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Review Paper on Reliability Improvement Warranties

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Abstract

An automobile with thousands of parts and interactions among them is a highly complex product. It makes detailed testing/analysis during product development, manufacturing, and assembly a prohibitively enormous, if not infeasible, task. Thus, when the vehicle is put on the market, the likelihood of unexpected poor quality and reliability resulting in high warranty costs is not uncommon. Success during product development, manufacturing, and assembly is often judged by lack of quality and reliability

Key words: Warranty, Reliability, RIW.

1. Introduction

The reliability improvement warranty is a class of warranty

Policies those are applicable for expensive products that are especially built for customers. The products can be divided into two groups: (i) new acquisitions by defense involving new state-of-the-art technologies, and (ii) complex systems (such as locomotives, power generating units, etc.) which are custom built to serve the needs of commercial or industrial customers. This requires assessing reliability at different stages of the process and modifications to improve reliability if the agreed performance measures are not achieved. The measure usually used to assess product reliability and improvements there in is the mean time between failures (MTBF), and most RIWs include an MTBF. However, RIW can include any agreed-upon measure of reliability. As a result, RIW policies are often quite complex. In contrast to a consumer-type warranty, where the manufacturer decides on the warranty policy based on several factors, as each RIW is a unique warranty contract, often covering only a few items and carefully negotiated by the customer and the manufacturer. As a result, the cost analysis (for both manufacturer and customer) of each RIW policy poses new challenges, depending on the reliability terms included in the policy. In this paper, we deal with the major issues associated with RIW policies. The outline of the paper is as follows. we take a more detailed look at some of the specific features of such policies. Where we define the six different stages of the process and compare it with that for products sold with non-RIW policies. Finally, it is worth noting that in the RIW literature, the manufacturer is often referred

to as "contractor" and the customer as "buyer" as the buyer contracts with the contractor to build the product. MTBF guarantee, logistics and other cost guarantees, mean time to repair, and similar guarantees Special features agreements – covering guarantees on characteristics such as ultimate life, Commercial service life, software, test and repair improvement, and other unusual or unique features.

RIW CONCEPT

RIW is a broader term that includes any warranty or guarantee that includes to improve product performance, reliability is product performance agreement (PPA). This class of warranties includes many types of contracts, RIW being just one warranty in one of four classes: Federal acquisition regulation agreements – covering inspection, supplies, design, performance specification, and technical data Contractor repair agreements – covering re-warranty of repaired or overhauled equipment, reliability guarantees, repair/exchange agreements, and RIW Field measurements agreements – covering MTBF verification tests, availability guarantees, RIW with MTBF guarantee, logistics and other cost guarantees, mean time to repair, and similar guarantees Special features agreements – covering guarantees on characteristics such as ultimate life, commercial service life, software, test and repair improvement, and other unusual or unique features.

RIW FEATURES

The original intent was to apply RIW in situations where operational (field), reliability, support costs, and potential reliability growth were all reasonably predictable. In such applications, many versions of RIW, with a wide variety of terms and features, were developed. Characteristics common to almost all applications include the following:

Complex equipment Clearly defined performance requirements Ability to evaluate field or operational performance Potential for reliability growth Contractor provision of field maintenance and repair Relatively long warranty terms (typically three to five years or more) Requirement for engineering analysis of failures Requirement for design changes to correct defects A fixed price contract Contractor fees based on demonstrated reliability improvements. Each bidding situation involving RIW may include many additional unique characteristics. Reliability, maintainability and supportability performance terms in an RIW policy may include one or more of the following items:

A guaranteed mean time between failures (MBTF)

A guaranteed turnaround time (TAT) for repaired or replaced units A supply of consignment spares for use by the buyer at no cost until the guaranteed MTBF is demonstrated Accuracy of testability System mission availability (point or interval availability).

ASSURANCE VERSUS INCENTIVE WARRANTIES

In case of assurance warranty performance meets some minimum level. In this the aim of the reliability improvement is to ensure that this is achieved. In contrast, in some cases the buyer is interested in encouraging the contractor to exceed the minimum level and as such the warranty contract includes incentive features to achieve this. This is accomplished by tying the payment to the performance level achieved by the contractor.

2. RIW PROCESS

The RIW process is different from that for items sold with non-RIW policies. There the manufacturer makes all the decisions regarding warranty terms. The buyer is directly involved only in that a selection is made among products with different warranties, although this could have an indirect effect in that adverse selection in sufficient numbers may influence the manufacturer to improve warranty terms. In contrast, in the case of products sold with RIW policies, the buyer is actively involved in the process from the beginning and, in fact, may influence some crucial warranty decisions, since warranty terms are usually negotiated by the two parties. In addition, the focus of RIW is on the total life cycle of the product rather than just the warranty period as in the case of non-RIW policies. As a result, the buyer has a strong input into product development and the nature of post-sale support needed subsequent to putting the product into operation. The RIW process involves six stages.

Stage 1 [Bid Proposal]: A bid is submitted in response to a Request for Proposal.

Stage 2 [Design and Development]: It is important to note that the contract might specify the type of testing to be carried out and the performance requirements to be met before the contractor can proceed to the next stage.

Stage 3 [Production]: As before, the contract might specify the type of testing to be carried out and the performance requirements to be met before the item is released for field operation.

Stage 4 [Field Operation]: Here the items are put into use. The buyer is required to ensure that the items are used in a manner stated in the contract. Should the operating environment deviate from that for which the product has been designed (that can arise later for example, the on some or all of the components of an item exceeding the design envelope), loads then it needs to be documented by the buyer and reported to the contractor. Also, the buyer might need to record other information that will be of assistance in fixing Problems on.

Stage 5(a) [Repair of Failed Items]: This requires planning of various resources, including spares, workshop facilities, technicians, and so forth.

Stage 5(b) [Engineering Change Proposals (ECP)]: This involves identification of failures and their causes and of modifications needed to prevent their future occurrence.

Stage 6 [Implementation]: This is concerned with actions required by Change Orders

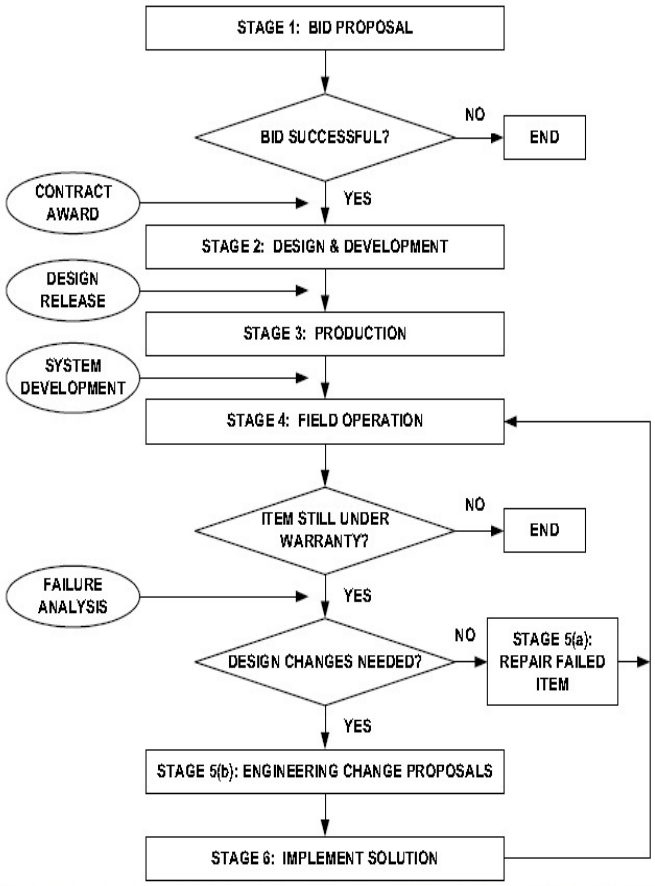

Fig Stage I Bid proposal

Bid Proposal [Stage 1]

The first stage of the RIW process is the bidding stage. A typical scenario begins with the buyer issuing a "Request for Proposal" (RFP) to one or more manufacturers, informing them of the specifications, including performance requirements, for the new product, along with other information needed to prepare a bid on the project. Manufacturers respond through an initial bid proposal that indicates how the new product can be realized and gives some indication of the performance levels and crude estimates of various costs. This is done using crude models based on limited data. The buyer carries out an evaluation of the proposals and decides on which ones are to be rejected and considers possible revisions to the performance requirements based on the bid proposals. The proposals not rejected go through a second stage where the process is repeated. The end outcome is the final contract that states the terms of the RIW policy.

1 CONTRACT

The contract needs to address the following issues.

What is the duration of the warranty period?

Is it an assurance or incentive warranty?

What are buyer and contractor obligations?

What issues are covered?

What are the exclusions?

How are the spare parts issues addressed? Are they delivered at the start

a) WARRANTY STATEMENT

This indicates which of the characteristics discussed in included. One or more of the following questions are addressed:

What is the duration of the warranty period?

Is it an assurance or incentive warranty?

What are buyer and contractor obligations?

What issues are covered?

What are the exclusions?

How are the spare parts issues addressed? Are they delivered at the start or

Over the operating life cycle of the product?

b) PRODUCT PERFORMANCE

The performance of the product must be stated properly so that there is no scope for ambiguity. Reliability-related performance needs to include the time frame for data collection, the type of data to be collected, and the procedures to assess performance in terms of the data. In the case of MTBF, one must specify whether a point or interval estimate is to be used. Similarly, during development the contract needs to indicate the kind of testing to be carried out and how to translate the test data into assessing performance at component, sub-system or system level. If these are not done properly, it can lead to disputes and litigation at a later time.

2 COSTS

There are several different types of costs involved. These include the following:

Development cost

Production cost

Support cost (for spares, etc.)

Warranty cost.

The contractor needs to take into account all of these costs in the pricing of the contract. The warranty cost must include the provision of replacements, repairs as well as upgrades. This depends on the duration and other terms of the warranty. Models are needed to predict these costs. From the buyer's perspective, the cost of interest is the total life cycle cost. The buyer might look at alternate warranty options and needs to assess the benefits of warranty traded against the warranty costs. All activities needed to build and support the product and, all the major factors that influence these activities must be converted into costs that are projected far enough into the future to cover the warranty period

3 RISKS

The contractor faces several kinds of risk. These include the following:

Technical risk: This results from not achieving the performance levels stated in the contract and, as a consequence, incurring a large penalty through high warranty costs and/or high cost of engineering design modifications

Project risk: This results from not delivering the product in time and/or cost overruns during development and production.

4 DISPUTE RESOLUTIONS

For most RIW policies, the product as well as the contract is complex. This implies that the contract might not address some issues that can lead to potential problems and disputes after the contract has been signed. Also, the interpretation of the contract (for example, the testing conditions or operating environment) and other unverifiable factors (for example, the cause of failure being either due to operator error or design weakness) can lead to possible conflicts. As such, both parties (buyer and contractor) need to look at alternate dispute resolution mechanism during Stage 1.

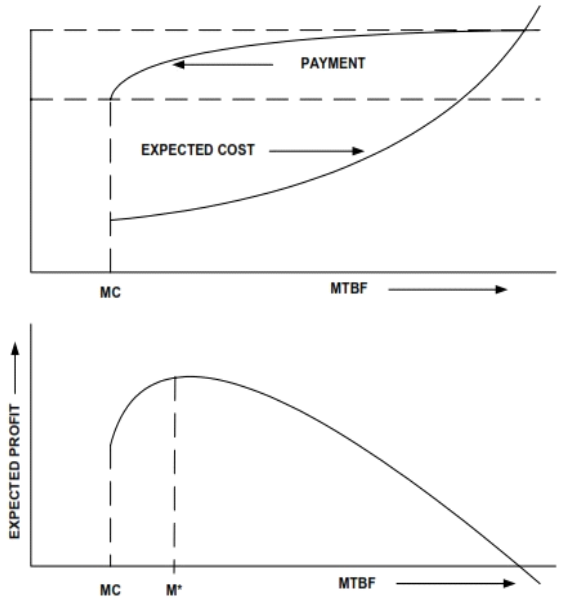

Fig Optimal MTBF under incentive RIW

MODELS

The RIW process is complex and varies considerably from contract to contract. As a result, quite sophisticated models are needed to capture all of the elements of RIW. The models need to include development, testing, and operational factors and related costs, reliability growth, randomness (uncertainty of outcomes), risk, other project-specific elements, and, in addition, must look at these from a life cycle perspective and from the points of view of both buyer and contractor. General models that embody all of these features have not been developed. Typically, what is done is to develop comprehensive computerized databanks to record as much information as possible about the RIW project.

EXAMPLES

Most of the examples are from the defense sector. A few examples of applications7 for which models were developed are:

PURCHASE OF AVIONICS BY THE MILITARY.

A batch of items was purchased, with a subset of these put into service and the remainder used as spares. The model expressed cost to the buyer as a function of purchase price, expected cost of failures, and cost of maintenance, and included a number of breakdowns into lower level cost elements, incentives for reliability improvement, and other relevant factors.

MILITARY ELECTRONIC EQUIPMENT: The model considered cost of RIW with guaranteed spares availability and turnaround time, and involved many related factors.

ECP AND IMPLEMENTATION

Although the predicted performance during design and development and during production tests may meet or exceed the stated performance measures, this does not guarantee that the desired performances are achieved during field operation. This is because of the limitations of models used prior to and during testing and of the data available from tests. However, if the root cause analysis indicates a major potential problem or that the performance terms are not being met, then the contractor needs to provide the buyer with engineering change proposals that will overcome the problem and ensure that the performance levels are met. This involves a proper evaluation of the modified design and in some cases test data to prove the claims of the contractor. Once the buyer gives approval, the contractor needs to carry out changes on all the items delivered or being held as spares.

It is worth noting that if an item is used in a mode that the product has not been designed for (for example, running a locomotive at speeds higher than designed or on poorly maintained tracks), then the warranty would become null and void. This implies that the buyer needs to ensure that proper operational and maintenance related data are kept in order to verify, if necessary, that the buyer's obligations are met.

3. MANAGEMENT OF THE RIW PROCESS

Some of the management issues for RIW are the same as for items sold with non-RIW policies and discussed in Chapter 4. However, there are some issues that are unique to RIW policies and we discuss these briefly in this section.

1 WARRANTY NEGOTIATIONS

This is a critical element of Stage 1 for both commercial and government acquisitions. The negotiation process serves to clarify issues so as to arrive at an agreement that is acceptable to both parties (contractor and buyer). The negotiations can be involved, as the interests of the two parties are different and so are the information and knowledge needed to evaluate costs and risks.

2 PROJECT MANAGEMENT

For a complex product, the contractor needs the involvement of several subcontractors to provide different sub-systems. For example, in the case of an aircraft, the engine manufacturer would be one of the main sub-contractors. It is the responsibility of the contractor to confirm that the components obtained from subcontractors conform to specifications. This implies that all design changes must be communicated effectively.

3 DATA MANAGEMENT

The contractor needs a system to track and collect relevant data needed to estimate achieved performance at different stages of development, during production and during field operation. The input to this database must include the following: Product design: detailed design specifications of original configuration; design changes based on field performance data Product operation: usage, failures, failure modes, failure times, etc. Repair: actions, time needed for repair, costs, etc. The buyer needs to keep track of operational-related data to ensure that the terms of the contract are not violated.

4 WARRANTY ADMINISTRATIONS

This deals with systems and procedures required to execute the various stages indicated in government acquisitions. It is important to specify requirements, procedures, and criteria for assessment of performance and to perform a careful cost analysis at the outset. In the bid preparation stage, careful attention must be paid to all of these factors as well as to the cost and feasibility of various warranty terms. The last is especially important since a key feature of RIW acquisitions is that warranty terms will be negotiated. Brennan offers many guidelines regarding bid preparation, including discussion of Risks and benefits Warranty trade-offs

Warranty costing

Performance guarantees

Warranty negotiating

Determination of cost effectiveness.

4. CONCLUSION

RIW is can be used very effectively to reduce warranty cost related with different products

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