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T AND E GUIDELINES COMMON TEST GEAR

Office of the Director of Defense Research
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DEPUTY DIRECTOR (TEST & EVALUATION)

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DEPUTY DIRECTOR (TEST AND EVALUATION)

T&E GUIDELINES FOR COMMON TEST GEAR

OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

WASHINGTON, D. C.

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FOREWORD

This report is an outgrowth of the work of the Defense Science Board Task Force on Test and Evaluation, and the checklists herein have been derived from the study of past major weapon system programs.

The T&E expert in reading this volume will find many precepts which will strike him as being too obvious to be included in checklists of this type. These items are included because examples were found where even the obvious has been neglected, not because of incompetence or lack of personal dedication by the people in charge of the program, but because of financial and temporal pressures which forced competent managers to compromise on their principles. It is hoped that the inclusion of the obvious will prevent repetition of the serious errors which have been made in the past when such political, economic and temporal pressures have forced project managers to depart from the rules of sound engineering practices.

In the long run, taking short cuts during T&E to save time and money will result in significant increases in the overall costs of the programs and in the delay of the delivery of the corresponding weapon systems to the combatant forces.

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T&E GUIDELINES FOR COMMON TEST GEAR

The checklist items presented here are specifically applicable to common test gear testing and evaluation. It is suggested that the user of this volume also refer to the Report of the Defense Science Board on Test and Evaluation which contains general checklist items also applicable to this system T&E program. The checklist items presented here are organized into time phases of the acquisition process oriented to the DSARC cycle.

The checklists cover various aspects of the major activities that should be underway during a given time period. Hence, a checklist might cover the (1) evaluation of work that occurred in the previous phase, (2) conduct of tests planned in the previous phase and executed in the subject phase, and (3) plans and other preparatory actions for test schedules to be conducted in a subsequent phase. For reasons such as this, items on some subjects, such as development test plans, may appear in more than one phase. In addition, since the Services and the DSARC have flexibility in deciding how rapidly to progress in the validation phase, there may be cases where the Request for Proposals (RFPs), proposal evaluations, source selections, or contract negotiations may occur after the DSARC approves full-scale development instead of before. For this reason, it is recommended that previous checklists in the Validation Phase be reviewed when entering the Full-Scale Engineering Development Phase. The following are the phases used in this report.

CONCEPTUAL PHASE

The checklist items in this phase are for guidance in evaluating T&E activities during the Conceptual Phase of the acquisition of the system. This phase (often research and exploratory development) precedes the first DSARC milestone and is focused on the development of a weapon system concept that offers high prospects of satisfying an identified military need.

Although not called for in DoD Directive 5000.1 specifically, the objectives of this phase should be:

1. To verify that there is a military need for the proposed system.
2. To demonstrate that there is a sound physical basis for a new weapon system.
3. To formulate a concept, based on demonstrated physical phenomena, for satisfying the military need.
4. To show that the proposed solution is superior to its competitors in terms of potential effectiveness, probability of success, probable cost, impact on the U.S. military posture, and development risks.
5. To analyze the technology outlook and the military need to show that it is better to start advanced development now rather than to wait for future technological improvements.
6. To identify the key risk areas and critical issues that need to be resolved before full-scale development is initiated.

The most important product of this phase is the Development Concept Paper (DCP) or its equivalent. The DCP defines program issues, including special logistics problems, program objectives, program plans, performance parameters, areas of major risk, system alternatives, and acquisition strategy.

VALIDATION PHASE

The checklist items in this phase are for guidance in conducting T&E during the Validation Phase (the time between when the DSARC recommends approval of the DCP for the first time and when the DSARC recommends full-scale development of the system).

While these objectives are not spelled out in the DoD Directive 5000.1, the objectives of the Validation Phase should be to confirm:

1. The need for the selected system in consideration of the threat, system alternatives, special logistics needs, estimates of development costs, preliminary estimates of life cycle costs and potential benefits in context with overall DoD strategy and fiscal guidance.
2. The validity of the operational concept.
3. That development risks have been identified and solutions are in hand.
4. Realism of the plan for full-scale development.

In the pursuit of the above objectives, it is likely that advanced development T&E will be conducted to resolve issues. In some cases, an RFP for full-scale engineering development will be prepared, proposals will be received and evaluated, and contracts negotiated in preparation for seeking DSARC approval for the next phase. Therefore, some checklist items are included to help ensure that this work properly reflects the T&E interests in this and subsequent phases. For example, the RFP must include adequate guidance to ensure that sufficient resources and time are available so that the engineering effort can properly support the initial DT&E with hardware, software, technical data, and training.

The primary emphasis of OSD/T&E activities is with items 3 and 4 above. Special attention should be given to the planning of IOT&E activity as it is incorporated in the engineering development contract as well as the DT&E associated with addressing the critical issues and areas of major risk identified in the DCP.

FULL-SCALE ENGINEERING DEVELOPMENT PHASE

The checklist items contained in this phase are for guidance in conducting T&E during the Full-Scale Engineering Development Phase. This includes the major DT&E and the IOT&E conducted prior to the major production decision. By this time, the system is well-defined and is becoming a unique item and, hence, sound judgment must be applied in using these checklist items.

To enter the Engineering Development Phase, the DSARC will have:

- Confirmed the need in consideration of the threat, alternatives, logistic needs, cost, and benefits.
- Identified development risks.
- Confirmed the realism of the development plan.

Given the above, the primary objectives of the DT&E should be to:

1. Demonstrate that the engineering and design and development process is complete and that the design risks have been minimized (the system is ready for production).
2. Demonstrate that the system will meet specifications.

The primary objectives of the IOT&E should be to:

3. Assess operational suitability and effectiveness.
4. Validate organizational and employment concepts.
5. Determine training and logistic requirements.

In addition, the validity of the plan for the remainder of the program must be confirmed by the DSARC before substantial production/deployment will be recommended to the Secretary of Defense.

The level of OSD/T&E activity is highest during this phase. The IOT&E plan must be designed, the tests conducted, and the data analyzed to evaluate the inputs associated with the primary objectives. These tests should not be conducted until the primary objectives of the DT&E have been met. Thus, OSD/T&E activity is required to assess that the DT&E major milestone--the system is ready for production--has been achieved. Close monitoring of the T&E Service activity is required during the latter stages of this phase.

SUBSTANTIAL PRODUCTION/DEPLOYMENT PHASE

The checklist items contained in this phase are for guidance in conducting T&E after the substantial production decision has been made by the DSARC. This includes DT&E and follow-on OT&E to be conducted on the early production items.

To enter the Production/Deployment Phase, the DSARC will have reviewed the program to confirm:

- The need for the system.
- A practical engineering design with adequate consideration of production and logistic problems is complete.
- All technical uncertainties have been resolved and operational suitability has been determined by T&E.
- The realism of the plan.

The primary objective of the DT&E in this phase should be to:

1. Verify that the production system meets specifications.

The primary objectives of the follow-on OT&E should be to:

2. Validate the operational suitability and effectiveness.
3. Optimize organization and doctrine.
4. Validate training and logistic requirements.

At this point, the OSD/T&E activity is similar to that in the previous phase; however, much of the testing is verification that the production system performance is as expected. Hence, most of the items in the previous phase are appropriate to this phase, especially those related to OT&E.

CONCEPTUAL AND VALIDATION PHASES

The prime objective of the Conceptual Phase of a Common Test Gear program is to determine that it is needed, to justify it sufficiently, and to establish the program. The genesis of the program is usually built on a growing need for test gear to replace and consolidate existing equipments in order to overcome serious deficiencies, or high costs, or to produce a more efficient new system. The new system is usually based on studies, IR&D, exploratory, or advanced development activities. In the Validation Phase, the issues raised by the DCP or equivalent documentation should be resolved by conducting tests of the systems. The development and operational test plans will be defined in considerable detail.

The design of a test plan for Common Test Gear should include the following areas of testing:

(a) Reliability/Availability - An important objective of these tests is to ensure that no software areas result in reinitialization. This is usually neglected and yet it is important to reduce the impact of failures.

(b) Serviceability/Maintainability - Tests should demonstrate how problems are determined, diagnosed and repaired and the times associated with each. In the case of software the procedures for diagnosis and elimination of "bugs" must be demonstrated.

(c) Compatibility - Tests to show the ability of the user to transfer from one item to another and continue to execute the jobs he has been executing.

(d) Usability - Tests for evaluating the human factor characteristics which are of special importance for these applications.

(e) Throughput - The plan should measure total time required to carry on a standard series of tests.

(f) Capability - Tests to indicate the ability of the product to function under various limits of physical stress and environment as well as work load.

(g) Security/Integrity - Tests to show that the data are protected.

(h) Publications - Tests to demonstrate the manuals are understandable, workable and presented in logical sequence.

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The test and evaluation checklist for these phases contains reminders regarding:

1. T&E Criteria
2. T&E Role In Verifying Effectiveness Of Design Specifications
3. Boundary Sizings
4. Critical Issues
5. T&E Actions Prior To DSARC I
6. T&E Report Format
7. Reliability Plan
8. Establishment Of Test Criteria
9. Software Testing
10. New Technology Caution

1. T&E CRITERIA

<u>T&E Criteria for selection from competitive designs should be specified in advance with critical issues identified for each design</u>.

Whenever competitive designs are under consideration, T&E criteria for selection should be specified in advance, with critical issues identified for each design. In addition the same criteria should be used to make comparisons with:

- Existing equipments
- Militarized versions of commercial devices
- Ad hoc combinations of separate units.

Evaluation criteria should be based on performance factors which are measurable through testing. (Examples are reliability, utilization rate, ease of handling, accuracy rates.) A data collection and evaluation plan should be developed which describes the procedure to be used in analyzing and evaluating the data collected.

2. T&E ROLE IN VERIFYING EFFECTIVENESS OF DESIGN SPECIFICATIONS

<u>T&E personnel should participate in systems definition to protect the intended system from tendencies to over extend its claimed capabilities</u>.

Test and evaluation participation at systems definition should verify the effectiveness of the specification to avoid unjustified or unnecessary overdesign. Sophisticated software test gear that is not designed for anything particularly but for everything in general is almost always overspecified.

In some recent programs the desire to "sell" the equipment generated exaggerated claims of general application. When the time came to write the software to back up the claims, the size of the job was so overwhelming as to compel a complete redefinition of the range of applicability of the common gear.

3. BOUNDARY SIZINGS

Before DSARC I, an analysis of at least boundary sizings should be made to determine the most cost-effective approach to test equipment.

It is recommended that no T&E plan be accepted that does not include analyses of at least boundary sizings to determine whether, for example, "built-in tests plus adequate spares and no field maintenance" is more economical and effective in the long term than standardized and custom test equipment in the field. The concept of a standarized test system seems often desirable; however, meaningfulness of the concept is not always certain since there are related factors such as improved reliabilities, micro-miniaturization, speed and payload of modern air transportation, etc. which in concert may make the former approach to testing more desirable. Results of the analyses should be documented as appropriate in the DCP or PM under "alternatives."

Past experience is not kind about the success of standarized test equipment. The time to worry is before DSARC I, not after DSARC II.

4. CRITICAL ISSUES

The major critical issues, especially those technological issues relating to Common Test Gear should be addressed in the T&E section of the initial management document.

In evaluating the initial DCP or its equivalent, it is important to ensure that the T&E section (objectives of the tests to be conducted during the time period from DSARC I to DSARC II) address the major critical issues, especially those technological issues which have been identified. For instance, in addition to the concerns listed in the previous items, issues to be considered may be, among others:

(a) Are the results of the tests proposed to be conducted on the Common Test Gear directly related to its final purpose and not limited to the determination of accuracy, stability, etc? For instance, in a device capable of testing radars for MTI performance, will the test equipment supply results that can easily be converted into cancellation ratios and subclutter visibility limits?

(b) In Common Test Gear, often calibrations are included in the software. One should ensure that the software is available, sufficiently accurate for its purpose, and complete.

Each test should have a single objective, if possible, and the objective should be simply stated. A plan for the conduct of the test and the data collection, reduction, and analyses must be in sufficient detail so that one can readily evaluate the performance of the system and whether or not the test objective can be met. A relationship between the identified performance parameters and the test results should be established prior to the conduct of the test. Further, the set of objectives for each of the tests should be clearly related to the program objective as defined. When this relationship is not clear, amplifying data should be required.

5. T&E ACTIONS PRIOR TO DSARC I

Prior to DSARC I, a T&E plan for those tests to be conducted prior to DSARC II should be developed.

Prior to DSARC I, sufficient material should be generated to allow for an initial evaluation of the overall T&E program. As part of this, a test and evaluation plan for those tests to be conducted prior to DSARC II to validate the concept and hardware approach to the Common Test Gear should also be developed. The plan must include statements of:

(a) The critical issues and the overall purpose of the test program.

(b) The class of equipments for which the test device will be employed and the mission and characteristics of these equipments.

(c) The major test objectives as related to the missions of (b) above.

(d) The schedule of test milestones--these milestones should specifically include use of the proposed equipment on some of the devices for which it is intended.

(e) The major resources required:

- Test environment, facilities and instrumentation
- Operational environment.

(f) The organizations which will conduct the test program.

(g) The analysis and evaluation approach--this analysis should include time required for a test series, lists of hardware failures, analysis of failure modes.

(h) The degree to which the service's independent test agency is involved.

6. T&E REPORT FORMAT

A T&E reporting format should be established and used throughout the duration of the program.

Establish a T&E reporting format for the program--insist on its use throughout the duration of the program. Use this to:

(a) Establish a closed loop reporting and resolution process which assures that each test failure at every level is closed out by appropriate action, i.e., redesign, procurement, retest, etc.

(b) Establish a relationship between T&E of the Common Test Equipment and the program offices of the equipments for which the device is intended.

7. RELIABILITY PLAN

A study of the test sample size versus the confidence level for reliability of Common Test Gear should be included in any reliability testing plan.

In order to provide a reasonable confidence of the reliability of the Common Test Gear, a large test sample size might be required. A study of the sample size versus the confidence level should accompany any reliability testing plan.

Remember that in Common Test Gear the presence of undetected failures or deteriorations can be fatal. In these equipments reliability includes a broader range of failures than in most other systems.

8. ESTABLISHMENT OF TEST CRITERIA

By the end of the systems definition phase for Common Test Gear, test criteria must be established so that tests may clearly determine performance failure or success.

By the end of the systems definition phase, test and evaluation should make certain that "test criteria" are established so there is no question as to what constitutes a test and what performance will constitute a success.

In Common Test Gear one should define:

(a) For what range of equipments the test gear will be employed.

(b) What measurements will be operationally significant.

(c) What results one must obtain to meet the minimum needs of the equipments listed under "(a)".

(d) What steps will be taken if one or another class of failures is found.

Never assume that Common Test Gear can be tested "per se" without tying it to its ultimate purpose.

9. SOFTWARE TESTING

Individual software units should be tested prior to full-scale testing of any software code.

Prior to full-scale testing of any software code, testing of individual software units (modules) should be conducted which requires machine execution of every (or most) logical path through that module. This testing should concern itself with the proper execution of only that particular test and, hence, the test results should not reflect the rest of the program, but just the information about that particular module. The main objective of these tests is to ensure that a module of code will operate correctly when it is tested as part of an overall software assembly. To achieve this objective, serial dependents within and between tests should be avoided. Special hardware, or set up conditions should be kept to a minimum and, when used, isolated; more important, tests should be designed so that they can be run remotely whenever possible.

10. NEW TECHNOLOGY CAUTION

When new technologies are used in Common Test Gear, the performance may be adversely affected in untried environments. T&E should be planned accordingly.

It is a natural tendency to use new technologies in Common Test Gear, for instance to generate microwave signals from solid state generators. In general, beware of the performance of these new technologies in untried environments! For instance, in one case electronic gear was installed in a ship compartment where the field of the ship radar was generating spurious signals that made the equipment inoperable.

FULL-SCALE ENGINEERING DEVELOPMENT AND PRODUCTION/DEPLOYMENT PHASES

In the Full-Scale Engineering Development, the Development Testing and the IOT&E are to be conducted. It is assumed that the test plans prepared during the previous validation phase will be refined and the testing will be conducted in this third phase aimed at demonstrating that a substantial production/deployment decision is warranted.

Many of the items listed in this phase may be more appropriate in the earlier phase in some programs; for example, contract checklist items may be proper in the earlier phase if the program is defined and contracts are negotiated preparatory for the Full-Scale Development DSARC. In other cases, the RFP for engineering development might not be issued until after the DSARC and, in this case, contracting checklist items may be more appropriate in the later phase.

Follow-on OT&E is conducted with the early production equipment. The lead time after the production decision and before the first system is produced is probably on the order of 2 years or more; consequently, the detailed planning for follow-on OT&E can probably wait until after the production decision. However, prior to that time the basic plans should have been made for manning assignments, personnel training, hardware and software requirements, and facilities.

The checklist includes:

1. Government Furnished Equipment and Facilities
2. Interface Evaluation
3. Time and Funding
4. Human Factors
5. Test Program Problem Indicators
6. Type Personnel Mix
7. Test Failure Procedures
8. Specification Verification
9. Software Incompatibility Tests
10. Configuration Testing

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11. System Parameter Measurements
12. Limitations Testing
13. Error Handling and Documentation Validity
14. Testing to Original Design Specifications and to Subsequent Modifications
15. Simulated Software Tests
16. Test Facilities
17. Relationship of Common Test Gear System to the Supported System
18. Technical Maintenance Data Package Testing
19. Pilot Tests
20. First Article Testing

1. GOVERNMENT FURNISHED EQUIPMENT AND FACILITIES

T&E should be concerned about the availability of GFE equipment as specified in the proposed contract.

If there are GFE and other government commitments in the proposed contract, be concerned about the following:

(a) Can the gear with requirement performance be available when required for the tests?

(b) Will equipment for which the test gear is intended be available?

(c) Avoid contract terms on fixed price contracts that vaguely commit the government. Don't include, "government support as required" or "test facilities will be made available when needed."

2. INTERFACE EVALUATION

The interface between the Common Test Gear and the equipment it services must be evaluated from several viewpoints.

The use of Common Test Gear imposes constraints upon the design of equipment that the test gear is designed to service.

In any T&E plan attention must be given to this factor to ensure that testing of the common gear includes testing of these features of the service equipment. The interface between the Common Test Gear and the gear to be tested should be evaluated from the viewpoint of complexity, durability, time required to make-up, and commonality with other interface connections.

3. TIME AND FUNDING

Analysis of the time and funding required to carry out the T&E plan should not presume that a series of tests can be completed without test stoppages.

As part of the T&E plan, provisions must be made to ensure that time and funding are included to carry on the necessary tests. In analyzing time and funding required do not assume that the series of tests can be carried on successfully as planned. When testing Common Test Gear, remember that failures of the serviced equipment can stop the tests just like

failures of the test gear itself. A significant percentage of the total tests (runs, trials, experiments) should be allowed for retesting.

4. HUMAN FACTORS

T&E should authenticate the human factors concepts embodied in the proposed system design as early as possible.

T&E should examine questions of safety, comfort, appropriateness of man-machine interfaces, as well as the number and skill levels of the personnel required and the training requirements. The numbers of personnel required should be validated against both operational and maintenance requirements. Testing early versions in the "human acceptability and compatibility" environment is extremely important. This will also help to validate the manning and training requirements.

In one development, a system designed for rapid testing of a variety of avionics devices was found to be much slower than originally intended because the position of switches, knobs and displays were placed so as to reduce the maximum throughputs by factors of three to four, thus eliminating the advantages claimed for the device when the program was approved.

5. TEST PROGRAM PROBLEM INDICATORS

An early detection scheme should be established to determine when a test program may be underfunded.

Establish an early detection scheme for government and contractor management to determine that a test program may be underfunded. At this time there may be a good possibility of recovery. Some of the indications of trouble are:

(a) Any repetitive failures.

(b) Major redesigns are suggested by test failures.

(c) The size of the memory required in the data processor is increasing at an alarming rate.

(d) A revision of schedule or incremental funding that exceeds the original plan. Predicted downstream recovery may not have a realistic basis.

(e) Any relaxation of basic requirements such as time to test, test accuracy, types of equipment to be serviced, etc.

6. TYPE PERSONNEL MIX

A mix of personnel with different type backgrounds is needed throughout the T&E program. The operator of the equipment to be tested (by the Common Test Gear) must be kept in the T&E loop.

Testers, evaluators, and operators have quite different backgrounds and needs which affect the T&E of the Common Test Gear system. Each has a different approach which has merit and utility at almost all points in the T&E program. A mix of these types is needed throughout the program. Early in the program, the lead emphasis should be from the tester, shifting to the evaluator and finally the operator, but at all times all parties and their needs should be coordinated.

In the case of Common Test Gear the operators of the equipment to be tested will be final judges of the operational suitability of Common Test Gear. Make sure that the T&E program includes these operators in the loop.

7. TEST FAILURE PROCEDURES

Test plans should include procedures whereby a record is kept of all failures, time lost and repair times.

The T&E plan should include procedures to:

(a) Keep track of all failures (even operator caused) whether due to software bugs, failure of components, random causes, improper design, etc.

(b) Keep track of time lost due to failures of the serviced equipment.

(c) Keep track of the time required to repair or fix every hardware box or software module.

8. SPECIFICATION VERIFICATION

Tests need to be conducted to verify that the specified functions associated with the Common Test Gear match the programmed functions.

Specifically, these tests should:

- Verify that the explicit functional specification has been correctly implemented.
- Verify that the explicit logic specifications have been correctly implemented.
- Verify that all programmed functions have been fully specified.

9. SOFTWARE INCOMPATIBILITY TESTS

Tests should be conducted which identify areas where the product has incompatibilities with existing support and standards.

Since a programming functional specification describes what the product does, why it is being provided, and how it is to be used, tests should be conducted which identify areas where the product has incompatibilities with existing support and standards. These should include incompatibilities in source, command, or control language. The tests should further identify changes in usage or human factors, as well as allow for investigation of comparison techniques required to resolve these incompatibilities. Measures of performance should include execution time and response time, real and auxiliary storage estimates.

10. CONFIGURATION TESTING

Configuration testing on Common Test Gear is required to verify that the product operates within the hardware and software systems that support it relative to hardware configuration.

Tests should exercise the hardware and the software code and should exercise the code on various hardware configurations to verify that there are no hardware deficiencies relative to software. Configurations tests are needed to verify that the function is viable in the support software environment such as sequential processing and multi-processing.

11. SYSTEM PARAMETER MEASUREMENTS

Testing should be designed to show that the combination of the appropriate software package(s) and hardware (both that of the test gear and the system to be tested) is such that all parameters of the system under test are measured.

Tests should exercise the hardware and the software code on various configurations to verify that there are no hardware deficiencies relative to software.

12. LIMITATIONS TESTING

Tests should be conducted to define and verify system limitations.

As soon as possible, limitations testing should be conducted on a Common Test Gear system to verify that the product limits are correctly stated. To do this, the product should be tested outside the limit, at the limit and within the limit. Relative to external limits, items that should be investigated are capacity and quantitative constraints stated in the specifications, such as the size of the record, depth of test, etc Internal limits should also be investigated including table size, queue limits, etc.

13. ERROR HANDLING AND DOCUMENTATION VALIDITY

The error handling facility of the Common Test Gear system should be tested for adequacy and verification of performance. Documentation associated with the system should be tested for validity and accuracy.

Tests need to be conducted on Common Test Gear to verify that the error handling facility of the product operates satisfactorily, and that these facilities are sufficient for the type of errors which are likely to occur. In order to do this, one can force the system to produce every known type of error message and verify the accuracy and clarity of each.

Testing should provide for investigation of errors from the operator, the source language and hardware failures. It is important that the publications associated with the Common Test Gear be accurate and clear. Tests

should be conducted to verify the validity of the publication; for example, the figures and tables concerning functions appearing in the documentation.

14. TESTING TO ORIGINAL DESIGN SPECIFICATIONS AND TO SUBSEQUENT MODIFICATIONS

T&E should not only verify original design specifications but also assess the impact of any new modifications into the system.

Test and evaluation should ensure that original specifications are met including MTBF, duration of unscheduled interruptions, and service hour criteria. If and when modifications are introducted into the system, additional evaluation should take place to measure the impact of these changes as they directly relate to the original objectives. Since the test gear's own availability/maintainability is a key ingredient to the overall economics, it is certainly appropriate that specific goals be set for the number of unscheduled interruptions of the system per month, the duration of unscheduled interruptions, and the maintenance hours required.

15. SIMULATED SOFTWARE TESTS

Simulated software tests should be conducted prior to the publication of the programming logic specifications.

Prior to the publication of the programming logic specifications, a simulated test should be conducted to assure that all interfaces have been considered and accounted for, and that the detail logic is error free. This simulation should include participation of the designer, the coders, the testers, and publication planners. A set of functional test cases should be prepared to determine how the programming logic implements the functional variations to be tested. The operating premise should be that the combination of all functional test cases hits all modules. This simulation should be used to identify additional testing which may be sensitive to the program's environment and data structure, for example, buffer length, loop control, etc.

16. TEST FACILITIES

Prior to completion of the development phase, test facilities requirements should be ascertained.

No later than completion of the development phase, planners should make certain that there are facilities to permit test sets to be developed and verified without inordinate expense and undue consequences to the overall program. The need for on-line debugging and test set validation is unavoidable; the complete absence of any simulation or remote debug and test capability is a significant handicap.

17. RELATIONSHIP OF COMMON TEST GEAR SYSTEM TO THE SUPPORTED SYSTEM

T&E of Common Test Gear systems must be interfaced with the supported prime weapon system at each phase of the latter's development.

It is very important that the Common Test Gear system be tested and evaluated with its prime weapons systems at each phase of the development of the prime weapon system. Test gear which has been conceived as a program intended to support a number of major weapons systems must be managed with emphasis placed on assessing how passing test gear milestones can be used to reduce the acquisition risks associated with the weapon systems. The T&E plan could usefully make reference to the milestones of the designated weapon systems to ensure that failure of one program to pass a milestone has no serious effects on the schedule of the other program.

18. TECHNICAL MAINTENANCE DATA PACKAGE TESTING

Prior to full-scale production, testing must ensure that the system can be maintained.

Prior to the decision to go into full-scale production of the system, a complete technical maintenance data package including the whole set of software module specifications, must be prepared and tested to ensure that the system can be maintained. The testing of this package should be considered first as part of DT&E and then as part of the IOT&E of the system. Criteria for successful demonstration of this package should be established in both types of tests.

19. PILOT TESTS

A pilot test should be run for the purposes of shaking down test plans.

Before any operational tests for demonstration of operational suitability and effectiveness is conducted, a pilot test should be held with the primary purpose of shaking down the test plan, the instrumentation concept and the data analysis plan. A secondary, but vital purpose should be to provide final training for the test participants. The pilot test should be conducted sufficiently prior to the OT&E so that sufficient time is available to make the necessary changes to the OT&E as dictated by the results of the pilot test.

20. FIRST ARTICLE TESTING

Preproduction, first article tests should be planned and conducted to confirm the adequacy of the equipment to meet specified performance requirements.

The preproduction, first article, testing and evaluation should be designed and conducted to confirm the adequacy of such factors as drift of critical performance parameters with time, failure modes and rates, etc. Development tests, usually conducted first by the contractor and then by the service, should be functional in nature and at the unit or black box level, and should be considered as a service acceptance test. These tests should be followed by OT&E which should include known failures of the equipment that the test gear is designed to support. For example, test gear for fire control systems should be evaluated as to time to detect and reliability of diagnosing a known failure in the fire control system.