Non SC/SS DID Controls Evaluation

By

M. K. Gupta, L. Eppler, and L. A. Wooten

1.0 Terms and Definitions

Anticipated – frequency that is greater than or equal to 10^{-2} per year.
Beyond Extremely Unlikely - a frequency of occurrence that is conservatively estimated to be less than 10^{-6} per year.
Defense in Depth – Defense-in-depth refers to the broad-based layers of controls that help to reduce the risk of operations to the public, the worker, and the environment. It is based on multiple layers of hazard control that defend against release by nonreactor nuclear facilities even though they do not possess the catastrophic accident potential associated with nuclear power plants. These controls may be SSCs classified as Safety-Class or Safety-Significant, may include SSCs classified as Production Support or General Service, and may be Administrative Controls.
Extremely Unlikely – frequency which is greater than or equal to 10^{-6} per year and less than 10^{-4} per year.
General Services - the Functional Classification assigned to all SSCs not required to provide a Safety Class, Safety Significant, or Production Support function.
Mitigate – to lessen the severity of consequences of an event.
Mitigated – taking credit for preventors and/or mitigators.
Non-SS/SC Control – a control that is not classified as Safety Significant or Safety Class.
Prevent – to lessen the frequency of an event.
Production Support – the Functional Classification that applies to those SSCs necessary to support continued operation of a Nuclear Production Facility and to selected environmental monitoring and Emergency Plan communications devices.
Public – population outside the Site boundary at the time of the event.
Safety Class (SC) Function – a preventative or mitigative function that must be performed to keep Hazardous Material exposure to the Public below the Offsite Evaluation Guidelines.
Safety Class SSC – an SSC that performs a Safety Class function.
Safety SSCs – the set of Safety Class and Safety Significant structures, systems, and components for a given facility.
Safety Significant (SS) Function – a preventive or mitigative function whose performance is a major contributor to Defense in Depth (i.e., prevention of uncontrolled material releases) and/or Worker safety as determined from Hazard Analysis.
Safety Significant SSC – an SSC that performs a Safety Significant Function.
Unlikely – frequency which is greater than or equal to 10^{-4} per year and less than 10^{-2} per year.
Unmitigated – taking no credit for either preventors or mitigators.
Worker – population within the site boundary.

Non SC/SS DID Controls Evaluation

2.0 Introduction

A new approach has been developed by Westinghouse Safety Management Solutions to augment the current authorization basis approach and identify new defense-in-depth equipment. This approach was developed to fulfill a need expressed by the Savannah River Site Department of Energy. The defense-in-depth philosophy is a fundamental approach to hazard control for nonreactor nuclear facilities. In keeping with the graded-approach concept, no requirement to demonstrate a generic, minimum number of layers of defense-in-depth is imposed. However, defining defense-in-depth as it exists at a given facility is crucial for determining a safety basis. Operators of Department of Energy facilities use the application of defense-in-depth thinking in their designs and operations. Such an approach is representative of individual operations with an effective commitment to public and worker safety and the minimization of environmental releases. These new defense-in-depth controls are referred to as non-safety class, non-safety significant defense-in-depth controls called NSDID controls and the evaluation process is called the NSDID process. The new controls have a unique limited treatment in operation.

3.0 Evaluation Process

The purpose of the Defense-in-Depth evaluation is to demonstrate lower, more "realistic" dose consequences and facility risk, when (potentially) more safety features than the limited set classified as Safety-Class are taken into consideration. While this Defense-in-Depth evaluation does not become part of a facility's authorization basis, it is meant to present a fuller picture of layers of defense that can reasonably be counted on to help prevent or mitigate accident events.

If the existing SC and SS controls do not meet the Offsite Defense-in-Depth Goals listed in Table 1, additional Defense-in-Depth SSCs and administrative controls shall be selected from the mitigators and preventers that currently exist in the hazard analysis (HA). These controls previously have not been selected to provide a Safety-Class or Safety-Significant function for the event (these newly selected SSC items shall be referred to as Non-SC/SS Defense-in-Depth or NSDID). A qualitative evaluation of the risk reduction, considering Safety-Class, Safety-Significant, and Non-SC/SS Defense-in-Depth controls, will be performed. The evaluation will be consistent with the methodology and level of conservatism for the just completed SC and SS evaluation. The same values will be consistently used for parameters that are equivalent phenomena (e.g., meteorology, release fractions, damage ratios, or inventory). However, the values for parameters that are new and unique for the Non SC/SS Defense-in-Depth items shall be based on engineering judgement and represent nominal (i.e. mean/median) values. The evaluation will be performed and documented to the requirements of an Engineering Calculation**.** The conclusions of the evaluation will be documented in the "Defense-in-Depth Qualitative Evaluation" Technical Report. This Technical Report will not be part of the Authorization Basis (i.e., it will not be approved by DOE). The list of Non-SC/SS Defense-in-Depth SSCs and administrative controls will be documented in an Authorization Basis document along with reference to the Defense-in-Depth Qualitative Evaluation Technical Report in a section immediately following the "Beyond Design Basis" text of the Design Basis Accident Section of the SAR (or the equivalent in a BIO). Additionally, a statement shall be provided in the Authorization Basis along with the reference to the Technical Report to reflect the risk of operation as found (expected to be well

below the values in the Authorization Basis) that credit the Safety-Class and Safety-Significant controls along with any selected Non SC/SS Defense-in-Depth items.

The Defense-in-Depth evaluation is qualitative in that the use of engineering judgement is permitted. It is quantitative in that consequence numbers generated during the evaluation are estimates made to evaluate the need for additional controls (with the exception that no consequence estimates are required for accidents that are judged to be incredible when DID controls are taken into consideration). The qualitative nature of the assessment may be expressed by listing results (i.e., dose estimates) as a range of values, rather than as a single value (suggested techniques for generating these ranges of values are described in Section 4.0).

The offsite consequences calculated during the DID process (which consider the additional controls described in the preceding paragraph) should be compared to the Defense-in-Depth Goal values listed in the Table 1.

The steps listed below are the responsibility of a team consisting of WSMS, facility, and (optionally) DOE representatives. Most of the work described below should be performed at meetings of the team.

In order to facilitate performing this work rapidly and efficiently, the WSMS Accident Analysis (AA) Group team member(s) facilitates team activities. This facilitation work includes preparing tables of accidents and "first cuts" for the various parts of the DID assessment prior to the team meeting. The AA group facilitation enables the team meeting to concentrate on evaluating and concurring with (or adjusting) preliminary estimates made by the facilitators and/or selecting from analysis options prepared by the facilitators, rather than having the meeting be a "brainstorming" session (which would be likely to generate the need for additional follow-up meetings). Following the team meetings, the AA Group prepares a draft of the Engineering Calculation documenting the team's efforts, incorporates comments made by other team members during their review of the draft Engineering Calculation, and serves as the official author and technical reviewer of the final Engineering Calculation.

The objective and format of the DID process and report can be modified to fit needs and objectives of specific facilities. However, such modifications do not reduce the scope of work or the contents of the technical report to levels below the minimum requirements.

IDENTIFICATION OF THE NEED FOR DEFENSE-IN-DEPTH

Defense-in-Depth accident analysis evaluation is required for accidents where unmitigated consequences exceed the Offsite Evaluation Guidelines. These guidelines could vary from site to site in the DOE Complex. This is the same set of accidents for which Design Basis Accident (DBA) Analyses are performed. A table containing the SC items, SS items, and additional HA items (items remaining after SC and SS items) for each accident is prepared. The SC, SS, and HA items are obtained from accident analysis, functional classification report, and hazard analyses,

respectively. A representative set of DBAs for a hypothetical facility are shown in Table 2. The set of DBAs that exceed the Defense-in-Depth Goal values listed in the Table 1 are evaluated as described below.

EVALUATION OF THE CONTRIBUTION OF SAFETY SIGNIFICANT CONTROLS

The DBA analysis in the SAR do not evaluate the contribution of safety significant controls. The contribution of the safety significant controls in reducing the frequency or the consequence to the offsite receptor is performed by a team for the DBAs identified in the preceding step. The set of DBAs that still exceed the Defense-in-Depth Goal values after considering SC and SS controls are evaluated as described below.

The team consists of Accident Analysis, Regulatory Programs, Facility, and DOE representatives.

DEFENSE-IN-DEPTH EVALUATION

Additional SSCs and/or administrative controls are selected from the HA list (4^{th} column in Table 2) for DBAs identified in the preceding step. A qualitative evaluation of SSC or Administrative Control's contribution in reducing the frequency or the consequence to the offsite receptor is evaluated by a team. This process of selecting additional SSCs and/or administrative controls is repeated till the offsite consequence are below the Defense-in-Depth Goal values. The NSDID items that reduce the frequency or consequence are shown as **Bold** and *italic* items in column 4 of Table 2.

An example of estimating reduction factors for an accident is given below.

4.0 Example of Typical Assessment for an Accident

This section describes a representative DID assessment for event 1 at a typical facility.

A facility-wide fire was analyzed by the Accident Analysis that resulted in an offsite dose of 2.9 rem. The accident was determined to be in the unlikely frequency category and thus, was below the offsite Evaluation Guideline value of 5 rem for an event in this frequency. Safety-Class items credited in the analysis were:

1. Building and cell design and construction.
2. Exhaust Air Tunnel
3. Sand Filters
4. Exhaust Fans
5. Portable Diesel Generator (DG) System.

6. Exhaust Tunnel Low Vacuum/Supply Fans Interlock

The safety significant items credited were:

1. Stack and Stack Liner
2. High Temperature Interlocks and Alarms
3. Electrical/Equipment Design Feature

The team qualitatively estimated that the frequency bin for event 1 would be Extremely Unlikely if SS items 2, “High Temperature Interlock and Alarms” and 3, “Electrical/Equipment Design Feature” are credited. The new frequency is calculated by applying frequency reduction factors for these items determined by the team.

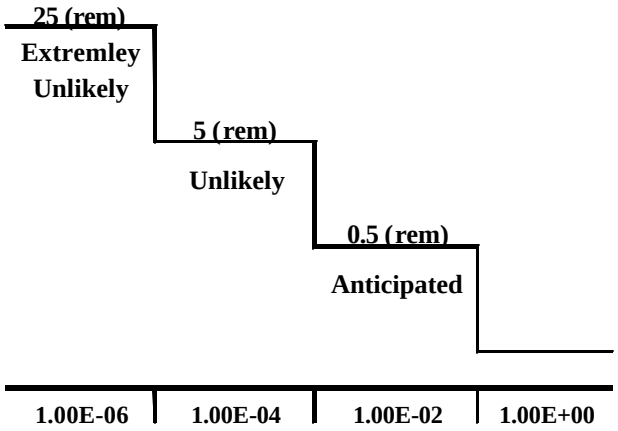
The following NSDID item was selected form Table 2 (shown in italic letters in 4th column)

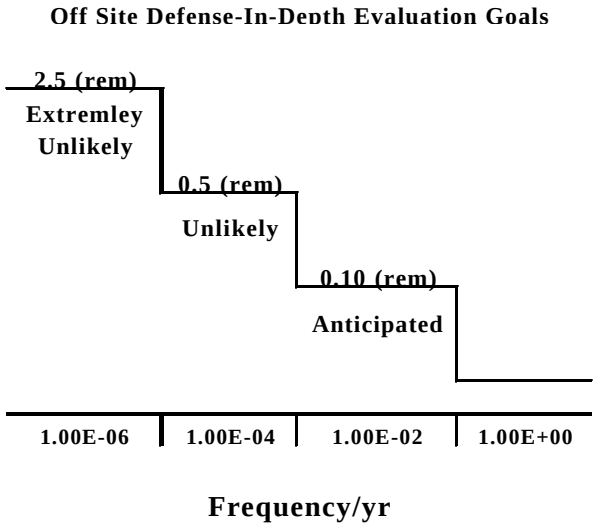
1. Sump level instrumentation and alarms

The team qualitatively estimated that the medium offsite consequence for event 1 would be reduced by 50%. Therefore, the consequences of fire are 1.45 rem after crediting NSDID item. The low and high reduction factors are 0.90 and 0.1, respectively.

Table 1

Off Site Evaluation Criteria





OFFSITE EVALUATION CRITERIA

FREQUENCY

If the frequency of an accident's release is less than 10^{-7}, then no additional Defense-in-Depth controls are required no matter what the offsite consequences may be.

TABLE 2: SAFETY CLASS, SAFETY SIGNIFICANT, AND HAZARDS ANALYSIS ITEMS

Event	Safety Class	Safety Significant	Additional Prevention and Mitigation Features from HA
EVENT 1: Fire – Organic or Solvent Material	1. Building and cell design and construction. 2. Exhaust Air Tunnel 3. Sand Filters 4. Exhaust Fans 5. Portable Diesel Generator (DG) System. 6. Exhaust Tunnel Low Vacuum/Supply Fans Interlock. 7. Exhaust System Failure Alarm.	1. Stack and Stack Liner 2. High Temperature Interlocks and Alarms 3. Electrical/Equipment Design Feature	1. Prevention Design Features A. Vessel level instrumentation and alarms B. Sump level increase response procedures C. Temperature limits 2. Mitigation Design Features A. Emergency Response procedures B. Deluge system C. Fire barriers D. Stack monitors E. *Sump level instrumentation and alarms*
EVENT 2: Coil and Tube failure to Segregated and Circulated Cooling Water Return System	1. Monitors, Alarms, and Timers 2. Diversion Valves and associated Motor Operators 3. Design Feature – Delay Basin	1. Design Feature – Cooling Coils	1. Prevention Design Features A**. Low Coil Pressure Alarm** B. Piping material and Design C**. Coil Pressure Control System** D. Operating procedures (including coil pressure control). 2. Mitigation Design Features A. Level instrumentation.
EVENT 5: Natural Phenomena - Earthquake	1. Vessel Design Feature 2. Building. 3. Exhaust Air Tunnel 4. Sand Filters 5. Exhaust Fans 6. Portable DG System. 7. Building Structure. 8. Exhaust Tunnel Low Vacuum/Supply Fans Interlock. 9. Exhaust System Failure Alarm. 10. Low Level Alarm 11. Administrative Control - One exhaust fan in operation within 48 hours of a DBE	1. Emergency Response Program	None