

**ESTABLISHING SYSTEM AVAILABILITY REQUIREMENTS FOR  
CONCEPTUAL FACILITIES**

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## ABSTRACT

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System design engineers must translate permitted overall facility downtime into detailed design and

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assigning overall facility reliability and maintainability requirements among systems is known as availability apportionment. Apportionment is normally required early in conceptual design when little or no hardware information is available. Apportionment, when coupled with availability prediction, enables the selection of viable alternative configurations, identifies problem areas, and provides redirection of the program into more productive areas as necessary. A method for apportioning, or budgeting, overall facility availability requirements using characteristic factors and expert opinion is presented.

Characteristics that influence equipment reliability and maintainability are described. Experts, using engineering judgment, score each characteristic for each system whose availability design goal is to be established. The Analytic Hierarchy Process is used to produce a set of weighted ranks for each characteristic of each alternative system. Expert elicitation relies on a series of exhaustive judgments that compare pairs of characteristics.

Characteristics chosen that influence reliability are system complexity, design immaturity, and stressful operating environment. System complexity may be evaluated by considering the probable number of parts or components that make up the system—the higher the number of parts the more likely there will be failures. The lack of a proven design increases the probable number of failures. Components operating in stressful conditions (e.g., high temperatures, vibration, and radiation fields) have more failures than those operating in benign environments.

Characteristics that influence maintenance are the elements of repair time: fault detection and diagnosis time, preparation time to conduct the repair, fault correction time itself, and time to restart the system once the fault is corrected.

The Analytic Hierarchy Process is used to produce sets of weighting factors for each alternative. The paired comparison procedure is implemented in two phases. During the first phase, relative importances of “characteristics” are established. Experts are asked, for example, to compare complexity and design maturity with respect to their importance in apportioning reliability. The second phase compares pairs of systems for each characteristic. All pairs are compared for each characteristic. The entire procedure is

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consideration of reliability and maintainability. The Expert Choice™ commercial software package is used to assist experts in working through the Analytic Hierarchy Process method.

A principal technical expert is chosen to represent each system. A structured interview is conducted for each expert individually. Team aggregation and final adjustments of availability allocations are performed at the conclusion of the structured interviews, and results are reviewed.

An example application is given.