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UNITED STATES AIR FORCE

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AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

A COMPARATIVE ANALYSIS OF THE APPLICATION OF PRODUCTION READINESS REVIEWS

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SLSR 2-76B

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Uncertainty permeates the entire weapons acquisition process. The Defense System Acquisition Review Council (DSARC) was established to review a military program's status and make a recommendation to the Secretary of Defense on the program's readiness to transition from one phase into the succeeding phase of the weapons acquisition process. The Air Force is using the Production Readiness Review (PRR) as a technique to prepare for the DSARC III review held prior to the production phase of the weapons acquisition process. This study was designed to analyze ~~three~~ 3 major Air Force weapon system programs ~~for the purpose of comparing~~ to compare their ~~Production Readiness Review~~ (PRR) program procedures. Responses were analyzed from System Program Offices and ~~Air Force~~ Plant Representative Offices to determine if differences did exist. Additionally, 10 ~~ten~~ Air Force Systems Command ~~(AFSC)~~ production management experts were ~~identified and~~ interviewed ~~in order~~ to determine if a standard approach is feasible for conducting future PRR programs. The study indicated that the ~~three~~ 3 major programs analyzed did apply different procedures in conducting their respective PRR programs. The ~~study culminated~~ authors conclude ~~with the conclusion~~ that a standard PRR approach is feasible and the PRR tasks can be grouped into areas of importance.

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A COMPARATIVE ANALYSIS OF THE APPLICATION OF PRODUCTION READINESS REVIEWS

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

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September 1976

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CHAPTER I

INTRODUCTION

The Production Readiness Review (PRR) is an Air Force procurement concept that evolved in the early 1970s to meet the demands of the dynamic weapons acquisition process. A PRR is a government analysis of a contractor's readiness to transition from the full-scale development phase into the production phase of the weapons acquisition process. The contractor may have produced some developmental hardware, but the question addressed by the PRR is whether or not the contractor is ready to produce the required quantity of production units efficiently and economically (41:3-4). Air Force Systems Command (AFSC) defines the Production Readiness Review (PRR) concept as follows:

> The PRR is a formal inspection to determine whether (1) a system or equipment under development is ready for efficient and economical quantity production; (2) all important production engineering problems encountered during development have been resolved; and (3) the contractor has accomplished adequate planning for the production phase [42:1-2].

A PRR is required for all major Air Force acquisition programs having an estimated Research, Development, Test, and Evaluation (RDT&E) cost exceeding $50 million or an estimated production cost exceeding $200 million. A PRR may be conducted on any other development or production program if the Air Force Program Manager determines that a PRR is necessary (42:1).

Statement of the Problem

Uncertainty permeates the entire weapons acquisition process. To help cope with the uncertainty in the weapons acquisition process, the Defense System Acquisition Review Council (DSARC) was established. The DSARC's job is to review a military program's status and make a recommendation to the Secretary of Defense on the program's readiness to transition from one phase into the succeeding phase of the weapons acquisition process (Figure 1, page 3). The Air Force is using the Production Readiness Review (PRR) as a technique to prepare for the DSARC III review (Figure 1, page 3) held prior to the production phase (42:5).

Air Force Systems Command (AFSC) published a regulation to provide general guidance for conducting a Production Readiness Review (42:1). The regulation does not provide for coordinated PRR planning efforts, standardized PRR implementation, or feedback of lessons learned in previous PRRs. Further, there is no centralized data source to which Air Force system program offices can go to receive expert assistance on how to plan and implement their particular PRR program (49). As a result, completely different PRR approaches were taken on existing major weapon system programs (15; 20; 45). Other major system

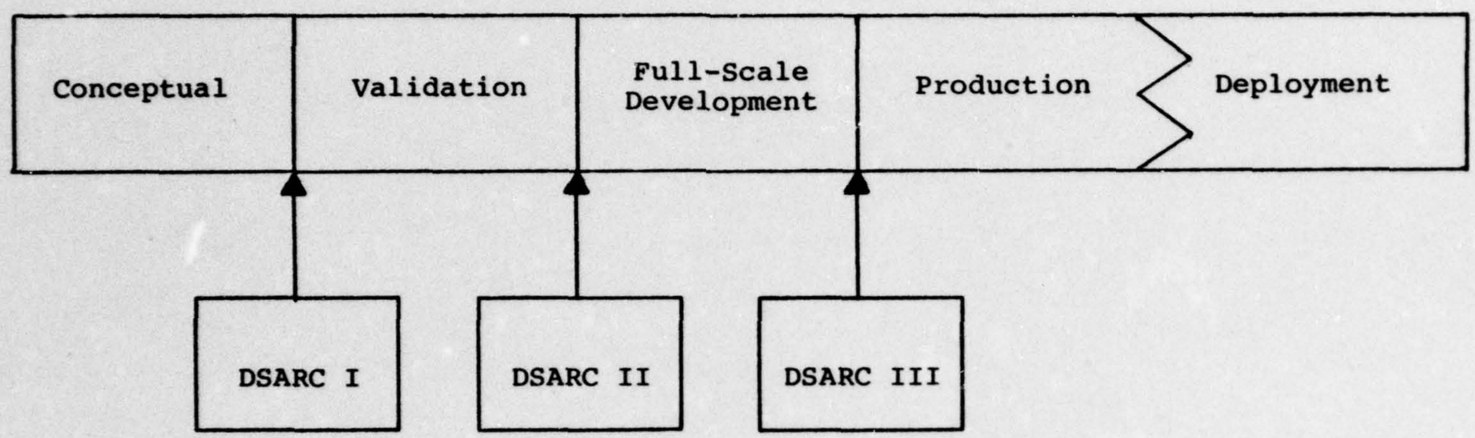

Fig. 1. Weapons Acquisition Process (14:12)

program offices are currently faced with the problem of creating their own PRR programs (6; 10).

Because of the lack of centralized assistance for planning and implementing PRR programs, the lack of standardized PRR procedures, and the lack of coordinated PRR planning efforts, major Air Force weapon system programs may be conducting the Production Readiness Reviews inefficiently. A need exists to determine if a standard PRR approach can be used by Air Force system program offices for planning and implementing future PRR programs in support of the DSARC III decision-making process.

Justification for Research

Relevance to Logistics Management Environment

According to a RAND Corporation study (3:10-12), since the advent of the atomic age, the emphasis on weapon systems acquisition has shifted from one of quantity to one of quality. The requirement for massive forces designed to deliver large quantities of explosives has been supplanted with highly complex and sophisticated weapon systems. The quality emphasis has not only resulted in changes in design philosophy but has also created many problems in procurement management. "It is a systems complexity that entangles the development, production, and maintenance problems together, creating the knottiest problem of procurement management [3:14]." It is this complexity and entanglement that have brought about the establishment of project type organizations for managing the procurement of the major weapon systems (3:10-12).

Cost growth and large cost overruns on many military programs in recent years have generated severe criticisms in the public press and in Congress (23:28). While inflation and an expanding technology are increasing the costs of weapon systems, the growing demand for public funds to support other government projects has resulted in a lesser proportion of the federal budget available for Department of Defense programs (Figures 2 and 3, page 6). McQuinn (23:28) stated that the military procurement environment has changed significantly. There is less money to spend, and the funds available must be used more efficiently. Industry and government must work together to improve the efficiency and economy in the procurement of military goods and services (23:28).

According to Fitzgerald (8:8), the cost growth in military procurement can partly be attributed to the manufacturing processes and controls currently being used in the aerospace industry:

> Production control techniques which had been carefully evolved and refined over a period of sixty to seventy years were effectively abandoned. Orders for parts to be made in the factories would be released and immediately lost. Hordes of "expediters"

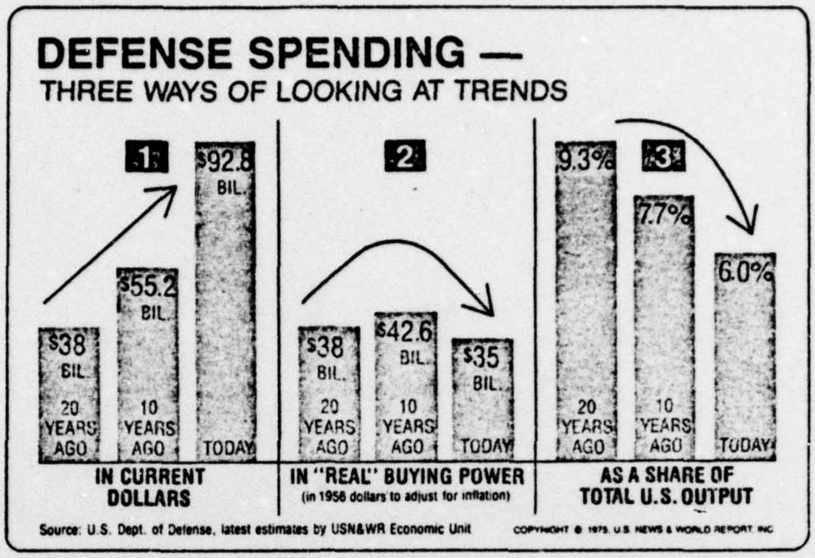

Fig. 2. Defense Spending: Three Ways of Looking at Trends (1:23)

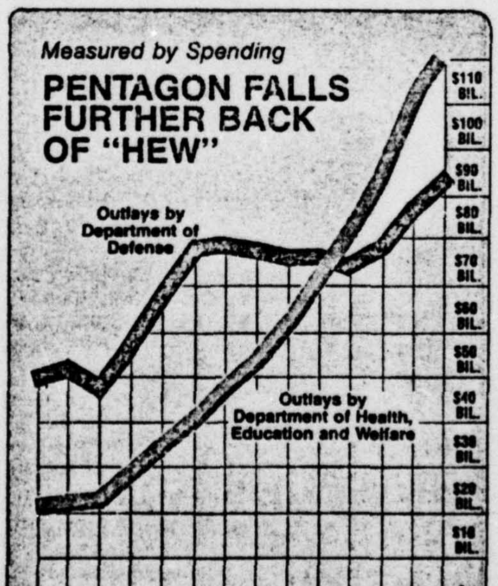

Fig. 3. HEW Exceeds Pentagon Spending (1:23)

> or "parts chasers" would then be unleashed to find the orders and shepherd the parts through the manufacturing process. By dint of much scurrying about, the parts chasers would round up enough parts to assemble a missile from time to time [8:8].

This is a dramatization of problems in an industry that has been plagued with waste and inefficiency. To help counteract this inefficiency and obtain the needed military products economically, the Air Force created the PRR concept (42:1).

The cost growth problem in military procurement has been investigated by the General Accounting Office (GAO).

> The General Accounting Office report cites increased costs of $31.5 billion in DOD acquisition of 45 major systems, or a 39 percent increase over planning estimates and a 20 percent increase over estimates made during the development phase. Among the systems cited as having major cost overruns were the C-5A cargo plane, the F-111 and F-14 aircraft, the M-60 Army tank, Poseidon submarines, and Minuteman missiles . . . .
>
> . . . .
>
> Causes of cost changes, according to the GAO report, can be attributed to inflation (30 percent), estimating errors (25 percent), and changes in requirements ordered by the military (45 percent). The last cause, which involves revisions in specifications, time schedules, and quantities, results from unrealistic performance targets at the outset and from "concurrency," that is, beginning production before full-scale development and testing have been completed [2:22-23].

Belden (2:22-24) advocated that top defense managers must be prepared to respond to all inquiries requesting explanations of unpredicted cost escalations in military procurement. In some cases, unexpected developments will escalate costs and may be excusable. But the Congress and the public will not and should not be expected to tolerate cost escalations clearly attributable to poor management or other avoidable procurement mistakes (2:24).

Hagen (14:1-17) stated that the acquisition of major weapon systems is designed to follow a systematic flow through well-defined phases. These phases are conceptual, validation, full-scale development, production, and deployment (Figure 1, page 3). A major step was taken in 1969 to achieve better coordination of the various phases of the weapons acquisition process. The Defense System Acquisition Review Council (DSARC) was formed to evaluate and review each major weapon system at three critical junctures--DSARC I before transitioning into the validation phase, DSARC II prior to moving into the full-scale development phase, and DSARC III before moving into the production phase (14:12).

The purpose of DSARC III is to provide a recommendation to the Secretary of Defense on moving a major weapon system into production (Figure 1, page 3) (26:4). The DSARC III must confirm, among other points, ". . . that a practical engineering design, with adequate consideration of production and logistics problems, is complete [36:4]." DSARC III serves as the basis for the decision on whether or not a weapon system will be produced for deployment. DSARC III meetings are held when the military department determines that engineering and operational systems development and testing have been substantially completed, all major development problems have been resolved, and the weapon system is ready to transition into production (26:4). The procuring military department must supply information addressing the following areas to support DSARC III in the decision-making process: program background and objectives, technical assessment (status of development and production engineering), production and procurement assessment, schedules, costs, program management, other (e.g., compliance with Equal Employment Opportunity Act, Armed Services Procurement Act, etc.), and source selection decisions (14:12).

In May, 1970, Deputy Secretary of Defense David Packard directed the services to improve their management procedures associated with major systems acquisition.

> The prime objective of the new policy guidance is to enable the Services to improve their management of programs. Improvement in the execution of the programs will be made to the extent the Services are willing and able to improve their management practices. The Services have the responsibility to get the job done. It is imperative that they do the job better in the future than it has been done in the past . . . [26:1].
>
> . . . .
>
> The start up of production must be scheduled to minimize financial commitments until it has been demonstrated that all major development problems have been resolved [26:4].

Utility of PRR Within Logistics Management Environment

Critical Production Time Period. The most critical time period in terms of the rate of expenditure of funds is the production phase of the weapons acquisition process (Figure 4, page 11). The technical uncertainty level should have been reduced by this time, and the major obstacle for the system program office is to convince DSARC and Congress that the program is ready to transition from the full-scale development phase into the production phase of the acquisition process (4). One estimate of a typical Air Force program's costs, excluding operation and support costs, is that about 33 percent of a program's funds are committed for research and development, and the other 67 percent are spent in the production phase of the weapons acquisition process (49). Both the greatest cost overruns and the greatest potential savings can occur in the production phase (49).

The large number of taxpayers' dollars which are expended in the production phase of major weapon system contracts justifies the need for research in the PRR area (31). According to Rogers (31), the Department of Defense production expenditures for fiscal year 1973 were approximately 2.2 times that spent for Research, Development, Test, and Evaluation (RDT&E) activities. The average amount of Air Force Systems Command production dollars spent in fiscal years 1971, 1972, and 1973 was

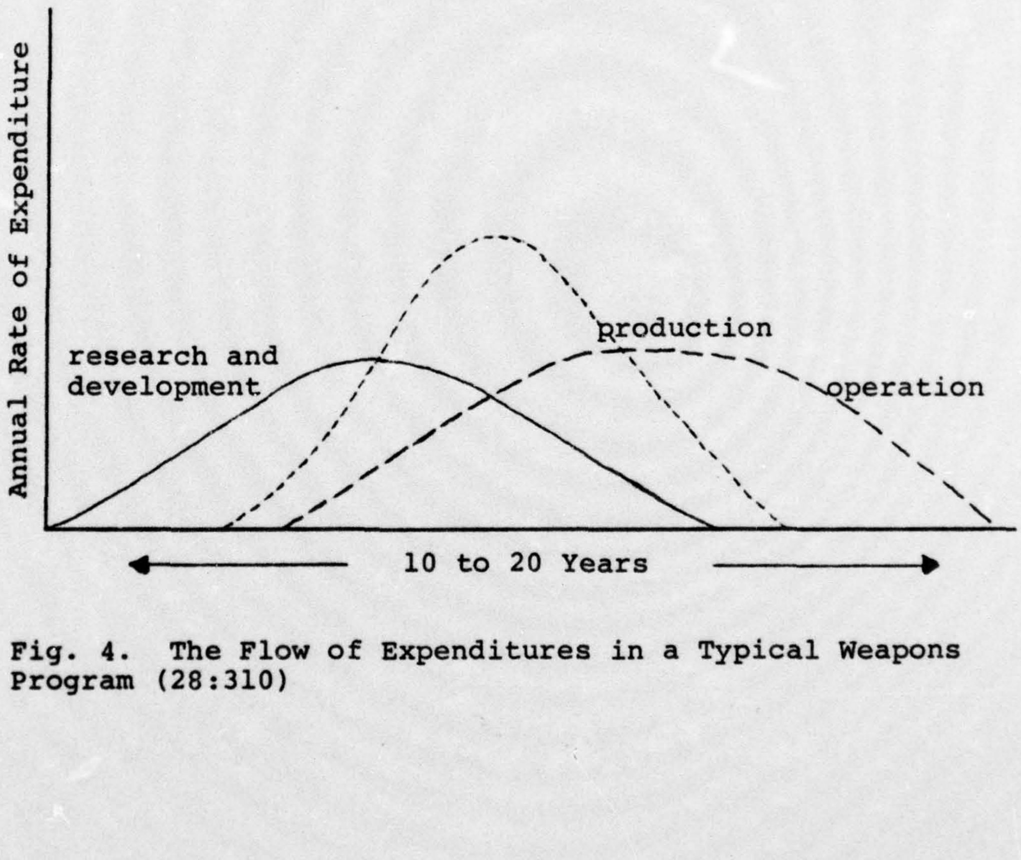

Fig. 4. The Flow of Expenditures in a Typical Weapons Program (28:310)

1.7 times greater than the expenditure for RDT&E activities (31). With the large cost overruns that have been experienced in military procurement programs in recent years, there is a need to reduce the uncertainty level for a weapon system prior to production authorization.

> . . . government should strive to minimize the total sacrifice made by taxpayers . . . [35:20].
>
> . . . .
>
> One objective of government intervention is to enhance the conditions under which economic activity takes place so that the realities of production match production possibilities [35:30].

Previous Production Phase Problems. The preferred method of managing the procurement program of a major weapon system is to prevent potential problems rather than react to problems after they occur (16:537-538). Unfortunately, reactive management has often occurred in the production management of some of our major weapon systems (48:154-166). One primary reason for this reactive management has been the lack of sufficient information by which to make decisions on whether or not to continue funding a major weapon system program. This lack of information commonly occurs when a production phase of a contract is started before the full-scale development phase has identified potential problem areas (48:154-166). The concurrency problem surfaced in the procurement of the C-5A and F-14 weapon systems:

> The C-5A and F-14 aircraft programs demonstrated the problems that can result from lack of early development tests. The Government has paid, and is

> continuing to pay, heavy "penalties" for authorizing extensive contractor production before completion of critical test phases. The overlap of production, development, and related testing is referred to as "concurrency." Illustrations of the impact of concurrency on use of test results follow. Production of all C-5A aircraft was started and more than half of them were produced before completion of ground testing and initial R&D flight tests. Operational aircraft later accepted by the Air Force had 47 major deficiencies of which 14 impaired the aircraft's capabilities to perform all or part of its six missions [48:158].

The need to evaluate a weapon system's readiness to transition from development to production is further discussed by David Packard:

> There has been real waste of both time and money in almost every program in which production was started before development and testing was completed. That includes almost every program [27:4].

The acknowledged production phase problems indicate the need for assessing a program's readiness to transition from development into production before authorizing a contractor to proceed into the production phase of the weapons acquisition process.

CHAPTER II

BACKGROUND

Weapons Acquisition Process Environment

A continuum of uncertainty exists throughout the weapons acquisition process (Figure 5, page 15). The levels of uncertainty can be classified as anticipated unknowns, unanticipated unknowns, and knowns (48:148). The highest degree of uncertainty exists in the very early phases of the weapons acquisition process (conceptual and validation phases). In these early phases the technical, cost, and schedule unknowns are the greatest. As a program proceeds through the weapons acquisition process, more program information is obtained which reduces the level of uncertainty (development and production phases). In these latter phases some unanticipated unknowns may be encountered, but the level of knowns in the uncertainty continuum has increased (48:148). As a weapon system moves into the deployment phase, complete cost, schedule, and technical information should be available for decision making (22:12).

Statement of Key Concepts

The Air Force is currently using various methods such as pre-award surveys, Manufacturing Management/

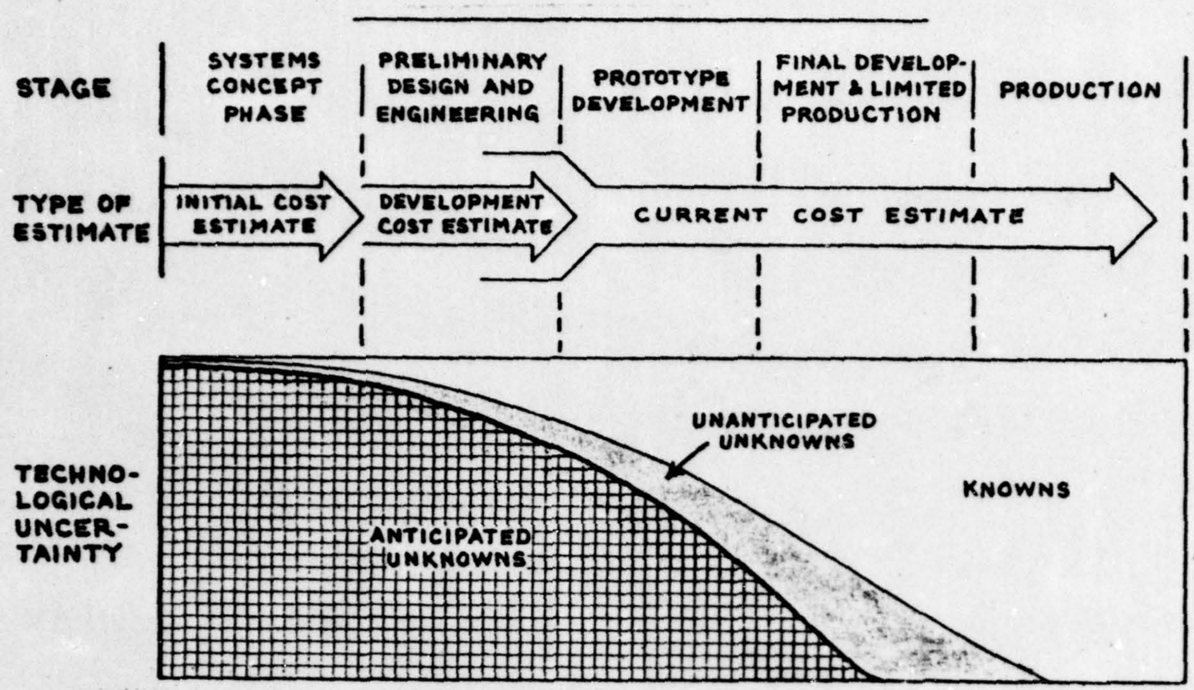

Fig. 5. Major Systems Acquisition--Relationship of Cost Estimates to Degree of Technological Uncertainty at Various Stages of a Major System (48:148).

Production Capability Reviews, and Production Readiness Reviews to reduce the uncertainty level in the production management area throughout the weapons acquisition process (5). Campbell (5) stated that some formal techniques are used prior to contract award, and others are used at selected points in the weapons acquisition process. The formal techniques are used to evaluate a contractor's current capability, potential capability to perform on a contract, or state of readiness to transition from one phase to the succeeding phase of the weapons acquisition process. In addition to the continuous contractor evaluation programs conducted by various government contract management organizations, the formal techniques which are used to evaluate the manufacturing or production capability of a contractor can be categorized into two time periods--source selection process and preproduction phase evaluation (5).

Source Selection Process. Uncertainties must be addressed in the early stages of the weapons acquisition process (21). One management and decision-making mechanism designed to cope with the early confrontation of risk is the source selection process (22:20). The prime objectives of the formalized source selection process are to ensure that:

1. Proposals are solicited and evaluated and the selection decision made with minimum complexity and maximum efficiency.

2. An impartial, equitable, economic but thorough evaluation of each offeror's proposal and related capabilities is accomplished so that the evaluation results can be properly compared and presented to the Source Selection Authority. The intent is to allow the source selection decision maker to objectively select the optimum proposal consistent with government requirements.

3. Solicitations and contracts are *appropriately* structured to equitably distribute technical, financial, and economic or business risks, consistent with the technical requirements and needs of the specific program.

4. The source selection process is sufficiently flexible to accommodate the objectives of the procurement strategy and that the source selection procedures are compatible with program requirements, risks, and conditions [22:20].

According to Mastromonico (22:21), the final evaluation and overall conclusions on the capabilities of a contractor are termed as strengths, weaknesses, and risks. To analyze these factors in the source selection process, realistic and measurable standards are developed. The standards are designed to represent a balance among system performance, schedule, and cost, to allow trade offs and comparisons between alternative proposals (22:21).

In the source selection process, the government has established minimum standards of responsibility to be met by competing prime contractors and their respective subcontractors (38:K-303.2).

Generally surveys include determinations as to whether the prospective contractor (1) has or can obtain adequate financial resources, (2) is able to meet delivery dates, taking into consideration all existing business commitments, (3) has a satisfactory record of performance and integrity, (4) has adequate facilities and technical capability, (5) has an adequate quality assurance program, and (6) is qualified and

> eligible under applicable laws and regulations to receive an award [23:13].

Three formal techniques are currently being used by Air Force procurement to evaluate the contractor's capability in the source selection process--pre-award surveys, Manufacturing Management/Production Capability Reviews (MM/PCR) and "should cost" teams (5).

1. *Pre-Award Survey.* Pre-award surveys (PAS) on potential contractors are requested by the procuring contracting officer (37:1-903.2). According to McQuinn (23:13-14), the PAS is a technique to obtain some information about potential contractors' capabilities in order to reduce the initial uncertainty. The PAS is defined as an evaluation by a government contract administration office of a prospective contractor's capability to perform under the terms of the proposed contract. In practice the pre-award survey is normally limited to an assessment of a contractor's capability, workload, and historical contract performance (23:13-14). A typical pre-award survey team may include the following functional experts: engineer (mechanical, electrical, general), industrial specialist, financial auditor, quality assurance specialist, specialized safety and flight operations officer, industrial labor relations officer, and industrial security officer (23:14).

In requesting the pre-award survey, the purchasing office usually specifies the scope and determines which factors should receive special emphasis (23:13). The procuring contracting officer uses the pre-award survey report, in conjunction with other available information, to determine whether the prospective contractor should be awarded the contract (37:1-903.2). The pre-award survey is used to help reduce the uncertainty concerning the contractor's capability to produce both before initial contract award and/or prior to any subsequent follow-on contract awards to the same contractor (23:13-14).

2. *Manufacturing Management/Production Capability Review (MM/PCR).* The MM/PCR is an effort on the part of AFSC's Aeronautical Systems Division (ASD) to supplement and improve upon the current pre-award survey as a source selection evaluation technique (5). The MM/PCR is not an attempt to replace the pre-award survey; the MM/PCR is recommended as a replacement for the current production management portion of the pre-award survey for major weapon systems (44:1).

The MM/PCR is performed on each contractor being considered for award as part of the source selection process. The MM/PCR was used in the source selection activities for the recent Air Combat Fighter (ACF) competition between General Dynamics and Northrop (5).

The purpose of a MM/PCR is to determine if a contractor has, or can obtain in a timely fashion, the

> required production capability to perform all existing and planned activities including the proposed procurement plus any anticipated follow-on production requirements [44:1].

A team approach is used in performing the MM/PCR (5). The MM/PCR team participants are selected from several government activities including the system program office, the system division production staff, contract management activities, and supplementary personnel from other AFSC divisions and technical organizations as required (44:3). The MM/PCR is used to analyze a contractor's manufacturing proposal at the operational level.

> The report(s) on initial MM/PCR(s) conducted during source selection--pre-award survey phase establish(es) a baseline(s) (point of departure) for subsequent Production Readiness Reviews. . . . [44:1-3].

3. *Should Cost.* A third technique currently being used to reduce uncertainty in the source selection process is "should cost." The technique has as its goal the detailed evaluation of a contractor's cost and performance data in order to establish a government position as to what the production of a particular item should cost (47:1).

A major task of military procurement is to select a suitable means to determine what constitutes a fair and reasonable price for a weapon system (23:28). A fair and reasonable price is one that provides an adequate profit to the defense contractor to keep him in business, but does not pay for any wasteful and unnecessary business practices (23:28).

McQuinn (23:29) stated that traditionally military procurement has negotiated weapon system prices based on past experience--sometimes called "historical costs" approach. The approach used as its basis the cost of producing a comparable weapon system with some adjustments for inflation, new technology, and more stringent performance requirements. According to McQuinn, Senator William Proxmire and other military procurement critics have denounced the historical approach. They argue that past costs may have been inflated intentionally, through inefficiency, or because no competition existed. Past costs then are misleading base figures to analyze future contracts (23:29). The "should cost" concept is a technique to determine what weapon systems should cost based on reasonable efficiency and economy of operations (12:47).

In general, "should cost" teams study the contractor's on-site operations for an extended period of time reviewing such areas as industrial engineering standards, plant layout, production methods, purchasing systems, accounting systems, and overhead structure. The "should cost" team documents its findings and quantifies the effect that recommended changes would have on the weapon system's final price using the assumption of reasonable economy and efficiency (23:30). The "should cost" approach is described explicitly in military procurement guidelines (47:1).

Preproduction Phase Evaluation. Formalized techniques (e.g., PAS, MM/PCR, "should cost") are available to reduce the uncertainty in the early phases of the weapons acquisition process. But in the latter phases of the process, few information-gathering techniques are available (40:16-23). Some techniques used to reduce uncertainty in the latter phases of the weapons acquisition process are discussed below.

1. *Production Readiness Review (PRR).* A prominent Air Force study group noticed an information gap when it came time to determine if a contractor was ready to transition from the development phase to the production phase of the weapons acquisition process (40:16-23). At this stage of the weapons acquisition process, many of the major weapon system acquisitions may be categorized as bilateral monopolies (21). The monopsonist is the government, and the monopolist is the sole-source contractor (18:264). The Air Force initiated the formal PRR procedure to obtain information for evaluating a sole-source contractor's readiness to make the development to production transition (14:13).

Air Force Systems Command Regulation (AFSCR) 84-2 (42:4) prescribes that the PRR team size and composition be established based on the scope of the review effort. Primary PRR team members normally possess expertise in the following functional areas:

(1) industrial or production engineering, (2) production management, (3) program or project planning and production control, and (4) manufacturing methods, tool design and test requirements, plant layout, etc. (42:4). Since the procurement process involves many related functional disciplines, the PRR team may need to be augmented by experts from other functional areas (14:13).

AFSCR 84-2 (42:3) also states that the PRR team conducts an on-site examination of the contractor's working papers, documents, production methods, processes, and techniques. To assess the contractor's readiness to transition into production, the PRR team looks at existing data and procedures. The contractor is not required to prepare any special data or reports for the review team (42:3). The PRR team uses some predetermined criteria as standards to conduct an orderly, penetrating, and conclusive review (42:4-6).

AFSCR 84-2 (42:3) further stipulates that if a contractor does not meet acceptable standards, then corrective actions within the scope of the contract may be required. The contractor's weak areas are identified in the PRR, and a schedule for subsequent reviews is developed. At the conclusion of the PRR, the PRR team director submits a formal report to the Air Force Program Manager. The report describes the contractor's weak areas and gives a recommendation on the program's production readiness status. Program Managers and other Air Force management levels use the final PRR report to make their final production recommendation to other Department of Defense agencies (42:3).

Air Force Systems Command (AFSC) has three major product divisions--Electronic Systems Division (ESD), Hanscom AFB, Massachusetts; Aeronautical Systems Division (ASD), Wright-Patterson AFB, Ohio; and Space and Missile Systems Organization (SAMSO), Los Angeles, California (20). Production Readiness Reviews have been conducted at each of these three divisions in some form. A background review disclosed the list of PRRs in Table 1 that have been completed or are in progress (13).

Table 1

Production Readiness Review Programs

AFSC Procuring Division	Number PRRs Completed or in Progress	Air Force Programs
ESD	1	AWACS
ASD	5	B-1 A-10 F-15 F-16 ARC 164
SAMSO	2	Minuteman Mark XII Shroud Communications Satellite/TRW

2. *Preproduction Evaluation Contracts.* Nolan (25:15-16) stated that one major problem area in making the transition from development to production efficiently and economically is the control or at least the identification of program impacts that may result from engineering changes after production go-ahead. One attempt to alleviate some of the problems in this area has been conducted by United States Army procurement through the use of Preproduction Evaluation contracts (25:15-16). This technique is an early attempt to stop cost escalation that would be associated with engineering changes that occur after contract award (25:15).

A persistent procurement problem is that of contractors "buying-in" with an unusually low bid and then planning for profits from engineering changes (4). To help prevent the problem, Army procurement requests that prospective contractors include an estimate in their initial contract proposal to cover any anticipated engineering changes that may be required for the end item to meet specifications. The Preproduction Evaluation contract is an early attempt to make the contractor analyze and identify the potential cost escalation factors to the procuring activity (25:15-16).

3. *Department of Defense Product Engineering Services Office (PESO).* PESO is a Department of Defense level organization that provides independent assessments

on a military program's readiness to transition from the full-scale development phase into the production phase of the weapons acquisition process (4). PESO, which reports directly to the Deputy Assistant Secretary of Defense (Installations and Logistics) for Production Engineering and Materiel Acquisition, conducts independent production assessment reviews at contractors' facilities. PESO provides a recommendation to DSARC III on the major procurement programs of each military department (4).

4. *Army and Navy Evaluation Techniques.* The formalized Production Readiness Review (PRR) concept is unique to Air Force procurement. The Army (34) and the Navy (9) do not have a comparable evaluation system to determine a contractor's readiness to transition from full-scale development into the production phase of the weapons acquisition process. The other services' buying activities do obtain information to support a DSARC III recommendation, but the review system is not formalized like the Air Force's PRR program (9; 34).

5. *Industry Evaluation Techniques.* Commercial practice is not burdened with many of the complications that surround and impact military procurement (20). Corporations conducting commercial business do not spend taxpayers' money and are not restricted by many of the internal and external factors that are placed on military procurement activities (2:13-26). Instead of meeting a

DSARC level review for program authorizations, program managers and functional managers in private industry normally have more freedom in the management of commercial projects (20).

According to England and Leenders (7:456-465), the factors evaluated by commercial firms in selecting acceptable suppliers are progressiveness, financial strength, honesty and fairness, adequate technical competence, and acceptable production capacity. Information is normally gathered from trade journals, industrial advertising, salesmen, catalogs, trade directories, samples, and plant visits (7:456-465). Nolan (25:6-9) discovered that the commercial firm's purchasing decision is normally based on best judgment. After a commercial firm makes an initial determination that another contractor is able to fulfill a contract, the buyer usually does not question the seller's capability to perform except when the quality of delivered units becomes unacceptable (25:6-9). Although there is sufficient literature on commercial procurement practices, no formalized production readiness evaluation techniques were discovered. The only commercial evaluation methods are those that recommend for the buyer to evaluate production, financial strength, and integrity using best judgment as the guide (25:6-9).

Related Research

The presence of uncertainty within the weapons acquisition process is well recognized (48:148). Military procurement personnel have a major responsibility to reduce the level of uncertainty to an acceptable level before committing taxpayers' money (28:v). To help cope with the uncertainty within the weapons acquisition process, major weapon system authorizations are currently being made in incremental steps by using DSARC in lieu of the old single decision method (26:1-5).

The background review was directed towards the research efforts that had been conducted on the information-gathering processes used by system program offices in making the production transition recommendations. Specifically, the background review concentrated on the research projects dealing with the information-gathering processes currently being used to support the final DSARC evaluation step--transition into the production phase of the weapons acquisition process. The related research can be categorized in three basic areas: (1) general research indicating the need for techniques like the Production Readiness Review (PRR), (2) unpublished reports that are primarily descriptive analyses of the PRR concept, and (3) the nature of the scientific research on the various applications of the PRR technique.

General Research. The majority of research efforts that have indicated the need for information-gathering techniques like the PRR have been government study projects (39:63-82; 40:1; 48:85-86). One well-known study panel discussed the uncertainty within the weapons acquisition process and the requirement to standardize control mechanisms within the procurement process as follows:

> Uncertainty is inherent in the nature of the programs which involve advances in technology and this uncertainty makes it inevitable that some degree of cost growth, delays, and short-falls in desired performance will occur in some programs. The frequency and magnitude of such problems which have been experienced, however, surpass significantly those which can be attributable to unavoidable causes. It is clear that a substantial portion of the acquisition problems must be attributed to management deficiencies [34:63].
>
> . . . .
>
> . . . there has been little standardization or reduction in the number of management control systems contractually applied [34:82].

The underlying problem in the acquisition of major weapon systems is "the lack of visibility over the key decisions that control the purpose and direction of system acquisition programs [48:70]." The Congress, DSARC, and other government leaders should receive sufficient information to make the "right" program decisions and funding commitments (48:85-86). The need to have sufficient information for the decision-making process was discussed in one report as follows:

> One of the primary findings of our study is that too much is committed to individual major systems

> before ideas, needs, designs, and hardware are tested and evaluated . . . .
>
> . . . .
>
> . . . just prior to a planned full-production commitment, tests should be conducted for the specific purpose of making a "go/no-go" decision [48:85-86].

In 1970, Mr. Philip N. Whittaker, the Assistant Secretary of the Air Force for Installations and Logistics, expressed concern about whether sufficient emphasis was being given within the Air Force to the preparation for and the management of the production phase of major weapon acquisitions (50:1). An Air Force study was conducted to determine if the Air Force had acceptable procedures to (1) accomplish production planning during the full-scale development phase of the weapons acquisition process, (2) formally document and review production criteria prior to the production go-ahead decision, and (3) continuously monitor the production program after the production decision is made (40:1). The study team conducted comprehensive reviews of Air Force Systems Command's production management activities in various field organizations, system program offices, and contractor plants. One specific recommendation of the study group was that the Air Force should conduct and document a formal Production Readiness Review (PRR) prior to the production decision for a major weapon system (43:3). As a result of the study, a PRR requirement was levied on all major weapon system procurements, and an AFSC regulation was published to cover application of the PRR concept (42:1). PRRs are currently being conducted by most of the production management organizations throughout Air Force Systems Command (13).

Unpublished Reports. Only two unpublished reports have been located on the PRR concept. In the first report, Hagen (14:1-17) made a cursory review of PRR as part of an analysis of the Air Force's current approach to production management. Although the production management function has been delegated the responsibility for the PRR, assistance is required from each functional directorate within the system program office, Air Force Plant Representative Office, various Air Force Laboratories, and the contractor's organization. The PRR must be coordinated to include the results of engineering, configuration, and testing outcomes (14:13).

In the second unpublished report, Lockwood stated that the PRR is useful for assessing the readiness of a program to enter the production phase of the weapons acquisition process and for anticipating future success on the program (19:i). The Air Force Systems Command's Aeronautical Systems Division has used the PRR concept on several programs (5). Lockwood (19:12-13) stated that even though application of the PRR concept is still in its infancy, a number of advantages have been derived from conducting PRR programs. First, the PRR participants become more familiar with the hardware being produced, the contractor's management systems, the functional disciplines other than production management, and the interactions required to develop a contractor/government management team. Second, a PRR increases the probability of detecting production problems early enough to implement corrective actions. Third, the PRR concept provides a reorientation to insure that producibility[1] aspects are considered earlier in engineering design activity (19:12-13). Lockwood further stated that:

> A Production Readiness Review that is considered with the objectives of (a) identifying current problems and solving them and (b) identifying potential problems and preventing them will lead to a decision to enter a production program that will minimize the sacrifice by the taxpayer. Objectively conducted in an open, cooperative manner, the Production Readiness Review can yield mutual benefits to both buyer and seller [19:15].

Status of Scientific Reseach. The Production Readiness Review was established to help reduce uncertainty and provide more control within the DSARC decision-making process (42:1-5). No scientific research was located that dealt solely with current applications of the Air Force PRR concept. The Logistics Management Institute (30:1) and the RAND Corporation have not conducted any research in the area of the Production Readiness Review concept. The Defense Documentation Center and the

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[1]Producibility means to design a product that can also be efficiently manufactured (12:20-21).

Defense Logistics Studies Information Exchange do not have any research publications pertaining directly to the subject of PRR.

Many organizations have expressed interest in receiving the end product of research conducted in the PRR area. Major organizations interested in the PRR research results include Headquarters AFSC (24), AFIT School of Systems and Logistics Continuing Education Division (13), F-16 System Program Office (10), Airborne Warning and Control System Program Office (49), B-1 System Program Office (6), and the Simulator System Program Office (11).

Scope of Research

Since the PRR requirement was levied by Air Force Systems Command in November, 1971, eight Production Readiness Reviews have been completed or are currently in progress (13). Of these eight PRR programs, this research effort was limited to three major weapon system programs that have completed a PRR program and have received a DSARC III decision. By limiting the research to the programs that have conducted a complete PRR program, the entire PRR program cycle from PRR program planning to final DSARC III review could be analyzed to determine the possible applications to future major weapon system PRR programs.

Research Objectives

The research effort had two objectives. The first objective was to analyze the PRR programs that have been completed on major Air Force weapon system programs to date to determine what disparities existed among the PRR approaches. The second objective was to determine if a standard PRR approach was feasible to satisfy the Air Force Systems Command Regulation (AFSCR) 84-2 requirements.

Research Hypotheses

1. Air Force major weapon system programs utilize different Production Readiness Review (PRR) program approaches to comply with AFSCR 84-2.

2. Air Force Systems Command major weapon system program offices can follow a standard Production Readiness Review (PRR) approach to comply with AFSCR 84-2.

CHAPTER III

RESEARCH METHODOLOGY

The previous two chapters described the background of the current production management situation as related to the Production Readiness Reviews (PRR) and discussed the need to reduce uncertainty before transitioning from the development phase into the production phase of the weapons acquisition process. The use of the Production Readiness Review (PRR) by AFSC to help reduce uncertainty before committing production funds for major weapon systems was also discussed. This chapter describes the universe and population of interest for the research, identifies and operationally defines the variables used in the data collection process, and describes the procedures used in analyzing the data obtained in the research.

Universe Description

Since Production Readiness Reviews (PRR) are unique to Air Force Systems Command (AFSC) procurement activities, the universe for the research consisted of those major weapon system programs that were required to adhere to AFSCR 84-2 and which had an estimated Research, Development, Test and Evaluation (RDT&E) cost exceeding \$50 million or an estimated production cost exceeding \$200 million (41:1). Two populations were identified within the universe. Population I consisted of those major weapon system programs within AFSC that had completed an entire PRR program and had met a DSARC III review. Population II consisted of those Air Force Systems Command major weapon system programs that are presently conducting PRR programs or will be required to conduct PRR programs in the future.

Population of Interest

A census of Population I was conducted in the research. Population I consisted of three major weapon system programs: (1) Airborne Warning and Control System (AWACS), which is being procured by AFSC's Electronic Systems Division,Hanscom AFB, Massachusetts; (2) F-15 System, which is being procured by AFSC's Aeronautical Systems Division, Wright-Patterson AFB, Ohio; and (3) A-10 System, which is being procured by AFSC's Aeronautical Systems Division, Wright-Patterson AFB, Ohio. The three major weapon system programs have gone through the entire PRR process beginning with the planning stage and culminating with the final DSARC III review.

Research Hypothesis No. 1

Data Collection

The interview technique was used as the means of collecting data for testing Research Hypothesis No. 1. Personnel in two types of government offices, the major weapon system program office (SPO) and the Air Force

Plant Representative Office (AFPRO) located at the pertinent prime contractor's facility, were interviewed to collect data on each of the three major weapon system programs which have completed PRR programs. The personnel within the SPOs and the AFPROs who had the primary responsibility for conducting the PRR programs were interviewed.

Interview Guide No. 1, which is furnished in Appendix A, was used to interview the personnel in both the SPOs and the AFPROs for all three major system programs. By requesting two different organizations (i.e., SPOs and AFPROs) to provide data on standard variables for each PRR program, internal validity of data gathering was enhanced.

Identification/Definition of Variables

The variables analyzed for Research Hypothesis No. 1 consisted of factors that could be objectively compared to determine if there were differences of practical importance among the three AFSC PRR programs that have been conducted to date. The variables that were measured and the corresponding measurement scales and value levels for the variables for the three major weapon system programs are provided in Table 2 (pages 38-39). Each variable for Research Hypothesis No. 1 is identified and operationally defined in the following discussion.

PRR Visits to Prime Contractor. PRR visits to prime contractor are the total number of visits that a

Table 2

Variables for Research Hypothesis No. 1

Name of Variable	Measurement Scale	Value Level* (Discrete)	F-15	A-10	AWACS
PRR Visits to Prime Contractor**	Ratio	Infinite			
PRR Visits to Subcontractors	Ratio	Infinite			
Different Skills (SPO)**	Ratio	Multiple			
PRR Team Members (SPO)**	Ratio	Infinite			
Different Skills (AFPRO)††	Ratio	Infinite			
PRR Team Members (AFPRO)††	Ratio	Infinite			
Supplemental PRR Team Members	Ratio	Infinite			
Duration of PRR Program†	Ratio	Infinite			

Table 2--Continued

Name of Variable	Measurement Scale	Value Level* (Discrete)	F-15	A-10	AWACS
Verbatim AFSCR 84-2 PRR Questions	Ratio	Infinite			
Additional PRR Questions	Ratio	Infinite			
PRR Program Cost (SPO)§ **	Ratio	Infinite			
PRR Program Cost (AFPRO)§ ††	Ratio	Infinite			

*All variables are classified discrete with the following value levels (46:211):
a. *Dichotomous*--2 categories of data.
b. *Limited*--3-6 categories of data.
c. *Multiple*--7-19 categories of data.
d. *Infinite*--Greater than 20 categories of data.

†Duration of PRR program reported to nearest month.
§PRR program cost reported to nearest dollar.
**For SPO interview only.
††For AFPRO interview only.

system program office PRR team of any size made to review the production readiness of the prime contractor using the AFSCR 84-2 questions as guidance (42:5-6).

<u>PRR Visits to Subcontractors</u>. PRR visits to subcontractors are the total number of visits that an entire PRR team of any size made to review the production readiness of any subcontractor using AFSCR 84-2 as guidance (42:5-6).

<u>Different Skills (SPO)</u>. Different skills (SPO) are the total number of functional skills represented in the system program office's PRR visits to any contractor. Functional skill is each different job classification as determined by an individual's position description.

<u>PRR Team Members (SPO)</u>. PRR team members (SPO) are the total number of visits to any contractor made by all personnel from the system program office as a participant on a PRR team using AFSCR 84-2 as a guide (42:5-6). Each visit made by each SPO PRR team member to any contractor was counted as one PRR team member (SPO).

<u>Different Skills (AFPRO)</u>. Different skills (AFPRO) are the total number of functional skills represented from the local Air Force Plant Representative Office (AFPRO) at all PRR meetings held with the prime contractor or any subcontractors using AFSCR 84-2 as guidance (42:5-6).

Functional skill is each different job classification as determined by an individual's position description.

<u>PRR Team Members (AFPRO)</u>. PRR team members (AFPRO) are the total number of times all Air Force Plant Representative Office personnel participated as a PRR team member on any review held at the prime contractor's facility or any visit to a subcontractor using AFSCR 84-2 as guidance (42:5-6). Each different visit or participation for each PRR team member was counted as one PRR team member (AFPRO).

<u>Supplemental PRR Team Members</u>. Supplemental PRR team members are the total number of visits to any contractor made by all personnel not in the system program office or AFPRO to participate on a PRR team with AFSCR 84-2 as guidance (42:5-6). Each visit made by each supplemental PRR team member to any contractor was counted as one supplemental PRR team member.

<u>Duration of PRR Program</u>. Duration of PRR program is the total amount of time (in months) from the start of the planning phase of the PRR program up to the time of the DSARC III review. The start of the PRR planning phase is defined as that point in time when the system program office actually began working on the PRR program.

Verbatim AFSCR 84-2 PRR Questions. Verbatim AFSCR 84-2 PRR questions (Appendix B) are the total number of the twenty-five standard AFSCR 84-2 PRR questions (42:5-6) that were used on any PRR visit for the entire PRR program. Each of the twenty-five questions was counted only once.

Additional PRR Questions. Additional PRR questions are the total number of questions used in the PRR program that were either modified AFSCR 84-2 questions or new questions addressing other areas not covered by the AFSCR 84-2 questions (42:5-6). Each additional PRR question was counted only once.

PRR Program Cost *(SPO)*. PRR *program* cost (SPO) is the total estimated cost incurred by the system program office in conducting the entire PRR program. The estimate included PRR contractual coverage expenses, temporary duty travel expenses, typing expenses, report publication expenses, manpower costs, etc. that could be directly attributed to the conduct of the entire PRR program.

PRR Program Cost (AFPRO). PRR program cost (AFPRO) is the total estimated cost incurred by the AFPRO in conducting the entire PRR program. The estimate includes temporary duty travel expenses, typing expenses, report publication expenses, manpower costs, etc. that could be directly attributed to the conduct of the entire PRR program.

Design to Test Research Hypothesis No. 1

Since a census of Population I was conducted for Research Hypothesis No. 1, statistical inference techniques were not appropriate (46:185). To determine the variability in the PRR approaches to date, the census data were tabulated and are discussed in the findings portion of the research. A coded variability (CV) value was computed for each variable for each of the three completed PRR programs. The basis and methodology for determining the CV values are explained in detail in Appendix C.

Criteria Test

The criteria test for Research Hypothesis No. 1 addressed the question of what practical importance is a difference in the PRR approaches taken by the major weapon system programs. The criteria test for Research Hypothesis No. 1 was determined after data collection by analyzing the actual data and looking for large average coded variability values ($\overline{CV}$) for the twelve variables among the three PRR programs. The researchers reasoned that if, on the average, the actual data values exceeded the lowest data value by a factor greater than one for a majority of the twelve variables, then Research Hypothesis No. 1 would be supported. An expert opinion was that if eight or more variables in Table 2 (page 38) could be determined to be different by a $\overline{CV}$ of greater than 1.5 for the three PRR programs, the conclusion would then be that the PRR programs were conducted differently (20).

Research Hypothesis No. 2

Data Collection

The personal interview technique was also the means for collecting data for testing Research Hypothesis No. 2. Interview Guide No. 2, which is furnished in Appendix D, was used to conduct the interviews. The survey respondents for the second hypothesis were ten production management experts within Air Force Systems Command (AFSC). The AFSC production management experts were required to possess the following qualifications: (1) active in the production management area for at least three years, (2) involved in the management of major Air Force weapon systems for at least five years, and (3) involved in the planning or implementation of at least one AFSC PRR program. The key determinant for selecting the production management experts was their previous PRR experience. The selection of the AFSC production management experts was limited by the fact that few AFSC personnel met the qualification of actually having participated in a PRR program (20). Therefore, the selection of AFSC production management experts was judgmental. The AFSC production management experts who were selected for the study effort are identified in Appendix E.

Identification/Definition of Variables

In collecting the data for testing Research Hypothesis No. 2, the ten AFSC production management experts were requested to rank the twenty-five standard PRR questions listed in AFSCR 84-2 (42:5-6) in order of importance for future PRR programs. The twenty-five AFSCR 84-2 PRR questions (42:5-6), which are furnished in Appendix B, are the variables for which the ordinal rankings were obtained. Interview Guide No. 2 (Appendix D) contains the following specific instructions that were used to request the experts to rank the PRR questions:

> To determine if a standard PRR approach can be developed to be universally and practically applied to different AFSC weapon system programs, rank the twenty-five standard PRR questions in AFSCR 84-2 (42:5-6) in order of importance. A "one" should be assigned to the PRR question that should have the greatest amount of time and resources expended for analysis and reporting, and a "twenty five" should be assigned to the least important question [Appendix D, page 122].

Design to Test Research
Hypothesis No. 2

To test the research hypothesis that a standard PRR approach is feasible, the following nonparametric Friedman two-way analysis-of-variance-by-ranks test (33:166) was used. The null hypothesis (H_0) for the Friedman test was that there was no difference among the mean ranks for the twenty-five AFSCR 84-2 PRR questions; therefore, the ten production management experts would not agree on the rankings for the twenty-five questions. The alternate hypothesis (H_1) for the Friedman test was that there were differences among the mean ranks for the twenty-five AFSCR 84-2 PRR questions; therefore, the ten experts would agree on the rankings for the twenty-five AFSCR 84-2 PRR questions. If the ten AFSC experts agreed on all twenty-five AFSCR 84-2 PRR questions (i.e., reject H_0), then Research Hypothesis No. 2 would be supported, and it may be concluded that application of the AFSCR 84-2 questions is universal regardless of individual weapon system program characteristics.

Friedman Two-Way Analysis-of-Variance-by-Ranks Test. Since the ranking data of the ten AFSC production management experts were on an ordinal scale, the Friedman two-way analysis-of-variance-by-ranks test was used to test the null hypothesis that the different columns of ranks (samples) from the ten AFSC production management experts were drawn from the same population (33:166). For the Friedman test, it was assumed that the observations were independent and the variables under study had underlying continuity (33:31). The data were placed in a two-way table having N rows and k columns (33:166). The rows represented the ten AFSC production management experts, and the columns represented the twenty-five AFSCR 84-2 PRR questions (Table 3, page 48). Each row gives the rank scores of one expert for the twenty-five AFSCR 84-2 PRR questions. The scores in each row were ranked independently with the ranks in any one row ranging from one through twenty five. The Friedman test determined if the columns of ranks came from the same population (33:166).

The following procedures were used to conduct the Friedman test (33:166-172):

1. The null hypothesis (H_0) is that there was no difference among the mean ranks for the twenty-five AFSCR 84-2 PRR questions; therefore, the ten production management experts did not agree on the rankings for the twenty-five AFSCR 84-2 PRR questions (42:5-6). The alternate hypothesis (H_1) is that there were differences among the mean ranks for the twenty-five AFSCR 84-2 PRR questions; therefore, the ten experts did agree on the rankings for the twenty-five AFSCR 84-2 questions (42:5-6).

2. The level of significance (alpha) for the Friedman test was set at .05.

Table 3

AFSC Production Management Expert Rankings for the Twenty-Five Standard AFSCR 84-2 PRR Questions (42:5-6)

AFSC Expert	Twenty-Five AFSCR 84-2 PRR Questions																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
Total																									

3. The rank order scores were placed in the two-way table having k columns (one column for each of the twenty-five AFSCR 84-2 questions) and N rows (one row for each of the ten AFSC experts).

4. The sum of the ranks was determined for each column (R_j).

5. The value of χ^2_{ranks} was computed in the following manner:

$$\chi^2_{\text{ranks}} = \frac{12}{Nk(k+1)}\sum_{j=1}^{k}(R_j)^2 - 3N(k+1)$$

where:

N = Number of rows in two-way table.

k = Number of columns in two-way table.

R_j = Sum of ranks in jth column.

$\sum_{j=1}^{k}$ = Directs one to sum the squares of the sums of ranks over all k.

6. The critical value for the .05 level of significance test was determined from the chi-square distribution table using $k-1$ degrees of freedom.

7. The χ^2_{ranks} was compared against the critical value obtained in Step 6. If the χ^2_{ranks} exceeded the critical value, the conclusion was to reject H_0 (the null

hypothesis of no difference among the mean ranks). The conclusion would then be that the ten AFSC production management experts did agree on the rankings for the twenty-five AFSCR 84-2 PRR questions (42:5-6).

Friedman Pilot Study Results

Since realistic data were not available until the actual interviews, a simulation technique was used to generate ordinal ranking data to test the Friedman two-way analysis-of-variance-by-ranks procedure for assessing agreement among the ten AFSC production management experts. Random numbers from "one" to "twenty five" were obtained to simulate the rankings of the twenty-five AFSCR 84-2 PRR questions for each of the ten AFSC experts. The random number table contained in the *CRC Standard Mathematical Tables* was utilized to select the ten AFSC experts' simulated responses (32:628-632). Ten different starting points or seeds were used, and different progression schemes were followed to select the ordinal rankings. The data in Table 4 (page 51) were collected by following the simulation procedure. The rows represented the ten AFSC production management experts, and the columns represented the twenty-five AFSCR 84-2 PRR questions. Each row represented the rank scores of one expert for the twenty-five AFSCR 84-2 PRR questions.

The simulated value of χ^2_{ranks} was computed in the following manner:

Table 4

Pilot Study of AFSC Production Management Expert Rankings for the Twenty-Five PRR Questions

AFSC Exp.	Twenty-Five AFSCR 84-2 PRR Questions											
	1	2	3	4	5	6	7	8	9	10	11	12
1	15	18	6	20	9	11	22	14	24	5	17	13
2	12	21	20	4	7	10	1	25	22	6	11	5
3	13	21	10	24	19	11	25	17	1	6	16	18
4	24	7	18	1	10	2	11	5	3	22	8	14
5	12	11	25	13	14	22	2	17	19	20	3	5
6	6	13	25	14	9	4	22	21	15	5	24	17
7	25	19	12	1	14	4	6	17	3	18	5	9
8	21	10	3	2	18	14	13	25	7	9	5	4
9	13	16	24	22	2	7	21	3	17	11	6	18
10	21	13	22	2	17	15	4	24	5	9	8	16
R_j	162	149	165	103	119	100	127	168	116	111	103	119

Table 4--Continued

AFSC Exp.	Twenty-Five AFSCR 84-2 PRR Questions												
	13	14	15	16	17	18	19	20	21	22	23	24	25
1	4	8	25	12	2	1	19	7	16	3	21	10	23
2	18	2	16	3	8	9	14	24	17	23	13	19	15
3	14	15	12	22	8	7	4	20	9	2	3	23	5
4	20	12	25	13	17	19	6	21	9	23	16	15	4
5	6	24	21	1	9	23	10	7	18	16	15	4	8
6	18	10	7	2	19	20	12	25	8	3	1	23	11
7	23	2	22	11	16	15	7	8	13	20	24	10	21
8	24	15	20	6	17	23	16	8	11	22	19	1	12
9	1	14	12	19	10	20	23	25	9	4	8	5	15
10	11	12	14	25	19	20	6	18	3	7	23	1	10
R_j	139	114	174	114	125	157	117	163	113	123	143	111	124

SOURCE: U.S. Air Force Systems Command. Production Readiness Review. AFSCR 84-2. Washington, D.C., 23 November 1971, pp. 5-6.

$$\chi^2_{ranks} = \frac{12}{Nk(k+1)} \sum_{j=1}^{k} (R_j)^2 - 3N(k+1)$$

where:

$N = 10$

$k = 25$

R_j = provided in Table 4 (page 51) for $j=1,2,...,25$.

$$\sum_{j=1}^{25} (R_j)^2 = 437,505$$

So,

$$\chi^2_{ranks} = \frac{12}{(10)(25)(26)} (437,505) - (3)(10)(26)$$

$$= 807.7015 - 780$$

$$= 27.7015$$

The critical value for the .05 level of significance test was obtained from the chi-square distribution table using $k-1=24$ degrees of freedom. So, $\chi^2_{critical}=36.4$. Since $\chi^2_{ranks}=27.7015$ was less than the critical value, the conclusion was to fail to reject H_0 (the null hypothesis of no difference among the mean ranks).

By using artificial data from the random number table, there was insufficient evidence to conclude that the ten AFSC production management experts did agree on the rankings for the twenty-five AFSCR 84-2 PRR questions. The conclusion was that the ten AFSC production experts did not agree on the rankings for the twenty-five AFSCR 84-2 PRR questions. Since the conclusion in the simulated Friedman test was to fail to reject H_0, it indicated that the twenty-five AFSCR 84-2 PRR questions could not be universally applied regardless of individual weapon system program characteristics. Since the artificial data were randomly generated, and since the random numbers were assigned as rank order values, the results of the Friedman two-way analysis-of-variance-by-ranks test was as anticipated. To have rejected H_0 in the Friedman test, the random numbers that were generated for the test would have had to simulate actual agreement among the ten AFSC experts' rankings.

Criteria Test

The criteria test for Research Hypothesis No. 2 addresses the question of what practical importance is standardization in the selection or use of the AFSCR 84-2 PRR questions (42:5-6). By highlighting the AFSCR 84-2 PRR questions that should receive the greatest emphasis in terms of resources expended regardless of program characteristics, greater returns should result from PRR program inputs (20). If the Friedman two-way analysis-of-variance-by-ranks test (33:166-172) determined that the ten AFSC production management experts did agree on the rankings for all twenty-five AFSCR 84-2 PRR questions (42:5-6) at the .05 level of significance, then the conclusion would be that a standard PRR approach is feasible.

Generalization

The findings in support of Research Hypothesis No. 1 were not generalized outside of Population I. But, after analyzing the data for Research Hypothesis No. 2, an attempt was made to predict the factors that should be emphasized in planning and implementing PRR programs for future Air Force major weapon systems.

Validity of Measurement Instruments

The measurement instruments that were used for collecting data for testing Research Hypotheses No. 1 and No. 2 were coordinated with production management instructors in the Air Force Institute of Technology Continuing Education Division (13) and with a Research Associate in the Air Force Business Research Management Center (20). Comments were received on the accuracy and validity of the measurement instruments, and the measurement instruments were modified to incorporate recommended changes.

Summary List of Assumptions

1. The data for analyzing Research Hypothesis No. 1 were independently provided by individuals from the system program offices and the Air Force Plant Representative Offices.

2. Any variables omitted in data collection and analysis had no significant impact on the research results.

3. All estimates supplied by the data sources reflect the real-world situation.

4. Interview respondents interpreted the twenty-five AFSCR 84-2 PRR questions (42:5-6) in the same manner.

5. For the nonparametric statistical tests, the observations are independent, and the variables under study have underlying continuity (33:31).

Summary List of Limitations

1. Any political, economic, technological, and social influences beyond the control of the major weapon system program office were omitted from the research.

2. Some aspects of data collection and analysis were limited by the researchers' experience.

3. Some of the original PRR program planners and participants who were involved in the three completed PRR programs were no longer available for interviews in the

system program offices or in the Air Force Plant Representative Offices.

4. Some variables may have been omitted from data collection and analysis.

5. Since a limited number of AFSC production management personnel met the qualifications established in the research, a judgmental selection process was used to obtain the AFSC production management experts.

6. PRR program cost data were not tabulated in the format requested, so the best estimates of the data sources were used.

CHAPTER IV

DATA ANALYSIS

Overview

This chapter includes the specific findings obtained in data collection, analyses of the findings used in testing Research Hypotheses No. 1 and No. 2, and corollary findings obtained from the study effort.

Research Hypothesis No. 1

Primary Findings

Census data were collected on the major Production Readiness Review (PRR) programs which have been conducted on the three major weapon systems that have undergone the DSARC III decision-making process--F-15, A-10, and AWACS. Data collected on each PRR program included: the number of PRR visits to prime contractor, PRR visits to subcontractors, different skills (SPO), PRR team members (SPO), PRR team members (AFPRO), different skills (AFPRO), supplemental PRR team members, duration of PRR program, verbatim AFSCR 84-2 PRR questions, additional PRR questions, estimated PRR program cost (SPO), and estimated PRR program cost (AFPRO). In an effort to analyze Research Hypothesis No. 1, ratio data were collected on the twelve variables listed above. The data were used to objectively assess if differences existed in the conduct of the three major PRR programs completed to date. The data collected for testing Research Hypothesis No. 1 are provided in Appendix F.

The following significant PRR program variations are easily recognizable from the data shown in Appendix F:

1. The AWACS program office made three major visits to the prime contractor to conduct its PRR program, whereas the F-15 and A-10 program offices made over twenty visits to their respective prime contractors solely to conduct PRR program activities. However, the F-15 PRR reviewed more than one prime contractor (20).

2. The F-15 program office made approximately fifty visits to subcontractors to conduct PRR program activities, while the A-10 and AWACS program offices held considerably fewer subcontractor PRR meetings.

3. There were fewer system program office (SPO) personnel involved in the AWACS PRR program effort than in both the F-15 and A-10 PRR programs.

4. The A-10 program office had more AFPRO PRR team members than did both the F-15 and AWACS program offices. This could indicate more AFPRO involvement in the A-10 PRR program effort than in the other two major weapon system PRR programs.

5. The F-15 program office did not use any supplemental PRR team members, whereas the A-10 and AWACS

program offices relied heavily on organizations other than the SPO and AFPRO resources for additional PRR program support.

6. The F-15 PRR program was conducted in five months, whereas the A-10 and AWACS PRR programs lasted thirty and twenty-nine months respectively.

7. The A-10 program office did not use any of the AFSCR 84-2 PRR questions verbatim, whereas the F-15 and AWACS program offices used most of the AFSCR 84-2 PRR questions verbatim.

8. The A-10 program office used approximately 250 additional PRR questions, while the F-15 and AWACS program offices used fewer additional evaluation questions in their respective PRR programs.

9. The A-10 program office spent considerably more dollars to conduct the A-10 PRR program than did both the F-15 and AWACS program offices.

To objectively test Research Hypothesis No. 1, the data provided in Appendix F were coded for comparison against the established criteria test. The coding methodology is provided in Appendix C. The actual calculated average coded variability values ($\overline{CV}$) for the twelve variables are provided in Appendix G.

Summary of Primary Findings

The easily recognizable differences mentioned above suggest that the three major PRR programs were conducted differently. The same indications were obtained from the coded variability calculations provided in Appendix G. Of the twelve variables used for testing Research Hypothesis No. 1, nine of the variables had average coded variability values ($\overline{CV}$) in excess of 1.5. The interpretation of these results is that when comparing each of the three observations for each variable with the lowest value for that particular variable, the average variability for nine of the twelve variables (75 percent) used for testing Research Hypothesis No. 1 exceeded the established criteria test value for the test, which had been set at eight of the twelve total variables.

Research Hypothesis No. 2

Primary Findings

To evaluate Research Hypothesis No. 2, ten Air Force Systems Command (AFSC) production management experts were requested to prioritize the twenty-five AFSCR 84-2 PRR questions. If the ten AFSC experts agreed on the relative importance of evaluating the production management areas covered in the twenty-five AFSCR 84-2 PRR questions, then this would provide support for the hypothesis that a standard approach is feasible for the conduct of future major weapon system Production Readiness Review (PRR) programs. The ten AFSC production management experts were requested to independently rank order the twenty-five AFSCR 84-2 PRR questions. Each expert assigned a "one" to the PRR question that was considered most important and a "twenty five" to the AFSCR 84-2 PRR question of least importance.

First Primary Finding

The actual ranking data from the ten AFSC production management experts for the twenty-five AFSCR 84-2 PRR questions are provided in Appendix H. The primary nonparametric statistical test used for evaluating the agreement among the ten AFSC experts for the twenty-five AFSCR 84-2 PRR questions was the Friedman two-way analysis-of-variance-by-ranks test. To provide additional support for the results obtained from the Friedman test, two additional statistical tests were performed. The second test was the nonparametric Kendall Coefficient of Concordance *W*, and the third statistical test used for verification purposes was the parametric *F* test using the Air Force Institute of Technology's (AFIT) Omnitab II computer program (29:1-44).

Friedman Two-Way Analysis-of-Variance-by-Ranks Test. To conduct the Friedman two-way analysis-of-variance-by-ranks test, the data were placed in a two-way table having ten rows and twenty-five columns. The rows represented the ten AFSC production management experts, and the columns represented the twenty-five AFSCR 84-2 PRR questions. Each row gave the rank scores of one expert for the twenty-five AFSCR 84-2 PRR questions. The scores in each row were ranked independently with the ranks in any one row ranging from one through twenty five. The Friedman test determined if the columns of ranks came from the same population and, hence, whether the ten experts agreed on the relative importance of the twenty-five AFSCR 84-2 PRR questions.

The specific procedure used in conducting the Friedman test was covered in the methodology section of this study, but the null hypothesis (H_0) and the alternate hypothesis (H_1) are iterated at this time for the reader's convenience. The null hypothesis (H_0) was that there would be no difference among the mean ranks for the twenty-five AFSCR 84-2 PRR questions; therefore, the ten AFSC production management experts would not have agreed on the rankings for the twenty-five AFSCR 84-2 PRR questions. The alternate hypothesis (H_1) was that there would be a difference among the mean ranks for the twenty-five AFSCR 84-2 PRR questions; therefore, the ten AFSC production management experts would have agreed on the rankings for the twenty-five AFSCR 84-2 PRR questions.

The actual value of χ^2_{ranks} was computed as follows:

$$\chi^2_{\text{ranks}} = \frac{12}{Nk(k+1)} \sum_{j=1}^{k} (R_j)^2 - 3N(k+1)$$

where:

N = Number of rows in two-way table.

k = Number of columns in two-way table.

R_j = Sum of ranks in *jth* column.

$\sum_{j=1}^{k}$ = Directs one to sum the squares of the sums of ranks over all k.

So,

$$\chi^2_{ranks} = \left[\frac{12}{(10)(25)(26)}\right](455{,}110) - (3)(10)(26)$$

$$= 840.2031 - 780.0000$$

$$= 60.2031$$

The critical value for the .05 level of significance test was determined from the chi-square distribution table using $k-1=25-1=24$ degrees of freedom. The critical value for .05 level of significance and 24 degrees of freedom was determined to be 36.4. Since the $\chi^2_{ranks}=60.2031$ exceeded the critical value of 36.4, the conclusion was made to reject H_0 (the null hypothesis of no difference between the mean ranks). The conclusion was that the ten AFSC production management experts did agree on the rankings for the twenty-five AFSCR 84-2 PRR questions. Since the conclusion was to reject H_0, it may be possible to apply the AFSCR 84-2 PRR questions universally regardless of individual weapon system program characteristics. The Friedman nonparametric test is conservative in nature (i.e., conservative with respect to rejection of H_0). Nonparametric tests are appropriate in those cases in which information concerning the distribution properties of population parameters is limited or not obtainable. As a result of such limitations, the conclusions reached in analyzing these data are more general in nature and the test of H_0 less powerful than if parametric methods requiring stronger assumptions had been utilized (33:19-21).

To further test the null hypothesis (H_0) in the Friedman test, two additional level-of-significance values were used to determine if the initial conclusion would be changed. The critical value at the .01 level of significance with 24 degrees of freedom was determined to be 43.0, and the critical value at the .005 level of significance with 24 degrees of freedom was found to be 45.6. In both cases, the conclusion was the same as before. The $\chi^2_{ranks}=60.2031$ exceeded the critical values, so H_0 was rejected in both cases. The final conclusion from the Friedman test was that the ten AFSC production management experts did agree on the rankings for the twenty-five AFSCR 84-2 PRR questions.

To verify the results obtained from the nonparametric Friedman two-way analysis-of-variance-by-ranks test, two additional statistical tests were conducted--

the nonparametric Kendall Coefficient of Concordance *W* and the parametric *F* test generated from an Omnitab II computer program (29:1-44).

<u>Kendall Coefficient of Concordance *W*</u>. The Kendall Coefficient of Concordance *W* (33:239) is useful for determining the agreement among several experts or the association among three or more variables. The Kendall Coefficient of Concordance *W* has special applications in providing a standard method of ordering entities (i.e., AFSCR 84-2 PRR questions) according to consensus when there is available no objective order of entities (33:239). The actual procedure followed in conducting the nonparametric Kendall Coefficient of Concordance *W* test is provided in Appendix I. The null hypothesis (H_0) for the Kendall Coefficient of Concordance *W* is that the experts' rankings are unrelated to each other. The observations provided in Appendix H were used to make the Kendall Coefficient of Concordance *W* calculations. The actual value of the mean of the R_j was computed as follows:

$$\overline{R_j} = \frac{\Sigma R_j}{N} = \frac{3,250}{25} = 130$$

where:

N = Number of entities to be ranked (25).

R_j = Sum of the ranks assigned to each entity.

$\overline{R_j}$ = Mean of the R_j values.

The sum of the squared deviations (s) of all twenty-five R_j values from $\overline{R_j}$ was calculated as shown below:

$$s = \Sigma(R_j - \overline{R_j})^2$$

$$= 32{,}610$$

An actual value for W was computed as follows:

$$W = \frac{s}{\frac{1}{12}k^2(N^3 - N)}$$

$$= \frac{32{,}610}{\frac{1}{12}(100)(15{,}600)}$$

$$= .25084617$$

where:

k = Number of experts assigning ranks (10).

Since N was larger than seven, the following formula was used to calculate a value for χ^2:

$$\chi^2 = \frac{s}{\frac{1}{12}kN(N+1)} = k(N-1)W$$

$$= 10(24)(.25084617)$$

$$= 60.20308$$

Referring to the table of critical values of chi square (33:249), it was found that the χ^2 greater than or equal to 60.20308 with degrees of freedom equal to $N-1=24$ has a probability of occurrence under H_0 of less than .001. It can be concluded with considerable assurance that the agreement among the ten AFSC production management experts was higher than it would be by chance. Since the probability under H_0 associated with a W value of .25084617 was very low, the null hypothesis (H_0) that the experts' rankings are not related to each other can be rejected. The Kendall Coefficient of Concordance W results gave credence to the outcome obtained from the Friedman two-way analysis-of-variance-by-ranks test.

Parametric F Test. To lend further credence to the results obtained from the Friedman two-way analysis-of-variance-by-ranks test and the Kendall Coefficient of Concordance W test, the parametric F test was used in conducting a one-way analysis of variance on the rankings obtained from the ten AFSC production management experts provided in Appendix H. The *F* test, while parametric, was not applied to the data as if the data permitted the assumptions required for the *F* test. However, when the results of the *F* test are identical to nonparametric test results, the nonparametric results are usually further supported (17). A computer library program (Omnitab II) was used to calculate the values associated with a one-way analysis of variance (29:1-44). The ten by twenty-five matrix of values was entered into the time sharing remote terminals of the CREATE computer at the Air Force Institute of Technology School of Systems and Logistics. The output obtained from the Omnitab II computer package is provided in Appendix J.

The calculated *F* ratio value furnished in Appendix J is 3.139. The *F* critical value for a .05 level of significance with 24 upper degrees of freedom and 225 lower degrees of freedom is 1.52 (32:622). Since the calculated *F* value of 3.139 is greater than the critical *F* value of 1.52, the conclusion was made to reject H_0 (the null hypothesis of no difference between the experts' rankings). There was significant evidence to conclude that the ten AFSC production management experts did agree on the relative importance of applying the twenty-five AFSCR 84-2 PRR questions in a PRR program. So, both nonparametric statistical tests--the Friedman two-way analysis-of-variance-by-ranks test and the Kendall Coefficient of Concordance *W*--and the parametric *F* test in the one-way analysis of variance evidenced the same conclusion that the ten AFSC production management experts did agree on the application and importance of the twenty-five AFSCR 84-2 PRR questions.

AFSCR 84-2 PRR Question Priority List. Since the ten AFSC production management experts did agree on the relative importance of all twenty-five AFSCR 84-2 PRR questions, the medians and means of the ten experts' rankings were determined for each one of the twenty-five AFSCR 84-2 PRR questions. The median and mean calculations are included in Appendix H. The PRR question that had the lowest mean or median value for the ten rankings was identified as the PRR question that should receive the most emphasis in a future PRR program, and the PRR question with the highest mean or median for the ten rankings should receive the least emphasis in future PRR programs.

A comparison of the rankings of the twenty-five AFSCR 84-2 PRR questions using the medians and the means for each column of experts' rankings is provided in Appendix K. As shown in Appendix K, the relative rankings using either the medians or means are very similar. But, the researchers chose to use the means of the ten rankings for each question for two primary reasons (17). First, there are fewer ties in the list of rankings for the twenty-five AFSCR 84-2 PRR questions, so the researchers reduced the subjectivity in placement of some of the tied rankings. Secondly, by using the means, the researchers were using the more parametrically efficient of the two central tendency measures (51:151). The means take into consideration the extreme values in the data set. Using the mean values for the ten rankings for each of the twenty-five AFSCR 84-2 PRR questions, the researchers developed a priority list of PRR questions from most important to least important (Appendix L). All ties are so indicated in Appendix L. Since there were only two pairs of tied rankings, the researchers determined that the tied rankings would have no significant impact on the research results, regardless of the order of placement in the prioritized list of AFSCR 84-2 PRR questions. For each pair of tied rankings, the smaller numbered question, as listed in the present AFSCR 84-2, is provided first in the prioritized list of PRR questions (Appendix L).

Second Primary Finding

In addition to the fact that the ten AFSC production management experts agreed on the relative importance of all twenty-five AFSCR 84-2 PRR questions, the following other primary findings were obtained from the data collection activity for Research Hypothesis No. 2.

The second primary finding was that six of the twenty-five AFSCR 84-2 PRR questions had mean R_j values much lower than the other nineteen mean R_j values. These six PRR questions were AFSCR 84-2 PRR question numbers 1 (producible engineering design), 2 (development engineering problems), 5 (design changes), 6 (advanced production planning), 13 (production impact of unresolved technical problems), and 14 (test program results). A review of the six AFSCR 84-2 PRR questions above indicated that five of the six questions addressed the completion of engineering and testing in some manner.

Third Primary Finding

In the interviews conducted to collect data to test Research Hypothesis No. 1, there was a general consensus of opinion expressed by the respondents that the twenty-five AFSCR 84-2 PRR questions were for the most part comprehensive, covering most of the relevant areas for conducting a PRR program for practically any type of weapon system acquisition. The consensus ranking of the twenty-five AFSCR 84-2 PRR questions by the ten AFSC production management experts (Appendix L) did not agree with the order of the AFSCR 84-2 PRR questions provided in the present AFSCR 84-2 document. Interpretation of this finding is that the present regulation does not prioritize the twenty-five AFSCR 84-2 PRR questions in a manner useful to the system program office charged with the responsibility of conducting a Production Readiness Review (PRR) program.

Summary of Primary Findings

The findings for Research Hypothesis No. 2 center around the fact that the ten AFSC production management experts did agree on the relative importance and application of the twenty-five AFSCR 84-2 PRR questions for future major weapon system programs. A group of engineering and testing completion related questions was placed at the top of the list of prioritized AFSCR 84-2 PRR questions, and there was considerable agreement on the high importance of assuring that the engineering tasks were completed prior to the start of the production phase of the weapons acquisition process. In addition, the current AFSCR 84-2 provides a list of twenty-five AFSCR 84-2 PRR questions that does not agree with the prioritized list of the same twenty-five questions from the ten AFSC production management experts that have had previous PRR program experience.

Corollary Findings

This research effort was directed to the collection, statistical analysis, and interpretation of data to determine first the differences among the three major PRR programs that have been completed to date and secondly the feasibility of using a standard approach to accomplish the Production Readiness Review (PRR) task. In the preceding sections of this chapter, the primary findings were presented. Corollary findings provided in this section are based on collected data, review of Air Force publications pertaining to PRR, discussions with production and procurement personnel who have been actively involved with PRR activity, and the researchers' interpretations of their studies and observations. Support for the two research hypotheses depends on the primary findings. However, the researchers believe that the corollary findings provide additional support for the research conclusions.

First Corollary Finding

An attempt was made in this study to conduct an initial survey concerning the following question: When should the PRR program activity actually begin in the weapons acquisition process? The ten AFSC production management experts were requested to indicate prior to which DSARC's (i.e., DSARC I, II, and/or III) should the twenty-five AFSCR 84-2 PRR questions be evaluated. The ten AFSC production management experts were told that any combination of responses could be provided for this initial survey. The specific responses from the ten AFSC experts are provided in Table 5 (page 75). As shown in Table 5 (page 75), all ten AFSC experts agreed that all twenty-five AFSCR 84-2 PRR questions should be evaluated

Table 5

Ten AFSC Production Management Experts' Responses on Phasing of PRR Evaluation Activity

AFSCR 84-2 PRR Question No.	DSARC I										DSARC II										DSARC III									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
1*			X				X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2*			X								X		X	X	X					X	X	X	X	X	X	X	X	X	X	X
3			X										X			X				X	X	X	X	X	X	X	X	X	X	X
4			X			X	X						X			X	X			X	X	X	X	X	X	X	X	X	X	X
5*	X				X						X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X
6*			X				X			X		X	X	X		X	X			X	X	X	X	X	X	X	X	X	X	X
7*	X		X				X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8*			X	X						X	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X	X	X
9*			X	X						X		X	X	X		X	X			X	X	X	X	X	X	X	X	X	X	X
10*			X	X			X			X	X	X	X	X			X			X	X	X	X	X	X	X	X	X	X	X
11*			X							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
12																				X	X	X	X	X	X	X	X	X	X	X
13*	X		X		X		X				X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X
14			X										X	X						X	X	X	X	X	X	X	X	X	X	X
15												X	X			X				X	X	X	X	X	X	X	X	X	X	X
16*			X									X	X	X			X	X		X	X	X	X	X	X	X	X	X	X	X
17*			X	X								X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
18*			X									X	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X
19*			X	X			X				X	X	X	X	X		X			X	X	X	X	X	X	X	X	X	X	X
20*			X	X						X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
21*							X					X	X	X			X	X		X	X	X	X	X	X	X	X	X	X	X
22*		X	X	X			X					X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
23*				X			X			X		X	X	X	X		X			X	X	X	X	X	X	X	X	X	X	X
24*			X	X			X			X		X	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X
25*			X				X					X	X	X			X			X	X	X	X	X	X	X	X	X	X	X

*Five or more of the ten AFSC production management experts agreed that these twenty AFSCR 84-2 PRR questions should be evaluated prior to DSARC II.

prior to DSARC III. In addition, all ten AFSC production management experts agreed that AFSCR 84-2 PRR question numbers seven (standardization of design) and eleven (make-or-buy structure) should be evaluated prior to DSARC II. Nine of the ten AFSC experts agreed that AFSCR 84-2 question numbers one (producible engineering design) and twenty (laboratory or model shop constraints) should be evaluated prior to DSARC II. In summary, five or more of the ten AFSC production management experts agreed that twenty of the twenty-five AFSCR 84-2 PRR questions should be evaluated prior to DSARC II. Some of the experts contended that some of the AFSCR 84-2 PRR questions should be initially evaluated prior to DSARC I (refer to Table 5, page 75). The consensus of the ten AFSC production management experts was that initial PRR activities should be conducted much earlier than just prior to the preparations for the DSARC III decision-making process.

Second Corollary Finding

It was the opinion of most of the interview respondents that the present AFSCR 84-2 document does not provide sufficient guidance on how to conduct a PRR program. The current AFSCR 84-2 document is vague in some key areas and incomplete in others. For example, there is a general inference in AFSCR 84-2 that a PRR should be a one-time effort accomplished just prior to DSARC III. The weakness of this inference was highlighted by the interview respondents and by the results provided in the first corollary finding. Another major weakness of the present AFSCR 84-2 highlighted by the interview respondents was the lack of sufficient guidance on the PRR team composition. The present AFSCR 84-2 primarily suggests production management personnel as team members and does not emphasize the fact that design engineers and other procurement personnel should be included on the PRR teams as required. The respondents also indicated that the present AFSCR 84-2 provides insufficient guidance on the extent of contractual coverage necessary to conduct a PRR program. PRR programs are presently being conducted under different levels of contractual coverage ranging from full contract coverage to little or no contract coverage for PRR activities.

<u>Third Corollary Finding</u>

The general consensus of the personnel interviewed was that there is a lack of readily available documentation on how previous PRR programs have been conducted to date. Each major weapon system PRR program plan prepared to date was developed from the beginning. No readily accessible lessons-learned information is available for those programs that are now required by AFSCR 84-2 to conduct PRR programs. In addition, the consensus of the interviewees was that there was no Air Force expert available in a staff level position who could provide assistance to a system program office to help develop the initial PRR program plan. Historically, it has been incumbent on each system program office to determine what previous PRR programs had been conducted, contact personnel that had been involved in those previous PRR programs to determine what had actually been accomplished in each PRR program, and finally develop a new PRR program plan, using their research information as a baseline, that would best fit their particular weapon system program.

Fourth Corollary Finding

In collecting data for testing Research Hypothesis No. 1, it became evident that accurate cost data on what it actually did cost the Air Force to conduct PRR programs to date are lacking. As a result, the PRR program cost figures supplied by the system program offices and the Air Force Plant Representative Offices for testing Research Hypothesis No. 1 were very rough estimates on what the PRR program cost each organization. In addition, no data were available on the potential savings that may have accrued to the Air Force as a result of conducting PRR programs. The researchers were unable to obtain any documented cost or savings data for the three major Air Force PRR programs that have been completed to date.

Fifth Corollary Finding

AFSCR 84-2 is directed at the major weapon system programs as defined by DOD Directive 5000.1 as having $50 million for development or $200 million for production (42:1). The AFSCR 84-2 does not provide much assistance for the smaller Air Force Systems Command programs that are just under the threshold levels. But, system program office personnel for the smaller programs are still tasked to make an assessment about the contractor's readiness to transition from the full-scale development phase into the production phase of the weapons acquisition process. Several interview respondents expressed the opinion that a mini-PRR program should be conducted on the smaller Air Force Systems Command weapon system programs.

Sixth Corollary Finding

The information gleaned from the background review indicated that the Air Force is the only military department that conducts a PRR type of analysis prior to movement into the production phase of the weapons acquisition process. The other military departments conduct continuous surveys and analyses in this area, but no formalized procedure or system has been developed to accomplish the task. Additional interviews conducted after the initial background review produced similar results. Based on our research findings, the Air Force remains as the only military department that has a formal PRR procedure. Since movement into the production phase of the weapons acquisition process is very critical and expensive, the researchers conclude that the other military departments should consider establishing similar procedures to ensure that a contractor is ready to make the transition from the full-scale development phase into the production phase of the weapons acquisition process.

CHAPTER V

CONCLUSIONS

Overview

This chapter contains conclusions related to the findings that were discussed in the previous chapter. This research effort had two major objectives. The first objective was to determine what disparities existed among the three PRR programs which have been conducted on major Air Force weapon system programs to date. The second major objective was to determine if a standard PRR approach is feasible in determining whether a contractor is ready to transition from the full-scale development phase into the production phase of the weapons acquisition process.

The primary conclusions are followed by corollary conclusions. The corollary conclusions are provided so that a more complete picture of the Production Readiness Review (PRR) process will be presented. The corollary conclusions were formed as interviews were conducted, documents were reviewed, pertinent data were gathered, and from personal observations of organizational and personal interactions in the organizations responsible for the PRR programs.

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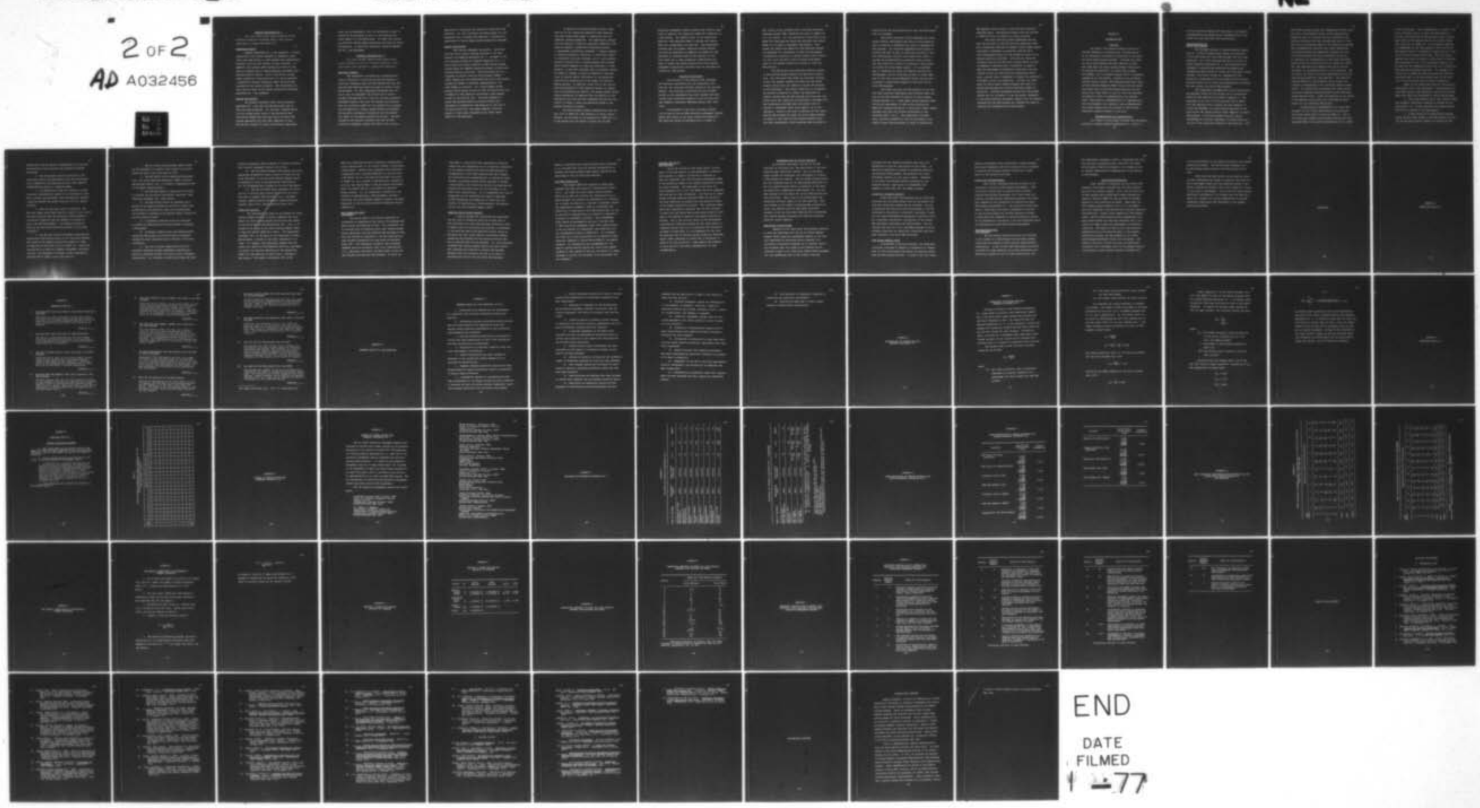

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Research Hypothesis No. 1

Air Force major weapon system programs utilize different Production Readiness Review (PRR) program approaches to comply with AFSCR 84-2.

Hypothesis Support

Research Hypothesis No. 1 was supported. A visual inspection of the twelve variables in Appendix F indicated that some factors in each program were substantially different from the same factors in other programs. In addition, the average coded variability values for the twelve variables used in testing Research Hypothesis No. 1 provided similar results. Nine of the twelve average coded variability values were over 1.5, which indicated a substantial average variability among the three PRR programs for the twelve variables. The established criteria test of eight of the twelve variables for Research Hypothesis No. 1 was exceeded.

General Conclusions

The primary conclusion after testing Research Hypothesis No. 1 was that the PRR approaches used to date have been different. So, the first research objective was accomplished, since it was discovered that significant disparities did exist among the three PRR program approaches that have been completed to date. The specific reasons for using the different approaches could not be determined. But, the conclusion is that it should not be necessary to start at the beginning for every aspect of a new PRR program. At least some factors or activities should remain essentially the same for future PRR programs. To test this contention, Research Hypothesis No. 2 was developed.

<u>Research Hypothesis No. 2</u>

Air Force Systems Command major weapon system program offices can follow a standard Production Readiness Review (PRR) approach to comply with AFSCR 84-2.

<u>Hypothesis Support</u>

The researchers contended that standardization could be obtained in conducting future PRR programs if there were agreement among the AFSC experts who have had previous PRR experience about how best to conduct future PRR programs. So, the researchers determined that one way to test the agreement and feasibility of using a standard PRR approach was to have the ten AFSC production management experts rank order the twenty-five questions that are provided in AFSCR 84-2 as guidance for reviewing various aspects of a weapon system program to determine the program's readiness to transition into the production phase of the weapons acquisition process. The data collection and analysis indicated that the ten AFSC production management experts did agree on the relative importance of evaluating the twenty-five AFSCR 84-2 PRR questions. So, this conclusion provided support for the hypothesis that a standard PRR approach is feasible for application in future weapon system acquisition programs.

General Conclusions

This section addresses the general conclusions from the three primary findings obtained in the data analysis for Research Hypothesis No. 2. As shown in the first primary finding for Research Hypothesis No. 2, a prioritized list should indicate to AFSC system program offices where the emphasis should be placed in future PRR program planning activities. The prioritized list is a consensus of opinion from Air Force Systems Command (AFSC) experts who have experienced the entire PRR process through the stages of planning, implementation, and final DSARC III activity. So, a major weapon system program office should be able to take the prioritized list of AFSCR 84-2 PRR questions and develop a PRR program around the prioritized list. The major emphasis in future PRR programs should be placed in those areas addressed by the AFSCR 84-2 PRR questions at the top of the prioritized list, and lesser emphasis should be placed in those areas addressed by the lower ranked AFSCR 84-2 PRR questions.

As shown by the second primary finding, there were six of the twenty-five AFSCR 84-2 PRR questions that were ranked much higher in importance over the remaining nineteen questions. The researchers conclude that the results on these six questions--AFSCR 84-2 PRR question numbers 1 (producible engineering design), 2 (development engineering problems), 5 (design changes), 6 (advanced production planning), 13 (production impact of unresolved technical problems), and 14 (test program results)--indicate that a system program office should place greater emphasis on these six questions in a PRR program. It was also concluded that a contractor should be tasked to respond to those six AFSCR 84-2 PRR questions in greater detail and earlier in the system program office's preparations for the DSARC III decision-making process. In addition, since five of the top six prioritized AFSCR 84-2 PRR questions pertain to completion of engineering and testing, the system program office should concentrate on assuring that the majority of the engineering activity has been completed and that the contractor is ready to begin the production phase of the weapons acquisition process.

The third primary finding indicated that the current list of AFSCR 84-2 PRR questions is fairly comprehensive, but the order of the questions in AFSCR 84-2 in no way agrees with the manner in which the ten AFSC production management experts perceive the relative importance of applying the twenty-five AFSCR 84-2 questions in a PRR program. The present format of the twenty-five AFSCR 84-2 PRR questions tends to confuse the requirements for accomplishing the PRR task. The researchers conclude that the present regulation should indicate the relative importance of applying the AFSCR 84-2 PRR questions to alleviate some of the confusion in the field about how to best accomplish a PRR program and where to expend the system program office and contract management organization resources that are available for conducting a PRR program.

Corollary Conclusions

This section of the research study addresses the corollary conclusions that the researchers made from the six corollary findings covered in the previous chapter. The corollary conclusions are the interpretations of the researchers from their studies and observations while performing research on the Air Force Systems Command's Production Readiness Review (PRR) technique.

As indicated in the first corollary finding, five or more of the ten AFSC production management experts agreed that twenty of the total twenty-five AFSCR 84-2 PRR questions should be addressed prior to DSARC II.

The initial survey indicated that a one-time Production Readiness Review (PRR) conducted just prior to DSARC III will not suffice. So, the conclusion is that many of the AFSCR 84-2 PRR questions should be evaluated long before DSARC III to insure a successful PRR program. Even though the twenty-five AFSCR 84-2 PRR questions address the readiness of a contractor to make the development-to-production transition, a system program office should not wait until the end of the full-scale development phase of the weapons acquisition process to start the PRR activity.

The second and third corollary findings covered in the previous chapter address the same major problem area. The conclusion from these two corollary findings is that the present guidance available for the system program offices that are tasked to conduct PRR programs is not sufficient. The present AFSCR 84-2 is incomplete and should be modified to reflect the experience or lessons learned from the PRR programs that have been conducted since the regulation was published in November 1971. The researchers concluded that the present level of production management staff level support is, in the aggregate, lacking in the area of planning for and implementing PRR programs for major Air Force weapon systems. An impact is that some critical system program office and other governmental office resources may be wasted by starting from the very beginning for each new PRR program that is initiated.

The fourth corollary finding addresses the costs versus savings relationship that the Air Force should be able to identify to determine the value of implementing PRR programs. The interview respondents were unable to provide cost data on what it costs the Air Force to conduct PRR programs, and the interviewees were unable to provide any documentation on potential dollar savings that may accrue as a result of conducting a PRR program on a major Air Force weapon system. It is concluded that to determine the value and benefits derived from PRR programs, the Air Force must be able to obtain some type of cost data and corresponding dollar savings data to provide a quantifiable measure of the worth of Air Force PRR programs.

The fifth corollary finding pertains to the fact that some interview respondents were concerned about the lack of any PRR guidance for smaller Air Force weapon system programs (i.e., those weapon system programs under $50 million development or $200 million production). AFSCR 84-2 pertains primarily to those major weapon system programs that meet the criteria established in DOD Directive 5000.1 (42:1). The researchers concluded that a portion of AFSCR 84-2 could be dedicated to the smaller weapon system programs in which an abbreviated

PRR approach could be used to cover the key production readiness areas. Preliminary guidance could be provided in AFSCR 84-2 for the smaller Air Force programs.

The final corollary finding addressed the fact that the Air Force is the only military department that has a formalized technique to assess a major weapon system contractor's readiness to transition from the full-scale development phase into the production phase of the weapons acquisition process. Since the Air Force PRR technique evolved from DOD level concerns about the lack of emphasis on assuring that a contractor is ready to make the development-to-production transition, the conclusion is that the other military departments should have a similar type of technique to assess the contractor's readiness to move into production. To date, the three major Air Force weapon system programs that have conducted PRR programs have received favorable DSARC III decisions. Although documented savings from PRR program efforts are not available, it was the general consensus of the AFSC production management experts that the benefits obtained from the PRR programs far exceeded the costs of planning and implementing the PRR programs.

CHAPTER VI

RECOMMENDATIONS

Overview

As noted in the previous chapters, the use of the PRR technique is relatively new, and application of the technique is primarily concentrated on the major Air Force weapon system programs. Although only three Air Force PRR programs have been completed to date, many more major Air Force system program offices will be required by AFSCR 84-2 to conduct PRR programs. For example, the F-16 System Program Office is presently conducting its PRR program. Because of the estimated contract dollar amounts, the Advanced Medium Short Take-off and Landing Transports (AMST) buying activity should soon begin some initial PRR program planning activity. During this study effort on the Air Force PRR programs, two specific areas of recommendations have emerged. First, some specific recommendations for implementation will be discussed; and, secondly, some recommendations for future research will be provided to help channel additional research efforts in this area.

Recommendations for Implementation

As a result of the primary findings and conclusions obtained in testing Research Hypotheses No. 1 and No. 2

and the corollary findings and conclusions, six specific recommendations are presented for implementation by different Air Force and other DOD organizations.

<u>Recommendations for Future PRR Programs</u>

The findings obtained in testing Research Hypothesis No. 1 were not generalized outside the population of the three major Air Force PRR programs that have been completed. But, after analyzing the data collected for testing Research Hypothesis No. 2, the researchers have attempted to provide some guidelines for planning and implementing PRR programs for future Air Force major weapon systems. The action offices for implementing this particular recommendation will be those Air Force system program offices and Air Force Plant Representative Offices who must conduct the future PRR programs.

The researchers recommend that future PRR programs be developed around the prioritized list of twenty-five AFSCR 84-2 PRR questions furnished in Appendix L. The questions at the top of the prioritized list of AFSCR 84-2 PRR questions should receive the most emphasis in future PRR programs; the lower-ranking questions on the prioritized list should receive lesser emphasis in future PRR programs. Future PRR program organizers should acknowledge the critical importance of accomplishing the top six of the twenty-five AFSCR 84-2 PRR questions. The future PRR program planners and implementers should recognize that a considerable amount of PRR program effort should be spent on insuring that most engineering and testing activities have been accomplished prior to movement into the production phase of the acquisition process. This recommendation parallels many recent suggestions of different panels and commissions assigned the task of evaluating present military procurement practices. To implement the recommendation, future SPOs and AFPROs should divide the prioritized list of twenty-five AFSCR 84-2 PRR questions into segments that can be covered thoroughly in incremental visits to the contractor. The contractor can then be initially approached with the six high priority AFSCR 84-2 PRR questions. The remaining nineteen AFSCR 84-2 PRR questions can be broken into sections as determined by the individual system program office. The researchers acknowledge that some new PRR evaluation questions may be generated by each individual system program office. These new questions can be placed in the baseline prioritized list as determined appropriate for the individual PRR program.

Another specific recommendation for future PRR programs is that initial PRR planning and evaluation activities should begin as early as DSARC II. Two of the three major weapon system program offices that have completed PRRs to date spent approximately thirty months on the PRR program. This recommendation is based on the first corollary finding in which the AFSC experts in the area indicated that the PRR program should actually begin early in the weapons acquisition process rather than just prior to DSARC III. An incremental approach is recommended for the PRR program in which the entire PRR program effort is conducted in stages that will coincide with other program activities. This incremental approach has proven successful on PRR programs that have been conducted to date. The incremental approach can be used with the segmented prioritized list of AFSCR 84-2 PRR questions mentioned previously. For example, the initial set of AFSCR 84-2 PRR questions that should be evaluated early in the PRR program would be the first six of the prioritized list provided in Appendix L.

Based on the primary and corollary findings and conclusions, and on the researchers' interpretations of the study results, some additional factors are provided below that should be considered in future PRR programs:

1. The system program office (SPO) should insure that adequate contractual coverage is secured for all contractors (i.e., prime contractor and subcontractors) who will be involved in the PRR program.

2. A PRR convention or preproduction meeting should be held early enough in the PRR program to bring all the PRR participants together to discuss the PRR

program plan and the specific implementation of the plan. The convention should prevent many potential problems downstream.

3. The PRR program should be tailored to the individual program characteristics using the prioritized list of AFSCR 84-2 PRR questions and the other specific recommendations above as a baseline model.

4. If subcontractor PRRs are conducted, a prime contractor representative should be in attendance at each PRR to prevent the government from inadvertently assuming a position between the prime contractor and his subcontractors.

5. When the PRR team visits a contractor, the PRR team leader should make explicit remarks in the initial and exit briefings that the contractor should assume no contractual direction from the comments or actions of any of the PRR team members. All direction should be given by the Procuring Contracting Officer to the prime contractor.

6. The SPO and contract management organizations should begin PRR planning early in the full-scale development phase of the weapons acquisition process in order to complete the PRR effort prior to DSARC III. Sufficient time should be allowed for schedule slippages, contractor revisits, and Department of Defense Product Engineering Services Office (PESO) visits (see page 25).

7. The Air Force Program Manager should direct all SPO personnel to consider their support to the PRR effort as being a very high priority task.

8. The SPO should utilize experienced personnel (e.g., Air Force Materials Laboratory (AFML), previous PRR program experts, etc.) to conduct a comprehensive PRR of the weapon system program.

9. The PRR team should be specifically tailored to evaluate the particular contractors, equipment, manufacturing processes, etc. under review.

10. The PRR subject should be addressed early enough in the weapons acquisition process to insure that producibility and production readiness considerations are included in engineering preliminary design reviews and critical design reviews.

11. A systematic approach should be developed to handle the administrative workload caused in managing a PRR program.

12. Government communication with subcontractors concerning PRR program activities should be conducted through the prime contractor and not directly to the subcontractors.

13. The SPO's routine communication with the secondary delegated contract management organizations should be conducted through the prime contract management organization. As a minimum, the SPO should keep the prime

contract management office informed of the SPO and secondary contract management office's activities.

14. The SPO should document PRR program activities. Background documentation that is used as a basis for the final PRR report to the Air Force Program Manager should be prepared in order to provide backup justification for the recommendations included in the final PRR report.

15. The SPO and AFPRO should determine the availability of existing data sources and utilize the available data to support PRR activities (e.g., pre-award surveys, AFCMD Contractor Management System Evaluation Program, should cost, source selection data, etc.).

AFSCR 84-2 Revision

The researchers are aware of the present Air Force Systems Command activity to write a pamphlet that will assist Air Force system program offices with the conduct of the future MM/PCR and PRR programs (24). But, it is presently the intent of Air Force Systems Command (AFSC) to keep the current AFSCR 84-2 intact. The researchers recommend that, on the basis of the experience of three PRR programs, a rewrite of the basic regulation is in order. For example, the researchers suggest that the twenty-five AFSCR 84-2 PRR questions should be rearranged to reflect the relative importance of the twenty-five AFSCR 84-2 PRR questions to help insure a successful PRR program. The present unorganized list of the

AFSCR 84-2 questions could be eliminated, thereby potentially reducing many of the initial hurdles in developing a PRR program. Another major suggestion that should be incorporated into a revised AFSCR 84-2 is the fact that a PRR should not be a one-time activity held just prior to DSARC III, but, instead, a PRR should be a program of activity that should begin in the full-scale development phase and should lead up to the DSARC III decision-making process. So, the researchers recommend for the Director of Manufacturing, DCS/Procurement and Manufacturing, Air Force Systems Command to rewrite the basic regulation on the Air Force Production Readiness Review (AFSCR 84-2).

More Production Staff Involvement

At present there is no central repository of information or expertise on how various PRR programs have been planned and conducted to date. The information can be obtained only by contacting each major system program office separately that has conducted PRR programs to date. With the turnover of personnel in the SPO organizations, some valuable information and experience are probably being lost. The researchers recommend that increased emphasis should be placed by staff level organizations (i.e., ASD staff, ESD staff, and AFSC staff) on the lessons learned from previous PRR programs. At least one individual in each staff level organization should be tasked with the responsibility for collecting information on the lessons learned from previous PRR programs for dissemination to the field organizations upon request. By centralizing this responsibility in production staff offices, any system program office required to conduct a PRR program in the future can utilize the expertise and request the assistance that will be available in the staff level organizations. It is recommended that overall responsibility for developing the central repository of PRR information and expertise be placed upon the Director of Manufacturing, DCS/Procurement and Manufacturing, Air Force Systems Command (AFSC).

Emphasize Costs Versus Benefits

A major problem that confronted the researchers was the lack of documented costs and savings data on the three major Air Force PRR programs conducted to date. A common trend in instituting new programs or techniques in the past has been blind adherence without trying to determine the cost versus benefit relationship between conducting new programs and the potential savings that may be realized from the new programs. So, the researchers recommend that system program offices and other government organizations required to conduct PRR programs document costs and potential savings in an effort to determine the value of the Air Force PRR technique.

Based on interviews with system program office personnel, it is concluded that cost and savings documentation is feasible and should produce some results indicating the usefulness of the Air Force PRR technique.

Mini-PRR Program Plan

The present AFSCR 84-2 applies to those major programs that meet the criteria of DOD Directive 5000.1 (42:1). For those Air Force weapon system programs which do not meet the criteria for classification as a major program, the guidance for determining if a contractor is ready to produce on a contract is somewhat limited. The researchers recommend a study to investigate the feasibility of developing a mini-PRR program plan for use by the smaller programs that are required to determine a contractor's readiness to produce. This recommended study should be performed by any one of the ASD, ESD, or AFSC production management staff level organizations. It may be feasible to incorporate a mini-PRR plan into the recommended revision of AFSCR 84-2. At a minimum, the first six of the prioritized list of AFSCR 84-2 PRR questions (Appendix L) should be reviewed for the smaller programs. By implementing this recommendation, the smaller system program offices will obtain some needed guidance on what should be done for the smaller Air Force programs to protect the interests of the government and the taxpayers.

Expanded DOD Use of PRR Technique

As of the writing of this study report, the Air Force is the only service to have developed a formalized PRR procedure to assess a contractor's readiness to make the transition from the full-scale development phase to the production phase of the weapons acquisition process for major programs. The experience on the three Air Force programs--F-15, A-10, and AWACS--that have completed PRR programs has been encouraging. All three major weapon system programs received favorable DSARC III decisions and were authorized to proceed into the production phase of the weapons acquisition process. The interview respondents were unanimous in agreeing that the PRR technique is beneficial and should help prevent many potential problems in the production phase of the weapons acquisition process. Due to the critical nature of the development-to-production transition process and the large amount of taxpayers' dollars that will be obligated when production go-ahead is authorized, it is recommended for the other military services to develop similar Production Readiness Review (PRR) procedures to insure that a contractor is ready to go into production. Some general DOD guidance in this area will facilitate implementation of this recommendation.

Recommendations for Future Research

As discussed previously, the use of the PRR technique is relatively new, and application of the technique has been relatively limited. But, as new major weapon systems are developed, the requirement to conduct a PRR program will prevail. The B-1 System Program Office has just completed much of its PRR program activities (6). The F-16 System Program Office is presently in the midst of conducting a comprehensive PRR program (10), and the AMST program will soon begin the initial PRR program planning activities. Much is yet to be learned about the usefulness and total impact of the PRR technique. With the increase in the number of PRR programs available for study, the possibilities for additional meaningful research on the Air Force PRR technique will be enhanced. This section briefly discusses five specific potential areas for future research.

Replication of This Study

Research on the three major PRR programs conducted to date and interviews with the ten Air Force Systems Command (AFSC) production management experts on the relative importance of evaluating certain features of a contractor's production readiness do not present conclusive evidence that the trends of the findings can be inferred to apply to all AFSC major weapon system programs. But, the methodology used in the instant study was validated and the research procedures have been well-documented to allow for replication of this study. As additional experience is gained in conducting effective and efficient PRR programs, the potential for future meaningful research in this area is great. Therefore, in an effort to establish greater confidence in the research results, replication is recommended with emphasis on other ASD, ESD, and SAMSO programs.

Contractor Viewpoint Analysis

Since this study has addressed the Air Force PRR technique and its effectiveness from the government side only, the conclusions reached may be one-sided. One way to determine the usefulness and effectiveness of the PRR technique on evaluating a contractor's readiness to make the full-scale development-to-production transition would be to determine contractors' perceptions of the present PRR technique's usefulness and effectiveness. The contractors for the A-10, F-15, and AWACS programs could be surveyed along with any additional contractors that have been involved in Air Force PRR activities.

Cost Versus Benefit Study

As disclosed in previous chapters, the background literature indicated an absence of information on comparisons of total PRR program costs versus the benefits gained from the PRR program activity. A study of the cost versus benefit relationship could concentrate on those programs which have documented some cost figures and have attempted to identify the monetary benefits accrued as a direct result of PRR program activities.

Pricing for PRR Requirement

Very little information has been printed on the contractor's pricing of PRR program requirements. Some contractors contend that no contract price increase resulted from the PRR requirement (49), while other contractors are specifically identifying contract line items with respective cost information for meeting Air Force PRR program requirements (6). The contractor methodology used in identifying the factors considered in arriving at the pricing figures has not been explicitly stated. A study should be conducted to identify potential factors to be considered in arriving at a fair and reasonable price for satisfying Air Force PRR program requirements.

PRR Responsibilities and Functions

The two primary organizations that are involved in the conduct of a PRR program are the system program office and the respective prime contract administration organization. It may be that some PRR program activities and AFSCR 84-2 PRR questions can be more efficiently and effectively handled by one of these organizations (20).

The researchers recommend a study to investigate and classify the major responsibilities, functions, and tasks which properly should be assigned to the respective SPO or contract administration organizations in the conduct of PRR programs.

Concluding Observations

After research in analyzing the Air Force's PRR technique, the authors conclude that the PRR technique has merit for several reasons. First, the Air Force can be more assured that planned major weapon systems will receive a positive DSARC III and Secretary of Defense approval on full production go-ahead. Three major Air Force weapon system programs--A-10, F-15, and AWACS--that have completed a PRR program have received production authorizations. Second, after completing a PRR program effort, the Air Force buying activity responsible for a major weapon system can feel more confident that a contractor is ready to make the development-to-production transition. The impact of this is that many potential problem areas will be corrected early in the weapons acquisition process, and the possibility of a major weapon system procurement fiasco will be reduced. And finally, there will be more Air Force and contractor interaction and involvement early in the weapons acquisition process to guard against potential problems that could be encountered in the production phase of the weapons acquisition process. The United States taxpayers will be the primary beneficiaries of the PRR program activities.

While much has been written on the need for insuring that contractors are ready to transition from the full-scale development phase into the production phase of the weapons acquisition process, very little research is found in this area of procurement. Since there are areas needing additional investigation, it is hoped that the study will serve as a catalyst for further examinations of the PRR technique's application and usefulness in the weapons acquisition process.

APPENDIXES

APPENDIX A

INTERVIEW GUIDE NO. 1

APPENDIX A

INTERVIEW GUIDE NO. 1

1† **How many PRR visits were made to the prime contractor's facility?**

PRR visits to prime contractor are the total number of visits that a system program office PRR team of any size made to review the production readiness of the prime contractor using the AFSCR 84-2 questions as guidance.

Response_______

2 **How many PRR visits were made to subcontractors?**

PRR visits to subcontractors are the total number of visits that an entire PRR team of any size made to review the production readiness of any subcontractor using AFSCR 84-2 as guidance.

Response_______

3† **How many different skills (SPO) were used in the PRR program?**

Different skills (SPO) are the total number of functional skills represented in the system program office's PRR visits to any contractor. Functional skill is each different job classification as determined by an individual's position description.

Response_______

4† **How many PRR team members (SPO) were involved in the PRR program?**

PRR team members (SPO) are the total number of visits to any contractor made by all personnel from the system program office as a participant on a PRR team using AFSCR 84-2 as a guide. Each visit made by each SPO PRR team member to any contractor will be counted as one PRR team member (SPO).

Response_______

5* **How many different skills (AFPRO) were used in the PRR program?**

Different skills (AFPRO) are the total number of functional skills represented from the local Air Force Plant Representative Office (AFPRO) at all PRR meetings held with the prime contractor or any subcontractors using AFSCR 84-2 as guidance. Functional skill is each different job classification as determined by an individual's position description.

Response______

6* **How many PRR team members (AFPRO) were involved in the PRR program?**

PRR team members (AFPRO) are the total number of times all Air Force Plant Representative Office personnel participated as a PRR team member on any review held at the prime contractor's facility or on any visit to a subcontractor using AFSCR 84-2 as guidance. Each different visit or participation for each PRR team member will be counted as one PRR team member (AFPRO).

Response______

7 **How many supplemental PRR team members were involved in the PRR program?**

Supplemental PRR team members are the total number of visits to any contractor made by all personnel not in the system program office or AFPRO to participate on a PRR team with AFSCR 84-2 as guidance. Each visit made by each supplemental PRR team member to any contractor will be counted as one supplemental PRR team member.

Response______

8† **What was the duration of the PRR program?**

Duration of PRR program is the total amount of time (in months) from the start of the planning phase of the PRR program up to the time of the DSARC III review. The start of the PRR planning phase is when the system program office actually began working on the PRR program.

Response______

9 **How many verbatim AFSCR 84-2 PRR questions were used in the PRR program?**

Verbatim AFSCR 84-2 PRR questions are the total number of the twenty-five standard AFSCR 84-2 PRR questions that were used on any PRR visit for the entire PRR program. Each of the twenty-five questions will be counted only once.

Response_______

10 **How many additional PRR questions were used in the PRR program?**

Additional PRR questions are the total number of questions used in the PRR program that were either modified AFSCR 84-2 questions or new questions addressing other areas not covered by the AFSCR 84-2 questions. Each additional PRR question will be counted only once.

Response_______

11† **How much did the PRR program cost the SPO?**

PRR program cost (SPO) is the total estimated cost incurred by the system program office in conducting the entire PRR program. The estimate will include PRR contractual coverage expenses, temporary duty travel expenses, typing expenses, report publication expenses, manpower costs, etc. that can be directly attributed to the conduct of the entire PRR program.

Response_______

12* **How much did the PRR program cost the AFPRO?**

PRR program cost (AFPRO) is the total estimated cost incurred by the AFPRO in conducting the entire PRR program. The estimate will include temporary duty travel expenses, typing expenses, report publication expenses, manpower costs, etc. that can be directly attributed to the conduct of the entire PRR program.

Response_______

***For AFPRO interviews only. †For SPO interviews only.**

APPENDIX B

STANDARD AFSCR 84-2 PRR QUESTIONS

APPENDIX B

STANDARD AFSCR 84-2 PRR QUESTIONS (42:5-6)

1. Milestones which demonstrate the achievement of a practical and producible engineering design have been met.

2. Engineering problems encountered during development have been resolved with appropriate trade-offs against stated operating requirements so that production costs/schedules are optimized.

3. Critical production engineering and production tooling have been demonstrated to prove that engineering has been satisfactorily accomplished.

4. Acquisition will smoothly transition from full-scale development to production.

5. System configuration has been reviewed to determine if any significant design changes will be required for manufacturing.

6. Adequate advanced production planning has been accomplished and required production controls established to ensure timely production.

7. A systematic approach to standardization has been accomplished in the design process and parts selection to maximize the use of military standard components, parts, and processes consistent with the system requirements.

8. Product assurance controls and tests to prevent manufacturing degradation of performance parameters have been established.

9. Assurance of readiness of the manufacturing and production equipment, methods, facilities, test and training equipment, and status of accessory and ancillary items.

10. Planned production schedules reflect economy of operations and minimize financial commitments until all major development problems have been resolved.

11. A thorough assessment of the make-or-buy structure has been accomplished and procedures exist so control and visibility of the vendors and subcontractors can be effectively maintained.

12. Change activity during development has been evaluated and the impact of outstanding changes on production has been assessed.

13. Results of technical reviews and the production impact of unresolved problems and risk have been assessed.

14. Test program results and the status of qualification testing to determine production impact and risk have been evaluated.

15. Specifications and drawings have been reviewed to assure their adequacy for the planned production phase.

16. Application of production tooling and test equipment to manufacturing during development has been

assessed and the application of same to the production phase has been defined.

17. Material management system for determination of requirements, procurement, receiving, inspection, materials handling and storage, inventory control, control of finished goods, and shipment is adequate.

18. Production management systems used for providing management with timely production status information are effective.

19. Production or manufacturing capabilities of major subcontractors and vendors have been technically evaluated and found adequate.

20. Constraints of laboratory or model shop capabilities versus quantity production requirements have been fully considered.

21. Quality controls and inspection procedures have been established for materials treatment or processes to be used in production.

22. Assessment of the GFP or services requirements, controls, management, and availability of suppliers has been accomplished.

23. Availability of production labor skill requirements has been assessed and their acquisition adequately planned.

24. The contractor is adequately organized to accomplish the production requirements.

25. Planning has been made to assure timely release of manufacturing instructions.

APPENDIX C

METHODOLOGY FOR CODING DATA FOR RESEARCH HYPOTHESIS NO. 1

APPENDIX C

METHODOLOGY FOR CODING DATA FOR RESEARCH HYPOTHESIS NO. 1

The data collected to test Research Hypothesis No. 1 were coded to provide a more meaningful comparison of the three major weapon system PRR programs that have been completed to date. By coding the data for Research Hypothesis No. 1, it was possible to objectively compare the variability between the high data values and the low data values for each variable. Variability, which is defined as a percentage above some base figure (lowest variable value), should not be confused with variance which is a measure of dispersion about the mean.

The formula used to code the twelve variable values was as follows:

$$CV = \frac{AV-LV}{LV}$$

where:

CV = The coded variability value (variability expressed as a decimal instead of as a percentage) for each variable for each PRR program.

AV = The actual value obtained for each variable for each PRR program.

LV = The lowest value obtained for each variable.

To illustrate the coding procedure, an example is provided. The number of PRR visits made to the prime contractor for the F-15, A-10, and AWACS programs were 27, 25, and 3 respectively. So, the actual value (*AV*) for the F-15 PRR program for the first variable was 27, and the lowest value (*LV*) for the variable was 3. The coded variability value calculation for the F-15 PRR program is shown below:

$$CV = \frac{AV-LV}{LV}$$

$$CV = \frac{27-3}{3} = \frac{24}{3} = 8.000$$

The coded variability value (*CV*) for the A-10 program for the first variable was 7.333:

$$CV = \frac{25-3}{3} = 7.333$$

The CV for the AWACS program for the first variable was 0.000:

$$CV = \frac{3-3}{3} = 0.000$$

After computing *CV* for the three programs (F-15, A-10, and AWACS) for each of the twelve variables used for testing Research Hypothesis No. 1, an average coded variability value was calculated for each of the twelve variables. To compute the average coded variability ($\overline{CV}$) for each variable, the following formula was used:

$$\overline{CV} = \frac{\sum_{i=1}^{n} CV_i}{n}$$

where:

CV_i = The coded variability value for each one of the twelve variables for the F-15, A-10, and AWACS programs.

n = The number of PRR programs completed to date ($n=3$).

$\overline{CV}$ = The average coded variability value for each variable.

Continuing with the example above, the $\overline{CV}$ for the "PRR visits to prime contractor" variable was 5.111. The computations are shown below:

$$CV_1 = 8.000$$

$$CV_2 = 7.333$$

$$CV_3 = 0.000$$

$$n = 3$$

$$\overline{CV} = \frac{\sum_{i=1}^{n} CV_i}{n} = \frac{(8.000+7.333+0.000)}{3} = 5.111$$

An average coded variability value was calculated for each one of the twelve variables used to test Research Hypothesis No. 1. It should be noted that for each variable having an actual value of zero a "one" was substituted for zero so that the *CV* procedure could be used for all twelve variables. Because of the magnitude of the other variable values for the two instances where this occurred, the substitution did not significantly impact the results of the $\overline{CV}$ analysis technique.

APPENDIX D

INTERVIEW GUIDE NO. 2

APPENDIX D

INTERVIEW GUIDE NO. 2

Ranking Interview Procedure

A. The interviewee will be given a copy of the AFSCR 84-2 PRR questions (Appendix B) and will be given sufficient time to rank-order the twenty-five AFSCR 84-2 questions.

B. The following specific instructions will be given to the AFSC production management expert:

> *To determine if a standard PRR approach can be developed to be universally and practically applied to different AFSC weapon system programs, rank the twenty-five standard PRR questions in AFSCR 84-2 in order of importance. A "one" should be assigned to the PRR question that should have the greatest amount of time and resources expended for analysis and reporting, and a "twenty-five" should be assigned to the least important question.*

C. The interviewer will record the rankings in the attached Table 3.

Table 3

AFSC Production Management Expert Rankings for the Twenty-Five Standard AFSCR 84-2 PRR Questions (42:5-6)

AFSC Expert	Twenty-Five AFSCR 84-2 PRR Questions																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
Total																									

APPENDIX E

SOURCES OF EXPERT OPINION FOR
RESEARCH HYPOTHESIS NO. 2

APPENDIX E

SOURCES OF EXPERT OPINION FOR RESEARCH HYPOTHESIS NO. 2

Ten Air Force production management experts were surveyed to provide their expert opinion on the relative importance of the twenty-five AFSCR 84-2 PRR questions for testing Research Hypothesis No. 2. Each one of the production management experts possessed the following minimum qualifications: (1) active in the production management area for at least three years; (2) involved in the management of major Air Force weapon systems for at least five years, and (3) involved in the planning or implementation of at least one AFSC PRR program. The key determinant for selecting the production management experts was their previous PRR experience.

The ten production management experts are listed below:

Lieutenant Colonel Jack B. Bryan, USAF
Chief of Production Management Branch
Deputy for F-15
Aeronautical Systems Division (AFSC)
Wright-Patterson AFB, Ohio

Mr. Thomas L. Campbell
Supervisory Industrial Specialist
Directorate of Production/Manufacturing
Aeronautical Systems Division (AFSC)
Wright-Patterson AFB, Ohio

Major Malcolm C. Edelblute, USAF
Chief of Production Support Division
Deputy for B-1
Aeronautical Systems Division (AFSC)
Wright-Patterson AFB, Ohio

Major Ronald S. Joyner, USAF, Chief of Manufacturing Management Division, Deputy for A-10
Aeronautical Systems Division (AFSC)
Wright-Patterson AFB, Ohio

Major Lyle W. Lockwood, USAF
Research Associate
Air Force Business Research Management Center (HQ USAF)
Wright-Patterson AFB, Ohio

Major Ronald D. Morris, USAF
Manufacturing Operations Division Chief
Detachment 9
AFCMD (AFSC)
The Boeing Company
Seattle, Washington

Lieutenant Colonel David E. Otteson, USAF
Chief of Production Division
Deputy for F-15
Aeronautical Systems Division (AFSC)
Wright-Patterson AFB, Ohio

Captain Leo Pavlow, USAF
Manufacturing Operations Division Chief
Detachment 44
AFCMD (AFSC)
Fairchild Corporation
Farmingdale, L.I., New York

Captain Stanley Vlasak, USAF
Production Engineer, Production Division
Deputy for Airborne Warning and Control System (AWACS)
Electronic Systems Division (AFSC)
Hanscom AFB, Massachusetts

Captain David S. Wayman, USAF
Contracting Officer
Surveillance, Navigation and Command and Management Systems
Deputy for Procurement and Manufacturing
Electronic Systems Division (AFSC)
Hanscom AFB, Massachusetts

APPENDIX F

VARIABLES FOR RESEARCH HYPOTHESIS NO. 1

APPENDIX F

Variables for Research Hypothesis No. 1

Name of Variable	Measurement Scale	Value Level* (Discrete)	F-15	A-10	AWACS
PRR Visits to Prime Contractor**	Ratio	Infinite	27	25	3
PRR Visits to Subcontractors	Ratio	Infinite	50	10	18
Different Skills (SPO)**	Ratio	Multiple	5	10	13
PRR Team Members (SPO)**	Ratio	Infinite	231	250	66
Different Skills (AFPRO)††	Ratio	Infinite	5	4	11
PRR Team Members (AFPRO)††	Ratio	Infinite	36	110	51
Supplemental PRR Team Members	Ratio	Infinite	0	55	66
Duration of PRR Program†	Ratio	Infinite	5 mos.	30 mos.	29 mos.

Variables for Research Hypothesis No. 1--Continued

Name of Variable	Measurement Scale	Value Level* (Discrete)	F-15	A-10	AWACS
Verbatim AFSCR 84-2 PRR Questions	Ratio	Infinite	20	0	21
Additional PRR Questions	Ratio	Infinite	5	250	10
PRR Program Cost (SPO)§ **	Ratio	Infinite	$85,000 ***	$250,000 ***	$26,000 ***
PRR Program Cost (AFPRO)§ ††	Ratio	Infinite	$1,500 ***	$5,000 ***	$15,000 ***

*All variables are classified discrete with the following value levels (46:211):
a. *Dichotomous*--2 categories of data.
b. *Limited*--3-6 categories of data.
c. *Multiple*--7-19 categories of data.
d. *Infinite*--Greater than 20 categories of data.

†Duration of PRR program reported to nearest month.
§PRR program cost reported to nearest dollar.
**For SPO interview only.
††For AFPRO interview only.
***Very rough estimates since actual cost data were not collected in format that allowed discrimination of costs solely attributable to PRR effort.

APPENDIX G

CODED VARIABILITY OF TWELVE VARIABLES FOR TESTING RESEARCH HYPOTHESIS NO. 1

APPENDIX G

CODED VARIABILITY OF TWELVE VARIABLES FOR TESTING RESEARCH HYPOTHESIS NO. 1

Variable	Variability Above Lowest Value	Average Variability
PRR Visits to Prime Contractor	8.000	
	7.333	
	0.000	
	15.333	5.111
PRR Visits to Subcontractors	4.000	
	0.000	
	0.800	
	4.800	1.600
Different Skills (SPO)	0.000	
	1.000	
	1.600	
	2.600	0.867
PRR Team Members (SPO)	2.500	
	2.788	
	0.000	
	5.288	1.763
Different Skills (AFPRO)	0.250	
	0.000	
	1.750	
	2.000	0.667
PRR Team Members (AFPRO)	0.000	
	2.056	
	0.417	
	2.473	0.824
Supplemental PRR Team Members	0.000	
	54.000	
	65.000	
	119.000	39.667

Variable	Variability Above Lowest Value	Average Variability
Duration of PRR Program	0.000	
	5.000	
	4.800	
	9.800	3.267
Verbatim AFSCR 84-2 PRR Questions	19.000	
	0.000	
	20.000	
	39.000	13.000
Additional PRR Questions	0.000	
	49.000	
	1.000	
	50.000	16.667
PRR Program Cost (SPO)	2.269	
	8.615	
	0.000	
	10.884	3.628
PRR Program Cost (AFPRO)	0.000	
	2.333	
	9.000	
	11.333	3.778

APPENDIX H

AFSC PRODUCTION MANAGEMENT EXPERT RANKINGS FOR THE TWENTY-FIVE STANDARD AFSCR 84-2 PRR QUESTIONS

APPENDIX H

AFSC Production Management Expert Rankings for the Twenty-Five Standard AFSCR 84-2 PRR Questions

AFSC Expert	Twenty-Five AFSCR 84-2 PRR Questions											
	1	2	3	4	5	6	7	8	9	10	11	12
1	20	17	7	10	19	1	16	15	2	13	8	22
2	6	2	13	1	7	14	23	16	9	17	18	8
3	24	1	4	25	11	5	22	17	12	13	7	3
4	2	11	5	9	1	3	18	21	15	17	14	13
5	1	2	24	4	20	5	25	12	10	21	11	19
6	1	2	15	16	8	6	17	18	19	20	21	4
7	5	12	13	22	6	2	4	18	9	1	24	8
8	5	2	13	25	1	16	4	22	21	14	6	15
9	4	10	6	11	1	2	13	15	12	5	14	20
10	4	10	13	1	11	6	22	24	2	3	23	18
Total	72	69	113	124	65	60	164	178	111	124	146	130
Mean	7.2	6.9	11.3	12.4	8.5	6.0	16.4	17.8	11.1	12.4	14.6	13.0
Median	4.5	6.0	13.0	10.5	7.5	5.0	17.5	17.5	11.0	13.5	14.0	14.0

AFSC Production Management Expert Rankings--Continued

AFSC Expert	Twenty-Five AFSCR 84-2 PRR Questions												
	13	14	15	16	17	18	19	20	21	22	23	24	25
1	18	21	14	3	4	12	9	23	24	25	6	11	5
2	5	3	4	15	21	19	11	20	10	12	22	24	25
3	2	9	21	10	8	15	6	20	14	19	23	18	16
4	4	7	12	6	20	16	8	19	22	10	25	24	23
5	9	15	16	22	7	17	6	23	8	18	13	3	14
6	3	5	7	22	23	10	9	12	11	24	25	13	14
7	11	7	16	15	20	23	10	14	17	3	21	25	19
8	3	17	18	19	23	7	9	8	20	10	11	12	24
9	16	3	9	19	22	24	23	18	17	25	8	21	7
10	5	12	14	25	15	19	17	9	7	20	21	16	8
Total	76	99	131	156	163	162	108	166	150	166	175	167	155
Mean	7.6	9.9	13.1	15.6	16.3	16.2	10.8	16.6	15.0	16.6	17.5	16.7	15.5
Median	5.0	8.0	14.0	17.0	20.0	18.0	9.0	18.5	15.5	18.5	21.0	17.0	15.0

SOURCE: U.S. Air Force Systems Command. Production Readiness Review. AFSCR 84-2. Washington, D.C., 23 November 1971, pp. 5-6.

APPENDIX I

THE KENDALL COEFFICIENT OF CONCORDANCE *W* SUMMARY PROCEDURE

APPENDIX I

THE KENDALL COEFFICIENT OF CONCORDANCE *W* SUMMARY PROCEDURE

1. Let *N* equal the number of entities to be ranked (25), and let *k* equal the number of experts assigning ranks (10). Arrange the observations in a *k* by *N* matrix.

2. For each entity (AFSCR 84-2 PRR question), determine R_j which is the sum of the ranks assigned to each question from the ten experts.

3. Determine the mean of the R_j. Express each R_j as a deviation from that mean. Square these deviations, and sum the squares to obtain *s*.

4. Compute *W* from the following formula:

$$W = \frac{s}{\frac{1}{12}k^2(N^3 - N)}$$

5. The method of determining whether the calculated value of *W* is significantly different from zero depends on the size of *N*. If *N* is larger than seven, use the formula:

$$\chi^2 = \frac{s}{\frac{1}{12}kN(N+1)} = k(N-1)W$$

to compute a value of χ^2 whose significance for $N-1$ degrees of freedom may be tested by reference to the table of critical values for chi square (33:249).

APPENDIX J

OMNITAB II OUTPUT FOR ONE-WAY ANALYSIS OF VARIANCE

APPENDIX J

OMNITAB II OUTPUT FOR ONE-WAY ANALYSIS OF VARIANCE

Source	df	Sum of Squares	Mean Squares	F Ratio	F Prob
Between Groups	24	3.261000E 03	1.358750E 02	3.139	0.000
Slope	1	1.331840E 03	1.331840E 03	28.307	0.000
Deviations About Line	23	1.929160E 03	8.387651E 01	1.938	0.008
Within Groups	225	9.739000E 03	4.328444E 01		
Total	249	1.300000E 04			

APPENDIX K

COMPARATIVE RANKINGS OF AFSCR 84-2 PRR QUESTION NUMBERS USING MEDIANS AND MEANS

APPENDIX K

COMPARATIVE RANKINGS OF AFSCR 84-2 PRR QUESTION NUMBERS USING MEDIANS AND MEANS

Ranking	AFSCR 84-2 PRR Question Numbers	
	Using Medians	Using Means
1	1	6
2	6,13	2
3	. . . . .	1
4	2	13
5	5	5
6	14	14
7	19	19
8	4	9
9	9	3
10	3	4,10
11	10	. . . . .
12	11,12,15	12
13		15
14	. . . . .	11
15	25	21
16	21	25
17	16,24*	16
18	. . . . .	18*
19	7,8*	17*
20	. . . . .	7
21	18*	20,22
22	20,22	. . . . .
23	. . . . .	24*
24	17*	23
25	23	8*

*Ranking differences are greater than two steps depending on whether means or medians are used for the rankings (Questions 8, 17, 18, 24).

APPENDIX L

AGGREGATE PRIORITY LIST OF TWENTY-FIVE AFSCR 84-2 PRR QUESTIONS FROM TEN AFSC PRODUCTION MANAGEMENT EXPERTS

APPENDIX L

AGGREGATE PRIORITY LIST OF TWENTY-FIVE AFSCR 84-2 PRR QUESTIONS FROM TEN AFSC PRODUCTION MANAGEMENT EXPERTS

Ranking	Current Question Number	AFSCR 84-2 PRR Question
1	6	Adequate advanced production planning has been accomplished and required production controls established to ensure timely production.
2	2	Engineering problems encountered during development have been resolved with appropriate trade-offs against stated operating requirements so that production costs/schedules are optimized.
3	1	Milestones which demonstrate the achievement of a practical and producible engineering design have been met.
4	13	Results of technical reviews and the production impact of unresolved problems and risk have been assessed.
5	5	System configuration has been reviewed to determine if any significant design changes will be required for manufacturing.
6	14	Test program results and the status of qualification testing to determine production impact and risk have been evaluated.
7	19	Production or manufacturing capabilities of major subcontractors and vendors have been technically evaluated and found adequate.

Ranking	Current Question Number	AFSCR 84-2 PRR Question
8	9	Assurance of readiness of the manufacturing and production equipment, methods, facilities, test and training equipment, and status of accessory and ancillary items.
9	3	Critical production engineering and production tooling have been demonstrated to prove that engineering has been satisfactorily accomplished.
10	4*	Acquisition will smoothly transition from full-scale development to production.
11	10*	Planned production schedules reflect economy of operations and minimize financial commitments until all major development problems have been resolved.
12	12	Change activity during development has been evaluated and the impact of outstanding changes on production has been assessed.
13	15	Specifications and drawings have been reviewed to assure their adequacy for the planned production phase.
14	11	A thorough assessment of the make-or-buy structure has been accomplished and procedures exist so control and visibility of the vendors and subcontractors can be effectively maintained.
15	21	Quality controls and inspection procedures have been established for materials treatment or processes to be used in production.

*Indicates tied pair of mean rankings.

Ranking	Current Question Number	AFSCR 84-2 PRR Question
16	25	Planning has been made to assure timely release of manufacturing instructions.
17	16	Application of production tooling and test equipment to manufacturing during development has been assessed and the application of same to the production phase has been defined.
18	18	Production management systems used for providing management with timely production status information are effective.
19	17	Material management system for determination of requirements, procurement, receiving, inspection, materials handling and storage, inventory control, control of finished goods, and shipment is adequate.
20	7	A systematic approach to standardization has been accomplished in the design process and parts selection to maximize the use of military standard components, parts, and processes consistent with the system requirements.
21	20**	Constraints of laboratory or model shop capabilities versus quantity production requirements have been fully considered.
22	22**	Assessment of the GFP or services requirements, controls, management, and availability of suppliers has been accomplished.

**Indicates tied pair of mean rankings.

Ranking	Current Question Number	AFSCR 84-2 PRR Question
23	24	The contractor is adequately organized to accomplish the production requirements.
24	23	Availability of production labor skill requirements has been assessed and their acquisition adequately planned.
25	8	Product assurance controls and tests to prevent manufacturing degradation of performance parameters have been established.

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BIOGRAPHICAL SKETCHES

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Captain Brechtel, a native of Jacksonville, Florida, received his BS Degree in Industrial Management from Sacramento State College through Airmen Education and Commissioning Program. While at Sacramento State College, Captain Brechtel was selected into the Beta Gamma Sigma and Phi Kappa Phi honor societies. After commissioning, he served as a production officer in Detachment 9, AFCMD, The Boeing Company, Seattle, Washington. While at AFIT Captain Brechtel was selected into the Sigma Iota Epsilon and Alpha Iota Delta honorary fraternities. After graduation from AFIT, he was assigned as a production officer to F-16 SPO at Wright-Patterson AFB, Ohio.

Prior to commissioning, Captain Lathrop served with Air Force Security Service for three years. He later served in Air Force Communication Service in Air Traffic Control for six years. In 1972, he received his Bachelor of Science Degree in Business Administration from Oklahoma State University through Airmen Education and Commissioning Program. After commissioning he served as procurement officer at Scott AFB, Illinois, and as an Administrative Contracting Officer at Detachment 40, AFCMD, AVCO Systems Division, Wilmington, Massachusetts. After graduation from AFIT, Captain Lathrop was assigned as a procurement officer to the B-1 System Program Office at Wright-Patterson AFB, Ohio.