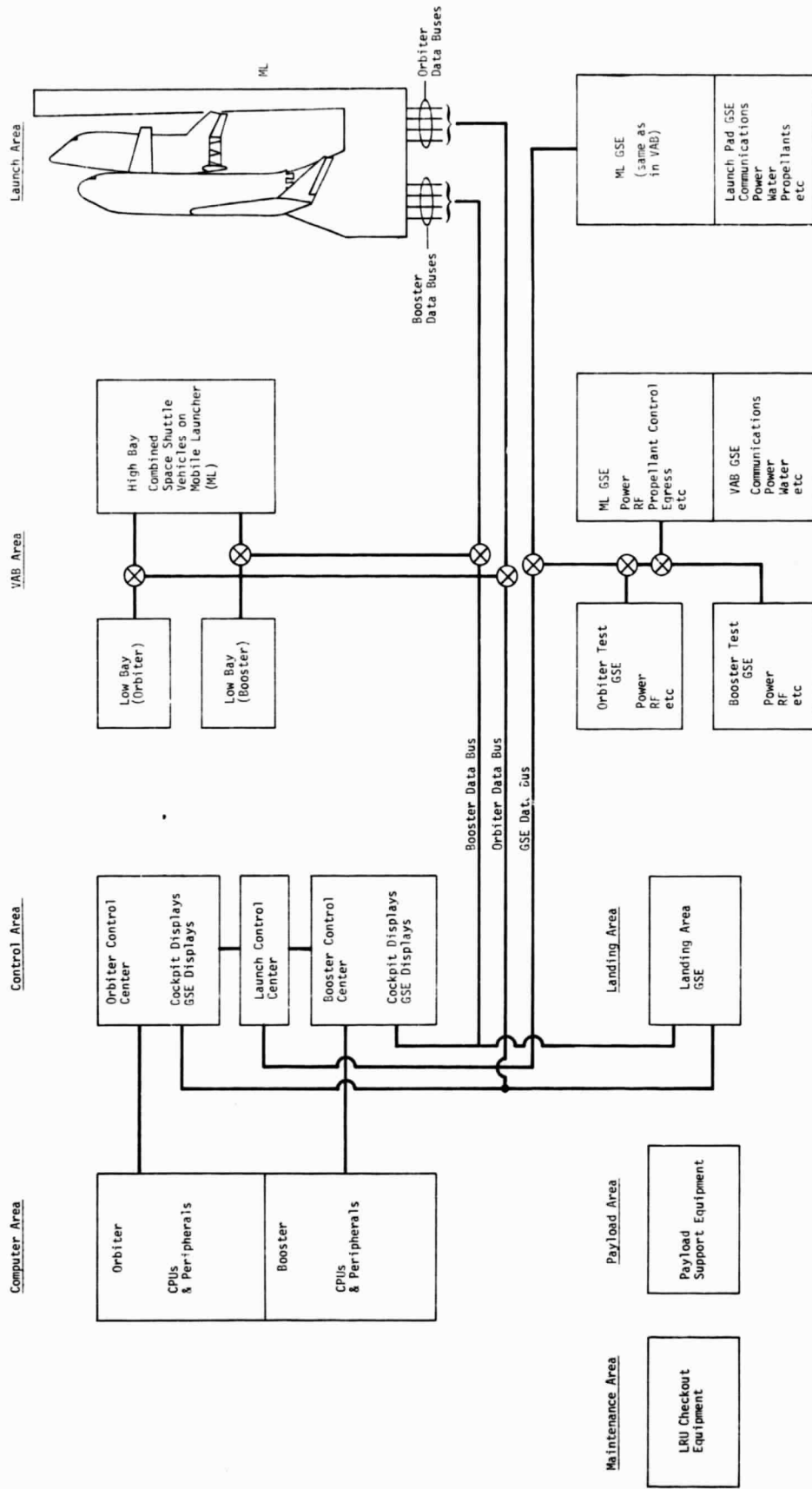
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BASE SUPPORT SYSTEMS

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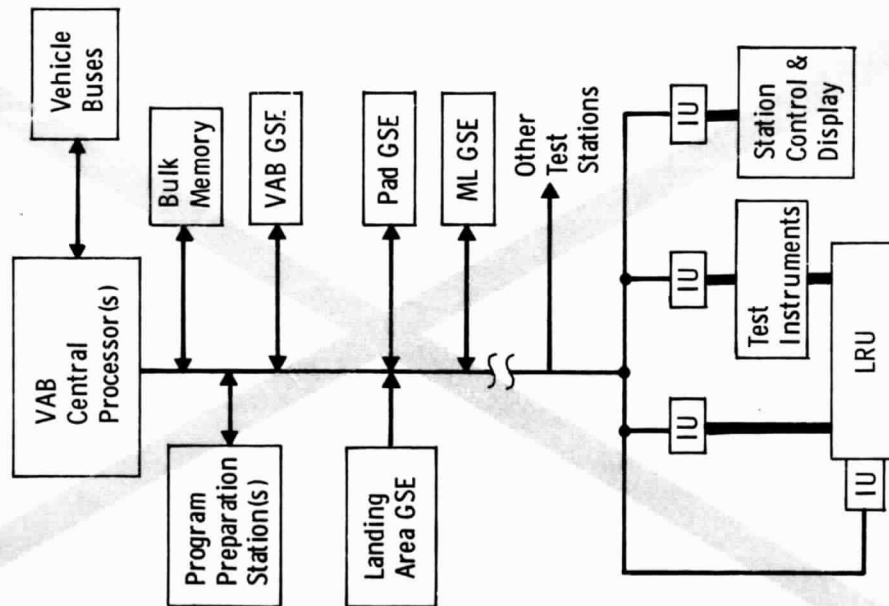
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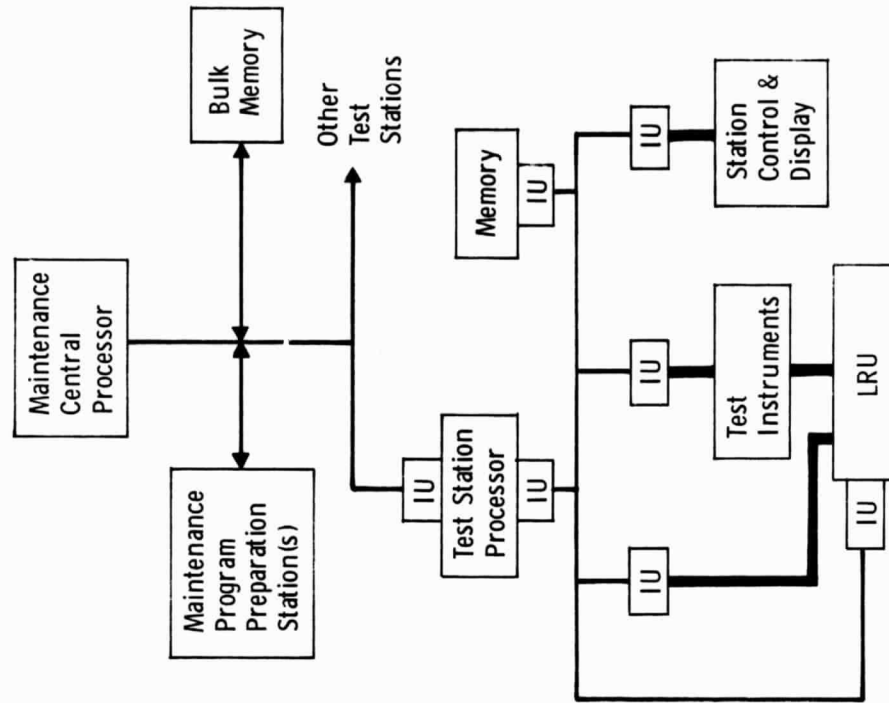
ALTERNATIVE MAINTENANCE TEST SYSTEMS

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SHARED VAB PROCESSORS



DEDICATED MAINTENANCE PROCESSORS



GROUND SUPPORT SYSTEMS RECAP

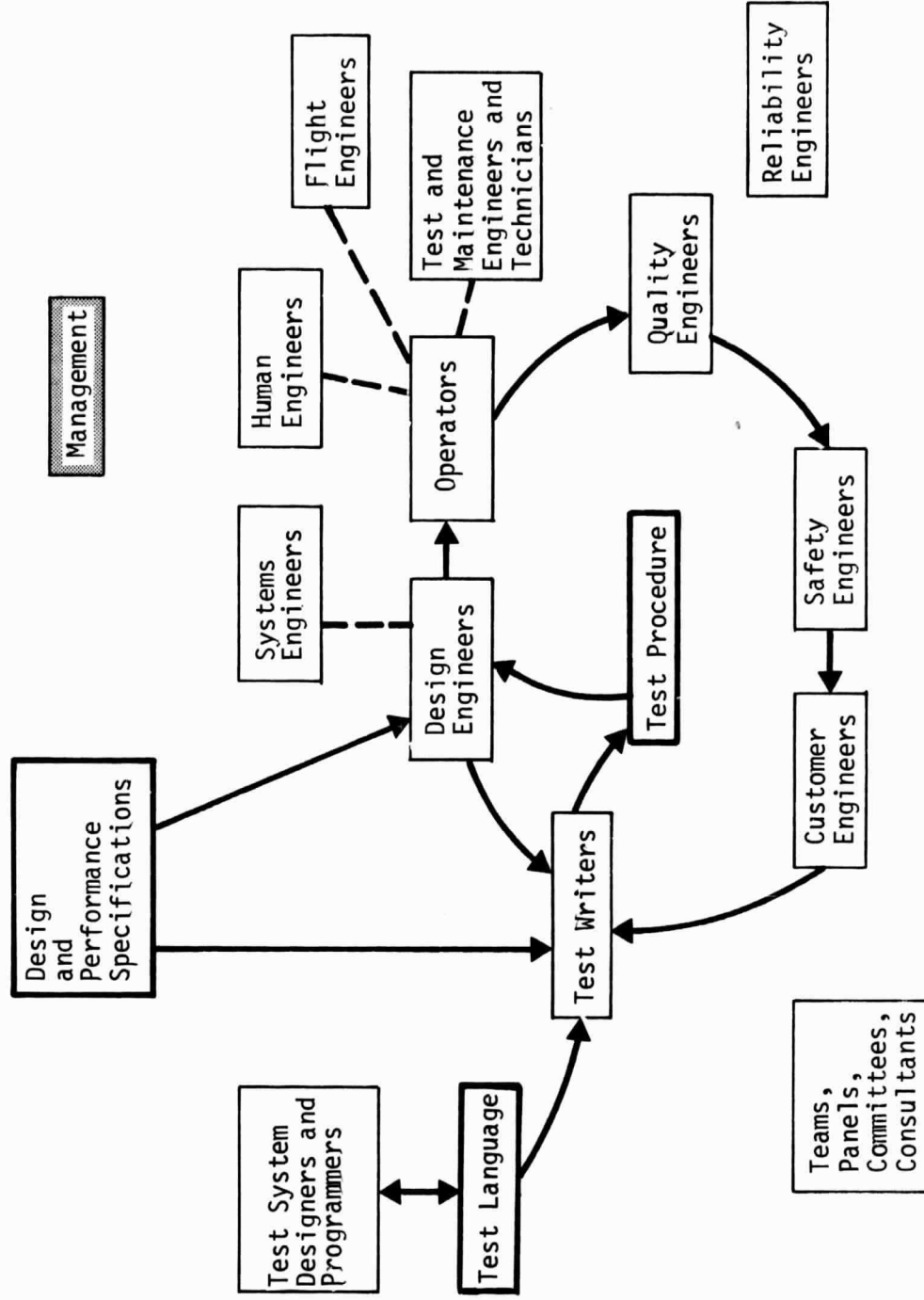
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- VEHICLE CONTROL CENTER
 - PROCESSORS AND PERIPHERALS
 - DISPLAYS AND CONTROLS
- VEHICLE TEST GSE, BOOSTER AND ORBITER
- MOBILE LAUNCHER GSE
- VAB SUPPORT SYSTEMS
- LAUNCH PAD SUPPORT SYSTEMS
- LANDING AREA SUPPORT SYSTEMS
- PAYLOAD TEST AND SUPPORT SYSTEMS
- MAINTENANCE AREA CHECKOUT EQUIPMENT

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Management



GENERAL CONCLUSIONS

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- THE LANGUAGE WILL BE USED TO PERFORM TEST AND CONTROL ACTIONS AT COMPLETE SYSTEM, SUBSYSTEM, AND UNIT LEVELS.
- THE LANGUAGE WILL BE USED FOR SEQUENCED CONTROL ACTIONS, CONTINUOUS MONITORING, STIMULUS AND RESPONSE TESTING, AND APERIODIC VERIFICATIONS.
- THE LANGUAGE WILL BE USED IN SEVERAL DIFFERENT COMPUTERIZED SYSTEMS, GENERALLY OF SIMILAR CONFIGURATIONS.
- THE LANGUAGE USERS WILL INCLUDE MANY ENGINEERS WHO SHOULD BE ABLE TO READ AND UNDERSTAND THE PROGRAMS WITH LITTLE TRAINING.

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A LANGUAGE ORIENTED TO FLIGHT ENGINEERING AND TESTING

A L O F T

OBJECTIVES

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- INDEPENDENCE WITH RESPECT TO TESTING EQUIPMENT
- FLEXIBILITY
- ENGINEERING READER ORIENTATION
- CONCURRENT TEST EXECUTION
- SELF-EXTENSION
- COMPUTER/COMPUTER AND COMPUTER/DIGITAL
INTERFACE UNIT COMMUNICATION
- MAXIMUM USE OF PAST LANGUAGE DEVELOPMENT
EFFORTS

CHARACTERISTICS

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TEST ORIENTATION

- TEST INITIATION
- APPLICATION OF STIMULUS
- MEASUREMENT OF OUTPUT
- COMPARISON OF RESULTS
- MAN/MACHINE INTERFACE
- RECORDS AND LOGS, TIME TAGS
- MONITORING
- CLOCK AND TIME CONTROLLED ACTIONS
- SYSTEM, SUBSYSTEM, AND UNIT TESTING

CHARACTERISTICS

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INDEPENDENCE WITH RESPECT TO TESTING EQUIPMENT

- DICTIONARY DATA BANKS
- COMMON CHARACTER SET
- FREE FORM WITH RESPECT TO INPUT MEDIA
- NO INTERACTION WITH OPERATING SYSTEM
- TEST WRITER CREATED SAFING FEATURES

CHARACTERISTICS

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FLEXIBILITY

- FULL ARITHMETIC AND RELATIONAL OPERATOR SET
- 32 CHARACTER DATA NAMES
- ARRAY AND STRUCTURE CAPABILITY
- SIMPLE LOOP CAPABILITY
- SUBROUTINES
- INTEGER, FIXED POINT, BOOLEAN, TEXT, BINARY, AND TIME DATA
- SIMPLE NUMERIC AND BOOLEAN ASSIGNMENT STATEMENTS
- UNCONDITIONAL AND SIMPLE CONDITIONAL TRANSFERS
- INTERRUPT INITIATED ROUTINES

ENGINEERING READER ORIENTATION

- ENGLISH WORDS FOR PRIMITIVES
- NATURAL ENGLISH FORMS AS DELIMITERS
- NATURAL STATEMENT STRUCTURE
- BLANKS AS DELIMITERS
- COMMENTS CAN BE INSERTED WHERE MULTIPLE BLANKS ARE ALLOWED

CHARACTERISTICS

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CONCURRENT TEST EXECUTION

- INITIATED VIA LANGUAGE PRIMITIVES
- SYNCHRONIZATION CAPABILITY
- MEANING DEPENDENT ON LANGUAGE PROCESSOR IMPLEMENTATION

CHARACTERISTICS

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SELF-EXTENSION

- MACRO DEFINITION CAPABILITY
- OTHER LANGUAGE CAPABILITY
- FOR USE BY PROGRAMMING ORIENTED TEST ENGINEER TO:
 - CREATE NEW PRIMITIVES FROM EXISTING CORE SET
 - CREATE SPECIALIZED SUBROUTINES IN OTHER LANGUAGES
 - ALL FOR USE OF NON-PROGRAMMING ORIENTED TEST ENGINEER
- CAPABILITIES AVAILABLE FOR DICTIONARY DATA BANK ONLY

CHARACTERISTICS

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COMPUTER/COMPUTER AND COMPUTER/DIGITAL
INTERFACE UNIT COMMUNICATION

- INCLUDED IN DICTIONARY DATA BANK
CAPABILITY
- DEFINED BY TEST SYSTEM ENGINEER
- TRANSPARENT TO TEST WRITER

CHARACTERISTICS

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MAXIMUM USE OF PAST LANGUAGE DEVELOPMENT
EFFORTS

- INCREASE UNDERSTANDING AND ACCEPTANCE
- INCREASE ABILITY TO COMMUNICATE AMONG USERS
- PRIME LANGUAGE IS "ATLAS"
 - MOST READABLE EXISTING LANGUAGE
 - ENGINEERING READER ORIENTATION
 - WIDE ACCEPTANCE

HIGHLIGHTS

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APPROACH TO LANGUAGE DESIGN

- CORE LANGUAGE
 - TEST ORIENTED ACTIONS
 - INTERNAL CONTROL ACTIONS
 - COMPILER DIRECTIVES
- EXTENSIONS
 - COMPOUND ACTIONS
(COMBINATIONS OF TEST ORIENTED ACTIONS
AND INTERNAL CONTROL ACTIONS)
 - SUBROUTINES
- TESTS CONSIST OF USE OF CORE LANGUAGE AND
EXTENSIONS

HIGHLIGHTS

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DICTIONARY DATA BANKS

- MAINTAIN TEST SYSTEM INDEPENDENCE
- PROVIDE FOR THE DEFINITION OF ANY TEST SYSTEM WITHIN THE LANGUAGE
- ARE GENERATED BY TEST SYSTEM DESIGNER AND PROGRAMMING ORIENTED TEST ENGINEER
- ENABLE TESTS TO BE WRITTEN WITHOUT KNOWLEDGE OF SPECIFIC TEST SYSTEM
- ALLOW A COMBINATION OF TEST SOURCE CODE AND REQUIRED DICTIONARY DATA BANKS TO COMPLETELY DEFINE A TEST ON A PARTICULAR TEST SYSTEM
- ENABLE A LANGUAGE PROCESSOR TO BE DEVELOPED BEFORE ANY SPECIFIC SPACE SHUTTLE TEST SYSTEM IS DEFINED

HIGHLIGHTS

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WRITING AIDS

- TEST WRITER DEFINED ABBREVIATIONS
- ABBREVIATES PRIMITIVES AND STRINGS OF PRIMITIVES
- EXPANDED SOURCE LISTINGS

HIGHLIGHTS

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LANGUAGE PROCESSOR

- OFF LINE PROCESSING
- TRANSLATOR-INTERPRETER
- PROCESSOR WRITTEN IN HIGHER LEVEL LANGUAGE
- EXTENSIVE ERROR CHECKING AND DIAGNOSTICS
- TEST OPERATION VALIDATION

PHASE III PREVIEW

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LANGUAGE SPECIFICATIONS

- SYNTAX DIAGRAMS
- SEMANTICS IN ENGLISH PROSE
- TERMINOLOGY SELECTION AND JUSTIFICATIONS

PHASE III PREVIEW

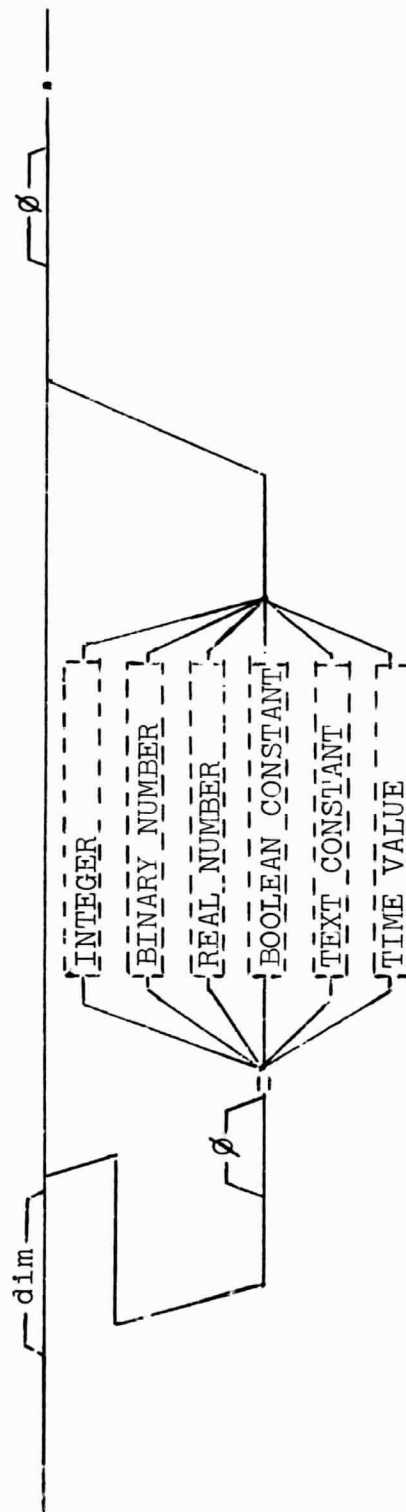
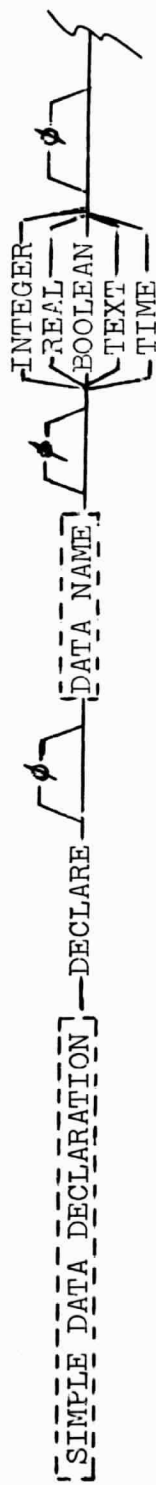
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SYNTAX DIAGRAMS

- ATLAS METALANGUAGE FORM
- CHOSEN FOR:
 - READABILITY
 - CLARITY
 - PRECISION

EXAMPLE SYNTAX DIAGRAMS



SAMPLE LANGUAGE STATEMENTS

- DECLARE ARRAY ALPHA INTEGER VOLTS
WITH INDEX BETA = 5 MAX AND VALUES 1, 2, 3, 4, 5.
- LET ALPHA (3) EQUAL $5.25 / (_B1_) + 2$.
- IF AILERON CONTROL NUMBER 1 IS BETWEEN 25.0 DEGREES
AND 30.0 DEGREES THEN GOTO STATEMENT 10.
- LEAVE ALOFT WITH ALPHA AND BETA.
- RESUME ALOFT WITH "RESULTING" OUTPUT.
- USE DICTIONARY DATA BANK GAMMA.

SUMMARY

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A LANGUAGE ORIENTED TO FLIGHT ENGINEERING AND TESTING (ALOFT)

- INCORPORATES KNOWLEDGE OF PREVIOUSLY DESIGNED TEST LANGUAGES
- INCORPORATES KNOWLEDGE OF SPACE SHUTTLE CONFIGURATION
- INCORPORATES KNOWLEDGE OF THE GENERAL TEST AND CHECKOUT PROBLEM

SUMMARY

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ALOFT PROVIDES:

- EASE OF READING, LEARNING, AND USE
- POWERFUL CAPABILITIES FOR MATCHING ANY TEST ENVIRONMENT
- INTERNAL GROWTH WITHOUT REDESIGN OF THE LANGUAGE
- POTENTIAL LONG TERM USE