Data Driven Analysis for Modernization Program Management

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ABSTRACT

NNSA is responsible for managing national nuclear security missions: ensuring a safe, secure, and reliable nuclear deterrent; supplying nuclear fuel to the Navy; and supporting the nation's nuclear nonproliferation efforts. However, over half of NNSA's facilities are more than 40 years old, and roughly one-third date back to the Manhattan Project. To execute its critical nuclear security missions, NNSA is making large investments to modernize its nuclear production capabilities. This ramp up represents NNSA's largest modernization effort since the Cold War.

Given the scale of these efforts, NNSA's Office of Secondary Stage Production Modernization has implemented data driven techniques to prioritize investments and inform strategic decision making. NNSA, with support from its site managing contractors, has developed and implemented an integrated schedule and risk management system to address the issues and limitations with the traditional approach. The multi-year integrated schedules are key to identifying program linkages and managing large portfolios comprised of many different projects and efforts. In conjunction with the integrated schedule, a new program risk management system has also been developed and implemented, which manages program risks and opportunities, along with specific mitigation strategies to reduce or eliminate the risks per timelines that are tracked in the integrated schedule. This paper is supplemented with a follow-on presentation on effective management of program material and throughput modeling.

THE MODERNIZATION EFFORT

The NNSA Office of Secondary Stage Production Modernization is responsible for developing, implementing, and overseeing efforts to modernize the production capabilities for enriched uranium (EU), depleted uranium (DU), lithium, and special materials (SM) to meet NNSA and United States (U.S.) Department of Energy (DOE) mission needs. The implementation of production modernization at the Y-12 National Security Complex (Y-12) requires the expanded use of integrated program scheduling, risk management, and material supply/demand modeling. These management tools promote a data-driven, risk-informed, performance-based approach to the life cycle management of mission-essential infrastructure in alignment with DOE/NNSA mission requirements, as specified in DOE Order 430.1C.

Modernization of the U.S. DOE/NNSA capabilities at Y-12 is a critical aspect for ensuring a safe, secure, and reliable nuclear deterrent, maintaining the supply of nuclear fuel to the U.S. Navy, and supporting the global nuclear nonproliferation efforts. As DOE/NNSA mission needs and requirements evolve, it is necessary for supporting capabilities and production capacity to evolve simultaneously. Investment in critical infrastructure, new technologies, and existing production processes is required to adapt to changing mission work in the future, and this investment strategy must be informed and guided by data-driven analysis to ensure that appropriate levels of resources and funding are in-place for each of the key strategic materials at the right time to achieve the overall NNSA mission. An overview of the modernization strategies for the key strategic materials follows, along with discussion on data-driven analysis and the analytical tools being implemented to manage the modernization efforts across the program portfolio.

Enriched Uranium

For nearly eight decades, most of the key EU processes at Y-12 have been centralized in Building 9212, with supporting functions, processes, and capabilities housed in Buildings 9204-2E, 9215, 9995, and the Highly Enriched Uranium Materials Facility (HEUMF). Building 9212 is a Manhattan Project-era building that contains the most hazardous EU operations and does not meet modern nuclear safety and security standards. For this reason, NNSA's overarching EU modernization strategy focuses on building a new processing facility, extended the operating life of Buildings 9204-2E, 9215, and 9995, development and deployment of new technologies, and reducing material-at-risk inventories in aging facilities, with the primary objective of phasing out mission dependency on Building 9212 as soon as possible. The EU modernization strategy is investing $6.5 Billion in the construction of a new Uranium Processing Facility (UPF), which will replace many of the key production processes historically performed in Building 9212. In parallel with the UPF project, development and deployment of new technologies and capabilities in Buildings 9204-2E and 9215 will allow relocation of other key processes from Building 9212 that are not included in the scope of UPF. Strategic infrastructure investments are also being made in Buildings 9204-2E, 9215, 9995, and HEUMF to sustain key capabilities in those facilities. Because Building 9212 is still needed to support the NNSA mission until UPF is fully operational, facility safety risk is being addressed by de-inventory of nuclear materials stored in Building 9212. The de-inventory of Building 9212 is on-going, and will continue as the facility is deactivated and eventually turned over for decommissioning.

With near-term priorities and plans for EU modernization in-place, NNSA will also begin long-term planning for the future Enriched Uranium Manufacturing Center, to replace EU operations currently conducted in Buildings 9215 and 9995, and the future Assembly and Disassembly Center to replace Building 9204-2E. This diverse strategy advances the resiliency of EU capabilities and promotes the safe, secure, and reliable operations will continue at Y-12 well into the future. An overview of the EU modernization strategy at Y-12 is presented in Figure 1.

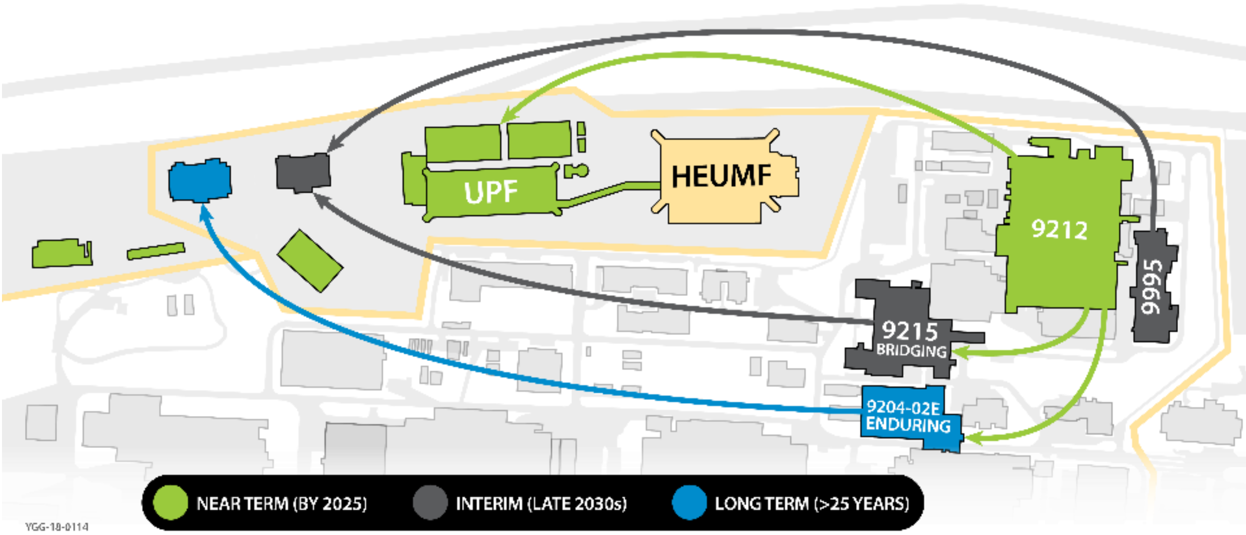


Figure 1. EU Modernization Strategy at Y-12

<u>Depleted Uranium</u>

The capability to produce certified components made from DU and DU alloy is critical to the NNSA mission. The DU modernization strategy consists of investing in a supply of high-purity DU (HPDU), restarting all DU and alloy production capabilities at Y-12, implementing process modifications to improve material stewardship, pursuing bulk DU recycle, developing manufacturing technologies for near-term and long-term insertion, investing in existing infrastructure, and construction of a new DU processing facility, currently identified as the Consolidated Depleted Uranium Manufacturing Complex (CDUMC).

<u>Lithium</u>

To support the national security mission, lithium modernization is focused on being able to provide an adequate lithium material inventory, ensuring security and fiscal responsibility in utilization of processing facilities and supporting infrastructure, and modernizing processes and technologies to sustain lithium material supply streams. The lithium strategy at Y-12 is focused on ensuring that these capabilities are available to meet U.S. Defense Program and other customer needs. Provision of a reliable lithium material inventory is being supplemented by dismantling and recycling lithium components. These processes are carried out by small-scale technologies which purify and convert the needed lithium. Like the EU infrastructure at Y-12, the current lithium-supporting infrastructure is original to the Manhattan Project in the 1940s. The capabilities housed in these older facilities are being sustained until a complete transition can be carried out to the new Lithium Processing Facility (LPF). Once the LPF is constructed and operational, new lithium processing and production capabilities are scheduled to be available by 2031.

INTEGRATING MODERNIZATION EFFORTS BY DATA DRIVEN ANALYSIS

Since each of the vital strategic materials programs have unique issues and are in different stages of planning and execution, it is important to make strategic decisions based on the best-available programmatic data to understand risk, schedule impacts, and mission needs. The NNSA Office of Secondary Stage Production Modernization is leading modernization efforts across the U.S. nuclear enterprise, while making strategic and tactical decisions based on analysis of programmatic data. The data driven management approach includes:

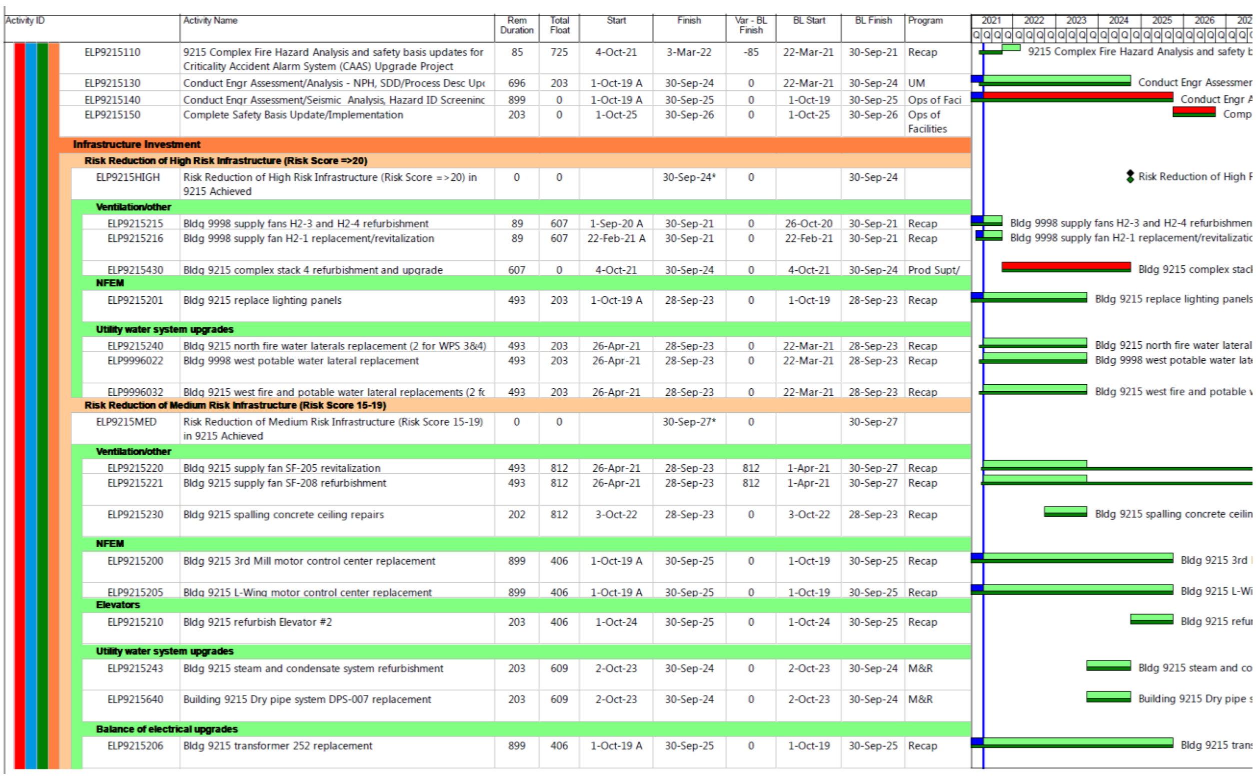
1. Development of an integrated schedule across key NNSA programs to better understand inter-program dependencies and impacts
2. Establishment of a program risk management system for all programs that comprise the Secondary Stage Production Modernization portfolio to quantify the likelihood and consequences of specific program risks and opportunities, identify the relationship of shared risks across multiple programs, and define mitigation strategies that burn down program risks consistent with timelines managed in the integrated schedule
3. Expanding the use of dynamic simulation modeling across all strategic materials to develop a more detailed understanding of material processing requirements, improve the ability to generate long-term supply and demand forecasts, and inform the required timing for deploying future capabilities

Developing these management tools for the various programs under the Office of Secondary Stage Modernization required a significant investment of time for the cross-program collaboration and iterative refinement needed to build functional versions of the tools. Each tool is continuously updated and refined as program requirements evolve, project schedules change, and new technical data are acquired. Data reports are generated periodically and management reviews are conducted to assess changes and potential program impacts that are identified. An overview these newly-deployed data analysis tools follows.

1. Integrated Scheduling

While developing detailed schedules is common practice in project and program management, constructing and maintaining a schedule that spans across multiple programs, some of which fall outside the management scope of the Office of Secondary Stage Modernization, has never been attempted previously. The objective in developing an integrated program schedule was to address the “silo effect” that often occurs within an individual program, where external factors and other programs can impact a particular program without warning. An example of a “silo effect” is when separate programs have inherent logic ties to one another that are not recognized. The logic tie could be an asset such as a large construction project, or services such as a labor resource, in which both programs are dependent. Each program maintains its own detailed schedule consisting of numerous important activities and milestones, but the two programs are not logically connected outside of a few key activities. The performance of an individual program can affect the other program(s) in different ways, depending on the quantity and type of logic ties. The importance of the integrated schedule is the capability to monitor and understand real-time performance and schedule impacts when various programs realize risks.

To develop an integrated program schedule, each program first compiled its own series of major activities and milestones, along with preliminary predecessors, successors, and need dates. Once the skeleton of the schedule was developed, collaborative working sessions between different programs and stakeholders were conducted progressively, to identify cross-connecting logic ties and identify competing priorities. These working sessions were iterative, and intended to test the schedule logic to ensure it yielded reasonable results when parameters were changed. The detail and fidelity of the schedule grew with each successive working session. As the schedule fidelity matured, additional programs and other key activities were gradually incorporated to build a big-picture schedule representation across the enterprise. A dedicated scheduling resource was assigned to programs to build and maintain the Primavera P6 schedule. On a monthly basis, the scheduler obtains updated data from dozens of individual project schedules and other program-specific updates in order to identify impacts to critical path activities and deviations in baseline plans. Presentations to senior program leadership are provided as impacts are identified, so that decisions can be made to accept or attempt to mitigate the impact on the affected programs. An excerpt from the integrated program schedule is provided in Figure 2.



Activity ID	Activity Name	Rem Duration	Total Float	Start	Finish	Var - BL Finish	BL Start	BL Finish	Program
ELP9215110	9215 Complex Fire Hazard Analysis and safety basis updates for Criticality Accident Alarm System (CAAS) Upgrade Project	85	725	4-Oct-21	3-Mar-22	-85	22-Mar-21	30-Sep-21	Recap
ELP9215130	Conduct Engr Assessment/Analysis - NPH, SDD/Process Desc Upc	696	203	1-Oct-19 A	30-Sep-24	0	22-Mar-21	30-Sep-24	UM
ELP9215140	Conduct Engr Assessment/Seismic Analysis, Hazard ID Screeninc	899	0	1-Oct-19 A	30-Sep-25	0	1-Oct-19	30-Sep-25	Ops of Faci
ELP9215150	Complete Safety Basis Update/Implementation	203	0	1-Oct-25	30-Sep-26	0	1-Oct-25	30-Sep-26	Ops of Facilities
Infrastructure Investment									
Risk Reduction of High Risk Infrastructure (Risk Score =>20)									
ELP9215HIGH	Risk Reduction of High Risk Infrastructure (Risk Score =>20) in 9215 Achieved	0	0		30-Sep-24*	0		30-Sep-24	
Ventilation/other									
ELP9215215	Bldg 9998 supply fans H2-3 and H2-4 refurbishment	89	607	1-Sep-20 A	30-Sep-21	0	26-Oct-20	30-Sep-21	Recap
ELP9215216	Bldg 9998 supply fan H2-1 replacement/revitalization	89	607	22-Feb-21 A	30-Sep-21	0	22-Feb-21	30-Sep-21	Recap
ELP9215430	Bldg 9215 complex stack 4 refurbishment and upgrade	607	0	4-Oct-21	30-Sep-24	0	4-Oct-21	30-Sep-24	Prod Supt/
NFEM									
ELP9215201	Bldg 9215 replace lighting panels	493	203	1-Oct-19 A	28-Sep-23	0	1-Oct-19	28-Sep-23	Recap
Utility water system upgrades									
ELP9215240	Bldg 9215 north fire water laterals replacement (2 for WPS 3&4)	493	203	26-Apr-21	28-Sep-23	0	22-Mar-21	28-Sep-23	Recap
ELP9996022	Bldg 9998 west potable water lateral replacement	493	203	26-Apr-21	28-Sep-23	0	22-Mar-21	28-Sep-23	Recap
ELP9996032	Bldg 9215 west fire and potable water lateral replacements (2 fc	493	203	26-Apr-21	28-Sep-23	0	22-Mar-21	28-Sep-23	Recap
Risk Reduction of Medium Risk Infrastructure (Risk Score 15-19)									
ELP9215MED	Risk Reduction of Medium Risk Infrastructure (Risk Score 15-19) in 9215 Achieved	0	0		30-Sep-27*	0		30-Sep-27	
Ventilation/other									
ELP9215220	Bldg 9215 supply fan SF-205 revitalization	493	812	26-Apr-21	28-Sep-23	812	1-Apr-21	30-Sep-27	Recap
ELP9215221	Bldg 9215 supply fan SF-208 refurbishment	493	812	26-Apr-21	28-Sep-23	812	1-Apr-21	30-Sep-27	Recap
ELP9215230	Bldg 9215 spalling concrete ceiling repairs	202	812	3-Oct-22	28-Sep-23	0	3-Oct-22	28-Sep-23	Recap
NFEM									
ELP9215200	Bldg 9215 3rd Mill motor control center replacement	899	406	1-Oct-19 A	30-Sep-25	0	1-Oct-19	30-Sep-25	Recap
ELP9215205	Bldg 9215 L-Wing motor control center replacement	899	406	1-Oct-19 A	30-Sep-25	0	1-Oct-19	30-Sep-25	Recap
Elevators									
ELP9215210	Bldg 9215 refurbish Elevator #2	203	406	1-Oct-24	30-Sep-25	0	1-Oct-24	30-Sep-25	Recap
Utility water system upgrades									
ELP9215243	Bldg 9215 steam and condensate system refurbishment	203	609	2-Oct-23	30-Sep-24	0	2-Oct-23	30-Sep-24	M&R
ELP9215640	Building 9215 Dry pipe system DPS-007 replacement	203	609	2-Oct-23	30-Sep-24	0	2-Oct-23	30-Sep-24	M&R
Balance of electrical upgrades									
ELP9215206	Bldg 9215 transformer 252 replacement	899	406	1-Oct-19 A	30-Sep-25	0	1-Oct-19	30-Sep-25	Recap

Figure 2. Excerpt from Integrated Program Schedule

2. Program Risk Management

Success across the modernization program portfolio requires recognizing and documenting the threats that pose risk to the successful execution of individual programs, and developing mitigation plans that reduce the likelihood or impact associated with those risks. Conversely, opportunities to improve program cost, schedule, and quality through innovative approaches and collaboration should also be identified as an integral part of the risk management plan. Risks and opportunities are organized for each program in a risk breakdown structure (RBS), similar to work breakdown structures typically used in project management. An example program RBS is provided in Figure 3.

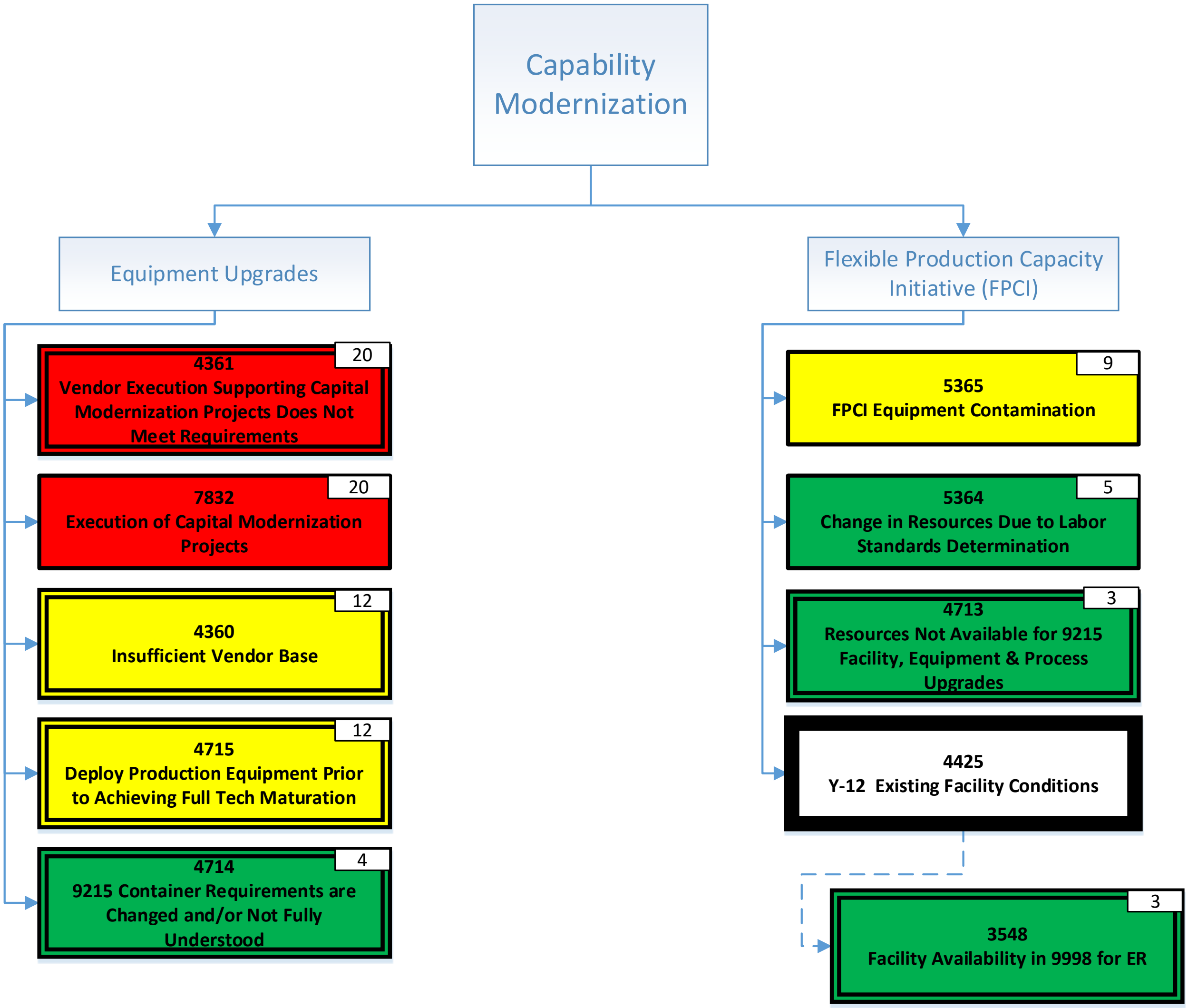


Figure 3. Example Risk Breakdown Structure for Uranium Modernization Program

Analysis of the program risks and opportunities involves determining the probability of the events occurring and the various consequences if the events are not mitigated. Scoring the individual risks for probability and consequence requires collaborative team working sessions involving stakeholders from program management, production, engineering, facility owners, etc. A pre-determined scoring matrix is used to standardize the risk management approach as consistently as possible across all programs. To properly track, prioritize, and manage the risks and opportunities that could affect the overall success of the modernization initiatives, a program risk register is developed. After scoring, risks and opportunities are color-coded based on the calculated probability and consequence/benefit, however the color-coding is somewhat subjective and can be adjusted based on the risk tolerance and thresholds defined by the program office. An example program risk register is provided in Figure 4.

ID	Title	Statement (If...Then...)	Inherent	Current	Target
5546	Production Facility Conditions	If B2 experiences additional facility degradation events prior to LPF becoming qualified, THEN damage to equipment, injury to personnel, and delays to mission deliverables will occur.	25	25	0
5545	Equipment Single-Point Failures	If any of the single-point-of-failure equipment critical to Li Production experience major failures or significant delays, THEN production impacts will occur impacting abiliyt to meet Mission Requirements.	12	12	0
5549	Critical Spares	If critical spares (equipment, supplies, or critical consumables) are not on-hand at Y-12, THEN Li Production will be halted when critical equipment failures or supply shortages are encountered.	12	12	0
5548	Lack of Qualified Chemical Operators to Support Li Modernization	IF Li Production is unable to sufficiently incentivize chemical operators to stay with the program, THEN future workforce issues will result when future HRP calls are made.	9	9	0
5570	9204-2 Lithium Process Relocation	If the lithium processes can be relocated into the new LPF, THEN mission dependency on 9204-2 can be reduced, workflows optimized and additional building space can be turned over to disposition.	0	0	-6
5566	Rapid Response - Clean Out A-Line Crusher	If the JHA and other operational and maintenance assessments can be completed on A-line to expedite cleanout in the event of a B-line crusher failure, THEN transition time from B-line to A-line will be reduced when a B-line crusher failure occurs.	0	0	-10
5565	Pre-Produce Pressed Blanks	If pressed parts can be produced (3-month supply) at a rate exceeding current production requirments, THEN a buffer inventory of product will be avilable to support future production requirements in the event of an up-stream production failure.	0	0	-12
5567	Rapid Response - Establish Back-Up A-Line Crusher in 9202	If an implementation plan can be developed to transition the prototype modern crusher in Development into a functional A-line crusher prior to an A-line crusher failure, THEN the transition time will be minimized.	0	0	-12
5563	Restart Pressure Vessel 3	If PV3 can be restarted and qualified, THEN the mission impact associated with a failure of PV4 would be reduced by having a second press operational and qualified to press material.	0	0	-15
5569	Building 9204-2 Equipment Removal	If OOS equipment can be deinventoried, cleaned out and removed from 9204-2, THEN the floor loading on 9204-2 will be lowered reducing the structural strain on this aging facility; and additional room will be availble to relocate existing operational equipment in the event portions of the existing building become unexpectedly unavailable.	0	0	-20
5564	Rapid Response - Modularized Salvage Operations Cart	If a modularized salvage operations cart can be designed, procured and delivered to Y-12 prior to any production delays related to 9204-2 infrastructure issues, THEN the impact to salvage operations from an spallation event would be greately reduced.	0	0	-25

Figure 4. Example Risk Register for Lithium Modernization Program

To ensure that every program risk and opportunity is accounted for and addressed, each event needs to have a mitigation strategy in place. For every mitigation strategy identified, there should be a documented plan, description, explanation, and justification to ensure full ownership and accountability, along with a corresponding timeline to either realize or mitigate each risk. The scoring data, mitigation actions, action owner information, and "risk burn-down" plan are then compiled into a summary tri-chart to provide a consolidated view of the plan for each program risk and opportunity. An example risk tri-chart is provided in Figure 5.

CNS | consolidated nuclear security, llc

Risk ID: 3985

Risk Status: Active

Lack of Coordinated Staffing Plan Between 9212 and UPF Impacts Resource Availability to 9212 and Eventual Turnover of 9212 to EM

Current Score: 10

Target Score : 8

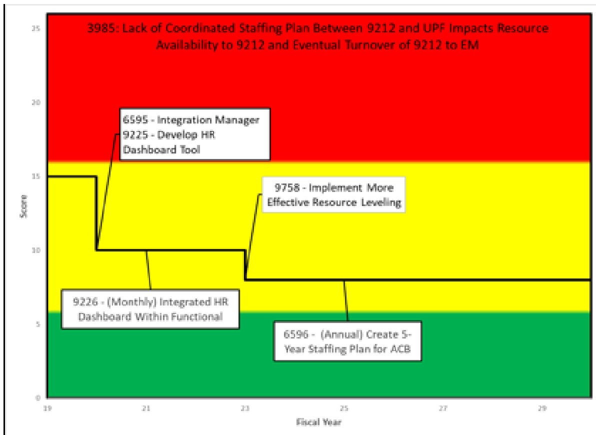
Owner: Malone, Michael
Org: 1.3 Program Integration

Risk Statement:

If an integrated staffing plan is not established between the UPF and 9212 Transition Strategy, then resources consumed by UPF start-up will impact eventual turnover of 9212 to EM.

Context:

Staff needs to transition from 9212 to UPF.



Response

Strategy: Mitigate | **Risk Owner:** Malone, Michael | **Response Owner:** Malone, Michael | **Last Reviewed:** 2/3/2021

High Level Plan:

Recovery:

ID	Mitigation	POC	Status	Due Date	Target Score	Percent Complete
6595	Integration Manager	Malone, Michael	Complete		10	100%
9225	Develop HR Dashboard Tool	Arrington, Brian	Complete	9/30/2020	10	100%
9226	(Monthly) Integrated HR Dashboard Within Functional Organizations	Mettler, Brandy M	Proposed	9/30/2021	10	0%
9758	Implement More Effective Resource Leveling	Mettler, Brandy M	Proposed	1/31/2023	8	0%
6596	(Annual) Update 5-Year Staffing Plan for ACB	Malone, Michael	Proposed	9/30/2025	8	0%
9229	Expedite Onboarding (Hiring, Clearing, and Training)	Mettler, Brandy M	Proposed	9/30/2026	8	0%

Figure 5. Example Risk Tri-chart

Reports are developed on a regular basis and updated with any changes in scoring, either due to realizing a previously identified risk, or implementation of a mitigation action that reduces the scoring of a risk. When analyzing program risks, management looks at how the current schedule could be delayed, how mission delivery for the program could be affected, how product quality could be affected, and how the cost to the program could be increased. After review of the data, the program manager can choose from four different handling strategies: risk avoidance, risk transfer, risk mitigation, or risk acceptance. Similarly, program opportunities can be accepted, enhanced, exploited, and shared. The overall goal is to help leadership identify which strategy they will use. Understanding the program risks and tracking their evolution also helps to inform management decisions on the application of cost and schedule contingency for related programs and projects, thus increasing the likelihood of success for the overall mission.

3. Dynamic Simulation Modeling for Strategic Materials

Historically, tracking the inventory of strategic materials and predicting the future supply and demand for them relied on manual manipulation of data at a macro level and extrapolation using spreadsheet calculations. The historical approach was limited by the number of variables and parameters that could be considered simultaneously, such as random equipment failures and changing production scenarios. Modeling specific production processes, determining equipment utilization, and evaluating alternate work schedules was also a challenge. The Nuclear Material Management Program, in conjunction with the Office of Secondary Stage Modernization, has been advancing the application of Extendsim® simulation software across all key strategic material streams and production processes to address the shortcomings associated with the historical approach. This dynamic modeling approach simulates decades of production operations, varying work schedules and multiple concurrent production missions. Having this enhanced modeling capability for each of the strategic materials greatly improves the ability to forecast supply and demand of materials, personnel, and equipment. A detailed paper and presentation on the dynamic simulation model is provided separately within this conference session.

CONCLUSION

Given the vast scope associated with the modernization efforts managed by the NNSA Office of Secondary Stage Modernization, it is critically important to make data driven management decisions to ensure that funding and resources are allocated to the appropriate priorities across the strategic materials portfolio, and overall DOE/NNSA mission. This modernization effort requires an investment not only in buildings, technology, and people, but also in the analytical tools needed to compile, track, and analyze key programmatic data. The development and deployment of the previously described analytical tools serve to support data-driven, risk-informed, and performance-based decisions for the investment and life cycle management of facilities and capabilities that are vital to the nuclear security mission of the United States.