March 5, 2009

To: J. N. McKamy Manager, NCSP

From: J. A. Morman Chair, CSSG

Subject: **CSSG Response to Tasking 2009-02**

In response to Tasking 2009-02 a subgroup of the Criticality Safety Support Group (CSSG) was organized to address the development of a uniform criticality incident categorization scheme.

The response team consisted of the following members.

James Morman, CSSG Member and Team Lead
David Erickson, CSSG Member
Ivon Fergus, *ex officio* CSSG Member
Adolf Garcia, CSSG Member
David Heinrich, CSSG Member
Davis Reed, CSSG Member
Tom Reilly, CSSG Emeritus Member
Hans Toffer, CSSG Member Emeritus
Robert Wilson, CSSG Member
Todd Taylor, End-Users Group Liaison

Sample categorization schemes were requested from users throughout the complex. Starting with those responses, the CSSG team formulated a categorization scheme that addresses the specific topics in the tasking statement (attached to the report).

The report was reviewed by the entire CSSG and minor comments were incorporated into the version that is attached. This version represents a consensus position by the entire CSSG.

cc: CSSG Members
J. Felty
N. Ellis
L. Scott

CSSG Response to Tasking 2009-02

Development and Recommendation of a Uniform Criticality Incident Categorization Scheme

March 5, 2009

Introduction

The Criticality Safety Support Group (CSSG) was directed in Tasking 2009-02 (see Attachment 1) to review existing criticality incident categorization schemes and develop a recommended scheme that could be used on a complex-wide (DOE) basis. A consistent scheme would make comparative evaluations more straightforward and proved a basis for communicating lessons learned to the criticality safety community. A subgroup of the CSSG was formed to address this task.

The CSSG response subgroup, with assistance from the chair of the end-users group, issued a call for examples of categorization schemes in use throughout the industry. The responses indicated that there were basically two broad systems in use today. The first general scheme is based on a few-group approach, reflecting whether several, one or no barriers exist to a criticality accident. The other set of examples address lower-level criticality safety incidents and typically had five or six levels of categorization. Since these examples were more comprehensive in the types of incidents that were categorized, they provide more opportunities to track minor incidents that might by symptomatic of a more serious problems in the criticality safety program at a site or across the complex. The CSSG response subgroup decided to base the recommended scheme on the more detailed example schemes that were submitted.

In the response to the tasking the CSSG was directed to address the following points.

- use of a graded approach
- differences between loss of control and unexpected changes in reactivity
- reduction in the margin of subcriticality vs. exceeding mass limits
- incident reporting requirements

Each of these points is addressed in the following sections.

Use of a Graded Approach

It is clear that some facilities operate with a larger margin of subcriticality than others, depending on the materials in use and the nature of the operations. The term “graded approach” is widely used, but often interpreted differently at individual sites or facilities. Since one of the main purposes for the establishment of a uniform incident categorization scheme is to facilitate tracking, trending and comparison of incidents across the DOE complex, encouraging the use of a site- or facility-specific graded approach would be counter-productive to this purpose.

The categorization scheme described below is inherently graded as it is based on the significance of the degradation and loss of controls. The development of criticality safety controls in the nuclear criticality safety evaluation (NCSE) should be done on a graded approach based on the nature of the materials and processes for which the controls are established. If the controls are properly established, the categorization scheme will implicitly apply the graded approach based on those controls.

Difference between Loss of Control and Unexpected Change in Reactivity

An unexpected change in reactivity might signal a degradation of a control, but not necessarily loss of that control. The categorization scheme described below takes this into account by differentiating between degradation of one or more controls (Severity Level 1) and loss of one or more controls (Severity Levels 2 through 5).

Reduction in the Margin of Subcriticality vs. Exceeding Mass Limits

A reduction in the margin of subcriticality can be considered the same as an unexpected increase in the reactivity of a system, which could be brought about by exceeding a mass limit or variation of some other controlled parameter. However, exceeding a mass limit may have an effect on the reactivity of the system ranging from negligible to large, depending on the nature of the system and the degree to which the mass limit was exceeded. For large, multi-kilogram processes with a conservative mass limit that maintains the system at a far subcritical level, exceeding the limit by a few grams would result in only a negligible reduction in the margin of subcriticality. The same mass difference in another system using small amounts of fissionable solutions with a relatively small margin of subcriticality could cause an unacceptably large change in the margin. For this reason, using mass limits as such to categorize an incident is not easily adaptable to a general categorization scheme. To use such a criterion would require a correlation between reductions in the margin vs. changes in mass. If mass limit controls are properly established, the criteria given in the scheme described below, based on degradation and loss of controls, will correctly account for the effect of exceeding mass limits on the reduction in the margin of subcriticality.

Incident Reporting Requirements

The DOE has established occurrence reporting criteria in DOE O 231.1A Chg 1, *Environment, Safety and Health Reporting*, and associated guidelines in DOE M 231.1-1A Chg 2, *Environment, Safety and Health Reporting Manual*, and DOE M 231.1-2, *Occurrence Reporting and Processing of Operations Information*. In order to avoid potential conflicts with these reporting requirements, the CSSG does not recommend instituting criticality safety specific reporting requirements associated with the categorization scheme presented below.

It is assumed that each DOE site or facility has established reporting programs for safety-related occurrences that are reported internally and externally. In general terms, the CSSG would expect that incidents categorized as Severity Levels 0, 1 and 2 need to be reported only within the responsible organization, with information sent to the local DOE field or site office based on prior agreements. There are some exceptions; for example, a number of minor events may indicate a negative trend, so management may choose to report these in the same manner as more significant events. Incidents categorized as Severity Level 3 or 4 must be reported through the Occurrence Reporting and Processing System (ORPS) according the manuals cited above. Additionally, the ORPS requires reporting of any violation of a specific administrative control (SAC) or any significant degradation of any structure, system or component (SSC) credited for criticality safety in the facility documented safety analysis (DSA) and technical safety requirements (TSRs) regardless of the severity level as defined in this document. Any criticality

accident will be reported according to the appropriate DOE emergency response guidelines and manuals.

The number of requirements already in place for reporting safety incidents is sufficient to ensure that criticality safety incidents will be appropriately reported once the categorization scheme is adopted..

Recommended Categorization Scheme

The CSSG recommends the following six-level scheme for categorizing criticality safety incidents. Definitions to assist in interpreting the severity levels follow the description of the categorization scheme.

Severity Level	NCS Controls Status	NCS Incident Description
0	All controls remain intact	A failure to comply with a criticality safety program requirement that does not adversely affect the criticality safety of a process.
1	Degradation of one or more controls; multiple controls remain intact	A failure to comply with a criticality safety program requirement that results in an increased reactivity of a process or the degradation of a control.
2	Loss of a single control; multiple controls remain intact	Violation of a criticality safety limit or loss of a control, but multiple controls remains in place.
3	Loss of one or more controls with only one control remaining intact	A loss of one or more controls such that an accidental criticality is possible from the loss of an additional control. .
4	Loss of multiple controls with no credited controls remaining intact	Loss of multiple controls such that no credited controls are in place to prevent an accident (no criticality occurred).
5	No controls remain in place	*Criticality accident occurs*

Severity Level 0*:* Failure to comply with a criticality safety program requirement that does not adversely affect nuclear criticality safety. Such incidents generally result from the following circumstances.

- A deviation that does not result in an unanalyzed increase to the reactivity of the system/activity, does not degrade a credited control, does not affect the ability to identify or account for fissile material, and does not affect the systems or means to comply with established controls.
- The discrepant condition is within another program (e.g., unreviewed safety question or training), and it is determined that the deviation would not result in an increase to the reactivity of the system/activity, does not degrade a credited control, does not affect the ability to identify or account for fissile material, and does not affect the systems or means to comply with established controls.

Severity Level 1: Failure to comply with a criticality safety program requirement that results in the degradation (but not loss) of one or more credited criticality safety controls that, for example,

1. Leads to an increase in the reactivity of a system or activity beyond that analyzed as being within the normal range of operations;
2. Represents the degradation of a control credited in an implemented criticality safety evaluation;
3. Represents an activity with fissionable material for which double contingency or incredibility has not been documented or for which implemented limits or controls have been determined to be invalid.

The judgment of whether a control is only degraded or is lost should be made by a qualified criticality safety engineer. Multiple controls remain intact to prevent the potential for a criticality accident.

Severity Level 2: A criticality safety requirement was violated that resulted in a loss of a control. Multiple controls remain intact to prevent the potential for a criticality accident.

Severity Level 3: One or more criticality safety requirements were violated resulting in a loss of one or more criticality safety controls such that an accidental criticality is possible from the loss of one additional control.

Severity Level 4: One or more criticality safety requirements were violated resulting in a loss of one or more criticality safety controls such that no valid controls are available to prevent a criticality accident. A criticality accident has not yet occurred.

Severity Level 5: A criticality accident has occurred.

Definitions

Since the incident descriptions in the above categorization scheme depend on several terms that are often used with different meanings, the following definitions are provided to clarify the incident categorization levels.

contingency (or contingent event). An event (e.g., process condition upset) that may occur but that is not likely or intended, and that has a direct effect on the criticality safety of the process.

parameter. One of a set of measurable factors, such as density and enrichment, that defines a system and determine its behavior.

control. An engineered feature or administrative requirement that

- constrains one or more parameters to the range of intended values, and
- has an unlikely or lower failure rate.

Controls may be set at the level of a Technical Safety Requirement (TSR), a Specific Administrative Control (SAC) or be defined in a criticality safety program.

credited control. A control for which either preventive or mitigative credit is taken in the approved documented safety basis (such as the NCSE) for the activity.

barrier. One or more controls, either credited or uncredited, that are established to prevent a criticality accident. Barrier is sometimes used to mean the same as control.

controlled parameter. A parameter that is controlled within specified limits to maintain the criticality safety of a process. Parameters may be defined to have normal operating limits only, or may be defined with both normal operating limits and an analyzed operating envelope. The range between a normal operating limit and the analyzed operating envelope may be considered a criticality safety incident but does not necessarily represent the loss of a control.

process. An operation or series of operations performed in the making or treatment of a product including but not limited to receipt of material, chemical and physical operations, storing material and transporting material.

process condition. A specific state of a process that is defined by the values of the total set of parameters that are attributable to that process (e.g., H:X ratio, enrichment, container geometry).

Attachment 1

CSSG TASKING 2009-02
Date Issued: January 5, 2009

Task Title:

CSSG Development and Recommendation of a Uniform Criticality Incident Categorization Scheme

Task Statement:

The CSSG is directed to review existing criticality incident categorization schemes used at DOE sites (and possibly NRC or foreign categorization systems) and develop a recommended scheme that can be used on a complex-wide basis. At a minimum, the categorization scheme should take into consideration:

- the use of a graded approach depending on
    - the nature of materials and operations and
    - the quantity of materials at a given facility;
- differences between loss of control and unexpected changes in reactivity;
- reduction in the margin of subcriticality vs. exceeding mass limits;
- incident reporting requirements imposed by DOE orders or rules.

Period of Performance:

The position paper will be developed within sixty days of the date the tasking is issued to the CSSG.

Resources:

The CSSG Deputy Chair will form a review/writing team composed of CSSG members. Contractor CSSG members of the writing team will use their FY09 NCSP CSSG support funding; DOE CSSG members of the team will provide funding from their site offices. CSSG emeritus members may be included in the team on a voluntary basis.

Task Deliverables:

Within forty-five days of the date the tasking is issued to the CSSG the writing team will forward a draft categorization scheme to the entire CSSG for comments.

Within fifteen days of the date the draft position paper is distributed to the CSSG the writing team will address all comments from the CSSG and incorporate any comments that are accepted. The writing team lead will submit the categorization scheme report to the CSSG Chair for transmittal to the NCSP Manager.

Task Due Date: March 6, 2009