



System Reliability Center
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Technique for Human Error Rate Prediction (THERP)

THERP is the best known, most frequently applied technique for human performance reliability prediction. It is a method for predicting human error rates and for evaluating the degradation of a human-machine system likely to be caused by human errors in association with factors such as equipment reliability, procedures, and other factors. THERP uses performance-shaping factors to make judgments about particular situations. In some cases, however, it may be difficult to accommodate all of the factors that are considered important. THERP has the advantage of simplicity but it does not account for a dependency of human performance reliability with time.

THERP involves five steps:

1. Define the system or process. This involves describing the system goals and functions and the consequences of not achieving them. It also requires identifying mission, personnel, and hardware/software characteristics.
2. Identify and list all the human operations performed and their relationships to the system or process tasks and functions. This requires an analysis of all operator and maintainer tasks.
3. Predict error rates for each human operation or group of operations. Errors likely to be made in each task or subtask must be identified. Errors that are not significant in terms of system operation are ignored. This step includes estimating the likelihood of each error occurring and the likelihood of an error not being detected.
4. Determine the effect of human errors on the system or process, including the consequences of the error not being detected. This requires the development of event trees. The left limbs of the event trees are success paths; the right limbs are failure paths. Probabilities are assigned to each path. The tree reflects the effects of task dependence. The relative effects of performance-shaping factors, e.g., stress and experience, are estimated.
5. Develop and recommend changes that will reduce the system or process failure rate. The recommended changes can be developed using sensitivity analyses, in which factors and values are varied and effects monitored. THERP makes no assumptions about the dependence or independence of personnel behaviors. Data are taken from available sources.

A key aspect of THERP is the determination of the probability that an error or class of errors will result in a system or process failure. This probability is assigned a value F_i . Branching trees are constructed to determine the paths to success and failure as shown in Figure 1. The probability that an error will occur is given by P_i . Table 1 shows some sample probabilities. $F_i P_i$ is the joint probability that an error will occur and that the error will lead to system failure. $1 - F_i P_i$ is the probability that an operation will be performed that does not lead to system failure. The probability that a class of errors will lead to system failure is given by:

$$Q_i = 1 - (1 - F_i P_i)^{n_i}$$

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where n_i is the number of independent operations. The total system or subsystem failure rate is given by:

$$Q_T = 1 - [\prod_1^n (1 - Q_k)]$$

where Q_T is the probability that one or more failure conditions will result from errors in at least one of the n failure classes.

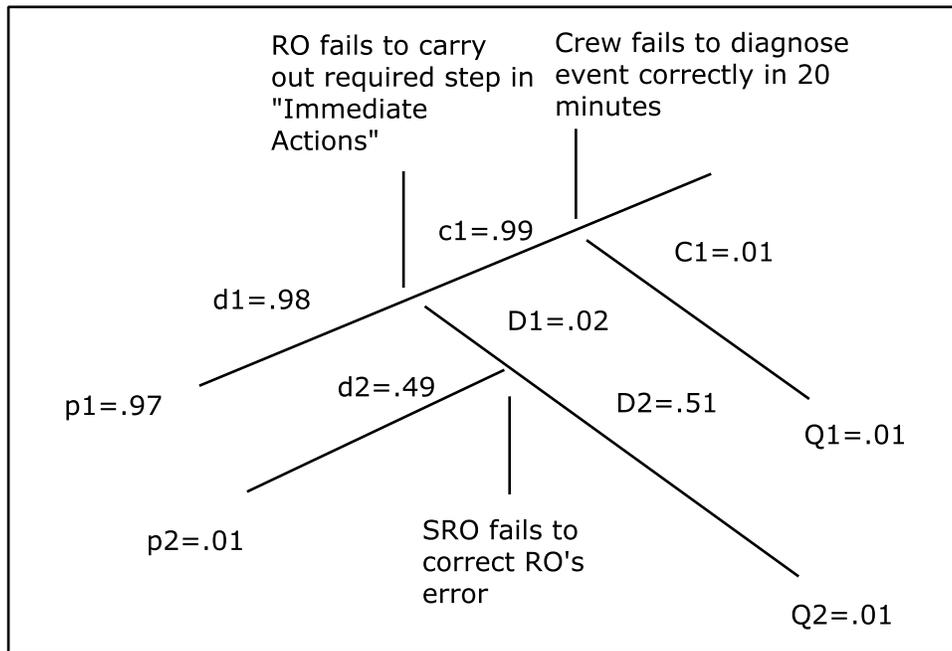


Figure 1. Sample THERP Probability Tree

Table 1. Sample THERP Error Probabilities

Item	Checking Operation	Human Error Probability	Error Factor
1	Checking routing tasks using written manuals	0.1	5
2	Same as above but without manual	0.2	5
3	Special short-term, one-of-a-kind checking with alerting	0.05	5



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THERP can be used for design analysis, manpower selection, prediction of system effectiveness, and determination of training requirements. For design analysis, it allows the comparison of alternative system or process configurations in terms of effect on operator capability. It also allows comparative analysis of initial configuration options and reconfiguration if deficiencies are identified. For manpower selection, THERP allows the determination of the types, numbers, and skill levels of the personnel required to operate the system. For system effectiveness, THERP allows an assessment of whether quantitative requirements will be met. The determination of training requirements is more implicit than explicit. Unacceptable task performance error rates suggest the need for training to improve proficiency. Hence, THERP can suggest the need for training rather than specific training topics.

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Source:

- LaSala, K.P., RAC Publication "*A Practical Guide to Developing Reliable Human-Machine Systems and Processes*", January 2002.

For More Information:

- Swain, A.D., "THERP", SC-R-64-1338, Sandia National Laboratories, Albuquerque, NM, August 1964.
- Swain A.D. and Guttman, H.E., "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications" (NUREG/CR-1278, SAND800 200, RX, AN), Sandia National Laboratories, Albuquerque, NM, August 1983.