Department of Energy
National Nuclear Security Administration
Washington, DC 20585

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DNF SAFETY BOARD

The Honorable Peter S. Winokur
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004

Dear Mr. Chairman:

This letter is in reference to your October 23, 2013, correspondence concerning the annual reporting requirement for the Department of Energy's Nuclear Criticality Safety Program. In addition to details regarding the annual report, the Board requested a report and briefing within 120 days that details the Program Secretarial Officer's assessment of the metrics relied upon to perform effective line oversight of criticality safety programs. The attached report provides the National Nuclear Security Administration's response to your request. After you have had the opportunity to review the report, we will schedule a briefing at a time that is mutually convenient.

Metrics are a useful and necessary part of an effective oversight program. They provide useful data that is integrated with other sources of data to provide comprehensive information for a robust line oversight program.

If you have any questions or comments, please contact me at (202) 586-4379, or Dr. Jerry McKamy at (301) 903-7980.

Sincerely,

James J. McConnell
Acting Associate Administrator
for Infrastructure and Operations

Attachment

cc: Todd N. Lapointe, EM-41
Robert E. Wilson, EM-CBC

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National Nuclear Security Administration
Report on Nuclear Criticality Safety Metrics

Executive summary

This report is in response to a request from Defense Nuclear Facilities Safety Board's letter dated October 23, 2013. The letter requested the Program Secretarial Officer's assessment of the metrics relied upon to perform effective line oversight of nuclear criticality safety (NCS) programs. This report provides that assessment.

The metrics used to monitor criticality safety in the National Nuclear Security Administration (NNSA) vary from site to site. The NNSA sites where the NCS program deals with a low overall criticality risk, have 4 to 6 metrics. At the NNSA sites with greatest risk, 12 to 15 metrics are used to provide greater granularity in the analysis. Where there are 10 or more metrics, the metrics provide an increased indication of whether the program is improving or degrading. In the past, metrics have been (at some sites) limited to the performance measures tied to the award fee in the contract. The best practices in the NNSA have shown that a robust set of metrics, periodically reviewed and revised as needed, are a useful element in supporting a broad range of oversight and periodic assessments used to monitor the criticality safety program. Metrics are an effective contributor to a comprehensive oversight process, when used as part of a comprehensive evaluation of program health. A detailed analysis and discussion of the metrics currently in use, follows in the body of this report.

Sandia National Laboratories (SNL) and the Pantex Plant have programs tailored to low criticality safety risk. The Nevada National Security Site's (NNSS) contractor NsTec program generally deals with waste emplacement and small fissile mass items. The experimental work at Nevada, at the National Criticality Experiments Research Center (NCERC) is performed under the Los Alamos NCS program. The Lawrence Livermore National Laboratory (LLNL) also conducts experiments at Nevada under the purview of its NCS program. The current, recently updated Los Alamos National Laboratory (LANL) program metrics are robust, but have only been in use about a year. The LANL criticality safety program is rebuilding from a severe degradation. A site assessment at the Y-12 National Security Site (Y-12) in the fourth quarter of Fiscal Year (FY) 2013, found that the criticality safety metrics and the contractor assurance system were well utilized in driving continuous improvement. The NPO-Y-12 and LLNL metric sets are mature and used to assist in continuous improvement.

Metrics used to monitor criticality safety programs are a useful indicator of the health and status of criticality programs when used as an element of a comprehensive line oversight process. As with all elements of oversight, these metrics must be continually evaluated, revised, and adjusted in the spirit of continuous improvement so that they remain an effective element of line oversight programs. The NNSA is committed to monitoring, reviewing, trending, and improving these metrics as we seek to achieve world class excellence in all of our safety programs.

NNSA realizes improvements are needed in both the application and use of metrics. Towards that end, the NNSA Office of Infrastructure and Operations (NA-00) will conduct quarterly reviews of site/lab metrics with the field office subject matter experts and provide a brief to senior NNSA management. NNSA will also evaluate and include specific NCS indicators in the weekly dashboard reports from the field offices to senior NNSA management.

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1. Assessment of the Metrics

The metrics used to monitor criticality safety in NNSA vary from site to site. The sites where the criticality safety program deals with a low overall criticality risk generally have 4 to 6 metrics, while the sites with greatest risk have 12 to 15. Where there are ten or more metrics, the metrics provide an increased indication of whether the program is improving or degrading. In the past, metrics have been limited (at some sites) to the performance measures tied to the award fee in the contract. The best practices in the NNSA have shown that a robust set of metrics, revised as needed, are useful in support to field oversight and periodic assessment of monitoring the criticality safety program.

SNL and Pantex are sites with low criticality safety risk. The NNSS contractor (NsTec) program generally deals with waste emplacement and small fissile mass items. The experimental work at NNSS, at the National Criticality Experiments Research Center (NCERC) is performed under the LANL's NCS program. LLNL) also conducts experiments at NNSS under the purview of its NCS program. The current, recently updated LANL program metrics are robust, but have only been in use about a year. The LANL criticality safety program is rebuilding from a severe degradation. A site assessment at Y-12 in the fourth quarter of FY 2013 found that the criticality safety metrics and the contractor assurance system were well utilized in driving continuous improvement. The Y-12 and LANL Metrics sets are mature, and used to assist in continuous improvement.

2. What Metrics are Used

This section of the report is a compilation of the metrics used in the NNSA complex. Several of the sites use measures of the same performance elements worded differently to meet local needs and understandings. No one site uses all these metrics. The Department of Energy (DOE) sponsored the 1999 Criticality Safety Self-Improvement Workshop which disseminated recommendations for the use and types of metrics including a strong recommendation to avoid using metrics tracking raw infraction or deviation totals. Several sites use metrics related to correction and recurrence control for deviations or infractions.

2.1. Leading Indicators

Several of the metrics used, as well as assessment results, are leading indicators of the direction of the criticality safety program. For those metrics where significant numbers are generated frequently, comparison of short and long term moving averages also gives an indication of the direction of the program. Some of the metrics listed are facility specific. Facility Specific Terms are *italicized*.

2.1.1. Training

Training and Professional Development metrics are considered leading indicators designed to monitor technical competency among both operations staff and criticality safety staff:

- Training compliance for operations staff, and others, when required by job assignment.
- Number of Criticality safety staff members attending national or international conferences with sessions devoted to criticality safety or NCSP activities.

- Number of criticality safety staff members attending national or international standards working groups
- Number of Criticality safety staff technical seminars (i.e., prepared by criticality staff for in group or in facility use.)
- NCS Professional Development Performance – Reports the percentage of the NCS engineering population that is engaged in credited development activities (e.g., technical courses, conferences, graduate studies, etc.).
- NCS Small Group Seminars – Reports the cumulative number of small group training sessions conducted with fissile material operations crews.

2.1.2. Criticality Safety Staff Field Awareness

The following metrics regarding NCS staff performance of reviews and inspections are leading indicators. Performance of the reviews and inspections as required fosters criticality safety staff communication and involvement with operations. Field support in terms of interface with operations staff, process walk-downs, procedure reviews, and informal walk-throughs also fall in this category.

- Criticality safety staff members conduct documented walk-through inspections of rooms with operations having a significant quantity of fissionable material.
- Criticality safety staff members conduct reviews of *Operational Safety Plans* or operating procedures at least annually for rooms having significant quantity of fissional materials.
- Criticality safety staff time in Field several sites have established quantitative criteria for this in terms of numbers, hours, or percentage of staff time.
- Material Access Area (MAA) Time Index –
  The metric tracks "MAA time," which is defined as time spent in MAAs for any purpose. This is a measure of NCS engineers' field support to the facility's current process improvement plan
- Criticality safety staff support of day-to-day activities
- Criticality safety staff support of procedure reviews
- Criticality safety staff support of process walk-downs, including the required annual reviews
- Status of NCS walk-downs against the approved plan and schedule
- NCS staff presence in fissile operations areas is considered a Leading indicator.

2.1.3. Process Improvements

Process Improvement metrics are leading indicators developed by contractor and field element criticality safety management to track desired changes to facility processes needed due to facility conditions or mission changes.

- Significant reduction in the number of approved items *due to site specific mission reduction.*
- Significant reduction in the number of *Standard Criticality Control Conditions due to site specific mission reduction.*
- Completion of rework to upgrade and modernize specific portion of the existing site evaluations has been used as a metric.

2.1.4. Criticality Safety Staffing

The qualification and continuing training status of the staff is considered a leading indicator.

NCS Engineer Task Qualification – This metric tracks the percentage of NCS staff and subcontractors qualified in various NCS tasks. This is a Contractor Assurance System metric at Y-12.

2.1.5. Trends in process deviations as leading indicators

The trends in process deviations can be a useful indicator if there is enough site data to develop trends. Of the six sites discussed in this report, one has had no infractions for more than two decades, two have an average of about one per decade, one site has two to five per year, and two sites have sufficient data to consider developing trends. The discussion in this section is largely developed by the NNSA site with the largest number of individual operating tasks. Our previous estimates for the process deviation rate have been between 1 and 5 per thousand for administratively controlled process actions. The NCS staff at that site tries to find systemic issues that contribute to process deviations.

The first of these consists of a rollup of the three-month average number of all levels of recorded process deviations from criticality safety requirements. The current and average values indicate expected performance. There are three additional metrics that break down the data in other areas of interest:

- Deviations by category – This metric tracks the number of process deviations occurring per month binned by category. The top six categories are displayed and information is provided for the number in the current month and average number per month in each category. The averages per month are based upon the past year's performance. The difference in the current and average indicates the direction to expect change in the next month.

- Deviations by Operating Area – This metric tracks the number of process deviations occurring per month binned by operating area. Data is provided for the number in the current month and average number per month in each area over the past year. It is a breakdown of the Overall Field Issues metric by location of issue. This is considered to be a leading indicator.

- Deviations by Cause Bin – This metric tracks the number of process deviations occurring per month binned by cause. Data is provided for the number in the current month in each cause bin and the average per month data is based upon the past year's performance.

Self-Reporting of NCS Issues – Reports the percentage of issues self-reported by the contractor's production and line oversight organizations (i.e., NCS engineering). This is also a Contractor Assurance System metric at Y-12.

NCS Repeat Deficiencies – Reports the number of NCS deficiencies that are deemed to be "repeat deficiencies" by the site Nuclear Criticality Safety Advisory Committee. This is also a Contractor Assurance System metric dealing with recurrence control at Y-12.

Number of inadvertent transfers of fissile solution - an inadvertent transfer is a one where the solution was transferred to an unintended location or by an unintended route. It does not include simple spills. This is an indication that the facility systems are not operating as designed/intended.

NCS Issue Trends – This metric provides two years' worth of data on NCS deficiencies and minor non-compliances. This is an interactive metric that allows one to choose among four categories of issues: implementation, infrastructure, legacy, and performance. The time horizon for the display of data is adjustable so that long term or short term trends can be evaluated. This metric links directly to the local NCS database and, with the exception of the category binning assignment, is fully automated. This can be used for rapid trend analysis.

2.2. Lagging Indicators

2.2.1. Process Evaluations for Criticality Safety

This is the effort to determine that any new or revised process will be subcritical under normal and credible abnormal conditions. The effort is recorded and measured by its documentation. The quality of the process evaluations is used as a performance measure.

- Criticality safety staff performance of Criticality Safety Evaluations
- Criticality Safety Evaluations Requiring Rework due to discovery issues
- Field Office Comment Requiring Rework
- Other External comments requiring rework
  (Rework due to internal review during the evaluation process may reflect the skill of or time pressure on the staff, but is an expected part of the process.)
- Operations conducted without a Criticality Safety Evaluation. (This is captured as an infraction also; however, it is a specific metric at one site.)

2.2.2. Corrective Action Implementation

Metrics addressing Correction Action Plans and compensatory measures associated with audits and reviews should be considered lagging indicators.

The contractor management prepares a Correction Action Plan (CAP) for all deficiencies identified in self-assessments and external assessments and completes corrections promptly.

LLNL is the only NNSA site where the criticality safety group has a major responsibility in code development. LLNL implements the following metric related to software quality assurance: *completes all required interim compensatory actions related to current 10CFR830 software quality assurance requirements for COG*. This is a site-specific metric.

2.2.3. Infractions as a metric

Although no NNSA site uses infraction count as a stand-alone metric, one site (with a small number of infractions) does use infractions as an indication of performance. However, the setting of a performance threshold is deliberately avoided so that self-reporting is not discouraged. NNSA does not use raw infraction rate as a sole or primary metric because of the unintended consequences of artificially suppressing self-reporting.

2.2.4. Timeliness of Operations Support

Site-specific metric deals with timely support in review of various documents, in a multiple-user operating environment. This metric provides a measure of operations support during document delivery and review. The required-by dates are the goal for this metric. This metric was in response to previous years when the group was late on reviews or document development that ended up causing operations delays. Timely support is also necessary to reduce the incentive to find work-around for inappropriate documents.

2.2.5. Event Response

This set of metrics deals with timely response to infractions, the composite severity of the infractions, self-identification of infractions, and recurrence control. It is similar to the leading indicators dealing with infraction trending, (§ 1.2.5) but in this case data is diagnostic but not yet sufficient to be predictive.

- NCS Infraction Severity Index
- NCS Infraction Severity Index 3-Month Rolling Average
- Identification of NCS Infractions
- NCS Infractions on Repeat Issues

Closure timeliness of NCS deficiencies and minor noncompliances, focusing on the total number open longer than 45 days is a Contractor Assurance System metric at Y12.

2.2.6. Performance Improvement

- Age of Open issues tracking system Issues
- Age of Open issues tracking system Actions
- Issues tracking system Closure Effectiveness

NCS Issue Age – This metric tracks the number of NCS issues that are open in several age bins. Issues range in significance from Infractions/Deficiencies to Minor Noncompliances which are administrative in nature largely.

2.2.7. Spills and Leaks

Number of spills of fissile solution less than 4 liters. A spill is an unplanned discharge of solution from its containment vessel. Leaks collected in approved containers are not considered to be spills unless the collecting container overflows. This is an indication of the physical state of the facility.

2.2.8. On-Board Staff

The number of qualified staff on-board compared to the staffing needs analysis is a lagging indicator. Staffing trends and turnover rates could be a leading indicator.

3. Reasons and Frequency for Changing Metrics

3.1. Reasons for Changes

NNSA criticality safety metrics are revisited and revised annually at several sites, and hardly ever at others. Elements that drive change to the metrics include:

- Lessons learned from other sites.
- Changes in facility operations that should be addressed. (*Such as the change from Security Category 1 to Security Category 3 operations at LLNL.*)
- Changes in facility conditions such as end-of-life wear
- Administrative changes such as contracts or staff loss
- Dealing with identified issues that require effort across several contractor disciplines
- Occasionally, "raising the bar" when it seems the metrics are too easily met.

3.2. Frequency of changes

At SNL and NNSS, the metrics are part of the approved criticality safety program and are changed infrequently. LANL used performance based indicators tied to NCS improvement plans through FY 2012, and developed a more extensive set of metrics in FY 2013.

At LLNL, the metrics set and weightings are revised annually.

The Pantex metrics are not changed unless there is some type of status change such as an NCS engineer leaves, or the Contractor has an NCS infraction, or other changes in facility conditions. (*An engineer leaving Pantex could represent 2/3 of their staff*). However, there is no credible risk of a criticality accident at Pantex, therefore, a small criticality safety staff is appropriate.

At Y-12, metrics are changed as needed either to improve the information presented to make it more actionable, or to cover new activities that management decides needs attention. For example: concurrent with initiation of the CSE Implementation Review Action Plan there was a recognized need to cancel as many old legacy TD/TDCs(Technical Deviations/Clarifications) for fissile material operations as possible. A metric to track closures against a scheduled plan was created during FY'2013. It provided management with monthly progress on those cancelations. Cancelations of those legacy TD/TDCs have now been completed to the point where the only ones remaining are those requiring incorporation into revisions of the appropriate Criticality Safety Evaluation/Criticality Safety Analysis/Criticality Safety Requirements. As a result, this metric may be dropped soon.

3.3. Comparison to Previous Metrics Lists

There were 25 metrics listed in previous annual reports to the Board on criticality safety. In FY 2013, three of these were not used, and six new metrics were developed (three each by LLNL and LANL), bringing the total number of unique criticality safety metrics in use in the NNSA to 28. The number of metrics in use at any one site is between 4 and 15.

4. How are the Metrics Used for Contractor Oversight

One NNSA site uses a point system to assign weight to each metric and provide an overall score. This is used to inform Field Office, contractor staff, and management of the status of the program.

The current set of metrics at LANL has provided minimal utility to date. There are two reasons for this:

- The metrics have not been in effect for very long, and historical data is not available to benchmark trends;
- Recent events at the laboratory have called for more direct management of known deficiencies; this environment makes management by metrics inefficient and ineffective.

The Los Alamos Field Office was aware of the degradation in criticality safety staff morale and the potential and eventual loss of almost the entire experienced criticality staff over a year before the exodus would have been detected by a staffing metric.

Criticality safety metrics are also used as bases for NNSA Site Office input to the contractor's Performance Evaluation Plan (PEP). This is frequently rolled in to larger evaluation areas so that criticality safety metrics are not seen in the final PEP evaluations. Since the metrics are used as the bases for input to the PEP, the metrics also provide incentives for management to provide the necessary resources for criticality safety staff participation in activities such as American Nuclear Society meetings and Standards Committee work.

At Y-12, metrics are generated monthly from records of NCS violations, (deficiencies and minor-non-compliances). These are presented both at the monthly NCS Advisory Council meetings as well as at the monthly meetings of the Corrective Action Review Board (CARB), which is a sub-committee within the Advisory Council. They are also reviewed by the Vice President, Head of Engineering, and his direct staff once each month at their regular staff meetings. Significant departures from the regular pattern of Deficiencies and Minor Non-compliances get attention. Expanded extent of condition reviews are sometimes ordered as a result and, per a recent change to the Council Charter, the CARB is specifically looking for situations that warrant issuance of formal Lessons Learned reports. One was recently identified, but has not yet been written.

Metrics at Y-12 have recently identified a trend of improving fissile material worker performance in that a rolling 6 month average of the rate of violations shows a steady drop. As mentioned elsewhere, short-term rolling averages compared to long-term averages can be predictive. It is important to restate that infraction count is not used as a primary metric, but is useful in context with other information. Also evident is a growing trend of equipment issues reflecting the aging infrastructure at Y-12.

4.1. Program trends

Each year, the Livermore Field Office issues an assessment report on the overall criticality safety program. This report includes summaries of ten topical areas which include superficial trending analysis of NCSD staffing, Self-Assessments, and Infractions. Other topical areas (such as training and qualifications, criticality safety evaluations, and facility implementation of criticality controls) provide a brief summary evaluation but are not trended, if no significant issues are being identified.

The metrics have provided insight on day-to-day performance of the program, based upon involvement before and during actual operations.

Metrics are also used to inform management about overall performance, in conjunction with other operational awareness activities.

Metrics have been tailored to drive performance, especially time in field.

At Y-12, Contractor NCS metrics which are part of the Contractor Assurance System are reviewed in contractor monthly reports from which contractor ratings are derived. These affect fee determinations. This input is provided under four topical areas (questions) as follows:

- Do contractor metrics provide the right information to enable contractor management to gauge the health of the applicable system(s)?
- Does the contractor use the metrics to help them manage their performance?
- Has the contractor identified the assumptions and conditions that must be in place to ensure validity of the metrics?
- Are the assumptions and conditions identified above continually validated and protected?

The compilation of points is used as a basis for the overall rating of the criticality safety program when compiling the assessment of contractor performance in the PEP.