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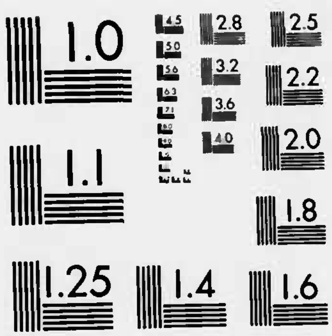

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Department of the Army
Assistant Secretary of the Army
Research, Development, & Acquisition
Washington, D.C. 20310

ARMY SCIENCE BOARD

REPORT OF

ARMY SCIENCE BOARD AD HOC SUBGROUP ON TESTING OF ELECTRONIC SYSTEMS

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REPORT OF

ARMY SCIENCE BOARD AD HOC SUBGROUP ON TESTING OF ELECTRONIC SYSTEMS

September 7, 1981

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I. INTRODUCTION

The Army Science Board (ASB) Ad Hoc Subgroup on Testing of Electronic Systems was established at the request of the Assistant Secretary of The Army (Research, Development and Acquisition), whose letter to the ASB Chairman included these statements (cf. Appendix A):

> "As increasingly sophisticated Army systems are developed, the testing and evaluation of these systems during the acquisition cycle become more challenging. Particularly difficult is the testing of the C^3I and computer-based portions of these systems in realistic battlefield environments that include anticipated levels of input-output, system software loading, electronic threats, and maintenance. Present approaches include simulation and field exercise. The expense of elaborate testing must be weighed against the risk of detecting potential system failure mechanisms and operational difficulties only after development and fielding.
>
> The ASB Panel should examine the overall facets of this subject, specifically addressing the following:
>
> 1. Are Army concepts, plans and equipments adequate for the testing of modern C^3I and computer based systems?
>
> 2. What changes should be made, if any?
>
> This investigation should include an assessment of relevant testing facilities, including TRI-TAC's Joint Test Facility at Fort Huachuca, the Automated Systems Test Bed at Fort Hood, and plans for the Modular Automated Integrated Systems Interoperability Test and Evaluation (MAINSITE) System. The adequacy of facilities, test equipment, procedures and plans to support testing of ASAS, PLRS, and TACFIRE should be addressed. In addition, suggestions for satisfactorily operationally testing future software systems would be appreciated."

The initial meetings of the Subgroup, devoted primarily to overviews of test organizations, facilities and approaches, were held in the Washington area. Subsequently, to engage in discussions with personnel directly involved in Army testing, visits were made to the Combined Arms Test Facility, Fort Hood; The Missile Command, Redstone Arsenal; the White Sands Missile Range; and the Electronic Proving Ground, Fort Huachuca.

Appendix B contains brief summaries of the several Subgroup meetings, along with a listing of all presentations given at the meetings. As noted, in addition to presentations by various Army testing agencies/activities, OSD/OUSDR&E perspective relative to testing was furnished by the Deputy Director for Tactical Air and Land Warfare Systems; and a series of presentations was requested from organizations involved in U.S. Navy testing to provide information that could be used to make a limited comparison of the testing approaches of the two Services.

For reference in this report, Appendix C contains viewgraph prints from a presentation made by Mr. J. P. Tyler (DAMA -- Policy, Plans, Management Division), entitled "An Overview of Army Materiel Testing"; it provides definitions of types of tests and related documentation, along with outlines of organizational relationships. Appendix D, prepared by LTC Dennis O'Connor, includes more detailed information relative to the missions of all major Army test facilities; a glossary of testing terms; and a series of outlines showing the progression of types of tests through the various facilities.

Also for reference in this report, Appendix E contains viewgraph prints from a presentation by BG Jerry Max Bunyard, PATRIOT Project Manager, entitled "PATRIOT Project -- Lessons Learned". Appendix F includes memoranda prepared by members of a PATRIOT Program Review Panel established by the Assistant Secretary of the Army (RD&A), incorporating suggestions relating to future Army development and testing.

Appendix G includes the Interim Report of the Subgroup, as presented to the Army Science Board meeting on March 16.

The members of the Subgroup would like to express their thanks to the Commanding Generals of the various installations visited, and to the presenters identified in Appendix B. The cooperation and interest of all participants made the investigation a rewarding experience for the Subgroup.

II. SUMMARY OF FINDINGS AND RECOMMENDATIONS

The primary questions for consideration by the Ad Hoc Subgroup on Testing of Electronic Systems were stated as follows:

1. Are Army concepts, plans and equipment adequate for the testing of modern C^3I and computer-based systems?

2. What changes should be made, if any?

To the extent of the findings of this report, it is the opinion of the Subgroup that the response to the first question must be in the negative. Additionally it is felt that the shortcomings currently associated with "testing" cannot be considered in isolation from more general problems of the system acquisition process. As a consequence, many of the recommendations developed in response to the second question are far-reaching and will be difficult to implement. The problems outlined in the findings are fundamental, however, and will not be solved without substantive action.

The primary findings and recommendations focus on the following:

1. The need for much stronger concept definition and more orderly design/testing in the early developmental phases of Army system acquisition;

2. The need to include software testing as an integral part of total system test plans using state-of-the-art software verification and validation tools;

3. The need to introduce parallelism in the Army's currently serial development/testing process, with special reference to parallel development of the computer-based test tools required for evaluation of software-intensive systems;

4. The need to strengthen the post-DSARC III testing and follow-on evaluation (FOE) of systems as they move from DT-II/OT-II to full production in order to combat the effects of employing prototype hardware and immature software for DT-II/OT-II tests;

5. The need for much more coordination of planning for electronic-system test facilities within the Army with regard to both development and usage;

6. The need to strengthen the extent and fidelity of interoperability testing.

7. The need to improve the Army's ability to provide technical continuity and corporate memory within programs and from program-to-program to combat the effects of long program lifetimes and organizational boundaries.

The findings and recommendations of these seven areas are summarized on pp. 5-11 and discussed in more detail in Sections III-VII.

It is recognized that considerations of over-all Army organization for testing are beyond the scope of this Subgroup; however, a few comments would appear to be in order. The relevant aspects of Army organization/facilities are outlined in Appendices C and D; as noted in Section VII of this report, the indicated organizational structure seems complicated and cumbersome. The assignments of responsibility for the various facets of test policy, test management, test implementation, and test evaluation appear in some cases to be fragmented and inefficient, and tend to amplify technical-continuity difficulties outlined in the findings and recommendations and discussed in Sections III, VI and VII. It is suggested that a reassessment of the Army's organization for testing may be in order, with a view toward increasing efficiency through centralization of responsibility.

FINDINGS

With the present approach to development, some systems have entered advanced phases of operational testing prior to the identification of major design faults; in some cases, problems that have occurred in operational tests are directly traceable to shortcomings in basic system concepts. Primary emphasis has been given to the meeting of established operational test (and ASARC/DSARC) schedules, with inadequate attention to actual design status and readiness for testing; in point of fact, adequate "visibility" relative to design status has in many instances been unavailable prior to the initiation of operational testing. The inflexibility of operational test schedules has been counterproductive, leading to subsequent prolonged program delays and increased program costs.

RECOMMENDATIONS

1. Additional effort should be devoted to the concept definition/concept evaluation/advanced development phases of system development; additional consideration should be given to early system simulation and to tradeoffs among performance and reliability/availability/maintainability; in this connection, Army in-house capability as "wise buyers" should be improved.

2. During engineering development. a philosophy of incremental step-by-step design/testing should be employed; additional emphasis should be placed on hardware and software subsystem testing and on hardware/software integration.

3. Additional attention should be given to the explicit understanding of design status at all times, with formal reviews (for both hardware and software) throughout engineering development; although planning/requirements for operational tests (OT) should be established early in the development process, development tests (DT) should in all cases be completed and evaluated prior to the related phase of OT; discovery of major design faults during DT should result in redesign/retest prior to OT.

4. It should be recognized that additional (higher-than-normal) funding in early program stages -- with effective program management -- can be expected to lead to reduced life-cycle costs and shortened time scales.

FINDINGS

Relative to software design and testing, it has not been understood that effective software design -- to an even greater extent than effective hardware design -- is dependent upon the existence of agreed, specific, properly-documented system requirements. It has not been generally recognized that techniques for reliable and comprehensive software testing are entirely different from comparable hardware testing techniques. Furthermore, advantage has not been taken of the fact that early software testing allows correction of design flaws at much less expense than correction later, and often permits a technically superior solution involving architectural and/or hardware changes which may become impractical later in the development cycle.

RECOMMENDATIONS

1. For all programs, additional emphasis should be given to early establishment and documentation of quantitative, "testable" system requirements, including environmental and operational factors; requirements/criteria "audit trails" should be provided throughout the testing process.[1]

2. Software designs should be required to be testable at module and subsystem levels (as well as on an over-all system basis); software designs should be directly relatable to system requirements. Program plans should include module, subsystem and system-level software tests in all phases of system design (with adequate funding provided); software testing should be a recognized, required aspect of formal development (DT) and operational testing (OT).

3. Based on the system specifications, and with flexibility in agreed areas, automated, computer-based test tools should be developed to drive (via simulation and stimulation) the engineering and initial production models of software-intensive systems; only in this way can operational environments be suitably represented in a reproducible fashion.

4. Facilities such as MAINSITE[2], to be an effective DT asset, should be designed and equipped for the special requirements of software testing, as well as for hardware testing; lessons learned by other Army testing agencies, and other Services, should be studied to assist in determining MAINSITE testing requirements.

5. To facilitate cost effective software testing with results that can be uniformly interpreted and "graded", a common library of software verification and validation tools should be developed and used on an Army-wide basis; the Army should recognize an opportunity to provide (DoD) leadership in this regard.

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1. Also discussed in report of the 1980 Summer Study on Statistical Techniques in Testing, 7-11 July 1980, pp. 6-7; and in report of the Panel on Design of Army Tests, 1 May 1981, pp. 2-3.

2. Modular Automated Integrated Systems Interoperability Test and Evaluation Systems located at the Electronic Proving Ground, Fort Huachuca.

FINDINGS

The extensive time required to develop and deploy systems is in part the result of the Army's serial development/testing process. Representatives of the users participate in the initial definition of system requirements, and are responsible for conducting operational tests; during system development, they are involved primarily as spectators. As a result -- and especially in view of turnover in personnel -- there are discontinuities/uncertainties in performance and testing requirements, especially in respect to test environments. Furthermore, for electronics/ software-intensive systems, the development of requisite computer-based test tools is a difficult, long-term task.

RECOMMENDATIONS

1. It is suggested that consideration be given to a radical change in the development/testing process, in recognition of the special characteristics of software-intensive systems; that the computer-based test tools required to represent the test (tactical) environment be provided by a contractor other than the system development contractor, in parallel with system development. In this approach, the testing/user activities should participate in the test contractor design reviews -- and should be required to quantify and document test requirements.

2. The indicated test drivers (environment simulators) should be developed for particular programs; however, they can be appropriately integrated into the plans for testing at various facilities.

3. The development of the test drivers should be in accordance with the disciplines previously outlined for software development and testing (cf. p. 6).

FINDINGS

For electronics/software-intensive systems, major difficulties in the system acquisition/testing process have occurred because the testing associated with initial production decisions (DT-II/OT-II) is not in general conducted on true production prototypes; key system elements are typically manufactured under "laboratory" conditions at that stage of development; the software is usually incomplete and immature. Thus DT-II/OT-II data are often unrepresentative of production designs. At present, there tends to be inadequate recognition of the foregoing points; as a result, there may be inadequate planning for design/testing follow-up during the period between the initial production decision (DSARC III) and the start of production. Furthermore, follow-on evaluations (FOE) on production hardware appear to be scheduled "as needed" -- and may therefore be underfunded and limited in scope.

RECOMMENDATIONS

1. For all electronics/software-intensive systems, additional efforts should be devoted to detailed establishment of relationships between the hardware/software employed for DT-II/OT-II and the ultimate production designs.

2. After OT-II, "visibility" relative to hardware/software status should be regarded as critically important; program check-points and phased demonstrations should be scheduled for both hardware and software improvements; the need for continuation of hardware/software integration tests should be recognized.

3. Follow-on evaluations on production hardware should be planned as a requirement (not on an "as needed" basis) to assure adequate funding and provision of test items; for FOE, there should be the same detailed attention to planning/data collection/data interpretation as that requisite for effective DT-II/OT-II testing; reliability-availability-maintainability (RAM) maturation programs should be regarded as essential.

4. It should be recognized that software designs (which control the operational performance of systems) will be evolutionary; that hardware/software integration testing will be necessary during the production phase; and that continuing visibility and adherence to design disciplines will be essential.

FINDINGS

Relative to plans/facilities for testing, the Subgroup was favorably impressed with the general excellence of facilities, and with the competence and dedication of the technical staffs involved. It is evident, however, that there is inadequate communication among testing agencies, and insufficient consideration of the time and cost savings -- and the improvements in the understanding of test results -- that could be generated by better coordination of testing, and by development of complementary facilities. The lack of coordinated planning presumably results in part from the Army's fragmented organizational alignments for testing; however, within the current organizational structure, improved coordination of facilities planning should be possible.

RECOMMENDATIONS

1. As one example, it is suggested that the development of complementary plans be required for MAINSITE (a C^3I DT test system at Fort Huachuca) and ATSTB (a C^3I OT test system at Fort Hood) -- although one facility is controlled by TECOM, and the other by FORSCOM/TRADOC. The indicated test systems require high levels/rates of expenditure, for tests of the same C^3I systems. Although both appear to be justified, it would seem that substantial advantages could be gained through coordinated planning and interactive employment of testing resources.

2. Again referring to planning for MAINSITE and ATSTB as an example, it is suggested that other software-oriented agencies/organizations become involved in a coordinated planning process to assure that the unique requirements of software testing are met -- although organizational boundaries must be crossed.

3. As another example, it is suggested that additional coordination would be desirable between the Electronic Proving Ground and the White Sands Missile Range relative to the design/employment of ECM test systems.

4. More generally, it is felt that additional coordination of detailed facility/test system planning would permit substantial cost/time savings, and that immediate steps should be taken to outline an over-all approach in this regard.

FINDINGS

In various presentations to the Subgroup (and in related discussions) reference was made to interoperability testing; there was little evidence, however, of coherent, coordinated over-all planning. Since interoperability will be of critical importance in a tactical environment, and interference among electronics-intensive systems may be a major factor, the apparent lack of specific test planning for interoperability appears to be a major inadequacy. In this connection it should be noted that interoperability involves not only Army systems, but also Air Force and other NATO equipments; furthermore, interoperability tests must consider interactions with "friendly" as well as enemy countermeasures.

RECOMMENDATIONS

It is possible that the Subgroup did not become aware of the extent of planning for interoperability testing; and it is recognized that not all aspects (not even all significant aspects) of interoperability can in fact be tested. It would seem, however, that more extensive over-all planning should be carried out; and that considered decisions should be made relative to the omission of testing for reasons of complexity or cost. In this regard, it is especially important that analyses and simulations be conducted to guide decisions, with recognition of the fact that appropriate complementary employment of systems can greatly enhance over-all Army combat effectiveness.

FINDINGS

As a system evolves from concept (TRADOC), through demonstration (contractor, development laboratory) and development (contractor, Project Manager), to fielding (readiness side of commodity command), technical continuity (on the part of the government) tends to exist only in an archival sense. In rare instances, not due to systematic process, individuals may shift jobs to follow a system through this cycle, but inadequate records (rationale for past choices, data) and insufficient personal recollections tend to dominate this problem. For high technology, complex systems, this problem is exacerbated by longer acquisition cycles.

Transfer of organizational responsibility at system milestones contributes to the indicated lack of technical continuity. Even within the time span a system remains under the responsibility of one office (e.g., PM), however, rotation of technical personnel, emphasis on schedules and costs, and tendencies toward insufficient documentation lead to erosion of technical knowledge.

Furthermore -- and this point is of great consequence -- knowledge gained in any given program is infrequently transmitted effectively to other programs; programs tend to be isolated, with limited communication across boundaries.

RECOMMENDATIONS

As previously noted (cf. p. 5) improvement of Army in-house capabilities as "wise buyers" is necessary; in addition, better-coordinated use of in-house capabilities (by continuity of assignments and coordination/cooperation across organizational boundaries) is essential and should be pursued on a high-priority basis. As a further action, it may be appropriate to consider an approach employed by other Services: to augment in-house capabilities by establishing a continuing, stable relationship with a non-profit organization (e.g., a Federal Contract Research Center or a hardware/software-oriented university laboratory). Advantages in terms of "corporate memory" and "transmittal of culture" from one program to another, and from current programs to future programs, could be highly significant.

III. MANAGEMENT OF TESTING; RELATED DEVELOPMENT ISSUES

In examining the question of testing of complex electronic equipment, several related issues need to be addressed. Most importantly, it is evident that the primary concern should not be testing alone, but rather the general subject of Army actions necessary to improve the reliability, maintainability, performance, and cost effectiveness of its equipment. Improved testing is only a small and often misunderstood part of the answer. For example, no amount of testing can correct an improperly specified system, a poor design, a software compatibility problem, an ECM problem, or a poor maintenance concept.

One objective of operational testing is to uncover problems that were missed during the design phase; however, these should be the exceptional cases rather than the rule. Too frequently, test-and-fix is used as a crutch for a poorly considered design. This is time consuming, always costly, and sometimes the implementation proves to be impractical. Much greater emphasis needs to be placed on the early design phases of programs.

Basic to any procurement is a realistic system specification (which recognizes technological bounds) establishing the equipment performance requirements, and the operating environment. The environment should include not only the usual physical aspects, such as temperature, humidity, vibration, etc., but also the ECM threat, reliability requirements, compatibility and interoperability (both hardware and software) with other friendly equipment, the skill level of the operation and maintenance crews, logistic support levels, etc. The Army's understanding of these requirements should be reflected in specifically tailored system specifications. This is a fundamental starting point for any procurement, and its importance cannot be overemphasized. Untailored system specifications, based on boilerplate military standards, more often than not result in equipment which does not meet the needs of the Army. Without a tailored specification, critical performance deficiencies will, despite a rigorous test program, remain largely undetected until the equipment enters the field. At that point in time, the cost to fix and retrofit often becomes prohibitive.

The source selection process is another area that needs Army top management attention. The services have long given lip service to reliability, availability, maintainability (RAM) and life cycle costs, while at the same time weighing source selection heavily in favor of near term development costs. More trade-offs between RAM and system performance need to be addressed during the source selection process. Contractual incentives should be included to stress not only operational performance, but also the product assurance aspects. While full compliance may not be achievable in the early phases of the program, progressive milestones need to be established, monitored, and related to incentives.

The period of greatest leverage in affecting operational performance, RAM, and ultimate cost is the early design phase. A great deal more effort is needed "up front" to prevent problems from occurring. This involves more trade-offs during the conceptual phase. It involves more emphasis on simulations of planned systems and their interactions with the expected tactical environment (and other related systems). It means greater design emphasis, and early testing, at the component and subassembly levels. The engineering should stress basics such as error budgeting, thermal, stress, and failure mode analysis, component deratings, parts standardization, producibility, etc. Modern computer techniques such as computer-aided design, finite element stress and thermal analysis, and other computer programs greatly simplify these engineering studies, and their use is strongly encouraged. Considerations relating to RAM should be addressed in the early design phase. Significant effort should be spent on hardware and software simplification, and in the design of built in test functions that simplify system maintenance. Carefully-prepared, complete documentation is essential in early program phases so that reference to trade-off studies and related decisions can be made throughout the program.

The design phase of the program requires especially careful monitoring by the Army's Program Manager and his technical staff.[3] Frequent design reviews should be held to assure that the basic design concepts are sound, and that all of the technical issues are being addressed. The effectiveness of a program is largely dependent on the technical expertise of the government team. It is the opinion of the Subgroup that this technical expertise has significantly deteriorated over the last decade, and this capability needs to be restored if the Army is to operate in a cost effective manner. Subcontracting the required evaluation and monitoring efforts to think-tanks and study houses is simply not a satisfactory solution; these organizations frequently do not have direct hardware/software design experience. As noted in other sections of this report (cf. Sections VI and VII) there are types of organizations that can help; but they cannot substitute for in-house capability.

An engineering test program should be an integral part of the design cycle. This should involve program peculiar components, subassemblies, and subsystems which are subjected to rigorous performance and reliability testing under environmental simulation; special attention should be devoted to software design and comprehensive software testing (cf. Sections IV and V and Appendix E).

The testing responsibility at this point in the program should be the responsibility of the system contractor, but with government monitoring.

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3. Relevant "Lessons Learned" in the PATRIOT Program are outlined in Appendix E, as discussed by the Project Manager.

In this way, design and quality deviations will become apparent to both the contractor and the Army early in the program, rather than at a much later time during full-scale system testing. In addition, the component and subsystem (hardware and software) testing should be conducted in the contractor's facility when possible. This allows the design team to observe firsthand any deficiencies, and permits rapid turnaround on fixes. Every failure or performance deviation should be recorded and analyzed, and fixed. This approach requires more up front funding, and often a longer design and development cycle; however, the over-all costs and the time to effective production should both be reduced.

The test community needs to become involved early in the program.[4] The Test Integrating Working Group (TIWG) is the established forum for this activity and includes representation from the program office, the contractor(s), the user, the training and logistics commands, as well as the test community. In addition, where there is a requirement for interoperability with other systems (or equipment), the TIWG should include specialists knowledgeable in these other systems, preferably from the respective program offices. Once established, changes in the TIWG membership should be minimal and, under normal circumstances, assigned individuals should continue for the life of the test program. The chairman of the TIWG should continue to be the Army's Program Manager or his deputy rather than a career-oriented member of the test community; this is to assure that the test program is compatible with the over-all program milestones, that the test resources are properly scheduled and prioritized, and that the test program is adequately funded.

The TIWG should start its planning very early in the program, and all test plans should be agreed to and documented from the start. Needless to say, the test plan must be consistent with the system specification, and this again emphasizes the need for a thoroughly tailored system specification. Particular emphasis should be given to interoperability testing, which in the past has been often treated as an afterthought or sometimes even ignored.

The management of the Development Testing (DT) program should be the responsibility of the Army's Program Manager with the tests monitored and evaluated by the TIWG. Actual testing should normally be performed by the contractor in his own facilities. However, it is recognized that contractors will generally not have specialized facilities such as flight test ranges, communications and jamming test ranges, EMP simulators, etc. These specialized tests should be performed in government facilities such as are available at Fort Huachuca, White Sands Missile Range, Fort Hood, and others. However, the basic management of the development testing should remain with

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4. A suggestion for "parallel" development of an automated test system (to provide the test environment/system loading) is discussed in Appendix F, p. F-4 and should be considered; cf. recommendation on p. 7.

the Program Manager, regardless of where the tests are performed, with active participation of the contractor. For all tests, careful attention should be given to Army documentation requirements; tests should not be conducted until requisite documentation is available.

The primary purpose of DT is to assure that the basic design meets the performance specification under simulated environmental conditions. The tests are also intended to provide early identification of areas of specification deviation, so that the design can be modified as required. In addition the inherent system RAM capabilities should be estimated analytically; the analytical results should be to establish goals and allocations to subsystems and components. Related test programs should be designed with successively more stringent RAM milestone demonstrations (starting with DT) in order to assure ultimate compliance for the production equipment. Early training concepts need to be formulated and verified during DT and limited user participation is useful at this stage. Sufficient numbers of equipment are needed to satisfy these needs, and this must be recognized by adequate up front funding.

Operational Testing (OT) should not be initiated until all of the major milestones of DT have been achieved. The purpose of operational testing is to obtain an estimate of the system's over-all operational effectiveness and suitability. This includes items such as survivability, vulnerability, safety, human factors, logistics supportability, and training requirements. In addition, OT objectives include identification of any operational deficiency that will require hardware or software modification. Again it should be emphasized that tests should not be conducted until relevant documentation is available.

Operational tests should be conducted at government facilities, under simulated field conditions, with progressively greater involvement of the user. For C^3I equipment, this testing would generally occur at Fort Huachuca, White Sands Missile Range, or Fort Hood (for ASTB). This effort should continue to be planned, coordinated, and evaluated by the TIWG group, and the over-all test responsibility should remain with the Program Manager; however, the special requirements of operational testing must be clearly recognized by the Project Manager. Deviations from those requirements should be explicitly justified. Contractor participation at this stage should be limited to that of a consultant and technical adviser.

It should be recognized that RAM maturation programs and follow-on evaluations (FOE) will be needed, since operational testing (prior to production decisions) is not in general conducted on production hardware and software; for these types of tests, there should be the same detailed attention to planning/data collection/data interpretation as that provided for prior development and operational tests.

Complex C^3I systems have in the past been plagued by compatibility and interoperability problems that are first identified during operational testing or later. As a result, the program experiences major cost overruns and schedule delays. In many cases, the issues were never addressed in the system specification or in the design phase. Obviously, expanding the operational test program is not the correct approach to solving this type of problem.

To summarize, the acquisition management approach for complex electronic systems should include:

1. A tailored specification based on user needs;

2. A procurement policy that recognizes total costs (life cycle costs) as opposed to developmental costs;

3. Emphasis on conservative design practices monitored by competent government personnel;

4. Early involvement of the entire test community (TIWG), with adequate attention to documentation requirements;

5. A test program that moves progressively from the component and subassembly level to a full-up system;

6. A test program that is the responsibility of the Program Manager, with explicit attention to user requirements;

7. Early attention to reliability and maintenance with milestone thresholds;

8. Adequate hardware ("hangar queens") so that design changes and product improvements can be quickly verified;

9. A follow-on evaluation program to assure quantitative understanding of production hardware and software designs;

10. An active program to assure quality improvements throughout production.

IV. SOFTWARE DESIGN TESTING AND VALIDATION: DEVELOPMENT OF TEST TOOLS

There is ample evidence to support the concern that there may be a substantial deficiency in the Army's current ability to load its advanced automated weapons systems with realistic battlefield operating conditions in order to perform thorough and effective development tests. Proposals have been advanced from several quarters for the development of automated, computer-based test tools to drive (via simulation and stimulation) the engineering and initial production models of new automated Army weapons systems during DT and (to somewhat lesser degree) OT (cf. reference memorandum, Appendix F, p. 1; and Section V of this report).

The need for the proposed automated test tools is supported by the ASB. In our view they could serve in three important ways to improve the Army's ability to successfully develop effective automated weapons systems:

1. Validation of the system's ability to meet the stated requirements (DT/OT);

2. Early detection, identification, and diagnosis of design faults and deficiencies (DT and pre-DT system/subsystem tests);

3. Source of guidance and motivation for system architects and designers to provide for early consideration of stating system requirements in a "testable" form; encouragement for supporting system/subsystem module tests concurrently with very early system concept definition.

Common to all of the advanced automated systems is the usage of embedded computers and extensive amounts of software. Key operational elements/aspects of system performance are determined by the software; this fact, which is central to how the embedded computers are used, implies that no phase of system testing can be accomplished without testing the software as well as the hardware. Consequently, test plans must include appropriate module, subsystem and system level software tests at all phases of system development.

While it may seem self-evident that software, as well as hardware, must be tested, it is a fact that the techniques for reliable and comprehensive software testing are entirely different from comparable hardware testing techniques. They are similar in only the "highest" philosophical sense; hardware testing techniques serve only as mildly useful analogies to suggest where and how to begin the task of designing software tests. The extent and nature of these differences has only over the past five years or so begun to be fully appreciated by the systems design and test community. As a result, a new technology called

"Software Verification and Validation" is now emerging in the field of computer science and design, consisting of statements of methodology and descriptions of techniques; e.g., Proceeding of Software Verifications and Validation Symposium, June 9-10, 1981, MITRE; or NSCCA/PATE Guidebooks Vol. III, June 1980, LOGICON; Tutorial: Software Testing and Validation Techniques, E. Miller, IEEE Catalog No. EHO 138-8.

Four specific recommendations for the Army's consideration are submitted as a result of the above findings. Briefly, they are:

1. From the outset, software should be designed to be testable;

2. Software testing should be made a part of DT and included as often as possible in pre-DT system development phases; automated computer-based test tools should be developed to provide appropriate representations of tactical environments (and system loading);

3. MAINSITE, to be an effective DT asset, should be explicitly designed and equipped for both software and hardware testing;

4. To facilitate cost-effective software testing which will yield results which can be uniformly interpreted and "graded", a common library of software verification and validation tools (tests) should be developed and used on an Army-wide basis by all of the developers and testers.

The following comments are offered in support of these recommendations. First, the notion that software must be designed to be testable is not dissimilar from the hard-learned lesson of hardware testing. Basically, the strategy to be followed by the software designers to insure testability begins during the formulation of system requirements and specifications with the designers insisting on getting an answer to the question: "How can compliance with this particular specification be confirmed?". A simple example here will illustrate this strategy. The TRI-TAC switch requirement to operate satisfactorily under realistic battlefield loads was not explored at the outset for testability, to the extent that "realistic battlefield loads" remained undefined (in a quantitative sense) until OT was initiated and "satisfactory operation" was not ever made measurable in terms of que-length margins and statistics, etc.! Furthermore, even if que-length margins and statistics had been specified, the TRI-TAC software was not designed to allow these parameters to be measured.

In general, automated systems containing embedded computers are more vulnerable to the failure of not designing for testability because their software is much more intimately responsible for achieving operational requirements and specifications than are current, more hardware-intensive manual systems. Unfortunately, those persons responsible for early system concept formulation usually want, and often promote, vagueness in operational requirements in order to "retain flexibility" or broaden the appeal of the concept. As a result, the software designers are denied critical information needed to insure a testable design and, by default, essential software performance features are obscured or rendered unmeasurable/unobservable by well-intentioned but uninformed unit level programmers. As a result, intrinsic design flaws in the software remain unexposed until OT or even later phases of system design. Careful adherance to the tightly disciplined early "design for testing" methodology now being articulated in the literature is an essential step in remedying current deficiencies in the Army's testing of automated systems.

The second recommendation to include software testing as a part of DT can, of course, be fully implemented only if the first recommendation has been implemented. The important point here is that DT is the appropriate phase of system development for confirming proper software performance, including acceptable software unit and subsystem tests. The intimate involvement of the software with operational aspects of the system invites confusion in the Army development/testing process and has often led to deferral of comprehensive software testing to the OT or later phase (e.g., PATRIOT). Early software testing allows correction of design flaws at much less expense than correction later and, furthermore, often allows a technically superior solution involving architectural and/or hardware changes which may become impractical later in the development cycle.

The third recommendation regarding MAINSITE is recognition of the intended centrality of the role MAINSITE is to play in DT for automated tactical systems. To date, most of the planning for the MAINSITE capabilities appear to have dealt with its abilities for testing and demonstrating hardware features of the system under test. While some form of software testing is currently expected to be executed by the system, implementing the previous two recommendations will enable the MAINSITE planners and designers to fully embrace the potential for testing the software as well as the hardware in DT. A broad collection of software verification and validation tools can and should be implemented and maintained up-to-date in MAINSITE facilities. Their availability at MAINSITE would also serve the purpose of reinforcing and guiding the particulars of how to "design for test" prior to DT; i.e. MAINSITE would serve to remind and suggest to the system designers what should be anticipated in DT. By virtue of the uniqueness of MAINSITE, software verification and validation tools will tend naturally to be standardized among Army developers. At a minimum, equipping and tasking MAINSITE with software testing will tend to standardize software interfaces critical for testing as well as to standardize many of the "measures" of software performance and design validity.

Finally, the fourth recommendation to develop a common library of software verification and validation tools should greatly relieve the cost burden of software testing on developers as well as aid the testers in becoming a more constructive and better understood player on the Army system development team. Nearly all of the current Army systems under development with embedded computers can exhibit a discouraging and lengthy list of sample incidents where the test and testers from one phase of the development are at odds with those of a later phase. It is difficult to separate design problems from communication/interpretation problems in these incidents. Clearly, employment of methodology -- a common library of tools -- would be a major step toward more effective orderly, development and testing.

The newness of the emerging software verification and validation concepts as a discipline places a strong technical obligation on the Army and carries all the usual risks of a developing technology. However, the newness also presents the Army with an opportunity to assume and provide leadership in a vital -- perhaps critical -- new discipline with application in the commercial and industrial as well as military sectors.

In addition to the preceding recommendations, it is also strongly suggested that consideration be given to the suggestion made in the reference memorandum reprinted in Appendix F, p. 4. It is proposed that the previously-discussed automated test systems (to provide the test environment/system loading) be developed by contractors other than the system development contractors -- in parallel with the development of the basic system. It is recognized that additional coordination would be required during engineering development; however, the advantages (as stated in the reference) could be highly significant in terms of program time scales, cost and performance.

V. LESSONS LEARNED FROM US AIR FORCE SOFTWARE DEVELOPMENT; RELATIONSHIP TO US ARMY PLANS FOR TESTING

It has been reported[5] that a survey of discrepancy reports of eighteen US Air Force (A/F) projects that were subjected to detailed review (i.e., verification and validation) processes indicated that certain types of software development problems were encountered repeatedly. Although the programs varied in application, language, development method, size and complexity, certain types of software problems occurred repeatedly. The A/F found that an understanding of common problem areas is an invaluable aid to the software evaluator and that such knowledge is transferrable from project to project.

The predictable areas of difficulty were found to be:

REQUIREMENTS PROBLEMS

- o Incomplete requirements
- o Inconsistent requirements
- o Incorrect requirements
- o Untestable, ambiguous, and questionable requirements

DESIGN AND CODE PROBLEMS

- o Initialization, reinitialization, restarts
- o Flags, counters, indices
- o Data definition and usage
- o Mathematics
- o Timing, interruptibility, process allocation
- o Interfaces
- o Miscellaneous errors
- o Questionable design and poor programming practices

DOCUMENTATION PROBLEMS

- o "As-Built" specifications
- o User documentation

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5. LOGICON Report R:SED-80204-III, Prepared for BMO/MNNC, Norton Air Force Base, California, dated June 1980, "NSCCA/PATE Guidebooks, Volume III: Lessons Learned from Past NSCCA/PATE Efforts". Related discussion conducted at LOGICON, San Pedro, California, on 21 April 1981, with member of Subgroup on Testing of Electronic Systems.

The A/F software applications included programs relating to command and control, chart-generation, targeting, data base generation, and range safety. Some were in real time, some were written in an assembly language, some were written in Fortran, some were hosted by UYK series processors and others were hosted by such commercial processors as the IBM 360 and CDC 3300.

The diversity of the applications leaves little doubt that the indicated problem areas will be representative of those that will be found in the development of software for the Army. At this point in time we know that software problem areas are among the items that should be explicitly tested and evaluated prior to the DSARC I, II and III decision points; therefore it is useful to examine the Army's current and planned T&E capabilities to find, evaluate, and fix the kinds of problems that are expected to be encountered in the software items utilized in sophisticated systems.

In that context, briefings from the MICOM System Software Center[6] indicated their sensitivity to requirements and development problems. With the definition of software testing presented in Figure 1, a clear understanding of cost problems was demonstrated in the discussion of Figure 2, where the cost of errors was correlated with the stage of development in which the errors were detected. Figure 3 was used to relate software testing to a pyramid, with requirements analysis and software design analysis as elements of the foundation, and integrated program testing at the tip.

In reference to the analogy of the pyramid -- one major concern of the Subgroup is that, for sophisticated systems with embedded computers, the current approach seems to involve the expenditure of large amounts of money and effort for testing at the tip, with far less attention to testing at the foundation. Furthermore, there seem to be "disconnects" between apparently-suitable plans/approaches as discussed by software-oriented organizations within the Army (e.g., the MICOM Missile System Software Center, or the BMDSCOM Testing Organization) and current implementation in tactical projects.

Similarly, there would appear to be "disconnects" relative to current planning of two major T&E test systems, MAINSITE[7] (Ft. Huachuca) and ATSTB[8] (Ft. Hood); essential aspects of the facilities are shown in Figures 4 and 5. As also discussed in Section IV, the test resources seem to be directed primarily toward hardware problems, with insufficient planning for software testing. For MAINSITE, a module-by-module comparison has been made (by the

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6. Presentation on MICOM System Testing Policy, 13 April 1981, Redstone Arsenal (cf. Appendix B, p. B-7).

7. Modular Automated Integrated Systems Interoperability Test and Evaluation System.

8. Automated Tactical Systems Test Bed

Subgroup) with the types of problems evidenced by the A/F analyses; although the analysis has been cursory, and may be based on an inadequate understanding of recent plans, it would seem that relatively few of the common problem areas identified by the A/F would be adequately investigated during DT at MAINSITE or OT at ATSTB. Nor does it seem that the experience/understanding of software-oriented Army organizations has been appropriately exploited.

It is important that the foregoing remarks not be regarded as an indictment of Army test and evaluation facilities in general, or of other aspects of MAINSITE and ATSTB planning. In fact, the Subgroup has been very favorably impressed by the general excellence of facilities -- existent and planned -- and by the competence and dedication of the associated technical staffs.

The problems relate to the evident fact that plans for future T&E facilities seem to be based primarily on hardware test experience -- experience that bears little relationship to software testing needs. Additional coordination within the Army, with consideration of types of tests to be conducted at the various facilities -- and the consequent requirements for test capabilities -- would appear to be urgent; in particular, the requirements for software testing should be reemphasized in all planning.

Figure 1

SOFTWARE TESTING

SOFTWARE TESTING IS AN ENGINEERING ACTIVITY INCLUDING CONTROLLED ANALYSIS AND A STIMULUS-RESPONSE PROCESS WHICH HAS THE OBJECTIVE OF ULTIMATELY DEMONSTRATING THAT THE SOFTWARE SYSTEM PERFORMS AS DESIRED. UNTIL THE OBJECTIVE IS ACCOMPLISHED, TESTING IS A MEANS OF DISCOVERING AND ISOLATING SOFTWARE ERRORS.

Figure 2

SOFTWARE ERROR COSTS AND DEVELOPMENT CYCLE

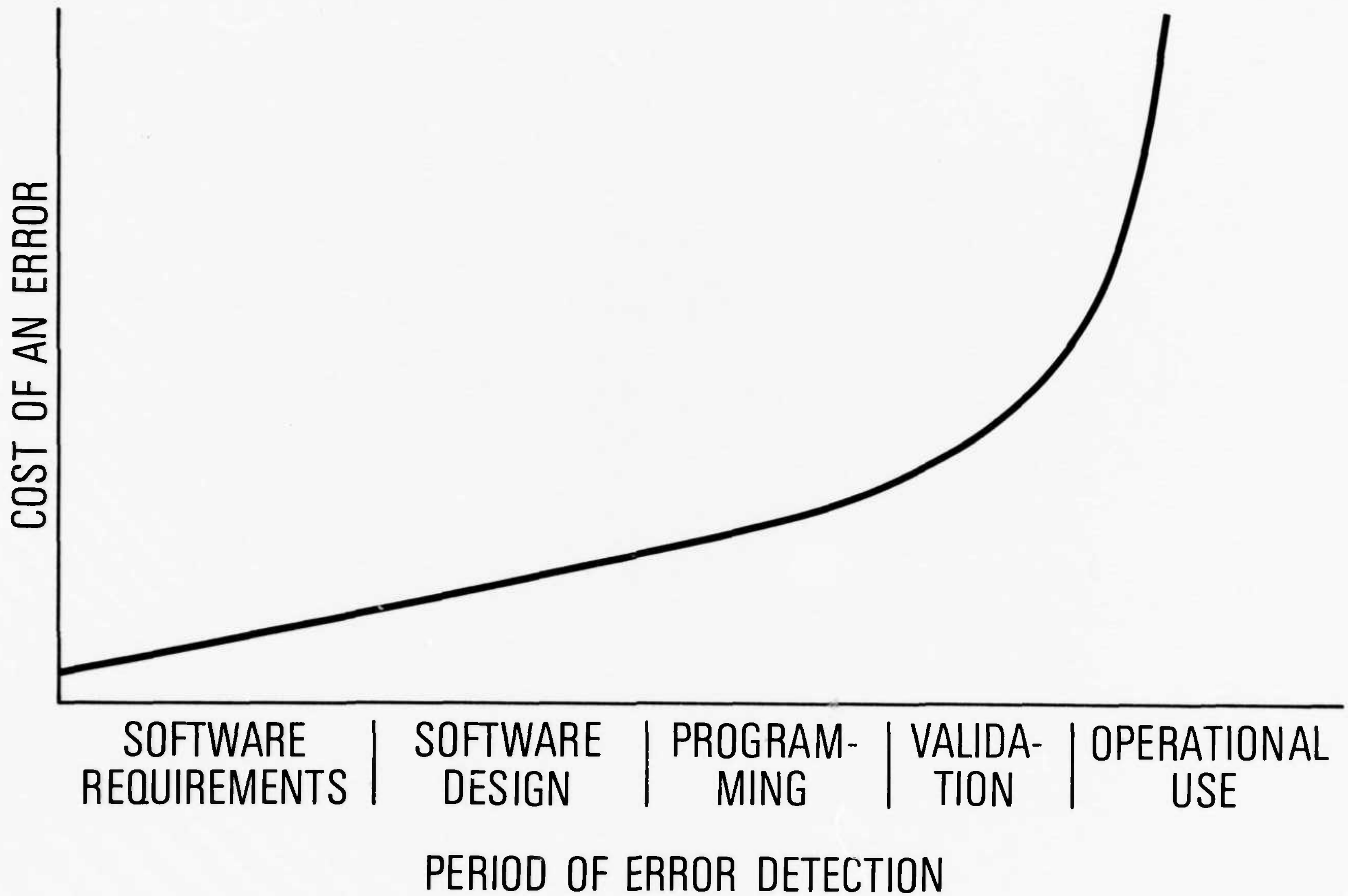


Figure 3

MISSILE SYSTEM SOFTWARE CENTER APPROACH TO SOFTWARE ANALYSIS/TESTING

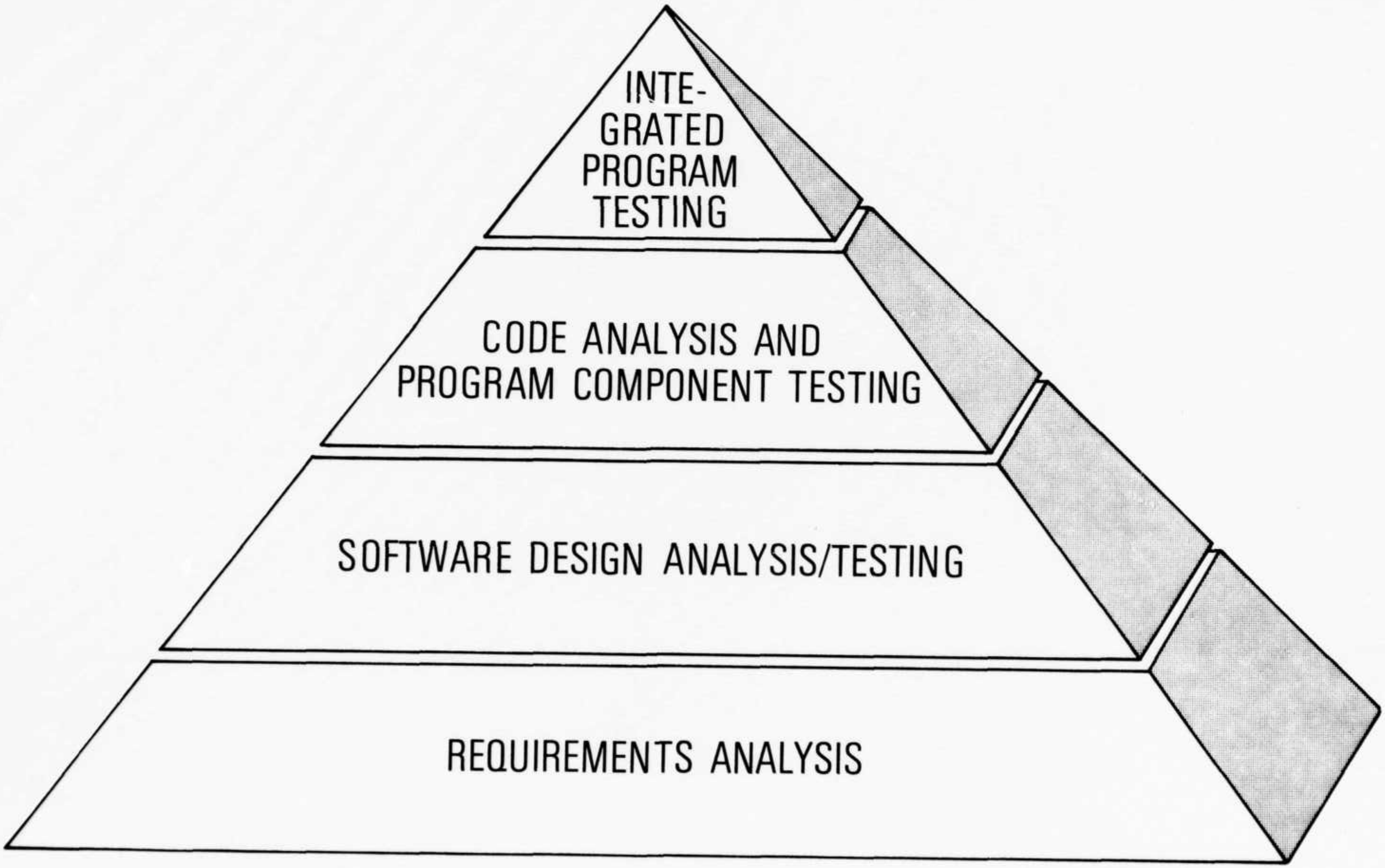


Figure 4

MAINSITE ARCHITECTURE

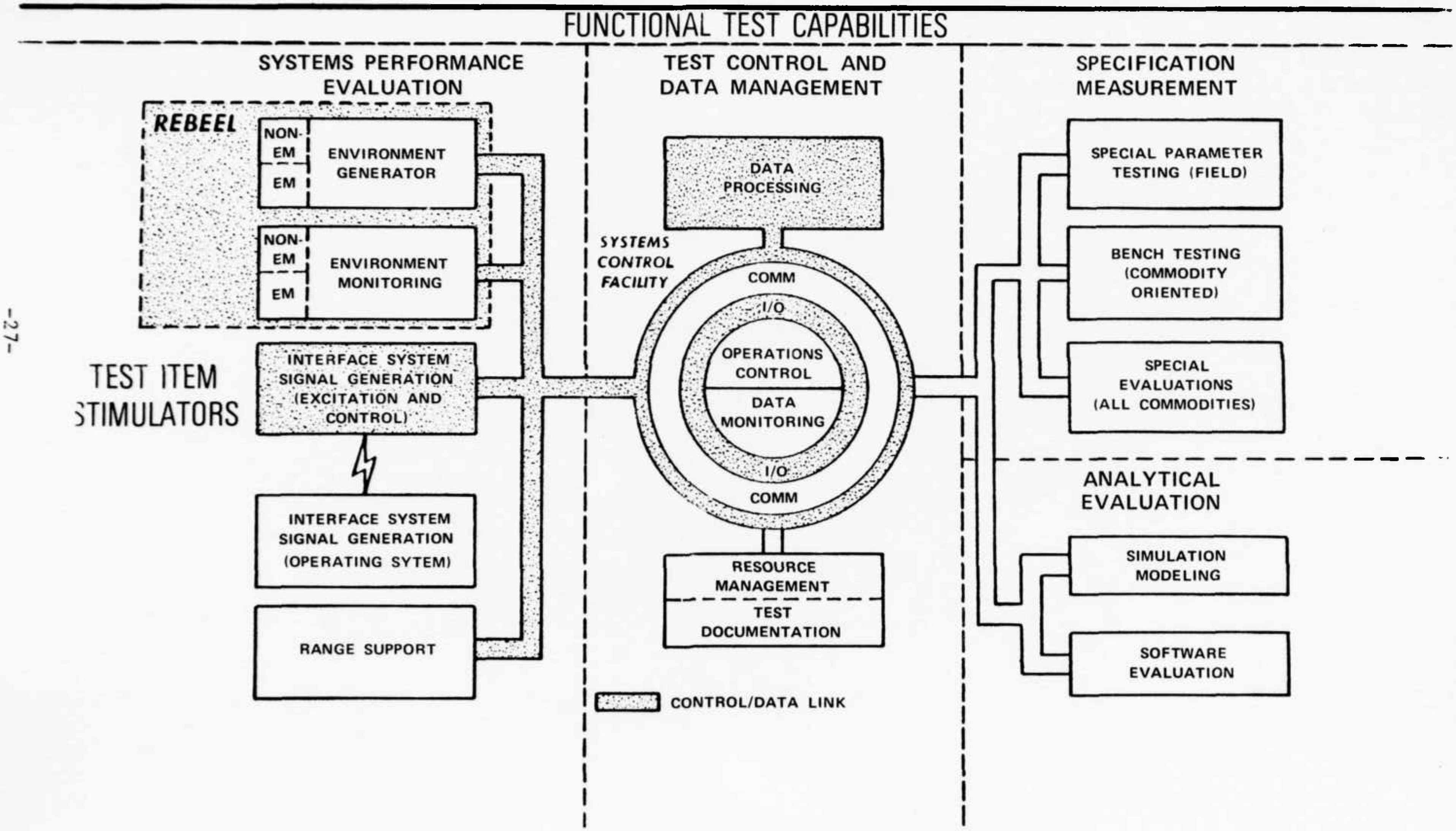
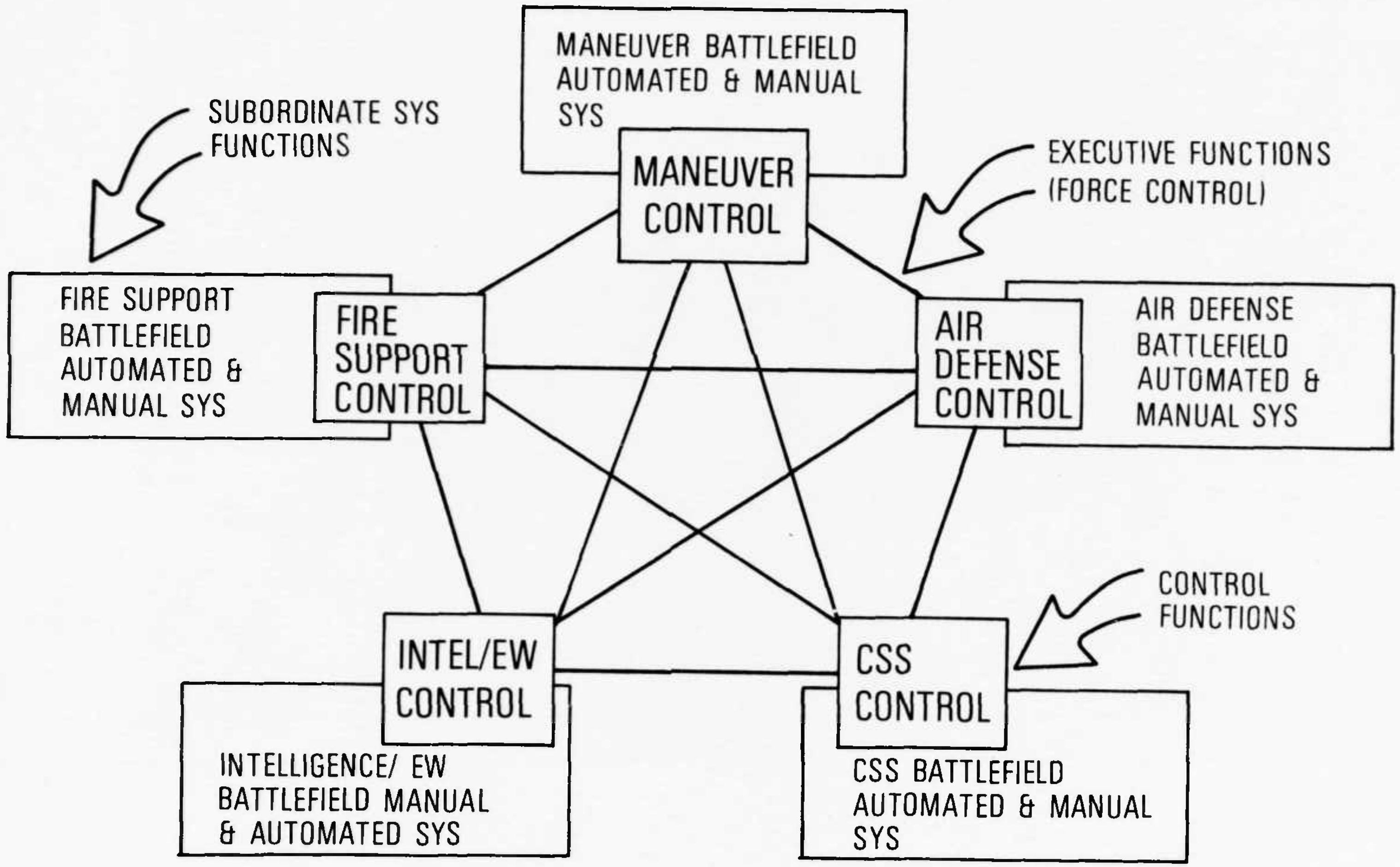


Figure 5


SUBORDINATE SYS FUNCTIONS
MANEUVER BATTLEFIELD AUTOMATED & MANUAL SYS
MANEUVER CONTROL
EXECUTIVE FUNCTIONS (FORCE CONTROL)
FIRE SUPPORT BATTLEFIELD AUTOMATED & MANUAL SYS
FIRE SUPPORT CONTROL
AIR DEFENSE CONTROL
AIR DEFENSE BATTLEFIELD AUTOMATED & MANUAL SYS
CONTROL FUNCTIONS
INTEL/EW CONTROL
CSS CONTROL
INTELLIGENCE/ EW BATTLEFIELD MANUAL & AUTOMATED SYS
CSS BATTLEFIELD AUTOMATED & MANUAL SYS

VI. NEED FOR IMPROVED EVALUATION OF DESIGN CONCEPTS AND EARLY TEST DESIGN; RELATIONSHIP TO IN-HOUSE CAPABILITIES

A. Introduction; Need for Improved Evaluation of Design Concepts

The design problems that have been revealed in many systems that are well along in the development and testing cycle are clear evidence of lack of competent attention to early design concepts. Such failures must surely reflect the erosion of quality of in-house capability and the need for improvement.

As C^3I and other computer-based systems become more and more complex, the competency and thoroughness with which the original system design concept is developed become of overriding importance. Whether this concept is created by contractor or in-house engineers is immaterial. In either case, in-house personnel must not only have a good understanding of the design concept, but must be able to relate it to the systems with which it must interact, both available and yet to come.

It is recognized that many personnel actions in recent years -- some not under the control of the Army -- have had a severe impact on the technical capabilities of the Army in-house R&D structure. Arbitrary cuts in manpower, arbitrary limitations on laboratory average grades, and arbitrary ceilings on the salaries of the higher grades must ultimately result in erosion of the quality and effectiveness of personnel whose responsibilities are those of the "wise buyers" needed for effective governmental control.

Major efforts should be made to improve the Army's capabilities for detailed evaluation of design concepts. If possible, the related personnel actions should be reversed; in any event, careful attention should be given to organizing the optimal use of available talent. Additional, further consideration should be given to the acquisition of contractual support on a long-term, continuing basis to assist in this area.

B. Need for Early Planning of Development and Operational Tests

Briefers from the Testing and Evaluation community have presented the Ad Hoc Working Group with their views that a considerable need exists for more sophisticated facilities than those presently available. There has not been an equivalent emphasis on early clarification of concepts, and on early planning for development and operational tests. The PATRIOT experience (cf. Appendix E) indicates a need for the early integration of test community requirements into the over-all design of the development, testing, and evaluation of complex systems, as well as a need for additional attention to software testing and to software/hardware integration. The Subgroup believes that earlier and greater emphasis on both general system and test design might have reduced the downstream problems that have caused expensive delays in the Army's ability to field complex systems. Costs escalate in a non-linear fashion when problems are not intercepted in advance of operational testing.

The Army lacks the equivalent of an Aerospace Corporation or a JHU/APL to assist in concept formulation/evaluation and in the definition/monitoring of testing. This being so, it would seem reasonable to look to the Army Science Laboratory research and development community for technical advice. However, such help is not forthcoming, or tends to be available in only a limited way. In the first place, considerable distances separate these laboratories from the proving grounds, i.e., New Jersey to Arizona. In addition, it may be said that some of the Army Science Laboratories are in need of technical advisers themselves, in order to carry out significant aspects of their missions. There has been a long process of erosion in the quality of the various laboratories and a decrease in the number of talented personnel available to them. This is attributed to salary and GS level limitations that are not competitive with industry and therefore severely limit the ability of the laboratories to attract and retain qualified engineers and scientists.

Given all of the above, together with the fact that the testing and evaluation missions are so closely defined as to virtually preclude the hiring of innovative engineers and scientists, it is understandable that inadequate attention has been given to initial project planning and design. It is also plausible to question the present wisdom of the historical separation of the research and development activities from the testing and evaluation facilities on a geographical basis. Once considered remote and undesirable locations, Sunbelt areas have experienced an influx of population in recent years, and excellent young engineers and scientists are now being graduated from university programs in these states. This suggests that it might now be quite realistic to expect that a significant percentage of the available talent would be interested in employment in Southwest locations, if there were also a professionally attractive mix of research, development and consulting work to do there. There would then be the additional possibility that technical advice could be available to the testing and evaluation projects at such sites as Fort Huachuca, White Sands and Dugway. This suggestion would not resolve the salary and promotion problems that burden the federal employment structure, but it does hold promise regarding the possibility of an influx of new talent for the Army's over-all effort, even if much of it departed when further promotions and raises were denied by government regulations.

It is also worth pointing out that some of the software problems that have plagued the Army's complex systems in the past might be alleviated in the future if young engineers and scientists could be attracted to T&E locations and used as advisers in the early phases of test design. Use of the computer is now an integral part of engineering and scientific education. It is taken for granted, rather than being viewed as something to be added on (as it was added on to the set of professional skills of older workers who have carried the project responsibilities for the last 20 years). If this newer point of view could be brought into all aspects of technical activity, particularly into the initial phases of system and test design, it could save the Army considerable time and expense.

VII. NEED FOR TECHNICAL CONTINUITY THROUGHOUT DESIGN AND TESTING; RELATIONSHIP TO US ARMY ORGANIZATION FOR TESTING

As a system evolves from concept (TRADOC), through demonstration (contractor, development laboratory) and development (contractor, Project Manager), to fielding (readiness side of commodity command), technical continuity (on the part of the government) tends to exist only in an archival sense. In rare instances, not due to systematic process, individuals may shift jobs to follow a system through this cycle, but inadequate records (rationale for past choices, data) and insufficient personal recollections tend to dominate this problem. For high technology, complex systems, this situation is exacerbated by longer acquisition cycles.

Transfer of organizational responsibility at system milestones contributes to the indicated lack of technical continuity. Even within the time span a system remains under the responsibility of one office (e.g., PM), however, rotation of technical personnel, emphasis on schedules and costs, and tendencies toward insufficient documentation lead to erosion of technical knowledge.

As discussed in Section VI, the Army should make every effort to improve in-house capabilities; and it may be desirable more systematically to transfer managers and engineers as system responsibility is shifted. Additionally, however, the Army could appropriately consider establishing an external technical monitor (e.g., an FCRC or hardware-oriented university laboratory) tasked to maintain technical continuity for major systems.

The lack of over-all program technical continuity includes a sub-set of problems associated with testing, particularly for complex electronic systems. These relate to definition of test needs and organizational responsibilities.

As discussed in previous Army Science Board reports[9], test data to be gathered by the contractor, in DT, and in OT -- over the pre-DSARC III life of a system -- need to be coordinated early. Particularly for electronic systems, key data and results need to be better related in an auditable manner to critical requirements in the Letter of Agreement, Decision Coordinating Paper, and Required Operational Capability documentation; rationale underlying the definition of pertinent test data is generally insufficient. Similarly, a holistic approach to assigning tests to be done at each stage (concept, DT, OT, etc.) could come closer to ensuring complete test coverage of truly key items without redundancy. For sophisticated electronic systems examined by the Subgroup, it may be more difficult (but not less important) to identify specific test procedures and measurements to be made in such a life-cycle manner; however, intensive front-end analysis containing a logical

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9. 1980 Summer Study on Statistical Techniques in Testing, 7-11 July 1980, pp. 6-7; Report of the Panel on Design of Army Tests, 1 May 1981, pp. 2-3.

definition of system criteria, and related tests to measure satisfaction of those criteria over time, could improve the value of testing.

The Army should strengthen and enforce policies aimed at early, intensive, logical, and coordinated determination of the entire testing need for each system.

All of the problems relating to technical testing continuity are complicated by the cumbersome, fragmented organizational structure of the Army test community. The assignment of responsibility for the various facets of test policy, management, accomplishment, and presentation of results seems inconsistent and inefficient. The members of this Panel had difficulty in reconciling, or in some cases understanding, the organizational responsibilities. For example:

1. OTEA is the unbiased, high level agency conforming to the independent test evaluator/manager philosophy, but other agencies have the oversight role in certain tests.

2. Tests appear to be assigned to test activities within a major command with (in some cases) a sense of arbitrariness; specialization of skills and test equipment in the several activities would suggest that all systems of a type be under the test jurisdiction of a commodity-oriented activity.

It would appear that greater objectivity, continuity, coordination, and efficiency would result from concentrating testing responsibility, in contrast to the current structure. No specific recommendation is offered in this area, but rethinking of the relationships of the developer (DARCOM), the requirements generator (TRADOC), both having considerable internal test and evaluation assets, and the independent agencies (OTEA) might clarify a currently confusing organizational alignment; as an interim measure it seems possible that an executive steering group (composed of DARCOM, TRADOC and OTEA representatives) could provide useful coordination and guidance. The plethora of test boards, proving grounds, ranges, and test beds under various headquarters may contribute to unnecessary duplication, e.g., the question of complementarity for MAINSITE and ATSTB and their relationship to similar data measuring systems in place or planned at CDEC[10] and NTC[11].

In conclusion, it appears that the Army should reassess its organization for testing, with a view toward increasing efficiency through centralization. The use of an external technical test contractor to provide testing continuity might be considered. Additionally, a separate agency/contractor might fulfill the independent validation, verification, and evaluation role. Expensive, potentially competing test and evaluation systems (e.g., MAINSITE, ATSTB, CDEC, NTC) need to be examined to ensure complementarity and to minimize duplication.

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10. Combat Developments Experimentation Command

11. National Training Center

Appendix A

TASKING LETTERS

DEPARTMENT OF THE ARMY
ARMY SCIENCE BOARD
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310

19 DEC 1980

Mr. Alvin R. Eaton
Assistant Director
Supervisor, Fleet Systems Department
The Johns Hopkins University
Applied Physics Laboratory
Johns Hopkins Road
Laurel, MD 20810

Dear Mr. Eaton,

I would appreciate your chairing an Army Science Board Panel to assess the testing of sophisticated electronic-intensive Army systems as requested in the enclosed letter. A list of potential participants is also enclosed.

The increasingly complex problem of testing new systems involves high costs of extensive testing versus the risk inherent in more economical, but less stressing, tests. The Panel should address this issue both in broad terms (Army concepts and plans) and in relation to specific facilities. As usual, the Army Science Board members participating in the study are responsible for the conclusions and recommendations in the final report.

I look forward to hearing of your progress in this area at the Spring General Membership Meeting in March.

Sincerely,

J. Ernest Wilkins, Jr.

J. Ernest Wilkins, Jr.
Chairman

2 Inclosures
As stated

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ARMY SCIENCE BOARD AD HOC SUB-GROUP ON TESTING OF ELECTRONIC SYSTEMS

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310

REPLY TO ATTENTION OF

Dr. J. Ernest Wilkins, Jr.
Deputy General Manager
EG&G Idaho, Incorporated
Post Office Box 1625
Idaho Falls, Idaho 83401

Dear Dr. Wilkins:

It is requested that you appoint a Panel of approximately eight Army Science Board members to examine the Testing of Electronic Systems.

As increasingly sophisticated Army systems are developed, the testing and evaluation of these systems during the acquisition cycle become more challenging. Particularly difficult is the testing of the C^3I and computer-based portions of these systems in realistic battlefield environments that include anticipated levels of input-output, system software loading, electronic threats, and maintenance. Present approaches include simulation and field exercise. The expense of elaborate testing must be weighed against the risk of detecting potential system failure mechanisms and operational difficulties only after development and fielding.

The ASB Panel should examine the overall facets of this subject, specifically addressing the following:

1. Are Army concepts, plans and equipments adequate for the testing of modern C^3I and computer-based systems?

2. What changes should be made, if any?

This investigation should include an assessment of relevant testing facilities, including TRI-TAC's Joint Test Facility at Fort Huachuca, the Automated Systems Test Bed at Fort Hood, and plans for the Modular Automated Integrated Systems Interoperability Test and Evaluation (MAINSITE) System. The adequacy of facilities, test equipment, procedures and plans to support testing of ASAS, PLRS, and TACFIRE should be addressed. In addition, suggestions for satisfactorily operationally testing future software systems would be appreciated.

The Panel should plan to complete their work by the end of May 1981 with a draft report to be briefed at the Spring General Membership meeting.

Sincerely,

Percy A. Pierre
Assistant Secretary of the Army
(Research, Development and Acquisition)

Appendix B

SUMMARY OF AD HOC SUBGROUP MEETINGS

INDEX OF PRESENTATIONS

Appendix B

SUMMARY OF AD HOC SUBGROUP MEETINGS

The Ad Hoc Subgroup on Testing of Electronic Systems held six meetings during the study. Meeting topics covered briefings on testing procedures and policies and also visits to a number of facilities. Summaries of the meetings follow:

29-30 January Meeting held at the Applied Physics Laboratory, The Johns Hopkins University, Laurel, Maryland: The primary objective of the meeting was to orient ASB members on how testing of electronic systems is currently conducted within the Army and to inform the members of the test facilities/sites that are utilized for this testing. During this meeting, the OASA(RDA) outlined the tasks to be addressed by the Ad Hoc Subgroup. ODCSRDA presented an overview of the Army testing and DARCOM addressed how the Army currently conducts development testing on electronic equipment plus the test facilities/sites utilized for testing this equipment and the associated software. TRADOC briefed on each of their test facilities/sites that are utilized for the operational testing of electronic systems and OTEA addressed how the Army currently conducts operational tests on electronic systems and how the requirements for test sites, equipment, and instrumentation for an operational test are established.

3-4 March meeting held at the Applied Physics Laboratory, The Johns Hopkins University, Laurel, Maryland: The primary objectives of the meeting were to discuss the need for the Automated Tactical Systems Test Bed plus obtain a perspective of similar testing in the Navy and the views of other agencies/activities not directly associated with testing in the Army. The rationale for developing the Automated Tactical Systems Test Bed was presented to the Subgroup. The Subgroup was briefed on what the testing community is expected to present to the ASARC from the ASARC perspective. Also briefed was the OSD perspective of Army testing and Navy testing of communications and C^3I developmental test and evaluation.

18 March meeting held at the TRADOC Combined Arms Test Activity, Fort Hood, Texas: The primary objective of the meeting was to orient the ASB members on the testing capabilities and facilities of the TRADOC Combined Arms Test Activity (TCATA). During this meeting, the ASB members were briefed on TCATA's force development test and experimentation testing mission, the testing of electronic systems, the design of tests, TRADOC's test methodology, and instrumentation to include the Automated Tactical Systems Test Bed and the Mobile Automated Field Instrumentation System. The members also visited TCATA's ADP facilities, observed some of their instrumentation, received a briefing on ongoing M1 Tank testing, and inspected the M1 Tank.

13-14 April meeting held at the US Army Missile Command, Redstone Arsenal, Alabama: The primary objective of the meeting was to gain an understanding of missile and associated software systems testing. Discussions were held on the testing of PATRIOT, HAWK, PERSHING, and Air Defense Command and Control. Additional discussions included MICOM's system testing policy, software testing policy and testing after operational test III. The Subgroup also toured many of the facilities at Redstone Arsenal to include a briefing on testing by BMDSCOM.

19-21 May meeting held at White Sands Missile Range, White Sands, New Mexico and the US Army Electronic Proving Ground, Fort Huachuca, Arizona: The primary objective of this meeting was an orientation/ introduction to Army test facilities. Items observed/discussed while at WSMR were: MLRS testing plus observing a test firing, software testing, range control, drone control center, and electronic countermeasure testing. Items observed/discussed while at Fort Huachuca were: update of MAINSITE, plans for testing PLRS plus a test site visit, software testing, TRI-TAC test facility, and countermeasures testing. The Subgroup also visited the Intelligence Security Board at Fort Huachuca and the Electromagnetic Environmental Test Facility at Tucson, Arizona.

9-10 July meeting held at the Applied Physics Laboratory, The Johns Hopkins University, Laurel, Maryland: The primary objectives for the meeting were to gain insight into how the TECOM test facilities are utilized and to discuss the production of a final report. TECOM presented a briefing addressing how the facilities complement each other, how the utilization of these facilities is prioritized and scheduled, and who performs the scheduling functions to insure efficient utilization. The discussion of the final report resulted in panel members being requested to provide inputs on their areas of particular interest.

ARMY SCIENCE BOARD

AD HOC SUBGROUP ON TESTING OF ELECTRONIC SYSTEMS

INITIAL MEETINGS OF 29-30 JANUARY 1981

THE JOHNS HOPKINS UNIVERSITY

APPLIED PHYSICS LABORATORY

LAUREL, MARYLAND

Introductory Remarks	Dr. Mark Epstein Deputy for Communications and Target Acquisition OASA(RDA)
* Overview of Army Materiel Testing	Mr. J. P. Tyler DAMA Policy, Plans, Management Division
* Development Testing of Electronic Systems	Mr. G. H. Banister Army Electronic Proving Ground Fort Huachuca, Az.
* Operational Testing of Electronic Systems	COL Myron Motski, MAJ Franklin Lehman OTEA, Falls Church, Va.
* Test Facilities at Fort Huachuca	Mr. G. H. Banister
* Test Facilities at White Sands Missile Range	Mr. F. G. Sebastian WSMR, NM.
* TRADOC Test Facilities and Boards	Mr. G. D. Reich Fort Monroe, Va. Dr. D. W. Collier Fort Hood, Tx.

*Unclassified Presentation Material Available

ARMY SCIENCE BOARD

AD HOC SUBGROUP ON TESTING OF ELECTRONIC SYSTEMS

MEETINGS OF 3-4 MARCH 1981

THE JOHNS HOPKINS UNIVERSITY

APPLIED PHYSICS LABORATORY

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** Rationale for the Automated Tactical Systems Test Bed Fort Hood, Tx.	MAJ R. L. Hemphill DAMO Requirements Directorate Command and Control Division
* The ASARC Perspective Organizational/Analysis of Testing DCP Goals/Thresholds Case Histories	LTC J. E. Easterbrook DAMA Command/Control Surveillance Division
* Discussion of Army Program Case History -- DT/OT	Dr. R. L. Norwood Deputy for Air & Missile Systems OASA (RDA) Mr. J. F. Bradshaw Member, OASA (RDA) Review Panel
*** OSD Perspective Requirements/Decision Process Case Histories Interaction with Services	BG Eugene Fox Deputy for Tactical Air & Land Warfare Systems ODD T&E COL R. O. Anderson COL R. W. Demont COL E. C. Robinson

* Unclassified Presentation Material Available

** Confidential Presentation Material Available

*** Secret Presentation Material Available

ARMY SCIENCE BOARD

AD HOC SUBGROUP ON TESTING OF ELECTRONIC SYSTEMS

MEETING OF 3-4 MARCH 1981

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* Navy C^3I Development Testing Facilities/Testing Methods Case Histories	Mr. C. T. Ogata Naval Ocean Systems Command San Diego, Ca.
*** Navy Testing of Oper. Communications Fleet Ballistic Missile Evaluation Responsive Threats Quantitative Methods Application to PERSHING Program	Mr. T. R. Evans JHU/APL
** Testing and Evaluation of the AEGIS Combat System Ashore and At Sea Concept Evaluation/DT/OT Combat System Engineering Development Center USS NORTON SOUND	CAPT R. C. Beers Project Manager Cruiser/Destroyer Acquisition CAPT G. R. Meinig, Jr. Technical Director AEGIS Shipbuilding Project NAVSEA, Washington, D. C.
* System Integration/T&E for Cruiser "New Threat Upgrade" Land-Based Test Site -- DT/OT Devel. Support for Deployed Systems	Mr. J. W. Schneider JHU/APL

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MEETING OF 18 MARCH 1981

HEADQUARTERS TRADOC COMBINED ARMS TEST ACTIVITY

FORT HOOD, TEXAS

TCATA/DCSTE	CofS
Electronic Testing Discussions	Dir, BATD
Test Design Discussions	P&O/M&A
TRADOC Methodology	ACS, M&A
Instrumentation	ACS, I

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MEETINGS OF 13-14 APRIL 1981

UNITED STATES ARMY MISSILE COMMAND

REDSTONE ARSENAL, ALABAMA

** PATRIOT System Testing	BG Jerry Max Bunyard
BMDSCOM System Testing	Mr. Richardson
* MICOM System Testing Policy	Mr. Black/Mr. McCutchen
* Software Testing Policy	Mr. Ciliax
* MICOM Testing after OT III	Mr. Irvin
* PM Testing - HAWK	Mr. Robins
* PM Testing - PERSHING	Mr. Tidwell
* PM Testing - Air Defense Command and Control	COL D. L. Wyatt

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MEETING OF 19 MAY 1981

US ARMY WHITE SANDS MISSILE RANGE

WHITE SANDS MISSILE RANGE, NEW MEXICO

* Software Testing	Mr. J. Ellis
PERSHING II	Mr. W. DeBusk
MLRS Firing and Briefing	Mr. L. Robinson
ECM Testing	COL J. Pollard, Mr. B. Miller

* Unclassified Presentation Material Available

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MEETINGS OF 20-21 MAY 1981

US ARMY ELECTRONIC PROVING GROUND

FORT HUACHUCA, ARIZONA

* TRI-TAC Joint Test Element/CTF	COL Rogers
USAEPG Command Briefing	COL Kosmider
* MAINSITE Update	Mr. G. H. Banister
INSBD Briefing	COL Dunlap

* Unclassified Presentation Material Available

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MEETINGS OF 9-10 JULY 1981

THE JOHNS HOPKINS UNIVERSITY

APPLIED PHYSICS LABORATORY

LAUREL, MARYLAND

* TECOM Workload Planning	Mr. Louis Teletski Aberdeen Proving Ground Aberdeen, Maryland
* TECOM Initiative Master Resource Programming	Mr. George Schroeter Aberdeen Proving Ground Aberdeen, Maryland

* Unclassified Presentation Material Available

AN OVERVIEW OF ARMY MATERIEL TESTING

Appendix C

AN OVERVIEW OF ARMY MATERIEL TESTING

- DEFINITIONS
- ORGANIZATIONS
- TYPES OF TESTS
- FUNDING

OFFICE OF THE DEPUTY CHIEF OF STAFF
FOR RESEARCH, DEVELOPMENT
AND ACQUISITION

DEVELOPMENT TESTING

DEVELOPMENT TESTING SCOPE

- BASIC POLICIES - DODD/AR
- DEFINITIONS
- TE FACILITIES AND ORGANIZATIONS
- LIFE CYCLE TESTING
- COORDINATED TEST PROGRAM (CTP)
- TEST DESIGN AND EVALUATION - SITC
- TEST INTEGRATION WORKING GROUP (TIWG)
- SPECIAL TESTING (RAM. PI. CLIM)
- PRODUCTION TESTING - NDI TESTING

WHY TEST?

- MEET REQUIREMENTS
- DATA FOR DECISIONS
- PROBLEMS CORRECTED
- RESOLVE CRITICAL ISSUES

DEVELOPMENT TEST AND EVALUATION (DT&E)

DT&E IS THAT TEST AND EVALUATION CONDUCTED TO ASSIST THE ENGINEERING DESIGN AND DEVELOPMENT PROCESS AND VERIFY ATTAINMENT OF TECHNICAL PERFORMANCE SPECIFICATIONS AND OBJECTIVES.

OBJECTIVES OF DEVELOPMENT TESTING AND EVALUATION (DT&E)

- TECHNICAL PERFORMANCE SPECIFICATIONS
- ENGINEERING DESIGN
- CONTRACTOR PERFORMANCE
- HUMAN FACTORS (SOLDIER/MACHINE)
- SAFETY
- LOGISTIC SUPPORTABILITY
- COMPATIBILITY - INTEROPERABILITY
- SURVIVABILITY/VULNERABILITY
- PRODUCIBILITY
- RELIABILITY - AVAILABILITY - MAINTAINABILITY - (RAM)

OPERATIONAL TEST AND EVALUATION (OT&E)

OT&E IS THAT TEST AND EVALUATION CONDUCTED TO ESTIMATE A SYSTEM'S OPERATIONAL EFFECTIVENESS (INCLUDING SURVIVABILITY/VULNERABILITY) AND OPERATIONAL SUITABILITY (INCLUDING AVAILABILITY, SAFETY, HUMAN FACTORS LOGISTIC SUPPORTABILITY AND TRAINING REQUIREMENTS), AS WELL AS THE NEED FOR ANY MODIFICATIONS.

OBJECTIVES OF OPERATIONAL TESTING (OT&E)

- ESTIMATE OPERATIONAL EFFECTIVENESS
- ESTIMATE OPERATIONAL SUITABILITY
- SURVIVABILITY/VULNERABILITY
- COMPATIBILITY/INTEROPERABILITY
- TRANSPORTABILITY
- RELIABILITY, AVAILABILITY AND MAINTAINABILITY (RAM)
- SAFETY
- HUMAN FACTORS (SOLDIER/MACHINE)
- LOGISTICAL SUPPORTABILITY
- TRAINING REQUIREMENTS
- ORGANIZATION/PERSONNEL
- DOCTRINE AND TACTICS

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FORCE DEVELOPMENT TESTING AND EXPERIMENTATION (FDTE)

TESTS THAT RANGE FROM A SMALL, HIGHLY INSTRUMENTED, AND HIGH-RESOLUTION FIELD EXPERIMENT, TO A LARGE, LESS INSTRUMENTED, LOW-RESOLUTION, BUT STILL A CONTROLLED SCENARIO, FIELD TEST.

OBJECTIVES OF FORCE DEVELOPMENT TESTING AND EXPERIMENTATION (FDTE)

- CONCEPT OF EMPLOYMENT
- OPERATIONAL FEASIBILITY
- OPERATIONAL ADVANTAGE/POTENTIAL
- ASSIST IN LOA DEVELOPMENT

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COORDINATED TEST PROGRAM (CTP)

A PLANNING DOCUMENT WHICH FORMALIZES THE ALL-INCLUSIVE TESTING ACTIVITIES RELATING TO A DEVELOPMENT PROJECT. IT IS EVOLUTIONARY IN NATURE, SECTIONALIZED BY MAJOR TESTS AND DEVELOPED AND MAINTAINED BY THE MATERIEL DEVELOPER ON AN ITEM OR SYSTEM BASIS.

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TEST AND EVALUATION MASTER PLAN (TEMP)

A BROAD PLAN THAT RELATES TEST OBJECTIVES TO REQUIRED SYSTEM CHARACTERISTICS AND CRITICAL ISSUES, AND INTEGRATES OBJECTIVES, RESPONSIBILITIES, RESOURCES, AND SCHEDULES FOR ALL TESTS AND EVALUATIONS TO BE ACCOMPLISHED.

OSD T&E OFFICES

USDRE -------- (DSARC) ------ **ASD (M,R&AL)**

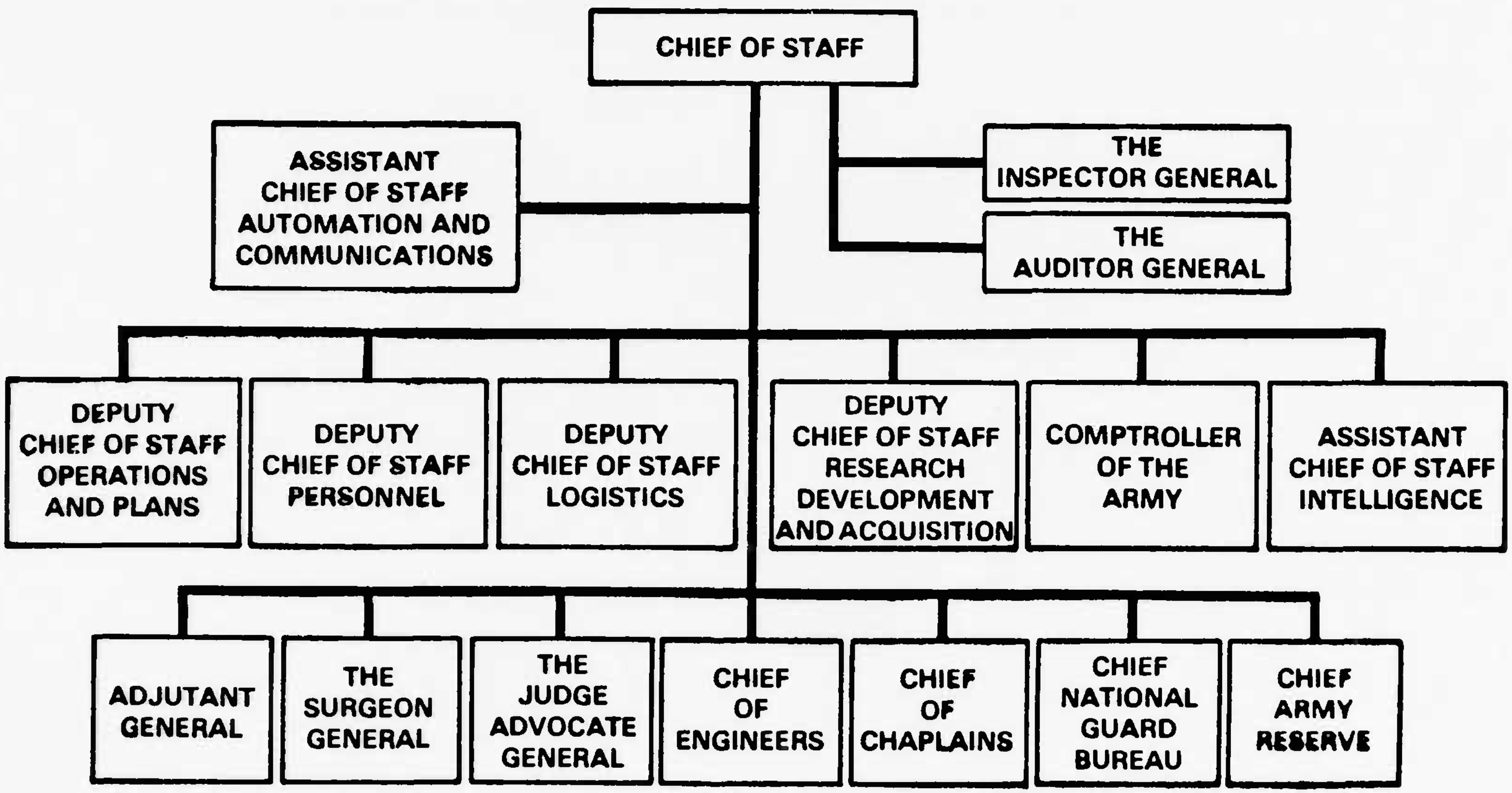
DIRECTOR DEFENSE T&E (DDTE)

- ADVICE TO DSARC
- TEST POLICY (DODD 5000.3)
- FACILITY BASE (DODD 3200.11)
- BUDGET
- APPROVE TEMP
- T&E PRE-DSARC REVIEWS

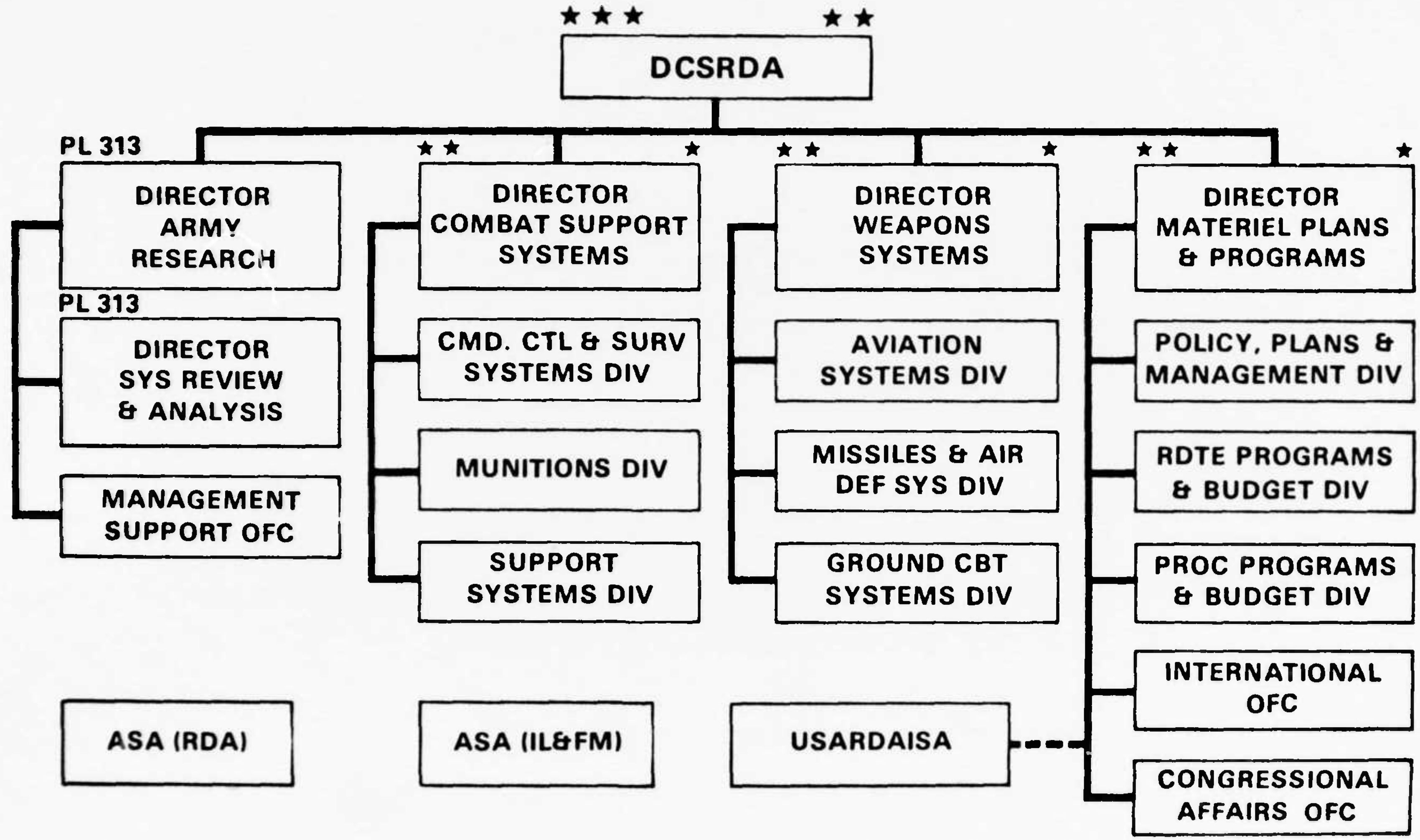
SPECIAL ASSISTANT FOR WEAPON SYSTEMS IMPROVEMENT

- MANPOWER AND LOGISTIC REVIEWS AND ANALYSIS
- SYSTEM RAM/O&S COSTS

ORGANIZATION ... HQDA



Office of the Deputy Chief of Staff for Research, Development and Acquisition



TEST TEAM FUNCTIONAL AREAS

POLICY

- TEST & EVALUATION
- RELIABILITY, AVAILABILITY & MAINTAINABILITY
- SECURE TELEMETRY

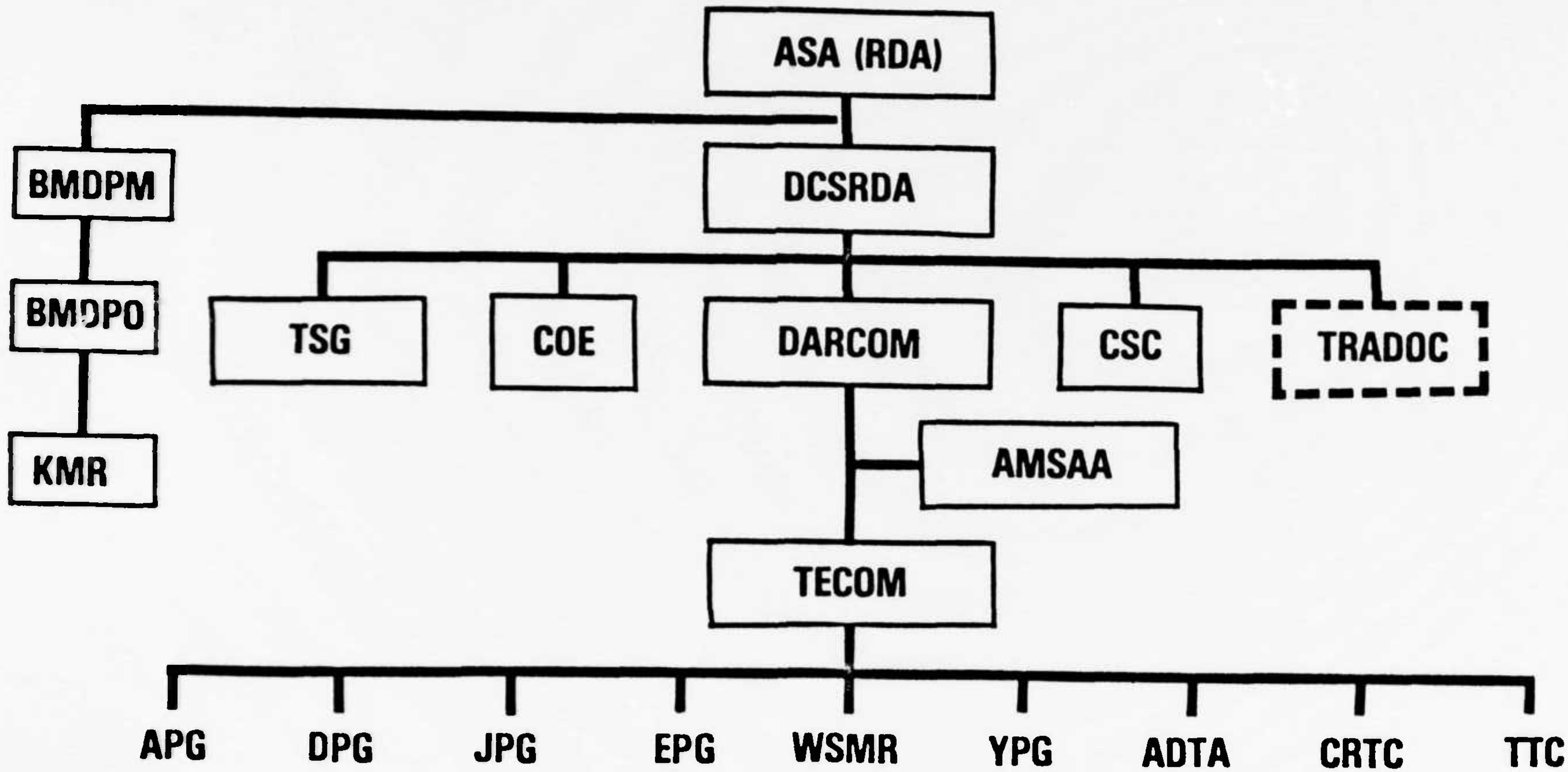
PLANS

- TEST & EVALUATION

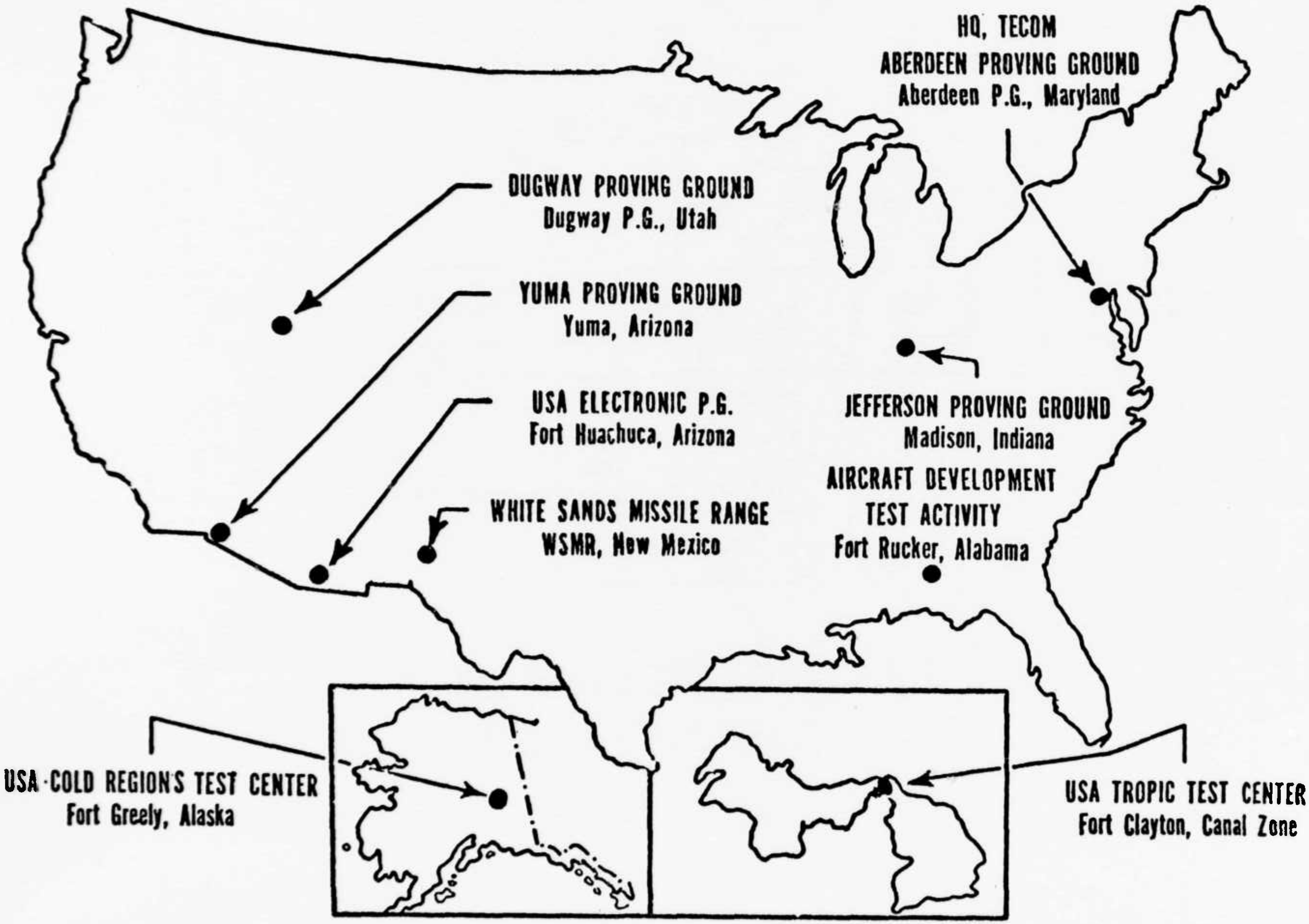
MANAGEMENT

- TEST & EVALUATION
- THREAT SIMULATORS
- BUDGET PROPONENT & ANALYSIS
- EDUCATION & TRAINING

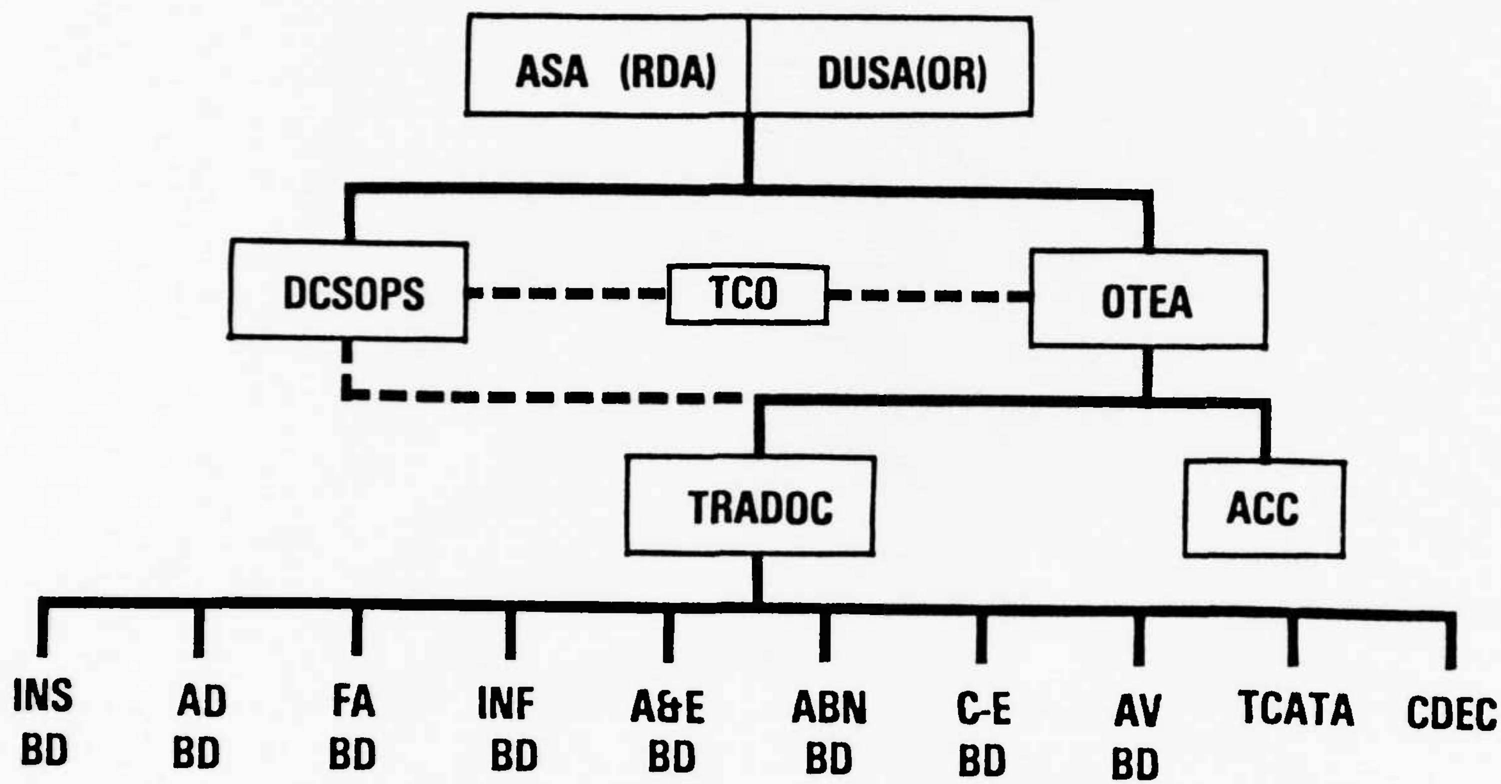
ARMY DEVELOPMENT TESTING MANAGEMENT STRUCTURE



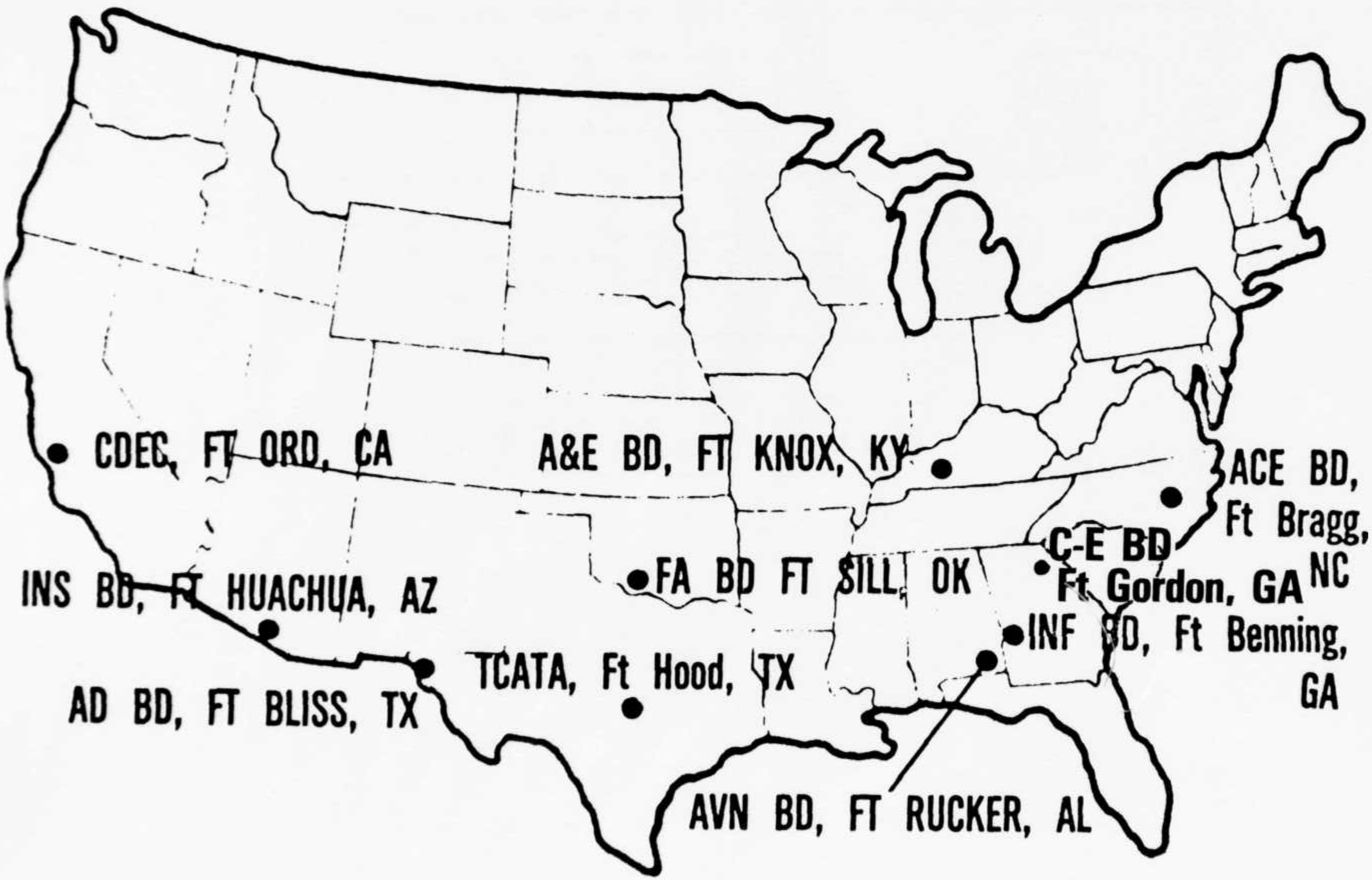
U.S. ARMY TEST & EVALUATION COMMAND



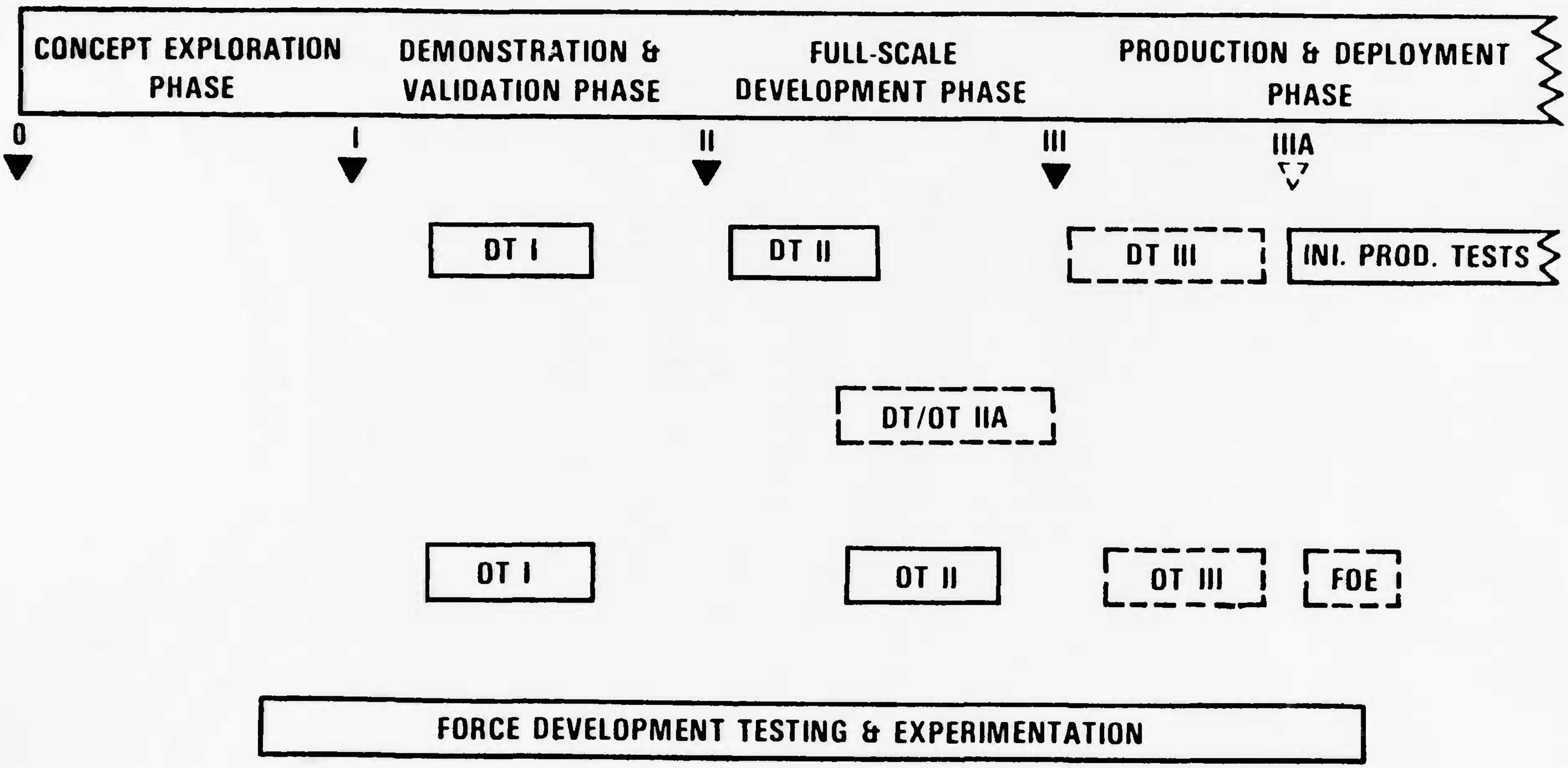
ARMY USER TESTING MANAGEMENT STRUCTURE



TRADOC TEST FACILITIES



ARMY MATERIEL ACQUISITION CYCLE TESTING



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DEMONSTRATION AND VALIDATION PHASE TESTING

DEVELOPMENT TEST I:

- IDENTIFY TECHNICAL APPROACH
- TECHNICAL RISK IDENTIFICATION

OPERATIONAL TEST I:

- EXAMINE TECHNICAL APPROACH
- REFINE CRITICAL ISSUES
- ESTIMATE POTENTIAL OF SYSTEM
- ESTIMATE ADEQUACY OF CONCEPTS
- EARLY IDENTIFICATION OF PROBLEMS

FULL-SCALE DEVELOPMENT PHASE TESTING

DEVELOPMENT TEST II:

- ENGINEERING DESIGN COMPLETE
- SIGNIFICANT DESIGN PROBLEM IN HAND
- CRITERIA FOR PRODUCTION MET

OPERATIONAL TEST II:

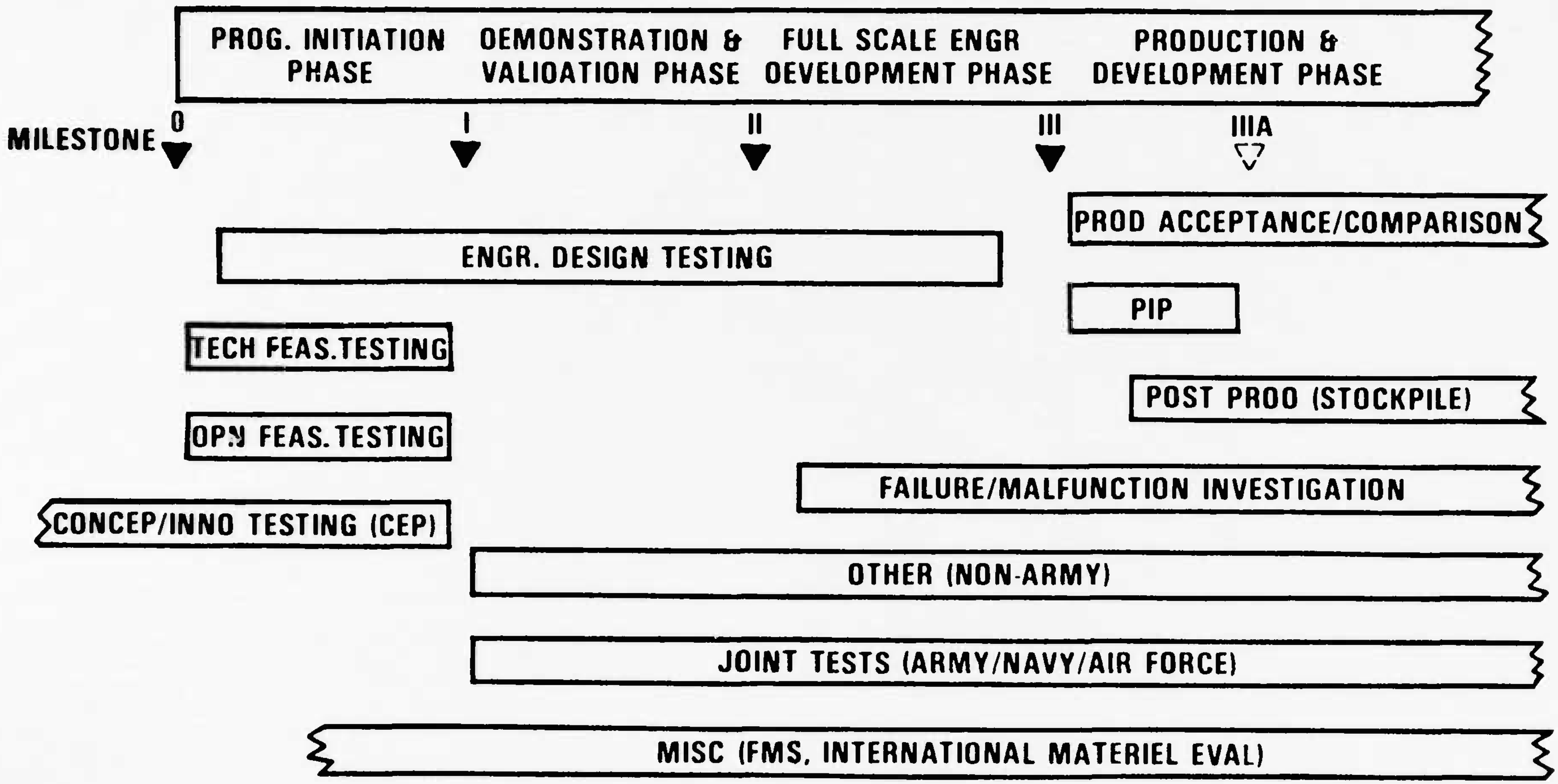
- ESTIMATE OPERATIONAL PERFORMANCE
- CHARACTERIZED BY:
  - ORGANIZATIONAL (TOE) UNIT
  - CONTROLLED FIELD EXERCISES
  - ASSESSMENT OF TRAINING SUPPORT PACKAGE
  - COMPARATIVE TESTING

PRODUCTION AND DEPLOYMENT PHASE TESTING

- PRODUCTION ACCEPTANCE TEST AND EVALUATION: TO DEMONSTRATE THAT PROCURED ITEMS FULFILL THE REQUIREMENTS AND SPECIFICATIONS OF THE PROCURING CONTRACT OR AGREEMENTS.

- FOLLOW-ON EVALUATION: CONDUCTED, AS REQUIRED, SUBSEQUENT TO THE PRODUCTION AND DEPLOYMENT DECISION TO PROVIDE INFORMATION NOT GAINED FROM EARLIER TESTING AND EVALUATION.

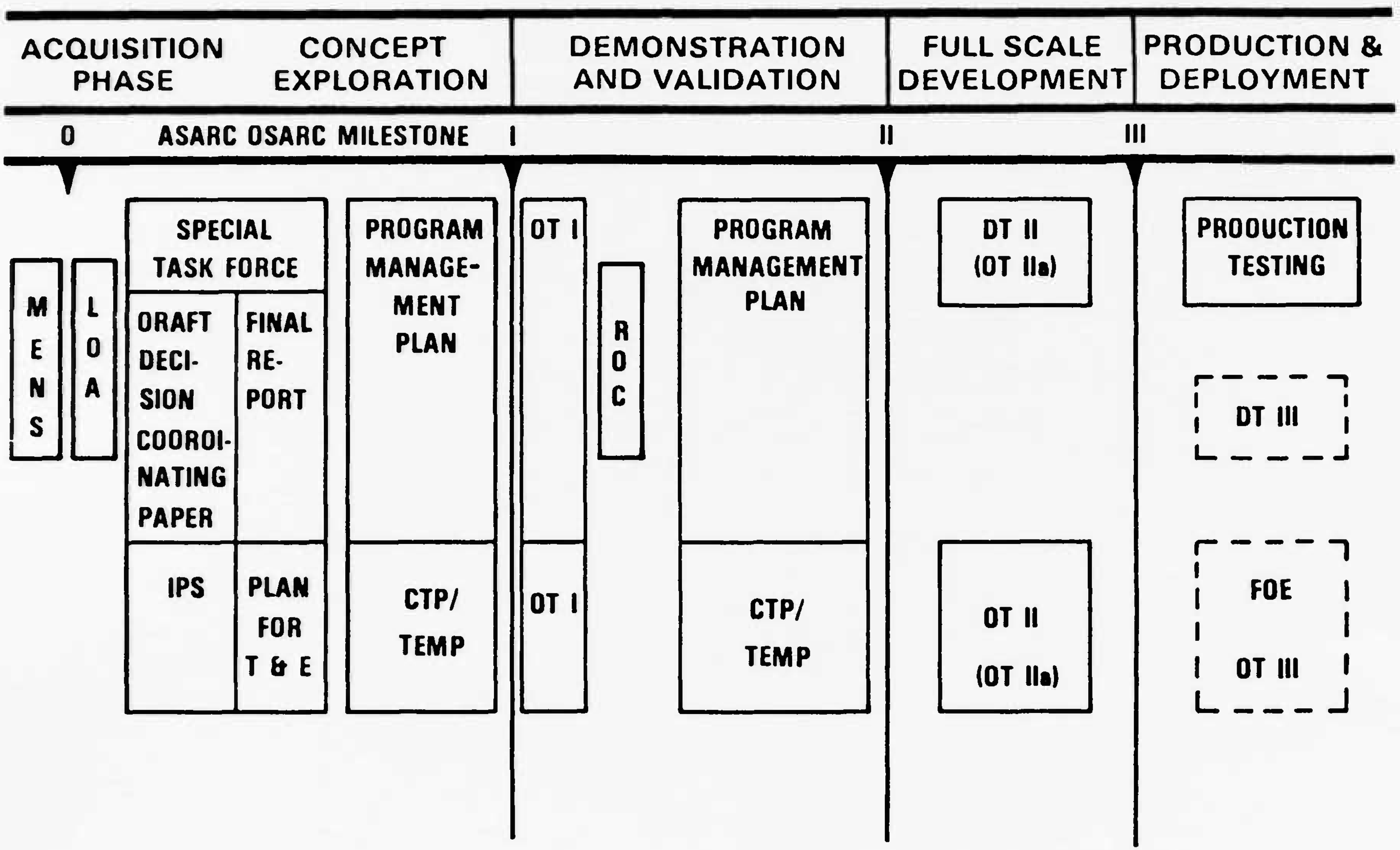
OTHER TESTING



CRITICAL ISSUES

CRITICAL ISSUES ARE THOSE ISSUES ASSOCIATED WITH THE DEVELOPMENT OF AN ITEM/SYSTEM THAT ARE OF PRIMARY IMPORTANCE TO THE DECISION AUTHORITY IN REACHING A DECISION TO ALLOW THE ITEM/SYSTEM TO CONTINUE INTO THE NEXT PHASE OF ACQUISITION.

CONCEPT OF OPERATION IN THE MATERIEL ACQUISITION PROCESS

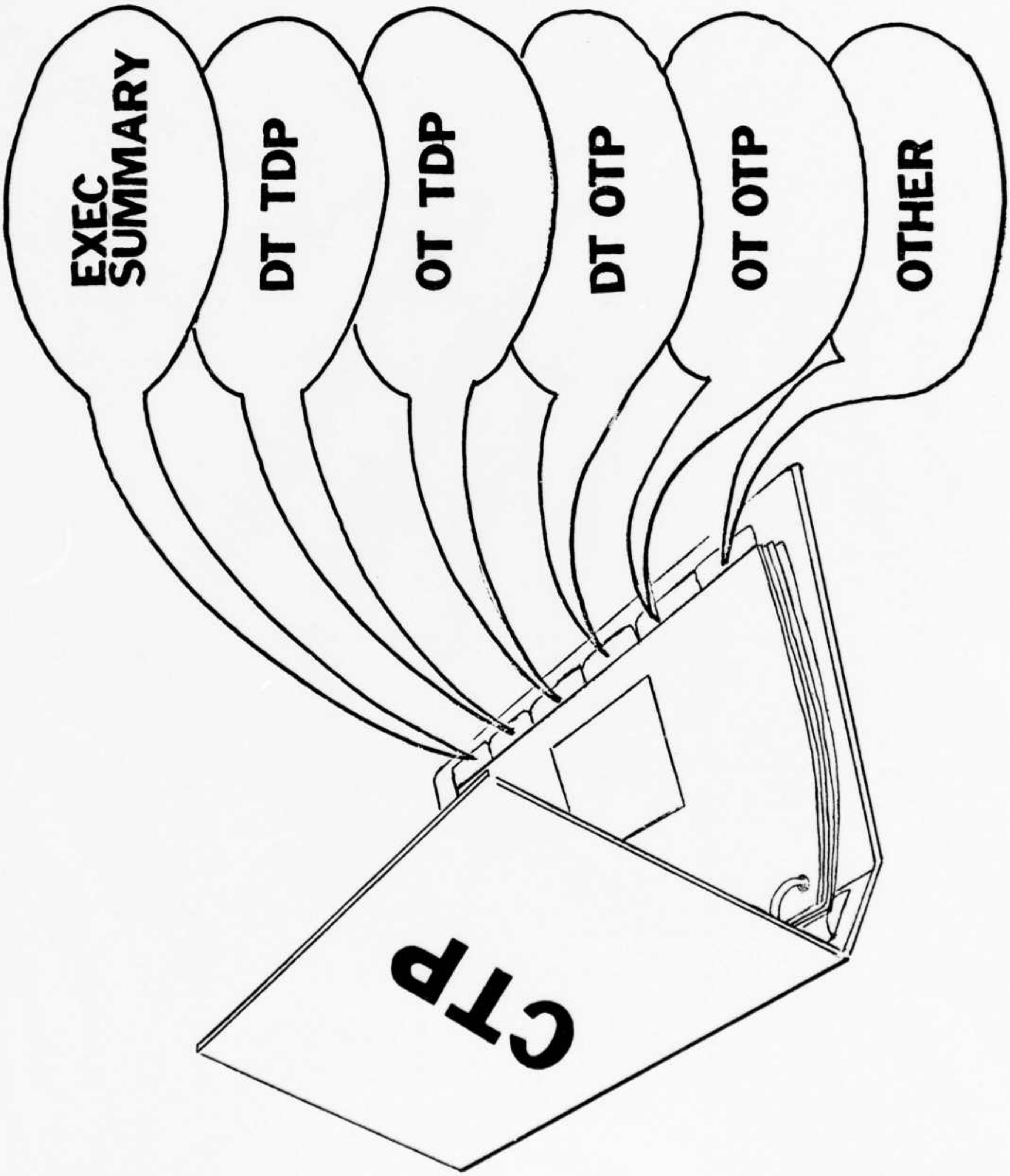


OSD AND HQDA MAJOR PROGRAMS

(TENTATIVE)

AAH	ABRAMS	ROLAND
ASH	*STINGER-POST	VRFW-S
AN/TPQ-37	MSE	SINCGARS-V
AN/TTC-39/CS	FVS	DSWS
COPPERHEAD	NAVSTAR-GPS	PLRS
YCH-47D	P II	ERG/ARP
DIVAD GUN	SOTAS	CSWS
MLRS	PATRIOT	SHORAD C^2
AHIP	SIGMA	TACSATCOM-SC
IMAAWS	RPV/TADARS	*TACSATCOM-MC
CNCE	TGW	
DS-ATSS	MTCC	
HELLFIRE		

(* - ASARC ONLY)


EXEC SUMMARY
DT TDP
OT TDP
DT OTP
OT OTP
OTHER
CTP

TEST INTEGRATION WORKING GROUP (TIWG)

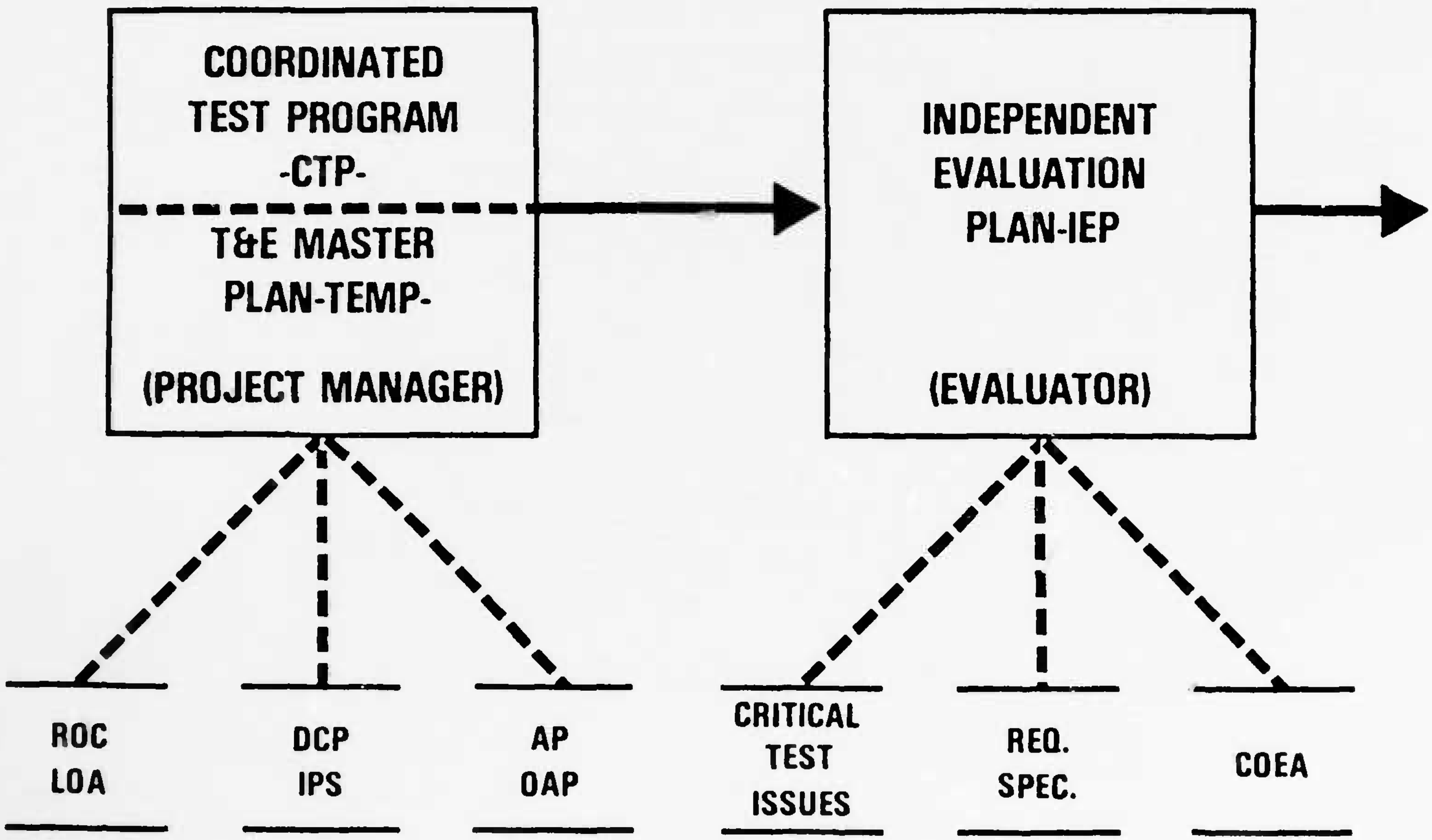
MEMBERS:

- Materiel Developer
- Combat Developer
- Operational Tester
- Development Tester
- OT Evaluator
- DT Evaluator
- User
- Contractor(s)
- Logistician
- Trainer
- Others

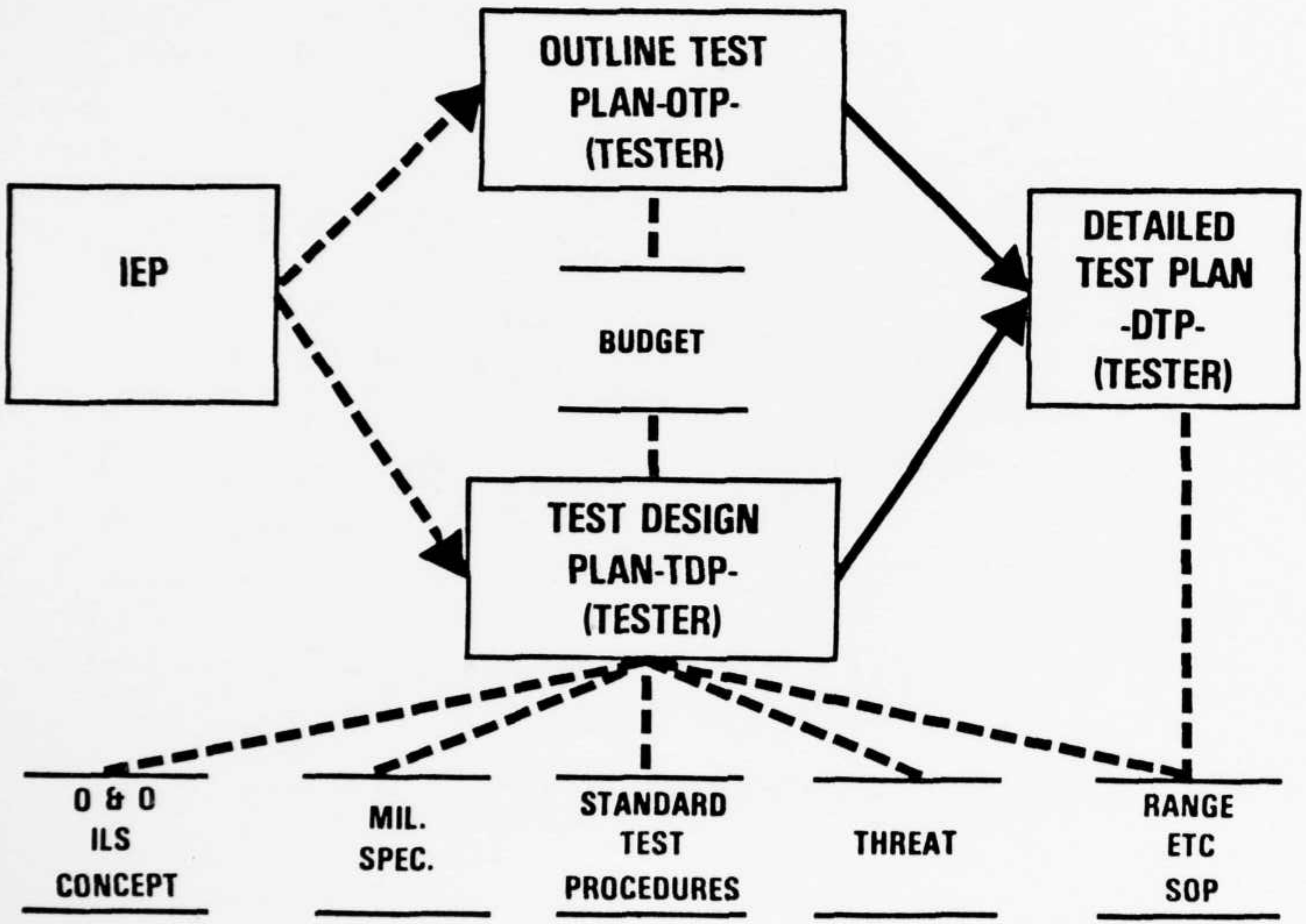
OPERATIONS:

1. PM chairs
2. Working/coordinating
3. Differences resolved higher
4. Test criteria and resources oriented
5. Basic products are CTP

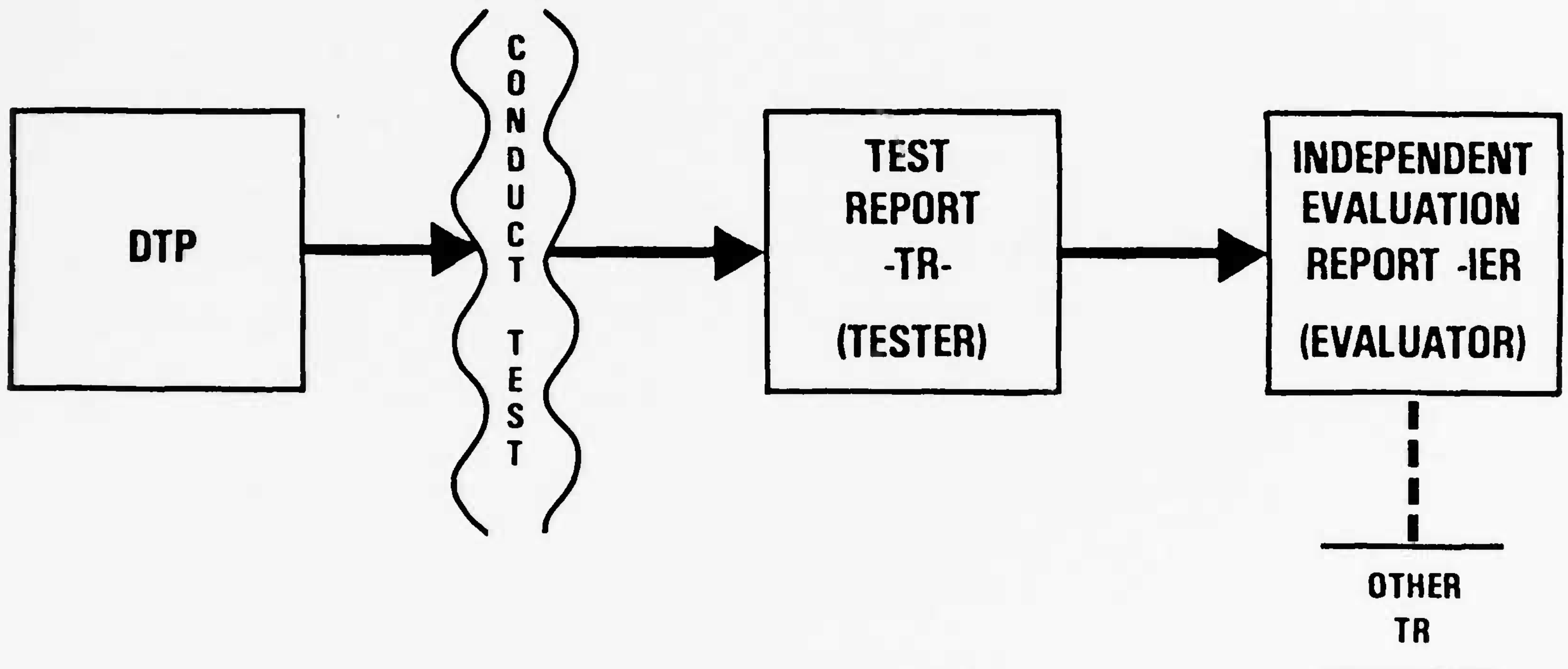
TEST AND EVALUATION DOCUMENTATION



TEST AND EVALUATION DOCUMENTATION



TEST AND EVALUATION DOCUMENTATION



T&E RELATED REGULATIONS

DOCUMENT	DATE	SHORT TITLE
DODD 5000.1	19 MAR 80	MAJOR SYSTEMS ACQUISITION
DODD 5000.3	26 DEC 79	TEST AND EVALUATION
DODD 3200.11	29 SEP 80	MANAGEMENT OF MAJOR RANGES
AR 1000-1	1 APR 78**	BASIC POLICIES FOR ACQUISITION
AR 70-1	1 MAY 75*	RDA MANAGEMENT
AR 70-10	1 JAN 76*	TEST AND EVALUATION
AR 71-3	8 MAR 77	USER TESTING
AR 702-3	1 JAN 77**	ARMY RAM
AR 702-9	1 APR 77	PRODUCTION TESTING
DA PAM 11-25	MAY 75*	LIFE CYCLE MANAGEMENT
DA PAM 70-21	MAY 76	COORDINATED TEST PROGRAM (CTP)

*UNDER REVISION
**REVISED AND STAFFED

Appendix D

U.S. ARMY TEST FACILITIES

SUMMARY OF TYPES OF TESTING CONDUCTED

Appendix D

I. Missions of US Army Test and Evaluation Command Facilities.

ABERDEEN PROVING GROUND

Mission. To conduct testing of tank and small arms weapons systems, ancillary munitions and components, survey and target acquisition material, armor plate, combat, general and special purpose vehicles, combat engineer and troop support equipment.

DUGWAY PROVING GROUND

Mission. To conduct testing of chemical weapons, chemical/biological defense, flame, incendiary and smoke munitions systems and provide technical assessments of Foreign Biological Threats; manage and execute the DoD Joint Chemical-Biological Contact program.

ELECTRONIC PROVING GROUND

Mission. To conduct testing of communications-electronics, optical/electro-optical systems, signal intelligence, electronic warfare systems and other electronic material.

JEFFERSON PROVING GROUND

Mission. To conduct production acceptance, post production, product improvement, malfunction investigation, propellant assessment and master calibration tests of ammunition and ancillary components.

WHITE SANDS MISSILE RANGE

Mission. To conduct testing of rocket and guided missile systems, ancillary guidance/navigation systems, air defense fire distribution systems, laser weapons systems, and other designated material.

YUMA PROVING GROUND

Mission. To conduct testing of tube artillery, aircraft armament and air delivery systems, air movable and mobility equipment and the natural desert environmental phases of developmental test of all classes of defense material.

AVIATION DEVELOPMENT TEST ACTIVITY

Mission. To conduct, evaluate and report on test elements of government developmental and product improvement testing and reporting on contractor test elements of the Single Integrated Development Test Cycle (SIDTC) of aircraft, aircraft components (time-between overhaul, time-between inspection) and aircraft related support equipment.

COLD REGIONS TEST CENTER

Mission. To conduct cold regions environmental testing of all classes of material/systems.

TROPIC TEST CENTER

Mission. To conduct tropic environmental testing of all classes of material/systems.

II. Missions of US Army Training and Doctrine Command Facilities.

US Army Combat Developments Experimentation Command Mission. To participate in the combat and training development process by conducting field experimentation to provide high resolution, accurate data, collected in an operational environment, necessary for improvement of combat effectiveness.

a. USACDEC supports the US Army Training and Doctrine Command (TRADOC) and the Operational Test and Evaluation Agency (OTEA) in operational testing and is responsible for test design and execution of small scale force development testing and experimentation (FDTE).

b. USACDEC plans, designs, and procures instrumentation systems for the collection of data and conducts methodology and feasibility tests to develop rationale for validation of data collection means.

c. USACDEC experiments are typified by force-on-force, statistically reliable tests utilizing real time casualty assessment.

US Army TRADOC Combined Arms Test Activity Mission. To plan and conduct operational and force development tests and evaluations in support of TRADOC combat development and training development programs and to develop instrumentation concepts and exportable advanced technology instrumentation to support testing, field exercises, and training. The scope of TCATA testing includes combined arms, combat service support, and logistics field testing relating to material, tactics, organization and doctrine; command systems testing relating to intelligence integration, electronic warfare and tactical ADP; and training developments evaluations of programs, simulators and devices.

TEST BOARDS

US Army Armor and Engineer Board

US Army Airborne Board

US Army Intelligence and Security Board

US Army Air Defense Board

US Army Aviation Board

US Army Communications-Electronics Board

US Army Field Artillery Board

US Army Infantry Board

Mission: The test boards are assigned the following missions in their respective commodity areas:

a. Plan, conduct, and report on operational and other user tests.

b. Participate in other testing as directed.

c. Provide advice and guidance on test matters to combat, training, and material developers, other services and private industry.

d. Conduct other tests and selected specific evaluations as directed by CDR TRADOC.

III. Glossary of Testing Terms

a. Testing Terms:

ADVT - Advance Development Verification Test

C - Contractor

DT-I - Development Test - I

DT-II - Development Test - II

EDT - Engineer Design Test

FOE - Follow-on Evaluation

G - Government

OT-I - Operational Test - I

OT-II - Operational Test - II

PQT - Prototype Qualification Test

PVT - Production Validation Test

b. Other Terms:

ADTA - Aviation Development Test Activity

AEFA - Aviation Engineer Flight Activity

ARRADCOM - Armament Research and Development Command

ATSTB - Automated Tactical System Test Bed

CDEC - Combat Development Experimentation Command

CECOM - Communication Electronics Command

CSL - Chemical Systems Laboratory

FORSCOM - Forces Command

TACOM - Tank Automotive Command

TCATA - TRADOC Combined Arms Test Activity

WSMR - White Sands Missile Range

IV. Summary of Types of Testing Conducted at Facilities/Activities

Activity / System	Aberdeen Proving Ground	Dugway Proving Ground	Electronics Proving Ground	Jefferson Proving Ground	White Sands Missile Range	Yuma Proving Ground	Aviation Development Test Acty	TRADOC* Test Boards
Aviation			DT-II (Avionics)			DT-II, OT-II (Armament)	DT-I, DT-II PVT-G, PIT	OT-I, OT-II FOE
Chemical/Biological/Incendiary/Smoke		DT-I, DT-II OT-II, PIT PVT-G						OT-II
Artillery	DT-I, DT-II OT-I, PVT-G PIT				DT-I, DT-II, PVT-G	DT-I, DT-II, OT-I, PVT-G PIT		OT-I, OT-II FOE
Tank/ Automotive	DT-I, DT-II, OT-I, PVT-G PIT					DT-I, DT-II, OT-I, PVT-G PIT		OT-I OT-II FOE
Missile					DT-I, DT-II, OT-I, OT-II, PVT-G, PIT			OT-II FOE
C^3I			DT-I, DT-II, OT-I, PVT-G PIT		DT-II			OT-I OT-II FOE
Munitions	DT-I, DT-II, OT-I			PVT-G	DT-I, DT-II, PVT-G	DT-I, DT-II OT-I		OT-I, OT-II FOE

*Conducts operational testing on non-major systems.

DT-Development Test
OT- Operational Test
PVT-G - Production Verification Test, Govt
PIT - Product Improvement Test
FOE - Follow-on evaluation

Progression of Types of Tests Through Army Facilities/Activities

A. Aviation Systems

B. Chemical/Biological/Incendiary/Smoke

C. Artillery Systems

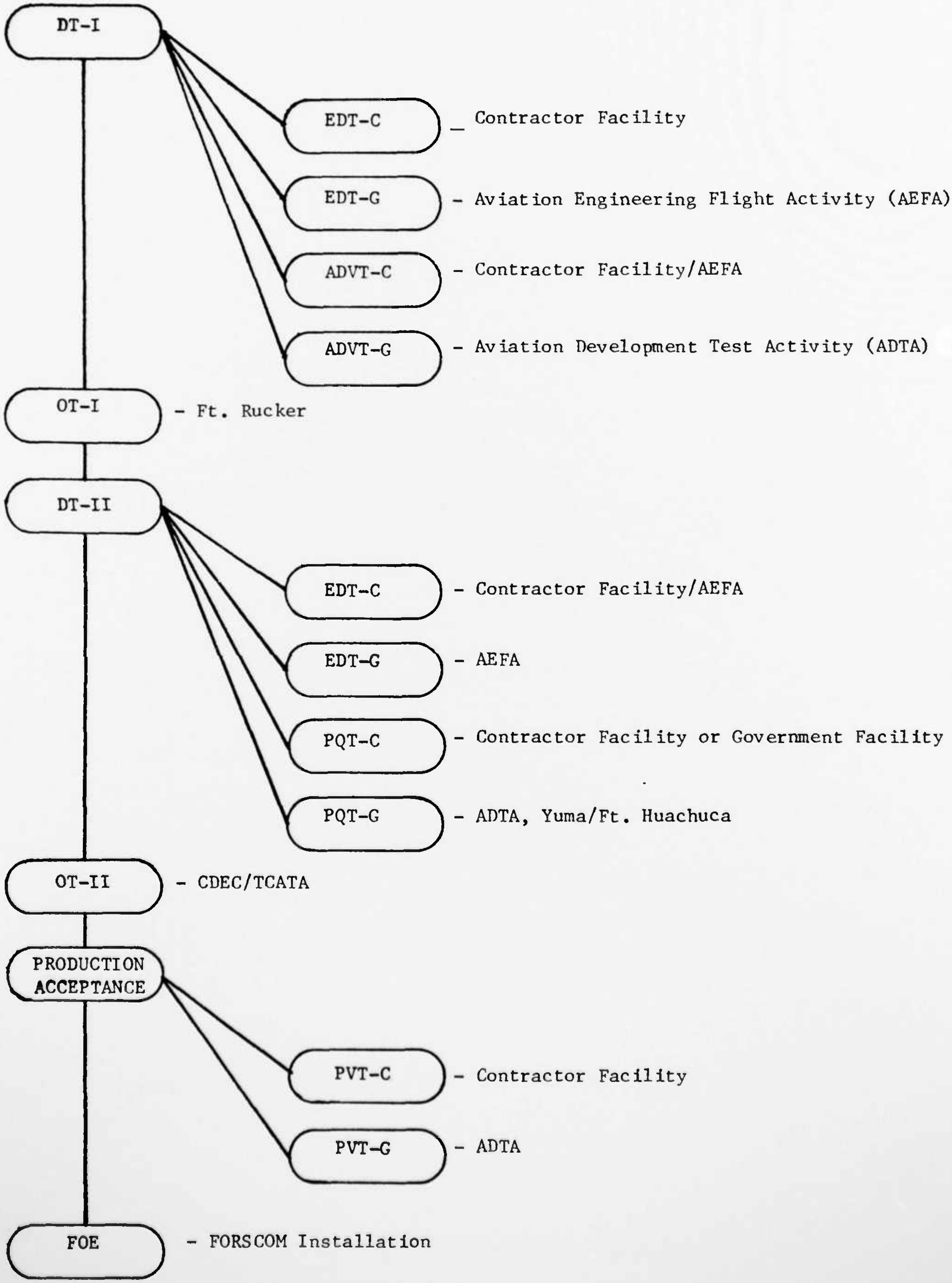
D. Tank/Automotive Systems

E. Missile Systems

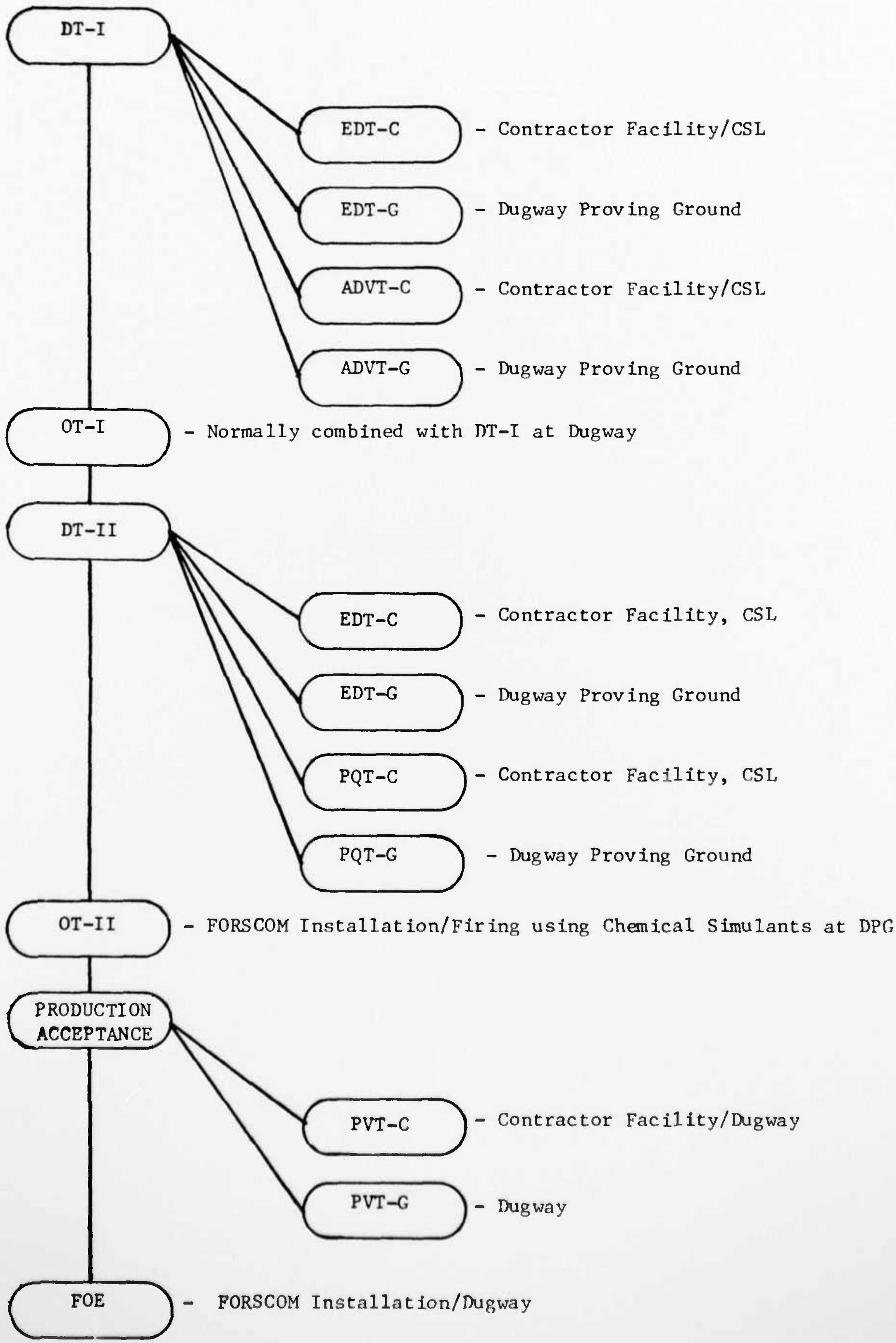
F. C^3I Systems

G. Munitions

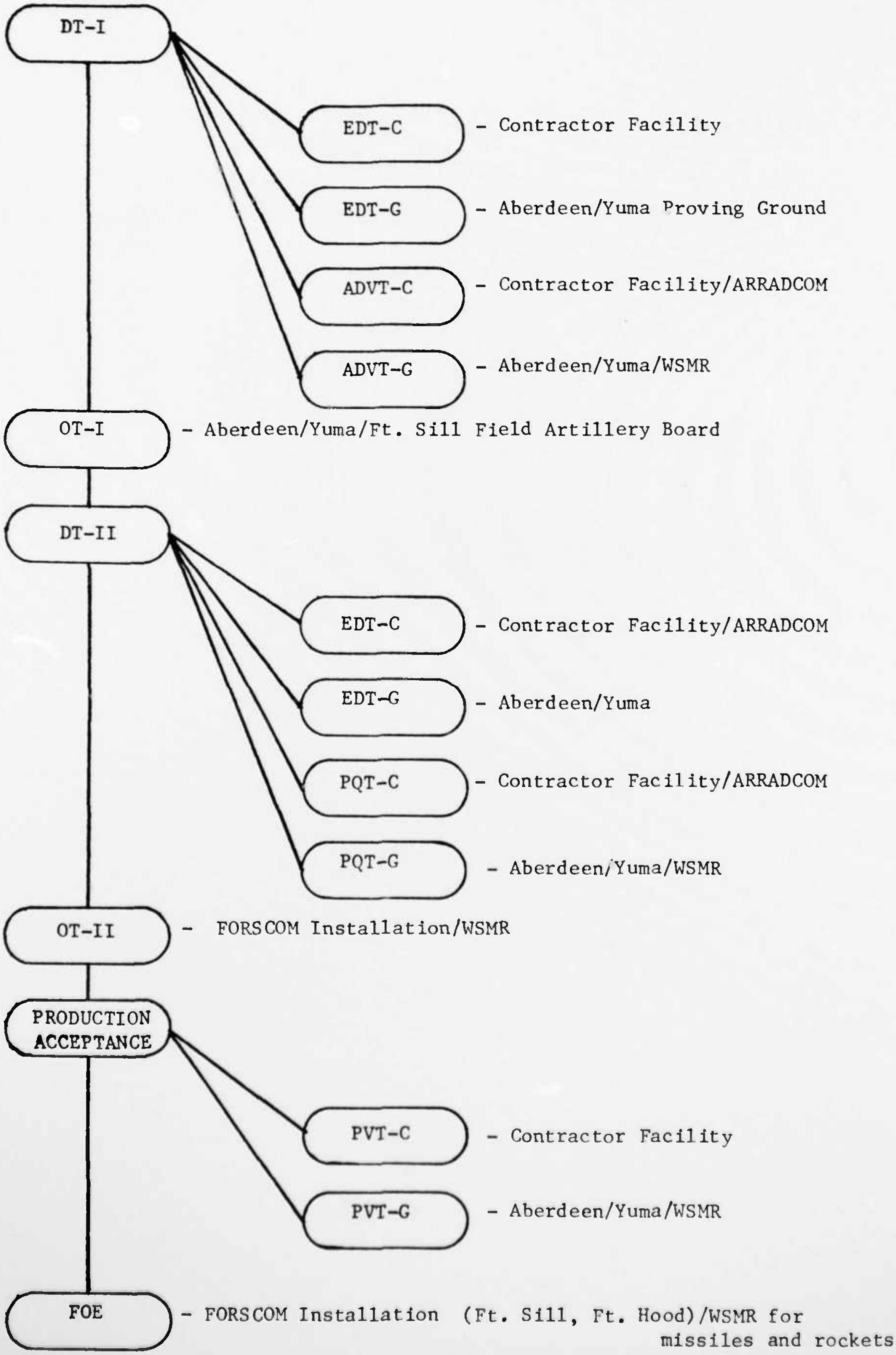
A. AVIATION SYSTEMS



B. CHEMICAL/BIOLOGICAL/INCENDIARY/SMOKE



C. ARTILLERY SYSTEMS



AD-A123 265 ARMY SCIENCE BOARD AD HOC SUBGROUP ON TESTING OF ELECTRONIC SYSTEMS(U) ARMY SCIENCE BOARD WASHINGTON DC 07 SEP 81 2/2

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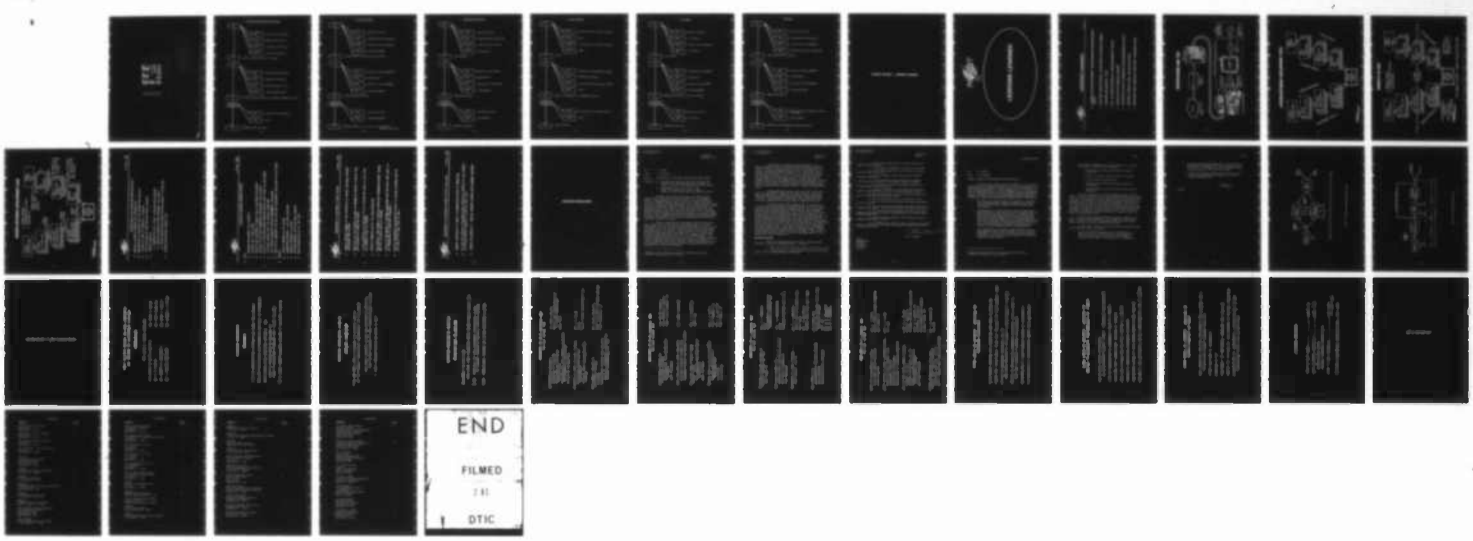
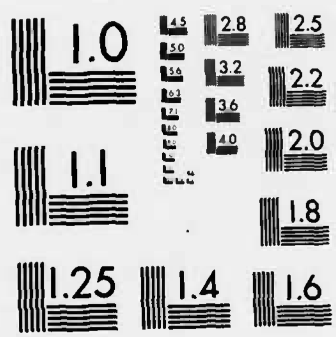
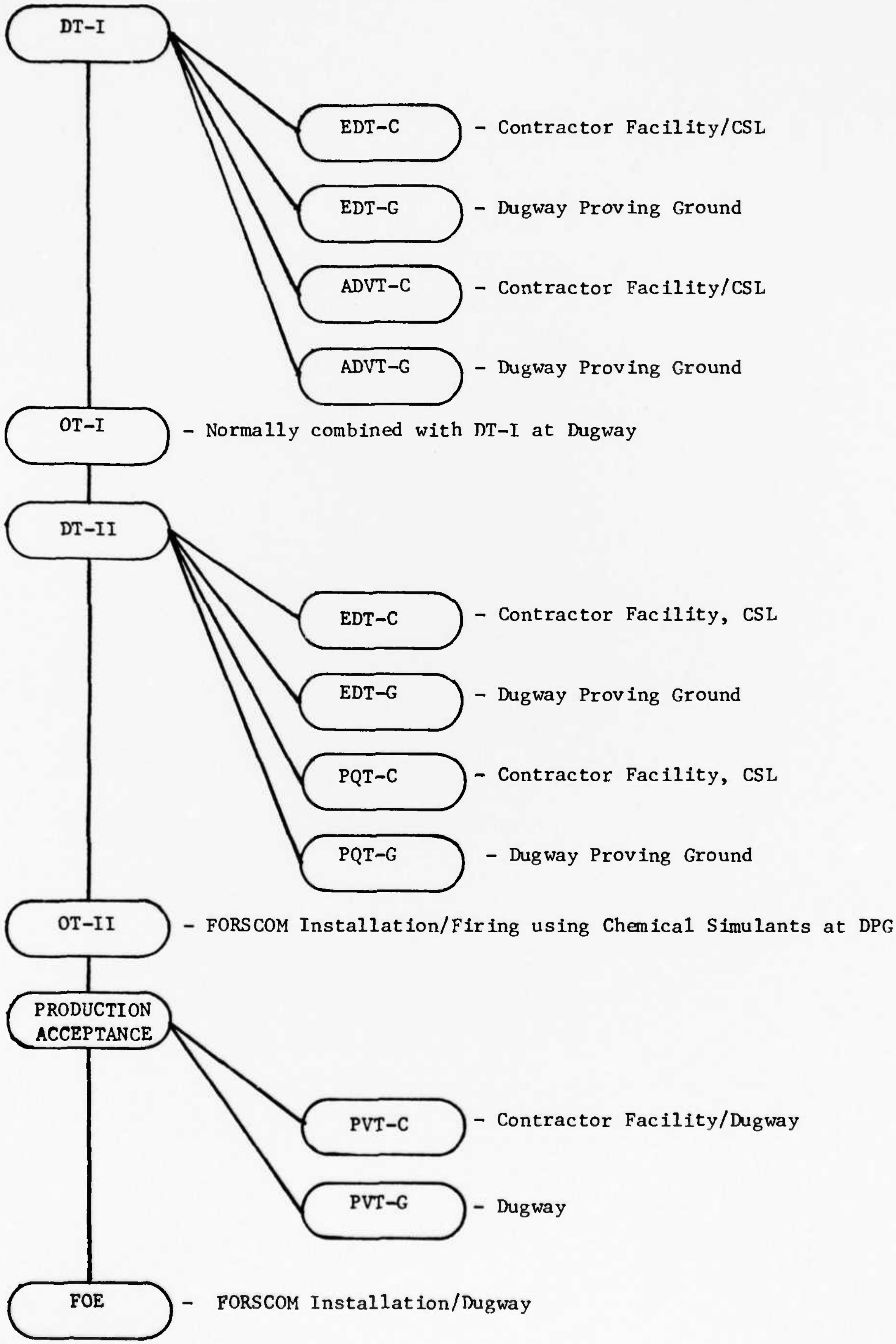


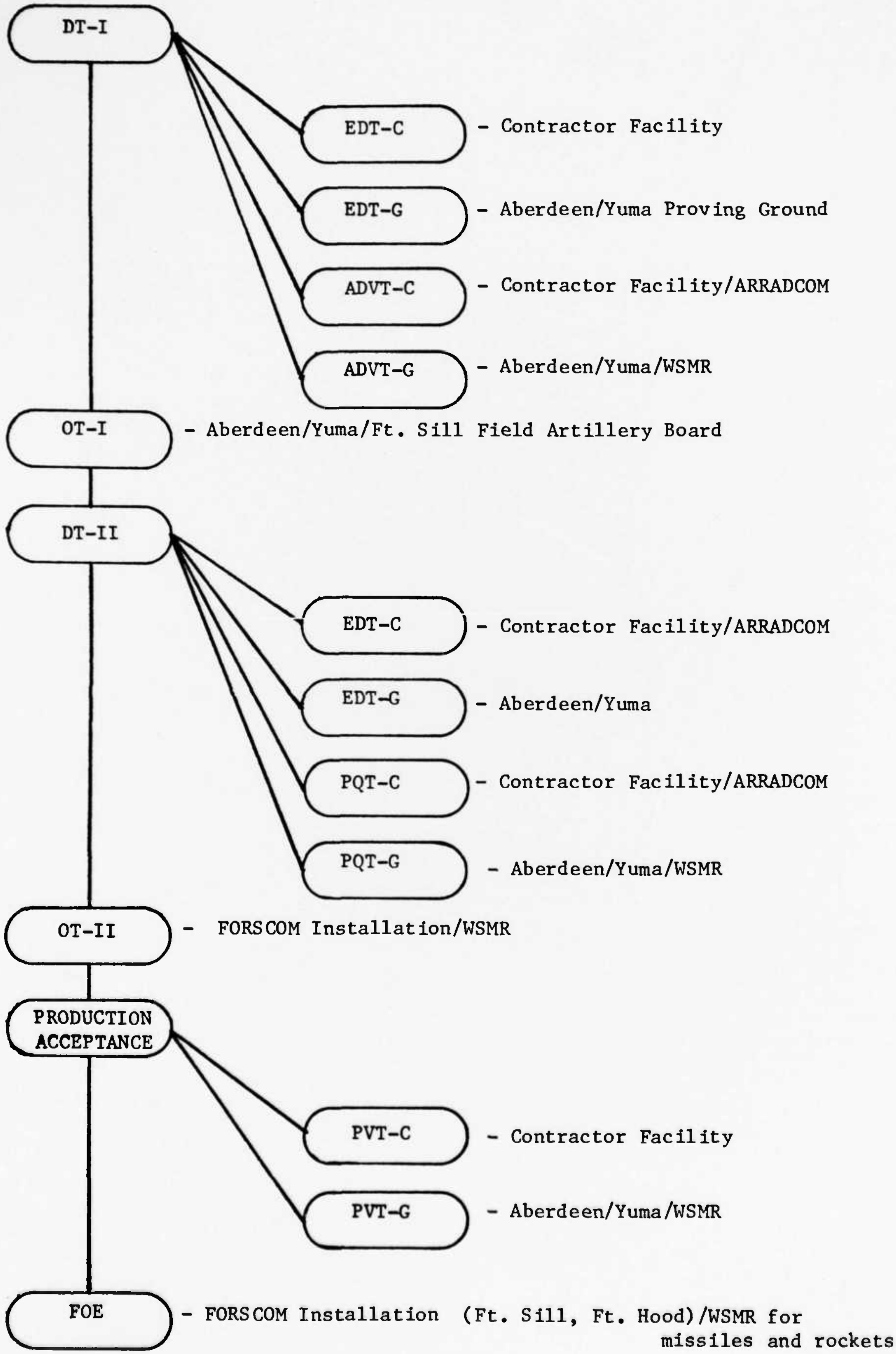


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

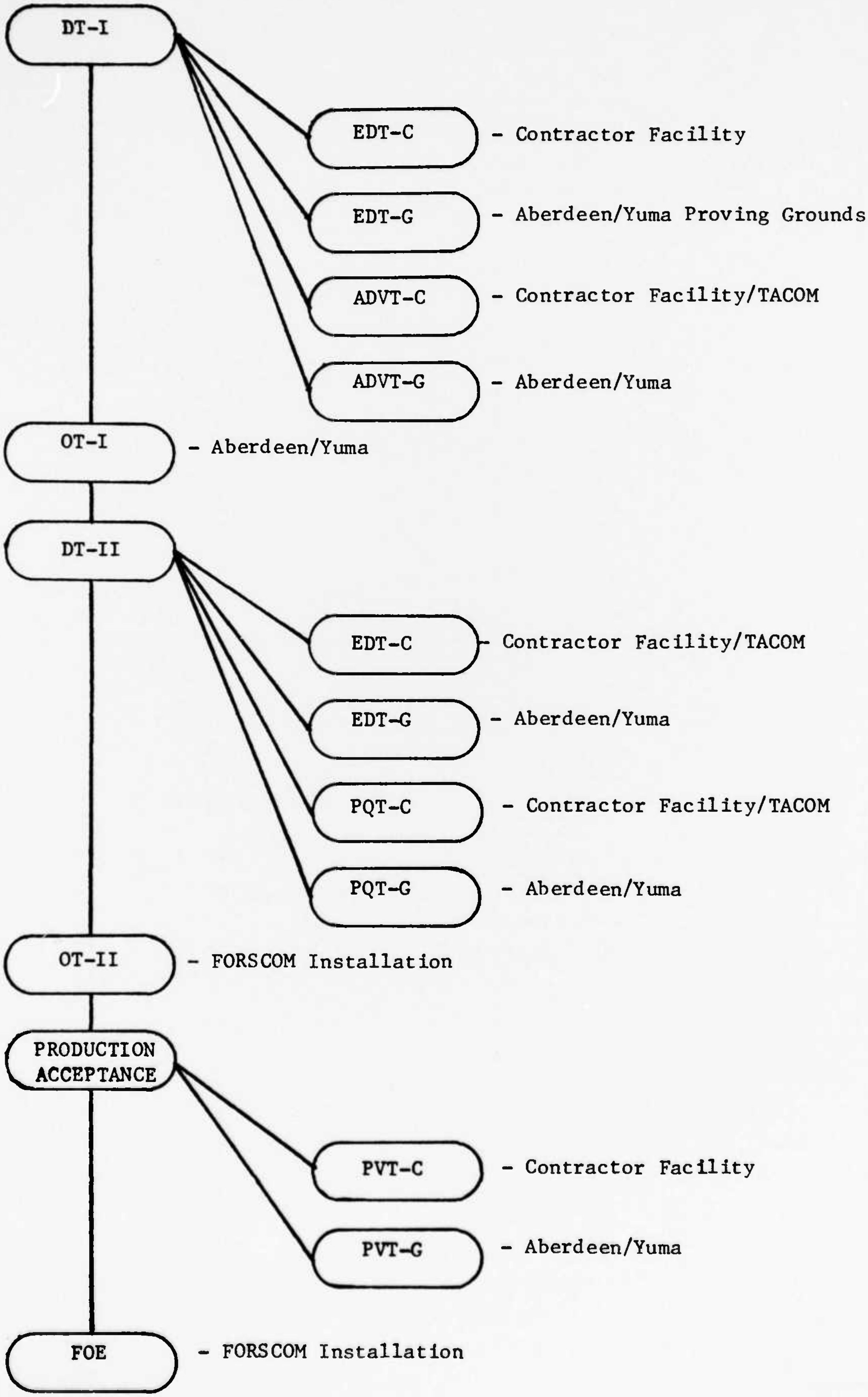
B. CHEMICAL/BIOLOGICAL/INCENDIARY/SMOKE



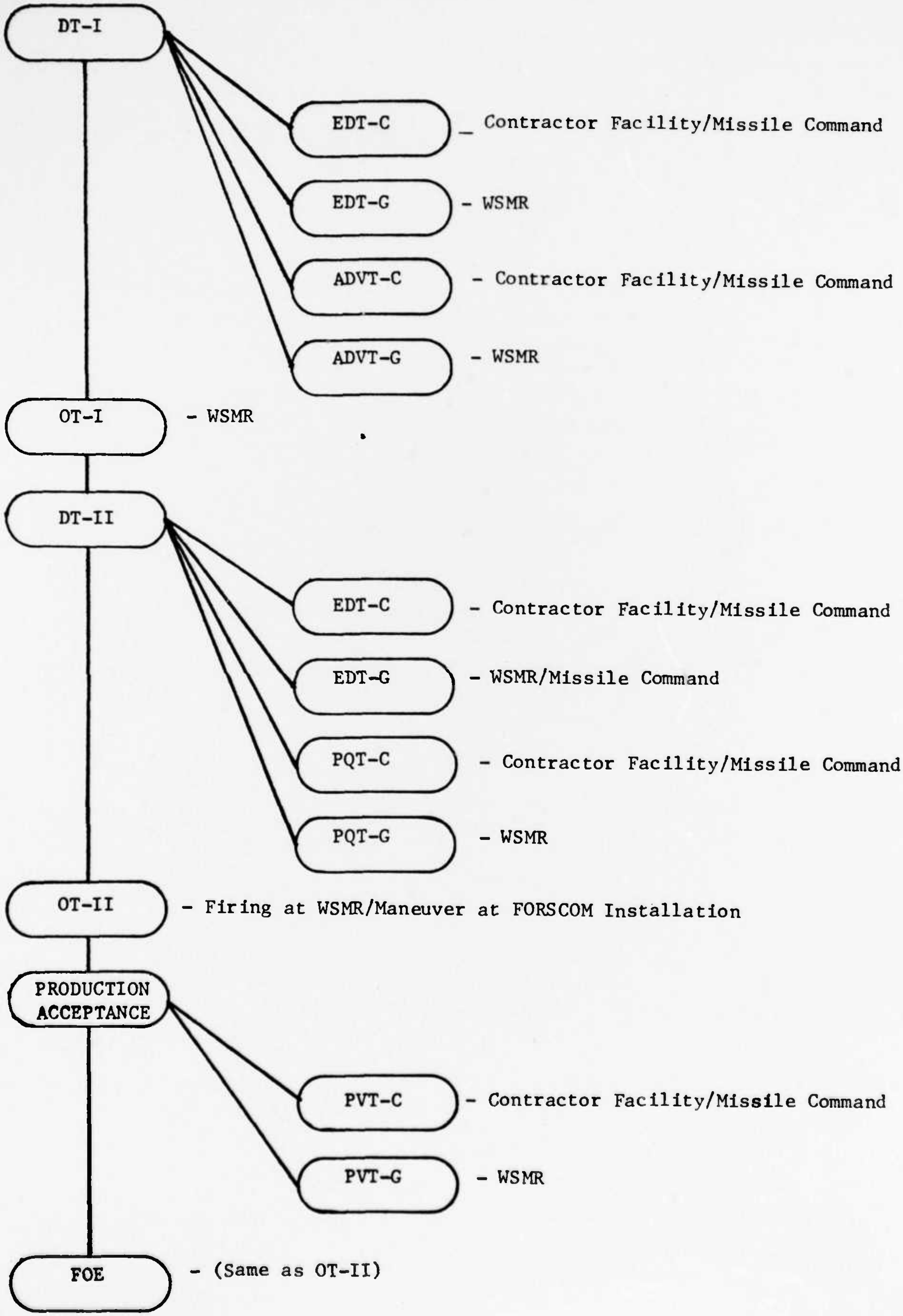
C. ARTILLERY SYSTEMS



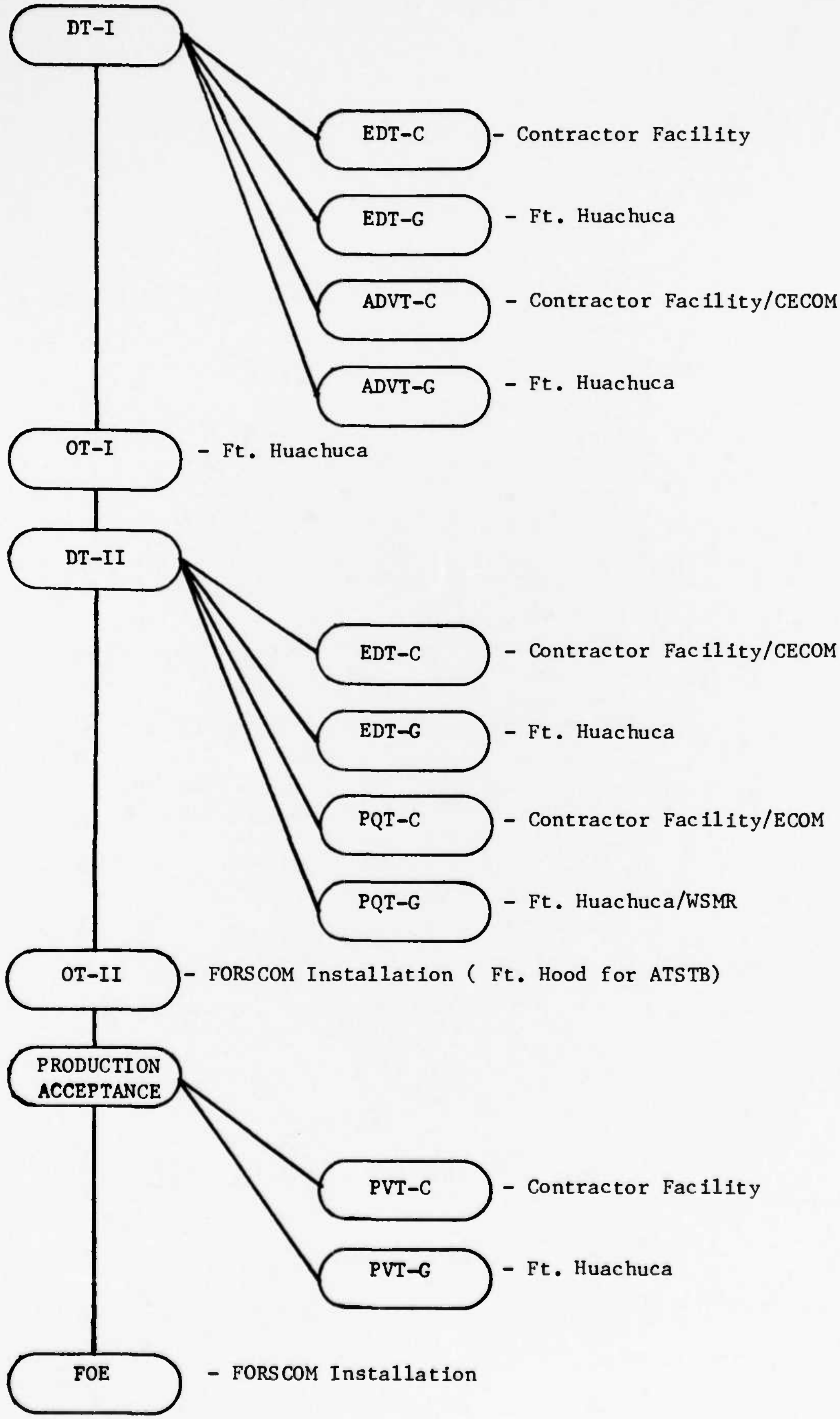
D. TANK/AUTOMOTIVE SYSTEMS



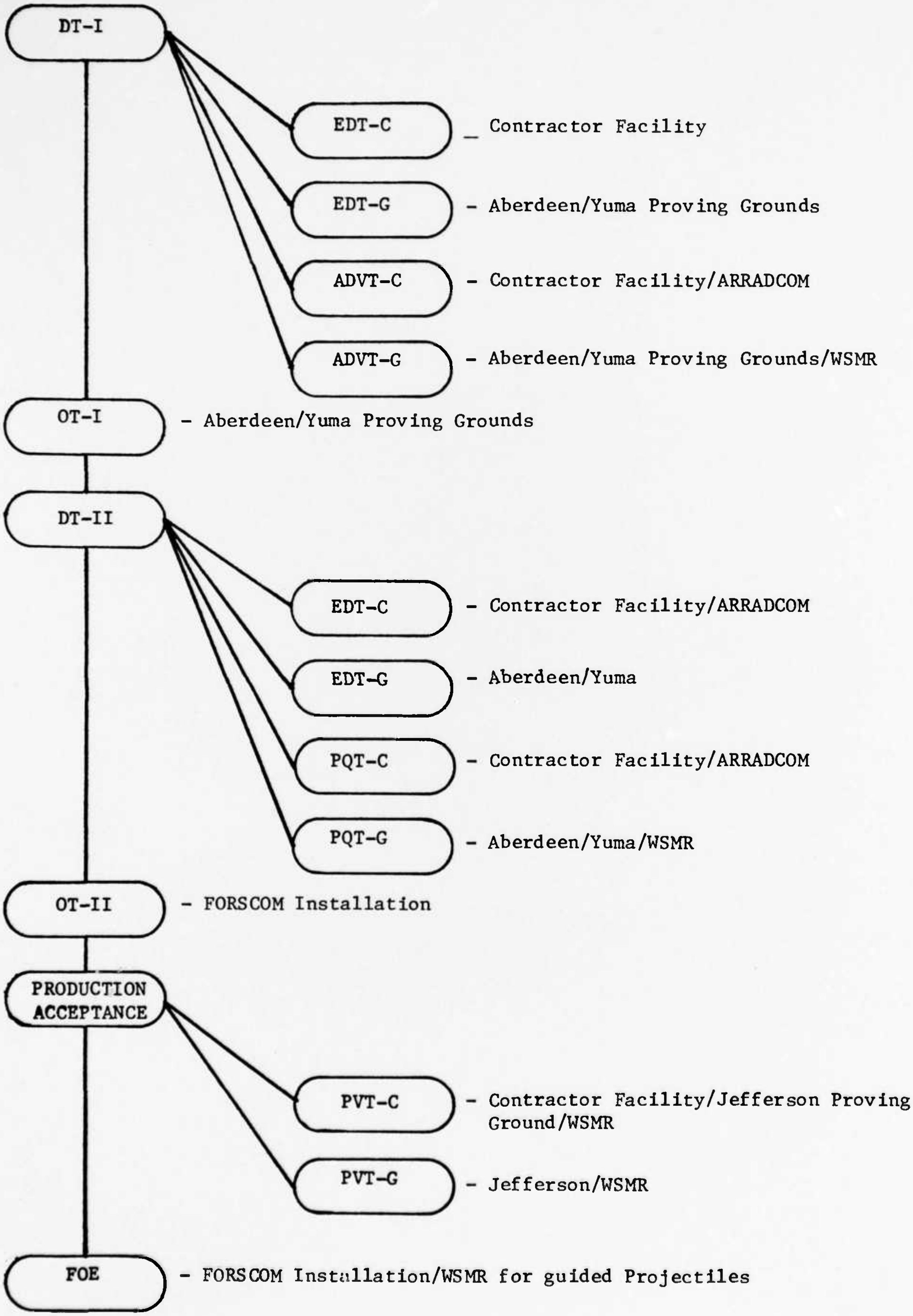
E. MISSILE SYSTEMS



F. C^3I SYSTEMS



G. MUNITIONS


DT-I
EDT-C
_ Contractor Facility
EDT-G
- Aberdeen/Yuma Proving Grounds
ADVT-C
- Contractor Facility/ARRADCOM
ADVT-G
- Aberdeen/Yuma Proving Grounds/WSMR
OT-I
- Aberdeen/Yuma Proving Grounds
DT-II
EDT-C
- Contractor Facility/ARRADCOM
EDT-G
- Aberdeen/Yuma
PQT-C
- Contractor Facility/ARRADCOM
PQT-G
- Aberdeen/Yuma/WSMR
OT-II
- FORSCOM Installation
PRODUCTION ACCEPTANCE
PVT-C
- Contractor Facility/Jefferson Proving Ground/WSMR
PVT-G
- Jefferson/WSMR
FOE
- FORSCOM Installation/WSMR for guided Projectiles

PATRIOT PROJECT -- LESSONS LEARNED

Appendix E

PATRIOT

LESSONS LEARNED

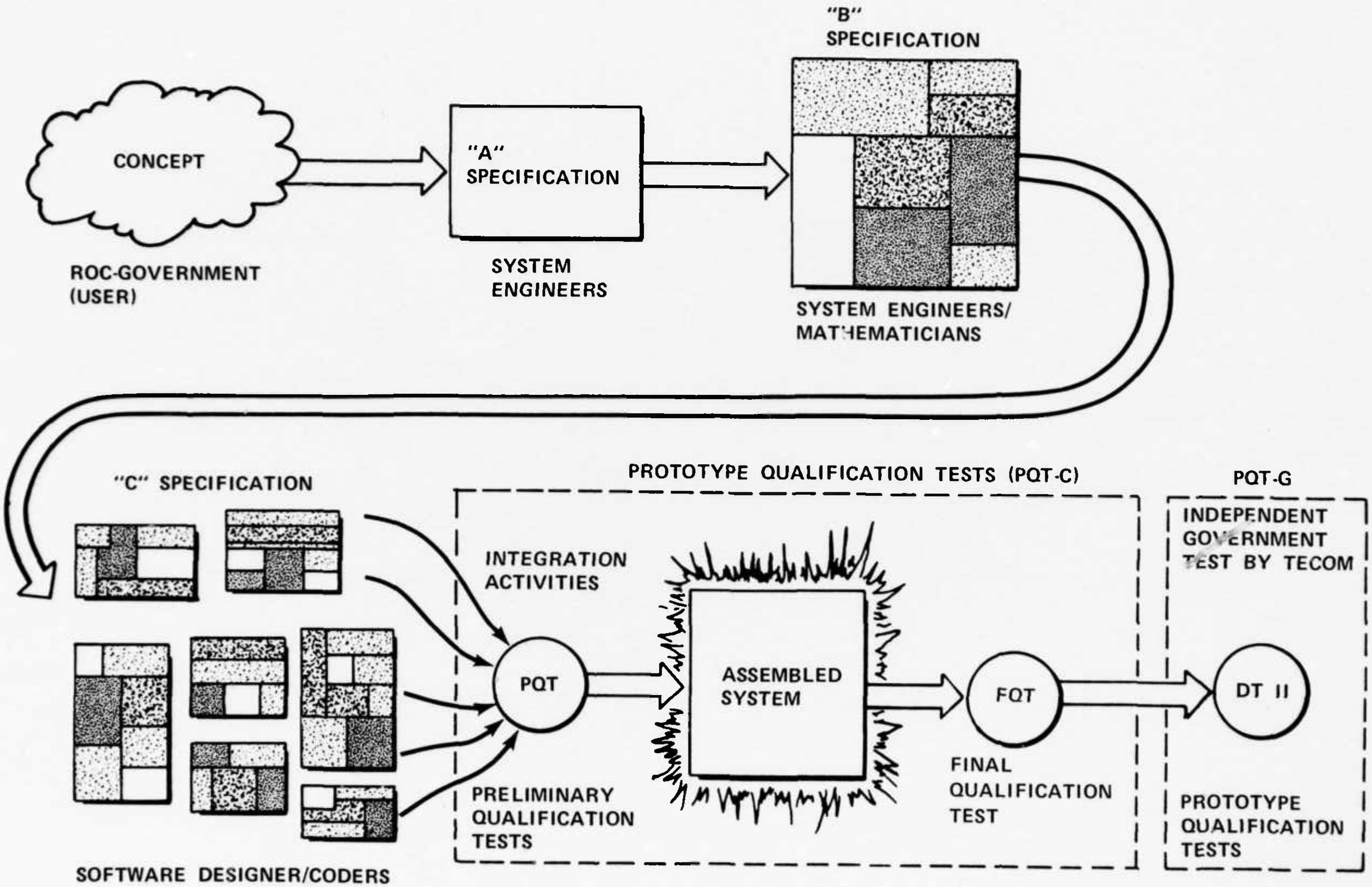
PATRIOT

LESSONS LEARNED

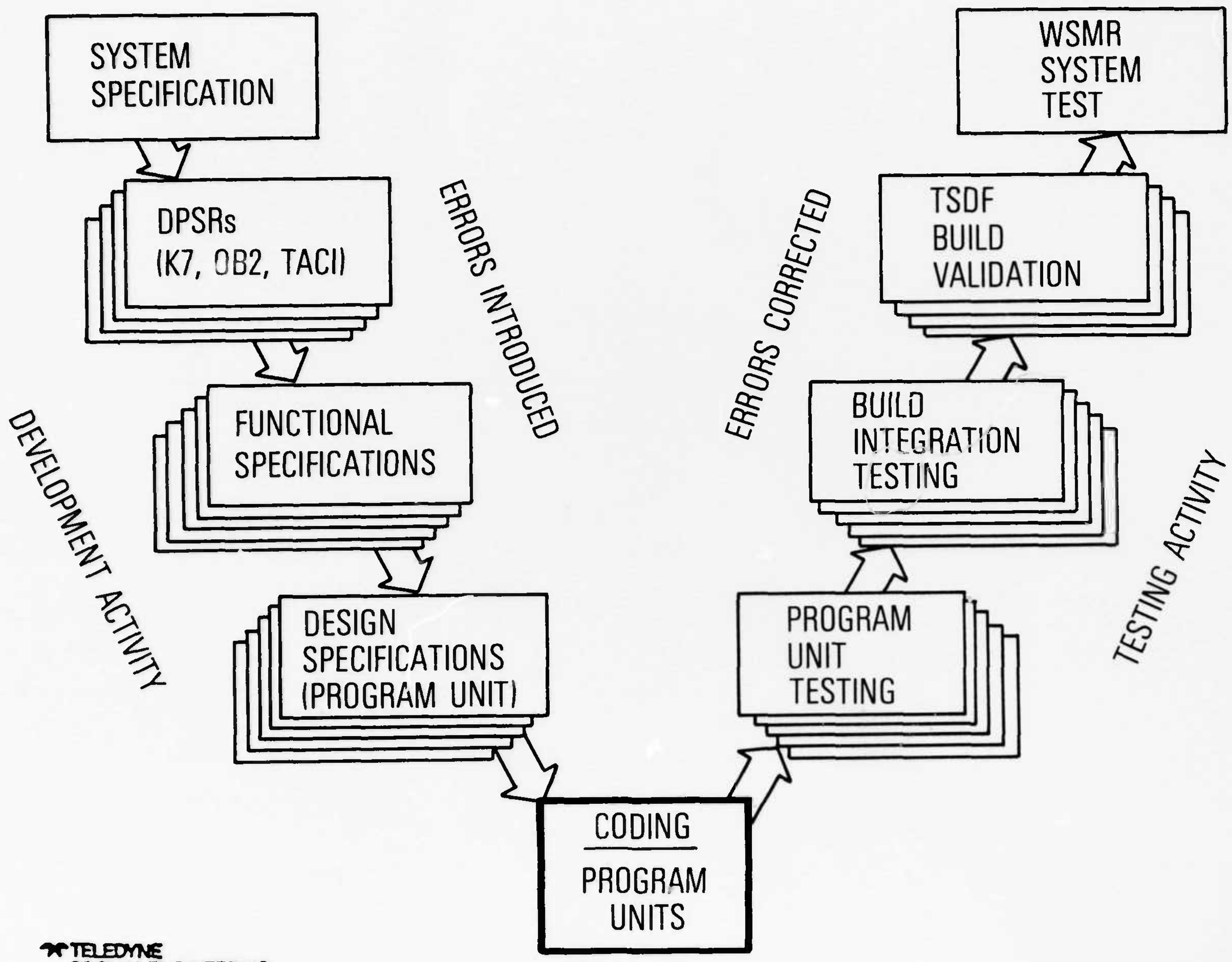
13 APR 81

- COMPLETE DEVELOPMENT TESTS BEFORE OPERATIONAL TESTS
- INCLUDE OPERATIONAL FUNCTIONS IN DEVELOPMENT
- EXPAND RELIABILITY TEST
- SET UP MAINTAINABILITY MEASUREMENT POINTS
- PROVIDE FOR HANGAR QUEEN
- INTEGRATE TEST COMMUNITY REQUIREMENTS EARLY
- EXPAND LOWER LEVEL QUALIFICATION
- PROCURE AND OPERATE ECM TEST TRANSMITTERS

SPECIFICATIONS AND TEST



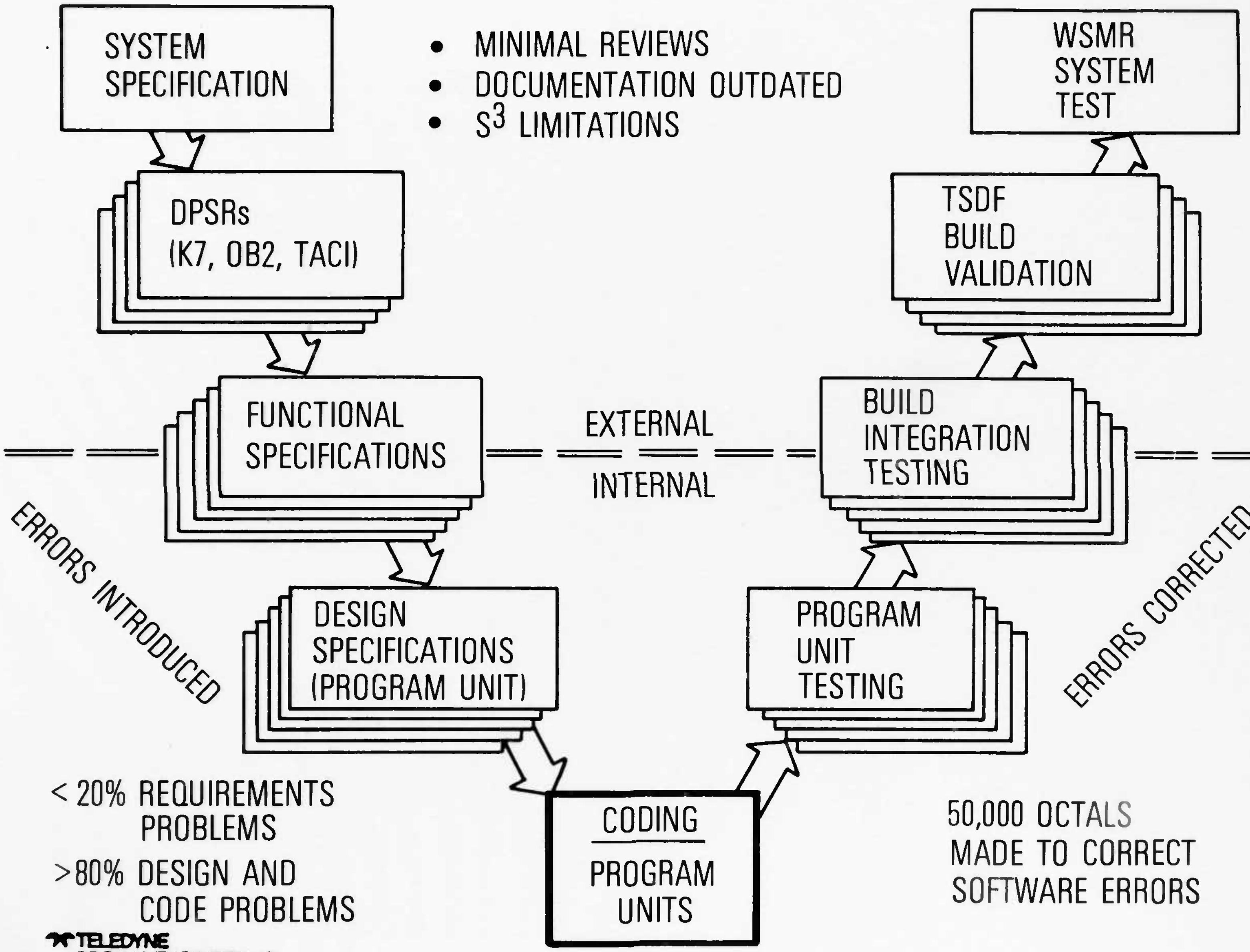
SYSTEM/SOFTWARE DEVELOPMENT CYCLE



TELEDYNE BROWN ENGINEERING

VISIBILITY IN PAST *

- MINIMAL REVIEWS
- DOCUMENTATION OUTDATED
- S^3 LIMITATIONS



< 20% REQUIREMENTS PROBLEMS

>80% DESIGN AND CODE PROBLEMS

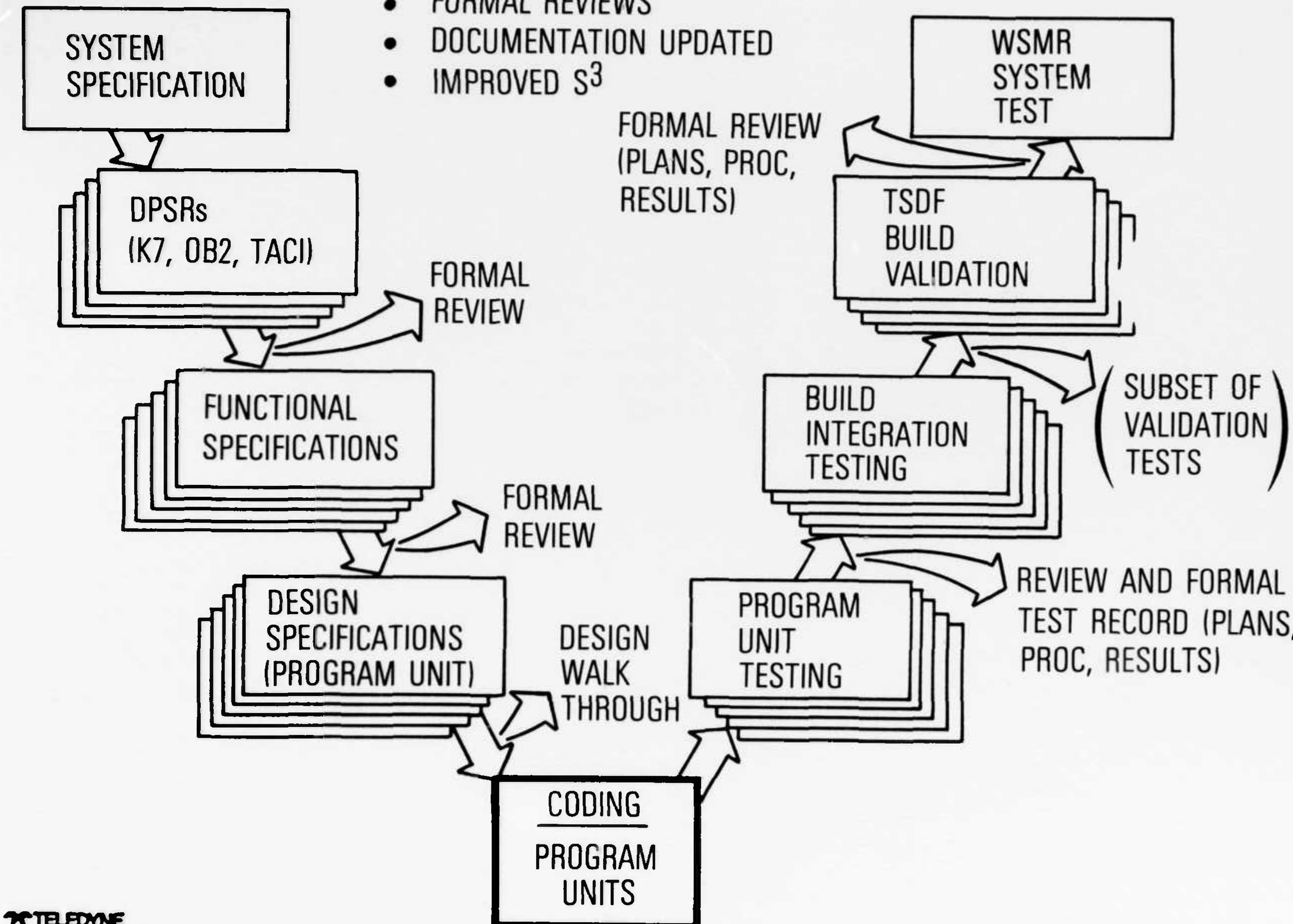
50,000 OCTALS MADE TO CORRECT SOFTWARE ERRORS

TELEDYNE BROWN ENGINEERING

* NOT UNIQUE TO PATRIOT - CONCEPT POPULAR DURING 1960's

REVISED SOFTWARE DEVELOPMENT PLAN

- FORMAL REVIEWS
- DOCUMENTATION UPDATED
- IMPROVED S^3



TELEDYNE BROWN ENGINEERING

INTERACTION OF TEST ACTIVITIES AND FACILITIES

- REQUIRES EXTENSIVE PLANNING AND COORDINATION
- REQUIREMENTS OF EVALUATORS MUST BE GERMANE AND REALISTIC
- FLEXIBILITY MUST BE INHERENT IN SCHEDULE
- DATA ACCEPTABILITY FROM VARIOUS SOURCES REQUIRED
- SCORING COMMITTEE
  - COMPOSED OF USER, TESTER, EVALUATOR AND DEVELOPER
  - COMMITTEE SHOULD BE SAME THROUGHOUT TEST SERIES
  - FAILURE DEFINITION/SCORING CRITERIA AGREED TO IN WRITING
- INTERACTION EFFECTED THROUGH TIWG

PATRIOT

13 APRIL 1981

TESTING OF SOFTWARE INTENSIVE SYSTEM

- PAST
  - HARDWARE DEVELOPMENT FIRST PRIORITY
  - SOFTWARE WILL "COME ALONG"
  - INSUFFICIENT GOVERNMENT INTEREST PAID TO SOFTWARE DEVELOPMENT
  - SOFTWARE VERIFICATION THROUGHOUT DEVELOPMENT CYCLE LACKING
  - MAJORITY OF SOFTWARE ERRORS SURFACED DURING LATER STAGES OF DEVELOPMENT
  - "PATCHING" DURING FINAL TEST PERIODS EXORBITANT
  - TEST SCHEDULE REDUCED TO MATCH PROGRAMMATIC MILESTONES
  - RESULTED IN INADEQUATE TESTING THUS POOR PERFORMANCE INDICATORS FOR THE SYSTEM
- PRESENT
  - LOGICAL SEQUENCE OF TEST EVENTS
  - COORDINATED APPROACH - TEST AND EVALUATION
  - ADEQUATE RESOURCES ALLOCATED
  - SOFTWARE/HARDWARE RECEIVING EQUAL EMPHASIS
  - MAKES MAXIMUM USE OF ALL TEST DATA

PATRIOT

IMPROVEMENTS TO ELECTRONIC SYSTEMS TESTING

13 APRIL 1981

- ACQUIRE ADEQUATE NUMBER OF FSED PROTOTYPES TO SUPPORT CONTINUED SOFTWARE DEVELOPMENT AND TESTING.
- MOVE TEST-FIX-TEST PROCESS UP FRONT IN PROGRAM AS OPPOSED TO END OF FSED AND BEGINNING OF PRODUCTION PHASE.
- ATTAIN COMMITMENT AND CONSENSUS ON TEST PROGRAM AND SOURCE OF DATA FROM T&E COMMUNITY EARLY IN PROGRAM.
- MAXIMIZE COMBINED (DT/OT) TEST AND EVALUATION
- NEED EMPHASIS (AND FUNDING) PLACED ON SUBSYSTEM (HARDWARE/SOFTWARE) DESIGN AND TEST IN EARLY STAGES OF PROGRAM.
- VISIBILITY AND CONTROL OF SOFTWARE DEVELOPMENT AND TEST MUST START EARLY IN THE PROGRAM AND BE CONSISTENT THROUGHOUT.
- PLAN FOR INDEPENDENT EVALUATION OF SYSTEM (TO INCLUDE SOFTWARE) MUST BE INITIATED AT THE EARLY PART OF FSED.

PATRIOT

IMPROVEMENTS TO ELECTRONIC SYSTEMS TESTING (CONTINUED)

13 APRIL 1981

- REQUIRE SUPPORTABILITY CONCEPT BE DEMONSTRATED PRIOR TO PRODUCTION.
- UTILIZE TEST DRIVERS TO MAXIMUM EXTENT POSSIBLE AS OPPOSED TO LIVE AIRCRAFT IN TESTING (BETTER LOADING OF SYSTEM AT LESS COST).
- IMPROVE ECM CAPABILITY - REQUIRES ADEQUATE FUNDING AND PERSONNEL RESOURCES.

REFERENCE MEMORANDA

Appendix F

THE JOHNS HOPKINS UNIVERSITY
APPLIED PHYSICS LABORATORY
LAUREL MARYLAND

JFB-P80-005
8 September 1980

To: A. R. Eaton

From: J. F. Bradshaw

Subject: An Approach for Testing High Technology Electronic Systems

References: (a) Memorandum for Assistant Secretary of the Army (RDA) dated 18 March 1980 from General John W. Vessey, Jr., Subject: Testing of High Technology Electronic Systems

(b) Memorandum for Vice Chief of Staff, Army dated 9 June 1980 from Dr. Percy A. Pierre, Subject: Testing of High Technology Electronic Systems

Reference (a) states an Army concern about its ability to perform adequate developmental testing for some of its advanced weapon systems. It is suggested that the Army does not have a good capability to load its advanced automated weapon systems with realistic battlefield conditions to perform thorough developmental tests. Sophisticated and complex battlefield environmental conditions cannot be adequately simulated to provide the density and fidelity required to stress these new systems during the development period. This results in costly operational tests to be run to discover deficiencies that should have been found earlier in the development process. Crucial operational performance information is lost because precious OT testing time is primarily used to isolate and debug developmental problems. Therefore, a comprehensive cost effective developmental test tool should be developed to relieve this problem.

There is a demonstrated system approach that has been used in other programs that can help cope with this testing problem. It uses a computer-based test tool to drive the operational system. This test tool has the capability to read and record all digital input and output data from the operational system. For example, it would prerecord forward observer data, battery computer system data, fire support officer data, air observer data and general support battalion data so that this information could be used to drive the operational system under test in a controlled manner. This digital recording technique could record all inputs to the operational system in heavy background load and ECM environments, thereby providing a ready library of high volume inputs for a variety of background situations. Since the environments would be recorded digitally, tactical situations could be replicated in a very controlled fashion.

Mr. Bradshaw is an employee of JHU/APL; he is a member of a PATRIOT Program Review Panel established by the Assistant Secretary of the Army (RD&A).

Complementing this background recording capability, the test tool would also have an automatic and manual interactive battlefield situation scenario scripting capability that could be operated with or without the recorded background environment data. This would allow for a variety of battlefield situation scenarios to be overlaid upon a variety of background environments, all of which would be completely repeatable since the data is in digital format. This system would also have the built-in capability of tracing message data to its original source and assessing whether or not the weapons operator correctly performed his duties. A system of this type would provide the density of data required and also control the test process so that when operational computer program faults occur the situation could be repeated in order to trap and isolate software errors.

Another significant feature of this test system would be the manual real time operator interactive scripting capability. This would allow a testing officer to change in real time the "canned" battlefield scenarios and thereby stress the operational system in particular areas, if desired. This particular feature has some rather significant payoffs for operator training during the early phases of operational testing.

It should be noted that this approach for a test tool does not test the input data hardware of the weapon system, but is used to drive the operational system automatic processing capability and record operator interaction and user output portions from the system. Sensor hardware testing would be conducted separately. This test tool has the added feature in that it can also be used after operational tests are completed. The recording portion of the system would be activated during the operational test and all interface data recorded in real time. When operational tests are complete and weapon system upgrades have been made, this recorded data could be played back into the weapon system to verify improvements. The complexities of the operational test are not lost and can be used over and over again to restress the weapon system, thus saving the enormous cost of repeating the subsequent operational test. This system provides the means of developing and testing complex weapon systems without the redundant expense of using actual attack aircraft or field units over and over again. Such a test tool can exercise the weapon system in a controlled repeatable manner to a much greater extent than is now possible.

RECOMMENDED APPROACH

There are several questions that should be considered before embarking on a test tool development process. These are:

1. What are the specific goals and objectives for this test tool?

2. Is this test tool to be considered universal for multi-systems tests or just for individual weapon systems tests?

3. Are there any written test tool system performance and compatibility requirements?

4. Is training to be considered a feature of the test tool?

5. At what levels should the test tool operate - division, battalion, battery, fire unit?

6. Are there adequate scenario descriptions to generate battlefield conditions?

7. Are there adequate statistical measures to modulate battlefield data as a function of environment - natural or manmade?

8. Is the Army data collection philosophy consistent with automated data reduction processing?

9. Are there independent test teams identified and working during the development phase? If yes, are they independently funded?

10. Are test system data collection requirements established prior to the design of the operational system?

11. Does the Army have a catalog of available test tools?

12. Has the Army established guidelines regarding a development-to-test cost ratio?

13. Are the test tools developed under the same discipline as the operational program? (Are we using test tools that haven't been tested?)

14. Does the Army have an independent audit team that conducts software audits during the software development process to establish system baseline descriptions?

15. Does the current development process support intermediate independent developmental testing?

It is recommended that a panel of experts be convened to formulate answers to these questions and begin formulating a requirements document for the proposed test tool.

J. F. Bradshaw

J. F. Bradshaw

JFB:jm
<u>Distribution</u>:

A.R.Eaton
B.D.Dobbins
R.L.Ely

19 September 1980

To: A. R. Eaton

From: N. A. Begovich

Subject: Testing of High Technology Electronic Systems

Large electronic decision systems (air defense, C^2, etc.) testing requires the use of computer simulation of the real world environment to fully load and test the system. Live testing, at best, can only give confidence the test environment is a faithful presentation of the real world at the live testing load level. The test environment computer program development is as difficult a task as the system operational program development. However, the hardware used in the test environment should be commercial or off-the-shelf so that the software/hardware change problem is non-existent.

- The DD963 and the AN/SYS-1 programs are examples of successful test environment computer program developments that provided a "real world" tactical environment for system testing and for crew training.

- The development of a large electronic decision system should be paralleled with the development of the test environment that will permit full tactical load system testing. The system and the test environment developments should be performed by different contractors. This will insure that the test environment will reflect the system requirements and not the system contractor concept of the requirement. Periodic program reviews with both the system and test environment contractors participating should prevent any system design/requirements incompatibilities.

- Army organizations, the particular school reflecting the user requirements and OTEA, should participate in the test contractor design reviews so that the test environment reflects the user requirements. This forces the user to quantify his requirements during the system development.

Dr. Begovich is a private consultant; he is a member of a PATRIOT Program Review Panel established by the Assistant Secretary of the Army (RD&A).

- The parallel development of the system and the test environment (see Figure 1) has the following advantages:

  - Minimum time and resources expenditure in fielding a new system
  - Minimum live target (aircraft, troops, etc.) testing
  - Realistic system training facility
  - Repeatable test scenarios for system correction and crew training
  - System requirements frozen during and not after system development.

The Army's present serial system development process is shown in Figure 2. The user participates initially in defining the system requirements. After the system is developed, the user again gets involved in conducting the system test. Unfortunately, sufficient time has elapsed that the user has a different concept on what the system should do resulting in the system being returned to the contractor for correction of deficiencies. This cycle of test, correction and retest has been repeated in some systems (Q-73, TACFIRE) developments so many times that when the system finally passes the user test, the hardware is obsolete. The Army then has the choice of procuring and deploying a system having a hardware design that is at least ten plus years old or not deploying any system.

A new computer hardware generation is occurring every three plus years. The threat, consequentially, is also changing on a similar time cycle. The Army's serial system development process that has a manyfold longer time period will always produce obsolete systems.

To insure timely success in the Parallel System Development process the following are absolute requirements.

- The test environment development should be performed by a contractor and not a government agency. The government must resolve problems between the system and test environment developers and cannot be a "judge and one of the contestants".

- The test environment development should be for a particular program and not a universal test bed. A universal test bed will result in a development for its own end purpose instead of being optimized to test a particular system.

- All the test environment hardware should be "off-the-shelf" so that the hardware baseline is fixed during the test software development process.

N. A. Begovich

NAB:mk

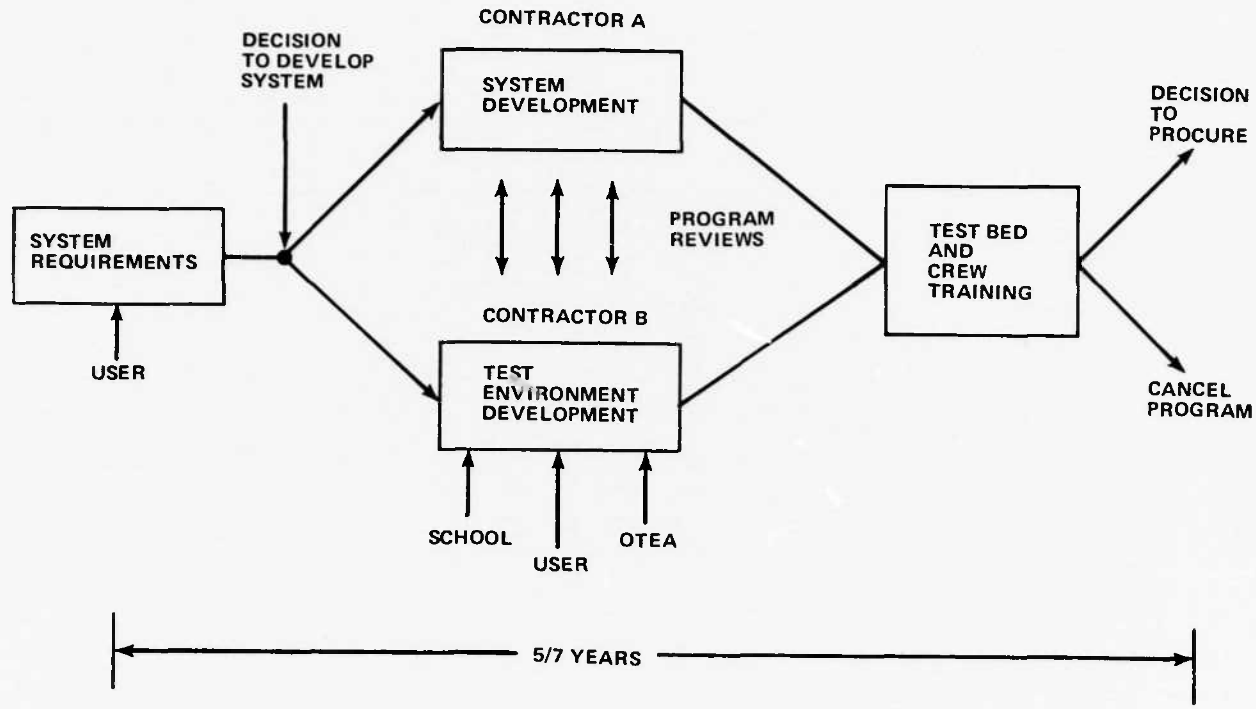


Figure 1 Parallel Systems Development Process

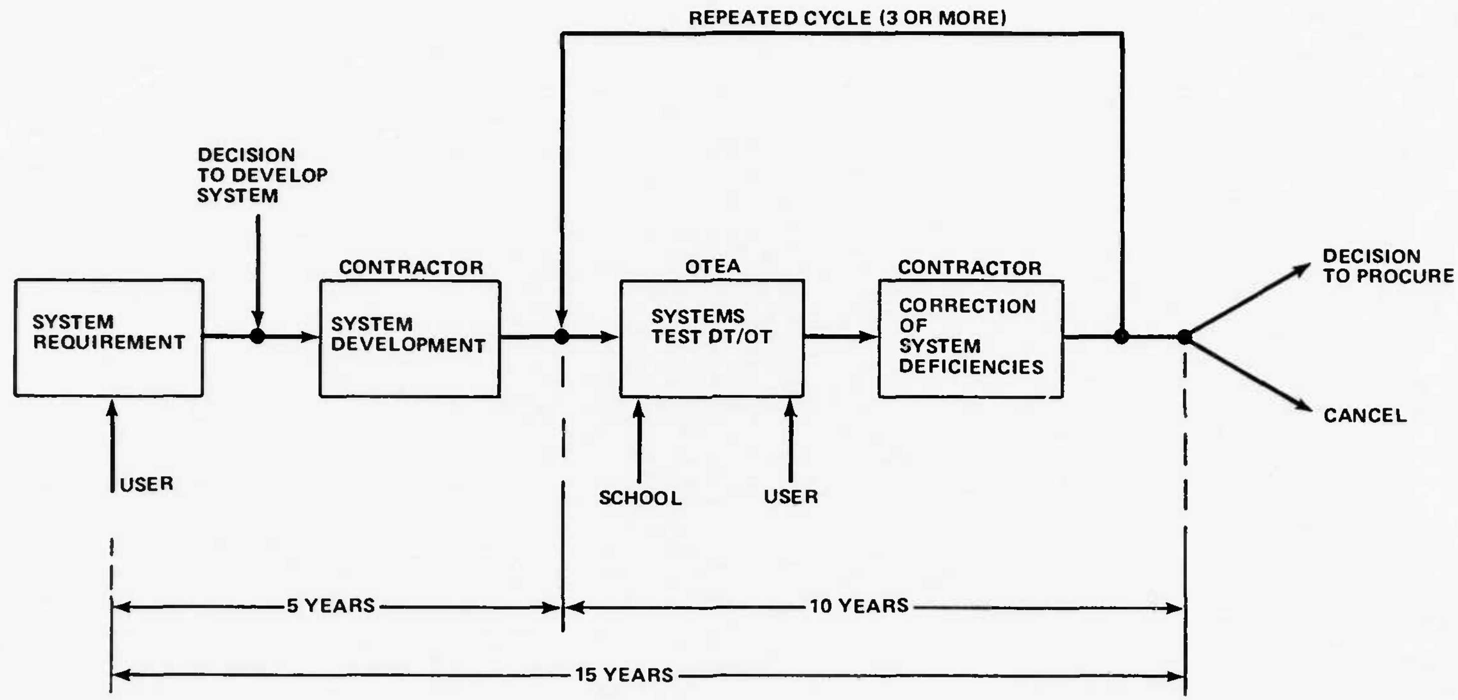


Figure 2 Serial Development Process

Appendix G

INTERIM REPORT TO ARMY SCIENCE BOARD

ARMY SCIENCE BOARD AD HOC SUBGROUP ON TESTING OF ELECTRONIC SYSTEMS

MEMBERSHIP

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LTG AUSTIN W. BETTS (USA-RET)

DR. E. O. HARTIG

DR. GEORGE H. HEILMEIER

DR. L. WARREN MORRISON

DR. IRENE C. PEDEN

MR. JUAN SANDOVAL

DR. JOHN R. TOOLEY

DR. ANDREW J. VITERBI

CHARTER HIGHLIGHTS

PREAMBLE

T & E OF SOPHISTICATED SYSTEMS EVER MORE CHALLENGING

REALISTIC BATTLEFIELD ENVIRONMENTS DIFFICULT TO REPRODUCE

SIMULATIONS / FIELD EXERCISES EXPENSIVE -- BUT

COSTS OF TESTING MUST BE WEIGHED VS.

RISKS OF DETECTING PROBLEMS ONLY AFTER FIELDING

C^3I & OTHER COMPUTER-BASED SYSTEMS OF GREATEST CONCERN

CHARTER HIGHLIGHTS (CONT'D)

SPECIFIC QUESTIONS

"THE ASB PANEL SHOULD EXAMINE THE OVERALL FACETS OF THIS SUBJECT, SPECIFICALLY ADDRESSING THE FOLLOWING :

1. ARE ARMY CONCEPTS, PLANS AND EQUIPMENTS ADEQUATE FOR TESTING MODERN C^3I AND COMPUTER-BASED SYSTEMS ?
2. WHAT CHANGES SHOULD BE MADE, IF ANY ?"

CHARTER HIGHLIGHTS (CONT'D)

INVESTIGATION TO INCLUDE

ASSESSMENT OF FACILITIES

FORT HOOD, FORT HUACHUCA, WHITE SANDS MISSILE RANGE, ETC.

ALSO -- ADEQUACY OF TEST EQUIPMENT, PROCEDURES, PLANS TO SUPPORT TESTING OF SEVERAL SPECIFIC SYSTEMS

ALSO -- OPERATIONAL TESTING OF FUTURE SOFTWARE SYSTEMS

MEETINGS OF 29-30 JANUARY, 1981
JHU/APL, LAUREL, MD.

INTRODUCTORY REMARKS DISCUSSION OF CHARTER IMPORTANCE OF REQUESTED INVESTIGATION PROBLEMS WITH TEST DESIGN & REALISTIC ENVIRONMENTAL SIMULATIONS EFFECTS OF AUTOMATION	DR. MARK EPSTEIN DEPUTY FOR COMMUNICATIONS & TARGET ACQUISITION OASA (RDA)
OVERVIEW OF ARMY MATERIEL TESTING DEFINITIONS / ORGANIZATION / MANAGEMENT TYPES OF TESTS / DOCUMENTATION / FUNDING	MR. J. P. TYLER DAMA POLICY, PLANS, MANAGEMENT DIV.
DEVELOPMENT TESTING OF ELECTRONIC SYSTEMS PLANNING DEVELOPMENT CONCEPT FOR MAINSITE MODULAR, AUTOMATED, INTEGRATION, SYSTEMS INTEROPERABILITY T & E	MR. GRADY BANISTER ARMY ELECTRONIC PROVING GROUND FORT HUACHUCA, AZ

MEETINGS OF 29-30 JANUARY, 1981
JHU/APL, LAUREL, MD.

OPERATIONAL TESTING OF ELECTRONIC SYSTEMS ORGANIZATION / TEST DEFINITION / PLANNING CASE HISTORIES	COL. MYRON MOTSKO MAJ. FRANKLIN LEHMAN OTEA, FALLS CHURCH, VA
TEST FACILITIES AT FORT HUACHUCA MULTIPLE, DIVERSE CAPABILITIES COMMUNICATIONS–ELECTRONICS TESTING	MR. GRADY BANISTER
TEST FACILITIES AT WHITE SANDS MISSILE RANGE TEST CONCEPTS / METHODOLOGIES / CAPABILITIES CASE HISTORIES	MR. F. G. SEBASTIAN WSMR, NM
TRADOC TEST FACILITIES & BOARDS MISSION / ORGANIZATION / RESPONSIBILITIES FACILITIES T & E CYCLES	MR. D. G. REICH FORT MONROE, VA DR. D. W. COLLIER FORT HOOD, TX

MEETINGS OF 3-4 MARCH, 1981
JHU/APL, LAUREL, MD.

RATIONALE FOR THE AUTOMATED TACTICAL SYSTEMS TEST BED	MAJ. R. L. HEMPHILL
FORT HOOD, TX	DAMO
	REQUIREMENTS DIRECTORATE COMMAND & CONTROL DIV.
THE ASARC PERSPECTIVE	LTC. J. E. EASTERBROOK
ORGANIZATION / ANALYSIS OF TESTING	DAMA
DCP GOALS / THRESHOLDS	COMMAND / CONTROL SURV. DIV.
CASE HISTORIES	
DISCUSSION OF ARMY PROGRAM	DR. R. L. NORWOOD
CASE HISTORY -- DT / OT	DEPUTY FOR AIR & MISSILE SYS.
	OASA (RDA)
	MR. J. F. BRADSHAW
	MEMBER, OASA (RDA) REV. PANEL
OSD PERSPECTIVE	BG EUGENE FOX
REQUIREMENTS / DECISION PROCESS	DEPUTY FOR TACTICAL AIR & LAND WARFARE SYSTEMS
CASE HISTORIES	ODD T & E
INTERACTION WITH SERVICES	COL. R. O. ANDERSON
	COL. R. W. DEMONT
	COL. E. C. ROBINSON

MEETINGS OF 3-4 MARCH, 1981
JHU/APL, LAUREL, MD.

NAVY C^3I DEVELOPMENT TESTING	MR. C. T. OGATA
FACILITIES/TESTING METHODS	NAVAL OCEAN SYSTEMS COMMAND
CASE HISTORIES	SAN DIEGO, CA
NAVY TESTING OF OPER. COMMUNICATIONS	MR. T. R. EVANS
FLEET BALLISTIC MISSILE EVAL.	JHU/APL
RESPONSIVE THREATS	
QUANTITATIVE METHODS	
APPLICATION TO PERSHING PROGRAM	
T & E OF THE AEGIS COMBAT SYSTEM	CAPT. R. C. BEERS
ASHORE & AT SEA	PROJECT MANAGER
CONCEPT EVALUATION/DT/OT	CRUISER/DESTROYER ACQUISITION
COMBAT SYSTEM ENGINEERING DEVELOPMENT CENTER	CAPT. G. R. MEINIG, JR.
USS NORTON SOUND	TECHNICAL DIRECTOR
	AEGIS SHIPBUILDING PROJECT
	NAVSEA, WASH., DC
SYSTEM INTEGRATION/T & E FOR CRUISER "NEW THREAT UPGRADE"	MR. J. W. SCHNEIDER
LAND-BASED TEST SITE -- DT/OT	JHU/APL
DEVEL. SUPPORT FOR DEPLOYED SYSTEMS	

SOME AREAS OF INTEREST -- RELATIVE TO PROGRAM STRUCTURE

DEVELOPMENT PROCESS FOR HARDWARE / SOFTWARE INTEGRATION

TIMING FOR "OPERATIONAL TESTS (OT)" RELATIVE TO "DEVELOPMENT TESTS"

STATUS OF HARDWARE / SOFTWARE FOR OT
(INCLUDING RELIABILITY, AVAILABILITY, MAINTAINABILITY TESTING)

TESTING OF PRODUCTION HARDWARE / SOFTWARE (AFTER DSARC III)
(FOR RAM / LOGISTICS PLANNING / PERFORMANCE)

INTEROPERABILITY / INTERFERENCE AMONG U.S. EQUIPMENTS

INTEROPERABILITY / INTERFERENCE AMONG NATO EQUIPMENTS

SOME AREAS OF INTEREST -- RELATIVE TO TESTING TO ESTABLISH PERFORMANCE VS. THREAT

OUT-OF-DATE THREAT DEFINITIONS
(IN DEVELOPMENT CONCEPT PAPERS -- THRESHOLD REQUIREMENTS)

LACK OF RECOGNITION OF RESPONSIVE / REACTIVE THREATS

FACILITIES FOR "LABORATORY" TESTING VS. THREATS

FACILITIES / CAPABILITIES FOR FIELD TESTING VS. THREATS

TESTING OF PRODUCTION HARDWARE / SOFTWARE

CONTINUING CAPABILITY FOR SYSTEM MODIFICATION / TESTING

CAPABILITY FOR DEVELOPING TACTICS / COMPLEMENTARY USE OF SYSTEMS

SOME AREAS OF INTEREST -- RELATIVE TO DESIGN/CONDUCT OF TESTS

TEST CONDITIONS / ANALYSIS / INSTRUMENTATION PLANNING FOR OT
(INTERACTIONS AMONG AGENCIES INVOLVED)

TREND ANALYSES VS. "SNAPSHOTS"

COMBINED OT / DT

"UNIVERSAL" VS. INDIVIDUAL – PROGRAM TEST FACILTIES

"SERIES" VS. "IN-PARALLEL" DEVELOPMENT OF TESTING TECHNIQUES

CONSIDERATION OF "INDEPENDENT" CONTRACTOR FOR TESTING
(CONTRACTOR OTHER THAN SYSTEM PRIME)

PLANNED MEETINGS

VISIT TO FORT HOOD ____________ MARCH 18

VISIT TO MICOM, HUNTSVILLE ____________ APRIL 13-14

MICOM ROLES / VIEWS

PROJECT MANAGER PERSPECTIVES

VISIT TO FORT HUACHUCA ____________ LATE APRIL OR EARLY MAY

FOLLOW-ON DISCUSSIONS / REPORT-WRITING ____ MAY / JUNE

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