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DOE STANDARD

SPECIFIC ADMINISTRATIVE CONTROLS

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ABBREVIATIONS AND ACRONYMS

AC	Administrative Controls
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE-STD	DOE Standard
DSA	Documented Safety Analysis
FHA	Fire Hazards Analysis
HRA	Human Reliability Assessment
INPO	Institute of Nuclear Power Operation
JTA	Job Task Analysis
LCO	Limiting Conditions for Operation
MAR	Material at Risk
NNSA	National Nuclear Security Administration
SAC	Specific Administrative Control
SC	Safety Class
SR	Surveillance Requirement
SS	Safety Significant
SSC	Structures, Systems, and Components
STD	Standard
TSR	Technical Safety Requirements
WEMS	Waste and Environmental Management System

1. INTRODUCTION

1.1 Scope

This Standard provides guidance applicable to Administrative Controls (AC) that are selected to provide preventive and/or mitigative functions for specific potential accident scenarios, and which, also have safety importance equivalent to engineered controls that would be classified as Safety Class (SC) or Safety Significant (SS) if the engineered controls were available and selected. This class of AC is designated as Specific Administrative Controls (SAC).

Similar to the classification of Structures, Systems, and Components (SSC) as Safety SSCs, not all ACs requiring specific actions related to individual accident scenarios rise to the level of importance of SACs, as discussed in the previous paragraph. Similar to SSCs of lower importance, which are sometimes referred to as “important to safety” or “defense in depth” SSCs, SACs of lesser importance can be addressed under the implementation of related Safety Management Programs. However, when a specific action AC is elevated to the class of SAC, then the guidance of this Standard should be used to enhance assurance of the effectiveness and dependability of these important administrative controls beyond that which might be experienced if the specific action AC were simply to be implemented under the auspices of a Safety Management Program.

The organization of this Standard is as follows: Section 1 introduces the concept of SACs and relates this to the existing requirements for derivation of safety bases, including hazard analyses, identification of hazard controls, derivation of Technical Safety Requirements (TSR), and the role of AC in the TSR. Section 1 also describes the general expectations for the formulation, implementation, and maintenance of AC.

Section 2 provides guidance for criteria used to classify ACs as SACs, the application of the safety approach from Department of Energy (DOE or Department) Order 420.1A, *“Facility Safety”*, to SACs, and how SACs are formulated, implemented, and maintained.

Section 3 provides guidance on measures, which should be used to improve the dependability of SACs.

Section 4 provides guidance on the formats for treatment of SACs in TSRs.

Section 5 discusses causal and failure analyses as applied to SACs.

Section 6 presents TSR examples.

1.2 Purpose

This Technical Standard clarifies and focuses existing requirements and guidance for the development and implementation of ACs relied on to perform specific safety functions of importance similar to those of safety SSCs. To focus attention on the unique issues associated with this type of AC, this Standard introduces a classification of AC to be known as a Specific AC (SAC). An SAC exists when an AC:

a. is identified in the Documented Safety Analysis (DSA) as a control needed to prevent or mitigate an accident scenario, and
b. has a safety function that would be SS or SC if the function were provided by an SSC.

This increased focus is intended to improve the dependability of these controls and to enhance their availability to perform specific safety functions when needed. This Standard should be used to comply with all DOE methods for DSAs and their associated TSRs for compliance with Code of Federal Regulations (CFR) 10 CFR Part 830, "*Nuclear Safety Management*," when developing and implementing SACs. It replaces interim guidance contained in Nuclear Safety Technical Position (NSTP) 2003-1, *Use of Administrative Controls for Specific Safety Functions.*

1.3 Applicability

The information contained in this Standard is intended for use by all Department elements, including the National Nuclear Security Administration (NNSA), and all contractors for DOE-owned or DOE-leased, hazard category 1, 2, or 3, nuclear facilities or nuclear operations. The guidance applies to DSAs complying with all the "safe harbor methods" of 10 CFR Part 830, and the associated TSRs.

1.4 References

a. 10 CFR Part 830, *Nuclear Safety Management*

b. NSTP 2003-1, *Use of Administrative Controls for Specific Safety Functions.*

c. DOE-STD-3009-94,CN2, *Preparation Guide for U.S Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*

d. DOE Guide (G) 421.1-2, *Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830*

e. DOE G 423.1-1*, Implementation Guide for Use in Developing Technical Safety Requirements*

f. DOE O 420.1A, *Facility Safety*

g. DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for Use With DOE O 420.1, Facility Safety*

h. DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, especially the Attachment to the Order, Chapters X, “Independent Verification”, XI, “Logkeeping”, and XVI, “Operations Procedures”

i. DOE O 5480.20A, Chg. 1, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*

j. DOE-STD-1029, Change Notice No. 1, *Writer’s Guide for Technical Procedures*, December 1998

k. DOE-STD-1120, *Integration of Environment, Safety, and Health into Facility Dispositioning Activities*

l. *Excellence in Human Performance,* Institute of Nuclear Power Operations, September 1997

m. *Guidelines for the Conduct of Operations at Nuclear Power Stations,* Institute of Nuclear Power Operations, INPO 01-002, May 2001

n. *Putting the Human into Hazard Assessment,* Helen Rycraft, BNFL, a paper presented at the 2003 annual meeting of the Energy Facility Contractors Group (EFCOG) Safety Analysis Working Group (SAWG), Salt Lake City, June 2003

o. “*Environmental Management Guidelines and Lessons Learned for Nuclear Facility Safety Control Selection and Implementation,*” May 20, 2003; Memorandum and its Attachment from the Assistant Secretary for Environmental Management

1.5 Relationship of DOE-STD-1186-2004 to 10 CFR Part 830, DOE G 423.1-1, DOE G 421.1-2 and Safe Harbor Methods for DSAs under 10 CFR Part 830

Subpart B of 10 CFR Part 830, "Safety Bases" requires contractors responsible for hazard category 1, 2, and 3 nuclear facilities to develop safety bases for those facilities. The safety bases consist of DSAs and hazard controls in TSRs derived from the DSA hazard analyses. Various guides and technical standards, such as this document, provide guidance to help interpret and implement requirements, including the DSA safe harbor methodologies listed in 10 CFR Part 830, Appendix A, Table 2.

The methodology in DOE-STD-3009-94, CN2, *Preparation Guide for U.S Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, is an acceptable method for preparation of a DSA for nonreactor nuclear facilities. STD-3009 CN2 provides detailed guidance for preparation of SARs (DSAs), including the derivation of TSRs. The general guidance of STD-3009 in methodologies for hazard analysis and specification of hazard controls and their classification is applicable to all the safe harbor methodologies (see DOE G 421.1-2, Section 5.3, *Hierarchy and Selection of Safety Items* (Hazard Controls), as is the guidance for SACs in this Standard.

Dispositioning activities such as decommissioning and environmental restoration provide unique challenges. In these types of activities, it is common that the hazards and the hazard control sets change as the work progresses. More application-specific guidance for dispositioning activities can be found in DOE-STD-1120, *Integration of Environment, Safety, and Health into Facility Dispositioning Activities.*

STD-3009 addresses derivation of ACs relative to the anticipated application of ACs with major significance to defense in depth, or worker safety. These ACs are typically implemented through safety management programs. Inclusion of these ACs in the TSRs formally acknowledges the importance of programmatic commitments (e.g., radiation protection, maintenance, quality assurance) to overall facility safety, but usually do not specify key aspects of each program as providing specific safety functions. The cumulative effect of these safety management programs is recognized as being important to overall facility safety, as opposed to specific accident risk reduction.

DOE Guide 423.1-1, *Implementation Guide For Use In Developing Technical Safety Requirements,* provides detailed guidance for developing TSR content, including ACs. Section 4.10.7 of the guide recognizes that ACs may be applied for risk reduction of individual accident scenarios. When ACs specifically state a limit or specific requirement rather than a generic programmatic reliance, failure to meet such statements can result in a TSR violation. In contrast, a TSR violation of a safety management program can only result from a gross program failure, significant enough to render the DSA assumptions invalid.

DOE G 423.1-1 and DOE STD-3009 continue to provide relevant guidance on the application of ACs as part of the DSA-required controls. However, this document provides additional amplification and clarification for the appropriate development and implementation of ACs.

1.6 Expectations for the Formulation, Implementation, and Maintenance of Specific Administrative Controls

The development, selection, and implementation of an effective set of hazard controls are among the most important elements of nuclear safety. DOE has established a priority process that favors preventive over mitigative measures, passive design features over active controls, and engineered controls over ACs. The approved process recognizes that, where necessary or practical, ACs may play an important role in hazard prevention and mitigation.

This Standard consolidates and clarifies existing DOE rule guidance and standards so that contractors may formulate, implement, and maintain ACs consistent with their importance to safety. This Standard also provides expectations for the formulation, implementation, and maintenance of ACs when relied on to provide specific safety functions of SS/SC importance, and to ensure existing ACs of this nature are evaluated and improved.

1.6.1 Formulation (Design), of Specific Administrative Controls

The general approach to formulating SACs, as described in this Standard, parallels existing guidance for designing safety SSCs. Primary guidance for nuclear safety design criteria is found in DOE O 420.1A, Section 4.1, and its associated implementation guide, DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for use with DOE O 420.1., Facility Safety*. These documents contain requirements and guidance for safety SSCs that have been adapted for SACs as follows:

1) Safety analyses shall establish the identification and functions of SACs and the significance to safety of the functions of the SAC.
2) The ensemble of safety controls including SACs, where designated, shall be designed and configured to provide multiple layers of protection to prevent or mitigate the unintended release of radioactive materials.
3) Defense-in-depth, as applied to the formulation of SACs shall include conservative “design” margins.
4) Engineering evaluations, trade-offs, and experience shall be used to develop practical SACs that achieve the functional safety objectives.
5) Adequacy of SACs to perform effectively their required safety functions shall be documented in the DSA.
6) SACs shall be formulated so that they can perform their safety functions when called upon and under a quality assurance program that satisfies 10 CFR 830, Subpart A.
7) Classification of Administrative Controls as SACs shall use the same criteria as used for Safety SSCs in STD-3009, *Preparation Guide For U.S Department Of Energy Nonreactor Nuclear Facility Documented Safety Analyses*.
8) SACs shall be configured with appropriate safety margins to support assurance of safety functions.
9) Appropriate human factors engineering should be integrated with the formulation of SACs.
10) In some cases, SACs rely on supporting SSCs to perform their intended safety function. These SSCs should meet performance requirements consistent with their safety importance.

Considerations and guidance for satisfying these corollaries to SSC design guidance, as applied to SACs, are provided in sections 2 and 3 of this Standard.

1.6.2 Derivation of Hazard Controls in the DSA

The provisions in 10 CFR 830.204 require a DSA to “Derive the hazard controls necessary to ensure adequate protection of workers, the public, and the environment, demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards, and define the process for maintaining the hazard controls current at all times and controlling their use.”

All hazard controls are identified and characterized in support of the DSA. Judgments must be made regarding what constitutes appropriate controls. These judgments should consider the level of the hazard and potential consequences, the practicality and effectiveness of possible control options, the importance of the mission of the facility, and other relevant factors, if any. These are all elements of the graded approach.

Hazard controls in the DSA are selected to reduce the risks of hazardous activities. Controls are classified by comparison to an evaluation guideline in the case of safety class SSCs for protection of the public, and by criteria described in DOE STD-3009 for safety significant SSCs for worker protection and defense-in-depth. SC and SS SSCs are expected to be addressed in TSRs.

When selecting hazard controls, it is preferable to choose engineering controls over ACs due to the inherent uncertainty of human performance. When choosing engineering controls, it is preferable to choose passive SSCs over active SSCs. When ACs are selected over engineering controls, and the AC meets the criteria for an SAC as provided in this Standard, the AC shall be designated as an SAC.

While SACs may be acceptable for ensuring safe operation, they must be evaluated carefully when choosing safety measures for long-term hazardous activities because of their generally lower reliability compared with engineered controls. The actual design and selection process should consider the ensemble of controls used to address a hazard, such as cost, availability, required reliability, and consequence of mechanical or human failure for each potential control. SACs have elevated safety significance, and have more stringent implementation and verification requirements to ensure their effectiveness and dependability, as described in this Standard.

Controls identified as part of a safety management program (e.g., fire, criticality, radiation protection, etc.) may or may not end up as controls that need to have enhanced dependability, as is the case with SACs, based on the designations derived from the hazards and accident analyses in the DSA. Hazard controls should be identified on a case-by-case basis and should be graded according to the guidance in DOE G 421.1-2, *Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830,* DOE STD-3009, and this Standard, with regard to the classification of hazard controls.

For site-wide safety management programs (e.g., radiation protection), the DSA should explain the features of those programs that are important to the facility safety basis and can refer to the site-wide program documentation for the details. As appropriate to the hazard, the DSA may identify specific controls (e.g., hazardous material inventory limits) that are required for safety. These controls should be considered for designation as an SAC as discussed in this Standard.

1.6.3 The Role of ACs in TSRs

There are instances where an AC may be the most important control. Such instances may include limiting the Material-at-Risk (MAR) for the facility. Accident analysis consequences could be unbounded if MAR is not established for the accident in question; therefore, MAR becomes the most important underlying assumption for all accident analyses as an AC. Another instance where an AC may be one of the most important controls for a nuclear facility is in controlling transient combustible loading. Fire accident scenarios have the potential to release large amounts of hazardous materials, including radioactive and chemical materials. Therefore, controlling fire accidents in DOE facilities is of vital importance. If a facility's fire protection system design assumes that the combustible loading does not exceed a certain level, then required controls to ensure this level is not exceeded are expressed as an AC. Because these instances represent bounding conditions for the safety basis, these ACs should be designated as SACs, following the guidance given in this Standard for improving the dependability of these controls.

1.6.4 Application of ACs and SACs

A clear distinction is made between programmatic ACs and SACs. Most ACs in the TSRs are designed to provide broad programmatic support for safety management programs supporting defense-in-depth, or worker safety. Failure to maintain all aspects of one of these programs will not result in a safety basis violation unless there is a gross failure significant enough to render the DSA assumptions invalid (i.e., a programmatic breakdown). These ACs are classified as programmatic ACs. Programmatic ACs should not be used to provide specific or mitigative functions for accident scenarios identified in DSAs where the safety function has importance similar to, or the same as, the safety function of safety class or safety significant SSCs. The classification of SAC, as defined in this Standard, was specifically created for this safety function. ACs meeting the criteria in this Standard for selection as SACs should be formulated, implemented, and maintained in accordance with the guidance in this Standard.

2. IDENTIFICATION, FORMULATION, IMPLEMENTATION, AND MAINTENANCE OF SACs

2.1 Identification of SACs

The specificity of ACs within the DSA/TSR will vary depending on the severity of hazards, the complexity of the facility, and the administrative control's overall contribution to controlling potential accident consequences (i.e., primary or supplemental control). SACs may also be needed to protect important initial conditions assumed in the hazard analysis (e.g., the assumption on combustible inventory limits).

Depending on the situation, some ACs that perform specific preventive or mitigative functions for accident scenarios may be identified in hazards analyses. These are more specific functions than implied by general commitments to safety management programs, and they may need to be raised to a higher importance level. Some of these ACs may have critical importance similar to or the same as those that would be classified as SC or SS, if the safety functions or objectives were performed by engineered safety systems. These types of ACs shall be classified as SACs in accordance with the criteria provided below:

If an administrative control:

a. is identified in the DSA as a control needed to prevent or mitigate an accident scenario, and
b. has a safety function that would be safety significant or safety class if the function were provided by an SSC,

then the AC shall be designated as an SAC. Identification as a control in a hazard analysis is a necessary criterion for an SAC. It may be explicitly specified as a control in the DSA (item a), or it may be a discrete attribute of a safety management program that was not specifically called out in the hazard analysis (item b).

Other factors that may be useful to designate an AC, identified as a control in a hazard analysis, as an SAC include:

a. The AC is the basis for validity of the hazard or accident analyses (e.g., a hazardous material inventory, such as combustible materials or Material-at-Risk (MAR) limit)
b. ACs provide the main mechanisms for hazard control (e.g., Safety SSCs are degraded, out of service, too costly to implement, or are impractical for a limited-life facility)

2.2 Formulation of SACs

DOE O 420.1A, *Facility Safety*, Section 4.1.1.2, addresses the design requirements for nuclear safety. The Order states:

> "Nuclear facilities shall be designed with the objective of providing multiple layers of protection to prevent or mitigate the unintended release of radioactive materials to the environment. Defense in depth shall include: … the provision of multiple means to ensure critical safety functions (those basic safety functions needed to control the processes, maintain them in a safe state, and to confine and mitigate radioactivity associated with the potential for accidents with significant public radiological impact)…".

These principles also apply to the formulation, development, and implementation of the ensemble of hazard controls, including SACs. Engineering evaluations, trade-offs, and experience shall be used to develop practical SACs that achieve the functional safety objectives.

Redundancy, independence, and diversity of hazard controls are important principles for ensuring that exposure to a high consequence accident does not come about due to the failure of a single barrier. When SACs are part of the hazard control ensemble, these principles are applied to the ensemble. Designation of an SAC as the primary line of defense (i.e., control) should be avoided whenever possible, because ACs are generally regarded as less dependable due to the introduction of potential human error. However, if an SAC is the primary line of defense for protection of the public, these principles should be applied to the SAC. The terms redundant, independent, and diverse are discussed below:

Redundant: Important safety functions should not be protected by a single control. The design process should strive to achieve an appropriate level of redundancy in the development of controls. In this context, redundancy refers to a second control to provide the same safety function (as distinguished from diverse controls).

Independent: Controls should be independent of the process being controlled, and to the extent practicable from other controls that have been credited.

Diverse: To avoid the increased likelihood of failure due to common-cause effects, diverse controls should be employed to the extent practicable. In this context, diversity refers to separate controls of a dissimilar nature (as distinguished from merely redundant controls).

The application of these principles acknowledges that an SAC may be included as a portion of the ensemble of hazard controls that satisfies the Order's requirements for providing multiple layers of protection to confine and mitigate radioactivity associated with the potential for accidents with significant public radiological impact. When SACs are used in this capacity, they should be formulated, implemented, and maintained following the guidance given in this Standard for improving the dependability of these controls and enhancing their availability to perform specific safety functions when needed.

The application of these principles also acknowledges that an SAC should not be designated as the only control provided to confine and mitigate radioactivity associated with the potential for accidents with significant public radiological impact, to ensure that exposure to a high consequence accident does not come about due to failure of a single barrier.

DOE O 420.1A, *Facility Safety*, Section 4.1.1.2 also requires that "Safety SSCs identified in accordance with this section shall, commensurate with the importance of the safety functions performed, be designed: (1) so that they can perform their safety functions when called upon to operate, and (2) under a quality assurance program that satisfies 10 CFR 830.120." These criteria also apply to SACs.

SACs should be formulated to reliably perform their safety function under those conditions and events for which their safety function is intended, with an appropriate margin of safety. The formulation should incorporate, commensurate with the importance of the safety function, multiple levels of protection against normal, anticipated, and accident conditions.

The DSA required by 10 CFR 830.204 furnishes the technical basis for hazard controls. DOE STD-3009 provides guidance to identify and document SC and SS SSCs as required in Chapter 4 of a DSA. Where SACs are used, similar identification and documentation should be provided in the DSA. For example, the reason for designating the control as an SAC and its preventative or mitigative safety function should be discussed. A description of how the SAC is to be implemented (i.e., important procedural features, including interfaces with sensors, etc.) should be presented. Pertinent aspects of the SAC that relate directly to the safety function, such as qualifications of personnel required and time available to perform associated tasks, should be described. Finally, an evaluation of the SAC that demonstrates its capability to perform the expected safety function should be described for each SAC.

The DSA should provide information (generally Chapter 5 of a DSA based on DOE STD-3009) to support the derivation of hazard controls described in the TSR document. This Chapter content is the linking document between the DSA hazard analysis that results in the designation of SACs and their required safety functions and attributes, and the TSR document. TSR and SAC procedure writers will refer to the DSA through this chapter to identify the accident scenarios that generated the need for the SAC (in Chapter 3), and information on its safety function and required attributes. Chapter 5 should provide a summary description of this information and references to the supporting information in Chapters 3 and 4.

The concepts of validation and verification are important to the formulation of SACs. These concepts, as they apply to SACs, are discussed below.

Validation: The functional requirements and performance criteria for safety SSCs are identified to support the safety functions identified in the DSA and to support subsequent derivation of TSRs. The formulation of SACs should include a similar process that validates plant operators can perform the task(s) called for in an SAC within the timeframes assumed in the DSA. If SACs require operator action and perform a function similar to a safety SSC, assurance should be provided that the operators can adequately perform their required tasks by analyzing the following human performance factors at a minimum:

- Adequacy of the description of the task in facility procedures
- Level of difficulty of the task
- Design of the equipment and feedback, e.g. indicators, alarms, etc.
- Time available to do the task or recover an error
- Stress levels induced by the external environment, e.g. noise, heat, light and protective clothing worn.

Formal engineering calculations may be necessary to ensure that plant operators have the appropriate time and resources to carry out the required tasks. For example, if it is assumed that operators will take actions to detect and isolate a leak, flow rate calculations will need to be performed to substantiate the available time interval necessary to accomplish the task. Consequences of incorrect implementation of the control should be evaluated and measures to prevent control failure should be factored into the control formulation.

If SACs require operator action and perform a function similar to a SC SSC, a human reliability assessment (HRA) should be performed as part of the Specific AC formulation. The HRA validates the dependability of an SAC and can identify weaknesses in the proposed procedures to implement an SAC and suggest additional measures to improve the overall dependability.

Verification: SACs implemented by TSRs must be initially (prior to operation) and periodically verified to perform their intended safety function. In the context of SACs, this may involve "dry runs," procedure walk-downs, tabletop exercises, or actual hazard/casualty exercises. Additionally, the verification process should be performed by knowledgeable individuals who were not part of the formulation of the control to assure an unbiased assessment of the effectiveness of the control. In addition, the control should be formulated so that it is easily and readily verifiable through appropriate and ongoing testing, examination or surveillance activities. Periodic re-verification that SACs are performing, or capable of performing, their intended safety function should be addressed through Limiting Conditions for Operation (LCO) Surveillance Requirements (SR) for SACs written as LCOs, or through facility operations and maintenance procedures if the Specific AC is incorporated into the AC section of the TSRs.

2.3 Implementation and Maintenance of SACs

SACs are generally procedures. These procedures should include specifications for implementation such as qualifications of involved personnel, steps involved, verification of identified limits, frequency of verification, requirements for any independent verifications, interfaces with measuring equipment, and the required accuracy of the equipment, etc. TSRs are the formal requirements that implement those procedures and recovery actions in the case of breakdown of the control. SACs are addressed through the TSRs generally by two forms as identified below.

a. LCO/Surveillance Requirement

Specific AC TSRs can often be written in the format of an LCO.

b. Specific “Directive Action” AC

A Specific "Directive Action" AC TSR can be in the Administrative Controls section of the TSRs.

These are discussed in Section 4 of this Standard.

Configuration Management: DOE O 420.1A, *Facility Safety*, Section 4.5.1.2 states:

> “Configuration management shall integrate the elements of system requirements and performance criteria, system assessments, change control/work control, and documentation control. Documents that define the system design basis (or when the design basis is not clearly defined, the identification of system requirements and performance criteria essential to the system’s performance of its safety function, the basis for the requirements, and how the current system configuration satisfies the requirements and criteria) and supporting documents shall be compiled and kept current using a formal change control/work control program.”

It is important that these requirements are applied to SACs to assure the continuing ability of SACs to perform their safety function when called upon.

3. MEASURES USED TO ENSURE THE DEPENDABILITY OF SACs

3.1 Lessons Learned on Human Actions Used for Safety Controls in Accident Scenarios

Human actions, either taken in response to an event or taken proactively to establish desired conditions, are subject to errors of omission or commission. Experience shows that ACs are prone to common cause failure. The following attributes have proven value in improving worker performance in utilizing ACs:

- Use of reader/worker/checker systems
- Independent verification
- Positive feedback systems
- Interlocks
- Warning signs and barriers
- Alarms and monitors
- Human factor analysis
- Operator training and certification
- Continuing training and re-qualification
- Abnormal event response drills
- Ergonomic considerations in procedures
- Dry runs for non-routine operations
- Use of double staffing or direct supervision for hazardous operations
- Human Reliability Assessment

Each of the above attributes used to improve worker performance in utilizing ACs should be carefully evaluated for improving the dependability of SACs. Implementation of each these attributes may not be practical or necessary for every Specific AC. DOE O 5480.19, *Conduct of Operations*, and this Standard provide guidance for improving the dependability of SACs based on the safety function performed by the Specific AC.

3.2 Conduct of Operations

The dependability of all hazard controls, including SACs, is improved by implementing the facility-appropriate sections of the guidelines for conduct of operations provided in DOE O 5480.19. Proper conduct of operations is a key safety management program and should be addressed in the facility DSA as such. The guidelines in DOE O 5480.19 form a compendium of good practices and describe key elements of programs that support operations at DOE facilities. These may be applied to improve the dependability of SACs.

Two key elements of a proper conduct of operations program that can improve the dependability of SACs are Independent Verification and Lockouts/Tagouts. Detailed guidance is provided in DOE O 5480.19 for each of these program elements. The following discussion provides specific guidance relative to improving the dependability of SACs.

3.2.1 Independent Verification

SACs, which require operation of components, or verification of components condition or position, should be included in the facility's independent verification program. As such, these verifications should be identified explicitly in facility procedures or other official documents. DOE O 5480.19 provides the following specific guidance on Independent Verification Programs.

> "Components that are critical to ensure safe and reliable operation should receive an independent verification of their position when circumstances warrant. These components should be identified explicitly in facility procedures or other official documents so that unnecessary interpretation of requirements will be minimized."

Independent verifications supporting SACs should be conducted in a manner so that each check constitutes an actual identification of the component or action, and a determination of both its required and actual positions or condition. To be independent, the integrity of the checks must be maintained by minimizing interaction between the personnel operating components and those performing the independent verifications. For example, it is not always possible to determine if an operator has completely shut or opened a valve by merely observing the action; mistakes in component identification or requirement determination might not be caught without both individuals reading the labels and procedures.

3.2.2 Lockouts and Tagouts

A Lockout /Tagout program as described in DOE O 5480.19 should be used to support implementation of SACs where the SACs require that equipment, components or equipment controls be placed in a specific position or condition during operations to support the safety basis. Use of this program to support an SAC further ensures that the requirements of the

Specific AC are implemented using detailed administrative procedures, training of personnel, and uniquely identifiable tags.

DOE O 5480.19 provides the following specific guidance on the use of Locks and Tags:

> "Locks and Tags should be used on those components that require special administrative control for safety or other reasons. Locks and Tags provide some security that a component will be operated only by authorized facility personnel performing required evolutions in a controlled fashion. Additionally, Locks and Tags should alert the operator of the importance of the component and remind him/her that special controls over repositioning are to be maintained. In this respect, all personnel should receive training regarding their responsibilities concerning the manipulation of locked or tagged controls."

A Tagout program meeting the guidelines in DOE O 5480.19 includes the placement of a Tagout device on an energy-isolating device, in accordance with an established procedure, to indicate that the energy-operating device and the equipment being controlled many not be operated until the Tagout device is removed. Similarly, a Lockout program meeting the guidelines in DOE O 5480.19 includes the placement of a Lockout device (e.g., a lock, or hasp with a lock in place) on an energy isolating device in accordance with an established procedure ensuring that the energy-isolating device and the equipment being controlled cannot be operated until the Lockout device is removed. An effective Lockout/Tagout program should be developed by each facility and should include detailed administrative procedures, training of personnel, and uniquely identifiable tags. The program should also exercise appropriate control over Lockout/Tagout preparation, approval, placement, and removal; provide for adequate documentation; and be consistent with the requirements of 29 CFR 1910.

3.3 Instrumentation, Controls and Support Equipment for SACs

Operators often must rely on effective instrumentation and controls and support equipment to implement SACs. For this reason, instrumentation and controls and equipment that support an SAC should meet performance requirements consistent with the importance of the safety function of the Specific AC.

3.4 Training and Qualification for SACs

Training requirements for contractor personnel are generally stated under the Quality Assurance requirements of 10 CFR Part 830 and in DOE O 5480.20A, Chg. 1, as discussed below. These requirements are applicable to all contractor personnel involved with nuclear facilities, including management and supervisory personnel, technical staff, and operations personnel. As a minimum, hazard analysts, personnel involved with formulation of SACs, and TSR writers should receive training on the guidance of this Standard. Training on TSRs for operations personnel should include specific training on attributes of the SACs as identified in the Safety Basis. Training should also include training on the implementing procedures for SACs.

3.4.1 10 CFR 830, Subpart A, Quality Assurance Requirements

The requirements for training of personnel in DOE nuclear facilities are addressed through Section 830.121, "Quality Assurance Program", and Section 830.122, "Quality Assurance Criteria."

Section 830.121 requires that: "(a) Contractors conducting activities, including providing items or services, that affect, or may affect, the nuclear safety of DOE nuclear facilities, must conduct work in accordance with the Quality Assurance criteria in § 830.122."

Section 830.122 establishes the following criteria for Management/Personnel Training and Qualification:

a. Train and qualify personnel to be capable of performing their assigned work
b. Provide continuing training to personnel to maintain their job proficiency

3.4.2 DOE O 5480.20A, Chg. 1

Detailed guidance on operator training programs is provided in DOE O 5480.20A, Chg. 1, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities.* The Order is implemented using a graded approach at DOE nuclear facilities based on the facility hazard categorization. Contractors at these facilities are required to prepare a Training Implementation Matrix, which defines and describes the application of the selection, qualification, and training requirements of the Order. This Matrix includes any exceptions to requirements, which are not implemented.

The following training issues should be evaluated carefully for applicability to new SACs, and existing SACs, as defined in this Standard.

Personnel Selection: The minimum qualification and experience requirements of the personnel performing the task should be considered carefully when formulating, implementing, and maintaining SACs. Some SACs may require operators with special knowledge, skills, or physical abilities. In the combustible loading example previously noted, such a control will require an individual with specialized knowledge and experience in assessing the fire hazards in an area. Some controls rely on the ability of the operator to distinguish color differences, to perform strenuous tasks, or gain access to relatively inaccessible areas. These specific factors must be considered explicitly in the formulation, implementation, and maintenance of SACs.

Job Task Analysis: The formulation of SACs should include a thorough job task analysis (JTA). A JTA will identify the required plant instrumentation, physical controls, operator skills and abilities, and other important variables necessary to successfully perform the task. The JTA should include or incorporate the appropriate human factors considerations in developing the controls.

Initial Qualification Requirements: Depending on the results of the JTA, the operator training and qualification requirements for tasks related to SACs should then be developed. The training requirements should account for and disposition each important variable in the JTA, hazard analysis, or other basis documents being used to develop the SAC. Many hazard and accident analyses contain assumptions (both implicit as well as explicit) regarding the ability of the operators to detect and respond to accident scenarios. It is important to identify clearly these assumptions so that operators are specifically trained with respect to the SACs that are credited in the analysis. The training program should identify explicitly the required training for SACs. Additionally, consideration must be given to the development of formal written and practical examination requirements for these ACs.

Continuing training requirements: In addition to formal, initial training requirements, the knowledge and skills set for SACs should be considered for inclusion in a continuing training program. This will ensure that the important training objectives for the controls are periodically reinforced to plant operators, supervisors, and managers. Additionally, such learning objectives should be considered in formal, periodic re-qualification programs.

3.5 Establishing a Safety Culture

There are many aspects, both organizationally and operationally, to establishing a safety culture in facilities involving hazardous operations. The Institute of Nuclear Power Operations (INPO) Excellence in Human Performance Initiative 2001 (Ref. k) identified the key principles in developing an appropriate safety culture to improve human performance. Excellence in human performance is more likely when both workers and managers embrace the following principles:

a. People are fallible, and even well trained and experienced staff can make mistakes
b. Error-likely situations are predictable, manageable, and avoidable
c. Individual behavior is influenced by organizational processes and values
d. People achieve high levels of performance based largely on the encouragement and reinforcement received from their leaders, peers, and subordinates
e. Most accidents can be avoided by understanding the reasons mistakes occur and applying the lessons learned from past events

Some of the INPO recommendations that are most relevant to dependable implementation of SACs include:

a. Communicate expectations and work plans accurately and frequently. When work processes are changing daily, job briefings and use of repeat backs are encouraged.
b. Inform coworkers, supervisors, and managers when there is a potential problem with performing a task. Perform post-job critiques to identify process improvements.
c. Anticipate error-likely situations. Most hazardous activities require both the worker and the backup/supervisor to understand the work process.
d. Verify instructions, equipment, location, and time constraints.
e. Focus attention on the task. Think through the steps and key decision points of a task before acting.
f. Expect success, but anticipate failure. Routinely ask "what if."
g. Take the time to do the job right.
h. Make sure schedules do not interfere with safety.
i. Follow approved procedures with a sense of caution.
j. Stop the task and collaborate with others when unfamiliar or unanticipated conditions arise.

Leaders and managers at DOE nuclear facilities should foster a work environment that encourages these behaviors on the part of the operations staff.

4. TREATMENT OF SACs IN TSRS

The TSR derivation section in the DSA provides a link between the identified hazards, safety SSCs, and ACs necessary to ensure safety.

4.1 TSR Treatment of Safety Controls Covered by Safety Management Programs

The traditional type of TSR ACs are the provisions relating to organization and management, procedures, record keeping, reviews, audits governing safe operations, and safety management program commitments. Existing DOE directives *(References b. and d.)* specify that the AC section of the TSR document will contain commitments to establish, maintain, and implement these programs at the facility and, as appropriate, facility organizational and administrative requirements.

Programmatic ACs are credited in safety basis documents with a significantly lower level of specificity than are SACs. Absent in their selection are specific limits or discernible operator actions relating to specific hazard or accident analysis conditions. Rather, these ACs contain basic program elements or features that constitute the viability of the safety management program to support safe operations.

These ACs typically flow down as performance requirements contained in organizational or company-level procedures. Prior to implementation of DOE approved TSR ACs, contractors should first take appropriate actions to ensure a control's availability and readiness. These actions may include programmatic assessments, development or modification of facility procedures, and training of facility personnel. Continuing implementation of the programmatic control is typically verified through continuing assessment and performance monitoring (trend analysis).

4.2 Implementing SACs in TSRs

When SACs are identified, they shall be controlled through the TSR. Two methodologies are acceptable for the appropriate treatment of SACs in TSRs. The first involves using the conventions for LCOs and associated SRs. Placement of the LCO and SR for an SAC should be in the Operating Limits and SR section of the TSR. This format should be used when the

Specific AC is well defined, clear corrective actions are available, and conditions supporting the Specific AC can be easily surveilled. An example of this type of format is shown in Example 1.

Guidance for developing and writing LCOs is provided in DOE G 423.1-1. Although this guidance is directed at LCOs used to support Safety SSCs, an SAC has a safety function with importance similar to, or the same as, the safety function of safety class or safety significant SSCs. As such, the guidance given in this section can be directly applicable to SACs written as LCOs. SACs written as LCOs should generally comply with the guidance given in DOE G 423.1-1 for LCOs including, but not limited to, Specification for Limiting Conditions for Operation, Action Statements, Operability, Surveillance Requirements, Violation of Technical Safety Requirements, and TSR Bases.

The second method available to incorporate SACs in a TSR document is to identify the specific requirement/action in a special section in the Administrative Control section of the TSR. This format may be appropriate when it is essential that the Specific AC be performed when called upon every time and without any delay (e.g., hoisting limits for nuclear explosives, MAR limits, or expected responses during criticality safety infractions not covered by an LCO) or when definitive program requirements for specific activities can be stated. An example of this type of format is shown in Example 2 of this section.

4.3 Considerations In Developing a Material at Risk (MAR) TSR Control:

MAR is the major analytic assumption that must be made before a hazard analysis can support any consequence binning beyond the purely subjective and before any non-qualitative accident analysis can be initiated. Further, MAR assumption violations place the facility in a formally unanalyzed space for which consequences would be unknown and potentially unbounded. It is essential that MAR assumptions be protected in a highly reliable and enforceable manner. However, it is not normally possible to control MAR with an active or passive SSC. Under normal circumstances, MAR cannot be controlled through a Design Feature or SSC based LCO. This leaves only administrative-type controls in the form of a TSR Section 3 / 4 (Operating Limits and Surveillance Requirements) LCO (in itself a type of Administrative Control) for MAR or a TSR Section 5 AC (Programmatic AC or Specific AC).

Use of an LCO is warranted when a defensible estimate can be made of how much of a MAR limit can be exceeded. Provided this estimate can be made, it may be possible to make an estimate of the risk involved in exceeding the analyzed MAR for some time interval to support LCO action times as well as associated surveillance frequencies. The surveillance frequencies are established to ensure a reasonably confident expectation that MAR will not be exceeded. This must be documented in the supporting BASIS statements. When it can be defended, use of a MAR LCO has the advantage of allowing the facility an action completion time which, if met, would preclude a TSR violation. There are also feasibility limits associated with the LCO approach in addition to the need for estimating the potential size and duration of MAR exceedances. An example of this would be a facility that needs to control MAR in a very large number of locations because of the way that the accident analysis was performed. If, for example, a facility analysis was performed on a glove box, room, wing, and facility wide basis and each of these yielded its own MAR limit. For consideration purposes, assume that for a large facility, there may be 200 glove boxes, 100 rooms, two wings, etc. In this example, each location may require its own entry in the TSR LCO creating a very large number of entries (in this case potentially more than 300 entries). This could make the TSR LCO unduly complex and unwieldy from a human factors reliability perspective.

In the event that no reasonably confident estimate can be made of potential MAR exceedances to support action times and surveillance frequencies, or if the LCO is too complex and unwieldy, it may be hard to defend an LCO approach. In this case, it would be appropriate to use a TSR Section 5 Specific AC. Because of the importance of controlling MAR to within the bounds of the analyzed consequence and hazard analyses, and the need for unequivocal MAR limits in a TSR, a directive action Specific AC is preferred. However, directive action SACs do not support action times to allow the facility some time to correct the MAR exceedance. For the case involving the use of SACs, directive language should be used in the form of a SHALL statement which sets the maximum MAR limit. A violation of this Specific AC limit is an immediate TSR violation in this case.

4.4 TSR Use and Application Modifications for SACs

In both cases, the Use and Application section of the TSR should define the ground rules for treating SACs, including treatment of non-compliances as TSR violations and associated reporting requirements. In addition, it is helpful to include a statement of the basis of the Specific AC where it is invoked.

4.5 Revising TSR Definitions to Reflect SACs

The treatment of SACs, which are distinguished from programmatic ACs, requires the addition of related terms to Section 1 of TSRs. Specifically, the following definitions would be needed.

Specific AC – An AC that provides a specific preventive or mitigative function for accident scenarios identified in the DSA where the safety function has importance similar to, or the same as, the safety function of a safety SSC. (e.g., discrete operator actions, combustible loading program limits, hazardous material limits protecting hazard analyses or facility categorization.)

5. SAC VIOLATION REPORTING AND FAILURE ANALYSIS

5.1 Notification Requirements for Violations of SACs

Violations of SACs in the TSRs must be reported to DOE in accordance with DOE O 231.1A, *Environment, Safety, and Health Reporting,* and DOE M 231.1-2, *Occurrence Reporting and Processing of Operations Information*.

5.2 Investigation and Reporting of Specific AC Violations

DOE G 231.1-2, *Occurrence Reporting Causal Analysis Guide*, provides guidance on how to determine the Apparent Cause(s) of specific reportable occurrences including TSR violations, and to explain the structure and nodes of the Causal Analysis Tree for use in occurrence reporting and failure analysis.

Identifying the causes for Specific AC violations is often difficult. The identification of human error as a root or contributing cause of violations provides little information about how to prevent similar problems from recurring. Recognizing human performance problems when they occur and accurately identifying their causes are necessary first steps to developing effective corrective actions. The investigator(s) should be both experts in human performance and the process or facility involved in the violation. See NUREG/CR-6751, *The Human Performance Evaluation Process: A Resource for Reviewing the Identification and Resolution of Human Performance Problems*.

TSR violations, including Specific AC violations, that may occur during operation of the facility, must be investigated to determine their specific or generic cause(s) and generic implications, corrective actions recommended, and those violations reported to the DOE as required by 10 CFR 830.205, DOE O 231.1A, and DOE M 231.1-2.

6. Examples

Example 1 – Example LCO Format for SACs

(TRU Waste Storage Facility)

<u>3/4 OPERATING LIMITS AND SURVEILLANCE REQUIREMENTS</u>

3.3 TRU Waste Storage Facility Material at Risk (MAR) Inventory Control

LCO: The quantity of nuclear material in containerized waste at TRU Waste Storage Facility **SHALL NOT** exceed the following MAR limits:

------------------------------------NOTE--

All MAR inventory limits are provided in curies equivalent of Pu239 unless otherwise stated.

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1. The total quantity of nuclear material present at WASTE STORAGE FACILITY SHALL NOT exceed 2000 Curies.

<u>AND</u>

2. No single 55-gallon drum shall be ≥ 150 Curies

<u>OR</u>

3. No waste boxes or crates shall be ≥ 300 Curies

MODE APPLICABILITY: At All Times

PROCESS AREA APPLICABILITY: Entire Facility

3.3 Limiting Condition for Operation: TRU Waste Storage Facility MAR Inventory Control ACTION(s)

CONDITION	REQUIRED ACTION COMPLETION	TIME
A. Total inventory of material within drums and waste boxes is exceeded	A.1 Suspend all waste container receipts at WASTE STORAGE FACILITY. **<u>AND</u>** A.2 Bring WASTE STORAGE FACILITY into compliance with quantity limits.	1 Hour 3 Weeks

B. Waste container Material at Risk limits are exceeded	B.1 Suspend all waste container movements within 10 feet of the non-compliant waste container. **AND** B.2.1 Remove the non-compliant waste container from WASTE STORAGE FACILITY **OR** B.2.2 Bring the non-compliant waste container into compliance with the material at risk limits.	1 Hour 3 Weeks 3 Weeks

SURVEILLANCE REQUIREMENTS	FREQUENCY
SR 3.3.1 Verify that quantities of waste in containers do not exceed the total limits for combined drums and waste boxes	Monthly
SR 3.3.2 Verify that the curie content of a containerized waste item that is to be received at Waste Storage Facility does not exceed the material at risk limits.	Before shipment OR At receipt

BASES:

BACKGROUND SUMMARY	Inventory Control and Material Management provides control for the location, storage configuration, and handling of nuclear material within WASTE STORAGE FACILITY based on the quantity, type, and form. This element protects the assumptions of the accident analysis that limit the amount of MAR available for potential release in the event of an accident.
APPLICATION TO SAFETY ANALYSIS	Accidents resulting from a breach of TRU waste containers can result in significant consequences to workers and potentially the public. Specific controls and restrictions are placed on radiological material inventory (containerized waste items and WASTE STORAGE FACILITY) to prevent the introduction of materials into WASTE STORAGE FACILITY that would invalidate the safety basis.

LCO 3.3	The total quantity of containerized waste that can be stored in WASTE STORAGE FACILITY is restricted to 2,000 plutonium-239 equivalent curies. Compliance shall be demonstrated by tracking the total quantity of nuclear material present within all waste boxes and other containers. The LCO set the initial MAR for accident scenarios that involve the entire WASTE STORAGE FACILITY waste inventory (i.e., major fire, seismic). The initial MAR determination for these scenarios is based on projected waste container loading to the Site 95th UCL + 20% values. Using these values represents a very conservative MAR determination for the entire WASTE STORAGE FACILITY inventory. The MAR loadings for the highest estimated single TRU containers were used in the safety analysis for scenarios involving just a few waste containers and are carried forward as requirements. Compliance with these requirements can be demonstrated by utilizing the Waste and Environmental Management System (WEMS) database and process knowledge, scan data, radiological surveys, or other assessment methods indicating that the waste is TRU. Therefore, WEMS must contain a curie value or a waste type designation of TRU prior to acceptance of a container. High Americium wastes do not fall in the category of TRU and are not evaluated in this safety analysis.
MODE APPLICABILITY	Waste storage is the only activity conducted in the WASTE STORAGE FACILITY.

ACTIONS A.1 and A.2	If WASTE STORAGE FACILITY exceeds the total quantity of material permitted, the building shall be brought into compliance to re-establish the assumptions of the WASTE STORAGE FACILITY specific safety analyses. Compliance may be re-established by removing container(s) from WASTE STORAGE FACILITY, re-assay to obtain a more accurate count, or expert review of an existing assay. Bringing WASTE STORAGE FACILITY into compliance within 3 weeks is required. Three weeks is considered adequate time for facility management to identify, communicate with, and coordinate a transfer to an appropriate on-site facility.[1]

[1] Each facility must provide technically a defensible basis for Action Statement time limits based on analyses performed for the respective LCOs and associated Action Statements.

ACTIONS B.1 through B.2.2	If a waste container in WASTE STORAGE FACILITY contains more that the specified nuclear material at risk limits, all container movement in the vicinity of the non-compliant waste container must be suspended within 1 hour. Based upon the simplicity of the container movement activities in WASTE STORAGE FACILITY, one hour is judged to be adequate to notify all workers in the vicinity to suspend movement activities and to safely secure the handling equipment and waste containers involved. If a waste container in WASTE STORAGE FACILITY contains more than the specified nuclear material limits, the waste container is to be removed from the facility or brought into compliance to re-establish the assumptions of the WASTE STORAGE FACILITY specific safety analyses within 3 weeks. Compliance may be established by re-assay to obtain a more accurate count or expert review of an existing assay. Three weeks is considered adequate time for facility management to identify, communicate with, and coordinate a transfer to an appropriate on-site facility or to re-establish container compliance. An increase in a specific waste container MAR does not have any impact on contiguous waste containers, other than for issues dealing with criticality. Therefore, for all accidents not involving a criticality, high MAR containers do not require container segregation. The Criticality Safety Program is credited for handling any criticality issues related to high MAR containers and their movement. The likelihood of an occurrence of an accident involving identified high MAR waste container(s) is small during the maximum three-week interval for removal.[2]
SR 3.3.1 and 3.3.2	Performance of SR 3.3.1 and 3.3.2 on a monthly basis assurances WASTE STORAGE FACILITY compliance with material at risk limits. Performance of SR 3.3.1 and 3.3.2 “before shipment” OR “at receipt” assures that WASTE STORAGE FACILITY is operated within the bounds of the safety analysis. A WEMS query may be used to perform SR 3.3.1, and SR 3.3.2.

[2] Each facility must provide technically a defensible basis for Action Statement time limits based on analyses performed for the respective LCOs and associated Action Statements.

Example 2 – Example Directive Action Format for SACs

Material-at-Risk Limit

Critical Safety Function

The material-at-risk (MAR) limit is the initial underlying assumption for the accident analysis performed in Chapter 3 of the DSA. The MAR limit protects this assumption and ensures that the consequences determined in the accident scenario are not invalidated placing the facility in formally unanalyzed space.

Control Description

The facility tritium limit SHALL be $\leq$ 50 grams.

Basis

The accident scenario in Chapter 3 of the DSA that produced the highest dose consequences (bounding scenario) to the public assumed a facility wide fire that consumed the entire facility inventory of 50 grams of tritium with 100% oxidation. Assuming a 100% oxidation of the tritium produces the highest dose conversion factor (DCF) for tritium uptake of 96 rem/Ci. Therefore, the MAR limit for the facility must be set to $\leq$ 50 grams of tritium to ensure that the bounding consequences are not exceeded as analyzed in the DSA.

CONCLUDING MATERIAL

Review Activity:	**Preparing Activity:**
EM	DOE EH-22
NNSA	
EH	**Project Number:**
NE	SAFT-0091
SC	

Field and Operations Offices:	**Area and Site Offices:**
CH	Brookhaven Area Office
OH	Los Alamos Site Office
ORP	Pantex Site Office
RL	Sandia Site Office
CBFO	Argonne Area Office
ID	Livermore Site Office
OR	Nevada Site Office
RFFO	Savannah River Site Office
SR	Y-12 Site Office