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AN ASSESSMENT OF THE APPLICABILITY OF PRODUCTION READINESS REVIEWS TO MULTINATIONAL COPRODUCTION PROGRAMS

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LSSR 42-81

JUN 1981

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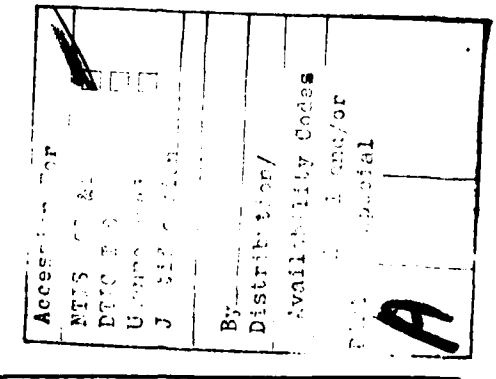

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Production Readiness Reviews (PRRs) are used by the Department of Defense to reduce the manufacturing risk during a major system acquisition. Not only are domestic contractors involved in U.S. weapons acquisition, but today foreign contractors are involved as well. The success of the F-16 multinational coproduction program makes future coproduction programs a certainty. This study finds that PRRs are applicable to foreign contractors in a multinational coproduction program. The PRR provides a one-on-one consultation between the System Program Office and the foreign contractor. This consultation can eliminate many potential problems early in the acquisition and can help ensure overall success of the coproduction program. A comparison is made between PRRs performed on foreign and domestic firms. The study finds in most cases the manufacturing areas requiring the greatest emphasis during a foreign PRR are different than those areas during a domestic PRR. The study takes a critical look at AFSCR 84-2 and makes specific recommendations aimed at making the regulation a more useful tool for foreign PRR planners.

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AN ASSESSMENT OF THE APPLICABILITY OF PRODUCTION READINESS REVIEWS TO MULTINATIONAL COPRODUCTION PROGRAMS

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 Requirement for the

Degree of Master of Science in Logistics Management

By

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has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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Chapter 1

INTRODUCTION

Uncertainty is present in all Major Weapon System Acquisitions. Design, performance, maintainability, production, schedule, and cost all present areas where substantial risk is present for the Department of Defense in all weapon acquisitions. As a weapon system travel through the acquisition cycle, it reaches the point where full scale development has been completed and production is ready to begin. This transition point is a milestone within the Major System Acquisition Cycle and is aptly named Decision Milestone III (15:16-19). At this point in the acquisition cycle, the question arises of whether or not the contractor is prepared to begin production of the equipment. The Production Readiness Review (PRR) is the technique used by the Department of Defense to reduce the uncertainty encountered when a major system faces the production point. Department of Defense Instruction 5000.38, Production Readiness Reviews (25:1), states that the

> . . . objective of a PRR is to verify that the production design, planning, and associated preparations for a system have progressed to the point where a production commitment can be made without incurring unacceptable risks of breaking thresholds of schedule, performance, cost, or other established criteria.

It is the policy of the Department of Defense to require a PRR before any major system enters the production phase. The DOD component is responsible for performing the PRR, then reporting findings and an assessment of the contractor's production readiness to the Defense System Acquisition Review Council (DSARC) at Decision Milestone III (25:1-2). Air Force Systems Command requires a PRR be performed by the program office with responsibility for the system's development and acquisition. According to AFSCP 84-4 (19:20):

> . . . the purpose of conducting a PRR program is to identify manufacturing risks by determining whether (1) a system of equipment under development is capable of being economically produced at required rates; (2) all important production engineering problems encountered during development have been resolved; (3) the contractor has accomplished adequate planning through the production phase.

Within the Air Force, the System Program Office (SPO) is the Systems Command organization responsible for the Major System Acquisition. Thus, it is the agency which performs the PRRs and presents the findings at Decision Milestone III. Through the PRR, the goal is to find the contractor in a state of production readiness (22:6).

Security Assistance Environment

The PRR is indeed applicable to a weapons system acquisition involving U.S. contractors. In an increasing number of cases, PRRs will be performed on foreign firms in multinational programs as well. An overview of U.S. Security Assistance is necessary to illustrate the increasing

cooperation between the U.S. government and foreign firms. A key element of the United States' implementation of foreign and national security policy is through the transfer of U.S. defense articles, services, training, and economic assistance to foreign allies. Today, this implementation of security policy is more commonly known as security assistance. Security assistance can be traced to the earliest recorded military history and has matured through time to what is presently defined as a:

> Group of programs authorized by the Foreign Assistance Act of 1969, as amended, and the Arms Export Control Act of 1976, as amended, or other related statutes by which the United States provides defense articles, military training, and other defense related services, by grant, credit, or cash sales in furtherance of national policies and objectives [23:306-307].

Since the 1960s, the greatest portion of U.S. security assistance to our allies has been rendered in the form of military hardware and training via Foreign Military Sales (FMS). "FMS is a type of security assistance where the recipient country provides reimbursement for the defense articles and services [18:p.9-10]." The doctrine suggests that supplying this hardware and training to our allies will allow these nations to acquire the capability to defend themselves. It further suggests this will ensure peace and thus promote U.S. foreign policy and national security interests. This strengthening of our allies is vital to the U.S. Total Force Concept (10:78). In reciprocal fashion, many foreign nations rely upon the U.S. to provide

military hardware and services for their purchase.

> The security of our friends and allies contributes directly to the security of the United States. For over thirty years, the U.S. has made available material services, and training to friendly countries to enable them to improve their own defense capabilities [26:223].

Thus the sale of military equipment to foreign countries is of material benefit to both the United States and the foreign customer. This trend can be expected to continue in the future (10:78-82).

As the complexity and sophistication of the weapons system increases so too does the price of the new hardware. For many of our allies, this results in a twofold problem. First, due to the high cost of these new weapons systems, the purchase price of the system may approach 50% or more of that country's total annual budget. Second, the direct purchase of weapons systems from the U.S. would limit the purchasing country's abilities to maintain its own industrial base which could hurt employment and balance of payments. The following quotation represents the feeling of many of our allies:

> The United States' formerly dominant position as the principle supplier of NATO's defense equipment has been increasingly eroded. Straight sales of U.S. weapon systems to European NATO nations are now difficult or impossible to achieve [7:3].

Our allies in this situation find such expensive weapon systems more attractive when the selling country offers some percentage of the production and development work to the purchasing country. Two alternatives are available to the

purchasing country: (1) secure a license to produce the system themselves, or (2) enter into a coproductive arrangement (18:pp.13.1-13.2).

> Coproduction encompasses any program wherein the U.S. Government, under the aegis of an international diplomatic level or Ministry of Defense to Department of Defense agreement, either directly through the FMS program, or indirectly through specific licensing arrangements by designated commercial firms, enables an eligible foreign government, international organization or designated commercial producer to acquire the "know how" to manufacture or assemble, repair, maintain and operate, in whole or in part, a specific weapon, communication or support system, or individual military item [24:2].

This situation has led to wide discussion of the "two way street" in arms transactions within NATO. In the Alliance arms sales, the phrase "two way street" is used to indicate the Europeans' desire for mutual sales and coproduction (7:3,16). United States allies have a strong desire to share in coproduction of major systems and to share in revenue gained by sales to third countries.

The 1979 GAO report, A New Approach is Needed for Weapons System Coproduction Programs Between the United States and Its Allies (28:3), states that the coproduction trend will continue in the future.

> Coproduction will likely be a frequent method of weapons system acquisition in the future, according to discussions with U.S. and foreign government and industry officials. Some of our allies will continue to require costly and sophisticated weapons systems which they would have difficulty producing on their own. Others may wish to codevelop systems in order to share the cost and be in a position to subsequently coproduce them.

It is generally felt that coproduction programs will be the rule in the future as the costs of military hardware continue to increase.

Coproduction arrangements will allow the production of specific equipment and components in several countries. In many cases, the foreign contractor may be producing not only for foreign consumption but for United States consumption as well. As millions of dollars worth of contracts and subcontracts are awarded to foreign firms, the United States faces a marketplace filled with risk. The uncertainty present in all weapons system acquisitions is increased when dealing in the foreign marketplace because of the many instances where foreign development and manufacturing technology is behind that of the United States. When foreign participants actually build a major segment of the equipment they purchase and produce parts of a system the United States will use, the Production Readiness Review (PRR) becomes a critical measure of the foreign firm's fitness for the production phase (8:259; 28:5).

The F-16 Multinational Coproduction Program has set a precedent in international industrial defense cooperation. Referred to as the "Grand Experiment," it has been an attempt to both partially fulfill economic needs of the Western Alliance and satisfy the companion military defense requirements (13:p.1-1). The coproduction of the F-16 by four European Participating Governments (EPGs)--Belgium,

Netherlands, Norway, and Denmark--is the largest multinational coproduction program attempted to date (6:580-H). Over two billion dollars in contracts have been awarded to participating European manufacturers. Segments are being produced for all sections of the aircraft: air frame, engine, electronics, radar, and landing gear. In many cases, parts produced by the foreign firms will be used on U.S. aircraft (16:59). So far, the F-16 program has demonstrated that multinational collaborative efforts can be implemented, and that "the F-16 will ultimately be considered an economic as well as military success by most (if not all) of the nations involved [13:p.1-1]."

Production Readiness Reviews were utilized by the F-16 System Program Office (SPO) to ensure that foreign companies involved were prepared to enter the production phase of the program. The PRRs performed have received high marks from both DSARC (14) and from participants interviewed by Maxfield Associates, the research institute publishing the F-16 lessons learned report.

> Generally, the PRR's have been planned and executed without significant difficulty. The deficiencies and potential problem areas identified during PRR's have, as a rule, been expeditiously corrected with the cooperation of the elements of European and U.S. industry affected. It is generally felt that PRR's contributed to industry and government confidence in the manufacturing capability of the European Industrial Elements involved [13:p.3-ii-16].

The F-16 PRR program reviewed foreign contractors in four European countries--Belgium, Denmark, Netherlands, and

Norway. Dealing with foreign firms presented new industrial management challenges and increased the uncertainty involved in the overall weapons system acquisition. In a coproductive program like the F-16 effort, the product's cost, quality, and schedule are greatly affected by each of the participating foreign contractors. A delay in the production of one component by a single foreign manufacturer could affect the delivery schedule of the overall system. The PRRs performed in the F-16 program were awarded high marks for their content and contributions. The late-Multinational Manager at the F-16 SPO (14) indicated, however, that many variances existed between the methodology of individual foreign PRRs. Although loosely based on the 1971 AFSCR 84-2 (20), the reviews did not follow any specific guidelines. Different survey team chiefs performed reviews designed and planned largely by themselves. These reviews placed emphasis on certain areas they felt were most important relative to production readiness of the foreign coproducer.

Problem Statement

The late-Multinational Manager at the F-16 SPO felt the areas of emphasis in the foreign PRR must be clarified. The important areas for manufacturing and production review should be identified and then compiled into a set of areas requiring special emphasis during a foreign PRR.

Research Objectives

The following research objectives have evolved from the problem statement and were pursued in this study.

1. Determine if similar areas of emphasis exist among different foreign PRR teams.

2. Determine if differences exist between areas of emphasis in domestic and foreign PRRs.

Research Hypotheses

Hypothesis I: Different PRR teams concentrated on similar areas of emphasis when performing PRRs on foreign firms in the F-16 program.

Hypothesis II: PRRs performed on foreign firms have different areas of emphasis than PRRs performed on domestic firms.

Summary

PRRs are used by the Department of Defense to reduce the manufacturing risk during a major system acquisition. Not only are domestic contractors involved in the U.S. weapons acquisition, but today foreign contractors are involved as well. The research objectives and matching hypotheses have been developed to study the applicability of the PRR process to multinational coproduction programs. The following chapter outlines background information and data available on this subject.

Chapter 2

BACKGROUND

The 1976 AFIT Thesis by Brechtel and Lathrop addressed the applicability of Production Readiness Reviews to DOD acquisitions from United States' industry. Their research involved a review of the guidelines and procedures for performing PRRs and then reviewed the PRR programs for three different major systems, the A-10, F-15, and AWACS. The three major systems had completed the entire PRR process beginning with the planning stage and culminating with the final DSARC review at Decision Milestone III. A comparison between the three programs allowed Brechtel and Lathrop to make two findings: (1) PRR approaches used to date have been different, and significant disparities did exist among the three PRR programs reviewed by the thesis; (2) standardization could be obtained in future PRR programs if AFSC experts could agree on what areas should be emphasized and how best to conduct future PRR programs (4:2-4,33,82-84).

Brechtel and Lathrop touched only major systems where United States contractors were involved. There are many facets of the international marketplace that are considerably different than the domestic marketplace (14; 13:p.1-2). There are numerous instances where

manufacturing technology is behind that of the United States (8:259). For many European industries, the issue of domestic employment is fundamental in all future industrial planning. In many cases, stability in employment is more important to the firm than profits (7:21). The F-16 SPO teams found less emphasis on quality control efforts within foreign contractors' plants than within domestic contractors' plants. The foreign work ethic is different than the United States ethic. Production in most foreign industries slows to a near stop during July when most employees take their vacation. National, religious, and local holidays frequently halt the production line. In Denmark and Belgium, one or two day wildcat strikes are common when the weather is alluring. For U.S. industries, such production irregularities would have devastating results. Thus, the attitude and mood of European industry is somewhat different than that of familiar U.S. industry (14).

The large number of taxpayer dollars allocated to the production phase of major weapons system contracts justifies research in the area of Production Readiness Reviews. The F-16 multinational coproduction program has awarded over two billion dollars in contracts and subcontracts to foreign industry (16:59). The technical uncertainty in doing foreign business creates risks that can be reduced by effective use of Production Readiness Reviews. The Brechtel and Lathrop thesis identified replication of the thesis as an area for

future research (4:101-102). The importance of foreign industry to future coproduction efforts makes research in the area of foreign production readiness reviews a worthwhile endeavor.

Related Research

The background review was seeded by the 1976 AFIT thesis by Brechtel and Lathrop. The majority of research efforts on Production Readiness Reviews up to 1976 were primarily government initiated (4:29). The research studies concentrated on information gathering techniques to cope with the high uncertainty present when entering the Production Phase of Major System Acquisitions. Research performed since 1976 can be categorized into three basic areas: (1) general research on Production Readiness indicating the need for some evaluation of a contractor's ability to proceed to production, (2) expert testimony by AFSC manufacturing personnel involved in the performance of PRRs, and (3) scientific research on how to apply the PRR techniques.

Brechtel and Lathrop's Study

Brechtel and Lathrop's 1976 thesis, A Comparative Analysis of the Application of Production Readiness Reviews (4), studied three major weapons system programs that had completed an entire PRR program and had met DSARC III review. Included in the population of interest were: (1) Airborne Warning and Control System (AWACS); (2) F-15 Air Superiority

Fighter; and (3) A-10 Close Air Support Attack aircraft. All three systems underwent PRR programs that began with the planning stage and culminated in DSARC III approval. At that time, AFSCR 84-2, Production Readiness Review (20), guided members of the System Program Office as they planned their PRRs.

The researchers used the 25 questions from the 1971 regulation, however, to compare the opinions of foreign PRR experts to the domestic PRR experts of Brechtel and Lathrop's study. This was necessary to ensure validity of the comparison between the two populations. The substance of the questions has not changed; only the arrangement is different. Thus, the researchers feel the use of the 25 questions from the 1971 regulation is valid for comparison purposes.

An objective of Brechtel and Lathrop was to determine if a standard PRR approach was feasible to satisfy AFSCR 84-2 requirements. They approached this objective through interviews with ten production management experts within Air Force Systems Command (AFSC). While based on three criteria, the key determinant for selecting production management experts was their experience in previous PRRs. During interviews, the ten experts were requested to rank the 25 standard PRR questions listed in AFSCR 84-2 (20:5-6) in order of importance for future PRR programs. The null hypothesis (H_0) was that no difference would exist among the

mean ranks for each of the 25 questions; thus, the experts did not agree on the importance of some areas over others. The alternate hypothesis (H_1) was that differences did exist among the means, and experts did agree on the relative importance of some areas over others. The Friedman Two-Way Analysis-of-Variance-by-Ranks test (17:166) was used to test the research hypothesis.

Domestic PRR findings. Brechtel and Lathrop found that the ten AFSC production management experts did agree on the relative importance of all 25 AFSCR 84-2 questions (4:70-71). The mean rank was computed for each question and the questions then assembled in order of their relative mean rank (4:144-147). The experts generally agreed that the areas at the top of the list should receive the greatest emphasis, and the areas at the end of the list should receive the least emphasis. Additionally, Brechtel and Lathrop noted that six of the 25 areas had mean values much lower (highest ranking) than the other 19 areas. Of these six areas, five addressed the completion of engineering and testing in some manner, thus there was high importance placed on the completion of engineering tasks prior to the start of the production phase. Finally, Brechtel and Lathrop noted that the order in which the questions were presented in AFSCR 84-2 did not agree with the prioritized order presented by the ten production management experts.

Thus, they felt the 1971 AFSCR 84-2 had not prioritized the 25 questions in a manner useful to the System Program Office charged with the responsibility of conducting a Production Readiness Review (4:82-85). This has been addressed by the 1981 rewrite of AFSCR 84-2.

General research. Several unpublished papers have been located which concern production readiness. Primarily, the papers deal with the question of what areas should be reviewed in a PRR (1; 6; 12). Additionally, the usefulness of a PRR in assessing production readiness was discussed.

General research revealed that the Air Force has been performing PRRs for over ten years. Air Force Systems Command Regulation 84-2, first published in November 1971, has been the forerunner of most DOD regulations concerning PRRs. In January 1979, the DOD published DOD 5000.38, Production Readiness Reviews (25). Following the issuance of this DOD instruction, each service component published its own guidance for performing PRRs. Additionally, Air Force Systems Command has rewritten AFSCR 84-2 and recently published a 1981 version of the regulation (21).

In addition to existing regulations, a community of PRR interest is growing within the DOD. This is evidenced by the November 1980 DOD/Joint Services Production Readiness Reviews Conference held at Wright-Patterson AFB. The objective of the conference was to provide a forum for people

involved in the PRR process to exchange lessons learned and ideas for improving the PRR process (27). The output of the conference was a list of 14 observations and action items concerning how the PRR process could be improved. None of these observations addressed foreign PRRs. While foreign PRRs were given a quick brush stroke during the conference, no substantive discussions were held concerning the unique challenges of the foreign PRR.

Finally, general research showed DOD Production Engineering Services Office (DPESO) performed a Cost/Benefit Study of Production Readiness Reviews and presented it as introductory information at the November 1980 DOD Conference. The report noted "PMOs (Project Management Offices) conducting foreign PRRs have problems not encountered on domestic PRRs [27:12]." Aside from this brief mention in the DPESO Cost/Benefit Study, no attention has been focused upon the unique problems posed by performance of PRRs on foreign coproducers.

Expert testimony. Within the F-16 SPO, several participants in previous F-16 PRR programs have been interviewed. Information provided has centered primarily on the differences between domestic and foreign contractors and the variances between PRRs conducted on different F-16 foreign contractors (14). Additionally, Major Lyle Lockwood, former Deputy Director of the Air Force Business Management Research

Center and long an observer of PRRs, has provided his expertise on the Air Force PRR system (11).

Lieutenant Colonel Thomas Fiorino, Director of Manufacturing and Quality Assurance for the F-16 SPO, provided invaluable insight into the foreign PRRs of the F-16 program (5). Further, Major Don Brechtel was interviewed. His detailed knowledge of the PRR process was of tremendous value when assembling a chronology for the development of the PRR (3). Aside from the actual performance of a PRR on a foreign firm, these men knew of no attempts to study the application of PRRs to foreign contractors.

Scientific research. Brechtel and Lathrop's 1976 thesis holds most of the scientific research conducted on the Production Readiness Review to date. No other research was located that dealt solely with the application of PRRs in domestic industry. The Defense Logistics Studies Information Exchange and the Defense Documentation Center have no information dealing directly to PRRs.

Summary

In no case was any material located dealing with the application of PRRs to foreign contractors. Only the experience of manufacturing experts within the F-16 SPO provides the link between PRRs and the multinational coproduction program. Thus, the replication of Brechtel and Lathrop's thesis on the F-16 multinational program provides

fruitful research concerning the applicability of PRR techniques to multinational coproduction programs. The following chapter discusses the comparison of domestic and foreign firms, identifies the population studied, and then describes the procedures used in analyzing data obtained in the research.

Chapter 3

RESEARCH METHODOLOGY

The F-16 PRR program reviewed the contractors in four European countries--Belgium, Denmark, Netherlands, and Norway. The previous two chapters discussed the importance of these reviews and highlighted the need to reduce the uncertainty involved when dealing with foreign contractors. Using techniques developed by Brechtel and Lathrop in their 1976 thesis, the researchers studied participants in the F-16 program and sought to determine if the participants share common areas of emphasis when performing PRRs on foreign industrial contractors. This chapter discusses the comparison of domestic and foreign firms, identifies the population studied, and then describes the procedures used in analyzing data obtained in the research.

Comparison of Domestic and Foreign Firms

The three major weapons system programs reviewed by Brechtel and Lathrop were systems developed and produced by United States contractors. Production Readiness Reviews were performed on many of the domestic firms involved, and the production management experts interviewed by Brechtel and Lathrop were experienced in the area of domestic PRRs.

Thus, the prioritization of the 25 AFSCR 84-2 questions was a ranking of the areas of emphasis for domestic PRR programs. These 25 areas have been listed in order of importance for a Production Readiness Review performed on a United States contractor (4:144-147).

The F-16 program has introduced foreign contractors to the major system acquisition cycle. System Program Offices may now face the task of performing PRRs on foreign firms as well as domestic firms. The System Program Office for the F-16 has performed Production Readiness Reviews on 23 foreign contractors. The procedures used by Brechtel and Lathrop were replicated using personnel from the F-16 program to study the areas of emphasis in foreign PRRs. The objectives of this study were: (1) determine similarities that exist between areas of emphasis for different foreign PRR teams and (2) determine if differences exist between areas of emphasis for domestic PRRs and foreign PRRs.

Population of Interest

The population of interest consisted of individuals who have participated in PRRs of foreign contractors in the F-16 program. A sample size of ten was used by Brechtel and Lathrop. The same sample size was used in this study. The ten individuals in the sample have been identified in Appendix F. The Manufacturing and Quality Assurance

Directorate of the F-16 System Program Office is the office charged with responsibility for conducting F-16 Production Readiness Reviews.

Research Hypothesis I

The questionnaire technique was used as a means for collecting data to test Research Hypothesis I. A sample of the questionnaire has been furnished in Appendix A. Personnel within the F-16 SPO who had prime responsibility for performing PRRs were asked to complete the questionnaire and were asked to rank the 25 standard PRR questions listed in the 1971 AFSCR 84-2 (20:5-6) in order of importance for future foreign PRR programs. The 25 questions have been furnished in Appendix B. The specific instructions used when requesting the F-16 personnel to rank the questions contained the following statements:

> This part of the questionnaire aims at determining whether a standard PRR approach can be developed to practically be applied to various foreign contractors in a major system acquisition. Additionally, the questionnaire will determine if differences exist in the areas of emphasis of PRRs conducted on domestic firms and foreign firms.
>
> Please rank the 25 PRR questions in AFSCR 84-2 in order of importance to a foreign PRR. A "one" should be assigned to the PRR question that should have the greatest amount of time, effort, and resources expended for analysis and reporting, and a "25" should be assigned to the least important question. Please rank the questions according to how you feel about performing a PRR on a foreign contractor.

Design to Test Research Hypothesis I

To test the research hypothesis that certain PRR areas require special emphasis when dealing with foreign contractors, the Friedman Two-Way Analysis-of-Variance-by-Ranks test (17:166) and the Kendall Coefficient of Concordance W (17:229) test were used. The null hypothesis (H_0) for both the Friedman test and the Kendall test was that there was no difference among the mean ranks for the 25 AFSCR 84-2 questions; therefore, the F-16 PRR personnel did not agree on the rankings for the 25 questions. The alternate hypothesis (H_1) for both tests was that there were differences between the mean ranks for the 25 AFSCR 84-2 questions; therefore, the F-16 PRR personnel agreed on the relative rankings for the questions. If the PRR personnel agreed on the relative rankings of the questions, then it may be concluded that certain areas require more emphasis than others when performing a foreign PRR. Both tests are discussed in the following chapter.

Research Hypothesis II

The questionnaire technique used for Hypothesis I was also used for Hypothesis II. The mean rank for each question was determined from the ten individual rankings of the 25 questions used in testing Hypothesis I. The mean rank determined for each question in this study (foreign PRRs) was then compared to the mean rank obtained from the

Brechtel and Lathrop study (domestic PRRs). The comparison has yielded insight into the disparities between areas of emphasis in the foreign and domestic environment.

Design to Test Research Hypothesis II

To test the research hypothesis that PRRs performed on foreign firms have different areas of emphasis than PRRs performed on domestic firms, the correlation between the mean ranks of the foreign PRR experts and those of the domestic PRR experts were studied. The Spearman Rank Correlation Coefficient (17:202; 9:275) and the Kendall Rank Correlation (17:213; 9:284) tests were used. High positive correlation indicated that there was little difference in the areas of emphasis between the two populations; whereas a high negative correlation indicated that there was great difference. No correlation indicated neither agreement nor disagreement in the areas of emphasis in the two populations. The null hypothesis (H_0) for the correlation tests was that there were differences between the areas of emphasis in foreign and domestic PRRs; therefore, the ranks assigned by the individuals in the F-16 SPO were different from the ranks assigned by the individuals studied by Brechtel and Lathrop. The alternate hypothesis (H_1) was that there was no difference between the areas of emphasis in foreign and domestic PRRs' therefore, the ranks assigned to the 25 questions were the same for both foreign and domestic participants. The

mechanics for both the Spearman test and the Kendall test have been discussed in detail in the following chapter.

If differences were determined to exist between the areas of emphasis in foreign PRRs and domestic PRRs, then the differences could be identified and addressed to aid planning and execution for future foreign PRRs. A study ensued to determine the applicability of the PRR process in multinational coproduction programs. The insight of the F-16 PRR participants have been helpful in approaching this question.

Additional Research Data

Not only was the questionnaire technique used as a means for collecting data to test Research Hypotheses I and II, but the questionnaire was also used as a means for collecting subjective data from the foreign PRR experts concerning the PRR process.

The first part of the questionnaire not only had the foreign PRR experts rank the 25 questions from one to 25, but it also asked them to prioritize each question in a ranking from A to E. An assignment of A indicated highest priority of importance, while an assignment of E indicated the lowest priority of importance. This data was used to help determine the importance of each question to the foreign PRR expert. The data obtained from this test complimented the test for Hypothesis I, and the mean priorities

for each question with an explanation on how these means were computed are furnished in Appendix A.

The questionnaire also contained questions which were designed to gather subjective data on the PRR process from the foreign PRR experts. These questions were contained in Part II of the questionnaire (Appendix A). The questions pertained to the timing of the PRR process, to the interest shown by the prime and associated U.S. contractors on the foreign firms, and to the feelings of the foreign PRR experts as to their perceived role in the PRR process. The final two questions asked the foreign PRR expert to identify areas in which the greatest difference existed between foreign and domestic PRRs and to relate a memorable personal experience or valuable PRR experience while conducting a PRR. The cumulative results from the responses to appropriate questions in Part II of the questionnaire have been furnished in Appendix A. Selected solicited and unsolicited comments to these questions in Part II and to other parts of the questionnaire have been furnished in Appendices H and I.

By collecting and analyzing the responses of the foreign PRR experts to the questions in Part II of the questionnaire, valuable information was assembled to aid in the planning and execution of future foreign PRRs.

Summary

The questionnaire technique was used as the data gathering method for both Hypothesis I and Hypothesis II. Using the results of the Brechtel and Lathrop thesis and the rankings provided by F-16 personnel, a study was made of the differences in areas of emphasis between domestic and foreign PRRs. In addition, the foreign PRR experts were asked to assign one of five priorities to each of the 1971 AFSCR 84-2 questions. The experts were also asked to give their opinion on more subjective questions which were used to gain a better understanding of the PRR process.

Chapter 4

DATA ANALYSIS

Overview

This chapter contains the specific findings emerging from analysis of Research Hypotheses I and II, and corollary findings brought to surface by the questionnaire.

The data indicates that PRRs are not only applicable to multinational coproduction programs, they are imperative. Every interview, every questionnaire, and every consulted source indicated that the foreign PRRs and their follow-ups contributed to the overall success of the coproduction program, and that they are essential to good management.

Furthermore, the data indicates that PRRs performed at foreign subcontractor's plants presented unique challenges not encountered when dealing with domestic defense contractors. The data revealed many areas that require special emphasis during the planning and execution of a foreign PRR.

The ten PRR "experts" were the source of a great deal of the data used to complete this study. It is appropriate here to acknowledge their expertise in the area of Production Readiness Reviews and to provide a brief portrait of their experience. The ten "experts" consisted of the six AF personnel and four civilian consultants listed in

Appendix F. Collectively, they have participated in over 400 domestic and foreign PRRs. Of the average 40 PRRs in which each man has participated, an average of 26 were foreign PRRs. The least number of foreign PRRs performed by any respondent was six. In addition to the ranking of the 25 standard PRR questions, each man provided thoughtful responses to the questionnaire which will aid in the planning, timing, and execution of future foreign PRRs.

Research Hypothesis I

Different PRR teams concentrated on similar areas of emphasis when performing PRRs on foreign firms in the F-16 program.

Primary Findings

To evaluate Research Hypothesis I, ten PRR experts who had participated in the F-16 foreign PRRs were asked to respond to the questionnaire furnished in Appendix A. The personnel were asked to rank the 25 standard PRR questions listed in AFSCR 84-2 (20:5-6) in order of importance for future PRR programs. If the F-16 PRR personnel agree on the relative rankings of the questions, then it may be concluded that the different PRR teams performing F-16 foreign PRRs concentrated on similar areas, and that the 25 standard questions may be ranked in order of importance to a foreign PRR.

First Primary Finding

The actual ranking data from the ten foreign PRR experts for the 25 standard PRR questions is contained in Appendix E. The primary nonparametric statistical test for evaluating the agreement among the ten rankings is the Friedman Two-Way Analysis-of-Variance-by-Ranks Test (17:166). The null hypothesis (H_0) for the Friedman test was that there was no difference among the mean ranks of the 25 AFSCR 84-2 questions; thus, the F-16 personnel do not agree on rankings. The alternate hypohtesis (H_1) for the test was that differences between mean ranks did exist; thus, the F-16 personnel do agree on the relative importance of the questions. To provide additional support for the Friedman test, the nonparametric Kendall Coefficient of Concordance W Test (17:229) was performed for verification. As discussed in the following section, the data supported H_1; the 25 PRR questions may be ranked in order of importance for a foreign PRR.

Friedman Two-Way ANOVA by Ranks test. This test is used on data from K matched samples which are in an ordinal scale, and is useful for testing to determine if the samples have been drawn from the same population. For this test the data were placed in a two-way table having N rows and K columns (Appendix E). The rows represent the ten F-16 production management experts, and the columns represent the 25 AFSCR 84-2 PRR questions. Each row gave the rank score

one of the experts gave to the 25 AFSCR 84-2 PRR questions. The scores in each row are ranked separately.

The procedure used in conducting the Friedman test was covered in the unpublished master's thesis by Brechtel and Lathrop (4:46-50), and from the text on Nonparametric Statistics by Sidney Siegel (17:166-173). The restatement of the null hypohtesis (H_0) and the alternate hypothesis (H_1) is in order at this time. The null hypothesis (H_0) is that there is no difference among the mean ranks for the 25 AFSCR 84-2 questions; therefore, the F-16 PRR personnel do not agree on the rankings for the 25 questions. The alternate hypothesis (H_1) is that there are differences between the mean ranks for the 25 AFSCR 84-2 questions; therefore, the F-16 PRR personnel agree on the relative rankings for the questions.

The formula used to compute the value for χ^2 Ranks is as follows:

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

where

N = Number of rows

k = Number of columns

R_j = Sum of the ranks in the j^{th} column

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

Therefore, in this study:

$N = 10$

$k = 25$

R_j = provided for in Appendix E for $j = 1, 2, \ldots, 25$.

$$\sum_{j=1}^{25} (R_j)^2 = 453,095$$

So,

$$\chi^2 \text{ Ranks} = \frac{12}{(10)(25)(26)} (453,095) - (3)(10)(26)$$

$$= 836.4831 - 780$$

$$= 56.4831$$

The critical value for the Chi-square distribution was set at a significance level of .05 using k-1=25-1=24 degrees of freedom. This was the same parameter used in determining the critical value in the work of Brechtel and Lathrop (4:64). The critical value was obtained from the C.. ..quare distribution table (2:90) and determined to be 36.4. Since the χ^2 Ranks = 56.4831 exceeded the critical value, the conclusion was made to reject H_0 (the null hypothesis) in favor of H_1 (the alternate hypothesis). The test concluded that the F-16 SPO PRR experts did generally agree on the prioritized ranks for the 25 AFSCR 84-2 PRR questions. This was also the same conclusion reached in the Brechtel and Lathrop study (4:64-65).

Even at higher significance level values, the conclusion was still the same. 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 the same degrees of freedom was found to be 45.6. The final conclusion from the Friedman test was that the ten F-16 SPO production management experts did agree on the prioritized ranks for the 25 AFSCR 84-2 questions.

To verify the results obtained from the nonparametric Friedman test, one additional statistical test was performed--the nonparametric Kendall Coefficient of Concordance W.

Kendall Coefficient of Concordance W (17:229-239). This test is useful in determining the association among the 25 sets of rankings. The Kendall test expresses the degree of association among the 25 questions and is particularly useful in studies of interjudge or interest reliability with applications in studies of clusters of variables. The procedure used in conducting the nonparametric Kendall Coefficient of Concordance W test is summarized in Siegel (17:237). The null hypothesis (H_0) for this test is that the F-16 SPO PRR personnel's rankings of the questions are unrelated to each other. The information provided in Appendix E was used to make the Kendall Coefficient of Concordance W calculations. The mean of R_j values ($\overline{R_j}$) was computed as follows:

$$\overline{R_j} = \frac{\Sigma R_j}{N}$$

where

N = Number of entities to be ranked = 25

R_j = Sum of ranks assigned to each entity.

Therefore,

$$\overline{R_j} = \frac{3245}{25} = 129.8$$

It was then required to find the sum of the squared deviations (S) for all 25 R_j values from $\overline{R_j}$ which was calculated as shown below:

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

$$= 31,894$$

This information was then used to compute the coefficient W:

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

where

k = Number of sets of rankings = 10.

Therefore,

$$W = \frac{31,894}{\frac{1}{12}(100)(15600)}$$

$$= .24533846$$

Since N was larger than seven, the following formula was used to calculate a Chi-square value:

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

$$= 10(24)(.24533846)$$

$$= 58.88123$$

Again, using the critical value obtained from the Chi-squared distribution table of 36.4, it can be safely concluded to reject H_0 (the null hypothesis) at a level of significance of .005 and degrees of freedom equal to N-1=24. It can be concluded with considerable assurance that the agreement among the ten F-16 SPO production management experts was higher than it would be by chance. The Kendall Coefficient of Concordance W results gave credence to the outcome obtained from the Friedman Two-Way Analysis-of-Variance-by-Ranks test.

AFSCR 84-2 PRR question priority list. Since the ten foreign PRR experts did agree on the relative importance of all 25 AFSCR 84-2 questions, the means of each of the ten rankings were determined for each question. Results of the mean calculation are contained in Appendix E. The PRR question that had the lowest mean value was identified as the question that should receive the most emphasis when performing a foreign PRR; the question receiving the highest

mean value is the question that should receive the least emphasis when performing a foreign PRR.

Second Primary Finding

The F-16 Multinational Coproduction Program tasked foreign coproducers with a "build to print" operation and no design or development responsibilities. Therefore, emphasis during the PRRs on these firms was placed on readiness for a production operation rather than design and development tasks. Responsibility for design and development rested with the domestic contractor and was treated in PRRs of the domestic contractor's plants.

This indicates a significant shift in emphasis from PRRs performed on domestic contractors but not an unexpected shift. "Coproduction will likely be a frequent method of weapons system acquisition in the future [28:3]." Arrangements will allow foreign contractors the same "build to print" production operations as is presently experienced in the F-16 program. Thus, this shift in emphasis is a significant difference between PRRs performed on domestic contractors and those performed on foreign coproducers.

Third Primary Finding

Several respondents emphasized that the list of 25 AFSCR 84-2 questions was not inclusive of all areas that should be reviewed in a foreign PRR. Most comments indicated special attention must be given to the traditions, values,

and cultures of the foreign country, and the effect of these items on the labor force. Another area that needs special attention is the guidelines affecting transportation of material and resources between foreign countries. A full discussion of these and other comments is provided later in this chapter.

Research Hypothesis II

PRRs performed on foreign firms have different areas of emphasis than those performed on domestic firms.

Primary Findings

Brechtel and Lathrop's 1976 thesis, "A Comparative Analysis of the Application of Production Readiness Reviews" (4), studied PRRs that had been performed on domestic defense contractors. Through interviews with ten AF production management experts, Brechtel and Lathrop determined that the experts did agree on the relative importance of all 25 AFSCR 84-2 questions. The mean rank was computed for each question and the questions then assembled in order of their relative mean ranks (4:144-147). The experts generally agreed that the questions at the top of the list should receive the greatest emphasis during a domestic PRR, and those at the bottom of the list should receive the least emphasis. The rankings found by Brechtel and Lathrop are shown in Appendix C.

In this thesis, the researchers have replicated the procedures used by Brechtel and Lathrop and have assembled a list of the same 25 questions as ranked by ten foreign PRR experts. This list is shown in Appendix C. As noted in the previous chapter, the 25 questions were drawn from the 1971 AFSCR 84-2. Use of the questions is necessary to ensure validity of comparison between the foreign and domestic PRR experts.

To test the hypothesis that PRRs performed on foreign firms have different areas of emphasis than PRRs performed on domestic firms, the correlation between the rankings of each of the above lists was studied using the Spearman Rank Correlation Coefficient Test. The Kendall Rank Correlation Coefficient Test was also performed for verification. High positive correlation would indicate there is little difference in the areas of emphasis between the two lists. Large negative correlation would indicate there is a strong inverse relationship between areas of emphasis. If this were true, those areas rated least important in domestic PRRs would be most important in foreign PRRs.

First Primary Finding

The null hypothesis (H_0) for the correlation test was that differences do exist between areas of emphasis; thus, the F-16 foreign PRR experts ranked the questions differently than did the domestic experts in Brechtel and

Lathrop study. The alternate hypothesis (H_1) states that there exists no difference between areas of emphasis, thus the questions were assigned the same rank by both groups.

As discussed in the following sections, the data supported H_0; differences do exist between areas of emphasis of domestic and foreign PRRs.

Spearman-Tau Rank Correlation Coefficient test. This test is a measure of the degree of association between the sample pairs of observations. For this test, the data were placed in X sample ranks and Y sample ranks. The X ranking and Y ranking represent the prioritized rankings of the 25 AFSCR 84-2 PRR questions. The X ranking is provided by Brechtel and Lathrop (4:144-147) and the Y ranking is provided by the foreign PRR experts ranking in this study. A comparison of the two rankings is shown in Appendix D.

The procedure used in conducting the Spearman Test was covered in two different texts: one by Siegel (17:202), and the other by Gibbons (9:275). The differences of each line of the X and Y rankings are computed, squared, and summed. If the relationship between the two sets of ranks were perfect, every difference would be zero. The larger the difference, the less perfect must be the association of the two rankings. A restatement of the hypotheses is in order at this time. The null hypothesis (H_0) for the correlation test is that differences do exist between areas of

emphasis; thus, the F-16 foreign PRR experts ranked the questions differently than the domestic experts in Brechtel and Lathrop's study. The alternate hypothesis (H_1) states that there exists no difference between areas of emphasis; thus, the questions were ranked the same by both groups.

The formula used to compute the coefficient was as follows:

$$\tau_s = 1 - \frac{6 \sum_{i=1}^{N} D_i^2}{N^3 - N}$$

where

D_i = The difference between the two ranks

N = Number of ranked variables

$\sum_{i=1}^{N}$ Directs one to sum the squares of differences between the two ranks

From the data,

$$\sum_{i=1}^{25} D_i^2 = 2630$$

$$\tau_s = 1 - \frac{6(2630)}{(25)^3 - 25}$$

$$= -.011538$$

The value of the coefficient of rank correlation defined by Spearman's Tau is always equal to or between +1.00 and -1.00 with the interpretation of +1.00 as being the maximum possible agreement or perfect agreement. The -1.00 value

indicates an inverse correlation or that of perfect disagreement. Hence, the absolute value of the Spearman coefficient of 1.00 reflects perfect correlation, and the sign of the number indicates the type or direction of correlation. When the coefficient is equal to zero, there is no correlation and hence neither agreement nor disagreement. The results of this test indicate that there is very little correlation, if any, and that correlation is negative.

A more precise conclusion can be reached through the use of the table of critical values of the Spearman's rank correlation coefficient (2:186). If the observed absolute value for Spearman's Tau equals or exceeds the value in the table, then the observed value is significant at the specified level indicated. For N=25 and a level of significance of .05, the value obtained from the published table for a two-tailed test is 0.400. Since the observed absolute value for Tau was .011538 and this value does not exceed or equal the tabled value, the conclusion is to accept H_0. The acceptance of the null hypothesis concludes that the rankings of the 25 PRR questions by the two groups of experts are different.

Since, in this test N was larger than ten, the significance of the obtained Spearman's Tau may be tested using the t-distribution. The Tau was transformed into a t-statistic using the following formula:

$$t = \tau_s \sqrt{\frac{N-2}{(1 - \tau_s)^2}}$$

where

$$\tau_s = -.011538$$

$$N = 25$$

Therefore,

$$t = .011538 \sqrt{\frac{25-2}{1-(-.00138)^2}}$$

$$= -.55338$$

The t-distribution table (2:82) shows that for the degrees of freedom equal to N-2=23 and the significance level of .05 (for a two-tailed test) the critical value was 2.069. Since the computed absolute t value of .055338 is less than the critical value, the conclusion is to accept the null hypothesis (H_0) that the rankings were unrelated. This test gives credence and affirms the results of the first test on this data.

For another verification of the results obtained from the nonparametric Spearman's Tau, one addition parametric statistical test was performed--the Kendall Rank Correlation Coefficient.

The Kendall Rank Correlation (Tau). The Kendall test (17:213; 9:284) is another measure of correlation between the two rankings of PRR questions by the experts. It is applicable in exactly the same sampling and inference

situations as the Spearman test. The Kendall Tau statistic measures association in a slightly different way, and hence, in most cases produces a numerical value different from the Spearman's results. Both tests utilize the same amount of information in the data, and thus, both have the same power to detect the existence of correlation in the population. The value for Tau is obtained by arranging one ranking in numerical order and then examining the corresponding rank values for the second ranking. The procedure considers all possible pairs of rank values in the second ranking, adding to the value of Tau for values which are in natural order and subtracting for pairs out of order. If the rankings are in perfect agreement, the value of Tau is 1.00, indicating the maximum possible agreement. If the rankings are in reverse numerical order, the value of Tau is -1.00. The Kendall Tau is a function of the minimum number of interchanges of ranks necessary to transform the second ranking into the same order as the first ranking and may be considered as a coefficient of disarray between the two rankings. The procedure and calculations for this statistical test are given in Appendix G. The calculated Tau was equal to -0.14.

The specific test of the null hypothesis is performed by comparing a value of $ for the rank order comparison to a critical value of $ obtained from a normal distribution table. The critical $ value identifies the allowable probability of

rejecting the null hypothesis when the null hypothesis is true.

To transform the Tau value to a Z value, the following formula was used:

$$Z = \frac{\text{Tau}}{\sqrt{\frac{2(2N + 5)}{9N(N-1)}}}$$

In this formula, Tau and N are defined as they have been used previously. The denominator in this formula is the standard deviation of Tau. Therefore,

$$Z = \frac{-0.14}{\sqrt{\frac{2\ 2(25) + 5}{9(25)(24)}}}$$

$$= -0.980909$$

The decision rule for hypothesis testing is based on a significance level of .05. An inverse relationship or positive relationship is considered equally conclusive for rejecting the null hypothesis of no agreement. The test becomes a two-tailed statistical test for a normal distribution. Any computed value of Z which is equal to or greater than 1.96 or equal to or less than -1.96 will cause the null hypothesis to be rejected. Since the calculated value is between the limits, the conclusion is to accept H_0 which is the same conclusion reached in the Spearman's Tau test. It can be concluded with considerable assurance that

the ranking of the 25 AFSCR 84-2 PRR questions by the foreign PRR experts does not agree with the ranking of the same questions by domestic PRR experts.

Second Primary Finding

These tests show that neither positive or negative correlation exists between the two ranked lists. The ranks assigned by the foreign PRR experts are different than those assigned by the domestic PRR experts. The researchers investigated the nature of the differences and observed several significance findings.

Change in rank. All 25 PRR questions received two ranks. One was the rank assigned by domestic PRR experts, the other by foreign PRR experts. The change in ranks between the two populations can provide interesting insight. The change in rank (D) ranged from 1 to 20. Eight questions had a $D \leq 5$, i.e., they changed positions by less than five places. At the other end of the spectrum, four questions had a $D \geq 15$, or changed position by at least 15 places.

The questions changing the least number of places may be typified by their concern for production capability, planning and tooling. Question numbers are assigned by 1971 AFSCR 84-2. Specifically, the following four questions changed only one position: Question number (3) . . . production tooling has been demonstrated . . ., (6) . . . advanced production planning has been accomplished . . .,

(12) . . . impact of changes on production have been assessed . . ., (19) . . . manufacturing capabilities have been technically evaluated.

The inference here is that the importance of reviewing these areas does not change when performing a PRR on a foreign firm rather than a domestic.

The questions changing the greatest number of places may be typified by their concern for the very basics of a producer's organization; is there adequate skilled labor and is the organization designed in a way to allow accomplishment of production. Specifically, the questions changing 20 and 18 positions, respectively, were question numbers (23) . . . availability of adequate labor skills has been studied . . ., and (24) . . . contractor is adequately organized to accomplish production. Both these questions shifted from very low importance in the domestic ranking to very great importance in the foreign ranking. One question shifted 20 places in the opposite direction. Question (2) . . . engineering and development problems have been resolved . . ., was found to be very important domestically but of little importance in a foreign PRR. As noted earlier, this is not surprising since the major U.S. contractors held all responsibility for design and development.

Top five questions. The foreign PRR experts indicated the five PRR questions to receive the most emphasis were (in order): (9) . . . assure readiness of production equipment,

methods, and labor . . ., (6) . . . advanced production planning accomplished . . ., (18) . . . adequate management information systems are present . . ., (23) . . . availability of adequate labor skills has been studied . . ., (24) . . . contractor is adequately organized to accomplish production . . . . The foreign PRR ranking has only one question in common with the top five of the domestic PRR experts, question (6) dealing with advanced production planning.

Conspicuously absent from the foreign Top 5 are four questions dealing with engineering, design, and development. Specifically, the questions removed from the foreign Top 5 include (13) . . . results of technical reviews and status of unresolved problems have been studied . . ., (1) . . . engineering design is practical and producible . . ., (22) . . . engineering problems have been resolved . . ., (5) . . . any significant design changes required have been implemented . . . .

It is evident the F-16 foreign coproducers were not responsible for design and development duties in the program, and the PRRs were adjusted to accommodate this. There are, however, a number of shifts in emphasis which do not deal with engineering and development duties. Foreign PRRs emphasized basic business needs such as labor supply, organizational design, and production technology. These areas

received much greater emphasis in the foreign firm than they would have received in the domestic contractor's plant.

Summary of Primary Findings

The findings of Research Hypothesis I and II conclude that Production Readiness Reviews on foreign coproducers require special emphasis on certain areas and that furthermore, the 25 PRR questions in AFSCR 84-2 may be ranked to reflect the relative importance of each area. Secondly, the areas of emphasis for a foreign PRR are different than the areas of emphasis for a domestic PRR. There are areas that must be carefully studied when doing a foreign PRR that do not need close scrutiny when performing a domestic PRR. The areas requiring the greatest emphasis during a foreign PRR pertain to the coproducer's organization, his production planning, his management information system, production tooling, and availability of skilled labor. A significant difference is the lack of attention to engineering, design, and development responsibilities. Also of interest here is the fact that many foreign PRR experts felt the list of questions in the 1971 AFSCR 84-2 was not inclusive of all areas to be reviewed in a successful foreign PRR. The list should be augmented by additional questions to suit the specific system or contractor. These points and additional data and observations have been discussed in the next section, Corollary Findings.

Corollary Findings

This research effort was directed to the collection, analysis, and interpretation of data to determine if differences exist between areas of emphasis in foreign and domestic PRRs, and then to investigate the nature of those differences. Based on this investigation, the researchers sought to determine if the PRR process was indeed applicable to the foreign coproducer in a multinational program. Preceding sections presented primary findings in support of Hypothesis I and II. In addition to primary findings, other interesting findings evolved from the reviews of DOD PRR publications, collected data, and interviews with PRR participants. These additional findings provided added support for the conclusions reached in Hypothesis I and II.

Most of these findings were spawned by the responses to the questionnaire (Appendix A). In addition to the ranking of the 25 PRR questions, the interviewee was asked five questions pertaining to his experiences in the PRR process. Each of the multipart questions covered one area of the PRR. As a result, the corollary findings have been presented in the same sequence as were the five questions that uncovered them.

First Corollary Finding (Question 1)

An investigation was made to determine the proper timing of the PRR. The regulation (AFSCR 84-2) calls for

termination of the PRR at the time of DSARC III, yet there may be cases where it is sound management to continue the process beyond this point. The first question focused on the timing of the PRR on the foreign coproducer.

All ten respondents said that the PRRs and their follow-ups extended beyond the DSARC III milestone. Furthermore, all said that these post-DSARC III reviews generated facts which improved the production process most of the time. Comments by the respondents indicated that follow-ups beyond this point were essential to good management, but that they should be limited to action items on specific areas of concern.

The respondents were equally divided when asked if they spent the greater amount of their time and effort before or after DSARC III. This could be a result of when they joined the program or an indication that a significant amount of time is spent after DSARC III Milestone. All felt that the time spent before DSARC III was always productive because the decision to "go" with foreign production came from the briefing prepared with these PRR facts. The PRRs revealed serious problems that had to be eliminated prior to the decision. Had these problems not been detected and corrected, a negative impact on production would have resulted.

The respondents unanimously felt that foreign PRRs should extend beyond the DSARC III milestone. PRRs are representative of sound management and will promote better

communication between the foreign firm and the U.S. government. Most felt that the PRRs should extend beyond this point in the form of follow-ups on areas where pre-DSARC III problems existed. They should be more informal than the pre-DSARC III PRRs and should eventually give way to normal surveillance. Lastly, PRRs should be initiated any time a major engineering change or schedule slippage occurs.

In short, the first corollary finding was that experts agree that the PRRs should not be limited to a pre-DSARC III activity. They are a useful management tool that provided benefits both before and after the decision milestone, and must be continued in the form of follow-ups after the production readiness decision is made.

Second Corollary Finding

All foreign firms reviewed during the PRR process were subcontractors to some U.S. contractor, in most instances the prime. It would seem that the prime would have enough vested interest in the foreign coproducer to perform the same type of inspection as a PRR. The second question focused on whether the U.S. contractor could have accomplished the same objectives as the government PRR team. If they could, it would be logical (and cost beneficial) to make the prime responsible for the production readiness of the subcontractor.

The ten experts felt that the prime had slightly less interest than the government SPO team in production areas examined by the PRR. Comments indicated the prime did not rely upon deliveries from coproducers to meet its own schedule, and often did not receive any of the foreign coproducer's output. Furthermore, one expert felt that the prime did not share all available information with the foreign coproducer when solving troublesome problems.

Six out of ten experts felt the prime could not have performed the PRR with as much success as the government directed SPO team. Their reasoning was the government approaches the coproducer in the role of an interested customer, while the prime approaches as a partner. Because of the difference in perspective, the prime will not put as much effort into the PRR or cover as broad a spectrum of production areas. One expert noted, however, there is a very strong marketing incentive for the prime to ensure the coproducers are successful and stay on schedule.

In summary, a majority of experts felt the primes should not be charged with responsibility for the PRR process. They lack the interest of a customer and are inclined to treat the foreign coproducer as a future competitor rather than partner. This results in reluctance to share technology and know how during the review process.

Third Corollary Finding

The official objective of the PRR is to gather facts pertaining to the production readiness of the foreign firm and to verify that the production phase may be entered without incurring unacceptable risks. The third question focused on the extent of the expert's involvement with the foreign coproducer. Did they only collect information and report back to the DSARC III, or did they in fact help solve troublesome production problems?

All respondents felt they both gathered information and solved problems to some degree. Three went further and stated the two tasks were inseparable. Responses were evenly divided among those spending more time gathering information, and those spending more time solving problems. Sometimes the problems with the foreign coproducers were apparent. In these cases, the coproducer relied upon the government for technical assistance and problem solution. The most commonly used procedure by the F-16 SPO was to identify actual or potential problems, establish action items or correct the problems, and then perform follow-up PRRs to ensure the discrepancies were resolved. To summarize, the experts felt that identifying the problem is the first step of problem solving, so the two tasks are inseparable. The PRR teams did, however, go beyond their "fact finding" charter and provide valuable technical assistance and problem solving skills to the foreign contractor.

The foreign coproducer's attitude towards the PRR may be summed up with this response to one of the questions. "The Europeans were worried about us until they found out we were not trying to run their business and that we were there as partners to make the program work." Another response gives us a similar view. "Initially they (foreign contractor) felt imposed upon (by PRR), but as we worked with them most of them became more receptive when they found out that we were not there to criticize but to help them." Seven out of ten experts felt that after overcoming initial resistance, the PRRs were welcomed by the foreign contractor.

Oddly, only one expert felt the PRR was inadequately marketed to the foreign contractor. All noted the initial resistance of the contractor but felt that no additional preparation was needed prior to the initial PRR. This indicates perhaps that the advance marketing of the PRR reduced resistance to a degree. Beyond this point resistance could only be reduced by working side by side with the government PRR team. The experts agreed that resistance broke down after the PRR teams got into the contractor's facilities and began work.

The third corollary finding was that the experts feel they did more than gather facts during the PRR process, and that the advance preparation of the foreign coproducer for the PRR was adequate. The government teams acted as technical advisors and problem solvers to some degree, and after

overcoming initial resistance, they were welcomed by the foreign firm.

Fourth Corollary Finding

Question four offered the experts an opportunity to identify and comment on the areas that required special emphasis when performing a PRR on a foreign contractor. Each respondent was asked to identify three areas that they felt were significantly more important in the foreign plant than in the domestic contractor's plant. Many areas were singled out as requiring special attention. Among these areas, several were repeatedly mentioned by the ten foreign PRR experts.

Labor environment. The area most often mentioned concerned the labor environment in the foreign country. The PRR team must be thoroughly familiar with local labor unions, labor legislation, and the work ethic of the particular country. Problems in any of these areas can have an acute impact on the production readiness and production capability of the foreign contractor.

Many of the respondents cited examples. In the case of one foreign firm, stable and full employment was more important than avoiding schedule slippages. Some firms operate on a one shift basis and are unwilling to increase working hours to adjust schedule or production changes. Overtime is virtually unheard of. Management and labor

unions permit surprise, one day strikes when the weather is nice. In short, the schedules and goals of the production line are not sacred. The PRR team must carefully study the impact this type of work ethic can cause on the production line.

Less middle management. Another area repeatedly mentioned by the ten experts was the organizational design of the foreign contractor. There is a conspicuous lack of middle management in the foreign firm, and the general manager absorbs much of the responsibility for handling all phases of the production line. Because there is less management, there is less specialized reporting to the general manager. The PRR team may not be presented facts and numbers in the same detail they could expect in a domestic firm. The general manager may be the single point of contact for the PRR team. His span of control may be large, and he relies upon foreman and floor supervisors to keep production moving. In this case, the PRR team member must possess great technical skill as he must often detect, compare and analyze his own data directly from the floor of the production line. The lack of middle managers means that many of the problems in the production line may go unnoticed until the PRR team arrives. The PRR team members need high technical skill to pinpoint trouble areas in the foreign coproducer's production line.

Longer lead times. The ten foreign PRR experts felt that foreign coproducers require longer lead times than domestic contractors. Several factors, they felt, contribute to this situation. In many cases, the contractor is unfamiliar with the new technology required for production and there is a very slow learning curve. More importantly, and harder to overcome, was the absence of a sense of urgency in some contractors. This again reflects the impact of the labor environment and work ethic encountered by the PRR experts. The lack of urgency coupled with the delays of handling new technology mean one thing to the PRR team; the time required to complete a task is greater for a foreign coproducer than for a domestic contractor. The PRR team must be well aware of the longer lead times required in the foreign sector and recognize the slow reaction of the foreign coproducer to schedule changes and surges.

Customs of the foreign country. The ten foreign PRR experts felt that dealing with the foreign contractor requires extreme sensitivity to the customs and culture of the country itself. Language differences present a frustrating hurdle, but a society's customs can present even a more tenacious obstacle. The experts found they could not charge into a plant, perform the PRR, then leave. Most foreign PRRs required a great deal more diplomacy than domestic contractors. Several days may be devoted to introductions and making acquaintances. The foreigners practice

much of the old world protocol with which contemporary domestic contractors long ago dispensed. The PRR teams may have to survive several days of decorum and protocol before they can get down to business. In addition, to language and protocol, other facets of the foreign country's culture may affect the contractor's ability to do business within the coproduction framework. National holidays may affect the coproducer's adherence to schedule. The foreign country's relations with a neighboring country may inhibit the transport of crucial materials and resources across borders. A difference in standards includes much more than a comparison of metric units versus the familiar mile, foot, and inch of U.S. measure. Is their standard workday as long as a domestic workday? Is the standard technical expertise of a worker the same as that of a domestic worker?

The PRR team members must do a careful study of the customs and cultures of the foreign country they are to visit. They should be familiar with any aspect of customs that may impact the production readiness of the coproducer. Further, they must be prepared to observe the customs themselves including an abundance of protocol at each meeting with the foreign contractor.

Quality control. Responses of the ten PRR experts indicated that the foreign contractor required particular scrutiny in the area of quality control. In many cases, the contractor was overwhelmed by new, high technology production

processes and had yet to develop a sound quality control program for the production line. Foreign quality control programs were not as well developed as domestic quality control programs. In this area, the PRR team is able to provide technical advice and help the contractor understand the importance and necessity of a solid, comprehensive QC program. The foreign PRR team should give special attention to quality control systems, especially in the case of coproduction where foreign produced parts may be installed on U.S. aircraft.

Other areas. Several other areas were identified by the experts as requiring special emphasis and consideration. Most of these additional areas were also brought to the surface by the ranking of the 25 PRR questions. Receiving the greatest emphasis was production planning and organization design. Typical comments point out that planning is more critical for the foreign contractor because often the output from his production line becomes the input to a different line, often in a different country. The sequencing and scheduling of events is also critical to prevent backlogs or overloads in scheduled deliveries. The emphasis on these areas has been pointed out in primary findings stemming from Hypothesis II. The PRR team should look at these areas more carefully during a foreign PRR.

Fifth Corollary Finding

The Department of Defense has recently become involved in the PRR arena. DOD Product Engineering Services Office (DOD/PESO) completed a study of PRRs which included a note about PRRs performed on foreign contractors.

> The PRRs at foreign subcontractor plants benefitted the PMO (Project Management Office) and contractors in other ways. The PRR teams provided consultant services and aided technology transfer by identifying deficiencies in the subcontractor production plan. The PRR also highlighted differences in business practices between domestic and foreign defense contractors . . . . Those experienced with PRRs at foreign contractor's facilities, found differences in culture or language which compounded the problems usually encountered on domestic PRRs. The form of government, Ministry of Defense Structure, industry/government relationship, and labor/management relationship are all differences that must be addressed during planning and execution of the PRR [27:16].

Summary of Corollary Findings

Responses from the questionnaire and investigation of related data have led to the following corollary findings:

1. The ten experts all feel future foreign PRRs should extend beyond the DSARC III milestone in the form of follow-up reviews.

2. A majority of the ten experts feel that the prime should not be charged with the responsibility for performing PRRs on foreign coproducers.

3. Nine out of ten experts felt the PRR was adequately marketed to the foreign contractor. They felt the SPO PRR teams acted as technical advisors and problem solvers, and after overcoming initial resistance, they were welcomed by the foreign firm.

4. The experts felt certain areas not covered by the AFSCR 84-2 questions deserve special attention during a foreign PRR. These additional areas included:

a. The labor environment of the country
b. The typical lack of middle management
c. The longer lead times required by foreign contractor
d. Customs of the foreign country
e. The lack of well developed quality control programs

5. The DOD has reviewed PRRs and made some observations on foreign PRRs. They note that team members should be well versed in tradition and culture of the foreign participants.

Summary

The primary findings of this chapter have emerged from the analysis of Research Hypotheses I and II. The corollary findings resulted from analysis of questionnaires, interviews, and study of PRR related material. The findings indicate that PRRs are imperative when dealing with a foreign contractor. In the next chapter, the conclusions reached from these findings are discussed.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter discusses conclusions associated with the findings of the previous chapter. Primary findings are related to the two major objectives of this study; corollary findings were discovered from additional data collected from research, interviews, and questionnaires. The researchers' major objectives were to determine if foreign PRRs require special attention to certain areas and to determine if these areas of emphasis were different for foreign and domestic PRRs.

The primary conclusions evolved from statistical analysis of the ten experts' ranking of 25 standard PRR questions. The corollary conclusions evolved as more data was assembled and reviewed. The corollary findings are presented to provide a more thorough picture of the foreign PRR and the special challenges it presents.

Research Hypothesis I

Different PRR teams concentrated on similar areas of emphasis when performing PRRs on foreign firms in the F-16 program.

Hypothesis Support

Research Hypothesis I was supported. The ten F-16 foreign PRR experts agreed on the relative rankings of the 25 questions. The Friedman Two-Way Analysis-of-Variance-by-Ranks test (17:166) showed that differences do exist between the mean ranks for the 25 questions. Thus, the ten experts felt that certain questions were more important than others when performing a foreign PRR.

General Conclusions

The primary conclusion resulting from the test of Research Hypothesis I was that certain areas are more important than others when performing a foreign PRR. Thus, the first research objective achieved by the discovery that different PRR teams concentrated on similar areas of emphasis when performing PRRs on foreign firms in the F-16 program. Comments from the respondents indicated these areas required more attention due to the unique challenges presented by the multinational coproduction program and by European industry. All experts felt that their experiences were not characteristic of the F-16 program alone but that similar challenges would be encountered any time the United States deals with a European contractor. The conclusion was that in future coproduction programs, foreign PRR teams should concentrate on certain areas of emphasis. To determine if these areas

of emphasis are the same as those of a domestic PRR, Research Hypothesis II was developed.

Research Hypothesis II

PRRs performed on foreign firms have different areas of emphasis than PRRs performed on domestic firms.

Hypothesis Support

Research Hypothesis II was supported. The mean ranks for the 25 questions of the foreign PRR experts do not agree with the mean ranks of Brechtel and Lathrop's domestic experts. The Spearman-Tau Coefficient of Correlation Test (17:279) shows there was no agreement between the two rankings of the 25 questions. Thus, the questions that are most important during a foreign PRR are not the same as the questions most important during a domestic PRR.

General Conclusions

The primary conclusion resulting from the test of Research Hypothesis II was that the areas of emphasis for a foreign PRR are different than the areas of emphasis for a domestic PRR. Thus, the second research objective was achieved by the discovery that foreign PRR teams should concentrate on areas different than areas of concentration for domestic PRR teams. Comments from the ten experts revealed that European industry presents unique problems and challenges not present when dealing with U.S. contractors. These unique problems are present throughout European industry

and are not confined to the F-16 coproducers. Further, the multinational coproduction program placed additional requirements upon the foreign firms, compounding the PRR challenge. The conclusion was that in the future, certain areas will require special emphasis when performing a PRR on a foreign firm; areas that would not require as much emphasis if a domestic firm was involved. Additionally, when a foreign contractor is also a coproducer, other areas need emphasis due to the demanding requirements of a multinational coproduction program. Areas requiring the greatest attention during a foreign PRR are discussed in the previous chapter, and are briefly recounted here. The top five questions were the five questions with the highest mean ranks (ranks 1-5).

Top five questions. The top five questions clearly indicated that attention must be focused on the foreign contractor's ability to plan the production. Adequate planning and preparation is crucial, especially in a coproduction effort. A delay in the production of a single component by a single contractor could affect the delivery schedule of the overall system. The foreigners lack experience in advance production planning of high technology systems and components. Often, they are unfamiliar with the technology and with the rigidity of the production schedule. Thus, a thorough review of the following questions is paramount to successful foreign PRRs. (Question numbers are those assigned by 1971 AFSCR 84-2).

Question 9. "Assurance of readiness of manufacturing and production equipment, methods, facilities . . . is available."

Question 6. "Adequate advanced production planning has been accomplished . . . ."

Question 18. ". . . systems for providing timely status information are effective."

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

Question 24. "Contractor is adequately organized to accomplish production requirements."

It is noteworthy that only one of these questions (number 6) was in the top five questions identified by Brechtel and Lathrop as being most important in a domestic PRR. There was a fundamental shift in emphasis towards basic production planning, labor availability, and management feedback systems. Questions in the domestic top five that dropped out of the foreign top five concerned engineering design and development. Further, the domestic PRR experts tended to de-emphasize the questions in the foreign top five, ranking three of those at the low ranks of 18, 23, and 24.

These observations led to the conclusion that foreign PRR teams must not presume the foreign contractors are familiar with state-of-the-art technology and production processes. In many cases, the foreign firm is not exposed to the rapidly changing environment that characterizes U.S. industry. For this reason, the foreign PRR team must "get back to basics" that can be assumed in good order in a

domestic contractor. The PRR team member may quickly find himself in the role of a management consultant providing technical advice and solving troublesome problems for the foreign contractor. The knowledge and expertise of the PRR team member is of critical importance. Often, he must not only recognize the problem, but he must have the answer as well.

The 1971 AFSCR 84-2 list of 25 questions was not comprehensive for a foreign PRR, and as listed, the order of the questions does not reflect the relative importance of each question when performing a foreign PRR. The 1971 format tends to imply a ranking of relative importance that does not agree with the ten foreign PRR experts' opinions of the relative importance of each question.

Summary of Primary Conclusions

The following conclusions were reached from the primary findings of Research Hypothesis I and II:

1. Certain areas are more important than others when performing foreign PRRs.

2. These areas of emphasis are different for PRRs performed on foreign contractors than for PRRs performed on domestic contractors.

3. As listed in the 1971 AFSCR 84-2, the questions do not reflect relative importance for foreign PRRs.

4. Foreign PRRs require special attention to the basics of production planning and call for technical expertise on the part of the PRR team member.

Corollary Conclusions

This section of the research addresses the conclusions drawn from the five corollary findings discussed in the previous chapter. As mentioned before, most of the corollary findings and hence, these conclusions, were spawned by the responses to the written part of the questionnaire (Appendix H). In addition to the questionnaire, interesting findings evolved from the review of DOD PRR publications, collected data, and interviews with PRR participants.

First Corollary Conclusion

While all regulations call for the PRR to terminate at DSARC III, all ten foreign PRR experts indicated that the foreign PRRs and their follow-ups extended beyond this milestone. They generally felt that follow-ups beyond this point were essential to good management but should be limited to previously identified action items or specific areas of concern. The researchers concluded that foreign PRRs should not be limited to a pre-DSARC III activity. They should continue beyond DSARC III because they are a useful management tool that will yield benefits both before and after the decision point.

Second Corollary Conclusion

Although all foreign coproducers are subcontractors to some U.S. contractor, the U.S. firm does not necessarily

show the same interest in the broad spectrum of areas covered by the PRR. The conclusion reached by the researchers was that the primes should not be charged with responsibility for performing the PRRs. This responsibility should remain with the government who assumes the role of a very interested and concerned customer.

Third Corollary Conclusion

The foreign PRRs did much more than generate facts for the production decision of DSARC III. All ten respondents felt they both generated information and solved problems to some degree. In most cases, the F-16 PRR teams went beyond their "fact finding" charter and provided valuable technical assistance and problem solving skills to the foreign contractor. The researchers' conclusion was that foreign PRRs require more than mere fact finding. The PRR teams must be prepared to get deeply involved in the trouble-shooting and problem solving areas during the PRR.

Fourth Corollary Conclusion

The PRR teams encountered initial resistance from the foreign coproducers, but resistance gave way to cooperation when coproducers realized the teams were not trying to run their business and were partners in the coproduction program. When the foreigners realized the SPO teams were not there to criticize but to help, they became receptive. A majority of ten experts felt the initial resistance

encountered was not serious. Nine out of ten experts felt the PRR was adequately marketed to the foreign coproducer. The researchers' conclusion was that the PRRs were adequately marketed to the foreign contractors. The working relationship between teams and coproducers improves after the intangible bond of trust is formed, but no amount of additional marketing could eliminate this need to "check each other out."

Fifth Corollary Conclusion

Corollary conclusion five through nine pertain to written comments made by the ten experts in response to question four in the questionnaire. Their written comments and the associated findings provide the basis for these conclusions.

The foreign labor environment was repeatedly noted by the experts as an area requiring special attention. Labor unions, labor legislation, skill levels, and the work ethic of the populace all make the foreign labor environment different than that of the United States. The PRR team must carefully study and paint an accurate portrait of the labor environment. An improper estimate of labor can lead to acute problems in the production process. The researchers' conclusion was that the foreign labor environment is distinctly different than the domestic labor environment and the PRR team must carefully study the impact of labor on a firm's production readiness.

Sixth Corollary Conclusion

The ten experts witnessed a lack of middle management in the foreign contractor's organizations. A general manager would typically absorb the responsibility for all phases of production. Because there is less management, there is less reporting of information to the general manager. The researchers' conclusion was that due to less middle management in the foreign firm, the PRR team must possess a sharp eye for detail and detect production problems not apparent to the coproducer. The PRR team members will find this to a much greater extent with a foreign contractor than with a domestic contractor.

Seventh Corollary Conclusion

Several factors necessitate longer lead times for foreign contractors than for domestic contractors. New technology, retraining requirements, the local work ethic, the lack of any sense of urgency, and the detailed coordination required for a coproduction program are all factors that make the time required to complete the task longer for the foreign contractor than for the domestic. The researchers' conclusion was that foreign coproducers react more slowly to changes than domestic coproducers, and that longer lead times are required when dealing with the foreign firm.

Eighth Corollary Conclusion

While U.S. firms are accustomed to dealing with the government and PRR teams can get to work quickly, the foreign coproducer requires more attention to protocol and decorum. Dealing with the foreign contractor requires extreme sensitivity to the cultures and tradition of the country itself. Language is only the most obvious of many differences between countries and cultures. PRR teams, as visitors in a foreign country, must be aware of and practice all local protocol habits. The researchers concluded that most foreign PRRs will require more diplomacy and protocol than domestic PRRs. Domestic contractors are more eager to "get to it," and have dispensed with lengthy introduction and familiarization routines that can cause delays.

Ninth Corollary Conclusion

Important in any production process, quality control and standardization are critically important in a multinational coproduction program. Parts and assemblies from 20 different contractors in four different countries must meet together on the assembly line and fit together perfectly. Responses of the ten PRR experts indicated quality control was an area requiring special emphasis during a foreign PRR. The underdevelopment of the foreign quality control system may be contributed to by the lack of middle management and thus, the lack of any specialized reporting. The researchers'

conclusion was that most foreign quality control programs are not as well developed as domestic quality control programs and the foreign PRR team must give special attention to this area.

Tenth Corollary Conclusion

The Air Force has been conducting PRRs for over ten years as compared with other services which have only recently begun the practice of PRRs. AFSCR 84-2, issued in November 1971, has been the forerunner of most regulations concerning Production Readiness Reviews. The Department of Defense has recently published DOD Directive 5000.38, Production Readiness Reviews, and the other services have published their own PRR regulations. There is no doubt that each service will continue performing PRRs in the future, and that inevitably, PRRs will be performed on foreign contractors. There will be new experiences with each new foreign PRR, and the lessons learned will be of value to all services. The researchers' conclusion was that each service will perform foreign PRRs in the future and that valuable lessons may be learned from each experience.

Summary of Conclusions

The researchers have found that Production Readiness Reviews are applicable to foreign coproduction programs, and they should continue in the future. The following primary

and corollary conclusions were drawn from the collection and analysis of data.

Primary Conclusions

1. In future multinational coproduction programs, certain production areas should receive more emphasis than others during a foreign PRR.

2. These areas requiring special emphasis are different for PRRs performed on a foreign firm than for PRRs performed on a domestic firm.

3. As listed in 1971 AFSCR 84-2, the PRR questions do not reflect the relative emphasis each should receive during a foreign PRR.

Corollary Conclusions

1. Foreign PRRs should not terminate at the DSARC III milestone and should continue in the form of follow-ups on specific areas of concern.

2. The prime contractor should not be charged with the responsibility of performing PRRs on foreign subcontractors.

3. In addition to gathering facts for the DSARC III briefing, foreign PRR teams must also get involved in troubleshooting and problem-solving with the foreign coproducer.

4. Foreign PRRs are adequately marketed to the foreign coproducers.

5. The labor environment in the foreign country is different than that in the U.S. and must be carefully studied by the foreign PRR team.

6. The foreign coproducer typically has less middle management than his domestic counterpart. This presents unique challenges for the foreign PRR team.

7. Foreign coproducers react more slowly to changes than domestic coproducers, and longer lead times are required when dealing with the foreign firm.

8. Most foreign PRRs require more diplomacy and protocol than domestic PRRs.

9. Most foreign quality control programs are not as well developed as domestic quality control programs.

10. Each component of the DOD will perform foreign PRRs in the future and valuable lessons may be learned from each experience.

Recommendations for Future Foreign PRRs

As a result of the primary findings and conclusions reached in testing Research Hypotheses I and II, and the corollary findings and conclusions, the following recommendations are made for future foreign PRRs.

The list of 25 standard PRR questions in the 1971 AFSCR 84-2 (20:3-4) provided a tool for valid comparison between foreign and domestic PRR experts. Brechtel and Lathrop used an identical list in their 1976 thesis. Using Brechtel and Lathrop's methodology, the same list was provided to the foreign PRR experts in this study. Although the 1971 AFSCR 84-2 has been superseded and the 25 questions are now presented in different format, the use of the earlier list of questions is valid for comparison purposes. In fact, the 1981 AFSCR 84-2 (21) has addressed one primary conclusion reached in this study. The third primary conclusion notes that as listed in the 1971 regulation, the PRR question did not reflect the relative emphasis each should receive during a foreign PRR. The 1981 regulation subjectively groups the questions into eight areas. Presentation of the PRR criteria

in this fashion is more useful to the PRR planner. Still, the foreign PRR planner has no indication of which of these subject areas need more emphasis during a foreign PRR.

First recommendation. Primary conclusions reached during the testing of Hypotheses I and II indicate that areas requiring special emphasis are different for PRRs performed on foreign firms than for PRRs performed on domestic firms. The particular areas requiring special emphasis during a foreign PRR are discussed in the Findings chapter and in Appendix H. The researchers recommend that future foreign PRR programs be developed around the prioritized areas of emphasis furnished in Appendix C. The questions at the top of the list indicate areas requiring the most emphasis during a foreign PRR. Lower ranking questions indicate areas requiring less emphasis.

Second recommendation. Another specific recommendation for future foreign PRR programs is that foreign PRRs should extend beyond the DSARC III milestone in the form of follow-ups on specific areas of concern. Deficiencies in production readiness must be identified and tracked until corrected. This may often require follow-up visits to the foreign contractor after the production decision is made at the DSARC III milestone. Further, any change in schedule or design may warrant a visit by the PRR team to the foreign contractor.

Third recommendation. The researchers' third recommendation is that U.S. contractors should not perform PRRs on their foreign subcontractors in a coproduction program. The responsibility for the PRR should remain with the government program office. The U.S. contractor may participate on the PRR team but should not be responsible for providing the government with all production readiness data on the foreign contractor. Only the government itself can truly gather objective information for the DSARC III decision and fill the role of the wary buyer.

Fourth recommendation. The fourth recommendation concerns the extent of the PRR team's involvement with the foreign contractor. Teams should be prepared to go beyond the fact-gathering phase of involvement and must often troubleshoot and help solve production problems. The PRR personnel and foreign contractors form a team; a team committed to the success and smooth operation of the production line. This often requires the PRR team members to act as technical advisors to relieve some of the pressure presented by new technology and production processes.

Fifth recommendation. The fifth recommendation is that foreign PRR teams should be prepared to deal with certain problems peculiar to foreign industry. These areas are not clearly addressed in the 1971 or 1981 AFSCR 84-2, but their consideration can enhance a foreign PRR team's ability to plan and execute the foreign PRR. The following six areas

are discussed in the Conclusions chapter and should be considered prior to conducting a foreign PRR.

1. The foreign PRR team is likely to encounter initial resistance from the foreign contractor, but this resistance will give way to receptiveness when the foreign contractor realizes the SPO teams are there to help.

2. The foreign PRR team must be sensitive to the labor environment in a foreign country. Many factors affect the skills, availability, and attitudes of the labor force.

3. The foreign PRR team must be prepared for less middle management in the foreign firm. They must expect less specialized reporting and less management information to be present for their use.

4. The foreign PRR team must recognize that longer lead times are typically required for any adjustments to the production process. Foreign firms adapt more slowly to change than domestic firms.

5. The foreign PRR teams must be prepared to respect the customs and traditions of the host country. Most foreign PRRs will require more diplomacy and protocol than domestic PRRs.

6. Most foreign quality control systems are not as well developed as domestic programs and thus deserve the special attention of the PRR team.

Sixth recommendation. The sixth recommendation is that a data base be formed to store information gained during foreign PRRs. Each component of the DOD will perform PRRs in the future. Valuable lessons will be learned from each experience, as well as detailed information about individual contractors. Each service component has an organization charged with responsibility for coordinating PRR efforts and ensuring they are accomplished. In the case of the Army, a Production Engineering Services Organization (ARPESO) was recently established within the Material Development and

Readiness Command (DARCOM). The Navy has established NAVPESO within its own Material Command. Air Force Systems Command manages PRRs for the Air Force through the Directorate of Manufacturing in each of five buying divisions. Each of these offices assist the program manager in the planning and execution of PRRs. Additionally, they must coordinate with DPESO on all PRR matters. DPESO acts as the coordinating body for each of the PRR organizations in the service components. At the November 1980 DOD PRR conference, it was noted that the defense production community needs a PRR data bank to include lessons learned and contractor assessments. ARPESO, with its associated DARCOM facilities, was proposed by DPESO to study the possibility of establishing such a data bank (27:294). DPESO is the agency most eligible to be responsible for such a data bank. Executive management of the data bank can be delegated to one of the services. It is recommended that this data bank include PRR data on foreign contractors as well as domestic. This information would be invaluable to the PRR teams during the planning phase for a foreign PRR. All available data sources should be presented to the SPO team for their utilization.

Summary of Recommendations for Future Foreign PRRs

As stated earlier in this study, the findings, conclusions, and recommendations may be generalized to foreign firms in the NATO sphere of influence. The F-16 SPO personnel

participated in PRRs on numerous European contractors, but there is a lack of experience in dealing with contractors in other geographic sectors of the world. The researchers feel consideration of these six recommendations during future PRRs on European contractors is necessary.

Summary

These recommendations for future foreign PRRs, along with recommendations for future research, are assembled in Chapter 6.

Chapter 6

FINAL RECOMMENDATIONS

Overview

As discussed in the previous chapters, multinational coproduction and U.S. government involvement with foreign contractors will be increasingly common in the future (28:3). The risk of the marketplace increases when the U.S. looks overseas for procurement of system and subsystems. The PRR provides a means for the U.S. to reduce risk when dealing with a foreign contractor. The F-16 multinational coproduction program has illustrated the success of a solid PRR program (13:p.3-ii-16). Based on conclusions reached in the preceding chapter, the researchers made specific recommendations for consideration when planning future foreign PRRs. Two types of recommendations have surfaced: first are recommendations for management action during future foreign PRRs; and second are recommendations for future research. Preceding these recommendations is a discussion of the applicability of the recommendations to Air Force Systems Command Regulation 84-2 (AFSCR 84-2) and a recommendation concerning a supplement to the regulation addressing foreign PRRs.

Air Force Systems Command Regulation 84-2

The Air Force has been conducting PRRs for over ten years. AFSCR 84-2, issued in November 1971, has been the forerunner of most regulations concerning Production Readiness Reviews. The Department of Defense recently published DODI 5000.38, Production Readiness Reviews, as a guide to all services for conducting PRRs. Since its issuance in January 1979, much experience has been gained in planning, conducting, and evaluating PRRs. The Defense Production Engineering Services Office (DPESO) is the issuing agency for the DOD regulation and the focal point for collection of PRR experiences and information.

In January 1981, Air Force Systems Command published a rewrite of AFSCR 84-2. The new regulation supersedes the November 1971 regulation and is in close harmony with DODI 5000.38. In fact, the 1981 AFSCR 84-2 uses the same criteria for evaluating production readiness as does the DOD regulation. The similarities between the two regulations are so apparent that the 1981 AFSCR 84-2 appears to have been a rewrite of DODI 5000.38, not of the 1971 AFSCR 84-2.

As was true in the 1971 AFSCR 84-2, the rewrite makes no mention of PRRs performed on foreign contractors nor any mention of PRRs performed on firms involved in a multinational coproduction program. Conclusions reached in this research effort indicate the foreign contractor poses unique challenges to the PRR team; challenges which may be identified

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AN ASSESSMENT OF THE APPLICABILITY OF PRODUCTION READINESS REVI--ETC(U)
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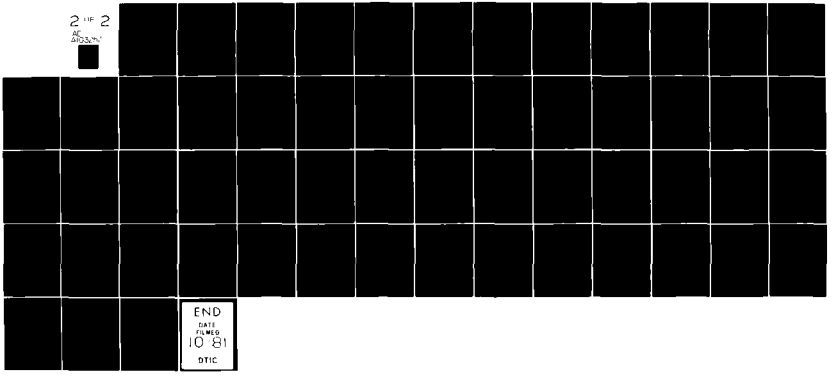

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and which will aid the program manager when planning future foreign PRRs. Neither the 1971 or 1981 AFSCR 84-2 addresses these unique challenges. Thus, the conclusions and recommendations in this research effort are as applicable after the rewritten AFSCR 84-2 was published as they were before.

Supplement to AFSCR 84-2

The 1981 AFSCR 84-2 does not list 25 standard PRR questions as does the 1971 regulation. Instead, the questions are grouped together in eight subject areas derived from DODI 5000.38. The subject areas and individual criteria are for use by PRR teams in determining production readiness. Program managers are encouraged to develop specific criteria to meet situational needs. The objective is to adequately evaluate production readiness. The researchers feel the AFSCR 84-2 presentation of criteria is far more useful than the random list of 25 questions. However, the new regulation still gives no attention to the case of a PRR performed on a foreign firm. The experiences and lessons learned from previous PRRs are not reflected in the 1981 regulation. There is no doubt the number of foreign PRRs will increase in the future. The omission of instructions concerning foreign PRRs is significant. The researchers feel AFSCR 84-2 should include discussion of foreign PRRs, thus it is their recommendation that AFSC publish a supplement to the 1981 regulation. The supplement should specifically address the case of

the foreign PRR and identify areas requiring special emphasis and management attention.

Recommendations for Management Action

As a result of the primary findings and conclusions reached in testing Research Hypotheses I and II, and the corollary findings and conclusions, the following recommendations are made for management action by different Air Force and DOD agencies. Once again, two areas of recommendations have been made: first are six specific recommendations for management action during future foreign PRRs; and second, recommendations for future research concerning foreign PRRs. The six specific recommendations were presented in the previous chapter. The action office for implementing the first five recommendations will be HQ AFSC's coordinating body for the Directorates of Manufacturing in each of AFSC's five buying divisions. The manufacturing directorates are the agencies responsible for ensuring the accomplishment of PRRs by program managers. DPESO will be the action office for the sixth recommendation as it is most eligible to coordinate the PRR data from each service component.

Recommendations for Future Research

The use of PRRs is expanding throughout the Department of Defense. It will soon be present during weapons system acquisitions for all services as it now is for the Air Force. The requirement to conduct PRRs as set forth in

DODI 5000.38 will prevail. Moreover, weapons systems will increasingly be the product of a cooperative effort among several countries. Multinational coproduction will be the rule rather than the exception in the future. The requirements for foreign PRRs will increase dramatically. With the increase in the number of foreign PRR programs available for study, the opportunities for meaningful research on foreign PRRs will increase. This section discusses four areas for future research on foreign PRRs.

Replication of This Study

As noted before, the conclusions and recommendations of this study are generalized for foreign contractors in the NATO sphere of influence. These contractors and their respective countries share certain characteristics and commonalities. The sample reviewed by the F-16 SPO personnel was a cross section of European industry. Based on this sample, the conclusions indicate expected conditions of the European industrial environment.

Each area of the world displays different industrial characteristics. As experience is gained in other sectors of the world, those areas may be studied through the personnel performing foreign PRRs in these areas. In an effort to gather information about foreign contractors in other areas of the world, replication of this study is recommended with emphasis on other non-European areas of the world.

Foreign Contractor Viewpoint

This study has addressed the foreign PRR from the government point of view only. The foreign contractor has many perceptions of the PRR process as well. It has been noted that foreign contractors are initially resistant to the foreign PRR teams. This resistance later yields to cooperation when the foreign contractor feels more certain of the U.S. government team's good intentions. A question that arises here is whether the initial resistance received during foreign PRRs is as great as resistance received during domestic PRRs. To better understand the contractor's point of view and perceptions of the PRR process, future study of the contractor's viewpoint is recommended.

Data Base for PRR Information

As the number of foreign PRRs increase and as all service components get involved in the review process, the information and facts generated by PRRs will reach enormous proportions. Some means of documenting and storing "lessons learned" and contractor information must be created on a DOD-wide basis. The data bank could disseminate information to individual agencies as they prepared for foreign PRRs. An observation made at the DOD PRR Conference in November 1980, stated "Experiences gained in conducting PRRs to date would be beneficial to others holding PRRs in the future [27:293]." Future research to establish some sort of data bank for PRR information is recommended.

Continuity of PRR Personnel

Comments made by personnel involved and related to PRRs indicated the PRR process is hampered by the continual reassignment of personnel. A major acquisition may last several years; yet PRR personnel may be reassigned after only one or two years. Continuity of personnel is important due to the corporate memory the individual possesses, and the rapport he has established with the contractor. Additionally, continuity of personnel would allow a uniform approach to be used with each successive PRR on a particular contractor. Research on the feasibility of longer duration assignment for PRR personnel is recommended.

Concluding Observations

Production Readiness Reviews are indeed applicable to multinational coproduction programs. The review of foreign contractors involved in a coproduction process should continue in the future for a number of reasons. The researchers feel the U.S. government is destined to develop weapons systems with other friendly countries in a cooperative manner. If such is the case, good management dictates that the fitness of the business partner be checked out. The PRR provides a "one-on-one" consultation between the military department and the foreign contractor. This consultation can eliminate many potential problems early in the program that could later hamper production schedules for all

involved parties. The PRR also reduces the uncertainty present when making the production decision at DSARC Milestone III. The facts generated during foreign PRRs were always useful in making this production decision. The Air Force can feel confident the foreign contractor can meet the production schedule. PRRs also foster good strong relationships between the government and the foreign contractor. When this rapport exists, the foreign contractor is more likely to easily adapt to schedule and design changes.

It is hoped that this research study will aid in the planning, execution , and results of future foreign PRRs and that it may provide a stepping stone for future research in the application and usefulness of the PRR process.

APPENDICES

APPENDIX A

SAMPLE QUESTIONNAIRE WITH CUMULATIVE RESPONSES

PRODUCTION READINESS REVIEW (PRR)
QUESTIONNAIRE

This questionnaire is in two parts. The first part is focused on the relative importance of the twenty-five standard PRR questions posed in Air Force Systems Command Regulation 84-2 (AFSCR 84-2). The second part focuses on your opinions and experiences concerning your participation in PRRs on foreign firms.

Please indicate the number of PRRs in which you have participated throughout your career. Indicate with the numerical number in which you have participated by category.

	Foreign	Domestic
AIRFRAME	_____	_____
ENGINE	_____	_____
AVIONICS	_____	_____
MECHANICAL SUBSYSTEMS	_____	_____
Totals	260	229

PART I

This part of the questionnaire aims at determining whether a standard PRR approach can be developed to practically be applied to various foreign contractors in a major system acquisition. Additionally, the questionnaire will determine if differences exist in the areas of emphasis of PRRs conducted on domestic firms and foreign firms. Part I consists of two tasks.

1a: Consider a priority system with 5 priority assignments A to E. An assignment of A indicates highest priority or importance, while an assignment of E indicates the lowest priority or least importance. Please review the following twenty-five standard PRR questions (AFSCR 84-2)

and assign a priority to each question. Please assign the priority according to importance when performing a PRR on a foreign contractor.[1]

STANDARD AFSCR 84-2 PRR QUESTIONS

1.	Milestones which demonstrate the achievement of a practical and producible engineering design have been met.	C
2.	Engineering problems encountered during development have been resolved with appropriate tradeoffs against stated operating requirements so that production costs/schedules are optimized.	C
3.	Critical production and engineering and production tooling have been demonstrated to prove that engineering has been satisfactorily accomplished.	B
4.	Acquisition will smoothly transition from full-scale development to production.	C
5.	System configuration has been reviewed to determine if any significant design changes will be required for manufacturing.	C
6.	Adequate advance production planning has been accomplished and required production controls established to ensure timely production.	B

[1]The alpha priority assignments were converted to numerical assignments for computation as follows:

A = 1
B = 2
C = 3
D = 4
E = 5

To decode the averages back to alpha symbols, the following was used:

A = 1.01 - 1.75
B = 1.76 - 2.50
C = 2.51 - 3.25
D = 3.26 - 4.00
E = 4.01 - 4.75

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. E

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

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

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

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 managed. B

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

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

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

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

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. E

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.	A
18.	Production management systems used for providing management with timely production status information are effective.	A
19.	Production or manufacturing capabilities of major subcontractors and vendors have been technically evaluated and found adequate.	A
20.	Constraints of laboratory or model shop capabilities versus quantity production requirements have been fully considered.	C
21.	Quality controls and inspection procedures have been established for materials treatment or processes to be used in production.	B
22.	Assessment of the GFP or services requirements, controls, management, and availability of suppliers has been accomplished.	C
23.	Availability of production labor skill requirements has been assessed and their acquisition adequately planned.	B
24.	The contractor is adequately organized to accomplish the production requirements.	C
25.	Planning has been made to assure timely release of manufacturing instructions.	E

1b: Please rank the twenty-five PRR questions in AFSCR 84-2 in order of importance to a foreign PRR. A "one" should be assigned to the PRR question that should have the greatest amount of time, effort, and resources expended for analysis and reporting, and a "twenty-five" should be assigned to the least important question. Please rank the questions according to how you feel about performing a PRR on a <u>foreign</u> contractor.

STANDARD AFSCR 84-2 QUESTIONS

1.	Milestones which demonstrate the achievement of a practical and producible engineering design have been met.	13
2.	Engineering problems encountered during development have been resolved with appropriate tradeoffs against stated operating requirements so that production costs/schedules are optimized.	22
3.	Critical production and engineering and production tooling have been demonstrated to prove that engineering has been satisfactorily accomplished.	8
4.	Acquisition will smoothly transition from full-scale development to production.	21
5.	System configuration has been reviewed to determine if any significant design changes will be required for manufacturing.	16
6.	Adequate advance production planning has been accomplished and required production controls established to ensure timely production.	2
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.	25
8.	Product assurance controls and tests to prevent manufacturing degradation of performance parameters have been established.	18
9.	Assurance of the readiness of the manufacturing and production equipment, methods, facilities, test and training equipment, and status of accessory and ancillary items.	1
10.	Planned production schedules reflect economy of operations and minimize financial commitments until all major problems have been resolved.	23

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 managed.	20
12.	Change activity during development has been evaluated and the impact of outstanding changes on production has been assessed.	11
13.	Results of technical reviews and the production impact of unresolved problems and risks have been assessed.	15
14.	Test program results and the status of qualification to determine production risks and risk have been evaluated.	19
15.	Specifications and drawings have been reviewed to assure their adequacy for the planned production phase.	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.	9
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.	7
18.	Production management systems used for providing management with timely production status information are effective.	3
19.	Production or manufacturing capabilities of major subcontractors and vendors have been technically evaluated and found adequate.	6
20.	Constraints of laboratory or model shop capabilities versus quantity production requirements have been fully considered.	24
21.	Quality controls and inspection procedures have been established for materials treatment or processes to be used in production.	12

22. Assessment of the GFP or services requirements, controls, management, and availability of suppliers has been accomplished. 14

23. Availability of production labor skill requirements has been assessed and their acquisition adequately planned. 4

24. The contractor is adequately organized to accomplish the production requirements. 5

25. Planning has been made to assure timely release of manufacturing instructions. 10

PART II

This part of the questionnaire is designed to collect information about your experiences as a participant in an F-16 PRR on a foreign contractor. By collecting and analyzing the responses of many participants in F-16 foreign PRRs, it is hoped that information will be gathered to be used in future PRR planning. The questions are aimed at your opinion of the PRR process and how well it works. Do not feel confined by the responses provided; please feel free to add any additional comments you like after each question. It is expected your thoughtful responses will aid in the timing and execution of future foreign PRRs.

1. By definition in AFSCR 84-2, the PRR program begins when the SPO starts planning the PRR, and terminates at the time of the DSARC III review. Although there is no requirement to extend the PRR process beyond the DSARC III milestone, there may be good reason to continue PRRs and their follow-ups beyond this point.

   a. Do you feel the foreign PRRs and their follow-ups in which you participated terminated at the DSARC III milestone?

      Yes 0 No 10

   Comments:

b. If not, was the greater part of your time and energy expended before the DSARC III milestone, or in the follow-ups after the decision point.

Before 5 After 5

Comments:

c. Did the PRR in which you participated generate facts that were useful during the production readiness decision?

Please circle your response.

None of the Time	Some of the Time	Half of the Time	Most of the Time	All of the Time
0	0	0	6	4

Comments:

d. If you participated in follow-ups of the DSARC III milestone, did these follow-ups generate facts which were useful in improving the production process?

Please circle your response.

None of the Time	Some of the Time	Half of the Time	Most of the Time	All of the Time
0	0	1	6	3

Comments:

e. Do you feel future PRRs on foreign contractors should be extended beyond the DSARC III milestone?

Yes 10 No 0

Comments:

2. All foreign firms reviewed in the foreign PRR program were subcontractors to some U.S. firm. Furthermore, General Dynamics and Pratt & Whitney were both primes to the government for overall F-16 coproduction.

a. Do you personally feel the primes and associated U.S. contractors showed more or less interest than the SPO team in those production areas examined by the PRR?

Please circle your response.

A Great Deal Less	Somewhat Less	About the Same	Somewhat More	A Great Deal More
0	4	6	0	0

Comments:

b. Do you feel the Primes could have accomplished the same objectives as successfully as the SPO PRR teams?

Yes 4 No 6

Comments:

3. The ultimate goal of the PRR process is to reduce the risk to the government when entering the production phase. The official objective of the PRR as stated in DOD directive 5000.38 is to verify that production planning has progressed to a point where the production phase may be entered without incurring unacceptable risks. The PRR must accomplish this "fact finding" as a minimum requirement, but the PRR team has the option of going beyond this point if they feel it is necessary. In fact, sound management may call for an extension of the PRR process beyond the information gathering stage.

a. When performing your PRR, do you feel you spent the greater part of your time and energy gathering information on the contractor's production readiness, or helping the contractor solve troublesome production problems?

Gathering Info 5 Solving Problems 5

Comments:

b. While you were visiting the foreign contractor, did you spend most of your time as a production inspector (problem identifier) or as a management consultant (problem solver)?

Please circle your response.

Production Inspector Only	Mostly Production Inspector	About the Same	Mostly Management Consultant	Management Consultant Only
0	2	4	4	0

Comments:

c. Do you feel the PRRs in which you participated were welcomed by the foreign contractor, or imposed upon him?

Welcomed 7 Imposed 3

Comments:

d. Were the PRRs you participated in adequately introduced and marketed to the foreign contractor?

Yes 9 No 1

Comments:

4. Subcontracting with a foreign firm presents some unique management challenges. In some cases, there may be very little difference between a foreign and domestic firm. In other cases, there may be a great disparity between foreign and domestic firms. Another consideration is the variability between individual firms in the United States may be greater than the variability between foreign and domestic firms.

When dealing with a foreign contractor, do you feel there are certain areas that are significantly more important than when dealing with a domestic contractor? Do these areas require additional emphasis during a foreign PRR? If you feel such areas exist, please identify the three areas in which the greatest difference exists. Comment on each.

5. During the PRRs in which you participated, was there an experience or finding that illustrates the value of the PRR process? Was there an event that generated facts, information, or improvements which benefited the overall production readiness of the contractor?

Please briefly relate your most memorable or most valuable PRR experience.

APPENDIX B

LIST OF AFSCR 84-2 QUESTIONS

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 tradeoffs against stated operating requirements so that production costs/schedules are optimized.

3. Critical production and engineering and production tooling have been demonstrated to provide 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 advance 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 the 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 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 managed.

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 risks have been assessed.

14. Test program results and the status of qualification to determine production risks 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

AGGREGATE PRIORITY LIST OF THE TWENTY-FIVE AFSCR 84-2 PRR QUESTIONS

Barnett & Wales Ranking	Brechtel & Lathrop Ranking	AFSCR 84-2 PRR Questions With Original Number	
1	8	9.	Assurance of readiness of the manufacturing and production equipment, methods, facilities, test and training equipment, and status of accessory and ancillary items.
2	1	6.	Adequate advanced production planning has been accomplished and required production controls established to ensure timely production.
3	18	18.	Production management systems used for providing management with timely production status information are effective.
4	24	23.	Availability of production labor skill requirements has been assessed and their acquisition adequately planned.
5	23	24.	The contractor is adequately organized to accomplish the production requirements.
6	7	19.	Production or manufacturing capabilities of major subcontractors and vendors have been technically evaluated and found adequate.
7	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.

Barnett & Wales Ranking	Brechtel & Lathrop Ranking	AFSCR 84-2 PRR Questions With Original Number	
8	9	3.	Critical production engineering and production tooling have been demonstrated to prove that engineering has been satisfactorily accomplished.
9	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.
10	16	25.	Planning has been made to assure timely release of manufacturing instructions.
11	12	12.	Change activity during development has been evaluated and the impact of outstanding changes on production has been assessed.
12	15	21.	Quality controls and inspection procedures have been established for materials treatment or processes to be used in production.
13	3	1.	Milestones which demonstrate the achievement of a practical and producible engineering design have been met.
14	22	22.	Assessment of the GFP or service, requirements, controls, management, and availability of suppliers has been accomplished.
15	4	13.	Results of technical reviews and the production impact of unresolved problems and risk have been assessed.
16	5	5.	System configuration has been reviewed to determine if any significant design changes will be required for manufacturing.

Barnett & Wales Ranking	Brechtel & Lathrop Ranking	AFSCR 84-2 PRR Questions With Original Number	
17	13	15.	Specifications and drawings have been reviewed to assure their adequacy for the planned production phase.
18	25	8.	Product assurance controls and tests to prevent manufacturing degradation of performance parameters have been established.
19	6	14.	Test program results and the status of qualification testing to determine production impact and risk have been evaluated.
20	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.
21	10	4.	Acquisition will smoothly transition from full-scale development to production.
22	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.
23	11	10.	Planned production schedules reflect economy of operations and minimize financial commitments until all major development problems have been resolved.
24	21	20.	Constraints of laboratory or model shop capabilities versus quantity production requirements have been fully considered.

Barnett & Wales Ranking	Brechtel & Lathrop Ranking	AFSCR 84-2 PRR Questions With Original Number
25	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.

APPENDIX D

COMPARISON OF THE RANKINGS OF THE TWENTY-FIVE AFSCR 84-2 PRR QUESTIONS FROM THE TWO STUDIES

Original Ranking	Brechtel & Lathrop (X)	Barnett & Wales (Y)	d_i (X-Y)	d_i^2
1	3	13	-10	100
2	2	22	-20	400
3	9	8	1	1
4	10	21	-11	121
5	5	16	-11	121
6	1	2	-1	1
7	20	25	-5	25
8	25	18	7	49
9	8	1	7	49
10	11	23	-12	144
11	14	20	-6	36
12	12	11	1	1
13	4	15	-11	121
14	6	19	-13	169
15	13	17	-4	16
16	17	9	8	64
17	19	7	12	144
18	18	3	15	225
19	7	6	1	1
20	21	24	-3	9
21	15	12	3	9
22	22	14	8	64
23	24	4	20	400
24	23	5	18	324
25	16	10	6	36
				2630 TOTAL

APPENDIX E

F-16 SPO EXPERT RANKINGS FOR THE TWENTY-FIVE STANDARD AFSCR 84-2 PRR QUESTIONS[1]

TWENTY-FIVE AFSCR 84-2 QUESTIONS

F-16 SPO Experts	1	2	3	4	5	6	7	8	9	10	11	12
1	19	22	20	4	21	11	25	17	1	13	23	14
2	3	20	4	24	11	1	19	2	10	18	5	6
3	24	23	6	7	4	11	25	16	8	20	13	1
4	25	24	23	22	17	2	18	13	1	20	21	16
5	2	1	5	9	25	4	22	13	14	15	16	24
6	15	13	7	9	8	10	24	23	6	17	11	12
7	15	24	14	25	22	2	20	16	8	19	10	23
8	19	20	21	22	23	10	24	8	9	11	13	12
9	9	10	1	17	2	18	25	19	3	11	20	12
10	1	12	2	13	3	14	15	16	4	25	17	5
TOTAL (R_j)	132	169	103	153	136	83	217	143	64	169	149	125
MEANS	13.2	16.9	10.3	15.3	13.6	8.3	21.7	14.3	6.4	16.9	14.9	12.5

TWENTY-FIVE AFSCR 84-2 PRR QUESTIONS

F-16 SPO Experts	13	14	15	16	17	18	19	20	21	22	23	24	25
1	16	2	6	18	7	5	15	24	12	10	3	8	9
2	12	13	14	15	24	8	2	23	16	17	21	22	9
3	2	3	5	9	14	10	12	21	17	22	15	18	19
4	14	15	12	6	3	4	10	19	7	11	5	9	8
5	6	18	17	8	10	7	11	21	20	19	12	3	23
6	14	20	22	21	16	19	3	25	2	4	5	1	18
7	17	18	12	21	7	4	11	13	5	9	6	1	3
8	14	15	25	5	4	6	17	16	3	18	2	1	7
9	21	22	4	13	5	6	7	24	23	14	15	8	16
10	18	19	20	6	7	21	8	22	23	9	10	24	11
TOTAL (R_j)	134	145	137	122	97	90	96	208	128	133	94	95	123
MEANS	13.4	14.5	13.7	12.2	9.7	9.0	9.6	20.8	12.8	13.3	9.4	9.5	12.3

[1]Format for this Appendix taken from the unpublished master's thesis of Brechtel and Lathrop (4:134-135).

APPENDIX F

FOREIGN PRR EXPERTS

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APPENDIX G

THE KENDALL RANK CORRELATION TAU PROCEDURE AND CALCULATIONS

1. The list of X and Y rankings are shown with the X ranking arranged in natural order. The X rankings are the results of the mean rankings of the twenty-five PRR questions by Brechtel and Lathrop (4:144-147), and the corresponding Y rankings are the results of the mean rankings of the twenty-five PRR questions by this work (Appendix E).

X	Y
1	2
2	22
3	13
4	15
5	16
6	19
7	6
8	1
9	8
10	21
11	23
12	11
13	17
14	20
15	21
16	10
17	9
18	3
19	7
20	25
21	24

X	Y
22	14
23	5
24	4
25	18

2. S is determined by starting with the first number at the top of the Y ranks and counting the number of rankings to the bottom which are larger. Then subtract from this the number of rankings which are smaller than the starting number. Do this for all ranks by going sequential down the list and then summing the results. The computation is shown below:

S = (23-1) + (3-20) + (11-11) + (9-12) + 8-12) + (5-14) + (14-4) + (1-17) + (12-4) + (3-12) + (2-12) + (7-6) + (4-8) + (2-9) + (4-6) + (4-5) + (4-4) + (7-0) + (4-2) + (0-5) + (0-4) + (1-2) + (1-1) + (1-0) = -42

3. N = number of questions ranked on both X or Y.

N = 25

4. The following formula was used to calculate the Kendall Tau:

$$\tau = \frac{S}{\frac{1}{2} N (N-1)}$$

$$= -0.14$$

APPENDIX H

SELECTED RESPONDENT COMMENTS ON SELECTED QUESTIONS

This appendix provides additional comments on selected questions which were included on the completed questionnaires. These solicited comments provide additional insight into the perceptions of the foreign PRR experts. Alterations of the comments were not made with the exception of deleting a respondent's name.

1. The first group of comments pertain to question 1a in the questionnaire which determined the respondent's feelings regarding whether the PRR process should terminate at the DSARC III milestone or continue. All ten respondents felt the PRR process did not terminate at the DSARC III milestone.

COMMENTS

"We had a number of follow-up areas and open action items to review (after DSARC III)."

"Follow-ups have continued throughout the programs and have been essential to good management."

"New starts, vendors, etc., require careful review after DSARC III. Many PRR's require follow-up for some time after DSARC III and well into the first production."

2. The next comment pertains to question 1c which surveyed the respondents' feelings concerning the ability of the PRR to generate facts that were useful during the production readiness decision. The ten respondents answered

that either most of the time or all of the time the PRR generated useful facts.

COMMENT

"The readiness decision was based to a great extent on the 2.5 hour briefing which displayed the information from PRR visits."

3. The next comment pertains to question 1d which surveyed the respondents' feelings regarding the value of follow-up visits to the contractors after DSARC III.

COMMENT

"Follow-ups kept pressure on U.S. contractors and foreign contractors to more efficiently communicate and to operate more in a partnership role vs. a normal subcontractor role. The visibility of a coproduction program is viewed at very high levels of host governments, as such, requires dedicated efforts to identify work problems from the onset."

4. The following comments pertain to question 1e which surveyed the respondents' feelings concerning the extension of future PRRs beyond DSARC III. All ten experts felt PRRs should continue past DSARC III.

COMMENTS

"The amount of surveillance needed is not an easy thing to measure...but it will always be necessary to conduct PRs whenever a schedule slippage appears. I realize this is not a PRR, but it is closely related and the function should be continued."

"As Appropriate to assess production readiness in the cases of major program changes (e.g., increases in workload, FMS sales, major design changes, etc.)."

"A modified PRR limited to producibility, for example, is needed beyond the milestone to surface any new or potential problems not apparent in pre-production or early production deliveries."

"But only where a discrepancy or action item initiated before DSARC III needs a follow-up for closure. PRR needs to give way to normal surveillance."

"Continuity of PRR and follow-up would be assured if both were attended by the same person."

5. The following comments pertain to question 2a which surveyed the respondents' feelings regarding whether the primes and associated U.S. contractors showed more or less interest than the SPO teams in the production areas examined by the PRR. The responses indicated that the respondents felt the Primes and associated U.S. contractors showed either somewhat less interest or about the same amount of interest.

COMMENTS

"Some contractors were not candid in their help to the foreign producer. They did not exchange all their information they had available to assist the contractor in solving any problems (direct/indirect)."

"It does appear to be a function of the dependency of the prime on his sub for maintenance of schedule deliveries as to the degree of interest."

6. The following comments pertain to question 2b which surveyed the respondents' feelings concerning the capability of the Primes to accomplish the same objectives

as those of the SPO teams in a PRR. The majority of the respondents believed the Prime could not accomplish the same objectives as the SPO teams.

COMMENTS

"SPO teams provide a different viewpoint than the Primes and serve as a "customer's" attitude instead of a "partner"."

"The Primes had a marketing incentive to make it successful, as such they did a good job of identifying problems and worked with the foreign company to resolve them."

"The PRRs were done to (1) aid in the government decision to proceed, and (2) correct deficient areas of readiness. Primes could not accomplish (1) but could do as well in (2) if motivated."

"The F-16 SPO personnel (as U.S. government representatives) as a whole probably attained the PRR objectives more efficiently and effectively because of the political nature of the F-16 program."

"Yes they could have...but I don't believe the examination would have been as close or as exacting. The "outside" questions were stimulating in many cases and caused some better procedures and methods to be adopted."

7. The following comments pertain to question 3a which surveyed the respondents' feelings on whether they spent more time and energy gathering facts or more on solving problems. The respondents were split 50/50 on the question.

COMMENTS

"We identified the problem areas. For the most part, we worked with Primes to solve the problems. Sometimes we gave direct advice."

"Since management systems in planning and controlling work was one of the weak areas, it required much effort in explaining needs to improve these areas."

"The information was generally available but the solutions had to (be) worked out in detail with the government serving as technical consultants."

"I don't know how a PRR team can gather information on the contractor's readiness without finding problems in his systems. Therefore, the answer is yes to both questions."

"I feel the question 3 Part II cannot be answered without explanation:

First, in very few cases have we been problem solvers for the contractors. We have and do make suggestions sometimes referring them to others we may know of that have had similar problems. There have been times our suggestions on basic manufacturing and parts supply systems have helped to mitigate chronic production delays. Our greatest function on the PRRs and manufacturing program follow-up has been that of evaluation. Obviously there needs to be much gathering of information to make a sound evaluation.

Our summary reports reflect our assessment of:

Whether sufficient and adequate facilities are in place.

Whether those to be acquired have sufficient lead time not only to procure but to debug and to train operators.

Whether production control systems in use are, in our opinion, adequate for the task.

Whether or not area has sufficient labor available, what training will be required, what are the unique requirements from the governments in respect to hiring, firing, laying off, working overtime and second and third shifts.

Whether the planned for lead times are overly optimistic or too loose.

Whether a schedule slippage has a real chance of being recovered in any kind of a reasonable time (i.e., restrictions on O.T. and shift work).

Whether second and third shift operations may be instituted to reduce elapsed times for limited periods.

What prior experience has the management had in working as a sub contractor, in monitoring and reporting to a prime.

Will he need to be especially monitored to see that he understands the need for anticipatory reporting to alert others outside of his facility of potential short falls so that alternate planning may be made.

Will program management concepts be an annoyance to the supplier or will he readily accept and develop a viable program control methodology.

What is the work pace you see in the factory?

How is the housekeeping?

How are the parts handled and protected?

What controls, inspection systems are in evidence to maintain quality.

Whether there is evidence that real planning for production has and is being accomplished or whether the planning briefed to the teams was just an exercise to satisfy the requirement.

When giving recovery forecasts, what chances are there for making recovery commitments. What is the demonstrated history.

One could continue for some time citing examples, but it is from this type of data obtained verbally, visually and from records that evaluations are made. What one looks at and in what depth depends on the program, product, complexity, and suppliers past experience and what you see and hear when you are on his premises.

I believe our main contributions to the F-16 SPO has been that of evaluating the data fed us by the supplier, that which we collected and from those observations we have made when visiting the manufacturing areas. Such evaluations have covered everything from production readiness to schedule recovery prospects, from adequacies of tooling to selection of fabrication shop equipment, from manufacturing management/ control production management concepts from production testing to equipment utilization, etc.

Thus the answers to Part II question 3 when circling the response do not truly reflect the activity which is a little "problem identifying" and some "problem solving" and mostly the evaluation needed for the program office manufacturing directorate to manage the manufacturing program in as crises

free manner as possible, anticipating problem areas and planning accordingly both in terms of actions and follow-up.

I realize that the questionnaire is directed at PRRs and my comments have been expanded to cover MMPR's, PRR's, MPR's and post DSARC III activity but the elements discussed can be limited to PRR's and still be valid."

8. The following comments pertain to question 3c which surveyed the respondents' feelings regarding whether or not the foreign contractors welcomed the PRR visit. The majority of the responses suggested that the foreign contractor welcomed the PRR team visit.

COMMENTS

"Initially it was imposed because foreign companies were not used to this requirement. Later these types of reviews were accepted but not necessarily welcomed."

"The Europeans were worried about us until they found out that we were not trying to tell them how to run their business and that we were there as partners to make the program work."

"At first there was some reluctance. This was overcome by limiting team size, assuring the competence and expertise of the government team was the best available, and recognizing the customs and attitudes of the host contractor."

"Initially they felt imposed upon, but as we worked with them most of them became more receptive when they found out that we were not there to criticize but to help them."

"These were new to most contractors and as such, somewhat feared. They all admitted at the conclusion that they were beneficial."

9. The following comments pertain to question 3d which surveyed the respondents' feelings concerning whether the PRR was adequately introduced to the foreign contractor or not. Most respondents felt they were.

COMMENTS

"Not early in the program, but since that time foreign companies have seen this can be a way to help resolve difficult management issues."

"We recognized early that protocol was a significant factor to assure the acceptance and the proper atmosphere."

"The foreign firms were adequately informed about the F-16 PRR objectives. As a whole, the F-16 PRR teams experienced less resistance from foreign contractors than was experienced from counterpart U.S. contractors during some F-16 PRRs conducted in the U.S."

10. The following comments pertain to question 4 which surveyed the respondents' opinion relating to what areas were felt to be the most important in dealing with a foreign contractor as opposed to the domestic contractor.

COMMENTS

"An understanding of the social legislation imposed as a means of assuring maximum employment, i.e., laws relating to dismissing employees, limitations on amount of overtime that may be worked and the financial impact on the employees whose social benefits can be reduced by increased overtime income resulting in a negative condition."

"A fundamental cultural difference in attitude towards job, i.e., enjoyment of life is paramount and job is a means to this end. Thus schedules are goals and not sacra-sanct. Night shifts are to be avoided and all holidays will be honored and observed."

"Usually bluntness and overly direct approaches are resented. A more formal and diplomatic approach following the prevailing social customs often yields more, both in respect and in responses."

"The greatest impact is on the elapsed times required to complete tasks. One must be aware of this fact and consider it in all plans, schedules and delinquencies."

"Middle management in foreign firms is usually nonexistent or at best very lean. Therefore, the manager has a closer vantage of production problems and requires greater technical skills to solve a problem since a large advisory staff does not exist."

"Usually, machinery and tooling procured in Europe are required to make a test piece to print before acceptance at builder locations. This process allows for debugging before shipment. U.S. firms can take a lesson from this experience."

"Labor is a much more complicated problem than in U.S.A. It is very political and demanding to company management and is a factor more complicated than we encounter. Their production plans are impacted by this and must be analyzed differently from U.S.A. PRR's."

"Internal laws of distributing work vary in each country. Here again their PRR will read differently to a U.S.A. one."

"Many exotic materials are not available internally or even in Europe, therefore, procurement plans for parts and material have to be minutely analyzed."

"Labor unions and foreign government influences on foreign contractors' management prerogative (e.g., single shift operation is standard operating procedure for foreign firms in Europe)."

"Sources of supply for material, parts, etc. (i.e., decision between U.S. sources or foreign sources of supply). Action laws and transportation plans (for parts, etc.) among foreign firms and with U.S. contractor counterparts. Drawing conversion activity (i.e., to metric)."

"Front End Coordination and Planning - Visits should be justified and planned well in advance with care. Coordination with all concerned parties is mandatory. The cognizant government people in the host country including the Armed Forces, the U.S. Embassy, Resident U.S. people, the

Prime Contractor, the U.S. Coproducer. Limit the size of the visiting group strictly. Review the agenda carefully for necessity of items."

"Dealing with Foreign Contractor's Management - You must be accepted by the general manager. They have few middle managers. Be prepared to deal with the G.M. the whole time. Select an agenda appropriate to his attention. Allow the G.M. to select topics and areas to review. Do not force the conduct of visit to your desires while there. All that should be precoordinated."

"Don't Play the Ugly American - Their systems and procedures are time-tested. Don't underestimate their ability. Relocate their approach and take the time to see results. Recognize their labor practices and the peculiar problems they present. Don't try to make them change just to be like U.S. firms."

"Unions in Europe are very strong. They only work one shift and 5 days per week consequently."

"Manufacturing spare times are up to 12-14 months longer than the U.S. which causes lead time problems and control problems."

"Europeans are not used to our year-to-year funding and would like to be put on contract for the full contract number of airplanes even though this spans many years. They are reluctant to spend money on facilities without this assurance."

"The domestic contractors must take more care in reviewing the basis for the foreign contractor planning. In many cases the foreign contractor planning is based on invalid assumptions due to lack of understanding or use of U.S. contractor standards which may not be applicable to the foreign contractors."

APPENDIX I

SELECTED UNSOLICITED RESPONDENT COMMENTS

This appendix provides additional unsolicited comments that were received with the questionnaire answer sheets returned by the respondent. The inclusion of a sampling of the candid comments in this appendix provides additional insight into the perceptions of the foreign PRR experts. Alterations of the comments were not made with the exception of deleting the respondents' names.

Enclosed Comments

"COMMENTS ON PRR FUNCTION

Preplanning a PRR.

(1) A specific series of subjects/questions should be generated and agreed upon between the SPO and the firm to be visited.

(2) The number of items should be kept at a minimum and must be related only to the situations under examination. For example: Some firms will dwell on how great they were in the past on certain programs. This type of information (salesmanship?) is not needed by the PRR team and is a waste of time for all concerned.

(3) After all presentations are complete and questions by the PRR team have been answered, the SPO team should evaluate all the information (privately) and then present the firm with their conclusions or recommendations. This is the outbriefing.

(4) A date should then be established for follow-up action if needed."

"Most of the foreign firms that were PRR'd conduct their business in basically the same manner. However, since many of them were in a similar (to them) line of business than was imposed by the F-16, they found themselves having to make many changes in methods and operations. These changes were new to them and were not always sufficient and

in some cases were not always adopted in time. Some failed simply because they were not aggressive enough in meeting their own dates to make the changes.

Many of the foreign firms decided the F-16 requirements was business as usual and this attitude had a somewhat negative effect on the preplanning and resultant startup of their program. Example: One firm in Denmark had a thriving and successful business of producing telephone equipment. It was assembly line type of work and yet was not related to what was required for F-16 flite computers. We continually advised them during the PRR of the complexity they would be getting into and how they would have to change their procedures to build the components for the F-16 at the scheduled rate.

The internal systems in some firms did not provide enough visibility of the hardware requirements which put them in a delinquent condition from day one. They then turned to GD for help which necessitated a great deal of support activity by coproducers in the US and related suppliers.

A number of firms did not put their "best" people on the F-16 program and in some cases used new people who did not have the experience to do the job. It also caused a condition to exist where top management did not support the F-16 and left it to the appointee until trouble started and then they used better management people.

SUMMARY

These are a few of the items that a PRR team must look at and continue to review:

(1) Attitude of the firm.

(2) Close examination of their system, operations, controls, particularly their parts system.

(3) Management types of people. Are they flexible? Aggressive? Dedicated?"

"When doing a PRR on foreign companies where the engineering responsibility is with the U.S. contractors, the emphasis must be placed on:

- completeness of engineering data received
- planning (not just milestone charts)
- management systems to handle
  - changes
  - in-process control
  - material control
  - purchasing

- levels of management and their responsiveness to anomalies
- tooling capacity (most have to sub for this capability). This is not a general comment for all European firms only or experienced with the F-16.
- production control

- communication channels due to distance and misunderstandings."

"The F-16 PRR process was an excellent opportunity to bring together the U.S. government representatives (e.g., F-16 SPO, F-16 CASEUR, AFPRO personnel), the prime contractors (GD and Pratt-Whitney), the U.S. subcontractors, and the European co-producers together on the site where production activity would occur to mutually identify problems and ascertain corrective actions.

"In addition, the F-16 PRR forum allowed for the cross-fertilization of ideas among U.S. and foreign firms in both directions. The communication process among all F-16 program participants was facilitated via the F-16 PRR process."

"There are other criteria that should be added to this list for application to foreign contractors (e.g., F-16 co-producers).

For example:

1. A management system or network has been established to ensure timely information dissemination among foreign contractors and U.S. contractors.

2. Transportation guidelines have been established to ensure the timely transfer of parts, equipment, etc., among foreign contractors and U.S. contractors.

3. Customs guidelines for shipping among countries have been fully developed to prevent program deals because of inadequate rules or regulations.

4. A training program has been established to ensure acceptable transfer of technology, skills, procedures, etc., among foreign contractors and U.S. contractors."

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