American Nuclear Society

time response design criteria for safety-related operator actions

an American National Standard

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Foreword

(This Foreword is not a part of American National Standard for Time Response Design Criteria for Safety-Related Operator Actions, ANSI/ANS-58.8-1994, but is included for information purposes only.)

The criteria contained in this standard establish timing requirements to be used in the design of safety-related systems for nuclear power plants. These criteria are used to determine whether safety-related systems can be initiated by operator action or require automatic initiation. The time response criteria given in this standard adopt time intervals and other restrictions to ensure that adequate safety margins are applied to system and plant design and safety evaluations. Guidance for design of associated instrumentation, controls, indicators, and enunciators necessary for operator action is provided.

The scope of this standard is limited to safety-related operator actions associated with those design basis events (DBEs) that result in a reactor trip and are required to be analyzed in safety analysis reports* (SARs). This limits the resulting requirements for potential automation by adhering to known safety-related operator actions. Should the scope of the SAR be expanded, this standard should be applied to new DBEs which require safety-related operator actions.

It is beyond the model and data base of this standard to use its timing requirements to calculate actual operator action times. In actual practice, the operator should be capable of reacting to DBEs correctly and performing the safety-related operator actions in less time than specified by the criteria in this standard. The criteria are not intended to serve as a basis for plant staffing or actual operator action times in procedures or training, but could provide useful input to these operational considerations.

Where analysis credits safety-related operator actions to meet the criteria of this standard, the actions should be regarded as time-critical tasks. Human factors professionals should consider the implications of such results and ensure that time-critical tasks can be readily performed in the actual system design.

The application of these criteria may indicate the need for system design modifications or automation of some actions that are intended by designers to be performed by the operator. However, it is not intended that automation be pursued for applications that would exceed the state of the art or be so complex as to jeopardize plant safety without reasonable assurance that such automation of operator actions has an overall beneficial effect in terms of increased nuclear safety.

Early drafts of the criteria in this standard were based on an extension of the "ten-minute rule" that had gained some acceptance in the industry. Some reviewers of these drafts felt strongly that this approach was an inadequate time allowance for some cases. After meetings with the Nuclear Regulatory Commission (NRC) and SC-6 of the Nuclear Power Engineering Committee (NPEC) of the Institute of Electrical and Electronics Engineers, Inc. (IEEE), the Working Group for Operator Actions decided to adopt the more comprehensive and, in some cases, more conservative requirements reflected in the criteria set forth in this standard.

The response times embodied in ANS-58.8-1984 criteria were based on simulator measurements of operator performance and plant data collected from actual events. The measurement programs were conducted by General Physics Corporation, under the sponsorship of the Electric Power Research Institute (EPRI), and by Westing-

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* Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," specifies DBEs.

house Electric Corporation. The test subjects represented skill levels ranging from initially qualified operators to experienced operators performing requalification training. Operators' responses to various anticipated operational occurrences and accident situations were measured to determine the promptness of their actions. The data were collected automatically and later reduced through the use of statistical methods.

These empirical data provide a basis for the standard to define time intervals of sufficient length for operator responses at a 95% confidence level. The data do not allow assignment of a given confidence level that the operator action will necessarily be correct. However, it is assumed that if the intervals used meet the time criteria of the standard, then other performance-shaping factors (e.g., training level, panel layout, procedures) might dominate the factor of "time available" in their combined influence on the probability of operator error.

This revision of the standard reflects a detailed review of additional data that became available since 1984. The purpose of this review was to determine whether the data validated the time tests of the standard or whether revisions were indicated in either the time tests or the philosophical basis of the standard.

The new data were collected by EPRI as part of the Operator Reliability Experiment (ORE). The purposes of the ORE project were (1) to develop models of operator reliability for control room decisions and actions; (2) to obtain data to validate the models, mainly through the use of plant simulators; and (3) to enable quantification of post-TMI benefits from changes in control room design, procedures, training, and operator aids.

The Accident Prevention Group (APG) analyzed the ORE data. A brief outline of this analysis is provided in the Appendix. The review of the APG analysis by the Working Group ANS-58.8 members determined that the analysis results validated the standard's required response times and suggested simplifications in its methodology. The Working Group believes that future studies should be directed to data collection, analysis, and interpretation to test a perceived trend of system-based procedures toward shortening or eliminating the time interval the operator has to diagnose the event and actions to be taken ($TI_{diagnosis}$) and lengthening the fixed and variable sub-intervals of the time the operator has to perform the actions ($TI_{operator}$). For a description of $TI_{diagnosis}$ and $TI_{operator}$, please refer to Section 2 of this standard.

Two significant changes have been made to the methodology:

(1) *Simplification of the terminology used to define the discrete time points and time intervals incorporating the time tests of the previous revision of this standard (Time Tests 1 and 2) into the appropriate time intervals.* In the text of the standard, Time Test 1 is incorporated in $TI_{diagnosis}$ and Time Test 2 is incorporated in $TI_{operator}$.

(2) *Unidirectional calculation of the time points and intervals from the beginning of the DBE to the conclusion of the DBE.* In the previous version of this standard, calculations were necessary from both the beginning and the conclusion of the DBE.

This standard has been reviewed by IEEE/NPEC/SC-7, as the coordinating body for nuclear industry human factors standards. That panel has approved this revision.

The members of Working Group ANS-58.8 who prepared this standard are:

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The American Nuclear Society's Nuclear Power Plant Standards Committee (NUPPSCO) had the following membership at the time of its ballot for approval of this standard:

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