CHAPTER 44

PRODUCTION RELIABILITY ACCEPTANCE TESTING (PRAT)

CONTENTS

1. INTRODUCTION

This chapter describes the purpose and philosophy of Production Reliability Acceptance Testing (PRAT), when the activity should be carried out and the advantages and disadvantages of different methods available.

2. SCOPE

The following topics are discussed in this chapter:

- Planning and managing PRAT;
- Purpose of PRAT;
- PRAT philosophy;
- Statistical risk;
- Sampling methods.

3. PLANNING AND MANAGING PRAT

Like all reliability techniques, the effectiveness of PRAT will be largely dependent on the adequacy of the planning and preparation and the effectiveness with which the task is managed. PRAT usually involves a significant amount of reliability testing with associated high costs. Therefore it is important that adequate provision has been made in the programme in respect of finance, test facilities, time and other resources needed for the satisfactory conduct of PRAT.

4. PURPOSE OF PRAT

4.1 The purpose of PRAT is to provide the customer with assurance that the reliability of production standard items meets or exceeds the specified requirements. Whilst PRAT does not directly improve reliability, under certain contracting strategies it may provide a hurdle which the contractor needs to clear and thereby provides motivation for him to address reliability throughout the design, development and production processes.

4.2 Ideally for this reason the PRAT plan, including the test conditions and the action to be taken in the event that PRAT fails to demonstrate that the reliability requirements have been attained, needs to be agreed between the purchaser and the contractor at the outset of the project. However a contractor will frequently see this as an additional risk and will off-set this risk by increasing the cost. A way round this is to declare in the contract the intention to conduct a PRAT in the event that the confidence in the R&M qualities of the acquisition is not forthcoming prior to the agreed point of acceptance.

5. PRAT PHILOSOPHY

PRAT usually involves the testing of a sample of items drawn from a production batch or lot. The results obtained from testing samples allow informed decisions to be made regarding the reliability of the entire population from which the sample was drawn. In order that such decisions can be made it is essential that equipments tested during PRAT are representative of

the population and that all test results are appropriately validated. This is usually achieved by drawing random samples from the population. For these reasons, the environmental conditions under which items are tested during PRAT should be as close as possible to the in-service environment agreed within the contract. The items to be tested should have been subjected to all standard production processes and tests; for example, each item should have been subjected to production standard environmental stress screening and functional testing.

6. STATISTICAL RISK

6.1 PRAT is a statistical sampling exercise. For one-shot devices (e.g. explosives, stored pressure devices) where testing is destructive, the need to test a sample is obvious. Even if all items in a production lot of repairable items are tested, however, they would normally only be tested for an element, or sample, of their expected service lives. Hence, because inferences are made about the population as a whole based on what is observed in the sample, there is a risk that such inferences are incorrect.

6.2 The actual reliability of the production lot may be better or worse than that observed in the sample. The risks associated with incorrectly rejecting a lot (based on a result from a test in a sample) which meets the requirements or similarly incorrectly accepting a lot which does not meet the requirements need to be specified. The former is usually known as the producer's or contractors risk the latter as the consumer's or purchaser's risk. Once such risks are specified standard statistical methods can be used to determine an appropriate test plan.

7. SAMPLING METHODS

7.1 PRAT may be conducted in a number of ways. The method most appropriate for the item concerned will depend on the nature of the item (e.g. explosive, avionic, mechanical), its complexity, the expected in–service environment and the number of items being produced. The two most common methods are:

- Batch sampling;
- All equipment testing.

7.2 Batch Sampling.

7.2.1 Generally this method is used for production items produced in a series of batches. It is commonly used in cases where items are shipped to the purchaser in batches. However cost and safety my influence this decision therefore while a fleet of new vehicles or a communication system may be batch tested new aircraft or warships are more likely to be individually tested although they may be delivered in batshes.

7.2.2 The size of samples to be tested (i.e. the number of items or test hours) and the associated pass/fail criteria (number of permissible failures) can be calculated from first principles or may be obtained directly from published International Standards for given levels of contractor's and consumer's risk.

7.2.3 Simple batch sampling plans require that all of the items to be tested be drawn in a single sample. More complex multiple sampling plans also exist where two or more samples may be drawn from one production lot.

7.2.4 An advantage of PRAT plans based on batch sampling is that once established they are easy to implement although frequently costly and time consuming.

7.2.5 The disadvantages of PRAT plans based on batch sampling are:

a) They do not provide very good discrimination between lots of high reliability items and those of poor reliability;

b) The contractor must store the entire production lot prior to commencing PRAT.

7.3 All Equipment Testing

7.3.1 This method requires every production item to be subjected to a test which is usually of short duration but sufficiently long that the accumulated test time after all items have been tested is adequate to demonstrate whether or not the specified reliability has been achieved.

7.3.2 All-equipment test plans utilise a sequential test method in which continuous assessment is made as each failure occurs against a pre-defined test plan. Unlike sequential test plans based on batch sampling these tests cannot be terminated by a decision to accept the lot. However, should the assessed cumulative reliability be sufficiently low, the test plan will indicate when the point is reached where the contractor should take corrective action. In this case such corrective action is applicable to the entire production lot, including any items already delivered to the customer.

7.3.3 The advantages of PRAT plans based on all-equipment testing are:

a) Every item is tested which provides a better check for drift in processes, inspection standards etc;

b) There is no need to store entire batches; individual items may be released to the purchaser after successful completion of their own test;

c) They provide better discrimination between very good and very bad lots than the equivalent batch sampling method.