APPENDIX D

FACTORS INFLUENCING FIELD MEASURES OF RELIABILITY

D-1. Design reliability versus field reliability

The reliability achieved by diligent attention to failure modes and mechanisms during design and manufacture is defined as design reliability. The reliability actually observed during operation of the system in its intended environment is defined as field reliability.

a. Design reliability. Design reliability is by definition the level of reliability inherent in the system as designed and manufactured. All failures are due to inherent weaknesses in the design, flaws in the materials, or defects from the manufacturing processes. The level of design reliability achieved is determined through analysis and test. Although in applying analytical methods and in testing the system (the "actual" system or prototypes), the design and development team attempts to simulate the actual operating environment, it is difficult if not impossible to account for some aspects of operation.

b. Field reliability. Field reliability is the measure a customer or user of a system uses. Whenever a system fails to perform its function(s) or requires maintenance, the customer will count such events as failures, regardless of the cause. Inherent weaknesses in the design, flaws in the materials, and defects from the manufacturing processes will cause such failures, but so will maintenance errors, improper operation, and changes in operating concept. In addition, if the operating environment is substantively different from that defined during design, more failures or failure modes may occur than were addressed during design and manufacturing. Consequently, field reliability can never be higher than design reliability and is usually lower.

D-2. Accounting for the differences

We can account for the differences between design and field reliability. We can do so in two ways: the way we design and develop procedures, and the way in which we develop design requirements.

a. Design and procedure. Recognizing that humans make mistakes, we can apply design techniques that minimize the chance of human error. For example, we can design mating parts to mate in only one way, preventing maintenance personnel from making an incorrect connection. We can design displays that are easy to read and use conventional symbols. We can design controls using standard orientation (e.g., turn right to shut off a valve). In a similar manner, we can write procedures that are clear, concise, and logical. Such attention to the human element during design can minimize the opportunity for human error.

b. Design requirements. If the customer needs a field reliability of 1000 hours Mean Time Between Failures (MTBF) for a system, we cannot use 1000 hours as our design requirement. If we did so, and missed one failure mode due to our inexact understanding of the operating environment, we would not meet the field reliability requirement. We must, therefore, design to a higher level. Of course, we should not set an arbitrarily high design reliability requirement. To do so would drive up costs unnecessarily. A commonly used approach for setting the design reliability requirement is to use past experience. If experience with previous systems indicates that the field reliability runs 10%-15% lower than what was measured during design and manufacture, then, as a rule of thumb, the design reliability requirement for new systems should be 12% higher than the field reliability requirement. For example, if the design reliability for past systems was 1,000 hours MTBF and the observed field reliability was only 850 hours (15% less), and the field reliability requirement for a new system is 1,000 hours, the design reliability requirement must be about 11.8% higher or 1,180 hours. If we achieve this level of design reliability, then we can expect our filed reliability to be 1180 - (15% x 1180) = 1,003 hours.