

Accident Sequence Initiators Cornerstone

Background

Licensees are required by 10 CFR 70.62 to implement a safety program that includes process safety information, an integrated safety analysis (ISA), and management measures to ensure that engineered controls and control systems that are identified as items relied on for safety (IROFS) are designed, implemented and maintained to ensure they are available and reliable. In developing the ISA, licensees are required to identify potential hazards and potential accident sequences caused by process deviations, other internal events, and credible external events. Licensees are required by 10 CFR 70.72 to implement a configuration management system to manage changes. Licensees are also required by 10 CFR 70 to track failures of IROFS or management measures.

In developing the revised 10 CFR Part 70, the NRC developed two key companion documents, NUREG 1520 (now revision 1), "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility" and NUREG-1513, "Integrated Safety Analysis Guidance Document." These NUREGs provide background information for this cornerstone. In explaining an accident sequence as used in developing an ISA, NUREG-1513 (Section 2.6.5.1) notes:

An accident sequence involves an initiating event, any factors that allow the accident to propagate (enablers), and any factors that reduce the risk (likelihood or consequence) of the accident (controls). The accident sequence is a sequence of specific real events. The initiating event is often the failure of some device or feature of the process that is an item relied on for safety. Such events are sometimes process upsets, but the frequency of such upsets is almost always controlled by features of the design or by operating procedures. Hence, these process features are being relied on for safety. Alternatively the initiating event could be a challenge from outside the system, that is, an external event. For an initiating event to lead to the consequences of concern it must usually be above a certain level of severity. For example, excursions of process parameters beyond normal conditions may be an upset, but if within safety limits, there is no chance of further progression. The subsequent events in the accident sequence are usually failures of hardware controls or manual procedures to limit or prevent damage.

Appendix C to NUREG-1520 (page 3-C-1) notes that initiating events can be (1) an external event such as a hurricane or earthquake, (2) a facility event external to the process being analyzed (e.g., fires, explosions, failures of other equipment, flooding from facility water sources), (3) deviations from normal operations of the process (credible abnormal events), or (4) failures of an IROFS in the process.

Appendix B to NUREG-1520 (page 3-B-4) notes that in developing the ISA, initial conditions and bounding assumptions must be identified and, if susceptible to change over the lifetime of the facility (such as through process deviations or facility changes), must be appropriately maintained. Appendix C to NUREG-1520 (page 3-C-4) notes that the safety program required by 10 CFR 70.62(a) should have provisions for implementing the appropriate management controls to maintain the validity of the initiating event frequencies.

The Accident Sequence Initiators cornerstone includes evaluation of the following elements to determine whether they were adequately analyzed by the licensee in the ISA or other safety

analysis and whether they continue the ISA's assumptions (such as frequency or credibility):

- Initiating events – external events (external to the facility); facility events external to the process being analyzed; and deviations from normal operations of the process (credible abnormal events). Failures of IROFS that are initiating events are considered in the Safety Controls cornerstone.
- Enabling conditions - conditions or assumptions whose increase or change is credible, and, if changed adversely, could cause an increase in accident frequency.
- Unforeseen events or errors of commission.

Objectives

The objectives of this cornerstone are to ensure that a licensee:

- limits the frequency of accident sequence initiators that lead to the need for IROFS, nuclear criticality safety (NCS) controls, or other safety controls.¹ The ISA or safety analysis assumed a frequency for accident sequence initiators in establishing IROFS, NCS controls, and other safety controls. These IROFS, NCS controls, and other safety controls would be required by the license or 10 CFR Part 70 as a result of the safety analysis, ISA or NCS analysis showing that they are needed to limit the likelihood of intermediate or high consequence accidents or prevent a nuclear criticality accident.
- evaluates and limits, as appropriate, accident sequence initiators that are not required to be limited or controlled by IROFS, NCS controls, or other safety controls (non-IROFS). These are accident sequence initiators that the licensee has determined do not need to be prevented or have their likelihood limited based on the ISA. This could be because the ISA shows that they may be allowed to occur without causing likelihoods or consequences defined in Part 70.
- has identified in the ISA or safety analysis all accident sequence initiators associated with uses of licensed materials and has appropriately assessed the accident sequences to identify those which require IROFS, NCS controls, or other safety controls to prevent or mitigate intermediate or high consequence events and prevent nuclear criticalities.

Desired Results

Demonstration that there is reasonable assurance that accident sequence initiator frequencies are consistent with the safety analysis or ISA (for both accident sequences that require and do not require IROFS, NCS controls, or other safety controls) and that all accident sequence initiators have been identified by the licensee.

Key Attributes and Scope.

¹ Other safety controls – NCS controls, chemical safety controls, or radiation safety controls at facilities not licensed under Part 70 that are identified in the license, technical safety requirements, license or certificate application, or safety analysis. For facilities licensed under Part 70, NCS controls, chemical safety controls, or radiation safety controls required by the license or described in the license application, ISA, or safety analysis that are not IROFS or NCS controls required by Part 70.

Those attributes of licensee performance that affect accident sequence initiators are shown in Figure 1.

1. Protection Against External Events

- a. Fire Protection Scope – This inspection is conducted to evaluate fire protection against fires external to the facility. The inspection is conducted in two phases. Phase one consists of annual assessment of conditions related to ignition sources, control of combustible materials, and fire protection systems and equipment. (For licensees with resident inspectors, Phase 1 is conducted at the frequency specified in resident inspection procedures.) Phase 2 is a periodic inspection that is a more in-depth review of fire protection for IROFS and other fire protection aspects required by the license or included in the license application.
- b. Flood Protection Scope - Inspection activities in this area focus on a licensee's readiness to protect IROFS, NCS controls, and other safety controls from potential internal and external flooding. These inspection activities would include walkdown of key plant areas to determine whether flood protection features are adequately implemented, review of procedures including verification of key operator actions credited for coping with flood, and evaluation of compensatory measures during impending conditions of flooding or heavy rains. The inspectors will also focus on determining whether the licensee's flooding mitigation plans and equipment are consistent with the licensee's ISA or safety analysis.
- c. Cold or Hot Weather Protection Scope - Inspection activities in this area focus on a licensee's readiness to protect IROFS, NCS controls, and other safety controls from potential impacts from cold and hot weather. These inspection activities would include walkdown of key plant areas to determine whether cold or hot weather protection features are adequately implemented, review of procedures including verification of key plant staff actions credited for coping with cold or hot weather and evaluation of compensatory measures during impending conditions of cold or hot weather. The inspectors will also focus on determining whether the licensee's cold or hot weather protection plans and equipment are consistent with the licensee's ISA or safety analysis.
- d. Offsite Power Reliability Scope – Inspection activities in this area focus on a licensee's actions to ensure the reliability of offsite power during adverse weather conditions such as freezing rain or high winds.
- e. Surveillance Testing Scope – Inspection activities focus on determining whether surveillance testing is adequate to determine the readiness for protecting IROFS, NCS controls, and other safety controls from external factors such as earthquakes, tornados, hurricanes, high winds, high temperatures, cold weather, fires external to the facility, and other adverse weather-related conditions. Inspectors determine whether IROFS, NCS controls, and other safety controls would perform within the design assumptions for adverse weather or other external events. Inspectors review surveillance test results for adequacy in meeting the requirements, observe ongoing testing to evaluate staff performance, and ensure that test acceptance criteria are in agreement with IROFS, NCS control, and other safety control specifications.

2. Design (to Identify Accident Sequence Initiators)

- a. Licensee Analysis Scope - Inspection activities in this area focus on selected systems processing licensed material to determine whether the accident sequence initiators and accident sequences evaluated as part of the safety analysis, ISA or ISA development effectively identified accident sequence initiators. Inspectors should review the licensee's analyses of selected systems and activities (included in the safety analysis or ISA or excluded from the ISA or safety analysis because the licensee determined that the accident sequence was non-credible). As part of this evaluation, inspectors should observe the installed equipment and licensee staff activities to operate the equipment. If inspectors are unable to observe equipment operation during the inspection, inspectors should conduct walk-throughs with plant staff to evaluate equipment operation. In evaluating whether the ISA or safety analysis has identified accident sequence initiators appropriately, inspectors should consider:
 - i. Staff Performance – Inspections should focus on whether the licensee's ISA or safety analysis considered appropriately the complexity of actions required by licensee staff and considered potential staff performance deficiencies appropriately in accident sequence initiator determination.
 - ii. Procedure Quality – Inspections should focus on whether the licensee's ISA or safety analysis considered appropriately the complexity of actions required by licensee staff and provided in procedures adequate guidance and considered potential staff performance deficiencies from deficient procedures appropriately in accident sequence initiator determination.
 - iii. Facility and Equipment Performance – Inspections should focus on whether the licensee's ISA or safety analysis appropriately considered potential facility or equipment failure modes and frequencies. Inspectors should observe equipment operation to identify potential failure modes and resultant accident sequence initiators and compare them to those analyzed in the ISA or safety analysis.
- b. Configuration Control Scope – Inspectors should review select systems to determine whether the licensee's ISA or safety analysis design has been adequately maintained in the equipment, as installed and used, such that the licensee did not introduce new accident sequence initiators with plant modifications. If the licensee has not maintained the ISA or safety analysis design, inspectors should identify any potential accident sequence initiators introduced by configuration control issues.

3. Accident Sequence Initiator Frequency

- a. Accident Sequence Initiators that Result in IROFS, NCS Controls, or Other Safety Controls Scope

Inspectors should first identify the accident sequence initiators (from the ISA or other safety analysis) for selected accident sequences that resulted in the licensee establishing IROFS, NCS controls, and other safety controls. Inspectors then should

determine the actual frequency of the occurrence of the initiators to the selected accident sequences. Inspectors should evaluate these actual frequencies to determine whether the actual frequencies of the initiators are consistent with the frequency assumptions in the ISAs or other safety analysis. Inspectors then should review the licensee's evaluation of the causes of the failures that resulted in the accident sequence initiator. If the licensee has not evaluated the cause of the initiator, inspections should determine the causes (such as staff performance, procedure quality, design, facility and equipment performance, or configuration control) and then determine the effectiveness of the licensee's actions to prevent or control the occurrence of the initiator.

b. Accident Sequence Initiators that do not Result in IROFS, NCS Controls, or Other Safety Controls Scope

Inspectors first identify the accident sequence initiators (from the ISA or other safety analysis) to selected accident sequences that, because of low likelihood, do not require that licensee's establish IROFS, NCS controls, and other safety controls. Inspections then determine the actual frequency of the occurrence of the initiators to the selected accident sequences. Inspectors evaluate these actual frequencies to determine whether the actual frequencies of the initiators are consistent with the frequency assumptions in the ISAs or other safety analysis. If the actual frequencies are higher than the frequency assumptions in the ISA or other safety analysis, review the licensee's actions as a result of the increased frequencies, such as establishing IROFS because of the increased likelihood of the accident sequence.

4. Corrective Action Program (CAP)

CAP Scope (Audits/Audit Findings, Infraction Follow Up, Event Follow Up, and Other CAP Findings) - Inspection activities include reviews of selected accident sequence initiator items in the licensee's CAP to determine whether the items were adequately identified and corrected. This inspection is to complement the periodic inspection of the CAP program that evaluates implementation of the overall CAP program. This process is a management measure for Part 70 licensees.

Metrics Used to Measure Key Attributes

Key Attribute	Area to Measure	Metric
Protection Against External Events	Fire protection	Licensee actions ensure availability and reliability of controls and IROFS per Part 70 and ISA or safety analysis and license
	Flood protection	Licensee actions ensure availability and reliability of controls and IROFS per Part 70 and ISA or safety analysis and license
	Cold or hot weather protection	Licensee actions ensure availability and reliability of controls and IROFS per Part 70 and ISA or safety analysis and license
	Offsite power reliability	Licensee actions ensure availability and reliability of controls and IROFS per Part 70 and ISA or safety analysis and license
	Surveillance testing	Results in capable, available and reliable per Part 70 and ISA or safety analysis and license
Design (to identify Accident Sequence Initiators)	Licensee analysis in ISA or safety analysis	Results in credible accident sequence initiators and accident sequences identified as required by Part 70 or license
	Configuration control to assure accident sequence initiators and accident sequences in ISA or safety analysis adequate	Meet 70.61 and 70.72 and license requirements
Accident Sequence Initiator	Those that result in IROFS, NCS controls, or other safety controls	Meet or below ISA assumed frequency

Frequency		
	Those that do not result in IROFS, NCS controls, or other safety controls	Meet or below ISA assumed frequency
Corrective Action Program (CAP)	Audits/audit findings	Audits conducted as required by license and findings resolved adequately and in a timely manner
	Infraction follow up	Follow up resolves issue, prevents reoccurrence and adequately considers extent of condition
	Event follow up	Follow up resolves issue, prevents reoccurrence and adequately considers extent of condition
	Other CAP findings	Other IROFS or Criticality Safety issues in CAP adequately resolved

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Figure 1

