Consistency in NRC's Treatment of "*Manual Actions*" Across Regulatory Applications

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ABSTRACT

The NRC staff evaluates manual actions for a variety of specific applications within its licensing, inspection, and enforcement processes. This report documents the review and findings of an ad hoc inter-office working group established to assess NRC's consistency across these applications and processes in regulatory treatment of manual actions. The report provides a comparative analysis that can facilitate identifying and guiding any subsequent initiatives that might be undertaken to improve the efficiency and effectiveness of NRC regulatory processes that rely on the crediting of manual actions. For the purposes of this report, a manual action is considered to be "credited" if the NRC finds the use of the manual action acceptable for a reasonable assurance determination or, if a regulatory application relies upon the use of quantified estimate of the reliability of the manual action. Only those manual actions that are evaluated for specific regulatory credit were considered to be within the scope of this review (e.g., actions for mitigating an accident or preventing an accident after an initiating event, if those actions are credited to help meet a regulatory requirement). The working group found that the NRC credits manual actions in licensing, inspection, and enforcement processes, with multiple specific applications within these processes. The working group found that the NRC staff has achieved a core level of consistency through common use of several high-level assessment factors to evaluate manual actions. These common factors are: time sufficiency, training/qualifications, procedures, environmental conditions, and required information/indications. When differences among applications for the evaluation of manual actions were identified, they were typically found to have a rational basis. Although applications share common assessment factors, the working group found substantial differences in level of guidance detail and noted that lack of detail, or lack of references to more specific guidelines, may lead to inconsistent implementation, within or among applications due to varying experience levels among NRC staff. Accordingly, this document provides a suitable basis for the publication of a NUREG\KM and the establishment of an inter-office SharePoint site on regulatory treatment of manual actions.

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ABBREVIATIONS

AOO	abnormal operating occurrence
ASP	accident sequence precursor
AST	alternate source term
ATHEANA	A Technique for Human Event Analysis
CCF	common cause failure
CDBI	component design basis integrity
COL	combined license
DBE	design-basis event
DC	design certification
D3	diversity and defense-in-depth
FCSS	Division of Fuel Cycle Safety and Safeguards
FPP	fire protection program
FRA	functional requirements analysis
GDC	General Design Criteria
HFE	human factors engineering
HFE	human failure event
HSI	human system interface
HLWRS	Division of High-Level Waste Repository Safety
HPI	high-pressure injection
HRA	human reliability analysis
HCR/ORE	Human Cognitive Reliability/Operator Reliability Experiments
I&C	instrumentation and control
IMC	Inspection Manual Chapter
IP	inspection procedure
IROFS	Items Relied on For Safety
ISA	integrated safety assessments
LCO	limiting conditions for operations
LOCA	loss of coolant accident
MCR	main control room
MDAFW	motor-driven auxiliary feedwater
MOV	motor-operated valve
NMSS	Office of Nuclear Material Safety and Safeguards
NFPA	National Fire Protection Association
NOED	Notice of Enforcement Discretion
NPP	nuclear power plant
NRC	Nuclear Regulatory Commission
NRO	Office of New Reactors
NRR	Office of Nuclear Reactor Regulation
NSIR	Office of Nuclear Security and Incident and Response
PA	postulated accidents
PC	plant conditions
PRA	probabilistic risk assessment
PSF	performance shaping factors
RCP	reactor coolant pump
RES	Office of Nuclear Regulatory Research
RHR	residual heat removal
RIS	regulatory issue summary

RG	regulatory guide
ROP	reactor oversight process
RPS	reactor protection system
RTNSS	regulatory treatment of non-safety systems
RWST	refueling water storage tank
SDP	Significance Determination Process
SFP	spent fuel pool
SFST	Division of Spent Fuel Storage and Transportation
SPAR	standardized plant analysis risk
SRM	staff requirement memo
SRP	standard review plans
SSC	structures, systems, and components
TA	task analysis
TS	technical specification
USAR	updated safety analysis report
V&V	verification and validation
VCT	volume control tank
WG	working group

Consistency in NRC's Treatment of "*Manual Actions*" Across Regulatory Applications

1. Introduction

This report documents the review and findings of an ad hoc inter-office working group to assess NRC's consistency across regulatory applications in crediting manual actions. The purpose of this report is to provide a comparative analysis that can facilitate identifying and guiding any subsequent initiatives that might be undertaken to improve the efficiency and effectiveness of NRC regulatory processes that rely on the crediting of manual actions. In addition, by providing a summation and comparison of available NRC guidance applicable to the crediting of manual actions, this report can serve as a resource for technical reviewers who may have a need to identify and consult alternative guidelines for crediting manual actions. However, this document does not constitute nor should be interpreted to provide review guidance. Readers should consult the original source documents to determine the applicability of any method or guideline (e.g., DI&C-ISG-05) to a specific matter under review.

1.1 Background

In the course of conducting a broad range of regulatory activities, the U.S. Nuclear Regulatory Commission (NRC) evaluates the feasibility and reliability of non-automated activities performed by reactor and fuel facility personnel that licensees use, or propose to use, as a means to prevent accidents or events, or to mitigate the impact of accidents/events should they occur. For the purposes of this document, these non-automated actions will be referred to as "manual actions" and may include, but are not limited to, those actions referred to as "operator manual actions" in some NRC guidance documents. The regulatory processes in which the NRC staff evaluates the use of manual actions include licensing (e.g., evaluation of requests for new licenses or amendments to existing licenses), inspections (e.g., baseline inspections that are part of the reactor oversight process (ROP) for operating nuclear power plants), and enforcement (e.g., evaluation for notices of enforcement discretion (NOED)). For some regulatory processes, the staff reviews the quantified reliability of manual actions (e.g., review of applications relying on probabilistic risk assessment (PRA)); in other cases, the staff conducts a qualitative assessment of the feasibility/reliability of proposed manual actions. The types of manual actions that are within the purview of regulatory review range from simple actions (e.g., control manipulations) that operators perform inside control rooms to more complex actions that may require entry into potentially hazardous or life threatening areas to perform recovery actions and repairs.

In spring 2010, NRC senior managers identified consistency across NRC's offices in regulatory treatment of manual actions as a topic to be addressed as a continuous improvement initiative. To that end, the NRC established a working group with representatives from the Office of Nuclear Regulatory Research (RES), the Office of New Reactors (NRO), the Office of Nuclear Material Safety and Safeguards (NMSS), the Office of Nuclear Security and Incident and Response (NSIR), and the Office of Nuclear Reactor Regulation (NRR). The charter (Appendix A) directed the working group to accomplish the following seven tasks:

1) Identify and tabulate the types of manual actions that are under regulatory purview in NSIR, NMSS, NRR, RES, and NRO.

2) Identify the different regulatory processes under which credit for these actions is reviewed (e.g., target set reviews, significance determination process [SDP], licensing, operator licensing, and inspections).

3) Group the various manual actions by type such that each group is composed of similar manual actions.

4) Identify the methods and criteria NRC uses to determine the acceptability of manual actions in each group; include whether the criteria are qualitative or quantitative.

5) Identify the need for consistency, or bases for inconsistencies among treatment of the manual actions among program offices and regulatory applications.

6) Identify the current initiatives/practices that ensure consistency within and across applications.

7) Identify reasons for diversity of regulatory treatment across applications where the diversity is acceptable.

The deliverables were specified as follows:

Deliverable 1: As the first step of the evaluation, the group should identify the regulatory processes that prompt regulatory review of manual actions and the type of manual actions reviewed under each of those processes. This deliverable encompasses tasks (1) and (2) above.

Deliverable 2: The working group should then develop a document that groups and records those manual actions, and define the set of manual actions that will be subjected to additional evaluations. This deliverable encompasses task (3) above.

Deliverable 3: The working group should then document its findings of facts and conclusions on whether differences exist, and the bases for the differences. These findings must be transmitted to the working group sponsors in a letter report. This deliverable encompasses tasks (4) through (7) above.

Deliverable 4: The working group should brief the program sponsors on its findings.

This report was developed by the working group and encompasses deliverables 1 and 3. During data gathering and through discussion, the working group decided that Task 3 (and associated deliverable 2) was unnecessary for accomplishing the mission of the working group, and was thus eliminated.

1.2 Scope of Manual Actions Considered

One task of the working group was to decide, for the purposes of this report, what constitutes a manual action and what should be the scope of manual actions included in this effort. The group decided that for the purposes of this report:

- The term manual actions, includes not only physical actions (e.g., control manipulations) but also includes cognitive activities (e.g., monitoring a plant parameter) that may be necessary to initiate or complete an associated manual action (e.g., manipulating a control, initiating communications). The term “manual” is therefore not intended to differentiate between physical and cognitive actions. Rather, the term “manual” is used to differentiate actions performed by plant personnel from other functions implemented through plant automation.

- Manual actions include actions performed by licensed operators, non-licensed operators, and other facility personnel. The term manual actions as used in this report is not limited to operator manual actions as defined in some NRC guidelines.

- A manual action is considered to be “credited” if the NRC finds the use of the manual action acceptable for a reasonable assurance determination or, if a regulatory application relies upon the use of quantified estimate of the reliability of the manual action.

- Only manual actions that are evaluated for specific regulatory credit would be considered to be within the scope of this review (e.g., actions for mitigating an accident or preventing an accident after an initiating event, if those actions are credited to help meet a regulatory requirement). Routine actions, which are part of day-to-day operations are outside the scope of this review because they are not subject to specific agency review.

- The review would include only published final versions (including revisions) of the applicable guidance documents.

Examples of manual actions within the scope of this effort are those credited for safe shutdown by nuclear power plant licensees to meet 10 CFR 50.48 fire protection requirements, or those administrative controls credited as “Items Relied on For Safety (IROFS)” by fuel facility licensees to meet §§ 70.61 and 70.62 requirements to limit the consequences of credible high-consequence events. (Additional examples are described in Appendices B-1 thru B-3.)

The working group considered several categories of manual actions that it determined to be outside the scope of this effort. The actions that were excluded are:

- Actions related to the execution of emergency response plans, e.g., licensees’ credit for accurate and timely declaration of emergency levels. After discussion, the group decided that these actions would be outside the scope of the current effort.

- Actions that would be required to maintain safe shutdown or spent fuel pool cooling in plants with passive safety systems by using non-safety systems. In the case of maintaining safe plant shutdown, these actions would not be required until at least 72 hours following the event. Although the Commission has provided direction via staff requirements memoranda (SRMs) to develop guidance regarding the regulatory treatment of non-safety systems (RTNSS), the guidance remains in the formative stages. As a result, it would be premature to address these actions within the report.

- For nuclear power plants, actions of fire brigades for fire suppression, the performance of fire watches by plant personnel, actions of plant operators to perform routine monitoring and control activities, and the actions of security personnel performing routine duties. Although these actions can serve important functions relative to the protection of public health and safety, they were determined to be outside the scope of this evaluation because in these instances the agency uses methods other than review of individual manual actions to perform its licensing, oversight, and enforcement functions.

The working group also considered including the operator licensing and requalification program as a specific application within the scope of this effort. The working group concluded that the operator licensing program serves the function of assessing the ability of individuals to perform licensed functions rather than assessing the acceptability of manual actions and therefore there is no unique or specific regulatory credit for manual actions that is based on initial or requalification licensing examinations. Thus, the group decided that the operator licensing program was outside the scope of the current effort.

For NMSS, the regulatory applications were limited to those related to fuel cycle facilities under the purview of the Division of Fuel Cycle Safety and Safeguards (FCSS). Discussions with staff in the Division of Spent Fuel Storage and Transportation (SFST) revealed that actions given regulatory credit are routine ones such as checking vents and temperatures on in-service casks, and hence are of the routine variety excluded from the scope of this effort. In the Division of High-level Waste Repository Safety (HLWRS), manual actions could be evaluated in the review of the Department of Energy's pre-closure and post-closure safety analysis (and human reliability analysis (HRA) contained therein) required in its license application, but the group did not pursue this program further because: (1) the status of the program is uncertain, and (2) the main guidance document (a HLWRS interim staff guidance document) for reviewing the HRA in the pre-closure safety analysis is derived from the HRA good practices guidance for reactors (NUREG-1792, Good Practices for Implementing Human Reliability Analysis (HRA)), which was included in this effort and discussed in section 3 below.

For each program office the regulatory applications considered within the scope of this effort are listed in Table 1.

Table 1 Regulatory Applications Involving the Crediting of Manual Actions

Office	Application
NMSS	Administrative controls identified as Items Relied on For Safety (IROFS) in fuel cycle facility integrated safety assessments (ISAs)
NRO	Accident and transient analyses
	Diversity and defense-in-depth analyses
	Probabilistic risk assessments
	Fire protection programs
NRR	Accident and transient analyses
	Diversity and defense-in-depth analyses
	Fire protection programs
	Alternate Source Term (AST) analyses
	B.5.b / 10 CFR50.54(hh)(2) mitigating strategies
	Power Uprates
	Control room modifications
	Other modifications affecting risk-important human actions
	Other changes to design/licensing basis
	Reactor Oversight Process (ROP)
	Significance Determination Process (SDP)
	Component Design Basis Integrity (CDBI) inspection
	Current licensing basis / technical specification compliance
	Notices of Enforcement Discretion
NSIR	Target set reviews
RES	Accident Sequence Precursor (ASP) analyses

1.3 Outline of Report

Section 2 of this report identifies the high level regulatory processes in which NRC may credit manual actions and briefly describes the specific regulatory applications within each of these processes for each program office. Section 2 addresses Deliverable 1 of the working group charter. Section 3 discusses and compares the guidance documents and criteria that NRC staff use to review and determine the acceptability of manual action credit. Sections 4 and 5 present the working group's analysis and conclusions respectively, encompassing Deliverable 3 of the charter.

2. Regulatory Processes that Credit Manual Actions

The working group discussed regulatory activities in each NRC office and reviewed agency guidance to determine the breadth of NRC regulatory activities in which manual actions may be credited. As described in Section 1.2, for the purposes of this report, manual actions are considered to be "credited" if the NRC finds the use of the manual action acceptable for a reasonable assurance determination or, if a regulatory application relies upon the use of quantified estimates of the reliability of a manual action. The working group found that the agency credits manual actions in three high level agency processes: (1) licensing, (2) inspection

and oversight, and (3) enforcement. Appendices B-1 thru B-3 to this report, summarize the specific regulatory applications that the working group identified in the areas of licensing, inspection and oversight, and enforcement, respectively. In addition, for each of these applications the appendices provide examples of the types of actions for which credit is considered, and identify the guidance that is available to the staff for making these determinations.

Appendix B-1 shows the range of licensing activities conducted by NMSS, NRO, NRR, and NSIR that may rely on crediting manual actions for performing a safety or security function. A review of Appendix B-1 reveals the following:

- In NMSS, the technical staff review Integrated Safety Assessments (ISA) for facilities licensed under 10 CFR 70, including manual actions identified in the ISAs as items relied on for safety (IROFS). These IROFS may include manual actions such as monitoring process parameters, labeling containers of special nuclear material, or securing chemicals upon failure of ventilation systems.

- Staff in NRO conduct reviews of licensing applications submitted under 10 CFR 52. These reviews include actions credited in transient and accident analyses for accident mitigation, actions credited in diversity and defense-in-depth (D3) analyses to perform safety functions in response to a common cause failure of a digital reactor protection system safety function, actions identified in a applicant's probabilistic risk assessment (PRA) as risk-significant human actions, and actions identified in the applicant's fire protection program as operator actions required for safe shutdown. An example of a reviewed manual action is isolating potable water to the control room under control room isolation conditions.

- In NRR, the technical staff review submittals for facilities licensed under 10 CFR 50. These reviews include actions credited safe shutdown in traditional fire protection programs, recovery actions identified in licensee applications to transition to the risk-informed, performance-based requirements of § 50.48(c), actions to mitigate the radiological consequences of accidents addressed in alternate source term (AST) analyses, actions that may be affected or required by an increase in an nuclear power plant's maximum licensed thermal power (power uprate), actions credited in transient and accident analyses for accident mitigation, risk important actions affected by plant modifications, control room actions affected by major changes to the main control room human-system interface, and actions to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities under the circumstances associated with the loss of large areas of the plant due to explosions or fire.

- In NSIR, the technical staff review manual actions required during a security event for nuclear power plant staff to prevent radiological sabotage (target sets). For operating power plants, 10 CFR 73.55(b)(4) requires the licensees to analyze and identify site-specific conditions, including target sets, and account for these conditions in the design of the physical protection program. The definition of target sets includes operator actions that if prevented from being accomplished would result in core damage or

exposure of spent fuel. NRC staff reviews the operator manual actions that are proposed for inclusion in target sets.

Appendix B-2 shows the inspection and oversight activities conducted by NRR and RES that may involve crediting manual actions or assessing licensee crediting of manual actions. Specifically, when evaluating the significance of plant operational events as part of the Reactor Oversight Process – Significance Determination Process, NRR technical reviewers consider those manual actions that can be taken to mitigate the event. An example of a manual action that could be evaluated for the SDP is the likelihood that operators would trip the reactor coolant pumps (RCPs) before seal damage in loss of seal cooling scenarios. Through direct inspection activities, such as Component Design Basis Inspections, NRC inspectors evaluate whether manual actions credited in licensees' Updated Safety Analysis Reports (USAR) can be accomplished consistent with the assumptions of the USAR. In addition, NRC inspectors periodically review operability determinations for structures, systems, and components (SSCs) required by unit technical specifications, including analyses supporting the use of manual actions as compensatory measures for degraded or non-conforming conditions. RES also considers manual actions for event mitigation in the assessment of plant events evaluated under the Accident Sequence Precursor (ASP) program, a risk-informed operating experience program.

Appendix B-3 summarizes NRC (NRR only in this case) consideration of manual actions as they pertain to potential NRC enforcement of license conditions and technical specifications. Specifically, as part of the process for consideration of enforcement discretion (e.g., where compliance with technical specification (TS) limiting conditions for operation (LCO) or other license condition may result in an unnecessary plant transient), NRC considers the success likelihood of certain manual actions in response to an initiating event.

Collectively, Appendices B-1 thru B-3 show that staff in several program offices (i.e., NMSS, NRR, NRO, and NSIR) assess the extent to which manual actions should be credited, and that these assessments are performed for a range of regulatory actions (i.e., licensing, inspection, and enforcement) and for diverse applications. The personnel at the licensed facilities who perform the manual actions evaluated for credit are typically, but not exclusively, licensed or non-licensed operations personnel. Exceptions include actions at materials facilities.
The specific actions may be performed inside or outside the control room and therefore are subject to a range of environmental considerations, including life threatening conditions such as fire, flooding, and adversaries. The credited actions include a range of tasks from simple monitoring to more complex sequences of equipment manipulations that require decision making, verification of actions, and coordination with other plant personnel. From a licensing perspective the actions may be credited on a permanent or temporary basis (e.g., compensatory measures for degraded or non-conforming conditions) and may be for design basis or risk-significant beyond design basis events. In addition, licensee applications requesting credit for a given manual action may be based solely on deterministic analyses or the application may be risk-informed. The staff's assessments and decisions in regard to the crediting of actions may be largely a paper-based review where many details relevant to the task have yet to be established (as may be necessary for the licensing of new facilities) or may include field inspection and walk-through of the proposed task and task environment.

To address these many differences, the agency has developed a range of guidance documents to aid the staff in crediting actions where specific task conditions, licensing considerations,

information constraints, or analytical methods are particularly relevant. The right column in each of the Appendix B tables identifies these guidance documents and shows their relevance to the specific regulatory applications. These guidance documents are discussed in greater detail in Section 3 of this report.

3. Overview and Comparative Analysis of Guidance for Regulatory Treatment of Manual Actions

3.1 Overview

The working group reviewed agency guidance for the evaluation and crediting of manual actions for each regulatory application identified in Table 1 (and further described in Section 2 and Appendices B1 thru B3 of this report). The working group found relevant guidance in standard review plans (SRPs), regulatory guides (RGs), agency NUREGs, inspection procedures (IPs), interim staff guidelines (ISGs), and industry consensus standards. Appendix C provides a short summary of each guidance document reviewed. The purpose of the review was to identify similarities and differences in the guidance provided for crediting of manual actions and to assess whether the differences have a justifiable basis.

3.2 Comparative Analysis

3.2.1 Scope and Nature of Guidance

The working group identified several dimensions upon which the guidance documents could be compared. These dimensions were: level of detail, scope of actions addressed, the goals or objectives of the guidance, the methods described for conduct of the review, and the level and type of resources required to conduct the review.

Level of Detail – One readily evident difference among the guidance documents is the level of detail at which the review of manual actions is addressed. Differences in level of detail can be attributed in large measure to where in the hierarchy of NRC's regulatory framework the document serves its purpose (see Appendix D for an overview of NRC's guidance hierarchy). At the highest level, NRC's regulations (as codified in Title 10 of the Code of Federal Regulations) generally do not explicitly address manual actions. At the next level down, NRC's SRPs and RGs typically provide high level guidance, with more detailed guidance being reserved for NUREGs and consensus standards. However, even amongst NUREGs, the working group identified substantial differences in the level of detail of guidance concerning manual actions. As a consequence, and as described in greater detail in Section 3.2.2, not all guidance documents addressed the same specific review criteria. These differences appeared to be largely a result of whether manual actions were a principal topic of the document or simply addressed in the context of a more general topic. An example is that SRP, NUREG-0800, Chapter 18, Human Factors Engineering, refers to NUREG-0711, Human Factors Engineering Program Review Model, for HRA review. NUREG-0711 stops at the level of describing what needs to be done and then refers the reviewer to NUREG-1624, Rev.1, Technical Basis and Implementation Guidelines for A Technique for Human Event Analysis (ATHEANA), for specific guidance on how to perform HRA reviews.

In the preceding example, lack of detailed guidance is not a concern because appropriate references are provided to ensure consistency in staff reviews. However, such references to more detailed guidance were not found in all circumstances. For example, multiple sections of NUREG-0800, Chapter 15, Transient and Accident Analysis, direct the reviewer to consider human actions credited in the transient and accident analyses without further guidance or reference to how these manual action reviews are to be performed. In other instances, differences in level of detail are more subtle but the impact of these differences can be more insidious. With detailed guidelines reviewers are more likely to rely on the document as a comprehensive guide and less apt to notice subtle, but potentially important omissions. As an example, NUREG-1764, Guidance for Changes to Human Actions, provides detailed guidance, including a full section on the allocation of functions to humans or automatic systems. However, this comprehensive guide does not highlight the need to consider design nuances that may complicate a change from automatic to manual operations, as does NRC Inspection Manual (IM) Part 9900: Technical Guidance, Operability Determinations and Functionality Assessments for Resolution of Degraded and Non-conforming Conditions Adverse to Quality or Safety. Although reviewers may infer the need to address this important consideration from a more generic guideline in NUREG-1764, the likelihood of this happening would be dependent on the skill of the reviewer and degree of rigor applied to the analysis.

Scope of Manual Actions Addressed - Another readily apparent difference in agency guidance for the review and crediting of manual actions is the scope of actions for which the guidance has been developed. As is common among NRC guidance documents, the guidance for the review and crediting of manual actions has frequently been developed for very specific topics, contexts, or regulatory applications. The following example documents reflect the specificity and diversity of this guidance:

- DI&C-ISG-05, Highly Integrated Control Rooms – Human Factors Issues, Rev 1. Crediting Manual Operator Actions in Diversity and Defense-in-Depth Analyses

- NUREG-1852, Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire

- RG 1.62, Rev 1, Manual Initiation of Protective Actions

- RG 5.81, Target Set Identification and Development for Nuclear Power Reactors

These documents differ substantially in their content because they reflect the staff's need for guidance that addresses unique circumstances which can have important influences on determinations of whether a manual action should be credited for a given safety function. DI&C-ISG-05 addresses the circumstance of manually performing safety functions given a common cause failure of a digital protection system concurrent with an abnormal operating occurrence or postulated accident. The guidance reflects the unique challenges presented by these conditions to the control room crew and provides a process for reviewers to make this licensing decision with limited design detail. In addition, the acceptance criteria in DI&C-ISG-05 are consistent with the recognition that the Commission considers such postulated conditions to be beyond design-basis events. In contrast to DI&C-ISG-05, which limited its scope to actions performed within the main control room (MCR), NUREG-1852 is focused on manual actions

performed in response to fire, with the primary emphasis on those actions performed external to the MCR, and the unique challenges presented by fire, smoke, water, and electrical hazards. Like NUREG-1852, RG 5.81 provides guidance for the review of manual actions performed external to the MCR, but unlike NUREG-1852, the primary concern regarding whether an action can be credited is not the harsh environmental effects of fire and fire suppressants but the potential for adversary interference. As demonstrated through these examples, many of the differences in the emphasis that these documents place on certain criteria or methods for reviewing manual actions have a rational basis in the specific application (e.g., within or beyond design basis) and the factors that are expected to be the dominant influences on human performance.

Goals and Objectives of Guidance – In addition to scope and level of detail, NRC's guidelines pertaining to the crediting of manual actions also differ with respect to their goals and objectives. For some applications, the guidance supports the modest objective of verifying that credited and risk significant manual actions are appropriately identified in licensee submittals (e.g., NUREG-1520, Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility). Other guidelines are intended to ensure that manual actions are appropriately modeled, their risk significance quantified, and related risk insights identified, in licensee PRAs (e.g., NUREG-0800, Chapter 19, Severe Accidents). Many of the guidelines are used by the staff when making an independent reasonable assurance determination that use of the manual action will support adequate protection of public health and safety (e.g., NUREG-1852, NUREG-1764, Rev 1). These differences in goals and objectives strongly influence the level of detail, nature, and content of the guidelines.

Review Methods – An important difference among NRC's guidelines for crediting manual actions is the review method described by the guideline. Much of NRC's guidance either prescribes a qualitative review of the manual action using human factors engineering (HFE) review criteria, such as ensuring appropriate interfaces, training, and procedures are in place (e.g., IM Part 9900, IP 71111.21, Component Design Bases Inspection), or a quantitative review using PRA methods (e.g., NUREG/CR-6883, The SPAR-H Human Reliability Analysis Method). Whereas the HFE methods tend to support yes-no decisions regarding whether to allow credit for a manual action, the PRA-based methods provide outputs that allow an assessment of the risk-impact or risk-significance of the manual action which can then be used as the basis for agency licensing and enforcement decisions.

The working group identified additional distinctions among the methods for crediting manual actions. For example, the human factors engineering guidance provided in IP 71111.21 provides guidance appropriate to in-plant reviews of manual actions and consequently focuses on the specific action and the associated interface details, training, etc. for that action. By contrast, NUREG-0711 and NUREG-1764 provide guidance for the review of licensee submittals pertaining to proposed manual actions or proposed changes to manual actions and are more focused on verifying the adequacy of the process used by the licensee to ensure that a manual action will be feasible and reliable. The need to focus on outcomes in one instance and conducting a prospective analysis focusing on process in another circumstance can substantially influence the method and content of the guidance. DI&C-ISG-05 and NUREG-1520, as examples, require licensees to demonstrate the ability to successfully perform the manual action. In the case of DI&C-ISG-05, multiple crews of licensed operators must demonstrate the ability to complete the actions within specified acceptance criteria for

completion times and under a range of plant conditions. Such acceptance criteria are not an option for certain prospective analyses where there is no reasonable means to accurately simulate the actions and the performance environment.

It should also be noted that not all HFE methods for analysis of manual actions are necessarily qualitative. ANS 58.8, Time Response Design Criteria for Safety-Related Operator Actions, provides an empirically based quantitative method for determining the adequacy of time available for safety-related operator actions. Furthermore, not all of the methods are based solely in HFE or PRA. For example, NUREG-1764 uses a risk-based screening methodology to determine the level of human factors review the staff should undertake based on the risk significance of the proposed manual action. Although the qualitative and quantitative methods for the review of manual actions provide distinctly different outputs for agency decision making, many of the specific factors considered by these approaches are the same or quite similar. The commonality in factors considered in NRC's various guidelines is addressed in detail in Section 3.2.2.

Level and Type of Resources to be Applied – As noted in Section 2, the NRC credits manual actions in a range of applications. These applications differ in terms of the time available and level of staff resources that can be applied to conduct the analysis. Licensing actions concerning major plant modifications may allow reviews to be carried out over a period of months whereas manual actions reviewed in the context of an inspection must be completed in a matter of hours. In the former case, it likely that a specialist in human factors or human reliability will conduct the review whereas in the latter case it is likely that the review will be conducted by an inspector who may not have been specifically trained in human performance. These differences in users and contexts for the guidance also contribute to the differences in methods and level of details described in agency guidelines.

3.2.2 Manual Action Assessment Factors

For each guidance document the working group identified the factors (e.g., characteristics) used to assess the expected feasibility or reliability of manual actions and to determine the extent to which they might be credited as supporting a given safety function. The results are shown in Table 2, Assessment Factors Addressed in Guidance Documents. In general, Table 2 only represents those documents that provide the most detailed level of guidance available for each regulatory application. However, the table does not provide a comprehensive list of the specific factors mentioned in each guidance document but rather the higher level categories of factors considered for crediting manual actions. These categories provide a sufficient level of detail to identify the commonalities and differences among the guidelines. For example, the category "time sufficiency" may be addressed more specifically in individual guidance documents as the factors "time available" and "time required" to perform the action. These more specific factors may be addressed by some guidelines in even more detail, depending on the specific application.

Table 2 presents the factor categories in two broad groups, Common Factors and Specific Factors. Those factors in first group, Common Factors, are identified for consideration in evaluating manual actions in all of the guidance documents. These common factors are:

- Time sufficiency,
- Training/Qualifications,
- Procedures,
- Environmental conditions, and
- Required information/indications.

The common factors tended to be the more general or broader factors relative to most of the other factors in Table 2 and therefore could be characterized as summary level factors for certain applications. The working group found that these factors are also considered in applications that rely more on staff judgment rather than formal guidance documents (e.g., in evaluations supporting NOED decisions).

Within the group of factors identified in Table 2 as Specific Factors, there are factors (e.g., Design/Human-Machine Interface, Personnel/Equipment Required, and Communications) that are considered in many, but not all the guidance documents. In addition, there are factors that are only considered in a small subset of the guidance documents (e.g., Change in Performance Context). Other factors, such as "Security" and "Changes to Plant Configuration," are unique to specific applications, in this case RG 5.81 and NUREGs 1520 and 1764, respectively.

The working group notes that the review results presented in Table 2 should be interpreted with the following considerations:

- Application specific factors – As discussed in Section 3.2.1, most NRC guidance is developed for specific applications and purposes. Differences in the applications and purposes influence which factors are discussed in the guidance. For example, NUREG-1792 was developed for applying HRA in Level-1, internal event PRA. IM Part 9900 was developed for reviewing applications to temporarily replace automatic functions with manual actions in the situations where the automatic functions were not available. NUREG-1520 and NUREG-1764 are for acceptance of changes to plant configuration. The differences in emphases affect the factors discussed in the guidance.

- Explicit and implicit assessment factors – Guidelines may not explicitly identify every factor to be considered but leave factors for expert judgment. For example, although RG 5.81 did not explicitly identify staffing as an assessment factor for crediting manual action in target sets, the RG guidance for sufficient time fundamentally implies that sufficient staffing is available to complete the manual action. The NSIR staff participating in this study indicated that the staffing is considered in the evaluation even though the factor was not explicitly identified in the guidance. Therefore, factors not explicitly identified in a guideline do not imply that the factor is necessarily excluded from applying the guidance.

- Proximate factors – The working group noted that a few high level factors tend to be most directly associated with decisions on crediting the manual actions. The proximate factors are the time sufficiency for completing the manual action, the duration of time that the manual action would be credited, and the risk significance of the action. Many applications implicitly use time sufficiency as a surrogate for the feasibility or reliability of the manual action.

In general, Table 2 shows a substantial degree of commonality in the factors considered in assessing the feasibility and reliability of actions to be credited. Where differences were identified, the working group believes that they could generally be attributed to differences in the scope or nature of the application. Such differences would not necessarily cause inconsistency in crediting manual actions. However, the working group acknowledges that assessment factors not explicitly mentioned in a guideline may be overlooked by staff implementing the guidance. Other factors such as the level and type of resources used in implementing application guideline may contribute to how a manual action would be assessed.

Table 2 Assessment Factors Addressed in Guidance Documents

Guidance Documents	Common Factors					Specific Factors																
	Time Sufficiency	Training / Qualifications	Procedures	Environmental Conditions	Required Information/Indications	Personnel / Equipment Required	Duration of time that manual action is to be credited	Design / Human –Machine Interface	Design nuances that may complicate manual action	Differences between automatic and manual mode	Range of plant conditions	Risk significance of action	Recognition of Action Initiators	Communication s	Teamwork	NRC precedent decision	Access / ingress / egress	Ability and time to recover from errors	Adversary Interference	Change in Automation?	Change in Tasks?	Change in Performance Context?
IN 97-78	1	x	x	x	x	x						x					x	x				
IM Part 9900, Operability	2	x	x	x	x	3	x	4	x	x							x			x		
ANSI/ANS 58.8	x	5	5	x	5	5		5				8	x	x			x	7	6			
NUREG-1764, (Screening)	x	9	9	9	25	x		9			x	x	25	9	9	9	25			x	x	x
NUREG-0800, Chapter 18 / NUREG-1764, Level 1 Review	FRA TA V&V	x	x	TA	TA	x		HSI	V&V		TA			TA V&V	V&V	x						
NUREG-1852	x	x	x	x	x	13					14			x	15		x	14				
NUREG-1792 (24)	x	x	x	x	x	x		x			x	x	x	x	x		x	x	x			
NUREG/CR-6883	x	x	x	30	32			x	31					33								
IP 71111.21	x	x	10	x	x	x						x					x	x				
DI&C ISG-05	x	x	x	11	x	x		12	12		x		12	12	12	x	11	x				
NUREG-1520	16	x	x	x	23	23	x	18	21	x		x	x	x	17	20	x	x	19	xv	x	x
NUREG-1513	x	x	x	x	x	x	x	x	x	x		x	x		17	x		x		x	x	x
Regulatory Guide 5.81	26	x	x	x	27, 29	x							27, 29	27, 29			28		x			
NEI 06-12	x		x	x	x	x	x				x			x			x		x			

Table 2 Notes

1. Guidance is to consider the specific action required which the WG interprets to include this factor.
2. Guidance is to consider timing of automatic action which the WG interprets to include this factor.
3. Guidance is to consider minimum staffing requirements which the WG interprets to include this factor.
4. Guidance is to consider design nuances that may complicate manual action which the WG interprets to include this factor.
5. Standard is based on the assumption that this factor meets specified minimum standards.
6. Standard indirectly/generically addresses this factor by requiring that all safety-related actions required within 30 minutes of the initiation of design basis event shall be capable of being performed from within the main control room.
7. Standard requires that a single operator error of omission does not result in exceeding any limiting requirement for the design basis event under consideration. In addition, no credit for operator action to identify and correct operator errors shall be necessary to meet the criteria of this standard.
8. Standard establishes criteria consistent with the best estimate frequency of occurrence per reactor year of the DBE under consideration.
9. Guidance is to consider any change in this factor.
10. Inspection should include review of associated normal, abnormal, and emergency operating procedures.
11. Guidance addresses this factor indirectly by limiting scope of applicability to MCR actions.
12. Guidance addresses this factor indirectly through requirement for validation of time required using a full scope plant referenced simulator for range of conditions under which credited action may be required
13. Includes personnel protection equipment
14. Guidance addresses this factor as uncertainty in estimating time to diagnose and perform actions given variations in plant and fire conditions and conditions that cannot be recreated in demonstration, were not anticipated, or are associated with variations in human performance.
15. Guidance addresses this factor indirectly through validation of staffing and demonstration requirements
16. For IROFS whose availability is to be relied on, the time interval between surveillance observations or tests of the item should be stated, since restoration of a safe state cannot occur until the failure is discovered.
17. ISA is performed by a team of people to address all relevant disciplines.
18. ISA adequately considers initiation of or contribution to accident sequences by human error through the use of human-systems interface analysis or other appropriate methods.
19. Addressed in physical protection plan.
20. ISA probabilities can be updated with operating experience. Usually pertains to, but not explicitly limited to, equipment failure.
21. Particular attention given to criticality evaluations.
22. In general, reliance is first placed on passive controls, then active controls, and lastly, on administrative controls.
23. Guidance stipulates that sufficient information should be provided about engineered hardware controls to permit an evaluation that, in principle, controls of this type will have adequate reliability. By extension, if a IROFS is an administrative control, then analogous information would be needed.
24. See Table 5-1 for specific performance-shaping factors (PSFs) identified
25. In Task Analysis discussion.
26. Sufficient time to implement required actions
27. These are included in the approved procedures guidance
28. These are included in environmental conditions
29. These are included in training
30. Captured under "Ergonomics/HMI" performance-shaping factor (PSF)
31. As "Ergonomics/HMI" PSF
32. Captured partially under "complexity" PSF
33. Captured under "work processes" PSF

Abbreviations:

FRA – Functional Requirements Analysis
HSI – Human-System Interface
IMC – Inspection Manual Chapter
TA – Task Analysis
V&V – Verification and Validation

3.3 Terminology

The working group reviewed the terminology used in NRC's guidance documents related to the crediting of manual actions. The purpose of the review was to assess consistency among the documents in the terminology used for key human performance concepts and how those terms are defined. Appendix F shows the terms and their definitions taken from six guidance documents cited in this report. The working group found only a few terms that were explicitly defined in more than one document (i.e., action, preventative action, task, and diagnosis time). However, in each case the definitions of the term differ in a way that reflects the level of detail or specific application for which the guidance document was developed. The working group also found that several terms were used for similar but different concepts. The diversity in terms reflects the intent to communicate specific concepts and to apply these concepts in specific regulatory applications. The following are examples of observed differences:

- Some applications define a term to fit the application specific needs. For example, the term "action" typically refers to human manipulation of plant equipment to achieve a goal. However, in NUREG-1880, ATHEANA User's Guide, the term "action" is defined to include non-action because this application requires the analyst to address errors-of-omission.

- Some applications differ in the specific factors they use to assess a more general factor, such as time sufficiency. Table 3 shows examples of different sets of factors that were used to assess time sufficiency in three different applications:

Table 3 Factors Considered for Assessing Time Sufficiency

Application	Factors Considered
NUREG- 1852 and 1764, etc.	Available Time and Required Time
HCR/ORE*	Available Time, Delay Time, Median Cognitive Response Time, and Manipulation Time
ANSI/ANS-58.8	First Indication Time, Earliest Credible Action Time, Manual Action Initiation Time, and Completing Safety-Related Action Time

*An HRA method widely used by NRC's licensees.

- Some applications use the same term to define similar concepts. NUREG-6883 defines the term "task" differently from NUREG/CR-1764. However, this difference was recognized by the authors of NUREG/CR-6883 who explicitly state that the term "task" is used at a higher composite level than the level at which it is defined in other documents (e.g., NUREG-1764). The difference in the definitions appears to be the natural result of applications for which the guidelines were developed. NUREG-1764 provides guidance for evaluating individual actions, whereas NUREG/CR-6883 provides guidance for evaluating human actions at the level of a PRA basic event, which tend to encompass multiple individual human actions. As another example, the term "preventative action" is defined in both Regulatory Guide 5.81 for target set reviews and NUREG-1852 for fire protection reviews. A preventative action serves to "prevent significant core damage and/or prevent an offsite release" in the case of the target set reviews, or "mitigate the

- potential effects of possible spurious actuations or other fire-related failures, so as to ensure that hot shutdown can be achieved and maintained" in the case of fire protection reviews. In addition, the NUREG-1852 definition provides much more detail regarding general assumptions and typical cases for "preventative actions." A similar explicit layout may not be possible in a publically available regulatory guide for the target set reviews.

- Some applications use different terms to convey similar concepts. Examples include "event limit time" (in ANSI/ANS-58.8), "available time" (in HRA/PRA in general), and "total system time window" (in HCR/ORE HRA method). All these terms refer to the time duration before undesired consequence occur. Another example, "task" (in NUREG/CR-6883), "human failure event" (in NUREG-1792), and "human error" (in general conversations) all refer to the human basic events in PRA models. In non-PRA application, "action" (in NUREG-1852) has a similar meaning.

Although there are concepts relevant to crediting manual actions that are common to several of the guidance documents, there are differences in the terminology used for, and definitions of, these concepts. This finding is not surprising given the diversity of applications for which the guidelines were developed and the range of disciplinary backgrounds and experience of the guidance authors. Nevertheless, consistent use of the technical terms is important for communication and maintaining technical consistency. Although the terminology differences described above are not expected to adversely affect NRC's regulatory decisions, variations in the technical terms and definitions could increase the burden for effective communication, especially for cross-discipline tasks.

4. Analysis

As discussed in this report, potential credit for manual actions is evaluated in a variety of programs and applications across NRC offices. In each case, NRC staff members assess whether there is a sufficient technical basis to conclude that the action can be accomplished reliably. The risk-significance of the action and requirements applicable to the safety function to be performed dictate how much assurance is needed.

4.1 Consistencies Across Applications

Table 2 in this report compares a range of NRC guidance documents in terms of the specific factors that they direct reviewers to address. As discussed in Section 3, there are several factors that the staff considers in the evaluation of all manual actions, regardless of the specific regulatory application. This finding is not surprising given that the common factors are derived from fundamental human factors and human performance literature. The consideration of these common factors is therefore an area of consistency across applications. The common assessment factors include: time sufficiency, training/qualifications, procedures, environmental conditions, and required information/indications. However, the guidelines describe these factors in varying levels of detail and may have different nuances in defining or describing these factors. Other factors (e.g., adversary interference, change in automation) are considered in only a subset of the guidelines. The reasons for these differences, and others, are described in Section 4.2.

4.2 Differences Across Applications

Section 3.2 of this report describes differences among applications in the methods/approaches taken, assessment factors considered, and terminology used for the evaluation of manual actions. Section 3.2, also describes several bases for these differences, including whether the conditions warrant or support a deterministic or probabilistic analysis, the specific goals and objectives of the analysis, and the level and type of resources applied to the analysis. These and additional bases are further discussed below.

Type of analysis – In some regulatory applications, manual actions are qualitatively evaluated for credit. For example, a proposed manual action is evaluated against specified review criteria resulting in a binary decision on whether or not credit is granted (e.g., yes or no, as in target set reviews). Qualitative analyses may more specifically address the “feasibility and “reliability” (in the qualitative sense), as is done in the fire protection program for reactors. In other cases, credit can be quantitative (e.g., quantified reliability in risk-informed applications using PRA). This quantification can also have varying levels of detail and rigor depending on the application, e.g., an order-of-magnitude estimate or more detailed quantification.

Safety or risk significance – General guidance to NRC staff is that the level of detail and rigor of a regulatory review should be commensurate with safety or risk significance. Accordingly, there will be some differences in the evaluation of manual actions according to the risk or safety significance of the application, and how the manual action fits into the overall application. For example, the standards for crediting manual actions required to mitigate transients that are expected to occur during the normal course of operations are different from those for manual actions required to mitigate challenges from low-probability accident initiators (e.g., low-probability fire scenarios where mitigating hardware has failed). In addition, different review resource levels may be applied or needed based on whether the application is relying on many elements of which the manual action is one (one element in the defense-in-depth), or whether it is particularly important on its own for meeting safety margin.

Time and resources available for staff to complete review – Differences in the amount of time and staff resources that are available for a manual action review can contribute to different levels of formality in the evaluations. For example, reviews of risk-informed applications that are conducted in accordance with standard schedules for license amendment applications are conducted with the benefit of a written HRA standard and a relatively detailed good practices NUREG. Hence, there are extensive and formal references (resources) for the staff to consult in the review. In contrast, evaluations of emergency (short-term) changes of unit technical specifications (TS) are done quickly and the evaluation of any associated manual actions that are proposed as compensatory measures is largely done using expert judgment. In the end, this is integrally related to the safety or risk significance of the compensatory measure, i.e., emergency TS change requests are typically for short-duration actions, and hence, should be less risk-significant.

Disciplinary background and expertise of staff completing review – For example, in some cases, staff members with a formal human factors educational background complete the review, while in other cases staff engineers with plant operations experience but no formal human factors education complete the review. Some reviews are self-contained within a programmatic group while other reviews are assigned by a project manager to the responsible technical disciplines,

including human factors analysts, to review the proposed manual actions (e.g., alternate source term evaluations).

Level of specificity of information available – If the program assesses the risk increase of events that have already occurred from the baseline risk (e.g., the ASP program), situation-specific information typically is available to use in the analysis of manual actions. For other applications, such as manual actions proposed to mitigate hypothetical accidents, the staff may not have the benefit of direct operational experience for the specific application (though there may be related operating experience, e.g., lessons learned from lower-level operational events at similar facilities). Similarly, whether the evaluation is for a change in an operating facility (with operating history) or a new facility not yet built determines the amount and quality of available information. Another factor that affects the type and level of information is whether the assessment is limited to a paper review or includes direct observation of the work environment. For example, the evaluation may be done or supported by inspectors who complete walk-downs of plant equipment on-site (e.g., CDBI inspections). Other reviews may be largely paper evaluations by headquarters staff (e.g., risk-informed licensing action reviews). The factors that can be considered, and criteria that can be used, will be different in these situations.

4.3 Current practices and Initiatives to Ensure Consistency Within and Across Applications

The NRC's principal method for ensuring consistency within applications pertaining to manual actions is for the staff to conduct reviews in accordance with written guidance and to include as part of their review consideration of relevant precedents (e.g., past relevant licensing actions). As described in this report, NRC's written guidance for the review and assessment of manual actions is provided through several types of documents, including NUREGs, regulatory guides, interim staff guidelines, and inspection procedures. These guidance documents detail methods and criteria that serve to ensure consistency in staff regulatory actions. For example, Regulatory Guide 5.81 "Target Set Identification and Development for Nuclear Power Reactors" provides detailed guidance for making an assessment about meeting the six operator action criteria. Examples of what would be considered acceptable and unacceptable are provided for clarity and consistent application of the six criteria.

In some cases, NRC's guidance documents pertaining to manual actions also serve to ensure consistency across regulatory applications. Although most of the guidelines described in this report were tailored to a single application, a review of Appendices B-1 thru B-3 reveals that a few guidelines (e.g., NREG-1764, Guidance for the Review of Changes to Human Actions) are applied across multiple applications. However, it is worth noting that available guidance is not always utilized. For example, while the HRA good practices NUREG was part of an initiative to ensure consistency in applications using PRA, the working group believes that this guidance is not always consulted during staff reviews of risk-informed applications. The working group did not directly assess whether inconsistent use of the guidance was consequential with respect to consistency of staff decisions concerning the crediting of manual actions.

Although not an explicit method for ensuring consistency, staff selection for, and experience with, conducting manual action reviews may also contribute to consistency. The working group believes that NRC reviews of manual actions are often conducted by a few, small groups of experienced staff. As a result, consistency within applications is likely gained in these

circumstances because the guidance is interpreted by a small number of individuals within the same organizational unit and these individuals have direct knowledge of precedent reviews. Staff selection and experience also likely contribute to consistency across a limited number of applications. For example, manual actions associated with applications for power uprates, alternate source terms, and control room modifications are generally all performed by a small group of human factors analysts within NRR that are readily available to each other for consultation.

Similarly, expert staff can (and often do) compensate for lack of detail in guidance documents. Since written guidance does not reflect the totality of what is considered in the reviews, the loss of staff and insufficient knowledge transfer to newer staff may cause inconsistencies in NRC's evaluations. The working group gained this insight during its information gathering and assessment, but further evaluation was beyond the working group's charter and was not pursued further. In addition, as noted previously, the working group did not directly assess consistency within applications (e.g., compare safety evaluations for similar license amendment applications).

An indirect, but important, method for ensuring consistency across applications pertaining to manual actions is the general process that NRC follows for the development of staff review guidelines. This process has three important elements:

(1) NRC guidance documents are typically developed by multi-disciplinary teams. For example, NUREG-1852 concerning manual actions in response to fire was developed by personnel with expertise not only in fire protection, but also in human factors and human reliability analysis.

(2) The efforts of these teams begin with reviewing related guidelines and standards. These preliminary efforts are specifically intended to minimize duplication and inconsistency and to ensure that where guidelines differ, these differences are intentional and have a sound basis. Again, by example, DI&C-ISG-05 for crediting manual actions in diversity and defense-in-depth analysis establishes unique guidance for failure of digital protection systems but was developed based upon substantial review of related guidelines, including NUREG-0711, NUREG-1764, NUREG-1852, and ANSI/ANS 58.8.

(3) Draft guidelines are published for comment prior to being issued as final. Public comment provides a means for a broad group of stakeholders to identify any conflicts or inconsistencies with related guidelines.

A current initiative that may help ensure consistency across applications is the initiative to update ANSI/ANS 58.8, Time Response Design Criteria for Safety-Related Operator Actions. ANSI/ANS 58.8 establishes timing requirements to be used in the design of safety-related systems for nuclear power plants. The criteria in the guideline are used to determine whether safety-related systems can be initiated by operator action or require automatic initiation. An ANS working group, which includes NRC staff, is currently exploring options for updating the standard to ensure it is valid for crediting operator actions using advanced control room human-system interfaces and to broaden its scope to address the verification and validation of operator action times. It is possible that the data gathered and methods developed through the revision

of this standard will provide a basis for a standardized approach to control room actions however it is not likely the methodology would be appropriate for actions outside the control room. The staff's objective is to support development of this standard such that NRC could endorse the revised standard through an NRC regulatory guide. The working group notes that NRC never formally endorsed this ANSI standard, though it is presently referenced by several NRC guidance documents.

Whereas the NRC has established a solid infrastructure of guidance documents to ensure consistency within applications, there are limited formal methods or initiatives for ensuring consistency across applications. However, the working group found that differences across the applications were typically justified by unique demands or limitations of the application. As a consequence, it is not clear that the lack of formal methods or initiatives to ensure consistency across applications has been consequential.

5. Conclusions

The ad hoc working group on manual actions compiled a list of regulatory applications across NRC offices where manual actions are evaluated for regulatory credit, and gathered information on how these evaluations are performed. The working group reviewed relevant guidance documents, reviewed past examples of evaluations (e.g., as captured in safety evaluations), and interviewed a limited number of NRC staff to gain insights on evaluation methods, assessment factors, criteria, and staff practices. Based on this review, the following general conclusions were drawn:

- A core level of consistency among NRC's application-specific methods is achieved through common use of several high-level assessment factors. As discussed in section 3.2.2 and 4.1, these common factors are:

    - Time sufficiency;
    - Training/Qualifications;
    - Procedures;
    - Environmental conditions; and
    - Required information/indications.

  The specific terminology used for these factors, the nuances emphasized, and the level of detail provided, vary across guidance documents, programs, and disciplines. Nonetheless, these common factors: (1) capture a broad range of high-level considerations that are widely recognized as important influences on the feasibility and reliability of human actions, and (2) provide a common basis for the evaluation of manual action credit across all NRC offices, programs, and applications. Two additional assessment factors that the working group considers to be amongst the most important are personnel/equipment required, and communications. These factors were identified in most, but not all, of the guidance documents reviewed.

- Differences among applications for the evaluation of manual actions typically were found to have a sound basis. These differences include: (1) the type of analysis conducted

(qualitative or quantitative); (2) the level and type of resources applied to the staff review; and (3) the review method used for the evaluation. In large part, these differences reflect certain situational conditions or constraints, which include: (1) the level of information that is available for a particular application and analysis; (2) the safety or risk significance of the application and specific licensee request; and (3) other application-specific considerations (e.g., the goal of the specific regulatory requirement, and unique aspects of the application).

- The NRC relies primarily on written guidance documents to provide consistency within and across applications pertaining to the crediting of manual actions. Gaps or lack of detail in these guidance documents are a potential vulnerability. For example, although applications share common assessment factors, lack of detail in acceptance criteria for an assessment factor could contribute to inconsistent implementation, within or among applications. Although use of experienced staff and repeatedly using the same staff to perform similar reviews can compensate for gaps or lack of detail in guidance, staff turnover without adequate knowledge transfer could expose such vulnerabilities.

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Appendix A – Working Group Charter

Working Group to Evaluate the Consistency in Crediting "*Manual Actions*" Within and Across NRC Offices in Regulatory Processes

Background:

NRC evaluates activities performed by reactor and fuel facility operating personnel (referred to as "manual actions" for the purposes of this document) to prevent accidents\events or to mitigate the impact of accidents should they occur. The regulatory processes in which NRC staff evaluates acceptability of manual actions include licensing (e.g., evaluation of requests for new licenses or amendments to existing licenses), inspections (e.g., target set reviews, fire protection triennials), and enforcement (e.g., Significance Determination Process (SDP)). In some regulatory processes, NRC staff reviews the quantitative credit assigned to manual actions (e.g., SDP, review of acceptability of probabilistic risk assessments); in other cases, the feasibility is assessed but no quantitative estimate is made.

The type of manual actions that are within the purview of regulatory review range from simple actions that operators perform inside control rooms[1] to more complex actions that include entry into potential hazardous or life threatening areas to perform recovery actions and repairs. They may include operator actions that prevent[2] accidents or events as well actions that are implemented to mitigate accidents or events.

NRC senior management concluded that there is a need to evaluate the consistency of regulatory treatment of manual actions across offices. This document establishes a working group, defines purposes and deliverables for the working group, and suggests an approximate level-of-effort and a schedule.

Working Group Make-up:

The Working Group will be led by NRR, and is be made up of one representative each from RES, NRO, NMSS, NSIR, and NRR. Each participating member possesses significant knowledge, and/or has the ability to assimilate how manual actions are being used in regulatory processes within their office. The program sponsors are one deputy division director from each of the following offices: RES, NRO, NMSS, NSIR, and NRR.

Working Group Purpose and Products:

The terminology used across NRC offices to designate actions that are generally considered "manual actions" is likely to be inconsistent. For example, the performance-based risk-informed fire protection rule (NFPA 805) defines all actions that are taken outside of the control room or a primary control center as "recovery actions." The deterministic rule (10 CFR 50 Appendix R) refers to these same set of actions as "operator manual actions." Therefore, this working group

[1] The working group will define the scope of manual actions to be examined early in the project. The final scope may or may not include control room actions.
[2] The working group will consider only manual actions that are credited in regulatory applications; normal operating activities that are not credited are not within the scope.

must first identify the various types of manual actions used by various NRC licensees. After identifying the types of manual actions used by various licensees under various regulatory processes, the working group must refine the scope of manual actions which should be considered for further evaluation, and seek the views of the sponsors, prior to moving forward to the next steps.

The consistency of credit for manual actions in risk-informed applications for reactors is already addressed through: (1) the human reliability analysis requirements in the ASME/ANS PRA standard, and the NRC's adoption with clarification of the PRA standard in RG 1.200; and (2) a current RES project to address a Commission SRM on improving consistency of HRA evaluations in PRA applications, given the diversity of HRA methods currently available and used. For the purposes of the working group, the entire set of human actions addressed in reactor PRA applications can be identified and addressed as one class of manual actions for comparison purposes.

The evaluation of whether NRC treats manual actions inconsistently within or across various offices in different regulatory processes should begin only after identifying the various types of manual actions to be considered.

Specifically, the working group should,

1) Identify and tabulate the types of manual actions that are under regulatory purview in NSIR, NMSS, NRR, and NRO.
2) Identify the different regulatory processes under which credit for these actions is reviewed (e.g., target set reviews, SDP, Licensing, Operator Licensing, Inspections)
3) Group the various manual actions by type such that each group is composed of similar manual actions.
4) Identify the methods and criteria NRC uses to determine the acceptability of manual actions in each group; include whether the criteria are qualitative or quantitative.
5) Identify the need for consistency, or bases for inconsistencies among treatment of the manual actions among program offices and regulatory applications.
6) Identify the current initiatives\practices that ensure consistency within and across applications.
7) Identify reasons for diversity of regulatory treatment across applications where the diversity is acceptable. .

As the first step of the evaluation, the group should identify the regulatory processes that prompt regulatory review of manual actions and the type of manual actions reviewed under each of those processes. This deliverable encompasses (1) an (2) above. **(Deliverable #1)**.

The working group should then develop a document that groups and records those manual actions, and define the set of manual actions that will be subjected to additional evaluations. This deliverable encompasses (3) above. **(Deliverable #2).**

The working group should then document its findings of facts and conclusions on whether differences exist, and the bases for the differences. These findings must be transmitted to the working group sponsors in a letter report. This deliverable encompasses (4) through (7) above. **(Deliverable #3)**

The working group should brief the program sponsors on its findings, and be prepared to discuss possible future actions at the brief. **(Deliverable #4)**

Working Group Scope/Limits:

The evaluation performed by the working group should primarily focus on evaluating consistency in the manner in which the NRC evaluates the acceptability of manual actions in regulatory processes. Investigating whether the NRC uses the term manual actions for activities that are different should be a focus of the working group. In this context, the working group should investigate terms such as operator manual actions, recovery actions, manual actions, operator actions and investigate the consistency of terminology before investigating consistency, or explaining the lack thereof in the manner in which these are credited in our regulatory processes. There is no intent to solve any inconsistencies identified. If the working group concludes that additional significant work needs to be performed to improve or establish consistency, then the working group should develop proposals (e.g. User Needs).

The intent is that the working group will utilize existing information and experience in categorizing manual actions. Sources of information likely include rules, personal experiences, regulatory guides, safety evaluation reports, and inspection procedures.

Working Group Timeline and Level-of-Effort:

This effort should be focused on a series of two-hour weekly working group meetings for a period of about 8 weeks. The working group leader is expected spend about four hours weekly for about 8 weeks.

The completed working group product, a letter report that summarizes the evaluation and renders recommendation should be provided to the Program Sponsors by the end of September, 2010.

Working Group Sponsors:

This Working Group is sponsored by:

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Appendix B-1 Regulatory Applications Where Manual Actions May Be Credited – Licensing

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
NMSS	10 CFR 70, Subpart H, Additional Requirements for Certain Licensees Authorized To Possess a Critical Mass of Special Nuclear Material. This section requires a licensee to perform and keep current an Integrated Safety Analysis (ISA).	Manual actions identified in license ISAs as items relied on for safety (IROFS). Examples include: • Designing equipment • Labeling containers of special nuclear material. Containers are labeled so that enriched nuclear material can be accounted for as it moves through the fuel fabrication process. • Scanning barcode on containers • Monitoring process parameters • Properly disposing of materials • Manual fire suppression • Responding to alarms and interlocks • Controlling moderator in various areas. Containers containing enriched uranium to make pellets are verified to belong to a specific batch and have the moisture content checked. Containers are manually checked for moisture and hydrogenous material to as to prevent an increase in a potential for a criticality accident. The staff review includes assessing the manner in which administrative controls are modeled (e.g., one person performing two checks being modeled	"Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility", NUREG-1520, Rev. 1, May 2010

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
		as independent, redundancy with other controls), the basis for quantifying the credit taken for the administrative controls, and the consequences assigned to accident sequences. Similar assessments are performed for human-machine interfaces.	
	10 CFR 52 (Part 52) Design Certification Rulemaking or issuance of Combined License (COL) – Safety evaluation of applicant's transient and accident analysis for design basis events and Anticipated Transient Without Shutdown (ATWS)	Actions credited in the transient and accident analysis for consequence mitigation. Examples include isolating potable water to the control room under control room isolation conditions. The staff review includes proposed manual actions to make a reasonable assurance determination that plant response to abnormal operating occurrence (AOOs) and postulated accidents (PAs) will meet the applicable general design criteria (GDC).	NUREG-0800, Chapter 15, Transient and Accident Analyses
NRO	Part 52 Design Certification Rulemaking or issuance of COL – Safety evaluation of Diversity and	Actions credited in defense-in-depth and diversity (D3) analysis to perform safety functions in response to a common cause failure of a digital reactor protection system safety function. Examples include: • Depressurize the reactor coolant system(RCS) • Bleed & feed the RCS	NUREG-0800, Chapter 7, Instrumentation and Controls, Branch Technical Position 7-19, Guidance for Evaluation of Diversity and Defense-in-Depth in Digital Computer-Based Instrumentation and Control Systems, Rev 5.

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
	Defense-in-Depth Analyses of Computer-based Instrumentation and Control Systems	The staff review includes manual actions credited in the D3 analysis to make a reasonable assurance determination regarding the adequacy of the diverse actuation system to support reactor protection system (RPS) safety functions in the event of a design basis event concurrent with a common-cause failure of an RPS function.	DI&C-ISG-05, Highly- Integrated Control Rooms – Human Factors Issues, Rev. 1 - Crediting Manual Operator Actions in Diversity and Defense-in-Depth Analyses
	Part 52 Design Certification Rulemaking or issuance of COL – Safety evaluation of applicant's Probabilistic Risk Analysis (PRA).	Actions identified in the applicant's PRA as risk-significant human actions. The staff review includes manual actions to: (1) verify that the plant's operation will reflect a reduction in risk relative to existing plants and (2) identify risk insights, including the risk significance of specific human actions.	NUREG-0800, Chapter 19, Severe Accidents
	Part 52 Design Certification Rulemaking or issuance of COL – Safety evaluation of applicant's Fire Protection Program	Actions identified in the applicant's Fire Protection program. The actions reviewed are operator actions required for safe shutdown The staff review supports a reasonable assurance determination that the FPP will prevent, detect, control and extinguish fires and ensure that fires not promptly extinguished will not prevent safe shutdown.	NUREG-0800, Chapter 9, Auxiliary Systems, Section 9.5.1.1, Fire Protection Program. NUREG-1852, Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
NRR	Fire Protection - Traditional 10 CFR 50.48(a), Part 50 Appendix A, General Design Criteria 3 Part 50 Appendix R Safety evaluation of applicant's Fire Protection Program	Actions credited for safe shutdown. Examples include: • Within 2 hours of a reactor trip in response to fires in certain fire areas, operators must manually de-energize and open one motor-operated valve (MOV) and de-energize and close another MOV to ensure adequate boron concentration is available for reactivity control. • Within 40 minutes of a fire in a certain fire zone, operators must open a breaker and manually open a valve to support maintaining a makeup pump minimum recirculation path. The staff review supports a reasonable assurance determination that the FPP, through a defense-in-depth philosophy, will prevent, detect, control and extinguish fires and ensure that fires not promptly extinguished will not prevent safe shutdown.	NUREG-1852, Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire Regulatory Issue Summary (RIS) 2006-10, "Regulatory Expectations with Appendix R Paragraph III.G.2 Operator Manual Actions" NUREG-0800, Sec. 9.5.1, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants Fire Protection Program" RG1.189, Revision 2, "Fire Protection for Nuclear Power Plants" IP71111.05T
	Alternate Fire Protection Rule, 10 CFR 50.48(c), NFPA 805 Safety evaluation of applicant's transition to the risk-informed performance-based fire protection program	Actions identified in licensee application to transition to a new risk-informed, performance-based fire protection licensing basis which would establish performance-based requirements based on a plant-specific PRA. Examples of actions credited as post-fire recovery actions include: • Recovery actions required to regain control of the RHR heat exchanger outlet valve and/or the RHR heat exchanger bypass valve in order to maintain decay heat removal post-fire	NFPA Standard 805, "Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants, 2001 Edition" (NFPA 805) Regulatory Guide (RG) 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants."

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
		• Local operation of the Volume Control Tank (VCT) outlet valves when necessary to shift the charging pump suction from the VCT to the refueling water storage tank (RWST) (when fire damage has removed the ability to remotely operate the VCT outlet valves) The staff review supports a reasonable assurance determination that the licensee's risk-informed, performance-based fire protection program is in compliance with National Fire Protection Association (NFPA) Standard 805.	NUREG/CR-6850, EPRI/NRC-RES, Fire PRA Methodology for Nuclear Power Facilities NUREG-0800, Section 9.5.1.2, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants Fire Protection Program, Section 9.5.1.2, "Risk-Informed, Performance-Based Fire Protection Program" NUREG-1852, Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire RG 1.200, An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities IP 7111.05XT
	B.5.b / 10 CFR 50.54(hh)(2) mitigating strategies	Actions identified in licensees' 10 CFR 50.34(i) description and plans for implementation of the guidance and strategies intended to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities under the circumstances associated with the loss of large areas of the plant due to explosions or fire. An Example is: Within 2 hours of diagnosing that external SFP	B.5.b Phase 1 Guidance of February 25, 2005 Nuclear Energy Institute (NEI) 06-12, Revision 2,

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
		makeup is required, operators must deploy a portable, independently powered pump and hoses to provide 500 gallons per minute of makeup flow to the SFP for 12 hours. The staff review supports a reasonable assurance determination that the licensee's mitigating strategies will be capable of maintaining or restoring core cooling, containment, and SFP cooling capabilities under the circumstances associated with the loss of large areas of the plant due to explosions or fire.	
	Alternate Source Term (AST) – Safety evaluation of licensee requests to revise the licensing basis in the area of radiological dose analysis for design-basis accidents.	Actions to mitigate the radiological consequences of accidents addressed in the AST analysis. Examples include: • Placing the control room emergency ventilation system in filtered recirculation within 10 minutes • Isolating the main control room within 4 hours after a main steam line break outside containment The staff review of actions addressed in the AST analysis supports a reasonable assurance determination that the actions can be performed consistent with the analysis.	NUREG-0800, Chapter 18, Human Factors Engineering, Section C, Review of the HFE Aspects of Modifications Affecting Risk Significant Human Actions NUREG-1764, Rev. 1, Guidance for the Review of Changes to Human Actions, 2007

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
	Power Uprates Safety evaluation of requests to amend licenses to increase a plant's maximum rated thermal power.	Actions that may be affected, or required, by an increase in an NPP's maximum licensed thermal power. Examples of existing actions that are evaluated for continued credit after the power uprate include: • Manually start standby liquid control system early for certain anticipated transient without scram events • Align one train of the residual heat removal system for the spent fuel cooling mode, in the event of loss of the fuel pool cooling system • Example of new action credited for an extended power uprate: • Close a manual isolation bypass header valve in the bypass line for which the associated motor-operated bypass header valve fails to isolate (for ultimate heat sink spray system) The staff review of actions addressed in the licensee's power uprate application supports a reasonable assurance determination that the actions can be performed consistent with the analysis.	NUREG-0800, Chapter 18, Human Factors Engineering, Section C, Review of the HFE Aspects of Modifications Affecting Risk Significant Human Actions NUREG-1764, Rev. 1, Guidance for the Review of Changes to Human Actions, 2007
	Other Changes to Design/Licensing Bases	Actions credited in Chapter 15, Accident Analyses. Examples include: • Manually start a third auxiliary feedwater pump within 15 minutes • Swap suction from refueling water storage tank	NUREG-0800, Chapter 18, Human Factors Engineering, Section C, Review of the HFE Aspects of Modifications Affecting Risk Significant Human Actions

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
		• to containment sump The staff review supports a reasonable assurance determination that the use of manual action in lieu of automatic action or modification of operator actions including changes to operator action times (i.e., modified actions or modified task demands) will not endanger public health and safety or common defense and security.	NUREG-1764, Rev. 1, Guidance for the Review of Changes to Human Actions, 2007
	Other Modifications Affecting Risk-Important Human Actions	Risk-important actions that may be affected by plant modifications. Examples include: • Manual actions affected by power uprates • Manual actions affected by alternate source term analyses The staff's review includes manual actions affected by plant modifications to (1) determine the risk associated with modification and (2) ensure that the modifications is implemented in a manner consistent with accepted HFEprinciples.	NUREG-0800, Chapter 18, Human Factors Engineering, Section C, Review of the HFE Aspects of Modifications Affecting Risk Significant Human Actions NUREG-1764, Rev. 1, Guidance for the Review of Changes to Human Actions, 2007 Regulatory Guide 1.62, Rev.1, Manual Initiation of Protective Actions
	Control Room Modifications	Actions performed in the control room that may be affected by major changes to NPP human-system interfaces (HSIs). An example is manual actions affected by conversion from analog to digital control systems.	NUREG-0800, Chapter 18, Human Factors Engineering, Section B, Review of the HFE Aspects of Control Room Modifications NUREG-0711, Human Factors Engineering Program Review Model, Rev 2. NUREG-0700, Human –System Interface Design Review Guidelines, Rev. 2

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
NSIR	10 CFR 73.55(b)(4) Requires the licensee to analyze and identify site-specific conditions, including target sets. (The definition of target set includes operators actions)	Actions required to prevent radiological sabotage. Examples include: monitoring plant parameters and manipulating plant equipment, such as changing the status of systems, switches, valves, or other component(s). The NRC staff reviews operator action(s) performed to prevent radiological sabotage in response to specific actions by adversaries, to verify that these operator actions included in site specific target will be accomplished with high assurance.	The statement of considerations for Section 73.55(f), Target Sets, specifically addresses the criteria for Credible Operator Actions RG 5.81, Target Set Identification and Development for Nuclear Power Reactors (OUO-SRI)

Appendix B-2 Regulatory Applications Where Manual Actions May Be Credited – Inspection/Oversight

Office	Application	Manual Actions and Reason for Review/Inspection	Primary Guidance Documents
NRR	Reactor Oversight Process (ROP) – Significance Determination Process (SDP)	Actions that could affect plant risk. Examples are: • Bleed & feed RCS in the loss of heat sink scenarios • Trip RCPs before seal damage in the loss of seal cooling scenarios The ROP assesses a licensee's safety performance by using inputs from the inspection findings (i.e., through the SDP) and the Performance Indicators (PIs) in the NRC's Action Matrix, which is described in the IMC 0305. The SDP estimates the risk significance of inspection findings using qualitative and quantitative risk assessment tools. The risk significance is represented by the change to the core damage frequency and is evaluated with considerations of both hardware and human reliabilities.	NRC Inspection Manual, Manual Chapter 0609, Significance Determination Process The standardized plant analysis risk (SPAR) PRA models The SPAR-H human HRA method supplemented with realistic analysis when procedure and training were not applicable. Risk Assessment of Operational Events Handbook (ML100850108).

Office	Application	Manual Actions and Reason for Review/Inspection	Primary Guidance Documents
	Component Design Basis Integrity (CDBI) Inspection	Manual actions are selected for the inspection sample based on several criteria including risk significance and operations margin (i.e., time critical operations). The actions include initiation, monitoring, control and shutdown. Specific examples include: • Alternate boration for the Standby Liquid Control system • Cross-tie of the Division 3 electrical bus with the Division 1 electrical bus • Reset of the reactor core isolation cooling trip/throttle valve • Restoration of the instrument air system • Restoration of the standby service water system The staff conducts CDBI inspections to verify that design bases have been correctly implemented for the selected risk significant components and that operating procedures and operator actions are consistent with design and licensing bases. The objective is to ensure that selected components are capable of performing their intended safety functions.	NRC Inspection Manual, Inspection Procedure 71111, Reactor Safety – Initiating Events, Mitigating Systems, Barrier Integrity, Attachment , 21, Component Design Basis Inspection

Office	Application	Manual Actions and Reason for Review/Inspection	Primary Guidance Documents
RES	Operating Experience Accident Sequence Precursor (ASP) – Risk Informed program	Actions that could affect plant risk. Examples are: • Bleed & feed RCS in the loss of heat sink scenarios • Trip RCPs before seal damage in the loss of seal cooling scenarios The ASP was established in response to a recommendation of the Risk Assessment Review Group report (NUREG/CR-0400, 1978) to use PRA tools to systematically assess the risk of plant operational experience based on the licensee event reports and inspection findings. The ASP provide input to the NUREG-1542 "NRC Performance and Accountability Report", which is submitted to the Congress annually.	The standardized plant analysis risk (SPAR) PRA models SPAR-H HRA method supplemented with realistic analysis when procedure and training were not applicable. Risk Assessment of Operational Events Handbook (ML100850108).

Appendix B-3 Regulatory Applications Where Manual Actions May Be Credited – Enforcement

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
NRR	Current Licensing Basis Compliance – Tech Specs Compliance	Actions licensees credit in operability determinations of degraded or non-conforming conditions of structures, systems, and components (SSC) required by unit technical specifications. Examples include plant staff monitoring a feedwater pipe and manually closing valves in the situation of feedwater line break as a compensatory measure for a broken signal line. This guidance is provided to NRC licensees to assess operability and functionality when degraded or nonconforming conditions affecting SSCs and to NRC inspectors to assist their review of the licensees' determinations of operability and resolution of degraded or nonconforming conditions. In certain limited circumstances, a licensee may find that strict compliance with the TSs or a license condition would cause taking an action that is not in the best interest of public health and safety. If there is time, the guidance recommends the licensee to obtain an amendment; otherwise, licensees may seek NOED from the NRC.	NRC Inspection Manual, Part 9900: Technical Guidance, Operability Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety
	Notice of Enforcement Discretion (NOED)	An example is a situation where a motor-driven auxiliary feedwater (MDAFW) pump has failed and risk insights have established that plant transient initiators may be risk-significant events because the plant has no primary feed-and-bleed capability and only limited secondary feed capability is available. As a compensatory measure during the period of enforcement discretion, the licensee may defer non-essential surveillances or other maintenance activities where human error contributes to the likelihood of a plant scram and subsequent demand on the remaining AFW pumps.	

Office	Application	Manual Actions and Reason for Review	Primary Guidance Documents
		The NOED process is designed to address unanticipated temporary noncompliance with license conditions and technical specifications only. When an NOED is granted by NRC, it is recognized that the licensee's operating license will be violated, but the NRC is exercising its discretion to not enforce compliance with the operating license for a specified time period. In request for a NOED, the licensee should address the quantitative and qualitative safety aspects of the request.	

Appendix C – Summaries of Guidance for Crediting of Manual Actions

ANSI/ANS 58.8, Time Response Design Criteria for Safety-Related Operator Actions – 1994
ANSI/ANS 58.8 establishes timing requirements to be used in the design of safety-related systems for nuclear power plants. The criteria can be used to determine whether safety-related systems can be initiated by operator action or require automatic initiation. Analyses performed in accordance with ANS 58.8 are based on a prescribed task sequence analysis. Elements of the task sequence are assigned pre-defined time values derived from empirical data and then summed to determine minimum timing requirements for the manual action. A predefined time value is included to account for event diagnosis, with the time value increasing as the estimated frequency of the event for which the mitigation action is required decreases. Although ANS 58.8 is referenced by other NRC guidelines, the NRC has not formally endorsed this guidance through a regulatory guide.

DI&C-ISG-05, Highly-Integrated Control Rooms – Human Factors Issues, Rev. 1 - Crediting Manual Operator Actions in Diversity and Defense-in-Depth Analyses
DI&C-ISG-05 provides an acceptable method for meeting the guidance in BTP 7-19 for manual actions credited in diversity and defense-in-depth (D3) analyses. Specifically, DI&C-ISG-05 provides a methodology, applicable to both existing and new reactors, for crediting manual operator actions as a diverse means of coping with Anticipated Operational Occurrences and Postulated Accidents (AOO/PA) that are concurrent with a software Common Cause Failure (CCF) of a digital Instrumentation and Control (I&C) protection system. The guidance outlines a 4-phase process that applicants may use to demonstrate the feasibility and reliability of the proposed action. These four phases are analysis, preliminary validation, integrated system validation, and maintaining long-term integrity of the credit action(s). The process includes demonstration of the ability to complete the actions in representative event simulations. Assurance of reliability of the manual actions is achieved through incorporation of a time margin equivalent to the time to recover from a worst case operator error. The guidance of DI&C-ISG-05 will be incorporated in the SRP as Appendix A to Chapter 18.

NEI 06-12, Revision 2, B.5.b Phase 2 & 3 Submittal Guideline, as endorsed
This guideline provides the performance attributes, guidance, and considerations for use in establishing the B.5.b/10 CFR 50.54(hh)(2) mitigating strategies.

NUREG-0800, Chapter 9, Auxiliary Systems, Section 9.1.3 Spent Fuel Pool Cooling and Cleanup System
Section 9.1.3 provides guidance for the review of licensee submittals pertaining to spent fuel pool cooling and cleanup systems, including provisions to provide adequate makeup to the pool for pools that are not designed to seismic Category I, Quality Group C guidelines. With regard to seismic Category I, Quality Group C makeup systems, the review guidance states: Engineering judgment and comparison with plants of similar design are used to determine that the time necessary to align systems and connect makeup systems not permanently installed is consistent with heatup times or expected leakage from structural damage. This section provides no additional guidance or references with regard to determining the time necessary to perform the manual action necessary to align systems and connect makeup systems that are not permanently installed or assessing the reliability of such actions.

NUREG-0800, Chapter 9, Auxiliary Systems, Section 9.2.2 Reactor Auxiliary Cooling Water System

Section 9.2.2 provides guidance for the review of licensee submittals pertaining reactor auxiliary cooling water systems, including provisions for control room operators to isolate the reactor coolant pump (RCP) seal coolant line by remote manual means. Subsection II.4.G requires a demonstration by testing that RCPs withstand a complete loss of cooling water for 20 minutes so that a period of 20 minutes is available for operators to have sufficient time to initiate manual protection of the plant. Subsection III.4.F directs the reviewer to verify that design provisions are made for the control room operator to have the necessary information to determine when it is appropriate to isolate the lines by remote manual means and how soon the lines should be isolated if they become release paths from the containment during a loss of coolant accident (LOCA). Section 9.2.2 provides no technical rationale for the adequacy of 20 minute criterion for manual action and provides no additional guidance or references with regard to assessing information that the operators will require to determine when it is appropriate to isolate the lines by remote manual means and how soon the lines should be isolated.

NUREG-0800, Chapter 9, Auxiliary Systems, Section 9.5.1.1, Fire Protection Program

Section 9.5.1.1 provides guidance for the review of licensee submittals pertaining to plant Fire Protection Programs, including plant layout, access and egress routes with respect to firefighting and local operator manual actions. This section provides guidance to ensure that smoke, hot gases or fire suppressants will not migrate into other fire areas to an extent that could adversely affect safe-shutdown capabilities, including operator actions, but otherwise provides no specific guidance for the review of manual actions.

NUREG-0800, Chapter 15, Transient and Accident Analyses

Chapter 15 provides guidance for the review of specific accident and transient analyses and generally includes guidance to evaluate manual actions as part of the sequence of events and determine whether the sequence of events is justified, based upon the expected values of the relevant monitored parameters and instrument indications. Chapter 15 provides no specific guidance for how the reviewer is to evaluate manual actions as part of the determination of whether the sequence of events and is justified (and therefore this guidance chapter is not included in Table 2 above).

NUREG-0800, Chapter 18, Human Factors Engineering, Section C, Review of the HFE Aspects of Modifications Affecting Risk Significant Human Actions.

Chapter 18 of the standard review plan (SRP) provides guidance for using a risk screening process to determine the level of review the staff should conduct for modifications affecting risk significant human actions. In accordance with the SRP, reviews for human actions identified as either Level I or Level II are generally conducted in accordance with NUREG-1764 (See the description of NUREG-1764 for details). A level III HFE review is generally limited to verification that the action is Level III.

NUREG-0800, Chapter 19, Severe Accidents, Section 19.2, Review of Risk Information Used to Support Permanent Plant-Specific Changes to the Licensing Basis: General Guidance

Section 19.2 provides guidance for reviewing the modeling in a nuclear power plant PRA of modifications to a plant’s design, operations, or other activities that require NRC approval,

including the impact or reliance on manual actions required in response to credible plant events (e.g., post-accident recovery of failed components).

NUREG-1513, Integrated Safety Analysis Guidance Document
NUREG-1513 provides general guidance to NRC fuel cycle licensees and applicants on how to perform an integrated safety analysis (ISA) and document the results. The document defines an ISA, identifies its role in a facility's safety program, identifies and describes several generally accepted ISA methods, and provides guidance in choosing a method.

NUREG-1520, Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility, Rev. 1, May 2010.
NUREG-1520 provides guidance to the staff to perform safety and environmental impact reviews of applications to construct or modify and operate nuclear fuel cycle facilities. Reviews are performed of the facility overview, organization, integrated safety analysis (ISA), radiation protection, criticality safety, chemical safety, fire safety, decommissioning, and management measures. A licensee designates, and the staff reviews, engineered and administrative items relied on for safety (IROFS) to determine, with reasonable assurance, that regulatory and performance requirements are met. The IROFS are subject to preventive and mitigative measures and through application of supporting management measures that are reviewed in the respective chapter.

NUREG-1764, Rev. 1, Guidance for the Review of Changes to Human Actions, 2007
NUREG-1764 provides guidance for review of changes to human actions that are credited for safety. The guide describes a two phase process that screens the risk importance of a proposed design modification and the associated human action(s) in phase 1 and for conducting a level of review commensurate with the risk importance in phase 2. The phase 1 screening uses guidance consistent with RG 1.174 and results in a determination of high (Level I), medium (Level II) or low (Level III) risk importance. The phase 2 process uses standard human factors review criteria, with detailed reviews for Level I, less detailed reviews for Level II, and minimal review for Level III.

NUREG-1792, Good Practices for Implementing Human Reliability Analysis
NUREG-1792 provides guidance for evaluating risk-informed applications that take credit (as assessed reliability) for human actions modeled in a plant's PRA. The good practices described in this NUREG support the implementation of RG 1.200, An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities, for Level 1 and limited Level 2 internal event PRAs with the reactor at full power. The NUREG includes guidance for the appropriate treatment of recovery actions (manual actions to bypass a failure that has caused loss of an SSC function). The guide does not constitute a standard and therefore there is no expectation that a submittal will conform to all good practices described in the guidance.

NUREG-1852, Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire
NUREG-1852 provides guidance for evaluating the feasibility and reliability of post-fire operator manual actions. The guidance can be used by staff to evaluate the acceptability of licensee

exemption requests from the requirements of paragraph III.G.2 of Part 50, Appendix R for a means of achieving hot shutdown conditions during and after fire events. NUREG-1852 focuses on the unique aspects of fire events for human performance. The guidance provides deterministic review criteria for assessing the feasibility of manual actions and addresses the reliability of manual actions by providing guidance to ensure that uncertainties in estimates of time available and time required have been identified and accounted for in the analysis.

NUREG/CR-6883, The SPAR-H Human Reliability Analysis Method
NUREG/CR-6883 describes the Standardized Plant Analysis Risk Human Reliability Analysis (SPAR-H) method, which is a simple HRA method for estimating the human error probabilities (HEPs) associated with operator and crew actions and decisions in response to initiating events at commercial U.S. nuclear power plants (NPPs). The document leads the analyst through the SPAR-H worksheet process for quantifying HEPs. The worksheet includes eight key performance-shaping factors for the analyst to consider in evaluating the reliability of human action.

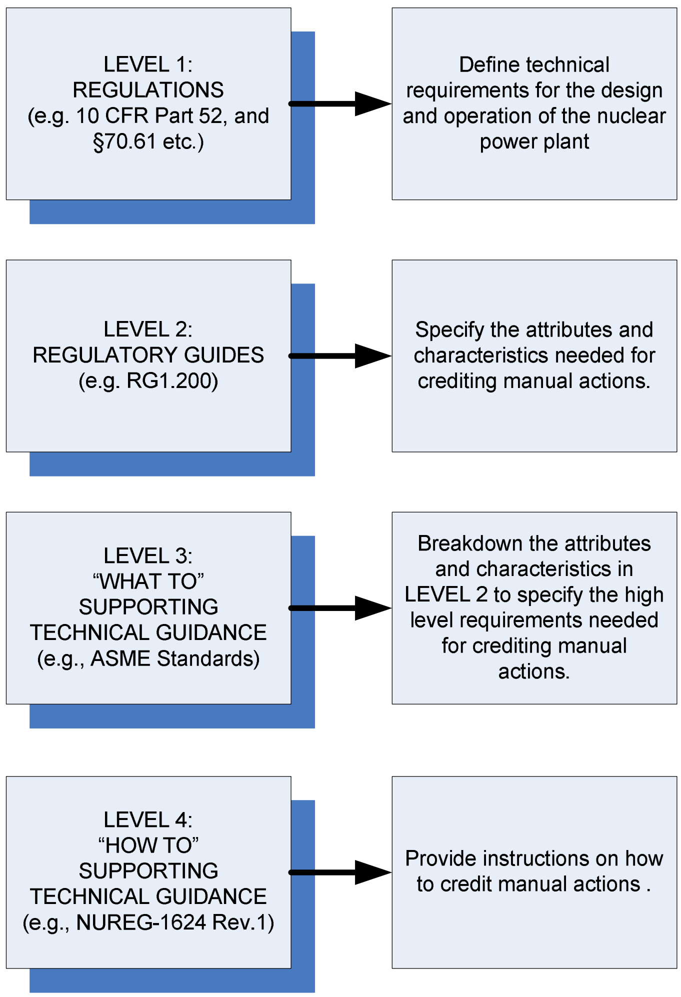
NRC Inspection Manual, Part 9900: Technical Guidance, Operability Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety
This inspection guidance addresses crediting manual initiation of a specified safety function in situations where a licensee proposes substitution of manual action for automatic action in determining operability of an SSC required by unit technical specifications. The guidance directs the inspector to focus the evaluation of manual action on the physical differences between automatic and manual action and the ability of the manual action to accomplish the specified safety function or functions and provides standard human factors review criteria.

Regulatory Guide 5.81, Target Set Identification and Development for Nuclear Power Reactors, Section 6.4, Consideration of Credible Operator Actions.
Section 6.4 of the guide provides guidance for the review of manual actions credited in target set(s) in response to an adversary attack to prevent significant core damage or spent fuel sabotage. The guidance includes attributes for six specific criteria to be fully met to give credit for the operator action included the target set. A description for each of the six criteria, with acceptable and unacceptable examples for each attribute, is presented within the guidance.

Appendix D – NRC Guidance Hierarchy and Level of Guidance Detail

NRC's guidance hierarchy can be divided into four levels, as depicted in Figure 1 below. Guidance in the highest level (level 1), the regulations, provides high level objectives for public safety codified in the code of federal regulations. The guidance in subsequent lower levels provides gradually increasing technical details for achieving the objectives and requirements specified in the guidance in levels above.

Figure 1 Four levels of guidance detail in crediting manual actions



Level 1 guidance (regulations) defines technical requirements for the design and operation of nuclear facilities, e.g., 10 CFR 52 for early site permits, standard design certifications, combined licenses, standard design approvals, and manufacturing licenses for nuclear power facilities. Level 2 guidance (regulatory guides) defines the attributes and characteristics that would make an application acceptable to NRC staff for meeting the regulations. Level-3 guidance defines what is required for satisfying the technical attributes and characteristics specified in the Level 2

guidance. Level-4 guidance (often captured in NUREGs) provides detailed instructions on how to accomplish the requirements specified in the Level 2 and Level 3 guidance. Consider the following example. 10 CFR Part 50, subpart 50.48, Appendix A General Design Criteria 3, and Appendix R are the relevant regulations for fire protection requirements at operating nuclear plants and hence comprise level 1 guidance. Then for traditional fire protection, Regulatory Guide 1.189, Fire Protection for Nuclear Power Plants, provides level 2 guidance; NUREG-0800, Section 9.5.1 provides level 3 guidance; and NUREG-1852 provides level 4 guidance.

Appendix E – SharePoint Site for Manual Action Working Group

The work group (WG) established a "Manual Actions Working Group" SharePoint site to facilitate its work. At the end of its task, the WG perceived that the information in the SharePoint site would be beneficial to whoever would follow up on the work, if any. The WG plans to remove draft WG material from the SharePoint site and further develop the site as an on-line resource for staff engaged in regulatory activities requiring the review and assessment of manual actions. The SharePoint site is accessible to NRC staff and can be accessed by the following steps:

1. Entering the Office of New Reactors SharePoint site at http://epm.nrc.gov/default.aspx
2. Selecting Inspection > Construction Inspection Program from the tabs on the top of the page
3. Selecting "Manual Actions Working Group" from the "Sites" section on the left of the page
4. Clicking "View All Site Content" on the upper left of the page, the information is stored in the following three sub-folders under "Document Library":
   - Analysis: the final WG report
   - Credited Actions: information related to the regulatory applications identified in the report
   - Guidance Collections: the guidance documents mentioned in the report

Appendix F – Definitions

The following are composite lists of definitions from six source documents (listed at the end). The lists of terms and the source documents used are by no means comprehensive. The terms have been grouped into the following general categories: Actions, Tasks, Errors, Events, Assessment Factors, and Times. The objective is to provide a perspective on the diverse nomenclature used in the review of credit for manual actions and illustrate the differences and similarities in the definitions of these terms. Note that the definitions are copied without modification from the source documents indicated.

Actions:

1. **Action** – An activity, typically observable and usually involving the manipulation of equipment that is carried out by an operator(s) to achieve a certain outcome. The required diagnosis of the need to perform the activity, the subsequent decision to perform the action obtaining any necessary equipment, procedures, or other aids or devices necessary to perform the activity, travel to the location to perform the activity, implementing the activity, and checking that the activity has had its desired effect, are all implied and encompassed by the term "action."[2]

2. **Action** – One or more operator manipulations or automatic actuations. One or more actions are necessary to accomplish a safety-related function.[4]

3. **Feasible Action** – An action that is analyzed and demonstrated as being able to be performed within an available time so as to avoid a defined undesirable outcome. As compared to a reliable action (see definition), an action is considered feasible if it is shown that it is possible to be performed within the available time (considering relevant uncertainties in estimating the time available); but it does not necessarily demonstrate that the action is reliable. For instance, performing an action successfully one time out of three attempts within in the available time shows that the action is feasible, but not necessarily reliable.[2]

4. **Function** – An action that is required to achieve a desired goal. Safety functions are those functions that serve to ensure higher-level objectives and are often defined in terms of a boundary or entity that is important to plant integrity and the prevention of the release of radioactive materials. A typical safety function is "reactivity control." A high-level objective, such as preventing the release of radioactive material the environment, is one that designers strive to achieve through the design of the plant that plant operations strive to achieve through proper operation of the plant. The function is often described without reference to specific plant system and components or the level of human and machine intervention that is required to carry out this action. Functions are often accomplished that some combination of lower-level functions, such as "reactor trip." The process of manipulating lower-level functions to satisfy a higher-level function is defined as a control function. During function allocation the control function is assigned to human and machine elements.[3]

5. **Manipulation** – A discrete element of an action.[4]

6. **Operator Manual Actions (Local Actions, in Response to a Fire)** – those actions performed by operators to manipulate components and equipment from outside the main control room to achieve and maintain postfire hot shutdown, but not including "repairs." Operator manual actions comprise an integrated set of actions needed to help ensure that hot shutdown can be accomplished, given that a fire has occurred in a particular plant area.[2]

7. **Other Operator Actions** – Operator actions that are not required by plant emergency procedures following a DBE.[4]

8. **Preventative Action** – Actions taken in response to an adversary attack to prevent significant core damage and/or prevent an offsite release.[1]

9. **Preventative Actions** – Those actions that, upon entering a fire plan/procedure, the operator(s) takes (without needing further diagnosis) to mitigate the potential effects of possible spurious accusations or other fire-related failures, so as to ensure that hot shutdown can be achieved and maintained. For these actions, it is generally assumed that once the fire has been detected and located ,per procedure, the control room crew will direct personnel to execute a number of actions, possibly even without the existence of other damage symptoms, to ensure the availability of equipment to achieve its function during the given fire scenario. In many cases, the only criterion for initiating these actions is the presence of the fire itself. [2]

10. **Reactive Actions** – Those Actions taken during a fire in response to an undesired change in plant condition. In reactive actions, the operator(s) detects the undesired change and, with the support of procedural guidance, diagnosis the correct actions to be taken. Thus, with reactive actions, the plant staff responds to indicators of changing equipment conditions caused by the fire, and then takes the steps necessary to ensure that the equipment will function when needed (e.g., manually reopening a spuriously closed valve). The plant staff may not initiate the actions until the procedure indicates that, given the relevant indications, the actions must be performed.[2]

11. Recovery Actions – Those activities to achieve the nuclear safety performance criteria that take place outside the main control room or primary control station(s) for the equipment being operated, including replacement or modification of components[7]

12. **Regulatory Position Number Four** – Modifies the application of the term "Contingency status," which Clause 3.6 of IEEE Std. 497-2002 defines as "alternative actions taken to address unexpected responses of the plant or conditions beyond its licensing basis (for example, actions taken for multiple equipment failures)." Clause 1.3 uses this term in defining the application of IEEE Std. 497-2002, while Clause 4.1 uses it in defining selection criteria for Type A variables. The staff agrees with the criteria in these clauses, except where they exclude contingency actions. Contingency actions were excluded from the scope of Revision 3 of this guide, by neither Revision nor its endorsed standard

provided a definition of the term “contingency action.” NSSS vendors have not used this term consistently in EPGs for current plant designs and, therefore, the staff recommends considering contingency actions in accordance with the modified criteria in Clause 4.1.[5]

13. **Reliable Action** – A feasible action that is analyzed and demonstrated as being dependably repeatable within an available time, so as to avoid a defined adverse consequence, while considering varying conditions that could affect the available time and/or the time to perform the action. As compared to an action that is only feasible, an action is considered to be reliable as well if it is shown that it can be dependably and repeatedly performed within the available time, by different crews, under somewhat varying conditions that typify uncertainties in the available time and the time to perform the action, with a high success rate. All reliable actions need to be feasible, but not all feasible actions will be reliable.[2]

14. **Required Operator Actions** – Operator actions that are required by the plant emergency procedures but are not safety-related operator actions and are not needed to accomplish a safety-related function.[4]

15. **Risk-Important Human Action** – An action that must be performed successfully by operators to ensure plant safety. There are both absolute and relative criteria for defining these risk important actions. From an absolute standpoint, a risk-important action is one whose successful performance is needed to ensure that predefined risk criteria are met. From a relative standpoint, the risk-important actions constitute the most risk-significant human actions identified.[3]

16. **Safety-Related Operator Action** – A manual action is required by plant emergency procedures that is necessary to cause a safety-related system to perform its safety-related function during the course of any Design Basis Event. The successful performance of a safety-related operator action might require that discrete manipulations by performed in a specific order.[3]

17. **Safety-Related Operator Action** – A manual action required by plant emergency procedures that is necessary to cause a safety-related system to perform its safety-related function during the course of any DBE. The successful performance of a safety-related operator action might require a discrete manipulations be performed in a specific order.[4]

18. **Unsafe Actions** - Those actions taken or omitted that lead the plant into a less safe state. Only a subset of human errors result in unsafe actions. Also, only some portion of unsafe actions lead to human failure events defined in the PRA model. For example, timing and available barriers may limit the number of unsafe actions that become human failure events.[6]

Tasks:

1. **Primary Tasks** – Those tasks performed by the operator to supervise the plant; i.e., monitoring detection, situation assessment, response planning, and response implemtnaton.[3]

2. **Secondary Tasks** – Those tasks that the operator must perform when interfacing with the plant, but are not directed to the primary task. Secondary tasks may include; navigating through a paging displays, searching for data, choosing between multiple ways of accomplishing the same task, and making decisions regarding how to configure the interface.[3]

3. **Subtask** - In this report, a human action at a level lower than a task (i.e., basic event) level. May also be called a subevent.[6]

4. **Task** - In this report, often refers to the human action(s) described in a SPAR model basic event [e.g., failure to recover residual heat removal (RHR)]. The level of these tasks often encompasses relatively large numbers of human actions, which might, in other circles, be called tasks in their own right.[6]

5. **Task** – A group of activities that have a common purpose, often occurring in temporal proximity, and that utilize the same display and controls.[3]

Errors:

1. **Human Error** - An out-of-tolerance action, or deviation from the norm, where the limits of acceptable performance are defined by the system. These situations can arise from problems in sequencing, timing, knowledge, interfaces, procedures, and other sources.[6]

2. **Operator Error** – In the context of the single failure criterion, a single incorrect or omitted action by a human operator attempted to perform a safety-related action in response to an initiation occurrence. Subsequent manipulations that are consistent with the results of the initiating error are not considered additional. (For example, if in a sequence of actions a component was aligned incorrectly, resulting in reduced (instead of increased) flow, all subsequent operator manipulations consistent with having reduced flow would be regarded as part of the original operator error, not as additional errors.)[4]

Events:

1. **Basic Event** - The term used in this report to describe a component failure, loss of function, unavailability, or failed human action in a SPAR model event tree. An example of a basic event might be “Operator fails to throttle high-pressure injection (HPI) to reduce pressure.”[6]

2. **Event** - A high-level generic term encompassing a non-normal occurrence at a nuclear power plant (or other facility).[6]

3. **Human Failure Event (HFE)** - A basic event that represents a failure or unavailability of a component, system, or function that is caused by human inaction or an inappropriate action (ASME RA-S-2002).[6]

4. **Initiating Event** - In the SPAR model terminology, one of the high-level scenarios under study (e.g., steam generator tube rupture, loss of feed water, loss of offsite power, etc).[6]

5. **Plant Conditions (PC)** – Categorization of events in terms of their likelihood of occurrence for the purpose of establishing nuclear safety criteria.[4]

Plant Condition	Best Estimate Frequency of Occurrence (f) per Reactor Year
PC-1	Normal Operations
PC-2	$F \geq 10^{-1}$
PC-3	$10^{-1} > F \geq 10^{-2}$
PC-4	$10^{-2} > F \geq 10^{-4}$
PC-5	$10^{-4} > F \geq 10^{-6}$

Assessment Factors:

1. **Accessible** – Means the ability of the adversary to gain physical contact without the aid of scaffolding or a ladder. [1]

2. **Identifiable** – Means that there is adequate information or a means to provide this information on the location and function of the cable target element (e.g., labels, observation through walk down, preexisting analysis, site documentation, etc.) and that the cable target element can be visually recognized by the adversary.[1]

3. **Negative PSFs** - In SPAR-H, negative performance shaping factors (PSFs) are those PSF values that increase the nominal value rate, i.e., the PSF values are greater than 1, are referred to as negative PSFs and figure in conjunction with positive PSFs in the overall HEP calculation. When the number of negative PSFs is three or greater, then the HEP adjustment factor is applied.[6]

4. **Performance Criteria** – The criteria against which measured performance is compared in order to judge its acceptability. Approaches to the establishment of the performance criteria include Requirement Referenced, Benchmark Referenced, Normative Referenced, and Expert-Judgment Referenced.[3]

5. **Performance Shaping Factor (PSF)** - A factor that influences human performance and human error probabilities is considered in the HRA portion of the PRA. In SPAR-H, this includes: time available, stress/stressors, complexity, experience/training, procedures, ergonomics human-machine interface, fitness for duty, and work processes.[6]

6. **Performance Shaping Factors (PSFs)** – Factors that influence human reliability through their effects on performance. PSFs include factors such as environmental conditions, HIS design, procedures, training and supervison.[3]

7. **Prompt** - A prompt is displayed plant data that causes the operator to consider the need for action.[4]

8. **Vigilance** – The degree to which an operator is alert.[3]

9. **Workload** – The physical and congestive demands placed on plant personnal.[3]

Times:

1. **Available Time (or Time Available)** – The time period from a presentation of a cue for an action to the time of adverse consequences if the action is not taken.[2]

2. **Dead ($TI_{dead} = t_{MAI} - t_{ECA}$ or $t_{MAI} - t_{SAC}$)** – Time interval(s) between $TI_{diagnosis}$ and TI_{safety} in which the analytic criteria permit operator action to be credited, but no safety-related operator actions occur in the analyzed sequences. A non-zero TI_{dead} may occur following t_{ECA} (for the first operator action) and following t_{SAC} (for any subsequent operator action, excluding the last.)[4]

3. **Diagnosis ($TI_{diagnosis} = t_{ECA} - t_{Ind}$)** – The time interval between the first indication of the DBE to the plant operators and the earliest time for which credit can be taken for indication of a safety-related operator action. During this interval, it is assumed that the operator verifies automatic responses, observes plant parameters, and plans subsequent actions in response to the DBE.[4]

4. **Diagnosis Time** – The time required for an operator(s) to examine and evaluate data to determine the need for, and to make the decision to implement, an action.[1]

5. **Discrete Time Points** – The time points during the course of DBE that defines the time intervals evaluated in an analysis of operator response times.[4]

6. **Earliest Credited Action (t_{ECA})** – The earliest time following t_{Ind} at which credit for the initiation of a safety-related operation action can be taken.[4]

7. **Implementation Time** – The time required by the operator(s) to successfully perform the manipulative aspects of an action (i.e., not the diagnosis aspects themselves, buy typically or as a result of the diagnosis aspects), including obtaining any necessary equipment, procedures, or other aids or devices; traveling to the necessary location; implementing the action; and checking that the action as had its desired effect.[2]

8. **Indication ($TI_{Indication} = t_{Ind} - t_{St}$)** – The time interval between the start of the DBE and the first indication of the DBE to the plant operator. In some DBEs, this time interval might be considered zero for the purpose of the analysis of this standard.[4]

9. **Indication of Event (t_{Ind})** – The time at which information is readily available, e.g., one or more alarm(s) or display indication(s) to the plant operators to indicate a DBE has occurred.[4]

10. **Event Limit (t_{Lim})** – The earliest time at which a limiting design requirement would be exceeded if a safety-related function has not been completed. (For some DBEs, t_{Lim} may occur several times due to motile limiting design requirements or recurring limiting design requirements.[4]

11. **Manual Action Initiated (t_{MAI})** – The point in time at which the analysis credits the initiation of an operator action.[4]

12. **Operator Response ($TI_{operator} = t_{SAC} – t_{MAI}$)** – Time interval during which the operator indicates and completes safety-related actions.[4]

13. **Process Response ($TI_{process} = t_{SPC} – t_{SAC}$)** – Time interval between the evaluated completion of a safety-related operator action and the indication of the corresponding safety-related function is completed through the response of the mitigating equipment and the response of the process. For some DBEs, this time interval might be considered zero for the purpose of the analysis of this standard.[4]

14. **Safety ($TI_{safety} – t_{Lim} – t_{SFC}$)** – The time interval between completing the last safety-related function and when the event limit would have even reached without operator action. A negative value of TI_{safety} indicates that a limiting design requirement has not been met.[4]

15. **Safety-Related Action Completed (t_{SAC})** – The time at which the safety-related operator action is evaluated to be comeplted.[4]

16. **Safety-Related Function Completed (t_{SFC})** – The time at which an indication is received that a safety-related system has performed its required safety-related function.[4]

17. **Start of Event (t_{St})** – The time at which the DBE begins.[4]

18. **Time Interval** – The elapsed time between two sequential discrete time points. Those time intervals include indication, diagnosis, dead, operator response, process response, and safety.[4]

<u>Reference Source Documents</u>

[1] Regulatory Guide 5.81 “Target Set Identification and Development for Nuclear Power Plants”
[2] NUREG-1852 “Demonstration the Feasibly and Reliability of Operator Actions in Response to Fire”
[3] NUREG-1764 “Guidance for the Review of Changes to Human Actions”
[4] ANSI/ANS-58.8-1994 “American National Standard Time Response Design Criteria for Safety-Related Operator Actions”
[5] Regulatory Guide1.97 “Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident”
[6] NUREG/CR-6883 “The SPAR-H Human Reliability Analysis Method”
[7] NFPA 805, “Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants,” Section 1.6.52, Recovery Action

Appendix G – Working Group Members

The following individuals participated as working group members and principal authors for this report:

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