Human Reliability and Error in Maintenance

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25.1 Introduction

Although humans have felt the need for maintenance of their equipment since the beginning of time, the beginning of the modern engineering maintenance may be regarded as the development of steam engine by James Watt [1736 – 1819] in 1769 in Great Britain (The Volume Library, 1993). Today, billions of dollars are being spent each year on equipment maintenance around the world. For example, each year United States industry alone spends over $300 billion on plant maintenance and operations and for the fiscal year 1997, the operation and maintenance budget request of the United States Department of Defense was $79 billion (Latino, 1999; 1977 DoD Budget, 1996).

Humans play an important role during equipment life cycle: design, production, and operation and maintenance phases. Even though, the degree of their role may vary from one equipment to another and from one equipment phase to another, it is subject to deterioration because of the occurrence of human error. A human error may be classified under six distinct categories: design, assembly, inspection, installation, operating, and maintenance (Meister, 1962, 1976). In particular, the maintenance error or poor human reliability occurs basically because of wrong repair or preventive measures and their two examples are incorrect calibration of equipment and application of the wrong grease at appropriate points of the equipment. A comprehensive list of publications on human reliability and error in engineering maintenance is available in Dhillon and Liu (2006). This chapter presents various important aspects of human reliability and error in maintenance.

25.2 Terms and Definitions

This section presents terms and definitions considered, directly or indirectly, useful for studying human reliability and error in maintenance (MIL-STD-721B, 1966; Dhillon, 1986, 2002; Hagen, 1976; AMCP, 1975; McKenna and Oliverson, 1997; Omdahl, 1988; Naresky, 1970):

- **Human error**: the failure to perform a specified task (or the performance of a forbidden action) that could result in disruption of scheduled operations or result in damage to equipment and property;
• **Human reliability**: the probability of accomplishing a task successfully by humans at any required stage in system operation within a stated minimum time limit (if the time requirement is specified);

• **Maintenance**: all actions necessary for retaining an item or equipment in, or restoring it to, a specified condition;

• **Inspection**: this is the qualitative observation of condition or performance of an item;

• **Human performance**: a measure of man-functions and actions under specified conditions;

• **Man-function**: that function which is allocated to the system’s human element;

• **Corrective maintenance**: the unscheduled maintenance or repair actions to put back items/equipment to a specified state and performed because maintenance personnel or users perceived failures or deficiencies;

• **Predictive maintenance**: the use of modern measurement and signal-processing approaches to diagnose equipment condition during operation;

• **Human performance reliability**: the probability that a human will satisfy all stated human functions subject to specified conditions;

• **Continuous task**: a task that involves some kind of tracking activity; and

• **Preventive maintenance**: all actions performed on a planned, periodic and specific schedule for keeping an item or equipment in specified working condition through the process of reconditioning and checking.

### 25.3 Human Reliability and Error in Maintenance-Related Facts, Figures, and Examples

Some of the important facts, figures, and examples directly or indirectly associated with engineering maintenance are as follows:

• Each year, the United States industry spends over $300 billion on plant maintenance and operations (Latino, 1999).

• A study of 213 maintenance events reported that 25.8% of the failures were partially or wholly due to human error (Robinson *et al.* 1970).

• A study of safety issues vs on board fatality of worldwide fleet of jets of the period 1982 to 1991, revealed that inspection and maintenance was the second most pressing safety issue in regard to onboard fatalities of 1481 (Russell, 1994; BASI 1997).

• In 1993, a study of 122 maintenance-related occurrences involving human factors revealed that the classifications of maintenance error breakdowns were omissions (56%), wrong installations (30%), wrong parts (8%), and other (6%) (BASI, 1997; Circular 243, 1995).

• A study of electronic equipment concluded that approximately 30% of all malfunctions were the result of operation and maintenance errors (AMCP, 1972).