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ARMY MISSILE COMMAND REDSTONE ARSENAL AL SYSTEMS EN--ETC F/G 5/1  
GUIDE FOR TRANSITIONING ARMY MISSILE SYSTEMS FROM DEVELOPMENT T--ETC(U)

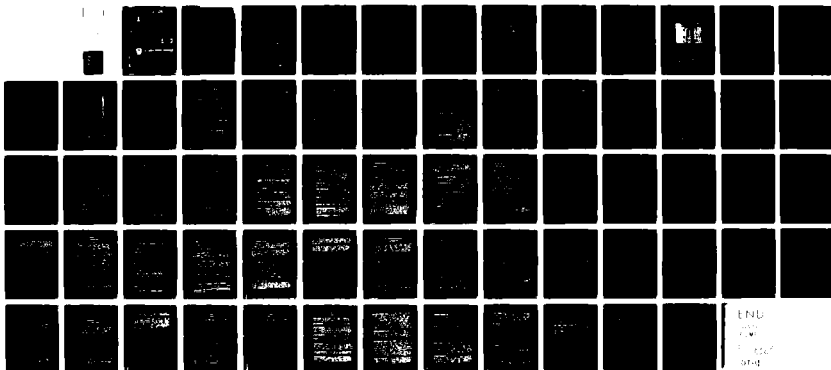
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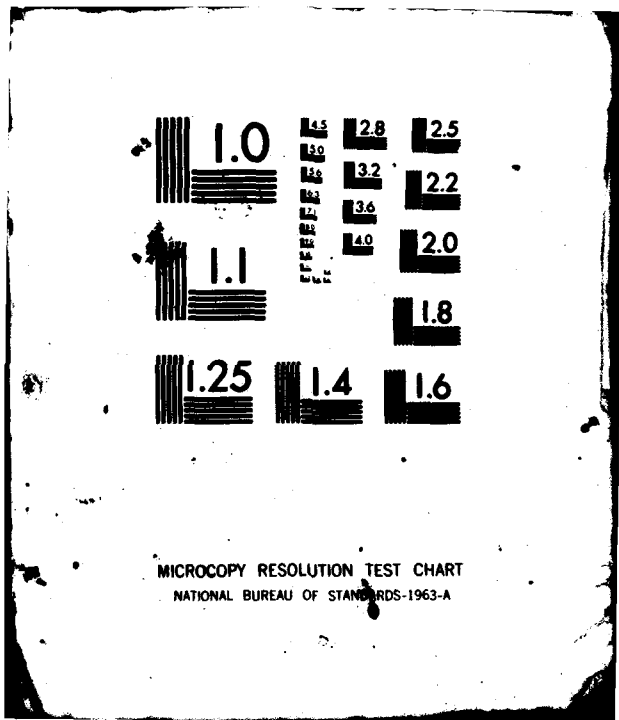
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TECHNICAL REPORT RS-81-6

GUIDE FOR TRANSITIONING ARMY MISSILE SYSTEMS  
FROM DEVELOPMENT TO PRODUCTION

Production Engineering Division  
System Engineering Directorate  
US Army Missile Laboratory

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July 1981



U.S. ARMY MISSILE COMMAND

Redstone Arsenal, Alabama 38809

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FOREWORD

The transition from development into production is an important and complex step in the life cycle of a new missile system. It represents the successful completion of numerous engineering, testing and planning tasks; recognition by higher authorities that the system is ready to enter production; initiation of the many activities needed for production start-up; and manufacturing of the system. The coordination and execution of these events is always demanding in today's acquisition environment. How well the Project Manager, in conjunction with MICOM functional elements and the contractor, can bring about a smooth and efficient transition into production greatly affects the Army's ability to deploy effective, maintainable and affordable missile systems.

This guide reflects the transition process and identifies major issues/actions that must be taken. It has been written for use by Project Managers, their staffs, and other MICOM elements involved in developing and producing new missile systems.

This guide will be updated as required to improve its content and incorporate changes in the acquisition process. Thus, comments on ways to improve future versions of the guide are welcomed.



Clifford M. Hoch  
Chief, Production Engineering

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## TABLE OF CONTENTS

	<u>PAGE</u>
1.0 INTRODUCTION -----	1
1.1 The Acquisition Process -----	1
1.2 Definition of "Transition" -----	4
1.3 Problems in Achieving the Transition -----	7
1.4 Managing the Transition -----	8
2.0 MAJOR PROGRAMS AND ACTIVITIES AFFECTING THE TRANSITION -----	13
2.1 Producibility Engineering and Planning -----	13
2.2 Initial Production Facilities -----	16
2.3 Manufacturing Methods and Technology -----	17
2.4 Production Readiness Reviews -----	21
2.5 Configuration Management -----	28
2.6 Standardization -----	29
2.7 Quality Assurance/Engineering -----	30
2.8 Design to Cost -----	32
2.9 Value Engineering -----	33
2.10 Integrated Logistics Support -----	34
2.11 Other Concepts -----	35
3.0 TRANSITION-RELATED ACTIVITIES DURING THE CONCEPTUAL PHASE -----	37
3.1 Production Feasibility Assessment -----	39
3.2 Acquisition Strategy -----	40
3.3 Design to Cost Goals -----	40

TABLE OF CONTENTS

(CONCLUDED)

	<u>PAGE</u>
4.0 TRANSITION-RELATED ACTIVITIES DURING THE VALIDATION PHASE -----	42
4.1 Preliminary Producibility Analysis -----	44
4.2 Initiation of Manufacturing Methods and Technology Projects -----	45
4.3 Refining Design to Cost Goals -----	45
4.4 Refinement of Full Scale Development Activities -----	45
5.0 TRANSITION-RELATED ACTIVITIES DURING THE FULL SCALE DEVELOPMENT PHASE -----	46
5.1 Producibility Engineering and Planning -----	48
5.2 Production Readiness Reviews -----	49
5.3 Functional Configuration Audit -----	49
5.4 Physical Configuration Audit -----	50
5.5 Long Leadtime Item Procurement -----	50
5.6 Initial Production Facilities -----	50
6.0 TRANSITION-RELATED ACTIVITIES DURING THE PRODUCTION PHASE -----	51
APPENDIX A - REFERENCES -----	53
APPENDIX B - DEFINITIONS -----	54

## 1.0 INTRODUCTION

One of the most important steps in the life cycle of a new missile system is the transition from development into production. It encompasses completion of engineering development; a successful outcome of the milestone review process for production entry; initiation of the activities needed for production start-up; and routine manufacturing of the missile system. Because of the large number of diverse events that must be successfully orchestrated to achieve the transition, it is a complex and difficult challenge.

Occasionally, major difficulties are encountered in the transition from development to production. These difficulties can include design deficiencies that require correction; higher than anticipated unit production costs; unusually long leadtimes for components and materials; problems with special tooling, manufacturing processes, and test and inspection equipment; failure to pass production acceptance tests and a myriad of other difficulties. Such problems adversely affect costs, delivery schedules and deployment dates.

Because of these difficulties and a desire to improve the weapon systems acquisition process, the transition from development into production has been receiving increasing emphasis in recent years from all levels within the decision making chain. This emphasis is reflected in new regulatory guidance, such as DoD Directive 5000.34, "Defense Production Management," and in the creation and use of new management tools, such as Production Readiness Reviews. It is expected that the emphasis on smooth and efficient transitions from development into production will continue to increase as competition for new funds intensifies in the future and means are sought to reduce the time required to develop and field new weapon systems.

This guide has been prepared to assist Project Managers for major and non-major systems in planning for and executing the transition for new missile systems. This chapter provides a brief introduction to the acquisition process and explores what is meant by a "transition" from development to production. The types of problems that are frequently encountered during the transition and issues that must be considered, as well as the importance of tailoring transition-related activities for the system being developed, are also discussed. Later chapters address specific concepts and activities that should be undertaken during development to help ensure a smooth and efficient transition.

### 1.1 The Acquisition Process

Basic policies for the acquisition of major missile systems are established in:

1. Office of Management and Budget Circular A-109, "Major Systems Acquisitions."
2. DoD Directive 5000.1, "Major System Acquisitions."

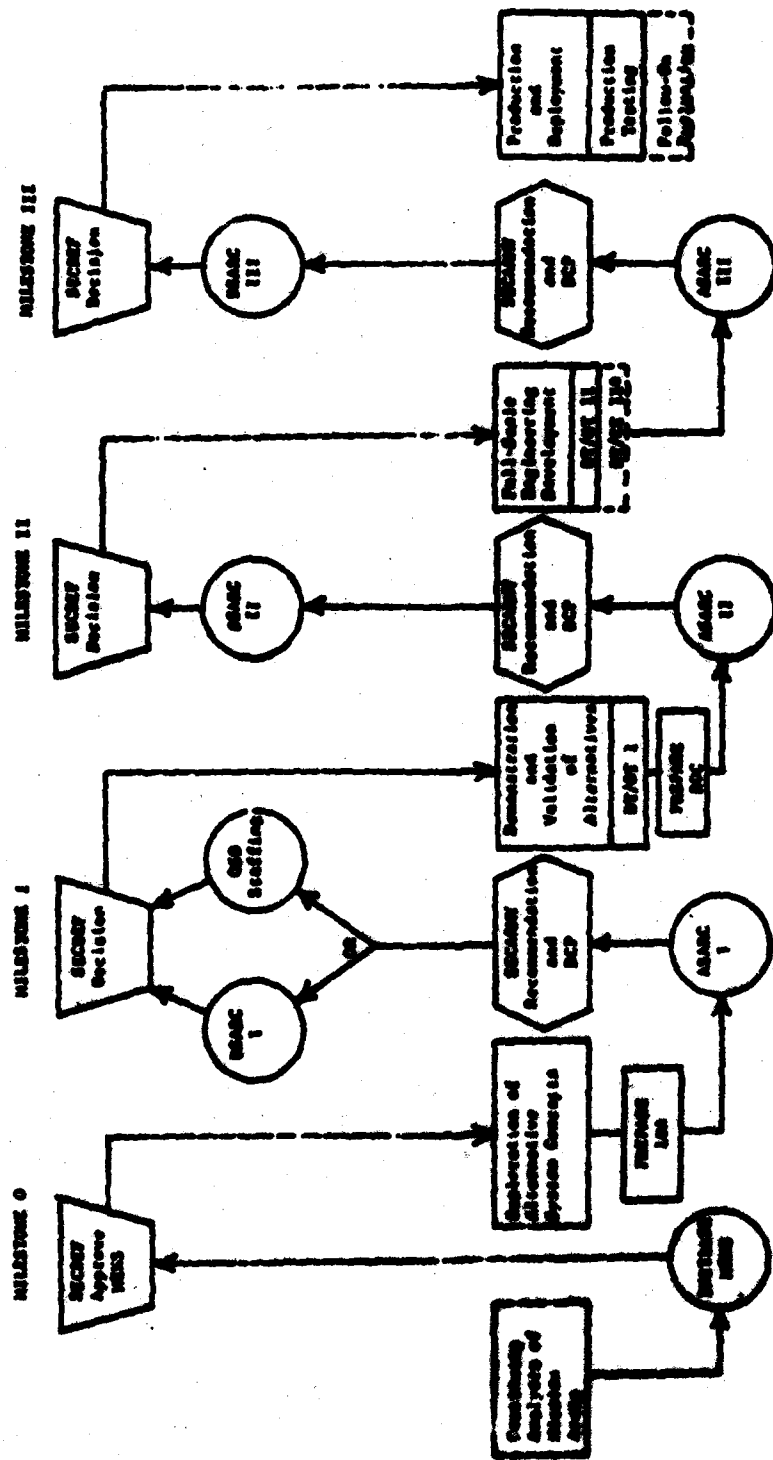


Figure 1-1. MATERIAL ACQUISITION PROCESS FOR MAJOR ARMY SYSTEMS.

3. DoD Directive 5000.2, "Major System Acquisition Procedures."

4. AR 1000-1. "Basic Policies for Systems Acquisition."

The need for a new Army missile system is generally satisfied through one of three alternative methods: product improvement of current standard equipment; the purchase of existing designs from other Services or allies; or initiation of a new missile system development program. Because the latter alternative is the most common means of satisfying Army missile system needs, this guide will focus almost exclusively on new missile system development programs.

As illustrated in Figure 1-1, the acquisition process for a new missile system is initiated upon DoD approval of a Mission Element Need Statement (MENS), which defines the operation task to be accomplished by the new system. Approval of the MENS is referred to as Milestone 0. The remainder of the acquisition process is divided into four phases:

1. Conceptual Phase. This is the first phase in the life cycle of a new missile system. Threat projections, technological forecasts, and joint service and Army plans are examined to determine operational capabilities, doctrine, organization and potential missile systems that will improve Army forces. The technical, military and economic bases for proposed systems are established and concept formulation initiated through pertinent studies and evaluation of experimental hardware. Critical issues and logistical support problems and actions are identified for investigation and resolution in subsequent phases to minimize future development risks. Additional tasks during the conceptual phase include: preparation of an initial cost and operational effectiveness analysis; preparation of a Letter of Agreement (LOA) requirement document; and preparation of a Decision Coordinating Paper (DCP) and Integrated Program Summary (IPS) for review by the Army Systems Acquisition Review Council (ASARC) and Defense Systems Acquisition Review Council (DSARC) at Milestone 1 to determine if the system is ready to enter the next phase.
2. Validation Phase. This phase consists of the following steps:
  - a) Verify preliminary
  - b) Definitize system requirements including reliability, availability, and maintainability
  - c) Accomplish necessary planning
  - d) Analyze trade-off proposals
  - e) Resolve or minimize logistics problems
  - f) Prepare a Required Operational Capability (ROC) requirements document
  - g) Validate the system concept for full scale development.

Prototypes are developed and tested in order to estimate the prospective system's technological feasibility, military utility, cost, environmental impact, human engineering, operational effectiveness, operational suitability, and to initially evaluate producibility considerations. The DCP and IPS are updated during the validation phase for ASARC/DSARC review at Milestone II for entry into full scale development.

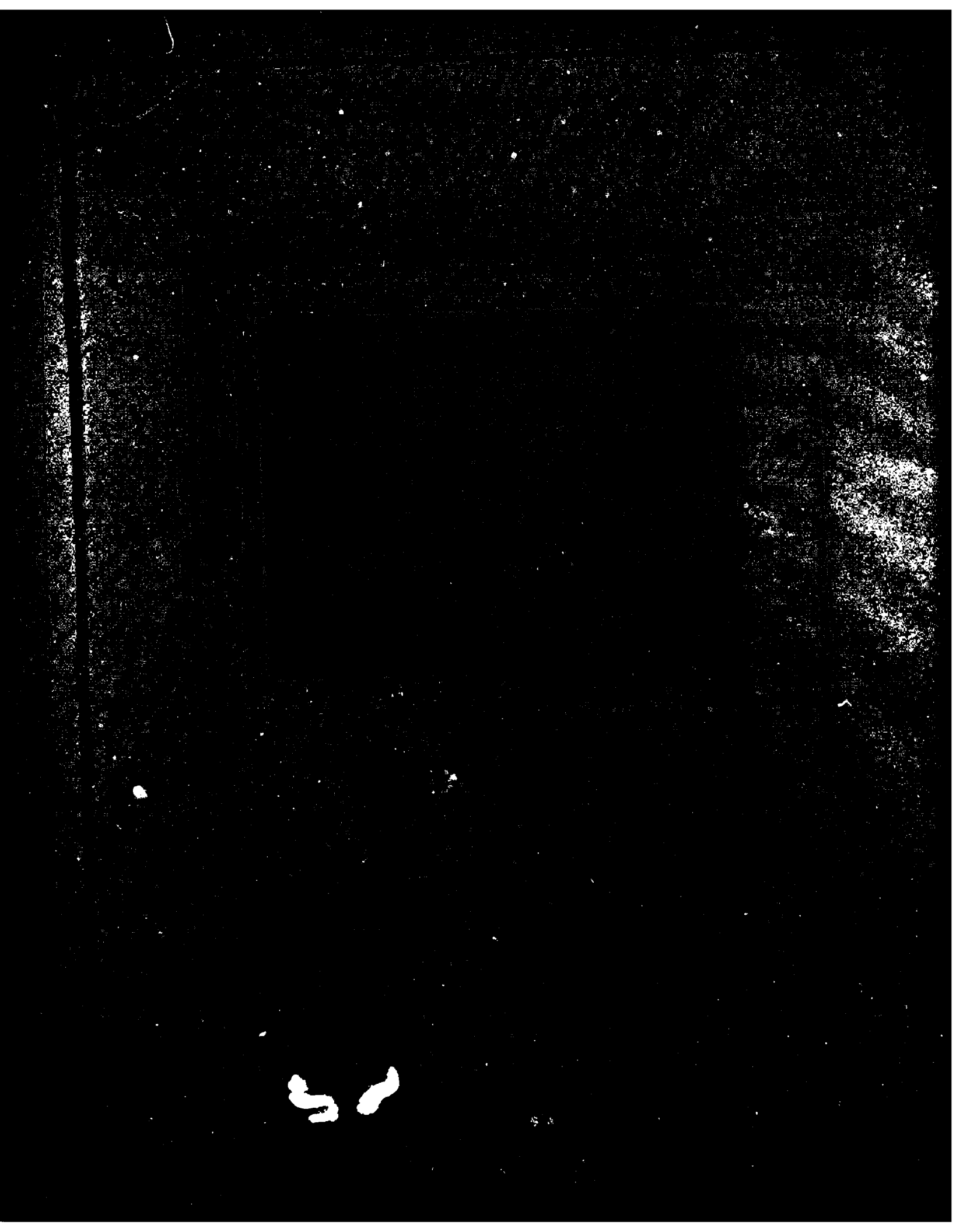
3. Full Scale Development. During full scale development, the missile system, including all items necessary for its support, is fully developed and engineered, fabricated and tested, and a decision is made whether the system is acceptable for production and deployment. The intended output is, as a minimum, a preproduction system that closely approximates the desired final product, the documentation necessary to enter the full scale or low rate production phase, planning and data required to field and support an integrated system, and test and reliability growth results which demonstrate achievement of the characteristics stated in the ROC. During this phase, emphasis is placed on reducing technical risks and establishing confidence that the system will function in the intended environment. At the completion of full scale development, a Milestone III review is held at both the ASARC and DSARC level to determine if the system is ready to enter the production and deployment phase.
  
4. Production and Deployment Phase. At the Milestone III review, a decision will have been made to type classify the missile system as "Standard" and proceed directly into full production or to type classify the system as "Limited Procurement" and undergo a Low Rate Initial Production (LRIP) period prior to full scale production. In either case, the full system is produced for the first time with production tooling. If the decision is made to enter LRIP due to technical or operational difficulties or risks, then a subsequent ASARC/DSARC milestone review is required prior to full scale production. Also during this phase, operational units are trained, equipment is distributed, logistical support is provided and product improvements are undertaken as appropriate.

#### 1.2 Definition of "Transition"

There is no universally accepted definition of what a transition from development to production encompasses. For the purposes of this guide, however, it is assumed that the transition includes the following key elements:

1. Satisfactory completion of full scale development.
2. Planning and engineering needed to establish a production base.
3. Department of the Army and Department of Defense approval to enter production.
4. Actual production start-up.

Using these key elements as a basis for defining the transition, it is easier to establish where the transition ends than to define its beginning. The transition ends when the missile system has entered production, has successfully passed First Article Tests and other production tests and is being routinely manufactured. In other words, the transition is complete when it has been successfully demonstrated that the system can indeed be manufactured



at the required rate and cost, while still maintaining the necessary technical performance. The beginning of the transition, however, is more difficult to pinpoint because some actions and decisions, such as acquisition strategy and funding thresholds, taken early in the acquisition process will have a major impact on the ability to successfully enter production. Thus in some respects the transition starts as early as the conceptual phase and intensifies as the system moves closer to production. This is illustrated in Figure 1-2, where the shaded area depicts the transition. Although it is difficult to precisely define where the transition begins, transition-related activities should be viewed as those actions and decisions that have a major impact on production entry.

A successful transition from development into production implies:

1. The missile system design meets the performance requirements specified in the Required Operational Capability and has successfully passed development, operational and production testing.
2. The system design has been adequately documented, controlled and verified through configuration audits.
3. The systems design is stable and reflects producibility considerations to facilitate manufacturing and achieve unit production cost targets.
4. The diverse resources and knowledge needed to manufacture the system have been adequately planned, implemented and integrated into a properly functioning production system.
5. The necessary logistics support, such as initial spares, field test and diagnostic equipment, training devices and simulators, and training and maintenance literature, are available and adequate to support deployment.
6. Proper control of the transition and sufficient time and funds to implement it.

In summary, the transition bridges the full scale development phase and the production/deployment phase of the acquisition process. It is a period characterized by intense activity as numerous engineering development tasks are completed, milestone reviews are prepared for and executed, and production is initiated. The smoothness of the transition is greatly affected by activities and decisions made early in the acquisition process. Few, if any, transitions from development to production take place as originally planned.

### 1.3 Problems in Achieving the Transition

The transition from development to production is difficult for most weapon systems due to the inherent characteristics of the systems acquisition process, with its limited resources, time pressures, milestone review procedures and regulatory constraints. The transition for new missile systems is particularly troublesome because they are complex items that are produced in relatively small quantities and frequently require unique production capabilities, highly skilled production workers and the use of non-standard materials and manufacturing processes.

From a product standpoint, some of the problems that have been encountered during the transition of new missile systems into production include:

1. High production unit costs - Occasionally the number of systems to be manufactured and delivered during a particular time period must be reduced from initial plans because of unanticipated growth in unit costs. There can be numerous reasons for this cost growth, such as unusually high inflation rates, incorrect learning curve rates, curve rates, changes in manufacturing techniques employed, design changes due to performance irregularities, unanticipated increases in material and component costs, lower productivity, etc.
2. Long leadtimes - On occasion, production and delivery schedules are missed due to the unavailability of some components and materials in the necessary timeframe. This has become an increasing problem for the DoD in the past decade and particularly impacts new systems entering production because they usually have to compete with ongoing demands for the same components or production capacity. Certain items, such as forgings, precision castings, specialty alloys, specialty fasteners and some high-reliability electronic components may have leadtimes that fluctuate from six months to two years depending on current demand. Further, it is difficult to forecast accurately what leadtimes will be experienced in the future. Although use of the DoD Priority Rating System to expedite purchases may help, it has not entirely eliminated the problem. Thus, production contracts predicated on optimistic estimates of these types of components and materials frequently encounter delays.
3. Poor quality - One of the major problems occasionally encountered during the first production contract is failure of new missile systems to pass quality acceptance tests. Sometimes this is due to poor quality assurance procedures on the part of the contractor, while in other instances it reflects the natural problems involved in adequately defining and controlling production processes and training production workers. If these problems become too severe, it can lead to the shutdown of the entire production line and will result in major slippage of delivery schedules.

4. **Lack of production capacity** - Occasionally, new missile systems cannot be manufactured in sufficient quantities due to inadequate production capacity. This typically occurs when production capacity is shared with other defense and commercial products; when inadequate capacity has been provided to incorporate total production requirements for the system, including spare parts for initial provisioning; when special purpose tooling and test equipment has not been designed to provide the necessary throughput; or when insufficient leadtime has been allotted for acquiring the necessary equipment and facilities. Usually these capacity problems only restrict the production volume of a few components or assemblies, but the end result is to limit the production and deployment of the entire system.
  
5. **Design changes** - As a missile system evolves during development, its baseline configuration continues to undergo changes in response to design refinements and correction of design deficiencies. Such changes, if they take place during the production contract (and some inevitably do occur), are expensive to incorporate and cause delays because they may entail scrapping and reordering of components and raw materials, redesign of production processes and tooling, and modification of systems and assemblies already produced. Therefore, the more stable the design, the easier the transition into production.

For a successful transition into production to take place, each of these pitfalls, and others, must be avoided while not breaching thresholds of cost, schedule, and performance. This can only be accomplished through a well planned and executed development program which adequately reflects the activities needed to ensure a smooth transition. It requires an integrated team effort between the Project Manager and his staff, the contractor, and the MICOM functional support elements.

#### 1.4 Managing the Transition

Although many difficulties may be encountered during production start-up for a new missile system, most of these can be traced to circumstances existing during the development phase of the system's life cycle. In fact, some aspects of the transition into production are affected as early as the conceptual phase of the acquisition process. Therefore, the Project Manager must have a good understanding of the factors and forces influencing the transition throughout development of the missile system.

First, it must be recognized that many aspects of the system's configuration, cost and production methods are locked-in early in the development program (see Figure 1-3). This comes about because firm commitments must be made to operational requirements during the conceptual phase which in turn limit design options for the system. As the system progresses through development, these constraints become even more rigid to the point where it is almost impossible to make major changes to engineering prototypes that have passed developmental and operational testing and qualification. There is little that can be done to prevent this natural "freezing" of the system configuration other than recognizing that it does happen and taking steps to pre-

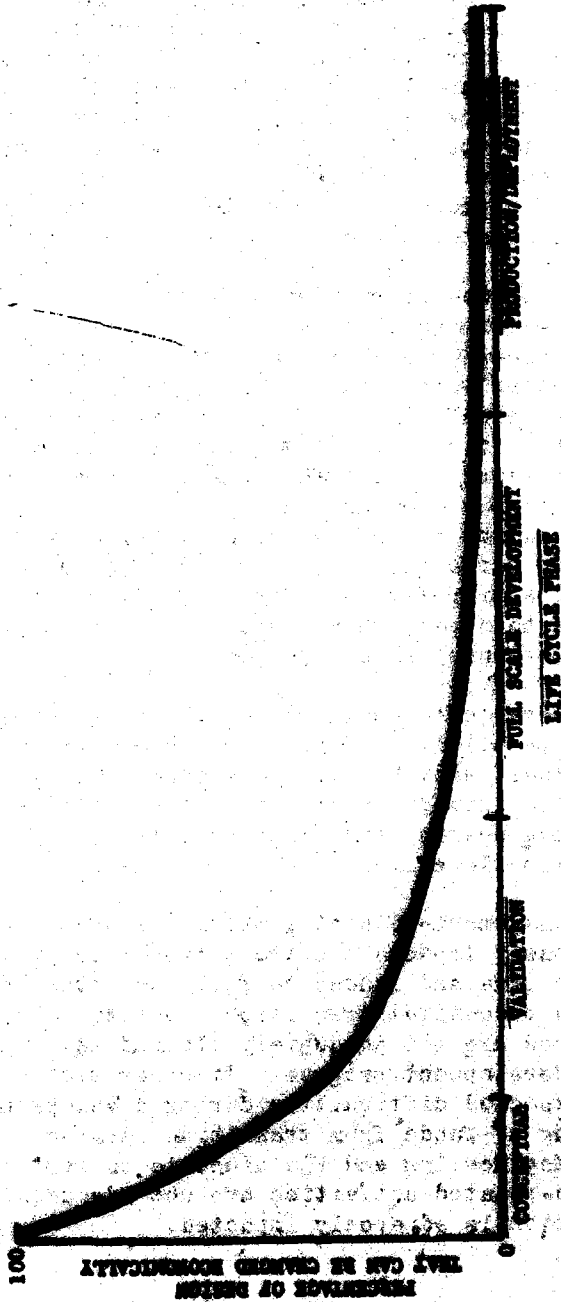


Figure 1-3. Relationship between life cycle phase and percentage of design "frozen".

vent unnecessary restrictions early in the development cycle. However, the fact that the design does begin to firm-up early in development does provide the Project Manager with the opportunity to identify and resolve transition-related risks prior to the first production contract.

Another "natural phenomenon" which tends to add to the problem of a successful transition into production is the relative importance that is placed on prototype technical performance during the development phase at the expense of other design features. In almost every design situation, trade-offs must be made between technical performance, producibility, reliability, maintainability, etc. However, during the development phase there is a tendency to "overdesign" the prototypes to insure adequate technical performance. This is because successful prototype performance must be achieved if the development program is to proceed on schedule. Thus producibility of the system design may be relegated a lesser priority than desirable during development.

The design trade-off problem between performance and producibility is sometimes made even more difficult because of the natural "gap" that exists between the engineering and production functions, both within the government and the contractors' organizations. Historically, engineering and manufacturing have been highly independent functions within most organizations and the cross-fertilization between the two has been minimal. Very few product development engineers are sufficiently familiar with manufacturing processes and equipment and how they are impacted by design parameters to adequately analyze the producibility of a design. Similarly, manufacturing engineers are not sufficiently versed in product design from a performance standpoint to be able to develop a properly functioning product. Because the new product must be designed for both performance and producibility, a team approach involving both types of personnel should be used.

It is preferable to undertake engineering development and production engineering in parallel in order to influence the producibility of the design before it "freezes" and to plan and execute the necessary activities for a smooth transition into production in a timely fashion. This is the reason Producibility Engineering and Planning is executed during engineering development of a new missile system.

Another management-related problem frequently encountered during development that adversely impacts the transition into production is lack of adequate resources (both time and funds) to fully undertake certain activities that contribute to a successful transition. Occasionally the problem materializes because resources are not adequately planned and budgeted during the early phases of the development program. At other times the shortfall comes about because of unexpected difficulties during development. This usually results in reprogramming of funds from transition-related efforts, such as Producibility Engineering and Planning, to correct the problems. Consequently some transition-related activities are not adequately funded or are delayed and the transition is adversely impacted.

Thus, it can be seen that there are numerous obstacles and counterproductive forces that, if not overcome, would severely impact the transition of a new missile system from development into production. These problems can be overcome, however, through the proper application of selected management techniques and tasks, as described in later chapters.

Based on lessons learned in transferring previous missiles from development to production, there are four key issues affecting the management of the transition:

1. Developing an effective acquisition strategy. The basic acquisition strategy for a new missile system is established during the conceptual phase. It should be tailored to the specific needs of the system and should take into consideration such factors as the desirability of competition during later phases of development and production, major activities and end-products during each stage of development, and overall management approaches to insure that transition-related problems are avoided.
2. Establishing realistic cost and schedule thresholds. History has shown that original estimates of development costs, schedules, production leadtimes, unit production costs, etc., have usually been too optimistic. Some of this optimism is justifiable in that it is impossible to foresee some of the problems that occur later in the development program. In other cases, however, overly optimistic cost estimates and schedules are due to unrealistic assessments of what must be accomplished to insure a smooth transition and the time required to complete these activities. Such unrealistic estimates almost always guarantee the system will experience transition-related difficulties.
3. Early identification and resolution of transition-related risks. Beginning in the conceptual phase and throughout development, transition-related risks should be identified and resolved. This includes production risks and costs. Although it is difficult to accurately identify transition-related risks early in the acquisition process due to the fluid nature of the system design, many of these risks can be pinpointed during the conceptual phase by conducting assessments utilizing experienced personnel from the NICOM functional support elements.
4. Adequate funding of transition-related activities. As mentioned previously, there is a tendency to underfund transition-related activities such as Producibility Engineering and Planning, or to use these funds to correct technical problems encountered during development. When this happens, the system will probably encounter production start-up problems and higher than anticipated production unit costs.

In summary, the transition from development to production for a new missile system is an important and complex task which begins early in the development process and ends when the system is routinely being manufactured in the necessary quantities and within the required cost limits. To effect a smooth transition in today's acquisition environment requires a well thought-out and adequately funded acquisition plan, along with close management attention on the part of the Project Manager and his staff to early identification and resolution of transition-related risks.

## 2.0 MAJOR PROGRAMS AND ACTIVITIES

### AFFECTING THE TRANSITION

This chapter provides the reader with an overview of major programs and activities that have a significant impact on the transition of a new missile system from development to production.

#### 2.1 Producibility Engineering and Planning

##### REFERENCES:

1. DoDD 5000.2, "Major Systems Acquisition"
2. DoDD 5000.34, "Defense Production Management"
3. AR 70-1, "Army Research, Development and Acquisition"
4. NICONR 70-33, "Production Engineering"

##### NICON FOCAL POINT:

Production Engineering Division, System Engineering Directorate  
(DRSNI-RSE)

Considerable engineering and planning effort is required during the development of a new missile system to prepare for production. Prototype designs must be reviewed from the standpoint of producibility and changed to reduce manufacturing costs and facilitate production; special test equipment and tooling must be designed and documented; production equipment requirements must be determined and plant layouts prepared; and a manufacturing plan must be developed for time-phased production start-up.

These activities are provided for by an RDT&E-funded Producibility Engineering and Planning (PEP) effort for the system which is executed parallel with full scale development. PEP may begin in either advanced development or engineering development and may overlap the first production contract, depending on the specific circumstances surrounding the system's development program. Conducting PEP during full scale development helps ensure that production risks are minimized and a smooth transition from development into production takes place.

The purpose of PEP is to ensure the reliable producibility of a new missile system prior to entering production. Specifically, the objectives of PEP are to:

1. Identify and resolve production risks.
2. Incorporate producibility considerations in the system's design and documentation.
3. Design and document special tooling and special inspection (SIE).
4. Provide the necessary forward-planning for production start-up.

Specific contractor efforts under PEP usually include:

1. Producibility analyses and trade-off studies for hardware designs and incorporation of changes to make the hardware more producible and less costly. The objectives of these analyses and trade-off studies are to:
  - a. Maximize: Simplicity of design; use of standard parts; number of potential suppliers and producers; process repeatability; product inspectability; interchangeability; and ease and speed of assembly.
  - b. Minimize: Manufacturing costs; leadtime; use of critical or limited data rights materials, parts and processes; special test equipment; special purpose tooling; adjustment or alignment at assembly; and special handling or safety precautions.
2. Development of a manufacturing plan, to include:
  - a. Make-or-buy analyses.
  - b. Leadtimes for all items, either procured or manufactured.
  - c. Production flow charts.
  - d. Plant layouts.
  - e. Manpower requirements.
  - f. SIE and special tooling required.
  - g. General purpose production equipment needs.
  - h. Capacity constraints.
  - i. Production control systems.

- j. Time and cost standards.
  - k. Time-phased plan for production start-up.
  - l. Production line training requirements.
  - m. Process specifications.
3. Preparation of manufacturing process data, including shop floor process sheets and methods standards.
  4. Establishment of a quality assurance program and procedures.
  5. Design and documentation of SIE and special gages, tooling, fixtures jigs, etc., and preparation of operating and calibration instructions.
  6. Design, documentation and validation of critical manufacturing processes.

The major activities involved in planning and executing a PEP effort include:

1. Determining scope and timing of PEP requirements. The scope, timing and resources required for PEP should be established during the conceptual phase of the acquisition process and refined as the system progresses through development. This should be accomplished as part of an overall production feasibility assessment during the conceptual phase which identifies production risks, producibility concerns, the need for new manufacturing technology, etc. When planning the PEP effort, consideration should be given to including a limited PEP program in the validation phase (advanced development) to assess the overall producibility of the system, identify candidate components and assemblies for intensive producibility studies during full scale development and determine long leadtime items for production start-up. The PEP effort during full scale development should begin as early as possible and overlap the Initial Production Facilities contract which provides the hard tooling and special test equipment needed for low rate production. There are no fixed rules on how large the PEP effort should be. The size and scope of the PEP effort must be tailored to the needs of the system being developed. Assistance in determining PEP requirements can be obtained from the Engineering Directorate's Production Engineering Division.
2. Inputs to Milestone reviews. DOD 3000.2, "Major Systems Acquisition," DOD 3000.3, "Defense Production Management," and AR 15-14, "Systems Acquisition Review Control Procedures," which require that production feasibility, production risks and plans of assuring the producibility of the system be considered at the milestone reviews for entry into the validation and full scale development phases. The scope, timing and funding levels for PEP should be included in the documentation for these reviews.

3. Preparation of the PEP Scope of Work. In addition to specifying the tasks required under the PEP effort, the scope of work should also require the contractor to document the proposed strategy for integrating manufacturing engineering with design engineering to accomplish producibility trade-offs and identification and resolution of production risks. Sample scopes of work for PEP programs, along with appropriate data item descriptions can be obtained from the Engineering Directorate's Production Engineering division.
4. Managing the PEP effort. The PEP program should be closely followed by one or more representatives of the Project Manager's staff to ensure that it stays properly focused and is successfully completed. Also, progress of the PEP effort should be an integral part of every major program review. Technical management and support for PEP is usually provided by the System Engineering Directorate's Production Engineering Division.

## 2.2 Initial Production Facilities

### REFERENCES:

1. AR 70-1, "Army Research, Development and Acquisition"
2. AR 700-90, "Army Industrial Preparedness Program"
3. NICONR 70-55, "Production Engineering"

### NICON FOCAL POINT:

Production Engineering Division, System Engineering Directorate  
(DESNI-RSE)

In order to initiate low rate production of a new missile system, a considerable amount of special tooling and special test equipment must be fabricated, verified and installed. This is provided for under a procurement-funded Initial Production Facilities (IPF) effort for the system. The design and supporting documentation for special tooling and special test equipment is an end product of the PEP effort for the system, therefore IPF is limited to translating those designs into a functioning production line. In limited cases, IPF may also provide production facilities if those facilities are of a special nature and are dedicated to supporting the new missile system. IPF does not provide general purpose production equipment; capital equipment of this type should be furnished by the contractor in accordance with appropriate Defense Acquisition Regulations.

It is the responsibility of the Project Manager to establish the scope, budget and timing of the IPF effort, as well as overall management of the effort while it is underway. The preliminary requirements for IPF should be established during the validation phase and refined during engineering development. Because leadtimes for special tooling and test equipment can be extremely long, special attention should be given to the time phasing of the IPF contract. Assistance concerning IPF efforts should be obtained from the System Engineering Directorate's Production Engineering Division.

### 2.3 Manufacturing Methods and Technology

#### REFERENCES:

1. DoDD 5000.2, "Major System Acquisitions"
2. DoDD 5000.34, "Defense Production Management"
3. DoD I 4200.15, "Manufacturing Technology Program"
4. AR 70-1, "Army Research, Development and Acquisition"
5. AR 700-90, "Army Industrial Preparedness Program"
6. NICOMR 70-32, "Manufacturing Technology"

#### NICOM FOCAL POINT:

Manufacturing Technology Division, System Engineering Directorate  
(DRSNI-RST)

The availability of appropriate manufacturing processes and equipment plays an important role in the transition of a new missile system from development into production. Such processes and equipment have a major impact on the missile system's cost, quality and performance. Because most new missile systems represent an advancement in the state-of-the-art, they frequently require the development of new manufacturing methods.

New and unproven manufacturing technology represents a major production risk for missile system developments predicated on such technology. What may appear to be a promising manufacturing process may turn out to be impractical due to technical difficulties, high costs, low yields, etc. Further, it frequently takes several years to develop a new manufacturing technology fully in the missile system development process so that these risks can be reduced to acceptable levels.

New manufacturing methods are developed in several ways:

1. Contractor's independent research and development programs.
2. 6.1, 6.2 and 6.3a R&D programs, particularly in materials research and manufacturing technology development.
3. As part of Producibility Engineering and Planning efforts for a specific missile system.
4. If generic (i.e., the technology is applicable to more than one weapon system), under the procurement funded Manufacturing Methods and Technology (MMAT) program.

Because most new manufacturing technology is developed under the MMAT program and PEP, which is discussed elsewhere, the remainder of this section will focus primarily on MMAT.

MMAT projects provide the engineering effort and prototype hardware required to investigate, evaluate and adapt new manufacturing and inspection methods, processes, techniques, tooling and equipment which will enhance materiel reliability, accelerate production, reduce cost and facilitate economic quantity production of missile system components and assemblies. Specifically, the objectives of an MMAT project will include one or more of the following:

1. Reduce production costs
2. Assure end item producibility
3. Assure economic availability
4. Reduce production leadtimes
5. Conserve energy and scarce resources
6. Increase productivity
7. Improve process and product reliability
8. Eliminate or reduce production safety hazards

MMAT projects are procurement funded rather than RDT&E funded, and must meet several criteria. First, the project must address a need for new or improved manufacturing technology; MMAT projects do not provide for the application of existing technology to a specific system. Secondly, the laboratory feasibility of the technology must be demonstrated prior to initiation of the

project. This feasibility demonstration can come from such sources as 6.1, 6.2 and 6.3a R&D programs, industry research etc. Thirdly, the results of the MM&T project must be applicable to more than one missile system. And lastly, the projects must be structured to provide for implementation of the results and have specific implementation targets.

Since 1965, NICOM has initiated more than 100 projects under its MM&T program. These projects span the entire range of manufacturing technology areas, including:

1. Metals
2. Plastics, composites and ceramics
3. Propellants
4. Electronics
5. Test and inspection
6. Computer aided manufacturing

Although each project will vary according to its specific needs, the projects generally provide for:

1. Process and equipment design
2. Fabrication of prototype production equipment
3. Pilot line production of hardware to refine process parameters
4. Process analysis, including technical and cost data
5. Preparation of draft standards and specifications for the process
6. Preparation of an implementation plan
7. A final report
8. An end-of-contract industry demonstration
9. Follow-up implementation surveys

MM&T projects are managed by the Manufacturing Technology Division of the Engineering Directorate, in conjunction with a project engineer in the laboratories or a Project Manager's office. The project engineer is responsible for preparation of a P-16 (the document used to justify and secure funding), preparation of the technical portion of the RFP, participating in some selection for the contract, monitoring the progress of the project's execution, preparation of status reports, and informing appropriate PM's of project results.

Each PM, however, is responsible for the early identification of manufacturing technology requirements and undertaking the necessary actions to insure that this technology is available when the system enters production.

The major activities in initiating and executing M&I projects are discussed below.

1. Identify manufacturing technology needs. Early in the system development process, an analysis should be made to determine what, if any, new manufacturing and inspection technology will be required to manufacture the alternative system design concepts. This analysis should take into consideration the inherent design characteristics and production rates of the system that will dictate manufacturing methods and the current state-of-the-art in these areas. Major cost reduction opportunities that could result from the development and application of new manufacturing technology should also be identified. How the PM plans to develop this technology should also be resolved.
2. Inputs to ASARC/DSARC reviews. Manufacturing technology needs and how they will be satisfied should be addressed in each of the program Milestone reviews.
3. Prepare P-16's for M&I projects. That technology which the PM proposed to develop under the M&I program must be documented by a P-16, as described in AR 700-90, "Army Industrial Preparedness Program." The P-16 is used to plan the project and justify funding. Major elements of the P-16 include:
  - a. A description of the manufacturing technology need and proposed solution.
  - b. Work to be completed under the project.
  - c. Benefits to be achieved
  - d. Systems supported
  - e. Cost estimates
  - f. Project end items
  - g. Related efforts
  - h. How the results will be implemented

The P-16 should be completed as early as possible but not later than ASARC II to allow adequate time for project funding and execution.

4. Conduct NM&T projects. Following funding approval, the NM&T projects are normally executed during full scale development so that the technology is available when the system enters production. This activity entails the normal tasks in executing a project: preparation of an RFP; source selection and contract negotiation; and contract monitoring. Execution of the NM&T project should be closely monitored by the PM to insure that acceptable results are provided in a time frame required for the system's development.

#### 2.4 Production Readiness Reviews

##### REFERENCES:

1. DoDD 5000.1, "Major System Acquisitions"
2. DoDD 5000.2, "Major System Acquisition Process"
3. DoDD 5000.34, "Defense Production Management"
4. DoDD 5000.38, "Production Readiness Reviews"
5. AR 15-14, "Systems Acquisition Review Council Procedures"
6. AR 70-67, "Production Readiness Reviews"
7. NICOMR 70-33, "Production Engineering"

##### NICOM FOCAL POINT:

Production Engineering Division, System Engineering Directorate  
(DRSMI-RSE)

Army missile systems subject to DSARC review at Milestone III (production decision) must undergo an independent OSD assessment of production readiness. This independent assessment is conducted by the DoD Product Engineering Services Office (PESO). Prior to the PESO assessment of the system's production readiness, the PM must execute a Production Readiness Review (PRR), which is a formal, documented, systematic examination of a system undergoing full scale development to determine if the system design is ready for production and if adequate planning has been accomplished for the production phase. An initial Production Readiness Review (IPRR) must also be undertaken by the PM early in the engineering development program to assess the production readiness of the system design and identify potential production and logistics problems. Non-major systems do not require an IPRR.

The primary purpose of a PRR is to identify and quantify risks in transitioning a new missile system from development to production. Such risks must be at an acceptable level to include not breaching thresholds of cost, schedules and technical performance before the production go-ahead can be given.

The purpose and objectives of an IPRR are similar to those of a PRR except that an IPRR is conducted early in the full scale development program or, on occasion, during advanced development (validation phase). An IPRR is used to surface production readiness problems that require resolution during engineering development.

Each major Army system development must have completed an IPRR 12 months prior to ASARC III and a PRR 2 months prior to ASARC III; however, the specific scope, timing and level of effort for these reviews is somewhat at the discretion of the PM and will depend on the unique circumstances surrounding the system's development program. For example, missile systems which are being developed by a prime contractor and several major subcontractors would require incrementally executed IPRR's and PRR's for each major subsystem and the prime contractor's integration efforts. Similarly, IPRR's for missile systems in advanced development (which may be the case when competitive developments are being pursued) would not be as extensive as those conducted during engineering development and would not focus as heavily on the adequacy of a contractor's production planning efforts at this stage of development. Thus each system's IPRR's and PRR's should be planned, budgeted and executed by the PM in accordance with the system's specific requirements.

In general, the following factors are investigated during a PRR:

1. Product Design

a. The design is low risk from the standpoint of producibility.

b. Design change activity has stabilized at a low level.

(1) Validation demonstration of the design has been accomplished, including qualification of subsystems and components as appropriate and the demonstration of performance and R&M characteristics.

(2) Incomplete portions of the design are identified and do not introduce significant risks to production.

(3) A system configuration audit has been accomplished and discrepancies resolved.

(4) The design is in consonance with the operational, maintenance, and support concepts, including meeting foreign interoperability requirements.

c. The technical data package will permit competitive acquisition and domestic and foreign co-production where appropriate.

d. Standardization has been accomplished in the design to facilitate production economies derived from the use of standard components, parts, materials, and processes.

- e. Critical and scarce materials are used only where dictated by required performance and such use is compatible with established DoD priorities and allocations.
- f. Alternates for critical materials or processes are identified in the design.
- g. Production cost projections have been made and are well supported.

## 2. Industrial resources

### a. Plant Facilities, Production Equipment, Test Equipment and Tooling.

- (1) Plant capacity is adequate for the required production rate taking into consideration other production efforts.
- (2) Consideration has been given to meet surge (peacetime) and mobilisation (declared emergency) production requirements. A commitment to participate in the DoD industrial preparedness planning program has been made.
- (3) Contractor and government-owned facilities, production equipment, special tooling, and special test equipment have been identified in terms of specifications, quality and finances. Acquisition and installation plans meet program requirements.
- (4) Needed plant modernization and productivity enhancements have been accomplished, including advantageous employment of CAD/CAM and other automated techniques. Associated computer software has been developed.

### b. Personnel

- (1) Skilled production manpower is available.
- (2) Necessary personnel training and certification are programmed.
- (3) No major labor relations problems are foreseen.

## 3. Production Engineering

- a. A comprehensive production plan has been developed.
- b. Production schedules are compatible with end item delivery requirements.

- c. The nature and sequence of manufacturing methods and processes, together with associated facilities, equipment, tooling, and plant layout, represent economical applications of proven technology consistent with:
  - (1) Product specification and quality requirements.
  - (2) Quantity and rate requirements.
  - (3) OSHA, environmental, and energy conservation requirements.
- d. There is demonstrated aggressiveness in applying value engineering and in seeking cost reduction improvements.
- e. Alternative production approaches are available to meet contingency needs.
- f. Drawings, standard and shop instructions are sufficiently explicit for correct interpretation by manufacturing personnel.
- g. Configuration management is adequate to assure configuration identification, control and status accounting during production.
- h. Provisions have been made for determining producibility and cost impacts of engineering changes introduced during production.
- i. A program manager has been assigned the authority and responsibility for manufacture and delivery of the system and the functional elements and staff of this manager's organization have been identified. Policies and procedures have been documented.
- j. A management information system exists which provides the status of production and sufficient visibility of problems to enable responsive managerial actions.

#### 4. Materials and Purchased Parts

- a. A complete and accurate bill of materials has been prepared.
- b. "Make-or-buy" determinations have been made for all significant or critical elements of the system and are supported by sound justifications.
- c. Long lead time materials have been identified and action initiated for advance procurement.
- d. Sole source items are identified and continuity of supply is assured.
- e. Government Furnished Material or Equipment (GFM/GFE) is identified and fully integrated with program and production plans, including associated lead time and schedule requirements.

- f. The contractor's material control/inventory system is adequate.
- g. The contractor's material procurement plan provides:
  - (1) Effective procedures to determine material needs, leadtimes, and delivery schedules.
  - (2) Criteria for selection of subcontractors and suppliers which emphasize timely delivery of acceptable material in sufficient quantities at a reasonable cost.
  - (3) Multi-sourcing of critical items to the extent practicable.
  - (4) Economic lot size orders.
  - (5) Visibility and control of vendors and subcontractors.

5. Quality Assurance

- a. The Quality Assurance function is organizationally placed and structured to permit independent and objective judgments.
- b. The contractor's quality program is in accordance with the contract requirements and the quality plan is appropriate for the production program.
- c. Necessary quality control procedures and quality acceptance criteria have been established.
- d. The Quality Assurance organization is a participant in the production planning and facilitation effort.

6. Logistics

- a. An integrated logistics support plan exists which identifies support requirements, schedules and critical support milestones which support the planned IOC.
- b. Production capacity exists to manufacture initial spares, including contingencies for high usage items during initial deployment.
- c. Operational support, test and diagnostic equipment have been developed and their state of production readiness will meet the system deployment schedule.
- d. Training aids, simulators, and other devices for operator and maintenance personnel have been developed and can be produced to support the system deployment schedule.

## 7. Contract Administration

- a. Adequate government representation (numbers, capabilities, and functional responsibilities) will be provided at the major production sites.
- b. Appropriate liaison exists between the DoD component Program Manager's Office, the on-site Government representation, and the contractor's production organization.
- c. Effective Government procedures have been established for timely processing of change proposals and issuance of change orders.

Major activities pertaining to the planning and execution of IPRR's and PRR's are briefly described in the following paragraphs.

1. Determine IPRR and PRR requirements for initial project planning and budgeting. Initial planning for development programs for major systems should reflect requirements for IPRR's and PRR's. This helps insure that adequate development funds are available to execute the reviews and demonstrates to DARCOM, DA and OSD the soundness of the development plans as they pertain to the transition from development into production.
2. Inputs to ASARC/DSARC reviews. Plans for conducting IPRR's and PRR's should be reflected in the documentation for the Milestone I and Milestone II program reviews.
3. Prepare IPRR and PRR inputs to engineering development RFP. Contractor support is required to execute the IPRR's and PRR's. Although these reviews rely primarily on data that has been generated for other purposes during the development program, they do require the contractor(s) to provide this data to the review teams and interface with the teams while they are on site. Thus, the engineering development RFP should reflect this requirement for support during the IPRR's and PRR's.
4. Negotiate contractor and other agency support for IPRR's and PRR's. In addition to negotiating contractor support as part of the engineering development contract, the Project Manager should also arrange for the necessary support from other government agencies, such as DCAS or other on-site government representatives or participation by other government organizations, as appropriate.
5. Prepare detailed IPRR plan. The IPRR plan should include identification of a chairperson; definition of the team organizational structure and personnel requirements; and establishment of the scope, depth, criteria, procedures and schedule to be followed during the review. The chairperson is a senior Army officer or civilian equivalent selected by the Project Manager and will determine team membership, organize and manage the team's efforts and supervise preparation of the findings. The team will consist of persons having

industrial and production training and experience and will include representatives from all areas affecting the development/production decision, such as production engineering, configuration management, and quality assurance.

6. Conduct IPER. After finalizing arrangements with the contractor(s) and other government agencies, the IPER is conducted on site and takes approximately one week to complete. Prior to this on site review, the IPER team will have met at least once and will have reviewed the necessary background documents. The contractor(s) will also have been notified of the types of data required to support the review prior to the visit. During the review, the team will evaluate the areas described previously and identify those issues which require resolution during the remainder of the engineering development program. The IPER is to be complete at least 12 months prior to ASARC III.
7. Prepare IPER report. The IPER report will consist of objective conclusions based on the review findings. This assessment will identify potential problem areas which could cause production, cost, quality, logistics or schedule risks. Each risk will be expressed in terms of its relative magnitude and potential effects.
8. Prepare detailed PRR plan. This plan is similar to the plan prepared for the IPER and described in activity 5, above. It differs in that it should include participation by individuals from DoD PRSO as observers, thus preparation of the plan should be coordinated with that organization. The PRR plan must also be submitted to the DARCOM Office of Manufacturing Technology at least one month prior to conducting the review.
9. Conduct PRR. The PRR is conducted in essentially the same manner as the IPER described in activity 6, above, but in more detail. The review also requires about one week on site at the prime contractor's facility, although shorter times may be used for on site review of subcontractors. The PRR must be completed two months prior to ASARC III.
10. Submit preliminary PRR report to ASARC. A preliminary report on the PRR findings must be submitted to the ASARC members 6 weeks prior to ASARC III.
11. Review and distribute PRR final report. The PRR final report will address the same issues as described in activity 7 for the IPER report. The PRR report will also contain a summary statement concerning the production readiness of the missile system. The final report will be distributed to the ASARC and DARCOM members prior to ASARC/DOAC III.
12. Inserts for ASARC/DOAC III. The results of the PRR are to be summarized in the documentation for ASARC/DOAC III.

## 2.5 Configuration Management

### REFERENCES:

1. AR 70-57, "Configuration Management"
2. DoD STD 480, "Configuration Control - Engineering Changes, Deviations and Waivers."
3. MIL STD 490, "Specification Practices"
4. MIL-S-83490, "Specification, Types and Forms"

### NICOM FOCAL POINT:

Engineering Standards and Data Systems Division, Systems Engineering Directorate (DESWI-RSD)

Configuration Management provides for the identification, documentation, control and audit of functional and physical characteristics of the missile systems and their component parts. It is a key element in the transition from development to production because the Technical Data Package (TDP) represents the major end product resulting from the full scale development program and dictates the configuration of the hardware that will be manufactured during the production phase.

Configuration Management is a well developed and documented discipline, and a comprehensive discussion of the subject is beyond the scope of this guide. Therefore, only those Configuration Management issues that have a direct bearing on the transition will be discussed here. Readers desiring additional information on the subject should consult the references at the end of this section or contact the Engineering Directorate's Engineering Standards and Data Systems Division, which is the NICOM focal point for Configuration Management.

Key transition-related configuration management issues include determining when the government should take over formal control of the technical data package and configuration audits.

Generally, the detailed product baseline is established early in full scale development. As the design evolves, changes to the product baseline are controlled by a Configuration Control Board, but the government does not take formal control of the TDP until either late in full scale development or early in production. Traditionally, NICOM Project Managers take over the control rather than the latter, and in turn have used the TDP as the basis for the first production contract. This places the burden of custody of the TDP on NICOM because it is formally theirs. Thus any subsequent design changes during initial production must be done through modifications to the production contract. Some people now feel that NICOM should not have formal control of

the TDP until after low rate production because of the design changes that inevitably take place. Although the government would still have to pay for the design changes, this would expedite the turnaround time for approving changes and reduce costs because of elimination of the need to modify the production contract. Therefore, when preparing the Configuration Management strategy and plan for a new missile system, the Project Manager should weigh the advantages and disadvantages of when the government should take control of the TDP before making a final decision.

Configuration audits are also important transition-related events. The three major configuration audits are:

1. Functional Configuration Audit (FCA). This audit is a means of validating that development of a configuration item has been completed satisfactorily. The purpose of the FCA is to assure that the hardware has achieved the performance specified in its allocated baseline documentation, as demonstrated through adequate test data.
2. Physical Configuration Audit (PCA). Prior to government acceptance of the TDP, a PCA is held. During this audit the TDP is checked against the last developmental prototype for completeness and accuracy. The purpose of the PCA is to insure that the "as built" configuration matches the TDP and that the acceptance testing requirements prescribed by the documentation adequate for acceptance of production units by the government. The PCA is conducted by a special team appointed command letter orders.
3. Configuration Item Verification Review (CIVR). The CIVR is a technical audit performed on one of the first production items to validate that the hardware produced conforms to the TDP, including approved changes at the time of the audit.

In summary, Configuration Management plays an important role in the transition from development to production by providing a TDP that accurately reflects the system design and quality assurance procedures and a means of controlling changes to the TDP.

## 2.6 Standardization

### REFERENCES:

1. DoD 4120-3, "Development Standard Programs"
2. AR 100-47, "Defense Standardization Program"

**NICOM FOCAL POINT:**

**Engineering Data and Standards Division, Systems Engineering Directorate (NSMI-RSD):**

The objectives of standardization are to reduce acquisition costs through the adoption of standard criteria, procedures and components. The use of standardized components, for example, generally reduces or eliminates component development costs, increases the number of suppliers and decreases unit costs.

During full scale development the contractor should be required to pursue a vigorous standardization program for the missile system, particularly in terms of component parts, material standards and processing and inspection procedures. However, it should be emphasized that the application of standards should be done on a cost effective basis. In some cases standards are applied that actually exceed the requirements for the system and thereby increase acquisition costs. Thus the development contractor should be encouraged to strike an optimum balance between over- and under- utilization of standards.

The full scale development contract should contain provisions for a standardization program for the missile system. The contractor's effectiveness in using standards is verified during the engineering development as part of: the initial review of technical drawings and specifications; the Producibility Engineering and Planning effort; the Functional and Physical Configuration Audits; and the Production Readiness Review.

**2.7 Quality Assurance/Engineering**

**REFERENCES:**

1. DoDD 4155.1, "Quality Assurance"
2. AR 702-4, "Procurement Quality Assurance"

**NICOM FOCAL POINT:**

**Product Assurance Directorate**

Quality Assurance (QA) encompasses that function of management which ensures that material conforms to the stated quality, performance, safety and reliability standards of the FDP. Quality Engineering includes functions to establish QA standards, design of inspection and test equipment necessary to determine product acceptance, and to insure least cost conformance to user requirements.

The following activities, which were previously discussed, should be undertaken during full scale development:

1. Establish QA requirements for inclusion in the TDP.
2. Develop a QA plan for inspection of the system and its components during initial production, including "fly-to-buy" criteria if appropriate.
3. Design and document special gauges and SIE.

The success in transitioning a missile system from development to production is highly dependent on the quality provisions of the TDP as it emerges from the development process. It is during the design process that consideration must be given to such key production-influencing factors as inspectability, testability, component qualification requirements, critical process controls and the nature of test equipment employed. If these issues are not adequately considered during development, then problems are inevitable when the system enters production.

A recently developed technique to insure that quality aspects have been adequately incorporated into the TDP and production planning is the Quality Readiness Review (QRR). The QRR is a formal, independent assessment of the quality assurance provisions and acceptance test procedures which is conducted to verify that:

1. The design is adequately characterized in the TDP.
2. Acceptance criteria relate to design and performance.
3. Quality assurance tests demonstrate system performance and reliability.

The QRR is conducted late in the full scale development phase and is aimed at minimizing quality assurance problems during the transition from development to production. In the future, it is anticipated that QRR's will be conducted in parallel with Production Readiness Reviews.

The PM must determine who will be tasked to conduct the review (e.g., Product Assurance personnel or the contractor), what the review should accomplish, who will participate in the review and the necessary milestones to control the effort. Specific issues to be addressed during the review must be tailored to the unique requirements of the missile system being assessed.

For each key to be included in the review, the following questions are typically included in the assessment:

1. What are the quality assurance provisions and test/inspection requirements for each area?
2. Do these provisions and requirements relate to the item's performance characteristics?

3. How are these requirements implemented?
4. Are these requirements properly defined and cost effective?
5. Were development problems associated with production properly addressed and eliminated?
6. Are defect classifications properly categorized (critical, major, minor)?
7. Are sampling plans adequate to achieve the desired level of quality?
8. What types of inspections are required for the defects?
9. Are proper examples, standards and calibration available for these inspections.
10. What special inspection equipment is required?
11. Is this equipment properly designed for its intended role?
12. What are the in-process controls used and planned for production?
13. Are the tolerances of the components consistent with the tolerances of the end item?
14. Is the TDP adequate to maintain consistent quality from manufacturer to manufacturer?
15. Is the end item meeting the performance characteristics originally established?

Following completion of the QRR, a final report is prepared listing all findings and recommendations made by the assessment team for subsequent corrective action.

## 2.8 Design to Cost

### REFERENCES:

1. AR 70-1, "Army Research, Development and Acquisition."
2. DARCON-P 700-6, "Design to Cost."

### NICOM FOCAL POINT:

Cost and Estimating Analysis Division, Comptroller

The major objective of the design to cost concept is to obtain a required operational capability within funding constraints, within the time frame required, and within approved operational and maintenance cost thresholds.

Design to cost is a management concept wherein unit cost goals (production, operational and maintenance) are established early in the development phase of the material requisition process to guide hardware design and control program cost.

The design to Unit Production Cost (DTUPC) goal is the unit cost goal to be achieved in the production phase of the life cycle and is based upon the existing best estimate of quantity, production rate, time frame, and, when available, cost/quantity relationships (learning curves). The DTUPC goal set forth in the development contracts should be difficult but achievable. The DTUPC goal represents the recurring hardware unit costs not including the costs of government furnish equipment.

The major thrust of the DTUPC effort is to develop a design that can be produced for a pre-established, affordable cost. To meet this objective, trade-offs must ensure the lowest cost while achieving the design effort that the proposed end item can be produced at the agreed to schedule (quantity and rate) at the stated unit production cost goal, while meeting minimum essential performance requirements. The DTUPC elements of cost will be structured so that DTUPC values can be clearly tracked into actual production cost proposals from the contractor. An active Producibility Engineering and Planning program can assist a contractor in meeting its DTUPC goals through improving the producibility of the system.

## 2.9 Value Engineering

### REFERENCES:

1. DA PAM 5-4-5, "Value Engineering Handbook"
2. DARCOM R 70-8, "Value Engineering Program"

### NICOM FOCAL POINT:

Value Engineering Office, Systems Engineering Directorate (DRSNI-RSV)

Value Engineering (VE) is an organized effort directed at analyzing the functions of defense systems, equipment, installation, operation, etc., for the purpose of achieving the required function at the lowest total cost of effective ownership, consistent with requirements for performance, reliability, quality and maintainability. VE has proven to be an effective means of reducing acquisition costs, particularly if applied early in the life cycle of the system.

Savings resulting from contractor-proposed VE changes are generally shared with the contractor as provided for in the contractual clauses. Since the advent of design to cost, however, VE provisions are only selectively applied to development contracts because under the design to cost provisions, the contractor is already being compensated for cost reduction efforts.

The key transition-related activity concerned with VE is to insure that the first production contract incorporates appropriate VE incentive clauses.

## 2.10 Integrated Logistics Support

### REFERENCES:

1. DoDD 4100.54, "Development of Integrated Logistical Supply for Systems and Equipment"
2. AR 700-127, "Integrated Logistics Support"
3. TM 38-703 Series, "Integrated Logistics Support"
4. DoDD 5000.59, "Acquisition and Management of Integrated Logistics Support for Systems and Equipment"

### NICOM FOCAL POINT:

ILS Office

Integrated Logistics Support (ILS) planning is performed within the Army to establish support and maintenance objectives for systems and equipment over their life cycle. The ILS process is integrated concurrently with the system's development process. The lack of timely and systematic support planning can adversely affect operational availability and total life cycle costs.

Major elements of ILS planning during development include:

1. A maintenance plan.
2. Support and test equipment.
3. Facilities required for operation and support of the system.
4. User training, including procedures and equipment.
5. Technical data such as operating instructions and maintenance manuals.
6. Personnel planning.
7. Supply support including acquiring, cataloging, packaging, preserving, storing, issuing and disposing of spare parts.
8. Transportation and handling including procedures, equipment and facilities.
9. Logistic support funding.

A comprehensive discussion of ILS planning during development is beyond the scope of this guide. However, from a transition to production standpoint, the following key issues should be considered:

1. Does production capacity exist to manufacture initial spares?
2. Is the state of development and acquisition of support equipment and test equipment sufficient to meet the system deployment schedule?
3. Can training devices be produced to support the deployment schedule?
4. Are contract technical logistic support data and requirements available to insure concurrent delivery of system support and hardware elements?
5. Are the "out years" logistic support requirements identified, planned for, and budgeted?

#### 2.11 Other Concepts

Over the years other concepts and techniques have been employed in an attempt to improve the transition from development to production. These concepts and techniques are briefly discussed below.

1. Production Line Verification. In the early 1970's, the DRAGON Project Office employed a technique known as Production Line Verification (PLV) to help insure smooth production start-ups. The objective of the PLV was to identify and resolve potential production problems by auditing production lines to determine if there was consistency between the TDP, the contractor's internal manufacturing documentation and the work being performed on the shop floor. Both the prime contractor and major second tier vendors underwent PLV's. It is believed that this type of audit helped eliminate production start-up problems and resulted in a high reliability of initial production units.
2. Use of "watch dog" contractors. Several recent missile system developments have employed the services of a contractor to assist the Project Manager in system evaluation and cost reduction. Such contractors are prohibited from participating in follow-on hardware procurements for the system. Their role is to provide an unbiased second opinion on alternative system design concepts and cost reduction opportunities. It is difficult to evaluate the cost effectiveness of employing such contractors due to the inability to trace the time origins of cost reduction ideas.
3. "Design maturation" programs. One missile system currently in full scale development, MLRS, has foregone the traditional engineering development approach in favor of a "design maturation" effort. The "maturation" phase consists of finalizing the system design, qualification testing, and preparation of the TDP. Concurrent with initiation of low rate production, the initial production facilities

effort is undertaken to design and fabricate high rate tooling. The use of this concurrent "maturation" approach considerably reduces the development costs and time required to achieve the Initial Operating Capability data. The key to undertaking such an approach was the high level of achievement during the validation phase (advanced development) and the low risk of concurrently committing procurement funds for IPF and low rate production. Since this system is still in development, it is too soon to judge the effectiveness of this approach.

In summary, it can be seen that there are numerous concepts and techniques that affect the transition of new missile systems from development to production. Each of these concepts and techniques should be tailored to the specific circumstances at hand, and the latitude exists for innovation of new approaches.

### **3.0 TRANSITION-RELATED ACTIVITIES DURING**

#### **THE CONCEPTUAL PHASE**

The conceptual phase is the first phase in the life cycle of a new missile system. Threat projections, technological forecasts, and joint Service and Army plans are examined to determine operational capabilities, doctrine, organization, and potential materiel systems that will improve Army forces. The technical, military and economic bases for proposed systems are established and concept formulation initiated through pertinent studies and the development and evaluation of experimental hardware. Critical issues and logistical support problems are identified for investigation and resolution in subsequent phases to minimize future development risks.

The conceptual phase is a highly interactive process with activities performed simultaneously and/or sequentially. How long a system remains in the conceptual phase depends on the characteristics and status of the operational and technical factors making up the proposed program, the urgency of meeting the perceived operational threat or environment, and resource constraints.

Initiation of the conceptual phase is dependent upon DoD approval of a Mission Element Need Statement (MENS), which defines the operational task to be accomplished by the new system. Alternative systems concepts are then explored under the aegis of a Special Task Force or Special Study Group. Additional tasks during the conceptual phase include: preparation of an initial cost and operational effectiveness analysis; preparation of a Letter of Agreement requirement document; and preparation of an outline acquisition plan. Also, a Decision Coordinating Paper and Integrated Program Summary are proposed for DA and DoD milestone reviews.

At the completion of the conceptual phase, the following items are considered at the Milestone I review for entry into the validation phase (see AR 15-14, "Systems Acquisition Review Council Procedures"):

1. **Need:** The mission element task is reaffirmed to be essential.
2. **Threat:** The threat is credible, addresses the correct time frame, and has been validated.
3. **Systems Alternatives:**
  - a. Satisfy the mission element need.
  - b. Adequately reflect the technology base.
  - c. Provide an acceptable competitive environment
  - d. Consider existing military equipment, use of available subsystems, product improvement of existing systems, foreign and other services' systems.

- e. Provide for service and NATO standardisation and interoperability.
- f. Insure that joint service, interoperability, and multinational considerations are adequately treated in planning.
- g. Includes environmental considerations.
- h. Insure that cost and operational effectiveness analysis supports the systems selected for validation.

4. Operational Factors:

- a. Cost/performance tradeoffs.
- b. Electromagnetic compatibility
- c. Vulnerability
- d. Minimum operating personnel

5. Logistical Factors:

- a. Minimum operating and support costs.
- b. Minimum maintenance and support personnel.

6. Acquisition Strategy:

- a. Insure that it is complete, effectively integrates the program technical, business and management elements and supports the achievement of program goals and objectives.
- b. Short- and long-term business planning effectively supports the acquisition strategy.
- c. Producibility and production risk considered.
- d. Competition maximised
- e. Contractor structure and types of contracts.

7. Constraints:

- a. Established program constraints are still valid.
- b. Projected characteristics, including projected resource investment, consistent with established constraints.

8. Risk: Areas of risk and uncertainty identified and adequately treated in planning.

9. Testing:

- a. Issues to be addressed
- b. Adequacy of planning and scheduling for preparation of the Coordinated Test Program.

10. Program Management Structure

A comprehensive discussion of all the activities undertaken during the conceptual phase is beyond the scope of this guide; however, several key issues will be presented that have an impact later on the transition from development to production.

### 3.1 Production Feasibility Assessment

During the conceptual phase, numerous alternative system concepts that could potentially satisfy the mission element need are explored. The most promising alternatives should also be evaluated in terms of their production feasibility. Although detailed designs are not available at this stage of development, the design concepts can be assessed in terms of:

1. Use of scarce or critical materials.
2. Available production capacity in the time frame proposed for the system and the need for new facilities.
3. Needs for new manufacturing technology development to produce the system in an economical and reliable fashion.
4. Components or subsystems that pose unique producibility problems.
5. Manufacturing cost drivers for the system.
6. Relationships between production rate and unit production costs.
7. Probable scope and magnitude of Producibility Engineering and Planning and Initial Production Facilities requirements.
8. Other production risks, such as long leadtime items, as appropriate.

The results of this production feasibility assessment should be considered when selecting the most desirable concepts for pursuit during the validation phase. Also, the findings should be reflected in the development and acquisition strategy.

### 3.2 Acquisition Strategy

An initial acquisition strategy must be developed for the system during the conceptual phase. This strategy will define the number of alternative systems to be pursued during validation and full scale development, the requirements for Government Furnished Equipment, the desirability of a second source production contractor and competitive buy out, contract types, planned production rates, the Initial Operating Capability date, etc.

Although the initial acquisition strategy may be changed during later phases of development, it is important that the original strategy be realistic and effective. If the original strategy is too optimistic or does not fully take into consideration the need for certain efforts, such as Producibility Engineering and Planning, then credibility problems are created for the program and it becomes very difficult to make up funding or schedule shortfalls.

Key considerations when preparing the acquisition strategy include:

1. Can competition during advanced development and production be used to reduce costs or minimize risks?
2. Is the Producibility Engineering and Planning adequately funded and initiated soon enough to be effective?
3. Will Initial Production Facilities be required for the system and are the time frame and funds sufficient?
4. Will long leadtime items need to be purchased prior to Milestone III in order to meet production schedules?
5. Is a low rate initial production program needed rather than the normal entry into full scale production?
6. Are activities like Initial Production Readiness Reviews and Production Readiness Reviews included in the schedule?

### 3.3 Design to Cost Goals

Design to cost goals are normally derived as part of the Baseline Cost Estimate for the system during the conceptual phase. The primary design to cost goal is the "unit flyaway cost" associated with the procurement investment costs for the major system equipment. DTCC goals are unit cost targets included in development contracts to which the contractor designs the system hardware. The Program Manager or developer prepares these goals for use in later development contracts.

At this stage in the life cycle, BWPC goals will probably be based more on parametric estimating techniques than on industrial engineering cost estimates. In any event, care should be taken in establishing the goals to insure that they are realistic and supportable. These goals should be based on an appropriate production rate and quantity corresponding to the first planned production buy.

In summary, the major activities during the conceptual phase that will impact the transition from development to production include: conducting a production feasibility assessment of alternative system concepts to identify production risks and the necessary producibility-related actions required during development; development of a realistic and effective acquisition strategy; and the establishment of preliminary design to cost goals.

#### 4.0 TRANSITION-RELATED ACTIVITIES DURING

##### THE VALIDATION PHASE

The validation phase consists of those steps necessary to verify preliminary design and engineering, accomplish necessary planning, analyze trade-off proposals, resolve or minimize logistics problems, prepare a formal requirements document, and validate the system concept for full scale development. The validation process may be conducted by competitive or sole source contractors or by in-house laboratories. Prototypes are developed and tested in order to estimate the prospective system's technologic feasibility, military utility, cost, environmental impact, human engineering, operational effectiveness, operational suitability, and to initially evaluate producibility considerations prior to entering full scale development.

At the completion of the validation phase, the following items are considered at the Milestone II review for entry into full scale development (see AR 15-14, "System Acquisition Review Council Procedures):

1. Need: The mission element task is reaffirmed to be essential.
2. Threat: The updated threat is credible, addresses the correct time frame and has been validated.
3. Recommended System/Program Alternatives:
  - a. Satisfies the mission element need.
  - b. Is cost effective
  - c. Is within established constraints
  - d. Is supported by results of demonstration and validation.
  - e. Considered foreign and other service alternatives.
  - f. Provides for service and NATO standardisation and interoperability.
  - g. Takes into account joint service implications.
  - h. Takes into account environmental considerations.
  - i. Establishes nuclear survivability criteria.
4. Operational Factors:
  - a. Insures electromagnetic compatibility and frequency supportability.
  - b. Identifies electronic/infrared/optical counter-countermeasure performance requirements.

- c. Provides adequate force structure plan and schedule for phase in.
- d. Addresses impact on Reserve Components.
- e. Addresses impact on MOS structure and individual training.
- f. Includes use of simulators for individual and unit training.
- g. Establishes performance goals and thresholds.
- h. Recommends disposition of current family or series of equipment being replaced or phased out.

5. Logistical Factors:

- a. Minimize operation and support costs.
- b. Minimize maintenance and support personnel
- c. Establish Reliability, Availability and Maintainability goals and thresholds.
- d. Plan for Integrated Logistics Support.

6. Cost:

- a. Establishes validity of cost estimates, including cost and operational effectiveness analysis.
- b. Establishes realistic design to cost goals and thresholds for hardware and operations and support.
- c. Program cost thresholds and fiscal year thresholds.

7. Acquisition Strategy:

- a. Has been updated, effectively supports achievement of program objectives, and is being executed in the conduct of program management.
- b. Short- and long-term business planning supports the strategy.
- c. Contract types are consistent with the program characteristics, risks, uncertainty and strategy.
- d. Producibility and production risk considered.
- e. Planning for selection of major subsystems is clearly stated, maximized sustained competition, and accepts the use of existing military and commercial equipment as appropriate.

- f. Requirements established for long leadtime procurement items, verification of production engineering and design maturity (i.e., Production Readiness Review), and establishing the production base.
8. Schedule: Goals and thresholds established.
  9. Risk:
    - a. Uncertainties and risks identified and acceptable.
    - b. Adequate plans to resolve remaining uncertainties and risks.
  10. Testing:
    - a. Results of development testing and operational testing during validation phase support recommendations.
    - b. Adequacy of testing, critical issues remaining to be resolved by testing, quality of test efforts, validity of test results, and plan for further testing.
    - c. Update of Coordinated Test Program
  11. Program Management:
    - a. Structure
    - b. Selected Acquisition Report (SAR) initiated if appropriate.
  12. Legal Review: Consistent with international law.

Although there are many separate activities that must be completed to successfully end the validation phase, the issues described in the following paragraphs are particularly important to the transition from development to production.

#### 4.1 Preliminary Producibility Analysis

The producibility analysis conducted during the conceptual phase should be updated and expanded in the validation phase. This can be accomplished by means of a separate Producibility Engineering and Planning effort during advanced development or through inclusion of appropriate requirements in the scope of work.

The producibility analysis activities during the validation phase should include:

1. Conducting and/or updating production feasibility and production risk analyses.

2. Producibility evaluations of selected assemblies and components to reduce cost and simplify manufacturing.
3. Identification of major special tooling and test equipment requirements and estimation of design, fabrication and proofing costs and leadtimes.
4. Evaluation of need for new or improved manufacturing and inspection technology that will be needed to support production.
5. Determination of facilities and equipment required for production and adequacy of existing capabilities.
6. Estimation of leadtime required for production start-up and the need for advanced procurement of long leadtime items.

#### 4.2 Initiation of Manufacturing Methods and Technology Projects

Manufacturing Methods and Technology (MM&T) projects can take several years to complete. Therefore, it is recommended that any MM&T project supporting a system be initiated during the system's validation phase to insure that the technology is available in a time frame that is useful to the system. In order to be useful, MM&T project results should be available early in the full scale development phase so that it can be incorporated in the Producibility Engineering and Planning and Initial Production Facilities efforts. Steps for initiating MM&T projects were discussed in Chapter 2.

#### 4.3 Refining Design to Cost Goals

Based on the results of the advanced development contract, the design to cost goals should be revised/updated as appropriate. Information generated during the preliminary producibility analysis and actual costs incurred for fabrication of validation prototypes should be considered, along with any changes in planned production rates and quantities.

#### 4.4 Refinement of Full Scale Development Activities

As the validation phase nears completion, the Project Manager should have a better understanding of the activities that will be required during full scale development. In particular, the requirements for Producibility Engineering and Planning, Initial Production Facilities, long leadtime procurements, Low Rate Initial Production and Production Readiness Reviews, should be considered in detail and included in the Milestone II review.

## **5.0 TRANSITION-RELATED ACTIVITIES DURING**

### **THE FULL SCALE DEVELOPMENT PHASE**

During full scale development, the missile system, including all items necessary for its support, is fully developed and engineered, fabricated and tested, and a decision is made whether the system is acceptable for production and deployment. The intended output is, as a minimum, a preproduction system that closely approximates the desired final product, the documentation necessary to enter the full scale or low rate production phase, the planning and data required to field and support an integrated system, and test results which demonstrate achievement of the characteristics stated in the requirement document.

The important objectives during the full scale development phase include:

1. Continue system engineering and configuration management to insure that the technical data matches the developing system and remains under control.
2. Undergo formal source selection, when this process applies.
3. Plan for and conduct development and operational tests (DT II and OT II).
4. Complete the system definition (specification, drawings, and associated documentation) so as to be adequate for production purposes.
5. Sufficiently define thresholds and design to cost goals to assure identification of major development and production program variances.
6. Continue to prepare for the production phase by completing Producibility Engineering and Planning.
7. Complete Materiel Fielding Plans, basis of issue plans, training and training publications, integrated logistics support, etc.
8. Achieve type classification "Standard" for those systems to enter full scale production as the next phase or type classification "Limited Procurement" for those systems which will undergo low rate initial production.
9. Make the necessary adjustments to schedules, plans and funding programs to accommodate low rate initial production, if this is anticipated.

During the full scale development phase, emphasis must be placed on reducing technical risks and establishing confidence that the system will function in the intended environment. The system or item developed during this phase must be fully representative of the materiel to be delivered as production items, differing only in the manufacturing aspects relative to "soft" tooling versus "hard" or production tooling.

At the completion of full scale development, a Milestone III review is held to determine if the system is ready to enter the production and deployment phase. The following items are considered at the review (see AR 15-14, "Systems Acquisition Review Council Procedures"):

1. Need: The mission element task is reaffirmed to be essential.
2. Threat: The updated threat is credible, addresses the correct time frame, and has been validated.
3. Recommended System:
  - a. Satisfies the mission element need.
  - b. Is the most cost-effective alternative.
  - c. Is within established constraints.
  - d. Is affordable.
  - e. Provides for NATO standardization and interoperability.
  - f. Balances cost, schedule and performance effectively through trade-offs.
4. Operational Factors:
  - a. Force structure and schedule for phase-in.
  - b. Impact on Reserve Components.
  - c. Impact on MOS structure and individual training.
  - d. Use of simulators for individual and unit training.
  - e. Performance goals and thresholds reaffirmed.
  - f. Disposition of current family or series equipment being replaced or phased out.
5. Logistical Factors:
  - a. Minimizes operational and support costs.
  - b. Minimizes Maintenance and support personnel.
  - c. Reliability, Availability and Maintainability (RAM) goals and thresholds reaffirmed.
  - d. Integrated Logistic Support planning to meet needs of operational units.

6. Cost:

- a. Validity of cost estimates, including cost and operating effectiveness analysis.
- b. Design to cost goals and thresholds reaffirmed for hardware and operating and support costs.

7. Acquisition Strategy:

- a. Has been updated and is being executed.
- b. Business planning supports the acquisition strategy and provides flexibility for production rates and quantities when options are used.
- c. Requisites defined for future production decisions.
- d. Competition/second source.

8. Schedule: Goals and thresholds reaffirmed.

9. Testing:

- a. Results of development and operation tests support recommendations.
- b. Adequacy of testing, critical issues remaining to be resolved, quality of test efforts, validity of test results, and plan for further testing.

10. Production Readiness Review Completed.

11. Program Management Structure.

12. Legal Review: Consistent with International Law

Although all full scale development activities are important, the issues discussed in the following paragraphs are particularly critical to the preparation for production entry.

5.1 Producibility Engineering and Planning

Producibility Engineering and Planning (PEP) should be started as soon as possible after initiation of full scale development and should continue through correction of deficiencies encountered during DT II/OT II. Specific PEP tasks include:

- 1. Subject product designs to industrial and production engineering analyses to insure that the technical data package fully reflects producibility considerations.

2. Include producibility considerations in cost-effectiveness trade-off studies and analyses.
3. Perform special studies to identify and resolve potential production problems, including details of unique manufacturing processes.
4. Identify the need for, and prepare any critical or unique process specifications or other engineering documents that must be incorporated in the technical data package.
5. Design and document special production equipment and tooling, including calibration and operating data and maintenance instructions.
6. Design and documentation of (SIE) and other inspection equipment and gages.
7. Prepare a production plan to support low rate and full production. The plan will contain described skill centers, manufacturing operations, inspection stations, production control functions, and scheduling and inventory requirements including production leadtimes.
8. Prepare detailed production data for each Army part number, to include required operations, set-up time, operating time, test and inspection time, repair and rework time, and required tools and equipment.
9. Descriptions of manufacturing methods for all assembly operations for the purpose of orienting production workers and indicating required production quantity.
10. Requirements and plans for facilities, standard production equipment and manpower.
11. Make-or-buy analyses for all items of system hardware.

An effective PEP program is a key step in readying a new missile system for production and has a major impact on the ability to achieve design to cost goals. Thus PEP should be closely followed and managed by the Project Manager's office and should be an integral part of all major program reviews.

### 5.2 Production Readiness Review

Each major Army system must undergo an IPRR at least 12 months in advance of the Milestone III decision to enter production. A follow-on PRR must be completed 2 months prior to Milestone III. Specific considerations in the planning and execution of IPRR's and PRR's were discussed in Chapter 2.

### 5.3 Functional Configuration Audit

An FCA is one means of validating that development of a system has been completed satisfactorily. FCA's are conducted on configuration items to assure that the technical documentation accurately reflects the items func-

tional characteristics, as well as those necessary physical characteristics, and that test and analysis data verify that the item has achieved the performance specified in its functional or allocated configuration identification.

#### 5.4 Physical Configuration Audit

The PCA is a means of establishing the product baseline as reflected in the product configuration identification that is used for the production and acceptance of the units of a configuration item. The PCA insures that "as built" configuration of a unit matches the technical data package and that the acceptance testing requirements prescribed by the documentation are adequate for acceptance of production units. The outcome of the PCA is formal acceptance of the technical data package which satisfies the contractual obligation. The PCA marks the beginning of mandatory engineering change control for design changes.

#### 5.5 Long Leadtime Item Procurement

Requirements for components which will require substantially greater time to produce or procure and are pacing items for overall leadtime of the system are identified as early as possible. Generally, the procurement of these items will occur subsequent to Milestone II. It is permissible to budget for long leadtime components in the year prior to the year in which the system procurement is budgeted if all of the following criteria are met:

1. The components have a leadtime which is significantly longer than the rest of the components which comprise the system.
2. There is a demonstrable requirement for these components even if the subsequent year's buy of the intended system is not authorized and appropriated.
3. The components are to be procured as Government Furnished Equipment (GFE) rather than a part of the end item prime contractor's effort.

Requests for funds for long leadtime procurements should be submitted at least 2 years prior to the beginning of the fiscal year in which they are needed.

#### 5.6 Initial Production Facilities

The IPF effort provides the specific tooling and test equipment needed to enter production. The design and supporting documentation for special tooling and test equipment is provided under EPR. Therefore, IPF is involved in translating these designs into a functional production line.

Specific IPF tasks include:

1. Fabrication and validation of special tooling, special production equipment, and verification of quantities.

2. Fabrication and validation of Special Inspection Equipment (SIE) and gages.
3. Initial set up of the production line, if appropriate.
4. Maintenance of special equipment.

#### 6.0 TRANSITION-RELATED ACTIVITIES DURING THE PRODUCTION PHASE

At the Milestone III review a decision will have been made to type classify the system as "Standard" and move directly into full production or to type classify the system as "Limited Procurement" and undergo a IRIP period prior to full scale production. In either case, the full system is produced for the first time with production tooling. Because "hard" tooling is being used for the first time, there may be a need for numerous changes to the technical data package. Thus a strong configuration management effort will insure that only essential changes are approved and that the initial production run will serve to improve the quality of the technical data package for subsequent procurements.

The important objectives of the production phase include:

1. Award of the production contract.
2. Acceptance of the Initial Production Facilities.
3. Plan for and conduct production tests.
4. Review all logistics support and training documents prepared during full scale development to insure full compatibility with the actual initial production configuration.
5. Perform a configuration audit to compare early production items with the production data package.
6. Update the technical data package in accordance with approved design changes or corrections.
7. Prepare and coordinate material fielding plans with each known gaining command.
8. Implement all Integrated Logistics Support plans to insure availability of trained personnel, manuals, spare parts, etc.

In most cases, full scale production will be initiated upon completion of the full scale development program. However, some systems may be allowed to enter IRIP prior to full scale production.

When an ERIP decision is made at Milestone III, subsequent testing includes sufficient DTIII integrated with production testing by the developer and OTIII by the operational tester to support a full scale development decision at ASARC IIIa.

It is not uncommon to encounter a significant number of technical and manufacturing problems during production start up. This can include, among other things, design deficiencies, problems in meeting quality assurance requirements, low production yields, unusually long leadtimes for materials and components, and vendor difficulties. Therefore sufficient engineering support must be available during the transition to full production rates. This is usually provided through an overlap of the engineering development contract with the first production contract or through an engineering services contract. Such support is also important to maintain continuity of the acquisition program and to prevent slippage in the Initial Operating Capability date.

**APPENDIX A**

**REFERENCES**

DODD 4100.34	"Development of Integrated Logistical Supply and Systems & Equipment"
DODD 4120.3	"Development Standardization Program"
DODD 4155.1	"Quality Assurance"
DODD 5000.1	"Major System Acquisitions"
DODD 5000.2	"Major Systems Acquisitions"
DODD 5000.34	"Defense Production Management"
DOD I 5000.38	"Production Readiness Reviews"
DoD 5000.39	"Acquisition and Management of Integrated Logistics Support for Systems and Equipment"
DoD I 4200.15	"Manufacturing Technology Program"
AR 15-14	"Systems Acquisition Review Council Procedures"
AR 70-1	"Army Research, Development and Acquisition"
AR 70-37	"Configuration Management"
AR 70-61	"Type Classification"
AR 70-67	"Production Readiness Reviews"
AR 700-90	"Army Industrial Preparedness Program"
AR 700-67	"Defense Standardization Program"
AR 702-4	"Procurement Quality Assurance"
AR 700-127	"Integrated Logistics Support"
DISCOM 70-32	"Manufacturing Technology"
DISCOM 70-33	"Production Readiness"

APPENDIX A

REFERENCES (Continued)

- DOD STD 480 "Configuration Control - Engineering Changes, Deviations and Waivers"
- MIL STD 490 "Specification Practices"
- MIL-S-83490 "Specifications, Types and Forms"
- DARCOM R70-8 "Value Engineering Program"
- DARCOM P-700-6 "Design to Cost"
- DA PAM 5-4-5 "Value Engineering Handbook"

TM 38-705 Series "Integrated Logistics Support"

## APPENDIX B

### DEFINITIONS

**Production Risk.** Any major problem involving production processes and methods, material, tooling, facilities, test equipment, or combinations thereof which is beyond the current state of the production art and potentially impacts program cost and/or schedule.

**Production Management.** The effective use of resources to produce on schedule the required number of end items that meet specified quality, performance and cost.

**Production Engineering.** The application of design and analysis techniques to produce a specific product. Included are the functions of planning, specifying and coordinating the application of required resources; performing analyses of producibility and production operations, processes, and systems; applying new manufacturing methods, tooling, and equipment; controlling the introduction of engineering changes; and employing cost control techniques.

**Production Feasibility.** The likelihood that a system design concept can be produced using existing production technology while simultaneously meeting quality, production rate, and cost requirements.

**Producibility.** The relative ease of producing an item or system which is governed by the characteristics and features of a design that enable economical fabrication, assembly, inspection, and testing using available production technology.

**Production Readiness.** The state or condition of preparedness of a system program to proceed into production. A system is ready for production when the completeness and producibility of the production design and the managerial and physical preparations necessary for identifying and sustaining a viable production effort have progressed to the point where a production commitment can be made without incurring unacceptable risks that likelihood of schedule, performance, cost, or other significant criteria will be breached.

**Production Readiness Review.** A formal examination of a program to determine if the design is ready for production, production resources are available, and the program has successfully completed testing for the production phase.

**Production Readiness Review Board.** A group of individuals who are responsible for the review and approval of the production readiness review process. The board is composed of representatives from the program and supporting organizations. The board is responsible for the review and approval of the production readiness review process.

**Manufacturing Technology Project.** Refers to the development or improvement of manufacturing processes, techniques, and equipment by the Government or private industry to provide for timely, reliable, economical manufacture of Department of Defense materiel. The objective is to bridge the gap between feasibility and full-scale production and to achieve parity between manufacturing technology and research and development advances which will smooth the translation of systems design criteria into reliable production hardware. Manufacturing technology projects may also provide engineering support to the modernization of the industrial production base to provide for improved capability to meet a military contingency. They are normally broad-based in application, are production oriented even when they are performed in a prototype environment, and are expected to result in a practical process for production. They may include the application of new or improved techniques or equipment to manufacture specific weapon systems, components, and items, and prototypes; and may be funded as a part of the specific weapons system program involved.

**Integrated Logistic Support (ILS).** A composite of all the support considerations necessary to insure the effective and economical support of a system during its life cycle. It is an integral part of all other aspects of system acquisition and operation. ILS is characterized by harmony and coherence among all the logistic elements. The principal elements of ILS, related to the overall system life cycle, include the maintenance plan, support and test equipment, supply support, transportation and handling, technical data, facilities, personnel and training, logistic support resource funds, and logistic support management information.

**Army Systems Acquisition Review Council (ASARC).** The ASARC provides key decisions on major Army programs. When a Defense System Acquisition Review Council (DSARC) is required, the ASARC provides the approval decision on proposed Army recommendations to the DSARC. Regular members of the ASARC are the Vice Chief of Staff of the Army (VCSA) (Chairman); Assistant Secretary of the Army (Research and Development); Assistant Secretary of the Army (Installations and Logistics); Deputy Under Secretary of the Army (Operations Research); Deputy Chief of Staff for Research, Development and Acquisition; Deputy Chief of Staff for Operations and Plans; Commander, US Army Development and Readiness Command, and the Commander, US Army Training and Doctrine Command. Special members of the ASARC who will attend on the call of the chairman are the Assistant Secretary of the Army (Financial Management); Deputy Chief of Staff for Logistics (DSCAL); Comptroller of the Army (CA); Commander, US Army Operational and Test Evaluation Agency (O&TEA); Commander, US Army Concepts Analysis Agency (CAA) and other Army Staff agencies and other subordinate commands when required for review of selected systems.

**Baseline Cost Estimate (BCE).** The BCE is a document prepared by the developer and is the first formal, detailed estimate of the total life cycle ownership cost. This estimate is prepared early in the development process (the earliest for all subsequent tracking and control purposes, including traceability). The initial BCE is prepared in an early stage of development considering the data available and is periodically updated throughout the life cycle in conjunction with updating the DDP.

Configuration Management (CM). CM is a discipline applying technical and administrative direction and surveillance to:

- A. Identify and document the functional and physical characteristics of an item or system.
- B. Control changes to those characteristics and
- C. Record and report change processing and implementation status. The CM process is tailored to the size, scope, phase of the life cycle, nature and complexity of the system involved.

Cost and Operational Effectiveness Analysis (COEA). A documented investigation of:

- A. Comparative effectiveness of alternative means of meeting a requirement for eliminating or reducing a force or mission deficiency.
- B. The validity of the requirement in a scenario which has the approval of HQDA, and HQ, TRADOC.
- C. The cost of developing, producing, distributing, and sustaining each alternative in the military environment for a time preceding the combat application.
- D. The analysis is updated by the combat developer at each major decision point to include the use of the DT/OT data.

Decision Coordinating Paper (DCP). A summary top-management document for the Secretary of Defense that presents the rationale for starting, continuing, reorienting or stopping a major development program at each critical decision point. It identifies the issues in each decision and assesses the important factors, including threat, program plans, risks, full military and economic consequences, critical issues to be resolved by test and evaluation, acquisition strategy, costs, and performance parameters that influence a decision. Once the Secretary of Defense has approved the DCP, it is a "contract" between the Secretary of Defense and the implementing Service Secretary which defines the latitude of the Service in managing the program within the thresholds of cost, performance and schedule that have been mutually agreed upon. The DCP is updated prior to each DSARC review.

Developmental Testing (DT). Testing of materiel systems which is conducted by the materiel developer utilizing the principle of a single integrated development test cycle to: demonstrate that the design risks have been minimized; demonstrate that the engineering development process is complete; demonstrate that the system will meet specifications; and estimate the system's military utility when introduced. DT is accomplished in factory, laboratory, and proving ground environments. An evaluation of health and safety characteristics of each system/item is conducted throughout DT.

**Letter of Agreement (LOA).** The LOA is a jointly prepared and authenticated document in which the combat developer and the materiel developer outline the basic agreements for further investigation of a potential materiel system. The purpose of the LOA is to insure agreement between the combat and materiel developers on the general nature and characteristics of the proposed system and the investigations needed to develop and validate the system concept, to define the associated operational, technical, and logistical support concepts and to promote synchronous interaction between the combat developer and materiel developer during the conduct of these investigations.

**Major Programs.** Systems which qualify for DSARC review and others which are critically important to the Army, complicated, expensive, controversial or for any other reason should involve the top management of the Army. The designation of major Army systems considers:

- A. OSD designation of DSARC systems;
- B. Significance of the added operational capability;
- C. The level of interest already expressed or anticipated (congressional, OSD, SA, or CSA);
- D. Overall resource impact;
- E. Relationships to other programs and materiel developers and;
- F. Requirements for cooperation with other DoD components and allied governments.

Programs not designated as major Army programs are considered as non-major programs.

**Operational Testing (OT).** Testing and evaluation of materiel systems which is accomplished with typical user operators, crews or units in as realistic an operational environment as possible to provide data to estimate.

- A. The military utility, operational effectiveness and operational suitability (including compatibility, interoperability, safety, reliability, availability and maintainability, supportability, operational man (soldier)-machine interface, and training requirements) of new systems;
- B. From the user viewpoint, the system's desirability, considering systems already available, and the operational benefits/drawbacks associated with the new system;
- C. The need for modification to the system, and;
- D. The adequacy of doctrine, organization, operating techniques, tactics, and training for employment of the system, the adequacy of logistic support for the system and, when appropriate, its performance in a countermasures environment.

**Type Classification. Type classification/reclassification:**

- A. Identifies the life cycle status of a materiel system by the assignment of a type classification designation.
- B. Records the status of a materiel system in relation to its overall life history as a guide to procurement, authorization, logistical support, asset and readiness reporting. The type classification designations are limited procurement, standard, contingency and obsolete.

**Defense Systems Acquisition Review Council (DSARC).** A council within the Office, Secretary of Defense to advise the Secretary of Defense on milestone decisions for major systems and such other acquisition issues as deemed appropriate. Members of the DSARC include a Defense Acquisition Executive (DAE) designated by the Secretary of Defense, the Under Secretary of Defense for Policy (USDP), the Under Secretary of Defense Research and Engineering (USDRR), the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) (ASD(MRA&L)), the Assistant Secretary of Defense (Comptroller) (ASD(C)), the Assistant Secretary of Defense (Program Analysis and Evaluation) (ASD(PA&E)) and the Chairman, Joint Chiefs of Staff (CJCS). Normally, the DSARC reviews the Service Secretary recommendations to: initiate validation; initiate full scale development; and initiate full production. Additional DSARC reviews may be required for procurement of long leadtime materiel or for evaluation of low rate initial production.

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