May 20, 2020

To: Angela Chambers, Manager, US DOE Nuclear Criticality Safety Program (NCSP)

From: D. G. Erickson, Chair, US DOE NCSP Criticality Safety Support Group (CSSG) dge

**Subject: Response to CSSG Tasking 2020-01: Update/Replace DOE-STD-1158 with a New Document**

In Tasking 2020-01, the CSSG was directed to develop a new document incorporating a review and update of the criteria and lines of inquiry from DOE-STD-1158-2010 (canceled) in accord with ANSI/ANS 8.19-2014. Given that DOE-STD-1158 was originally written for the self-assessment of NCS Programs and the trend toward reliance on Contractor Assurance Systems, lessons learned were reviewed for incorporation. Consequently, the CSSG subgroup reviewed the *1999 NCS Self-Improvement Workshop* and developed an

updated *What's Wrong with Criticality Safety Programs?* presentation to be a companion to the newly developed *Contractor Assurance Best Practices Guide for Self-Assessment and Continuous Improvement of Nuclear Criticality Safety Programs* document. Both referenced documents are included as a part of this package.

The CSSG subgroup was comprised of the following members:

- D. K. Hayes (Team Leader)
- C. M. Hopper (Emeritus)
- J. A. Morman
- T. P. McLaughlin
- J. N. McKamy (Emeritus)
- R. E. Wilson

The attached documents were developed by the CSSG Subgroup and reviewed by the entire CSSG with suggestions incorporated.

The CSSG is available to answer any questions that may arise regarding this tasking and response.

cc:

CSSG Members

L. Scott

Attachments:

1. As Separate Document: Contractor Assurance Best Practices Guide for Self-Assessment and Continuous Improvement of Nuclear Criticality Safety Programs
2. As Separate Document: What's Wrong with Criticality Safety Programs?

# CONTRACTOR ASSURANCE BEST PRACTICES GUIDE FOR SELF-ASSESSMENT AND CONTINUOUS IMPROVEMENT OF NUCLEAR CRITICALITY SAFETY PROGRAMS

**DOE CRITICALITY SAFETY SUPPORT GROUP**

**May, 2020**

## DEFINITIONS

**(Consistent with LA-11627 where applicable)**

Fissile Nuclide: A nucleus capable of undergoing fission by thermal neutrons provided the effective neutron production cross section exceeds the effective absorption cross section. The common fissile nuclei are $^{235}U$, $^{239}Pu$, and $^{233}U$.

Fissile material: A material (including mixtures) containing $^{235}U$, $^{239}Pu$, or $^{233}U$, or isotopes with a critical mass as indicated in ANSI/ANS-8.15 and capable of significant neutron multiplication and capable of a self-sustained fission chain reaction when in sufficient quantity or under certain conditions. (Significant is important in order to avoid calling materials such as rad waste "fissile.")

Fissionable Nucleus: A nucleus capable of undergoing fission by neutrons of some energy. Includes all fissile nuclei.

Fissionable Material: A material (including mixtures) capable of significant neutron multiplication from neutrons of some energy. Fissionable material encompasses fissile material and materials such as depleted uranium which may not be able to attain a self-sustaining chain reaction.

Management: All Line Management to include the contractor senior most executive with line of sight through, and including, all line middle managers down to, but not including, the floor line supervisor.

Supervisor: The first, direct, line supervisor of workers performing work with fissionable material.

## ACRONYMS

CAS – Contractor Assurance System
CSE – Criticality Safety Evaluation
CSO – Criticality Safety Officer
CSSG – Criticality Safety Support Group
FMH – Fissile Material Handler
ISM – Integrated Safety Management
LOIs – Lines of Inquiry
NCS – Nuclear Criticality Safety

## REFERENCES


10CFR830, *Nuclear Safety Management*

ANSI/ANS 8.1-2014 (R2018), *Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors*

ANSI/ANS 8.3-1997 (R2017), *Criticality Accident Alarm System*

ANSI/ANS-8.5-1996 (R2017), *Use of Borosilcate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material*

ANSI/ANS 8.7-1998 (R2017), *Nuclear Criticality Safety in the Storage of Fissile Materials*

ANSI/ANS 8.14-2004 (R2016), *Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors*

ANSI/ANS-8.15-2014 (R2019), *Nuclear Criticality Safety Control of Selected Actinide Nuclides*

ANSI/ANS 8.17-2004 (R2019), *Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors*

ANSI/ANS 8.19-2014 (R2019), *Administrative Practices for Nuclear Criticality Safety*

ANSI/ANS 8.20-1991 (R2015), *Nuclear Criticality Safety Training*

ANSI/ANS-8.21-1995 (R2019), *Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors*

ANSI/ANS 8.23-2019, *Nuclear Criticality Accident Emergency Planning and Response*

ANSI/ANS 8.24-2017, *Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations*

ANSI/ANS 8.26-2007 (R2016), *Criticality Safety Engineer Training and Qualification Program*

CSSG Taskings, complete list may be found at https://ncsp.llnl.gov/cssg_tasking.php

Tasking 2014-02, *Validation with Limited Benchmark Data*

Tasking 2009-01, *Position Paper on the Purpose, Structure, and Operation of Criticality Safety Committees*

DOE O 420.1, *Facility Safety*

DOE O 426.2, Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities

DOE-STD-3007-2017, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Nonreactor Nuclear Facilities*

DOE STD 1134-99 (archived, no longer actively maintained) *Review Guide for Criticality Safety Evaluations*

# INTRODUCTION

A sound Contractor Assurance System (CAS) and associated implementation practices are essential to maintain and monitor criticality safety programs to ensure safe, efficient operations with fissionable material at Department of Energy facilities. These practices are basically an application of Integrated Safety Management (ISM) principles to the specific field of criticality safety. Line Management is responsible for criticality safety in a direct line from the senior-most executive in the contractor organization, through middle management, to the hands-on supervisor on the floor. Every line manager in the chain has ongoing, recurring, and pro-active responsibilities for maintaining operations in a subcritical state with technical advice and assistance from their criticality safety staff. As with any application of ISM, all the organizations from NCS to Operations, Engineering to Maintenance, Independent Oversight to QA, and Security to NDA, etc., must function as a team, understanding and respecting each other's individual as well as integrated roles.

Fortunately for criticality safety, there already exists a set of mandatory national consensus standards that DOE has adopted in its orders and contracts. These are the ANSI/ANS-8 Series Standards. ANSI/ANS-8.19, *Administrative Practices for Nuclear Criticality* Safety, has long been the requirements document for criticality safety programs displaying what might now be called ISM for criticality safety.

The introduction to ANSI/ANS-8.19-2014, the current version, states the following:

> *An effective nuclear criticality safety program fosters an acceptable balance of risk and benefit. This includes cooperation among management, supervision, nuclear criticality safety staff, and workers. Criticality safety relies on evaluations, implementation and maintenance of controls, and each employee's conformance with operating procedures. Although the extent and complexity of safety-related activities can vary greatly with the size and type of operation with fissile material, certain safety elements are common. This standard represents a codification of such elements related to nuclear criticality safety.*
>
> - Introduction of ANSI/ANS-8.19-2014

# PURPOSE

The purpose of this guidance is to promulgate revised and updated best practices for monitoring and maintaining criticality safety programs in their totality, not just criticality safety engineering staff responsibilities. The DOE Criticality Safety Support Group (CSSG) first developed and promulgated these best practices in 1999. The CSSG herein provides the following:

1. A qualitative description of what an excellent criticality safety program looks like (separate PowerPoint file, "What's Wrong with Criticality Safety Programs?");
2. Root causes for the most often seen observable deficiencies;
3. A revised and updated Contractor Assurance Best Practices Guide for Self-Assessment of Criticality Safety Programs that may be used by DOE facilities in lieu of the archived

DOE-STD-1158-2010, *Self-Assessment Standard for DOE Contractor Criticality Safety Programs*; and,

4. A revised and expanded set of performance metrics for criticality safety.

Properly utilized in an effective CAS this guide will enable contractors:

- to understand and establish a performance standard to achieve and maintain;
- to illuminate typical root causes of deficiencies;
- to implement a 'how-to' guide to identify problems and back track into these root causes; and,
- to monitor the NCS program by a set of forward leaning metrics that alert management to get ahead of problems before the deficiencies become severe.

## BACKGROUND

The DOE found itself in a cycle of collapsed and severely degraded criticality safety programs that caused the loss of over 7.5 years of facility operations during the 6-year period from 1994-1999. Rocky Flats, LLNL, LANL, Y-12, and Hanford PFP all had major production and laboratory facilities shut down due to criticality safety concerns. The DOE Deputy Secretary made the decision to launch a self-improvement initiative aimed at Field Office and Contractor Senior Executives. The 1999 Nuclear Criticality Safety Self-Improvement Workshop in Las Vegas, Nevada on August 3-4, 1999, kicked off this initiative slightly more than one month in advance of the fatal criticality accident in Tokaimura, Japan on September 29, 1999. Deputy Secretary Glauthier in his July 8, 1999 letter announcing the workshop, wrote:

> *During the last few years, Department of Energy (DOE) activities at several sites have been severely hampered by work stoppages resulting from infractions or violations of nuclear criticality safety criteria. The cost of these shutdowns was significant. Beyond cost impacts, some sites have experienced loss of technically qualified and talented nuclear criticality safety staff. This attrition of experienced staff has hampered our ability to recover from these work stoppages. Consequently, I believe that a self-improvement initiative focusing on criticality safety is warranted to facilitate the safe and efficient operation of our facilities. The goal of this initiative is to help ensure that sound criticality safety programs facilitate: (1) continuous improvements in the safety and efficiency of operations, and (2) stability of the criticality safety function. This initiative complements our Defense Nuclear Facilities Safety Board commitments in Recommendation 97-1, and is endorsed by the DOE Nuclear Criticality Safety Program Management Team and the Criticality Safety Support Group, two groups established as part of our implementation plan for Recommendation 97-2.*

The DOE finds itself in a similar situation today having had most of LANL's plutonium facility shuttered for more than two years beginning in 2013. In addition, well documented deficiencies in the Y-12 criticality safety program have had impacts on effective and safe production. Both DOE and contractors have suffered the depletion of experienced, qualified criticality safety staff over the past five years. Finally, DOE has moved the primary responsibility for safety oversight to the Management and Operating (M&O) Contractors with mostly inexperienced and transient staff on both the operations and criticality safety staffs and an ever-changing management

structure due to contract changes. The DOE is in much the same situation it found itself in in 1999.

The CSSG, therefore, reprised the concepts and materials promulgated at the 1999 Self-Improvement Workshop in this effort. The DOE suffered no protracted facility shut-downs due to criticality safety concerns during the period from 1999 through 2012.

## SCOPE

Contractor self-assessment of elements included herein will evaluate whether the program meets the requirements of ANSI/ANS-8.19-2014, *Administrative Practices for Nuclear Criticality Safety*, as well as related ANSI/ANS-8 series standards and some requirements of DOE Order DOE O 420.1C. These ANSI/ANS-8 standards represent the consensus practices for criticality safety programs. This guide may be used for evaluating nuclear criticality safety programs for facilities and activities that involve, or potentially involve, nuclides in quantities that are equal to or greater than the single parameter limits for fissionable materials listed in ANSI/ANS-8.1 and 8.15.

This document encompasses all elements of the Contractor Criticality Safety Program at DOE facilities as addressed in ANSI/ANS-8.19-2014. The effectiveness of the criticality safety program is dependent upon management implementing its roles and responsibilities to integrate criticality safety into work practices as stated below.

An effective nuclear criticality safety program includes cooperation among management, supervision, and the criticality safety staff; for each employee, the program relies upon conformance with operating procedures. (Introduction to ANSI/ANS-8.19-2014)

This self-assessment guide uses the five primary elements of ANSI/ANS-8.19-2014. These are summarized in the specific lines of inquiry under the following broad categories:

- Management Responsibilities
- Supervisory Responsibilities
- Nuclear Criticality Safety Staff Responsibilities
- Evaluations for Nuclear Criticality Safety
- Implementation and Maintenance of Nuclear Criticality Safety Controls

## HOW TO USE THIS GUIDE

This guide contains suggested lines of inquiry (LOIs) keyed to specific sections of ANSI/ANS-8.19-2014. **These LOIs are not to be used as a verbatim compliance checklist but to stimulate in-depth understanding and thoughtful discussions with appropriate personnel.** Appropriate personnel include, but are not limited to, Management, Fissionable Material Operations Supervisors, Nuclear Criticality Safety (NCS) Staff and ancillary personnel potentially impacting NCS of fissile/fissionable material operations (e.g., Physical Security, Fire Protection, Engineering, Maintenance, and Quality Assurance personnel). The overarching key for the review team to discern is whether or not the implementation practice at the facility matches the intent and purpose of the various individual sections of the guide. The crux of the matter is

accurate, consistent flow-down of best requirements and best practices, on-the-floor knowledge, and use of these practices by personnel handling fissionable material. Utilized properly, these LOIs will result in a reliable safety culture review and an Integrated Safety Management (ISM) review as they apply to the vertical slice through criticality safety. These LOIs represent typical discussion points and areas that are widely applicable. They should be tailored to site-specific language to include specific roles and organization titles and functions that correspond to the relevant areas of the guide. They may be augmented as needed and should be deleted where they don't apply.

DO become familiar with the presentation, "What's Wrong with Criticality Safety Programs?" and understand it prior to utilizing the LOIs below.

DO use this guide as a means for continual self-improvement. It is **NOT** a compliance checklist, for compliance checklists tend to lead to a false sense of acceptable performance.

DO utilize review staff who are familiar with best criticality safety practices as applied to the fissionable material operations at the facility/site.

DO utilize review staff who have demonstrated a working level of knowledge of the ANSI/ANS-8 Standards.

DO perform a review of all the elements in this guide no less frequently than every three years for every facility that exceeds the minimum mass requirements for a criticality safety program per DOE Order 420.1C.

Management, on occasion, MAY desire to cover the entire scope of this guide in a single review conducted in a short time frame. If that is the case, past practice has shown that the entire scope of this guide MAY be covered in a single intensive week IF the team has at least seven team members, one of which is the team leader. The team must be comprised of senior operations and criticality safety personnel ALL OF WHOM have more than 20 years of experience. Otherwise, break the scope into manageable parts as part of an ongoing CAS and cover the entire scope on a given cycle not to exceed three years with personnel described in the preceding paragraphs.

DO perform document reviews ahead of conducting interviews and performing facility/process walkdowns.

**DO perform extensive facility and operations walkdowns.** It is imperative that the review team spend an appreciable amount of time on the operations floor, preferably observing work being done involving fissionable material. This should be done in an unobtrusive manner, utilizing sub-teams of the overall review team if the review team has four or more members. It is strongly recommended that the smallest sub-team consist of a minimum of two members. Avoid having any walkdowns or interviews conducted by a lone team member.

DO conduct as many of the interviews as possible while in the facility walking down operations.

DO conduct interviews of all involved personnel as applicable to the selected scope. To cover the entire scope included herein, interviews must include the senior-most executive at the site, line middle-management, supervisors, foremen, operators, criticality safety officers (if utilized) and FMHs, the criticality safety manager, criticality safety group leads, criticality safety

engineers, non-destructive assay experts, and nuclear materials control and accountability personnel. It is recommended that the intent of the self-assessment be clearly identified for senior management review and organizational accountabilities of the NCS Program health.

If a nuclear criticality safety committee is utilized at the site, they must also be interviewed. The review team should look at the actual work products of the committee and verify that recommendations are implemented and effective.

The intent is to identify and clarify roles, responsibilities and performance of personnel regarding the health of an NCS program. Failure to conduct thoughtful interviews and discussions with this span of personnel will result in a flawed understanding of the state of the criticality safety program and safety posture and culture of the site/facility.

Additionally, it is recommended that the following overarching questions, LOIs, should address, as appropriate, the following questions about:

1. Who
2. What
3. Where
4. When
5. Why
6. How and how frequently an action or verification is performed.

## 1.0 MANAGEMENT RESPONSIBILITIES

**Criteria: ANSI/ANS-8.19-2014, Section 4.1**

- What level of management approves the formal, documented NCS program?
- How many different organizations and levels of management participated in the development and approval of the formal NCS program as submitted to DOE?
- Does the NCS program description document specify in detail what recommendations (i.e. "should" statements) in the applicable ANSI/ANS-8 Standards are NOT implemented and justify why they are not implemented?
- Does the NCS program description document clearly define the expectations for determining and analyzing the criticality hazard and how the risk is reviewed and accepted by management prior to authorizing operations?
- Does the NCS program specify roles, responsibilities, authorities, and accountabilities for the various organizations and managers impacting, influencing, or implementing NCS?
- Does the NCS program clearly delineate what is considered to be within the purview of the NCS program and what is not? (e.g., ANS-8 activities, ANS-1 activities, less than significant quantity activities).
- Is it clear what the NCS hazard assessment documents are called and what form they take in documenting the ANSI/ANS-8.1 process analysis requirement (e.g., CSE's, 'technical deviations,' 'double contingency analyses,' etc.)?
- Does management demonstrate a continuing commitment to criticality safety as evidenced by establishment of a formal approach to clearly identifying organizational responsibilities for nuclear criticality safety, including training and periodic retraining of all operating and support personnel, conducting safety meetings, issuing safety bulletins, inspecting facilities?
- Does management demonstrate a continuing commitment to criticality safety as evidenced by regularly scheduled meetings with the criticality safety engineers and the Nuclear Criticality Safety (NCS) manager?
- Does management demonstrate a continuing commitment to criticality safety as evidenced by direct participation in NCS improvements through design enhancements (e.g., changing an operation to be passive engineering centric and not operator centric) or by improvements in operating processes (e.g., fissile material movements).

**Criteria: ANSI/ANS-8.19-2014, Section 4.2**

- Does the Contractor have a written criticality safety policy?
- Are all fissionable material handlers and their supervisors familiar with the criticality safety policy?
- Do fissionable material handlers and their supervisors believe that management adheres to the principles contained within the policy?
- Do fissionable material handlers and their supervisors believe that management addresses their NCS concerns and feedback?
- Is compliance with the contractor's criticality safety policy required of all program personnel performing work?
- How is effective implementation of the criticality safety policy measured?
- How is the criticality safety policy promulgated to employees?

**Criteria: ANSI/ANS-8.19-2014, Section 4.3**

- Are the roles and responsibilities of the NCS Engineers implemented as intended?
- Are the roles and responsibilities of the NCS Manager and Organization implemented as intended?
- Are the roles and responsibilities of the Criticality Safety Officers (CSOs) implemented as intended, if applicable?
- Do the roles and responsibilities of the NCS engineers and CSOs limit their effectiveness in implementing safety on the process operations floor?
- Is there conflict between the roles of the CSOs and the NCS Engineers and are they working as an effective team?
- How is operations management being effective in meeting their assigned responsibilities for criticality safety?
- To whom has contractor management assigned responsibility for oversight of the NCS program and how have they been effective in keeping senior management engaged?

**Criteria: ANSI/ANS-8.19-2014, Section 4.4**

- Does the contractor provide sufficient funding to assure adequate support by NCS Staff?

- What level of discretionary funding and qualified staff has management provided to the NCS manager to address site- or facility-wide issues, such as to maintain and improve the NCS program documentation, and to ensure that criticality safety codes and platforms are current, verified and validated?

- Does the NCS staff have adequate priority and resources (funding and qualified staff) to perform program infrastructure actions and improvement actions?

- Does the NCS Staff have independent access to the facility and to the operations personnel?

- Is the NCS Staff allotted sufficient time to interact with the facility and operations personnel, and observe operations?

- Does the contractor have a plan or policy to assure the NCS Staff is familiar with fissionable material operations? Does the contractor issue requirements for the qualification and training of NCS Staff, including subcontractors?

- Is the contractor NCS Staff administratively independent of operations?

**Criteria: ANSI/ANS-8.19-2014, Section 4.5**

- Has management established a qualification program for the criticality safety staff?

- Does the training and qualification program meet the requirements of ANSI/ANS-8.26?

- Do all members of the NCS Staff have technical degrees in physics or nuclear engineering or another technical degree, or other training and experience judged to be appropriate by NCS management?

- How are the requirements and recommendations of DOE O 426.2 and ANSI/ANS-8.26 implemented?

- Is the contractor's schedule and budget for training and qualification adequate to assure qualified NCS staff for supporting operations and maintaining the site criticality safety program?

- Is the contractor's documentation of staff qualification satisfactory?

    (a) Can the initial and ongoing qualification of staff members be quickly observed from the training records?

    (b) Are the records consonant with the training requirements of the site criticality safety program?

(c) See the lines of inquiry for staff development in section 4.6 below.

- Has management provided sufficient numbers of qualified NCS staff members? The following can be indicators regarding sufficient numbers of staff.

  (a) Is the backlog of evaluations excessive?

  (b) Is Operations complimentary, dissatisfied, or non-committal with regard to NCS field response to questions and issues?

  (c) How much overtime is used?

  (d) Are Infractions (significant or otherwise) unresolved for more than a few days?

  (e) Is there excessive reliance on subcontractor staff?

  (f) Is maintenance of the NCS program infrastructure or are planned improvements delayed because of lack of priority in the operations schedule?

  (g) Are operational reviews being missed or inadequate because of insufficient time being allotted?

  (h) Do NCS evaluations get held up because of the lack of senior qualified personnel to do peer reviews?

**Criteria: ANSI/ANS-8.19-2019, Section 4.6**

- Has management defined audit requirements and criteria for the NCS Program?
- Who is responsible for monitoring the criticality safety program?
- Are criticality safety related performance metrics in place and used by management to monitor the effectiveness of the program and make decisions regarding improvements in the program?
- Are the metrics effective?
  - Do the metrics provide clear indications of whether the program is improving?
  - Do the metrics encourage continuous improvement?
  - Are metrics used to determine the causes of inadequate performance and to establish paths for improvement?

- Do the criticality safety performance metrics encourage self-reporting of deficiencies?
- Do the criticality safety performance metrics promote practices that prevent repeat criticality safety infractions of the same type or for the same operation or process?
- Are the criticality safety performance metrics measurable and objective?
- Are operations metrics used for improving on the floor implementation of NCS?
- Do the criticality safety performance metrics encourage development of a strong staff and program by measuring performance? Areas to be monitored may include (this list is not exhaustive):

  (a) training and qualification program of nuclear criticality safety staff;

  (b) professional development;

  (c) participation in the American Nuclear Society Nuclear Criticality Safety Division;

  (d) preparation of technical papers;

  (e) attendance at criticality safety courses.

  (f) teaching of criticality safety courses.

- Are assessment applications geared to a specific operation (i.e. vertical slice assessments) used to indicate how well the general program is working?
- Are deficiencies identified by various audits and assessments related to criticality safety entered into a corrective action tracking system?
- Are mechanisms in place to validate closure of NCS issues entered into a corrective action tracking system?
- Does management maintain awareness of criticality safety deficiencies through the use of a corrective action tracking system?
- Is there a program or procedure for trending deficiencies in the criticality safety program?
- Does the contractor perform assessments of compliance to operating procedures?
- Does the contractor assess implementation of conduct of operations?

- How are NCS funding levels proposed, agreed upon and approved?
- How does management determine that funding for NCS is sufficient? Is there a mechanism for adjusting the funding during the fiscal year?

**Criteria: ANSI/ANS-8.19-2014, Section 4.7**

- Does management participate on review teams or committees to assess facility criticality safety?

  (a) Is the participation frequent enough to be considered reasonable and prudent?

  (b) Is there a systematic schedule of audits or assessments that will assure all areas of the program are assessed periodically, e.g., every three years?

  (c) Are biennial or triennial reviews by management and off-site consultants used?

- Does management perform self-assessments of their criticality safety staff and program?

**Criteria: ANSI/ANS-8.19-2014, Section 4.8**

- Does management utilize a nuclear criticality safety committee to assist in monitoring and improving the criticality safety program?
- How does the charter, membership, roles and responsibilities of the nuclear criticality safety committee compare to the CSSG publicly available report on best practices for nuclear criticality safety committees (Tasking Response 2009-01, *Position Paper on the Purpose, Structure, and Operation of Criticality Safety Committees)*?
- If nuclear criticality safety committees are used, do they report directly to senior management?

  (a) Are the findings from the nuclear criticality safety committee, or equivalent, entered into a tracking database?

  (b) Are corrective actions implemented?

  (c) Is a presentation made to senior management on some defined, periodic frequency to provide assessments of the health of the program?

(d) Is there evidence of senior management engagement in response to the assessment of the program and recommendations by the committee?

- Are outside consultants utilized to provide an independent viewpoint on the overall criticality safety program?
- How does management evaluate the effectiveness of the nuclear criticality safety committee?

**Criteria: ANSI/ANS-8.19-2014, Section 4.9**

- Are facility and process conditions important to criticality safety clearly identified in safety documents? (e.g. process evaluations for criticality safety, facility design documents, authorization basis documents, as needed)
- Are these conditions communicated to operational and maintenance staff?
- Is there a reliable, documented process to control changes to these conditions to assure proper consideration of criticality safety?
- Are facility and process conditions important to criticality safety being managed in accordance with the defined configuration management program? Are responsible and accountable organizations actively engaged in monitoring and maintaining the expected configuration of the facility?

**Criteria: ANSI/ANS-8.19-2014, Section 4.10**

- Has management established a process for developing and maintaining operating procedures that involves a team representing the diversity of aspects impacting NCS such as NCS engineers, material control and accountability staff, non-destructive assay experts, etc.?
- Is there a mechanism to assure that only current, approved procedures, process evaluations for criticality safety, and postings are used for operations?
- How are changes, such as changes in safety documentation, communicated to operators?
- How timely is this communication?
- Does a clear, unambiguous link exist between the process evaluation for criticality safety, the operating procedure, and any posting such that it is traceable from floor level documentation?

## 2.0 SUPERVISORY RESPONSIBILITIES

**Criteria: ANSI/ANS-8.19-2014, Section 5.1**

- Do supervisors accept responsibility for criticality safety of their operations? Is ownership demonstrated by the following:

  (1) reviewing and approving criticality safety postings;

  (2) reviewing and approving operating procedures;

  (3) participating in the development of process evaluations for criticality safety to include defining the process itself and playing a lead role in defining assumptions used in the CSE;

  (4) playing a lead role in the development of credible process upsets for the NCS staff to consider;

  (5) demonstrating active risk acceptance in accepting for analysis only those process upsets deemed reasonable and credible;

  (6) approving criticality safety evaluations for operations; and,

  (7) consulting with NCS staff when intentional process changes, unintended process drift, or upsets are identified?

- Do supervisors promote operator participation in the development of process evaluations for criticality safety, identification of credible process upsets, and identification of limits and controls including engineered controls?

**Criteria: ANSI/ANS-8.19-2014, Section 5.2**

- How do supervisors review credible process upsets and criticality accident scenarios identified during development of the criticality safety evaluation? How are the results of this review documented and incorporated into the evaluation?

- Do supervisors and operators under their supervision identify practical engineered controls that can be implemented in lieu of administrative controls during the development of CSEs?

- Do supervisors understand the underlying assumptions in CSEs such as the expected performance characteristics of the process/operation, configuration of equipment, facility modifications, and isotopic composition?

- How do supervisors monitor for process drift? What indicators are there that supervisors have detected and properly responded to process drift before a criticality safety deficiency or violation identifies the problem?

- Has the supervisor defined how to monitor process drift in procedures and trained operators accordingly? Are thresholds for pausing operations due to process drift established that are NOT a result of violation of established NCS limits and controls?

- Is the Nuclear Criticality Safety Staff requested to provide NCS training to supervisors?

- Does the NCS staff provide advice and assistance to management and supervision regarding implementation of NCS controls?

- Do supervisors identify the majority of NCS issues in the field or is that done by operators or by NCS staff?

**Criteria: ANSI/ANS-8.19-2014, Section 5.3**

- Do personnel who manage, work in, or work near facilities where the potential exists for a criticality accident receive criticality safety training in accordance with ANSI/ANS-8.20, "Nuclear Criticality Safety Training?"

- Has the contractor implemented DOE O 420.1C (or successor), and routinely performed self-assessments to verify continued effectiveness?

- Is training tailored to the personnel's responsibilities?

- Do supervisors provide job-specific training on procedures?

- Are walkthroughs and dry-runs on operational procedures provided?

- Do pre-job briefings cover criticality controls specific to the operations at hand?

- Do plan-of-the-day meetings address criticality safety related topics such as work restrictions due to criticality safety infractions, availability of new procedures and postings, results of recent criticality safety assessments or surveillances? Do NCS staff participate when requested?

- Do supervisors maintain training records for their personnel?

- Do supervisors ensure that their personnel are current in criticality safety classroom training?

- Are there required reading records or other evidence that personnel are knowledgeable of changes to procedures and to criticality safety postings?

- Can supervisors generally describe the normal conditions, key assumptions, credible abnormal conditions, and controls for their operations? If applicable, can supervisors also describe the necessary engineered features and key facility assumptions?

- Do supervisors ensure that personnel have demonstrated an understanding of procedures and criticality safety postings prior to authorizing work?

- Are there records of job specific training on operational procedures and criticality safety postings?

- Do supervisors request assistance from the Nuclear Criticality Safety Staff to provide training for operations personnel?

- Do firefighters receive criticality safety training?

- Are firefighters aware of any moderator-controlled areas or processes?

- Are firefighters made aware of locations where a mist condition could credibly affect criticality safety?

- Do operations support, engineering & design, and maintenance personnel receive criticality safety training commensurate with their assigned responsibilities?

**Criteria: ANSI/ANS-8.19-2014, Section 5.4**

- Are all fissionable material handling operations performed according to approved procedures that include NCS limits and controls?

- Are operations personnel and supervision involved in developing procedures?

- How does the supervisor know when to authorize work?

- How does supervision verify that NCS requirements have been met?

- How does the supervisor know that modifications to the controls and procedures have been implemented?

**Criteria: ANSI/ANS-8.19-2014, Section 5.5**

- What is the process for ensuring that no new or modified operation is started until all applicable verification steps have been performed, including the presence of approved CSEs, postings, and operating procedures?

- Are appropriate surveillance frequencies established for engineered controls relied upon for criticality safety to ensure that the controls are performing their intended function?

- Are transfers from favorable to unfavorable geometry analyzed for their impact on criticality safety?

**Criteria: ANSI/ANS-8.19-2014, Section 5.6**

- Are there procedures or mechanisms in place and implemented to ensure that modifications to equipment, particularly engineered controls, and changes to processes result in a review of the applicable CSEs, operating procedures, and criticality postings prior to implementing the modification?

- Are there documented surveillances or methods that ensure that new or modified operations conform to applicable CSEs, operating procedures, and criticality postings?

- Are periodic inspection, testing, and maintenance requirements being effectively implemented?

- What is the role of supervision in these processes?

**Criteria: ANSI/ANS-8.19-2014, Section 5.7**

- Are empty fissionable material containers labeled as such if there could be uncertainty as to whether or not containers are empty?

- Are gloveboxes with criticality drains free of loose debris which could potentially clog the drain?

- Is fissionable material stored in approved containers?

- Is there a procedure to verify compliance with criticality safety requirements prior to beginning work?

- Is there evidence of fissionable material holdup or filings in process equipment?

- Are criticality drain liquid traps monitored for adequate liquid levels periodically?

**Criteria: ANSI/ANS-8.19-2014, Section 5.8**

Section 5.8 is a permission, not a requirement, so development and utilization of LOIs are at the discretion of management. It is appropriate that management verify that supervisors have the support needed, and that the support is effective.

## 3.0 NUCLEAR CRITICALITY SAFETY STAFF RESPONSIBILITIES

**Criteria: ANSI/ANS-8.19-2014, Section 6.1**

- Does the NCS Staff provide design input for all new or modified equipment and its layout?
- Is the design input provided early enough to be incorporated without rework?
- Does the NCS Staff review all operating procedures involving fissionable materials?

**Criteria: ANSI/ANS-8.19-2014, Section 6.2**

- Have the Nuclear Criticality Safety staff been trained in the Hazard Assessment methods listed in STD 3007-2017?
- Does the Nuclear Criticality Safety Staff understand and know how to properly utilize Monte Carlo codes (e.g., KENO and MCNP), criticality safety handbooks, critical experiment data, hand-calculations, etc.?
- Are there any other evaluation methods used?
- Are the staff skilled with all the methods mentioned and any other methods used at the site?
- Does the NCS staff demonstrate appropriate use of ANSI/ANS standards and DOE Orders in performing criticality analyses?
- Does the Nuclear Criticality Safety Organization maintain verified and validated computational techniques for performing process evaluations for criticality safety for the site? Is code verification and validation conformance with ANSI/ANS-8.1, 8.24, and 8.17 (as applicable) documented?
- Does the NCS Staff utilize the CSSG recommendations on validation with few or no benchmarks (CSSG Tasking 2014-02)?
- Does the Contractor NCS Staff participate in professional development activities such as ANS Standards Committees, ANS Meetings, workshops and training courses sponsored by the Nuclear Criticality Safety Program, or university courses, consistent with the contractor's training and qualification program requirements?
- Does the NCS Staff have working knowledge of criticality safety related standards, guides, and codes?

**Criteria: ANSI/ANS-8.19-2014, Section 6.3**

- Does a synergistic interaction exist among NCS Staff assigned to specific facilities and the remainder of the contractor NCS staff?
- Does the NCS Staff consult with off-site criticality safety experts as needed, particularly retirees from the facility?
- How often does NCS Staff find it useful to consult with off-site criticality safety experts?
- Do external experts periodically review contractor NCS documents and provide feedback and suggestions for improvement?
- Does the NCS Staff engage other discipline experts during the development of process analysis?

**Criteria: ANSI/ANS-8.19-2014, Section 6.4**

- Does the NCS staff observe fissionable material handling and processing operations for which they provide guidance?
- Are members of the NCS Staff knowledgeable and conversant with facility operators about credible abnormal process upsets applicable to facility operations?
- Does the NCS Staff attend operations planning meetings for new or restarted processes?
- Does the NCS Staff have access to and familiarity with fissionable material operating procedures?
- Does the NCS Staff attend pre-job briefs and plan-of-the-day meetings?
- Does the NCS Staff work with cognizant systems and process engineers to understand process operations and the impacts of process changes and upsets?
- Does the NCS Staff maintain familiarity with reports of deviations from expected process conditions (e.g., procedural errors, equipment failures, spills, leaks) even if these deviations do not result in a criticality infraction?
- Does a collegial, synergistic working relationship exist between NCS staff and the operations/production supervisors and management they support?

**Criteria: ANSI/ANS-8.19-2014, Section 6.5**

- Does the NCS Staff participate in training personnel?

- Is the training documented?
- Does the training provided by the NCS Staff include job specific criticality safety related information?
- Besides basic information on NCS controls, what information from the CSE is conveyed to the operators (e.g. assumptions, process description, credible abnormal events, etc.)?
- Is the essential information to be conveyed clearly identified?

**Criteria: ANSI/ANS-8.19-2014, Section 6.6**

- Has management defined audit expectations for the NCS Staff? (e.g., audits of operations, procedures, configuration control systems, and emergency response, number, frequency, and depth of audits and walkthroughs)
- Does the NCS Staff participate in periodic audits of operations and procedures?
- Are the results of audits shared among the NCS Staff and operations staff?
- Are the results of audits reported to appropriate management?
- Are corrective actions developed for deficiencies?
- Are corrective actions taken in an expeditious manner?

**Criteria: ANSI/ANS-8.19-2014, Section 6.7**

- Are nonconformances with criticality safety requirements reported to and reviewed by the NCS Staff?
- Does the NCS Staff formally report findings and recommendations to management?
- Are lessons-learned and recommendations to prevent recurrence provided to management?
- Are all criticality safety related deficiencies captured in a database and tracked until closure is verified?
- Is there a mechanism for trending criticality safety related deficiencies so that the collective significance of multiple minor incidents can be assessed and corrected?
- How are lessons learned from criticality safety related deficiencies at either local or off-site facilities developed and applied by the NCS Staff?

- How does the NCS staff develop and apply lessons learned from accidents not apparently related to criticality safety? (e.g., Chernobyl, Bhopal, Columbia, Challenger)

**Criteria: ANSI/ANS-8.19-2014, Section 6.8**

- Do staff periodically review criticality safety evaluations to affirm continued validity?
- Is the review period appropriate for the pace of operational changes?
- Is the review undertaken by those with relevant expertise?
- Does the NCS Staff involve other disciplines including operations in the periodic review?
- Are periodic reviews performed in a timely manner and given adequate priority to be completed?

## 4.0 EVALUATIONS FOR NUCLEAR CRITICALITY SAFETY

**Criteria: ANSI/ANS-8.19-2014, Section 7.1**

*General Issues*

- Do the CSEs document that operations will remain subcritical under normal and credible abnormal conditions?
- Is there evidence of applying the double contingency recommendation in lieu of the requirement to demonstrate that operations will remain subcritical under normal and credible abnormal conditions?
- Do procedures exist for generating CSEs?
- Are NCS staff involved in the development of the CSEs familiar with the facility and operations under consideration?
- Does the NCS Staff have access to predecessor CSEs?
- Do criteria exist to determine whether a proposed process change can be implemented without revising the CSE?

*Hazard Evaluation*

- Is an appropriate hazard evaluation used to identify credible upset conditions that could lead to a criticality accident?

- Does the Hazard assessment process determine which, if any, natural phenomena hazards need to be addressed?

- Does the evaluation demonstrate that no single credible event or failure can result in a criticality accident with personnel present?

- Are these hazard identification processes documented sufficiently so that a qualified reviewer can confirm the conclusions?

- Are firefighting scenarios considered (e.g., addition of moderator, displacement of fissionable material in water streams, etc.)?

- Does the hazard evaluation incorporate lessons learned from previous facility upset conditions and criticality control nonconformances?

- Are the contingencies to be evaluated jointly developed by the NCS staff and responsible operations personnel?

- How do personnel from other organizations and disciplines (e.g., systems and process engineering, material control and accountability, safeguards and security, health physics) aid in the development of contingencies?

- Does the NCS Staff work as a team with operations to develop credible accident scenarios and controls?

- How is double contingency defined? Is the double contingency principle applied to all fissile/fissionable operations or are other ANSI/ANS-8.1 risk acceptance criteria relied upon as allowed? Where double contingency is applied, is it done appropriately, and does it avoid simplistic approaches previously promoted in now-defunct DOE orders and standards such as “multiple-controls on a single parameter” and “identifying only two controls for crediting double contingency?”

*Role of Calculations*

- Is comparison to experiment used in preference to calculations for determining subcritical limits?

- Does the NCS Staff apply simplified methods such as bounding (hand) calculations, critical experiment data, handbook data, etc., where appropriate, to efficiently generate CSE input.

- Where hand calculations, handbook data, experiment data, etc., are used, are they applied as intended and within the recommended areas of applicability of the method or data?

- Is a sensitivity and uncertainty analysis technique (e.g., TSUNAMI, WHISPER) used to select and verify applicability of the selected benchmarks?

- How are Upper Subcritical Limits established for the application?

- If light water reactor fuel is handled, how are ANSI/ANS-8.17, "*Criticality Safety Criteria for Handling, Storage, and Transport of LWR Fuel Outside Reactors*" and ANSI/ANS-8.27, "*Burnup Credit for LWR Fuel?"* applied?

- How are calculational methods validated? If validation is being reviewed, consult ANSI/ANS-8.24, "*Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations?"* for more detailed guidance.

- Has the CSSG Tasking 2014-02, "Validation with Limited Benchmark Data" been utilized?

- Is the validation, including the determination of bias and bias uncertainty, documented?

**Criteria: ANSI/ANS-8.19-2014, Section 7.2**

- Do CSEs and procedures for evaluations reflect the preferred order of controls (i.e., passive engineered controls, active engineered controls, then administrative controls)?

- If computer-assisted techniques, such as an online mass verification step at the workstation comparing it to established limits, have been utilized to enhance administrative controls, what quality assurance and quality control procedures and processes have been implemented to avoid unintended negative NCS outcomes?

- Are controlled parameters, unlikely changes in process conditions, and credited controls explicitly documented?

- Are the effects of changes in process parameters or in process conditions understood over the credible range of values they could take? Are both upstream and downstream effects of those changes understood and evaluated?

**Criteria: ANSI/ANS-8.19-2014, Section 7.3**

- Is DOE-STD-3007-2017, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*, (or equivalent) applied in the preparation of CSEs?

- Do the CSEs contain a system or process description with enough detail for an independent reviewer, familiar with the process and performing an on-the-floor

review, to understand the system or process sufficiently to judge the results of the criticality safety analysis?

- Is there a change control and document control system in place for CSEs?
- Are internal memoranda ever used to communicate limits and controls instead of CSEs?
- Are temporary limits and evaluations (i.e., those that expire after a specified period) used?
- Are assumptions needed to assure subcriticality documented in the CSE?
- Are appropriate sections of the CSE (e.g., the process description, discussion of contingencies and credible abnormal events, criticality safety controls) written for ease of review and understanding by the supervision?
- How are evaluations and material containing sensitive or classified data handled?

**Criteria: ANSI/ANS-8.19-2014, Section 7.4**

- Do all CSEs receive an independent technical peer review by both NCS and operations staff before approval for use?
- Does the peer review go beyond mathematical checking?
- Does the peer review include a walkdown or visit to the work location?
- Is there a process for confirming that all credited engineered features of a system or process are in place and meet the specifications anticipated by the evaluation prior to starting operations?
- Is the review done in accordance with an established procedure? DOE STD 1134 is an archived DOE standard for reviewing CSEs that can be used to provide ideas for what makes a good peer review procedure.

**Criteria: ANSI/ANS-8.19-2014, Section 7.5**

- Does the operations supervisor confirm that the CSE adequately identifies normal and credible abnormal conditions and establishes requirements that are verifiable and compatible with the planned operation?
- Does the supervisor delegate responsibility for the above to Criticality Safety Officers or some other staff?
- How is this supervisory confirmation documented prior to authorizing work to begin?

## 5.0 IMPLEMENTATION AND MAINTENANCE OF NUCLEAR CRITICALITY SAFETY CONTROLS

**Criteria: ANSI/ANS-8.19-2014, Section 8.1**

- Are criticality controls that the operator can influence included in operating procedures?
- Is there a clear, unambiguous, link between criticality controls in procedures and postings and their parent CSE?
- Does the contractor have a documented process for determining which controls are incorporated into procedures?
- Does the contractor have a process to know what documents are affected if there is a change to an NCS evaluation or a change to an operating procedure?
- Does maintenance place appropriate priority on maintaining and repairing structures, systems, and components relied upon for criticality safety?
- Do pre-fire plans, as needed, incorporate criticality safety controls?
- Are firefighters trained and familiar with applicable criticality safety controls and practices?
- Are criticality related instructions in pre-fire plans and firefighting procedures judged to be practical by fire department supervision under actual conditions of responding to fires?

**Criteria: ANSI/ANS-8.19-2014, Section 8.2**

- Is there a mechanism to assure that only current, approved operating procedures, CSEs, and criticality postings are used by operations?
- How are changes such as changes in safety documentation communicated to operators?
- How timely is this communication?
- How does the supervisor know when to authorize work?
- How does supervision verify that NCS requirements have been met?
- How does the supervisor know that modifications to the controls and procedures have been implemented?

**Criteria: ANSI/ANS-8.19-2014, Section 8.3**

- Has the extent and frequency of needed reviews to ensure conditions have not changed been justified and documented?
- Are these reviews effective in assuring conformance to established assumptions and controls for the post-shutdown process conditions?
- Are these reviews being conducted where required?

**Criteria: ANSI/ANS-8.19-2014, Section 8.3.1**

- How are changes to a process communicated to the criticality safety staff
- How are changes to a process evaluated for impact on criticality safety?
- Do changes that adversely affect NCS result in revised CSEs prior to implementation and authorizing work?

**Criteria: ANSI/ANS-8.19-2014, Section 8.3.2**

- Do identified, changed conditions result in implementation of different limits and controls? Are they verified prior to restart? Are workers retrained as needed?
- Has out of service equipment/processes been physically isolated from in-process equipment?

**Criteria: ANSI/ANS-8.19-2014, Section 8.3.3**

Section 8.3.3 is a permissive not a requirement and development and use of LOIs are at the discretion of management.

**Criteria: ANSI/ANS-8.19-2014, Section 8.4**

- Are there procedures or mechanisms in place and implemented to ensure that modifications to equipment, particularly engineered controls, and changes to processes result in a review of the applicable CSEs, operating procedures, and criticality posting sets prior to implementing the modification?
- How does the configuration management system capture out-of-service equipment and processes?
- Are there documented surveillances or methods that ensure that new or modified operations conform to applicable CSEs, operating procedures, and criticality postings?

- Are periodic inspection, testing, and maintenance requirements being effectively implemented?
- What is the role of supervision in these processes?
- How is interaction among containers of fissionable material in storage controlled? (e.g., fixed arrays, attached engineered spacers, type B containers)
- When administrative spacing controls are used, has the process evaluation for criticality safety demonstrated that the system will remain subcritical in a seismic event?
- How are potential violations of administrative spacing controls addressed in CSEs?
- Where engineered features are credited for criticality control, are initial and periodic inspections conducted to verify they are capable of performing the intended function?
- Are the periodic review frequencies for engineered controls justified and documented?
- For solution storage areas, is solution stability understood? For example:

  (a) are procedures in place to detect credible concentration and stratification changes in the solution?

  (b) Are liquid levels or solution concentrations that could credibly pose a criticality accident hazard prevented by engineered controls where practical?

  (c) Are fissile solutions periodically and appropriately monitored for changes in pH?

  (d) Do double-block-and-bleed valve arrangements, or equivalent, where the addition of fissile material is prohibited, protect isolated, inactive fissile solution storage tanks?

  (e) Are temperature dependent effects and reactions considered?
- Does fissionable material holdup in process vessels, gloveboxes, the HVAC, and other accumulation points present a credible criticality accident scenario?
- Are programs and procedures in place for detecting and characterizing accumulations as required by DOE orders (e.g. DOE O 420.1C) for facilities and equipment that could inadvertently accumulate significant quantities of fissionable materials?
- Is holdup of fissionable material being effectively monitored and controlled as required?

- Will fissionable material remain subcritical under credible firefighting scenarios, including within or adjacent to moderator-controlled areas?

- Are fissionable material storage areas consistent with ANSI/ANS-8.7, "Guide for Nuclear Criticality Safety in the Storage of Fissile Materials?"

- Are practices dealing with control of moderators consistent with ANSI/ANS-8.22, "*Nuclear Criticality Safety Based on Limiting and Controlling Moderators?*"

**Criteria: ANSI/ANS-8.19-2014, Section 8.5**

- Does a clear, unambiguous link between the CSE, operating procedure, and criticality posting exist such that it is traceable from documentation readily available to the operator at or near the workstation?

**Criteria: ANSI/ANS-8.19-2014, Section 8.5.1**

- Are criticality control descriptions and discussions in operating procedures clear, concise, free of criticality safety jargon, and easily identifiable?

- Is the criticality safety related information presented in procedures free of unnecessary detail and directly applicable to the job task being performed?

- Do the operators find the criticality safety related instructions easy to understand and follow?

**Criteria: ANSI/ANS-8.19-2014, Section 8.5.2**

- How are procedures used in the work area, e.g., in-hand, readily available? Is the basis for the determination of the type of procedure used justified and documented?

- Does the contractor have a formalized process for determining which controls are incorporated into procedures?

- Do pre-fire plans incorporate criticality safety controls?

- Are firefighters trained and familiar with applicable criticality safety controls and practices?

- Does the NCS staff review and provide specific input to safety assessments and evaluations of other hazards that may involve criticality safety concerns?

- Are criticality related instructions in pre-fire plans and firefighting procedures practical under actual conditions of responding to fires?

**Criteria: ANSI/ANS-8.19-2014, Section 8.5.3**

- How is the population of affected procedures identified by a change in operations?
- Do new or revised operating procedures that have a potential impact on criticality safety receive review by the NCS Staff? How is the determination of potential impact made?
- Does the NCS staff periodically review and/or observe operations in progress?
- Is there a documented mechanism for resolving conflicting comments from the NCS Staff and other reviewers?

**Criteria: ANSI/ANS-8.19-2014, Section 8.5.4**

- Are methods other than criticality postings (e.g., checklists, flow sheets, or automated systems) used to supplement operating procedures?
- How do methods other than criticality postings provide aids to compliance with criticality safety limits and controls?
- If methods other than criticality postings are used, how do they provide equivalent or better aid to compliance than would be provided by criticality postings?
- Are criticality postings easy to understand by operators?
- Do the criticality postings contain only information controlled by the operator performing the task?
- Do the criticality postings require any analysis on the part of the operator such as decoding “IF-THEN”, “EITHER-OR” type options to select appropriate controls?
- Are the criticality controls on postings verbatim versions of those in procedures?
- Are there criteria for determining which controls appear on postings and which appear in procedures?
- What mechanism is in place to ensure that the controls in the criticality posting are consistent with those documented in the parent CSE?
- Are criticality postings easy to read from normal operator positions at the workstation?
- Which has precedent to the operator, criticality safety controls in procedures or those on postings?

- Are all nuclear criticality safety controls that are to be implemented by operators included in criticality postings? If not, are the operators knowledgeable of or trained on how to find all the controls applicable to the process?

- Is it possible to comply with the controls on the criticality posting and still incur a criticality safety infraction because additional controls are contained in the procedures? If so, are operators trained to and knowledgeable of the complete set of controls?

- Are postings reviewed by operators prior to starting a fissionable operation?

**Criteria: ANSI/ANS-8.19-2014, Section 8.5.5**

- Has management defined periodic review criteria, including what is meant by "periodic?"

- Are procedures periodically reviewed?

- Does the NCS Staff periodically participate in reviews of active operating procedures?

- What mechanisms are in place to ensure that all procedures are reviewed as planned?

**Criteria: ANSI/ANS-8.19-2014, Section 8.6**

- Are all active operations reviewed at least annually?

- How is the periodicity for performing reviews determined?

- How do (annual) reviews determine that procedures are being followed?

- Do audits and reviews monitor the configuration of the facility and equipment which could adversely affect criticality safety, such as movements of criticality detectors, installation of new equipment, inoperable emergency enunciators, etc.?

- Do personnel with NCS experience and knowledge of the operations participate in the reviews?

- Do the reviews include observing the fissionable operation?

- Do the reviews examine CSEs to verify that changes to the process have not compromised criticality safety?

- Are the results of the review reported to senior management as well as other appropriate management?

- Are deficiencies and proposed corrective actions documented and tracked to closure?

- Are procedures in place that assist in verifying that changes to process equipment over time have not degraded compliance with criticality safety controls?
- Does the annual review of operations verify the vertical traceability of controls from floor level documents back to the parent CSE including verification that these chains are current and maintained properly?
- Do annual reviews of operations look at all the elements of the criticality safety program affecting operations?

**Criteria: ANSI/ANS-8.19-2014, Section 8.6.1**

- Are the annual reviews led by staff knowledgeable in criticality safety?
- Are the reviews led by individuals not directly responsible for the operation?

**Criteria: ANSI/ANS-8.19-2014, Section 8.6.2**

- Are the reviews documented?

**Criteria: ANSI/ANS-8.19-2014, Section 8.7**

- How are infractions graded?
- Does the nonconformance reporting system encourage discovery and reporting by operations personnel?
- Do NCS Engineers investigating an infraction refer directly to all applicable CSEs?
- Is the process for recovery from an NCS infraction documented?
- How does the NCS staff determine the remaining controls and controlled parameters when an infraction, violation, or deviation condition is discovered? This should be documented in the “recovery process.”
- Do procedures exist to properly characterize the severity level of infractions, taking into account adverse trends, as appropriate?
- What is the required response when a potential infraction is identified? How is this communicated to operations and supervision?
- When does the NCS Staff respond to the scene of a potential infraction?
- Are the responsibilities defined for responding to a potential infraction?

- Does the NCS Staff participate in management critiques of infractions, assigning levels of infraction, and developing corrective actions?
- Are infractions resolved promptly and normal operations restarted?
- When the NCS Staff recommends immediate corrective actions to recover from an infraction, are these recommendations made in writing, peer reviewed, and approved by management?
- Are corrective actions stemming from criticality infractions entered into a tracking database and monitored until closure?
- Are minor criticality infractions tracked and trended?
- Are root causes determined where trends or patterns are identified?
- Are root causes of nonconformances determined and documented?
- When Formal Root Cause Determinations are not done, how are recurrence prevention actions determined? Are approved methodologies (e.g., training, procedures, or skill-of-the-craft) used?
- Are all criticality infractions, regardless of severity, properly analyzed and dispositioned?

**Criteria: ANSI/ANS-8.19-2014, Section 8.8**

- Are all deviations with criticality safety program requirements, limits, and controls reported to and reviewed by the NCS Staff?
- Does the NCS Staff formally report findings and recommendations to management?
- Are lessons-learned developed and recommendations to prevent recurrence made to management?
- Are all criticality safety related deficiencies captured in a database and tracked until closure is verified?
- Is there a mechanism for trending criticality safety related deficiencies so that the collective significance of multiple minor incidents can be assessed and, as needed, corrected?
- How are lessons learned from criticality safety related deficiencies at either local facilities or other sites applied by the NCS Staff?

- How does the NCS staff apply lessons learned from accidents not apparently related to criticality safety? (e.g., Chernobyl, Bhopal, Columbia, Challenger)

**Criteria: ANSI/ANS-8.19-2014, Section 8.9**

- Is access to fissionable material handling areas controlled such that only authorized personnel can handle fissionable material?
- Does management or supervision verify the qualification of fissionable material handlers prior to authorizing work?

**Criteria: ANSI/ANS-8.19-2014, Section 8.10**

- Are procedures in place to control the movement of fissionable material between material balance areas?
- Are procedures in place to control movement of fissionable material within a single material balance area?
- Are procedures in place to control transfers of fissionable material into and out of the facility?
- Do the procedures have requirements to verify compliance with criticality safety limits at the shipping and receiving points of the transfer prior to performing the movement?
- Is there a formal process to maintain a running log of fissionable mass contained in gloveboxes, storage arrays, or other fissile material handling operations? Is this log readily available to the operators?

**Criteria: ANSI/ANS-8.19-2014, Section 8.11**

- Are movement and storage requirements simple and easy to perform such that administrative errors are minimized?
- How does operations track the movement and storage of fissionable materials?
- Do fissionable material labels, where used, contain the information necessary to determine compliance to applicable NCS controls?
- What other systems and processes, besides labeling, inform the operators that the fissile/fissionable materials they are handling are in conformance with their established limits and controls? Are these readily available and easily understood at the work site?

- Are all fissionable material storage areas posted, with criticality controls clearly identified?
- Can the mass and location of all fissionable materials in a glovebox be determined by operator or supervisor inspection of logs (or equivalent) posted on the glovebox? Are these logs (or equivalent) readily available to contractor and DOE oversight personnel?
- Can the operator readily determine compliance with applicable limits from the information available at the workstation?

# Contractor Assurance Performance Metrics for Criticality Safety Programs

**DOE CRITICALITY SAFETY SUPPORT GROUP**
**May, 2020**

Contractor management should adopt a set of performance metrics tailored to the size, scope and complexity of fissionable material operations at their site. Metrics should be diagnostic in nature so as to trend performance and provide information useful to improving specific elements of the criticality safety program and associated work processes. Metrics should not be created for the sole purpose of demonstrating compliance.

These criticality safety performance metrics are effective only if the Contractor Senior Executive and appropriate line management routinely monitor them and ask probing questions seeking for continuous improvement and directing resources to remedy identified weaknesses and undesired trends.

What follows is a list of performance areas that have proved useful at various DOE sites and laboratories.

Contractor Management should choose from these, appropriately tailored, to monitor and make management decisions. These should not be used as pro-forma window dressing. Choose and implement only those metrics that Management is willing to use to actually evaluate, monitor and manage the criticality safety program. Some organizations have found it useful to assign a scoring system to the metrics and define what corresponds to a red, yellow, or green program.

- Severity of criticality safety infractions
- Repeated, related/similar criticality safety infractions in a rolling 12-month period
- Number of times operations supervision unilaterally pauses an evolution to verify the adequacy of a criticality safety evaluation, particularly its assumptions and controls, without an infraction occurring to stimulate the pause
- What organization first identifies criticality safety deficiencies/organizations
- Work pauses originated by operations staff and supervisors to address NCS questions and concerns due to suspected process drift or unexpected behavior of the process
- Percentage of NCS infractions identified by operators and supervisors
- Process and procedure improvements related to NCS requested by operators and supervisors
- How much funding and commensurate NCS staff FTE is available at the sole and unilateral discretion of the NCS manager to resolve cross-cutting and programmatic weaknesses independent of, and in addition to, resource allocated to direct support to operations
- Percent of criticality safety staff having unescorted access to facilities and appropriate access to information necessary for evaluating processes
- Percent of criticality safety staff that are fully qualified in various positions (e.g., peer reviewers)
- Percent of criticality safety staff that attend ANS, EFCOG, CSWEG, NDAG, or WPEC meetings

- Percent of criticality safety staff on ANSI/ANS-8 Standards Committees
- Tracking and trending periodic training of NCS engineers in criticality safety areas
- Length of time criticality safety infractions remain open
- Number of open criticality safety program deficiencies in the tracking databases
- Time in facility for NCS staff performing process walkdowns, training, meeting with operations personnel, etc.
- Number of on-the-job-training briefings and technical discussions and seminars presented by criticality safety staff to operations
- Number of times a criticality safety evaluation is reworked before implementing
- Number of peer review/independent review cycles required for criticality safety evaluations
- Time in facility for middle and senior management doing criticality safety walk-abouts

# What's Wrong with Criticality Safety Programs?

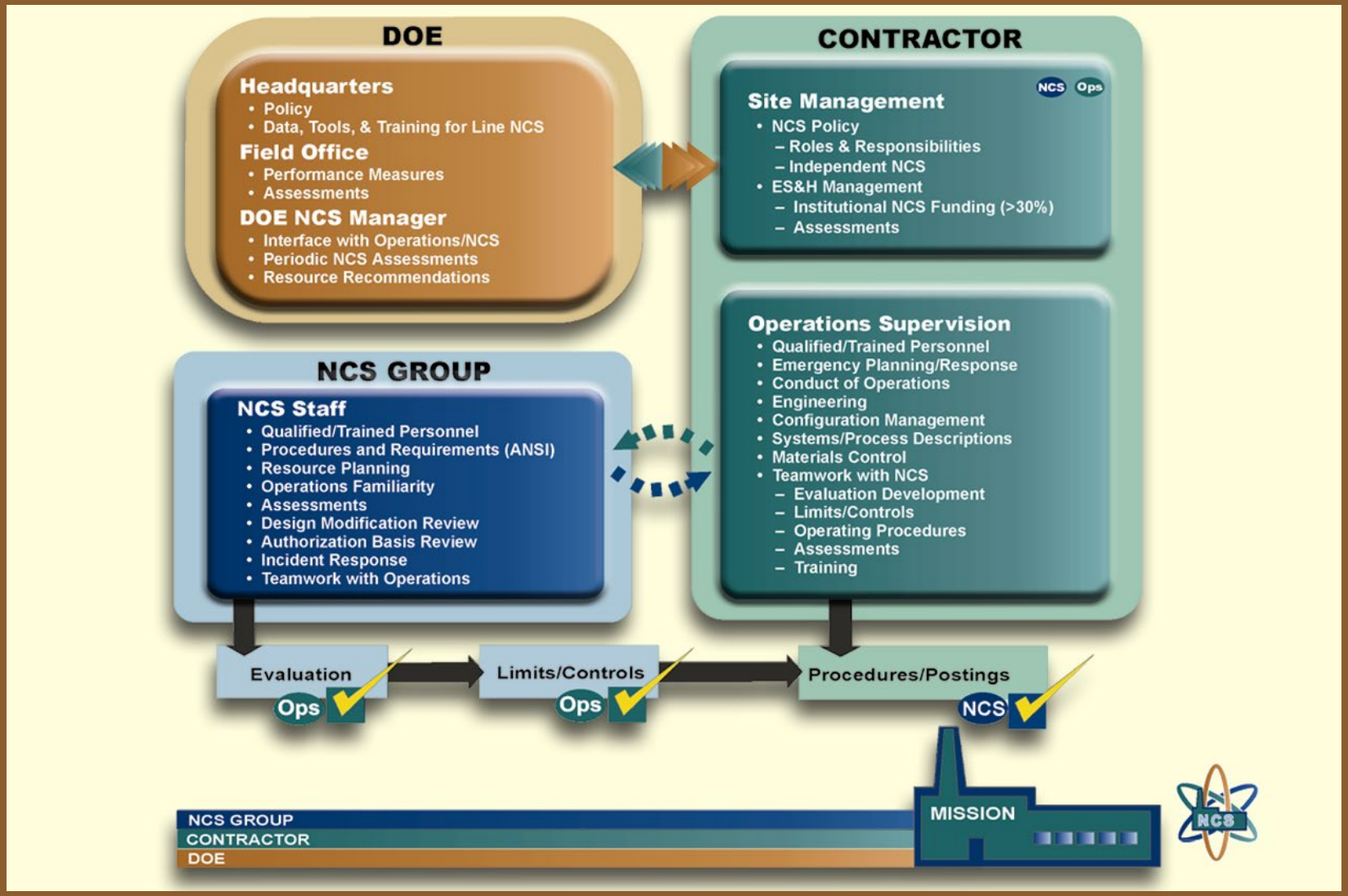
DOE Criticality Safety Support Group

2020

# Key to Understanding this Presentation

- The graphics in this presentation communicate function or states of deliverables.
- The main blocks show the main program elements comprising the overall criticality safety program.
- The hard arrows going both direction between DOE and Contractor Management indicate open, regular communication.
- The curved dashed arrows between Operations and Criticality Safety indicate not only open, regular communication but collegial TEAMWORK and joint ownership.
- The three important implementation deliverables show the organization responsible for generating them AND the organization that must review, understand, and concur with them.
- The bottom bar shows how the mission and safety may be adversely affected by root failures in the major organizational components.
- In what follows, the observable deficiencies (i.e. occurrences and audit findings, etc.) are shown in red in 'flat' graphics and the root failures of the organization that caused the observables are shown in red in the 'raised' graphic.

# Key Elements of a Healthy NCS Program



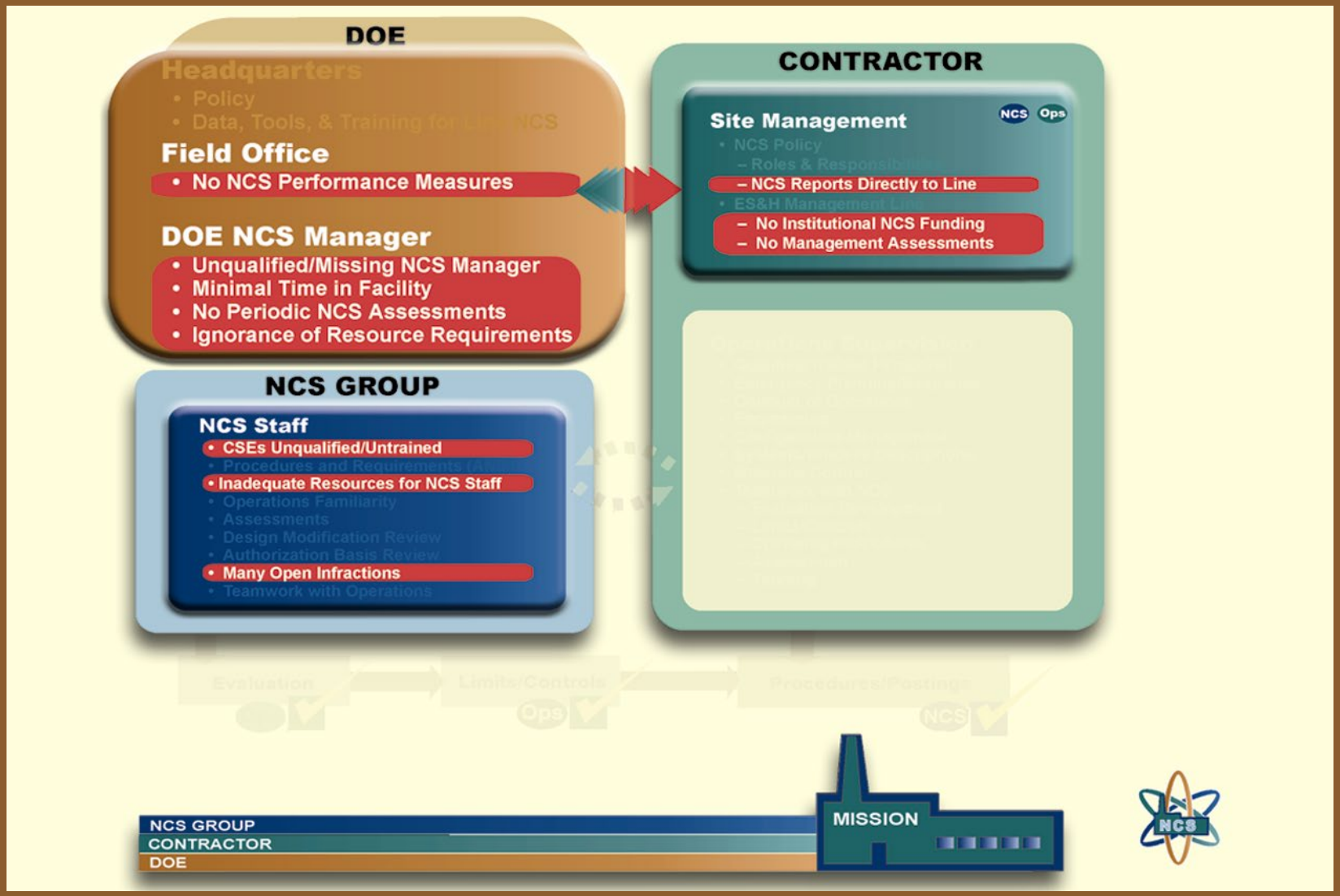
# Elements of a Sound Criticality Safety Program

- The program implements the ANSI/ANS-8 Series Criticality Safety Standards.
- Criticality safety engineers are familiar with the facilities, spend time in process facilities doing walkdowns and working with operators, use structured hazard identification process, and they work collegially with a multidisciplinary team to produce criticality safety evaluations.
- Senior management actively supports criticality safety and where complex sites/processes are involved utilizes criticality safety committees reporting directly to senior management for feedback on the implementation of the criticality safety program.
- A reasonably large amount (~30%) of the criticality safety budget is indirect for training, professional development, code verification and validation, special studies, site-wide evaluations, program mtce. etc. The Criticality Safety Manager unilaterally directs this resource in the form of both funding and qualified staff to address cross-cutting criticality safety program concerns. THIS is a necessary AND sufficient condition for independence from operations. Organizational independence on an org chart is a necessary but NOT sufficient condition for independence.

# Elements of a Sound Criticality Safety Program (cont'd.)

- Operations line management and staff actively participate in preparing and approving criticality safety evaluations, particularly the identification of credible process upsets and designing practicable controls. **Line management and staff must know the assumptions of the evaluation especially as they affect equipment configuration and process definition.**
- **Line supervision and staff have a questioning attitude and, knowing the assumptions of the criticality safety evaluation, promptly calls for a pause in work activities to assess any change in conditions at the earliest time they are detected, regardless of whether or not there is a criticality limit violation. Operations are restored only after line supervision has consulted with criticality safety staff and validated that the extant criticality safety evaluation, assumptions, process definitions, credible upset conditions, and controls remain valid.**
- Line management ensures adherence to good conduct of operations principles (plan of the day, pre-job briefings, pre-job criticality surveillances, compliance to procedures, trained operators, etc.)

# Impacts of Typical Weaknesses in DOE Field Office



# Root Cause: Weakness in DOE Field Office

Typical Observables:

- NCS Reports Directly to Line
- No NCS Discretionary Funding and Staff Resource allocated to NCS Manager
- Absence of Senior Management and middle line management in NCS program as evidenced by no tracking of metrics or self-assessment reports to these levels of management.
- Large fraction of unqualified and untrained crit engineers; no pipeline of Qs to replace retirees and staff turnover
- Inadequate resources (training, code maintenance & validation, time in facility, participation in ANS and Standards, etc.)
- Operations continue with large number of open infractions, temporary limits, one-off limits, back log of self-identified deficiencies that never get resolved.

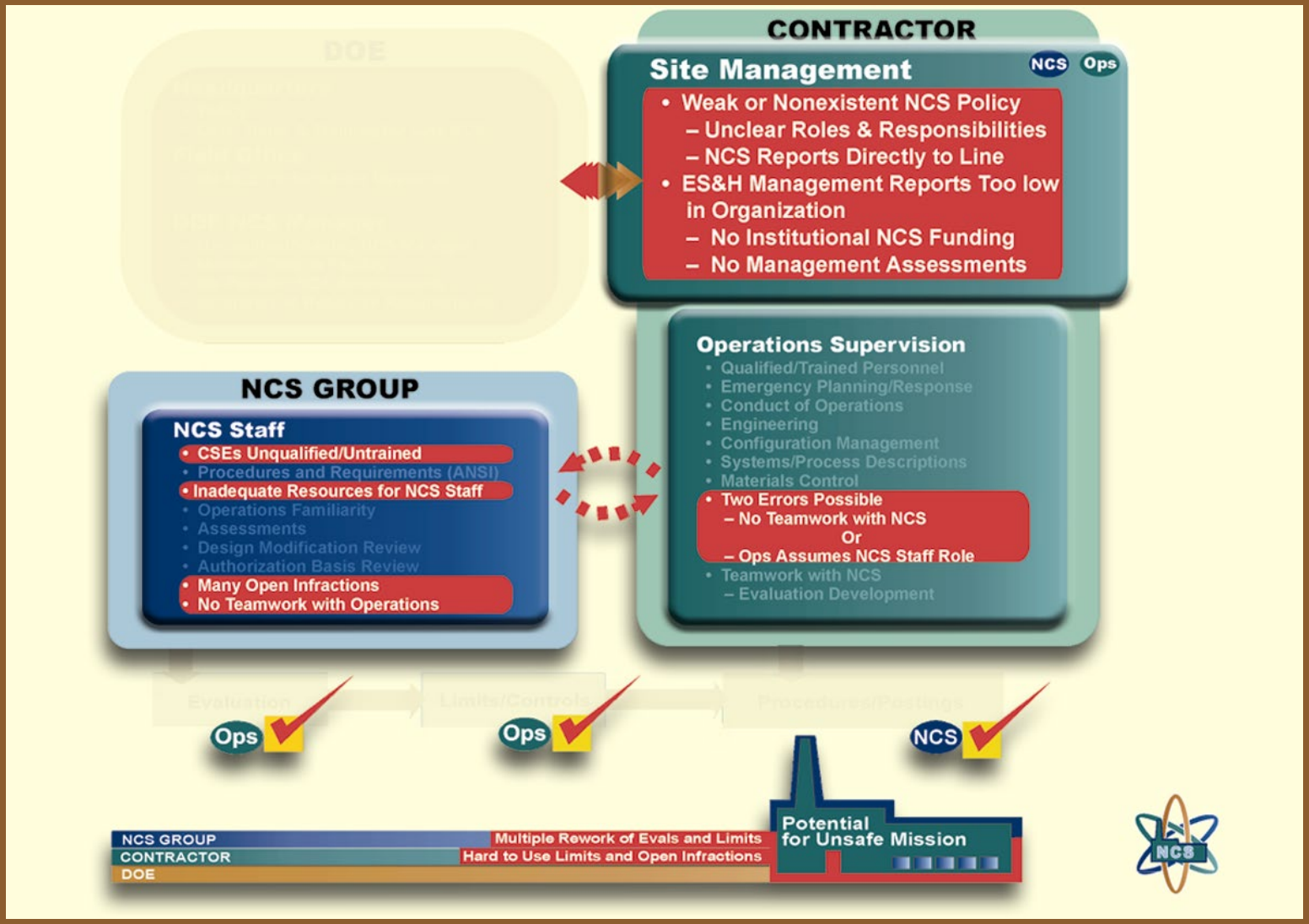
Root Causes:

- DOE FOM doesn't engage Contractor counterpart on NCS regularly
- DOE has no/inadequate NCS Metrics in the contract. Contractor Senior Management never has reason to track or to discuss NCS with DOE.
- DOE has no insight into resource needs of Contractor NCS Staff.
- No DOE NCS expert with time in facility and expert knowledge of Standards

Impact on Mission & Safety: Indeterminate

- A good Contractor can overcome flawed DOE

# Impacts of Typical Weaknesses in Contractor Management



# Root Cause: Site Management

Site Management = All line management above the floor supervisor to include the Contractor Senior Executive.

Typical Observables:

- Completely broken teamwork and collegial communication between Operations Supervision and NCS Staff. Work is 'thrown over the fence.'
- Another, rarer, variant is that Ops literally owns NCS and they report to the line and NCS Staff is distributed to the Line such that there is nothing independent about NCS. NCS must do what the line tells them to do.
- Operations Supervision doesn't review or concur on criticality evaluations.
- Operations Supervision doesn't review, help develop or concur on controls while they're being developed.
- NCS Staff is not engaged in reviewing ops procedures, infraction response, work packages, drawings, engineering mods, etc.
- Large fraction of unqualified and untrained crit engineers; no pipeline of Qs to replace retirees and staff turnover
- Inadequate resources (training, code maintenance & validation, time in facility, participation in ANS and Standards, etc.)
- Operations continue with large number of open infractions, temporary limits, one-off limits, back log of self-identified deficiencies that never get resolved.

# Root Cause: Site Management (cont.)

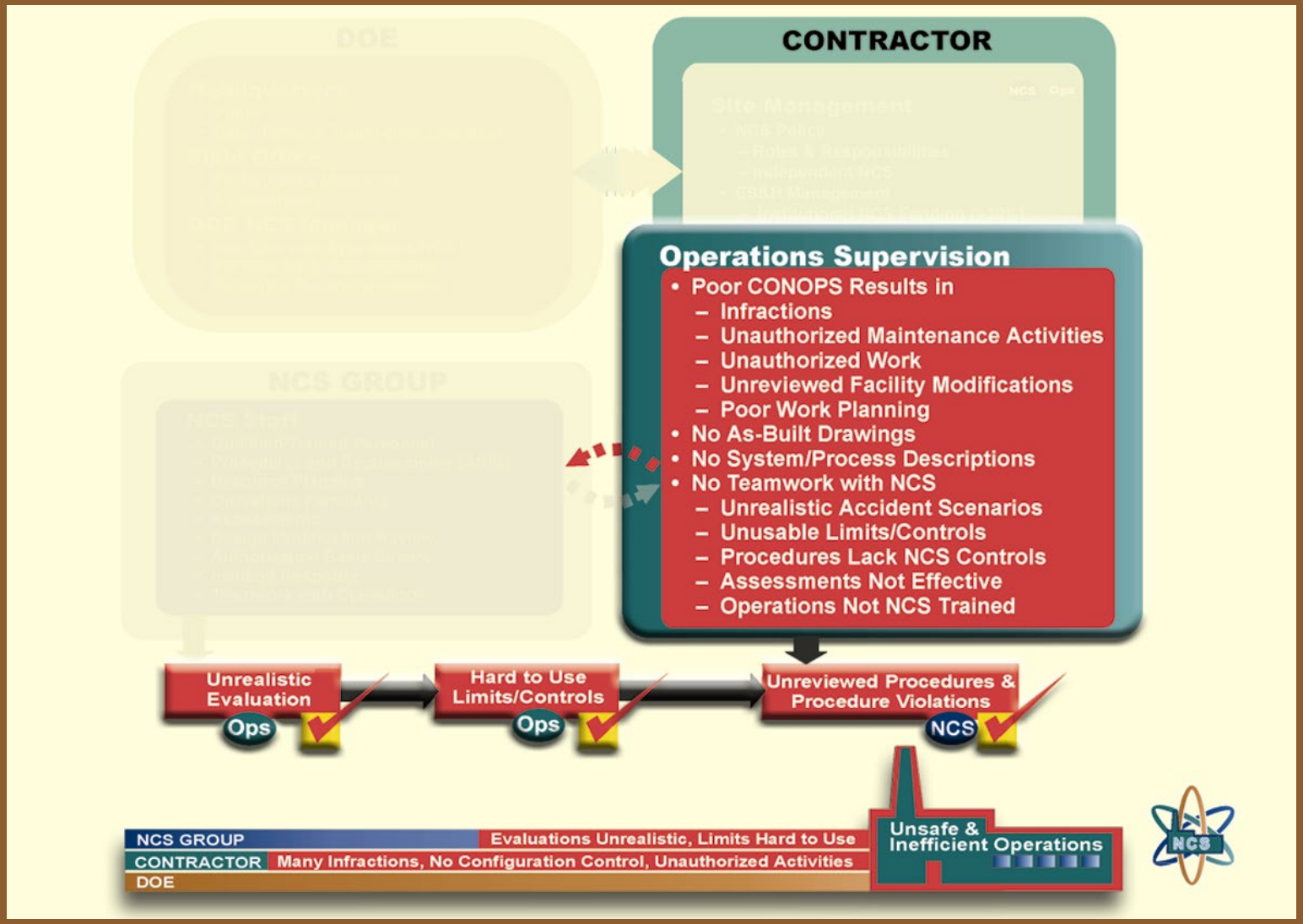
Root Causes:

- Weak or Nonexistent NCS Policy
  - Unclear Roles & Responsibilities for NCS
  - NCS Reports Directly to Line and is Controlled by Ops
- ESH, and especially NCS, reports too low into the management chain; no access to the Contractor Senior Executive and their direct reports
- No Discretionary funding or staffing resource for NCS Manager
- No Management assessments or involvement in NCS.
- No Management (up and down the line) facility time/walk-abouts dealing with NCS

Impact on Mission & Safety: Potential for UNSAFE Operations or Mission Failure

- Multiple Rework of Crit Evals, Limits, and Postings
- Hard to Use Limits placing unworkable constraints on operations
- Operations ongoing with many open infractions and large open deficiency database.

# Impacts of Typical Weaknesses in Operations Supervision



# Root Cause: Ops Supervision

Typical Observables:

- Line Supervision never engages NCS staff other than to obtain limits as a task order product or to respond to infractions
- Line Supervision has nothing to do with NCS other than to maintain compliance to postings.
- Line Supervision does not participate in the hazard identification process or the selection of necessary limits and controls.
- No operations participation in the development of criticality safety evaluations associated process descriptions and important assumptions about the parameters of the process that are important to bound the credible process upsets.
- This results in:.
  - Unrealistic Criticality Safety Evaluations that over-constrain operations or miss credible process upsets and leave them uncontrolled
  - Limits and controls are inefficient or unverifiable in practice
- No NCS Staff engagement in reviewing procedures, engineering or maintenance mods or in corrective actions for infractions

# Root Cause: Ops Supervision (cont.)

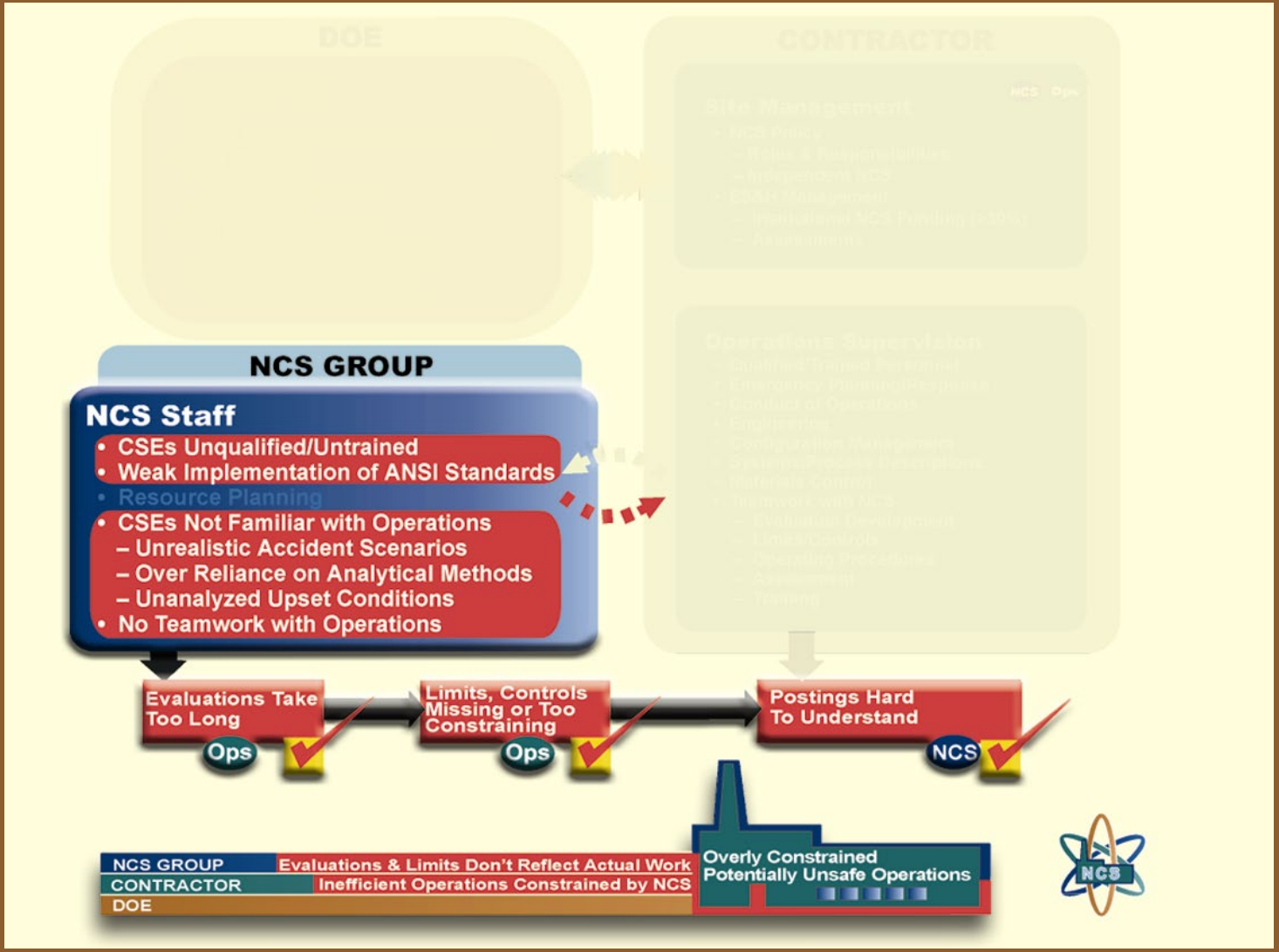
Root Causes:

- Failed CONOPS
  - Unauthorized operations and maintenance activities without NCS involvement
  - Ops corrects their own infractions and do not engage NCS Staff
  - Poor work planning with no NCS input or NCS emphasis
- No teamwork with NCS
- No interest in owning the criticality safety of their operations, no self-assessments, no NCS controls in procedures – Ownership of crit safety abdicated to NCS staff
- Ops personnel not trained to assumptions and controls in evaluations
- No Ops generated process descriptions
- No as-built drawings and weak configuration management

Impact on Mission & Safety: UNSAFE and Inefficient Operations

- Evaluations Unrealistic; Limits Hard to Use
- Many Infractions; No Configuration Control; Unauthorized/unreviewed operations (e.g. Rocky Flats Unauthorized Tank Draining Near Miss & LANL PF-4 Vault failure of config management for credited neutron absorber)

# Impacts of Typical Weaknesses in the NCS Group



# Root Cause: NCS Staff

Typical Observables:

- Criticality Safety Evaluations Take Way Too Long
- Limits and Controls are either missing entirely for credible process upsets OR
- Limits and Controls are severely over-constraining operations.
- NCS postings hard to understand and follow (written in 'crit language')
- NCS doesn't engage ops
- NCS Staff not seen much in the facility; Operators unfamiliar with crit engineers.

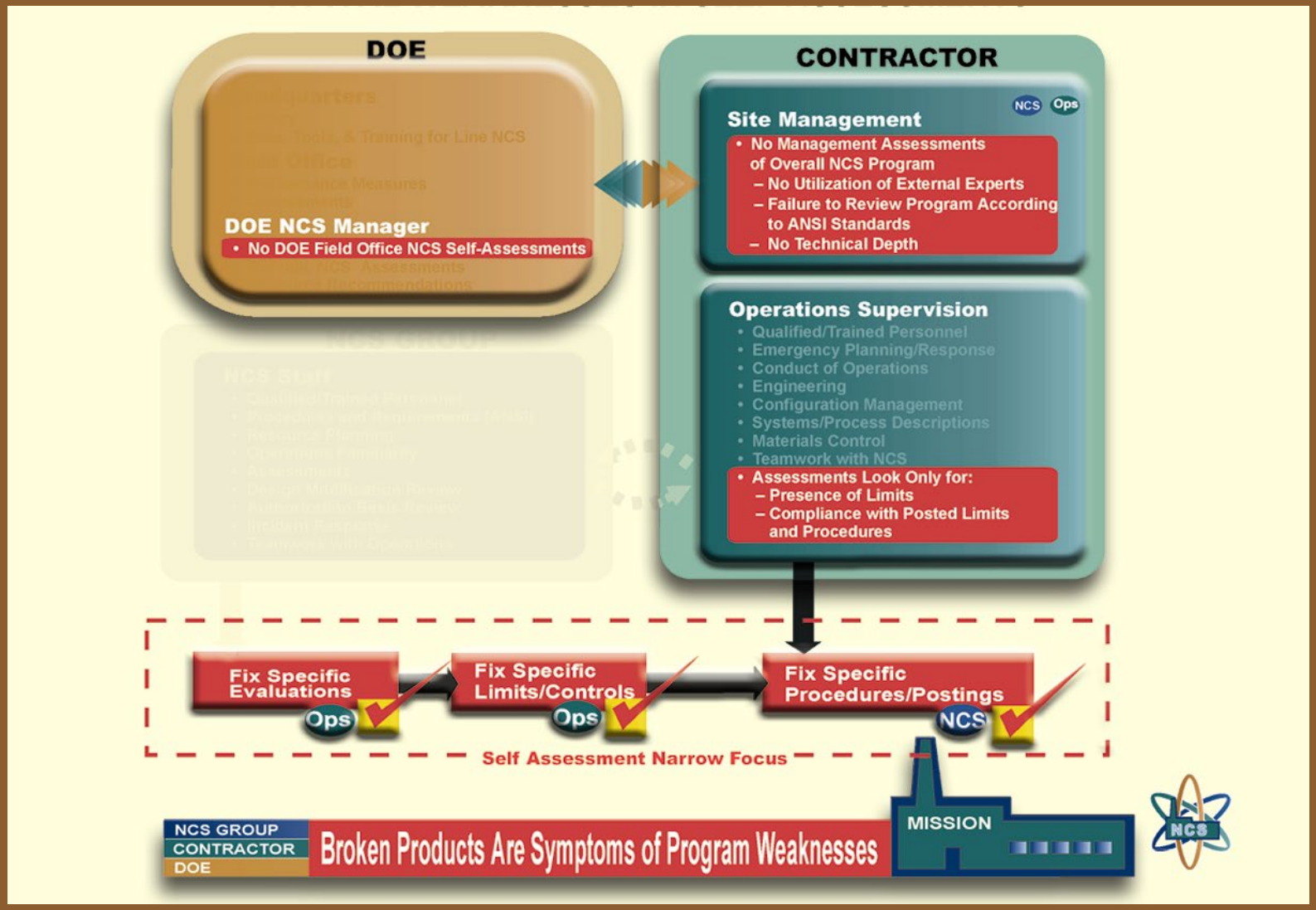
Root Causes:

- NCS Staff works in a vacuum and doesn't engage Ops Supervision and other staff in identifying credible hazards
- Crit Engineers unqualified or untrained and unfamiliar with hazards identification methods
- Crit Engineers weak in Implementation of ANSI/ANS-8 Standards
- Crit Engineers not familiar with operations; little facility time.
- Over-reliance on computer modeling in office analyzing conceivable vice credible process upsets
- Credible process upsets are missed completely because the NCS staff never talks to ops or observes ops

Impact on Mission/Safety: Overly Constrained, Potentially Unsafe Operations

- Evaluations and Limits Don't Reflect Actual/Realistic Work
- Inefficient Operations Burdened by Constraining NCS Limits/Controls

# Typical Weaknesses in Self-Assessments



# Root Cause: Weak Self-Assessments

Typical Observables:

- Identify and Fix Specific Flawed Crit Evaluations
- Identify and Fix Specific Flawed Postings and Limits
- Identify and Fix Specific Problems in Procedures

Root Causes:

- Other than NNSA Bi-Annual Assessments, DOE Field Offices Rarely do Self-Assessments of their Crit Program
- Self-Assessments at all levels of the contractor are narrowly focused on fixing the punch-list items
- Constrained or incomplete extent of condition follow-up
- Self-Assessments do not point to organizational and culture root cause weaknesses
- Site Management Doesn't Utilize Outside, Independent Experts to Perform Assessments for them
- Site Management Doesn't Utilize the ANSI/ANS-8 Standards to structure their NCS Assessments
- Ops Supervision assessments look only for:
  - Presence of Limits
  - Compliance with Posted Limits and Procedures

Impact on Mission/Safety: Failure to Realize Broken Products are Symptomatic of Program Weaknesses and The Programs Are Never Improved.

# Characteristics of an UNSAFE Criticality Safety Program

- Management has no independent, external, review of the overall implementation of the program.
- Criticality safety engineers are inexperienced, unfamiliar with the facility and operations, and a number of them work for consulting firms.
- The criticality safety engineer funding for evals and program support is 100% direct and tied to production of criticality safety evaluations.
- Criticality Safety Management does not have access to, and regular face-to-face communications with, Senior Management.
- Line supervision does not participate in developing criticality safety evaluations or limits and **is not aware of the underlying assumptions in the evaluations.**
- Line management appoints criticality safety representatives with superficial criticality safety credentials to implement limits and controls only.
- Criticality safety engineers have very little interaction with the facility and staff.