Improving Configuration Management at the NBSR

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1. Introduction

The NIST Center of Neutron Research (NCNR) is part of the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland. Its activities focus on providing neutron measurement capabilities to the U.S. research community. The National Bureau of Standards Reactor (NBSR) reactor facility design and construction completed with issue of an operating license in 1967. The NCNR has been in a steady state of evolution resulting in numerous upgrades to increase reactor output to 20MW and expand the number of instruments for use in experiments from 1967 – Present.

The NCNR experienced an operating event in Feb. 2021 resulting in fuel damage followed by a long shutdown. NIST investigations of the event identified weaknesses in configuration management, operations, and maintenance processes [1]. After NCNR and the Nuclear Regulatory Commission (NRC) investigated the event, a confirmatory order (CO) was issued by NRC identifying a corrective action plan [2].

According to the root cause investigation report, the weaknesses developed as experienced and knowledgeable members of the workforce began retiring the decade prior to the incident. Over the 4 decades of reactor operations a small stable group of workers streamlined operations and maintenance processes. The streamlined processes relied on performers possessing extensive experience and knowledge of the facility. Newer workers performing the same activities possessed less institutional knowledge and experience of the facility creating an increased risk for human error and potential events. The NCNR completed numerous assessments on these weaknesses and developed prioritized corrective and improvement action plans. This paper focuses on the improvements to the configuration management processes.

2. Evaluation and Resolution Plans

2.1 Evaluation

Assessment results revealed that at the time of original design, construction, and licensing of the NBSR few prescriptive regulatory requirements existed for formal documentation of configuration management processes beyond the Safety Analysis Report and 10CFR50.59 Changes, Tests and Experiments. Operators and engineers involved in the original design and construction of the facility were relied upon to maintain configuration control of configuration information and items based on their knowledge and experience. Summaries of configuration management activities were reported to the Nuclear Regulatory Commission (NRC) annually as part of the licensing requirements.

Reliance on the knowledge and experience of the individual performers resulted in inconsistent documentation of configuration management details and storage of related information. The inconsistency caused a reliance on individual performers knowledge when other workers required access to the details or status associated with changes to configuration documentation and items. As personnel began to retire the NBSR documented configuration management and problem identification and resolution processes in place were insufficient for the workforce possessing less historical knowledge and experience in the facility operations. As the number of personnel retiring increased risk of errors in performance of activities directed by processes reliant on historical knowledge also increased until the event occurred in 2021.

2.2 Resolution Plan

The NCNR determined that a sustained effective solution addressing all potential configuration management knowledge gaps and reconciling configuration items would require a systematic approach starting with a baseline of existing and physical design information. The contents of configuration managements are design requirements, physical configuration, and configuration information as shown in Fig. 1. Design requirements are regarding to code 10 CFR and standards ANSI/ANS 15 series. Configuration information are documents such as Safety Analysis Report (SAR), technical specification, etc. Physical configurations indicate system, structures, and components (SSC) as shown in Fig. 2.

The planned final state requires NBSR to modernize all legacy configuration information. The information will be transferred into central information repositories designed for its storage. Data relationships established

between the centralized repositories and the physical configuration items provide the data structure necessary to support development of applications used by the operations, engineering, and maintenance staff to retrieve configuration information necessary for work activities. The final versions of applications and information repositories are expected to provide users with tools to support efficient retrieval of configuration information and status of configuration items. Integration of the problem identification and resolution processes will support trending and analysis of performance data. The trending and analysis data will be used to improve aging reactor maintenance and operational performance.

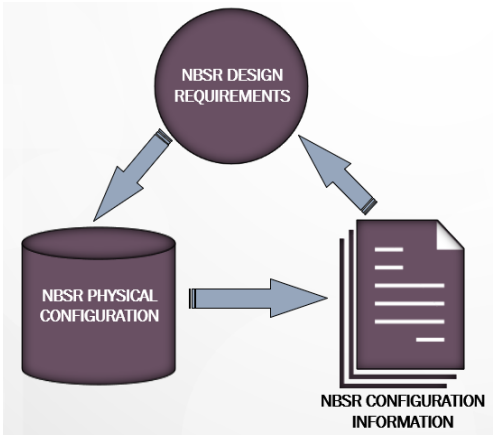

Fig. 1 NBSR Configuration Management Model

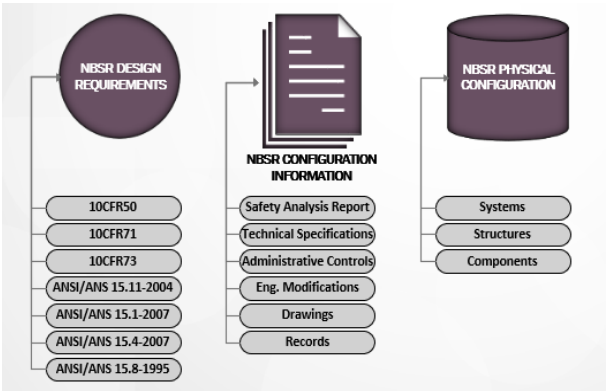

Fig. 2 Configuration management detail

2.3 Execution

The modernization project selected a tailored Six Sigma methodology to plan and execute consisting of define, measure, analyze, improve and control as in Fig. 3. The NCNR completed a review of all configuration management systems and stored information produced from 1967 – present. This review defined the scope of configuration information to be modernized as a first step of six sigma.

Initial design of storage repositories for physical design configuration information started in June 2023 as shown in Fig. 4 phase 1. The user interface application was designated as the Master Equipment List. The application and supporting data repositories were designed to support tools used to measure and analyze the repositories functionality. The tools allow the project leads to identify improvements as necessary during the deployment of the application and loading of the data repositories.

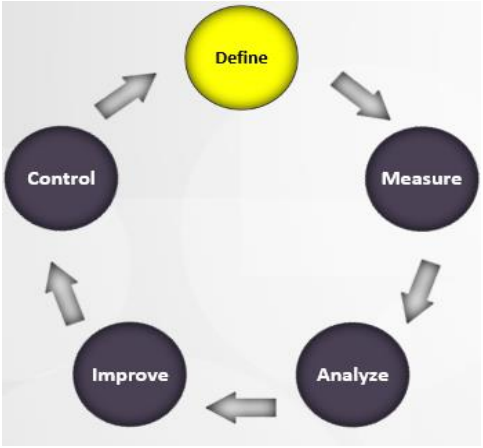

Fig. 3 Six Sigma methodology

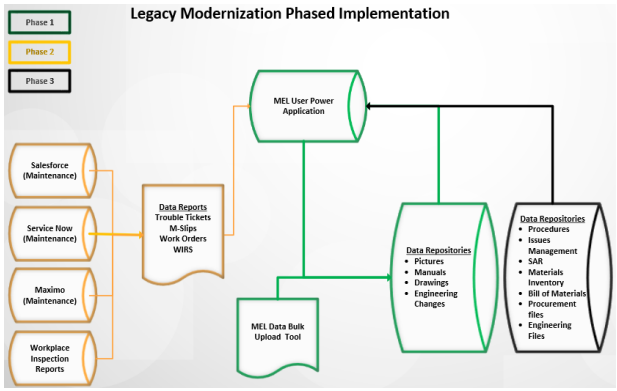

Fig. 4 Legacy modernization phased implementation

The NCNR chose Microsoft (MS) Sharepoint Online, MS Power Application and MS Power Automate to serve as interim data repositories and user application interface. The data collection will be aligned with establishing a documented baseline of the physical configuration. A complete inventory of all components will be accomplished through a combination of historical design records review and physical walkdowns of the facility.

The data repositories and application development and deployment are planned in three phases as shown in Fig. 5. The phased approach will allow the project leads to systematically review and process the supporting historical information into the applicable repositories. The planed period for Phase 1 is from Jun. 2023 to Apr. 2024 and Phase 2 is from Sep. 2023 to Jun. 2024. Phase 3 will be start after Phase 1.

MS Power BI is used throughout implementation of the three phases to monitor information transition and make any necessary improvements to transition methods and data quality as shown in Fig. 6.

Phase 1 Data Collection Targets	Component ID	Component Type	Description	Normal Operating Status
	System	Subsystem	Maintenance Owner Group	Drawing Review
	Field Review	Status	Pictures	Manuals
	Drawings	ECNs		
Phase 2 Data Collection Targets	Location	Location Notes	Safety Related	Safety Function
	Installation Date	Refurbish Date	Critical Component	Technical Specifications
	Manufacturer	Model	Serial Number	Size
	Trouble Tickets	M-Slips	OFPM Work Orders	Safety Function
	Workplace Inspection Reports	Last SRT Review	Last QA Review	
Phase 3 Data Collection Targets	Procedures	Safety Analysis Report	Materials Inventory	Bill of Materials
	Power Source	Voltage	Amperage	Control Style
	Diaphragm RD			

Fig. 5 Three phase data collection targets

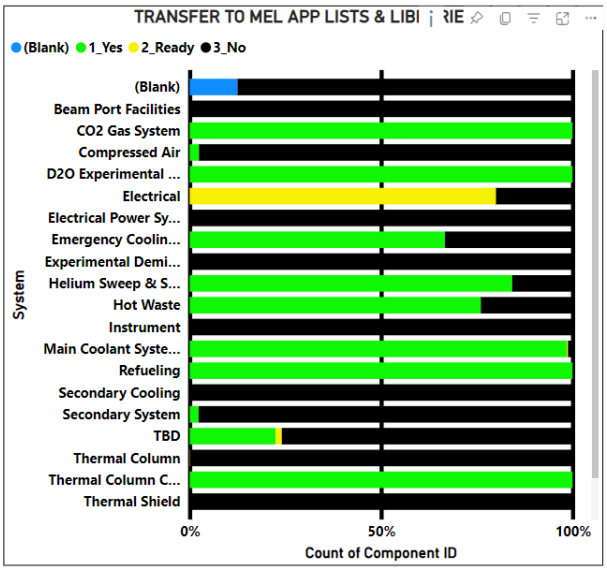

Fig. 6 Transfer status to MEL APP

3. Conclusions

The project is arranged to document configuration alignment between the design requirements, physical configuration, and configuration information of the NBSR. The modernization project is expected to complete the end of 2024. The configuration management information will be stored and organized using technology supporting efficient user access and retrievability. This project is expected to eliminate identified weaknesses caused by reliance on worker knowledge and experience versus configuration information controlled through configuration management processes.

REFERENCES

[1] NCNR Technical Working Group, Root Cause Investigation of February 2021 Fuel Failure, Revision 2, 2021.
[2] NRC, NRC Issues Confirmatory Order to National Institute of Standards and Technology for Fuel Damage Event at Reactor, NRC NEWS, No. 22-030, 2022.