Department of Energy
Washington, DC 20585

September 26, 2023

The Honorable Joyce L. Connery
Chair, Defense Nuclear Facilities Safety Board
625 Indiana NW, Suite 700
Washington, DC 20004

Dear Chair Connery:

This letter is to notify you that the Department of Energy has completed Deliverable 5.1.2, "Perform Benchmark Review," of the Department's Implementation Plan, in response to the Defense Nuclear Facilities Safety Board Recommendation 2020-1, *Nuclear Safety Requirements.*

Enclosed is the Benchmark Review Final Report for Aging Infrastructure Management. The report was a joint effort between the Office of Environmental Management, the Office of Science, and the National Nuclear Security Administration and describes approaches, capturing common elements, best practices, and process enhancements to manage aging infrastructure.

If you or your staff have any questions, you may contact me at (301) 903-7440.

Sincerely,

Garrett Smith
Director, Office of Nuclear Safety
Office of Environment, Health, Safety, and Security

Enclosure

BENCHMARK REVIEW FINAL REPORT

FOR

AGING INFRASTRUCTURE MANAGEMENT

A JOINT INITIATIVE BY

ENVIRONMENTAL MANAGEMENT (EM)

NATIONAL NUCLEAR SECURITY ADMINISTRATION (NNSA)

SCIENCE (SC)

September 26, 2023

Executive Summary

On September 8, 2021, the Department of Energy (DOE or the Department) accepted the Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2020-1, *Nuclear Safety Requirements*, including the sub-recommendation, *Aging Infrastructure*, to develop and implement an integrated approach, including requirements, for the management of aging infrastructure that includes formal processes to identify and perform infrastructure upgrades necessary to support the safety functions of facilities and structures, systems, and components (SSCs).

Within the acceptance letter, the Department supports the nuclear safety regulatory framework of requirements to ensure that facilities and safety SSCs, both active and passive, perform their safety functions. The Department's response to the Draft Recommendation, dated December 17, 2019, included an extensive discussion regarding DOE expectations for the performance of safety SSCs within DOE policy documents. Compliance with 10 CFR Part 830, including the requirements to derive hazard controls necessary to demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards, is required for all nuclear facilities.

The Office of Environmental Management (EM), National Nuclear Security Administration (NNSA), and Office of Science (SC) have established processes to identify, prioritize, and plan safety-related infrastructure upgrades at defense nuclear facilities and have associated planning and budgeting processes to prioritize needs to meet respective mission objectives.

As committed to in Milestone 5.1.2, "Perform Benchmark Review," of the Department's *Implementation Plan for DNFSB Recommendation 2020-1, Nuclear Safety Requirements*, dated June 27, 2022, the Department performed benchmark reviews with EM, NNSA, and SC to examine processes, approaches, planning, budgeting, and execution of infrastructure activities necessary to ensure that facilities, SSCs, and supporting infrastructure continue to perform their safety functions. The purpose of these reviews was to describe and improve the Department's approach, including requirements, for the management of aging infrastructure. The desired outcome of these reviews is to identify and apply, as appropriate, best practices and process enhancements in the planning, evaluation, and prioritization approaches in support of risk-based budgeting[1] to ensure continued safe operations for all infrastructure and adequate protection of workers, the public, and environment at all defense nuclear facilities.

The benchmark reviews examined EM, NNSA, and SC's processes to identify, prioritize, and plan infrastructure investments, including safety related infrastructure, within the federal budgeting process to sustain operations and pursue long-term investment needs. The reviews identified unique infrastructure management characteristics within each program, and the Department's integrated project team identified common elements to all programs. Best practices and process enhancements were identified and compared across each program's aging infrastructure methods, funding strategies, and prioritization processes, leading to an initial determination whether each could be applied across the Department, multi-program, or only with the program originator.

[1] Risk-based budgeting is not defined in DOE Orders. DOE programs have established data-driven, risk-informed, performance-based approaches for life-cycle management of real property assets, consistent with DOE O 430.1C, *Real Property Asset Management*. These approaches, which align with the Federal budgeting process for EM, NNSA, and SC programs, are described in this report.

Additional details may emerge when Milestones 5.1.3, "Share Results Across the Department," and 5.1.4, "Implement Best Practices and Process Enhancements Based on Results of Benchmarking Review," are released (December 2023 and March 2024, respectively).

The benchmark reviews were completed on March 21, 2023, with routine engagement of the integrated project team to share insights across program offices and with program champions. This final report summarizes and integrates the results with common elements, best practices, and process enhancements as outlined in the titled sections.

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Introduction

The Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2020-1, *Nuclear Safety Requirements*, was accepted by the Secretary of Energy on September 8, 2021. A Department of Energy (DOE or the Department) Implementation Plan was approved by the Secretary on June 27, 2022. The Implementation Plan reiterates that the Office of Environmental Management (EM), National Nuclear Security Administration (NNSA), and Office of Science (SC) have established processes to identify, prioritize, and plan safety-related infrastructure upgrades at defense nuclear facilities and have associated planning and budgeting processes to ensure the needs are prioritized to meet mission objectives. This document outlines the steps and results of benchmark reviews that identify common elements, best practices, and process enhancements for managing aging infrastructure.

Scope

The scope of the benchmark reviews varied by program office. EM and NNSA's reviews focused on real property infrastructure across the nuclear security enterprise; SC's review focused on one defense nuclear facility, the Pacific Northwest National Laboratory Radiological Processing Laboratory. Each benchmark review pursued five objectives:

1. Examine each program's processes to identify, prioritize, and plan safety related infrastructure investments within the federal budgeting process and evaluate how the integrated safety management guiding principle, balanced priorities, is applied to the prioritization and execution of safety-related aging infrastructure needs for defense nuclear facilities' SSCs
2. Apply recommended sustainment, modernization, and replacement opportunities to identify possible process enhancements for assessing degradation of safety-related infrastructure
3. Consider ANSI/ANS-3.14-2021, *Process for Infrastructure Aging Management and Life Extension of Nonreactor Nuclear Facilities*, and applicable DOE requirements to guide benchmark activities
4. Consider concerns already identified within DNFSB Recommendation 2020-1, and
5. Compare and identify best practices from each program's aging infrastructure methods, funding strategies, and prioritization processes while addressing long-term investment needs and plans, maintenance and expansion of operations, and infrastructure supporting safety functions

Team Composition

	Benchmark Integrated Project Team		
Roles	**NNSA**	**EM**	**SC**
Team Leaders	James Winter	Nancy Buschman	Carrie Branch
Subject Matter Experts	Michelle Cann	Zahira Cruz-Perez Scott Boyd	Joseph Lebbie
	Review Committee Members/Advisors		
Chairperson	James Winter (NNSA)		
Co-Chairperson	Carrie Branch (SC)		
Champions	Tyson Deschamp (NNSA)		
	Mike Weis/Richard Verhaagen (SC)		
	Jessica Kratchman (EHSS)		
	Robert Seifert (EM)		

Conduct of Benchmark Reviews

EM, NNSA, and SC jointly performed benchmark reviews to identify common elements, best practices, and process enhancements. Each benchmark review was performed with the understanding that the current regulatory framework in 10 CFR 830, Subpart B, as revised by rulemaking (October 2020) and the DOE directives system, provides adequate protection of workers, the public and the environment across the DOE complex.

EM Approach

EM's mission is to complete the safe cleanup of environmental legacy resulting from decades of nuclear weapons development and government-sponsored energy research. There are over 2,400 non-operating, excess buildings awaiting demolition and final remediation of surrounding sites. Buildings awaiting disposition are continually surveilled; EM has a robust, documented system to manage this aged infrastructure. To support the cleanup mission, EM also operates disposal, treatment, and waste storage facilities. EM performs infrastructure management activities for these operating facilities. All operating and non-operating facilities are included in EM's continuous assessment and management of infrastructure policies and practices. EM currently has methods to identify, survey, and consolidate infrastructure conditions across the nuclear security enterprise to enable a logical, consistent, and risk-informed approach to invest in and manage facilities prior to their eventual demolition, including currently operating facilities. These processes include the following programs:

- Annual update of the Strategic Infrastructure Management Plan Condition Assessment Surveys System Health Checks
- Conduct of Operations and Maintenance
- Prioritized investment list using Mission Dependency and Excess Risk Indices
- Preventive and Predictive Maintenance Assessments
- Deep Dives

NNSA Approach

Since 2015, NNSA's Office of Infrastructure has worked diligently to overcome a decades-old culture of stove-piped infrastructure. NNSA has developed and continues to improve a suite of data-driven and risk-informed infrastructure stewardship tools to revolutionize how NNSA prioritizes and oversees the execution of infrastructure sustainment, modernization, and replacement. NNSA's benchmark review addressed the science-based infrastructure stewardship for all assets, including aging and nuclear assets.

While new facilities are constructed and existing ones recapitalized, historical investment in NNSA's infrastructure has not kept pace with the growing need to modernize or replace aging facilities. Recognizing NNSA's infrastructure challenges, the *National Defense Authorization Act for Fiscal Year 2018* (FY 2018 NDAA) directed an Infrastructure Modernization Initiative to reduce deferred maintenance. The FY 2022 NDAA updated the goal to reduce the ratio of deferred maintenance to replacement plant value by not less than 45 percent by 2030. Achieving this goal will require NNSA to work with Congress to increase resources for maintenance and repair, recapitalization, and line-item construction while further maturing decision-making tools for more effective use of resources. NNSA is optimizing existing resources by aggressively working to dispose of unneeded facilities, improve project management, and use streamlined and non-traditional practices to ensure cost effective delivery of new, non-complex facilities.

SC Approach

The Office of Science uses a Laboratory Planning Process that provides each Office of Science laboratory guidance on expectations for what core capabilities are to be maintained within their portfolio and provides them an opportunity to describe their vision for maintaining and expanding these capabilities. The laboratories submit plans that include their Lab Campus Plan and Infrastructure Strategies, which are developed to deliver the mission. Specifically for the Office of Science Defense Nuclear Facility at the Pacific Northwest National Laboratory (PNNL), the Lab Plan and related presentations with the Office of Science Headquarters Programs and the Pacific Northwest Site Office ensure alignment with Department expectations. The Department utilizes the arrangement with their contractor partner Battelle to manage and operate the Radiochemical Processing Laboratory in Building 325 and maintain and expand capabilities to meet our nation's scientific and national security needs. Under this arrangement, PNNL works with numerous agencies and DOE programs to define strategic needs, associated facility and equipment needs, and corresponding infrastructure to support those needs.

The Office of Science and the Pacific Northwest Site Office work with PNNL to ensure that these efforts are integrated and are consistent with the contract. Battelle, utilizing an approved cost accounting process, works with sponsors to collect overhead dollars for operation, maintenance, and investment in the laboratory's infrastructure and related capabilities. This approach leads to the development of an investment portfolio that either benefits all customers of the laboratory or only benefits the parties who utilize a specific capability or resource. Ultimately, operating activity adjustments are made based on available funds and program priorities, with the understanding that facility operations will only occur when all conditions defined in the approved safety basis and contract requirements are met. The bookend to this approach is the Performance Evaluation Measurement Plan to evaluate PNNL's success in strategically planning for future missions, making appropriate investments, and maintaining facility infrastructure to enable the mission while meeting-contract requirements.

Results

Each program measured their success by benchmarking infrastructure management processes, strategies, and performance to determine best practices and process enhancements. The programs also sought continuous improvement through learning from other programs while participating in DOE's teaming approach.

The benchmarking activities illustrated different approaches based upon distinct missions. EM's mission is to complete the safe cleanup of environmental legacy from prior nuclear weapons development and government sponsored nuclear energy research. NNSA's mission involves maintaining cutting-edge scientific, experimental, production, and computing facilities with reliable utilities and modern office and laboratory space. SC's mission is to support fundamental research for national security needs, which is accomplished through a collaborative funding model. Even though program missions and approaches to infrastructure management are unique, collaboration among programs found common elements.

These common elements form the framework for how infrastructure management is performed across the Department. Common elements begin with DOE requirements, including federal regulations, as the foundation that mandates how infrastructure is managed, maintained, modernized, replaced, and dispositioned. Departmental and program guidance and processes follow to implement infrastructure management predictably and repeatedly. Strategic planning and metrics are essential to define and guide programs in meeting long-term infrastructure goals. These goals are implemented by the annual planning, programming, budgeting, and execution process required by the Department, including the execution and maintenance of over-target requirements in a limited-funding environment. Required condition assessments are the building blocks that define and prioritize infrastructure needs, including those caused by age-related degradation or technical obsolescence of nuclear facility SSCs. These needs formulate the near-term and long-term funding and execution priorities. Finally, disposition of excess infrastructure maintains footprint availability for new construction and optimizes funding to maintain existing infrastructure.

Best practices are a compilation of good outcomes as determined by the benchmark reviews. In some cases, the benchmark integrated project team determined that a practice was applicable Department-wide or to multiple programs. For single program best practices, no commitments have been made to expand these to either multi-program or Departmental best practices, as mission differences or other factors make such commitments impractical.

The Department leverages information from the Facilities Information Management System (FIMS) to identify mission risks. Specific to defense nuclear facilities, the Department ensures operational readiness of systems supporting hazard Category 1, 2, and 3 nuclear facilities with required system engineering programs. System monitoring results are then planned, scheduled, coordinated, and controlled by the required nuclear maintenance management program for safe, efficient, and reliable operation of safety SSCs. The Department prioritizes removal of obsolete or aging structures following their shutdown to reduce costs, minimize risk, and maximize program opportunities. Other multi-program or single program best practices are listed later in the report.

Process enhancements are good business practices that will improve business processes for optimal performance. In several cases, the listed process enhancements were already identified and improvements were being worked during this benchmark activity. As a result, when process enhancements are limited to one program, it may reflect ongoing improvements for that program. When such process enhancements are fully implemented, there may be opportunities for later consideration by other programs to adopt some form of single-program process enhancements.

Departmentally, there is broad agreement that guidance for conducting inspections to evaluate aging related degradation and technical obsolescence of nuclear facility SSCs should be improved. ANSI/ANS-3.14-2021, *Process for Infrastructure Aging Management and Life Extension of Nonreactor Nuclear Facilities*, is a resource to be considered for application within DOE guidance. Finally, expanded use of technology advancements to perform infrastructure condition checks, assessments, and surveys could benefit from effective evaluation and monitoring of aging-related degradation. Other single program process enhancements are also listed later in the report.

A compiled list of Common Elements, Best Practices, and Process Enhancements follow.

Common Elements

1. The Department manages real property assets over their lifecycle from initial acquisition, through sustainment, to ultimate disposition in accordance with federal regulations and DOE requirements.
2. Federal regulations and DOE requirements are implemented with Departmental and Program Office guidance and processes.
3. Strategic plans and metrics guide infrastructure stewardship, implemented with tools and innovative initiatives to sustain, modernize, and replace infrastructure.
    a. Performance measures link performance of program goals and budgets to desired outcomes.
    b. Annual planning guidance states expected programming outcomes.
4. Annual planning, programming, budgeting, and execution processes guide program office and departmental decisions to safely accomplish mission activities and sustain the nuclear security enterprise.
    a. Five-year forecasts (by fiscal year), updated annually support strategic plans;
    b. Risks are identified with quantified or qualified risk rankings;
    c. Program offices have structured approaches to assess and prioritize investments; and
    d. Over Target Requirements are systematically defined, addressed, or maintained.
5. Condition assessments are performed periodically (five years or less) for age related degradation and technical obsolescence of nuclear facility SSCs to determine needs to:
    a. Sustain maintenance and repair activities for facilities, systems, and components, including replacement of failing or obsolete systems and components;
    b. Modernize infrastructure recapitalization and minor construction projects to reduce risk, improve safety, and/or extend the life of facilities or systems; and
    c. Bridge and replace line-item construction to replace facilities identified as beyond repair/modernization or construct expanded/new capabilities and capacities. Replaced facilities may have bridging strategies.
6. Disposition of excess infrastructure is a priority and includes de-inventory, re-routing utilities, transferring assets or demolition, and managing waste generation.

Best practices and process enhancements are categorized by **Common Elements:**	**Best Practices**	**Process Enhancements**
1. Regulations/Requirements	1, 2, 3, 19	
2. Guidance & Processes	7, 12, 13	1, 6
3. Strategic Plans & Metrics	6, 8, 15, 18	7
4. Planning, Programming, Budgeting, and Execution	5, 9, 11, 14, 16, 17	3, 5, 8
5. Condition Assessments	10, 18	2, 4
6. Disposition Excess Infrastructure	4	

Best Practices

Departmental Best Practices:

1. DOE leverages information from the established corporate database, FIMS, to identify risks to the mission.
2. DOE System Engineering Programs ensure operational readiness of systems supporting hazard Category 1, 2, and 3 nuclear facilities.
3. DOE's Nuclear Maintenance Management Program plans, schedules, coordinates, and controls maintenance and repair activities for safe, efficient, and reliable operation of safety SSCs.
4. DOE prioritizes removal of obsolete or aging structures following their shut-down to reduce cost, minimize risk, and maximize program opportunities.

Multi-Program Best Practices:

5. NNSA and SC optimize project execution and infrastructure renewal by managing at the program level while empowering Management and Operating (M&O) Partners to transparently manage at the project level.
6. NNSA and EM leverage infrastructure Deep Dives to help align near-term decisions with long-term vision by linking program, infrastructure, and site planning outputs to programming and budgeting inputs.
7. Comprehensive utility outage programs are employed at some EM and NNSA sites to maintain utility systems (e.g., electrical, water, steam, chiller) and address system-wide risks.

EM Best Practices:

8. EM's Strategic Infrastructure Management Plan integrates information collected by the sites, with quantitatively assessed mission priorities to guide EM's infrastructure investment.
9. EM uses FIMS data to calculate a mission dependency index (MDI) for operating facilities and an excess facilities risk index for excess facilities. These indices, along with long term liability reduction and sustainability improvement measures, support project prioritization within and across EM sites.
10. EM identifies aging infrastructure risks by performing infrastructure health checks, condition assessment surveys, and quantitative risk analysis.
11. EM improves FIMS data quality by emphasizing accurate collection and confirmation of FIMS data.

NNSA Best Practices:

12. NNSA implements repeatable, predictable, and standardized processes that allow for effective and efficient execution, timely change control, and rapid analysis across the nuclear security enterprise.
13. NNSA uses automated processes to eliminate redundant data collection, streamline reporting, and establish a structured approach to assess infrastructure and to inform infrastructure renewal decisions based on current and predicted system conditions, mission priorities, and acceptable risk tolerance levels.
14. NNSA implements a Program Management System that provides transparency to infrastructure projects and cost accounts.

15. NNSA enhances integrated infrastructure planning with an annual Master Asset Plan, an enterprise-wide, long-term infrastructure strategic plan.
16. NNSA uses area planning to create a framework for modernization with viable infrastructure options to mission requirements, including support infrastructure.
17. NNSA integrates MDI ratings for greater risk insights into prioritization strategies where vital services, such as utilities, could halt mission work.
18. NNSA bridges asset sustainment to replacement using robust, requirements-based infrastructure lifecycle planning tools, condition surveys, and strategies.

SC Best Practices:

19. SC-PNNL performs detailed assessments of all real property assets annually to identify maintenance issues and reliability risks. The assessments serve as key inputs to project prioritization, the annual budgeting process, and accurate accounting of FIMS deferred maintenance and repair needs.

Process Enhancements

Departmental Process Enhancements:

1. The Department will develop a new DOE handbook to expand guidance for Section M, *Aging Degradation and Technical Obsolescence*, in DOE Guide 433.1-1A, Chg. 1. ANS/ANSI-3.14-2021 is an appropriate reference for the new Handbook.
2. The Department is continuing and expanding the use of technology advancements to perform aging infrastructure checks, assessments, and surveys.

EM Process Enhancements:

3. EM is developing wiring diagrams for operational facilities that identify key supporting infrastructure assets and assess their health. This initiative improves infrastructure maintenance prioritization by providing a visual diagram of the flow of products through facilities.

NNSA Process Enhancements:

4. NNSA is instituting an archival process for how BUILDER's Standards and Policies and the Cost Engine are maintained under configuration controls and saved from year to year, and how the condition assessments, including cost calculation, are calculated.
5. NNSA is learning and improving how risk is managed across the enterprise, documented in future updates of the NNSA Real Property Asset Management (RPAM) Guide, Appendix C7: Enterprise Risk Management.
6. NNSA is capturing the Weapons Activities Line-Item Planning Integration process into the NNSA RPAM Guide.
7. NNSA continues to pursue full implementation of BUILDER Sustainment Management System by FY 2025, to better inform investment prioritization and maintenance decisions across the nuclear security enterprise.

SC Process Enhancements:

8. SC is developing a criteria-based quantitative risk methodology for prioritizing projects within the maintenance and repair portfolio.

Conclusion

Collaboration by EM, NNSA, and SC has generated common elements, best practices, and process enhancements to manage all infrastructure, including aging infrastructure, at defense nuclear facilities. These results will be shared with the Department (Milestone 5.1.3) to highlight process enhancements and recommend adoption of best practices by December 27, 2023. Beginning no later than March 27, 2024, implementation of accepted best practices and process enhancements will begin (Milestone 5.1.4) in response to the benchmark reviews.

Appendix A: EM Benchmark Review

Office of Environmental Management Aging Infrastructure Management

In response to

DNFSB Recommendation 2020-1, SUB-RECOMMENDATION 1: AGING INFRASTRUCTURE

The first step in benchmarking is for each organization to separately identify and document their processes, in this case how we manage aging infrastructure. This appendix documents how EM meets the six aging infrastructure management objectives outlined in the DOE implementation letter dated December 22, 2022. The main body of the report above summarizes and compares EM, NNSA and SC best practices.

The Office of Environmental Management's (EM's) mission is to complete the safe cleanup of the environmental legacy resulting from decades of nuclear weapons development and government-sponsored nuclear energy research. This mission is unique in the Department. EM's approach to management of aging infrastructure differs from NNSA and SC whose focus is on operating facilities. EM already has a successful and continuously improving aging infrastructure management program that supports its unique mission. EM performed a benchmarking exercise for the purpose of looking across DOE to discover best practices and consider implementing useful ones.

Removal of obsolete aging structures as soon as possible following shut-down is the best approach for reducing cost and minimizing risk of decommissioning and demolition projects. When an abandoned structure is empty, but before it is decommissioned, EM ensures that the structure is stabilized and rigorously inspected. Facilities that have not been stabilized and degrade while awaiting disposition are more difficult and less safe to demolish. To support end-of-life removals, EM employs preventive, predictive, and corrective maintenance to avoid that eventual building degradation.

The next steps in benchmarking are to find common elements across the aging infrastructure management programs, identify best practices in each program, and incorporate applicable process enhancements into the EM aging infrastructure management program.

This appendix documents EM processes to manage aging infrastructure, organized around objectives outlined in the DOE implementation letter.

The letter outlines the following objectives:

1. Examine each programs' process to identify, prioritize, and plan safety related infrastructure investments within the Federal budgeting process.
2. Evaluate how the Integrated Safety Management principle of balanced priorities is applied when addressing safety-related aging infrastructure needs and prioritization for defense nuclear facilities' SSCs.
3. Apply recommended maintenance, repair, upgrade, and replacement opportunities to identify possible enhancements for assessing degradation of safety-related infrastructure.
4. Consider ANSI/ANS-3.14-2021 national standard and applicable DOE requirements to guide benchmark activities.
5. Consider concerns already identified within DNFSB Recommendation 20-1, Aging Infrastructure.
6. Compare and identify best practices from each program's aging infrastructure methods, funding strategies, and prioritization processes while addressing long-term investment needs/plans, maintenance/expansions of operations, and infrastructure supporting safety functions.

1. Examine each program's process to identify, prioritize, and plan safety related infrastructure investments within the Federal budgeting process

EM is responsible for over 2,400 buildings, almost 3,000 other structures and facilities, and over 1,200 trailers across 17 sites, as well as supporting roads and site utilities. EM spends approximately $1 billion/year on site infrastructure and services. Many of the EM facilities and supporting infrastructure are 50-70 years old and need significant maintenance, repair, or replacement to support eventual environmental cleanup.

EM has a decentralized funding model that focuses on management by individual sites. This contrasts with peer programs that manage infrastructure investment with centralized funding. EM has begun employing a systematic, complex-wide approach, described below, to address the highest risks across the overall EM mission through a strategic process by 1) identifying risks, 2) quantitatively ranking the risks, 3) prioritizing investments based on a standard set of criteria, and 4) potentially implementing aging infrastructure investments to ensure reliability of real property assets based on the availability of funds.

To further enhance the process, EM is evaluating a portfolio decision analysis model to make informed selections from a range of alternatives through mathematical modelling that accounts for multiple relevant constraints, preferences, and budget uncertainties.

The following individual processes inform safety-related infrastructure investment:

- EM Budgeting Process
- Strategic infrastructure management plan

The paragraphs below describe each of these activities.

EM Budgeting Process:
EM HQ sets priorities for EM and leads annual budget request preparation. Budget requests support Congressional appropriation decisions that fund the EM mission, including infrastructure management, the conduct of compliant and safe operations, and site decommissioning and demolition. EM HQ sets priorities and communicates them to external stakeholders, including DOE partner program offices, the National Nuclear Security Administration (NNSA), Congress, and the field offices. For the longer term, EM HQ annually reviews the EM five-year plan and adjusts as needed to ensure program continuation.

Strategic Infrastructure Management Plan:
EM develops a Strategic Infrastructure Management Plan that uses Multi-Attribute Utility Theory (MAUT) for portfolio decision analysis. This Plan integrates information collected from the sites, with quantitatively assessed mission priorities as reflected in the infrastructure priority list. This list establishes a prioritized plan for EM's infrastructure investment. This approach helps EM increase understanding of infrastructure needs and challenges, associated funding needs, and implications for mission completion. The plan is updated periodically to reflect changing EM investment priorities and to address mission risk.

2. Examine EM processes/approaches to evaluate how the Integrated Safety Management principle "Balanced Priorities" is applied and addressed for safety-related aging infrastructure

We use the integrated safety management approach to ensure focus on projects that address safety-related aging infrastructure issues. The following approaches describe how balanced choices among safety-related infrastructure improvement projects are made:

- Integrated Safety Management (ISM)
- Nuclear Maintenance Management Program (NMMP)
- System Engineering
- Master Equipment List (MEL)
- Utility Outage Programs
- Quantitative Risk Analysis
- Lessons Learned/Best Practices/Knowledge Sharing
- Wiring Diagrams

The paragraphs below describe each of these activities.

Integrated Safety Management:
Integrated Safety Management (ISM) provides the core safety principles used throughout the implementation of the EM infrastructure maintenance management program including safety-related aging infrastructure. The objective of ISM is to perform work in a safe and environmentally sound manner per the DOE P 450.4, Safety Management System Policy. ISM incorporates DOE's five core safety functions:

- **Define the scope of work –** Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.
- **Analyze the hazards –** Hazards associated with the work are identified, analyzed, and categorized.
- **Develop and implement hazard controls –** Applicable standards, policies, procedures, and requirements are identified and agreed upon; controls to prevent/mitigate hazards are identified; and controls are implemented.
- **Perform work within controls –** Readiness is confirmed, and work is performed safely.
- **Provide feedback and continuous improvement –** Information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified, and independent oversight is conducted.

EM utilizes safety culture attributes, management systems, supplemental safety actions, performance objectives, and measures and commitments for each of the five core functions and seven ISM guiding principles. These systems and management actions help achieve a safety conscious workplace.

ISM guiding principles: ISM guiding principles are communicated, known, understood, and applied across EM for work planning, maintenance, repair, upgrades, and operations:

1. Line Management Responsibility for Safety

2. Clear Roles and Responsibilities
3. Competence Commensurate with Responsibilities
4. **Balanced Priorities**
5. Identification of Safety Standards and Requirements
6. Hazard Controls Tailored to Work Being Performed
7. Operations Authorization

ISM Principle 4: "Balanced Priorities": This approach specifically addresses the DNFSB recommendation. EM applies balanced priorities at sites to achieve robust safety management of aged infrastructure with various safety-related risks. With limited available funding, resources are effectively balanced and allocated to address safety, programmatic, and operational considerations. Protecting the public, workers, and the environment is a top priority when work activities are planned and performed, including and repair and maintenance of aged infrastructure.

Nuclear Maintenance Management Program:
EM sites rigorously apply the requirements in Section 4 of *DOE O 433.1B Maintenance Management Program for DOE Nuclear Facilities* and implement a nuclear maintenance management program performed under a Documented Safety Analysis (DSA). Dedicated Facility Managers/Operations Managers, supervisors, facility and system engineers and trained maintenance teams have well-established roles and responsibilities so that ownership is established to ensure compliance with all nuclear facility maintenance, surveillance, and safety requirements.

System Engineering Program:
A System Engineering Program is in place to ensure performance and coordination of maintenance activities. The system engineering program safeguards facilities by prioritizing maintenance, establishing performance measures, and creates bridging strategies that create a safe condition during outages or corrective maintenance activities. The cognizant system engineering program per DOE O 420.1C makes use of engineering evaluations for major repairs considering anticipated remaining life before decommissioning. Additionally, programs are in place for:

- Configuration management controls to prevent unauthorized modifications to safety SSCs.
- Suspect and counterfeit items program to prevent the use of suspect and counterfeit items in maintenance procedures and work instructions.
- Critical spares management assures adequate stores are available to support required maintenance.
- Inspections to evaluate aging-related degradation and technical obsolescence to determine whether the performance of SSCs is threatened.
- Surveillance and maintenance program is implemented on a graded approach commensurate with the facility/utility system's condition, mission need, and schedule for decommissioning.

Master Equipment List (MEL):
A Master Equipment List (MEL) is created and maintained to support scheduling and performance of preventive and predictive maintenance. The MEL also supports performance of condition inspections, and configuration management of facilities.

Utility Outage Programs:

EM sites are employing a utility outage program that enables a comprehensive approach to preventive and predictive maintenance of utility systems (electrical, water, steam, chiller, etc.). The program improves scheduling of outages so that system-wide risks are addressed.

Quantitative Risk Analysis:
QRA using the MDI/ERI indices to perform a quantitative risk analysis of data from system health checks is fundamental to achieving balanced priorities and determining infrastructure investment through the portfolio decision analysis model.

Lessons Learned/Best Practices/Knowledge Sharing:
This program enables sharing of best practice approaches across the EM complex:

- Infrastructure Deep Dives are planned for EM sites every two-three years for the sharing of best infrastructure management practices with EM and DOE staff. The Deep Dives also provide an opportunity for management to review the management effectiveness.
- Infrastructure Summit brings together the EM community of practice on a periodic basis to discuss current topics and challenges.

Wiring Diagrams:
EM recently initiated development of wiring diagrams for key operational systems. Wiring diagrams provide a graphic view of the health of various infrastructure SSCs that support major site operations. Wiring diagrams visually present key risks to better enable balancing of priorities for the EM mission. Figure 1 provides an example wiring diagram displaying the various facilities, utilities, and systems necessary for continuous, safe operation of the Hanford Waste Treatment Plant.

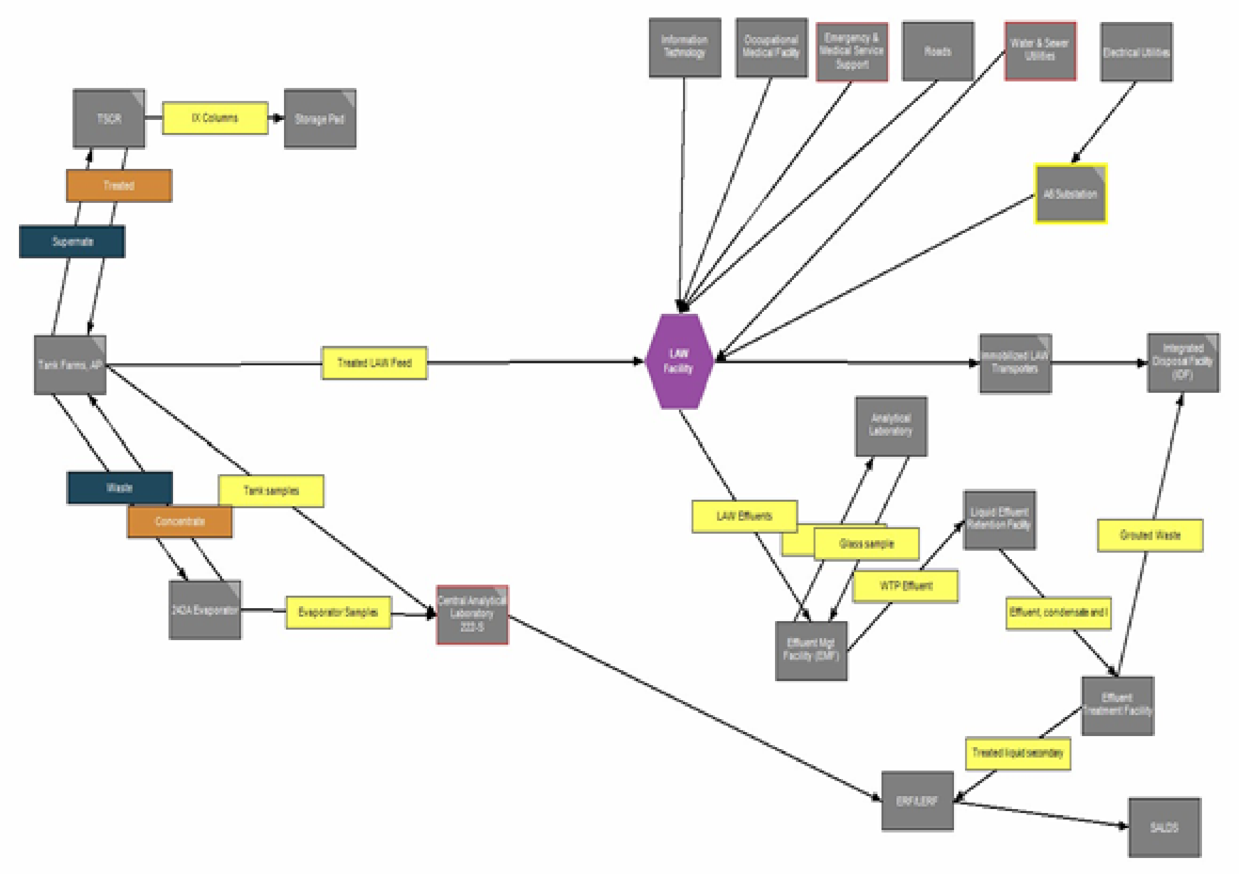


Figure 1: Wiring diagrams display how risk to SSCs can affect an overall process.

3. Apply recommended maintenance, repair, upgrade, and replacement opportunities to identify possible process enhancements for assessing degradation of safety-related infrastructure.

EM's process for identifying recommended maintenance, repair, upgrade, and replacement of aging infrastructure is focused on cost-effectively preserving assets in a safe condition. To accomplish this, EM employs a maintenance management program in line with DOE O 430.1C and DOE O 433.1B. Additional EM processes include a quantitative risk analysis, the strategic infrastructure management plan and utility outage planning, these additional processes are described in objectives 1 and 2 above. Mainly , EM uses the following approaches:

- Condition Assessment Surveys (CAS)
- Predictive Maintenance/Condition-based Maintenance Practices
- Drone Technology

The paragraphs below describe each of these activities.

Condition Assessment Surveys:

Condition Assessment Surveys help us identify process enhancements. The CAS program includes Inspectors and use of the Condition Assessment Information System (CAIS). This program provides direction and guidance regarding the management of repair needs and tracks deferred maintenance (DM). It implements requirements mandated through contractual agreements to include DOE Order 430.1C, and other work procedures. At some EM sites the program is integrated with facility lifecycle studies and infrastructure health checks.

A CAS Inspector develops an annual list of property inspections and submits the list to the DOE site manager. The CAS Inspector queries the Computerized Maintenance Management System (CMMS) and notes any CAS identified items. The inspector coordinates assessments with Facility/Building Manager. An Inspection Unit (IU) level inspection is conducted, and a repair needs list is developed. IU level inspections produce a prioritized list of risks and defects and the CAIS is updated.

Predictive Maintenance/Condition-based Maintenance Practices:
Predictive Maintenance/Condition-based Maintenance Practices are employed across the EM complex to enhance the maintenance and condition assessment of safety related and non-safety related SSCs. Predictive maintenance and condition-based maintenance practices employ such techniques as thermography/infrared imaging, vibration analysis, acoustic (sonic/ultrasonic) monitoring, oil analysis, emissions testing, and partial discharge analysis that enable early detection and more accurate assessment of defects and degradation of infrastructure assets.

Drone Technology:
Drone technologies are a process enhancement that help us assess degradation of safety-related infrastructure. EM sites are now employing drone technologies as well as remote cameras to enable inspection or monitoring of SSCs in locations where access is difficult, or access poses an unacceptable health and safety risk due to heights, high radiation fields, or confined space. For example, use of drones at Hanford supports inspection of high voltage transmission lines, roofing, and structures to identify degraded conditions. Likewise, the Savannah River Site employs drones for inspecting the site perimeter fence and for thermographic inspection of the electrical distribution system.

EM's focus for activities related to managing aging infrastructure include ensuring a robust safety culture and reliable safety functions. For safety related SSCs, the asset management process concentrates on assessing and maintaining the condition of assets in a manner that promotes operational safety, worker health, environmental and DSA compliance, property preservation and cost-effectiveness while meeting the program's missions in line with DOE O 433.1B. To accomplish this, EM employs a system for assessing degradation using site nuclear maintenance management programs that are coordinated with CASs, and system health checks.

4. Consider ANSI/ANS-3.14-2021 National Standard and Applicable DOE Requirements to Guide Benchmark Activities.

EM applies proven processes, successful experiences, and best-practices to EM management of aged infrastructure. ANSI/ANS-3.14-2021, Process for Infrastructure Aging Management and Life Extension of Nonreactor Nuclear Facilities and DOE O 430.1C are applied across the EM complex for the management of real property assets. EM follows actions outlined in these:

- ANSI/ANS-3.14-2021, Process for Infrastructure Aging Management and Life Extension of Nonreactor Nuclear Facilities

- DOE Order 433.1B, Maintenance Management Program for DOE Nuclear Facilities
- Benchmarking efforts

The paragraphs below describe each of these activities.

ANSI/ANS-3.14-2021, Process for Infrastructure Aging Management and Life Extension of Nonreactor Nuclear Facilities:
ANSI/ANS-3.14-2021, *Process for Infrastructure Aging Management and Life Extension of Nonreactor Nuclear Facilities,* provides criteria and guidance to systematically evaluate SSCs for remaining lifetime and determine the need for additional analysis and inspection to address aging infrastructure management that supports non-nuclear reactor facility life extensions.

The standard also provides an approach for conducting in-depth studies and inspections beyond routine maintenance programs needed for extending the life of selected SSCs through appropriate Aging Management Programs (AMP). Development of an AMP consists of the following processes:

Screening of Facility SSCs: The initial screening of systems and structures and selection of SSCs for review is a specific process outlined in the ANSI standard. The ANSI standard includes various processes identified in the DOE orders and currently implemented at EM sites such as. These processes include:

- Conduct of operations and maintenance
- Maintenance work control
- MEL development and updates
- Materials shelf-life program
- Preventive and predictive maintenance
- Quality assurance programs
- Development and maintenance of DSAs
- Spare parts program
- SSC performance monitoring and system health reports.

Benchmarking Summary: The ANSI standard provides a structured process for identifying SSCs, reviewing aging mechanisms, and managing the aging degradation mechanisms that provide enhanced risk reduction for some EM facilities. Additionally, the ANSI standard provides detailed tools and processes to:

- Address unknown conditions
- Conduct risk prioritization activities
- Aging infrastructure management
- Development of a life-extension program
- Aging structure evaluation

Management of Aging Degradation Mechanisms: The product of the AMP per the ANSI standard is the Management of Aging Degradation Mechanisms. This includes the development of aging management plans; obsolescence program; prioritization of activities; structural evaluation; and life extension plans.

Key elements of the AMP Program are:

- Preventive actions - Preventive actions mitigate or prevent age-related degradation.
- Parameters monitored or inspected - Parameters monitored or inspected are linked to the degradation of the components' intended function(s).

- Detection of aging effects - Detection of aging effects occurs before there is a loss of component intended function(s). This includes aspects such as method or technique (e.g., visual, volumetric, surface inspection), frequency, sample size, data collection, and timing of new/one-time inspections to ensure timely detection of aging effects.
- Monitoring and trending - Monitoring and trending provide predictability of the extent of degradation and provide timely corrective or mitigating actions.
- Acceptance criteria - Acceptance criteria, against which the need for corrective action will be evaluated, ensure that the component intended function(s) are maintained under all design conditions.
- Corrective actions - Corrective actions, including root cause determination and prevention recurrence, are executed in a timely manner.
- Operating experience - Operating experience of the aging management activity, including past corrective actions resulting in program enhancements or additional programs or activities, provides objective evidence to ensure that the effects of aging will be adequately managed.

Additional ANSI Tools: The ANSI standard provides a structured process for identifying SSCs, reviewing aging mechanisms, and managing the aging degradation mechanisms that provide enhanced risk reduction for some EM facilities. Additionally, the ANSI standard provides detailed tools and processes to:

- Address unknown conditions
- Conduct risk prioritization activities
- Aging infrastructure management
- Development of a life-extension program
- Aging structure evaluation

Review of Aging Mechanisms: The ANSI standard identifies the review of materials and operating environments, identification of aging potential by comparison to known degradation mechanisms, and identification of locations for age-related degradation as the primary methods.

Some EM aging infrastructure approaches support more than one objective. The following approaches support this objective and Objectives 1 and 2: Strategic Planning, and Wiring Diagrams. Please reference the objective sections above for a full description of these EM approaches.

Additionally, EM conducted a high-level review of ANSI/ANS-3.14-2021 *Process for Infrastructure Aging Management and Life Extension of Nonreactor Nuclear Facilities*. The review concluded that most of the actions cited for management of aging degradation mechanisms in the ANSI standard are already applied in some form at EM sites. The review covered routine maintenance practices, condition assessments, and implementation of DOE O 430.1C and DOE O 433.1B requirements. These DOE orders include ongoing implementation of industry best practices. The ANSI standard provides a structured set of tools and processes that can add enhanced risk reduction for some EM facilities.

DOE O 433.1B, Maintenance Management Program for DOE Nuclear Facilities:

DOE O 433.1B provides rigorous requirements for managing nuclear facilities and infrastructure focused on EM sites with Hazard Category 2 and 3 facilities. EM sites, in compliance with the DOE order have nuclear maintenance management programs featuring three-year assessments of the program and periodic self-assessments. These assessments include planning, scheduling, and coordination of preventive, predictive, and reliability-centered maintenance. The order also requires formal training and maintenance team qualification. This extensive order also establishes creation and update of MELs, asset configuration management, an obsolescence program, calculation, and analysis of performance measures, and finally facility condition inspections.

Benchmarking efforts:
Benchmarking and review efforts are performed by EM against government and industry best practices including:

- DOE O 430.1C, *Real Property Asset Management* and *DOE O 433.1B Maintenance Management Program for DOE Nuclear Facilities.* EM sites implement maintenance practices from DOE orders for managing general infrastructure assets and for managing nuclear facilities to ensure safe and reliable SSCs.
- American National Standard Institute ANSI/ANS-3.14-2021, *Process for Infrastructure Aging Management and Life Extension of Nonreactor Nuclear Facilities.*
- ISO 55000, *Asset Management International Standard.* EM recently completed benchmarking EM infrastructure management against the ISO 55000 standard. The study revealed that current EM processes align with the ISO standard. One recommendation of the benchmarking study is to update and combine the three EM infrastructure management guidance documents into a single document.

5. Consider DNFSB observations identified in Recommendation 20-1, Aging Infrastructure.

DNFSB Recommendation 2020-1 for aging infrastructure calls for the "development and implementation of an integrated approach—including requirements—for the management of aging infrastructure that includes formal processes to **identify** and **perform** infrastructure upgrades necessary to ensure facilities and structures, systems, and components can perform their safety functions."

Several processes to identify infrastructure upgrades are already explained in the paragraphs above. Generically, EM's process to perform infrastructure upgrades may include some of the following steps:

1. Identify a need
2. Perform analysis to determine the best alternative
3. Estimate the cost of the chosen alternative
4. Obtain funding using the budgeting process
5. Write a scope document
6. Use an existing, or award a new contract to perform the work
7. Oversee, track, and manage contractor performance

Depending on the size of the maintenance project, DOE O 413.3B, Program and Project Management (PM) for the acquisition of capital assets, may apply.

6. Compare and identify best practices from each program's aging infrastructure methods, funding strategies, and prioritization processes while addressing a) long-term investment needs/plans, b) maintenance/expansions of operations, and c) infrastructure supporting safety functions

EM is implementing best practices for the strategic management of aging infrastructure by adopting and adapting the best practices from NNSA and SC. Our practices are continually updated to improve strategic investments, operations and maintenance, and overall performance to reduce infrastructure risk to the EM mission. The following are those processes being implemented by EM:

- Facility Information Management System (FIMS)
- NNSA Economy of Scale approach
- Sustainability and Climate Resilience

The paragraphs below describe each of these activities.

Facilities Information Management System Database:
EM is working to identify risks to the mission using existing information from the Facilities Information Management System (FIMS) database. FIMS contains a continually updated list of EM, NNSA, and SC assets. EM assessed FIMS data quality at the various sites and found that sites emphasize FIMS accuracy. Use of FIMS leads to more informed decision-making about infrastructure condition.

NNSA Economy of Scale approach:
Many tasks are common across all EM sites. Central management and funding of these common tasks enables economy of scale efficiencies. EM is assessing several NNSA initiatives such as: Roof Asset Management Program (RAMP), Cooling and Heating Asset Management Program (CHAMP), Standardized Acquisition and Recapitalization Initiative (STAR), and Streamlined Project Execution, Acquisition & Recapitalization (SPEAR). Centrally managing common activities enables consistent approaches to address common concerns in a cost-effective manner. EM is working to identify other tasks that make sense to centrally fund and manage such as road resurfacing, large electrical projects, and transfer of excess personal property between sites. Centrally managing these tasks maximizes return on investment (ROI).

Sustainability and Climate Resilience:

EM minimizes impact on the environment by making infrastructure operations as efficient as possible. Additionally, EM is working on sustainability and climate resilience (S&CR) projects across the complex to address the impact of climate change. EM sites have reduced use of electricity and water by over 20%. EM sites reduced production of greenhouse gas (GHG) emissions by 65% over the past decade.

Conclusion

This appendix identifies how EM meets the six aging infrastructure management objectives outlined in the December 22, 2022, DOE implementation letter. Identifying how each organization meets these objectives is the first step of the benchmarking process. The main body of this report uses processes outlined in the Appendices to capture common elements, highlight best practices, and recommend process enhancements.

This benchmarking exercise highlighted further the differences among DOE elements. EM's mission is to complete the safe cleanup of the environmental legacy from decades of nuclear weapons development. This contrasts with NNSA and SC missions. The uniqueness of our respective missions causes different approaches to management of aging infrastructure.

Appendix B: NNSA Benchmark Review

Executive Summary

The National Nuclear Security Administration (NNSA) performed this aging infrastructure benchmarking review in response to the Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2020-1, *Sub-Recommendation 1, Aging Infrastructure*. The DNFSB recommended the Department of Energy (DOE) develop and implement an integrated approach, including requirements, for the management of aging infrastructure that includes formal processes to identify and perform infrastructure upgrades.

Bottom Line Up Front:

- NNSA's suite of data-driven and risk-informed infrastructure stewardship tools have revolutionized how NNSA prioritizes and oversees the execution of our infrastructure sustainment and modernization programs.
- While there is still some implementation work to be done, NNSA is confident that these tools have significantly improved our understanding of condition and risk.
- With this enhanced insight, NNSA better identifies and prioritizes infrastructure needs to maximize risk reduction and optimize return on investment.

Since 2015, NNSA's Office of Infrastructure (NA-90) has worked diligently to overcome a decades-old culture of stove-piped infrastructure. Historically, the tools and processes used by NNSA to track and report infrastructure risks were ineffective, providing limited insight and based upon subjective physical condition assessments using differing interpretations of guidance and definitions. NNSA has developed and continues to improve a suite of data-driven and risk-informed infrastructure stewardship tools to revolutionize how NNSA prioritizes and oversees the execution of infrastructure sustainment and modernization programs. Departmental regulations and directives have guided the Office of Safety, Infrastructure, and Operations (NA-50), and now NA-90, to institute these tools in NA-90 processes.

> **NNSA Reorganizations**
>
> In 2015, NA-50 was established to improve the prioritization and management of NNSA infrastructure. In 2022, the new NA-90 was formed to focus upon timely and innovative delivery of infrastructure modernization with elements from the prior offices of NA-50 and Office of Acquisition and Project Management (NA-APM).

NNSA's approach to asset management is guided by the NNSA Strategic Vision and informed by experienced professionals managing a complex array of facilities. The NNSA Real Property Asset Management (RPAM) guide outlines the acquisition, sustainment, disposition, and space management policies, processes, and tools. The Master Asset Plan (MAP) captures NNSA's long-term Enterprise-wide infrastructure strategy. The Office of Infrastructure Lifecycle Management (NA-91) Program Management Plan (PMP) provides guidance to execute project and portfolio management.

NNSA's goal is to sustain and improve the effectiveness and efficiency of infrastructure across the Nuclear Security Enterprise (NSE) while supporting DOE's nuclear safety framework to protect the public, worker health and safety, and the environment. NNSA's benchmark review addressed the science-based infrastructure stewardship for all assets, not just aging assets, or nuclear assets, to identify nine best practices and five process enhancements.

NNSA Best Practices

1. Implement repeatable, predictable, and standardized processes that allow for effective and efficient execution, timely change control, and rapid analysis across the Enterprise.
2. Use automated processes to eliminate redundant data collection, streamline reporting, and establish a structured approach to assess infrastructure and to inform infrastructure renewal decisions based on current and predicted system conditions, mission priorities, and acceptable risk tolerance levels.
3. Bridge asset sustainment to replacement using robust, requirements-based infrastructure lifecycle planning tools, condition surveys, and strategies.
4. Leverage infrastructure Deep Dives to help align near-term decisions with long-term vision by linking program, infrastructure, and site planning outputs to programming and budgeting inputs.
5. Integrate Mission Dependency ratings for greater risk insights into prioritization strategies where vital services, such as utilities, could halt mission work.
6. Enhance integrated infrastructure planning with improvements to the annual MAP, an Enterprise-wide, long-term infrastructure strategic plan.
7. Use area planning to create a framework for modernization with viable infrastructure options to mission requirements, including support infrastructure.
8. Manage at the program level while empowering management and operating (M&O) partners to manage at the project level with appropriate transparency to optimize project execution and infrastructure renewal.
9. Implement a Program Management System that provides transparency to infrastructure and operations project and cost accounts.

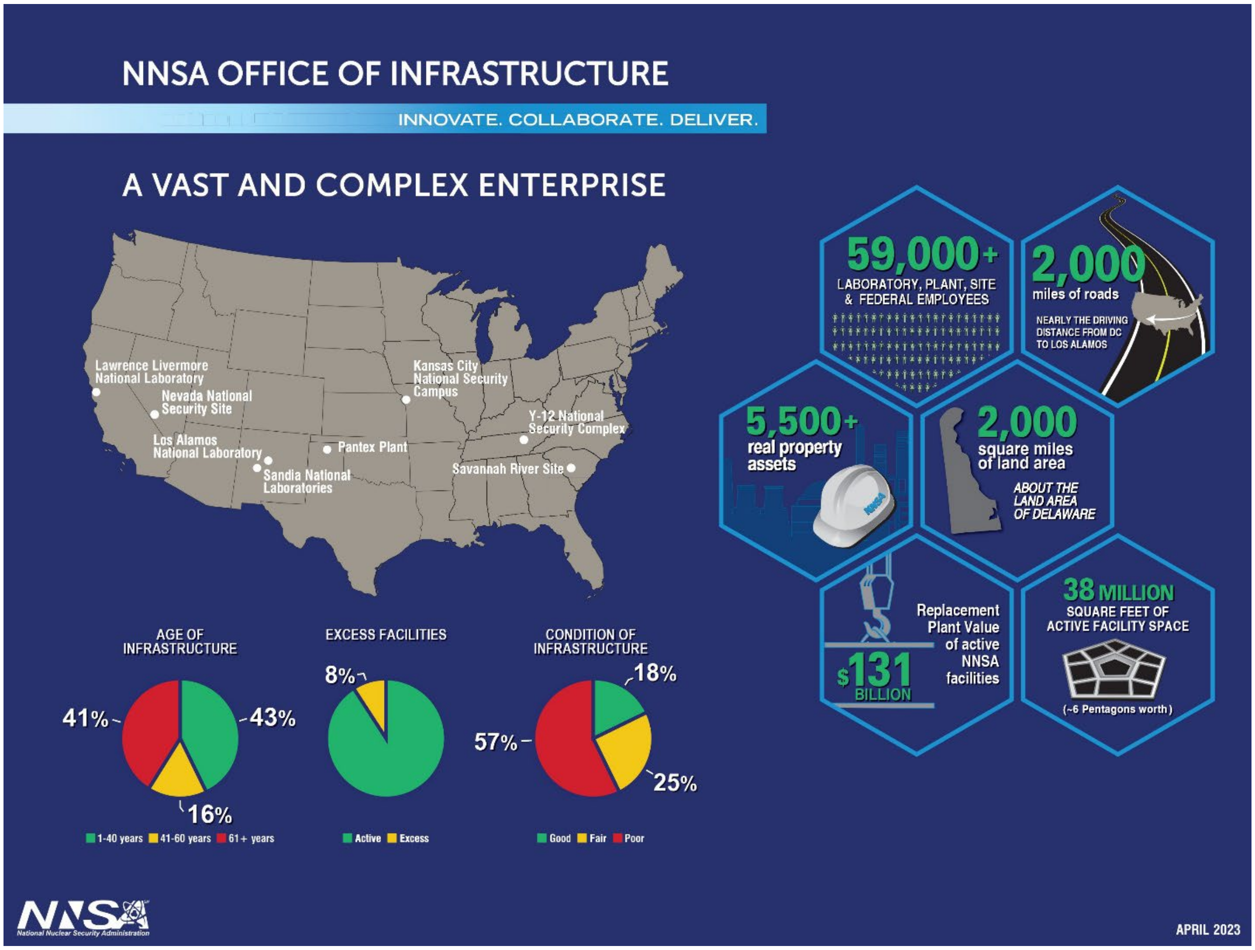
NNSA Process Enhancements

1. Develop a new DOE handbook to expand guidance for Section M, Aging Degradation and Technical Obsolescence, in DOE Guide 433.1-1A, *Maintenance Management Program for DOE Nuclear Facilities.* ANS/ANSI-3.14-2021 is an appropriate reference for the new Handbook.
2. Institute an archival process for how BUILDER's Standards and Policies and the Cost Engine are maintained under configuration controls and saved from year to year, and how the condition assessments, including cost calculation, are calculated.
3. Learn and improve how risk is managed across the enterprise and document in future updates of the NNSA RPAM Guide (Appendix C7: Enterprise Risk Management).
4. Capture the Weapons Activities Line-Item Planning Integration process into the NNSA RPAM Guide.
5. Continue to pursue full implementation of BUILDER, planned for fiscal year (FY) 2025, to better inform investment prioritization and maintenance decisions across the enterprise.

The Benchmark Review was conducted to:

1. Identify process enhancements for assessing any degradation of safety-related infrastructure and identifying recommended maintenance, repair, upgrade, and replacement
2. Examine NNSA processes for identifying, prioritizing, and planning safety related aging infrastructure investments
4. Examine NNSA processes and approaches to evaluate how Integrated Safety Management Principle "Balanced Priorities" is applied and addressed for safety-related aging infrastructure
5. Compare and identify best practices from each program's aging infrastructure methods, funding strategies, and prioritization approaches and address:
    a. Long-term investment needs/plans
    b. Maintenance/expansion of operations
    c. Performance of infrastructure supporting safety functions
6. Consider DNFSB concerns identified in Recommendation 2020-1
7. Examine aging infrastructure monitoring methods required in DOE Order (O) 430.1C and DOE O 433.1B and compare with recently published ANSI/ANS-3.14-2021, *Process for Infrastructure Aging Management and Life Extension of Nonreactor Nuclear Facilities*

Introduction



Achieving the NNSA multiple national security missions requires the Enterprise to maintain cutting-edge scientific, experimental, production, and computing facilities; reliable and efficient utilities; and modern office and laboratory space. While new facilities have been constructed and existing ones recapitalized, historical investment in NNSA infrastructure has not kept pace with the growing need to modernize or replace aging facilities.

Recognizing NNSA's infrastructure challenges, the *National Defense Authorization Act for Fiscal Year 2018* (FY 2018 NDAA) directed NNSA to establish an Infrastructure Modernization Initiative (IMI) to reduce its deferred maintenance, which had been trending above seven percent of replacement plant value for several years. NNSA has succeeded in halting the growth of deferred maintenance and stabilized it just below five percent of replacement plant value. In FY 2022, the NDAA updated the IMI to achieving a deferred maintenance to replacement plant ratio of 2.67 percent by FY 2030. Achieving this goal will require NNSA to:

- Increase resources for Recapitalization, Maintenance, and Repair and line-item construction
- Dispose of unneeded facilities
- Mature decision-making tools for more effective use of resources

- Improve project management and use of streamlined and non-traditional acquisition practices to ensure cost effective delivery of new, non-complex facilities

Planning & Analysis

NNSA is implementing planning and management tools to improve the data and analyses used to inform decision making when prioritizing investments in infrastructure. These tools are used in the planning, programming, budgeting, and execution cycle to:

- Understand the programmatic requirements for NNSA infrastructure
- Identify infrastructure gaps in meeting program requirements
- Quantify and rank the gaps based on a normalized risk index from 1 to 100
- Prioritize projects for investment based on risk reduction per project cost

NNSA's data-driven, risk-informed infrastructure tools involve an agile, iterative process of identifying key metrics that have the greatest correlation to risk, including mission requirements, infrastructure-related safety risk, age, and condition. The formulas and tools are continuously improved to better understand, analyze, and visualize trends, opportunities, efficiencies, and metrics to inform decision making. NNSA frequently solicits feedback from stakeholders to ensure investments are achieving expected results.

Best Practice
Implement repeatable, predictable, and standardized processes that allow for effective and efficient execution, timely change control, and rapid analysis across the Enterprise.

Program Management Plan (PMP)

The NA-91 PMP provides the principles and framework under which programs are implemented to manage NNSA's complex risks associated with safety, infrastructure, materials, and the environment to enable mission results. NNSA also issues annual programming meeting guidance upon which the Future-Years Nuclear Security Program is developed each spring. A key purpose of the annual NA-91 programming meeting is to prioritize the scope and required funding for the integrated priority list, to buy back the highest priority unfunded requirements, and to identify NA-91's highest priority over targets for consideration in the NNSA programming process.

Real Property Asset Management (RPAM)

The NNSA RPAM Guide was established in 2019 as a living document to describe the tools and processes NNSA uses to manage real property assets over their lifecycle from initial acquisition, through sustainment, to ultimate disposition, in accordance with DOE O 430.1C and NNSA Supplemental Directive (SD) 430.1. The RPAM Guide has expanded annually to better describe processes for lifecycle planning, acquisition, sustainment, disposition, and space management.

Master Asset Plan (MAP)

The MAP planning process communicates the vision and efforts underway to accomplish a single NNSA infrastructure plan that communicates an integrated Enterprise composed of infrastructure investments, program requirements, and infrastructure gaps with proposed options, priorities, timeframes, locations, and costs. Long-range, requirements-based, integrated infrastructure planning leverages the Deep Dives, MAP, G2, and other current planning efforts in these four steps:

1. Collection of Infrastructure Needs in G2: All infrastructure needs are collected to reflect site priorities and plans, allowing transparency to NNSA offices and programs on site infrastructure needs.
2. Validation and Prioritization of Needs: The needs identified by the sites are validated and prioritized based on program requirements. Each need is prioritized at the program level, the organization level, and the Enterprise activity level.
3. Analysis and Programming: Data and information is analyzed, funding sources and acquisition methods are determined, and projects are programmed by program offices.
4. Development of One Plan: Decisions and outputs are cataloged in G2 Program Management System as a single source for the infrastructure plan, consistent with the NNSA Strategic Vision, and clearly documented in the MAP.

Real Property Lifecycle Planning Tools

Remaining tools manage NNSA real property by performing lifecycle planning in alignment with NNSA strategic plans and mission requirements. Lifecycle planning allows NNSA to ensure cost-effective operations by forecasting:

- Repair, maintenance, and revitalization investments for a facility's major systems as they age
- A facility's replacement schedule
- A facility's disposition costs

Most NNSA facilities are designed to have a 40- to 60-year lifecycle, with recurring 20- to 25-year revitalization periods. As reflected in the BUILDER Sustainment Management System (BUILDER) component condition and design life data, many of the major systems that make up the facility are projected to be much shorter, ranging from 16 to 51 years. Investments made in a facility's maintenance, repairs, and revitalization throughout its service life heavily influence how long the facility can operate and the risk it poses to the mission.

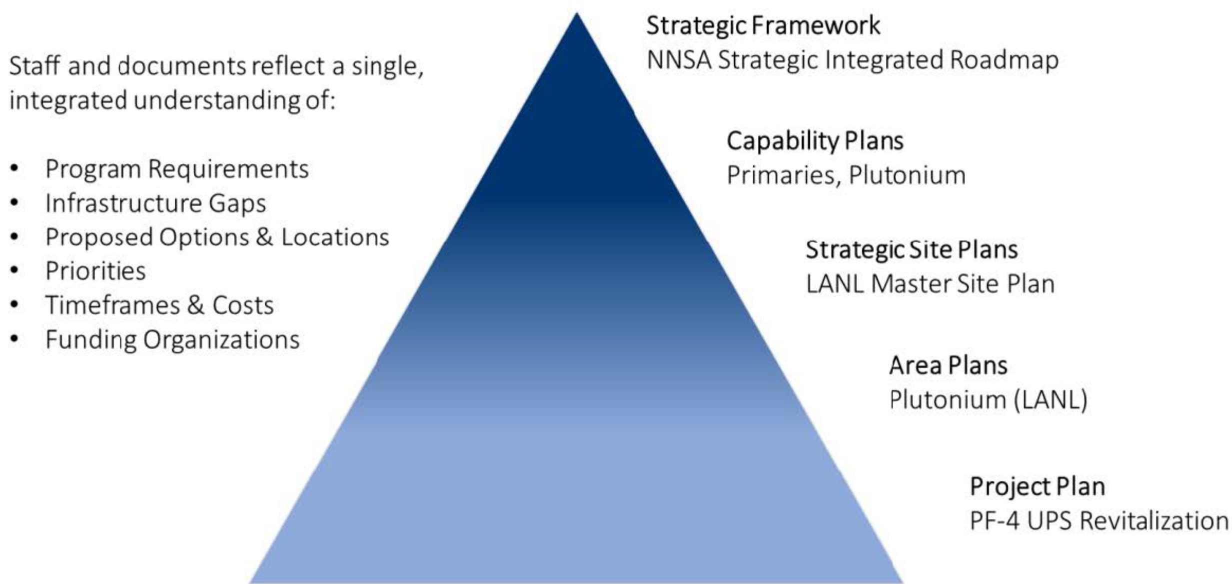
NNSA employs bridging strategies when investments to replace a facility's major systems are intentionally reduced once a replacement facility is less than 20 years away. This is a prudent use of resources and management of risks.

Many NNSA facilities are required to remain in operation past their intended design life, and therefore programs to extend life are employed to mitigate the mission risk of aging system failures that could take a facility offline.

NNSA uses predictable and repeatable processes to assist with real property planning. To make the right things happen at the right times, every level of NNSA planning must remain in alignment. Using requirements-based, integrated planning, NNSA develops a single integrated understanding of program requirements, infrastructure gaps, proposed options and locations, priorities, timeframes and costs, and appropriate levels of detail for the replacement horizon. As a result, products at every level of the planning process inform actions toward the same end state.

NNSA leadership communicates core, top-level requirements to establish the framework needed for program offices to craft more detailed capability plans. M&O partners then use the requirements captured in the capability plans to create their strategic site plans. The strategic site plans can then be broken down into discrete area plans. Area plans illustrate the sequencing of interdependent project plans that must be implemented to meet mission requirements. Frequent communications among staff at all levels, including at infrastructure Deep Dives and quarterly program reviews, keeps the planning process in alignment.

Requirements-Based Integrated Planning

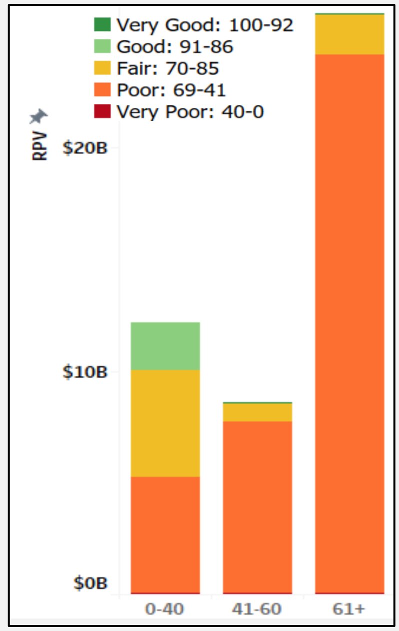


Enterprise Condition for Nuclear Hazardous Facilities

NA-90 capabilities are enhanced as the tools described are employed to best understand the risks and threats to the Enterprise. As an example, the NNSA Enterprise Condition is illustrated and described for Nuclear Hazardous Facilities. A similar table is included for NNSA Hazardous Facilities, inclusive of nuclear hazardous facilities. NNSA documents condition in BUILDER, a web-based asset lifecycle management application, that helps management decide when, where, and how to best maintain, repair, and recapitalize real property.

Approximately 36 percent of NNSA's assets are nuclear hazardous facilities by estimated value. NNSA is responsible for more than 5,000 assets, of which 167 are nuclear hazardous facilities, 50 are more than 61 years old, 53 are less than 40 years old, and 64 are 41 to 60 years old. Approximately 45 percent of the nuclear assets are in poor or very poor condition (79 percent by Replacement Plant Value [RPV]).

Nuclear Hazardous Facilities



Nuclear Hazardous Facilities

	Very Good	Good	Fair	Poor	Very Poor
0-40		6 assets 2,107,542,789	24 assets 4,782,746,303	19 assets 5,187,246,248	4 assets 79,889,148
41-60	2 assets 4,107,882	5 assets 17,988,485	35 assets 864,390,325	20 assets 7,645,246,447	2 assets 66,140,483
61+	2 assets 2,363,917		18 assets 1,846,950,321	26 assets 24,032,341,005	4 assets 113,047,034

Nuclear Hazardous facilities are associated with one or more of the following hazard categories in the DOE FIMS database: Nuclear Facility Category 2 and Nuclear Facility Category 3.

Hazardous Facilities

	Very Good	Good	Fair	Poor	Very Poor
0-40	33 assets $261.38M	57 assets $8,517.88M	113 assets $10,158.09M	71 assets $12,468.25M	5 assets $10.87M
41-60	3 assets $1.27M	16 assets $134.11M	60 assets $2,313.96M	76 assets $12,583.15M	9 assets $81.89M
61+	7 assets $9.16M	19 assets $1,077.30M	127 assets $3,268.33M	122 assets $21,475.99M	13 assets $11,201.43M

Hazardous facilities are associated with one or more of the following hazard categories in the DOE FIMS database: Nuclear Facility Category 2, Nuclear Facility Category 3, Radiological, Chemical Hazard, Nanoparticle, Beryllium, Bio Safety Level 2, and Bio Safety Level 3.

Aging Infrastructure Monitoring Methods

As part of NNSA's holistic approach to infrastructure stewardship, M&O partners monitor and field offices oversee the monitoring of aging infrastructure, including obsolescence, as directed by DOE regulations, directives, and guidance. For nuclear facilities, the conduct of inspections to evaluate aging-related degradation and technical obsolescence (DOE O 433.1B) determines whether the performance of safety systems structures, systems, and components (SSC) is threatened. The Cognizant System Engineer Program carries out these inspections per DOE O 420.1C, *Facility Safety*, to maintain overall cognizance of assigned systems, provide systems engineering support for operations and maintenance, and provide technical support for line management safety responsibilities to ensure continued system operational readiness. These inspections also extend to high-value components approaching end-of-life in DOE O 430.1B. The entirety of these inspections informs NNSA's management tools to plan, program, budget, and execute work for NNSA's Enterprise.

As functional assessments are performed every five years to determine an asset's physical condition and capability to meet mission requirements, some assets identified as mission unique or critical, or posing an increased risk to life safety or the environment may be performed more frequently. In each case, the estimated time to failure and optimum period for repair and/or replacement informs the planning and budgeting process.

NNSA relies upon M&O partners to have a comprehensive understanding of safety SSCs and their ability to perform design functions in the future, considering age-related degradation or technical obsolescence. The planning and budgeting processes rely upon M&O partners' assurance programs and NNSA's oversight directed in DOE O 226.1B, *Implementation of DOE Oversight Policy*. NNSA sites also collaborate with internal and external stakeholders to further mature their processes and workforce knowledge, such as the Maintenance Manager Working Group and subgroup activities, NNSA Aging Infrastructure Management Workshops, and EM Exchange of Critical Lessons Learned on Aging Infrastructure Management Workshops.

The nuclear maintenance order, DOE O 433.1B, CHG 1, requires a process for conducting inspections to evaluate aging-related degradation and technical obsolescence to determine whether performance of SSCs is threatened. The Order provides related requirements for design features, timely detection of aging effects, inclusion of high value components defined in DOE O 430.1B, and the ability to address operating experience so that the effects of aging will be adequately managed.

DOE Guide 433.1-1A, Chg. 1, identifies nine topics the Nuclear Maintenance Management Program (NMMP) should address on aging-related degradation and technical obsolescence. The Institute of Nuclear Power Operations, AP-913, *Equipment Reliability Process Description*, is a reference to consider when establishing aging management processes within the NMMP. NNSA recommends adding ANSI/ANS-3.14-2021, *Process for Infrastructure Aging Management and Life Extension of Nonreactor Nuclear Facilities*, as a reference to identify effective screening of SSCs and management of aging mechanisms and technical obsolescence.

Process Enhancement
Develop a new DOE Handbook to expand guidance for Section M, *Aging Degradation and Technical Obsolescence*, in DOE Guide 433.1-1A, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1*. ANSI/ANS-3.14-2021 is an appropriate reference for the new Handbook.

ANSI/ANS-3.14, *Process for Infrastructure Aging Management and Life-Extension of Non-Reactor Nuclear Facilities*, was approved in 2021. This standard provides criteria and guidance to systematically evaluate SSCs for remaining lifetime and determine the need for additional analysis and inspection to address aging management in support of extending the life of non-reactor nuclear facilities.

For NNSA SSCs as defined in the safety basis of Nuclear Facility 1, 2, and 3 hazard categories, reliable performance is implemented by the maintenance management program for nuclear facilities required by 10 CFR 830.204(b)(5) per DOE O 433.1B. Each NNSA site's NMMP includes processes for conducting inspections to ensure design features within the safety basis can continue to perform their intended safety functions, including evaluation of aging-related degradation and technical obsolescence. Monitoring, inspection, testing frequency, and sample size determines timely detection of aging/obsolescence effects. Nuclear facility SSC condition assessment monitoring results are integrated into BUILDER.

The regulatory framework for non-reactor nuclear facilities also includes safety credited SSCs that meet specified design requirements. Each safety SSC is subject to requirements that ensure safety functions are met for prescribed design basis event(s). Each system undergoes commercial grade dedication to ensure they meet the design imposed critical characteristics prior to installation. Each SSC must maintain qualification over its lifetime and be subject to surveillance, periodic maintenance adjustments and calibrations to ensure their ability to perform on demand.

Data-Driven and Risk-Informed Tools

BUILDER

A best-in-class, web-based tool developed by the U.S. Army Corps of Engineers that provides a consistent, repeatable, quantitative method to track and predict the condition of facilities and their systems, components, and subcomponents.

Mission Dependency Index (MDI)

A 1-100 score calculated for each facility to measure its impact to the mission by combining the consequences of whether the facility is lost, difficult to replace, and interdependent with other facilities.

Excess-Facility Risk Index (ERI)

A 1-100 score for each excess facility that calculates the risk posed by structural and safety conditions, the potential impact of contaminants, and the facility's proximity to personnel, the public, environmental receptors, and high-MDI facilities.

Deep Dive

An infrastructure planning process that consists of site visits and shows each site's vision and plans using a consistent repeatable approach to assess gaps and risks to assure the site's infrastructure will support mission needs.

Master Asset Plan (MAP)

A long-term planning process which results in NNSA's annual, Enterprise-wide infrastructure strategic plan that provides an integrated view of NNSA infrastructure and a prioritized roadmap for reducing mission risk.

Area Planning

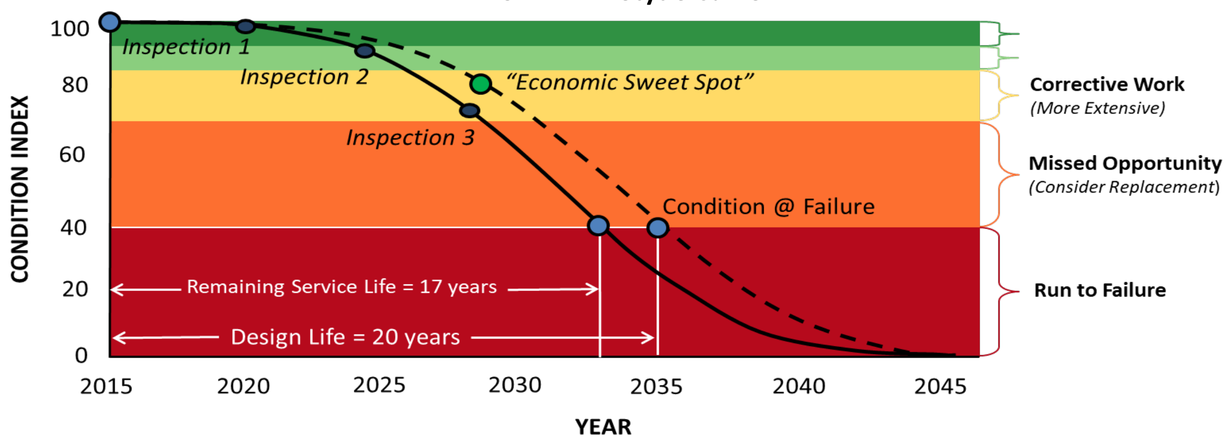
Plans that create a framework for modernization and drive prioritized, integrated infrastructure investments by integrating mission requirements with viable infrastructure investment options.

BUILDER

BUILDER provides a consistent, repeatable, quantitative method to track and predict the condition of assets and their systems, components, and sub-components across the NSE.

BUILDER is a web-based tool that can help inform decisions on when, where, and how to best maintain, repair, and recapitalize infrastructure. It uses a knowledge-based method to compare inspection data against engineered lifecycle curves to predict system wear and identify the optimal time to invest (i.e., the "Economic Sweet Spot"). Unlike deferred maintenance, which is only backward-looking, BUILDER predicts building and building system condition and degradation over time. As a result, BUILDER provides greater insights to aid investment decision making.

BUILDER Lifecycle Curve



In accordance with DOE Order 430.1C and NNSA Supplemental Directive (SD) 430.1, NNSA conducts physical condition assessments on each real property asset at least once every five years and tracks that condition in BUILDER. BUILDER is a best-in-class, web-based tool developed by the U.S. Army Corps of Engineers that provides a consistent, repeatable, quantitative method to track and predict the condition of facilities and their systems, components, and subcomponents). BUILDER uses physical condition assessment data in combination with predictive analytics to:

- Calculate current and future asset and component condition using engineered lifecycle data (based on Weibull probability distribution curves)
- Calculate asset and component replacement costs burdened by site-specific cost modifiers (on the order of a class 5 estimate)
- Calculate asset Deferred Maintenance (DM), Repair Needs (RN), RPV, and Overall Asset Condition in accordance with annual federal real property reporting requirements
- Recommend optimum fiscal year to replace components that are in a failed condition or are at high risk of catastrophic failure due to age or natural deterioration
- Identify assets that are candidates for revitalizations due to a high DM/RPV ratio
- Conduct elementary analysis of different spending scenarios to buy-down asset and component risk (this funding analysis is still in its infancy and is expected to mature and become more integrated into the overall real property planning process over the next several years)

- Track how well assets meet specified mission requirements based on functionality assessment data starting in FY 2023 (sites have conducted functionality assessments in accordance with DOE Order 430.1C in the past but are transitioning to a more standardized evaluation process in FY 2023)

The NNSA procured BUILDER in October 2014 and first used BUILDER metrics for planning and federal reporting in FY 2019. From FY 2019 to FY 2022, fully implemented BUILDER data was only available for NNSA-owned-and-operated buildings and trailers and was blended with datasets generated by systems other than BUILDER (e.g., Facilities Information Management System [FIMS], Condition Assessment Information System) for non-operating or other structures and facilities (OSF) NNSA-owned assets. NNSA continues to actively implement BUILDER across its real property infrastructure portfolio with the goal of reaching full program sustainment by the end of FY 2024. NA-90 will start reporting BUILDER metrics for a subset of OSFs in FY 2023, including all standby and shutdown assets and all remaining real property assets in FY 2024 to include federal permits and leased assets.

Upon achieving full program implementation in FY 2024, NNSA will work with BUILDER data to develop a new infrastructure risk metric that is more holistic than deferred maintenance. The goal is to create a forward-looking metric that expands beyond infrastructure condition risks to incorporate the capacity and functionality elements of an asset. With a building-level risk metric that allows projections 20-40 years into the future, NNSA will be able to better assess the health of the Enterprise over time and make timely, targeted investments that would have otherwise been missed if the focus only were on condition.

BUILDER does not specifically identify or tag safety class equipment due to system classification concerns (BUILDER is only approved up to UCNI). However, all real property safety equipment will generate condition, cost, and remaining service life data to inform infrastructure renewal decisions.

BUILDER has significantly improved NNSA's ability to uniformly identify key infrastructure risks and to consistently calculate asset condition and cost data across the Enterprise. It is critical to the overall planning process and gives stakeholders ability to prioritize investments based on acceptable risk tolerance levels and available resources. NA-90 will continue to review BUILDER annually to ensure accurate metrics calculation based on evolving mission needs and as part of a continuous improvement model.

Best Practice
Use automated processes to eliminate redundant data collection, streamline reporting, and establish a structured approach to assess infrastructure and to inform infrastructure renewal decisions based on current and predicted system conditions, mission priorities, and acceptable risk tolerance levels.

The NNSA Real Property Office (RPO) funded the development of new and updated custom asset models and a new software application called the Cost Engine to generate more accurate RPV for NNSA's unique facilities. The system uses both the assigned asset model and actual BUILDER inventory data to calculate a bottom up RPV cost. The new BUILDER-generated RPVs more closely reflect the Enterprise's true value and are reviewed monthly by the RPO to ensure they meet program needs and expectations.

Process Enhancement
Institute an archival process for how BUILDER's Standards and Policies and the Cost Engine are maintained under configuration controls and saved from year to year, and how the condition assessments, including cost calculation, are calculated.

Per the RPAM Guide, NNSA is investigating the best ways to measure infrastructure functionality (e.g., capability and capacity) across NNSA's diverse facilities.

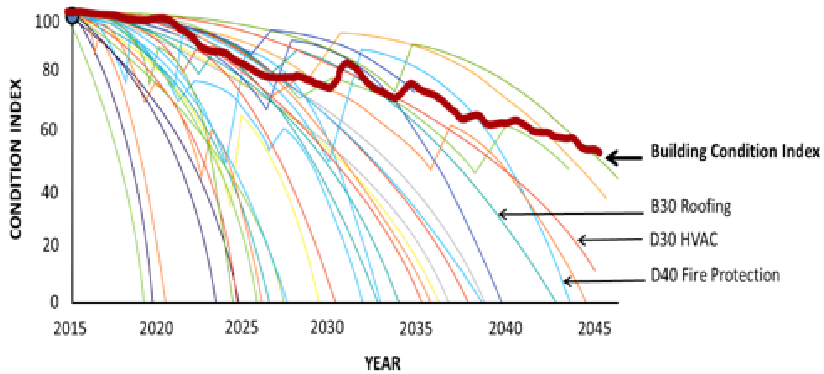
The NNSA RPAM Guide details how active real property assets will be maintained to meet mission requirements. NNSA conducts these activities in accordance with BUILDER Standards and Policies to prevent premature aging or wearing of the asset, specifically to:

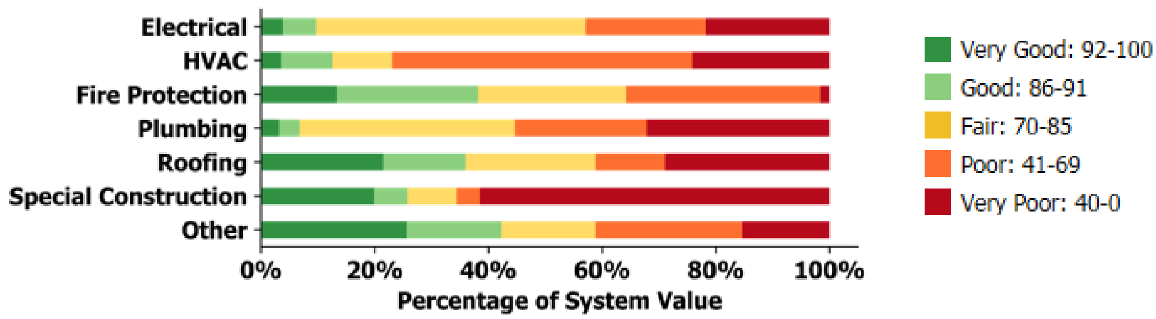
- Fully maintain and revitalize the condition and functionality of assets with no clear plan to be replaced or retired in the near future
- Strategically perform only critical repairs and maintenance for assets that have a clear plan to be replaced or retired, while intentionally allowing non-critical components to run to retirement
- Continue to perform maintenance to ensure safety, security, and environmental stability for excess facilities awaiting disposition (all other maintenance on excess facilities will be at greatly reduced levels to preserve resources)

BUILDER provides NNSA with a single, structured approach to assess infrastructure and to inform infrastructure renewal decisions based on current and predicted system conditions, mission priorities, and acceptable risk tolerance levels. Condition assessment scores from 0 to 100 are assigned at the system subcomponent level (e.g., boilers and furnaces). These scores are then rolled up to the system level, known as the System Condition Index (SCI). SCI scores are then rolled up to the building level, known as the Building Condition Index (BCI).

Other real property managed by BUILDER uses multi-level condition index structure to pinpoint its risks and develop tailored investment strategies based on the precise type of asset. For example, NNSA may wish to accept more risk with heating, ventilation, and air conditioning (HVAC) systems that provide comfort for office spaces than with HVAC systems that provide nuclear weapons component manufacturing requirements for humidity and temperature tolerances or as part of safety systems that maintain ventilation controls. The detailed systems information from BUILDER combined with an asset's MDI create a powerful tool for making data-driven, risk-informed investments.

SCI scores help identify where investments are most needed within a facility and roll up to BCI scores that provide a bigger picture view and can be used to compare the condition of different facilities across the NSE.



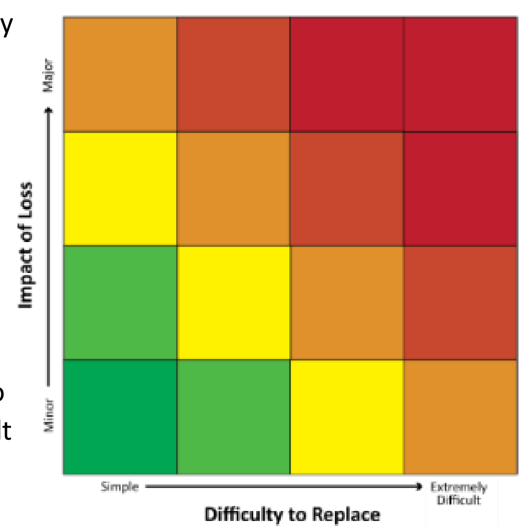


To lower the overall cost and ease of using the BUILDER system, NNSA has integrated BUILDER with each site's local Computerized Maintenance Management System using a translation software application called SPIRE. These systems track condition and daily maintenance activities, document replacement of components, and offer a variety of features such as preventive maintenance scheduling, warranty management, and space planning, which all help our sites to maintain effective and streamlined operations.

Mission Dependency Index (MDI)

MDI measures the impact to the mission by combining the consequences of whether the facility is lost, difficult to replace, and interdependent with other facilities.

MDI scores range from 1 to 100, with higher scores representing greater impact to the mission. Large, unique, essential assets with high replacement plant values have higher MDI scores, whereas smaller, less critical, and/or less expensive to replace assets typically have lower MDI scores. Assets that provide vital services to multiple highly ranked assets, such as utilities that could halt mission work, also have higher MDI scores. In the past, these assets would be categorized as "Non-Mission Dependent," and were often overlooked.



MDI Model

MDI links facilities to the capabilities they support, which provides greater risk insights. MDI scores are used in BUILDER to set mission priorities for risk tolerance and are used in NNSA's recapitalization project prioritization methodology.

Best Practice
Integrate Mission Dependency ratings for greater risk insights into prioritization strategies where vital services, such as utilities, could halt mission work.

MDI is fully implemented. MDI scores have been established for all NNSA operating assets and are used in prioritizing investment. MDI data and formulas are being continuously improved through an iterative, annual process known as MDI 2.0.

Excess-Facility Risk Index (ERI)

ERI helps NNSA prioritize disposition and risk reduction investments for NNSA's portfolio of excess facilities.

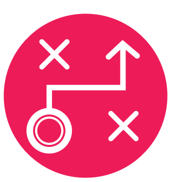
Currently eight percent of NNSA's facilities are excess to mission needs. Excess facilities are a drain on NNSA resources and pose safety, security, and program risks. NNSA developed ERI to better assess risks of excess facilities. ERI is also considered when prioritizing investments that reduce the risks posed by excess facilities and communicate disposition priorities with DOE's Office of Environmental Management (DOE-EM), whose expertise is needed for large, process-contaminated facilities.

ERI combines impact and likelihood into a single risk score from 1 to 100 to quantify the distribution of risk over the 292 excess facilities on NNSA sites. Factors to calculate ERI are:

- Facility's structural and safety system(s) conditions
- Type and extent of contaminants
- Proximity to workers, the public, environmental receptors, and high MDI facilities

ERI is fully implemented and data is collected for all currently excess facilities on NNSA sites and those that will be excess within the next 10 years, even if ultimate disposition is the responsibility of a program office other than NNSA. ERI scores will be phased in for facilities that will become excess in the next 10 to 25 years.

Master Asset Plan



The MAP is NNSA's Enterprise-wide, long-term infrastructure strategic plan and depicts the infrastructure needed to meet current and planned mission requirements during the next 25-plus years.

The MAP offers an integrated view of NNSA infrastructure and a prioritized roadmap to reduce risk and help align infrastructure investments with mission requirements by:

- Facilitating internal coordination within NNSA
- Providing information about gaps and risks
- Informing sites about NSE investment plans

The annual MAP report provides an overview of NNSA's infrastructure and the tools and initiatives underway to manage it. The MAP originally broke out the asset data into 17 different infrastructure capabilities, presenting lists of major assets in each capability. Dozens of MAP area plans were also published as an appendix to the report, exploring the infrastructure needs for current and planned mission requirements during the next 25-plus years. From 2019 to 2022, the number of MAP area plans published grew from 16 to 89. In 2023, MAP area plan development was paused to revamp the MAP into an Enterprise-wide shorter main document, with an improved, integrated description of the vision, gaps, and challenges facing NNSA. This effort will add the Strategic Infrastructure Priorities Roadmap, detailing high visibility projects on a 22-year timeline.

The MAP is used as a reference document for informing programming requests as part of NNSA's budget prioritization and decisions. This ensures alignment with planning and strategy. The MAP helps programs and sites understand major infrastructure gaps, risks, and plans and offers a common communication tool for concisely summarizing and visualizing how preferred infrastructure options connect to NNSA's strategic vision.

Best Practice
Enhance integrated infrastructure planning with improvements to the annual Master Asset Plan (MAP), an enterprise-wide, long-term infrastructure strategic plan.

The MAP is fully implemented and will be improved continually over time based on user feedback. In 2022, NA-90 kicked off an effort to update the annual MAP to a more comprehensive, executive-level document that will debut in 2023. These changes are part of a broader effort to enhance, integrated infrastructure planning.

Area Planning

NNSA develops targeted area plans as a planning and communication tool to drive prioritized, strategic infrastructure investments across the enterprise. Area plans create a framework for modernization by integrating mission requirements with viable infrastructure options, including support infrastructure.

Regularly updated to reflect new developments, area plans include multiple funding sources and preferred investment options.

Best Practice
Use area planning to create a framework for modernization with viable infrastructure options to mission requirements, including support infrastructure.

NNSA's area plan goal is to establish bridging strategies when a facility reaches 20 years before replacement or retirement to ensure mission needs are met. A bridging strategy determines how and when to maintain the asset, while allowing non-critical components to run to retirement per BUILDER Standards and Policies.

Original area plan templates were based on content briefed during the Deep Dives. Now, area plans are being integrated into the Deep Dive templates, and products are refreshed annually so that visualization techniques, asset groupings, and investment prioritizations remain consistent. By using a familiar format across major infrastructure planning products, it is easier for NNSA program offices, Congress, and sites to understand issues, share ideas, and manage risk.

The RPAM Guide has guidance on Area Plans and Detailed Area Plans with detailed outlines and templates for M&O partners to follow. The Guide provides a series of strategic elements to be evaluated to support a project or projects. Outlines provide the structure for the review process and gives examples and sample data in the tables to ensure consistency in the reporting. The process identifies what activities are needed to successfully scope work in advance of executing projects. Resulting reports summarize findings and gaps that need to be evaluated. All data is integrated into the G2 system.

Deep Dives

NNSA's Enterprise-wide infrastructure planning process involves regular site visits where participants from across the Enterprise are presented a detailed overview of the site's infrastructure readiness and needs for supporting mission requirements.

Infrastructure Deep Dives at each NNSA site serve a critical role in the planning process, creating a framework to align near-term decisions with long-term vision by linking program, infrastructure, and site planning outputs to programming and budgeting inputs. They provide a forum for discussion to help align infrastructure investment priorities with NNSA's goals and resources by offering attendees a more detailed understanding of:

- Mission requirements that drive infrastructure needs
- Infrastructure risks, such as condition, age, and capacity gaps
- Planned, ongoing, and recently completed investments aimed at reducing those risks

Deep Dives include M&O partners and field office and program personnel from across NNSA. Other stakeholders also are included, such as other DOE offices (e.g., DOE-EM, Office of Asset Management), the Defense Nuclear Facilities Safety Board, Office of Management and Budget, and other federal agencies. NNSA uses outputs from the Deep Dive planning process to build the annual MAP and to inform programming and budgeting decisions.

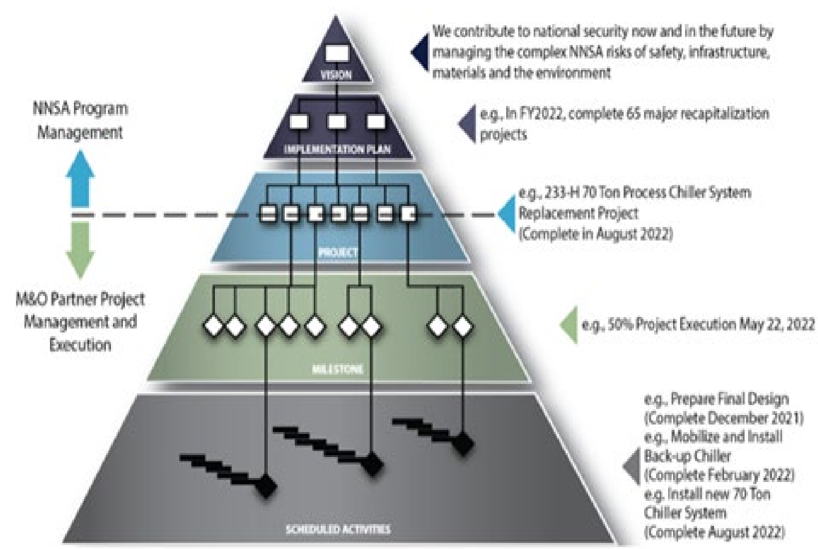
Best Practice
Leverage infrastructure Deep Dives to help align near-term decisions with long-term vision by linking program, infrastructure, and site planning outputs to programming and budgeting inputs.

The Deep Dives are fully implemented. Beginning in 2016, Deep Dives were conducted in-person at each site once every two years. When the Deep Dives moved to a virtual format in 2020, the existing schedule was maintained and participation soared. With seating limits and travel times eliminated, participation in the Deep Dives grew by approximately 200 percent. Hundreds of representatives from across the NSE and the government have streamed presentations and participated in discussions. Though valuable site tours and in-person networking were paused from 2020 to 2022, the virtual conferences enabled NNSA to expand its audience to improve integration within the Enterprise.

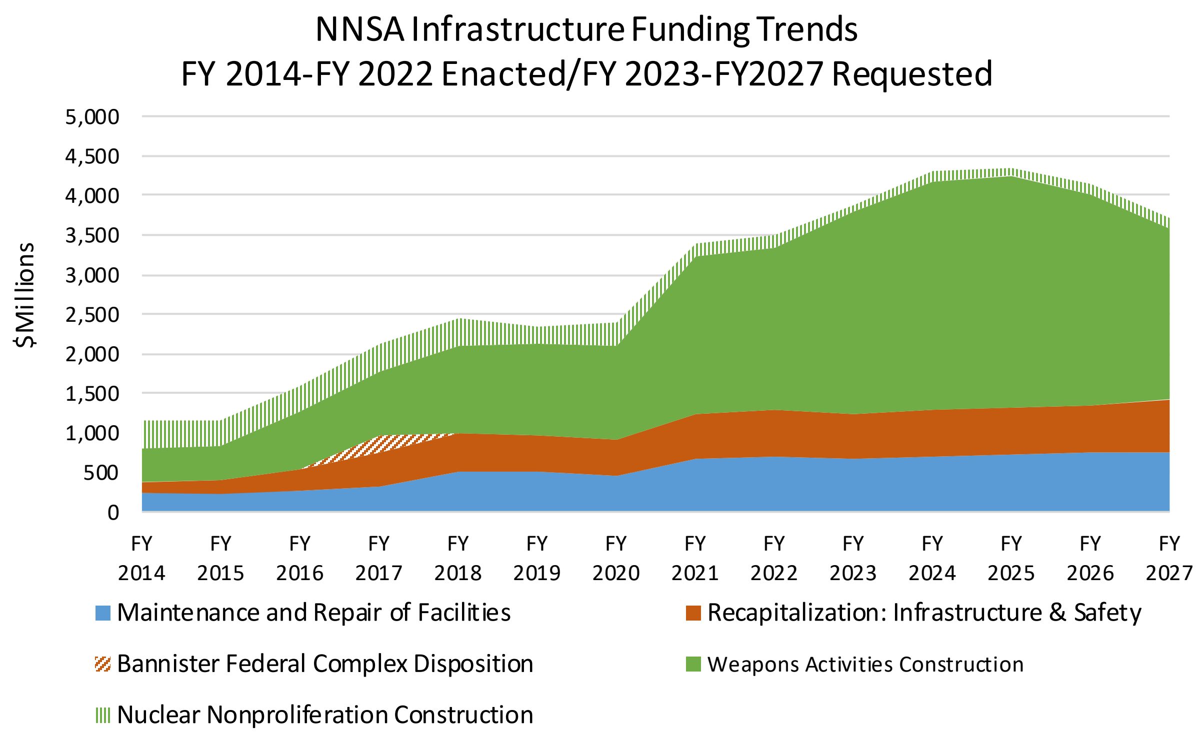
In 2022, NNSA moved to a triennial Deep Dive schedule. For 2023, a hybrid model of in-person and virtual meetings have maximized value to stakeholders. The results of these Deep Dives are assessed, and the model is continually refined.

Funding and Prioritization Strategies

With support from Congress and other stakeholders, NNSA has successfully increased resources for infrastructure modernization and maintenance to address the risks posed by aging infrastructure. While infrastructure funding is allocated in the Weapons Activities appropriation, it supports the needs of all NNSA programs, including nonproliferation, counterterrorism, counterproliferation, safety, security, emergency response, as well as select infrastructure technology and physical security needs.



Each fiscal year, NA-90 creates implementation plans outlining specific scope, schedule, and costs to achieve mission and strategic objectives. NA-90's program management model is organized around a performance cascade as a mechanism to ensure that all projects, milestones, and activities directly supports the achievement of our mission.

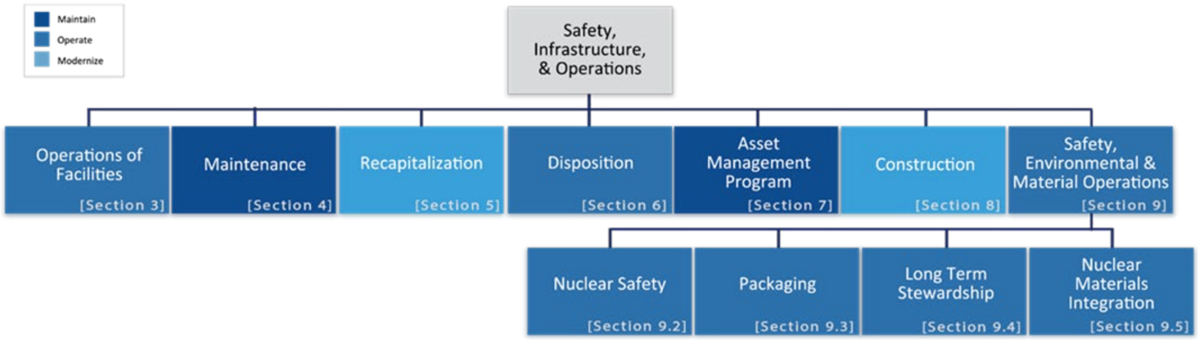


Infrastructure modernization is implemented through a three-pronged, comprehensive approach:

1. Line-item construction to replace facilities identified as beyond repair, expand the capabilities and capacities provided by existing facilities, and add new capabilities and capacities.
2. Smaller infrastructure recapitalization and minor construction projects to extend the life of facilities and systems, improve worker safety, and reduce risk.
3. Maintenance activities to sustain facilities, systems, and components and replace in-kind systems and components that are failing.

Best Practice
Manage at the program level while empowering M&O partners to manage at the project level with appropriate transparency to optimize project execution and infrastructure renewal.

Each NA-90 program consists of Work Breakdown Structure (WBS) elements designated as projects and/or cost accounts. Project elements contains work with discrete start, finish, and funding with monthly cost and schedule performance reporting. Cost accounts contains work with discrete funding levels and no schedule reporting when there is no significant value (e.g., Maintenance and Repair, Operations of Facilities).



NA-90 and the Office of Environment, Safety, and Health Program Work Breakdown Structure

Best Practice
Implement a Program Management System that provides transparency to infrastructure and operations project and cost accounts.

For effective program oversight and evaluation, NNSA developed standardized performance reporting requirements for the Recapitalization and Maintenance programs. Each month, M&O partners are required to report current cost and schedule performance data using NNSA's standardized WBS elements. All performance reporting is automated through the G2 program management tool, which reduces data entry time and errors compared to manual reporting.

Schedule performance reporting is required for all recapitalization, disposition, roof asset management program, and cooling and heating asset management Program projects, including forecasting future milestone dates. Once project schedule status reporting is initiated for a project, performance reporting is required until the last milestone is marked complete or the project is formally cancelled. Comments regarding the status of the project and any relevant issues and accomplishments also are required. Reported changes to schedule performance does not change the project or account baseline. This process allows NNSA to monitor schedule progress against the schedule baseline through schedule variance and exception reporting.

The detailed cost and schedule performance data is combined in G2 to give federal program managers and senior executives alike a holistic view of project and/or program performance across the Enterprise.

Process Enhancement
Learn and improve how risk is managed across the enterprise and document in future updates of the NNSA RPAM Guide (Appendix C7: Enterprise Risk Management).

Line-Item Project Prioritization

Before making major Federal acquisition decisions, NNSA performs long-term planning activities through the Weapons Activities Line-Item Planning Integration process. The Weapons Activities Line-Item Planning Integration process, established in September 2021, implemented procedures to consolidate the line-item data collection process and synchronize infrastructure planning across Weapons Activities programs. Going forward, the guidance will be captured in the annual RPAM Guide.

Process Enhancement
Capture the Weapons Activities Line-Item Planning Integration process into the NNSA RPAM Guide.

NNSA develops and updates prioritized lists of programmatic and mission enabling line-item construction projects based on validated program requirements that are defensible across the Enterprise. The projects have realistic estimates for cost, schedule, and timeframe during the next 25 years. The Weapons Activities Line-Item Planning Integration guidance is the foundation of a predictable annual process for soliciting M&O partner inputs and program office validation of inputs for the annual MAP, Stockpile Stewardship Management Plan, and programming process.

For line-item construction, including all Office of Defense Programs, Office of Defense Nuclear Nonproliferation, Office of Defense Nuclear Security, Office of Counterterrorism and Counterproliferation, and NA-90 projects, sites are expected to ensure that:

- All project proposals with a mission need within the next 25 years (FY 2023 through 2048) are entered and saved into the G2 Planning Module
- All existing projects already in the G2 Planning Module are current
- Entries indicate whether they add a new capacity or capability or are a replacement of existing capacity or capability
- Entries are linked to the relevant FIMS Real Property Unique Identifiers of the asset(s) that the project directly replaces or upgrades
- Cost and schedule estimates incorporate footprint disposition required and needed to enable construction

By leveraging existing processes and tools, the Weapons Activities Line-Item Planning Integration process minimizes data collection burdens on sites and ensures a consistent, repeatable process for all line-item construction projects. The process also provides more direct control for Weapons Activities program managers, a structured approval process for leadership, and the creation of an achievable, long-range line-item construction plan based on realistic funding levels.

NNSA uses different prioritization criteria for programmatic and mission-enabling construction due to variations of mission needs and scope. The following charts summarize the current processes, which are under review and may be updated. The list of proposed line-item construction projects is reviewed and updated on an annual basis to address changes in requirements and priorities. NNSA continues to look for ways to further enhance and improve our line-item planning.

Factors	Mission-Enabling Construction Description	Weight
Mission Gap	Support of program requirements or the risk posed to the mission	35%
Infrastructure Risk	Risk of the infrastructure including the condition, age, MDI	35%
Safety Risk	Safety risks of current infrastructure and the improvement as a result of the project	15%
Efficiency/Sustainability	Efficiency and sustainability gains as a result of the project, including reduced resource consumption and lower annual operating costs	10%
Deferred Maintenance	Deferred maintenance reduction by Total Project Cost (TPC)	5%

Factors	Programmatic Construction Description
Requirements Flow Down	Directives and reports from the President, Department of Defense, Nuclear Weapons Council and NNSA leadership
Facility Condition and Age	Legacy facility BUILDER data and ages, when applicable
Facility Mission Dependency Index	Legacy facility MDIs capture the potential degree of loss to the mission if a failure were to occur, when applicable
Facility Construction and Modernization Cost	Broader impacts of each project on the budget and potential alternative options to new construction
Alternate Facility Options	Review of existing facilities across the NSE to see if they could perform the mission
Alternate Project Options	Review of a range of other potential project methods, such as a campus approach of smaller facilities
Site Executability	Site's ability to effectively execute the volume of line-item projects proposed
Site Equity	Consideration of the holistic distribution of major infrastructure investments across the NSE

Recapitalization Prioritization

For Recapitalization projects, a prioritization methodology ranks investments to optimize risk reduction per dollar by evaluating key criteria: program requirements and risk reduction, safety risk reduction, increases in operational efficiency and/or productivity, and deferred maintenance reduction.

The program risk reduction portion is weighted by the facility's impact to mission measured by MDI. This information is reviewed by federal program managers to validate during programming and adjustments are made to maximize risk reduction across the Enterprise. The table below lists prioritization criteria and are combined with priority rankings from M&O partners, cost estimate maturity, and stakeholder support to determine a rank order on the Recapitalization Integrated Priorities List using weighted criteria.

Factor	Recapitalization Project Description	Weight
Safety Risk Reduction	Safety risks range from expensive, productivity limiting compensatory measures to significant events (e.g., accidents, environmental releases) that could shut down operations for extended periods. The calculation is based on the total Safety Risk Reduced divided by TPC.	35%
Program Risk Reduction	Program risks range from older systems with less capability and throughput than current models to obsolete systems with no replacement parts and frequent shutdowns for corrective maintenance. The calculation is based on the total Program Risk Reduction multiplied by MDI divided by TPC.	35%
Sustainability and Productivity Return on Investment	Savings range from reduced resource consumption and lower annual operating costs. The calculation is based on the total sustainability, operating, and programming cost savings divided by TPC.	20%
Deferred Maintenance Reduction	The calculation is based on the Deferred Maintenance Reduction divided by TPC.	10%

The final prioritization is influenced by and adjusted based on subject matter expert (SME) and Program review input for each of the factors. Complete and articulate project proposals from the site are important for ensuring that a project's impact on stated criteria is appropriately factored into project rankings.

Consistent with Integrated Safety Management (ISM) Guiding Principle, *Balanced Priorities*, resources are allocated to effectively address safety, programmatic, and operational considerations. Other attributes evident from execution of the Recapitalization program include:

- Managers recognize that aggressive mission and production goals can appear to send mixed signals on the importance of safety. Managers are sensitive to detect and avoid these misunderstandings, or to deal with them effectively if they arise.
- The organization demonstrates a strong sense of mission and operational goals, including a commitment to highly reliable operations, both in production and safety. Safety and productivity are both highly valued.
- Safety and productivity concerns both receive balanced consideration in funding allocations and schedule decisions.
- Modern infrastructure and new facility construction are pursued to improve safety and performance over the long term.

Disposition Prioritization Criteria

Disposition of excess facilities is a vital element of modernizing the NSE. Over the next 10 years, an additional 761 assets with more than 4 million gross square feet (GSF) are planned to become excess on NNSA sites. In FY 2022, 73 excess facilities totaling approximately 135,000 GSF were eliminated. Deferred maintenance and long periods between shutdown and demolition combine to increase risks. NNSA and DOE-EM have enhanced their collaboration in preparation for working closely in coming decades to dispose of the current and soon-to-be excess facilities at NNSA sites. Through excess facility disposition, NNSA can:

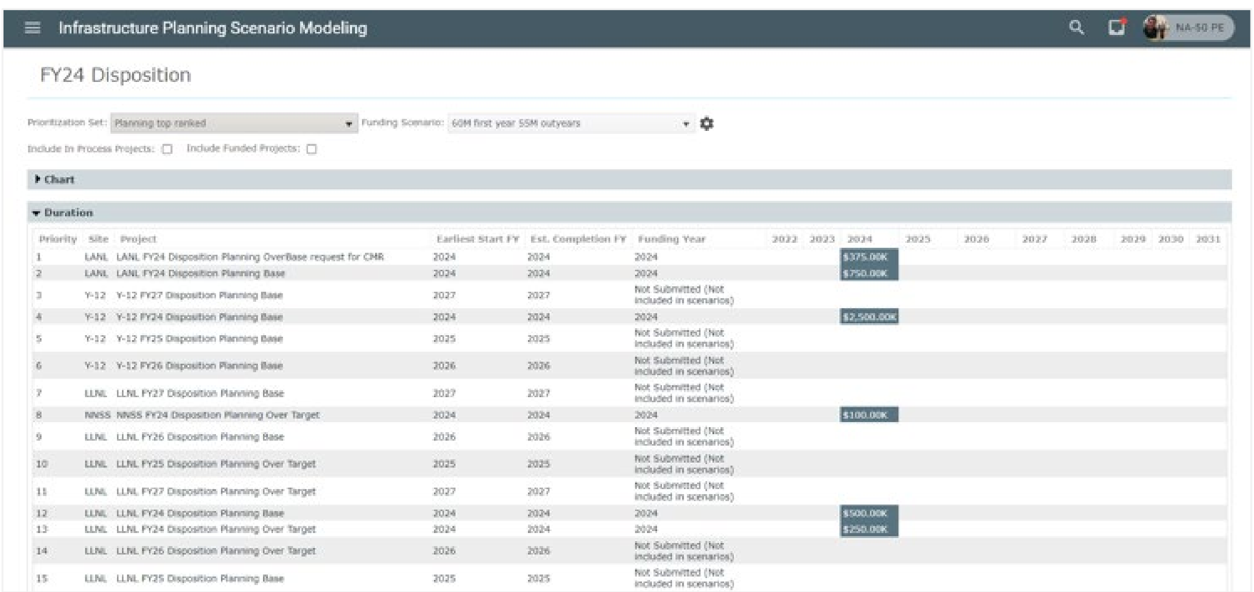
- Reduce the risks posed to workers, the public, the environment, and the mission
- Reduce the carrying costs of excess facilities
- Retire associated deferred maintenance and repair needs
- Reduce the NNSA footprint

NNSA's highest disposition priorities are to stabilize degraded process-contaminated facilities, characterize hazards and conditions, remove hazardous materials, and place the facilities in the lowest risk condition possible. NNSA's complete strategy for reducing the risks posed by excess facilities is outlined in the annual NNSA Disposition Strategic Plan.

To inform annual disposition planning, NNSA has developed a prioritization methodology based on weighted criteria. Disposition information is reviewed by SMEs to validate and adjust data where needed. The Disposition Program Manager then places the projects in rank order on the disposition integrated priority list.

Factors	Disposition Project Description	Weight
Risk Reduction	The ERI for the highest risk asset included in the project is used to estimate the risk being addressed by the project.	70%
Cost Effectiveness	The calculation is based on the total gross square footage reduction divided by TPC.	20%
Cost Savings	The calculation is based on the cost for maintenance, surveillance, repairs, and operations divided by TPC.	10%

NNSA developed a module in NNSA's G2 program management information system that helps automate the Disposition prioritization process. The module allows NNSA Program Managers to easily adjust the prioritized order, run scenarios for different funding profiles, and save multiple lists.



Priority	Site	Project	Earliest Start FY	Est. Completion FY	Funding Year	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1	LANL	LANL FY24 Disposition Planning OverBase request for CMR	2024	2024	2024			$375.00K							
2	LANL	LANL FY24 Disposition Planning Base	2024	2024	2024			$750.00K							
3	Y-12	Y-12 FY27 Disposition Planning Base	2027	2027	Not Submitted (Not included in scenarios)										
4	Y-12	Y-12 FY24 Disposition Planning Base	2024	2024	2024			$2,500.00K							
5	Y-12	Y-12 FY25 Disposition Planning Base	2025	2025	Not Submitted (Not included in scenarios)										
6	Y-12	Y-12 FY26 Disposition Planning Base	2026	2026	Not Submitted (Not included in scenarios)										
7	LLNL	LLNL FY27 Disposition Planning Base	2027	2027	Not Submitted (Not included in scenarios)										
8	NNSS	NNSS FY24 Disposition Planning Over Target	2024	2024	2024			$100.00K							
9	LLNL	LLNL FY26 Disposition Planning Base	2026	2026	Not Submitted (Not included in scenarios)										
10	LLNL	LLNL FY25 Disposition Planning Over Target	2025	2025	Not Submitted (Not included in scenarios)										
11	LLNL	LLNL FY27 Disposition Planning Over Target	2027	2027	Not Submitted (Not included in scenarios)										
12	LLNL	LLNL FY24 Disposition Planning Base	2024	2024	2024			$500.00K							
13	LLNL	LLNL FY24 Disposition Planning Over Target	2024	2024	2024			$250.00K							
14	LLNL	LLNL FY26 Disposition Planning Over Target	2026	2026	Not Submitted (Not included in scenarios)										
15	LLNL	LLNL FY25 Disposition Planning Base	2025	2025	Not Submitted (Not included in scenarios)										

Maintenance Prioritization Criteria

Funding for the maintenance and repair of facilities is prioritized within an Enterprise risk management framework based on mission needs, probability of failure of a system or a component, and risk determination regarding safety, security, and environmental requirements. Investments focus on structures, systems, and components that are considered essential to NNSA's national security missions.

Process Enhancement
Continue to pursue full implementation of BUILDER (planned for FY 2025) to better inform investment prioritization and maintenance decisions across the Enterprise.

BUILDER capabilities will allow NNSA to take less risk maintaining critical building systems (e.g., fire protection) and higher MDI facilities than other less critical systems and lower MDI facilities. BUILDER's standards and policies will be used to assist NNSA in assigning maintenance and replacement priorities to specific facilities and specific systems in those facilities as very high, high, medium, low, or no repair.

Level of Effort programs (e.g., Maintenance and Repair, Operations of Facilities) must also balance priorities relative to safety. For example, radioactive waste management programs must ensure safe and compliant waste characterization, packaging, and disposition while minimizing waste generation and reducing onsite storage. Continued success of NNSA's mission is ensured by maintaining capabilities to process radioactive waste and protecting the public, workers, and the environment from exposure to radiation and radioactive materials. NA-90 leadership, program managers, and staff collaborate with M&O partners to plan and execute program requirements while addressing changing conditions.

NA-90 has developed a variety of data-driven, risk-informed tools and innovative execution initiatives while benefiting from Congress' sustained and predictable funding the past several years. Large year-to-year fluctuations in funding may not be fully executable due to the lead time for ramp-up (e.g., human capital, project mobilization) or coordination with production schedules in active facilities. An agile, iterative planning process manages lifecycle investments while tools are continuously refined to provide better data for visualizing trends, mitigating risks, and recognizing opportunities. Frequent feedback is sought from stakeholders to ensure NNSA's risk-driven plan for improving infrastructure is appropriately targeted. Attributes of ISM's balanced priorities principle while executing these level-of-effort programs include:

- Organization managers frequently and consistently communicate the safety message, both as an integral part of the mission and as a stand-alone theme
- Pockets of resilience are established through redundant resources so that resources remain adequate to address emergent issues
- The organization develops sufficient resources to rapidly cope with and respond to unexpected changes
- Resource allocations are adequate to address safety (if funding is not adequate to ensure safety, operations are discontinued)

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Appendix C: SC Benchmark Review

Office of Science Benchmark Review of its Aged Infrastructure for Performing Needed Upgrades to Ensure Safety In response to DNFSB Recommendation 2020-1, Sub-Recommendation 1: Aging Infrastructure

Introduction

This report documents the DOE Office of Science (SC) review for the execution of planning and budgeting processes consistent with the DNFSB Recommendation 2020-1, Sub-Recommendation 1: Aging infrastructure. Comparative reviews by EM and NNSA of completed benchmarking activities will identify common elements, lessons learned within a program, integrated best practices, and possible process enhancements.

The Pacific Northwest National Laboratory, managed and operated by the Contractor (Battelle Memorial Institute) on behalf of the U.S. DOE Office of Science, has established processes to identify, prioritize, and plan safety-related infrastructure upgrades at the Pacific Northwest Laboratory Radiological Processing Laboratory (325RPL), which is its only Defense Nuclear Facility. The Contractor has in place associated planning and maintenance processes to assure the aging infrastructure associated with 325RPL is maintained, operational, and investments are prioritized to focus resources on those elements representing the greatest risk to continuing safe, secure, compliant, and reliable operations.

The 325RPL was designed and constructed to perform general radiochemical research, development, demonstration, and analytical services. Laboratory operations and activities in 325RPL involve research and development in radiochemical process science and engineering: evaluation, analysis, and testing of radioactive, radiochemical, and physical material properties; development and experimentation in the design and application of radiation generating devices; and development and conduct of analytical procedures in support of research activities. Because 325RPL is a R&D facility, work conducted in the facility frequently changes consistent with programmatic objectives. PNNL is meeting Clause H-44, Real Property Asset Management. The contract clause requires applying industry leading practices, voluntary consensus standards, and customary commercial best practices where practicable.

A reliability program has been established to minimize operational downtime and costs. The reliability program encompasses all the processes, procedures, and tools necessary to maintain PNNL facilities in a mission ready state that is safe, secure, compliant, reliable, and sustainable. The reliability program consists of twelve key elements: corrective maintenance, planned major maintenance, preventive maintenance (PM), asset lifecycle planning, maintenance work prioritization, maintenance and repair cost tracking, Computerized Maintenance Management System (CMMS), minimum acceptable level of condition, plant engineering drawings, spare parts and inventory management, configuration management (CM), and performance monitoring. The program provides assurance that the desired outcomes are being achieved through performance monitoring. Safety SSCs are prioritized according to their classification.

Program's planning and budget process(es) overview

PNNL has several tools and processes that facilitate planning and budgeting. Historically, PNNL's annual maintenance investment has been 2% of the replacement plant value (RPV) of DOE owned and contractor owned real property assets. All deferred maintenance identified at 325RPL in PNNL's long and short-term planning processes. The 325RPL extended life plan includes projects that reduces deferred maintenance identified in the planning processes.

Long term planning (5-10 years)

PNNL uses a RS Means based lifecycle analysis tool (CostLab) to track the service life of all facility owned equipment. Initial service life estimates are based on manufacturers information and are adjusted annually based on condition, operational performance, maintenance history, and engineering judgement. PNNL maintains a 10-year facility sustainment planning list that uses an assumed annual budget and schedules the replacement of equipment based on the estimated remaining service life. Also included in the long-term planning strategy are known major maintenance or modernization issues that cannot be scheduled in the near term due to budget availability. Large maintenance investments are incorporated in the long term planning strategies based on funding availability.

Short term planning (2-3 years)

PNNL generates a proposed project list using a lifecycle analysis tool (CostLab), results from condition assessment surveys, annual assessments performed at all real property that document FIMS reportable repair needs, deferred maintenance, and modernizations. The proposed project list is prioritized holistically across the entire PNNL site and highest priority projects are selected based on available budgets. PNNL sends a formal letter with the selected project list to DOE and requests approval on those projects that exceed $500,000 (capital acquisition threshold). Once DOE formally replies to the letter and approves the projects larger than $500,000, PNNL assigns the projects to project managers for execution.

Best Practices

1. SC-PNNL performs detailed assessments of all real property assets annually to identify maintenance issues and reliability risks. The assessments serve as key inputs to project prioritization, the annual budgeting process, and accurate accounting of FIMS deferred maintenance and repair needs.

SC optimizes project execution and infrastructure renewal by managing at the program level while empowering Managing and Operating (M&O) Partners to transparently manage at the project level.

Safety-related infrastructure investment methodology

Consistent with ISM's Guiding Principle, *Balanced Priorities*, PNNL's safety related infrastructure investment methodology effectively allocates resources to address safety, programmatic, and operational considerations. The methodology includes the following attributes:

- A risk-based approach to identifying and prioritizing maintenance investments
- Funding methods and allocations that assure the continued long-term operability of 325RPL:
  - Facility Space Service Center
  - Radiochemical Processing Laboratory (325RPL) Nuclear Operations Pool
  - Extended Life Plan for the Radiochemical Processing Laboratory
- A measurement of the current condition of 325RPL as defined by deferred maintenance and condition index.

PNNL generates a proposed project list using a lifecycle analysis tool (CostLab), results from condition assessment surveys, annual assessments performed at all real property that document FIMS reportable repair needs, deferred maintenance, and modernizations. Proposed projects are calibrated across the PNNL campus to establish a priority. The calibration is a risk-based decision process giving priority to activities that have the highest mission impact or have been identified as deferred maintenance. Other factors considered include safety, security, importance of a building or system, likelihood of failure, cost of repair, and the ability to operate in an impaired or failed state. Annual budgets for corrective maintenance and preventive maintenance activities are developed and are based on actual cost information from the previous 5 years. Upgrades and large maintenance activities are funded from a separate pool shared by all DOE owned real property assets and are prioritized holistically across the PNNL site. PNNL uses a RS Means based lifecycle analysis tool (CostLab) to track the service life of all facility owned equipment. Initial service life estimates are based on manufacturers information and are adjusted annually based on condition, operational performance, maintenance history, and engineering judgement. PNNL maintains a 10-year maintenance planning list that uses an assumed annual budget and schedules the replacement of equipment based on the estimated remaining service life. PNNL is committed to performing the corrective, preventive, and planned major maintenance necessary to keep the infrastructure supporting safety equipment in good working order.

As a part of the reliability program an overall asset condition is documented annually. The condition and functionality for all systems within a FIMS asset are evaluated and documented every 5 years in the condition Assessment Survey and Functionality Assessment form. This is described in the Life Cycle Asset Management Implementation Procedure. The Asset life cycle planning is a process that assesses the condition of all facility Systems, Components, and Structures (SSC) and is defined in ADM-360, *Life Cycle Asset Management Implementation*. The process consists of four key elements:

- Evaluate the service life of facility equipment using a life cycle analysis tool (e.g., CostLab).

- Perform Facility Information Management System (FIMS) required condition assessment surveys on a five-year frequency.
- Identify and categorize all FIMS reportable deferred maintenance, repair needs, and modernizations on an annual frequency.
- Maintain and manage a backlog of deferred maintenance.

The completed assessments are stored in Vault and document each of the FIMS reportable deferred maintenance, repair needs, and modernization activity by FIMS asset. The results of the assessments are used to develop a multi-year maintenance investment strategy of planned major maintenance (PMM) activities. This maintenance investment strategy is re-evaluated on an annual basis. The process of how the formal maintenance and repair notifications and approval requests are made to the DOE Site Office is documented in *Annual Work Plan and PNSO Authorization/Notification for Battelle, DOE, and Lease Property Maintenance*.

Funding Sources

Facilities Space Service Center

The cost of operating, maintaining, or occupying facilities is accumulated in the Facilities Space Service Center (FSSC) (also referred to as the B&U (Buildings and Utilities) pool or (B&U)). The pool is a Lab-level Service Center. Most, but not all, of the facilities associated with the Pacific Northwest National Laboratory (PNNL) are included in the FSSC. In general, costs incurred to operate, maintain, or enable occupancy of a building are charged to the FSSC when the item benefits all tenants (or all future tenants). However, costs incurred for the benefit of a specific organization or project to make the tenant operable are charged to the benefiting organization or project. Costs are distributed out of the Facilities Space Service Center using a rate based on the billable square feet of space.

The FSSC funds corrective maintenance, preventive maintenance, planned major maintenance, and minor construction projects on non-nuclear SSC's within 325RPL that are necessary to operate and maintain the facility.

RPL Nuclear Operations Pool

The Radiochemical Processing Laboratory (325RPL) Nuclear Operations Pool (Pool 98634) covers shared costs unique to the capability and function of the Radiochemical Processing Laboratory, including costs associated with Nuclear Materials Management, and charges benefiting organizations ….

The 325RPL consists of all specialized facilities supporting radiochemical process development, chemical and physical separations, thermal processing, radio-materials characterization, radioisotope production, and analytical chemistry. Specialized facilities such as the hot cell laboratory space and floor storage container space (defined as a "Special Facility" in CAS 418) are in the 325RPL Nuclear Operations Pool. Functions and activities of the Hot Cells Manipulator Center are also included in this pool. Hot Cells are a capability provided for the 325RPL including providing manipulators for Hot Cell radioactive work, transloading of radioactive samples and nuclear material storage. The pool includes minor construction activities and equipment purchases driven by the special facility need.

Radiochemical Processing Laboratory (RPL) Extended Life Plan (ELP)

325RPL was designed and constructed in 1953 and is in the 300 Area of the Hanford Site. PNNL is one of two DOE-SC sites managing Hazard Category II non-reactor nuclear facilities. Lifecycle extension for 325RPL is required to address the aging infrastructure and space configurations to continue to meet mission needs and operate efficiently.

PNNL is executing upgrades of the 325RPL facility that is crucial for long-term support of critical research. Because NNSA is a primary sponsor of this research, DOE-SC has reached an agreement with the National Nuclear Security Administration (NNSA) to make direct investment totaling $150 M in the next 10 years in the 325RPL facility.

The following NNSA funded projects will extend the life and mission capability of 325RPL and are planned to be executed between FY22-FY31 (additional project details are provided in Appendix A).

- *325RPL Roof Replacement*
- *325RPL Siding Replacement*
- *325RPL Building Systems Upgrade*
- *325RPL Manipulators*
- Cf-252 Source Replacement
- *325RPL Steam to Hydronics*
- *325RPL Plutonium Tritium Processing Laboratory Upgrade*
- *325RPL Plutonium Metal Glovebox Laboratory Upgrade*
- *DNN 325RPL RPL Inorganic Synthesis Laboratory Upgrade*
- *DNN 325RPL Plutonium Analytical and On-Line Monitoring Laboratory Upgrade*
- *325RPL Mass Spectrometry and Solvent Extraction Laboratory Upgrade*
- *325RPL Tritium and Microscopy Laboratory Upgrade*
- *325RPL Impacted Laboratory Upgrade*
- *325RPL Tritium Extraction Capability Laboratory Upgrade*

In addition to the NNSA funded projects at 325RPL listed above, PNNL has increased the Nuclear Operations Pool funds by $2 M in annual funding to support facility infrastructure projects from FY23-FY28 (Additional project details are provided in Appendix A). The prioritization is a risk-based decision process giving priority to activities that have the highest mission or safety impact or have been identified as deferred maintenance. Other factors considered include security, importance of a building or system (safety significant SSC), likelihood of failure, cost of repair, and the ability to operate in an impaired or failed state. The development and prioritization of activities is performed annually.

- *325RPL A-Cell Refurbishment*
- *325RPL Comparator Panel*
- *325RPL Data Acquisition Systems Upgrade*

- *325RPL SAL Shield Door Modification*
- *325RPL SAL Loading Dock Modification*
- *325RPL SAL, HLRF Floor*
- *325RPL Manipulators Procurement*
- *325WSPAD Upgrade*

Past Investments

PNNL has made numerous major investments into the safety significant and defense in depth systems at the 325RPL building to keep the facility modern, reliable, and capable of performing mission work. Table 1 below provides the 325RPL Major Investments Over the Past 10 Years by system and SSC designation (safety significant / defense in depth).

Table 1: 325RPL Major Investments Over the Past 10 Years

System	SSC Designation	Project Title of Major Investment
Fire Suppression System	Safety Significant	Fire Riser 3 lead in piping and Sanitary Water Replacement (S718319)
Fire Suppression System	Safety Significant	Replace Buried Piping Service Fire Riser 1 and 2 lead in piping and alarm check valve (S750639)
Fire Suppression System	Safety Significant	Replace Fire Riser 4 and 5 lead in piping and alarm check valve (S750639D)
Criticality Alarm System (CAS)	Safety Significant	CAS Mark III Detector Install (S760499)
Criticality Alarm System (CAS)	Safety Significant	CAS coverage rooms 525 and 427 (S762232)
Criticality Alarm System (CAS)	Safety Significant	Add a new Criticality Neutron Detector in the north end of room 603 (S768351)
Criticality Alarm System (CAS)	Safety Significant	CAS Coverage Room 97 (S776324)
Criticality Alarm System (CAS)	Safety Significant	Change out Metasys Integrator to a FEC in the Plant Operator's alarm panel (S784798)
Criticality Alarm System (CAS)	Safety Significant	Spare parts testing and dedication (S695304, S706007)
Criticality Alarm System (CAS)	Safety Significant	Install a CAS Remote Reset Relay (S681118)
Glove Boxes	Safety Significant	Lab 406 Glovebox Installation (S823193)
Glove Boxes	Safety Significant	Lab 415 Inert Glovebox Installation (S802528)
Glove Boxes	Safety Significant	Lab 504 Glovebox Installation (S804766)
Glove Boxes	Safety Significant	Lab 52 Inert Glovebox Installation (S823193)
Glove Boxes	Safety Significant	Lab 409 Glovebox Installation (S747480, S791859)
Glove Boxes	Safety Significant	Lab 515 Glovebox Installation (S737708, S734568)
Hot Cells	Safety Significant	B Cell Window Refurbishment (S673775)

System	SSC Designation	Project Title of Major Investment
Hot Cells	Safety Significant	A Cell Gasket Changeout (S793404)
Fire Alarm System	Defense in Depth	New heat detectors in various locations related to facility modifications; Room 420/525 ventilation, Mezz H&V, Room 52 and 504 renovation, Room 406 renovation and Room 409 glovebox.
Fire Alarm System	Defense in Depth	Replacement of heat detectors that are greater than 10 years old in various locations; main exhaust plenum, gloveboxes in Rooms 528, 603 and 525, HLRF exhaust duct.
Fire Alarm System	Defense in Depth	All dual modules (FDMs) were replaced over a period of that last five years due to random failures.
Exhaust Ventilation System	Defense in Depth	Lab 420/525 full exhaust ductwork and filter (S734383)
Exhaust Ventilation System	Defense in Depth	Quiet suite project (S724158)
Exhaust Ventilation System	Defense in Depth	Lab 324/325 Primary HEPA filter addition
Exhaust Ventilation System	Defense in Depth	Lab 48 Fumehood and ducting

ELP Equipment and Minor Construction Descriptions

325RPL Roof Replacement ($5.3M)

The 325 Roof Repair Project requires maintenance and repair activity necessary to preserve and maintain the 325 RPL facility. Failing roofing material will be replaced with current industry standard and like-in-kind Thermoplastic Polyolefin roofing membrane, and damaged insulation will be replaced in areas where leaks have occurred, as necessary. Other activity includes like for like replacement of degraded existing walk pads, roof penetration flashings, and parapet caps to maintain the facility in an acceptable condition and extend the building life. This project has been determined as maintenance. The roof membrane replacement will extend the life of the facility for the next ~30 years. The roof is within 3–5 years of its useful life, making the infrastructure replacement timely.

325RPL Siding Replacement ($4.3M) The current siding is at the end of its useful life. This project will install a new stucco siding system over the existing degraded paint and metal siding at RPL. The exterior siding surface area is approximately 90,000 sq. feet. Installation of new siding system (over old siding material) will avoid hazardous worker safety and environmental conditions created by the removal of the existing siding and paint, reduce increased demolition risk, and reduce waste disposal costs. Upon completion, this project will keep the 325RPL in an acceptable condition and preserve it for at least 20 years into the future. A minor benefit is a small increase in insulating value due to the components of the finish. This project has been determined as maintenance.

325RPL Manipulators ($1.8M) The High-Level Radiochemical Facility (HLRF) will be configured with new manipulators having upgraded electrical and mechanical components replacing older models with less capability. There are four operating stations in HLRF with each station fitted with two manipulators. This project includes manipulator procurement, installation, and disposal of replaced equipment. This project updates all 8 HLRF manipulators and having two spare manipulators as back-ups, bringing the total manipulator procurement count to 10.

325RPL (Radiochemical Processing Laboratory) Building Systems Upgrade ($17.25M) The RPL-ELP Building Systems Upgrade Project will upgrade the existing electrical system as well as the heating, ventilation, and air-conditioning (HVAC) system within the 325RPL building. Electrical system upgrades include additional power feed(s) (i.e., normal, standby) from the commercial provider and will likely include electrical equipment such as transformers, panel boards, lighting panels, motor control centers, controls, and transfer switches. The HVAC upgrade includes the addition of a variable frequency drive fans, heat exchangers, high-efficiency particulate air filters and automated controls essential to perform radiological work in hot cells, glove boxes and fume hoods. This project provides additional HVAC and electrical capacity for the needed equipment availability and use in the facility and extends the useful life of the facility.

325RPL Inert Glovebox ($750K) Inert negative pressure is required to perform work on moisture sensitive radiological materials such as Pu metals. A 12-foot single sided glovebox (GB) will be inert capable. Modifications, i.e., ventilation, vacuum system, and electrical tie-ins, will be made in room 406 for GB installation. GB acceptance will be based on factory acceptance testing and post-installation acceptance testing at RPL. The installed GB will allow research on plutonium (Pu) metal and to conduct fundamental actinide chemistry.

APPENDIX A - EXTEND THE LIFE AND NUCLEAR MISSION CAPABILITIES OF THE 325RPL FACILITY PROJECT DESCRIPTIONS

Cf-252 Source ($4M) The current Cf-252 source has decayed to the point it can no longer be used for this last purpose and in ~2 years, it will not be able to support high dose instrument calibration. A Californium radiological source (Cf-252) will be procured to provide a certified radiological standard fission spectrum for testing/ calibrating key instruments and dosimeters for mission essential capabilities. Once manufactured, the Cf-252 source will be sent to the National Institute of Standards and Technology for certification and calibration and then to PNNL. Replacement of the high dose Cf-252 source ensures continuous operations at 325RPL for NNSA and other program missions. NNSA is the largest user of neutron instrumentation at 325RPL.

325RPL Plutonium-Tritium Processing Laboratory Upgrade ($6.5M) Several labs will be combined into a single laboratory space to support plutonium processing research specifically the Laboratory-Scale Plutonium Oxide test platform and a new Laboratory-Scale Fluorination System providing new capability to perform fluorination at a complementary scale. General purpose gloveboxes will be procured and installed as equipment under separate work scope. Redesigned laboratory space supports modernization of core TTP tritium measurements and enable coupling to expensive instrumentation. Modernized laboratory space will support Laboratory-Scale Plutonium Oxide test platform coupling this to a new capability to perform fluorination at a complementary scale.

325RPL Plutonium Metal Glovebox Laboratory Upgrade ($11.1) Upgrade and consolidations of laboratory spaces will be performed to stand up fundamental research on plutonium metal and provide a training and mockup glovebox (GB) for new systems and process development. A limited area island (LAI) space will be created separate from current High Level Radiochemistry Facility LAI space with new storage capacity installed. A small laboratory space will be reconfigured to provide a modern laboratory with GB capability to support increasing needs for uranium and salt processing. General purpose gloveboxes will be procured and installed as equipment under separate work scope. An entirely new capability in the 325RPL to perform fundamental research on plutonium metal and provide a training will be accomplished.

DNN 325RPL (Radiochemical Processing Laboratory) Inorganic Synthesis Laboratory Upgrade ($9.4M) This establishes a new research and development space by consolidating several offices and laboratories into a single science and technology space to house and support the bench-scale Pu processing capability. Modify and upgrade office spaces for radiological instrumentation and wet chemistry. This effort supports R&D associated with plutonium and tritium processing, accountancy, and workforce competency stewardship.

DNN 325RPL Plutonium Analytical and On-Line Monitoring Laboratory Upgrade ($9.2M) Upgrade and modernize the laboratory space to consolidated Online Monitoring development efforts. Increase the available radioactive laboratory space to support nuclear forensics or other emerging needs by consolidating a small laboratory and office space into single laboratory. Merge adjacent rooms into a single laboratory space to support plutonium analytical chemistry. Convert office space provide non-radiological instrumentation and wet chemistry. Updated and co-located laboratory space will improve distribution of equipment, provide space for system development, and streamline equipment movements for online process monitoring. Provides enhanced laboratory space for forensics science and isotope separations.

APPENDIX A - EXTEND THE LIFE AND NUCLEAR MISSION CAPABILITIES OF THE 325RPL FACILITY PROJECT DESCRIPTIONS

325RPL Mass Spectrometry and Solvent Extraction Laboratory Upgrade ($8.895) Provides for infrastructure upgrades for new research capability to install laboratory-scale pulse columns. The mass spectrometry laboratory will be expanded to provide better air flow, temperature stability, while consolidating mass spectrometry instrumentation. Office space will be converted for radiological laboratory space with laboratory space being modernized for nuclear archaeology testing. Provides suitable laboratory space to install large-scale pulse column systems. Update one GB laboratory and upgrade GB to inert or inert-capable. Upgrades adjacent office space to expand the laboratory space and consolidate mass spectrometry instrumentation. Increases the radiological laboratory space by converting an office to a laboratory. Upgrade and modernize laboratory space for nuclear archaeology testing.

325RPL Tritium and Microscopy Laboratory Upgrade ($10.0M) This project consolidates and modernized microscopy laboratory space for both uranium and tritium microscopy preparation providing dedicated space for microscopy preparation of uranium and tritium samples, providing a larger single laboratory to support molten salt and salt processing missions.

This delivers enhanced microscopy sample preparation, improves efficiency and quality of sample preparation, and brings microscopy preparation into alignment with current investments in new microscopy instrumentation. Updated and consolidated laboratory space improves distribution of samples, reduces risk, and modernizes tritium analysis capabilities for the Tritium Technology Program.

Impacted Laboratory Upgrade ($9.9M) Combine two small, cramped laboratory space to a more usable space by replacing fume hoods and integrating them into the flow of an adjacent laboratory. This project will provide a modern laboratory with GB capability to support increasing needs for uranium and salt processing. It will also convert a storage location to a new, modern instrument laboratory to support growing DOE Complex needs.

Tritium Extraction Capability Laboratory Upgrade ($7.7M) This project will upgrade and modernize two laboratories to provide a modern space for tritium extraction testing. Renovate two laboratories and convert a storage area to a laboratory space to prepare for future investments in instrumentation.

325RPL Steam to Hydronics Conversion ($6.7) The current boiler delivers steam to heat the 325RPL facility. Replacing the entire steam system with a hydronic system allows the system to operate more efficiently, requires less maintenance (e.g., external boiler inspections) and chemistry control, has fewer components that may fail, and is safer due to lower temperatures of the water/glycol mixture. The steam boilers will be replaced with a new electric hydronic system heat source. The steam and condensate piping will be removed, and new hydronic system piping will be fed into the building for the preheat and reheat systems. The boiler replacement will provide long-term fundamental heating within the facility ensuring environmental conditions are maintained for NNSA's current and future projects and investments.

Hot Cell Renovation (TBD) This project will renovate or expand hot cell capabilities based on a mission needs analysis. This analysis is expected to complete in FY 23.

APPENDIX A - EXTEND THE LIFE AND NUCLEAR MISSION CAPABILITIES OF THE 325RPL FACILITY PROJECT DESCRIPTIONS

Nuclear Operations Pool Projects

325RPL A-Cell Refurbishment *($3.5 M – RPL Nuclear Operations Pool)*: This project will clean out and refurbish the 325RPL A-Cell to repair three shielded viewing windows with failing gaskets that result in oil leakage from the assembly. This project is planned to be complete in FY 2022.

325RPL Comparator Panel Replacement *($600 K – RPL Nuclear Operations Pool)*: The Comparator Panel receives signals from detectors and initiates horns to evacuate the facility. The function and operation of the Comparator Panel is very similar to that of a Fire Alarm Panel but is required for a nuclear criticality. At PNNL, this capability it unique to 325RPL. Components within the Comparator Panel have failed twice in the last few years. The Comparator Panel was assessed by engineering to be antiquated and spare parts are obsolete. The new Comparator Panel will have updated components but is a like-in-kind replacement with identical functionality. This project includes purchase of two panels. One will be used for testing (to assure adequate resilience) and the other will be installed. This project is planned to be initiated in FY 2023.

325RPL Data Acquisition Systems Upgrade *($400 K – RPL Nuclear Operations Pool)*: The Data Acquisition System (DAS) is located in the High-Level Radiochemical Facility (HLRF), which monitors critical system instrumentation (i.e., differential pressures, tank levels, sump levels, and area radiation levels). The DAS communicates these alarms to the 325RPL master alarm panel located in room 900. The DAS upgrade will allow for individual alarm response instead of a general alarm for multiple conditions. This project is planned to be initiated in FY 2023.

325RPL SAL Shield Door Modification *($2 M – RPL Nuclear Operations Pool)*: The scope of this project is to replace the 325RPL Shielded Analytical Laboratory (SAL) hot cell #2 main shield door with a new shield door containing a larger transfer port. The scope also includes fabricating inner/outer port shield doors, modifying the interior of the hot cell for the installation of a new hoist, installing an enclosed recessed area under the deck, and providing customized equipment to accommodate the remote handling of shielded waste containers specifically designed for highdose waste packaging. This project is planned to be initiated in FY 2023.

325RPL SAL Loading Dock Modification *($200 K – RPL Nuclear Operations Pool)*: Enhance hot cell operations by expanding the size of the loading dock (10 feet increase to the west), extend monorail 4 feet to the west, add lighting, install material lift to end of loading dock, replace handrails, replace stairs, and provide cover over the loading dock. This project is planned to be initiated in FY 2025.

325RPL SAL, HLRF Floor Renovation *($1.8 M – RPL Nuclear Operations Pool)*: The floor surface, which includes fixed contamination areas in SAL and HLRF, requires new coatings to allow hard non-porous surface that can be decontaminated during hot cell operations. The floors would include 200, 201, 202, 203, 601, 603, and 610. This project is planned to be initiated in FY 2024.

325RPL Hot Cell Lighting, Seals, and Penetrations Repair *($1 M – RPL Nuclear Operations Pool)*: Upgrade Hot Cell services (Modular, SAL, and HLRF) by installing new lighting and shield plug assemblies. This project is planned to be initiated in FY 2025.

APPENDIX A - EXTEND THE LIFE AND NUCLEAR MISSION CAPABILITIES OF THE 325RPL FACILITY PROJECT DESCRIPTIONS

325RPL Manipulators Procurement *($2 M – RPL Nuclear Operations Pool)*: Modular hot cells (Mechanical Examination Cell and Process Development Cell) will require procurement of new manipulators with longer through tubes to allow shielded facility operations technicians full range of motion. In addition, new manipulators for the other modular hot cells (Isotope Separations Cell and High-Activity Separations Cell) will provide extended life and services. This project is planned to be initiated in FY 2026.

325WSPAD Upgrade *($4 M – RPL Nuclear Operations Pool)*: The West Storage Pad (325WSPAD) will receive remote-handled waste containers from the East Storage Yard (ESY) and waste drums from the North Storage Pad (325NSPAD). The movement of drums from the ESY will prevent a potential exposure hazard for a failed drum near the building intakes. This will require the design of two structures. One structure will require establishing the security systems to store the remote handled drums, which could contain up to accountable quantities of fissionable material. The other structure will store new shield waste cask assemblies and WIPP compliant containers in a controlled environment. This project is planned to be initiated in FY 2027.