RISK REDUCTION THROUGH APPLICATION OF ESSENTIAL PERFORMANCE REQUIREMENTS WARRANTIES*

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ABSTRACT

The contemporary acquisition environment is characterized by pressure to reduce the Department of Defense (DoD) budget and by concern that full value be received for every dollar expended. Congress also has insisted that guarantees (Title 10, USC 2403) be used for military procurements. For the effective application of guarantees (warranties), new acquisition tools and methods are needed. One such tool is the Essential Performance Requirement (EPR) Warranty—a procurement tool by which the Government can economically motivate the contractor to produce a system that is responsive to customer requirements. This paper presents the background and provisions of the current warranty law and, in particular, the EPR Warranty. It describes methods for analyzing risks associated with the acquisition of high-technology weapon systems and with other acquisitions. It examines risks in the context of the overall procurement goals and objectives and explores the ways in which EPR warranties might contribute to meeting these goals and objectives. In addition, the paper addresses trade-off analyses of the economic aspects of EPRs. Warranties can assist program managers in fielding effective systems that have lower life-cycle costs. Motivating the contractor to satisfy these prime user requirements is the ultimate goal.

INTRODUCTION

The Federal Acquisition Regulation defines warranty as "a promise or affirmation given by a contractor to the government regarding the nature, usefulness, or condition of the supplies or performance of services furnished under the contract."

History of Military Warranties

Experimentation with the use of warranties in military procurements began in the 1960s with the publication of Section 1-324 of the Armed Services Procurement Regulation (ASPR). Early Government steps to avoid acquiring defective material included warranty control against latent defects. In the late 1960s and 1970s, more extensive warranty forms were tried, such as the failure-free warranty (FFW) and the reliability improvement warranty (RIW). Initial success with these warranties encouraged the Office of the Secretary of Defense (OSD) and the services to initiate a trial period for more extensive forms of warranty. A dialog was initiated between industry and the Department of Defense (DoD) concerning warranties, and even more extensive warranty forms were implemented by the services.

The successful use of warranties in the 1970s provided a basis for extending warranty applications more broadly in the 1980s. The first Product Performance Agreement (PPA) Guide (Reference 1) was published in 1980. That document summarized the features of 21 forms of product performance agreements that could be employed in weapon system procurements. Air Force Regulation 70-11 (Reference 2) defines a product performance agreement as "a form of warranty, guarantee, or incentive used in a government contract to achieve performance or supportability in the operational environment."

In 1982, the Product Performance Agreement Center (PPAC) was created at Wright-Patterson Air Force Base, in a joint effort of the Air Force Logistics Command (AFLC) and Air Force Systems Command (AFSC), to function as the Air Force focal point for warranty data and to provide guidance and technical assistance to Air Force acquisition activities in the application of warranties to Air Force systems.

Warranty Law

The current warranty law was implemented with the Defense Procurement Reform Act, which became effective on 1 January 1985. That legislation established Title 10, Section 2403, of the United States Code (10 USC 2403), "Major Weapons Systems: Contractor Guarantees." Implementing DoD guidance is contained in Defense Federal Acquisition Regulation Supplement (DFARS) Subpart 46.7. The law states, "The head of an agency may not ... enter into a contract for the production of a weapon system unless each prime contractor for the system provides the United States with written guarantees. ..." Weapon systems are defined as "items that can be used directly by the Armed Forces to carry out combat missions and that cost more than $100,000 or for which the eventual total procurement cost is more than $10,000,000." Production is defined as mature, full-scale production. If an item fails to meet the terms of the warranty, the contractor is required (1) to correct the failure at no cost to the Government, or (2) to pay for reasonable costs incurred by the Government in taking corrective action. Warranties that are required by law may be waived only if they can be shown to be counter to the national defense interest or not cost-effective.

The law requires prime contractors to warrant that their warranted products (1) meet design and manufacturing requirements, (2) have no defects in material or workmanship, and (3) meet essential performance requirements. Design and manufacturing requirements, as defined in DFARS Subpart 46.770, are "structural and engineering plans and manufacturing particulars, including precise measurements, tolerances, materials and finished product tests for the weapon system being produced." This warranty is intended to assure that the finished product meets the requirements of the production contract specification. Both 10 USC 2403 and DFARS Subpart 46.7 state that warranted items will be free from defects in material or workmanship at the time of delivery (DFARS Subpart 46.7 adds "acceptance or delivery"), which implies an intent to control latent defects. Essential performance requirements (EPRs) are defined in DFARS Subpart 46.770 as "operating capabilities and/or maintenance and reliability characteristics ... necessary ... to fulfill the [designated] requirements. ..." The EPR type of warranty, introduced for the first time in 10 USC 2403, represents a significant change from previous contracting practices. EPRs are warranted requirements that are essential to the overall performance of the system and that cannot be demonstrated prior to product acceptance. Performance is measured and verified in the field during the period of the warranty. Field performance that does not achieve the guaranteed value for a warranted item may result in the contractor's being required to implement remedies as defined in the warranty clause.

The warranties covering design and manufacturing requirements and defects in material and workmanship are relatively uncomplicated as compared with the EPR warranty. They provide assurance that the system is designed and manufactured in accordance with the specification and that it is free of defects. The EPR warranty, on the other hand, can be more difficult to define, measure, and enforce; however, it can also be a much more effective tool for managing risk. The remainder of this paper will focus on EPR product performance agreements.

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CLASSIFICATION OF PRODUCT PERFORMANCE AGREEMENTS (PPAs)

There are numerous ways to classify PPAs. The classification method discussed in this paper divides all PPAs into either assurance or incentive forms. An assurance form assures that the contractor's product meets design quality and performance levels. There are no profit incentives for the contractor to exceed the minimum specified requirements. The incentive form does provide profit incentives for the contractor to exceed stated design, quality, and performance levels. The basic difference between the two is that the incentive PPA is designed so that the risks of failing to achieve the minimum performance requirement, or the potential rewards (profit) associated with exceeding the minimum performance requirement, will motivate the contractor to attempt to exceed the minimum performance requirement.

An example illustrates the difference between the two forms as applied to EPR PPAs. We suppose that a system to be procured has a field reliability requirement that results in an expected number of failures, F, over the warranty period. For an assurance PPA, the contract might require reimbursing the contractor for time and materials expended in repairing all failures during the PPA period up to the expected value, F. Failures beyond F that occur during the PPA period would be repaired by the contractor at its own expense. Under this form of PPA, the contractor is motivated to meet the specified reliability but receives no benefit from exceeding it.

For the same example, we suppose that the contractor is to perform depot repair for a fixed price over the warranty period. The fixed price is based on an average cost per repair multiplied by the expected number of failures, F. The "up front" payment provides contractor motivation to keep failures at the lowest level to increase profits. There is an incentive to invest in design, production, and quality control improvements to reduce the number of expected failures during the warranty period. The contractor is also motivated to detect systemic failures and design corrective measures for them early in the warranty period. This example shows that the incentive warranty is a way of motivating the contractor economically to support the Government's acquisition goals.

Table 1 (Reference 3) lists various factors and their relationship to these two warranty forms; it is provided to help the reader clarify the differences between assurance and incentive warranties.

As previously stated, the current law contains three basic warranties: (1) design and manufacturing requirements, (2) defects in material and workmanship, and (3) essential performance requirements. Our discussion of PPA classification has divided all PPAs into either assurance or incentive forms. The next section addresses the use of essential performance requirements with the incentive form of PPA.

Table 1. Comparison of Assurance and Incentive Types of PPA

Factor	Assurance PPA	Incentive PPA
Basic Intent	Meet minimum performance and R&M levels.	Exceed minimum levels.
Warranty Price	Expected to be minimal, from 0 up to 1% or 2% per year of hardware price.	May be significant, up to 7% or 8% per year of hardware price.
Warranty Duration	Limited—generally 1 year or less.	Can be extensive—3 or more years.
Technology Factors	Warranted item is well within state of the art (SOA), or SOA is so severely "pushed" that only limited warranty protection is realistic.	Warranted item pushes SOA, so there is need to protect against failure and there is opportunity for growth.
Contractor	Contractor has limited opportunity to control and improve performance prior to and during warranty.	Contractor has significant opportunity to control and improve performance.
Competition	Should not reduce future competitive climate.	May significantly reduce competitive climate.
Administration	Generally not a severe burden.	May require complex procedures.

EPR INCENTIVE PPAs

The combination of EPRs employed with incentive PPAs can yield very effective risk-management tools. This form of PPA involves measuring field performance over time and comparing the measurement with a guaranteed value. It provides for contractor liability beyond acceptance testing and provides incentives for the contractor to meet the Government's operational needs. The advantage of this type of PPA is the potential for a "win-win" situation. Because the contractor is economically motivated to exceed the Government's performance requirements, both parties to the contract stand to "win": The contractor has the opportunity to make extra profit, and the Government has the opportunity to exceed its performance requirements and to control life-cycle cost (LCC).

It is essential to exercise care when selecting EPRs. The first step is to determine the risks that must be controlled, and it should include a review of the documentation supporting the acquisition. The Statement of Need, the System Operational Requirements Document, the Program Management Directive, and other pertinent program documentation should be reviewed to identify candidate EPRs. The list of candidates should then be reduced to those with the highest associated risk. Next, each EPR candidate should be screened to determine the contractor's authority to control the design. When all of these steps have been completed, an attempt should be made to again reduce to a minimum the number of EPRs that are primary contributors to the mission capability of the warranted system.

To be considered for PPA application, EPRs should conform to certain general characteristics. For example, EPRs should be directly relatable to specified requirements. Otherwise, they may not be appropriate for warranty consideration, because of the lack of traceability to the system requirements or an inability to administer and enforce during the warranty period. Therefore, EPRs should also be capabilities or characteristics that can be observed, measured, verified, and enforced by the Government. Defects in EPRs must be correctable by the contractor. The measurement of EPRs should be accomplished, recorded, and transmitted through currently available means whenever possible, such as the AFTO Form 349 for reliability and maintainability characteristics. Standard quantification methods that are consistent with the contract specification requirement (e.g., mean time between maintenance actions for the reliability EPR) should be employed. Every attempt should be made to develop reliability/maintainability EPRs so that they can be accommodated in the existing Air Force Maintenance Data Collection System. Unique data systems for handling PPA data are discouraged.

PPA SELECTION

There are many PPA types available to the acquisition manager, ranging from relatively simple assurance warranties to complex incentive forms. The PPA Guide, published by PPAC, lists 28 different PPAs. The

PPAC's automated warranty tool, the Decision Support System (DSS), contains 17 PPA alternatives in its PPA selection criteria module (PSCM) (Reference 4). Other subsystems in the DSS assist the user in performing PPA cost/benefit analyses and in structuring the PPA contract clause. In addition, the DSS library subsystem provides remote access to abstracts of more than 2,000 warranty-related documents through its key word search capability.

The selection of a particular PPA form for a given acquisition program is usually based on many factors, including program objectives such as support scenarios, cost issues, and performance goals. Equipment characteristics will also influence the selection of PPA type. Factors such as operating time, operational lifetime, complexity, and degree of development will have an impact on the type of PPA finally selected. The PSCM is designed to assist acquisition managers in minimizing the number of PPA forms from which the final PPA can be chosen.

Assurance PPAs have been developed for a wide variety of applications. They range from very simple statements covering material and workmanship to complex PPAs containing numerous EPRs. Their major shared attribute, however, is that they do not contain stated or implied incentives for exceeding stipulated performance levels.

The most commonly used forms of incentive PPAs listed in the PPA Guide are the Reliability Improvement Warranty (RIW), the Mean Time Between Failures Guarantee (MTBFG), the Availability Guarantee (AG), and the Logistics Support Cost Guarantee (LSCG). These four incentive forms are summarized in Table 2 (Reference 3). It should be noted that all of these PPAs address reliability and maintainability characteristics only. Incentive PPAs addressing operational performance EPRs have thus far not been widely applied, although there have been several that control such performance factors as engine fuel consumption and thrust.

COST/BENEFIT ANALYSIS

There are at least three good reasons for performing a cost/benefit analysis (CBA) of a proposed weapon system PPA: (1) a CBA is required by DFARS Subpart 46.7 and AFR 70-11, Weapon System Warranties; (2) it is good management practice to understand the cost trades associated with the warranted procurement; and (3) performing CBAs on a small number of warranty types can enable the acquisition manager to select the most cost-effective form from an otherwise ambiguous set of alternatives.

Costs associated with warranty acquisitions include the contractor's costs for failure analysis in accordance with the warranty, contractor-funded design changes and retrofit of fielded units, warranty data tracking and analysis, and warranty administration, as well as the cost associated with perceived risk. Government costs include the price of the warranty (which is the contractor costs plus fee) and the cost of Government warranty administration. Savings attributable to warranties include the lower initial and reprocurement spares costs associated with increased reliability as well as lower maintenance labor and materials costs. Intangible benefits include the increased availability and mission success associated with high system reliability. Savings associated with operational EPRs, such as range, speed, and accuracy, will include varying tangible and intangible benefits.

The basis for PPA cost/benefit analysis is life-cycle cost. The computed LCC of a system acquired under a PPA is compared with that of a system not acquired under a PPA. The positive differential obtained by subtracting the LCC of a warranted system from that of a nonwarranted system is called the warranty benefit. CBAs should be performed on several plausible PPA types to determine which provides the greatest warranty cost advantage. Different values of warranty-dependent parameters (such as mean time between failures) should be examined to determine the sensitivity of LCC to variation in such values. The cost/benefit analysis should be performed early in the acquisition cycle (initially during the demonstration-validation phase) and should be updated periodically as new and more accurate program data become available.

WARRANTY RISK ANALYSIS

Adding an incentive PPA to a weapon system development and acquisition program does not necessarily reduce the overall risk associated with the program. When properly applied, however, a PPA can shift some of the development and acquisition risk from the Government to the contractor. If the resources are available to structure and implement an incentive PPA, the likelihood of meeting or exceeding minimum requirements is enhanced.

Table 2. Summary of Four Incentive Forms of PPA

Incentive Form	Objective	Approach	Remedies	Application
Reliability Improvement Warranty (RIW)	Achieve acceptable reliability and motivate contractor to improve.	Contractor performs depot maintenance for at least two years under a fixed price	Contractor repairs all covered failures and has the option of implementing no-cost ECPs for R&M improvement.	Units must be depot-repairable. Reduced military self-sufficiency must be tolerable.
Mean Time Between Failures Guarantee (MTBFG)	Provide assurance that required field MTBF level will be achieved.	Contractor guarantees field MTBF. Measurements are made and compared with guaranteed value.	Contractor must develop and implement solution if guarantee value is not achieved.	MTBF is appropriate reliability parameter, and field measurement can be made.
Availability Guarantee (AG)	Provide assurance that required operational availability will be achieved.	System availability is measured in the field or through special tests and compared with guaranteed values.	Same as for MTBF guarantee.	Availability is appropriate readiness parameter, and acceptable measurement methods can be implemented.
Logistics Support Cost Guarantee (LSCG)	Control logistics support costs.	Contractor "bids" target logistics support cost through use of a model. Field parameters are measured, and the same model is used for obtaining measured logistics support costs and compared with target.	Contractor price is adjusted on the basis of measured versus target values; a correction of deficiency may be required.	Appropriate LSC model exists. Generally requires a special test program to obtain measured values.

Contractor Motivation

Reliability is a key system performance characteristic addressed by the current warranty law, 10 USC 2403. Reliability pertains to the operational performance of the system over time, thus making it an ideal candidate for consideration as an EPR. Reliability is difficult to predict for new systems, on which little information is available, and is thus a risky parameter. Incentive PPAs provide a reasonable management tool for mitigating this risk.

Figures 1 and 2 (Reference 3) illustrate contractor profit motivation without a warranty and with a warranty, respectively. In Figure 1, θ_{min} represents the specified reliability, and the horizontal dashed line is the contract price without a warranty. The curved line describes the contractor's increasing production cost as reliability increases. The difference between the Contract Price line and the Production Cost curve represents the contractor's profit. As can be seen in the figure, this difference has its greatest positive value at the specified reliability value. The contractor is motivated to maximize profit by producing a system with the minimum reliability value that still meets the contract specification.

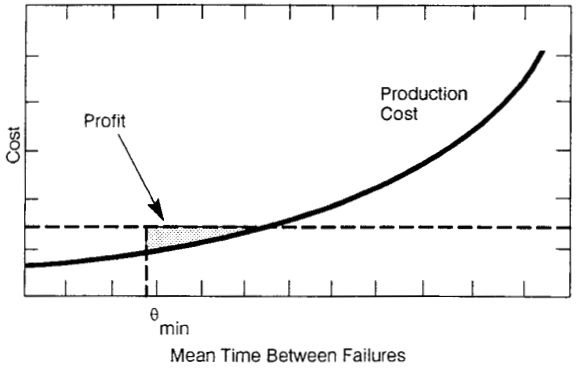

Figure 1. Contractor Profit Motivation—No Warranty

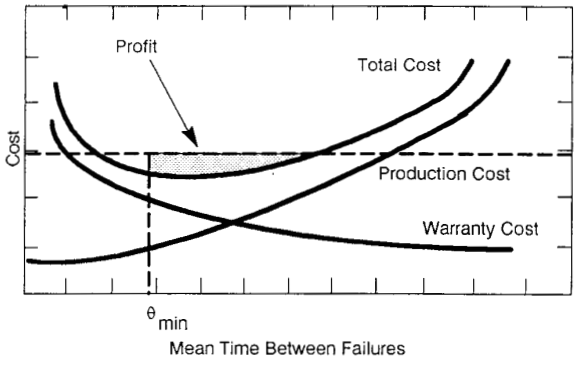

Figure 2. Contractor Profit Motivation—Warranty

Figure 2 shows the same procurement under an incentive PPA. The reliability EPR has the same value as the specified reliability in a nonwarranted case (Figure 1). The warranted contract price is considerably higher than the nonwarranted case (typically up to 135% of the nonwarranted contract price). This increase is due to the contractor's costs, as detailed previously, plus the fixed price paid to the contractor for performing repairs over the warranty period. The curve that describes this value in relationship to reliability is labeled "Warranty Cost." It can be seen that in the warranty case the contractor's total cost is now the sum of production and warranty costs and the profit is maximized at some point to the right of the specified reliability, θ_{min}.

Contractor Risk

Contractor risks must also be considered in developing and implementing PPAs. A contractor's warranty price will increase with a perceived increase in risk. If a contractor faces large losses, the entire program may be threatened. If a contractor fails badly, the Government may lose its only production source and, depending on the size of the program, may suffer several years of slippage in the program schedule. Table 3 (Reference 3) lists a number of contractor risk factors and approaches to reducing their effect or eliminating them.

Risk in Operational Performance Parameters

To date, EPRs have primarily addressed the reliability, maintainability, and availability of the warranted systems or equipment. Most operational performance parameters, such as speed, accuracy, range, and power, are verifiable at acceptance and are therefore not usually used as EPRs. However, the risk associated with the long-term degradation of these operational parameters is an appropriate consideration in warranty programs. The warranting of operational-performance sustainability is an additional acquisition tool by which the Government can reduce risk in operational systems. A prerequisite for this type of EPR, of course, is to establish a realistic operational-performance baseline so that degradation from that baseline can be measured and verified. For an operational-performance sustainability warranty, therefore, it will be necessary to define initial operational performance much more concisely than in present practice. Further analysis of the application of this type of EPR could result in significant benefit to the Government.

SUMMARY

The current warranty law requires PPAs to be applied to weapon systems for which certain criteria are met. It is important to apply PPAs in a manner that will enhance the overall acquisition goals for the system and will provide a means by which the Government and the prime contractors can share risks. These objectives can be met by carefully selecting and applying EPRs in an incentive form of PPA, whose cost-effectiveness has been ensured by a thorough LCC analysis. A successful PPA also requires an opportunity for and a commitment from management to follow through with effective administration and enforcement throughout the life of the warranty.

The application of incentive EPR PPAs to acquisition programs can enable both industry and the Government to exceed their respective goals—more profit for the contractor and a better product at lower life-cycle cost for the Government.

REFERENCES

1. *Product Performance Agreement Guide*, U.S. Air Force Product Performance Agreement Center, 1 November 1985.
2. AFR 70-11, Weapon System Warranties, 1 December 1988.
3. *Warranty Handbook,* ARINC Research Publication 1512-01-1-4048, June 1986.
4. *Product Performance Agreement Center Decision Support System User's Guide,* U.S. Air Force Product Performance Agreement Center, 30 April 1987.

Table 3. Contractor Risk Factors and Risk-Reduction Approaches

Risk Factor	Risk-Reduction Approach
Late Notification of Intent to Use Warranty	The contractor should be aware of the intent to use warranty as early as possible during engineering development so that there will be maximum opportunity for design optimization.
Detailed Government Specification of Item	The use of functional specifications should be maximized to allow for design optimization.
Application of Incentive Warranties to Advanced Technology	Incentive warranties may not be appropriate for completely revolutionary design. When they are applied to new technology, the program funding and schedule should allow for adequate reliability test effort. A cost-sharing warranty agreement could be considered.
Reliability-Prediction Uncertainty	The Government should specify only a minimum acceptable level of reliability. Operational and environmental data should be provided to the contractor. Adequate time and funding for necessary reliability testing should be included in the development contract.
Unpredictability of Inflation Rates for Long-Term Agreements	The warranty price should be coupled with economic adjustment provisions to account for inflation.
Failures Outside Contractor Control	Exclusions should be provided; they would normally include Acts of God, fire, explosion, submersion, flood, combat damage, accident, and unauthorized tampering by Government personnel. Exclusions for mishandling should be carefully worded.
Large Number of Unverified Failures ("Test O.K.s") Returned to Contractor	Contractual provisions should be carefully tailored so that costs of processing returns are equitably shared.
Item Usage Rate Not Precisely Known	The contract should provide for a price adjustment for significant usage-rate variations or possibly have a cut-off on total operating time.
Data Not Supplied to Contractor as Required	Contract provisions should include Government responsibilities for meeting data obligations in a timely manner. Contractor obligations for warranty performance may be related to receipt of applicable data.
Uncertainty About Shipping Destinations of Warranted Items at Time of Bidding	If there is significant uncertainty about shipping costs, the Government should assume those costs.
Effect on Turnaround Time of Events Outside Contractor's Control (e.g., Strike and Uneven Flow of Failed Units)	Relief from turnaround-time obligation for specified conditions should be included as part of the contract.
Time-Consuming Procedures for ECP Approval	Warranty provisions should provide for expeditious approval of ECPs—perhaps by automatic automatic approval—unless notification is given within a certain time limit.

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