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Achieving Exceptional Cost and Schedule Efficiencies through Optimized Crane Utilization, Proactive Waste Recycling, and Controlled Explosive Demolition at the S1W Reactor D&D Project

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Summary

The Submarine First Generation Westinghouse (S1W) Reactor Decontamination & Decommissioning (D&D) project has significantly exceeded expectations, achieving substantial cost and schedule efficiencies that contributed to this project completing with a final total project cost of $42.3M, $15.9M below the $58.2M budget. This success stems from four key strategic decisions: unexpectedly recommissioning an existing 120-ton overhead crane, realizing millions in savings and accelerating the schedule; implementing a proactive, recycling-first waste management strategy that enabled extensive metal recycling previously thought impossible; the ability to utilize an onsite mixed low level waste disposal facility; and executing controlled explosive demolition, providing a safe, rapid, and cost-effective method for structural removal. These innovations, coupled with adaptive management of inter-organizational dynamics, resulted in the safe removal of all S1W reactor structures, over 90% non-hazardous waste diversion, zero recordable safety incidents, and on-schedule completion, establishing critical best practices for future D&D endeavors.

Background

The S1W reactor, a foundational prototype for early U.S. Navy nuclear propulsion systems, has undergone comprehensive Decontamination & Decommissioning (D&D) at the Naval Reactors Facility (NRF) within the Idaho National Laboratory (INL). This part of a partnership between EM and Naval Reactors is codified in a Memorandum of Agreement (MOA) between the Naval Reactors program and EM (signed May 2019). Following decades of defueling, stabilization, and deactivation, the S1W reactor complex was slated for full demolition and site restoration. The project, led by Department of Energy (DOE) Idaho Cleanup Project (ICP) contractors and supported by Naval Reactors, achieved its primary goal of safely decommissioning the historic facility and remediating the site to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) residential cleanup standards.

The S1W D&D project was completed in November 2025, two weeks ahead of schedule. This complex undertaking involved addressing significant challenges, including the safe dismantlement of a large reactor structure with radiological and hazardous material inventories. The project team developed and implemented several innovative field strategies that demonstrably reduced risk and enhanced efficiency, resulting in significant cost and schedule benefits. Initially, cost estimates provided by the Project Enhancement Corporation (PEC) predicted approximately $2.5 billion and 15 years to complete the D&D for all three NRF prototypes. However, the Idaho Environmental Coalition (IEC) is on track to complete this work in under 9 years for approximately $500 million, representing a substantial favorable variance.

Discussion

The S1W Reactor D&D Project yielded critical lessons in achieving exceptional cost and schedule efficiencies through strategic planning and the innovative application of advanced techniques. Three key areas, supported by unforeseen favorable conditions and proactive contractor engagement, directly contributed to these successes:

1. Optimized Crane Utilization for Sequential Component Dismantlement (Significant Cost Savings):

- **Issue:** During initial scoping walkdowns of the S1W facility, a 1940's-era 120-ton overhead crane was present. However, initial information from Naval Reactors (NR) indicated the crane was not working, had not been serviced for almost 30 years, and that parts were unavailable. Consequently, IEC originally bid the work on the assumption that significant sizing of components would be required for removal using smaller, individual lifting equipment such as forklifts, strand jacks, and portable gantries, thereby increasing projected costs and schedule duration.
- **Discussion:** After facility turnover, IEC proactively hired a consulting company to re-evaluate the crane. This evaluation found the crane to be in pristine condition, requiring only a minimal $288,000 investment for maintenance and recommissioning. IEC was subsequently able to utilize this existing 120-ton overhead crane for over 5,000 heavy lifts of components and hull parts, significantly simplifying the entire demolition process.
- **Impact:** The successful recommissioning and use of this crane represented a significant cost saving of millions of dollars. It eliminated the need to rent or purchase additional lifting equipment and accelerated demolition work by months by enabling the faster movement of larger pieces. With a project burn rate of approximately $2.3 million per month, the cost savings returned on this $288,000 investment were exceptionally high, making it one of the best for the project to date.
- **Lesson Learned:** Thoroughly re-evaluate assumptions about the condition and functionality of all existing facility infrastructure, even those reported to be unusable. A relatively small, proactive investment in assessing and potentially restoring existing large-scale equipment can yield significant returns on investment, substantially reducing capital expenditure, accelerating schedules, and simplifying complex demolition processes.

2. Proactive Waste Management with Extensive Metal Recycling (Significant Cost Avoidance):

- **Issue:** At the time of bid, DOE was operating under a Secretarial moratorium for metal recycling from Department of Energy (DOE) sites, making it unclear whether this moratorium would apply to work for NR. IEC had to assume, based on NR reports, that significant contamination was present in the facility, necessitating that most metals would require disposal in the Idaho CERCLA Disposal Facility (ICDF). The baseline accordingly assumed that hundreds of tons of potentially contaminated structural metals would require significant man-hours to size, package, transport, and place into the ICDF. Significant costs were also assigned to managing nearly 50 tons of lead and other hazardous metals (e.g., brass, copper) that would require sizing, packaging, and off-site disposal.
- **Discussion:** After IEC began work, detailed characterization revealed that radiological contamination was not as extensive as originally anticipated. Crucially, due to the rigorous practices during S1W facility characterization, most metals were found to be suitable for recycling. Following a headquarters (HQ) evaluation, EM Headquarters (EM-HQ) granted approval for widespread recycling.
- **Impact:** This resulted in significant cost avoidance. Direct cost avoidance from the recycling effort amounted to $1.8M saved from disposal fees alone. Substantial project man-hours were also saved from the avoided sizing, packaging, handling, and transportation that would have been required otherwise if all these materials had to be sent to ICDF or off-site hazardous waste facilities. This also contributed directly to meeting sustainability goals and reducing the project's environmental footprint.
- **Lesson Learned:** Even under strict moratoriums and initial conservative contamination assumptions, proactive radiological characterization and transparent communication with higher authorities can unlock significant

recycling opportunities. The ability to recycle large volumes of metals, confirmed through detailed investigation, results in substantial cost avoidance by diverting material from more expensive disposal routes, minimizing associated labor for handling and packaging, and enhancing project sustainability metrics.

3. Controlled Explosive Demolition for Accelerated and Safer Structural Removal:

- **Issue:** The S1W facility's 105-foot-high bay presented a significant demolition challenge. Due to site footprint constraints, "pulling down" the structure was not a viable option in any direction. This left high-reach equipment and painstaking girder-by-girder dismantlement as the primary alternatives for the top 50 feet. These conventional methods were projected to be significantly slower and more dangerous for workers. At the time of bid, it was unclear whether NR would approve the use of explosive demolition, a technique never utilized at an NR facility.
- **Discussion:** Despite the novelty and the 18-month approval process, IEC successfully obtained NR approval to employ controlled explosive demolition for the high bay. This method was identified as the most effective and safest for the structure.
    - **Radiological Assessment and Risk Reduction:** Explosive demolition was implemented after safely removing Material at Risk (MAR) during facility deactivation and validating contamination boundaries through modeling and sampling. The estimated (significantly reduced) remaining contamination was used to calculate contamination that could potentially spread. This ensured compliance and risk transparency.
- **Impact:** The successful execution of controlled explosive demolition saved the project at least three months on the schedule and corresponding operational costs. This approach avoided the prolonged and highly dangerous manual/mechanical dismantlement of the upper sections of the high bay, significantly reducing worker risk and project duration.
- **Lesson Learned:** Actively pursuing and advocating for innovative, highly efficient, and inherently safer demolition methods, even those new to a specific facility type, can yield substantial schedule accelerations and cost savings. Thorough planning, rigorous risk assessment, and transparent communication, particularly regarding radiological aspects, are vital to securing necessary approvals and successfully implementing such advanced techniques. In addition, the ability to safely dispose of radioactive and mixed waste on-site using the Idaho CERCLA Disposal Facility (ICDF) was also a strong advantage for both increased safety and cost savings - as opposed to the alternative of shipping the waste off-site for disposal.

Favorable Variance, Incentive Application, and Broader Impacts:

Completing the S1W, with a favorable variance of $15.9M, is directly attributed to these combined factors. This success allowed for greater flexibility in resource allocation and operational sequencing. For instance, the early demolition of S1W allowed for more crews to become available earlier, enabling work originally planned for sequential execution across three levels to be performed in parallel. Additionally, better-than-anticipated radiological conditions allowed for earlier removal of non-hazardous, hazardous, and asbestos materials in -A1W and S5G.

- **Cost Incentive:** For the S1W work, IEC earned the maximum of $1,199,263 in cost incentive. The remaining cost savings are made by DOE-ID to be used on other work at NRF.

- **Application to A1W:** The early success and underrun at S1W significantly influenced the next A1W project. DOE directed IEC to initiate characterization and deactivation at A1W earlier than planned, leveraging the S1W underrun until the complete A1W baseline could be added to Task Order 5.1. The maximum cost incentive for the A1W scope is $1,706,025.
- **Challenges and Continuous Improvement:** Despite these significant gains, the project encountered initial schedule setbacks stemming from differing institutional work practices, and documentation requirements between the EM and Naval Reactors organizations. The project's ultimate success stems from both organizations' commitment to establishing a shared operational framework and acting in good faith to resolve these differences collaboratively.

The experience gained at S1W has significantly shaped the approach for the remaining work on the next naval reactor projects in the queue to be completed as part of the MOA between NR and EM: A1W and Submarine 5th Generation by General Electric (S5G). NR has chosen to fund Idaho D&D separately from the national Indefinite Delivery Indefinite Quantity (IDIQ) contract, providing a budget of $39 million per year to complete the demolition of the three NRF prototypes. This necessitates a tighter baseline for the remaining work, implying that the scale of underruns experienced at S1W will not be replicated for A1W and S5G. However, IEC has had much more time to examine facility conditions and has learned extensively about working with NR, which will inform the approach for the remaining work. In addition, the Idaho site is maintaining the capability for onsite disposal of radioactive and mixed waste onsite through the Additional ICDF Landfill Disposal Cell and Evaporation Ponds Project.

The S1W Reactor D&D Project achieved notable success, demonstrating the effectiveness of these innovative strategies in a complex nuclear D&D environment:

- Substantial cost savings relative to initial estimates and a significant contribution to the overall ICP D&D Project Cost Performance Index.
- Significant schedule acceleration, contributing to the overall ICP D&D Project Schedule Performance Index.
- Safe removal of all S1W reactor structures.
- Over 90% of non-hazardous waste is diverted for recycling or reuse.
- Zero recordable safety incidents during 3 years of complex D&D.
- Final site restoration was completed on November 17, 2025.

Conclusion

The S1W Reactor D&D Project stands as an exemplary demonstration of how strategic innovation and adaptive management can lead to exceptional outcomes in complex nuclear decommissioning. By successfully leveraging an unexpectedly functional existing crane, implementing a proactive and expansive metal recycling program, and judiciously applying controlled explosive demolition, the project achieved a remarkable favorable variance in both cost and schedule. These integrated approaches not only delivered the safe and timely removal of the S1W reactor structures but also yielded significant financial savings, expedited completion, high waste diversion rates, and maintained an impeccable safety record. The success of S1W, particularly in navigating initial uncertainties and inter-organizational dynamics, underscores the critical importance of challenging assumptions, embracing innovative technical solutions, and fostering collaborative relationships. The lessons derived from this project are directly informing ongoing D&D efforts at NRF, providing a proven roadmap for enhancing efficiency, safety, and sustainability in future endeavors across the DOE complex.

Recommended Actions:

- **Integrate Advanced Planning for Crane Operations:** Incorporate detailed engineering, modeling, and coordination to optimize crane utilization for sequential dismantlement from project inception, minimizing mobilizations and maximizing efficiency. Proactively assess existing equipment for potential refurbishment and reuse over new acquisitions.
- **Prioritize Recycling in Waste Management Plans:** Integrate aggressive waste minimization and recycling targets into all D&D project plans, supported by real-time tracking, on-site processing, and proactive engagement with commercial recycling partners. Base waste disposition assumptions on current, detailed characterization rather than historical, conservative estimates.
- **Evaluate and Utilize Innovative Demolition Techniques:** Systematically assess and employ advanced demolition techniques, such as controlled explosives, when justified by robust radiological analysis, engineering controls, and comprehensive risk-benefit analyses. Advocate for these methods early in the planning process.
- **Maintain Proactive Stakeholder Engagement:** Foster continuous, transparent communication and formal agreements with all relevant agencies and stakeholders to ensure alignment, manage expectations, and facilitate proactive problem-solving for complex D&D challenges, recognizing and navigating potential differences in work practices and information sharing.

Critical Decision(s):	All
Facility Type(s):	All
Work Functions(s):	Project Management
Technical Discipline(s):	All

References:

1. EM-5.22 Lessons Learned Bulletin, " Lessons Learned in the Demolition of Nuclear Facilities,". August 2023.
2. EM-NR Memorandum of Agreement was signed in May 2019.
3. WM2024 Conference, March 10 – 14, 2024, Phoenix, Arizona, USA. "Promoting Sustainability During Decontamination and Decommissioning at the Idaho Cleanup Project - 24040." (Woodhouse, R. et al.)
4. DOE/ID-12046, Revision 0. "Engineering Evaluation/Cost Analysis (EE/CA) for the Naval Reactors Facility S1W and A1W Final End States Including Disposition of Reactor Vessels." U.S. Department of Energy Idaho Operations Office, October 2022.