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Final Technical Report

(U) TEST PLANNING FOR IN-PLACE HARDNESS DEMONSTRATION

Volume I

STUDY REPORT SUMMARY

Air Force Contract F04694-67-C-0134

Prepared By
TRW Systems Group
Redondo Beach, California

15 February 1968

Prepared For
Department of the Air Force
Headquarters, Space and Missiles Systems Organization
SMNP-1
Air Force Systems Command
Norton Air Force Base, California

56

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UNCLASSIFIED ABSTRACT

This study has developed a test program plan for demonstrating the in-place hardness of an advanced ballistic missile weapon system. A test requirements analysis methodology was devised, utilizing a systems approach, to examine a WS-120A system baseline design with respect to a given weapons effects environment criteria, define the testing required to assure hardness of each system element, trade off applicable simulation techniques, and recommend a series of test concepts. These concepts were then logically combined into efficient and cost-effective in-place hardness demonstration test programs for the launch facility and launch control facility.

This report has been divided into five volumes and classified as follows:

Volume I	Study Report Summary (Unclassified)
Volume II	Methodology (Unclassified)
Volume III	Test Requirements Analysis (Secret, RD)
Volume IV	Test Program Plan (Unclassified)
Volume V	Selected LF Subsystems Test Plan (Unclassified)

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FOREWORD

(U) This document is the final technical report of the Test Planning for In-Place Hardness Demonstration Study submitted to SAMSO/NAFB in January 1968. This study was conducted by the Systems Support Group, Science and Technology Department of TRW Systems Group, Redondo Beach, California, for the Space and Missile Systems Organization, Air Force Systems Command, Norton Air Force Base, California, under Contract No. F04694-67-C-0134, dated 1 June 1967.

(U) The study effort covered by this report was initiated in June 1967 and completed in February 1968. The United States Air Force management control for this task was provided by Mr. C. B. Totten, SMNP-1. Technical direction was provided by Mr. S. Italia and Mr. C. R. Smith, Weapon Systems Division, Aerospace Corporation, San Bernardino Operation.

(U) Mr. C. K. Stein was TRW Systems Group's project engineer for this study and was responsible for attaining its overall objectives. Mr. J. P. Bednar (TRW) and Mr. J. Karagozian (consultant) were co-authors of the Final Technical Report.

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(U) This technical report has been reviewed and is approved.

Charles B. Totten

Charles B. Totten
Project Officer
Resources, Planning and Programming Division
Directorate of Civil Engineering

CONTENTS

ILLUSTRATIONS

1. INTRODUCTION

1.1 PURPOSE

The purpose of this study is to provide the Air Force with a test program plan for demonstrating the in-place hardness of an advanced ballistic missile weapon system.

1.2 SCOPE

The scope of this study includes the performance of a test requirements analysis in which the WS-120A system baseline design and weapons effects environment criteria are examined, applicable simulation techniques are identified, and test concepts are recommended. It also includes the logical development of the recommended test concepts into a test program plan and the preparation of a single test plan for a selected test concept.

1.3 BACKGROUND

Since 1959, the Air Force has sponsored a series of studies on new generation ballistic missile weapon systems capable of surviving the effects of a nuclear environment in extreme high overpressure regions. The criteria for design were largely developed on the basis of advanced analytical techniques, and judgment was obtained from nuclear experimental results. Field test data from underground nuclear tests and high explosive simulation tests have been extrapolated where appropriate and combined with advanced analytical techniques for the development of facility configurations capable of surviving the high overpressure region.

The AEC/DOD have designed underground nuclear effects tests at the Navada test site which have improved the design technology for hardened facilities. Predominantly, the directly transmitted shock wave environment on hardened tunnel liners was simulated in these tests. However, some thought has been given to an underground nuclear explosive shock tube (NEST) in which both the air induced and directly transmitted shock environment together with thermal and nuclear radiation environment may be simulated on a subscale hardened facility.

The Air Force has developed a high explosive simulation technique (HEST) which has been used to confirm the design techniques on the Minuteman weapon system. Presently, the Air Force Weapons Laboratory is developing the direct induced high explosive simulation technique (DI-HEST) as a means for design verification tests on new systems. Peak pressure, shock wave velocity, impulse, and durations will be tailored to match estimates of the nuclear phenomena. DI-HEST, when developed, is expected to be used in combination with HEST to simulate air overpressure and ground shock simultaneously.

The advanced hardened missile system will require in-place hardness demonstration tests using simulation techniques. This study performed a test requirements analysis and subsequently prepared a test program plan that prescribes the spectrum of testing required to ensure hardness of the system.

1.4 STUDY REPORT CONTENT

This technical report presents the study material in a logical and conveniently usable manner, as follows:

Volume I:	Study Report Summary
Volume II:	Methodology
Volume III:	Test Requirements Analysis
Volume IV:	Test Program Plan
Volume V:	Selected LF Subsystems Test Plan.

The technical tasks specified in the statement of work (SOW) are hereby satisfied with the submission of this technical report. Specifically, SOW Task 2.0, test concepts task, is accomplished in Volume III, Test Requirements Analysis (TRA), and SOW Task 3.0, test planning task, is satisfied by Volume IV, Test Program Plan and Volume V, Selected LF Subsystems Test Plan. Volume II, Methodology, is provided in response to an informal request by the customer for a description of the methods used in the TRA.

This volume presents the results of the study in the form of a summarized test program plan for the launch facility (LF) and the launch control facility (LCF) in Section 3.0. (Complete method and results are in Volumes II, III, and IV.) The test plan for the selected test (Volume V of this report) was developed for a specific system defined by SAMSO/ Aerospace and is not one of the system tests recommended from the TRA; the selected LF subsystem test plan is summarized in Section 4. Conclusions are summarized in Section 2. Recommendations for extending the system approach to hardness demonstration are given in Section 5.

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2. CONCLUSIONS

This study program has resulted in two significant conclusions. One is that the methodology developed for the study is a good approach, with high potential for use in the development of other test plans. The second conclusion is that the test program plan developed in this study includes some areas of uncertainty that must be recognized and dealt with at the appropriate time.

2.1 METHODOLOGY

A methodology was developed during the course of the study to permit the systematic examination of the weapon system elements with respect to the weapons effects environment it would experience, the identification of test requirements, the tradeoff of simulation techniques, and the recommendation of test concepts. This methodology is described in detail in Volume II of this report. The test requirements analysis in Volume III of the report is the product of the in-place hardness test planning task accomplished in accordance with the methodology.

The TRA results have shown that a systems approach methodology can be used effectively in the planning of test programs for complex systems. Although the methodology described in Volume II was developed for the in-place Hardness Demonstration Test Planning Study, it certainly could be used effectively for airborne hardness test planning; and, with some modifications, it would be a valuable tool in the preparation of system development or system life cycle test program plans.

2.2 TEST PROGRAM PLAN UNCERTAINTIES

The test program plan presented as Volume IV of this report is felt to be a good, comprehensive treatment of the in-place hardness demonstration testing problem. It is the product of a unique test requirements analysis. The pattern of tests it describes reflects the information that was available as inputs to the study.

There are, then, uncertainties in the test program plan caused by the use in the TRA of :

a) An assumed, and very general, system configuration

b) Free field environment data acknowledged to be imprecise

c) Cursory information regarding the characteristics of key weapons effects simulation techniques.

All of the test program plan uncertanities can be resolved by the application of more detailed and/or more valid input data to the test requirements analysis. The methodology adopted for the TRA was developed to be insensitive so that such changes in input data can be introduced without loss of continuity or effectiveness.

Recommendations for overcoming these uncertainties in the TRA input information are included in Section 5.

3. SUMMARY OF RESULTS—TEST PROGRAM PLAN

The results of this study are in the form of a test program plan for in-place hardness demonstration of an advanced weapon system. The test program plan is described in four parts:

1) System Description
2) Test program flow
3) Documentation tree
4) Test phasing schedule.

The system description identifies the weapons systems analyzed for the launch facility (LF) and the launch control facility (LCF) in the test requirements analysis. The test program flow identifies the recommended test concepts and appropriate test facilities determined from the TRA. The documentation tree describes the proposed systematic organization and documentation requirements for proper implementation of the test program. Finally, the test phasing schedule shows the complete time cycle for testing from the facilities definition phase through the facilities construction phase. The test program plan for the LF and LCF are given in Subsections 3.1 and 3.2.

The basic premise upon which the in-place hardness demonstration test program plan has been developed is that the sum of a series of inter-related components tests, subsystems tests, systems tests, and total facilities tests would constitute a hardness demonstration (reference Figure 3-1). It must be emphasized that the hardness demonstration test program is the summation of these sequential tests up through each system level to the complete facility, and no one test demonstrates hardness completely.

A test requirements analysis (Volume III of this report) was conducted in which tests were considered for all system elements at every level of system complexity in a manner that would progressively increase confidence in total system hardness. The results of that analysis are represented on the test program flow (reference Figure 3-2).

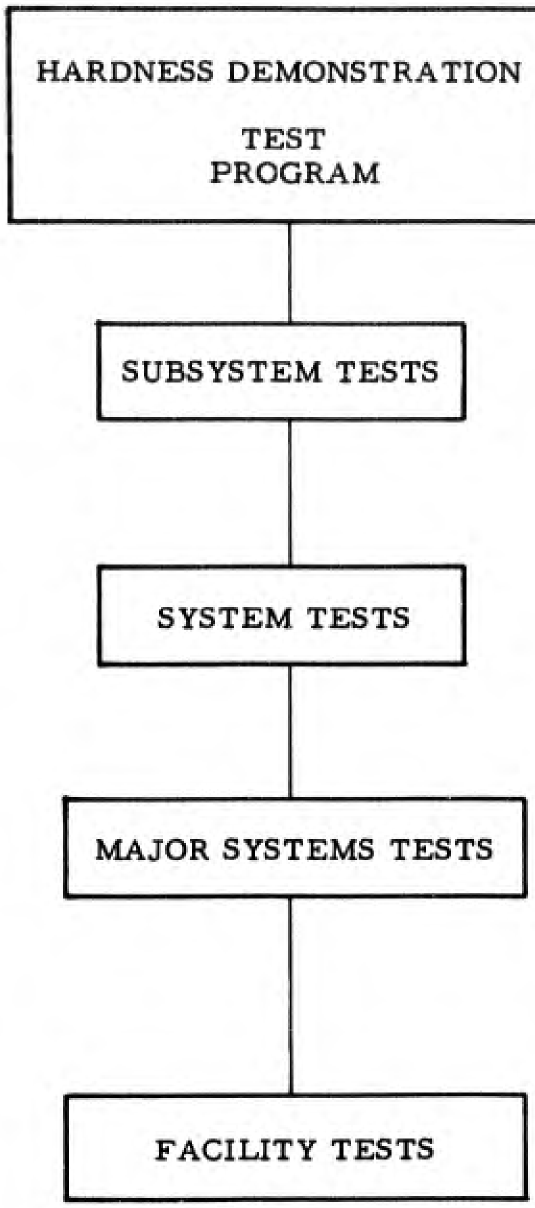
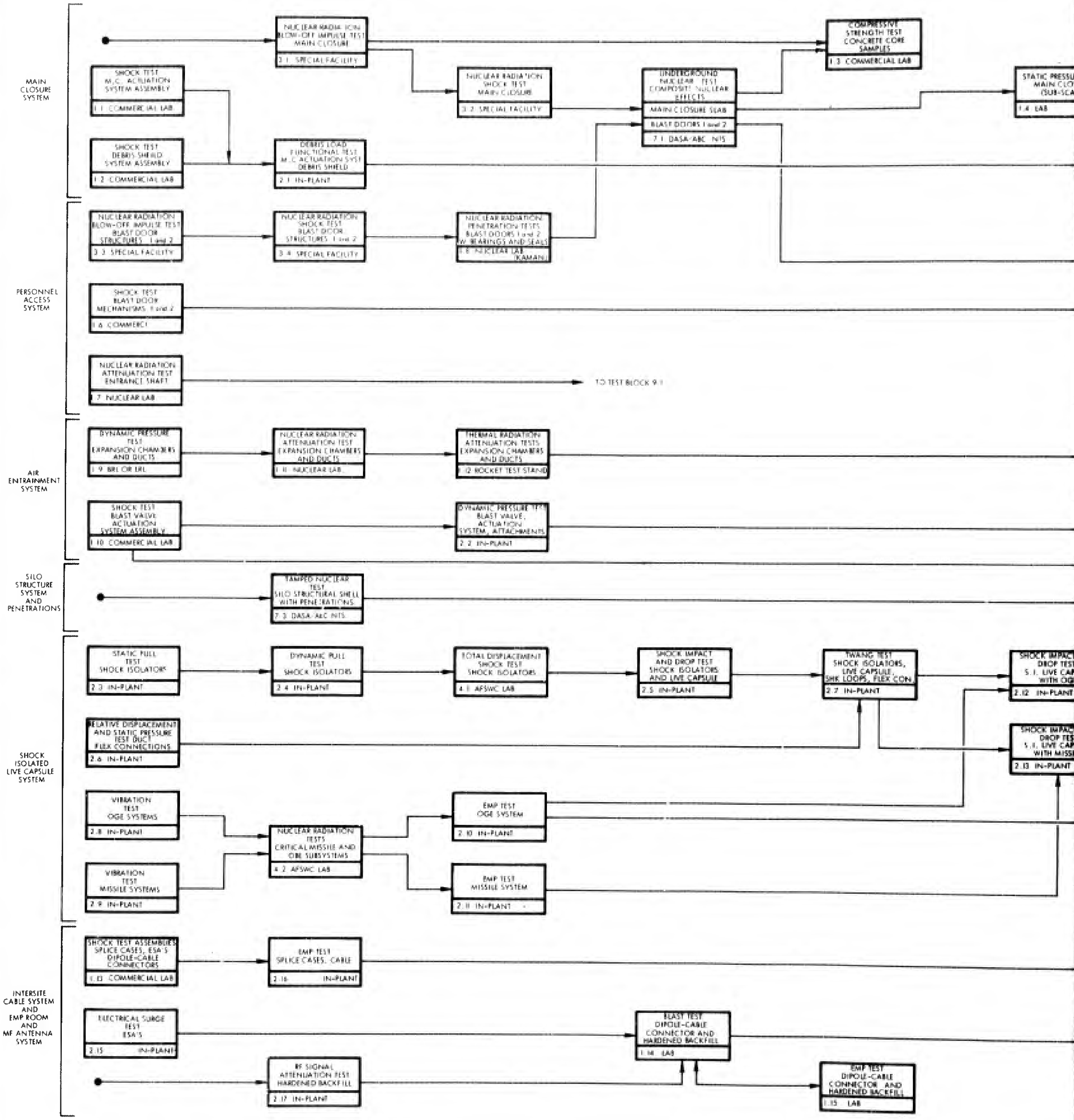
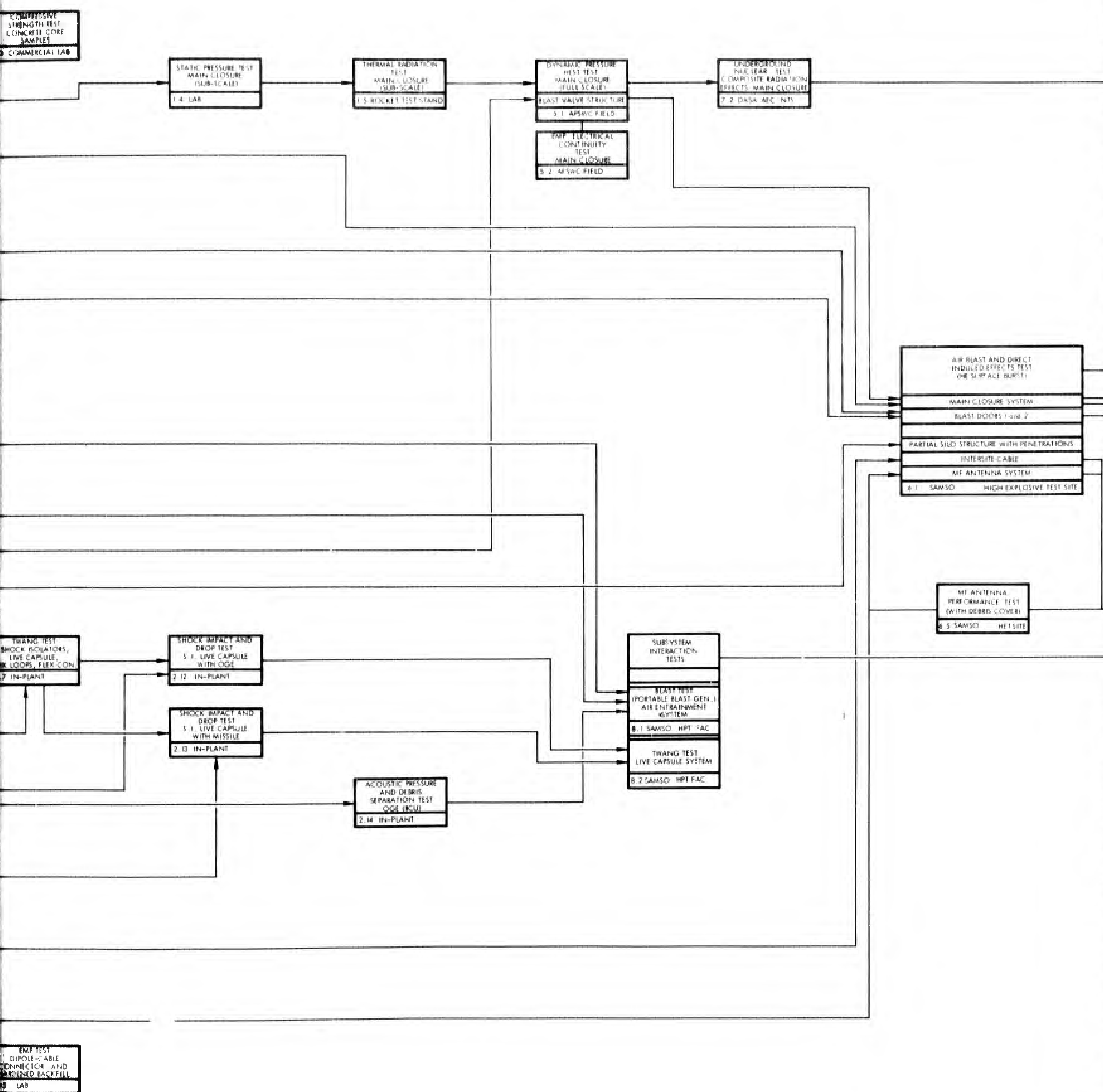


Figure 3-1. Hardness Demonstration Test Program Composition


MAIN CLOSURE SYSTEM
NUCLEAR RADIATION BLOW-OFF IMPULSE TEST MAIN CLOSURE
3.1 SPECIAL FACILITY
COMPRESSIVE STRENGTH TEST CONCRETE CORE SAMPLES
1.3 COMMERCIAL LAB
SHOCK TEST M.C. ACTUATION SYSTEM ASSEMBLY
1.1 COMMERCIAL LAB
NUCLEAR RADIATION SHOCK TEST MAIN CLOSURE
3.2 SPECIAL FACILITY
UNDERGROUND NUCLEAR TEST COMPOSITE NUCLEAR EFFECTS
MAIN CLOSURE SLAB
BLAST DOORS 1 and 2
7.1 DASA-AEC NTS
SHOCK TEST DEBRIS SHIELD SYSTEM ASSEMBLY
1.2 COMMERCIAL LAB
DEBRIS LOAD FUNCTIONAL TEST M.C. ACTUATION SYST DEBRIS SHIELD
2.1 IN-PLANT
PERSONNEL ACCESS SYSTEM
NUCLEAR RADIATION BLOW-OFF IMPULSE TEST BLAST DOOR STRUCTURES 1 and 2
3.3 SPECIAL FACILITY
NUCLEAR RADIATION SHOCK TEST BLAST DOOR STRUCTURES 1 and 2
3.4 SPECIAL FACILITY
NUCLEAR RADIATION PENETRATION TESTS BLAST DOORS 1 and 2 W/ BEARINGS AND SEALS
1.8 NUCLEAR LAB (KAMAN)
SHOCK TEST BLAST DOOR MECHANISMS 1 and 2
1.6 COMMERCI
NUCLEAR RADIATION ATTENUATION TEST ENTRANCE SHAFT
1.7 NUCLEAR LAB
TO TEST BLOCK 9.1
AIR ENTRAINMENT SYSTEM
DYNAMIC PRESSURE TEST EXPANSION CHAMBERS AND DUCTS
1.9 BRL OR LRL
NUCLEAR RADIATION ATTENUATION TEST EXPANSION CHAMBERS AND DUCTS
1.11 NUCLEAR LAB
THERMAL RADIATION ATTENUATION TESTS EXPANSION CHAMBERS AND DUCTS
1.12 ROCKET TEST STAND
SHOCK TEST BLAST VALVE ACTUATION SYSTEM ASSEMBLY
1.10 COMMERCIAL LAB
DYNAMIC PRESSURE TEST BLAST VALVE, ACTUATION SYSTEM, ATTACHMENTS
2.2 IN-PLANT
SILO STRUCTURE SYSTEM AND PENETRATIONS
TAMPED NUCLEAR TEST SILO STRUCTURAL SHELL WITH PENETRATIONS
7.3 DASA-AEC NTS
SHOCK ISOLATED LIVE CAPSULE SYSTEM
STATIC PULL TEST SHOCK ISOLATORS
2.3 IN-PLANT
DYNAMIC PULL TEST SHOCK ISOLATORS
2.4 IN-PLANT
TOTAL DISPLACEMENT SHOCK TEST SHOCK ISOLATORS
4.1 AFSWC LAB
SHOCK IMPACT AND DROP TEST SHOCK ISOLATORS AND LIVE CAPSULE
2.5 IN-PLANT
TWANG TEST SHOCK ISOLATORS, LIVE CAPSULE, SHK LOOPS, FLEX CON.
2.7 IN-PLANT
RELATIVE DISPLACEMENT AND STATIC PRESSURE TEST DUCT FLEX CONNECTIONS
2.6 IN-PLANT
2.12 IN-PLANT
2.13 IN-PLANT
VIBRATION TEST OGE SYSTEMS
2.8 IN-PLANT
NUCLEAR RADIATION TESTS CRITICAL MISSILE AND OGE SUBSYSTEMS
4.2 AFSWC LAB
EMP TEST OGE SYSTEM
2.10 IN-PLANT
VIBRATION TEST MISSILE SYSTEMS
2.9 IN-PLANT
EMP TEST MISSILE SYSTEM
2.11 IN-PLANT
INTERSITE CABLE SYSTEM AND EMP ROOM AND MF ANTENNA SYSTEM
SHOCK TEST ASSEMBLIES SPLICE CASES, ESA'S DIPOLE-CABLE CONNECTORS
1.13 COMMERCIAL LAB
EMP TEST SPLICE CASES, CABLE
2.16 IN-PLANT
ELECTRICAL SURGE TEST ESA'S
2.15 IN-PLANT
BLAST TEST DIPOLE-CABLE CONNECTOR AND HARDENED BACKFILL
1.14 LAB
RF SIGNAL ATTENUATION TEST HARDENED BACKFILL
2.17 IN-PLANT
EMP TEST DIPOLE-CABLE CONNECTOR AND HARDENED BACKFILL
1.15 LAB
A.



COMPRESSIVE STRENGTH TEST CONCRETE CORE SAMPLES
COMMERCIAL LAB
STATIC PRESSURE TEST MAIN CLOSURE (SUB-SCALE)
1.4 LAB
THERMAL RADIATION TEST MAIN CLOSURE (SUB-SCALE)
1.5 ROCKET TEST STAND
DYNAMIC PRESSURE HEST TEST MAIN CLOSURE (FULL SCALE)
BLAST VALVE STRUCTURE
5.1 AFSWC FIELD
EMP ELECTRICAL CONTINUITY TEST MAIN CLOSURE
5.2 AFSWC FIELD
UNDERGROUND NUCLEAR TEST COMPOSITE RADIATION EFFECTS MAIN CLOSURE
7.2 DASA AEC NTS
AIR BLAST AND DIRECT INDUCED EFFECTS TEST (HE SURFACE BURST)
MAIN CLOSURE SYSTEM
BLAST DOORS 1 and 2
PARTIAL SILO STRUCTURE WITH PENETRATIONS
INTERSITE CABLE
MF ANTENNA SYSTEM
6.1 SAMSO HIGH EXPLOSIVE TEST SITE
MF ANTENNA PERFORMANCE TEST (WITH DEBRIS COVER)
6.5 SAMSO HE TSITE
TWANG TEST SHOCK ISOLATORS, LIVE CAPSULE, LOOPS, FLEX CON.
7 IN-PLANT
SHOCK IMPACT AND DROP TEST 5.1. LIVE CAPSULE WITH OGE
2.12 IN-PLANT
SHOCK IMPACT AND DROP TEST 5.1. LIVE CAPSULE WITH MISSILE
2.13 IN-PLANT
SUBSYSTEM INTERACTION TESTS
BLAST TEST (PORTABLE BLAST GEN.) AIR ENTRAINMENT SYSTEM
8.1 SAMSO HPT FAC
TWANG TEST LIVE CAPSULE SYSTEM
8.2 SAMSO HPT FAC
ACOUSTIC PRESSURE AND DEBRIS SEPARATION TEST OGE (BCU)
2.14 IN-PLANT
EMP TEST DIPOLE-CABLE CONNECTOR AND HARDENED BACKFILL
LAB

B.

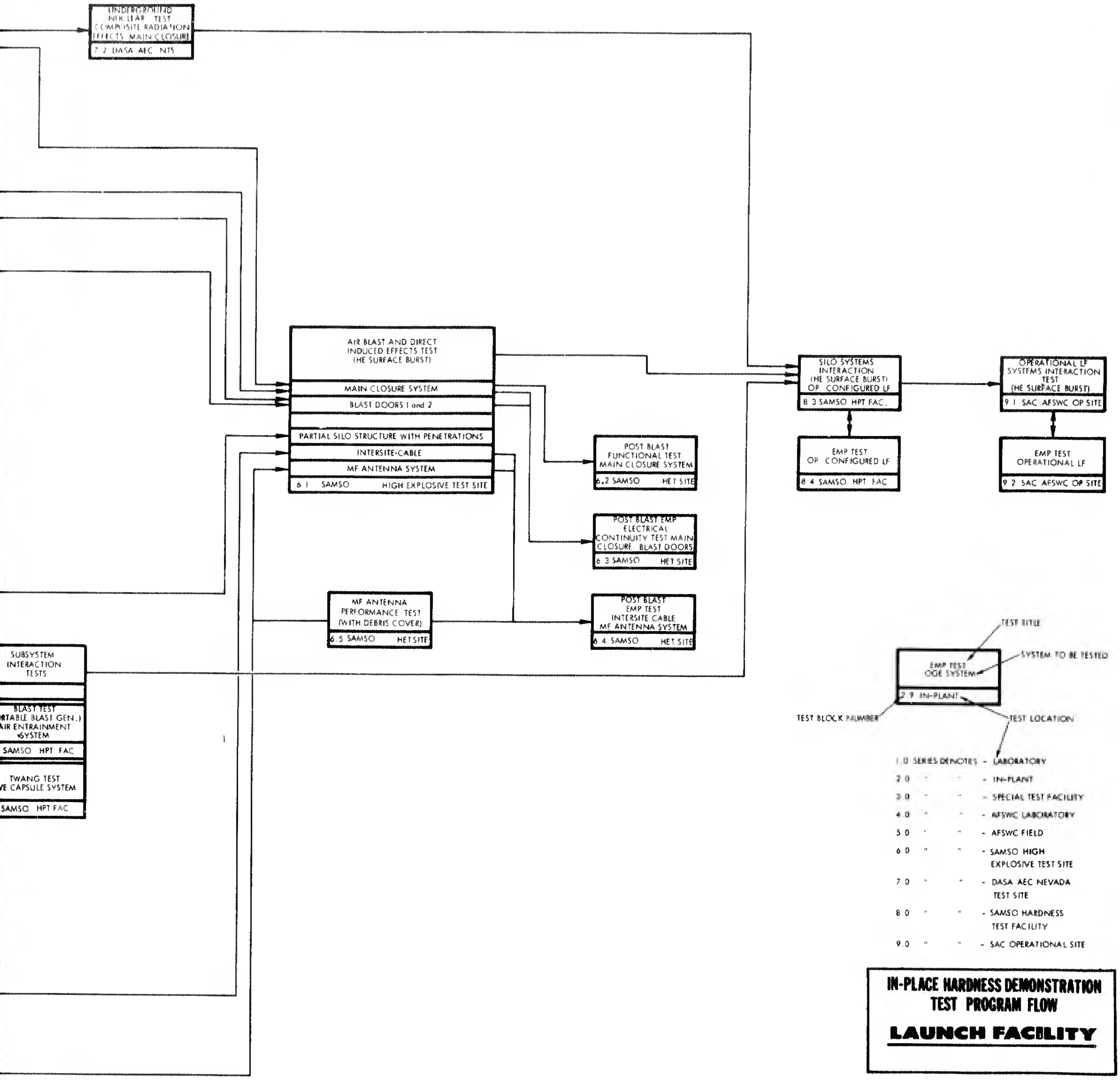

UNDERGROUND NUCLEAR TEST COMPOSITE RADIATION EFFECTS MAIN CLOSURE
7.2 DASA AEC NTS
AIR BLAST AND DIRECT INDUCED EFFECTS TEST (HE SURFACE BURST)
MAIN CLOSURE SYSTEM
BLAST DOORS 1 and 2
PARTIAL SILO STRUCTURE WITH PENETRATIONS
INTERSITE-CABLE
MF ANTENNA SYSTEM
6.1 SAMSO HIGH EXPLOSIVE TEST SITE
POST BLAST FUNCTIONAL TEST MAIN CLOSURE SYSTEM
6.2 SAMSO HET SITE
POST BLAST EMP ELECTRICAL CONTINUITY TEST MAIN CLOSURE BLAST DOORS
6.3 SAMSO HET SITE
MF ANTENNA PERFORMANCE TEST (WITH DEBRIS COVER)
6.5 SAMSO HET SITE
POST BLAST EMP TEST INTERSITE CABLE MF ANTENNA SYSTEM
6.4 SAMSO HET SITE
SILO SYSTEMS INTERACTION (HE SURFACE BURST) OP CONFIGURED LF
8.3 SAMSO HPT FAC.
EMP TEST OP CONFIGURED LF
8.4 SAMSO HPT FAC
OPERATIONAL LF SYSTEMS INTERACTION TEST (HE SURFACE BURST)
9.1 SAC AFSWC OP SITE
EMP TEST OPERATIONAL LF
9.2 SAC AFSWC OP SITE
SUBSYSTEM INTERACTION TESTS
BLAST TEST
RTABLE BLAST GEN.)
AIR ENTRAINMENT
SYSTEM
SAMSO HPT FAC
TWANG TEST
E CAPSULE SYSTEM
SAMSO HPT FAC
TEST TITLE
SYSTEM TO BE TESTED
EMP TEST
OGE SYSTEM
2.9 IN-PLANT
TEST BLOCK NUMBER
TEST LOCATION
1.0 SERIES DENOTES - LABORATORY
2.0 " " - IN-PLANT
3.0 " " - SPECIAL TEST FACILITY
4.0 " " - AFSWC LABORATORY
5.0 " " - AFSWC FIELD
6.0 " " - SAMSO HIGH EXPLOSIVE TEST SITE
7.0 " " - DASA AEC NEVADA TEST SITE
8.0 " " - SAMSO HARDNESS TEST FACILITY
9.0 " " - SAC OPERATIONAL SITE
IN-PLACE HARDNESS DEMONSTRATION
TEST PROGRAM FLOW
LAUNCH FACILITY

Figure 3-2.

In-place hardness demonstration tests are considered to be those tests that confirm or provide data that increases confidence in the hardness of the system element tested. These tests will normally use prototype systems as test articles. However, in some cases a more developmental type of testing (e.g., using subscale models, engineering models) may be required. Development testing will be called for only if it is a necessary prerequisite to a subsequent demonstration test. Note that certain system development tests, when completed successfully, can be accepted as hardness demonstration tests.

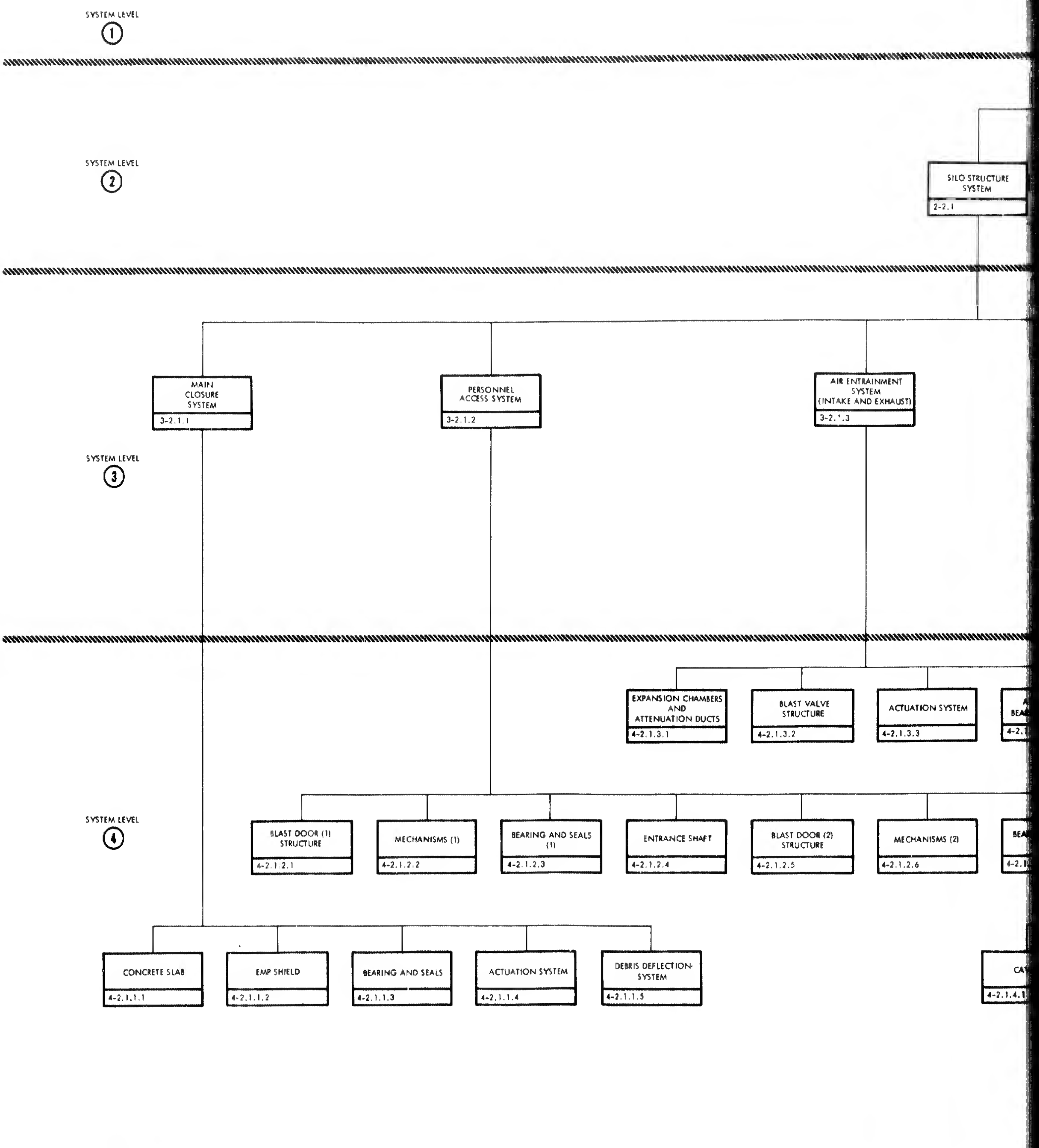
The in-place hardness of a system can be demonstrated to some degree at every stage of the system development cycle. With careful and early planning, a spectrum of testing can be identified that will ensure hardness of certain elements very early in the development stage, thus providing a strong data base upon which to design (or redesign if necessary) interacting system elements. Examination of the total system piece by piece will allow the identification of system elements that lend themselves to early testing. It will also identify more complex systems that would more logically be tested later in the development program. The hardness demonstration tests can follow much the same pattern as system development tests, that is, systems elements are evaluated in their simplest form first; then, as the components are combined, more complex testing is conducted. This method provides a test base that accumulates as each test is conducted until hardness is ensured. It also provides an inherent insensitivity to design changes that in the redesigned components or subsystems may be re-evaluated with simple tests; this eliminates having to retest a large complex system to ensure hardness.

3.1 TEST PROGRAM PLAN—LAUNCH FACILITY

The launch facility configuration shown in Figure 3-3 identifies the facility systems considered in the test requirements analysis. The systems are defined at four levels,

Level 1: The complete facility

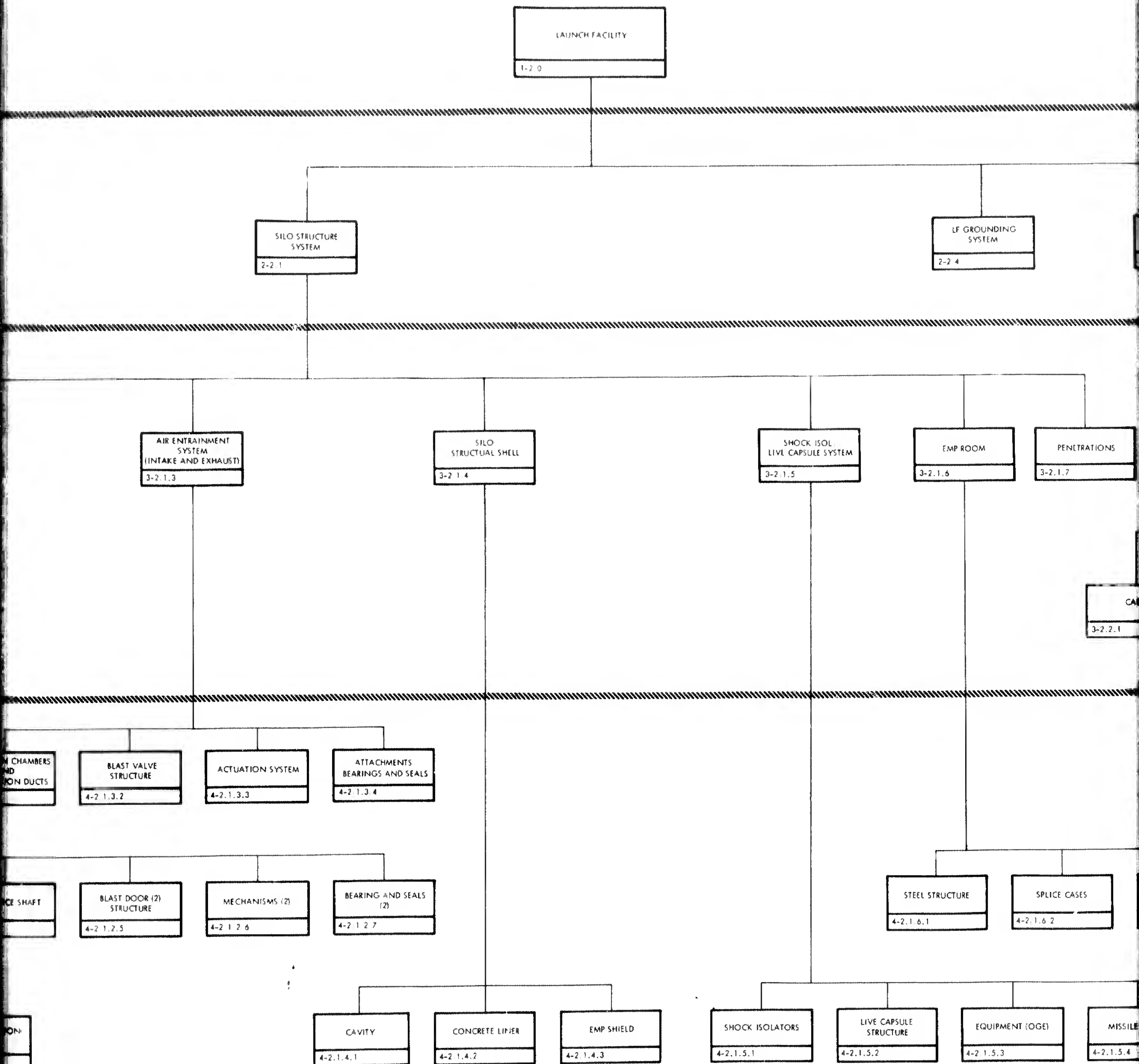
Level 2: Major parts of the complete facility



SYSTEM LEVEL 1
SYSTEM LEVEL 2
SILO STRUCTURE SYSTEM
2-2.1
SYSTEM LEVEL 3
MAIN CLOSURE SYSTEM
3-2.1.1
PERSONNEL ACCESS SYSTEM
3-2.1.2
AIR ENTRAINMENT SYSTEM (INTAKE AND EXHAUST)
3-2.1.3
SYSTEM LEVEL 4
EXPANSION CHAMBERS AND ATTENUATION DUCTS
4-2.1.3.1
BLAST VALVE STRUCTURE
4-2.1.3.2
ACTUATION SYSTEM
4-2.1.3.3
BLAST DOOR (1) STRUCTURE
4-2.1.2.1
MECHANISMS (1)
4-2.1.2.2
BEARING AND SEALS (1)
4-2.1.2.3
ENTRANCE SHAFT
4-2.1.2.4
BLAST DOOR (2) STRUCTURE
4-2.1.2.5
MECHANISMS (2)
4-2.1.2.6
CONCRETE SLAB
4-2.1.1.1
EMP SHIELD
4-2.1.1.2
BEARING AND SEALS
4-2.1.1.3
ACTUATION SYSTEM
4-2.1.1.4
DEBRIS DEFLECTION SYSTEM
4-2.1.1.5
4-2.1.4.1

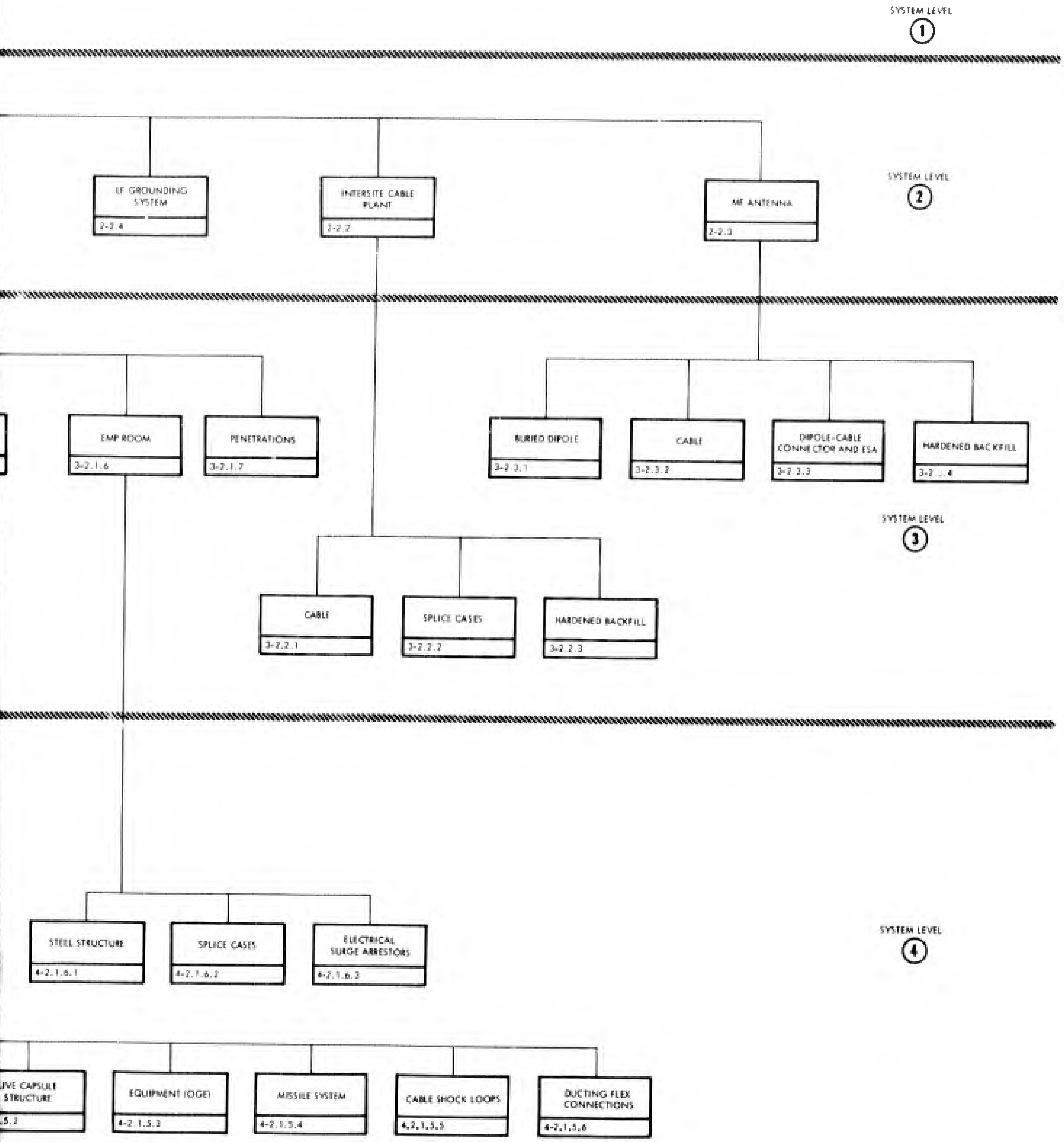
A.

B.


LAUNCH FACILITY
1-2 0
SILO STRUCTURE SYSTEM
2-2 1
LF GROUNDING SYSTEM
2-2 4
AIR ENTRAINMENT SYSTEM (INTAKE AND EXHAUST)
3-2.1.3
SILO STRUCTUAL SHELL
3-2 1 4
SHOCK ISOL LIVE CAPSULE SYSTEM
3-2 1.5
EMP ROOM
3-2.1.6
PENETRATIONS
3-2.1.7
3-2.2.1
CHAMBERS
ON DUCTS
BLAST VALVE STRUCTURE
4-2 1.3.2
ACTUATION SYSTEM
4-2.1.3.3
ATTACHMENTS BEARINGS AND SEALS
4-2 1.3 4
CE SHAFT
BLAST DOOR (2) STRUCTURE
4-2 1.2.5
MECHANISMS (2)
4-2 1 2 6
BEARING AND SEALS (2)
4-2 1 2 7
STEEL STRUCTURE
4-2.1 6.1
SPLICE CASES
4-2.1.6 2
CAVITY
4-2.1.4.1
CONCRETE LINER
4-2 1.4.2
EMP SHIELD
4-2 1.4.3
SHOCK ISOLATORS
4-2.1.5.1
LIVE CAPSULE STRUCTURE
4-2.1.5.2
EQUIPMENT (OGE)
4-2 1.5.3
MISSILE
4-2.1.5.4

B.

LAUNCH FA



SYSTEM LEVEL 1
LF GROUNDING SYSTEM
2-2.4
INTERSITE CABLE PLANT
2-2.2
MF ANTENNA
2-2.3
SYSTEM LEVEL 2
EMP ROOM
3-2.1.6
PENETRATIONS
3-2.1.7
BURIED DIPOLE
3-2.3.1
CABLE
3-2.3.2
DIPOLE-CABLE CONNECTOR AND ESA
3-2.3.3
HARDENED BACKFILL
3-2. . .4
SYSTEM LEVEL 3
CABLE
3-2.2.1
SPLICE CASES
3-2.2.2
HARDENED BACKFILL
3-2.2.3
STEEL STRUCTURE
4-2.1.6.1
SPLICE CASES
4-2.1.6.2
ELECTRICAL SURGE ARRESTORS
4-2.1.6.3
SYSTEM LEVEL 4
IVE CAPSULE STRUCTURE
.5.2
EQUIPMENT (OGE)
4-2.1.5.3
MISSILE SYSTEM
4-2.1.5.4
CABLE SHOCK LOOPS
4.2.1.5.5
DUCTING FLEX CONNECTIONS
4-2.1.5.6

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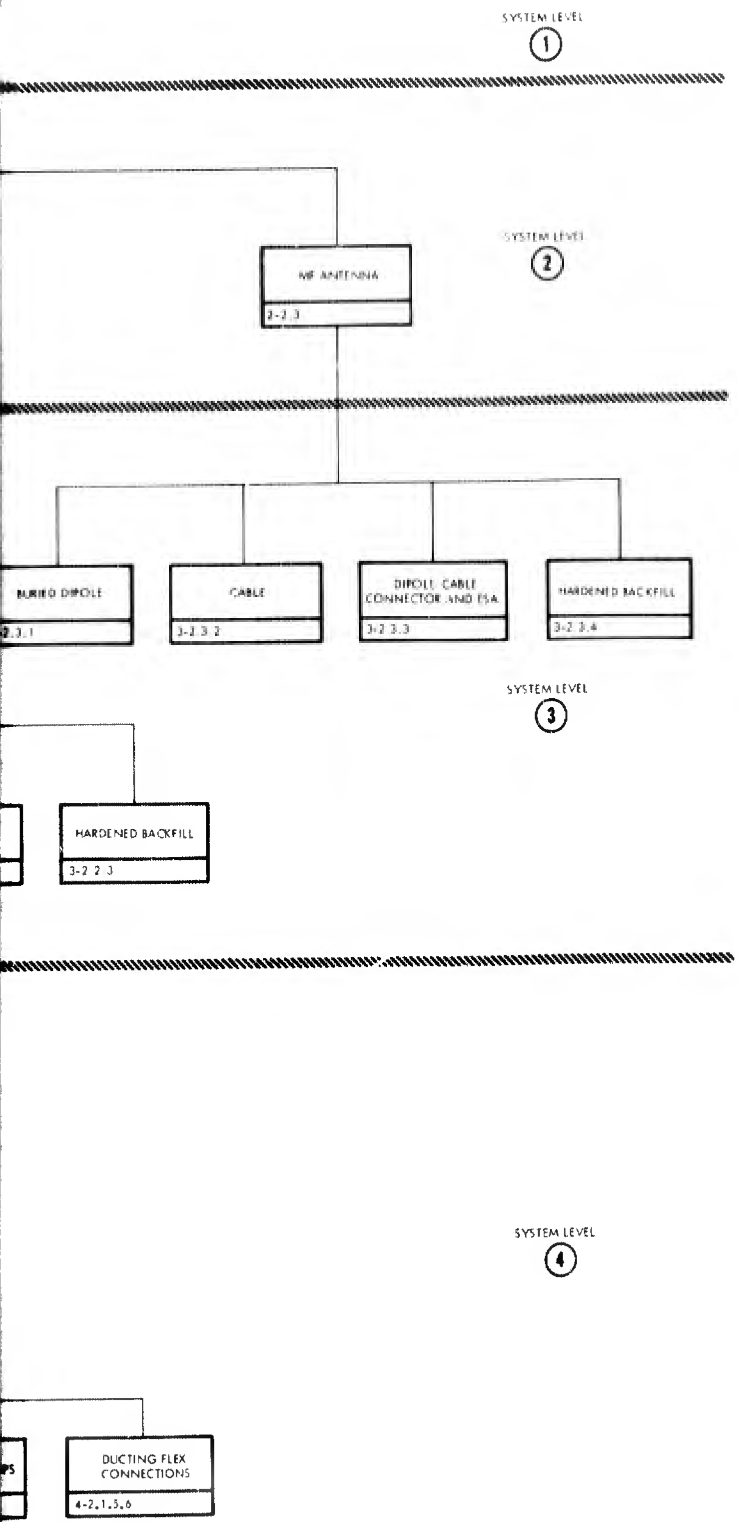
C.



LAUNCH FACILITY SYSTEM CONFIGURATION

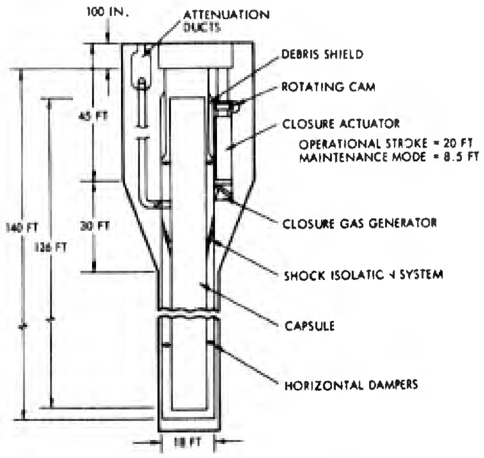


Figure 3-3.

C.

D.

Level 3: Major systems

Level 4: Subsystems with lines leading to the parent Level 3 system.

It identifies system elements that are meaningful or critical to the hardness and vulnerability problem. These elements represent either the missile and launch essential equipments that are sensitive to an attenuated weapons effects environment or the elements that are functional in protecting the sensitive system elements from the free field weapons effects environment.

The launch facility test flow (Figure 3.3) was developed as the result of a test requirements analysis (as documented in Section 2 of Test Requirements Analysis, Volume III of this report) in which LF system elements were first identified, the weapons effect input to the element established, and consideration given as to whether tests were necessary to ensure hardness. Test requirements were then written for each element requiring test, and simulation techniques tradeoffs performed to establish recommended testing concepts.

The test concept flow presents a progression of recommended tests that, if accomplished, will provide increasing measures of confidence in system hardness. The flow covers the total spectrum of hardness demonstration testing required to ensure in-place hardness of the LF. Beginning at the left of the launch facility test concept flow with components and combinations of components, and progressing to the right through systems and system combinations of increasing degrees of complexity, all components, subsystems, and systems are examined. Where testing is recommended, simulation techniques have been tradedoff, and appropriate test facility recommendations have been shown.

A feature of the launch facility test program worth noting is that the bulk of the testing is done at the component, subsystem, and combined subsystem levels in an attempt to ensure hardness of those system elements to the environments that they will experience. This approach simplifies the requirement for testing at the major system or complete facility level to the evaluation of system interaction in response to the simulated weapons effects environment. The environments considered to cause system interaction are direct-induced and air-blast-induced ground motion and EMP. It is felt that the ground motion need not be simulated in exact magnitude but that the composite characteristics of the environment should be produced to a degree that it will shake the total system. A high explosive contact surface burst technique is believed to produce an acceptable environment.* As for EMP, the most meaningful tests are those conducted while the total system is functioning in a standard operating mode. The test program plan requires these EMP tests to be done with a large Marx generator before and after the system interaction ground motion tests.

The documentation tree (Figure 3-4) contains a block listing of the required documentation to systematically control and manage the launch facility test program plan.

The launch facility test program phasing chart (Figure 3-5) presents a time phasing relationship between the test blocks shown on the launch facility test program flow (Figure 3-2). The phasing chart also schedules each test block with respect to the weapon system development schedule (reference WS-120A Preliminary Technical Development Plan). The test scheduling judgments shown on Figure 3-5 are based on normal conditions of funding and nominal planning and construction time. The basic in-place hardness test planning philosophy of ensuring system hardness before it becomes operational is reflected on the phasing chart with the major testing being scheduled for completion at about the time of the facility critical design review (CDR).

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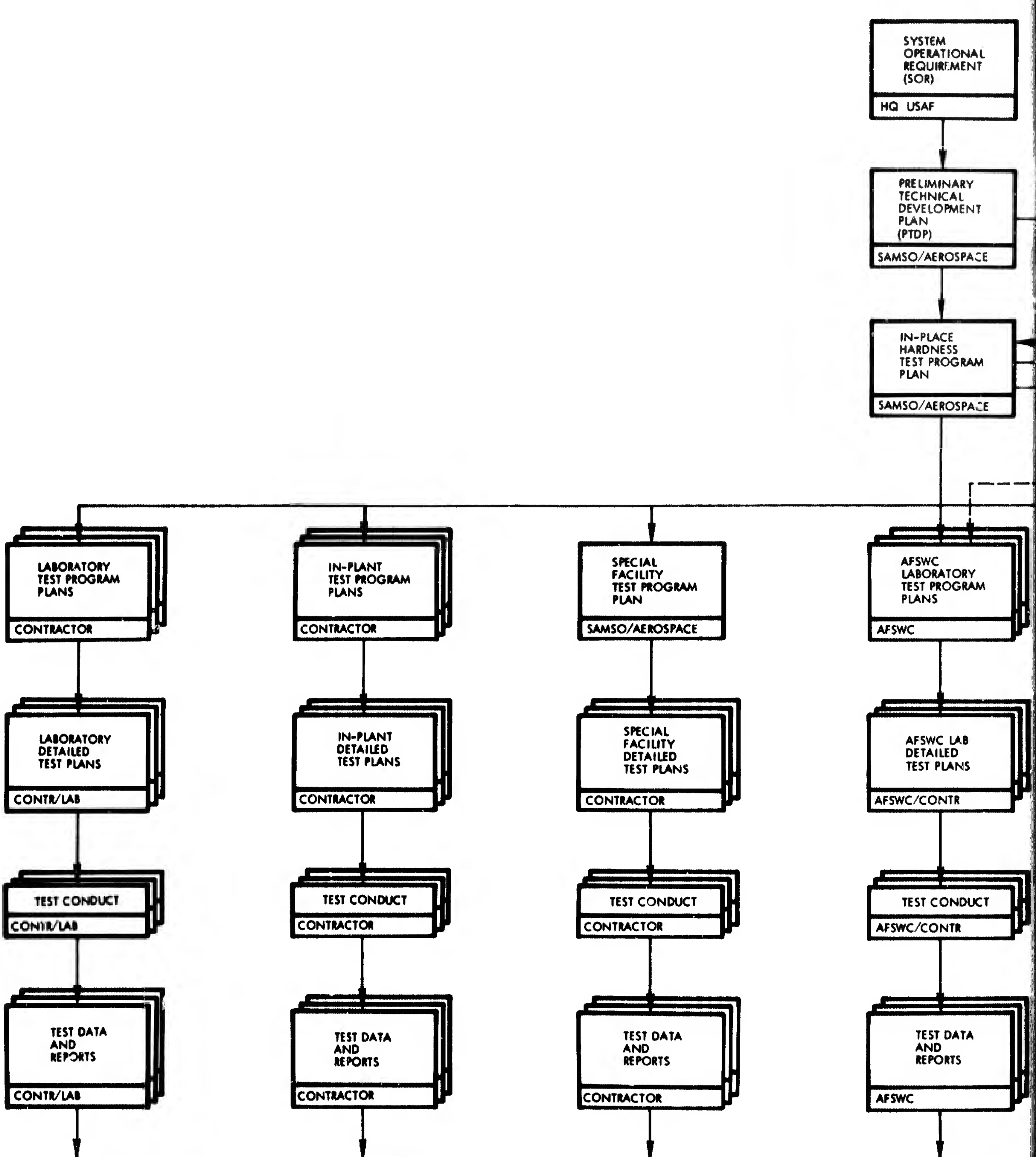
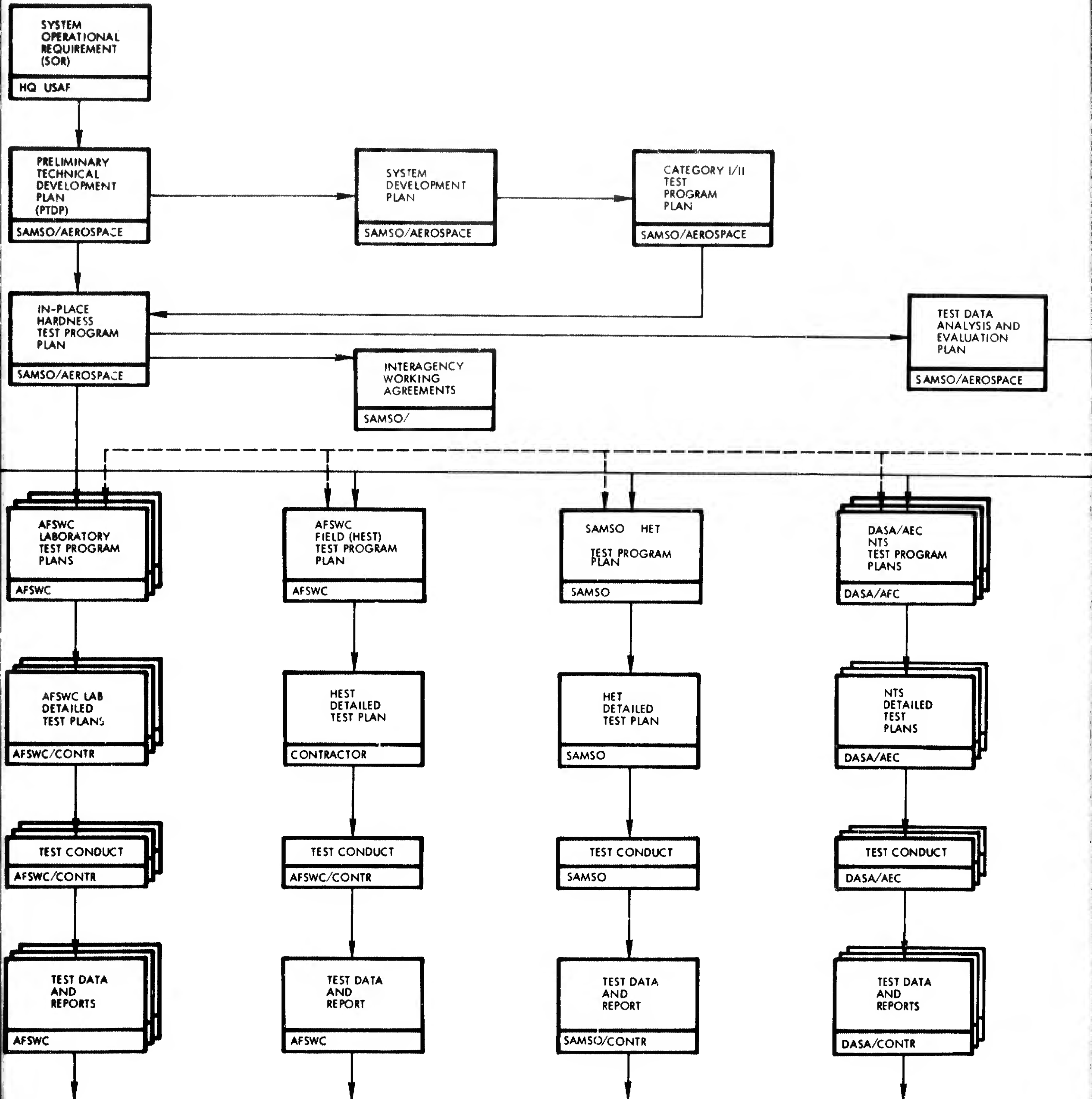
*Further evaluation and development is definitely needed to identify the most useful test concept for ground motion simulation.



SYSTEM OPERATIONAL REQUIREMENT (SOR)
HQ USAF
PRELIMINARY TECHNICAL DEVELOPMENT PLAN (PTDP)
SAMSO/AEROSPACE
IN-PLACE HARDNESS TEST PROGRAM PLAN
SAMSO/AEROSPACE
LABORATORY TEST PROGRAM PLANS
CONTRACTOR
IN-PLANT TEST PROGRAM PLANS
CONTRACTOR
SPECIAL FACILITY TEST PROGRAM PLAN
SAMSO/AEROSPACE
AFSWC LABORATORY TEST PROGRAM PLANS
AFSWC
LABORATORY DETAILED TEST PLANS
CONTR/LAB
IN-PLANT DETAILED TEST PLANS
CONTRACTOR
SPECIAL FACILITY DETAILED TEST PLANS
CONTRACTOR
AFSWC LAB DETAILED TEST PLANS
AFSWC/CONTR
TEST CONDUCT
CONTR/LAB
TEST CONDUCT
CONTRACTOR
TEST CONDUCT
CONTRACTOR
TEST CONDUCT
AFSWC/CONTR
TEST DATA AND REPORTS
CONTR/LAB
TEST DATA AND REPORTS
CONTRACTOR
TEST DATA AND REPORTS
CONTRACTOR
TEST DATA AND REPORTS
AFSWC

A.



SYSTEM OPERATIONAL REQUIREMENT (SOR)
HQ USAF
PRELIMINARY TECHNICAL DEVELOPMENT PLAN (PTDP)
SAMSO/AEROSPACE
SYSTEM DEVELOPMENT PLAN
SAMSO/AEROSPACE
CATEGORY I/II TEST PROGRAM PLAN
SAMSO/AEROSPACE
IN-PLACE HARDNESS TEST PROGRAM PLAN
SAMSO/AEROSPACE
TEST DATA ANALYSIS AND EVALUATION PLAN
SAMSO/AEROSPACE
INTERAGENCY WORKING AGREEMENTS
SAMSO/
AFSWC LABORATORY TEST PROGRAM PLANS
AFSWC
AFSWC FIELD (HEST) TEST PROGRAM PLAN
AFSWC
SAMSO HET TEST PROGRAM PLAN
SAMSO
DASA/AEC NTS TEST PROGRAM PLANS
DASA/AFC
AFSWC LAB DETAILED TEST PLANS
AFSWC/CONTR
HEST DETAILED TEST PLAN
CONTRACTOR
HET DETAILED TEST PLAN
SAMSO
NTS DETAILED TEST PLANS
DASA/AEC
TEST CONDUCT
AFSWC/CONTR
TEST CONDUCT
AFSWC/CONTR
TEST CONDUCT
SAMSO
TEST CONDUCT
DASA/AEC
TEST DATA AND REPORTS
AFSWC
TEST DATA AND REPORT
AFSWC
TEST DATA AND REPORT
SAMSO/CONTR
TEST DATA AND REPORTS
DASA/CONTR

B.

LAUNCH FACILITY TEST PROGRAM

DOCUMENTATION

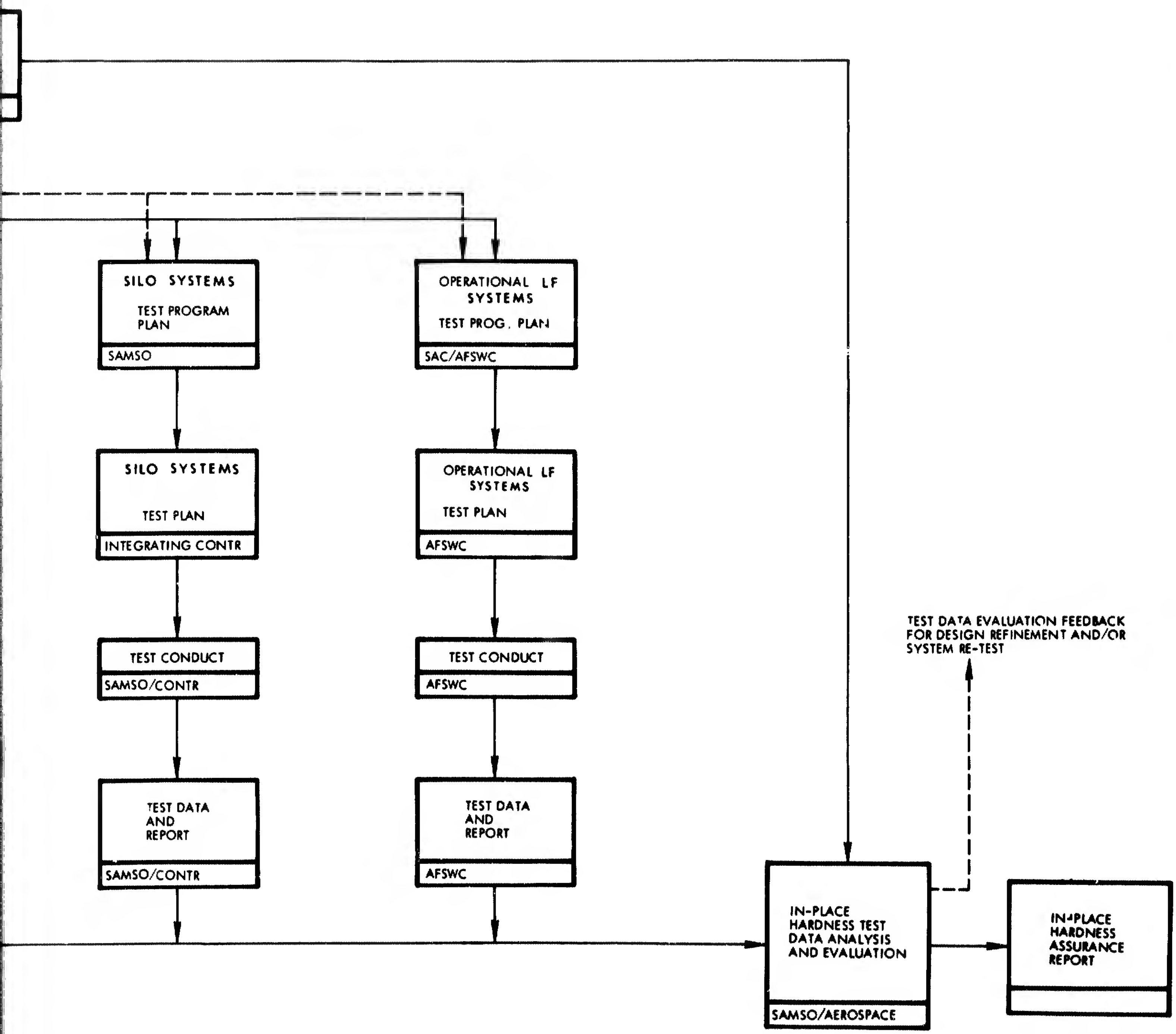
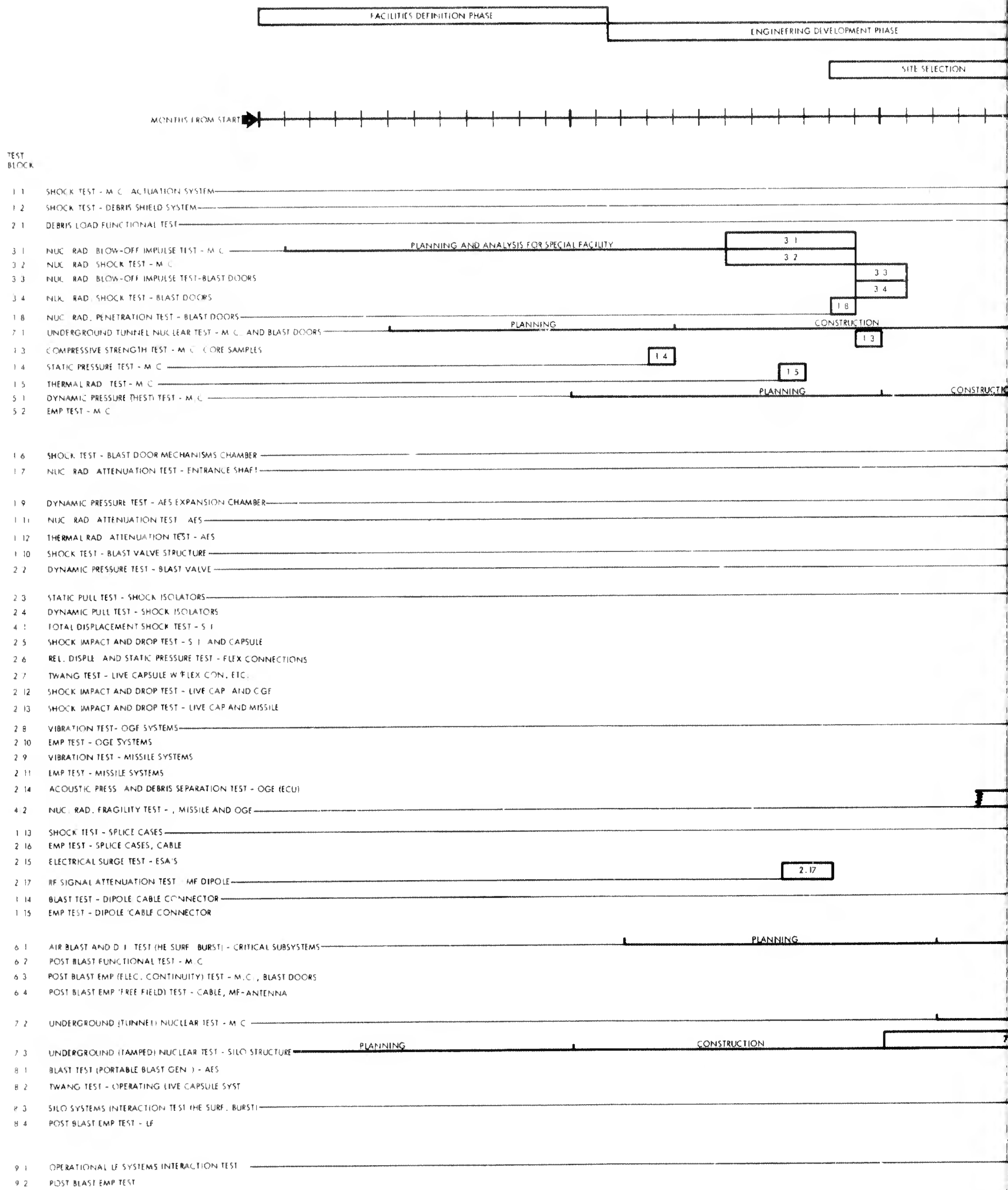
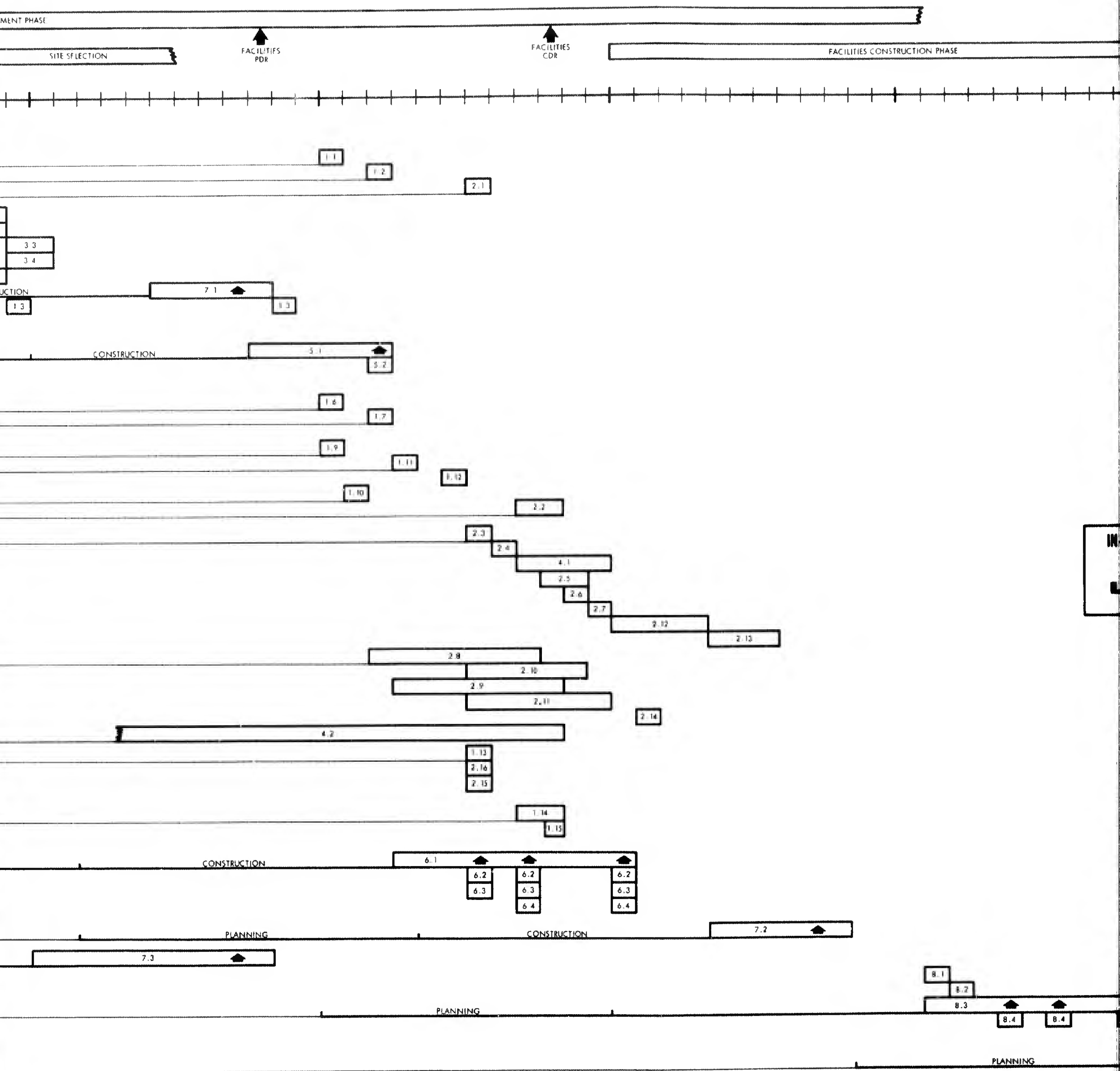


Figure 3-4.



FACILITIES DEFINITION PHASE
ENGINEERING DEVELOPMENT PHASE
SITE SELECTION
MONTHS FROM START
TEST BLOCK
1 1 SHOCK TEST - M C ACTUATION SYSTEM
1 2 SHOCK TEST - DEBRIS SHIELD SYSTEM
2 1 DEBRIS LOAD FUNCTIONAL TEST
3 1 NUC RAD BLOW-OFF IMPULSE TEST - M C
PLANNING AND ANALYSIS FOR SPECIAL FACILITY
3 1
3 2 NUC RAD SHOCK TEST - M C
3 2
3 3 NUC RAD BLOW-OFF IMPULSE TEST-BLAST DOORS
3 3
3 4 NUC RAD SHOCK TEST - BLAST DOORS
3 4
1 8 NUC RAD. PENETRATION TEST - BLAST DOORS
1 8
7 1 UNDERGROUND TUNNEL NUCLEAR TEST - M C AND BLAST DOORS
PLANNING
CONSTRUCTION
1 3 COMPRESSIVE STRENGTH TEST - M C CORE SAMPLES
1 3
1 4 STATIC PRESSURE TEST - M C
1 4
1 5 THERMAL RAD TEST - M C
1 5
5 1 DYNAMIC PRESSURE (HEST) TEST - M C
PLANNING
CONSTRUCTI
5 2 EMP TEST - M C
1 6 SHOCK TEST - BLAST DOOR MECHANISMS CHAMBER
1 7 NUC RAD ATTENUATION TEST - ENTRANCE SHAFT
1 9 DYNAMIC PRESSURE TEST - AES EXPANSION CHAMBER
1 11 NUC RAD ATTENUATION TEST AES
1 12 THERMAL RAD ATTENUATION TEST - AES
1 10 SHOCK TEST - BLAST VALVE STRUCTURE
2 2 DYNAMIC PRESSURE TEST - BLAST VALVE
2 3 STATIC PULL TEST - SHOCK ISOLATORS
2 4 DYNAMIC PULL TEST - SHOCK ISOLATORS
4 1 TOTAL DISPLACEMENT SHOCK TEST - S I
2 5 SHOCK IMPACT AND DROP TEST - S I AND CAPSULE
2 6 REL. DISPL. AND STATIC PRESSURE TEST - FLEX CONNECTIONS
2 7 TWANG TEST - LIVE CAPSULE W FLEX CON, ETC.
2 12 SHOCK IMPACT AND DROP TEST - LIVE CAP AND OGE
2 13 SHOCK IMPACT AND DROP TEST - LIVE CAP AND MISSILE
2 8 VIBRATION TEST- OGE SYSTEMS
2 10 EMP TEST - OGE SYSTEMS
2 9 VIBRATION TEST - MISSILE SYSTEMS
2 11 EMP TEST - MISSILE SYSTEMS
2 14 ACOUSTIC PRESS AND DEBRIS SEPARATION TEST - OGE (ECU)
4 2 NUC. RAD. FRAGILITY TEST - , MISSILE AND OGE
1 13 SHOCK TEST - SPLICE CASES
2 16 EMP TEST - SPLICE CASES, CABLE
2 15 ELECTRICAL SURGE TEST - ESA'S
2 17 RF SIGNAL ATTENUATION TEST MF DIPOLE
2.17
1 14 BLAST TEST - DIPOLE CABLE CONNECTOR
1 15 EMP TEST - DIPOLE CABLE CONNECTOR
6 1 AIR BLAST AND D I TEST (HE SURF BURST) - CRITICAL SUBSYSTEMS
PLANNING
6 2 POST BLAST FUNCTIONAL TEST - M.C
6 3 POST BLAST EMP (ELEC. CONTINUITY) TEST - M.C., BLAST DOORS
6 4 POST BLAST EMP (FREE FIELD) TEST - CABLE, MF-ANTENNA
7 2 UNDERGROUND (TUNNEL) NUCLEAR TEST - M C
7 3 UNDERGROUND (TAMPED) NUCLEAR TEST - SILO STRUCTURE
PLANNING
CONSTRUCTION
8 1 BLAST TEST (PORTABLE BLAST GEN) - AES
8 2 TWANG TEST - OPERATING LIVE CAPSULE SYST
8 3 SILO SYSTEMS INTERACTION TEST (HE SURF. BURST)
8 4 POST BLAST EMP TEST - LF
9 1 OPERATIONAL LF SYSTEMS INTERACTION TEST
9 2 POST BLAST EMP TEST

A.


MENT PHASE
SITE SELECTION
FACILITIES PDR
FACILITIES CDR
FACILITIES CONSTRUCTION PHASE
CONSTRUCTION
PLANNING

B.

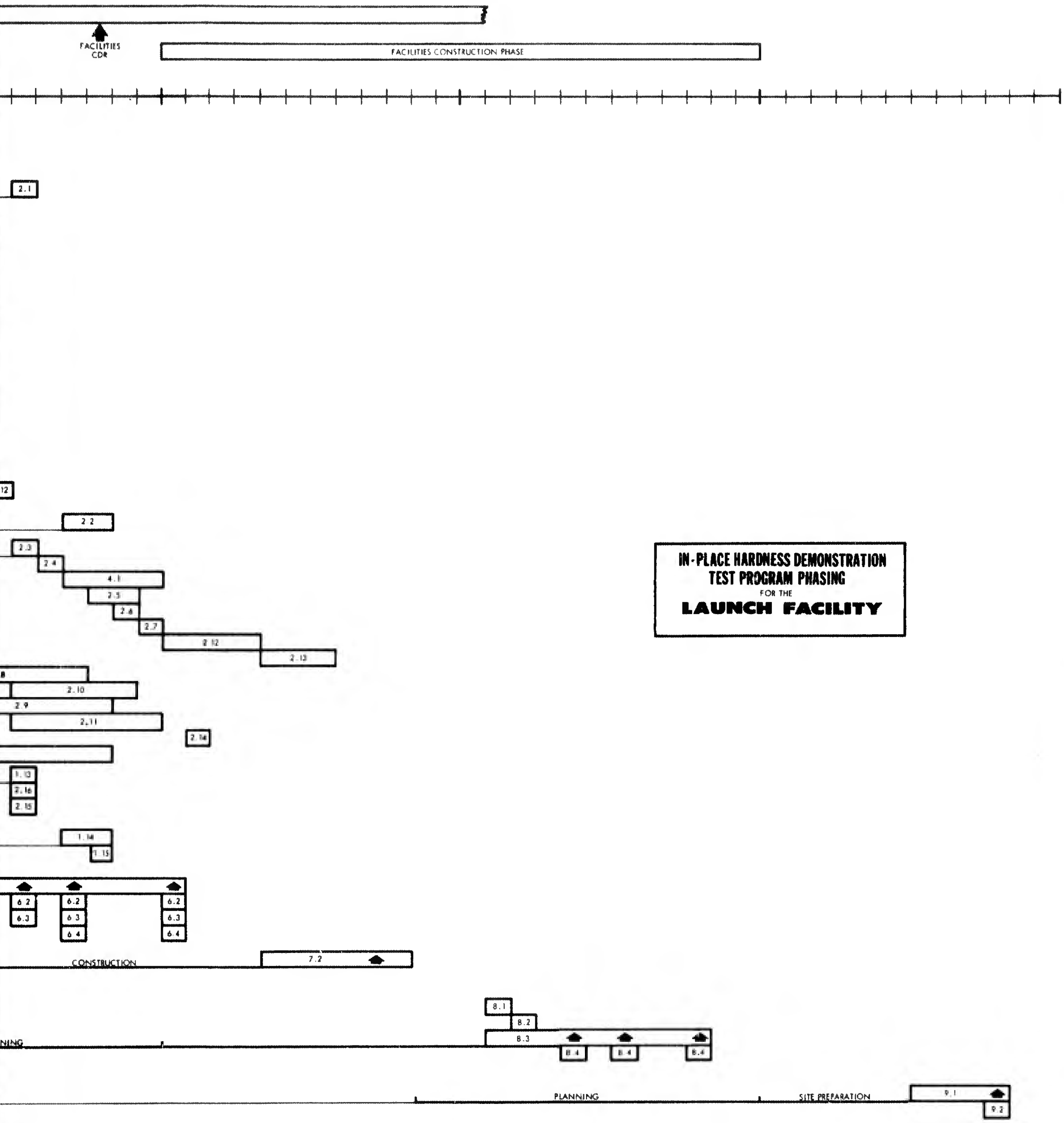

FACILITIES CDR
FACILITIES CONSTRUCTION PHASE
2.1
2.2
2.3
2.4
4.1
2.5
2.6
2.7
2.12
2.13
2.10
2.9
2.11
2.14
1.13
2.16
2.15
1.14
1.15
6.2
6.3
6.4
CONSTRUCTION
7.2
8.1
8.2
8.3
8.4
PLANNING
SITE PREPARATION
9.1
9.2
IN-PLACE HARDNESS DEMONSTRATION
TEST PROGRAM PHASING
FOR THE
LAUNCH FACILITY

Figure 3-5.

C.

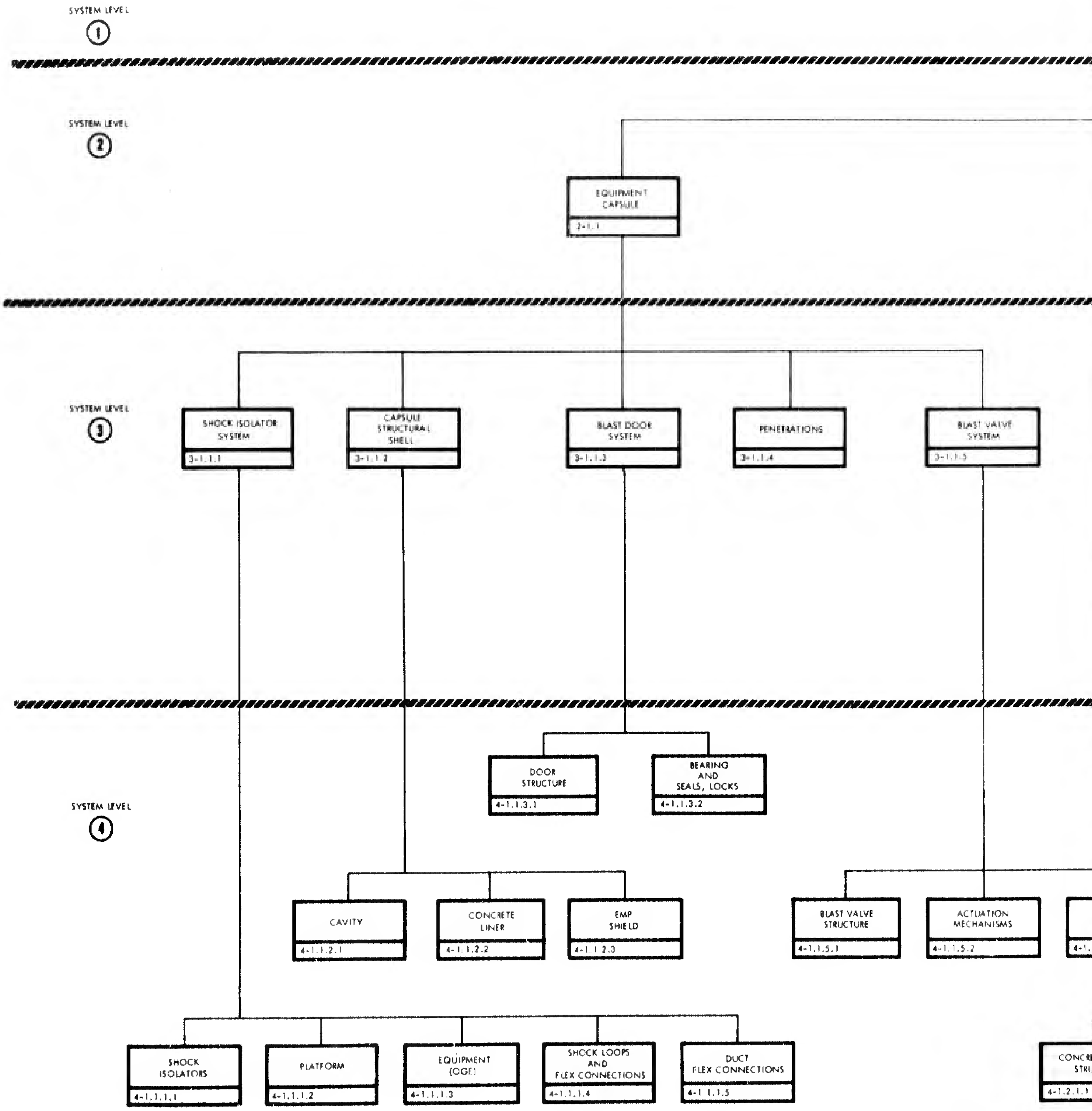
3.2 TEST PROGRAM PLAN—LAUNCH CONTROL FACILITY

The launch control facility (LCF) is identified like the launch facility (LF) (see Figure 3-6) with systems at four levels. It should be noted that this facility has eight major systems (i.e., Level 2 systems).

Equipment capsule
Access shaft
Personnel capsule
Intersite cable plant
HF antenna
UHF antenna
MF antenna
LCF ground system (undefined).

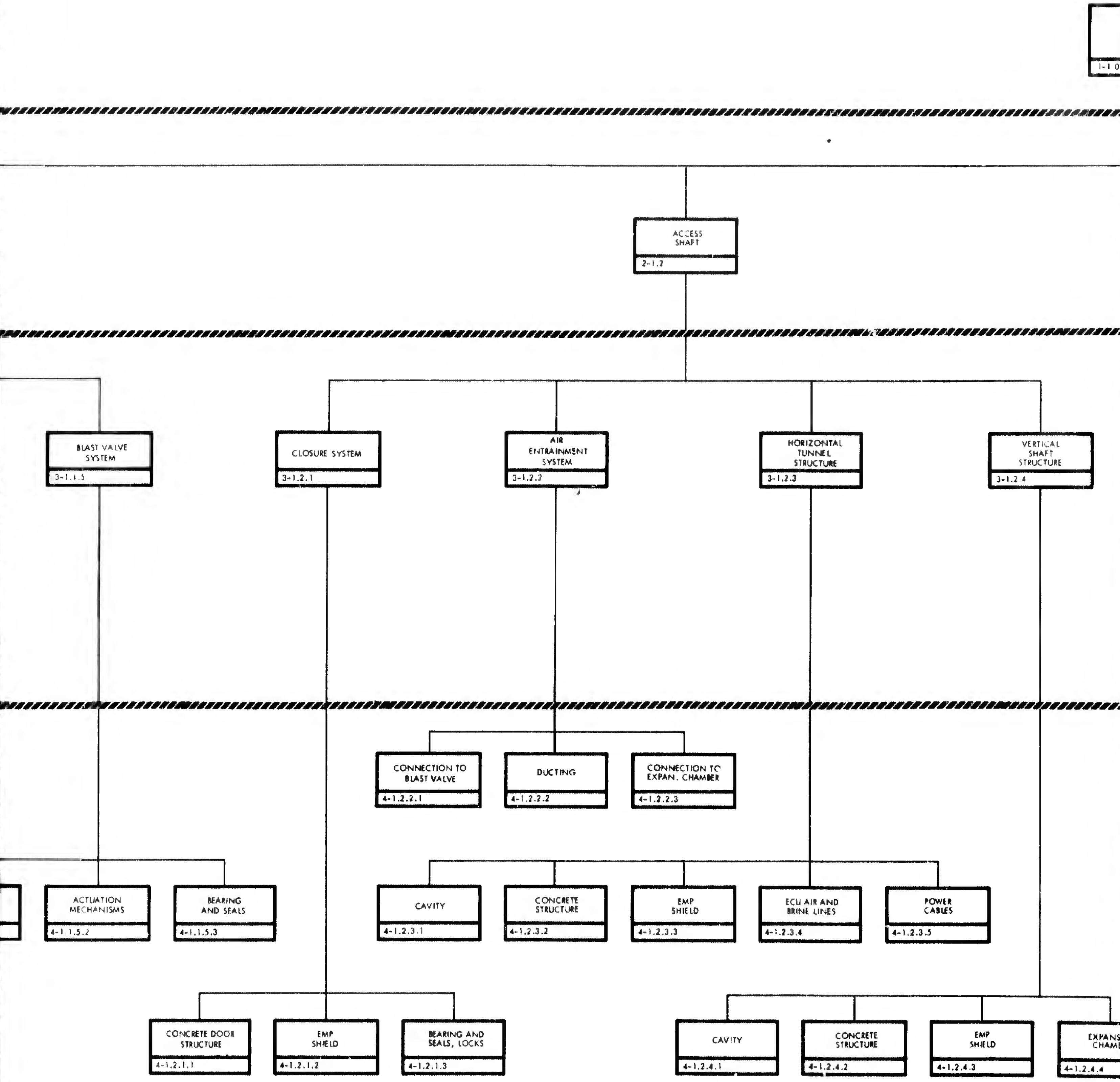
The first three systems, equipment capsule, access shaft, and personnel capsule, have strong structure interaction, and the other systems interact with each other through critical cable connections. The importance of testing combinations of Level 2 systems lies in the vulnerability of these connection links to differential ground motions resulting from the direct and crater induced weapon effects. The LF, by comparison, is a more compact system without any Level 2 systems with strong structural interaction. The Level 3 and Level 4 systems are similar to systems in the LF and consequently similar test concepts will be recommended at the lower level subsystems.

The test program features are similar to those in the LF test program plan; that is, the bulk of the testing is done at the component, subsystem, and combined subsystem levels in an attempt to ensure hardness of those system elements to the environments that they will experience. This approach simplifies the requirement for testing at the major system or complete facility level to the evaluation of system interaction in response to the simulated weapons effects environment. The environments that will cause system interaction are direct induced and air blast induced ground motion and EMP. It is felt that the ground motion need not be simulated in exact magnitude but that the composite characteristics of the environment should be produced to a degree that it will shake the total system. It is believed that a high explosive contact

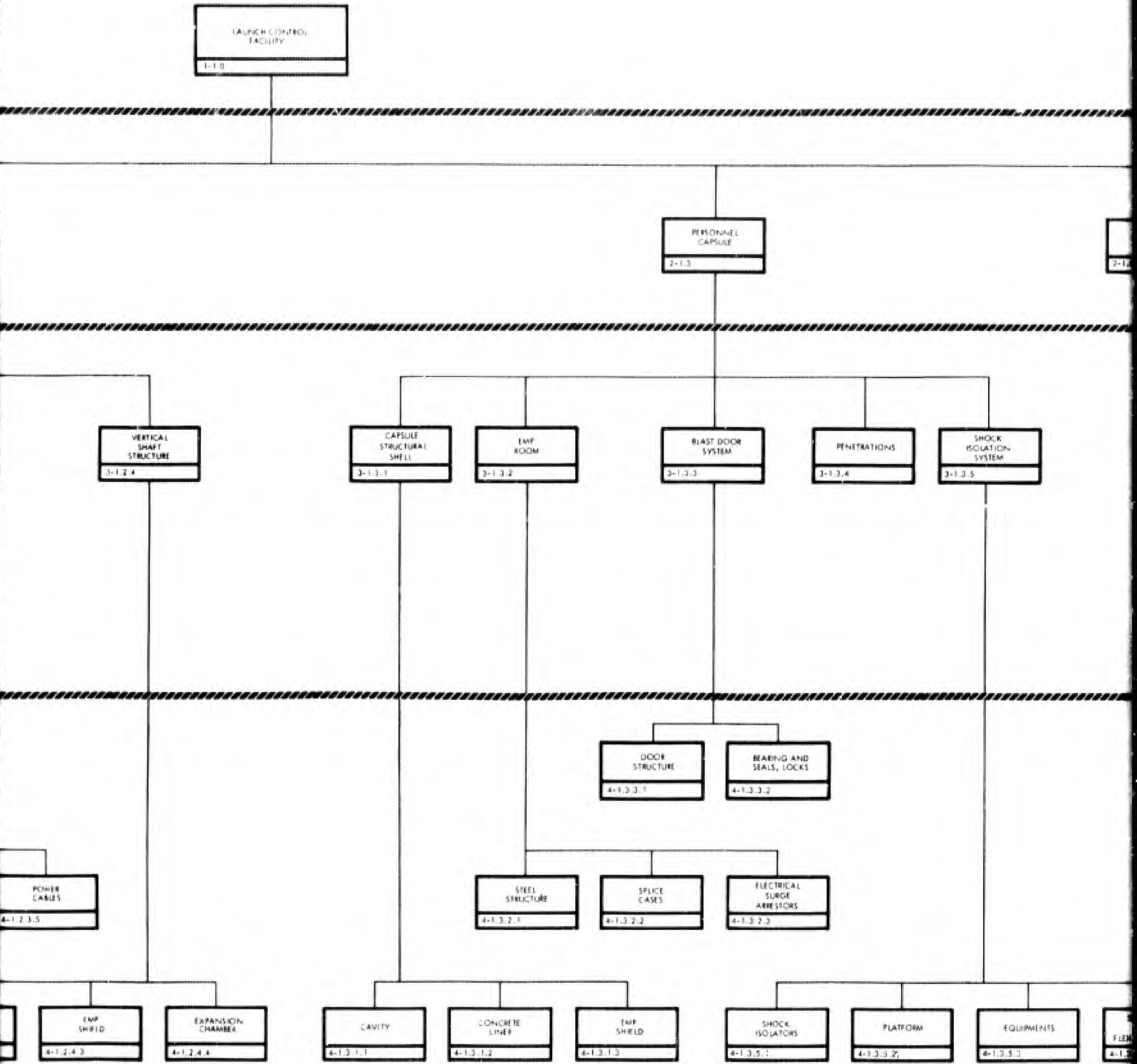


SYSTEM LEVEL
1
SYSTEM LEVEL
2
EQUIPMENT CAPSULE
2-1.1
SYSTEM LEVEL
3
SHOCK ISOLATOR SYSTEM
3-1.1.1
CAPSULE STRUCTURAL SHELL
3-1.1.2
BLAST DOOR SYSTEM
3-1.1.3
PENETRATIONS
3-1.1.4
BLAST VALVE SYSTEM
3-1.1.5
SYSTEM LEVEL
4
DOOR STRUCTURE
4-1.1.3.1
BEARING AND SEALS, LOCKS
4-1.1.3.2
CAVITY
4-1.1.2.1
CONCRETE LINER
4-1.1.2.2
EMP SHIELD
4-1.1.2.3
BLAST VALVE STRUCTURE
4-1.1.5.1
ACTUATION MECHANISMS
4-1.1.5.2
SHOCK ISOLATORS
4-1.1.1.1
PLATFORM
4-1.1.1.2
EQUIPMENT (OGE)
4-1.1.1.3
SHOCK LOOPS AND FLEX CONNECTIONS
4-1.1.1.4
DUCT FLEX CONNECTIONS
4-1.1.1.5

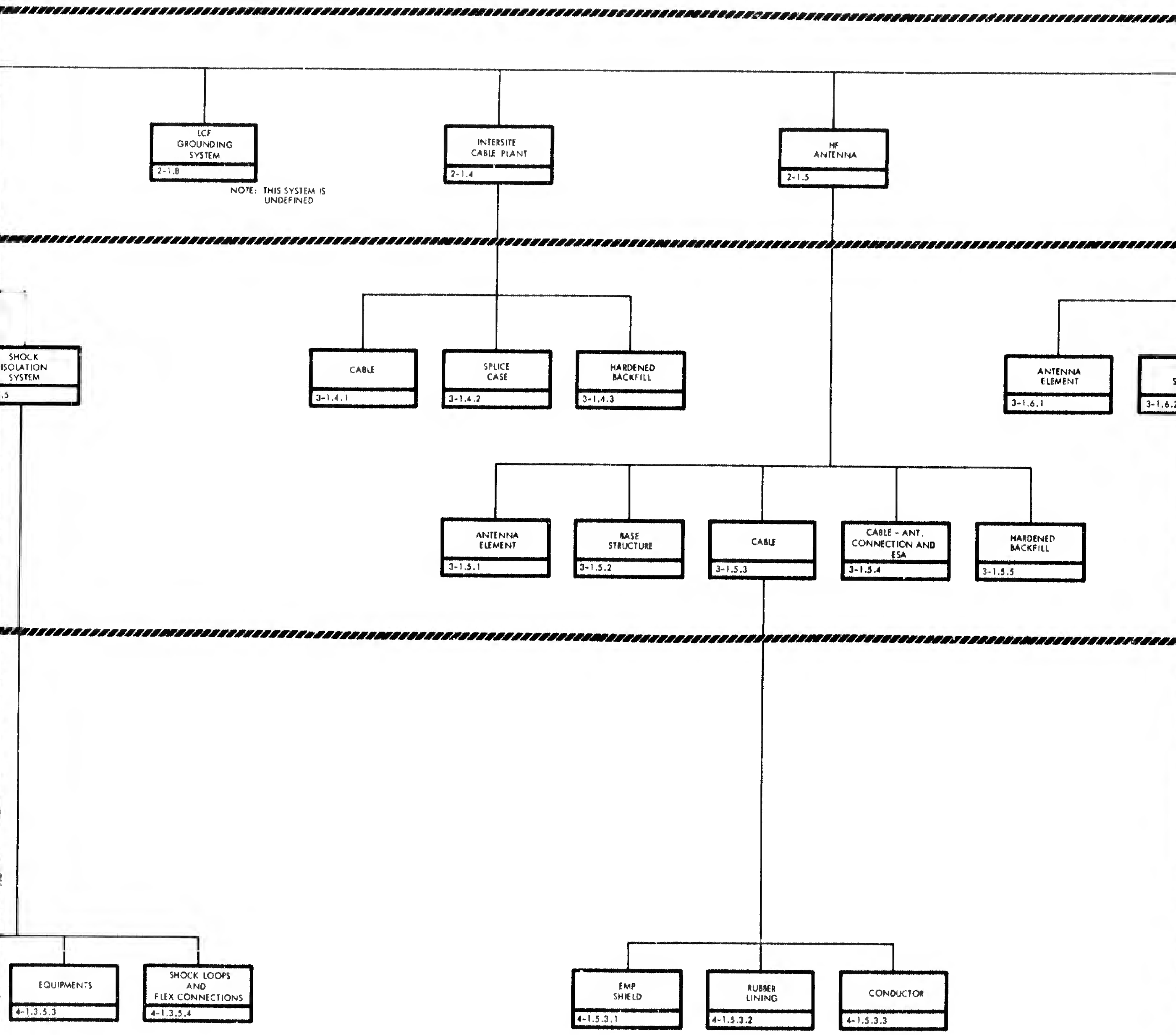
A.


ACCESS SHAFT
2-1.2
BLAST VALVE SYSTEM
3-1.1.5
CLOSURE SYSTEM
3-1.2.1
AIR ENTRAINMENT SYSTEM
3-1.2.2
HORIZONTAL TUNNEL STRUCTURE
3-1.2.3
VERTICAL SHAFT STRUCTURE
3-1.2.4
CONNECTION TO BLAST VALVE
4-1.2.2.1
DUCTING
4-1.2.2.2
CONNECTION TO EXPAN. CHAMBER
4-1.2.2.3
ACTUATION MECHANISMS
4-1.1.5.2
BEARING AND SEALS
4-1.1.5.3
CAVITY
4-1.2.3.1
CONCRETE STRUCTURE
4-1.2.3.2
EMP SHIELD
4-1.2.3.3
ECU AIR AND BRINE LINES
4-1.2.3.4
POWER CABLES
4-1.2.3.5
CONCRETE DOOR STRUCTURE
4-1.2.1.1
EMP SHIELD
4-1.2.1.2
BEARING AND SEALS, LOCKS
4-1.2.1.3
CAVITY
4-1.2.4.1
CONCRETE STRUCTURE
4-1.2.4.2
EMP SHIELD
4-1.2.4.3
4-1.2.4.4

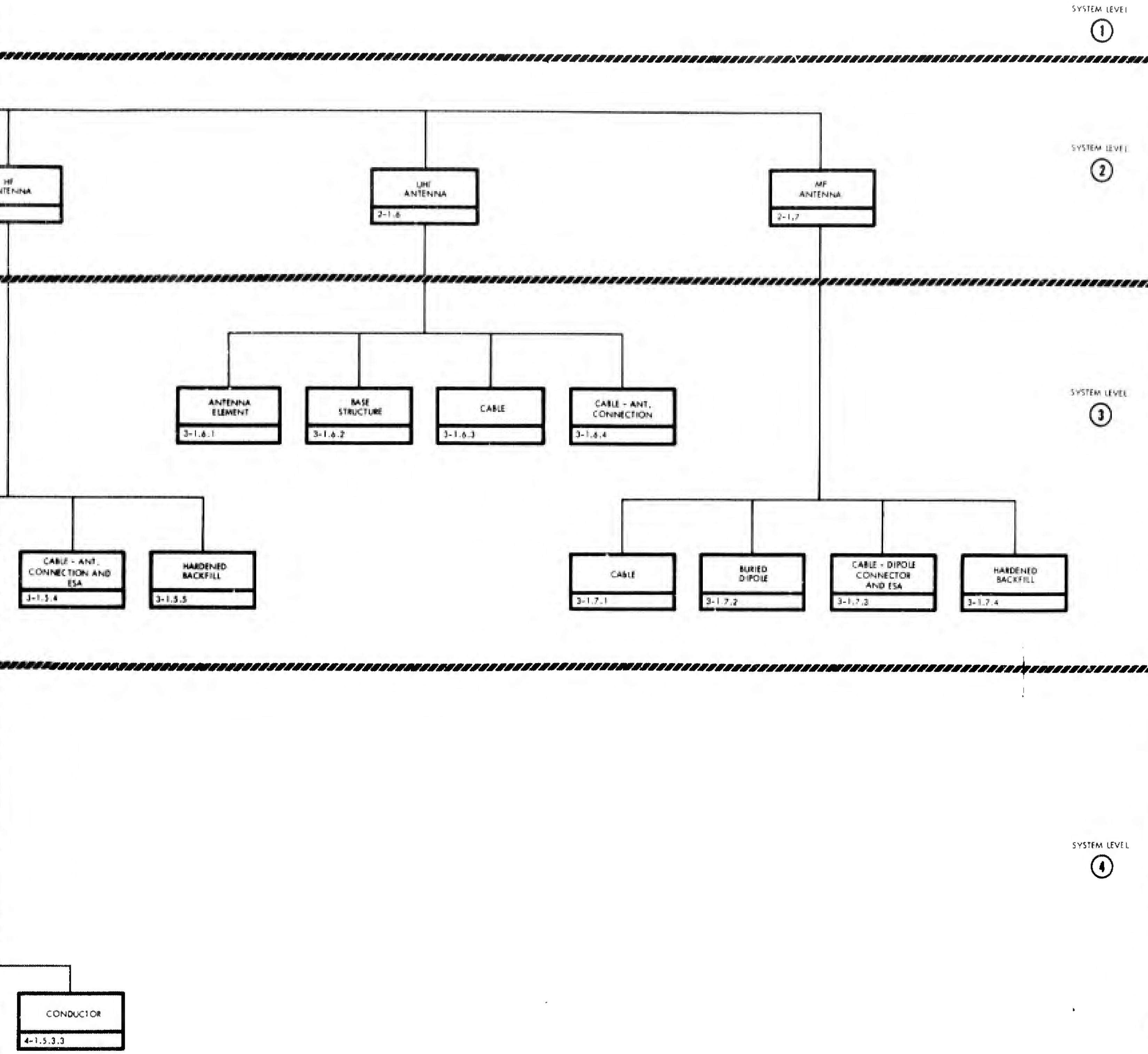
B.



LAUNCH CONTROL FACILITY
1-1.0
PERSONNEL CAPSULE
2-1.3
VERTICAL SHAFT STRUCTURE
3-1.2.4
CAPSULE STRUCTURAL SHELL
3-1.3.1
EMP ROOM
3-1.3.2
BLAST DOOR SYSTEM
3-1.3.3
PENETRATIONS
3-1.3.4
SHOCK ISOLATION SYSTEM
3-1.3.5
DOOR STRUCTURE
4-1.3.3.1
BEARING AND SEALS, LOCKS
4-1.3.3.2
POWER CABLES
4-1.2.3.5
STEEL STRUCTURE
4-1.3.2.1
SPLICE CASES
4-1.3.2.2
ELECTRICAL SURGE ARRESTORS
4-1.3.2.3
EMP SHIELD
4-1.2.4.3
EXPANSION CHAMBER
4-1.2.4.4
CAVITY
4-1.3.1.1
CONCRETE LINER
4-1.3.1.2
EMP SHIELD
4-1.3.1.3
SHOCK ISOLATORS
4-1.3.5.1
PLATFORM
4-1.3.5.2
EQUIPMENTS
4-1.3.5.3

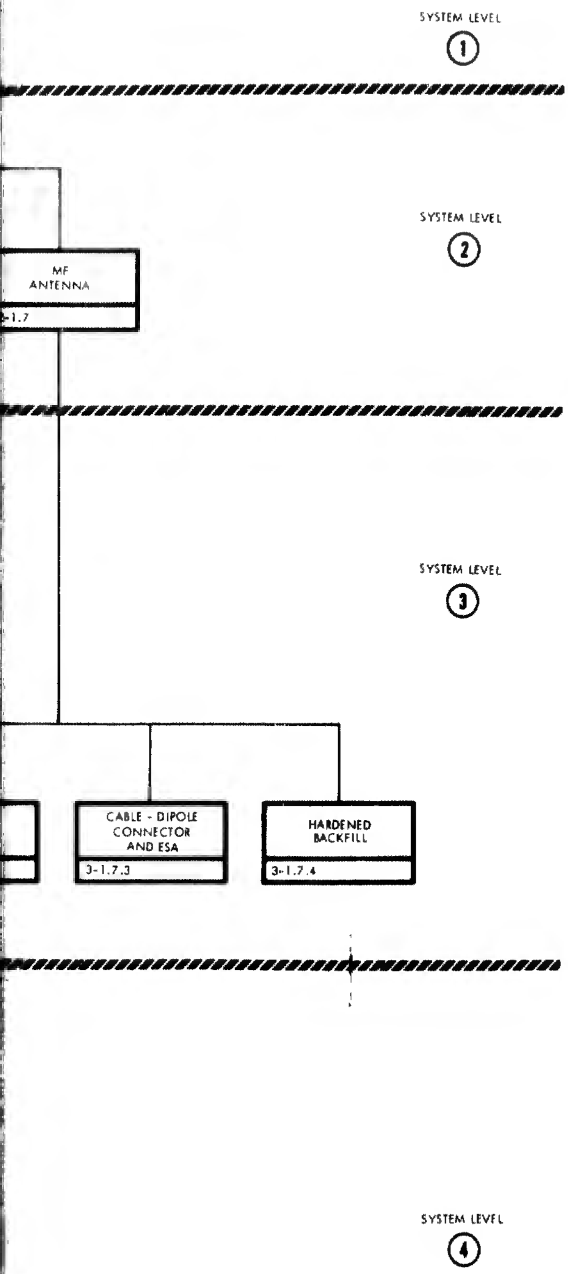

LCF GROUNDING SYSTEM
2-1.8
NOTE: THIS SYSTEM IS UNDEFINED
INTERSITE CABLE PLANT
2-1.4
HF ANTENNA
2-1.5
SHOCK ISOLATION SYSTEM
CABLE
3-1.4.1
SPLICE CASE
3-1.4.2
HARDENED BACKFILL
3-1.4.3
ANTENNA ELEMENT
3-1.6.1
ANTENNA ELEMENT
3-1.5.1
BASE STRUCTURE
3-1.5.2
CABLE
3-1.5.3
CABLE - ANT. CONNECTION AND ESA
3-1.5.4
HARDENED BACKFILL
3-1.5.5
EQUIPMENTS
4-1.3.5.3
SHOCK LOOPS AND FLEX CONNECTIONS
4-1.3.5.4
EMP SHIELD
4-1.5.3.1
RUBBER LINING
4-1.5.3.2
CONDUCTOR
4-1.5.3.3

D.



SYSTEM LEVEL
1
HF
ANTENNA
UHF
ANTENNA
2-1.6
MF
ANTENNA
2-1.7
SYSTEM LEVEL
2
ANTENNA
ELEMENT
3-1.6.1
BASE
STRUCTURE
3-1.6.2
CABLE
3-1.6.3
CABLE - ANT.
CONNECTION
3-1.6.4
SYSTEM LEVEL
3
CABLE - ANT.
CONNECTION AND
ESA
3-1.5.4
HARDENED
BACKFILL
3-1.5.5
CABLE
3-1.7.1
BURIED
DIPOLE
3-1.7.2
CABLE - DIPOLE
CONNECTOR
AND ESA
3-1.7.3
HARDENED
BACKFILL
3-1.7.4
SYSTEM LEVEL
4
CONDUCTOR
4-1.5.3.3

E.



LAUNCH CONTROL FACILITY

SYSTEM CONFIGURATION

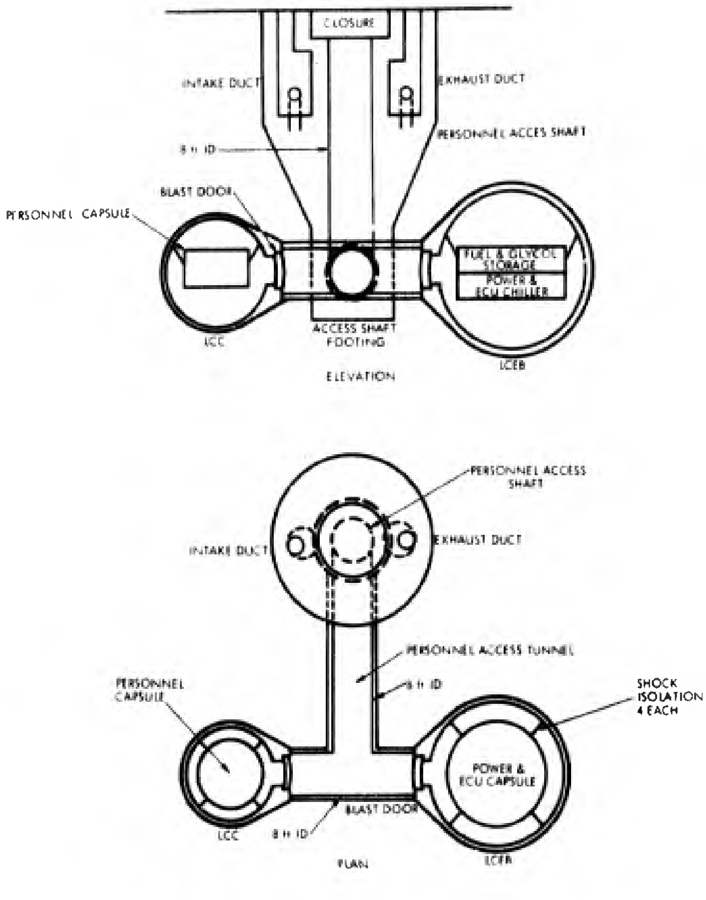


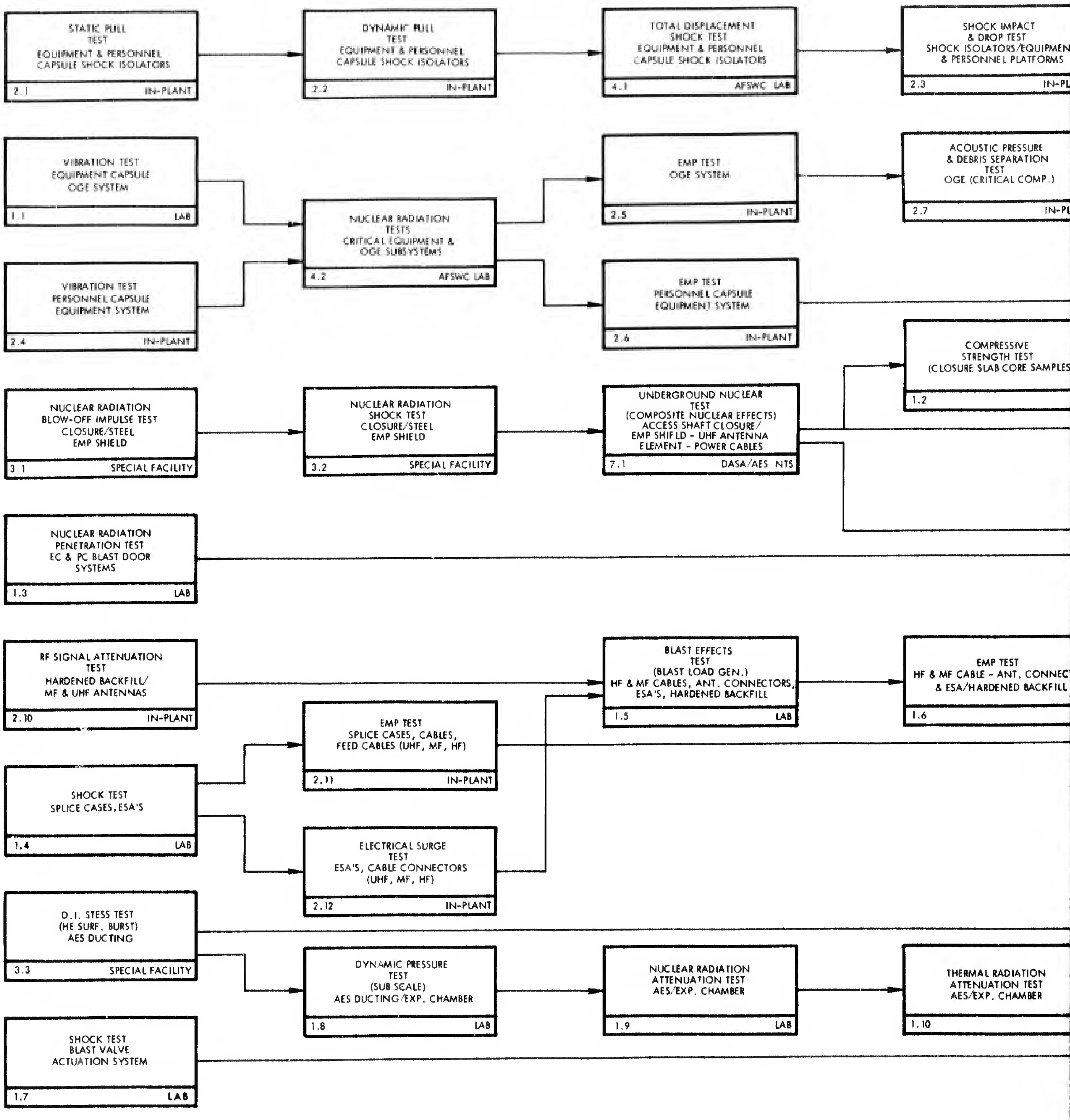
Figure 3-6.

F.

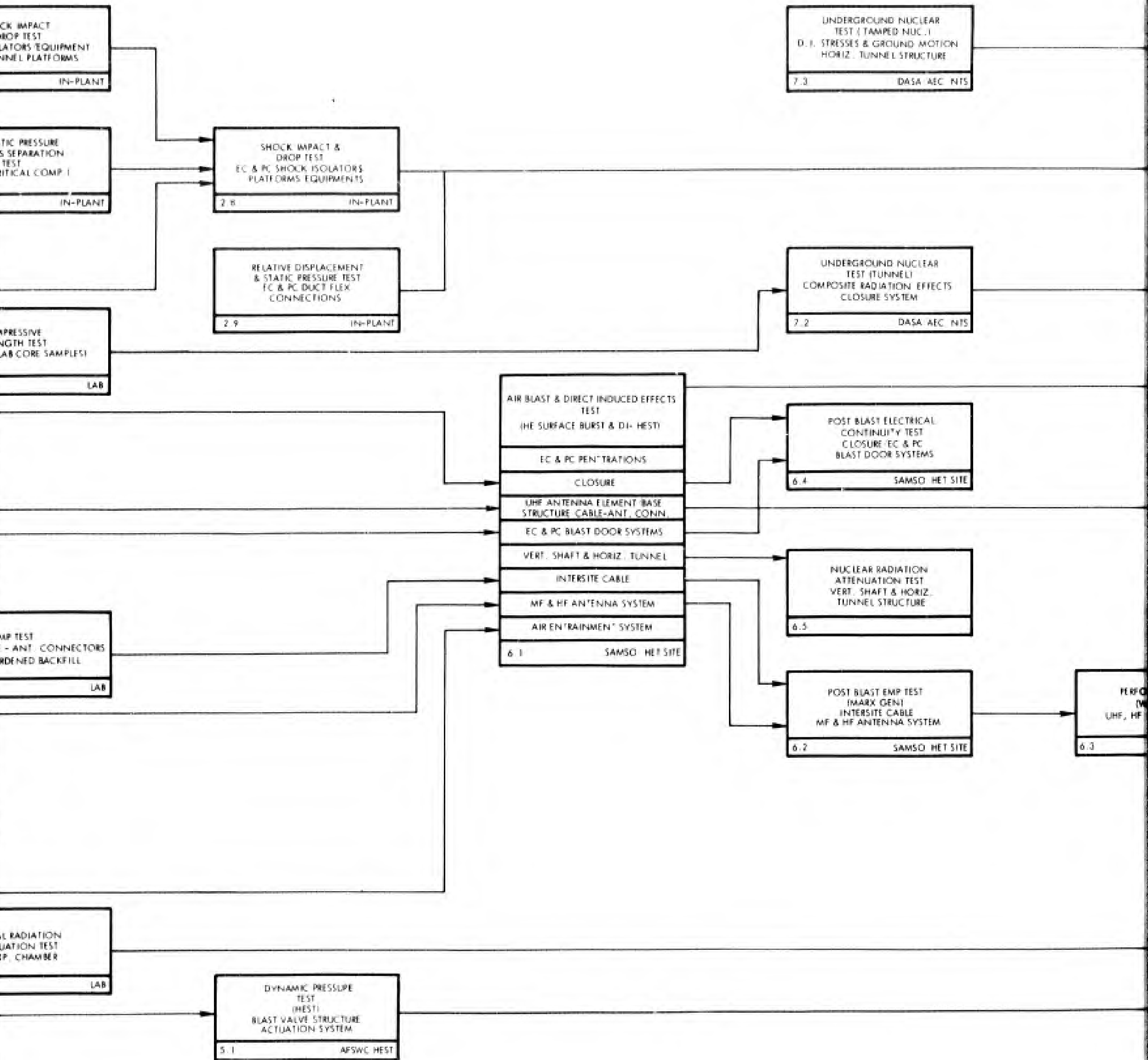
surface burst technique will produce an acceptable environment. As for EMP, the most meaningful tests are those that are conducted while the total system is functioning in a standard operating mode. The test program plan requires these EMP tests to be done with a large Marx generator before and after the system interaction ground motion tests.

The test concept flow and documentation tree for the LCF are presented in Figures 3-7 and 3-8, respectively. The testing and documentation philosophy reflected here is basically the same as that presented for the LF system.

The launch control facility test program phasing chart (Figure 3-9) presents a time phasing relationship between the test blocks shown on the Launch Control Facility Test Program Flow (Figure 3-7). The phasing chart also schedules each test block with respect to the weapon system development schedule. The test scheduling judgments shown on Figure 3-9 are based on normal conditions of funding and nominal planning and construction time.

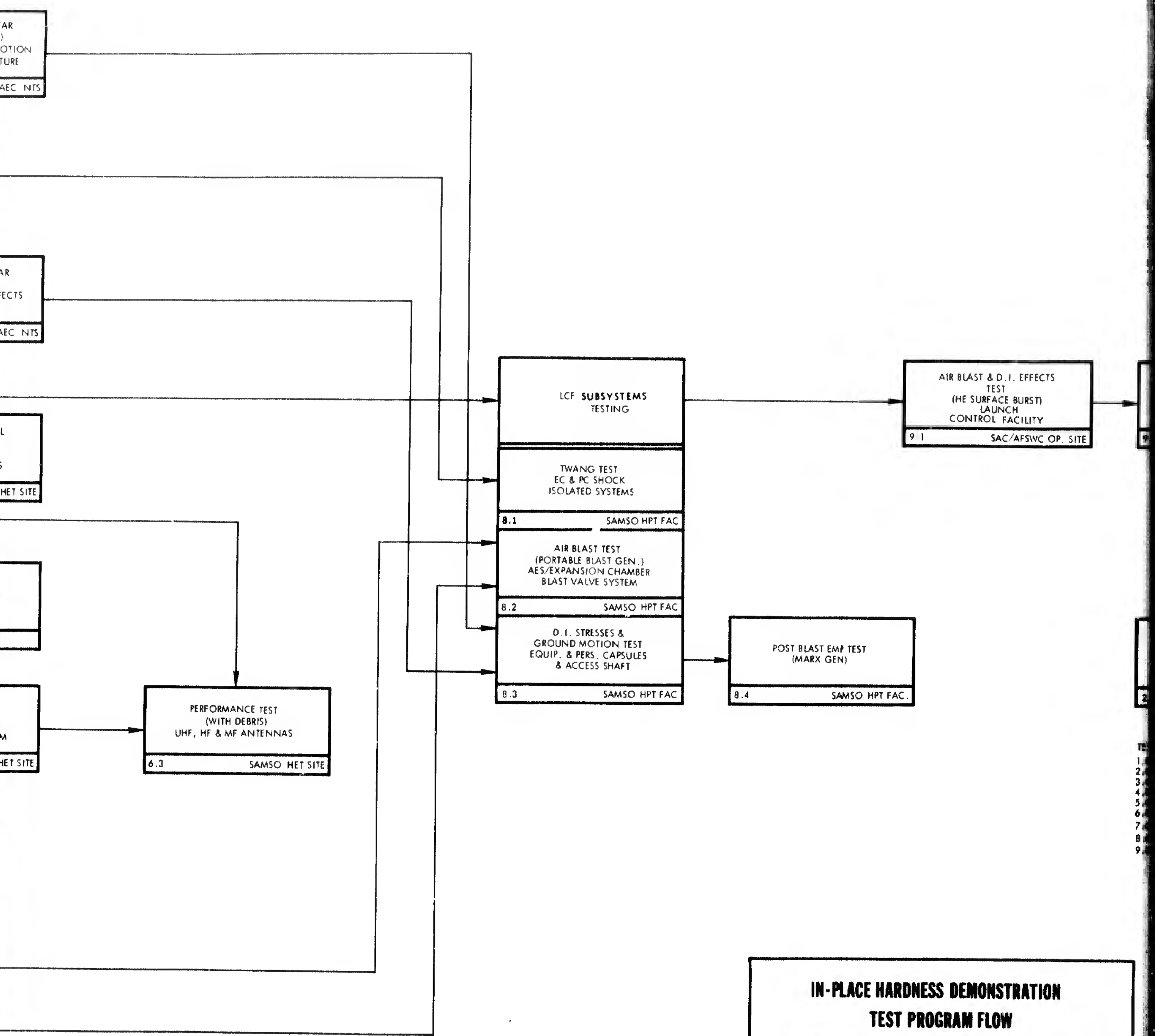

STATIC PULL TEST EQUIPMENT & PERSONNEL CAPSULE SHOCK ISOLATORS
2.1 IN-PLANT
DYNAMIC PULL TEST EQUIPMENT & PERSONNEL CAPSULE SHOCK ISOLATORS
2.2 IN-PLANT
TOTAL DISPLACEMENT SHOCK TEST EQUIPMENT & PERSONNEL CAPSULE SHOCK ISOLATORS
4.1 AFSWC LAB
SHOCK IMPACT & DROP TEST SHOCK ISOLATORS/EQUIPMEN & PERSONNEL PLATFORMS
2.3 IN-PL
VIBRATION TEST EQUIPMENT CAPSULE OGE SYSTEM
1.1 LAB
NUCLEAR RADIATION TESTS CRITICAL EQUIPMENT & OGE SUBSYSTEMS
4.2 AFSWC LAB
EMP TEST OGE SYSTEM
2.5 IN-PLANT
ACOUSTIC PRESSURE & DEBRIS SEPARATION TEST OGE (CRITICAL COMP.)
2.7 IN-PL
VIBRATION TEST PERSONNEL CAPSULE EQUIPMENT SYSTEM
2.4 IN-PLANT
EMP TEST PERSONNEL CAPSULE EQUIPMENT SYSTEM
2.6 IN-PLANT
COMPRESSIVE STRENGTH TEST (CLOSURE SLAB CORE SAMPLES
1.2
NUCLEAR RADIATION BLOW-OFF IMPULSE TEST CLOSURE/STEEL EMP SHIELD
3.1 SPECIAL FACILITY
NUCLEAR RADIATION SHOCK TEST CLOSURE/STEEL EMP SHIELD
3.2 SPECIAL FACILITY
UNDERGROUND NUCLEAR TEST (COMPOSITE NUCLEAR EFFECTS) ACCESS SHAFT CLOSURE/ EMP SHIELD - UHF ANTENNA ELEMENT - POWER CABLES
7.1 DASA/AES NTS
NUCLEAR RADIATION PENETRATION TEST EC & PC BLAST DOOR SYSTEMS
1.3 LAB
RF SIGNAL ATTENUATION TEST HARDENED BACKFILL/ MF & UHF ANTENNAS
2.10 IN-PLANT
BLAST EFFECTS TEST (BLAST LOAD GEN.) HF & MF CABLES, ANT. CONNECTORS, ESA'S, HARDENED BACKFILL
1.5 LAB
EMP TEST HF & MF CABLE - ANT. CONNEC & ESA/HARDENED BACKFILL
1.6
EMP TEST SPLICE CASES, CABLES, FEED CABLES (UHF, MF, HF)
2.11 IN-PLANT
SHOCK TEST SPLICE CASES, ESA'S
1.4 LAB
ELECTRICAL SURGE TEST ESA'S, CABLE CONNECTORS (UHF, MF, HF)
2.12 IN-PLANT
D.I. STESS TEST (HE SURF. BURST) AES DUCTING
3.3 SPECIAL FACILITY
DYNAMIC PRESSURE TEST (SUB SCALE) AES DUCTING/EXP. CHAMBER
1.8 LAB
NUCLEAR RADIATION ATTENUATION TEST AES/EXP. CHAMBER
1.9 LAB
THERMAL RADIATION ATTENUATION TEST AES/EXP. CHAMBER
1.10
SHOCK TEST BLAST VALVE ACTUATION SYSTEM
1.7 LAB

A,



CK IMPACT
ROP TEST
LATORS/EQUIPMENT
NNEL PLATFORMS
IN-PLANT
TIC PRESSURE
S SEPARATION
TEST
RITICAL COMP.)
IN-PLANT
SHOCK IMPACT &
DROP TEST
EC & PC SHOCK ISOLATORS
PLATFORMS EQUIPMENTS
2.8
IN-PLANT
RELATIVE DISPLACEMENT
& STATIC PRESSURE TEST
EC & PC DUCT FLEX
CONNECTIONS
2.9
IN-PLANT
UNDERGROUND NUCLEAR
TEST (TAMPED NUC.)
D.I. STRESSES & GROUND MOTION
HORIZ. TUNNEL STRUCTURE
7.3
DASA AEC NTS
UNDERGROUND NUCLEAR
TEST (TUNNEL)
COMPOSITE RADIATION EFFECTS
CLOSURE SYSTEM
7.2
DASA AEC NTS
MPRESSIVE
NGTH TEST
LAB CORE SAMPLES)
LAB
AIR BLAST & DIRECT INDUCED EFFECTS
TEST
(HE SURFACE BURST & DI- HEST)
EC & PC PENETRATIONS
CLOSURE
UHF ANTENNA ELEMENT BASE
STRUCTURE CABLE-ANT. CONN.
EC & PC BLAST DOOR SYSTEMS
VERT. SHAFT & HORIZ. TUNNEL
INTERSITE CABLE
MF & HF ANTENNA SYSTEM
AIR ENTRAINMENT SYSTEM
6.1
SAMSO HET SITE
POST BLAST ELECTRICAL
CONTINUITY TEST
CLOSURE EC & PC
BLAST DOOR SYSTEMS
6.4
SAMSO HET SITE
NUCLEAR RADIATION
ATTENUATION TEST
VERT. SHAFT & HORIZ.
TUNNEL STRUCTURE
6.5
MP TEST
- ANT. CONNECTORS
RDENED BACKFILL
LAB
POST BLAST EMP TEST
(MARX GEN)
INTERSITE CABLE
MF & HF ANTENNA SYSTEM
6.2
SAMSO HET SITE
PERFO
UHF, HF
6.3
L RADIATION
UATION TEST
P. CHAMBER
LAB
DYNAMIC PRESSURE
TEST
(HEST)
BLAST VALVE STRUCTURE
ACTUATION SYSTEM
5.1
AFSWC HEST

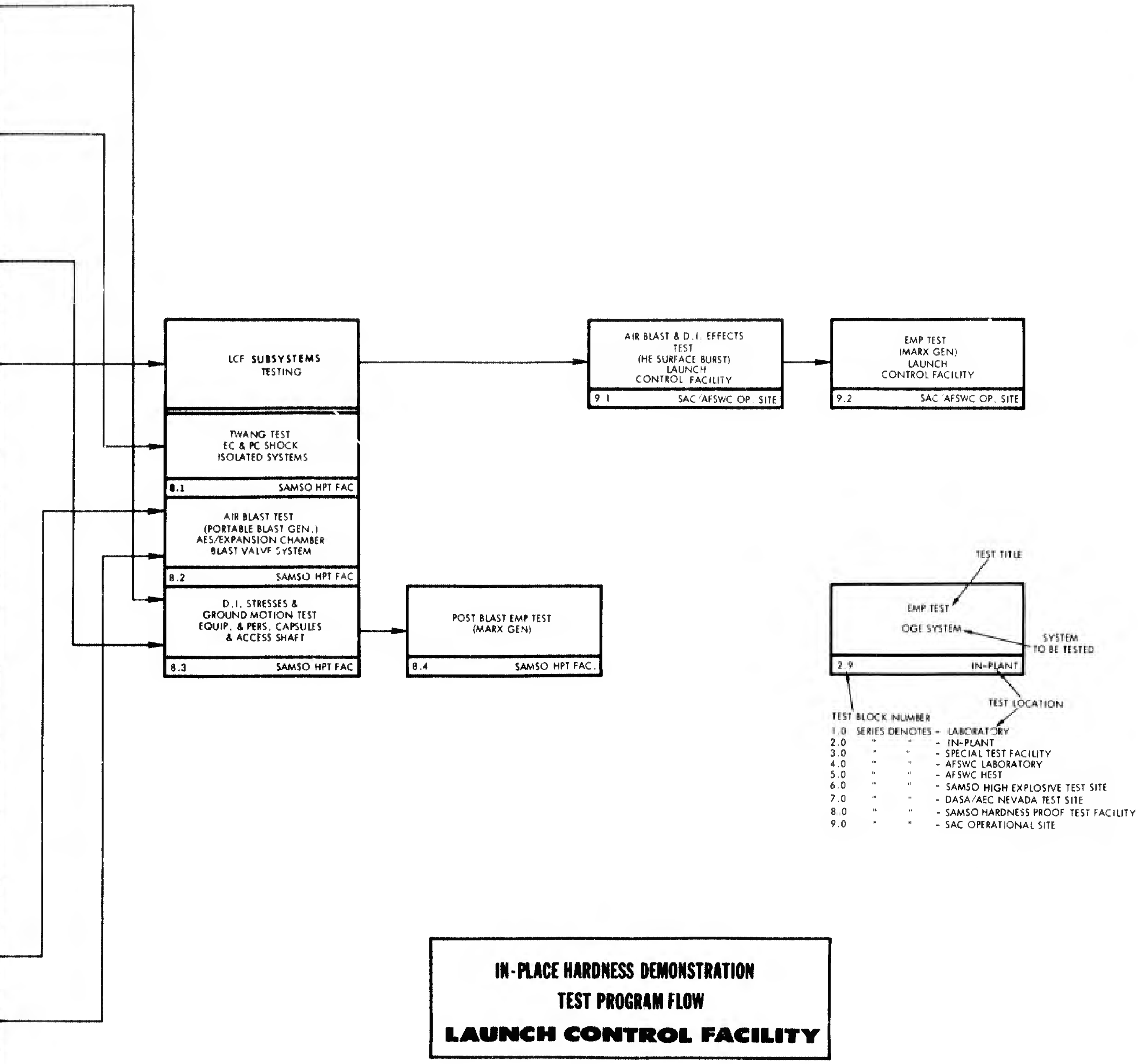
B.



IN-PLACE HARDNESS DEMONSTRATION
TEST PROGRAM FLOW
LAUNCH CONTROL FACILITY

Figure

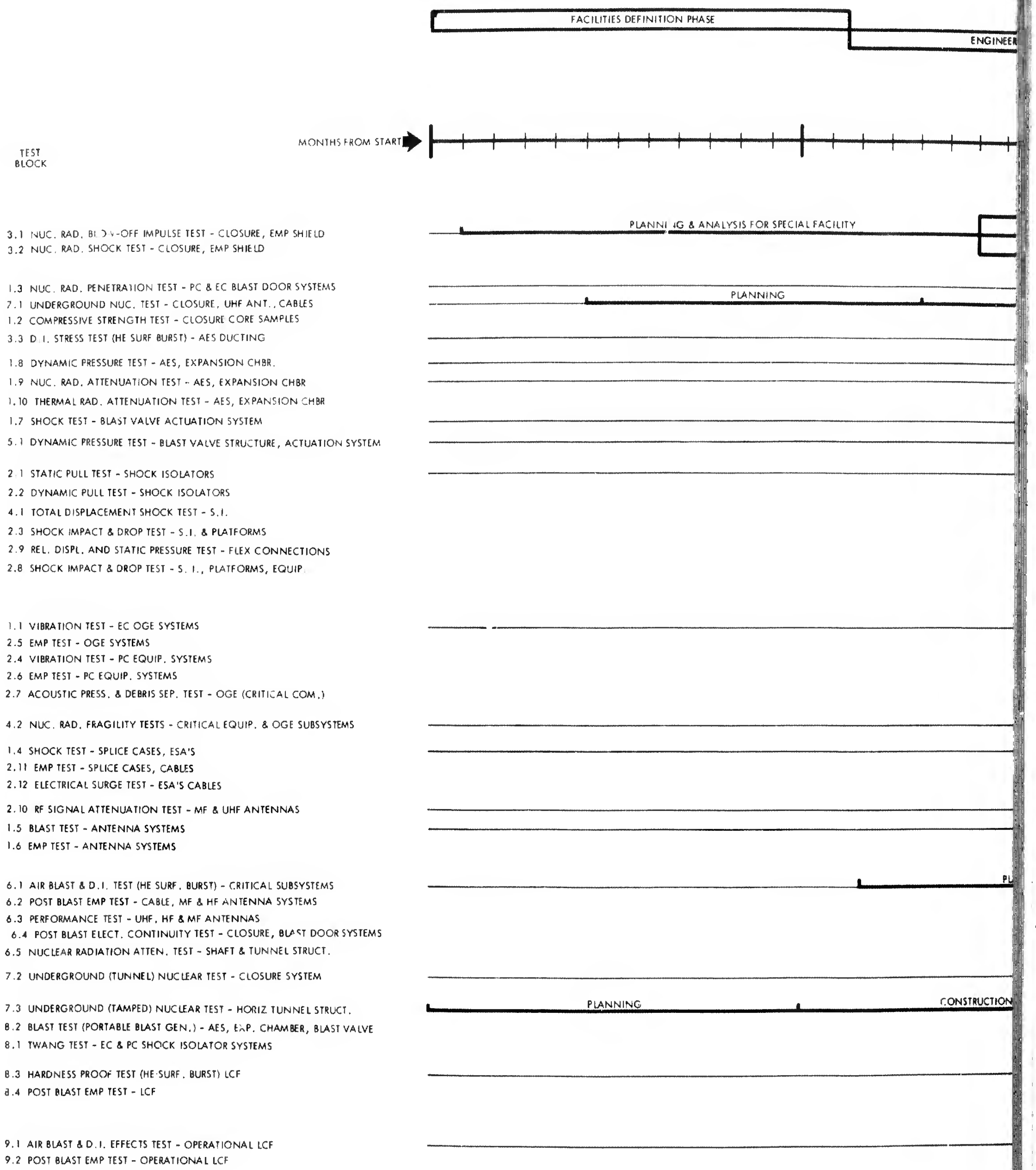
C.



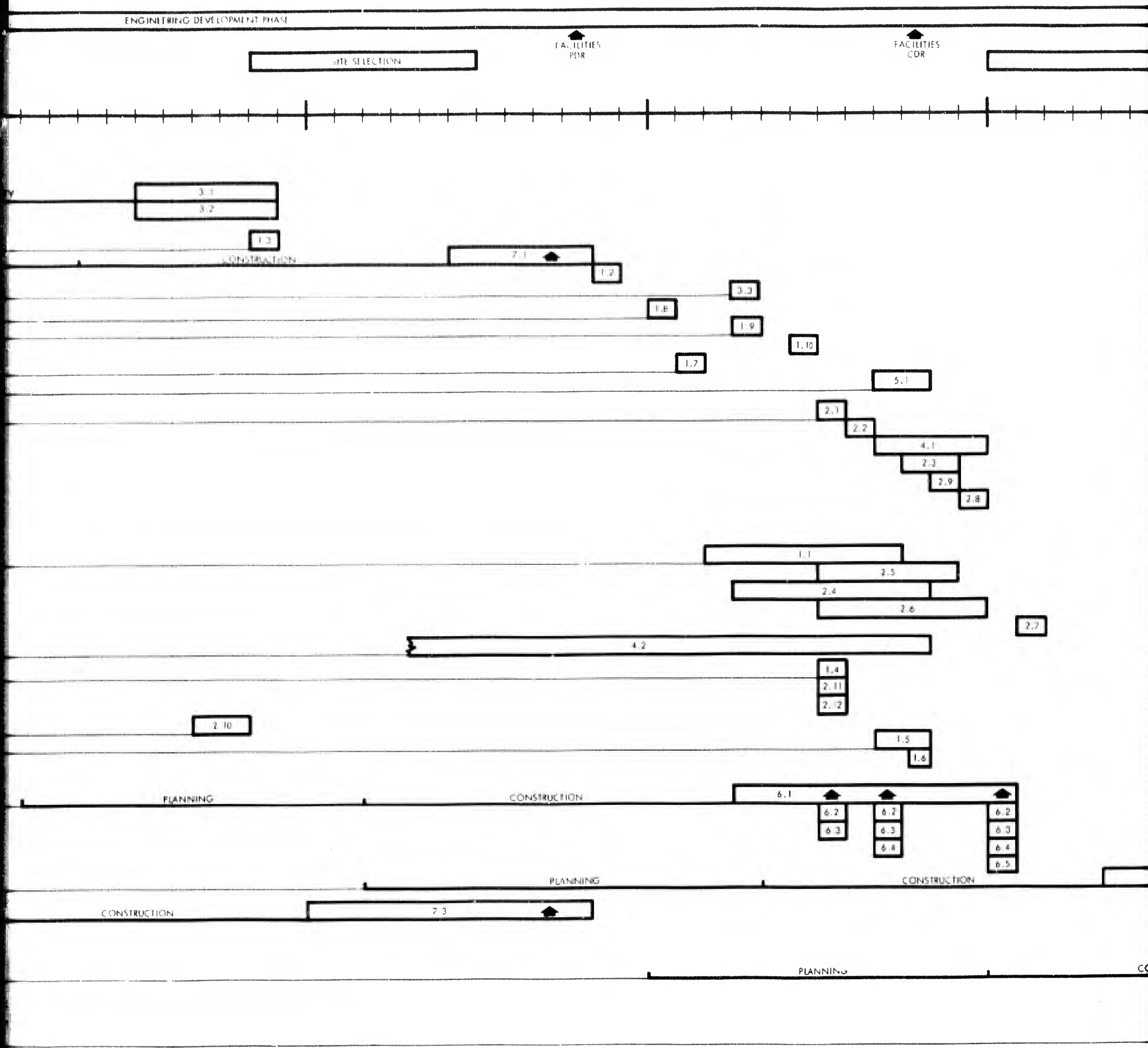
LCF SUBSYSTEMS TESTING
TWANG TEST EC & PC SHOCK ISOLATED SYSTEMS
8.1 SAMSO HPT FAC
AIR BLAST TEST (PORTABLE BLAST GEN.) AES/EXPANSION CHAMBER BLAST VALVE SYSTEM
8.2 SAMSO HPT FAC
D.I. STRESSES & GROUND MOTION TEST EQUIP. & PERS. CAPSULES & ACCESS SHAFT
8.3 SAMSO HPT FAC
POST BLAST EMP TEST (MARX GEN)
8.4 SAMSO HPT FAC.
AIR BLAST & D.I. EFFECTS TEST (HE SURFACE BURST) LAUNCH CONTROL FACILITY
9.1 SAC/AFSWC OP. SITE
EMP TEST (MARX GEN) LAUNCH CONTROL FACILITY
9.2 SAC/AFSWC OP. SITE
TEST TITLE
EMP TEST
OGE SYSTEM
SYSTEM TO BE TESTED
2.9 IN-PLANT
TEST LOCATION
TEST BLOCK NUMBER
1.0 SERIES DENOTES - LABORATORY
2.0 " " - IN-PLANT
3.0 " " - SPECIAL TEST FACILITY
4.0 " " - AFSWC LABORATORY
5.0 " " - AFSWC HEST
6.0 " " - SAMSO HIGH EXPLOSIVE TEST SITE
7.0 " " - DASA/AEC NEVADA TEST SITE
8.0 " " - SAMSO HARDNESS PROOF TEST FACILITY
9.0 " " - SAC OPERATIONAL SITE
IN-PLACE HARDNESS DEMONSTRATION
TEST PROGRAM FLOW
LAUNCH CONTROL FACILITY

Figure 3-7.

C. D.


FACILITIES DEFINITION PHASE
ENGINEER
MONTHS FROM START
TEST BLOCK
3.1 NUC. RAD. BL W-OFF IMPULSE TEST - CLOSURE, EMP SHIELD
3.2 NUC. RAD. SHOCK TEST - CLOSURE, EMP SHIELD
PLANNING & ANALYSIS FOR SPECIAL FACILITY
1.3 NUC. RAD. PENETRATION TEST - PC & EC BLAST DOOR SYSTEMS
7.1 UNDERGROUND NUC. TEST - CLOSURE, UHF ANT., CABLES
PLANNING
1.2 COMPRESSIVE STRENGTH TEST - CLOSURE CORE SAMPLES
3.3 D.I. STRESS TEST (HE SURF BURST) - AES DUCTING
1.8 DYNAMIC PRESSURE TEST - AES, EXPANSION CHBR.
1.9 NUC. RAD. ATTENUATION TEST - AES, EXPANSION CHBR
1.10 THERMAL RAD. ATTENUATION TEST - AES, EXPANSION CHBR
1.7 SHOCK TEST - BLAST VALVE ACTUATION SYSTEM
5.1 DYNAMIC PRESSURE TEST - BLAST VALVE STRUCTURE, ACTUATION SYSTEM
2.1 STATIC PULL TEST - SHOCK ISOLATORS
2.2 DYNAMIC PULL TEST - SHOCK ISOLATORS
4.1 TOTAL DISPLACEMENT SHOCK TEST - S.I.
2.3 SHOCK IMPACT & DROP TEST - S.I. & PLATFORMS
2.9 REL. DISPL. AND STATIC PRESSURE TEST - FLEX CONNECTIONS
2.8 SHOCK IMPACT & DROP TEST - S.I., PLATFORMS, EQUIP.
1.1 VIBRATION TEST - EC OGE SYSTEMS
2.5 EMP TEST - OGE SYSTEMS
2.4 VIBRATION TEST - PC EQUIP. SYSTEMS
2.6 EMP TEST - PC EQUIP. SYSTEMS
2.7 ACOUSTIC PRESS. & DEBRIS SEP. TEST - OGE (CRITICAL COM.)
4.2 NUC. RAD. FRAGILITY TESTS - CRITICAL EQUIP. & OGE SUBSYSTEMS
1.4 SHOCK TEST - SPLICE CASES, ESA'S
2.11 EMP TEST - SPLICE CASES, CABLES
2.12 ELECTRICAL SURGE TEST - ESA'S CABLES
2.10 RF SIGNAL ATTENUATION TEST - MF & UHF ANTENNAS
1.5 BLAST TEST - ANTENNA SYSTEMS
1.6 EMP TEST - ANTENNA SYSTEMS
6.1 AIR BLAST & D.I. TEST (HE SURF. BURST) - CRITICAL SUBSYSTEMS
6.2 POST BLAST EMP TEST - CABLE, MF & HF ANTENNA SYSTEMS
6.3 PERFORMANCE TEST - UHF, HF & MF ANTENNAS
6.4 POST BLAST ELECT. CONTINUITY TEST - CLOSURE, BLAST DOOR SYSTEMS
6.5 NUCLEAR RADIATION ATTEN. TEST - SHAFT & TUNNEL STRUCT.
7.2 UNDERGROUND (TUNNEL) NUCLEAR TEST - CLOSURE SYSTEM
7.3 UNDERGROUND (TAMPED) NUCLEAR TEST - HORIZ TUNNEL STRUCT.
PLANNING
CONSTRUCTION
8.2 BLAST TEST (PORTABLE BLAST GEN.) - AES, EXP. CHAMBER, BLAST VALVE
8.1 TWANG TEST - EC & PC SHOCK ISOLATOR SYSTEMS
8.3 HARDNESS PROOF TEST (HE SURF. BURST) LCF
8.4 POST BLAST EMP TEST - LCF
9.1 AIR BLAST & D.I. EFFECTS TEST - OPERATIONAL LCF
9.2 POST BLAST EMP TEST - OPERATIONAL LCF

A.


ENGINEERING DEVELOPMENT PHASE
SITE SELECTION
FACILITIES PDR
FACILITIES CDR
3.1
3.2
1.3
CONSTRUCTION
7.1
1.2
3.3
1.8
1.9
1.10
1.7
5.1
2.1
2.2
4.1
2.3
2.9
2.8
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2.4
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2.7
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1.4
2.11
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1.6
PLANNING
CONSTRUCTION
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6.2
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PLANNING
CONSTRUCTION
CONSTRUCTION
7.3
PLANNING

B.

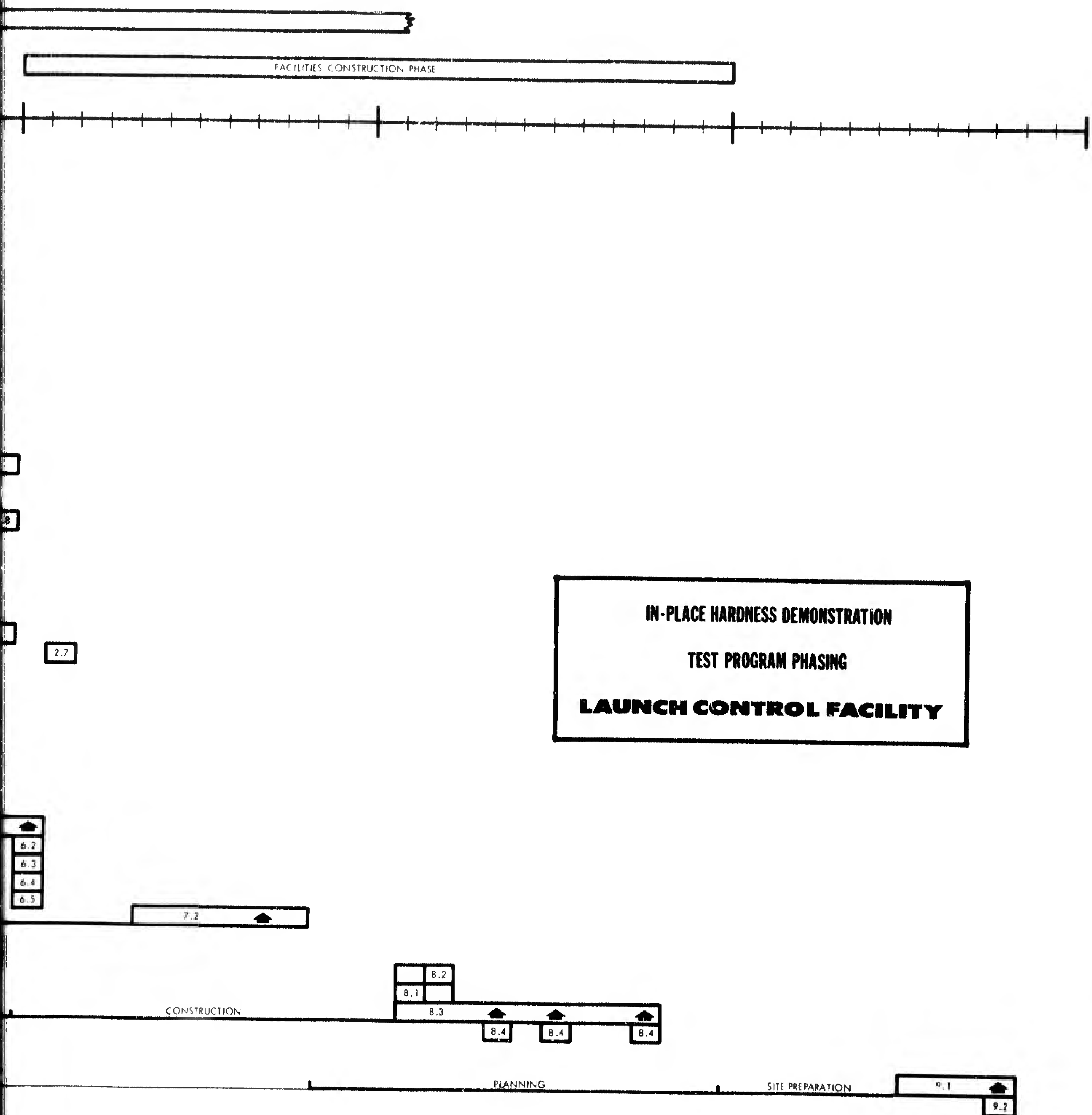
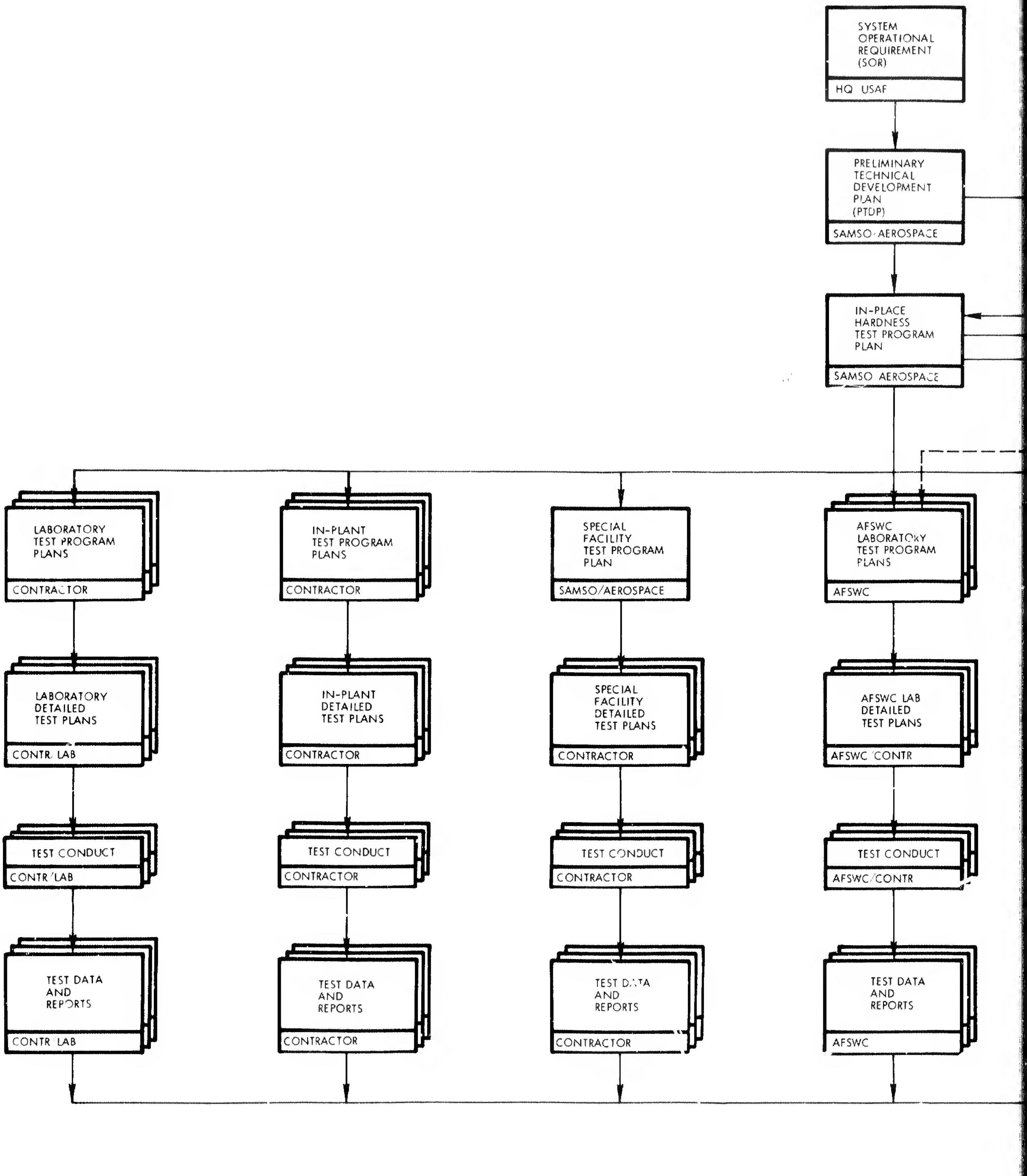

FACILITIES CONSTRUCTION PHASE
IN-PLACE HARDNESS DEMONSTRATION
TEST PROGRAM PHASING
LAUNCH CONTROL FACILITY
2.7
6.2
6.3
6.4
6.5
7.2
8.1
8.2
8.3
8.4
CONSTRUCTION
PLANNING
SITE PREPARATION
9.1
9.2

Figure 3-8.



SYSTEM OPERATIONAL REQUIREMENT (SOR)
HQ USAF
PRELIMINARY TECHNICAL DEVELOPMENT PLAN (PTDP)
SAMSO-AEROSPACE
IN-PLACE HARDNESS TEST PROGRAM PLAN
SAMSO AEROSPACE
LABORATORY TEST PROGRAM PLANS
CONTRACTOR
IN-PLANT TEST PROGRAM PLANS
CONTRACTOR
SPECIAL FACILITY TEST PROGRAM PLAN
SAMSO/AEROSPACE
AFSWC LABORATORY TEST PROGRAM PLANS
AFSWC
LABORATORY DETAILED TEST PLANS
CONTR/LAB
IN-PLANT DETAILED TEST PLANS
CONTRACTOR
SPECIAL FACILITY DETAILED TEST PLANS
CONTRACTOR
AFSWC LAB DETAILED TEST PLANS
AFSWC/CONTR
TEST CONDUCT
CONTR/LAB
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TEST CONDUCT
AFSWC/CONTR
TEST DATA AND REPORTS
CONTR/LAB
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CONTRACTOR
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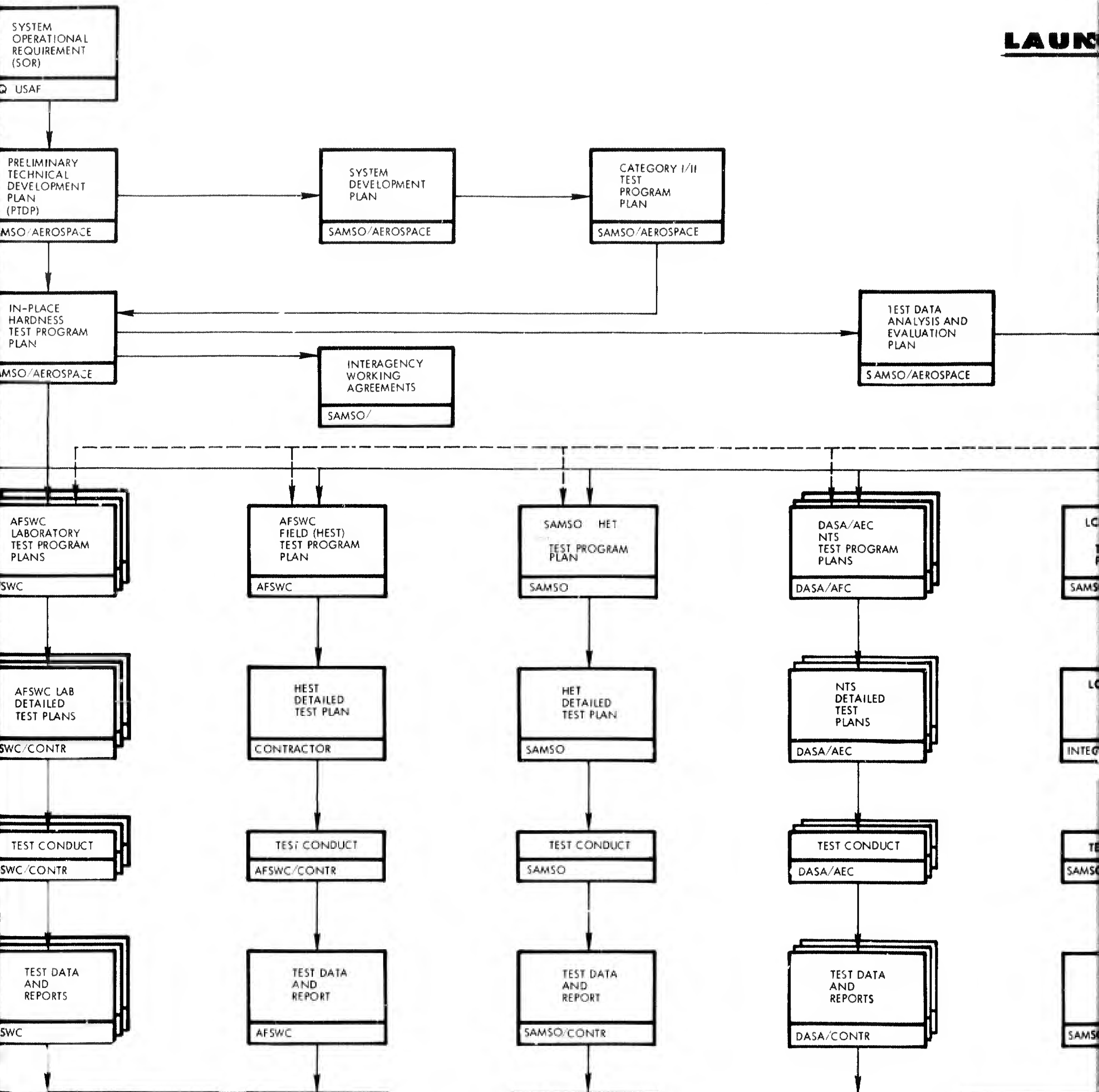
TEST DATA AND REPORTS
AFSWC

A.


LAUN
SYSTEM OPERATIONAL REQUIREMENT (SOR)
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IN-PLACE HARDNESS TEST PROGRAM PLAN
MSO/AEROSPACE
INTERAGENCY WORKING AGREEMENTS
SAMSO/
TEST DATA ANALYSIS AND EVALUATION PLAN
SAMSO/AEROSPACE
AFSWC LABORATORY TEST PROGRAM PLANS
SWC
AFSWC FIELD (HEST) TEST PROGRAM PLAN
AFSWC
SAMSO HET TEST PROGRAM PLAN
SAMSO
DASA/AEC NTS TEST PROGRAM PLANS
DASA/AEC
AFSWC LAB DETAILED TEST PLANS
SWC/CONTR
HEST DETAILED TEST PLAN
CONTRACTOR
HET DETAILED TEST PLAN
SAMSO
NTS DETAILED TEST PLANS
DASA/AEC
TEST CONDUCT
SWC/CONTR
TEST CONDUCT
AFSWC/CONTR
TEST CONDUCT
SAMSO
TEST CONDUCT
DASA/AEC
TEST DATA AND REPORTS
SWC
TEST DATA AND REPORT
AFSWC
TEST DATA AND REPORT
SAMSO/CONTR
TEST DATA AND REPORTS
DASA/CONTR

B.

LAUNCH CONTROL FACILITY TEST PROGRAM

DOCUMENTATION

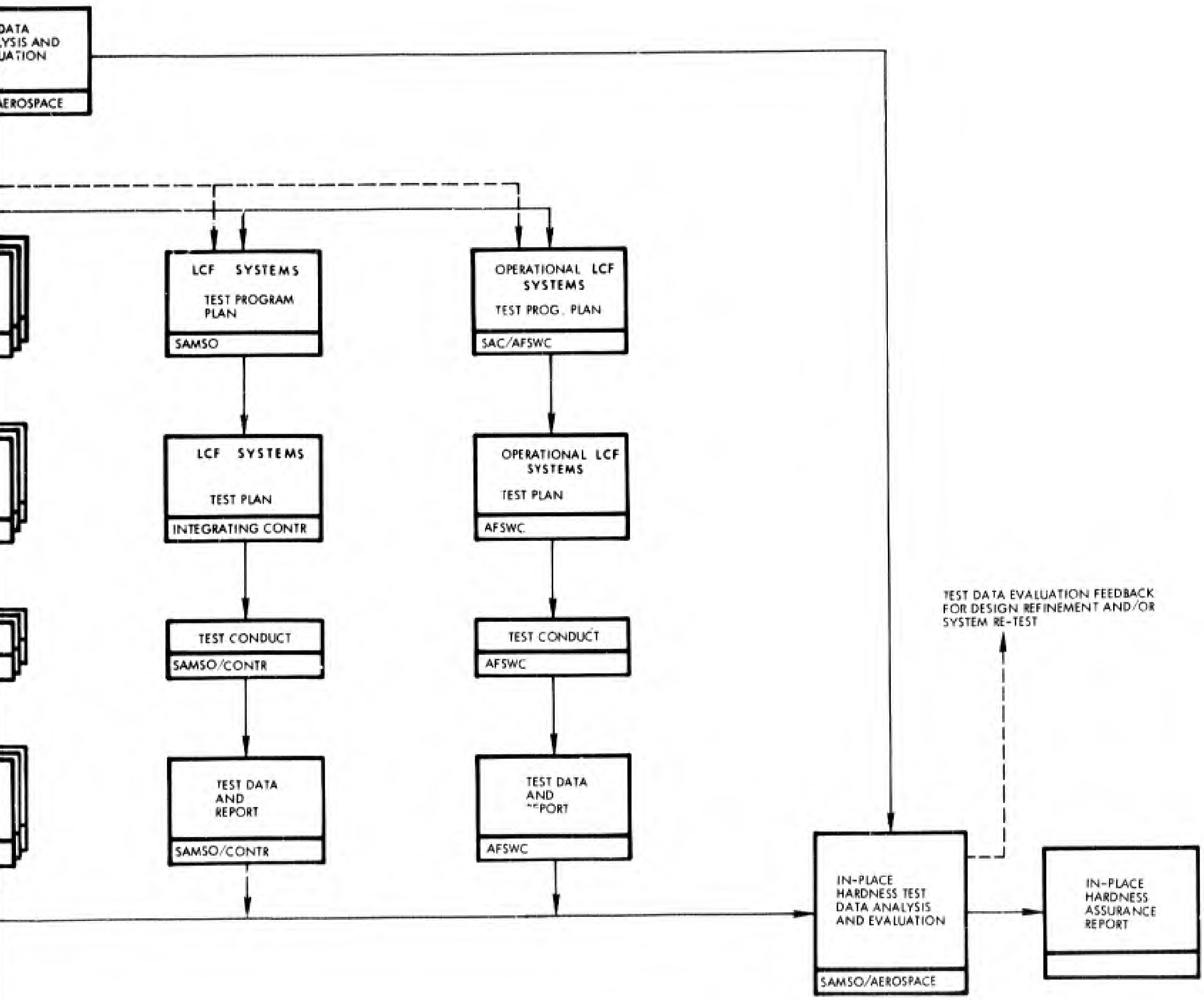

Figure 3-9.

4. SELECTED LAUNCH FACILITY SUBSYSTEMS TEST PLAN

The test plan developed for the selected test is presented as Volume V of this report. The test selected by SAMSO/Aerospace was not one of the test concepts recommended as a result of the test requirements analysis (TRA). It is, however, a test that will fulfill in a timely manner a number of test requirements identified by the TRA.

4.1 BACKGROUND

To ensure high confidence in the hardness of the dual capability facility (DCF), a series of hardness demonstration tests have been prescribed by the in-place hardness demonstration test program plan. DCF system elements basic to the hardness of the system are those that have been identified as critical subsystems. These include the silo structural shell, the main closure, MF antenna, antenna feed cable, and silo penetrations. These subsystems must withstand the air blast and ground motion effects associated with a high overpressure environment.

Because the desired environment may not be produced with nuclear devices in the atmosphere, the effects must be simulated.

The overpressure environment can be adequately simulated with a high explosive simulation technique (HEST). Coupled with the overpressure pulse, direct induced ground motion effects can be simulated to some degree with the direct induced high explosive simulation technique (DI-HEST). The technique of coincidentally simulating the overpressure and the direct induced effects (HEST/DI-HEST) will be used for the LF subsystems test.

4.2 TEST PLAN SUMMARY

The purpose of this LF subsystem test plan is to prescribe a test program that will provide high confidence in the capability of critical launch facility subsystems to withstand the simulated air-blast and direct-induced effects of a high overpressure environment.

The plan outlines the requirement for the test program, describes the LF system elements to be tested, and prescribes test objectives and success criteria. It also identifies the controlling test documentation, specifies test program tasks and designates how and when they will be accomplished.

5. RECOMMENDATIONS

During the course of the study it became evident that a number of things could be done to alleviate some of the problems associated with demonstrating in-place hardness with a high degree of confidence. A basic factor in the solution of the problem, the test program plan, is presented as a result of this study. Three future activities are recommended in the following subsections as logical supplements to this initial step in the development of a sound in-place hardness demonstration program. These include development of test techniques, test program plan updating, and publication of test management and data evaluation plans.

5.1 TEST TECHNIQUE DEVELOPMENT

The most critical factor affecting confidence in system hardness demonstrations, is the validity of the simulation techniques available to do the required testing. For purposes of this study, test validity was defined in terms of:

a) The degree to which the simulation technique reproduces the desired nuclear weapons effect

b) The degree to which the test article simulates the operational configuration

c) Past performance record of the test technique.

In the evaluation of the validity of currently available simulation techniques, it was found that the magnitude and characteristics of some weapons effects environment inputs to the system elements could not be adequately simulated.

The test concepts recommended in the test requirements analysis range from laboratory and in-plant tests that simulate a weapons effects environment input to a component or subsystem, to a number of field test concepts that simulate an effects environment input to a major system or a total facility. Laboratory and in-plant test concepts are state of the art, and a good experience record exists for the recommended concepts.

However, our experience with field tests is limited, the cost of field tests will be high, and the validity of field tests for increasing confidence in hardness may be very low.

The important test techniques considered in the test requirements analysis are as follows:

a) Nuclear underground cavity test (NEST)

b) High explosive simulation technique (HEST)

c) Direct induced high explosive simulation technique (DI-HEST)

d) High explosive contact surface burst

e) Underground nuclear burst (tamped nuclear)

f) Underground nuclear tunnel test

g) EMP by synthetic pulse diagnosis (SPUD)

h) Blast simulation technique for testing air entrainment systems and blast valves.

These critical test techniques are discussed in Section 4 of Volume III, Test Requirements Analysis. More detailed evaluation and development of each of these test techniques is required to increase the validity of this study to demonstrate hardness for the postulated nuclear burst.

Further development of the current simulation techniques and the investigation of new simulation concepts is therefore recommended.

5.2 TEST PROGRAM PLAN UPDATE

The in-place hardness demonstration test program plan submitted as Volume IV of this report is completely valid only for the weapon system configuration and weapons effects environment described in the test requirements analysis (Volume III). It is recommended, therefore, that a test program plan update and improvement task be initiated to introduce more detailed and up-to-date configuration and weapons effects environment data into the test requirements analysis. In addition, critical simulation techniques should be studied carefully and experiment design analysis be performed where possible to determine the optimum use of simulation techniques in the test program.

As the configuration of the system evolves and the physical and function characteristics of system elements become more definite, the test program plan should be re-evaluated, through the mechanism of the test requirements analysis, and updated as necessary to reflect the design changes as well as further knowledge about simulation techniques. Likewise, should the weapons effects environment criteria change to reflect, perhaps, free field environment magnitudes in which there is greater confidence, the test program plan will require re-examination.

5.3 TEST PROGRAM MANAGEMENT AND DATA EVALUATION PLANS

The test program plan presented as Volume IV of this report represents a system approach to test planning. It is recommended that the implementation of that test program plan and the evaluation of the resulting test data follow the same basic philosphy.

A common failure of test programs is that, even though the planning may have been diligent and the test documentation complete, management of the test program implementation (e.g., the pretest engineering and analysis, test conduct) has failed to maintain and support the originally planned test concepts. Planned test objectives, success criteria, test configurations, and data measurement requirements are misinterpreted or misplaced so that the once carefully planned sequence of tests that were meant to cover a particular spectrum of requirements becomes distorted to the point where the validity of the total test program may become questionable.

Another area in which test programs are commonly deficient is in the use of the test data. Results of test programs are, more often than not, written into reports and promptly forgotten. Too often individual tests become ends in themselves. It is desirable in all test programs that test data be quickly evaluated and the proper feedback be generated to dictate system design refinements and/or retesting where required. Though desirable on all test programs, a proper data evaluation and feedback loop is mandatory for a test program that has been developed with the systems approach. A test program based on the "systems" philosophy will inherently include a series or progression of tests that are interdependent. That is, certain tests would not be profitable to conduct without first having the benefit of the resulting data from prior tests.

The two problem outlined above can be effectively eliminated if they are first recognized as significant problems, and then the proper planning is initiated to avoid the specific pitfalls experienced in past programs. This can be done by the preparation, publication, and implementation of test program management plan and a test data evaluation plan.

The test program management plan would describe the hardness demonstration test program lines of authority and responsibility within the system development team. It would also include interagency agreements and prescribe modes of operation.

The test data evaluation plan would provide a charter for the hardness test data evaluation group and prescribe the manner in which test data will be handled and evaluated. Feedback loops to design and test functions will also be specified.

ABBREVIATIONS

AEC	Atomic Energy Commission
AES	Air Entrainment System
AFSWC	Air Force Special Weapons Center
AFWL	Air Force Weapons Laboratory
AGE	Aerospace Ground Equipment
AVE	Aerospace Vehicle Equipment
BV	Blast Valve
CBR	Chemical, Biological, and Radiological
CDR	Critical Design Review
CG	Center of Gravity
DASA	Defense Atomic Support Agency
DI	Direct Induced
DIHEST	Direct Induced High Explosive Simulation Technique
DOD	Department of Defense
EC	Equipment Capsule
ECU	Environmental Control Unit
E-M	Electric and Magnetic
EMP	Electromagnetic Pulse
ERDL	Engineering Research and Development Laboratories
ESA	Electrical Surge Arrestor
FAC	Facility
GTM	Ground Test Missile
HE	High Explosive
HEST	High Explosive Simulation Technique
HET	High Explosive Test
HF	High Frequency
HPT	Hardness Proof Test
IITRI	IIT Research Institute
LASL	Los Alamos Scientific Laboratory
LCF	Launch Control Facility
LF	Launch Facility
MC	Main Closure
MF	Medium Frequency

ABBREVIATIONS (Continued)

NEST	Nuclear Explosive Shock Tube
NTS	Nevada Test Site
NWSSG	Nuclear Weapon System Safety Group
OGE	Operating Ground Equipment
OP	Operational
PC	Personnel Capsule
PDR	Preliminary Design Review
PSI	Pounds per Square Inch
PTPD	Preliminary Test Development Plan
RF	Radio Frequency
SAC	Strategic Air Command
SAMSO	Space and Missile Systems Operation
SI	Shock Isolator
SOR	System Operational Requirement
SOW	Statement of Work
SPUD	Synthetic Pulse Diagnosis
TRA	Test Requirements Analysis
TREES	Transient Radiation Effects, Electronics System
TSE	Test Support Equipment
UHF	Ultra High Frequency
WES	Waterways Experiment Station

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13. ABSTRACT

This study has developed a test program plan for demonstrating the in-place hardness of an advanced ballistic missile weapon system. A test requirements analysis methodology was devised, utilizing a systems approach, to examine a WS-120A system baseline design with respect to a given weapons effect environment criteria, define the testing required to assure hardness of each system element, trade off applicable simulation techniques, and recommend a series of test concepts. These concepts were then logically combined into efficient and cost-effective in-place hardness demonstration test programs for the launch facility and launch control facility.

This report has been divided into five volumes and classified as follows:

Volume I	Study Report Summary (Unclassified)
Volume II	Methodology (Unclassified)
Volume III	Test Requirements Analysis (Secret, RD)
Volume IV	Test Program Plan (Unclassified)
Volume V	Selected LF Subsystems Test Plan (Unclassified)

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Unclassified
Security Classification

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
In-Place Hardness Demonstration Test Requirements Analysis LF and LCF Hardness Test Plan Test Concept						

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