National Nuclear Security Administration

Office of Safety, Infrastructure, and Operations

NNSA Safety Roadmap

May 2021

Safe Operations
Effective Infrastructure
Enterprise Services

U.S. DEPARTMENT OF ENERGY

Foreword

This Safety Roadmap provides the strategic framework, initiatives, and timelines the Office of Safety, Infrastructure, and Operations will work towards to achieve our strategic objectives to:

- Make better use of regulatory and contract oversight information using state of the art data science techniques,
- Leverage M&O contractor performance to streamline federal transactional oversight,
- Optimize use of NNSA Safety Subject Matter Experts' (SME) assessments and maximize the effectiveness of safety professionals.

The National Nuclear Safety Administration (NNSA) Safety Roadmap outlines key elements of a redesigned oversight system, including specific milestones for implementation and measures of effectiveness. Importantly, the proposed redesign remains consistent with the principles and core functions of Integrated Safety Management, the backbone upon which the Department of Energy (DOE) and NNSA perform our vital mission safely.

Approval: James J McConnell Date: May 3, 2021

James J. McConnell
Associate Administrator
Office of Safety, Infrastructure, and Operations

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Roadmap Configuration Control

Date	Version	Major Changes
November 2018	1	▪ Original Release
May 2021	2	▪ Describes the progress made since the November 2018 Roadmap ▪ Highlights and provides details on SAFER as a key tool to achieving strategic objectives ▪ Describes new knowledge transfer initiative

Contents

Introduction

The National Nuclear Security Administration (NNSA) mission is to protect the American people by maintaining a safe, secure, and effective nuclear weapons stockpile; by reducing global nuclear threats; and by providing the U.S. Navy with safe, militarily-effective naval nuclear propulsion plants.

This mission involves over 400 nuclear and hazardous facilities and 50,000 laboratory, plant, and site employees.

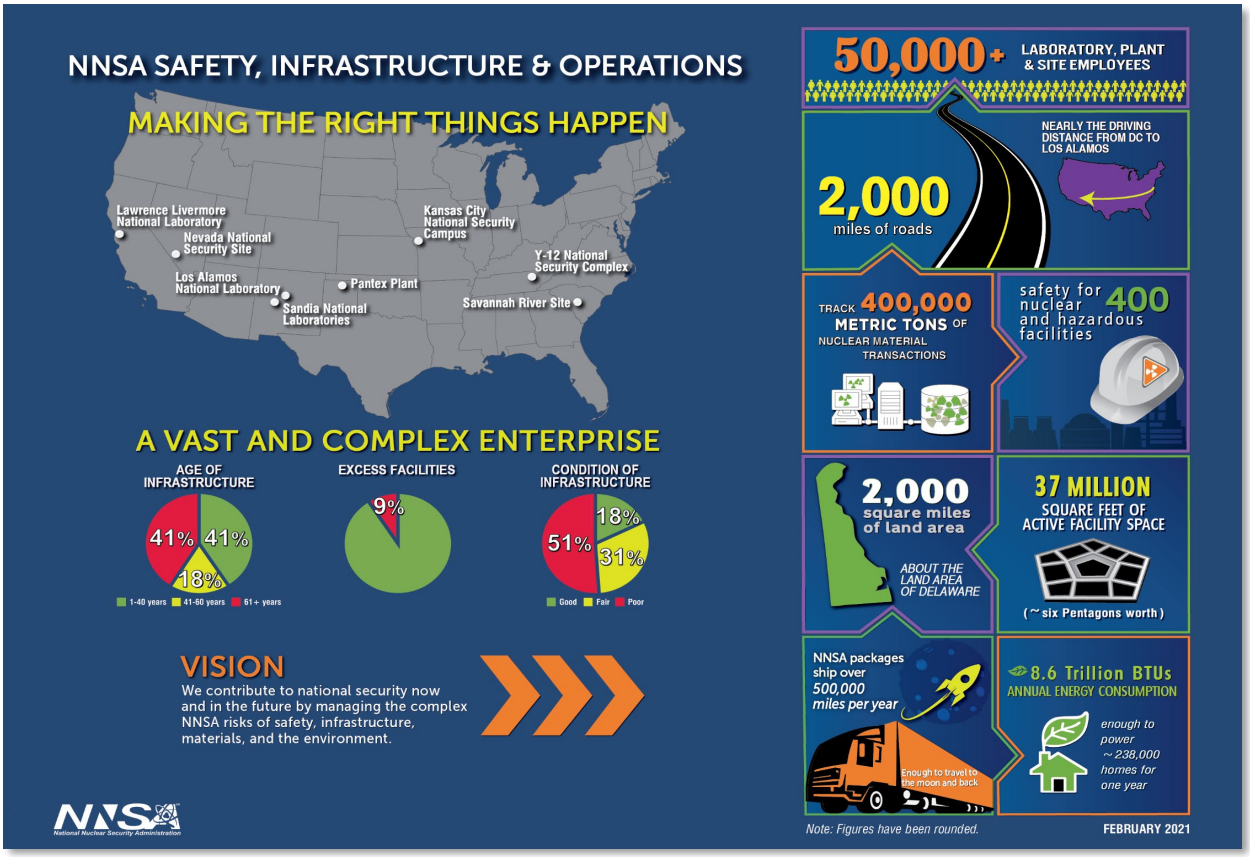


Figure 1: NNSA Safety, Infrastructure and Operations Overview

Mission success depends on safe operations, and the Office of Safety, Infrastructure, and Operations (NA-50), is responsible for managing the complex safety risks facing the Enterprise.

The challenges related directly to safety include:

- enabling the safe execution of a growing mission without a commensurate increase in resources,
- building organizational capacity and employing resources in an integrated manner, and
- leveraging 21st century tools and processes and balancing resources across the Enterprise.

A discussion of the challenges facing safety oversight written by the Associate Administrator for Safety, Infrastructure, and Operations was included in the 2018 version of this roadmap as: *Challenges Facing Safety Oversight*. That document has been updated, see Appendix 1, and published in a special 2020 edition of the NNSA Technical Bulletin available at https://nnsaportal.energy.gov/collab/na-50/na-50-tracking/NNSA%20Technical%20Bulletins.

The following three goals have been identified for NNSA:

- Make better use of regulatory and contract oversight information using state of the art data science techniques,
- Leverage M&O contractor performance to streamline federal transactional oversight,
- Optimize use of NNSA Safety SME's assessments and maximize the effectiveness of safety professionals.

Adapting to a demanding future will not be accomplished by doing the same things harder. This roadmap lays out the direction for a reimagined approach to safety oversight.

Purpose of the Roadmap

This roadmap provides direction for initiatives that facilitate an effective and efficient safety oversight program integrated across NNSA. Through these initiatives, we deploy a strategy that will maximize the use of operational data to improve situational awareness and allow for efficient, risk-focused oversight activities.

Combined, the initiatives provide Program and Field leadership with awareness and understanding of our Management & Operating (M&O) Partners' success in implementing integrated safety management, nuclear safety requirements, and safety management programs. This will promote an operating model which focuses resources on the areas of highest risk as close to the work as possible.

Figure 2: Creating Conditions Where Mission Work is Accomplished Safely

Integrated Safety Management (ISM) defines the framework for how the DOE, NNSA, and our M&O Partners achieve mission success while protecting the public, the workers, and the environment. The role of safety professionals in NNSA is to foster conditions where mission work is accomplished safely (see figure 2).

Collectively, we have established a governance model consistent with DOE Policy and Orders that relies on the effective coordination of Federal and M&O partner oversight (see figure 3). The policy requires that the Administrator, the Cognizant Secretarial Officer, NNSA Central Technical Authority, and NNSA Field Office Managers provide effective oversight of our M&O Partners' operational and business functions through their Contractor Assurance Systems (CAS). The CAS provides a mechanism to monitor M&O effectiveness in meeting DOE Acquisition Regulations that codify the principles and core requirements of ISM.

Figure 3. NNSA Federal Governance Model

Where We Are

Figure 4 is a simplified model of information flow within NNSA. This model only shows information flow in one direction - between our M&O Partners up to the NNSA front office. It does not portray how information flows across field offices, functional offices, or program offices. Nevertheless, it represents the circuitous paths information can take through our Enterprise, with potential for time lapse and miscommunication in each path.

The biggest problem with the current model of safety information flow is that it is not trackable, and cannot be trended, analyzed, or queried across the Enterprise, or over time. This makes it difficult for NNSA to integrate safety information, accumulate knowledge, and produce comprehensive safety metrics and insights for management.

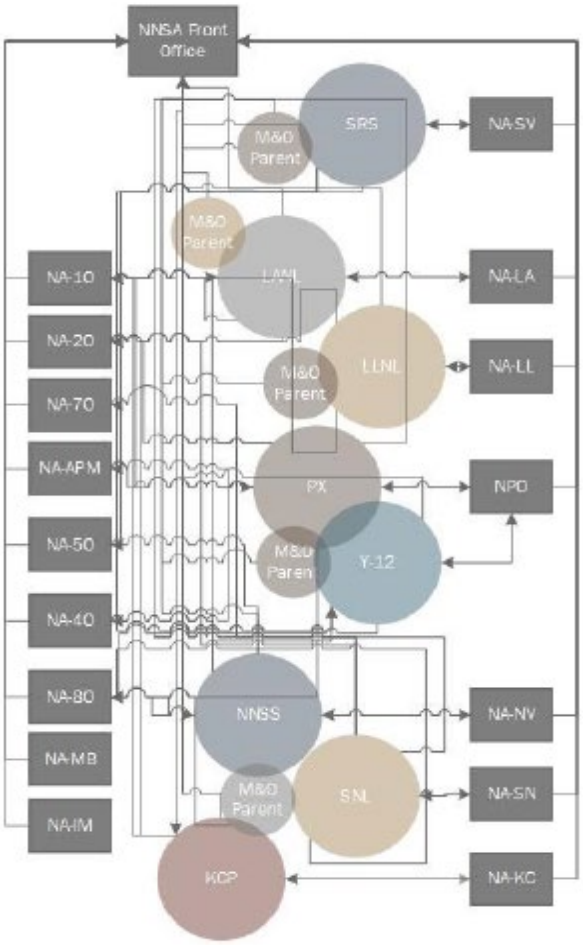


Figure 4. Simplified Model of the Current State of Information Flow

Where We Are Going

NNSA is deploying new data driven, risk informed, tools aimed at improving our communication, including the data, analysis, and visualizations we use to inform decision makers. Central data management provides the first steps toward supporting a coherent Enterprise, operating from a common source of information and capable of identifying and maximizing efficiencies.
Visualization and analysis are central for turning vast amounts of data into actionable insight.

Roadmap Initiatives

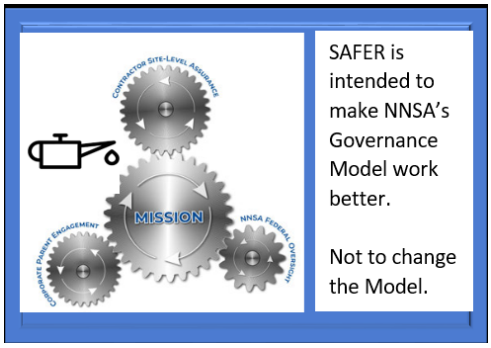
The initial Safety Roadmap (issued in November 2018) identified five initiatives to support NA-50 achieving the desired result. These were:

1. **Technical Qualification**: Leading an NNSA-wide Technical Qualification Program (TQP) Accreditation for federal technical staff, resulting in a high level of technical competence, supported by a streamlined and consistent qualification process.
2. **Safety Analytics**: Developing a Safety Analytics, Forecasting & Evaluation Reporting (SAFER) solution capable of analyzing CAS information, narrative reports, and structured data sets.
3. **Safety Basis Review Pilot**: Piloting a Safety Basis review and approval process to establish consistency in meeting nuclear safety requirements.
4. **Program Health Checkerboard**: Establishing visuals depicting current safety and health program status across the Enterprise, summarized by functional area.
5. **Enterprise Safety Risk Dashboard**: Establishing summaries of NNSA Enterprise safety risks suitable for leadership engagement.

Initiatives 1, 3, and 5 from the 2018 Roadmap have reached the milestones originally mapped out. An overview of these three completed initiatives (including actions to continue to reap benefits from these completed initiatives) follows the discussion of the three initiatives identified for this 2020 Safety Roadmap.

This version of the roadmap expands on the previous iteration to develop and integrate the Safety Analytics and Program Health Checkerboard initiatives with new goals and milestones. It will cover new ground by developing a knowledge transfer initiative that will retain, promote, and expand the technical skill base of the federal work force in a time of demographic change.

Initiative 1: Safety Analytics - The Safety Analytics, Forecasting & Evaluation Reporting Project



The SAFER Project is equipping our current and future workforce with modern tools that add value and efficiencies and better support NNSA's governance model by empowering each element of the model. SAFER began as a Safety Oversight Pilot commissioned to explore if modern data science techniques could gain efficiencies and prove beneficial in the safety environment. The pilot transitioned into a project with the objective of producing a platform capable of integrating enterprise-wide data for rapid analytics on a real-time basis. Figure 5 illustrates the desired future state of central data management and increased data capability.

Transitioning from a large, expert-based system of oversight to one that is evidence-based and supported by data, requires an incremental maturation of NNSA data model. Data management, data governance, data capabilities, data culture, and the physical information systems will be considered.

NNSA is pursuing opportunities to address the data management, data capabilities, and information systems aspects as described in this roadmap. Data culture is primarily based on an organization's willingness to trust and use the data that is being presented. Data governance will be driven by a need to standardize and maintain data once an organization begins to realize the value of good data. NNSA does not have a shortage of data. The regulations and directives associated with safety performance of NNSA operations include numerous requirements for development, maintenance, and reporting performance measures, metrics, and status updates. There are also numerous sources of federal oversight assessment results. Realization of these opportunities will allow direct federal oversight to be less resource intensive, but more effective.

Transitioning from a large, expert-based system of oversight to one that is evidence based and supported by data requires an incremental maturation of the NNSA data model.

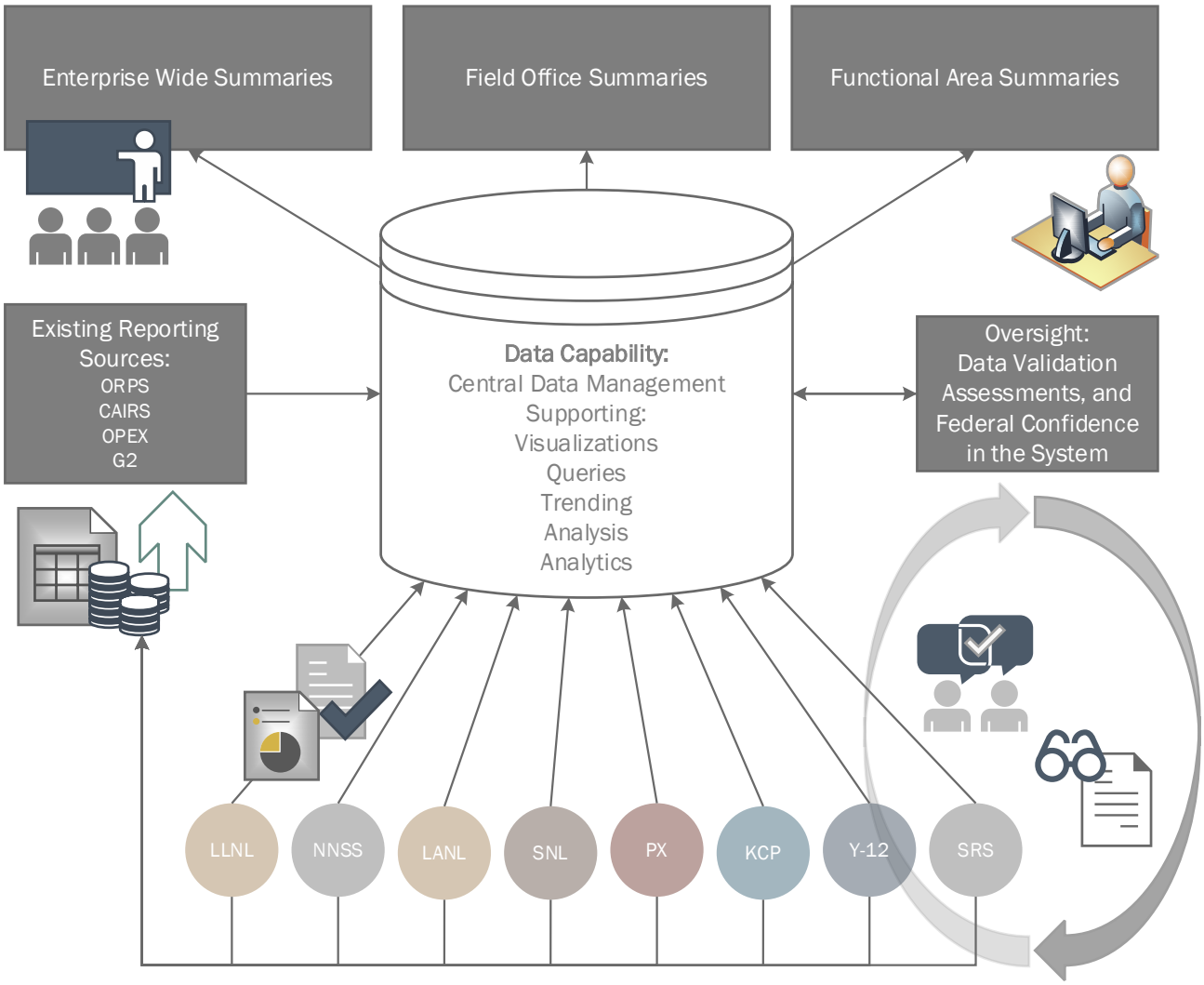


Figure 5. Desired Future State of Central Data Management and Increased Data Capability

Next Steps and Milestones

The next steps and major milestones for the SAFER project are:

- Completing the Maintenance Pilot,
- Enhancing data connections to provide for efficient and timely uploads to SAFER,
- Identifying and Prioritizing the Safety Management Programs (SMP) to be included into SAFER,
- Developing User Guides and Home pages for each User Group for SAFER,
- Supporting the Checkerboard and Risk Dashboard Processes,
- Adding capabilities to enhance oversight planning and prioritizing based upon holistic evaluation of Enterprise safety risks, and
- Adding advanced analytics capabilities.

Completing the Maintenance Pilot

The maintenance pilot will be considered complete when all the data needed to support the five pilot sites have been incorporated into SAFER, User Interfaces and Guides have been developed, and all metrics and functions needed to support the SME are in place. A meeting to discuss the lessons learned from each of the pilot participants will be held to identify enhancements needed to support SAFER going "operational" for the maintenance functional area and means to improve development of SAFER for follow on SMPs.

Enhancing Data Connections

A key activity for moving SAFER from a pilot to an operating system is establishing connection with existing real-time safety data: in particular, real time access to M&O data. There are technical, logistical, and organizational issues that need to be addressed to accomplish this, including establishing confidence and trust in the secure and appropriate use of the data.

Identifying and Prioritizing SMPs for inclusion in SAFER

Following the completion of the maintenance pilot, a workshop will be held to discuss lessons learned that can be applied as SAFER is expanded to SMPs. The SAFER team will solicit recommendations from Headquarters and Field SMEs on priority for the addition of the SMPs. The priority will be based upon factors such as safety and mission value to be gained by better data access an integration for a given functional area, availability of performance indicators, level of difficulty, and resource impacts.

Developing User Guides and Home pages

User Guides and Home pages will be developed for each User Group for SAFER. User Groups are:

- Headquarters safety managers and SMEs,
- Field office safety managers and SMEs, and
- M&O safety managers and SMEs.

Supporting the Checkerboard and Enterprise Safety Risk Dashboard Processes

NA-51 uses the Safety Management Program Checkerboard and Enterprise Safety Risk Dashboard to understand the health of safety management programs and the source of risks that could impact safety and mission success. This current data and processes will be incorporated into SAFER.

Adding capabilities to enhance oversight planning and prioritizing

A main purpose of the Safety Roadmap and SAFER is to provide tools and processes that will enable NNSA to perform smarter and more efficient contract assurance and oversight. Insights are being identified through the development of the maintenance pilot, this will help focus oversight resources that will provide important safety and mission support benefits. The SAFER team plans on adding capabilities (e.g., additional data, metrics, and data analytics) that will be valuable to NNSA.

Figure 6 illustrates the functionality that the SAFER project will be working to achieve with the SAFER tool as it matures.

Figure 6. SAFER Functionality

Figure 7 illustrates the SAFER Project Milestones

<table>
<tr><th>Establish Basic Infrastructure
Jan – Jun 2021</th><th>Support Checkerboard
Jan – Jun 2021</th><th>Expand SAFER Scope
2021 – 2025</th><th>Expand SAFER Capabilities
2021- 2027</th></tr>
<tr><td rowspan="2">Completing the Maintenance Pilot and developing lessons learned

Enhancing data connections to provide for efficient and timely uploads to SAFER

Developing User Guides and Home pages for each User Group for SAFER</td><td>See Checkboard Milestones</td><td>2021 – Add the following SMPs:
Radiation Protection
Electrical Safety
Safety Basis
Fire Protection

2022 – Add 4 SMPs

2023 – Add remaining SMPs

Continue to refine and expand functionality for all SMPs</td><td rowspan="2">In parallel with data integration and functionality development explore use of advance data analytics</td></tr>
<tr><td>Support Checkerboard 2021 - 2025

See Checkboard Milestones</td></tr>
</table>

Figure 7. SAFER Project Milestones

Initiative 2: Checkerboard - Capturing Current Safety and Health Program Status

NA-50 created a system to characterize the well-being of the safety and health programs that are vital to achieving our mission. This Checkerboard uses federal SME judgement supported by data and specific program performance metrics to capture the performance of safety functional areas across the Enterprise. Functional areas currently tracked in the Checkerboard are: Worker Safety & Health, Criticality Safety, Safety Basis, Fire Protection, Explosives Safety, Radiation Protection, Electrical Safety, Quality Assurance, and Beryllium Safety.

Key Milestones from the 2018 Roadmap that have been completed are.

- Concept Development
  - Initial checkerboard designed
  - Information collected and analyzed
  - First Checkerboard developed and presented

- Concept Refinement
  - Design enhanced
  - Rating criteria clarified
  - Second iteration of Checkerboard
  - Process document drafted
- Process Establishment and First Phase of Expansion

- First cycle completed using documented process
- First Field Office identified to provide input
- First iteration of checkerboard using Field Office input

- Process Expansion
  - Input incorporated from all Field Offices
  - Repeatable process established and used for Triannual Safety Updates

Three times a year, federal SMEs from headquarters and the field offices work together to collaboratively generate this Checkerboard. Designated safety functional area leads (SFALs) from NA-51 are responsible for engaging with their communities of practice and federal safety leadership to answer the three questions below and provide a short supporting narrative at each site for their assigned functional areas.

- **Consequence**: What is the consequence of unsatisfactory performance in this functional area?
- **Confidence:** How confident are you in your evaluation of this functional area?
- **Health**: How robust or healthy is the functional area?

Knowing the answers to these questions for each functional area at each site supports NNSA management in risk-informed resource allocation and decision making. Figure 8 provides a portion of an example checkerboard. The number displayed is the health rating, the circles below the number represent the consequence and confidence ratings. Selecting a health rating can bring up the more detailed view of Figure 9.

NA-51 Standard Operating Procedure NA-51-226.1C, *NA-51 NNSA Checkerboard/Dashboard Procedure*, provides details on the process for developing the content of the Checkerboard.

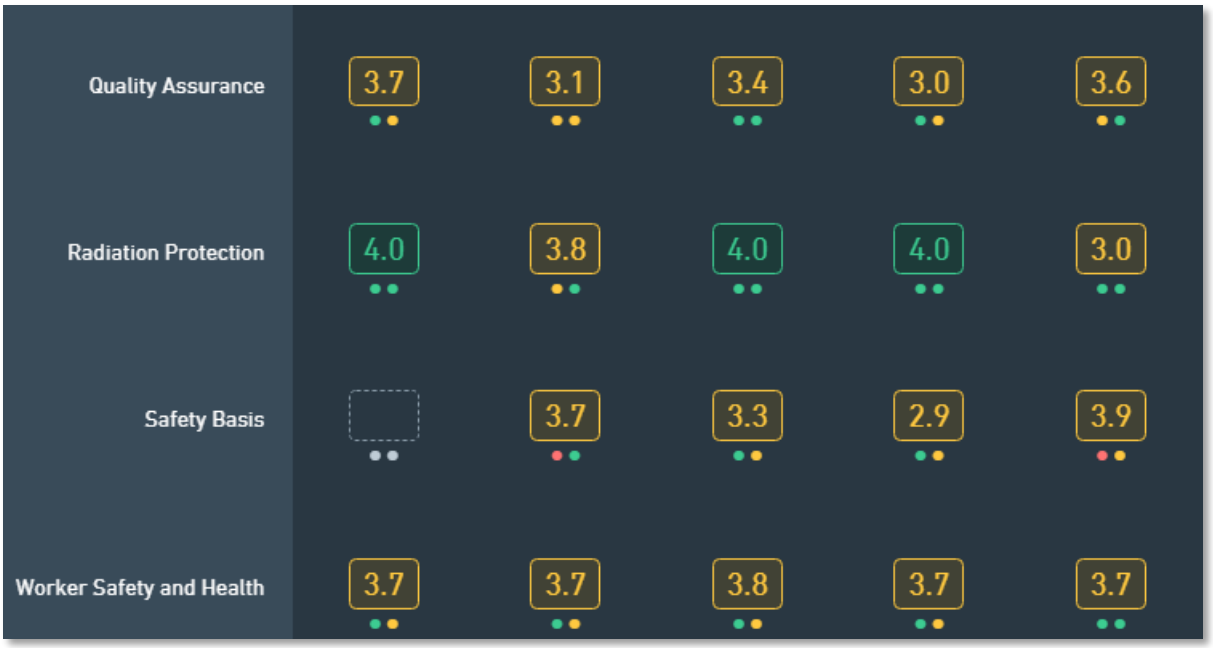


Figure 8: Checkerboard example

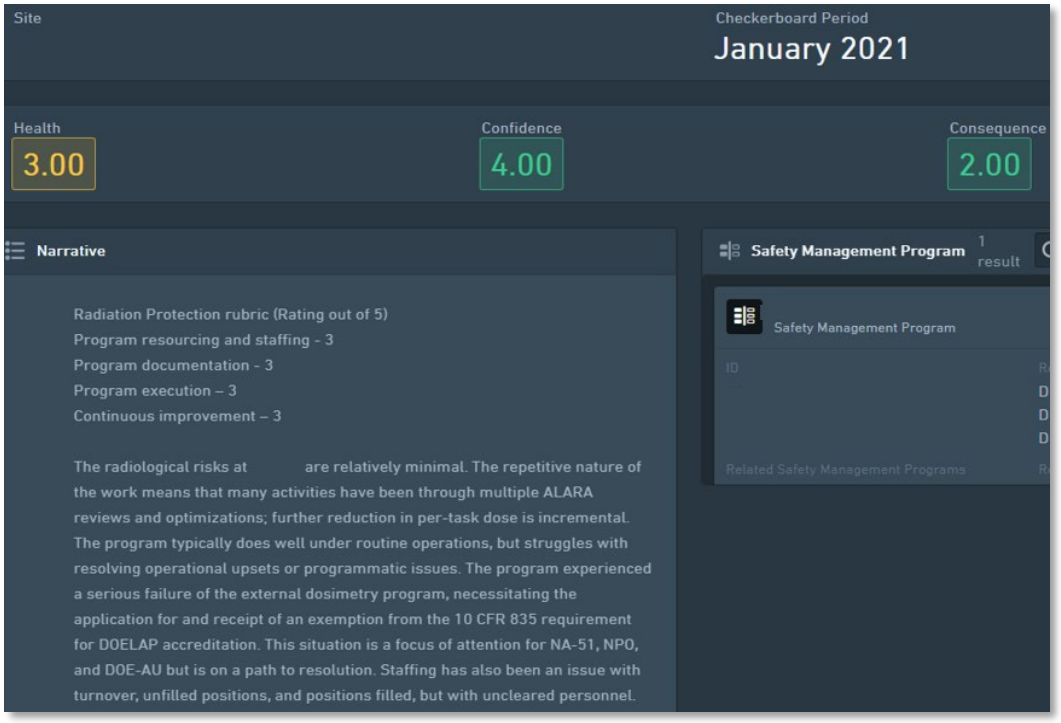


Figure 9. *Site-specific Checkerboard view*

Next Steps and Milestones

There are three major new activities for the Checkboard:

- integration of the Checkerboard into SAFER,
- refinements of metrics for SMP Health, and
- addition of SMPs to Checkerboard.

SAFER Integration

The Checkerboard is being integrated into the SAFER project with the following goals:

- SAFER can be used to generate Checkerboard outputs (e.g., visuals) based upon SME Inputs and support management reviews
- Final Checkerboards (and archived Checkerboards) will be easily assessable via SAFER
- SAFER data, data analysis and metrics will support the Checkerboard data development by SFALs in the various safety functional areas

This project is underway and undergoing refinement. Figures 8 and 9 were generated within SAFER.

Refinements of Metrics

NA-51 is refining the metrics that are used to gauge the health of the safety functional areas. This is a joint effort between the NA-51 and Field Office SMEs. Emphasis is being placed on a coordinated

approach to these metrics to ensure ratings at different sites and in different functional areas are commensurable.

Addition of SMPs

There are plans to include Maintenance as a new functional area in the Checkerboard. This effort will involve the identification of an SME to serve as the maintenance SFAL as well as identification of metrics to support determinations of the consequence, confidence, and health ratings on a triannual basis. As this project matures SAFER will be used to gather and inform the Checkerboard ratings, not simply, as is currently the case, provide a user interface to visualize the output. Furthermore, the Checkerboard team will work with the NA-51 leadership to identify and prioritize addition of other functional areas, such as Conduct of Operations, as appropriate.

Key milestones are shown in Figure 10 below.

SAFER Interface Established Jan – Jun 2021	Checkboard Metrics Jan – Jun 2021	Expansion of Checkboard Jan – Mar 2021	SAFER Integration 2021 – 2025
Checkerboard Team provides SAFER Team: ▪ Desired layout, features, and functionality of the Checkboard module in SAFER ▪ Current data on health, consequence, and confidence **SAFER team provides the Checkerboard Team:** ▪ Visual and interactive display of checkerboard results. ▪ Access to safety professionals from both functional offices (NA-50), Field Offices, and M&O partners	Safety Functional Area Leads establish and document a unified approach towards Checkerboard ratings, ensuring scores across functional areas are commensurable.	Expand Checkerboard to include maintenance functional area and assign a maintenance SFAL. Identification and prioritization of other functional areas as appropriate	SFALs work with SAFER team to develop data pipelines for each functional area on a set schedule 2021 – Add 4 SMPs 2022 – Add 4 SMPs 2023 – Add remaining SMPs

Figure 10. Checkerboard Project Milestones

Initiative 3: Federal Technical Capabilities – Knowledge Transfer Initiative

This initiative is a follow-on to the NNSA TQP Accreditation and is the next step toward continuous improvement in the development of a technically top-tier federal work force at the NNSA. This initiative will be an on-going process and the milestones to measure success will involve the establishment of the key ongoing elements which are discussed below. These elements will become the standard way of doing business at the NNSA to capture and preserve knowledge, to enhance corporate processes for passing on this knowledge, and to provide opportunity for a technically diverse and well-rounded work force.

The elements that comprise this initiative include the following –

- Knowledge Capture – Short, easily digestible, lessons from our senior staff
- Mentoring and Development – Connecting senior staff with our newer employees
- Career Progression – Development of a recommended career path to senior positions

These are aspirational goals and while we will work to establish the processes within the outlined goals, it is anticipated that these will be continuing elements as the NNSA strives to maintain the highest federal levels of technical competence.

Knowledge Capture

One of the key elements of the knowledge transfer initiative of the NNSA Safety Roadmap is to capture and retain the crucial knowledge and experiences of NNSA SMEs, senior leaders, and managers. The senior members of the NNSA have a vast wealth of experience in a multitude of challenges the NNSA has faced over the past decades. As NNSA is currently experiencing a large talent turnover, this experience must be captured and retained for the benefit of incoming staff.

The National Training Center will partner in the NNSA Safety Roadmap initiative to capture and retain these knowledge elements. These will be used to enhance current training efforts, but also provide the content for new and innovative approaches to retain and transfer knowledge. Some examples include virtual mentoring, video task instruction, and the like.

These processes will be on-going and form the basis for continuous improvement and knowledge transfer in the NNSA. These efforts will contribute to NNSA maintaining a federal staff in the top tier technically. We are looking broadly across the NNSA federal staff for ideas and input in the development of these knowledge capture elements. First to identify key knowledge elements to capture and then, if appropriate, to participate with NTC in their development.

- Milestone – implement process for knowledge capture by 30 September 2021
    - Establish agreements with NTC to support – complete.
    - Mobilize NNSA team to identify and prioritize knowledge elements – April 30, 2021.
    - Develop and prioritize knowledge elements for NTC action, July 31, 2021.

Mentoring and Development

- Establishing and incentivizing senior SMEs to mentor and assist less experienced/new SMEs,
- Including in performance elements for senior experts,

- Establishing management expectation/duty to make mentorship assignments, and
- Developing additional qualifying officials (QOs) for subject areas.

The NNSA must recognize the need across the board, for the transfer of knowledge from senior to junior staff. In the military model, driven by the required periodic rotation of personnel, it is an understood duty to train your relief for your job. While this is not driven by the NNSA corporate structure, we need to take other actions to amplify the importance of this task with the federal staff in the NNSA. There is additional complexity when junior staff are not collocated with senior staff that can serve as mentors in their functional area.

This is an element that should be incorporated into the performance planning and development of all NNSA federal personnel. All personnel that are in the qualification process are assigned Qualifying Officials to support their initial qualification in the Technical Qualification Program (TQP). Qualification requirements and timeframes are now included in the performance evaluations of all employee in the TQP. Following qualification however, there are few drivers to connect senior personnel with junior personnel to form mentoring relationship and knowledge transfer opportunities. Steps need to be taken to advance these relationships and make them a normal element of the development of the workforce in the NNSA.
The needed tools are available in the personal systems currently, but it will require senior management direction and advocacy to put these tools into practice to achieve the needed knowledge transfer results.

- Milestone – having these processes in place and functioning by 30 June, 2021.

<u>Career Progression</u>

- Training requirements – Establish pattern for expert development.
- Rotational Assignments – Establish positions or details in important areas for skill development.
- Key Events – Participation in Readiness Reviews, Accident Investigations, Safety Basis Review Team (SBRT) Participation, Integrated Project Team (IPT) for source selection, IPT for Major Construction Project, etc.

As part of the NNSA process for delegation of nuclear safety authorities, technical requirements are specified for persons that receive these delegations. The achievement of these requirements ensure that the individuals have the capabilities to properly execute these functions. This principle should be developed and applied at all responsibility levels in the federal technical workforce.

Much of this is defined in the hiring processes for technical positions. Candidates must fulfill certain educational requirements to be considered for those positions. In the same way, as personnel are advancing in their careers to new levels of responsibility, key background and experience requirements should be developed. This will allow these personnel to seek out the experience needed to be competitive for more responsible positions. This will also document senior staff's responsibility to transfer this knowledge to more junior personnel in the normal course of NNSA business.

- Milestone – Develop map of career milestones by 30 September, 2021

Next Steps and Milestones

Key milestones are shown in Figure 11 below.

Mentoring and Development June 2021	Knowledge Capture September 2021	Career Progression September 2021
In partnership with the National Training Center (NTC) and the Associate Administrator for Management and Budget (NA-MB) deploy a process for promote mentoring and employee development.	Implementing a process for knowledge capture.	Establishing a formal system to support experience requirements or recommendations for career progression.

Figure 11. Knowledge Transfer Initiative Milestones

Completed Initiatives from 2018 Safety Roadmap

Improving Federal Technical Capabilities – Technical Qualification Program Accreditation

Increasing Federal Technical Capabilities will always be a NNSA focus consistent with the ISM principle of continuing on-going initiatives in the Safety Roadmap. The milestones and activities associated with the 2018 Roadmap have been completed. The final milestone being NNSA Technical Qualification Program accreditation by an independent board chaired by AU. This confirmed NNSA successfully established a program that met the requirements. The purpose being to strengthen our TQP, developing people with the experience, knowledge, skills, and abilities necessary to perform their work and create processes that execute our mission as efficiently as possible.

NNSA organizations under the purview of DOE Order 426.1 (i.e., oversight of defense nuclear facilities) can follow a streamlined and consistent process, achieving a technically competent federal workforce efficiently with negligible subjectivity to program requirements. Additionally, NNSA will work with the DOE Federal Technical Capabilities Program to align TQP expectations and processes with NNSA's expectations for oversight per SD 226.1B, *NNSA Site Governance*. The new initiative in this roadmap outlines the next step in maintaining and improving federal technical capability.

Improving Safety Basis Reviews: The Enterprise Safety Basis Review Team Project

The 2018 Roadmap identified a Safety Basis Review Team initiative whose goal was to develop and pilot a process for better using existing technical personnel resources at the field offices and headquarters to staff safety basis review teams for major safety analysis submittals and project safety basis documents and to improve the safety basis review process.

The Enterprise Safety Basis Review Team Project aims at leveraging human resources across the Enterprise and promoting best-in-class processes as the standard for doing business

The project has completed two of the three key results with the result being the approval of a revised directive for safety basis reviews. The project has also completed project milestones that included pilot SBRT efforts, a six-sigma reviews of the process, and a final six-sigma report. The remaining effort is to complete a directive that outlines the process for corporate integration of the process. A draft directive has been prepared and submitted to NNSA Directives for processing and promulgation.

The project successfully used resources from field offices and headquarters to provide SMEs and review team members needed by Safety Basis Approval Authorities to review safety basis document submittals at NNSA sites. The principal objective of the project was to better integrate corporate resources into performing safety basis reviews at NNSA sites and improve the overall process for review and approval. The project worked with each of the field offices and their safety basis review team leaders to identify needed technical resources. Additionally, six-sigma reviews were conducted to look at process improvements. The forthcoming NNSA directive identifies process improvements and formalizes the process to better integrate corporate NNSA resources for safety basis reviews.
NA-50 will continue to support safety basis review and improvements in these reviews across the complex. A strong community of practice, led by the NA-50 Safety Functional Area Lead, has been assembled to support these improvements.

Enterprise SAFETY RISK Dashboard: Presenting Executive Summaries for Site and Enterprise Safety Risk

Pulling together data from the other initiatives in this roadmap to effectively and concisely present the status of NNSA's safety and health programs was the goal of what has been referred to as the Dashboard. The intent is to help senior leadership at HQ and in the field develop an understanding at an Enterprise level of where safety risk exists to support actions including reallocation of resources when appropriate.

This effort included all NNSA sites as sources of information and risk analysis, with NA-50 serving as the functional manager to consolidate, assist with analysis, and present Enterprise safety risk information gained. An example of the dashboard is shown in Figure 12 below.

Key elements of characterizing safety risk associated with the dashboard include:

- Baseline Risk.
- Special operating considerations affecting risk.
- Infrastructure.
- Implementation Observations.
- Federal Staffing.

Each of these are defined and discussed in NA-51 Standard Operating Procedure NA-51-226.1C, *NA-51 NNSA Checkerboard/Dashboard Procedure.*

The development of the Dashboard has been completed. Some refinements may occur as SAFER matures to be a tool to support the Checkerboard and the Dashboard. The Dashboard will continue to be an important element of NA-50 communication on Enterprise safety risk to NNSA senior leadership.

Safety Risk Ratings *(Low/Low-Moderate/Moderate/Moderate-High/High)*						
Site	**Baseline Risk**	**Special Operating Considerations Affecting Risk**	**Infrastructure**	**Implementation Observations**	**Overall Risk (site)**	**Staffing Risk (Including TQP Qualifications)**
	M&O					**FEDERAL**
Site 1	High	Moderate - High	Moderate - High	Moderate	Moderate - High	Moderate
Site 2	High	High	Moderate - High	Moderate - High	High	Low-Moderate
Site 3	High	High	High	Moderate	High	Low-Moderate
Site 4	Moderate	Low - Moderate	Moderate	Low-Moderate	Moderate	Low-Moderate
Site 5	Moderate	Moderate	Moderate	Moderate	Moderate	Low
Site 6	Moderate	Moderate	Moderate	Low - Moderate	Moderate	Low-Moderate
Site 7	Moderate	Moderate	Moderate	Moderate	Moderate	Low-Moderate
Site 8	Low	Low	Low	Low - Moderate	Low	Low

Figure 12. Enterprise Safety Risk Dashboard

Defining Success and Tracking Progress

A timeline of major milestones for the major initiatives is shown below.

YEAR	CHECKBOARD	SAFER	KNOWLEDGE TRANSFER
2021	• Jan – Jun 2021 Integration of the Checkerboard into SAFER • Jan – Mar 2021 Refinements of metrics for SMP Health. Safety Functional Area Leads establish and document a unified approach towards Checkerboard ratings, ensuring scores across functional areas are commensurable. • Jan – Mar 2021 Expanded Checkerboard to include maintenance functional area and assign a maintenance SFAL. • 2021 – 2025 SFALs work with SAFER team to develop data pipelines for each functional area on a set schedule • 2021 – Add 4 SMPs	• Jan – Jun 2021 Completing the Maintenance Pilot and developing lessons learned Enhancing data connections to provide for efficient and timely uploads to SAFER • Developing User Guides and Home pages for each User Group for SAFER • 2021 Expand SAFER Scope. Add 4 SMPs: o Radiation Protection o Electrical Safety o Safety Basis o Fire Protection • 2021 – 2027 In parallel with data integration and functionality development explore use of advance data analytics.	• Jun - 2021 Deploy a process to promote mentoring and employee development. • Sep - 2021 Implement a process for knowledge capture. • Sep - 2021 Establish a formal system to support experience requirements or recommendations for career progression.
2022	• 2022 – Add 4 SMPs	• 2022 Add 4 SMPs.	
2023	• 2023 – Add remaining SMPs	• 2023 Add remaining SMPs. Continue to refine and expand functionality for all SMPs • SMEs effectively utilizing SAFER for day-to-day work activities.	

Figure 13. Checkerboard and SAFER Major Milestones

NA-50 is tracking (figure 14) how well the Roadmap Initiatives support the Roadmap objectives to:

- Make better use of regulatory and contract oversight information using state of the art data science techniques,
- Leverage M&O contractor performance to streamline federal transactional oversight,
- Optimize use of NNSA Safety SME's assessments and maximize the effectiveness of safety professionals.

Metrics
Checkerboard and SAFER used to enhance NA-50 Technical Support ▪ Improves operational awareness to understand where technical challenges exist ▪ Provides better access to technical information from across complex ▪ Supports focus and target assessments (e.g. enables easy identification of areas of good performance and/or low risk that do not need to be assessed) ▪ Optimizes where NA-50 applies resources working with field offices to best address risk ▪ Supports NA-50 annual input to SIAPs SAFER used to help make HQ Assessments more efficient (e.g., Biennial Reviews) ▪ Reduces impact on Field Offices to support the BR (e.g., reduction in data/info needed from field) ▪ Supports focus and target assessments (e.g., enables easy identification of areas of good performance and/or low risk that do not need to be assessed) and supports a more performance based approach in assessment SAFER used to help make Field Office Assessments more efficient ▪ Improves analysis of M&O assessment and operational data that can reduce the need for assessments ▪ Provides insight to help focus and target assessments ▪ Reduces impact of assessments on M&Os (e.g., reduced need for data calls) ▪ Facilitate reassignment of safety oversight activities to increase Safety Professional time in facilities when SAFER integration and use is mature SAFER used to enable better allocation of personnel and financial resources to address near and longer-term safety and operational risks and to support mission success ▪ Improves safety program health ▪ Reduces safety events resulting in operational pauses ▪ Improves equipment reliability and availability ▪ Reduces time to perform safety analyses and reviews Knowledge Transfer enhances NNSA Technical Competence ▪ Captured knowledge elements are available to all TQP participants. ▪ Senior Level NNSA Technical Experts are participating as Mentors or Qualifying Officials ▪ Career Progress milestones and prime developmental assignments are available to all NNSA staff

Figure 14. Roadmap Metrics

NA-50 will evaluate success on the metrics through stakeholder input and make course corrections as appropriate.

Conclusion

NNSA safety professionals execute the important task to foster the conditions where work is accomplished safely.

NNSA safety professionals must foster the conditions where mission work can be safely accomplished. To facilitate this effort, we are building the tools and techniques necessary to leverage human capital and communicate the results of safety oversight to leadership. This allows us to be better aligned, more aware of the challenges we are facing, and closer to our strategic objective of managing safety risks in a holistic and Enterprise-wide approach.

The initiatives described in this roadmap represent the important steps toward transforming safety management. These initiatives involve a considerable investment in human resources and capital resources, particularly during the early stages of implementation. However, by following the directions in this roadmap we will minimize impacts to mission and safety during the investment period. Commitment to the vision outlined in this roadmap will take us from these discussed initiatives, through the difficult investment period, and ultimately to more sustainable and effective safety oversight.

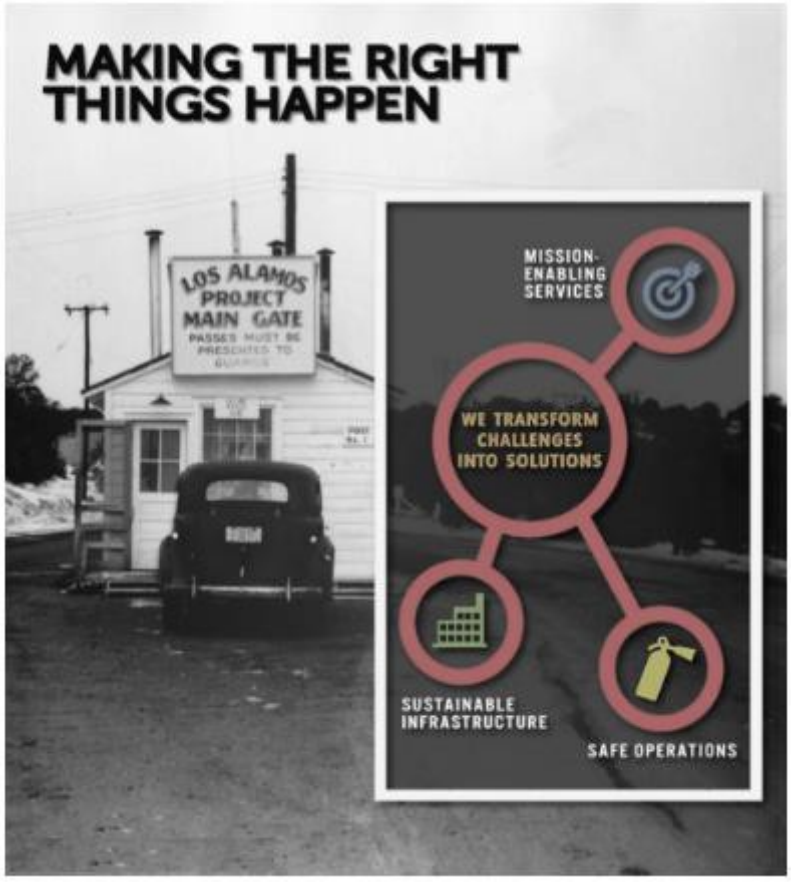
> ***Good ideas and innovations must be driven into existence by courageous patience.***
>
> -ADMIRAL RICKOVER

A. Appendix: Challenges Facing Safety Oversight

NA-50

National Nuclear Security Administration

U.S. DEPARTMENT OF ENERGY



Challenges Facing Safety Oversight:

A New Approach to be Purpose Driven and Mission Focused

Revised September 2020

Abstract

This update of the original report reflects changes in the mission, people, and Governance & Management of NNSA during the last two years as well as refinement in the oversight model and lessons learned from COVID-19. There remains a case that the Department of Energy and National Nuclear Security Administration approach to safety oversight must evolve to improve efficiency and effectiveness to support our crucial mission. This paper goes on to describe updated actions to address the challenges facing safety oversight

James J. McConnell
Associate Administrator for Safety, Infrastructure & Operation

Challenges Facing Safety Oversight:
A New Approach to be Purpose Driven and Mission Focused

Purpose

This update of the original report reflects changes in the mission, people, and Governance & Management of NNSA during the last two years as well as refinement in the oversight model and lessons learned from COVID-19. There remains a case that the Department of Energy and National Nuclear Security Administration approach to safety oversight must evolve to improve efficiency and effectiveness to support our crucial mission. This paper goes on to describe updated actions to address the challenges facing safety oversight.

This paper starts by outlining the current issues to be solved which lead to the need to redefine and redesign NNSA's safety oversight as a dynamic, integrated system. The need stems from long-understood inefficiencies, captured recently by the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise[1] (Augustine-Mies Panel) and the Commission to Review the Effectiveness of the National Energy Laboratories[2] (CRENEL). The need also arises from risks and opportunities facing NNSA during the next 5-10 years due to externalities such as increased production demands and an aging workforce. This section also uses the tool of dynamic system modeling to provide a plausible explanation of recent NNSA safety and oversight trends. This model and explanation show that Integrated Safety Management (ISM) and oversight combine to form a dynamic system with feedback loops and interacting effects that can be hard to understand or manage. This is a likely reason why NNSA's oversight is seen as inefficient and ineffective despite the large effort and resources NNSA applies to safety oversight.

Next, this paper proposes a way to conceive of NNSA oversight as an integrated system and proposes a specific redesign of the work process for NNSA safety oversight. The importance of this section of the paper is to begin the process of accurately depicting NNSA and M&O oversight as a dynamic system. The model presented is but one way, hopefully a good way, to do that.
Finally, this paper concludes with a discussion of specific oversight problems to be solved. The NNSA Safety Roadmap outlines key elements of a redesigned oversight system, including specific milestones for implementation and measures of effectiveness to test these first steps. Importantly, the proposed redesign remains fully consistent with the principles and core functions of ISM, the backbone and foundation upon which DOE and NNSA perform our vital mission safely. This proposal assimilates concepts of agile development and Dynamic Work Design[3] to make NNSA's approach to safety oversight more responsive, productive, efficient, and ultimately more effective.

[1] Final Report of the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, November 2014, A New Foundation for the Nuclear Enterprise
[2] Final Report of the Commission to Review the Effectiveness of the National Laboratories, Volumes 1 and 2, Securing America's Future: Realizing the Potential of the Department of Energy's National Laboratories
[3] A concept and term developed by Repenning and Kieffer, see MIT Sloan Management Review, Winter 2018, Vol. 59, No 2, 29-38

The Current Challenges Facing Safety Oversight

The problem and challenge for NNSA as laid out by the Augustine-Mies and CRENEL reports are: "Establish a New Foundation for the Nuclear Enterprise", and "Secure America's Future by Realizing the Potential of the DOE's National Laboratories." These high-level challenges are not the explicit focus of this paper, but the two reports describe a hierarchy of issues which can be traced down to lower-level, more specific issues and ultimately to issues and concerns with safety oversight. Some of the key issues and findings of the reports that relate to oversight are paraphrased in the list below and are shown graphically in figure 1:

- Dysfunction in Management Practices
    - Lack of proven management practices, including dysfunction between line management and mission-support functions has undermined the management culture.
    - Dysfunctional relationship between the Government and the Management & Operating (M&O) contractor partners has encouraged burdensome transactional oversight rather than management focus on mission execution.
    - A need to practice risk management rather than risk avoidance.
    - A need to establish metrics for assessing and improving enterprise management.
- Lack of Clear Roles and Responsibilities
    - Lack of clarity within NNSA's Roles, Responsibilities, Accountabilities, and Authorities (R2A2.)
    - Lack of clarity in R2A2 between the Government and M&O Partners.
    - Tension in defining the roles of M&O and federal mission-support officials.
- Poorly Planned and Coordinated Oversight
    - A need to overhaul oversight planning so that risk is better assessed and balanced with the needs of mission execution.
    - A need to overhaul oversight from detailed and transactional to strategic and performance-based.
    - A need to better understand and measure performance.
    - Inability of line management to push back against external reviews.
    - Burdensome practices not characterized well enough to lead to targeted interventions.
    - Lack of definition for an effective, mission focused oversight model.
    - Continued practice of burdensome and uneven oversight.
    - Continued practice of excessive, uncoordinated, and resource intensive inspections

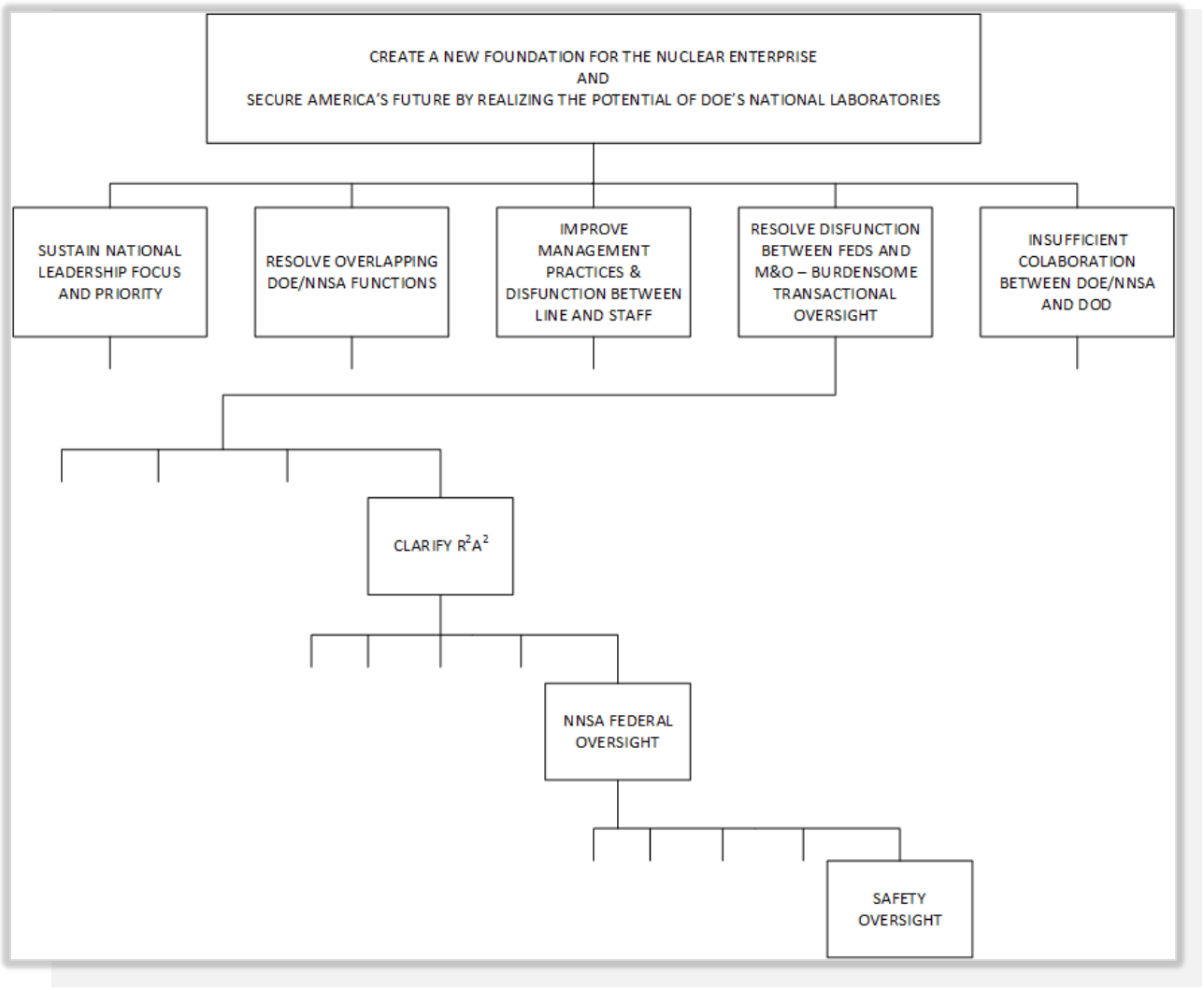


Figure 15: A Hierarchal Display of Current Issues

It is important to note that the criticisms and issues highlighted above can pertain to other functional areas besides safety and perhaps some of the points above do not pertain to safety at all. Some of these comments can be seen as expressions of the Fundamental Attribution Error, but this is only a representative list of issues. There are underlying problems with the conduct and outcomes of NNSA's approach to oversight.

NNSA is in the early stages of a significant production increase to meet growing national security requirements. NNSA is now working on several Life Extension Programs and major weapon system alterations at the same time. By some measures, the amount of activity in the near future could increase by a factor of three or more (see figure 2). To maintain the current level of safety oversight, using current methods, NNSA would need to significantly increase the number of reviews it performs with a commensurate increase in the number of people performing those reviews and the funding required to sustain that effort. Even assuming the output stays constant, the absolute number of safety events and problems would increase, because the increased workload would increase the opportunity for errors and events. NNSA would not consider such an increase acceptable, so the efficacy of safety oversight must increase as fast as or faster than the increase in activity.

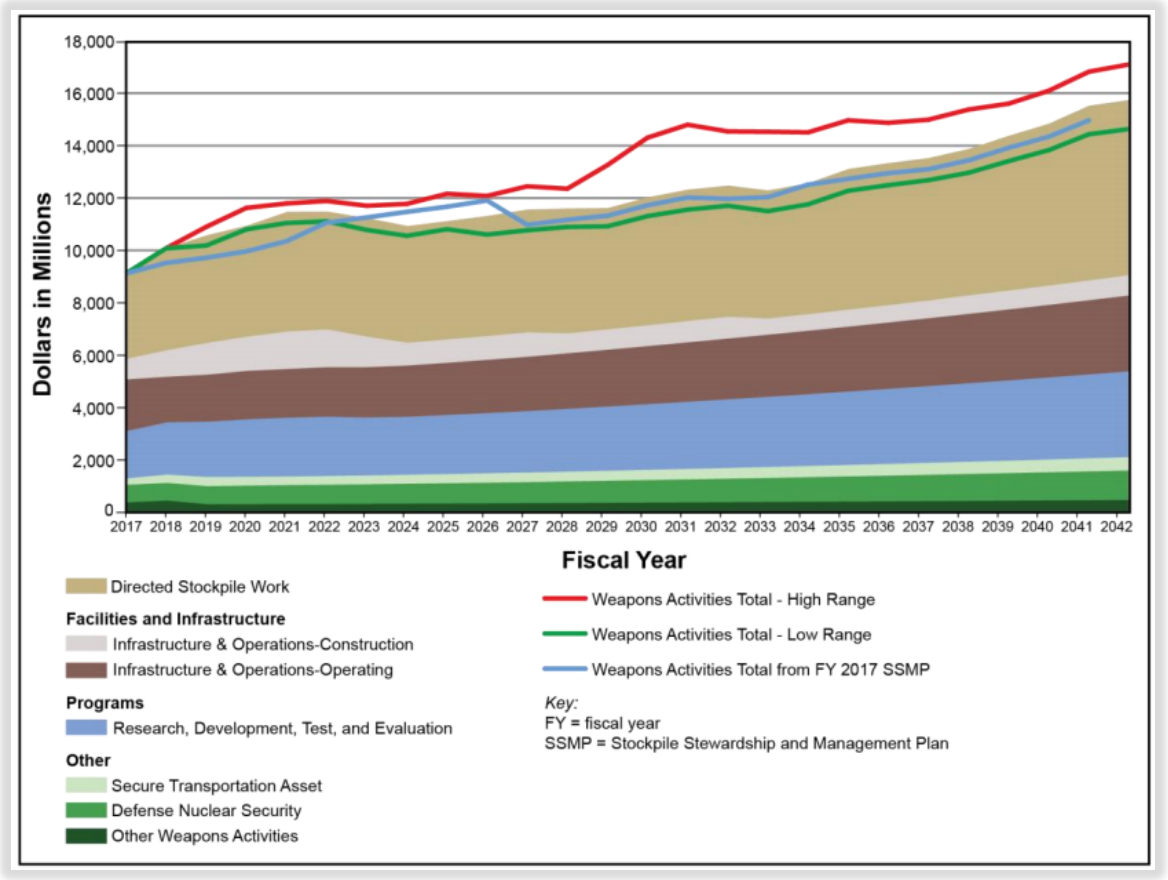
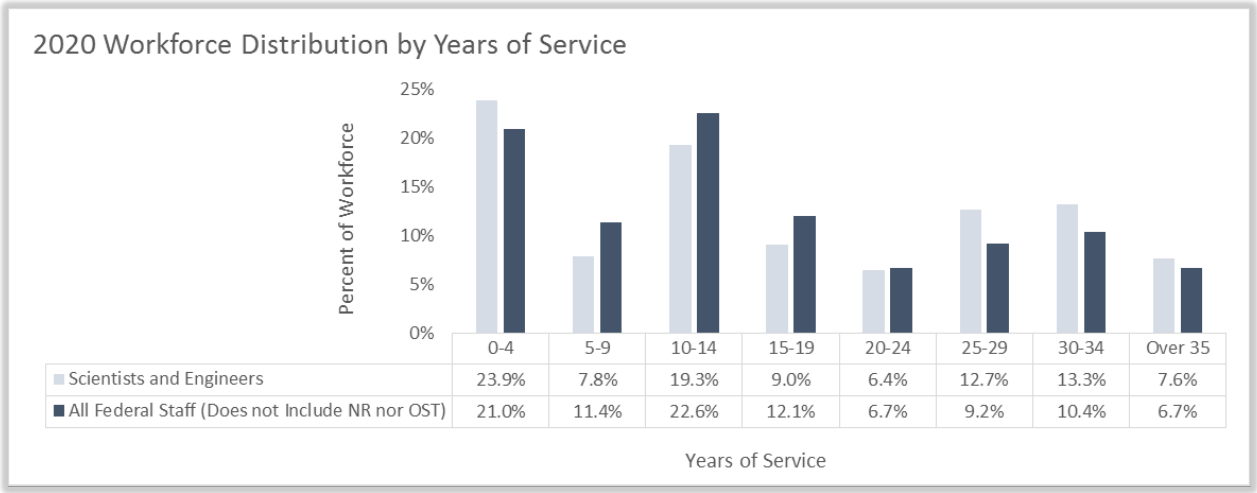


Figure 16: NNSA Upcoming Work Load

At the same time, NNSA's cadre of safety professionals, those people with the skills, training, and experience to perform safety oversight, is aging and many safety SMEs are at or near retirement (see figure 3). Approximately half of the people in NNSA safety organizations will reach retirement age by 2025. NNSA is recruiting an impressive group of early career safety professionals but the net loss of experience during the next decade will be dramatic. The shifting demographics also reduce the opportunity for experienced SMEs to mentor less experienced SMEs.

The efficacy of safety oversight must increase as fast as or faster than the increase in activity

Finally, as a result of learning from the COVID-19 pandemic, NNSA is altering its Governance and Management approach, including reducing the amount of travel that federal employees such as safety SMEs use to conduct on-site reviews at labs, plants, and sites. This change does not affect the expectations or requirements for oversight but will affect the models, tools, and systems NNSA uses to execute its oversight functions. There will be an unavoidable learning curve as NNSA adjusts to new approaches and stands up new capabilities, so it is important to define these new approaches and develop the new tools with a sense of urgency to match the growing pace of mission operations and potential increases in safety risk.



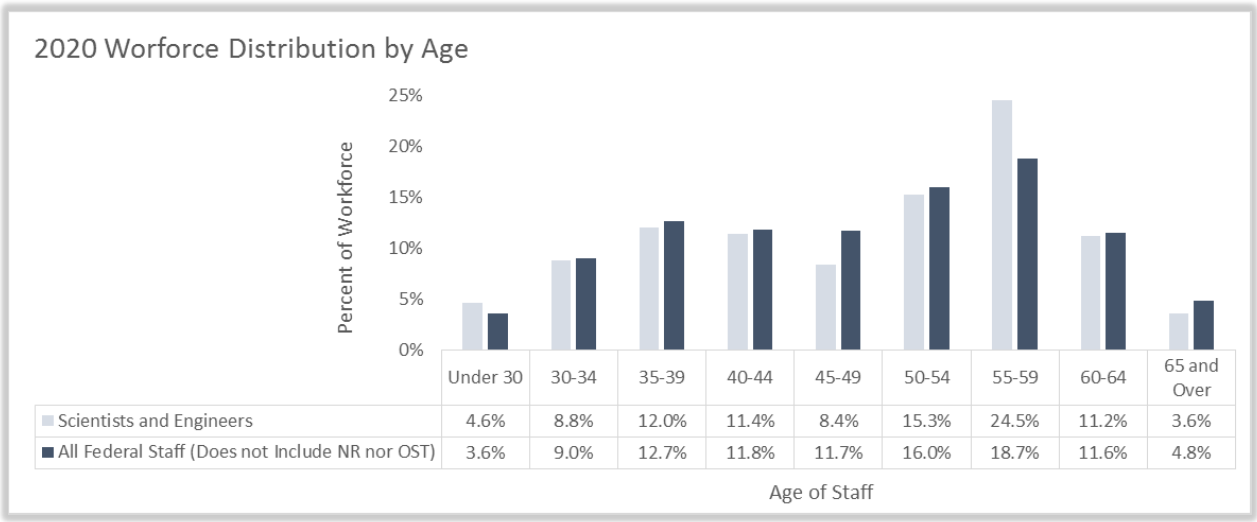


Figure 17: NNSA Workforce Demographics in 2020

The combination of the need to address design and performance issues with the current approach to oversight, and the need to adapt to a challenging future that cannot be solved by simply doing the same old things harder, clearly point to the need to reimagine the current approach to safety oversight.

Safety Oversight as a Dynamic and Complex System

DOE and NNSA have done a good job of defining and implementing ISM as a system. However, the policies and directives on oversight generally treat each element individually and do not adequately tie all the components into an integrated system where each element is described in relation to the others. Nevertheless, during actual oversight, the people conducting assessments and the people being overseen do respond as a system, specifically a dynamic system which includes both positive (reinforcing) and negative (balancing) feedback loops. These feedback loops cause the system to respond in ways that are hard to anticipate based on a static analysis of the policies and directives.

In these coupled, interactive systems it is entirely possible for the reinforcing feedback loops to dominate the balancing loops and create a cycle that changes steadily in the same direction over time.

These responses can either be beneficial (a "virtuous" cycle) or detrimental (a "vicious" cycle.) Unfortunately, it appears that we can describe a vicious cycle that accounts for our recent NNSA safety experience. Specifically NNSA has been applying steadily more resources to oversight in the expectation that safety will improve, but actual safety is not improving and may be getting worse. The figures below depict a model that is a plausible explanation of the vicious cycle in which NNSA safety oversight is trapped[4]. NNSA will need to develop a specific model and test it against empirical data to gain confidence that we have the correct, or at least a useful, model.

As shown in figure 4 at any given point in time, an NNSA activity has a specific number of latent safety defects (even if we cannot know the exact number.) This is the "stock" of latent safety defects that NNSA and its M&O partners wish to minimize to achieve the highest safety performance possible. The number of latent safety defects created is affected by things like the pace and complexity of operations, the condition of facilities and equipment, training, staffing, and the quality of procedures. Latent safety defects are removed from the system through one of two ways: they are eliminated by identifying and correcting them through feedback and improvement (F&I) efforts driven by the line ISM improvement system or they progress to an actual safety issue and are identified and corrected through oversight.

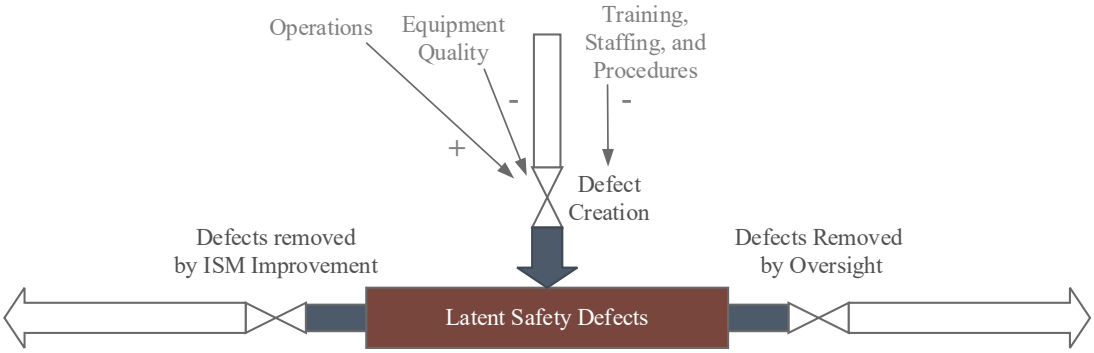


Figure 18: Stock and Flows of Latent Safety Defects

NNSA and its M&O partners have implemented feedback loops to guide actions and drive down the occurrence of latent safety defects (see figure 5.) As the number of latent safety defects increases, the number of F&I initiatives generated by ISM increases. These F&I improvement activities often involve production personnel and require plant or procedure modifications, or training (we will call these F&I pauses.) More safety improvement pauses lead to more elimination of latent safety defects and the prevention of future latent safety defects. This is the intended balancing loop that explains why we do F&I as part of ISM (the ISM improvement balancing loop, B1). One other outcome is that increasing F&I pauses leads to reduced plant uptime in the immediate, short-term until improvement efforts have time to take effect. NNSA and our M&O Partners communicate often that this tradeoff is a net positive and we encourage workers to pause when they are unsure.

At the same time, an increase in latent safety defects leads to an increase in accidents and actual safety issues which leads to an increase in operational shutdowns due to things like TSR violations or directed shut-downs (we will call these regulatory and oversight (R&O) shutdowns.) Increasing R&O shutdowns lead to increasing corrective action plans.

[4] The model, its description, and the overall concepts discussed here come from the teaching of Dr. John D. Sterman, MIT Sloan School of Management and his book, "Business Dynamics: Systems Thinking and Modeling for a Complex World"

Increasing corrective action plans result in decreasing latent safety defects and the prevention of future latent safety defects. This is the intended balancing loop of oversight (the oversight improvement balancing loop B2). Increased R&O shutdowns decrease plant uptime in the same way that increased F&I pauses do.

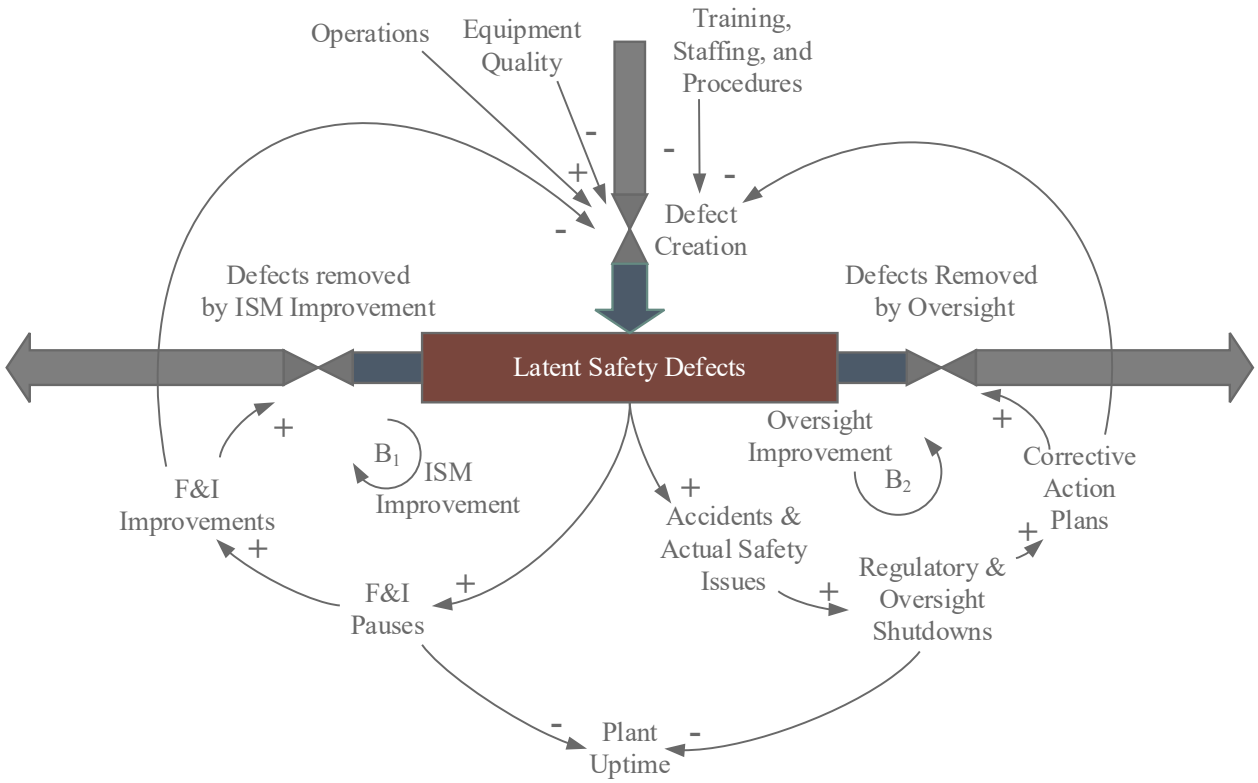


Figure 19: Intended Balancing Loops of ISM Improvement and Oversight

However, there are other feedback loops that are not part of these intended loops but have a real impact on the overall performance of our system (see figure 6.) Below are a few main unintended loops that contribute to a vicious cycle:

1) As plant uptime goes down (due to both F&I pauses and R&O shutdowns) pressure builds to keep the plant operating to meet mission requirements. It is not possible to elect to ignore R&O shutdowns, so only F&I pauses can be reduced. This leads to fewer latent safety defects being corrected and increased generation of future latent safety defects. More latent safety defects leads to more actual safety issues which leads to more R&O shutdowns which further reduces plant uptime. This is the "too busy to improve" reinforcing loop R1.

2) As R&O shutdowns increase, corrective action plan development and implementation actions increase. The operations, safety, and management personnel and resources that develop and implement corrective action plans are the same as those that perform ISM F&I. So as resources for corrective action plans go up, resources for F&I go down. As F&I resources go down, fewer current and future latent defects are eliminated through F&I. As latent defects increase, accidents & actual safety issues increase and so R&O shutdowns further increase. This is the "fire-fighting instead of improvement" reinforcing loop R2.

3) Actual accidents, even if people are not harmed, can result in physical damage to the plant, the spread of contamination, or other follow-on issues (whether they are recognized at the time or not) that can expand the scope of problems to be solved beyond the direct impact of the initial latent safety defect that caused the accident. This "extended condition" increases the creation of defects which increases the number of latent defects which further increases the number of accidents. This is the "extended conditions" reinforcing loop R3.

4) Corrective action plans after actual accidents and significant regulatory shutdowns often have effects wider and longer than the initial event which caused the shutdown. This could be things like accident investigations, enforcement proceedings, formal restart processes, and increased future scrutiny. Including these tasks is not wrong, and these enhanced assurance steps are often necessary to restore confidence in response to R&O shutdowns. Nevertheless, they extend the time that the plant is down which reduces plant uptime. This feeds into the loop described in #1 above. This is the "lost confidence" reinforcing loop R4.

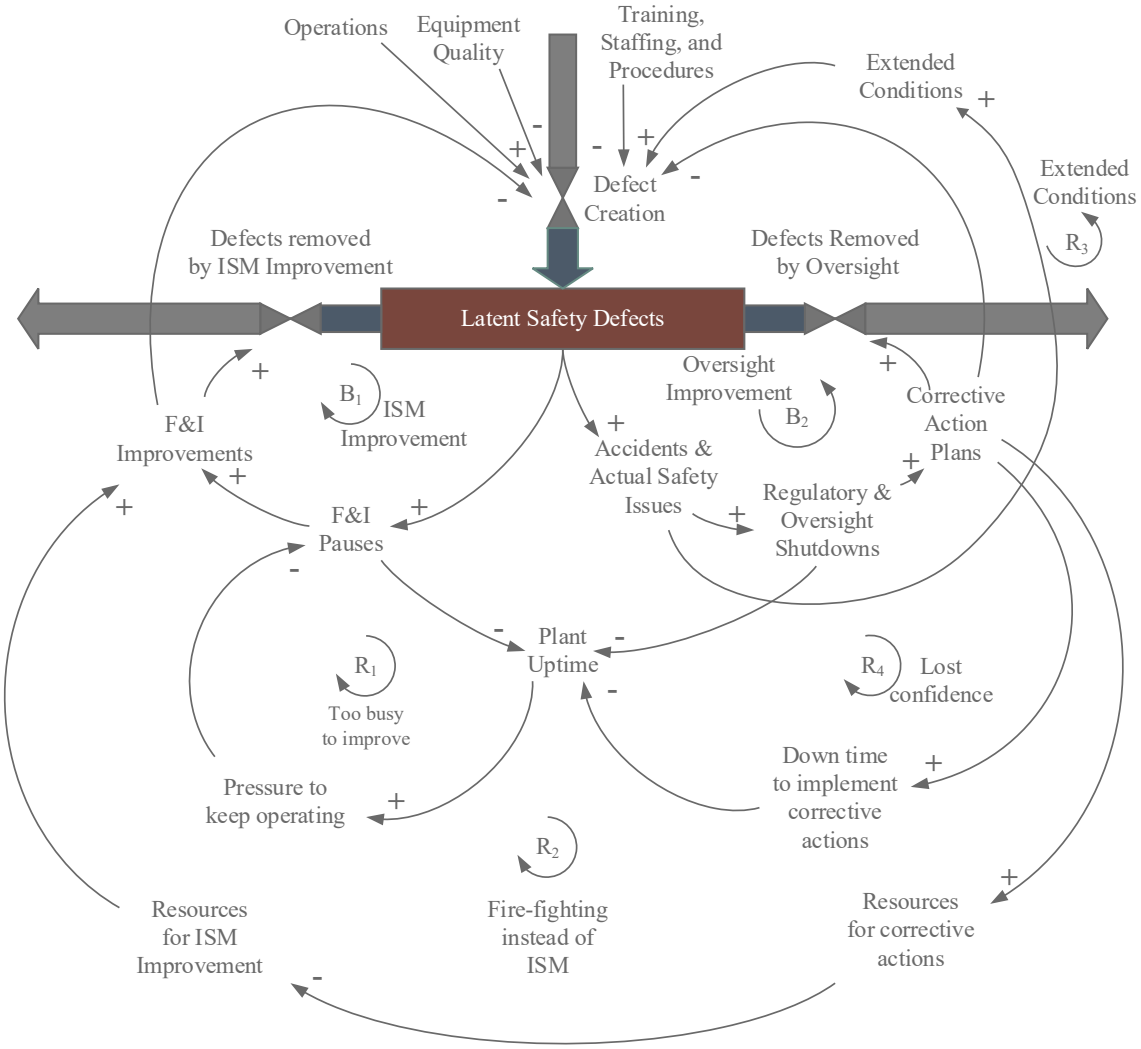


Figure 20: Positive Feedback Loops Undercutting Line Management ISM

It is important to note, that if NNSA and our M&O Partners can get to the point where latent safety defects are decreasing, R&O shutdowns are decreasing, and plant uptime is increasing, then the reinforcing loops described above can become virtuous cycles rather than vicious cycles. To achieve that goal, we must define and manage oversight correctly as a dynamic system, increase F&I, and commit to stay the course.

A New Design for Safety Oversight- Back to First Principles

Moving back to first principles, we need to address the intent and purpose of Federal safety oversight. Simply put, Federal safety oversight in NNSA exists to enable the success of NNSA's mission. The mission of the National Nuclear Security Administration, as described in the NNSA Act, is:

1) to enhance United States national security through the military application of nuclear energy;
2) to maintain and enhance the safety, reliability, and performance of the United States nuclear weapons stockpile including the ability to design, produce, and test, in order to meet national security requirements;
3) to provide the United States Navy with safe, militarily effective nuclear propulsion plants and ensure the safe and reliable operation of those plants;
4) to promote international nuclear safety and nonproliferation;
5) to reduce global danger from weapons of mass destruction; and,
6) to support United States leadership in science and technology[5].

The NNSA Act goes on immediately to state that this mission must be carried out consistent with certain principles. The first two principles cited are:

1) protecting the environment and
2) safeguarding the safety and health of the public and the workforce of the Administration[6].

Our mission cannot be sustained unless it is achieved without undue harm to the public, our workforce, or the environment. The purpose of the overall safety functional area and NNSA safety professionals is to enable this crucial attribute of our mission. The simultaneous achievement of these goals (safety and mission) is vital. We cannot be successful if we minimize safety risk but fail in our mission. Likewise, we cannot sustainably achieve our mission if we are not adequately safe.

The simultaneous achievement of these goals (safety and mission) is vital. We cannot be successful if we minimize safety risk but fail in our mission. Likewise, we cannot sustainably achieve our mission if we are not adequately safe.

The "we" in the statements above encompasses all of the people engaged in the NNSA mission, both federal and M&O partners. It is precisely because everyone engaged in the NNSA mission has some role in safety that a comprehensive system, clear R2A2, and well defined processes are crucial to conducting efficient and effective oversight.

[5] NNSA Act, 50 USC 2401 Section 3211 (b)
[6] NNSA Act, 50 USC 2401 Section 3211 (c)

We conduct safety oversight to collect information supporting the following actions and decisions:

a) to determine if hazardous operations meet minimally acceptable safety performance requirements and to determine if M&O processes and procedures comply with regulatory requirements, to determine if the risk of active operations is acceptable to the government. **We will call this form of oversight "regulatory oversight"**;
b) to evaluate safety performance of our M&O Partners to determine if performance is consistent with contract expectations. **We will call this form of oversight "contract oversight"**;
c) to communicate overall safety status or specific safety event information to higher level personnel in the organization. **We will call this form of oversight "status and communication (S&C) oversight";** and,
d) to enable continuous improvement of safety systems (i.e. ISM) and safety performance by providing data, analysis, and insights to assist line management in its safe execution of mission requirements. **We will call this form of oversight "feedback and improvement (F&I) oversight.**"

These forms of safety oversight are fundamentally different. They have different customers, different timescales, and different decision or action thresholds. However, they all have similar data and information requirements.

Regulatory Oversight

As the regulator and ultimate acceptor of risk[7] NNSA must, when necessary, take an active role to ensure that the M&O partner achieves minimally acceptable safety performance or does not conduct work. This form of federal safety oversight requires timely and comprehensive data on specific performance conditions, but not necessarily large numbers of SME assessments, let alone burdensome federal transactional oversight[8]. In addition, NNSA must ensure that M&O systems and processes comply, and maintain compliance, with regulatory requirements, which requires appropriately focused SME assessments. This aspect of regulatory oversight has much in common with "contract oversight" described below. Regulatory oversight is performed by NNSA and the DOE Office of Enforcement within EA. Many other elements inside and outside DOE/NNSA (e.g., the DNFSB) focus on this significant safety threshold but ultimately, their results fall into "feedback and improvement oversight."

Contract Oversight

The intent of this form of safety oversight is to ensure that the government fulfils its requirements as expressed in the contract and evaluates the M&O partner's performance against the contract and to form the basis for safety inputs to the annual M&O partner Performance Evaluation Report. This form of federal safety oversight includes systems-level assessments and periodic implementation checks of M&O processes and procedures. Consistent with the ISM DEAR clause, this form of oversight also

[7] DOE Policy 450.4A

[8] Transactional Oversight: Oversight activities that assess contractor performance through evaluating contractor activities at the work, task, or facility level: direct interaction with personnel at any level within the contractor organization; and direct independent Federal staff evaluation of activities, physical conditions, and contractor documentation. When taken to extremes, this is referred to as burdensome transactional oversight.

includes evaluating to ensure that the M&O partner maintains a robust system aimed at excellence, including that the M&O partner appropriately addresses inevitable process upsets.

[Note that the capability to deal with process upsets is part of the expectations of the M&O's ISM system. Merely having a safety issue and using the corrective action system is not inherently a failure of the M&O ISM system, or a need for NNSA to transition from oversight to active problem-solving.] This form of oversight benefits from data along with appropriate SME assessments focused on the system level (i.e., "systems oversight".) As the federal party to the contract, virtually all federal contract oversight is performed by NNSA.

Status and Communication Oversight

DOE/NNSA, like any large, complex, and geographically dispersed organization, has the need to ensure timely and accurate flow of information from the decentralized execution elements back to key site-level leaders and centralized HQ senior leaders. This information includes status and performance data from activity-level work, through site-level contract performance, to enterprise-level performance. It includes periodic reporting and ad-hoc reports, particularly if there are issues or problems. Reporting is primarily a line management responsibility, but oversight systems are useful because they are often set up to collect the information required and include standard processes to distribute information. This form of oversight needs to collect mostly systems-level and outcome-level performance for periodic reporting, but is often very detailed and transactional at the activity-level when reporting on specific issues or problems. Many of the oversight elements external to NNSA also conduct S&C oversight for their own element which they may or may not share with NNSA.

Feedback and Improvement Oversight

Feedback and Improvement oversight is intended to improve the safety system and performance of the entity being overseen. Given that the M&O partner has the most direct impact on actual hazards and physical safety risk, this means federal F&I oversight is usually directed at the M&O partner, so the M&O partner should be the major customer and focus. Federal organizations also have an impact on safety and so some F&I oversight is aimed at helping those federal organizations improve.

Safety Professional Roles that do not Constitute Oversight- Product and Activity Approval

Among the most significant functions NNSA safety professionals execute are the inherently governmental elements of projects to develop 1) safety-related documents and plans and 2) performance-based validations of readiness to execute hazardous operations. These efforts are aimed at supporting approval by a federal decision-maker.

Safety-related written products are usually documents including safety analyses (e.g., Documented Safety Analysis and Technical Safety Requirements) and safety management program descriptions (e.g., ISM system descriptions and Conduct of Operations Implementation Matrices.) NNSA safety SMEs also conduct performance-based reviews that, while including oversight, differ in purpose and intent. Activities to confirm readiness (e.g., Operational Readiness Reviews) involve data collection and analysis and SME observation and evaluation. They are a one-time (per each activity startup or restart), structured process to confirm and accept the design and implementation of a specific work scope. Upon

successful completion of the readiness demonstration, a designated NNSA authority approves the start of the activity.

A key aspect of these activities is that they directly support an explicit NNSA decision. Federal efforts to develop, review and approve documents and operations in these cases do not constitute oversight.

These activities require interactions with our M&O Partners that are more collaborative in nature, while still maintaining clear roles, responsibilities, accountabilities, and authorities. The M&O partner is accountable for the quality and timeliness of these products and preparations but collaborates with NNSA safety SMEs to produce final documents and results that satisfy the requirements and expectations of DOE rules, orders, and standards. NNSA safety SMEs collaborate with the M&O partners as appropriate during the development stage and ultimately evaluate the results to ensure the products and performance meet Government expectations prior to recommending approval by designated NNSA safety decision-makers.

Once an analysis or plan has been approved or an activity has been released for operation, the periodic work to monitor the process for contract performance and/or regulatory compliance with the approved authorization basis represents a significant portion of the oversight performed by NNSA, its M&O partners, and independent/external elements. Assuming the review and approval process is of high quality, the key point of operational oversight is to detect drift from expected performance or to detect if changes in the work, physical environment, or other factors require a change to the approved safety documentation and/or implementation.

Sometimes we monitor and only transition to an active role when the situation requires. I call that oversight. However, when we are the customer for specific deliverables, we need to be more active and collaborative. Following the "oversight" model in these cases can look like "bring me a rock" perpetuating a frustrating cycle that increases time, risk, and cost if we are not careful.

The importance of this discussion -*What Constitutes Federal Oversight*- is to understand that in some cases we monitor and only transition to an active role when the situation requires. We call that oversight. In other roles, when we are the customer for specific deliverables, we need to be more active and collaborative. Following the "oversight" model in these cases can look like "bring me a rock" perpetuating a frustrating cycle that increases time, risk, and cost if we are not careful.

One Possible Model of NNSA Safety Oversight as a System

"Transactional oversight, performed by the right element and for the right reason, is not inherently bad"

The following is a quote from George H. Miller, Director Emeritus, Lawrence Livermore National Laboratory, cited in the Augustine-Mies report: "Transactional oversight entails setting precise steps to be followed and examining implementation of each step with more than 100 Federal employees at each site and hundreds of external audits annually. By its very nature, this process is extremely conservative, risk-averse, and avoids appropriate cost-benefit considerations[9]." Without a doubt this is excessive and in many ways non-value-added as a model for federal safety oversight. On the other hand, if this activity were being performed by line management within the

[9] Augustine-Mies, page 71, Footnote 64, "Opening Remarks and Summary"

M&O partner, it would look like an element of the Toyota Production System and, with a few modifications, might be considered a best practice. The points here are that federal safety oversight is a specific, focused application of data gathering, analysis, and reporting and the design of each safety oversight process in the overall oversight system must be linked clearly to its specific intent. Another point is that transactional oversight, performed by the right element and for the right reason, is not inherently bad.

One way to describe the current issue with overall NNSA safety performance having plateaued at the same time that oversight is widely considered onerous, is that the federal government is doing too much transactional oversight and the M&O partners are doing too little. The success of the "Kansas City Model" is that the M&O partner there has deployed a successful version of the Toyota Production System (which is transactional, but designed by and for the needs of the M&O partner) and the local NNSA Field Office has focused its oversight at the system level. Of course, the Kansas City Model benefits from there not being a nuclear safety regulatory need at the site. Nevertheless, the rest of NNSA can make progress in improving oversight if it focusses more on the principles that have been applied at Kansas City and less on the specific tools and practices that may, or may not, translate. Efforts across NNSA to implement this approach will address one of the key themes from the Augustine-Mies and CRENEL reports–improving management practices and dysfunction between line and staff.

For this paper, we assume that the M&O partner's ISM system has established appropriate site-, facility- and activity-level safety controls and safety management systems. We also assume that the M&O partner collects data and uses metrics and measures to identify if work down to the activity level is being conducted as intended, or within a reasonable control band. This can be depicted using a statistical process control-like approach (see figure 7 below) to determine if measured parameters are within an acceptable range or not and to detect adverse trends within the acceptable range. This control band should support efficient predictable mission performance and also ensure high safety performance consistent with DOE/NNSA's safety goals and policies. The approach must also include qualitative inputs from SMEs that are crucial to a robust overall perspective, particularly for factors that are not amenable to quantification and numerical limits. SMEs will need to establish qualitative thresholds and ways to measure trends.

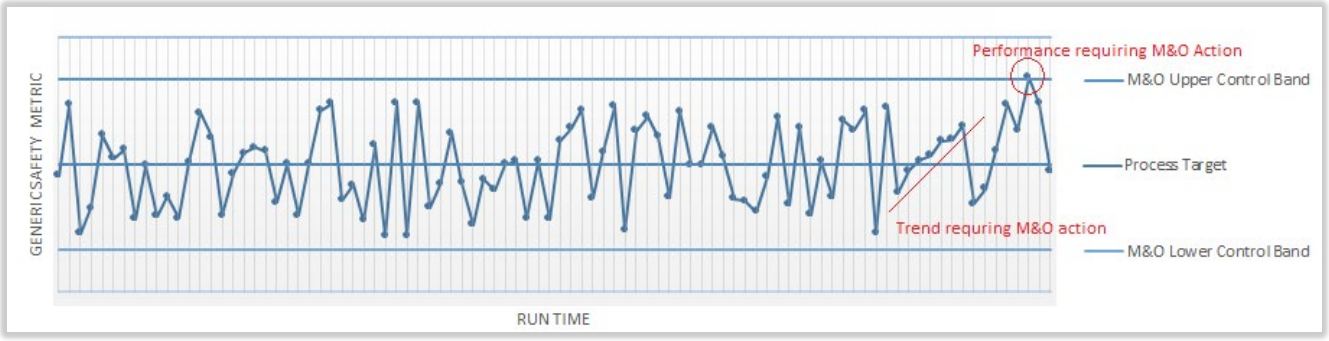


Figure 21: Generic Safety Parameter with M&O Partner Control Band Trigger

If measured data as collected through Feedback and Improvement oversight stays within the control band, then operations are being performed as expected and operations continue in the "normal" or "factory" mode with personnel following established work processes and no need for oversight intervention. If performance is noted outside the acceptable control band or a significant negative trend is identified in the control band, then M&O line management is alerted by a "trigger" that some form of intervention is required. Exceeding a trigger causes the M&O system to transition from "factory" mode

to a less-structured, more collaborative "studio" mode to start F&I problem solving. Once the issue is reliably addressed and performance returns to the acceptable control band, the activity returns to "factory" mode for optimum mission performance. This entire process of normal "factory" operations and occasional controlled entry into and out of problem solving "studio" mode is anticipated and captured in the M&O partner's ISM system description.

As long as safety performance stays within the acceptable range or periodic safety issues are handled promptly before safety performance deteriorates too much, the M&O partner is performing within contract expectations for ISM as defined in the M&O partner's ISM system description. In this condition NNSA need only monitor M&O data, metrics, measures, and performance and should not intervene. ***This is a critically important point. Safety is highest and performance is best when the system encourages line management continuous improvement and organizational learning and only resorts to disruptive intervention when clearly necessary.***

Safety is highest and performance is best when the system encourages line management continuous improvement and organizational learning and only resorts to disruptive intervention when clearly necessary.

However, there is a control band wider than the one used by the M&O partner that NNSA uses as a "trigger" (see figure 8 below.) If data analysis through Contract oversight exceeds this trigger then performance is not currently within NNSA's contract expectations and NNSA line management transitions from monitoring (i.e., the "factory" mode for NNSA) to the "studio" mode to collaborate with the M&O partner or, if necessary, direct problem solving and corrective actions to return to within contract expectations. Exceeding this trigger may also stimulate status and communication oversight. Once performance has reliably returned to within contract expectations, then NNSA returns to its "factory" mode of monitoring.

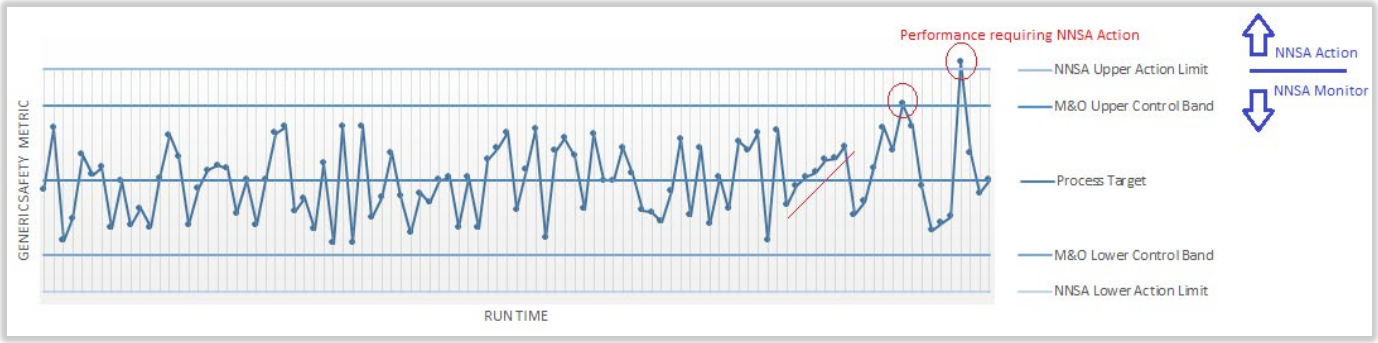


Figure 22: Generic Safety Parameter with M&O and NNSA Contractual Control Bands

There is a third control band even wider than the NNSA contractual oversight trigger. It is the regulatory control band and the focus of Regulatory oversight (see figure 9 on next page). It is set at the minimum acceptable safety performance per regulation, assuming the parameter being measured has an explicit regulatory limit. Performance outside this control band is unacceptable and DOE/NNSA will take action as necessary to ensure safety (e.g., suspending operations) and will initiate the process to evaluate and consider regulatory enforcement actions. NNSA and the M&O partner will work together to determine how best to resolve the safety regulation violation and return performance to the acceptable range.

Exceeding this threshold will activate Status and Condition oversight. When those actions are complete, DOE/NNSA will have an active role in ensuring performance is once again acceptable.

Figure 23: Safety Parameter with M&O ISM, NNSA Contractual and Regulatory Control Bands

Together, these three control bands and the organizations setting and monitoring them form the basic core of an integrated oversight system that integrates all four types of oversight. The system presumes, and is dependent on, a rigorous and comprehensive structure of data collection and analysis using carefully chosen measures and metrics. The M&O partner has the greatest need for and ability to produce data and has the largest number of safety SMEs focused on a specific scope of work; therefore, the M&O partner should provide the majority of the data and analysis used by the whole system. However, each element of the system must maintain its own ability to evaluate the data and reach conclusions to maintain our system of checks and balances and to avoid group think.

Summary

The oversight system described above is not perfect and it is one of many different systems that could be constructed. An important point is that it is presented as an overall system of interdependent and interacting parts. This type of construct allows for more holistic evaluation and design to optimize the entire system, which is what matters in the end, rather than sub-optimizing different parts.

Specific Oversight Problems to Solve and Opportunities to Seize:

Problem #1: We must optimize our use of data gathered and analysis conducted by our M&O Partners and share it broadly but securely with all valid users in the oversight system

The first problem/opportunity is the often heard concern about burdensome transactional oversight. As discussed above, transactional oversight is often used to capture the same data that could be collected through more automated systems or, at the very least, could be provided primarily by the M&O partner who presumably has the greatest need for activity-specific data to inform its management and ISM system. The data are presumably extremely valuable to the M&O partners to enable continuous improvement, performance excellence, and mission success. Leveraging M&O contractor performance metrics should reduce the need for federal transactional oversight. Data collected through the work process rather than through outside inspection should be timelier, more accurate, more comprehensive, and less burdensome, so it should be the strongly-preferred source of transactional data. Nevertheless we employ transactional oversight for three main reasons:

1) we have no data source or we do not have confidence in the data/measures/metrics to serve as an adequate trigger;
2) we do not have enough trust among organizations (federal/M&O or HQ/field) to share data; or,
3) our culture, habits, or policies lead to transactional federal SME oversight.

Overcoming these three challenges may well prove to be the most difficult and time-consuming part of reimagining our oversight system. We will need a system to collect all the disparate data already produced and protect the data while still sharing it transparently with those who have a legitimate need throughout the system. This leads us to the first major problem statement of this paper:

Problem #2: We need to optimize our use of NNSA Safety SME assessments.

Even with better use of data and performance metrics, we will still need SME assessments. Collecting safety information through SME assessments allows for focus, judgement, and the application of subjective expertise. Further, SME oversight results provide context, validation, and a deeper understanding of the performance metrics gathered by our M&O Partners. But conducting SME assessments can be resource intensive both for the personnel conducting the oversight and for the people being overseen. Also, this form of data gathering is limited to the times and locations where the SMEs go. The activities SMEs observe can be altered simply by the presence of the observers. Additionally, as discussed in the introduction sections of this paper, the total available resource for safety oversight is limited. Given that this data source is resource intensive it is crucial that the information gathered be clear, accurate, timely, risk-informed, and actionable for the key consumers of the information. For this, we must design safety assessments to be purposeful, maximizing the valuable information gathered, rather than check-the-box oversight activities.

Problem #3: We must make better use of regulatory and contract oversight information to drive F&I oversight. We should only add additional F&I oversight if there is a gap and only if line management is ready to use it.

The third item is that NNSA and its M&O partners are not adequately controlling the gross number of oversight activities, particularly F&I oversight to maximize "return on investment." One key aspect of F&I oversight is that while most, or even all, oversight elements contribute feedback, only the M&O partner (and occasionally NNSA) executes the improvement portion. Another way to express this is that a good feedback and improvement approach follows the Deming "Plan→Do→Check→Act" loop. Everyone in the system is active in the "Check" step, but only the M&O partner performs the Act→Plan→Do portion. While having lots of feedback from diverse sources is clearly a good thing, the system does run the risk of overwhelming the ability to use feedback to create actual improvement. For example, too much time can be allocated to gathering more feedback information if known critical improvements are not being executed. Another problem is that the lack of a clear prioritization and work flow system for issues management (or an issues management system that is overwhelmed) can lead to inefficiency and constant reprioritization, switching back and forth between tasks and negatively affecting the desired actual improvement. In production, this is an example of using a "push" system when a "pull" system would be a better strategy. That is, we often push too much feedback into the overall system without evaluating line management's ability to make effective use of new information. Often in actual circumstances of too much external feedback input, the M&O partner over emphasizes newly identified issues or issues identified by senior personnel rather than focusing on more significant existing issues or issues raised by individuals lower in the organization despite the fact that the individuals closest to the work often have the most knowledge about what needs to be fixed.

Problem #4: We must improve the SIAP process to better integrate all oversight functions and include all oversight elements to optimize the use of resources and minimize the impact on the personnel responsible to continue mission work.

Finally, we must integrate the system of oversight not just in terms of scope, intent, methods, and data streams, but also temporally. We must seek to optimize the planning and scheduling to minimize impacts and costs. The formal system for this is called the Site Integrated Assessment Planning (SIAP) process. The process can be improved to include as many federal oversight entities as is possible (while respecting the independence of other elements as appropriate) and to integrate better across functional areas. In addition, the current premise of the SIAP process is that each element determines its oversight plan individually and then the plans are de-conflicted in the SIAP. A better approach may be to determine what NNSA oversight is required holistically, and then apportion the assignments to maximize effective oversight and align with available resources (see problem #2).

Moving Forward

Developing actions to address these problems should significantly improve NNSA safety oversight, clarify R2A2, and help to resolve the dysfunction between the federal staff and our M&O counterparts, including reducing (or even eliminating) burdensome federal transactional oversight. They are a reasonable solution to the major challenge caused by our increasing operational tempo, retiring cadre of safety SMEs, and changes to our Governance and Management oversight model post-COVID-19.

They will not, however, necessarily improve our current state where safety performance has plateaued, unless these actions are coupled with a significant, sustained commitment to reinvigorate line-management-led ISM feedback and improvement. As discussed previously, we are currently in a vicious cycle where we invest ever more time and resources on federal oversight but we get little or no safety improvement (and perhaps even safety degradation) as a result. Sustained commitment to line management ISM feedback and improvement can turn this vicious cycle into a virtuous one, but that will not happen right away.

In fact, increased time, attention, and resources dedicated to line management ISM feedback and improvement will lead to increased F&I pauses, which will reduce plant uptime, which reduces plant productivity, which reduces mission output **in the short term**. It is only as the other feedback loops with more time delay start to take effect and the number of latent safety defects starts to decline, that overall plant productivity and mission output will start to increase. The NNSA Safety Roadmap outlines key elements of a redesigned oversight system, including specific milestones for implementation and measures of effectiveness to test these first steps.

There is an unavoidable, temporary decrease in mission performance that must be expected and accepted to get to the point where improvement above the initial performance is possible. NNSA and its M&O partners must "weather the storm" through this period. It is possible that a misguided element of this improvement plan will have caused such an event, but we should not assume that is the case without careful analysis. There will be pressure to return to increased oversight (and therefore reduced line management F&I) simply to demonstrate federal concern and federal bias for action. We must resist that pressure!