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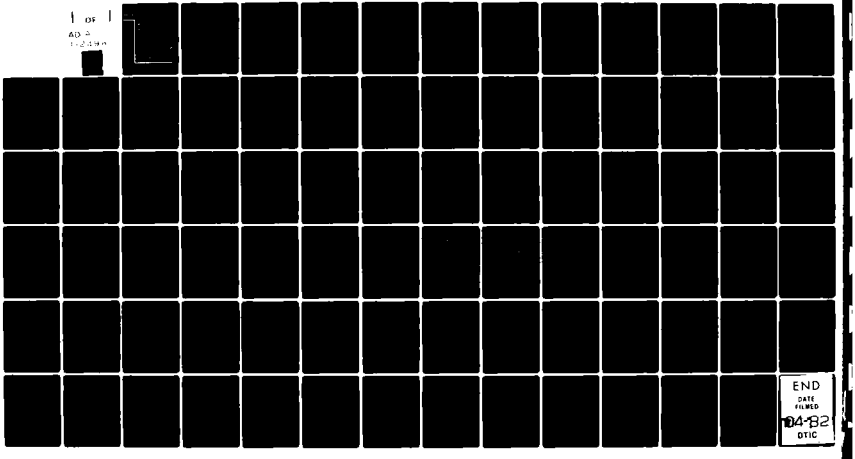

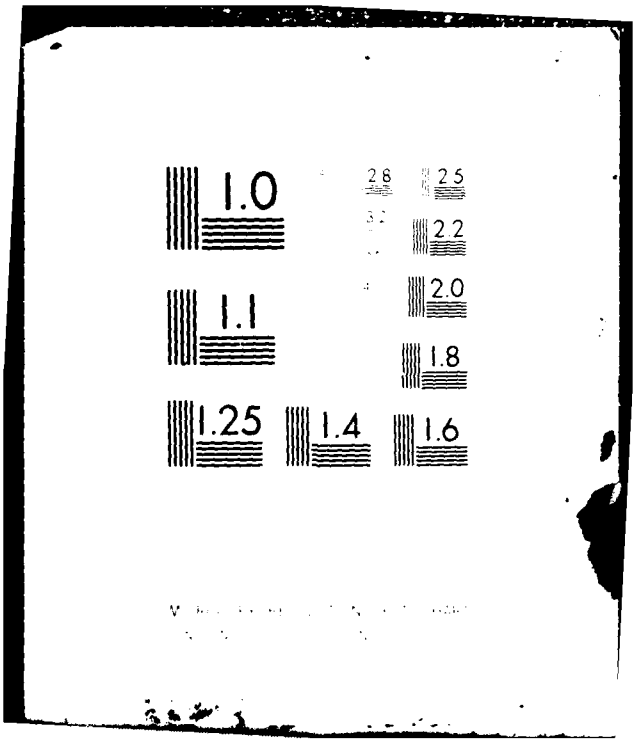
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AIR FORCE HUMAN RESOURCES LABORATORY

OPERATIONAL TEST AND EVALUATION HANDBOOK FOR AIRCREW TRAINING DEVICES: PLANNING AND MANAGEMENT

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February 1982

Final Report

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The Public Affairs Office has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

THOMAS H. GRAY
Contract Monitor

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Operations Training Division

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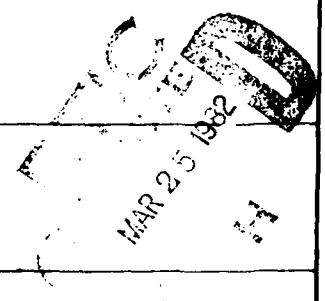

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The Handbook is comprised of three volumes, and is intended to provide guidelines and procedures appropriate for Air Force Operational Test and Evaluation (OT&E) personnel to use in planning, conducting, and reporting the results of simulator assessment efforts. Although of value to all test personnel, it is primarily for the typical novice test manager/director—a person who has subject matter expertise (e.g., a qualified pilot or operator), but who may have little or no previous OT&E experience. The Handbook provides detailed coverage on OT&E planning and management, with special emphasis on measuring device operational effectiveness and suitability. In accord with its objectives, the Handbook was prepared to serve as a supplement to Air Force Manual 55-43, "Management of Operational Test and Evaluation," by providing those specific additional evaluation concepts and techniques necessary for aircrew training device test and evaluation.

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PREFACE

This volume (Volume I. Planning and Management) is one part of a three-volume Handbook produced for the U.S. Air Force Human Resources Laboratory/Operations Training Division (AFHRL/OT). The Handbook is entitled, "Handbook for Operational Test and Evaluation (OT&E) of the Training Utility of Air Force Aircrew Training Devices." This effort has been accomplished by the Seville Research Corporation under Contract No. F33615-78-C-0063. Dr. Thomas H. Gray served as the Air Force Laboratory Contract Monitor (AFLCM) on the project. For Seville, Dr. William H. Hagin was Project Director, and Dr. Wallace W. Prophet was Program Manager.

The three volumes which comprise the total Handbook are intended to provide guidelines and procedures appropriate for use of Air Force ATD OT&E test team personnel in planning, conducting, and reporting the results of aircrew training device OT&E efforts. The three Handbook volumes are:

Volume I. Planning and Management

Volume II. Operational Effectiveness Evaluation

Volume III. Operational Suitability Evaluation

It is important that the reader understand that this Handbook was prepared to serve as a supplement to AFM 55-43, "Management of Operational Test and Evaluation" by providing those specific additional evaluation concepts and techniques necessary for ATD test and evaluation.

ACKNOWLEDGEMENTS

The authors would like to thank the many individuals and organizations whose cooperation, interest, and support made possible the accomplishment of this work: in particular, Dr. Thomas H. Gray, who served as the Air Force Laboratory Contract Monitor (AFLCM) for this project and who offered many valuable suggestions throughout the course of the work and provided helpful reviews and comments during preparation of the handbook; Dr. Peter Sassone, Georgia Institute of Technology; Mr. Robert Sisson, American Airlines; and Dr. William Spears, Seville Research Corporation, who participated in the early stages of this project.

The following listed organizations and agencies contributed to this program by participating in technical discussions, interviews, and reviews of draft written materials.

AIR FORCE
- Air Force Human Resources Laboratory
- Air Force Test and Evaluation Center
- Deputy for Simulators, ASD
- Tactical Air Warfare Center, Tactical Air Command
- Headquarters, Strategic Air Command
- 4200 TES, Strategic Air Command
- Headquarters, Military Airlift Command
- Headquarters, Air Training Command
- Air Force Logistics Command

NAVY
- Navy Training Equipment Center
- Training Analysis and Evaluation Group

ARMY
- Army Research Institute
- Program Manager Training Devices (PM TRADE)
- TRASANA

INDUSTRY
- Singer, Link Division
- American Airlines
- United Airlines

UNIVERSITY
- Georgia Institute of Technology
- University of Illinois
- Arizona State University

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CHAPTER 1

HANDBOOK OVERVIEW

INTRODUCTION

The U.S. Air Force has utilized ground-based aircrew training devices (ATDs) to support inflight aircrew training programs for many years. The devices used have included cockpit familiarization and procedures trainers, part-task trainers, instrument flight simulators, mission trainers, operational flight trainers, and complex weapon system trainers. Until relatively recently, ATDs were viewed as "nice to have" additions to the use of aircraft for training, but not as critical elements in training programs. The contribution to aircrew training effectiveness of familiarization and procedures trainers, part-task trainers, and even instrument flight simulators was essentially presumed. Furthermore, there were no formal requirements to justify ATD acquisition on the basis of device versus aircraft cost-benefit trades.

Importance of ATD Training

The 1974 oil embargo-caused fuel shortage is widely recognized within the Air Force as having been a "trigger" for the generation of greater concern about the real training value of the full array of aircrew training devices. At all echelons of Air Force management, there was an increased awareness of the need to define, much more precisely than had ever before been required, the role of ATDs in all aspects of Air Force aircrew training--from the undergraduate level to that of the combat mission leader.

Concern for ATD training effectiveness is particularly acute today in view of the almost prohibitive cost of aviation fuel--especially when present fuel costs are projected toward the future. The role of ATDs as an essential, if not critical, component of Air Force aircrew training is unquestioned. As a result of significant advances in both flight simulation and aircrew training technologies, the potential contribution of ATDs toward improved quality of aircrew training, and to substantial cost avoidance in the conduct of that training, has become increasingly recognized and ATDs have become a major component of nearly all USAF aircrew training programs. In fact, there are some aircrew training programs in which the trainee spends almost as much time in ATDs as he does in the aircraft itself.

From the perspective of enhancing combat readiness training, the advantages of modern ATDs are remarkable. State-of-the-art ATDs

enable aircrews to practice combat flying skills without regard to weather conditions, aircraft downtime, insufficient weapons ranges, and limited live ordnance (missiles and ammunition). They allow trainees to practice with simulated friendly and threat aircraft, submarines and surface forces, and electronic countermeasures. These capabilities permit aircrews to maintain enhanced levels of combat readiness that would be otherwise unattainable. Of course, ATDs do not eliminate the necessity for flying aircraft. Aircraft must always be flown to polish combat skills, to exercise critical maintenance and logistics support systems, and to validate the airborne effectiveness of those techniques and procedures which were learned in ATDs.

Need for Quality ATD Evaluation Data

The present role of ATDs in support of Air Force aircrew training makes it more important than ever before that the Air Force have a means of assuring that ATD training is effective. As increased commitments are made to the exploitation of ATDs in enhancing aircrew training, and as training resource costs (personnel, fuel, munitions, etc.) escalate, more and more aircrew training necessarily will be conducted in ATDs. It is important, therefore, that the Air Force have a suitable data base which demonstrates convincingly that these devices do, in fact, meet operational training needs.

The ATD training effectiveness literature, upon which the presently available data base rests, consists mainly of numerous research-oriented ATD study reports, although there is a growing number of actual ATD OT&E reports. This developing data base will be used to support many critical ATD acquisition and utilization decisions. It is important, therefore, that future ATD OT&Es be conducted with the maximum precision that circumstances will allow so as to produce the highest quality ATD evaluation data possible.

Handbook Purpose

AFM 55-43, "Management of Operational Test and Evaluation" explains the Air Force operational test and evaluation program (OT&E) as it exists to implement the general testing and evaluation policies outlined in AFR 80-14, "Operational Test and Evaluation." AFM 55-43 is directed toward meeting the needs of both the OT&E manager and the "doers." Volume I of that manual provides background information and general guidelines for planning, managing, conducting, and reporting OT&Es. Volume II of the manual contains highly specific procedures and techniques for accomplishing the full range of OT&E activities. This material includes, for example, specification of detailed test procedures, standard formats for plans and reports, checklists, etc.

The guidance provided in AFM 55-43 is intended to apply to all Air Force OT&E--including the test and evaluation of aircrew training

devices. Experience has shown, however, that there are specific aspects of ATD testing for which substantial supplementary guidance is needed. It is the purpose of this Handbook to provide that supplementary, ATD-specific, information and guidance. Although it is intended primarily for use by typical new or novice test personnel with subject matter expertise (e.g., a qualified pilot), but who may have little or no previous OT&E experience, the Handbook should also be helpful to more experienced OT&E personnel.

User Guidance

Since this Handbook was prepared to serve as a supplement to AFM 55-43, "Management of Operational Test and Evaluation," being thoroughly familiar with the content of that manual is a necessary prerequisite to effective use of the Handbook. Users, therefore, are urged to "operationalize" this Handbook as an ATD OT&E-oriented annex to AFM 55-43: Read AFM 55-43 first for general OT&E guidance and direction and read (as appropriate) the volumes of this Handbook for ATD-specific instructions.

HANDBOOK ORGANIZATION AND CONTENT

There are three functions with which the ATD OT&E test director must be concerned and for which Handbook coverage is deemed appropriate. The first of these functions deals with overall ATD OT&E planning and management; the second and third functions are concerned with evaluating the actual operational effectiveness and suitability of a given device. The Handbook has been organized in alignment with these specific functions into three volumes:

Volume I: Planning and Management

Volume II: Operational Effectiveness Evaluation

Volume III: Operational Suitability Evaluation

Provided below are brief summaries of the contents of each of these three Handbook volumes.

Volume I: Planning and Management

Volume I of the Handbook serves three functions: It first provides an overview of the content of the entire Handbook. This overview serves somewhat as an "Executive Summary" for the reader who may only be interested in the big picture of the Handbook's content. Second, it is concerned with describing both general and specific ATD OT&E planning and management considerations and links those events which occur early in the ATD acquisition process to later ATD OT&E

planning and management activities. It defines the various evaluation concepts that are germane to understanding ATD OT&E, and it describes the two major ATD OT&E activities: - Initial/Qualification OT&E and Follow-on OT&E.(IOT&E/QOT&E and FOT&E). Major emphasis in this regard is directed toward a detailed "roadmapping" of the procedural events and milestones with which ATD OT&E test director personnel will be concerned in managing either IOT&E/QOT&Es or FOT&Es. Identified also are the critical personnel and materiel resources required for meeting the more important of these events. The third area addressed in Volume I concerns matters of ATD value and worth to the Air Force. The acquisition and life cycle costs associated with modern ATDs make such concerns important.

Chapter 1: Introduction. This first chapter consists of brief overviews of the content of the three Handbook volumes. These overviews are intentionally brief so that the reader may obtain a relatively quick, but inclusive, understanding of the scope of the entire Handbook. Chapter 1 of this volume thus is, in effect, an Executive Summary of the total Handbook.

Chapter 2: Understanding ATD Acquisition and Test. Chapter 2 of Volume I provides a general background discussion of the ATD acquisition and test process. The scope of this discussion ranges from the initial Statement of Need (SON), through the acquisition and manufacturing stages, to the device test and evaluation (T&E) phase. The coverage of T&E presented is intended to give the reader a basic understanding of the major types of T&E, and to develop an awareness of the T&E roles and responsibilities assigned the various Air Force organizations involved in the T&E process.

Chapter 3: Planning and Management of ATD OT&E. Chapter 3 specifically addresses ATD OT&E planning and management. It deals with the planning and management of both Initial and Qualification Operational Test and Evaluation (IOT&E/QOT&E) and Follow-on Operational Test and Evaluation (FOT&E). The intent of this chapter is to provide the ATD OT&E test team an understanding of the basic structure and critical milestones for the planning, conducting, and reporting of an ATD IOT&E/QOT&E or FOT&E.

Chapter 4: ATD OT&E Event Flow and Resource Requirements. It is important that the test director/team have a clear conceptualization of the "temporal" flow of ATD OT&E events. For this reason, Chapter 4 presents an hypothetical (but nonetheless representative) "time-lining" of the ATD acquisition and OT&E process. In that time-line, a distinction is made between events that occur while the ATD is in-plant or on-site and between pre- and post-acceptance testing OT&E activity. Of significance in that presentation also is the identification of critical OT&E supporting manpower and materiel resource requirements.

Volume I concludes with a Glossary of Terms (Appendix A) and an Annotated Bibliography of selected Air Force documents and research reports (Appendix B).

Volume II: Operational Effectiveness Evaluation

Volume II treats the assessment of ATD training during OT&E. Because of its direct importance to ATD training effectiveness evaluation, and because AFM 55-43 provides little ATD-specific effectiveness evaluation information, this volume of the Handbook is somewhat exhaustive in its treatment of the effectiveness evaluation subject matter. Volume II has seven chapters. The first four chapters basically comprise a tutorial on the fundamentals of ATD utilization, evaluation concepts, and evaluation approaches. The next two chapters address specific training evaluation techniques as they pertain to direct evaluation of an ATD's training effectiveness. The final chapter, in recognition of the fact that ultimate ATD effectiveness is also very much a function of its instructor/operator station (IOS) design, provides highly specific guidance for IOS evaluations.

Chapter 1: Introduction. Chapter 1, as its title suggests, is mainly an introduction. It defines the intent, scope, and content of Volume II and "roadmaps" its organization. It also provides a very brief overview of the content of each of the remaining chapters, Chapters 2 through 7, inclusive.

Chapter 2: Aircrew Training. This chapter discusses the nature of aircrew training. An important distinction is made in this chapter between initial aircrew training, as contrasted with continuation training or the maintenance of already acquired skills. The import of that distinction for ATD utilization and planning is emphasized strongly in this chapter. It is stressed that the test team must be fully cognizant that the effectiveness of ATDs may not be the same for both categories of training and that ATD OT&Es need to be conducted in the specific context of their intended application--initial and/or continuation training.

Chapter 3: ATD Effectiveness: Definition and Evaluation Methods. Chapter 3 of Volume II continues the thrust of the distinction in Chapter 2 between initial skill acquisition and subsequent skill maintenance, from the perspective of ATD effectiveness. It also provides several definitions of ATD effectiveness, including an "official" Air Force definition. Having thus communicated an awareness of the meaning of ATD effectiveness, the chapter then summarily reviews a number of evaluation models that have been used within either the research or the training applications community to evaluate ATD effectiveness. Chapter 3 also develops a distinction between those evaluation models that employ analyses or judgments obtained from subject matter experts (analytic models) and those evaluation models that

involve actual training (demonstrations models). This distinction is useful to the test team in the context of IOT&E/QOT&E and FOT&E.

This review is not intended to endorse or reject any one of the models per se, but is provided for general information purposes. Recommendations for specific evaluation model applications are provided in subsequent chapters.

Chapter 4: Selecting An Evaluation Approach. Chapter 4 begins with a discussion of a number of factors which the ATD OT&E test team must consider when selecting either an analytic or demonstration approach appropriate to a particular ATD OT&E requirement and/or evaluation environment. This list of factors includes the site where the evaluation is to be conducted; the calendar time available to complete the evaluation; the level of management commitment to the evaluation; the design and intended use of the ATD to be evaluated; the availability of adequate criterion measures; the accessibility of the ATD and the operational equipment for evaluation purposes; the availability of instructor pilots, subjects, and other necessary resources; and, finally, the characteristics of the available subject population.

After these factors are discussed, Chapter 4 continues by providing general guidance to the test director and his team on how to select an evaluation approach, using this information. It then discusses how to apply this general guidance to the selection of an approach within a particular testing environment. Finally, the importance of identifying and managing user attitudes towards the ATD to be evaluated is discussed and guidance on how to do so is provided.

Chapter 4 concludes by pointing out that Chapters 1 through 4, inclusive, have been oriented primarily toward establishing a basic background for an understanding by the test team of the planning, management, training program, device, measurement, attitude, and other factors with which they must be familiar as they proceed with the conduct of an ATD OT&E. It is recognized at this point in the Handbook that the test team also needs very specific, detailed instructions concerning a number of the evaluation tools and techniques they will employ in performing either an analytic or an applications type ATD OT&E. As a result, the remaining chapters of Volume II are devoted to the presentation of such information.

Chapter 5: Rating Scales and Questionnaires. This chapter acquaints the test director with the techniques he will need in order to construct, pre-test, and use rating scales and questionnaires during an ATD OT&E. The chapter opens with a brief discussion of the advantages and limitations of the rating scale concept. That discussion is followed by the technical body of the chapter which is organized into three major sections.

Section A develops the rating scale concept and procedures for rating scale construction to a level such that the test director will have the background necessary to effective application of rating scale methodology. He is introduced to the principles of rating scale construction and is given guidance on how to construct many types of rating forms.

Section B of this chapter describes specific rating scale procedures he may use in conducting (by use of the rating method) two important elements of ATD OT&E evaluation: fidelity assessments and training capability evaluations of the crew station. It should be noted here that the rating method is also used in part to evaluate the instructor/operator station (IOS). However, in view of its unique evaluation requirements, evaluation of the IOS has been addressed separately from the scope of this rating scale method chapter. The procedures for IOS evaluation are provided in the last chapter of Volume II, Chapter 7.

Section C of this chapter points out that questionnaires are extensively used during OT&E because they are relatively inexpensive to develop, simple to administer, and allow large amounts of data to be gathered quickly. This section also makes the point, however, that poorly constructed questionnaires can be troublesome, in that they are likely to result in distorted data and possibly lead one to unwarranted conclusions. In order to minimize the likelihood of a test director using improperly prepared questionnaires, this chapter provides specific guidance on the construction of questionnaire statements and procedures for their formatting and organization.

Chapter 6: Transfer of Training. This chapter constitutes one of the most important elements of information presented in Volume II: It provides a quantitative method for ATD OT&E evaluation which depends not on expert opinions or IP judgments, but which involves actual ATD training activity.

The chapter's technical content is presented in two sections. The first section provides guidance concerning the general conduct of a TOT study from planning, through execution, to reporting. In anticipation that a greater degree of specificity would prove of use, the second section of Chapter 6 presents four types of TOT designs that a test team might find applicable under many ATD OT&E situations. The breadth and depth of coverage in these two sections is such that the test team should be able to implement an effective TOT.

Chapter 7: IOS Evaluation. Chapter 7 is the concluding chapter of Volume II. As noted earlier, it reflects an application of rating methodology to the problem of ATD IOS evaluation during IOT&E/FOT&E. The importance of the IOS to effective ATD utilization is recognized early in the chapter. The chapter identifies the types of instructor/

operator tasks likely to be performed at an IOS and relates those tasks to the specific instructional features with which an IOS may be equipped. The chapter provides specific procedures for, and aids to, the conduct of an IOS evaluation.

Volume III: Operational Suitability Evaluation

This volume is concerned with assessing the impact of operational suitability factors on ATD usefulness. Operational suitability factors pertain to how well the device meets accepted equipment serviceability requirements within its intended operating and maintenance environment. There are two principal components of ATD suitability that must be examined during ATD OT&E, i.e., hardware suitability and software suitability. Assessment of ATD operational suitability during OT&E is an important area of concern, and one requiring great care in its planning and execution. This volume is intended principally for the purpose of helping the ATD test director in identifying the appropriate suitability assessment technical personnel and of understanding better the activities they perform. Accordingly, this volume is not intended to be a substitute for technical how-to manuals, but rather an information source and test planner/director guidebook for ATD suitability assessments during OT&E. The following are brief summaries of Volume III chapters:

Chapter 1: Purpose and Organization of Volume. This chapter provides a brief introduction to the concept of operational suitability, definitions of suitability factors, a statement of the intended informational uses of the volume, and a roadmap to the content of the volume.

Chapter 2: Hardware Suitability. This chapter presents the major hardware suitability evaluation concerns of reliability, maintainability, availability, logistics supportability, and operating and support costs. For each major suitability element, discussions are provided that define that element in the context of ATD OT&E. In addition, under the heading of "Test Director Concerns," generic personnel requirements are identified and practical guidelines are provided that may serve to inform the test director of possible lead time requirements, and phase of test specific concerns to aid in the successful accomplishment of the various operational suitability assessments.

Chapter 3: Software Suitability. This chapter provides an introduction to software suitability assessments for ATD OT&E. Software suitability is defined in terms of maintainability and usability. It is noted that the technology of software evaluations is a currently evolving area requiring access to appropriate evaluation personnel. The content of the chapter corresponds to the evaluation elements of maintainability and usability and defines the subelements under each along with a description of evaluation procedures carried out by qualified software evaluation personnel.

CHAPTER 2

UNDERSTANDING ATD ACQUISITION AND TEST

INTRODUCTION

Organization and management of an effective test program requires that the test director and his team have a basic understanding of the role of test and evaluation (T&E) in ATD acquisition and employment. This chapter provides the background information necessary for that understanding. There are two major topics covered: (1) ATD acquisition procedures; and (2) ATD OT&E concepts and responsibilities. The discussion of the ATD acquisition process is intended to provide the OT&E test team a summary of the major phases in the procurement of an ATD. It is provided mainly to familiarize the test team with the ATD acquisition process and its associated documentation. As such, it is not intended as a detailed guide for procurement or test and evaluation staff activities. Detailed procedures for such activities may be found in the internal documentation of the organizations and staff agencies responsible for these functions.

The second topical discussion begins with a description of those early OT&E planning activities that go on simultaneously with ATD acquisition. It concludes with an identification of the various types of ATD OT&E, their respective goals, and organizational responsibilities.

THE ATD ACQUISITION PROCESS

Program Initiation

Acquisition of aircrew training devices by the Air Force is handled by the Deputy for Simulators (Simulator System Program Office--SimSPO) of the Aeronautical Systems Division, Air Force Systems Command (ASD/AFSC). The SimSPO follows established procedures for ATD procurement planning, scheduling, and monitoring from ATD project inception through contract award, qualification/acceptance testing, and final transfer of the ATD to the using command and the Air Force Logistics Command (AFLC).

Acquisition of a new ATD is initiated by a Statement of Operational Need (SON), or a Mission Essential Needs Statement (MENS). Either document is originated by one of the Air Force Major Commands (MAJCOM). An ATD SON or MENS is, by necessity, a very general statement of requirements. In fact, the ATD portion of the pertinent document for a new weapon system (e.g., F-16) may be simply a statement

that associated training devices would be required. During the SON/MENS process, the using command and AFSC work together to define realistic ATD solutions to the expressed need prior to sending a final evaluation (including a recommended solution) of the SON/MENS to USAF for approval and further direction.

HQ USAF provides program management direction and guidance at the outset of the procurement cycle by issuing a Program Management Directive (PMD). The PMD reflects approval of the program by HQ USAF and specifies the actions required to translate the SON/MENS into a proposal for a new program. At this point, the program is assigned to the SimSPO, and a program manager is appointed. The PMD is also forwarded to the using command, the Air Force Test and Evaluation Center (AFTEC), the Air Force Logistics Command (AFLC), and other participating commands or agencies so that necessary advance planning may be initiated.

Proposal Phase

Procurement activity begins with the Request for Proposal (RFP). Preparation of the Specification and Statement of Work (SOW) to be contained in the RFP is the process wherein the SimSPO and using command come to a mutual understanding as to the desired ATD configuration. A draft of the RFP may be issued to industry for comment as part of this process. A synopsis of the program is prepared and published in the Commerce Business Daily (CBD) so that all ATD manufacturers who possess appropriate capabilities may request copies of the final RFP. Copies of the final RFP are then distributed to industry in accord with the government's view of the qualifications of the various interested vendors.

Upon receiving the RFP, the responding ATD manufacturers prepare detailed technical proposals describing their individual design concepts for the subject ATD, and their program management and scheduling plans. In addition to the technical proposal, each manufacturer prepares a cost proposal which contains that offeror's bid for the design and production of the device. At a date specified in the RFP, vendor proposals are submitted to the Air Force for evaluation.

A systematic evaluation of offerors' proposals is then carried out to select from among those submitting proposals those firms that may be considered for award of the contract. Evaluations consider both technical responsiveness to the RFP and price factors. One or more offerors judged to be within the competitive range may then be invited to negotiate further or clarify proposals on technical and/or price factors, and to submit a best and final offer (BAFO) to the government.

After receipt of the best and final offers, a Source Selection Committee conducts a final evaluation and awards the ATD contract to

one of the offerors. In some cases, more than one contract may be awarded, and a "fly off" between contractors may be conducted. In such instances, a final source selection would be based upon test and evaluation results of the prototype devices.

Production Phase

The production phase consists of three major acquisition efforts: Preliminary Design, Detailed Design, and Fabrication and Acceptance Testing. Contract specifications, the Statement of Work (SOW), and the Program Schedule are key documents for understanding precisely what is to be built and when OT&E-relevant acquisition milestones should occur.

Preliminary design phase. During this phase the ATD contractor conducts a detailed review of the specification and develops a preliminary design approach. The resulting preliminary design is then presented to the Air Force during a Preliminary Design Review (PDR). As part of the PDR, a mock-up review is usually held. During mock-up review the Air Force customer may examine a nonworking model of the device (this may include both trainee station and instructor/operator station).[1] The PDR provides an opportunity for Air Force inputs regarding device design and conformance to contractual requirements, including requirements related to the trainee station, instructor station, computational system, math model, motion system, visual system, safety system, reliability, maintainability, etc. Air Force attendees at PDR usually include SimSPO, AFTEC (OT&E team), and using command representatives. Representatives from other participating commands and agencies may also be present.

Detailed design phase. During this phase specific details of the ATD are addressed to arrive at actual hardware production drawings, and computer processing functions are flow-charted. This design activity incorporates the Air Force input received during PDR and mock-up review. Periodic design reviews are held to ensure that all subsystems are designed to interface correctly. Software module development and testing is begun, and hardware/software interface requirements are defined. At the end of the detailed design phase a Critical Design Review (CDR) is held to allow the Air Force to review the detailed design of the ATD. At this point design discrepancies identified during PDR are reviewed to ensure that they have been corrected before hardware manufacture begins.

Fabrication phase. This phase consists of a number of activities: hardware fabrication, software development, and systems

[1] Mock-up may occur independently of PDR. If so, OT&E team representation is appropriate.

integration. Hardware fabrication includes manufacture of certain hardware items as well as integration of purchased hardware (indicators, display systems, etc.) with manufactured hardware. All hardware contained in major ATD subsystems, i.e., trainee station, instructor/operator station, visual system, motion system, computational system, etc., is completely assembled into the ATD. Critical functional software modules developed include trainee station simulation drive modules (e.g., flight characteristics, tactical environment, target characteristics, emergency procedures) and instructor/operator station modules (e.g., problem set up, performance monitoring, instructional features).

System integration and checkout occurs when all ATD subsystems (including hardware and software) are fully integrated. This is often referred to as Hardware/Software Integration (HSI). Verification tests, an in-house quality control activity, are then conducted. They involve using the preliminary QTPs to test major systems and subsystems. Any deficiencies that may be identified are then corrected.[1]

Development of Qualification Test Procedures (QTP) also occurs during this phase. A preliminary set of QTPs is prepared and submitted to the Air Force, usually 120 - 180 days prior to the start of formal testing. A repetitive review, correction, and revision process is used in the development of the QTP that will be followed during the test. A final QTP is delivered, under the contract, prior to testing.

Following verification testing activities and submission of the final QTP (and assuming any deficiencies found are corrected), the ATD is declared "ready for Air Force test and acceptance."

Acceptance Test and Evaluation (AT&E) Phase

This final phase of activity in the ATD acquisition process includes qualification/acceptance tests by the Air Force to demonstrate that the engineering design is complete, that design and production risks are minimized, and that the requirements and specifications of the procurement contract are fulfilled. Completion of this phase is formalized by DD 250 signoff.

Economic Analyses During ATD Acquisition

Economic analyses of military systems are required by Department of Defense Instruction (DoDI) 7041.3, "Economic Analysis and Program

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[1] Contractor verification testing is often monitored by the Defense Contracts Administration Service (DCAS) to validate the contractor's readiness for test.

Evaluation for Resource Management."[1] DoDI 7041.3 states as policy that project officers and managers should be prepared to demonstrate the cost-effectiveness of budget proposals and to submit detailed analyses in support of budget estimates provided in accord with DoD 7110-1-M, "Department of Defense Budget Guidance Manual." In developing and justifying resource requirements, an economic analysis is required for budget proposals which involve a choice or trade-off between two or more options, even when one of the options is to maintain the status quo or to do nothing.

Such analyses are particularly important during ATD acquisition as evidenced by those economic analyses which were conducted for the B-52, C-130, F-15, and F-16 ATD programs.

Definition of economic analysis. DoDI 7041.3 defines an economic analysis as "a systematic approach to the problem of choosing how to employ scarce resources and an investigation of the full implications of achieving a given objective in the most efficient and effective manner." Determinations of efficiency and effectiveness are implicit in assessment of the cost effectiveness of alternative approaches.

Such assessments during ATD acquisition are accomplished by:

1. Identifying systematically the benefits, other outputs, and costs associated with alternative training program concepts.

2. Identifying the assumptions on which ATD procurement and employment decisions are based, including technical, operational, schedule, and other performance considerations.

3. Evaluating alternative methods of supporting an ATD acquisition, e.g., lease or buy; contractor vs. Air Force maintenance.

4. Using benefits and costs to compare the relative merits of relevant alternatives as an aid in recommending the preferred alternative.

Scheduling of economic analyses. DoDI 7041.3 specifies that economic analyses are to be initiated as early in the acquisition process as practical and updated whenever significant developments occur which could invalidate or significantly alter the cost-benefit relationships upon which previous decisions were made. DoDI 7041.3 also calls for

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[1] DoDI 7041.3 has been implemented in the Air Force through Air Force Regulation (AFR) 178-1, which essentially is a paraphrase of DoDI 7041.3.

periodic program evaluations to assess the cost effectiveness of ongoing activities.

DoDI 7041.3 provides for three exceptions to the requirement for economic analysis. An economic analysis is not required:

1. When it can be shown that cost of the minimum level of effort required to do the analysis would exceed the worth of the benefits to be gained from such an analysis.

2. In cases where DoD instructions and issuances prescribe equipment or age replacement criteria, labor and equipment trade-off standards, or requirements computations which, in turn, have been based on an economic analysis as called for in the DoD instruction.

3. When proposed actions are specifically directed by legislation or prior irrevocable management decisions which preclude any choice or trade-off among alternative ways to accomplish a program/project.

ATD economic analysis models. The economic analysis models currently available to the Air Force for use during ATD acquisition are not true cost-effectiveness models, in that they do not allow a real evaluation of the effects of variations in training effectiveness. The models generally in use treat effectiveness as "fixed." The assumption is made in each of these models that the training alternatives of interest are equally effective, and that simple cost comparisons will suffice for cost-effectiveness analysis purposes.

There are two such cost models actively utilized by the SimSPO during the ATD acquisition cycle: the RCA Cost Model and the Logistic Support Cost Impact Model.

RCA Cost Model. The RCA Cost Model[1] is utilized by the Air Force Simulator System Program Office (SimSPO) to estimate simulator hardware costs. For each simulator subsystem the contractor provides parametric hardware information such as size, weight, mechanical/electric interfaces, electronic packing densities, number of electronic parts, material used in structure, method of cooling, weight and volume of discrete electronic modules, etc. Based on this information, the model calculates a hardware system cost estimate. The

[1]Details are proprietary to RCA.

model is used by the SimSPO primarily to provide an "independent" estimate (relative to that of the contractor) of simulator hardware costs to support management decisions which must be made during the early phases in procurement of an ATD.

Logistic Support Cost Impact Model. The Logistic Support Cost Impact Model (LSC) is used by the SimSPO to estimate the operating and support (O&S) costs that may be incurred by adopting a specific system/product design configuration. This model is used in two ways: (1) as a decision aid when discriminating among design alternatives during the advanced development and detailed design phases for an ATD; and (2) to estimate the differential logistics support costs between the proposed design configurations of two or more potential ATD suppliers during source selection.

ATD T&E CONCEPTS AND RESPONSIBILITIES

There are two primary categories of ATD T&E: Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E). DT&E is conducted principally to determine that the ATD meets the engineering design and development specifications. OT&E is conducted to assess the training utility of the ATD, and to develop estimates of its operational suitability. Funding for T&E comes from either RDT&E funds, or from Operations and Maintenance (O&M) funds.

Development Test and Evaluation (DT&E)

DT&E is that test and evaluation conducted to demonstrate that ATD engineering design and development are complete, that design risks have been minimized, and that the system will meet engineering and operational specifications. DT&E involves essentially a detailed engineering analysis of the ATD's performance, beginning with individual subsystems and progressing through a complete system. System design is tested and evaluated against engineering and performance criteria provided by the Air Force.

The SimSPO is responsible for management of DT&E. AFTEC and the MAJCOMs participate in DT&E as specified in the program directives and in the coordinated planning documents. DT&E, a natural part of the contractor development process, is initiated as early in the development cycle as possible and includes testing of component(s), subsystem(s), and prototype or preproduction model(s) of the entire system.

DT&E for systems where there is no development funding is known as Qualification Testing (QT&E). As with regular DT&E, qualification tests are conducted to demonstrate that engineering design is complete, that design and production risks are minimized, and that the

items fulfill the requirements and specifications of the procuring contract or agreement. QT&E is managed and conducted in a manner similar to DT&E.

Operational Test and Evaluation (OT&E)

Operational Test and Evaluation (OT&E) is divided into two subsets: IOT&E and FOT&E. IOT&E is conducted to provide an initial estimate of the operational training effectiveness and operational suitability of the device, to identify operational deficiencies, and to suggest appropriate changes to overcome those deficiencies. IOT&E is accomplished by test teams consisting of Air Force operational and support personnel representative of those who are expected to use and maintain the ATD when it is deployed. Either AFTEC or the using MAJCOM (AFTEC monitored) may be responsible for IOT&E.

IOT&E may be combined with DT&E. When combined, testing may include shared DT&E/IOT&E test events and separate DT&E and IOT&E test events. It should be noted that combined testing does not mean that one type of testing predominates or that all IOT&E objectives can or will be satisfied by shared test events. It should be noted that Qualification Operational Test and Evaluation (QOT&E) is conducted in lieu of IOT&E for ATDs where there has not been any RDT&E funding. QOT&E is functionally equivalent to IOT&E with regard to test objectives and procedures. The funding source is the only differentiating factor.

Follow-on Operational Test and Evaluation (FOT&E)

FOT&E, that test and evaluation conducted after IOT&E/QOT&E, is normally conducted in two phases. Phase I FOT&E is conducted to refine and expand assessments made during IOT&E. Further, it confirms that corrections for previously noted operational deficiencies work and it ensures that the implemented device performs as predicted based upon experience gained during earlier T&E. AFTEC is responsible for managing Phase I FOT&E on major and designated nonmajor programs. Otherwise, Phase I OT&E is the responsibility of the using MAJCOM. Phase II FOT&E is normally conducted by the using command. Its purpose is to develop and refine further the utilization of the ATD within its specific training context. FOT&E programs are supported by the using MAJCOM's O&M budget.

CHAPTER 3

PLANNING AND MANAGEMENT OF ATD OT&E

INTRODUCTION

The test and evaluation of ATDs in the Air Force requires involvement of a number of organizations and agencies. In some instances that involvement is one of direct management responsibility and participation, while in others a support role is required. The general nature of T&E involvement and responsibility among Air Force organizations is as follows:

HQ USAF

HQ USAF: (1) provides T&E direction via PMDs and test directives; (2) establishes, and publishes in appropriate documents, the initial critical questions and areas of risk which are then subsequently refined by the implementing command, the participating commands, and AFTEC; (3) designates the agencies or commands to be responsible for specific test and evaluation programs, including the extent of AFTEC and MAJCOM participation in OT&E; (4) reviews test requirements and approves the allocation of HQ USAF controlled resources; (5) provides instructions for the disposition and support of test articles in the PMD before the production decision; (6) resolves any inter-command differences which may exist concerning T&E; and (7) finalizes inter-service agreements, as required.

AFTEC

The Air Force Test and Evaluation Center: (1) plans, directs, conducts, controls and independently evaluates (and reports to the Chief of Staff of the Air Force) major OT&E programs and USAF designated nonmajor programs; (2) accomplishes detailed planning and budgeting for OT&E; (3) participates with AFSC in preparation of the TEMP; (4) provides information on operational deficiencies to the system program manager and to the affected MAJCOM; and (5) monitors OT&Es conducted by using commands.

AFSC

As the implementing command, AFSC: (1) plans programs, and defines the scope and concept of DT&E; (2) exercises final responsibility for the conduct of DT&E; (3) identifies the critical questions and areas of risk to be addressed as test objectives during T&E; (4) develops and plans the T&E program to meet the program decision milestones; (5) prepares the Test and Evaluation Master Plan (TEMP),

detailed combined test plans, and other program documents; (6) plans and budgets for required update or modification of test articles; (7) collects, analyzes, and evaluates test data and prepares and distributes reports on DT&E; and (8) provides pre-operational support.

The AFSC SimSPO. The AFSC program manager is the SimSPO. The SimSPO has responsibility for the ATD acquisition program. The SimSPO test management responsibilities include managing DT&E, incorporating the OT&E requirements into the test program, and providing support for ATD OT&E. AFTEC, or a designated MAJCOM, not the SimSPO, has the responsibility for managing ATD OT&E.

The AFSC AFHRL. The Air Force Human Resources Laboratory (AFHRL) of AFSC is a behavioral science research organization that can provide technical assistance in development of the test design and evaluation procedures for assessment of ATD training effectiveness during OT&E. That assistance may include preparation of detailed operational effectiveness questionnaires and rating scales, monitoring of test progress to assure validity of training effectiveness data, design of transfer of training studies, and preparation of training effectiveness portions of the test report.

There are no fixed procedures whereby the participation of AFHRL can be arranged. As a result, AFHRL support requirements must be identified as early as practicable and formally negotiated with the AFHRL commander.

MAJCOMs

The MAJCOM designated to use the system: (1) provides operational employment and maintenance concepts for T&E, (2) identifies critical questions, areas of risk, test objectives, and data requirements in the operations and logistics areas for T&E; (3) plans, budgets, and provides (from within the command) the resources (personnel, equipment, flying hours, and fuel) necessary to accomplish OT&E; (4) participates early in the planning and programming of T&E; (5) manages IOT&E when designated; and (6) manages FOT&E.

AFLC

The Air Force Logistics Command: (1) provides logistic support and planning for test programs; (2) identifies critical questions, areas of risk, test objectives and data requirements in logistics areas for new systems under T&E and (3) participates on test teams for planning, conducting, and determining logistics supportability for DT&E, and verifying or assessing these factors for OT&E.

ATC

The Air Training Command acts as a supporting command for the responsible OT&E command or agency by evaluating whether Air Force personnel with system training can operate, maintain, and support the system as required by the operational and maintenance concepts. ATC: (1) provides for the training of Air Force personnel to support the test program; (2) provides OT&E objectives relative to the evaluation of training for maintenance personnel; (3) participates in OT&E test planning conferences; (4) coordinates on OT&E test plans; (5) provides maintenance training inputs to the operational suitability annex of the test plan; (6) provides evaluators to test teams to accomplish maintenance training-related test and evaluation objectives; (7) participates in preparation of OT&E test reports; and (8) provides training costs for cost of ownership studies.

PHASES OF OT&E ACTIVITY

The process of ATD OT&E planning and management may be conveniently partitioned into three phases of activity--Planning, Execution, and Reporting. Each phase corresponds to a logical separation of functional activity. The Planning Phase includes preparation of the test plan and precoordination among test elements and resources to carry out that plan. The Execution Phase includes the active collection of data. Finally, the Reporting Phase includes data reduction and interpretation and preparation of requisite reports and briefings as to the results of the OT&E.

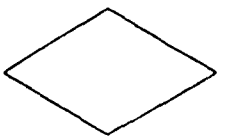
The presentation that follows corresponds to the three logical phases identified above and has been formatted in accord with the diagram symbols shown below:

Indicates the beginning of activity

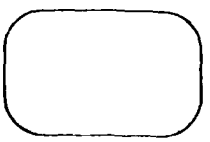
Indicates a preparation activity

Indicates a process

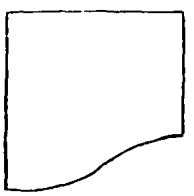
Indicates data



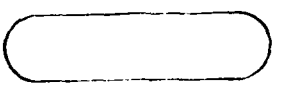
Indicates a decision point



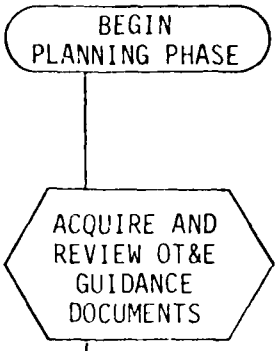
Indicates a briefing or review



Indicates a document/report



Indicates the termination of activity

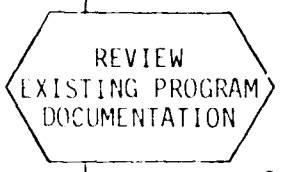


The test director must first acquire and review those OT&E guidance documents and related materials which will be needed in planning and managing the test. Of particular importance in this regard is AFM 55-43, "Management of Operational Test and Evaluation." In two volumes, AFM 55-43 contains a wealth of information and guidelines for OT&E planning and management throughout the Air Force. It is, in fact, the basic guidance document to be followed.

As a supplement to AFM 55-43, major commands may set specific command policies and procedures for OT&E planning and management. If involved in a MAJCOM-managed test, the appropriate MAJCOM regulations and manuals also should be reviewed. These include:

- TAC: USAFTAWCR 55-8, "Operational Test and Evaluation Management Procedures"
- MAC: MACR 55-80, "*Test and Evaluation*"
- SAC: SACR 55-57, "Operational Test and Evaluation"

In addition to these relevant Air Force guidance documents, the test director should thoroughly familiarize himself with the contents of this ATD OT&E Handbook. This is important because neither AFM 55-43 or the above referenced MAJCOM materials are ATD OT&E specific, but, instead, deal with general OT&E of any system. Many of the special considerations that must be taken into account when dealing with ATD OT&E are not explicitly covered in these Air Force documents, e.g., methods for the assessment of training utility of ATDs. The test director should also assure that his test team personnel become familiar with these guidance materials.



Review of, and familiarization with, existing program documentation can provide the test director a basic understanding of the history of the program, its anticipated schedule, and the nature of involvement among organizations in the test and evaluation of the ATD. At a minimum, the following documentation should exist for an IOT&E/QOT&E program and should be acquired and referenced.

- Program Management Directive (PMD)

Upon receipt of the PMD, a Test Planning Working Group (TPWG) is established by the system program manager. The TPWG will normally include representatives from the SimSPO, AFSC test agencies, AFTEC, using command, AFLC, ATC, and other agencies to be involved in the test program. The purpose of the TPWG is to provide a forum for test related subjects, to assist in establishing test objectives and evaluation baselines, to define organizational responsibilities and relationships, to estimate test costs and schedules, and to identify required test resources. The TPWG assists the ATD program manager in preparing the Test and Evaluation Master Plan (TEMP), the Program Management Plan (PMP), and other test related documents.

- Test and Evaluation Master Plan (TEMP)

The Test and Evaluation Master Plan (TEMP) is an overall test and evaluation plan designed to identify and integrate the effort and schedules of all T&E to be accomplished in the ATD acquisition program. The TEMP reflects an agreed-upon T&E approach, an overall summary for upper management of planned T&E, and a framework for the more detailed test planning to follow. The TEMP should ensure that all necessary test related activities are planned before key program decision points. In contrast to the management orientation of Section 5 of the PMP (discussed above), the TEMP emphasizes test objectives, test methodology, test measurement, and test resources to be required. It should specify expected methods of testing to verify these objectives, measures of system performance, data requirements, resource requirements, and data reduction and analysis requirements.

- Program Management Plan (PMP)

The Program Management Plan (PMP) is the principal management baseline document for the program. The document is written and issued by the ATD program manager and it shows the integrated, time-phased tasks and resources required to accomplish the requirements of the PMD. Preparation of the PMP requires considerable cooperation and coordination of other major commands and organizations, such as AFLC, ATC, using command, and AFTEC. Section 5 of the PMP emphasizes the test management relationships, resources, basic T&E objectives, test milestones, and schedules.

- Test Program Outline (TPO)

AFTEC's fundamental document for OT&E planning and budgeting is the Test Program Outline (TPO). It is normally written after management responsibilities for the OT&E program are identified. The TPO is used for inputs to the budget, PMP, TEMP, and system Test Plan. The document generally includes the basic OT&E issues, objectives, critical questions, test concepts and methodology, tentative evaluation criteria, and test profiles. Further development and refinement of these OT&E objectives, test methodologies, and evaluation criteria occur during actual Test Plan development.

- Statement of Intended Operational Employment

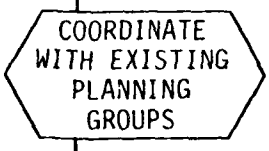
- Contractor's Statement of Work (SOW)

For an ATD FOT&E, at a minimum the following additional documentation should exist for a program and should be referenced:

- IOT&E or QOT&E Documentation including plans and reports, if available

- Production Contract and Statement of Work (SOW)

- Using command ATD operational/maintenance concepts



As noted earlier, advance planning for ATD OT&E begins as early as possible after a program has been identified; i.e., either formally through receipt of a PMD, or informally through interfaces with the procuring organization. The advance planning process for an ATD OT&E may have included inputs from a number of organizational elements. In AFTEC, for example, the management of advance planning is the responsibility of Plans (XR) personnel. Inputs to evaluation approaches for ATD operational effectiveness will have been generated by Operations Analysis (OA), and for operational suitability by Logistics (LG) elements. Working together, these elements and others produce initial concepts for the ATD evaluation approach and develop preliminary resource estimates for carrying out the test in the form of a Test Program Outline (TPO). In addition, a preliminary OT&E program schedule will have been prepared showing anticipated test start dates and other key program milestones.

In coordinating with the existing test planning groups and reviewing the preplanning to date, anticipated test resources, and program schedule, the test director should take into account a number of considerations. First, it must be remembered that much of the advance planning that may have occurred up to this point can be at a formative stage of development. This means that involvement of the test director can be critical to the constructive refinement and development of test plans. Second, estimates of anticipated test resource requirements made up to this point will have likely been based upon experience gained in earlier similar programs. They will have been made of necessity at an earlier stage to allow for budget submissions, manpower planning, and lead time requirements for AFTEC, MAJCOMS, and other organizations that may have some involvement in the OT&E (e.g., AFLC, AFHRL, and ATC). It should be expected that, as test planning continues, the TPO will be periodically updated/revised to reflect the actual requirements of the test plan. Third, with regard to program schedule, it can be expected that delays in the program may occur. Experience has shown that aircrew training devices can be expected to be delayed in schedule from three to twelve months or more.

COORDINATE WITH OTHER TEST ELEMENTS

In addition to coordinating with the immediate test planning groups, it is necessary also to coordinate with the other organizations and agencies that will be involved in the OT&E. During advance planning, a certain amount of precoordination and preplanning will have occurred. At this point, however, it is essential for the test director to determine the key personnel in those other organizations and establish a working liaison. A number of organizations should be contacted including the SimSPO, AFLC, MAJCOM, and ATC. The SimSPO will have specific information as to program schedule, contractor contacts, and DT&E/Qual test plans. The AFLC will be involved in planning the test of device suitability factors. The MAJCOM (using command) which will be providing personnel resources (i.e., aircrews and maintenance personnel) for the test should be contacted as early as possible and kept up-to-date on test resource requirements. The ATC will be able to provide information regarding planned or in-being training programs.

ESTABLISH TEST PROGRAM TEAM

The OT&E test director should now be up to date as to the current status of the ATD T&E program and aware of the general test objectives to be accomplished. His next task is that of establishing the necessary test team. A test program team must be established within the responsible test agency (MAJCOM or AFTEC) to assist the test director in preparing the test plan. Depending upon a number of factors (e.g., the size of the program), a preliminary test program team may already exist and may even have made inputs for test resources in an initial TPO. Otherwise, the OT&E test director will need assistance from appropriate personnel to plan the test. Inputs to evaluation approaches for ATD operational effectiveness may be obtained from AFTEC/MAJCOM Operations Analysis (OA) or AFHRL personnel, and those for ATD operational suitability from AFTEC/MAJCOM Logistics (LG) personnel.

DEVELOP/REFINE TEST DESIGN AND METHODS

Once the foregoing preparatory tasks have been carried out, it is time to address the details of test planning. Required activities will include development and refinement of specific test objectives and subobjectives, measures of effectiveness (MOEs), and evaluation criteria.

GENERATE OBJECTIVES AND SUBOBJECTIVES

The operational test and evaluation of an ATD has two principal objectives. The first of these is to evaluate the operational effectiveness of the device including, among others, assessments of fidelity, training capability, and instructional utility. The second overall objective is to evaluate the operational suitability of the device. It is evident that these objectives have meaning in a more general sense; they are not, however, adequate in themselves for detailed test planning purposes. What must be done is to refine further and break down the global objectives into concrete and manageable subobjectives. The operational suitability subobjectives are well defined and include assessments of device reliability, maintainability, availability, and logistics supportability. ATD OT&E subobjectives in the area of operational effectiveness, however, are somewhat more difficult to generate. The test director may refer to past ATD OT&E test plans as one source of ideas in developing subobjectives. Caution should be exercised, however, when reviewing old test plans, as they may contain methodological errors and be otherwise unsuitable to the current program. (See AFM 55-43, Vol. II, Ch. 8-5, Operational Effectiveness: Formulation of Objectives and Detailed Planning.)

The operational suitability subobjectives are usually better defined and include specific criteria for assessments of device reliability, maintainability, availability, and logistics supportability. Again, however, the test director should exercise care in seeing that all necessary subobjectives have been specified.

FOT&E objectives and subobjectives are of particular concern since the general purpose of an FOT&E is to provide information needed to integrate the ATD effectively within its

intended training environment. The identification of deficiencies and verification of correction of previously identified deficiencies is also an important part of the purpose of FOT&E.

AFM 55-43 distinguishes two phases of FOT&E (AFM 55-43, Vol. I, Ch. 4-9). Phase I FOT&E is done to refine and expand assessments made during IOT&E or QOT&E, and it tests changes or modifications made to correct deficiencies. (AFTEC manages Phase I for major and designated nonmajor programs.) Phase II FOT&E is generally conducted by the using command (and monitored by AFTEC). Phase II is done to provide information needed to implement the ATD into its intended training environment. For a given ATD, a Phase I FOT&E may have been made unnecessary (1) by the on-site phase of the initial OT&E, or (2) incorporation of the Phase I FOT&E objective of checking that deficiencies have been corrected into a Phase II FOT&E.

Since the ATD FOT&E will always be conducted within the using command environment, more extensive and longer term evaluations can be accomplished. Accordingly, the test objectives appropriate for FOT&E may well be more extensive and of wider scope than those of a I/QOT&E. For example, a "full mission" ATD installed at an operational base may have unique capabilities to simulate selected threat environments. A meaningful FOT&E objective in this case, then, might be to determine the capabilities of the ATD for training threat countermeasures and combat tactics development. This determination likely would require considerably more in the way of time and aircrew resources than would be appropriate during initial or qualification OT&E, e.g., measures of effectiveness would have to be more complex than the simple ratings of fidelity that might be used in a QOT&E.

DEVELOP MOEs

Measures of effectiveness (MOE) refer to the information needed to support the specific test subobjectives. For example, if one of the test subobjectives is to assess the fidelity of simulation for the training of low level navigation, a measure of effectiveness might be a rating of the fidelity of visual

cues represented, as perceived by experienced pilots who have performed low level navigation in the ATD. Given the possibility of conducting a transfer of training evaluation in FOT&E, a more objective MOE might be used, such as the number of trials or amount of time required to reach criterion level on low level navigation tasks in the airplane following training in the ATD.

DEVELOP/REFINE EVALUATION CRITERIA

Once specific test objectives, subobjectives, and MOEs have been established, it is necessary to determine appropriate evaluation criteria, i.e., specified values and standards that can aid the decision making process. For OT&E data, AFTEC has defined three levels of evaluation criteria: thresholds, standards, and goals. A threshold is the minimum level of acceptable performance or capability. A standard is that level of performance or capability that will satisfy the operational requirements as contained in the system operational and maintenance concepts and other appropriate documentation. A goal is a level of performance or capability that enhances the system, i.e., a level of performance superior to that defined by the system operational concept. Since the criteria that would be appropriate for one type of ATD within a specific context of operational training utilization may differ widely from the criteria appropriate for another device and training environment, selection of evaluation criteria must be specifically tailored to each ATD OT&E. For example, a device that is adequate for training in the UPT context may be quite inadequate for the continuation training context.

REFINE TPO

Once test objectives and subobjectives have been defined and their associated evaluation procedures developed, it is necessary to assess the adequacy of resource requirements to support the test. This involves updating and refining the test program outline (TPO) to assure that the various organizations and agencies to be involved in the OT&E are willing and able to

provide the necessary support. The availability of user's resources can impact greatly the overall test design relative to its capability to accomplish the defined objectives. (See AFM 55-43, Ch. 7-3, Test Program Outline.)

COORDINATE RESOURCE REQUIREMENTS

Concurrently with refining the TPO it is necessary to coordinate resources among organizations for supporting the test. This is a repetitive process wherein resource estimates and requirements are updated as commitments for support are made more and more concrete. Once appropriate resource coordinations have been completed, the test planner should obtain associated Memoranda of Agreement (MOA) for those resources from the agencies concerned. In most cases, MAJCOM response to the TPO will serve the purpose of MOAs or MOUs (Memoranda of Understanding). As part of this coordination activity, procedures for reporting Test Discrepancies and Service Reports (TD/SR) should be developed in accordance with the guidelines contained in TO-00-35D-54. (See AFM 55-43, Ch. 7-1, *Resource Management.*)

RESOURCES ADEQUATE?

In the process of coordinating test resources for personnel and materiel requirements, decisions will be required as to whether the available resources are adequate to support the test as it is planned. These are especially important decisions, since a "well planned" test is worth little if it cannot be supported adequately. Because ATD OT&E may involve testing at the contractor's facility or on-site at the using command's facility, coordination as appropriate for each is required. If the test director determines that some element(s) of the test cannot be supported, it may be necessary to revise and otherwise modify a particular subobjective or change the evaluation procedure to accommodate the subobjective with the available resources. In any case, it will be necessary to revise/modify some portion of earlier planning.

REVIEW TEST APPROACH

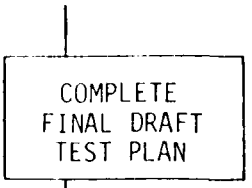
Prior to writing the OT&E test plan, the test director must review the test approach with working level participants in the test planning effort to obtain inputs regarding test resources and the general assignment of responsibilities to accomplish the test program. At this review, any problems or potential problems related to test resource commitment and test scheduling should be addressed.

PREPARE DRAFT TEST PLAN

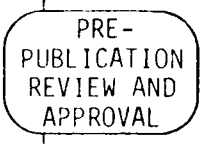
A draft of the test plan should now be written in accordance with the format established by AFM 55-43 or the appropriate MAJCOM OT&E planning guidance documentation. Annexes to the test plan directed to the technician level may be added or deleted, as required, for communicating the methodologies and detailed procedures to be used. Volume II, Annex 8-8, of AFM 55-43 contains the general format and content requirements for OT&E Test Plans. In preparing this draft of the test plan it will not be necessary to have completed the development of all procedures that will be employed in testing and evaluating the operational effectiveness or operational suitability objectives. A representative sample of the procedures to be employed should, however, be included as an annex to the plan. These might include, among others, the rating scales to be used in fidelity and training capability assessments, a list of ATD training tasks to which those scales are to be applied, and the methods for analyzing and interpreting the data.

REVIEW DRAFT TEST PLAN

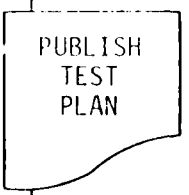
The Draft Test Plan must now be reviewed and coordinated within AFTEC and with the MAJCOMs and other interested agencies. Several reviews and meetings may be needed to finalize the test plan and obtain the required coordination of test resources.



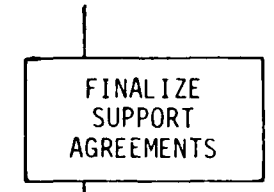
Based upon inputs received during review of the Draft Test Plan, a final version of the Test Plan is prepared reflecting the most current stage of planning.



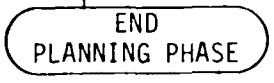
Prior to publishing the Test Plan and its distribution to the relevant ATD OT&E participants, it is reviewed and approved in accord with established administrative procedures (e.g., USAFTAWCR 55-8, Ch. 5C). This review and approval process should address all aspects of the plan to assure that it meets technical and quality standards. It will include review of test objectives, evaluation approach, and any unresolved issues that may exist at this time. The review process may often include briefings by the test director for various levels of management within and outside his organization. The factors mentioned above may be covered in these briefings, as well as issues relating to test resource coordination among organizations. For example, in the case of combined DT&E/IOT&E or Qual/QOT&E programs, the Test Plan should take into account the data gathered by the SimSPO and its applicability to operational effectiveness/suitability objectives. Also, there may be a sharing of resources during a combined evaluation that should be taken into account both from a budget standpoint and from the standpoint of the quantity of resources available for the time in question. Based upon review of the completed Test Plan, the appropriate AFTEC or MAJCOM commander may recommend modifications and/or refinements prior to publishing and distributing the Test Plan. This may necessitate changes to test objectives, evaluation approach, distribution of responsibility, or other aspects of the plan.



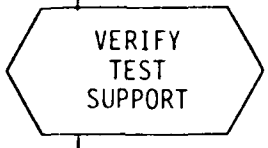
Following review and approval, the OT&E Test Plan is published and distributed to participating commands and agencies. Concurrently with the publishing of the Test Plan, detailed test procedures are further developed and refined.



In the time between the publishing of the Test Plan and the beginning of the "Execution Phase," it will be necessary to continue updating and finalizing test resource agreements. Often, a substantial period of time may pass, and priorities within supporting organizations and agencies can change. It is important, therefore, to maintain an appropriate level of communication and coordination among test elements. Memoranda of Agreement (MOA) should be continually updated and validated. Also, some time between the planning and execution phases, the test director must plan for housing and transportation of his personnel to and from the test site.



EXECUTION PHASE



Concurrently with activation of the test team, it is critical to verify that negotiated test resources (aircrews, maintenance personnel, test equipment, etc.) are available and ready to support the test. Test support problems identified during this verification must be resolved by the test director as early as possible to avoid adverse impacts on the test schedule. Also, prior to commitment of resources the test director should determine the progress of the contractor and his readiness for an operational test. Often, the contractor is not prepared for evaluation other than his own acceptance test procedures. If possible, a "ready for test" checklist should be used to assure that device engineering development is complete and device availability figures are such that an "operational" training configuration exists.

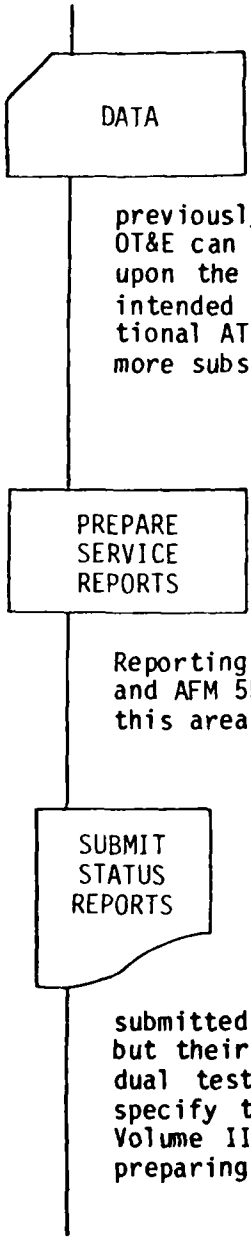
TRAIN PERSONNEL

Prior to the start of actual data collection on the ATD, provisions should be made for the training of test personnel (maintenance personnel and aircrews) in the operation and use of the device. This training should include both familiarization with device basic operation as well as the use of instructional features. Training should include a certain amount of hands-on practice to minimize confusion in the operation of the device during the subsequent test.

PERFORM TESTS

Once the preceding activities have been accomplished, execution of the test plan begins. The test director and his deputies are responsible for the overall management of the test and the associated data collection. The test director should ensure that the detailed, day-to-day test procedures are being carried out to support the objectives of the test plan. For the combined DT&E/IOT&E or Qual/QOT&E programs, this should be done in close coordination with the Qual Test Director. As noted earlier, during the in-plant OT&E, emphasis is upon assessing ATD fidelity, training capability, and ATD reliability (during the reliability demonstration). The on-site phase of OT&E will be concerned with maintainability assessment, during which time the system would not be available for training capability since faults would be inserted that would interrupt continuous training use of the ATD. In some cases, however, a schedule can be developed whereby suitability data collection may occur in shifts that are not required for effectiveness testing, e.g., aircrews 0800-1600, M-demo 1700-0100, etc. (See AFM 55-43, Ch. 9, Test Execution.)

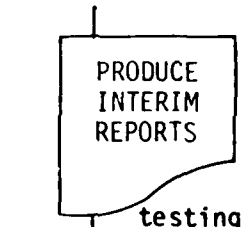
During the in-plant phase of the OT&E, device maintenance actions will typically be handled by the contractor. During the on-site phase of testing, i.e., the maintainability demonstration, device maintenance actions will be carried out by the appropriate Air Force test team personnel. Therefore, provision should be made for any maintenance personnel training that may be necessary for the on-site phase.



Data collected in-plant will include device fidelity, training capability, IOS capability (operational effectiveness), and the ATD reliability and software suitability assessments. As previously discussed, the data coming out of an on-site ATD OT&E can be directed to a wide range of objectives depending upon the information required to integrate the ATD into its intended operating environment. These data may include additional ATD operational suitability assessments as well as the more substantive operational effectiveness determinations.

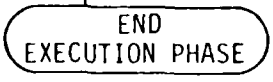
One of the primary functions of an OT&E is to detect and report deficiencies that may have an adverse impact on the operational effectiveness or suitability of a system. The Service Reporting guidelines and procedures contained in TO-00-35D-54 and AFM 55-43, Chapter 10, should be reviewed and followed in this area.

Status reports provide periodic updates and important test findings to interested Air Force and MAJCOM agencies before the operational test program is complete and the final report is submitted. They are usually submitted by letter or message, but their format and content may be adjusted to meet individual test program requirements. The OT&E test plan should specify the format and frequency for these status reports. Volume II of AFM 55-43, Annex 11-2, contains guidelines for preparing status reports.

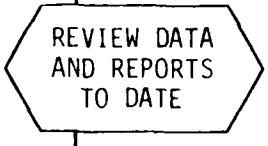


An interim report is more formal than a status report. It is generally prepared only upon specific MAJCOM or HQ USAF request to support a major program milestone or to report problems in testing. It should provide a summary of the test results, from the beginning of the test to date. Generally, this coordinated report should cover each specific test objective in the test plan. (AFM 55-43 recommends that unless an interim report is absolutely necessary, it should be avoided, because erroneous conclusions can be drawn from insufficient data and incomplete testing.)

The test director will normally give periodic test program status briefings to his management throughout the active test period. Briefings are presented to a series of audiences including immediate management, HQ USAF, AFTEC, SimSPO, MAJCOMs, and other organizations and/or agencies that have some interest or involvement in the test program (e.g., AFHRL). (AFM 55-43 contains guidelines for briefing content in Volume I, Ch. 11-13.)



REPORTING PHASE



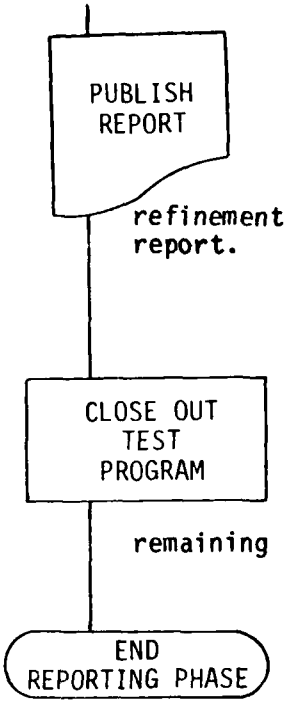
A number of inputs covering various test objectives will have been prepared by the test team members in the form of status reports, progress reports, and other initial draft material. The first activity in the reporting phase, then, is to review those initial drafts and associated supporting data for accuracy and readability.

In conjunction with the above activity, the test director prepares a Draft Report of the ATD OT&E, as appropriate. This report covers the test results, conclusions, and recommendations. This document, when finalized, serves two important purposes. First, it disseminates the test information required by decision makers, planners, and operators, and, second, it provides a formal, permanent document of the test results for the Air Force.

AFM 55-43, Volume II, Annex 11-1, contains specific guidance for preparation of this report. The reporting format described in AFM 55-43 is intended to be appropriate for both AFTEC- and MAJCOM-managed programs; however, specific guidance may also exist within the MAJCOM for report format and content that should be followed. Reference to earlier ATD OT&E reports may provide additional insights and guidelines for formatting the report. With regard to the technical content of the report in key areas of interest, the appropriate volumes of this Handbook provide specific guidance.

The test director schedules a review of the final draft of the ATD OT&E report within HQ AFTEC and/or the MAJCOM, as appropriate. Several cycles of review and modification may be needed to finalize the report.

Based upon inputs received during the review a Draft Final Report is prepared for command approval.



Following review of the completed Final Report, the AFTEC or MAJCOM commander, as appropriate, may approve its publication. However, he may recommend that further modifications and/or refinements be made prior to publishing and distributing the report.

The test director closes out the case file in accord with appropriate MAJCOM or AFTEC procedures. This will include storing/filing data, completing financial actions, and disposition of remaining test equipment, among other activities.

CHAPTER 4

ATD ACQUISITION/T&E EVENT FLOW

INTRODUCTION

The preceding two chapters have described the ATD acquisition and OT&E processes largely as unrelated and somewhat time independent activities, even though these two processes are, in reality, closely interrelated and highly time dependent. They were presented as separate entities mainly to allow a more straightforward explication of each process. It is, however, important that the test director have a clear understanding of the temporal relationship between those ATD acquisition events described in Chapter 2 and the Air Force test and evaluation activities enumerated in Chapter 3. The purpose of this chapter, therefore, is to show that relationship.

The relationship between the acquisition and T&E processes is also affected by the "size" of the ATD procurement of interest. ATD procurements may range in complexity, for example, from programs as big as the B-52 WST to some as small as a single CPT. Understandably, variations in size and complexity of ATD acquisition programs have an impact on ATD OT&E planning and execution. This chapter is also intended to illustrate that effect.

ATD ACQUISITION AND OT&E INTERFACE

The temporal interface between the ATD acquisition process and ATD OT&E planning and execution is shown in Figure 4-1. Those blocks above the time-line depict the more significant acquisition events; those below the time-line represent the major OT&E activities. From Figure 4-1 it can be seen that both acquisition and T&E activities begin with the issuance of a Program Management Directive (PMD). This event marks Air Force approval of a MAJCOM Mission Element Needs Statement (MENS) and signals the beginning of both advanced procurement and test and evaluation planning. Obviously, only a relatively low level of advanced OT&E planning is required up to the award of a development/production contract to one or more vendors.

Contract award marks the start of the Production Phase which includes preliminary and detailed design of the ATD and its fabrication. Detailed ATD OT&E planning begins during the production phase and normally intensifies around the time of critical design review (CDR). At the end of the production phase, the ATD is declared "Ready for Test" (RFT). All OT&E planning and preparatory activity must have been completed by the time the device becomes RFT, so that necessary test and evaluation activities can proceed as smoothly as possible.

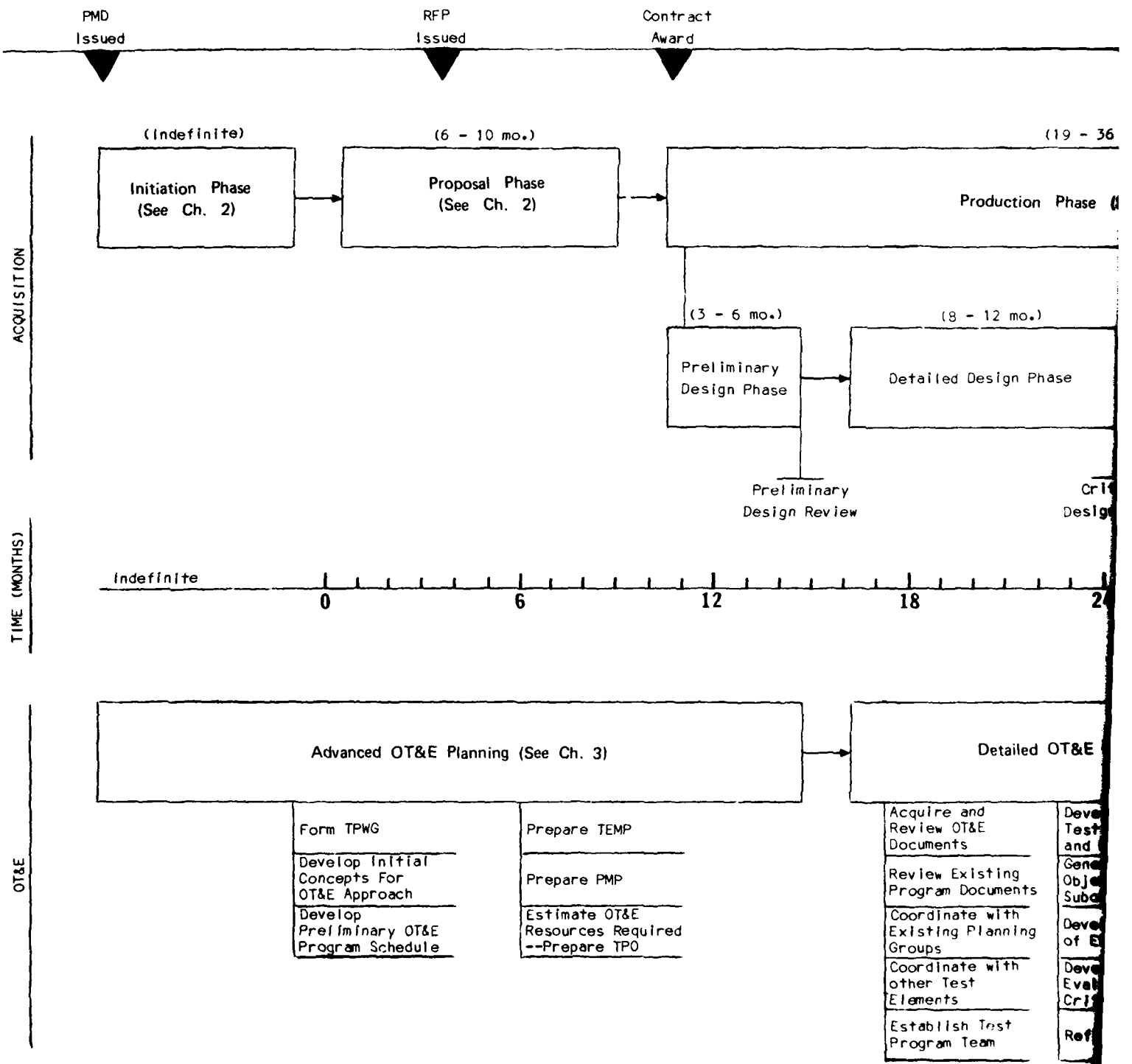
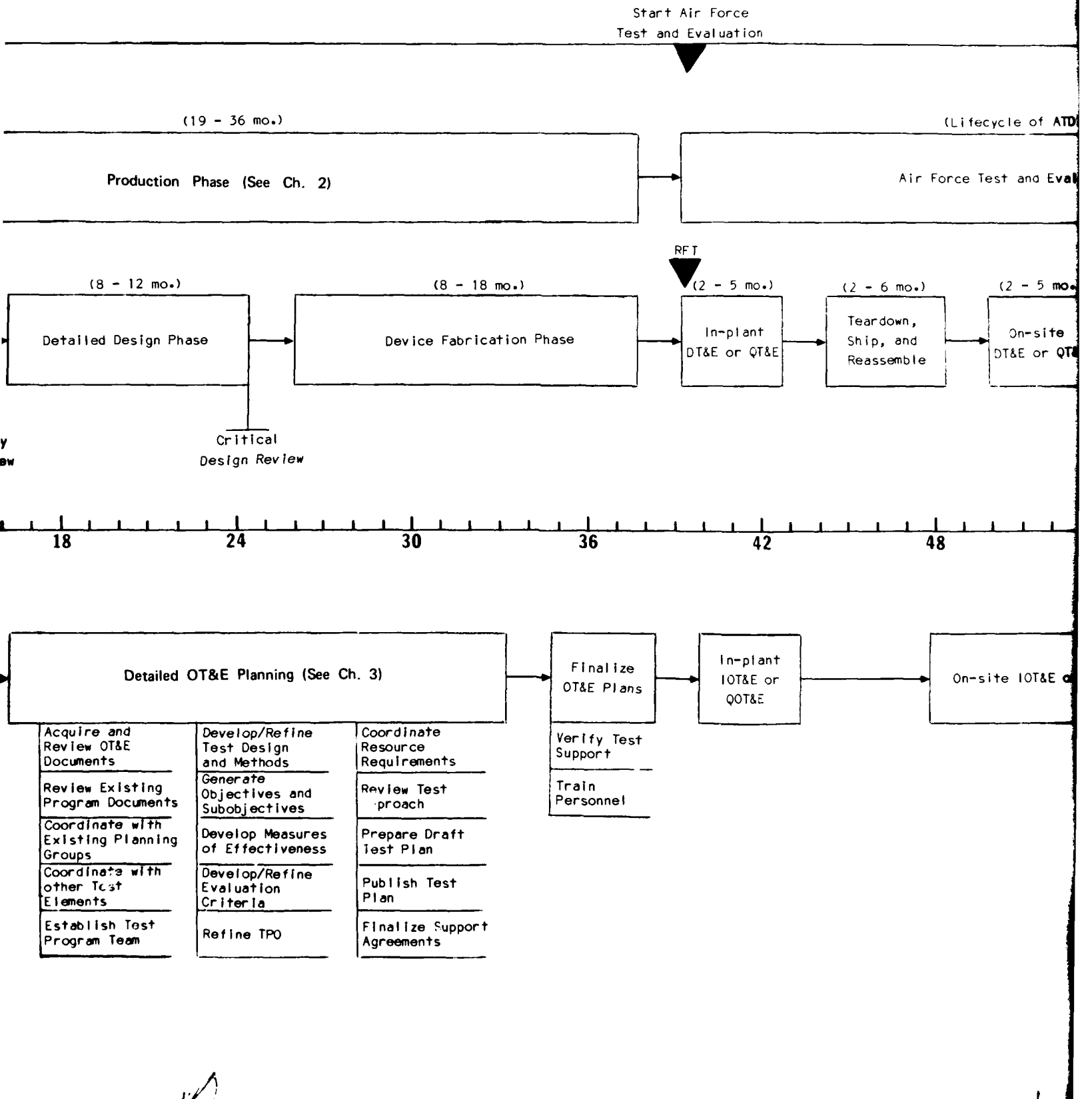
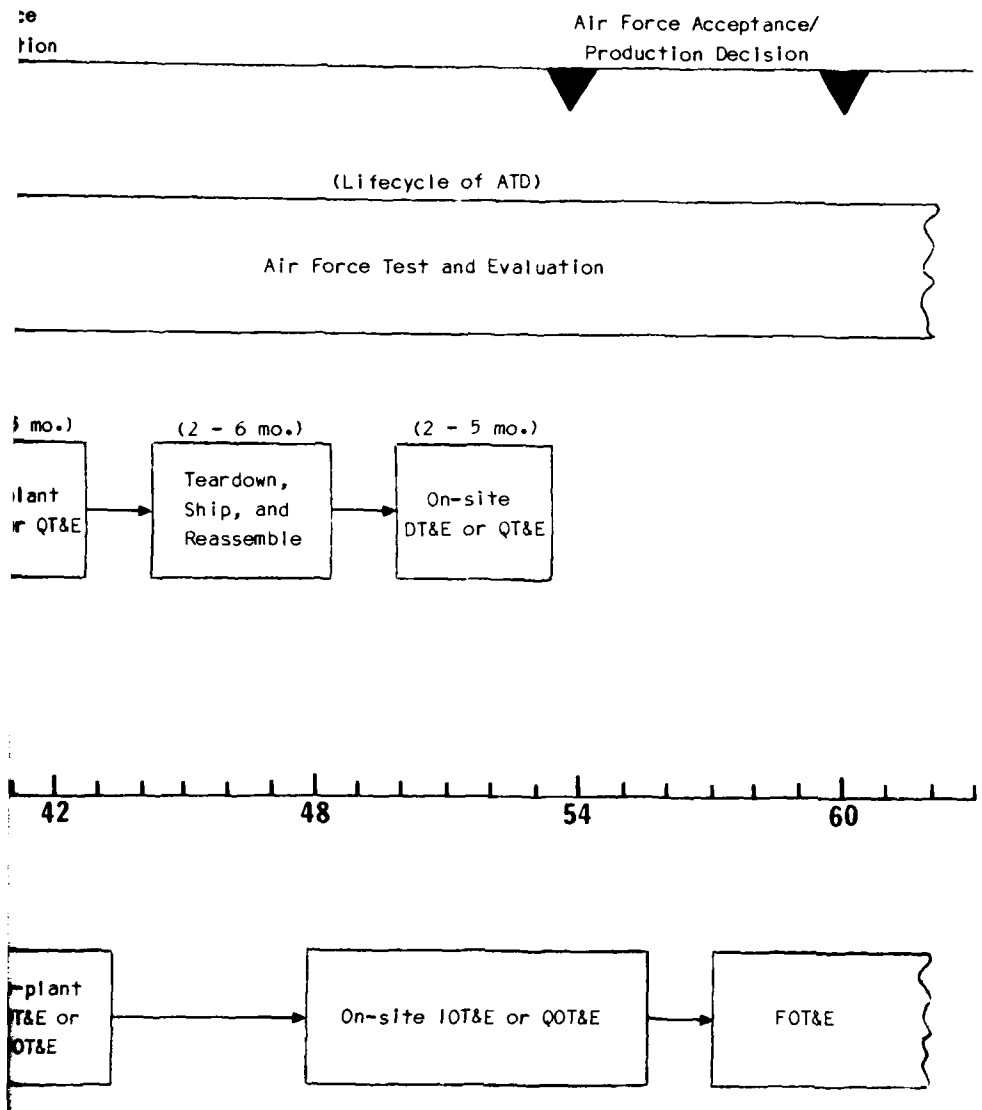


Figure 4-1. ATD acquisition and T&E flow.


Start Air Force
Test and Evaluation
(19 - 36 mo.)
(Lifecycle of ATD
Production Phase (See Ch. 2)
Air Force Test and Eval
RFT
(8 - 12 mo.)
(8 - 18 mo.)
(2 - 5 mo.)
(2 - 6 mo.)
(2 - 5 mo.
Detailed Design Phase
Device Fabrication Phase
In-plant DT&E or QT&E
Teardown, Ship, and Reassemble
On-site DT&E or QT
Critical Design Review
18
24
30
36
42
48
Detailed OT&E Planning (See Ch. 3)
Finalize OT&E Plans
In-plant IOT&E or QOT&E
On-site IOT&E
Acquire and Review OT&E Documents
Review Existing Program Documents
Coordinate with Existing Planning Groups
Coordinate with other Test Elements
Establish Test Program Team
Develop/Refine Test Design and Methods
Generate Objectives and Subobjectives
Develop Measures of Effectiveness
Develop/Refine Evaluation Criteria
Refine TPO
Coordinate Resource Requirements
Review Test proach
Prepare Draft Test Plan
Publish Test Plan
Finalize Support Agreements
Verify Test Support
Train Personnel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tion
Air Force Acceptance/
Production Decision
(Lifecycle of ATD)
Air Force Test and Evaluation
mo.)
(2 - 6 mo.)
(2 - 5 mo.)
lant
r QT&E
Teardown,
Ship, and
Reassemble
On-site
DT&E or QT&E
42
48
54
60
-plant
T&E or
OT&E
On-site IOT&E or QOT&E
FOT&E

Concurrent or Combined Testing

As can be seen from Figure 4-1, a portion of the OT&E effort occurs after the ATD has been installed at its operational location. The early OT&E (IOT&E or QOT&E) which occurs at the vendor's plant, normally occurs concurrently with development of qualification testing (DT&E or QT&E).[1] The on-site QT&E may or may not occur concurrently with development testing. Concurrent OT&E and DT&E/QT&E are generally referred to as "Combined Testing." Testing activities are combined whenever separate testing activities would be less efficient in the use of available testing time or support resources.

Combined DT&E/IOT&E activities begin as soon as possible after the device is determined to be ready for testing. Some DT&E/QT&E specific events usually occur first because they are critical technical and engineering tests that must be performed to clear the system for further testing. However, even during this very early DT&E/QT&E test period, OT&E personnel participate as observers to become familiar with the system and to gain access to any test data that may support the OT&E effort.

Following these front-end DT&E/QT&E events there are a number of joint DT&E/QT&E and IOT&E/QOT&E test events. An excellent example of a shared test event is the DT&E/QT&E Reliability Demonstration during which OT&E personnel may also be performing specific operational effectiveness evaluations such as device functional fidelity assessments and/or trainability estimates. As much as possible of the in-plant operational effectiveness evaluation usually takes place during the Reliability Demonstration. Not all OT&E objectives can or will be satisfied by shared test events. As a result, there will be a few T&E activities that will occur either before or after combined testing. Close coordination with the SimSPO program manager and the contractor is required to assure that all necessary such test events are properly scheduled.

In-plant combined T&E continues until sufficient data have been collected to support a conditional acceptance of the ATD being tested. Following this in-plant testing and any required deficiency corrections, the ATD is disassembled and shipped to where it will be used operationally. Disassembly, shipment, and reassembly may take from 2-6 months. After the ATD is reassembled at its on-site location,

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[1] It will be recalled that the key to understanding the distinction between DT&E/IOT&E and QT&E/QOT&E is the source of funding for such tests. Testing supported by RDT&E funds is called DT&E/IOT&E; and testing funded by O&M dollars is referred to as QT&E/QOT&E. Otherwise, DT&E/IOT&E and QT&E/QOT&E procedures are basically the same.

combined testing resumes on-site and continues until the Air Force acceptance is effected by DD-250 sign-off.

Post DD-250 Sign-off Testing

As Figure 4-1 shows, IOT&E/QOT&E usually continue for some time following Air Force acceptance until all remaining test objectives have been satisfied. Whereas the OT&E test director shared the device with SimSPO personnel during combined testing, he now must share the device with MAJCOM user personnel. These people are anxious to become operational and, as a consequence, the test director may expect some problems regarding the availability of device time and its controlled utilization for test purposes.

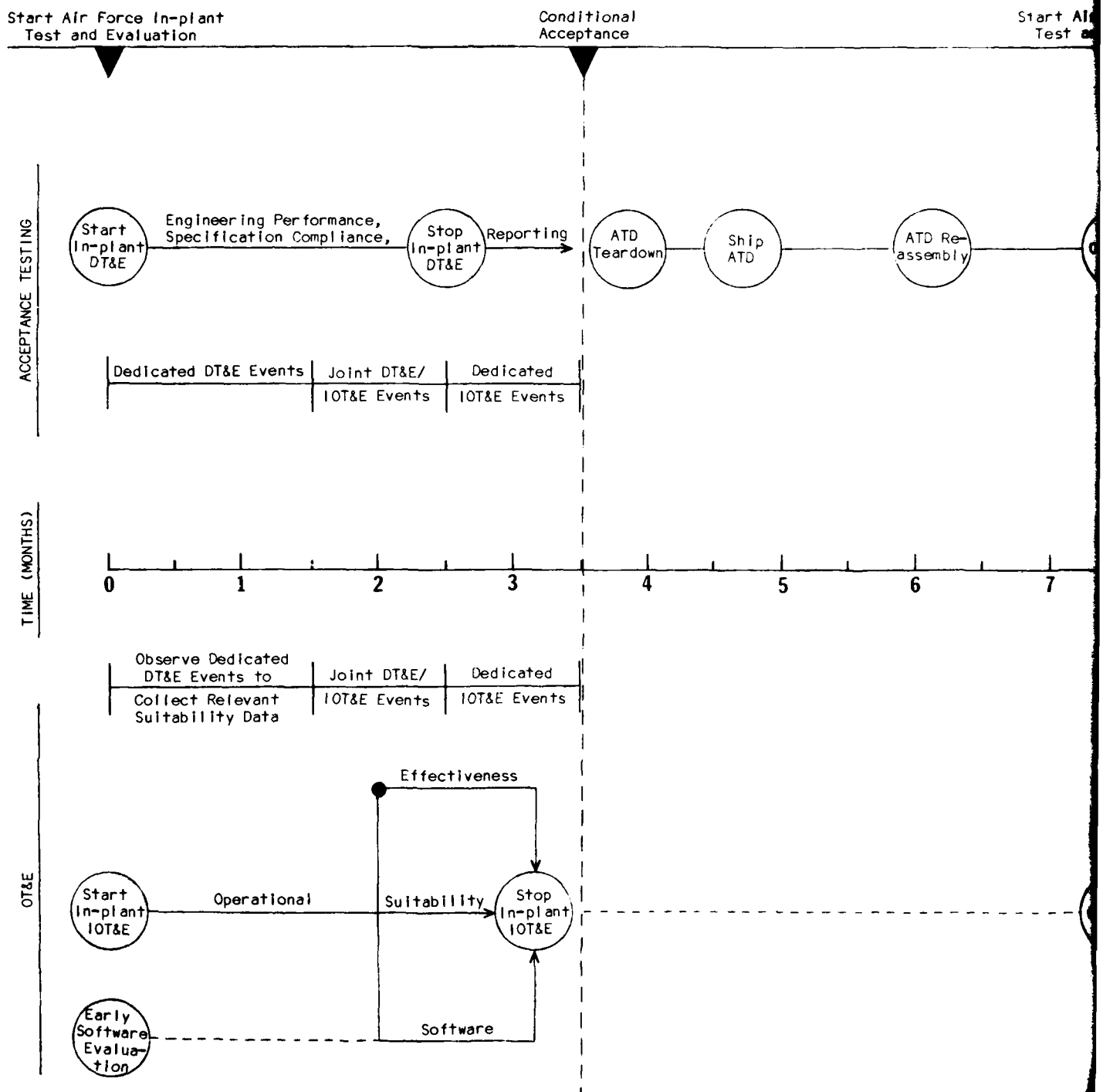
Completion of IOT&E/QOT&E marks the end of OT&E for many ATDs. However, it is possible that additional follow-on operational test evaluations (FOT&E) may be required. As indicated in Figure 4-1, these may occur at any time during the life-cycle of the ATD. Such FOT&Es as are required usually address some specific area of device effectiveness or suitability concern. A modification to a device's visual system, for example, might generate an interest in a training transfer evaluation of that capability for additional syllabus coverage. Another example of an FOT&E requirement might result from post-IOT&E software suitability concerns or a need for updated supportability information.

INFLUENCE OF PROCUREMENT COMPLEXITY

Although, as previously pointed out, the basic procedures involved in DT&E/IOT&E or QT&E/QOT&E are pretty much the same, there are a few differences in the time sequencing of key events and the implications drawn from the test results for subsequent ATD procurement action. The major factor influencing the time sequencing of T&E activities is the complexity of the procurement itself. Figures 4-2 and 4-3 are provided to illustrate the nature of T&E event sequencing for procurements of differing levels of complexity. Figure 4-2 shows the T&E event flow for an ATD procurement involving some RDT&E monies, and Figure 4-3 shows the T&E event flow for a procurement not involving RDT&E funds. Figure 4-2 also is representative of a one-of-a-kind device (e.g., the Aerial Refueling Part-Task Trainer or the Simulator for Air-to-Air Combat), while Figure 4-3 is illustrative of a larger-scale multiple device procurement (e.g., the B-52 WST).

One-of-a-Kind Developmental Procurements

A number of ATD procurements involve untried technology applications or are for devices for which training transfer effectiveness may not previously have been demonstrated. Although decision may later be


Start Air Force In-plant Test and Evaluation
Conditional Acceptance
Start Al
Test a
ACCEPTANCE TESTING
Start In-plant DT&E
Engineering Performance, Specification Compliance,
Stop In-plant DT&E
Reporting
ATD Teardown
Ship ATD
ATD Re-assembly
Dedicated DT&E Events
Joint DT&E/ IOT&E Events
Dedicated IOT&E Events
TIME (MONTHS)
0
1
2
3
4
5
6
7
Observe Dedicated DT&E Events to Collect Relevant Suitability Data
Joint DT&E/ IOT&E Events
Dedicated IOT&E Events
OT&E
Effectiveness
Start In-plant IOT&E
Operational
Suitability
Stop In-plant IOT&E
Early Software Evaluation
Software

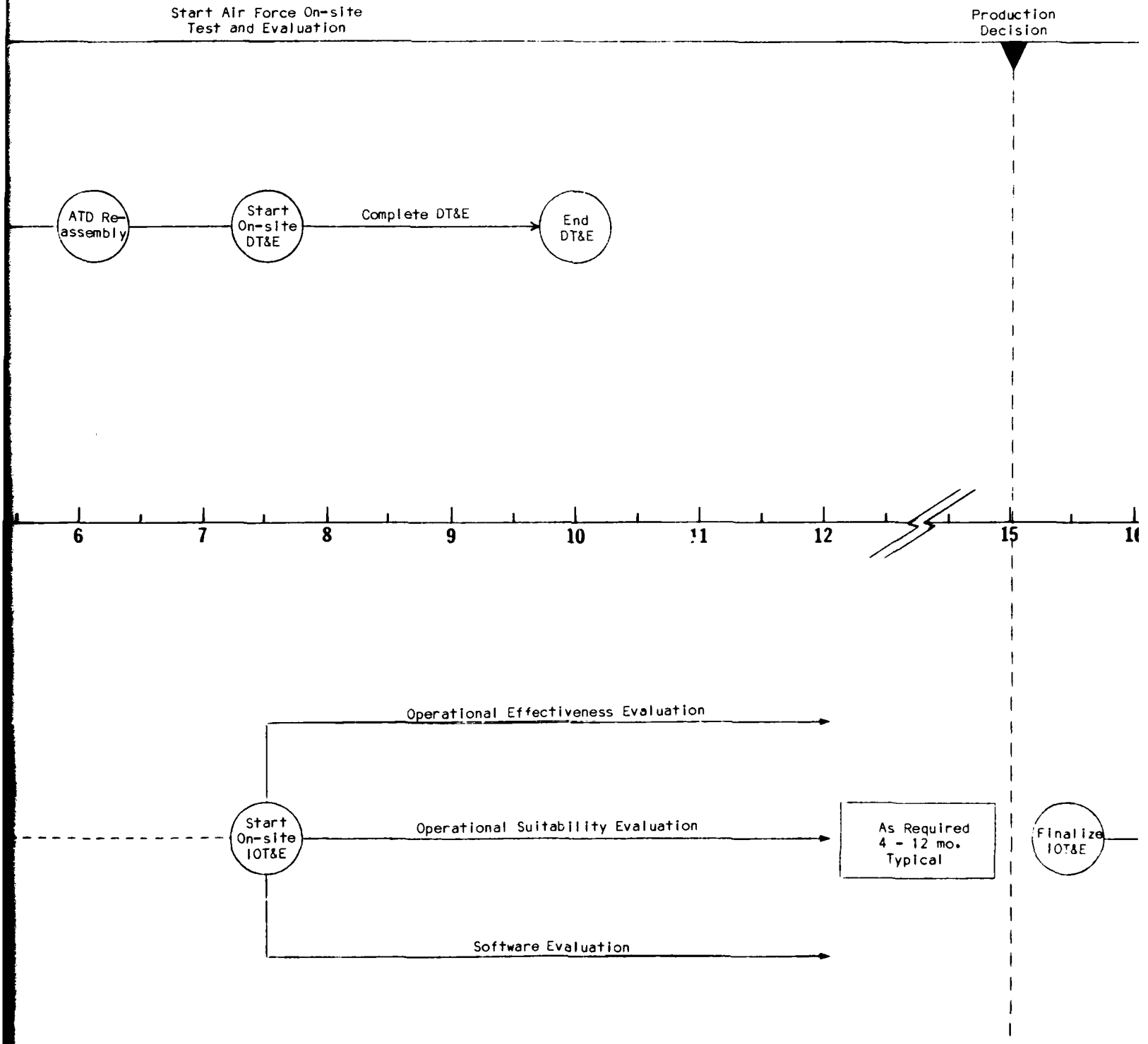
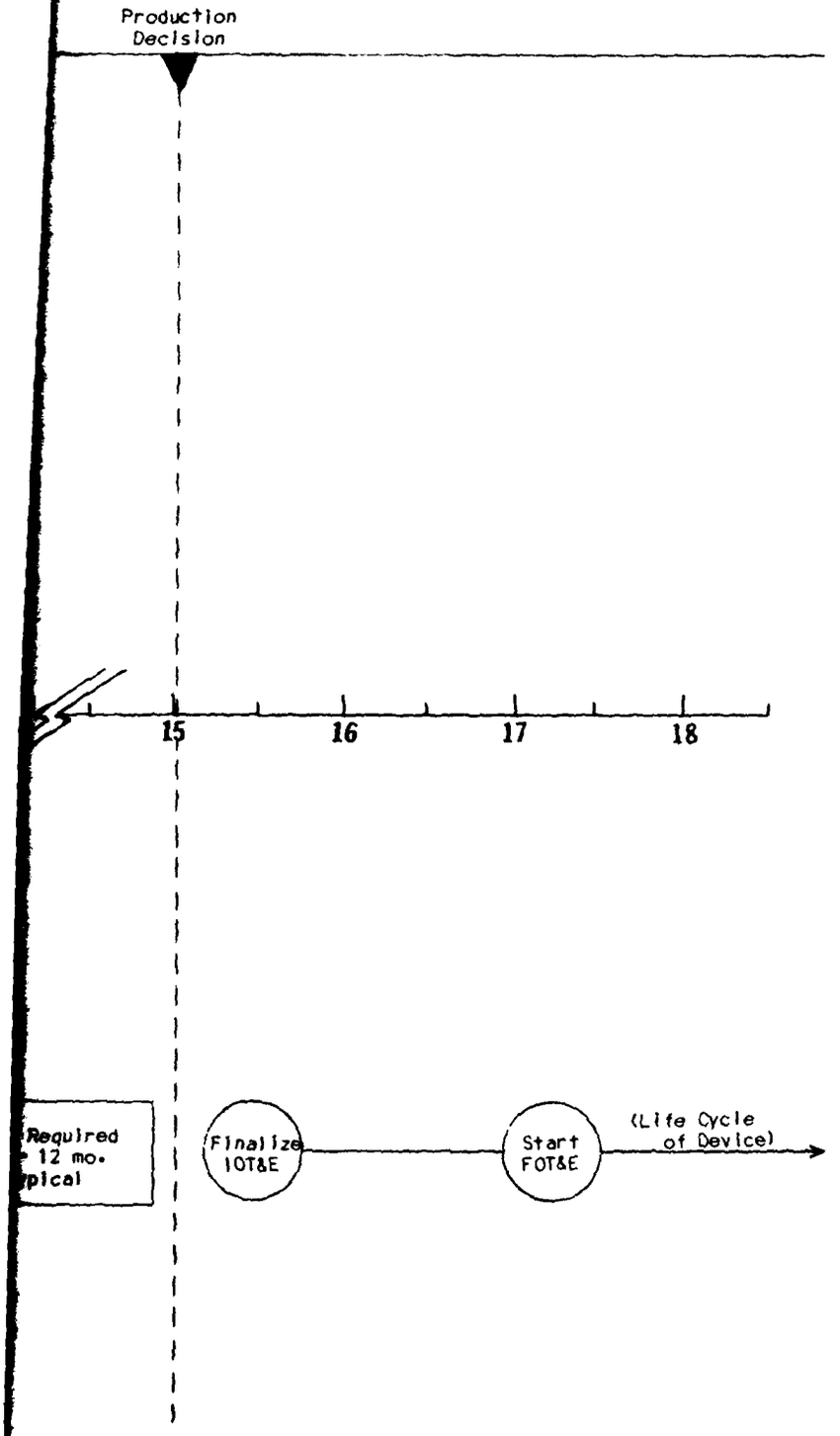


Figure 4-2. Event flow for typical DT



Event flow for typical DT&E/IOT&E.

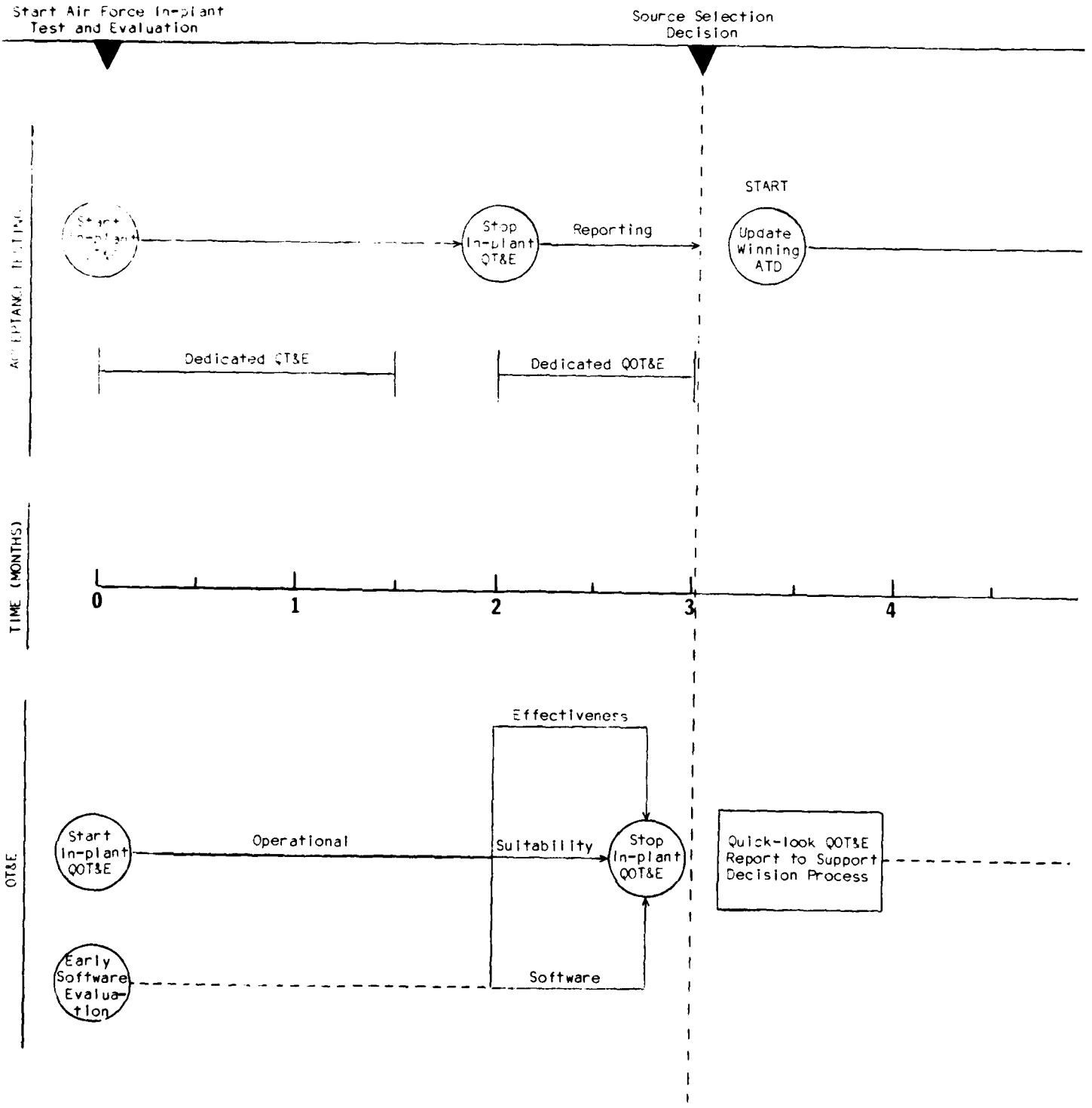
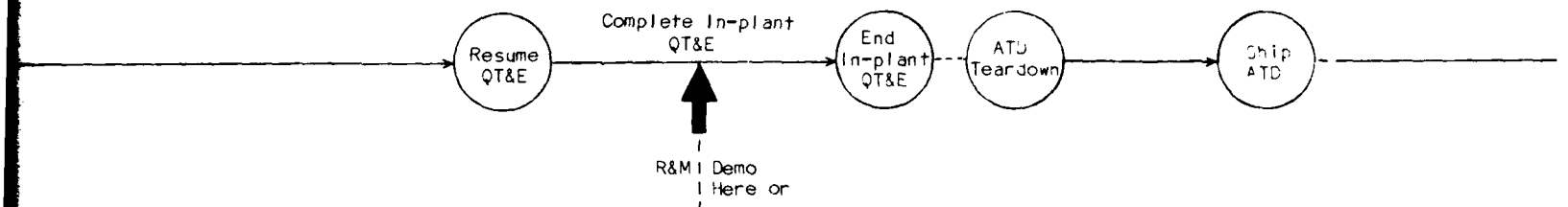
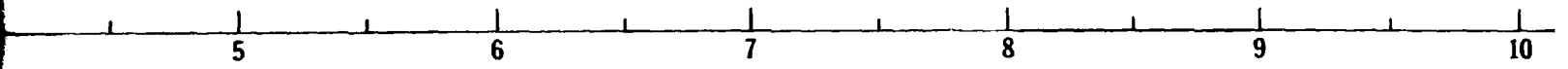


Figure 4-3. Event flow for QT&E/QOT&E (includes Source Selection).


Resume QT&E
Complete In-plant QT&E
End In-plant QT&E
ATD Teardown
Ship ATD
R&M Demo Here or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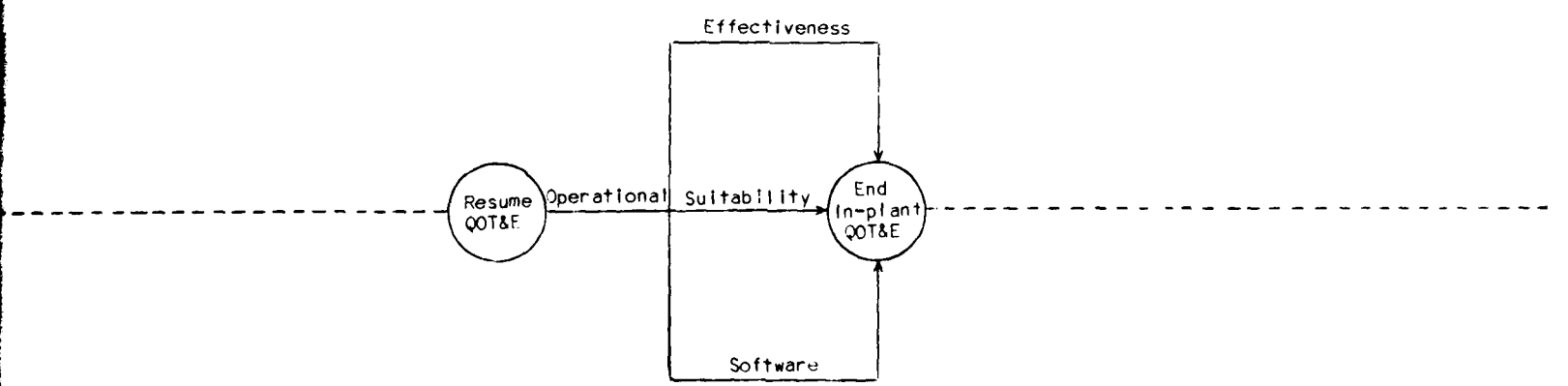
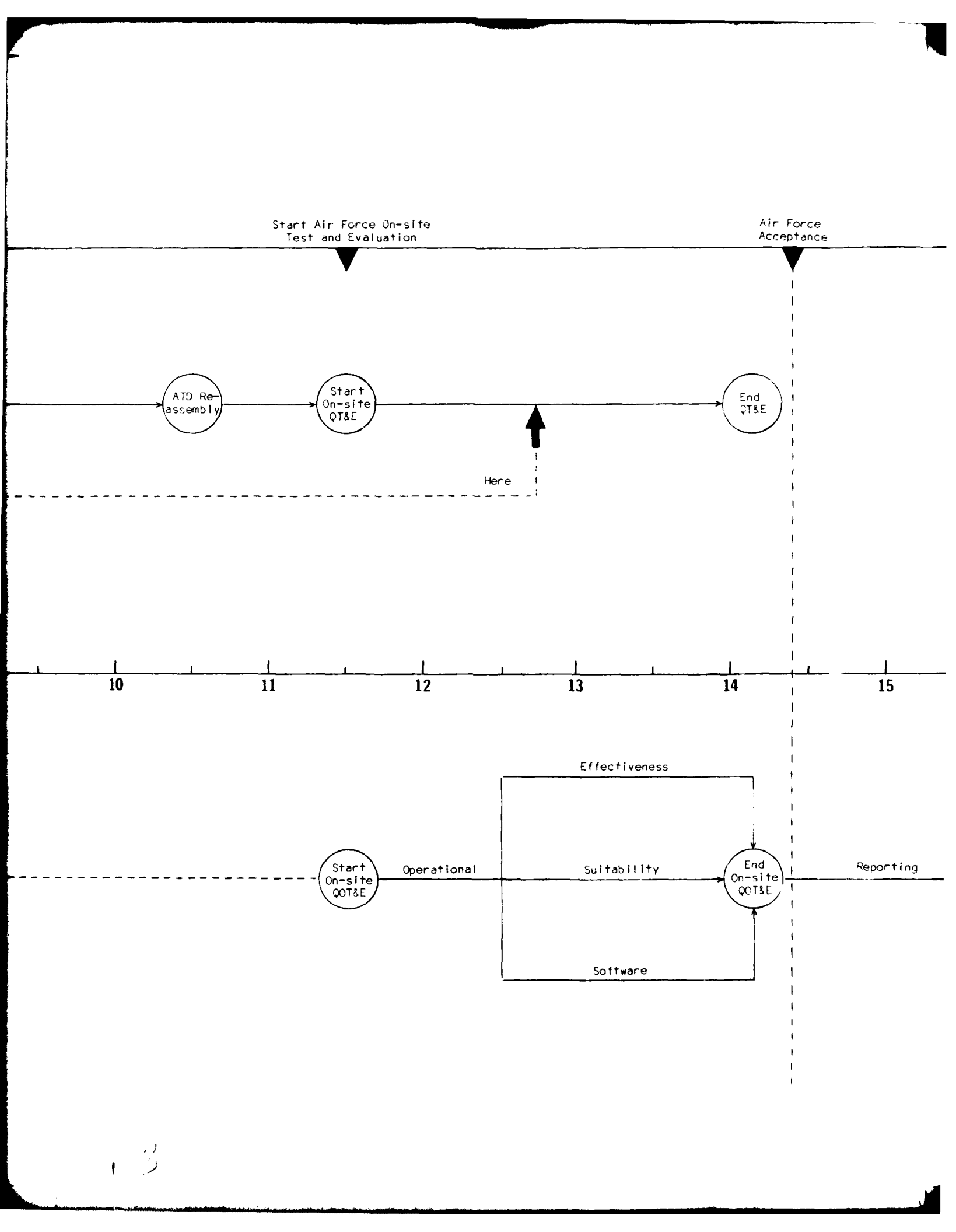
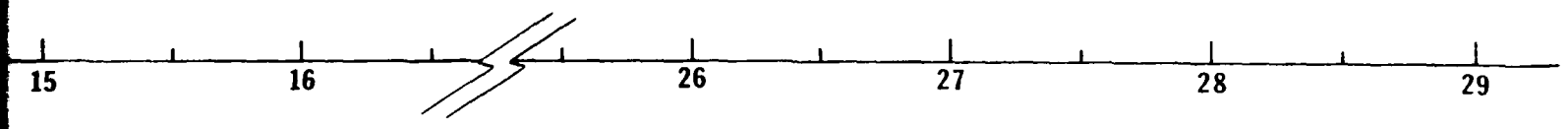

Effectiveness
Resume QOT&E
Operational
Suitability
End In-plant QOT&E
Software


Start Air Force On-site Test and Evaluation
Air Force Acceptance
ATD Re-assembly
Start On-site QT&E
End QT&E
Here
10
11
12
13
14
15
Effectiveness
Start On-site QOT&E
Operational
Suitability
End On-site QOT&E
Reporting
Software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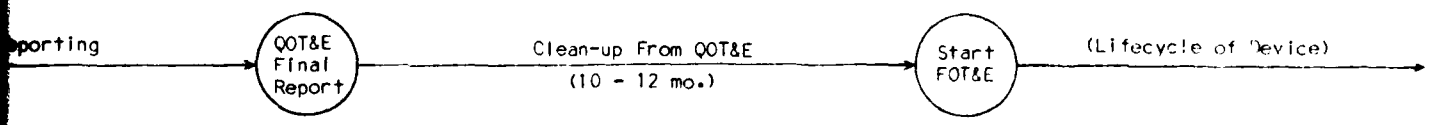
porting
QOT&E Final Report
Clean-up From QOT&E
(10 - 12 mo.)
Start FOT&E
(Lifecycle of Device)

made to procure additional devices of the type being tested, the device initially is considered a one-of-a-kind developmental device, being procured from a single vendor.

As can be seen from Figure 4-2, a portion of IOT&E may be conducted before the first full production decision using prototypes, preproduction items, or pilot production items. The primary purpose of that part of IOT&E is to give decision makers an estimate of the probable operational effectiveness and operational suitability of an ATD before the final production go-ahead decision is made. In this way any uncertainties regarding the ultimate operational effectiveness/suitability of the ATD (such as would perhaps be present if the ATD were being designed to exploit a new visual or motion cueing technology) can be resolved prior to a major expenditure.

Large Scale, Multiple ATD Procurements

OT&E as shown in Figure 4-3 is conducted on large scale systems mainly to verify that the ATD will perform to specification and that it should meet user effectiveness expectations. This type of OT&E is also used during "fly-before-buy" competitive procurements such as the B-52 WST. Of particular significance in this situation is the "Quick-look" OT&E report (see Figure 4-3). That report is based on comparable T&E (QT&E and QOT&E) activities performed in each vendor's facility. The results provided in that report are based on a number of specific and possibly selection sensitive dedicated OT&E tests that will have occurred. These tests must be carefully evaluated and objectively summarized in that brief OT&E report for use in support of the source selection process.

After the source selection decision has been made, the winning contractor updates and refurbishes the ATD as is necessary prior to renewed OT&E. Additional in-plant QT&E/QOT&E is then performed, as required, on the winning device before it is disassembled and shipped to its operational location.

Reliability and maintainability demonstrations for the winning device can be conducted either during the completion of in-plant testing or after the device has been installed and checked out at its on-site location.

Once the ATD has been installed on-site, additional OT&E is accomplished as necessary. OT&E/QOT&E ends with formal acceptance of the ATD by the Air Force (signified by signing of the DD-250). Following Air Force acceptance of the ATD, further OT&E activities may continue for as long as 10-12 months. Such activities may be limited to "clean-up," or they may involve one or more transfer-of-training studies.

It is important that the test director be prepared for the administrative and management pressures characteristic of this type of ATD OT&E. The major pressure usually comes from those deadlines which are tied to the source selection process. Both the contractors and the SimSPO have a great deal of interest in those OT&E events which will contribute to the ultimate source selection. As a result, the test director often is pressed to meet these source selection deadlines, and must compress and/or streamline some of his presource selection QOT&E activities.

APPENDIX A

GLOSSARY

This glossary contains terminology and acronyms related to aircrew training device design, utilization, and testing. Many of the terms and definitions provided here relate to the technology of ATD design and development generally, rather than to OT&E specifically.

ATD: Aircrew Training Device. Refers to training media which provide for some form of active trainee practice through simulation of essential task characteristics. These training media include cockpit familiarization and procedures trainers, operational flight trainers, part-task trainers, instrument flight trainers, and weapon system trainers.

ATP: Acceptance Test Procedures. Tests conducted to demonstrate that ATD engineering design is complete, that design and production risks are minimized, and that the device fulfills the specifications of the procuring contract.

AUGMENTATION: Providing information which does not exist in the real world, or an enhancement of naturally occurring information.

AUTO-DEMO: Automated Demonstration. An instructional feature that permits the standardized presentation of a mission segment or entire simulated flight. All cues of consequence, including the visual scene (if present), motion cues, primary flight controls and displays, crew communications and sensor displays, are reproduced for the selected mission segment or maneuver through computer control.

AUTOMATED CONTROLLERS: Computer-based systems that use mathematical models to determine controller messages and issue controller messages using computer generated speech.

AUTOMATED PERFORMANCE ALERTS: Signals intended to enhance the monitoring of student performance by combining the capabilities of automated performance measurement with automated alerting signal generation for instructors and/or students.

AUTOMATED PERFORMANCE MEASUREMENT (APM): The computer-based application of technology to monitoring, recording, processing and displaying objective, quantitative information that describes student performance and assists in diagnosing student learning problems.

AVAILABILITY: Availability reflects the readiness of the ATD to perform its training mission.

AVERAGE DEVIATION: A measure of variability that describes the extent to which, on the average, individual scores depart from the mean. Average deviation is the sum of the absolute differences of individual scores from the mean, divided by the total number of scores.

BAFO: Best and Final Offer

BITE: Built-in Test Equipment.

CAMERA/MODEL SYSTEM: A type of simulator visual system which consists of a scale model of terrain, aircraft, or other features, and is viewed by a closed circuit television camera.

CCT: Combat Crew Training.

CCTV: Closed Circuit Television.

CDR: Critical Design Review. A premanufacture review of detailed device design.

COMPUTER IMAGE GENERATION (CIG): Creation of synthetic visual images by computer processing of a numerical data base containing information about the objects and features which are part of a displayed visual scene.

CPT: Cockpit Procedures Trainer.

CT: Continuation Training: Training conducted routinely in operational squadrons, or proficiency training conducted periodically.

CUE: In this Handbook, cue means some critical feature or stimuli which gives important information to a pilot or other aircrew member.

DCAS: Defense Contract Administrative Services.

DELAY: The difference in time between when a change occurs in a simulated visual scene, movement of the cockpit, or response of a force cueing device and when it should have occurred.

DISPLAY CHANNEL: An independent ATD visual system display. Multiple display channels often are used to create large field of view visual systems.

DT&E: Development Test and Evaluation.

ECP: Engineering Change Proposal.

FIDELITY: The degree of correspondence between a simulated aircrew station and environment and the actual aircrew station and environment. Also see: physical fidelity; psychological fidelity; and realism.

FIELD OF VIEW: The dimensions of the area of a visual display which can be seen. Expressed in terms of visual angle.

FLIGHT CHARACTERISTICS FIDELITY: The extent to which aircraft control and response characteristics are reproduced accurately in an ATD.

FORCE CUEING DEVICES: ATD mechanizations that are intended to provide onset and sustained motion-related flight cues. They include: G-seats; G-suits; seat shakers; helmet loaders; arm loaders; and visual system greyout/blackout capabilities.

FOT&E: Follow-on Operational Test and Evaluation.

FREEZE: An instructional support feature that allows simulator parameters to be fixed at values existing when freeze is actuated.

HARDCOPY: An ATD instructional feature that enables the Instructor/Operator to reproduce on paper data displayed at the IOS.

HUMAN FACTORS: The application of information about human capabilities and limitations to the design, use, and evaluation of machines, systems, and devices of all kinds.

ILITIES: See Operational Suitability.

IMAGE. The picture or scene created by a simulator visual system which is viewed by a pilot or other aircrew member.

IMAGE QUALITY: Characteristics of the appearance of an image, independent of the scene content of the image.

INITIALIZATION: Initialization involves specifying, usually from the instructor/operator console, the parameters of interest and their values for positioning and configuring an ATD within a gaming area.

IN-PLANT: At the contractor's facility

INSTRUCTIONAL SUPPORT FEATURE: ATD capabilities that allow the instructor to manipulate, supplement, and otherwise control trainee learning experiences to increase the rate of learning and to maximize the level of skill achieved.

INSTRUCTOR CONSOLE: See Instructor/Operator Station (IOS).

INSTRUCTOR/OPERATOR STATION (IOS): The aircrew training device man-machine interface where active control and monitoring of training events occurs.

INTERVAL SCALE: A rating scale that utilizes name or number categories, implies order among categories, and approximates equal intervals between items.

IOT&E: Initial Operational Test and Evaluation.

IRON PILOTS: Computer controlled adversaries, typically used in air combat maneuvering training in ATDs.

ISD: Instructional system development: Procedural approaches to the analysis of training requirements and the development of training programs and systems.

LOGISTICS SUPPORTABILITY: Logistics supportability includes a number of concerns, each of which relates to the support and/or maintenance of the ATD. These concerns include supply, test support equipment (SE), technical data, facilities, personnel and training, and transportation and handling.

LSET: Logistics Supportability Evaluation Team.

MAINTAINABILITY: A characteristic of system design and installation that affects the ease or difficulty with which that system may be retained in, or restored to, a specific serviceable condition.

MAJOR PROGRAM: An acquisition program involving more than $75 million RDT&E or $300 million production costs.

MEAN: The average of a set of scores; i.e., the sum of all scores divided by the total number of scores.

MEDIAN: The middle score of a set of rank-ordered scores. For an odd number of scores the median is simply the middle score; for an even number of scores the median is the average of the two middle scores.

MOA: Memorandum of Agreement.

MOCK-UP REVIEW: A review by the Air Force of a nonworking model of the device to be built. Mock-up review is usually held concurrently with PDR.

MODE: The score that occurs most often. Sometimes a set of scores will be multi-modal, i.e., two or more scores occur equally often.

MOE: Measure of Effectiveness.

NOMINAL SCALE: A rating scale that utilizes name categories, without suggesting any numerical relationship among those categories.

NONMAJOR PROGRAM: An acquisition program involving less than $75 million RDT&E or $300 million production costs.

O&M: Operations and Maintenance.

OFT: Operational Flight Trainer.

ON-SITE: At the user's facility.

OPERATIONAL DEFICIENCY: A deficiency in the design or performance characteristics of an ATD in terms of its operability and training utility.

OPERATIONAL EFFECTIVENESS: How well the device fulfills its intended mission in its intended environment. For ATDs, operational effectiveness means training utility.

OPERATIONAL SUITABILITY: Operational suitability factors pertain to how well the device meets accepted equipment serviceability requirements within its intended operating and maintenance environment. These factors include hardware reliability, mairtainability, availability, logistics supportability, and software suitability.

ORDINAL SCALE: A rating scale that utilizes name or number categories and which implies rank order among those categories, but does not concern the size(s) of the interval between items.

OT&E: Operational Test and Evaluation.

OTEMP: OT&E Master Program.

PDR: Preliminary Design Review.

PERCEPTION: The acquisition of information about the world through the human senses.

PHYSICAL FIDELITY: The degree to which an ATD replicates precisely the aircraft it represents.

PLATFORM MOTION SYSTEMS: ATD mechanizations that provide typically from 3 to 6 degrees of freedom of ATD cockpit movement. Flight motion simulated may include pitch, roll, yaw, heave (vertical movement), front/back and left/right (lateral movement).

PMD: Program Management Directive.

PMP: Program Management Plan.

PRACTICE: Repetition of task performance to improve or maintain proficiency on that task.

PROGRAMMED MISSION SCENARIOS: Highly structured sets of events that are caused to occur automatically, under computer control.

PSYCHOLOGICAL FIDELITY: The degree of correspondence of cues and responses accompanying task performance in an ATD to those characteristics of analogous performance in an aircraft.

QOT&E: Qualification Operational Test and Evaluation.

QTP: Qualification Test Procedures: See ATP.

RATING SCALE: A data collection tool that enables a person to express an estimate, judgment, or opinion about some quality or quantity in terms of a category or number.

RATIO SCALE: A rating scale that possesses all the properties of an interval scale, plus has an absolute zero point.

REALISM: The extent to which an aircrew member's experiences in an ATD correspond to experiences as they actually would occur in the aircraft under a given set of conditions. Also see physical fidelity.

RECORD/REPLAY: The instructional feature that provides the capability in an ATD to record relevant system parameters and then use these data to present student pilot performance in a review mode in the ATD.

RELIABILITY: The likelihood that the ATD, and its major subsystems will work satisfactorily when needed for training. Reliability is expressed in terms of the frequency with which failures occur (e.g., Mean Time Between Critical Failure, Mean Time Between Maintenance Action).

REMOTE DISPLAY: An ATD instructional feature that permits alphanumeric and graphic data on an IOS display to be displayed simultaneously at the trainee station.

RESOLUTION: The smallest separation between two objects in a display that can be detected, usually by the human eye.

RESPONSE: Any motor, perceptual or mental act by a person, generally refers to an element of an overall action as opposed to the overall action itself.

RETENTION: The capacity to remember task performance requirements after a period of time when the task has not been practiced.

RDT&E: Research and Development Test and Evaluation.

RFP: Request for Proposal.

RTA: Responsible Test Agency.

SAT: Software Analysis Team.

SimSPO: Simulator System Program Office.

SIOE: Statement of Intended Operational Employment.

SOFTWARE: Computer Programs.

SON: Statement of Operational Need.

SOW: Statement of Work.

SPECIFICATION: A contractual statement describing the device to be built in terms of its functions and characteristics.

SPO: System Program Office.

STANDARD DEVIATION: A measure of variability of individual scores about the mean. The standard deviation is the square root of the sum of squared deviations about the mean divided by the total number of scores.

STORE/RESET: An ATD instructional feature that permits the simulation to be returned or reset to a set of conditions that existed at an earlier point in time. This feature is often used for repetitive practice of training maneuvers.

T&E: Test and Evaluation.

TD: Test Director.

TEMP: Test and Evaluation Master Plan.

TEST PLAN: The formal document that contains the test objectives, methods, and the resources required to conduct, analyze, and report the test.

TM: Test Manager.

TO: Technical Order.

TPO: Test Program Outline.

TPWG: Test Planning Working Group.

TRAINING EFFECTIVENESS: The demonstrated improvement in trainee performance following practice in the ATD. Often expressed in terms of the transfer effectiveness ratio (TER).

TRAINING EFFICIENCY: The extent to which available resources (including time) are used economically during training.

TRAINING OBJECTIVES: Explicit statements of the goals of training including tasks to be performed, the performance standards for each task, and the conditions under which those tasks are to be performed.

TRAINING REQUIREMENTS: General statements of task performance skills required for operational proficiency. Also, general statements of performance skills that require periodic practice in order to maintain proficiency.

TRAINING SCENARIO: A predefined sequence of training events used to exercise the capabilities of an ATD in a specific area of intended training usage.

TRANSFER OF TRAINING: The transfer of skills learned in one context (e.g., an ATD) to a different context (e.g., an aircraft). The carry-forward of trained performance to real world applications.

TRANSITION TRAINING: Training for aircrew members transitioning to different operational aircraft.

VIRTUAL IMAGE: In visual simulation, a virtual image appears to be at a greater distance (e.g., optical infinity) than the actual display surface.

WST: Weapon System Trainer.

APPENDIX B

ANNOTATED BIBLIOGRAPHY[1]

This annotated bibliography contains summaries of selected documents, regulations, and other publications relevant to ATD operational test and evaluation. As a guide to secondary sources for technical information, this bibliography is formatted to facilitate access and retrieval of needed materials.

[1]Portions of this bibliography (designated *) were excerpted from Spears, Sheppard, Roush, and Richetti, Simulator training requirements and effectiveness study (STRES): Abstract bibliography (AFHRL-TR-80-38). Brooks AFB, TX: Air Force Human Resources Laboratory, January 1981.

ADMINISTRATIVE/MANAGEMENT DOCUMENTS

Department of the Air Force. Test and Evaluation (AFR 80-14). Washington, DC: Headquarters US Air Force, July 1976.

This regulation defines "policy and procedure for managing test and evaluation activities during the development, production and deployment of defense systems in the Air Force." It establishes the management relationships among the implementing command, the Air Force Test and Evaluation Center, and the operating and supporting commands in successive phases of a system's life cycle, from the conceptual phase through deployment and employment. It includes discussion of the various types of test and evaluation, test documentation, assignment of responsibilities, administration, and a glossary of terms relating to test and evaluation. AFR 80-14 applies to all Air Force organizations.

Department of the Air Force. Test and Evaluation (MAC Regulation 55-80). Scott AFB, IL: Headquarters Military Airlift Command, December 1976.

This regulation establishes "policies and outlines procedures for managing, conducting, and supporting programs for test and evaluation of new or improved systems and equipment within MAC." It contains brief definitions of the various types of test and evaluation, and assigns administrative and fiscal responsibilities among organizations who participate in T&E. Included are general formats for use by agencies and organizations requesting test programs, preparing test plan outlines, test orders, test plans, and final reports. A brief glossary is provided that defines terms relating to test and evaluation. MACR 55-80 applies to all MAC organizations and agencies with regard to test and evaluation.

Department of Air Force. Management of Operational Test and Evaluation (AFM 55-43). Washington, DC: Headquarters U.S. Air Force, June 1979 (Vol. I), July 1979 (Vol. II).

In two volumes, AFM 55-43 is designed to explain the operational test and evaluation (OT&E) program, and how it relates to other Air Force and DoD activities. In summarizes the principles and procedures that will promote consistent OT&E management throughout the Air Force. It establishes guidelines for standardizing the planning, conducting, and reporting of OT&E programs in the Air Force; however, because the scope of those programs

varies, judgment must be used in applying these guidelines to each individual program. The major commands may set specific command policies and procedures not only to implement the manual, but to provide for specific procedures and tests outside its scope. The two volumes of AFM 55-43 correspond topically, but differ in terms of the scope of their coverage. Volume I is directed to "all levels of management and presents the background and underlying philosophy for current OT&E policies and procedures. It provides the general guidelines on planning, managing, conducting, and reporting on OT&Es." The intent of Volume II is more to provide the how-to information and is directed to the "doers" (i.e., the test planner, test director, and test team member). It contains a wealth of specific guidance, techiques, and procedures relevant to OT&E. This is a must-have source document for the OT&E test manager/director. The content of AFM 55-43 volumes is shown below (chapters are same for both volumes).

Chapter 1. Introduction

Chapter 2. Evolution of Air Force OT&E

Chapter 3. OT&E Organization and Management

Chapter 4. Types of Operational Test and Evaluation

Chapter 5. Objectives of Operational Test and Evaluation

Chapter 6. The Role of OT&E in the Requirements and Acquisition Process

Chapter 7. Test Funding

Chapter 8. Test Planning and Management

Chapter 9. Test Execution

Chapter 10. Deficiency Reporting

Chapter 11. Test Reporting

Department of the Air Force. Test and Evaluation: A Guide for Test and Evaluation Management (ASDP 80-14). Wright-Patterson AFB, OH: Headquarters, Aeronautical Systems Division (AFSC), October 1978.

This document provides guidance for management of test and evaluation (T&E) during the acquisition phase of weapon systems or

equipment. The purpose of this document is to assist program managers in focusing on those essential actions that must be accomplished as key events during both major and nonmajor acquisition programs. This guidance is oriented primarily toward T&E as regulated by AFR 80-14; however, the concepts and procedures may be tailored for application to any Air Force T&E program. The information in this document emphasizes the required T&E planning and program documentation, and it is organized to serve middle management such as test managers and project officers. A second thrust is to identify actions or situations that require special attention because they illuminate pitfalls or successful experiences, a knowledge of which will aid test managers destined to encounter similar situations in the system acquisition process.

Department of the Air Force. Logistics Assessment (AFTECP 400-1). Kirtland AFB, NM: Headquarters Air Force Test and Evaluation Center, May 1978.

This document is a guide for logistics program managers of Air Force Test and Evaluation Center (AFTEC) who participate in planning, execution, and reporting of operational test and evaluation of systems during the acquisition process. Although this document is intended for personnel assigned to the AFTEC Directorate of Logistics, portions may also be useful to other Air Force activities involved in operational test and evaluation of equipment. Included are discussions of the acquisition process, computerized maintenance and logistics data systems, test planning, execution, and reporting. Appendices contain information on abbreviations, definitions, computerized products, and publications that are applicable to operational test and evaluation.

Air Force Test and Evaluation Center (AFTEC). Cost of Ownership Handbook. Kirtland AFB, NM: Author, May 1976.

This procedure handbook was prepared for use in assessing the cost of ownership (COO) during system test efforts. It defines cost of ownership and each of the cost elements that comprise the term. In addition, it describes a methodology, equations, and techniques that may be used for the development of cost of ownership reporting requirements. A rather detailed description is included of AFTEC's life cycle cost of ownership model. This handbook is heavily oriented toward aircraft systems, although cost elements are identified for a number of other systems including airborne missiles, communications, electronic, and

meteorological systems, ICBM systems, drone systems, and simulators.

Department of the Air Force. Operational Test and Evaluation Management Procedures (USAFTAWCR 55-8). Eglin AFB, FL: USAF Tactical Air Warfare Center (TAC), January 1980.

This regulation "establishes operational test and evaluation (OT&E) policies and guidance, and presents procedures and [defines] responsibilities for the accomplishment of USAFTAWC's OT&E mission." Like AFM 55-43, this document contains a wealth of information relevant to system OT&E. The range of coverage is broad, from general OT&E policy and guidance to specific instructions and directives for project planning, execution, and reporting. A number of useful tables and figures are provided including, among others, a sample test program schedule, project plan, and project report. This document was written to minimize the need for extensive reference to other source documents. Consequently, there is a large measure of redundancy to AFM 55-43. Nevertheless, this is a must-have document for the TAC test manager/director of an ATD OT&E.

TECHNICAL DOCUMENTS

Bryan, G. L., & Regan, J. J. Chapter 13: Training system design. In H. P. Van Cott & R. G. Kinkade (Eds.), Human engineering guide to equipment design. Washington, DC: U.S. Government Printing Office, 1972. (Pp. 633-666) *

The purpose was to present a conceptual design of training based on educational technology and system design techniques. Design of devices must be concerned specifically with the configuration and capabilities of instructor and student stations. The instructor must be able to exercise system functions and capabilities in a timely and effective manner, and the student should receive the guidance, feedback, etc., in an efficient and effective way. (An earlier warning was repeated regarding realism for the sake of realism "since the student station is the place where costly and unnecessary realism is apt to show up in a simulator." The instructor's station must also provide selected information about students' performance, and automatic data acquisition should be considered to aid in interpreting performance. "In short, the designer should repeatedly ask himself what the instructor must be able to do to assist the student maximally, and then arrange for the instructor to be able to do those things with the machine and not in spite of it." Once training equipment is designed, a utilization guide should be prepared. It should establish procedures for distribution of practice and rest periods, pacing task presentations, ensuring "overlearning" as needed, preparing for practice, and incorporating mental practice. It should also describe special methods of use such as demonstrations and joint practice by two or more trainees. Trade-offs regarding preprogrammed (canned) training and flexible adaptations of content should be approached carefully, though with computers (and presumably, modules) preprogrammed content can be used with considerable flexibility. Provisions should be made to ensure user acceptance of training devices and related training systems, which requires carefully planned communication between designers and users. Finally, an evaluation of the training system should be made over a "reasonably long period of time" with the system in full operation.

Caro, P. W., Pohlmann, L. D., & Isley, R. N. Development of simulator instructional feature design guides (Tech. Rep. TR 79-12). Pensacola, FL: Seville Research Corporation, October 1979. *

There is no "convenient mechanism to acquaint simulator designers with training requirements that pertain specifically to

instructional features." The purpose of this project was to develop guides for defining instructional feature (IF) requirements that could be used for user-designer communication. The approach aimed at a set of guides appropriate for a variety of simulators, using a particular device currently under development (an F-16 simulator) as a vehicle for developing them. Information regarding IFs was obtained through observations and reviews of existing simulators, simulator instruction and roles of training personnel and training practices and requirements for the F-16. Twelve IFs were selected for exemplar development: (a) Record/Playback--permits replay of a preceding recorded segment of device operation; (b) Store/Reset Current Conditions--permits device to be reset to an earlier set of conditions; (c) Remote Display--for displaying alphanumeric and graphic data to the learner; (d) Hardcopy--for printouts of performance records; (e) Manual Freeze--permits simulated actions to be suspended or "frozen"; (f) Automatic Freeze--similar to (e) except that it occurs automatically under specified conditions; (g) Parameter Freeze--for selective freeze of only one or a few parameters rather than all simulator operation; (h) Demonstration--permits automated task performance by the device itself to illustrate how tasks may be performed, and the conditions and effects; (i) Demonstration Preparation--permits an instructor to prepare his own Demonstration for future use; (j) Automatic Malfunction Insertion--inserts predetermined simulated malfunctions automatically under specified conditions; and (k) Automatic Malfunction Insertion Exercise Preparation--permits an instructor to prepare his own automatic malfunction exercises. The guides for each feature were presented in a format consisting of the feature identification, its definition, its purpose and intended use, concurrent events that are compatible/incompatible with use of the feature, and a flow diagram of the functions involved in its use.

Charles, J. P. Instructor pilot's role in simulator training (Phase II) (NAVTRAEQUIPCEN 76-C-0034-1). Orlando, FL: Naval Training Equipment Center, August 1977. *

An earlier conducted Phase I of this effort found that "the simulator instructor for pilot training is typically untrained for that job, is not provided essential information for the task . . . and is expected to perform at a console not designed for the job." Pursuant to overcoming these difficulties, the present Phase II study determined an instructor pilot's (IP) functions in simulator training. IP functions are grouped under ten heads, each including subheads. The ten simulator IP functions were: (1) Prepare; (2) Brief; (3) Initialize; (4) Train; (5) Evaluate;

(6) Debrief; (7) Manage Data; (8) Develop Syllabus; (9) Train IP; and (10) Train Self/Peer.

Flexman, R. E., Roscoe, S. N., Williams, A. C., Jr., & Williges, B. H. Studies in pilot training: The anatomy of transfer. Aviation Research Monographs, 1972, 2(1).

This document contains a discussion of the measurement of transfer, including the concepts of a Transfer Effectiveness Ratio (TER) and Incremental Transfer Effectiveness Ratio (ITER). It reports two early experimental studies on the transfer effectiveness of flight simulators as a function of specific contact and instrument flight tasks. A number of worthwhile insights are provided in a conclusion section that relate to the measurement of transfer. The complexities of measuring simulator transfer effectiveness in the context of a total training curriculum were noted, and the need was stressed for more comprehensive research strategies to deal with those complexities.

Jeantheau, G. G. Handbook for training systems evaluation (NAVTRADEVCEN 66-C-0113-2). Orlando, FL: Naval Training Device Center, January 1971. *

The purpose of this report was to present the basic notions underlying training device effectiveness in the context of practical constraints on research in training device settings. Four levels of evaluation were discussed: (1) qualitative assessment, (2) noncomparative measurement, (3) comparative measurement, and (4) transfer of training. The first level, qualitative assessment, does not involve measurement of any kind, but is based on judgments made against a prior criteria of cost of the device, and the training situation that research and experience have shown contribute to effectiveness. The second level, noncomparative measurement, is the crudest form of quantitative assessment. It involves a measurement of training performance from the beginning to the end of training. The gain scores represent the effectiveness of training with the device. Level three, comparative measurement, is where statistical evidence and experimental control come into play. Comparisons of group progress using different media or training programs are the bases for evaluating separate media and programs. To ensure comparability between situations, control must be exercised over the training. The fourth level, transfer of training, requires establishing that training in the simulator results in improved performance in an operational situation. Each succeeding level provides increasing

rigor and entails increased problems of coordination and cooperation with the training activity, but provides the investigator with increasing levels of validity and reliability. Illustrations and blank evaluation forms are provided to help clarify the discussion. Evaluation techniques are placed in perspective relative to each other and to situational constraints that affect their utility.

Miller, R. B. Handbook on training and training equipment design (WADC Tech. Rep. 53-136). Wright-Patterson AFB, OH: Wright Air Development Center, June 1953. *

The purpose was to provide a handbook of principles for specialists in training. Theoretical, empirical, and intuitive grounds for the principles were explained as well. As a handbook, points are presented briefly (although clearly), and each point is itself an abstract of an often voluminous research literature. It was written for persons who already have more than an introductory knowledge of the psychology of learning. (Nevertheless, persons who are not specialists in this area can gain considerable insight into training issues from it.) There are seven lengthy sections covering topics as follows: Section 1 provides an overview of human learning emphasizing cues and mediational processes (especially verbal mediation) and learning conditions and criteria that lead to cue and response discriminations and their retention. Section 2 defines the role of the instructor as he must motivate, direct, and evaluate students, and arrange the learning situation. Section 3 addresses the role of demonstration (guidance) in training, with special emphasis on the use of training devices. Section 4, which comprises 40 percent of the text of the report, goes into detail regarding the use of knowledge of results (feedback) to manage and control student learning. Section 5 addresses problems of simulation, device requirements. Section 6 discusses student motivation as determined by biographical factors, aspirations, prestige, etc. Then, factors emerging during training that affect motivation are explained. Section 7 provides a schema for preparing specifications for a training device. An index is included that is especially valuable for location of discussions of the concepts. This is a classic document on training and the use of training devices. The author had an unusual mastery of the psychology of learning, and he could state it in a straightforward manner. It would be well for persons involved in simulator programs to return to this report for guidance.

Semple, C. A. Executive summary: A report of the simulator training requirements and effectiveness (STRES) (AFHRL-TR-80-63). Brooks AFB, TX: Air Force Human Resources Laboratory, 1980.

The Simulator Training Requirements and Effectiveness Study (STRES) was conceived as a means of identifying and making available the existing information related to Air Force simulator training. The purpose was to assemble a technical data base to provide guidance for the enhancement of present training, as well as for the focus of R&D needed to enhance future simulator-based training. A series of reports was produced that address a number of relevant issues, i.e., device fidelity, instructional support features, device utilization, life cycle cost and worth of ownership. In addition, areas of information "gap" were identified and research plans developed to address those areas. Finally, a comprehensive abstract bibliography was prepared to provide meaningful background information to users and to serve as a guide for secondary sources of technical information. In addition to the "executive summary" referenced above, the following six reports were prepared:

Semple, C. A., Hennessy, R. T., Sanders, M. S., Cross, B. K., Beith, B. H., & McCauley, M. E. Aircrew training device fidelity features (AFHRL-TR-80-36). Brooks AFB, TX: Air Force Human Resources Laboratory, 1980.

Semple, C. A., Cotton, J. C., & Sullivan, D. J. Aircrew training device instructional support features (AFHRL-TR-80-58). Brooks AFB, TX: Air Force Human Resources Laboratory, 1980.

Caro, P. W., Shelnutt, J. B., & Spears, W. D. Aircrew training devices: Utilization (AFHRL-TR-80-35). Brooks AFB, TX: Air Force Human Resources Laboratory, 1980.

Allbee, K. E., & Semple, C. A. Aircrew training device life cycle cost and worth of ownership (AFHRL-TR-80-34). Brooks AFB, TX: Air Force Human Resources Laboratory, 1980.

Prophet, W. W., Shelnutt, J. B., & Spears, W. D. Future research plans: A report of the simulator training requirements and effectiveness study (STRES) (AFHRL-TR-80-37). Brooks AFB, TX: Air Force Human Resources Laboratory, 1980.

Spears, W. D., Sheppard, H. J., Roush, M. D., II, & Richetti, C. L. Abstract bibliography: A report of the simulator training requirements and effectiveness study (STRES) (AFHRL-TR-80-38). Brooks AFB, TX: Air Force Human Resources Laboratory, 1980.

Wheaton, G. R., Rose, A. M., Fingerman, P. W., Korotkin, A. L., & Holding, D. H. Evaluation of the effectiveness of training devices: Literature review and preliminary model (Research Memorandum 76-6). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences, April 1976.

The purpose of the report was to develop the foundations for, and present a preliminary statement of, a model for predicting transfer of training (TOT) value of a training device. This report compares and contrasts in a succinct, critical manner several ways of trying to determine a priori the value of training devices. Second, it presents a detailed summary of the effects of various conditions and variables on transfer of training. Within the scope of the report, both topics were covered well. Two tables cross-referencing transfer variables with individual research reports alone make this report a valuable reference.

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