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Materials and Fuels Complex Operations Management Improvement Strategy for Fiscal Year 2022

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Idaho National Laboratory

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Idaho National Laboratory
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ACRONYMS

5YS	Five-year investment strategy
AEL	Affected Equipment List
AFF	Advanced Fuels Facility
AGS	American Glovebox Society
AHJ	Authority having jurisdiction
ALARA	As low as reasonably achievable
ALD	Associate Laboratory Director
AMWTP	Advanced Mixed Waste Treatment Project
ANL	Argonne National Laboratory
AOP	Abnormal Operating Procedure
APADs	Air Permitting Applicability Determinations
ARL	Analytical Research Laboratory
ARP	Annunciator Response Procedure
ARPA-E	Advanced Research Projects – Energy
AS	Asset Suite
AS9	Asset Suite 9
ASME	American Society of Mechanical Engineers
ATR	Advanced Test Reactor
BCP	Baseline Change Proposal
BDSIS	Business Decision Support Information System
BEA	Battelle Energy Alliance, LLC.
BED	Building Emergency Director
BFM	Building Facility Manager
BOM	Bills of Material
BOQ	Basic Operator Qualification
BWXT	BWX Technologies, Inc.
CAA	Clean Air Act
CAPIE	Characterization and Advanced Post-irradiation Examination
CARB	Corrective Action Review Board
CAS	Contractor Assurance
CCP	Central Characterization Project
CDI	Continuous Document Improvement
CEI	College of Eastern Idaho
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act

CFR	Construction Field Representative
CGD	Commercial Grade Dedication
CGDIT	CGD Improvement Team
CHC	Complex Health Committee
CH-TRU	Contact-handled transuranic (waste)
CINR	Consolidated Innovative Nuclear Research
CM	Configuration management
CO	Contracting Officer
COO	Chief Operating Officer
Co-op	Cooperative education
CS	Contract Specialist
CSE	Cognizant Safety Engineer
CSF	Critical Safety Functions
CVR	Component Value Ranking
CX	Categorical Exclusion
CY	Calendar year
DBOT	Down-Blend Offering for Tritium
DCR	Document change request
DLA	Dynamic learning activity
DM	Document Management
DOE	Department of Energy
DOE-ID	DOE Idaho Operations Office
DOE-NE	DOE Office of Nuclear Energy
DSA	Documented Safety Analysis
EAM	Emergency Action Manager
EAP	Employee Assistance Program
EBR-II	Experimental Breeder Reactor II
EC	Engineering Change
ECAR	Engineering Calculation and Analysis Report
ECC	Emergency Control Center
ECP	Environmental Compliance Permit
EDMS	Electronic Document Management System
EFCOG	Energy Facility Contractors Group
EIS	Environmental Impact Statement
EJ	Engineering job

EMT	Electrometallurgical treatment
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ER	Equipment reliability
ERO	Emergency Response Organization
ERP	Equipment reliability program
ES&H	Environment, Safety, and Health
ESA	Experimental Safety Analysis
ESH&Q	Environment, Safety, Health, and Quality
ESTEC	Energy Systems Technology and Education Center
EVMS	Earned value management system
F&SS	Facilities and Site Services
FacReps	Facility Representatives
FACT	Functional Area Coordination Team
FASB	Fuels and Applied Science Building
FCF	Fuel Conditioning Facility
FDS	Facility Disposition Specialist
FFNMM	Fuel Fabrication and Nuclear Material Management
FM	Facility Manager
FMH	Fissionable Material Handler
FTE	Full time equivalents
FY	Fiscal year
GAIN	Gateway for Accelerated Innovation in Nuclear
H&R	Hoisting and rigging
HALEU	High-assay low-enriched uranium
HASP	Health and Safety Plan
HBCU	Historically Black Colleges and Universities
HEO	Heavy-equipment operator
HEU	Highly enriched uranium
HFEF	Hot Fuel Examination Facility
HLW	High-level waste
HPI	Human Performance Improvement
HPT	Health Physics Technician
HR	Human Resources
HR&D	Human Resources and Diversity

HRP	Human Reliability Program
HVAC	Heating, ventilating, and air conditioning
I&C	Instrumentation and control
I&D	Inclusion and diversity
iCAMS	Issues and Corrective Action Management System
ICS	Incident Command System
ICV	In-container vitrification
IDEQ	Idaho Department of Environmental Quality
IFM	Idaho Facilities Management
IFR	Integral Fast Reactor
IH	Industrial Hygiene(ist)
ILL	Immediate Lessons Learned
IMCL	Irradiated Materials Characterization Laboratory
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IP	Implementation plan
IPL	Integrated priority list
IPT	Integrated project team
IRPT	Integrated Resource Planning Tool
ISA	Idaho Settlement Agreement
ISMS	Integrated Safety Management System
ISU	Idaho State University
IWP	Integrated Work Plan
IWTS	Integrated Waste Tracking System
L&OD	Leadership and Organizational Development
LDRD	Laboratory Directed Research and Development
LI	Laboratory Instruction
LIDAR	Light detection and ranging
LLW	Low-level waste
LO/TO	Lockout/tagout
LRSA	Low-Risk Simple Activity
LTAM	Long-Term Asset Manager
M&O	Management and operations
MAR	Material at risk
MBTA	Migratory Bird Treaty Act

MCRE	Molten Chloride Reactor Experiment
MEAAL	Master Equipment and Activities List
MEL	Master Equipment List
MFC	Materials and Fuels Complex
MLLW	Mixed low-level waste
MOP	Management Observation Program
MP	Maintenance Procedure
MRM	Management review meetings
MSA	Management self-assessment
MSI	Minority-Serving Institution
MSTI	Management Systems Transformation Initiative
MTRU	Mixed transuranic waste
MWO	Model Work Order
MWP	Mobile Work Package
N&HS	National and Homeland Security
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFM	Nuclear Facility Manager
NFMBoK	Nuclear Facility Manager Book of Knowledge
NNSA	National Nuclear Security Administration
NOP	Normal Operating Procedure
NRAD	Neutron Radiography Facility
NRC	Nuclear Regulatory Commission
NRIC	National Reactor Innovation Center
NSGI	Nuclear Services Group Inc.
NSUF RTE	Nuclear Science User Facilities Rapid Turnaround Experiments
NSUF	Nuclear Science User Facilities
NTP	National TRU Program Users Group
O&M	Operation and maintenance
ODS	Ozone depleting substances
OJT	On the Job Training
OMI	Operations Management Improvement
ONA	Office of Nuclear Assurance
OSD&D	Over, short, damaged, and discrepant
OSHA	Occupational Safety and Health Act

OTC	Over the counter
PA	Performance Analyst
PCA	Project Controls Analysts
PdM	Predictive maintenance improvements
PDSA	Preliminary documented safety analysis
PEMP	Performance Evaluation Management Plan
PEP	Project Execution Plan
PERSEC	Personnel Security
PFC	Planning and Financial Controls Specialist
PISA	Potential inadequacy in the safety analysis
PM	Preventative Maintenance
PMCR	Preventative Maintenance Change Request
PMJ	Preventive Maintenance Justification
PMO	Preventative Maintenance Optimization
PMR	Permit Modification Request
POC	Point of contact
POW	Plan of the week
PPA	Procedure Professionals Association
PPP	People Planning Process
PR	Principal researcher
PTC	Permit to construct
QA	Quality Assurance
QLD	Quality Level Determinations
R&D	Research and development
R&S	Requirements and Systems
R2A2	Roles, Responsibilities, Authorities, Accountabilities
RadCon	Radiological Controls
RadIssues	Radiological Issues
RadWork	Radiological Work
RAM	Reliability, Availability, and Maintainability
RCA	Root cause analysis process
RCB	Research Collaboration Building
RCRA	Resource Conservation and Recovery Act
RD&D	Research, development, and demonstration
REC	Research and Education Campus

RFI	Request for information
RFID	Radio-frequency identification
RHLLW	Remote-handled low-level waste
RMAC	Radioactive Material Acceptance Coordinator
ROD	Record of decision
ROM	Rough-order-of-magnitude
RPZ	Reduced pressure zone
RSWF	Radioactive Scrap and Waste Facility
RWDP	Remote Waste Disposition Project
SAR	Safety Analysis Report
SAT	Systematic approach to training
SCMS	Sodium Components Maintenance Shop
SDD	System Design Descriptions
SEALION	Searchable Liner Online
SERP	System equipment reliability prioritization
SFP	Subcontractor field problems
SLT	Senior Leadership Team
SME	Subject Matter Expert
SNF	Spent nuclear fuel
SNM	Special nuclear materials
SOMD	Site Occupational Medical Director
SOU	Stipulation of understanding
SPL	Sample Preparation Laboratory
SPO	Security Police Officer
SR	Surveillance requirement
SS	Shift Supervisor
STAR	Stop, Think, Act, Review
STP	Site Treatment Plan
SVR	System value ranking
TEV	Technical evaluation
TRAIN	Training Records and Information Network
TREAT	Transient Reactor Test Facility
TRISO	Tristructural isotropic
TRU	Transuranic
TSDF	Treatment, Storage, and Disposal Facilities

TSR	Technical Safety Requirement
U of I	University of Idaho
U&IS	Utilities and Infrastructure
UDASS	Universal Drum Assay Scanning System
USQ	Unresolved safety question
VEE	Visual examination expert
VTR	Versatile Test Reactor
WAC	Waste acceptance criteria
WBS	Work breakdown structure
WCAC	Work Control Administration Center
WCUC	West Campus Utility Corridor
WDC	Work discipline code
WEO	Waste Examination Operator
WGS	Waste Generator Services
WICD	Waste Item Characterization Database
WIPP	Waste Isolation Pilot Plant
WMP	Waste Management Plan
XRF	X-ray fluorescence
YRA	Young Researchers Association
ZPPR	Zero Power Physics Reactor

Materials and Fuels Complex Operations Management Improvement Strategy for Fiscal Year 2022

1. INTRODUCTION

The Materials and Fuels Complex (MFC) continues to experience growth in terms of staff, research, and production. MFC operational performance is effectively keeping pace with this growth. However, to capture the continuous improvement actions needed to improve effectiveness and efficiency of MFC's management systems, a broad operations management strategy is necessary.

The MFC Operations Management Improvement (OMI) Strategy is complementary to the MFC Five-Year Mission and Investment Strategies and the MFC Management Plan. The OMI strategy is structured to address the management systems outlined in the Nuclear Facility Management Standard Operations Model, Figure 1.

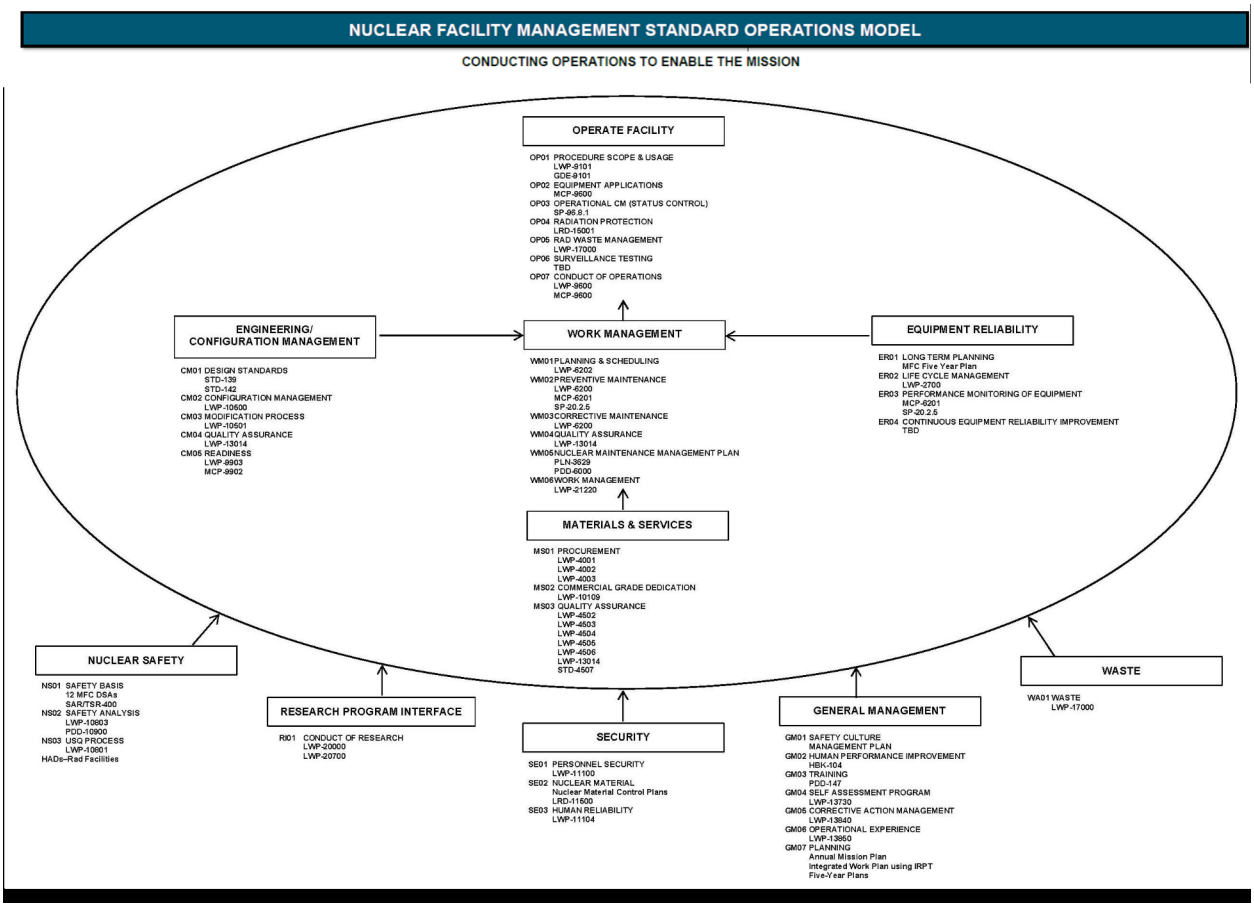

Figure 1. Nuclear Facility Management Standard Operations Model.

Selected management systems are evaluated independently in chapters that describe the prior 5 years of performance improvement, a description of improvement actions for the MFC staff that directly perform within or contribute to the management system, process improvements, and any needed equipment improvements. Chapter selection is based on a management system's need for improvement. In some cases, management systems may be combined in a single chapter. Additional chapters are added to address subject areas not formally described in the standard operations model.

The OMI strategy actions are structured to have cross cutting impacts for improvements pertaining to the entire directorate or a single division. All division improvement agendas are aligned to the OMI strategy.

The content of each chapter addresses the following:

- "A Look Back" – This section summarizes the performance improvements associated with the management system for the past 5 years through present day. The summary includes examples of prior actions taken to improve performance, and a qualitative assessment of effectiveness.
- "People" – This section describes areas of strong, acceptable, or needed improvement with respect to the ability of staff to own and execute the management system. Within this section examples are used to describe the level of performance.
- "Process" – This section addresses areas of strong, acceptable, or needed improvement with respect to processes required to effectively execute the management system. Examples are used to describe the level of performance.
- "Equipment/Tools" – This section summarizes areas of strong, acceptable, or needed improvement with respect to equipment or tools necessary to effectively implement the management system.
- "Actions FY-22" – This section describes actions for the current fiscal year.
- "Looking Forward (FY-23 and Beyond)" – This section describes actions to be taken in the following two to four years.

Goals for this strategy include, but are not limited to, the following:

- People
  - Establish a clear vision and strategy for continual improvement, which all staff are aligned to.
  - Ensure roles and responsibilities for all staff are clear.
  - Obtain and develop talent for current and future needs through effective recruitment, training, qualification, and establishment and maintenance of proficiency.
  - Improve the training and development of the current workforce and leadership.
  - Foster a learning organization that values benchmarking, independent and self-assessment, use of operating experience, and other methods of learning.
  - Fully engage the workforce through inspiration, motivation, communication, participation, coaching, and fostering accountability in a positive atmosphere of mutual trust and respect.
  - Manage risk through effective decision-making and conflict resolution, while involving appropriate stakeholders.
  - Achieve sustained results through team commitment to mutual success and relentless pursuit of high performance.
- Process
  - Establish, maintain, and rigorously follow high quality guidance for research, engineering, operations, maintenance, radiological controls (RadCon), project management, and other disciplines within the directorate.
  - Simplify documented safety analysis reports (SARs) and technical specification requirements (TSRs) to ensure proper interpretation and consistent adherence.
  - Continue improvements for cause analysis quality, timeliness, and corrective action quality and effectiveness.
  - Continue improvements for the work management process and its implementation.
  - Improve internal oversight through better implementation of the contractor assurance (CAS) program, effective safety culture monitoring and assessment, and improved implementation of the

management observation program (MOP) and trending.

- Work with external organizations to improve funding management, shared risk of funding loss, and more timely communication of future projects, experiments, and the funding necessary to prepare the MFC organization for future workload.

- Equipment
  - Improve the effectiveness and efficiency of tools, software, and other support equipment necessary to safely execute operations, maintenance, research, RadCon, and training.
  - Implement effective facility and complex health committee (CHC) programs that result in improved facility system health.

2. ORGANIZATIONAL CULTURE

2.1 A Look Back

The MFC organization's culture has improved over the past 7 years. Early improvement was primarily the result of development and implementation of the MFC Management Plan. The plan defines a management model by which all managers are held accountable, and key elements of a sound culture are defined. The model continues to provide consistent expectations for management. Improvement has accelerated since the implementation of the first OMI in December 2020. The OMI has provided a targeted and focused approach to improving performance. Over the course of the fiscal year, some improvement has been achieved in every aspect covered by the OMI.

The elements of the MFC organizational culture specifically include Human Performance Improvement (HPI), Nuclear Safety Culture principles, Just Culture, Science Culture, and a set of values for MFC. Identifying these elements has allowed for each to be defined, and to facilitate improvement.

Fundamental expectations relative to HPI, Nuclear Safety Culture, and Just Culture are codified in HBK-104, "Materials and Fuels Complex Human Performance and Nuclear Safety Culture Pocket Guide." The pocket guide has been in place for approximately five years, and further describes key fundamental behaviors all staff need to demonstrate to support a healthy organizational culture. Improved use of the pocket guide over the past two years has contributed to improvements in organizational culture.

Human Performance Improvement concepts are defined in HBK-104, and each division is expected to apply these concepts to their work as deemed appropriate. After a series of Idaho National Laboratory (INL) wide events, the entire laboratory adopted the HPI concepts, developed a lab-based team with expertise, and began taking action to improve human performance at INL. The MFC Associate Laboratory Director (ALD) serves as the senior leadership champion, and MFC has established leadership for the implementation of HPI concepts INL-wide.

MFC defined a set of values that were incorporated in both HBK-104 and the MFC management plan. INL established a set of values at the laboratory level that were similar in content. Together, these values continue to provide a basis for interactions inside and outside of MFC; developing performance measures; hiring staff; addressing issues and resolving conflicts; and improving inclusivity and addressing employee disabilities.

Nuclear Safety Culture principles were developed from commercial nuclear power industry guidance and influenced by Battelle's safe conduct of research principles. The principles are used to describe and reinforce the behaviors necessary to both work with nuclear technology, and to remain free from occupational injury. Members of the MFC organization have demonstrated commitment to both nuclear and occupational safety as exemplified by typically low injury rates, and improved recognition of the special characteristics and uniqueness of nuclear technology.

MFC leadership continues to improve workforce trust and transparency using Just Culture principles by responding to events in a just manner and seeking to learn from mistakes. The Just Culture principles have resulted in improved self-reporting of errors, and an increase in staff willingness to discuss errors with fuller transparency.

The Science Culture was defined in the MFC five-year mission plan and receives specific evaluation in a separate part of this improvement plan.

Improvements in MOP implementation at MFC has contributed to overall improvement in field leadership effectiveness, employee performance, and promoting a sound Nuclear Safety Culture and Just Culture. Leaders are engaging employees better through open dialogue, reinforcement of good performance, and providing constructive feedback on performance improvement opportunities. Improvements in observation quality are resulting in improved trend information for identifying areas of focus. Observations are also identifying needed improvements in procedures and processes. MFC staff typically respond positively and embrace the coaching and feedback provided through observations.

Leaders have improved their use of HBK-104 during their interactions with staff, especially during morning meetings and pre-job briefings. Continued focus is still needed however, to strengthen discussions on HPI tool use and when tools should be applied during a specific work activity. Improved dissemination and use of lessons learned and external operating experience has contributed to improvements in MFC organizational learning. Continued focus is also needed to ensure the improvement is sustained.

2.2 People

As with any organization, the journey toward excellence is never ending. Events and assessments in support of an optimal MFC organizational culture continue to identify some vulnerabilities that exist regarding personnel performance.

In the last two years, aggressive and proactive action to reduce the frequency and severity of events at MFC in lockout/tagout (LO/TO), TSR compliance, subcontractor oversight, radiological worker behaviors, pyrophoric and reactive material management, and worker safety have been effective. However, other events and regular observations of work activities indicate opportunities for improvement remain with respect to human performance, especially in the areas of procedure use and adherence, pre-job briefing quality, independent verification, understanding and managing employee fitness for duty, and waste management. Actions are in progress or have been taken to address these improvement opportunities. For example, management observation focus areas have been established in procedure use and adherence, pre-job briefings, and independent verification. MFC Significant Lessons Learned were issued on LO/TO, subcontractor oversight, radiological worker behaviors, pyrophoric and reactive material management, and heat stress with appropriate actions entered into the laboratory's issues management system, LabWay.

A November 2021 MFC mission area assessment of the Production Facilities organization indicates improvement in Nuclear Safety Culture. Employee observations and interviews indicate a strong questioning attitude, high levels of trust, and decision-making that reflects safety first.

2.3 Process

An annual laboratory-wide "Safety, Leadership and Engagement Culture Survey" provides insight on employee's opinions regarding many areas of organizational culture. The FY-21 results indicate general improvement across most areas surveyed. However, three areas need follow-up to improve performance: manager/supervisor promotion of employee professional development, progress on simplification of programs and processes, and teamwork across organizational lines to do what is best for the laboratory. Work is ongoing to revise programs and processes across the laboratory through the Process Architecture Continuous Excellence (PACE) initiative and MFC procedure revisions continue. More specific actions need to be taken in response to employee concerns regarding professional development and teamwork across organizational lines.

There is currently no process or program in place that results in a regular internal MFC assessment of performance against the Nuclear Safety Culture principles. The principles continue to receive some internal review during mission area assessments; however, these assessments were suspended for most of the past two years due to COVID-19 impacts. When performed, these assessments occur approximately once every two years for each mission area. This potentially contributes to an inaccurate real-time picture of Nuclear Safety Culture performance across the MFC organization and prevents a timely, proactive approach to determining and taking action in regard to identified vulnerabilities.

A review of several MFC division communications plans indicates missed opportunities for deliberate communications on Nuclear Safety Culture and Just Culture. Root-cause and apparent-cause evaluations rarely address shortfalls in adhering to Nuclear Safety Culture principles as part of post-event causal analyses.

2.4 Equipment/Tools

There are currently no specific equipment or tools associated with Organizational Culture at MFC.

2.5 Actions FY-22

- Work with MFC Division Directors to establish an MFC action plan to appropriately respond to MFC FY-21 "Safety, Leadership and Engagement Culture Survey" results. (Dave Coates, July 30, 2022)
- Assign each MFC division director an action to incorporate appropriate Nuclear Safety Culture and Just Culture messaging into their division communication plans at the next revision with a due date of November 30, 2022. (MFC Division Directors, February 28, 2022)
- Work with the Performance Assurance Manager to establish an MFC requirement to assess impacts on Nuclear Safety Culture principles during each apparent and root cause evaluation. (Dave Coates, September 30, 2022)
- Monitor and identify further areas of focus through the MFC MOP. (Dave Coates, September 30, 2022)
- Monitor and identify improvement opportunities in MFC leadership and staff use and application of HBK-104. Use of HBK-104 may include but is not limited to management observations, staff meetings, pre-job briefings, all hands meetings, or other interactions between staff and their leadership. (Dave Coates, September 30, 2022)
- Monitor and identify further improvement opportunities for MFC leadership and staff use and application of Department of Energy (DOE) OPEX Share, INL iShare, MFC Significant Lessons Learned, and MFC Immediate Lessons Learned (ILL). (Dave Coates, September 30, 2022)
- Improve MFC leadership's ability to regularly monitor, assess, and act on vulnerabilities in Nuclear Safety Culture by developing and implementing a recurring MFC Nuclear Safety Culture monitoring and assessment program. The program should provide regular reviews of recent events and other pertinent data to determine performance with respect to each of the Nuclear Safety Culture principles as described in HBK-104. The reviews should incorporate behaviors associated with Nuclear Safety, Occupational Safety, and Just Culture. The program should also provide for the development and implementation of appropriate corrective actions. (Dave Coates, September 30, 2022)

2.6 Looking Forward (FY-23 and Beyond)

- Develop employee guidance, methods, tools, and training to improve the application of Nuclear Safety Culture principles. The guidance and methods should be consistent with HBK-104 and INL's Integrated Safety Management System (ISMS) Guiding Principles.

3. RESEARCH PROGRAM

3.1 Research Work Control

3.1.1 A Look Back

Research work control (i.e., laboratory instructions [LIs]) at MFC has remained relatively unchanged over the past five years. Individual directorates—and the facilities they perform research in—have control as to the level of detail (specifically in "Instructions" [Section 5]) included in the work control. While the Operations group has had several focused improvement areas (i.e., Material Handling and Lock Out Tag Out), there has been very few coordinated efforts for improvement at MFC regarding research work control. The instances where efforts have been made were mainly driven by incidents resulting in immediate attention (i.e., green pellet fire at FASB). However, individual facilities have made improvements in research work control that are aligned with the direct need of the facility.

From a historical perspective, this level of stability in research work control is in contrast to a previous five-year period (2010-2015), where a philosophical debate as to the level of detail, actions of support personnel (mainly Health Physics support), and which template (research vs. nuclear operations) was to be used at MFC created constant change and confusion among research staff. This approach also meant that in some instances, personnel who were not experts and would not be performing the research activities would create cumbersome procedures that introduced unneeded activities that diminished the effectiveness of processes and unduly hindered the researcher without providing any additional safety measures. The top down approach to the content of the work control was not effective in engaging research staff in the procedure development process, or in providing a useful document to be used and referenced by the research staff. This previous period is only mentioned to document that this type of approach should not be repeated.

Research scope and productivity—measured by peer reviewed publications and research staff increase—at MFC has increased significantly over the past 5 years. Research activities involve a wide range of skill sets and hazards, and are performed in nuclear facilities, radiological facilities, and non-radiological facilities. The work is performed by staff permanently assigned to MFC, staff matrixed to MFC, and visitors to MFC.

While the format of the work control is the same, the level of detail in the research work control varies greatly between facilities at MFC. For research with the same level of hazards and quality implications, some facilities tend toward expert-based work control, while other facilities have more procedural based work control. This level of variance between facilities can make procedure compliance difficult for personnel working in multiple facilities and increases confusion regarding the role and importance of the work control.

The effectiveness of research work control varies across MFC facilities and is due to a variety of causes. The documentation is cumbersome and can contain "important" information that serves to muddy information pertinent to the research/experiment at hand. When everything is important, nothing is important. The hazard tables are not prioritized in order of the importance, are too long, and are not always prescriptive as to the mitigations (i.e., Radiological hazards - follow RWP and good radiological practices, chemical use). The relative importance of hazards and critical steps is lost, and work control can be viewed as an administrative requirement, rather than a tool that adds value to quality, performance, and safety. The revision processes for work control vary from facility to facility, depending on staffing. Some facilities have dedicated staff to perform changes, while others employ operators to perform this function. Either way, the change process does not support efficient conduct of research activities. When a problem is identified (i.e., incident occurs), researchers are typically overwhelmed by the event investigation process, indicating that they were not adequately prepared for the event and were inadequately prepared for the investigation process. This issue may also indicate more work to be done in the area of "Just Culture" at MFC.

In some specific cases, improvement efforts have been successful and have revealed that there must be a separation from the operations work control model. A few procedures have been developed where an expanded scope allowed for researchers to make necessary adjustments within the controls developed. This has proven to provide reasonable bounding for the scope, appropriate controls for the research, without overly restrictive/prescriptive steps, and allowed the creativity essential to successful research.

3.1.2 People

The research staff at MFC has increased greatly over the past 5 years. The Analytical Research Laboratories Directorate has added 15 researchers (9 with advanced degrees), the Fuel Fabrication Directorate has added 9 new staff (6 with advanced degrees), and the Characterization and Advanced Post-irradiation examination (CAPIE) Directorate has added 23 research staff (20 with advanced degrees). The MFC directorates have been extremely successful in attracting world class talent to support the research programs. However, the number of senior staff has declined over the same period, leaving fewer mentors to guide new researchers.

The new research staff have a varied level of experience, but most have little to no experience working in the National Laboratory system (this may also vary by facility). INL provides little training in conduct of research/conduct of operations for new research staff. This training is vital to understanding the role and purpose of the work control in various facilities (like many activities, this can vary from facility to facility at MFC). In contrast, new operators in a facility are trained through Basic Operator Qualification (BOQ) school to ensure a consistent knowledge base. the BOQ training process also provides a cadre of more experienced mentors in the field, although the quality and quantity of mentoring appears to vary by facility/director/SS within the division.

The involvement of researchers in the work control process is typically relegated to the “Instructions” (Section 5) and “Hazard and Mitigations” (Section 2) for hazards unique to the research. Researchers then review work control and are part of the walk down process. Additional involvement of the researchers in procedure content development will give researchers more ownership of the document and should lead to increased quality and more consistent procedure use. Empirical observations indicate junior researchers have limited knowledge of research risks, impacts of errors, or the acceptable level of risk for research activities at MFC.

The effort and time required for the extremely important task of **mentoring** should not be minimized, especially given the limited support for developing a researchers’ fundamental skills. More experienced experts available for consultation on a wide range of research topics would be beneficial. However, it must be noted that not all experts are experts at all topics, especially in the extremely varied facilities and research activities encountered at MFC. This may be improved with the improvement of the principal researcher (PR) program within each division, allowing for more expertise and dedicated mentors to assist in research and development (R&D) work.

The recruitment of research staff appears to be dependent on the research needs and positions to be filled, as some positions are easily filled with excellent candidates while others have proved difficult to fill with qualified individuals. Typically, the research performed at MFC sells itself. The ability to perform research that is done nowhere else in the world is often appealing to scientists and attracts top talent. Given the appeal and importance of the research, new researchers to the laboratory often do not understand the requirements of conducting research in a high-hazard nuclear environment. New scientists—with little experience at National Laboratories—must be conditioned to the slower pace of work, performing research in the nuclear research environment, the observance of safety precautions, the heightened sense of awareness that must be maintained, and conducting research in a structured environment as they begin a career at MFC. Again, this may be performed and reinforced by improving the mentoring at MFC.

Overall, research staff are capable, willing, and want to perform work within the work control system. The lack of baseline knowledge in conduct of research requires improvement, especially in the mentoring process. The lack of senior research staff available to mentor new individuals poses a challenge to junior researchers. Mentoring is essential to the development of the new researcher's work and safe/compliant execution of the work. In addition, the PR program is not consistently used, is lacking in PRs, and is currently not adequate to support increasing research activities at MFC.

3.1.3 Process

One of the most important processes that needs to be improved is the ability to make timely changes to work documents. The process of generating work control for research activities is currently inefficient, requires inputs from personnel that are overburdened (typically Environment, Safety, and Health [ES&H]), and often struggles to meet the needs of the research community. As discussed previously, various facilities have different degrees of support to facilitate the generation of work control, therefore the experience varies greatly for researchers across MFC. When an aspect is incorrect or needs to be adjusted in the research, researchers are asked to stop and change the work control. Typical times to revise work control documents range from days to weeks, depending on the changes, reviews needed, expertise of the person supporting the changes, etc. Work control processes should be simplified to encourage consistent and correct work control documents, while still having the needed review of senior experts with accountability. In addition, improvements should be made to ensure work control documents allow for some flexibility, so changes in the work that do not have an effect on the controls in place could be made without having to go through the entire review process again.

Compliance to research work control needs improvement. There has been a disconnect between the research and operations communities at MFC. In some instances, researchers view work control documents as an operations requirement that adds little to no value to their work. There have been multiple instances in LabWay detailing less than adequate use of work control documents for research. Over the last several years, the focus of management observations has been on work control and usage of work control in the various MFC facilities.

The inclusion of HPI tools into the work control process needs improvement. Currently the HPI tools are introduced into the briefings/discussions of work. Inclusion of the HPI tools into the work control, in the correct spot, seems a prudent addition to stimulate job-specific applications to specific jobs or equipment.

A review of the LWP-15031, "Radiological Control Confinement/Containment Determination" process should be performed. While this activity will fall under the radiological control improvement strategy, the scientists at MFC spend significant amounts of time performing these calculations to support research activities. The review should focus on action levels and developing bounding calculations to facilitate lower activity work more efficiently.

3.1.4 Equipment/Tools

The common tool used for the creation, review or modification of the research work control is the document change request (DCR) system. As discussed previously, the system is typically used by specialists who enter the information. The documents are then electronically sent out to reviewers. While it is efficient, typically it takes "chasing" people down to status the progress. Researchers are typically not involved (nor do they want to be) but are reliant on how busy/motivated/bothered the individuals are to get the final approvals to the document. While workable and efficient for information transfer, the attention of the reviewers is often less than desirable for efficient processing of the documents.

A means to perform fast changes to work control needs to be resurrected or used on a more routine basis. The ability to red line a procedure to affect quick changes should be discussed and employed. The ability to generate something along the lines of a "notebook procedure" for one time activities should be considered and evaluated, especially if the major hazard (rad material) can be removed for the validation of the procedure. The "notebook procedure" would require Industrial Hygiene (IH) and management approval (technical and facility) before utilization.

In FY-21, a small group of MFC staff, with experience working at other national laboratories, provided input regarding the laboratory work controls used at those laboratories. As well, detailed interviews with a manager of technical operations at an industry partner provided insight to the development, approval process, and utilization of research work control at that facility. A synopsis of these findings is below.

- Industry work control summary:
  - Involvement of subject matter experts (SMEs) at development stage of work control
  - A dedicated committee for review/approval of work control
  - Document owners/writers are technically competent of the procedure/process
  - Peer check required before presenting to work control committee
  - Difference in work control written for knowledge-based workers versus other workers
  - Streamlined process to make changes to work control
  - Combine or eliminate procedures
  - Extension pre-job walkdowns and safety checklist with involvement of all workers
  - Ranges of variables (temp, pressure, chemical amounts, etc.) rather than discrete values
  - Incorporation of HPI tools for knowledge-based workers
  - Inclusion of applicable lessons learned in pre-work safety checklist.
- Other laboratories work control summary:
  - Lack of graded approach
  - No consistency (Rad facility has more rigorous work control than Hazard Category 2 facility)
  - Procedures are lengthy and error likely for workers who can end up in "do-loop"
  - Document owners/approvers are not technically competent of the procedure/process
  - Hands-on workers may be asked to provide input to work control but are rarely asked to author or approve work control documents
  - Procedures only allow for discrete values vs bounded ranges for variables
  - Work control written for "lowest common denominator"
  - When changes are required to work control, it is labor and time intensive.

A small working group was formed under the guidance of the MFC Chief Scientist and the Analytical Research Laboratory (ARL) Director (Technical Leadership Council [TLC]) for MFC research staff to discuss suggestions to work control as well as other topics. This group will evaluate suggestions from the review of industry and other national laboratories work control practices.

Input for changes to research work control has been obtained from multiple individuals representing several MFC mission directorates. Most notable was a work control assessment within the Fuel Fabrication and Nuclear Materials Management Directorate. This resulted in a summary document following a thorough ISMS review of research work control within this directorate. Many adaptations and improvements were based off practices within the ARL, including the use of special instructions and peer review from a knowledgeable person for work control documents.

Within MFC directorates, Rad Engineering has made available to research staff the LWP-15031 calculations for sample types to avoid rework and recalculations. Furthermore, Rad Engineering has

worked towards "bounding" calculations for similar sample types to reduce rework by research staff. These calculations can be accessed via the RadCon homepage.

To begin preparing work control in a new format for review, the ARL developed a general hazard document for hazards (LST-1245, "Analytical Research Laboratory General Hazards and Risks," effective 3/31/21). This LST allows for other research work control to simply reference this document and focus on instructional steps and warnings rather than 12-15 pages of general hazards imbedded within the LI. LST-1245 was added as a required read for anyone having unescorted access to the facility. This ensures everyone is familiar with hazards that may be encountered while performing maintenance and other work in the facility. ARL staff are trained and qualified to the specific hazards (i.e., corrosives, oxidizers, chemical hygiene plan)

The ARL also evaluated and updated its dissolution LI (ARL-5000-NOP-002, "Material Dissolution," effective 4/06/21) while maintaining use of special instruction FRM-900, "Analytical Laboratory Special Instructions." This allows knowledge-based workers to develop and execute the necessary work steps to perform dissolutions, separations, and sample preparation. In addition to the analyst that develops the SI, a peer review from an independent analyst is required as well as approval from the Rad Engineer and Nuclear Facility Manager (NFM). The SI can be printed and used as a notebook procedure. Any needed changes can be redlined and approved by the same initial approvers without subjection to a full review and approval in the DCR system. The use of SIs has been adopted by the Fuel Fabrication Division following an extensive review of their research work control.

To streamline the documented process of turning over construction projects to Operations, the ARL developed a parent LI (ARL-7000-NOP-004, "Equipment and System Testing") and special instructions (FRM-2953, "Equipment and System Testing" for ARL). These will be used in place of one time use ATPs for turnover activities. Multiple support organizations, research staff, and facility operations reviewed these documents. These two documents have been through the unresolved safety question (USQ) process and approved. Permission from the LWP-21220, "Work Management," document owner and laboratory work control SME has been obtained to include these documents in the allowed special instructions appendix of LWP-21220. These will be utilized for the first time in the turnover of B111 to the facility after major renovations. This document can be adopted for use in other nuclear facilities with minimal changes.

In FY-21, MFC saw the creation of the Technical Leadership Council (TLC) as previously mentioned. One of the first outputs of the TLC was the development of the MFC Informational Series. This informational series will include ongoing presentations on a variety of topics ranging from science/engineering to operations to business that will be of interest to the wider MFC population. The goal is to increase understanding of how all aspects of MFC's myriad of facilities and functions facilitate work to contribute to the MFC mission. The first several topics have been scheduled and more than a dozen are lined up for the coming year. To ensure awareness of these talks, an "Upcoming Events" link has been set up on the MFC Homepage along with a calendar link. It is also expected that these presentations will be recorded. Access to the recorded presentations will be available via a link on the MFC Homepage.

3.1.5 Actions FY-22

- Incorporate TLC member into work control change activities. (Donna O'Kelly, September 30, 2022)
- Provide multiple MFC Informational Series sessions throughout FY-22. (Donna O'Kelly, September 30, 2022)

3.1.6 Looking Forward (FY-23 and Beyond)

No additional actions for beyond FY-22 have been identified at this time.

3.2 Laboratory Space Management

3.2.1 A Look Back

After inception of the OMI in FY-21, MFC continued its current trajectory and continued to experience growth in research output, scientific instrumentation, and personnel, in spite of the COVID-19 pandemic. MFC will be a primary player in the development of advanced nuclear fuels. Therefore, increased support is needed to ensure MFCs aging facilities are able to meet the challenges of the future.

The efficient utilization of all spaces—land, office, and laboratory—has varied across MFC in the past. Issues that hindered the ability to efficiently manage and utilize space include:

- A lack of modernization/aging facilities with ineffective/inefficient layouts
- Legacy, obsolete, and/or out-of-service items left in place
- Competition for the same limited space and time resources
- Lack of funding
- Resistance of excess unneeded items because of perceived future usefulness
- Lack of resources to effectively manage space utilization.

The first four issues require a coordinated, long-term strategy, while the remainder may be addressed by the facilities, individually and as a team.

To address the above issues, there has been a dedicated effort over the last several years to modernize MFC and address the demand for office and laboratory space for the current and impending workload of the coming decades. The Research Collaboration Building (RCB) was completed and occupied in 2019; the Sample Preparation Laboratory (SPL) broke ground during 2020 and made excellent progress in FY-21 despite the pandemic. The Administrative Building, which began construction in 2019, was completed in 2021. The Administrative Building contains a new cafeteria, 63 offices, and an expanded conference/meeting area. In early 2021, demolition of the old parking lot began, with completion expected by the end of October 2021. The redesigned parking lot will have a better routing design that minimizes the interaction of cars and humans, well-defined walking paths and sidewalks, better illumination across the parking lot, and more than 250 additional parking spots. A new office building will be designed in FY-22 with construction planned for FY-23.

In May 2017, an effort began to improve the MFC grounds to create a safer working environment and to improve visual aesthetics. Trash and debris, such as pallets and scrap metal, was moved to a temporary holding location prior to removal to a permanent off-site disposal location. This location is now used by site construction projects as a temporary storage area during construction and renovation. This effort led to a great improvement in the apparent organization of outside areas which continues to this day.

Laboratory space management at MFC is the responsibility of the individual facilities. Periodically, site management designates a “clean up” day for personnel to devote to clean up and organization in and around their respective facilities. Many facilities have embraced the realization that effective housekeeping in nuclear and radiological facilities is an important aspect of a safe working environment and have embarked on campaigns and programs to revamp and revitalize working laboratory spaces.

The majority of facilities are space-limited and have limited resources to be devoted to organization and cleanup on a regular basis. Some facilities have incorporated a modified 5S methodology for efficiently and effectively organizing their workspaces, storing inventory, maintaining spaces, and ensuring long-term compliance with the effort. The 5S methodology has been described elsewhere.

In FY-21, several actions were taken to further improve laboratory space management.

- MFC Utilities & Infrastructure (U&IS) developed and implemented a program that ensures MFC personnel understand how to discard of excess material and equipment. Facility personnel have been

tasked with maintaining their exterior facility areas free of unsafe and unsightly debris/junk/equipment. U&IS has designated a point person for the effort and each facility has a point of contact.

- An MFC plan view has been developed that displays the responsible party for geographical areas, physical assts, and necessary system boundaries.
- MFC Transport Operations identified and established ownership of a number of casks/containers along with the respective support equipment used for intra-INL transportation and MFC inter-facility transfers.

3.2.2 People

N/A.

3.2.3 Process

N/A.

3.2.4 Actions FY-22

- Develop evaluation and cost basis that details required Sodium Components Maintenance Shop (SCMS) facility capabilities to fully utilize the SCMS as a central location for cask storage and maintenance activities. (Robert Miklos, September 30, 2022)
- Continue working with stakeholders to ensure casks/containers are maintained in a ready-to-use state. (Robert Miklos, September 30, 2022)
- Train and qualify a second cask engineer to ensure cognizant engineering authority support is readily available. (Robert Miklos, September 30, 2022)
- Develop necessary funding levels for FY-23 and beyond to support cask/container Preventative Maintenance (PM)/Corrective Maintenance (CM) activities as required. (Robert Miklos, September 30, 2022)
- Provide a talk in the MFC Informational Series regarding 5S methodology. (Donna O'Kelly, September 30, 2022)

3.2.5 Looking Forward (FY-23 and Beyond)

No additional actions for beyond FY-22 have been identified at this time.

3.3 Research Integrity and Review

3.3.1 A Look Back

3.3.1.1 *Research Metrics*

Until the end of FY-21, the only research performance metric consistently available was tabulation of published and/or submitted papers with one or more MFC authors, which contribute to impact as indicated by H index. With emphasis in recent years on increasing journal publications, metric tracking with the H index was essential in tracking research performance. Other metrics reported in the past include numbers of post-docs and interns hosted, numbers of external users supported, and numbers of proposals submitted.

During FY-21, two OMI actions related to research metrics were completed:

- GA 2021-0056; Key Research Metrics

  MFC Chief Scientist and MFC directors identify key research metrics to be tracked as a performance indication.

- GA 2021-0057; Research Metrics Tracking

MFC Chief Scientist define and implement a scheme or process for identifying research metrics to be tracked and reviewed annually.

For the first action, GA 2021-0056, the Chief Scientist, working through the newly established MFC TLC, identified the following five research metrics that are important to the state of MFC research:

1. Number of publications with at least one MFC author or that reference MFC facilities
2. MFC people attrition
3. Percent success rate for proposals
4. External funding amount
5. Number of external and internal users.

These metrics were reviewed and endorsed by the MFC Division Directors and ALD.

For the second action, GA 2021-0057, a tracking process for the five metrics was developed with the following principal elements:

- Trending and analysis will be completed by the MFC TLC and reported monthly at TLC meetings. This includes identifying data sources for each metric.
- Metrics status will be reported bi-monthly to MFC leadership by the Chief Scientist or TLC designate at the management review meetings (MRM) meetings.

Tracking, analysis and reporting of the metrics started in FY-22.

3.3.1.2 *Research Integrity*

No notable incidents related to research or scientific integrity have been raised at MFC in recent years. INL's research integrity program is overseen by the INL Chief Research Officer and is described in PDD-221, "Research Misconduct and Research Process Concerns," which addresses occasions of Research Misconduct (i.e., fabrication of data and results, falsification/manipulating/omitting to misrepresent data, plagiarism). The program calls for the appointment of an INL Research Integrity Officer and Deputy (typically appointed from the R&D staff) and an Investigation Committee to investigate allegations or concerns of research and scientific integrity. MFC, along with the other mission directorates, nominates MFC staff members to serve terms as Research Integrity Officer or Deputy.

At least anecdotally, it appears that some MFC research staff are not familiar with INL's research integrity standards or processes. INL qualifications for R&D Principal Researcher (QNRDPRIN), are documented by Form 361.A61, "Science & Technology Principal Researcher (PR) Qualification Checklist," and for Hands-On Researcher (QNCONRES), by Form 361.A60, "Science & Technology Hands-on Researcher Qualification Checklist." A review of the forms' checklists indicates that the qualifications address work control, integrated safety management and ES&H topics, but research integrity is not explicitly addressed.

3.3.1.3 *Mission Work Planning*

For each of the recent years, MFC managers have endeavored to plan for work in the upcoming fiscal year based on defined scope and planned budgets. Most MFC mission work is funded by programs managed within INL and nationally. In some cases, mission work is funded by Nuclear Science and Technology (NS&T) and National and Homeland Security (N&HS) personnel, and those personnel communicate to MFC counterparts the future scope and budget expected, usually in an ongoing manner throughout the year. Each year that process is complicated and challenged by the incompleteness of planning information available prior to the beginning of the fiscal year, which is largely attributable to the programmatic ambiguity of the federal appropriations process; DOE program managers are reluctant to commit to plans until the year's appropriations budget is approved by Congress, and even then, there is ambiguity until DOE settles on details. For that reason, NS&T and N&HS program managers can, at best, provide their impression of the upcoming plans for the year but are occasionally unable to provide detail. As a result, MFC enters each fiscal year with an unclear picture of programmatic expectations.

During FY-21, two OMI actions related to Mission Work Planning were completed:

- GA 2021-0073; Annual Workforce Planning Process

  ALDs clarify and communicate their expectations for annual workforce planning, with a practical and manageable process to be agreed upon.

- GA 2021-0074; FY-22 Planning Schedule

  MFC directors establish and keep to a FY-22 planning schedule.

For the first action (GA 2021-0073), the Annual Workforce Planning was completed with each ALD reviewing their staffing plans and rolling up the information across the laboratory. NS&T has committed to use the Integrated Resource Planning Tool (IRPT) for work involving MFC facilities and resources.

For the second action (GA 2021-0074), the FY-22 Planning Schedule has been established, and is updated as needed to remain current.

3.3.1.4 *Research and Data Quality*

Much of the work at MFC is performed to collect data and generate information, initially for investigation but increasingly to support design and safety bases. INL provides two procedures to control such activities: LWP-10107, "Engineering Test Control," governs "non-research tests or test procedures that may be used as qualification testing… or for other testing of engineered design," and MCP-1380, "Research and Development Test Control," governs testing "used to verify compliance with selected R&D requirements or to collect data/information for selected R&D work activities." Surprisingly, it is MCP-1380 that is to be used when collecting data for fuel qualification and design, which would apply to much of the testing and data collection at MFC. MCP-1380 directs the performer to address quality assurance (QA) requirements for data collection and control, including reference to NQA-1 Part 1. Other than a vague direction to consult with a quality engineer, no specifics are provided. Quality requirements for specific programs are typically implemented to MFC work through the INL program managers, which has been mostly successful, as evidenced by the recent U.S. Nuclear Regulatory Commission (NRC) approval of the Tristructural isotropic (TRISO) fuel qualification Licensing Topical Report submitted by the Electric Power Research Institute (EPRI) and compiled by INL and other contributors. However, other anecdotal evidence suggests that research data quality requirements should be made clearer to MFC staff and managers. Quality requirements in this context touch on the engineering process as applied to equipment to be used in data collection; data collection, measurement techniques, and quality measures; and data storage and control.

During FY-21, three OMI actions related to Research and Data Quality were undertaken:

- GA 2021-0060; MFC Testing & Measurement Quality Guide

  MFC directors commission drafting of an MFC testing and measurement quality guide to be used in accordance with LWP-10107 and MCP-1380; FY-21 work will identify scope, approach, and develop the outline for the guide.

- GA 2021-0061; Research Equipment and Data Storage and Control

  MFC mission directors commission drafting of objectives and requirements for the engineering of research equipment and for data storage and control.

- GA 2021-0062; MFC Science Talk Series

  MFC Chief Scientist resumes the MFC Science Talk series, starting with a presentation on the Transient Reactor Test Facility (TREAT).

To address the first two actions, GA 2021-0060 and GA 2021-0061, the TLC was engaged to develop the scope and approach of a guide, and came up with the following recommendation:

> *As research and development activities cover a broad spectrum of concept maturity, guidance for the required testing and measurement quality must be scalable to a wide range of R&D activities. The development of this guidance will rely on INL quality professionals as well as current INL procedures and guidance and industry standards including but not limited to LWP-10107, MCP-1380, and NQA-1.*
>
> *The proposed approach to developing the guidance will rely on a small team of active R&D professionals working to identify the critical aspects of testing and measurement quality as it applies to the different stages of R&D. The team will draft a guidance document and submit to a wider audience of R&D and Quality professionals. After the initial review, case studies will be identified to test the guidance document and work out deficiencies. Upon satisfactory completion of the case studies and resolution of identified deficiencies, the guidance document will be reviewed with MFC Leadership for comments and endorsement. Once this endorsement is received, the guidance document will be issued.*
>
> *The scope of the guidance document will specifically cover measurement instruments, data collection, data storage and retention systems, and the access controls on the data. This guidance document will supplement MCP-1380. Specifically excluded from this guidance will be the measurement and testing processes associated with safety systems and measurement and testing for qualification or verification of non-R&D systems as these are covered by other INL processes and procedures.*

The recommended approach described above will be reviewed with MFC Leadership and, if approval is received, execution will start in FY-22.

For the third action (GA 2021-0062), the MFC Science Talk series was resumed in March 2021, with a talk on the TREAT facility. Two other talks were given as part of the series during FY-21, and bi-monthly talks are planned for FY-22 and beyond.

During FY-21, the TLC identified two additional areas that could be targeted to improve research quality at MFC:

- Alignment of priorities for Research and Operations, and
- Processes perceived as cumbersome to the conduct of research.

  Actions related to these two areas will be pursued in FY-22.

3.3.2 People

The MFC Chief Scientist leads efforts to measure and improve the MFC research culture. A key action taken during FY-21 was the institution of the MFC TLC. The TLC is composed of research personnel representing the six research divisions of MFC, and its purpose is to advise the MFC Chief Scientist on matters related to research culture and the performance of research work at MFC.

Since MFC mission and research work is directed and administered within MFC divisions, MFC divisions are responsible for staffing the research work they support. Staffing plans are presented in the separate division 5-year plans. In general, personnel needed to support MFC Research and Integrity actions can be identified from the existing roles and staff.

3.3.3 Process

Research Metrics

As already covered in Subsection 3.3.3 on Research Metrics, new metrics, and a process for tracking them were developed in FY-21. This process will be implemented in FY-22.

Research Integrity

The process for addressing concerns and occasions related to research integrity is described in PDD-221. This lab-wide process is sufficient for meeting MFC needs in these matters. MFC directors can consider how best to ensure personnel are familiar with research integrity expectations and PDD-221.

Mission Work Planning

The FY-21 actions described in Subsection 3.3.1 should improve the process to plan mission work for the upcoming fiscal years. Program managers and directors should continue to collaborate in entering into the IRPT the best available data at the appropriate time in the planning process and updating that data as DOE plans become clear. MFC directors should adhere to the FY-22 Planning Schedule that has been established.

Research and Data Quality

As mentioned in Subsection 3.3.1, the scope and approach to providing more explicit guidance on data quality for testing that is not engineering verification was developed during FY-21. Issuance of this guide—planned in FY-22—will benefit testing and data quality of MFC and INL programs, and potentially simplify the engineering process governing research equipment that does not have a safety function.

3.3.4 Equipment/Tools

Research Metrics

To the extent practicable, existing tools and/or databases will be used for tracking research metrics. For example, the MFC Business Division already tracks INL publications with one or more MFC author, and this monitoring can be extended to publications that make use of MFC facilities by incorporating the appropriate keywords. As another example, the INL Proposals Management group is implementing a tool that will simplify the tracking of submitted INL proposals, which can be leveraged to track the success rate of MFC-led proposals.

Mission Work Planning

Annual workforce planning at MFC can be supported well using IRPT, which is now familiar to MFC leaders; the bigger concern for planning is uploading and entering information reflecting mission commitments.

Research and Data Quality

Other than a process or guide useful for MFC staff and managers, no other tools are envisioned at this time.

3.3.5 Actions FY-22

Research Metrics

- Initiate reporting of research metrics at MRM meetings. (Abdul Dulloo, February 28, 2022)

Research Integrity

- Arrange for talk on the INL Research Integrity Program to be delivered as part of the MFC Informational series. (Donna O'Kelly, September 30, 2022)

Research and Data Quality

- Gain MFC Leadership endorsement for approach and scope of MFC testing and measurement quality guide. (Abdul Dulloo, February 28, 2022)
- Issue Revision 0 of the MFC testing and measurement quality guide. (Abdul Dulloo, September 30, 2022)
- Evaluate issue related to alignment of priorities for Research and Operations and, if needed, propose approach to improve. (Abdul Dulloo, February 28, 2022)
- Evaluate issue related to cumbersome processes and, if needed, propose approach to improve. (Abdul Dulloo, February 28, 2022)

3.3.6 Looking Forward (FY-23 and Beyond)

Research Metrics

- Show year-over-year improvement or sustained performance on key metrics.

Mission Work Planning

- MFC directors continue to establish a sustained planning rhythm and streamline the process to identify, enter, and update data in the MFC IRPT, as reflected in better fidelity in IRPT.
- MFC ALD continue to champion and encourage the use of IRPT, or a similar and compatible tool, by the NS&T and N&HS organizations for their work at MFC.

Research and Data Quality

- TLC continue to identify and work on areas of improvement for conduct of research at MFC.

3.4 Mentoring

3.4.1 A Look Back

Mentoring takes on many forms, beginning during on-boarding and lasting for a career. Mentoring may fulfill different objectives at different times, such as learning the ropes of a new organization, identifying, and pursuing skills development, and charting career progression.

Mentoring and personal/professional development are related and may use similar tools. Mentors may help personnel identify and select good development opportunities, such as those offered by INL's Employee Development Network and Assessment Center. INL's Learning and Organizational Development division offers and facilitates many programs and courses. Therefore, mentoring may be considered a part of employee development.

While mentoring at MFC occurs on an informal basis, there is presently no formal mentoring program in effect at MFC, making it difficult to provide a detailed 5-year look back. Furthermore, it has been

reported that attrition within the ranks of senior research staff has caused a decline in the number of mentors available to guide new researchers in some areas. Last, a 2021 survey performed by the INL Young Researchers Association (YRA) of post-docs and researchers at INL, who received their last degrees within the past 10 years, found mentoring to be a high-priority need within that population.

In response to these concerns, an OMI action (GA 2021-0063; MFC Mentor/Mentee Program) was created in FY-21, directing the MFC Chief Scientist to develop an MFC Mentor/Mentee program that focuses on personnel in scientific research roles. The Chief Scientist, working in collaboration with the TLC, first developed a set of attributes for an effective mentoring program. These attributes include:

- Leveraging what INL already has on mentoring and, if needed, supplement that material
- Fostering active participation of mentors and mentees
- Providing consistent information on the career progression options available to employees
- Attracting management buy-in at all levels
- Providing incentives for mentors who perform their mentoring assignment well.

These attributes were then used as a basis to develop several recommendations for creating the mentoring program at MFC. The recommendations will be implemented during FY-22, some in the form of FY-22 OMI actions.

3.4.2 People

The hiring process identifies good candidates and brings them to INL; then on-boarding introduces new hires to the basics of INL. Following these activities, mentoring is needed to help employees learn how to navigate INL, how to perform work in MFC's nuclear environment, and to learn some of the specific skills needed for projects and programs at MFC. With time and experience, mentoring is expected to include additional topics that may be related to skill development (e.g., professional, technical, and managerial skills), knowledge transfer, and career development.

Given current workforce demographics and projected retirements, along with recent and anticipated growth at MFC, mentoring across generations will be critical to transfer technical and institutional knowledge to accomplish INLs mission. Much of the specialized work performed at MFC is not taught in books, schools, or training programs; rather, it is learned through practice, hands-on work, and from those who have done it before. Mentoring is an important tool in providing additional education specific to MFC.

MFC is committed to sponsoring development for all employees, including in the form of mentoring. Mentoring can occur both formally and informally. Formal mentoring may occur when an employee and mentor are matched up based on a specific skill set or development goal and follow a structured set of activities. Informal mentoring may develop between employees more organically as employees find common interests and support each other in those areas. Mentoring is often a relationship between a more experienced and a less experienced employee; however, peer-mentoring, where peers share their experiences on certain topics, can also be valuable.

To assist employees with mentoring, a web page dedicated to mentoring will be created on the MFC Nucleus site in FY-22. This page will link MFC employees to available resources on mentoring, publicize upcoming mentoring training, and provide the opportunity to provide feedback and share lessons learned.

3.4.3 Process

Since FY-19, MFC management has set a goal of conducting two performance reviews per year with each employee. MFC managers are expected to discuss employee development during performance reviews; these discussions should also include mentoring. Managers will help employees find mentors and will help employees become mentors to others, based on employees' career needs.

3.4.4 Equipment/Tools

Currently, mentoring occurs mostly informally and organically (employees develop relationships, and activities are not tracked). A more structured program is being instituted that will provide more training for employees, mentors, and managers, with examples to help participants develop mentoring activity ideas. As described in the Subsection 3.4.2, a web page will be created as part of the structured program to allow employees to provide feedback, as well as tips and suggestions.

3.4.5 Actions FY-22

- Create page on MFC web site dedicated to mentoring. (Abdul Dulloo, March 31, 2022)
- Announce Mentor of the Year Award creation. (Abdul Dulloo, February 28, 2022)
- Seek nominees and select winner of FY-22 Mentor of the Year Award. (Abdul Dulloo, September 30, 2022)

3.4.6 Looking Forward (FY-23 and Beyond)

- Review mentoring relationships and look for cross-organizational opportunities to pair employees to achieve goals.
  - Mentoring relationships should cross boundaries and directorates throughout INL.
- Create a demonstrated record of mentoring a requirement for progression to the top levels of an employee's Career Series.
  - For example, employees seeking progression to Level 5 and/or Level 6 on the INL Professional Individual Contributor Career Series would be required to provide evidence that they have successfully mentored one or more junior colleagues during their careers.
  - This requirement would be a strong incentive for employees to become active mentors.
- Customize mentoring programs for participants and their needs. The opportunities for mentoring are varied and endless, and it would be beneficial to look into differentiating between mentoring and coaching.
- Make mentoring accessible to everyone and expected of MFC leaders and managers. This will result in improved employee development and retention.

3.5 University Partnerships

3.5.1 A Look Back

University engagement has steadily improved as awareness of the strategic importance of university partnerships to MFC recruiting and research collaborations has increased. Recruitment in Mission Divisions and the Engineering Division at MFC have benefited from building long-term relationships with university departments and specific university faculty. These relationships have shifted the selection of student interns from an ad hoc basis to one based on recommendations from faculty that wish to build long-term, mutually beneficial relationships and joint research programs. Productive undergraduate or graduate internships often result in new hires that are familiar with INL culture, work processes, the local area, and have completed some degree of INL training. Hiring in this way results in new employees that are immediately productive and improves employee retention.

Research collaborations resulting from university partnerships have steadily increased. These collaborations provide the opportunity for researchers to pursue personal research interests or to address critical knowledge gaps that have not been identified or funded by programs. Funded research collaborations provide the opportunity to host top-tier students as interns over multiple years, building university relationships and often resulting in an advanced degree associated with research at INL. Funded research collaborations result mostly from DOE Office of Nuclear Energy's (DOE-NE) Consolidated Innovative Nuclear Research (CINR) program, Nuclear Science User Facilities Rapid

Turnaround Experiments (NSUF RTE), and INL Laboratory Directed Research and Development (LDRD) projects. There are a few ARPA-E (Advanced Research Projects – Energy) funded programs. Another avenue to foster research collaboration with universities is to enlist university faculty to serve on external advisory bodies. As an example, university faculty members are serving on the External Advisory Committee tasked to advise MFC on optimizing research and collaboration at the SPL when it becomes operational.

Graduate fellowships facilitate long-term relationships between top-tier graduate students, university professors, and MFC research staff. These relationships require a 3-year funding commitment for graduate research at MFC. Postdoctoral fellowships are the traditional entry point into a research career and are increasingly common at MFC as our research culture matures. Distinguished postdoctoral fellowships (Heath, Seaborg, de Boisblanc) offer the opportunity to hire a Ph.D. researcher on a 50%-funded, 2-year appointment. Postdoctoral programs provide excellent opportunities for evaluating and hiring research staff. MFC currently has seven postdoctoral fellows, including two distinguished postdoctoral fellows.

Joint Appointments provide the opportunity for MFC staff to be embedded in a university as an instructor or member of the faculty. Joint appointments provide the opportunity for MFC staff to deliver lectures or to develop entire courses that benefit MFC and the nuclear enterprise; engage with top-tier students as potential employees; and perform research at universities. One MFC researcher currently holds an outgoing joint appointment—at the Massachusetts Institute of Technology. Joint appointments also provide the opportunity for college or university faculty to be embedded at MFC as a staff member; there is currently one incoming joint appointment at MFC—from the University of California at Berkeley (UC Berkeley).

Education programs and MFC have established a cooperative education (co-op) program that provides the opportunity for extended interaction at MFC for promising undergraduate students in engineering and other fields. Furthermore, the CAPIE Division is preparing to offer a graduate-level class consisting of seminars led by INL experts on materials-related subject to students at the University of California at Berkeley. This class can potentially be offered to other universities in the future, providing opportunities to establish long-term collaborations with these universities.

Recruitment of nuclear operators from Idaho State University's Energy Systems Technology and Education Center (ESTEC) has provided MFC with several operations personnel. The relationship could be further improved through closer association of MFC senior operations personnel with the Idaho State University (ISU) program. The College of Eastern Idaho (CEI) may also provide an opportunity to develop degree programs or training courses that are focused on meeting MFC personnel resource needs.

During FY-21, two OMI actions related to University and Vocational/Technical School Engagement were completed:

- GA 2021-0055; University Engagement
  - Each research division will develop a strategy for engagement of universities in their division 5-year plan.
- GA 2021-0023; Strategies for Engagement of Schools
  - Each support and operations-focused division will develop a strategy for engagement of vocational/technical schools (universities as appropriate).

For the first action, GA 2021-0055, a university engagement strategy template was developed, and reviewed with the MFC Division Directors. The template provides guidance on setting five-year goals and metrics for measuring the effectiveness of relationships with university and vocational/technical institutions. In addition, the table of contents of the 5-Year Division-Level Strategy Plan was revised to include a section on University Engagement. Going forward, Division Directors have the action to include university engagement planning in their 5-Year Division-Level Strategy Plan.

For the second action, GA 2021-0023, one central MFC vocational/technical (VoTech) engagement strategy has been established. All divisions are part of this plan and will coordinate their input with the Operations and Maintenance Directors who are participants on the ESTEC Technical Advisory Board. Goals include division presentations for ESTEC students, internships in Operations/Maintenance divisions, and ad hoc program support. Success will be measured by successful internships, hires, and presentations. Each division will establish a link/statement in their division strategic plans indicating participation in this VoTech initiative. In FY-21, both NRAD and SSPSF have presented to ESTEC students, the Maintenance and Operations Directors have attended the ESTEC Technical Advisory Board meeting, and AL and FMF personnel have assisted with developing their glovebox training curriculum. Furthermore, MFC is engaged with the local tribal technical schools, and provides guidance to the INL University Partnerships staff regarding steering activities and needs.

3.5.2 People

Division directors are responsible for the university engagement strategy for their division, with the assistance of the MFC Chief Scientist. Each division assigns personnel to engage with specific universities or technical/vocational schools that are strategically important to the division's mission. Personnel in support and operations-focused divisions engage with appropriate technical development programs and undergraduate internships. Personnel in research divisions also engage in recruiting and mentoring candidates for INL's Graduate Fellowship and Distinguished Postdoctoral Fellowship Programs.

In keeping with the INL value of Inclusivity, MFC seeks to achieve an employee base that is diverse and inclusive. An important component of this effort is to foster strong relationships with universities and colleges that primarily serve students from under-represented communities. In FY-21, MFC developed and started implementing an engagement plan targeted at strengthening relationships with Historically Black Colleges and Universities and Minority-Serving Institutions (HBCUs/MSIs). This effort is being led jointly by the MFC Chief Scientist and the TREAT Director, working in close collaboration with the INL Talent Acquisition team. Outreach activities were initiated with HBCU and Native American universities that offer engineering or science degrees (undergraduate or graduate) and will continue in FY-22. Added emphasis will be placed on actively soliciting applications from these institutions for entry-level MFC positions.

3.5.3 Process

University engagement strategies are identified in each division's 5-year plan. Each division should identify universities and specific faculty that are strategic to their mission area and assign personnel to engage with those universities. Engagement should include recruiting of top-tier students and development of joint research programs. Specific funding strategies may need to be developed based on available funding sources. There may be overlap in the identification of strategic universities within MFC mission areas and with NS&T; these overlaps should be identified, communicated, and coordinated. Division personnel assigned to each university leverage resources in the INL University Partnership Program to meet division goals for university engagement. As described in Subsection 3.5.1, a university engagement template was created in FY-21 to facilitate capture of university and Vo/Tech institution strategies in the 5-Year Division Strategy plans.

3.5.4 Equipment/Tools

INL has a mature University Partnerships program that assists in university engagement through undergraduate and graduate internships, graduate fellowships, postdoctoral appointments, distinguished postdoctoral fellowships, and joint appointments. Training in effective mentorship is also provided.

Interaction with vocational/technical colleges tends to rely more on personal relationships that appear to be less effective in establishing a talent pipeline; these relationships could be strengthened by developing division specific engagement strategies in this area.

Indicators that allow tracking and identify specific areas of improvement for university engagement at MFC are not defined. The University Partnership Program tracks many parameters that could be accessed for use.

3.5.5 Actions FY-22

- Execute university engagement strategies captured in Division 5-Year Strategy Plans. (MFC Division Directors, September 30, 2022)
- Continue to seek opportunities to collaborate with HBCU and attract faculty and students from these institutions to perform research or work at MFC. (Doug Crawford, September 30, 2022)
- Continue to seek opportunities to collaborate with tribal universities and attract faculty and students from these institutions to perform research or work at MFC. (Abdul Dulloo, September 30, 2022)
- Each MFC director will work with the MFC Chief Scientist to actively solicit applications from HBCUs/MSIs for at least one entry-level position. (MFC Division Directors, September 30, 2022)
- Leverage INL's University Partnerships program to provide data for indicators of university engagement. (Abdul Dulloo, September 30, 2022)
- Offer graduate-level class to UC Berkeley students. (Colin Judge, September 30, 2022)

3.5.6 Looking Forward (FY-23 and Beyond)

- Annually update engagement strategies based on lessons learned and evolving needs for research and recruitment.
- Consolidate goals for university and vocational/technical engagement into a simple set of indicators that track progress against goals and identify areas where additional focus is needed.
- Offer graduate-level class to universities other than UC Berkeley.

4. STRATEGIC PLANNING

4.1 5-Year Mission Plan

4.1.1 A Look Back

In 2016, MFC issued its first Five-Year Science Strategy and its first Five-Year Investment Strategy (5YS). The Five-Year Science Strategy served the important purposes of defining MFCs core strengths; placing the varied MFC capabilities into the context of a single R&D site serving government, industry, and university R&D objectives; outlining key research and research infrastructure needs; and defining objectives for MFC as a user facility. Annual updates were informal and consistent with the INL Lab Agenda and Lab Plan, and strategies issued by NS&T and N&HS. The strategies from the other directorates are now issued documents, but in previous years the strategies were communicated informally. In 2019, the science strategy, INL/EXT-19-52612, was retitled the "Materials and Fuels Complex Five-Year Mission Strategy FY-19 – FY-23" to reflect the increasing emphasis on supporting private initiatives to develop and demonstrate new reactor and fuel cycle technology with the goal of technology demonstration through National Reactor Innovation Center (NRIC). The strategy continues to support planned research capabilities as a necessary factor for enabling new technology and maintaining the existing reactor infrastructure; for example, through DOE-NE and National Nuclear Security Administration (NNSA) technology development programs, Gateway for Accelerated Innovation in Nuclear (GAIN), and Nuclear Science User Facilities (NSUF). In the past, the document served as a helpful reference for mission and science objectives but was of limited strategic value. As such, the scope of the document was changed in FY-21 to better focus on strategy and associated actions, through the following two OMI actions:

- GA 2021-0053; Five-Year Mission Strategy
  - The MFC Chief Scientist will revise the scope and outline for the Five-Year Mission Strategy, with input from the MFC directors and ALD.
- GA 2021-0054; Five-Year Mission Strategy Update
  - The MFC Chief Scientist will lead preparation of and issue the Five-Year Mission Strategy update, in accordance with the new scope and outline, with input provided by MFC divisions, through their directors, and appropriate NS&T and N&HS leaders.

As part of the completion of these two OMI actions, the MFC 5-Year Mission Plan with an updated scope and outline was sent to MFC Directors and ALD for two rounds of review and comments during the January – March 2021 period. Furthermore, staff from DOE-NE-3 reviewed and contributed comments on the document. After addressing comments from these sources, the FY-21 – FY-25 5-Year Mission Strategy was released in June 2021 (INL/EXT-21-61296). The principal changes from prior editions are:

- Adoption of an outcome-oriented strategy, focused on delivering five key outcomes
- Addition of a chapter on Risk
- Clearer description of alignment with higher-level DOE-NE and INL mission strategies
- Streamlined main body (37 pages vs. 84 pages), with detailed information moved to appendices.

4.1.2 People

The MFC Chief Scientist is responsible for the annual update to the Five-Year Mission Strategy, with support from the MFC directors and others. Support from MFC program support personnel and document preparation personnel has been excellent, and contributions from those roles should continue.

4.1.3 Process

The MFC Chief Scientist will initiate each annual update in accordance with the intended issue date communicated by the ALD. The MFC Mission Strategy will be developed to meet objectives as communicated through the DOE-NE Strategic Vision, INL Laboratory Agenda, INL Laboratory Plan, NS&T strategy, and N&HS strategy. It is assumed that these documents translate DOE strategies into laboratory level actions. Each MFC division updates annually a 5-year division strategy informed by both 'bottom up' and 'top down' needs in response to DOE, Lab, industry, small business, and university needs. The content of those strategies will inform the MFC Five-Year Mission Strategy.

4.1.4 Equipment/Tools

The tools used for annual updates will consist primarily of the DOE-NE, Laboratory and mission directorate strategy documents, and collaboration tools, such as meetings, videoconferencing, group directories, and email.

4.1.5 Actions FY-22

The Mission Strategy will drive the development of both the Five-Year Funding Strategy and the Operations Improvement Strategy to meet mission needs.

- The MFC Chief Scientist will update the Five-Year Mission Strategy, with input from the MFC directors and ALD, as well as from key documents such as the DOE-NE Strategic Vision, INL Laboratory Agenda, INL Laboratory Plan, and NS&T and N&HS strategic plans. (Abdul Dulloo, March 31, 2022).
- The MFC Chief Scientist will ensure the INL Laboratory Plan is communicated to MFC staff when it has been updated and released. (Abdul Dulloo, September 30, 2022 [annually]).

4.1.6 Looking Forward (FY-23 and Beyond)

- Annual updates will include an evaluation of core strengths of MFC as compared with national and laboratory needs for the development of nuclear energy, identifying needed updates of current capabilities and establishment of new capabilities
- The scope of the strategy will include a 10-year outlook, though the planning will continue to focus on actions for the upcoming 5-years.

4.2 5-Year Funding Plan

4.2.1 A Look Back

Funding for investments in infrastructure and scientific capabilities was minimal during the final years of Argonne National Laboratory (ANL) management of MFC and the early years of incorporation into INL. Historically, the appropriation to INL for Idaho Facilities Management (IFM) was limited to compliance-level operations and maintenance. Without the needed investment funding, facility reliability in all nuclear and radiological research facilities at MFC decreased. The MFC ALD commissioned a 5 - year investment strategy to identify investments that increase facility reliability, increase experiment throughput, and expand DOE-NE test bed research capabilities. Subsequent increases in IFM appropriations for FY-18 – FY-21 provided additional funding to specifically address items identified in the MFC 5YS. This 5YS has been integral in communicating needs that address plant health and expansion of the DOE-NE Test Bed capability that supports the NRIC mission and GAIN initiative. To date, approximately $130 million in funding has been directed to support 5YS investments.

4.2.2 People

MFC has a Director of Projects to oversee 5YS projects. These projects range from operations and maintenance efforts to capital asset projects. Execution of these projects incorporates a graded project management approach dependent upon complexity and risk. Project managers are identified to lead each 5YS project and report status and progress directly to the Director of Projects. Project managers supporting the Director of Projects are either MFC staff or project managers matrixed through the INL Project Management Office, since increasing MFC staff size is a risk given the uncertain level of future funding for 5YS work.

MFC leverages matrixed support and staff augmentation subcontracts to support the level of resources necessary to execute 5YS projects. Engineering resources are stretched thin across MFC. Traditionally, resources at MFC are staffed to execute normal operations and maintenance. Staffing levels to execute the large increases in funding and scope have been generally less than adequate, and staff augmentation expertise specific to work execution in nuclear facilities is limited. Despite these challenges, significant improvements in resource support have been realized since the inception of 5YS work execution. Service subcontracts have been established to leverage staff augmentation resources to the extent practicable. Laboratory resources matrixed from other INL organizations, such as the INL Project Management Office, are also reducing staffing impacts.

4.2.3 Process

The primary need for process improvement is advanced planning sufficient to improve the quality of scope and cost estimates included in the 5YS. The lack of adequate advanced planning has resulted in 5YS estimates that are generally significantly less than actual costs and take considerably more time than anticipated. This is a result of poor upfront scope definition and risks inherent in executing work in aging facilities. These deficiencies create downstream financial risks and undermine recent successes (i.e., Remote-Handled Low-Level Waste [RHLLW] Facility, RCB construction) that have increased federal sponsors' confidence in MFC's ability to execute important work. Additional effort and engineering support are essential to reduce uncertainty in scope and costs. MFC has requested indirect investment in pre-conceptual design planning (advanced planning) to define work scope and cost estimates more accurately.

Another process improvement is identifying candidate scope to add to out-year investment profiles. A Complex Health Committee (CHC) was formed with the objective to populate an integrated priority list (IPL) focused on facility reliability/plant health scope. The CHC process has not yet matured enough to generate and incorporate an IPL into the 5YS planning process. The Director of Engineering owns the CHC process. The individual Mission Directors are responsible for implementing the process, and the MFC ALD chairs the CHC meetings.

4.2.4 Equipment/Tools

Effective incorporation of the CHC process into the 5YS process.

4.2.5 Actions FY-22

- The MFC Projects Division will initiate advanced planning with the funds granted through the IPL (Brady Orchard, September 30, 2022 [annually])

4.2.6 Looking Forward (FY-23 and Beyond)

No additional actions for beyond FY-22 have been identified at this time.

4.3 Department of Energy Performance Evaluation Management Plan

4.3.1 A Look Back

The INL Performance Evaluation Management Plan (PEMP) establishes performance measures used by the DOE to evaluate the Battelle Energy Alliance, LLC (BEA) management and operations (M&O) of INL. The PEMP is incorporated into the BEA prime contract on an annual basis. The PEMP provides a standard by which to determine whether the INL contractor is responsibly managing the Laboratory and is meeting the mission objectives and performance expectations of the Department, as stipulated within the prime contract.

The PEMP defines Performance Goals, Performance Objectives, and a set of Notable Outcomes developed in accordance with expectations set forth within the prime contract, which provides evaluation criteria considered in determining the annual BEA award fee. The Notable Outcomes within the PEMP are developed in coordination with DOE Idaho Operations Office (DOE-ID) and DOE-NE program offices, as appropriate. Table 1 illustrates the FY-22 PEMP hierarchy and primary area of MFC involvement.

Table 1. FY-22 PEMP Areas Strongly Influenced by MFC.

Goal	Objective	Notable Outcome
GOAL 1.0 Efficient and Effective Mission Accomplishment.	Objective 1.1: Nuclear Energy.	Notable Outcome 1.1.B – National Reactor Innovation Center.
		Notable Outcome 1.1C – Fuel Cycle.
		Notable Outcome 1.1.D – Advanced Fuels.
	Objective 1.4: Collaborations.	Notable Outcome 1.4B – NASA Programs.
GOAL 2.0 Efficient and Effective Stewardship and Operation of Research Facilities.	Objective 2.1: Provide effective Facility Design(s) as required to Support Laboratory Programs (i.e., activities leading up to CD-2).	Design of the new office building has been authorized.
	Objective 2.2: Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components (execution phase, post CD-2 to CD-4).	Notable Outcome 2.2.A. – Construction and Commissioning of new facilities/capabilities: • Sample Preparation Laboratory: – By the end of FY-22, the project will complete dry-in of the building, excluding a portion over the hot cell left open to facilitate construction thereof.

Goal	Objective	Notable Outcome
	Objective 2.3: Operation and Maintenance of Facilities.	Notable Outcome 2.3.A – ATR and MFC Infrastructure Investment for reliability improvement.
		Notable Outcome 2.3.B – Maximize EBR-II driver SNF receipts at MFC in support of the 2019 Supplemental Agreement milestone.
	Objective 2.4: Utilization of facility(ies) to provide impactful S&T Results and Benefits to Internal and External User Communities.	None specified.
GOAL 3.0 Sound and Competent Leadership and Stewardship of the Laboratory.	Objective 3.1: Leadership and Stewardship of the Laboratory.	None specified.
	Objective 3.2: Management and Operation of the Laboratory.	None specified.
	Objective 3.3 Contractor Value-Added.	None specified.
GOAL 4.0 Sustain Excellence and Enhance Effectiveness of Integrated Safety, Health and Environmental Protection.	Objective 4.1: Provide an efficient and effective Worker Health and Safety Program.	None specified.
	Objective 4.2: Provide an efficient and effective Environmental Management System.	None specified.

4.3.2 People

MFC senior leadership works with DOE-ID and DOE-NE to identify notable outcomes specific to MFC in collaboration with the NS&T organization. This effort is updated annually and PEMP content changes annually with shifting research priorities and emergent research initiatives.

4.3.3 Process

The PEMP development includes a formal process led by the BEA Contracting Officer (CO) on behalf of the two Deputy Laboratory Directors and supported by the ALDs and senior leadership. PEMP language including Goals, Objectives, and Notable Outcomes are developed, negotiated, and agreed upon by senior management from DOE-ID, DOE-NE, and INL. Specific Notable Outcomes reflect each year's research priorities and initiatives. The PEMP is a contractual document that can be amended, through formal change control, as needed during the year. These amendments may be based on changes in priorities, funding allocations, or circumstances.

Progress on PEMP Goals, Objectives, and Notable Outcomes is formally submitted to DOE-ID on a triannual basis. This effort is coordinated by the BEA CO and staff on behalf of the Deputy Laboratory Directors. Various individuals across INL have been identified as technical leads for each section of the PEMP. The leads collect progress reports from individual program and facility staff, and summarize these into sections associated with each Goal, Objective, and Notable Outcome. The input is collected and assembled into a single PEMP Trimester report that includes proposed "grades" on progress for each Goal and Objective. The PEMP Trimester report is then submitted to DOE-ID. DOE-ID reviews the report and responds with their own evaluation and grades. Closeout meetings are held between INL and DOE-ID staff to discuss these grades, and instances where grades might vary significantly between INL and DOE-ID. The DOE-ID Field Office Manager makes the final determination on grades and the final trimester report is submitted through the two contracting offices. These final grades are the basis for establishing the award fee earned annually by BEA.

In addition to measures identified in the PEMP, individual research program milestones are established by the sponsoring organizations, usually DOE-NE program offices and by INL research program leaders and executing organizations such as MFC. These are collected by MFC into a Mission Outcomes table that is used by MFC senior leadership to monitor performance at MFC. Performance against these milestones is monitored and reported monthly to MFC senior leadership, research program technical leaders, and DOE-ID MFC technical leads.

4.3.4 Equipment/Tools

No areas of weakness with either equipment or tools impact this area.

4.3.5 Actions FY-22

- Report on PEMP progress on a trimester basis during the fiscal year (Tiffany Leavitt, September 30, 2022 [annually]).

4.3.6 Looking Forward (FY-23 and Beyond)

No additional actions for beyond FY-22 have been identified at this time.

5. HUMAN PERFORMANCE IMPROVEMENT

5.1 A Look Back

MFC has made significant strides towards improving knowledge and integrating the philosophy of HPI into all activities performed by MFC organizations within the past 5 years. Individuals, leaders, and organizations have been encouraged to integrate HPI into daily work activities with the ultimate goal of reducing the frequency and severity of events triggered by human error. The development of GDE-863, "INL Human Performance Improvement Guide" in 2018 formalized INL's commitment to this philosophy and has guided the strategy to increase knowledge and integration of HPI philosophies and tools. GDE-863 identified the HPI Vision as: "Reduce Human Error, Enhance Human Ingenuity, and Create a Capacity for Resilience. Resilience is not the absence of mistakes, errors, or failures but the presence of defenses and controls." The guide also defined Risk Important Steps and introduced the use of the Resiliency Scale to be used when evaluating a critical step to assist in determining the organization's level of dependency on humans to manage the capacity for resilience to manage unwanted outcomes. Thus, building a capacity for resiliency or "Failing Safely."

Since the development of GDE-863, PLN-4479, "Human Performance Improvement Plan for the Materials and Fuels Complex (MFC)," has been revised to reflect MFC's commitment to integrating the philosophy of HPI as a core fundamental of its management model and underlying belief system. The updates to PLN-4479 identified the following:

- Core HPI tools for all employees to learn and use
- The need for development of a single subject matter expert (SME) as an MFC HPI Lead
- Expectation that the MFC HPI Lead will work with staff in each MFC division to develop HPI Practitioners
- HPI Practitioners will help embed HPI tools and concepts with personnel in their divisions
- Defined a Just Culture as "a culture of trust, learning, and accountability" in which the primary purpose is to give people the confidence to report safety issues, knowing that the organization will respond fairly
- Developed goals, actions, and a timeline to achieve the ideals of the plan.

5.2 People

The overarching goal for MFC has been to reestablish a baseline for fundamental HPI knowledge and tool usage by MFC personnel. Strong progress has been achieved in developing and establishing this baseline.

- HBK-104 was created in 2017 and has been revised to include the principles of Human Performance and Just Culture that were outlined in PLN-4479
- Each employee at MFC has been provided a copy of the latest revision to HBK-104.
- At least 92 % of all MFC employees have attended 0INL1757, "Human Performance Improvement (HPI) Introduction" course and course 0INL1816, "INL Human Performance Improvement Guide 863 Workshop" for building a capacity for resilience.

Strong progress has also been made regarding the development of the HPI program at MFC through the creation and identification of the following:

- The Human Performance Improvement Academy has been created to support training of new personnel joining the HPI Team

- A Lead HPI Practitioner has been identified for MFC and is moving forward with continuing the implementation of the goals outlined in PLN-4479
- MFC personnel have been identified to attend the 0INL1758, “HPI Tool Selection and Use” training.

MFC is fortunate to have Procedure Professionals Association (PPA) certified instructors available on-site. PPA is a writer certification program that is based on Human Performance Principles that are proven to improve human performance and reduce error by teaching methods to write human factored procedures and work instructions. Several certification classes have been completed with MFC personnel as well as individuals from other facilities at INL. Overall feedback from these classes has been exceptionally positive with many attendees indicating a strong desire to incorporate the principles in their writing.

The PPA instructor has also created a Continuous Document Improvement (CDI) group specific to the MFC Planning Department. This group focuses on building consistency in documents and assisting planners in continuing to develop abilities to human factor work controls. Through this influence, discussion regarding the functional application of HPI tools in documents has permeated all planning and work activities at MFC and continues to grow.

5.3 Process

Re-establishment of baseline knowledge of HPI tools by personnel has been strong. Reminders to use HPI tools can be found in many areas and applications throughout MFC.

- A 15-minute HPI Overview presentation is provided at every new hire orientation.
- HBK-104 is readily available to all MFC personnel in hard copy, on the MFC home page, and on the Nucleus web page.
- HPI posters and information can be found in various locations throughout MFC.
- Use of fundamental human performance tools are incorporated in personnel activities such as pre-job briefings and planning activities.
- Use of monthly continuing training sessions to ensure knowledge and development of personnel with regards to HPI practices.
- Additional HPI training opportunities and resources are available on the HPI home page and through the INL HPI Academy.

Improvement is needed in developing strong procedures and work control. Procedures and work instructions are the primary interface between humans and the asset, so functionally incorporating HPI into MFC documents is paramount to reducing error. Unfortunately, most procedures at MFC contain error precursors and put the performer in Knowledge Base, increasing the chances of human error to occur. The PPA Certification class teaches how to identify the error precursors in documents as well as human factoring methods that eliminate errors and significantly reduces the opportunity for unwanted events. Encouraging personnel that develop, write, revise, review, and use work control documents to become PPA certified will eliminate error precursors in documents resulting in procedures that are more efficient with less opportunity for human error.

5.4 Equipment/Tools

Implementation of HPI tools at MFC has been adequate. However, improvement is needed in continuing to grow the knowledge of personnel in understanding and mastering the use of HPI tools. Error precursors such as perceived time pressures, fear of speaking up, not clearly understanding how to implement HPI tools, and situations that put personnel in Knowledge Base, continue to challenge the effective use of HPI tools, leading to events. There are several ways to reinforce and grow the knowledge base and use of HPI tools.

- Continue to train HPI Practitioners in each directorate to assist in communicating effective use of HPI tools and strengthen the ability of personnel to effectively use HPI tools in challenging situations
- Use the developed dynamic learning activities (DLAs), as allowed by pandemic restrictions during the next fiscal year, to expand personnel knowledge and reinforce the use of HPI tools
- Encourage participation in PPA Certification classes to give personnel the knowledge to eliminate error precursors and Knowledge-Based situations from MFC documents
- Expand CDI groups to build consistency between all forms of work control and improve writers' skill at human factoring documents.

5.5 Actions FY-22

- Qualify at least one individual from each division as an HPI Practitioner. (Shawn Hill, September 30, 2022)
- Complete 0INL1759, "HPI for INL Leaders and Supervisors" course for all individuals that were identified by training to perform leader and supervisor functions. (Shawn Hill, September 30, 2022)
- Train and certify procedure developers and writers to teach personnel how to functionally incorporate human factored wiring into procedures. (Tiffany Leavitt, September 30, 2022)
- Create additional DLAs to expand personnel knowledge and reinforce the use of HPI tools. (Shawn Hill, September 30, 2022)
- Assess and develop a strategy to address specific areas of human performance needing improvement as identified by the Performance Improvement Working Group and Management Review Meetings. (Dave Coates, September 30, 2022)

5.6 Looking Forward (FY-23 and Beyond)

- Develop an HPI refresher course for MFC personnel
- Evaluate the progress of FY-22 actions and adjust these actions to provide continued improvements.

6. CONDUCT OF OPERATIONS

6.1 Procedure Scope and Usage

6.1.1 A Look Back

The productivity and output demand of the MFC Document Management (DM) organization has increased on a yearly basis over the past 5 years. New capabilities within facilities, new projects, and facility growth have been significant catalysts for driving the number of changes to MFC procedures and document processes.

DM significant improvements since FY-16 include the following:

- Updated DM's processes to MFC's required standards from the Procedure Professional Association's (PPA's) PPA AP-907-005, "Procedure Writer's Manual," and incorporating those standards in MFC-ADM-0001, "MFC Procedure Writing Instructions" and MFC-ADM-0004, "Managing MFC Documents"
- Trained employees to the new processes
- Initiated rewriting MFC operation procedures
- Completed the PPA Trainer Certification course for one member of the DM team and certified four additional DM personnel and Business Division director
- Identified key facility procedures to update to the new format through collaboration with facility NFMs
- Improved writing instructions for Laboratory Instructions (LIs), Normal Operating Procedures (NOPs), and Maintenance Procedures (MPs) to strengthen employees' understanding of human factored writing and to build consistency within MFC's procedures
- Updated Use Types 1 and 4 to align with standards outlined by PPA, which included the removal of Use Type 2 as an option for operating procedures
- Created a method for incorporating associated forms as attachments in procedures to align with PPA and HPI requirements
- Developed "Responsible Reviewer – Review Guidelines" as an HPI tool for the review of document revisions and periodic reviews.

Even though hundreds of procedures are executed daily at MFC appropriately, the understanding and implementation of Procedure Usage at MFC has room for improvement. Findings have identified that some recent events may have been prevented if procedures had been used correctly. Improvements have been made to enhance personnel's ability to maintain procedure compliance.

Some of the MFC-wide improvements since FY-16 include the following:

- Conducted training on procedure usage for new employees
- Employed Conduct of Operations Procedure use simulators (HuPerT)
- Continued training for employees to reinforce procedure compliance requirements
- Issued a revision to MFC-ADM-9600, "Conduct of Operations for Materials and Fuels Complex Facility Operations," for clarity.

6.1.2 People

The DM staff are engaged, knowledgeable, and service-oriented, as demonstrated by continued support of the programs, projects, and operations at MFC.

DM has experienced very little increase in staff. Although head count has remained fairly constant, turnover has been, and will continue to be, an issue. Thirty-eight percent of the DM staff have worked at MFC 2 years or less and another 15% are retirement age.

The changes to the procedure process require rewriting MFC's procedures to ensure the processes are correct and HPI tools are integrated. Currently, the facilities do not have enough staff to support the rewrite initiative. The workload has noticeably increased over the last 5 years due to:

- Revising MFC's procedure processes
- Converting procedures to the updated format
- The upsurge of daily work due to new facilities and new processes
- Increased awareness of MFC's requirements to produce well-written procedures with reduced error traps.

DM's workload is expected to continue to increase due to the 5-year plan rewrite initiative, the creation of new facilities, and the increase of new projects.

An understanding that procedure compliance and adherence is necessary to ensure the highest probability of safe and repeatable outcomes resonates through MFC. As discussed, efforts have been made to improve procedures over the past 5 years. Along with these improvements, efforts have been made to enhance personnel's procedure usage and adherence. A significant number of operations, research, and craft personnel have been hired in the last 5 years. Continual training has been conducted across MFC, as well as training new employees to the same standards.

6.1.3 Process

DM processes and procedures are continually improving, striving for safe and accurate work performance. DM and the facilities are working to eliminate ambiguous information from procedures so workers can follow the instructions safely, efficiently, and accurately, allowing the MFC and INL missions to be met in a timely manner.

To improve human performance, MFC needs to functionally incorporate human factored writing into procedures, eliminate non-value-added information, and structure work instructions to emphasize critical information. Technology improvements, innovations, and training will be valuable assets to assist in continuous improvements while refining MFC processes.

6.1.4 Equipment/Tools

Tools and equipment for electronic procedures have progressed and are robust. DM needs enhanced technology to promote collaboration while creating/editing the procedures with customers.

Software upgrades for Asset Suite (AS) and Electronic Document Management System (EDMS) will increase efficiency, improve configuration management (CM), and enhance human performance.

6.1.5 Actions FY-22

- Issue the following administrative procedures (Tiffany Leavitt, September 30, 2022):
  - MFC-ADM-0008, "MFC Abnormal Operating Procedure Writing"
  - MFC-ADM-0009, "MFC Annunciator Response Procedure Writing"
  - MFC-ADM-0013, "MFC Procedure Usage."

- Continue to strengthen employees' understanding of human factored writing to build consistency within MFC's procedures by improving the writing instructions for Abnormal Operating Procedures (AOPs), and Annunciator Response Procedures (ARPs) (ongoing through the MOPs, coaching, and mentoring). (Tiffany Leavitt, September 30, 2022 [on-going])

6.1.6 Looking Forward (FY-23 and Beyond)

- Logic tie associated work documents (forms, logs, checklists, etc.) on EDMS required to perform a specific task/evolution
- Work with Training to continually update, improve, and reinforce procedure adherence
- Continue training selected facility/support personnel to PPA standards to learn the methods for functionally incorporate human factored writing into MFC's procedures
- Evaluate the use of dynamic procedures.

6.2 Logkeeping

6.2.1 A Look Back

In October of 2017, DOE-ID Facility Representatives (FacReps) wrote a finding against logkeeping at MFC stating, "Contrary to the requirements of MCP-9600, 'Conduct of Operations for Materials and Fuels Complex Facility Operations,' operations logs at MFC nuclear facilities contain insufficient content and clarity of information." In August of 2019, DOE-ID FacReps had not seen a significant improvement in logkeeping and opened a concern. Through significant actions taken at all operating areas at MFC, the concern was closed in August of 2021. Logkeeping is controlled and directed by LWP-9600, "Conduct of Operations for the Idaho National Laboratory" and MFC-ADM-9600. Administrative control of logkeeping practices at MFC in recent years has undergone substantial changes, notably a major revision to MCP-9600 in 2014 which added Appendix K for detailed logkeeping instructions and a change to MFC-ADM-9600 in 2021 that split the detailed logkeeping instructions into two different appendices, one for paper logs and one for electronic logs. Further analysis of individual facility log keeping practices has revealed that compliance or non-compliance, noteworthy practices and/or improvement issues are varied and, in many cases, distinct to each facility.

Significant improvements from the past 5-years include:

- MFC-ADM-9600, Rev 0 replaced MCP-9600 on July 21, 2021, and added separate appendices for detailed logkeeping instructions for both paper and electronic formats. The appendices greatly expanded the "how" and provided numerous examples.
- MFC has incorporated the logkeeping module of eSOMS in multiple facilities and will continue to pilot/implement eSOMs.
- Between 2018 and 2021, logs were collected on three separate occasions and sent to all SSs and NFMs to review. This resulted in several facilities noting good practices from other facilities and adopting these practices.
- Training delivered a DLA that involved a member of the BEA Legal Department. The objective of the training was to stress the importance of log content when defending a court case.
- The majority of MFC related logkeeping problems stem from inadequate content. Most of the actions taken over the past 4-years have been targeted around obtaining better (more complete) daily content. The information contained in a log should provide enough detail to recreate the activities that occurred during the day.

6.2.2 People

Shift Supervisors, each day, must prioritize the day's activities and subsequently logkeeping in all MFC facilities. SSs and NFMs must review logs on a timely basis and provide feedback to ensure

logkeeping meets requirements.

6.2.3 Process

Logkeeping is controlled and directed by LWP-9600 and MFC-ADM-9600.

6.2.4 Equipment/Tools

Multiple MFC facilities have implemented the use of electronic logs (eSOMS) and many others are piloting the software. This system will be rolled out to remaining MFC facilities in 2022.

6.2.5 Actions for FY-22

- Monitor, identify, and address any log keeping deficiencies. (Shawn Hill, September 30, 2022)

6.2.6 Looking Forward (FY-23 and Beyond)

- Monitor and maintain robust logkeeping at all MFC facilities.

6.3 Turnover

6.3.1 A Look Back

Turnovers and assumptions of responsibility at MFC is a structured and organized process. From the facilities, to the roundsmen and security, all have a formal way of performing turnovers. In the past few years, MFC has increased its workload and added multiple buildings and facilities in which operational and backshift duties, and new personnel has increased. One of the key elements in communicating a turnover and assumption of responsibilities is the narrative logs. MFC has been working on a continuous improvement agenda to train, coach, and improve the detail of the narrative logs to assist in a proper turnover. The use of MOPs as a tool for identifying worker behavior issues with turnovers is apparent and critical when reviewing past performance. Key improvements that have been made to improve turnover are shown in Table 2. In addition, a key focus at MFC is on human performance. While performing turnovers and assumption of duties it is important to identify and address HPI concerns and consistencies. This focus has helped train and address key HPI issues involved in turnovers.

Table 2. Recent MFC Turnover Improvements.

MFC Turnover Improvements	
Procedures/Process Improvements • MCP-9600 "Conduct of Operations for Materials and Fuels Complex Facility Operations" • LWP-9600 "Conduct of Operations for the Idaho National Lab" • DOE O 422.1, "Conduct of Operations" • DOE O 422.1, "Conduct of Operations," Chg. 3 • DOE-HDBK-1226-2019, "Conduct of Operations Implementation"	**Training /Qualification Improvements** • QNCOP001 – INL CONOPS CORE • MCQ1303L – CONOPS PINC 12 • 000INL93 – Standards of Conduct • 00INL869 – Laboratory Excellence Program Core Training • 0INL1471 – Walkdowns and Verifications
Technology Improvements • eSOMS electronic log systems to help with turnover and trending.	**Personnel Improvements Key Personnel Development** • Strategic Hiring • Continuous improvements using MOPs • Continuing training for Human Performance

	Improvements

6.3.2 People

MFC personnel are highly trained and capable professionals. With the increase of workload and growth at MFC over the past few years it has been necessary to increase the size of the support team. The retention of experienced employees is a concern with the possible loss of knowledge and expertise. Recent changes and future changes that are being discussed along with active progression plans will help to change that trend. MFC has tried to be proactive in the hiring processes in the past to hire and train operations personnel to fill positions due to attrition, but it is an area to always be aware of.

6.3.3 Process

The Turnover and Assumption of Responsibility process is acceptable and with continuous improvement and continuing training it is becoming more consistent. The description of turnovers and assumption of responsibility within MCP-9600 and LWP-9600 is descriptive and detailed. The detail for a good turnover may contain information as to current status of facility operations, maintenance activities in progress, abnormal system conditions or lineups, out-of-service equipment, existing problems identified by off-going shift personnel and troubleshooting activities taken or in progress. Reviewing how the different facilities at MFC execute this process differs in how it is implemented, but the key aspects lined out in MCP-9600 and LWP-9600 are being used consistently. The use of management observations for identifying issues and the associated coaching is documented well in LabWay. The use of the management observations and associated conditions as lessons learned improves consistency across MFC. Additionally, the continued use of HPI tools within the process will reduce error likely situations. The continued facility-specific training on the process and compliance focus, within the facility, is shown by the operator ownership in each facility.

6.3.4 Equipment/Tools

The tools needed for the turnover process are strong and continue to change and develop. The use of eSOMS for tracking, trending, and efficiency is being evaluated. Also, continuous improvement of facility logs, updated information, training, and HPI efficiencies aides in the progression of turnover processes.

6.3.5 Actions FY-22

- Complete implementation of eSOMS logkeeping at MFC facilities. (Shawn Hill, September 30, 2022)

6.3.6 Looking Forward (FY-22 and Beyond)

- Continue to evaluate and improve upon MFC facility turnovers.

6.4 Operational Configuration Management and Status Control

6.4.1 A Look Back

In the past 5 years, MFC facilities have increased both staffing and operational tempo, performing more research related work than at any other time in MFC history. This has resulted in facility modifications and new equipment installation in nearly every nuclear facility at MFC. Managers and supervisors have been afforded several tools to understand the status of equipment in their facilities. In the past several years, MFC has provided two electronic equipment status tools (one is now only used by RadCon, the other is not used at all), a Standard Practice, SP-96.8.1, “MFC Control of Equipment and System Status,” an equipment alignment form, FRM-1387, “Miscellaneous System/Equipment Alignment,” and guidance on control of equipment and status through laboratory-wide procedure

LWP-9600 and management controlled procedure MCP-9600.

Facility NFMs and Shift Supervisors were consulted on the effectiveness of their operational configuration management and status control practices, and each of the responding facilities felt confident in their ability to perform those functions effectively. The tools being used range from logbook turnover (every facility reported doing this), keeping an updated status board (either manually or with an automated electronic system), or utilizing SP-96.8.1 and FRM-1387 (some used these tools infrequently, while others used them on a scheduled basis to routinely verify all components in every system in the facility).

Recent incidents at MFC have either come directly from or have been complicated by shortcomings in the practice of operational configuration management and status control. Hot cell over-pressurizations at FCF and HFEF are examples where robust status control and operational configuration management could have helped prevent or mitigate these events.

In the cell over-pressurization event, the FCF supervisor relied on verbal directions to operators and operator manipulated equipment without any written instruction. If FCF had utilized the tools available for status control, specifically SP-96.8.1 and FRM-1387, to control abnormal system alignments, the tools may have prevented the operator from mistakenly securing equipment which resulted in cell over-pressurization. Furthermore, the use of approved written instructions for attempting to reestablish a negative cell pressure could have prevented the subsequent cell low pressure received during the operator's recovery actions.

Operational configuration management at HFEF failed to recognize that an upgrade to the facility pressure control system, while functional, was not yet released by engineering as it had not been fully tested and the engineering job (EJ) had not been closed out. Using the new, untested automatic pressure control system, as well as making assumptions on the operational characteristics of this system, resulted in cell over-pressurization when power was secured to the system and the (untested) transfer switch failed to transfer to a backup power supply.

Looking even further back than the last 5 years, a lack of status control on multiple independent components required for the function of an Argon-West hood system at the Zero Power Physics Reactor (ZPPR) exacerbated the consequences of a plutonium release from a damaged fuel plate, and ultimately resulted in a plutonium uptake by MFC staff members.

Operational configuration management and status control at MFC is occurring effectively in most cases across all facilities, but as past incidents show, every facility could benefit from a critical evaluation and improvements.

6.4.2 People

Roles/Responsibilities & Accountabilities

DOE O 422.1, Paragraph 2, H, dictates that DOE contractors establish a Control of Equipment and Status portion of the Conduct of Operations program. The details of these requirements are further discussed in DOE-STD-1039-93, "Guide to Good Practices for Control of Equipment and Status Control." The DOE Standard and DOE Order require that DOE contractors meet the following criteria within the Control of Equipment and Status Control programs:

- The operations supervisor maintains proper facility configuration, including authorizing changes to equipment and system status.
- A system is in place to ensure and document proper alignment of equipment and systems prior to placing them in service.
- A LO/TO program is in place to provide protection to personnel and equipment, and to aid in the control of equipment and system status (covered by DOE-STD-1030-96, "Guide to Good Practices for Lockouts and Tagouts").

- Administrative controls are established to document compliance with operational limits.
- Operating personnel receive accurate information reflecting the status of control panel and local panel alarms.
- A system is in place to document equipment deficiencies.
- All activities, including maintenance, on equipment that are important to safety, that affect operations, or that change control indications or alarms, are properly analyzed, documented, and authorized.
- Operational testing is performed following maintenance to demonstrate that equipment and systems can perform their intended function.
- A system is in place to control temporary modifications to facility equipment or systems.
- A document control system is in place to ensure operating personnel have the latest revision to documents necessary for proper control of equipment and systems.

To implement the requirements of the DOE Order and Standard, INL has incorporated the required elements into LWP-9600 and again locally into MCP-9600, and MCP-3955, "Conduct of Operations for the Transient Reactor Test (TREAT) Facility." Supplemental tools available at MFC include SP-96.8.1, and FRM-1387 which both MFC and TREAT use.

The basic structure of these documents mandates that NFMs determine which facility systems are important to the safety and the safe operation of the facility, and therefore, require configuration management and status control. NFMs should also work with supervisors to determine ways to incorporate these status and configuration systems into facility operating practices. Facility Operators have the responsibility to keep supervisors informed of equipment status changes and deficiencies. All other responsibilities become the responsibility of the Operations Supervisors (Shift Supervisors/Foremen).

Recruitment

Recruiting operations managers and supervisors that understand the importance of status control and configuration management is important to the overall conduct of operations mission at MFC. Hiring managers should include these topics during initial candidate interviews.

Training & Qualification

Conduct of Operations is an integral part of MFC operator, supervisor, and management training; however, little training is available specifically for status control and operational configuration management. Most training associated with these topics is covered by required readings of LWP-9600 and MCP-9600. A classroom version of training is available for SP-96.8.1 (non-repeating), and up until 2016 there was an annual conduct of operations written exam. A new training needs to be developed, further described in Subsection 6.4.5.

Decision-Making

Ultimately, decisions regarding which systems require configuration management and status control and practicing diligence in using available tools to ensure configuration management and status control is performed is paramount to this system being successful. Managers must take a conservative approach when determining which safety systems and other support systems are important to the safe operation of the facility and require status control and operational configuration management. Managers should then formalize the list of systems and ensure operators and supervisors are trained and informed on the importance of maintaining configuration management and status control of these systems. Operators must inform supervision of changes and degradation to equipment, while supervisors must find an effective way to track changes/issues. Most of the decision-making responsibilities lie with the supervisors as they are responsible for maintaining an overall view of the facility's systems and are responsible for directing operators in response to abnormal conditions. Poor configuration management and status control decisions by supervisors in each of the cases mentioned earlier either contributed to causing the issues or

complicated them.

Conflict Resolution

Conflicts between individual facilities and the MFC operations group over what was perceived to be an onerous administrative requirement concerning operational configuration management and status control have arisen in the past. The two MFC-wide computer systems used to track status and configuration of systems at MFC in the past have either been abandoned (MFC Facility Status Workbook) or transferred to RadCon (Facility Equipment Status Board, now the RadCon Instrumentation Status Board). This shows that an MFC-wide equipment status tracking program will not add value to the individual facilities. Additionally, some facilities interviewed were reluctant to use the existing Status Control binders, which incorporated the use of SP-96.8.1 and FRM-1387, as use of the Status Control binder was viewed as an unnecessary administrative task. Other facilities viewed SP-96.8.1 and FRM-1387 as a requirement to be performed on all systems, regardless of the operating tempo and existing operating instructions.

The answer to this conflict is somewhere in the middle; a few of the facilities use these tools as intended. Using the tools available with a graded approach could alleviate the stigma of undue administrative burden. In some cases, the tools may make operation of these systems more efficient. For example, if a procedure is paused mid-work for any kind of reason, and the operations supervisor determines that a piece of equipment that was secured per the procedure needs to be restarted until work on the procedure can continue, the operations supervisor can use FRM-1387 to give written instruction to the operators to start the equipment, while tracking this action so that when the procedure is resumed the supervisor is able to ensure that operators will re-secure the equipment before proceeding with the procedure. If these steps had been taken in the FCF over-pressurization incident, there is a much smaller chance that the over-pressurization would have happened at all.

On the other hand, continuously performing configuration checklists on systems that are routinely operated using approved written instructions could lead to confusion between the procedural system alignment and the anticipated lineup per the checklist as the system may have been operated since the creation of the checklist. Additionally, repeated performance of configuration checklists on benign systems or systems that rarely change configuration, may lead to complacency. Determining the right time (i.e., after major maintenance, deviations from operating instructions, or if the system has not been checked in a long time) could aid in operations staff viewing the configuration checklists as a useful tool instead of an undue administrative burden.

6.4.3 Process

Contract Requirements

BEA is contractually required to adhere to all applicable DOE Orders and Standards. This includes Conduct of Operations requirements and, therefore, Operational Configuration Management and Status Control.

Compliance performance

While DOE O 422.1 states that the Control of Equipment and Status Control program must adhere to items (a) through (j), DOE-STD-1039-93 is a “Guide to Good Practices” that DOE contractors can use to perform Control of Equipment and Status Control, while allowing the contractor to find other ways to fulfill requirements (a) through (j). INL and MFC (including TREAT) have incorporated these practices into LWP-9600, MCP-9600, MCP-3955 (TREAT), SP-96.8.1, and FRM-1387. Additionally, when an incident regarding status control or configuration management has occurred, it has been considered by management and DOE oversight that the issue is a procedural non-compliance failure, rather than a Control of Equipment and Status Control program failure.

Efficiency

Increased use of configuration management and status control would result in an increase in facility efficiency. The gain in efficiency would be realized not necessarily from performing status control checklists, but from preventing lost time that could result from system misalignments, fact findings, damaged equipment, etc.

Innovation

An opportunity is available to use technology innovation to assist operations supervisors in maintaining status control and configuration management, discussed below in Subsection 6.4.4, "Equipment/Tools."

Human Performance Improvement

Human Performance Improvement is an area of which the most advances could be made in terms of improved status control and operational configuration management. Operations supervisors need to utilize tools and systems that are intuitive and easy to understand in order to make informed decisions about the status of safety systems and systems that are important to the safe operation of the facility. This is an essential element of supervisors making decisions that reflect "safety first."

Furthermore, understanding how and when to use the status control and operational configuration management tools accurately will assist in procedure use and adherence, effective communication practices, verification practices, and a questioning attitude, which are all discussed in HBK-104.

Procedure use and adherence is important in that it provides operations supervisors with a tool to provide written guidance for equipment configuration, FRM-1387, and allows for the manipulation of individual plant components for specific reasons. This same tool also allows the operations supervisor to communicate, through written instruction, a way to configure plant components so that compliance with other operating instructions and procedures is possible. A combination of written guidance given by the operations supervisor and approved operation procedures ensures that no components associated with safety are operated without written instruction.

The use of a methodical system of operational configuration management and status control provides a format for clear, concise, complete, and consistent communication and transfer of critical information, all of which are essential for effective communication practices. Status boards, miscellaneous equipment/system alignment forms, live building monitoring systems, and equipment status log entries are all useful tools for communicating the status of facility equipment and components.

On systems vital to safety or related to the safe operation of the facility, operations supervisors may need to employ a mechanism for confirming the position of equipment in those systems. FRM-1387 provides operations supervisors with a tool to give written instruction to operators to perform concurrent or independent verification on any system/component whose configuration may be in question. These verification practices are an important HPI tool that operations supervisors need in their tool kit. Operations supervisors should deploy this tool when error precursors such as unexpected equipment conditions, changes from the routine, confusing indications, and out-of-service indications or equipment exist.

Clear and easy to understand tools for determining the status and configuration of important systems (status boards, checklists, schematics, electronic monitoring systems, etc.) also provide operations supervisors the opportunity to question systems that do not look right. If the tools are easy to use, then the operations supervisor can easily ascertain when systems are not aligned as they normally are or see how out-of-service equipment may affect other components in the same or adjacent systems. A questioning attitude regarding plant conditions is easier to cultivate when a clear picture is provided.

6.4.4 Equipment/Tools

Tools Needed

Operations supervisors currently have several tools available to perform adequate status control and operational configuration management. However, these tools would still benefit from improvements, or at least could be employed in appropriate situations more often. For all facilities, a reminder on what tools are available and how to employ the tools, is needed. Some facilities would benefit from a more robust form of status control, such as a P&ID used as a status board or converting from a manual status board to a live-updating electronic one. Ultimately, the individual Facility Supervisors and Managers will need to determine which form of status control and operational configuration management is appropriate.

All facilities should investigate improvements to their current system. For example, a facility that only uses logbook turnover for the status of systems, equipment, and components may explore using a manual status board. Facilities that use a manual status board may try to incorporate an electronic monitoring system after the next equipment upgrade. Facilities that have an electronic monitoring system may review the current system to ensure that the information displayed is vital or to determine if other vital information is missing from the current system.

Computer Systems & Information Management Upgrades

For facilities that do not have an electronic monitoring system, equipment upgrades should be chosen that have remote monitoring capabilities. A corresponding computer system for displaying this information would then be installed after an adequate number of system components have this capability. Facilities that already have an electronic monitoring system may need to update/upgrade the existing systems to prevent obsolescence issues or displaying incomplete/inaccurate information.

Automation Potential

Electronic monitoring systems remove the human error of remembering to update manual status boards and logbook entries. The use of these types of systems should be used to the maximum extent possible where complexity and importance warrant their use.

6.4.5 Actions FY-22

- NFMs and operations supervisors shall assess and critically evaluate the facilities current method of status control/operational configuration management and look for improvement (Shawn Hill, September 30, 2022)
    - Facilities that do not use a status board may evaluate if the use of one would help, facilities that use a manual status board may explore an electronic one, and facilities that have an electronic monitoring system may determine if the information provided by it is useful and if other important information is missing.

6.4.6 Looking Forward (FY-23 and Beyond)

- Assess the current level of training regarding Operational Configuration Management and Status Control.
    - If additional training is deemed necessary, then develop training for operations supervisors detailing the importance of status control and operational configuration management.
    - This training should include an overview of the facility-specific tools currently used and additional tools that are available and should also give scenario-based exercises that help illustrate the usefulness of these tools.
    - Discuss lessons learned from configuration management and status control shortcomings in the past.
- NFMs and operations supervisors should review SP-96.8.1 and determine its applicability to each individual facility.

- Review and formally declare which systems require status control and operational configuration management (all safety systems and support systems that affect the safe operation of the facility are required to adhere to the status control and operational configuration management program).
- Document these systems and the method of status control/operational configuration management to be used with each system in the facility's administrative requirements procedure (systems that are operated in accordance with an approved operating instruction do not necessarily require status control updates unless the procedure is paused or interrupted).

- All facility managers and supervisors should/may consider bringing automated electronic status monitoring into their facilities to the maximum extent possible.
  - Facility upgrades and updates should preferentially include equipment with the capacity to incorporate into an electronic system.
- Consider including status control and operational configuration management discussions with all potential supervisors and operations managers (internal or external hires).

6.5 Lockout/Tagout

6.5.1 A Look Back

MFC had a rash of Lockout/Tagout (LO/TO) issues in 2012. Several performance issues were identified which led to the implementation of several improvements, including learning seminars, procedure improvements, planning (roundtable) requirements, clarification of exclusion control both for cord-and-plug and for gas cylinders. Unfortunately, the learning seminars lost priority and were quickly discontinued. There were also several actions that were suggested but never implemented. The actions are now included in this improvement agenda. Recently, MFC has developed and implemented a complex specific LO/TO procedure and has taken great strides to improve the vast Multiwire Branch Circuit (Edison Circuit) issues that existed. Personnel have performed a significant number of LO/TOs in the last 5 years, with an incredibly high percentage of the LO/TOs resulting in successful task completion, with no issues. Unfortunately, the LO/TOs completed in the last 5 years have not been 100% successful in mitigating hazards to personnel, thus leaving room for needed improvements in the LO/TO procedure. A review of LO/TO events that have occurred within the last 5 years revealed that the overwhelming majority are electrical hazard related. Therefore, a special emphasis on electrical issues is needed to confront this challenge.

Regarding specific lessons learned over the last 5 years at MFC, LO/TOs have been identified as needing improvement in the areas of procedure use and adherence and in utilizing HPI tools when executing the LO/TO process. As noted above, MFC uses a facility-specific LO/TO procedure. When the procedure is executed properly, employees can adequately perform lockouts/tagouts in a safe and compliant fashion. Proper use of the procedure as a tool for the performance of LO/TO activities will help prevent future LO/TO issues. Dynamic learning activities relating to procedure use specific to the performance of lockouts/tagouts could provide opportunities to improve personnel performance at MFC for LO/TO work.

In addition to proper procedure use and adherence, other LO/TO lessons learned identified a significant number of human performance behavioral issues. Questioning attitudes and the use of STAR (Stop, Think, Act, Review) principles were noted in recent MFC LO/TO events as areas for improvement. Utilizing HPI tools and practicing proper conduct of operations principles will improve the execution of lockouts/tagouts at MFC.

In calendar year 2021 the following actions were taken to improve LO/TO implementation and performance:

1. A Timely Order to Operators was published to provide independent review of the LO/TO planning process and independent review of the LO/TO to ensure isolation devices were correctly positioned and LO/TO devices were correctly installed. The Timely Order also described a new engineering process to revise or create needed drawings in a timely manner.

2. An MFC LO/TO Committee was formed, and a charter (CTR-493, "MFC Lockout and Tagout Committee") was developed and published to promote and achieve consistency and excellence in the execution of lockout and tagout activities at MFC.
3. MFC training created multiple DLAs to support LO/TO performance.
4. MFC Training developed a DLA to help with identifying and locating drawings required for LO/TO.
5. A LO/TO procedure rewrite group consisting of MFC operations, maintenance, and engineering personnel was convened to identify shortcomings in the current LO/TO procedure (SP-94.0.0, "MFC Lockouts and Tagouts Supplement to LWP-9400") and provide a procedure/process that would limit pitfalls/HPI errors.
6. MFC-ADM-9400, "MFC Lockouts and Tagouts, Supplement to LWP-9400" was developed and is currently in the EDMS review process. The new procedure is used for reference and LO/TO implementation will be through the use of Use Type 1 checklists.

6.5.2 People

Lockout/tagout qualified personnel are professional and knowledgeable in their specific fields. These fields vary between qualified electrical workers, mechanics, radiological control personnel, and operations. The LO/TO program is specifically required under 29 CFR 1910, "Occupational Safety and Health Standards," and is one of the top safety programs in any industrial industry. Personnel safety is a top priority to INL and MFC. The personnel at MFC are the greatest asset to the organization, and as such, the LO/TO program is of the upmost importance to keep personnel safe.

The MFC LO/TO Committee will remain cognizant of LO/TO issues and has the authority and responsibility to correct these issues. The committee will continue to look at trends, perform periodic observations, and crosscut throughout different facilities to collect positives and negatives. The committee will develop activities to keep correct LO/TO actions at the forefront of personnel's minds by encouraging positive reinforcement. By focusing on positive reinforcement, instead of working in reactive mode to an abundance of issues, the MFC LO/TO committee will work to decrease LO/TO incidents. Additionally, the committee is responsible for recognizing personnel for outstanding LO/TO performance, and being involved in the development of LO/TO seminars, newsletters, etc. A special emphasis on reinforcing positive behaviors is important since human tendency is to follow routines.

6.5.3 Process

The LO/TO processes and procedures are acceptable and are continually improving. One of the improvement process goals includes identifying areas of the program that can be simplified and made easier to use, while still maintain the rigor needed to ensure personnel safety from energy sources. The use of HPI tools and Human Factored Documentation will improve the clarity and usability of the LO/TO program. Additional resources or outside programs will be evaluated to consider other options or methods used to further develop the program and may lead to the development of a simpler LO/TO plan and better HPI tools. The goal is to minimize the amount of information personnel need to review when generating an adequate LO/TO.

6.5.4 Equipment/Tools

Tools and equipment for LO/TO are effective and reliable. With few exceptions across MFC, aging equipment and/or unknown changes to facility design over the past 40 years has been a significant battle for properly isolating hazards prior to performing work. Most facilities have the equipment and tools that are needed to fulfill mission goals safely and successfully. To increase HPI and efficiency, additional equipment, tools, or facility modifications are being performed to provide better understanding of the hazards and how to control them.

Equipment, system upgrades, and tools that will increase efficiency and human performance will be part of the new process that is being evaluated. New software capabilities, such as LO/TO plans

developed using Asset Suite or other similar software, should be evaluated, and developed for future capabilities. Utilizing these software systems will decrease the likelihood of human error and realign MFC with private industry standard practice.

6.5.5 Actions FY-22

- Streamline LO/TO preparation documentation by using Human Factored Documentation (Shawn Hill, April 30, 2022)
  - Complete publication of MFC-ADM-9400 and associated checklists.
- Improve MFC personnel proficiency, awareness, attitude, and training regarding the LO/TO program (Shawn Hill, June 30, 2022)
  - Develop, and begin implementation of, a plan for training improvement that includes MFC-specific topics for LO/TO personnel, as well as affected employees and line management.
  - Evaluate and provide suggestions to the INL training department for improvement of LO/TO training, as well as developing a LO/TO continuation training program (using the LO/TO advisory group).

6.5.6 Looking Forward (FY-23 and Beyond)

- Develop software options for LO/TO preparation
  - Assist Engineering and Business Management in building/developing an electronic process for LO/TO preparation generation for standard preventative maintenances (PMs), as a method to improve HPI practices
  - Implement the new electronic process and create procedures as the tools are developed.

6.6 Safety Basis Document Implementation

6.6.1 A Look Back

This chapter describes the past and present state of SAR/TSR implementation at MFC and provides suggestions for continued improvement.

A review of how MFC is implementing Safety Basis documents, Safety Analysis Reports (SARs) and Technical Safety Requirements (TSRs), in the facilities was conducted; this review looked at where MFC was in the past, where it is today, and how it can improve in the future.

Based on this review, three weak areas were identified. Those areas, and a summary of suggested corrective actions are as follows:

- Training – Training needs to improve and increase in facility-specific safety basis documents and the INL SAR/TSR-400 document, including evaluation, and diagnostic skills.
- Current TSR Controls – Facilities should identify and compare their hazard analysis to the Evaluation Guidelines to see where restrictions can be reduced.
- TSR/SAR Implementation Tracking – Facilities should assess and improve SAR/TSR implementation, as necessary.

INL identified and categorized facilities at MFC that meet the requirements of Hazard Categories and published that list in LST-715, "INL Hazard Category 1, 2, and 3 Nuclear Facilities." Those facilities are listed in Table 3 below.

Table 3. MFC Facilities categorized as Hazard Category 1, 2, and 3 Nuclear Facilities.

No.	Facility/Activity Name Hazard Category	Building(s)/ Structure(s)	SAR/TSR
1.	Analytical Laboratory (AL) Hazard Category 3	MFC-752	SAR/TSR-401
2.	Fuel Conditioning Facility (FCF) Hazard Category 2	MFC-709/765	SAR/TSR-403
3.	Fuel Manufacturing Facility (FMF) Hazard Category 2	MFC-704	SAR/TSR-404
4.	Hot Fuel Examination Facility (HFEF) Hazard Category 2	MFC-785	SAR/TSR-405
5.	Irradiated Materials Characterization Laboratory (IMCL) Hazard Category 2	MFC-1729	SAR/TSR-418
6.	Material Security and Consolidation Facility Hazard Category 2	CPP-651	SAR/TSR-416
7.	Neutron Radiography Facility (NRAD) Hazard Category 2	MFC-785	SAR/TSR-406
8.	Radioactive Scrap and Waste Facility (RSWF) Hazard Category 2	MFC-771	SAR/TSR-407
9.	Remote-Handled Low-Level Waste (RHLLW) Disposal Hazard Category 2	B21-630/632	SAR/TSR-419
10.	Space and Security Power Systems Facility (SSPSF) Hazard Category 2	MFC-792A	SAR/TSR-408
11	Transient Reactor Test Facility (TREAT) Hazard Category 2	MFC-720 MFC-724	SAR/TS-420
12.	Zero Power Physics Reactor - Reactor Cell/Workroom/Vault (ZPPR-RC-W/V) Hazard Category 2	MFC-775/776/777	SAR/TSR-412

There are also several nuclear transportation activities that fall under the Hazard Categorization of level 3 and above that impact MFC, shown in Table 4.

Table 4. Nuclear Transportation activities at MFC that are Hazard Category 3 and above.

No.	Facility/Activity Name Hazard Category	Safety Bases
1.	Intra-INL Transportation and MFC Inter-Facility Transfers Hazard Category 2	SAR/TSR-413
2.	Transport Plan for Transfer of Material between MFC, ATR Complex, and AMWTP Hazard Category 2	PLN-3243
3.	Transfer of EBR-II Driver Fuel between INTEC and MFC Hazard Category 2	PLN-3524
4.	Transport Plan for the Transfer of SFTP Between MFC and INTEC Hazard Category 2	PLN-4517
5.	Transport Plan for the Transfer of the BRR Cask Hazard Category 2	PLN-4518
6.	Transport Plan for the Transfer of Irradiated Experiments between ATR and HFEF Hazard Category 3	PLN-4609
7.	Transport Plan for the Transfer of the 55-Gallon RH-TRU Overpack Hazard Category 2	PLN-4949
8.	Transport Plan for the Transfer of RH-LLW in the HFEF-5 Cask Hazard Category 3	PLN-5495

All facilities identified had safety basis documents prepared as required by DOE per 10 CFR 830, "Nuclear Safety Management - Quality Assurance Requirements," however, the facilities did not necessarily follow the format and guidelines of DOE standards. MFC facilities upgraded their safety basis documents to meet DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis," during the past several years to meet the 17-chapter format and guidelines of that document. MFC safety analysis documents are now standardized with a few exceptions.

- NRAD followed DOE-STD-3009-94, with appropriate consideration of format and content for research reactor safety analysis reports as described in GDE-470, "Documented Safety Analysis (DSA) Conversion Guide for the Neutron Radiography Reactor Facility (NRAD)."
- TREAT followed Reg. Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," and NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants."
- Transportation safety basis documents, which include SAR/TSR-413 and other Transportation Plans, followed 10 CFR 830 Subpart B, DOE-STD-3009-94, DOE-STD-1027-92, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports," DOE O 460.1D, "Hazardous Materials Packaging and Transportation Safety," and PDD-2500, "INL Transportation Safety Document (TSD)."

SAR-400, "INL Standardized Safety Analysis Report" and TSR-400, the INL Standardized SAR and TSR, were also developed in the standardized format based on DOE-STD-3009-94. These documents were developed to relieve the repetition each facility would have in certain chapters of the facility SAR. SAR-400 and TSR-400 deal with standardized definitions and usage rules, generic LCO and Surveillance applications, and other common areas such as siting, INL-wide programs, and emergency response.

All facilities currently have SARs and TSRs based on a standardized format.

A review of recent Initial Notification Reports identified the following problems with respect to SAR/TSR implementation:

- On 05/30/2021 a transfer of material from one zone to another that is prohibited by criticality control list LST-390 was performed at FCF. This was identified by another operator on 6/2/2021. This was a violation of SAC 5.403.4; ORPS reportable under 3A(1) H.
- On 6/01/2020, two Technical Safety Requirement Surveillance Requirements (SRs) were missed in the IMCL.
- On 7/30/2020, during review of an Experimental Safety Analysis (ESA) for an upcoming experiment, it was discovered that the ESA for the ongoing ATF-RIA-1 test series did not address the experiment reactivity effect of a burst disc rupture or blowdown mechanism for an experiment capsule filled with water.
- On 10/07/19 in the ZPPR Facility, operations were accessing material storage locations. At 1325, upon opening a storage location access door, a bin storage tube location door was found in the open position, with fissionable material located inside of the storage tube. Previously, three storage locations had been opened which meant a total of four storage locations were open at one time. The ZPPR Facility criticality control list, LST-392, "Zero Power Physics Reactor Criticality Control List," had the following requirements:
  - Bin storage tubes containing fissionable material must have a hinge door bolt-lock in the locked position with a hitch pin inserted.
  - The number of approved storage locations allowed to be open during fissionable material handling activities is limited to less than or equal to three.

  This constituted a violation of SAC 5.412.3 in TSR-412, "Technical Safety Requirements for the Zero Power Physics Reactor Complex."

Along with these examples, in 2018 ONA performed a Technical Safety Requirements Implementation Review at MFC, TREAT, and ATR. ONA teamed with representatives from each complex to develop scenario-based questions that tested conceptual knowledge of TSRs. Generic hypothetical questions were developed to assess performance across facilities applying the general LCOs and SRs, as well as facility-specific questions to ensure operators had sufficient knowledge to navigate their facility's TSRs.

A summary of the overall results included that:

- Most personnel were unfamiliar with general LCOs or SRs within TSR-400.
- Several personnel did not know that surveillances were not required to be performed on inoperable equipment.
- Action time limits and specific caveats were missed (e.g., mode changes when not meeting a SR, time specified to initiate action to change modes when actions are not provided or not met).
- Personnel did not enter each associated action per LCO 3.400.2.
- Personnel knew the defined term IMMEDIATELY but had varying answers when challenged with a scenario.

MFC-specific comments indicated a need for improved training on INL SAR/TSR-400 and SAR/TSR in general. Those comments included:

- Some personnel were unfamiliar with what constituted a TSR violation.
- Some individuals did not recognize that failure to meet an SR resulted in failure to meet the LCO.
- Several personnel were unfamiliar with the requirements of LCO 3.400.3.
- The concept of mission time with regards to SSC operability was not understood by some individuals.
- When using TSR-400 to determine the requirements for a particular answer, several personnel applied the wrong motherhood LCO.
- General level of knowledge of the TSR requirements varied based on past work experience (e.g., commercial nuclear industry, other DOE complex facilities). Those with only MFC experience had an overall lower level of knowledge of TSR requirements and usage.
- Some were not familiar with an Evaluation of the Safety of the Situation or how it related to the safety basis.

ONA also conducted a review of four TSR violations at MFC, including two which happened in 2020:

- FCF Criticality Control (CO 2020-0216)
- Missing SR during Material Transfer (IMCL MFC-1729, CO 2020-0880)

Their review focused on four questions/areas:

1. Was the TSR necessary?
2. Is the TSR clear in its intent, is there any ambiguity, and can it be followed easily?
3. Verify/review implementation of the TSR. Is it implemented appropriately? Is it clean and workable?
4. Were the corrective actions to the TSR violation adequate?

One of the weaknesses noted in this review was that often TSR controls were based on very conservative interpretations of the hazard's analysis, leading to restrictions that impact the ability to conduct and accomplish work in safe but more efficient ways.

This is in line with recent MFC Management observations concerning the margin of safety used in the derivation of controls compared to the Evaluation Guidelines, as outlined in DOE-STD-3009 (1994 and 2014) and reiterated by NE-ID in a recent letter from the Idaho Operations Office (CCN 247290). In some instances, identified by MFC management, the controls put in place severely restrict operations compared to that allowed by the Evaluation Guidelines. This impacts work in a negative manner and can increase workload and stress to workers while complicating or even preventing accomplishing daily work processes.

Actions taken in calendar year 2021 to address these issues:

1. TSR writing guide issued by program office for use in development of new TSRs and review of existing TSRs.
2. MFC Nuclear Safety wrote and is currently using MFC-ADM-0012, "Annual and Triannual Updates to MFC Nuclear Facility Safety Bases" for detailed guidance on updating safety bases. For example, the RSWF safety basis review improved the following:
    a. A revision for single confinement containers to allow for drums to by handled and stored in RSWF.
    b. Resolution was increased to recognize the difference between TRU waste and accountable material waste and the requirements for handling each.

3. Rewrite of some Criticality Control lists to improve clarity and ease of implementation.
4. MFC Nuclear Safety has worked to improve engagement in order to support NFM's and Operation's understanding of safety requirements and strategies and encouraging them to reach out with questions prior to proceeding in the face of uncertainty. The following are examples of recent questions received by Operations allowing nuclear safety to help them prior to receiving TSR violation.
    a. FCF contacted nuclear safety to discuss TSR requirements prior to punching four new penetrations in FCF argon cell. FCF worked with nuclear safety to rewrite their implementing procedure for cell leak rate check surveillance to be able to perform the four new penetrations without violating TSRs.
    b. IMCL reached out to nuclear safety to clarify dose rate limits. Nuclear Safety reviewed the analyses that established the limits which showed they were based on gamma limits and not beta radiation limits. This additional insight was documented to allow IMCL to proceed with receiving material in question.
    c. FCF flame cabinet requirements for Cadmium storage and handling.
    d. AL questioned what constituted a penetration to hot cell.
    e. There were several questions regarding the rollover of Transport Plans and how the requirements where now included in SAR-413, "Safety Analysis Report for Intra-INL Transportation and MFC Inter-Facility Transfers."
5. SBIM reviews have been expanded to include Lists and other documentation that reference TSRs or are used for TSR requirement implementation.
6. Criticality alarm systems for FMF (almost done) and ZPPR replaced and the associated TSRs have been rewritten to reduce the likelihood of future violations.
7. Nuclear Safety has removed exemptions from Mode of Applicability statements in SARs and combined LCOs when able to in order to reduce the documentation Operations has to use while implementing controls.
8. Rewrite LCO/SAC as SAC to remove vague and confusing SRs that were risk pitfalls for TSR violations.
9. Currently developing a LIST wellness program to ensure various LISTS that implement TSR requirements are fully compliant with DOE-ID expectations and do not introduce additional pitfalls regarding implementation.
10. Engineering Process has been moved to Asset Suite to streamline the process. This will help prevent future failures similar to the one that allowed a plastic container being approved as a radioactive material container in FCF.
11. Nuclear and Criticality Safety has developed a strategy to remove criticality control list from the TSRs. A revision to SAR-400 that supports this has been submitted to DOE for review and approval. This will be implemented at a facility level through the annual updated process.
12. At the request of MFC senior management, ONA conducted two TSR focused reviews in FY-21. The first reviewed all the SRs at each MFC facility. This review also focused on conducting an in-depth evaluation of implementation methods for each SR to ensure adequacy and identify potential gaps. The second review is an evaluation of each TSR related event from January 1, 2015, to the present. Numerous opportunities for improvement were identified and acted on.

6.6.2 Process

10 CFR 830, Subpart B, "Safety Basis Requirements," establishes safety basis requirements for Hazard Category 1, 2, and 3 DOE nuclear facilities. The MFC Facilities that have been categorized as Hazard Category 1, 2, and 3 can be found in Table 3 above. The MFC activities categorized Hazard Category 3 or above can be found in Table 4 above. Furthermore, 10 CFR 830 requires that the contractor must perform work in accordance with the DOE-approved safety basis for a Hazard Category 1, 2, or 3 DOE nuclear facility and, in particular, with the hazard controls that ensure adequate protection of workers, the public, and the environment.

The contractor responsible for a Hazard Category 1, 2, or 3 DOE nuclear facility must establish and maintain the safety basis for the facility. In establishing the safety basis for a Hazard Category 1, 2, or 3 DOE nuclear facility, the contractor responsible for the facility must:

- Define the scope of the work to be performed
- Identify and analyze the hazards associated with the work
- Categorize the facility consistent with DOE-STD-1027-92
- Prepare a DSA for the facility

Establish the hazard controls upon which the contractor will rely to ensure adequate protection of workers, the public, and the environment.

6.6.3 Actions FY-22

- Monitor, identify, and address deficiencies in MFC SAR/TSR content and implementation. (Shawn Hill, September 30, 2022)

6.6.4 Looking Forward (FY-23 and Beyond)

No additional actions for beyond FY-22 have been identified at this time.

7. RADIOLOGICAL PROTECTION

7.1 A Look Back

Radiological Controls (RadCon) performance at MFC is strong. Radiological Work (RadWork) has increased nearly 50% and Radiological Issues (RadIssues) have been reduced by four times the amount, over the last 5 years. Technology upgrades have allowed for more reliable measurement capability and efficiency increases throughout the organization. Detailed facility characterization has been performed to clearly define source term and refine controls. With few exceptions throughout the last 5 years, performance has improved, and issues have decreased, which has resulted in providing consistently safe, efficient, and reliable radiological coverage and compliance surveys to support the INL and MFC mission.

Since FY-15 many improvements have been made to the MFC RadCon organization. The more significant improvements include the following improvements in Table 5.

Table 5. MFC RadCon significant improvements from FY-15 to FY-21.

MFC RadCon Improvements		
Air Sampling Improvements • Barcode accountability • Electronic database • Air-Flow Studies of each facility • Instrumentation upgrades and understanding increases (iCAMS and Alpha 7a Upgrades).	**RadCon Count Room Improvements** • Automatic data entry • Direct link to air sample database • Barcode readers on instruments • Alpha spectroscopy capability • Significant software upgrades.	**Dosimetry Improvements** • Increased routine measurement periods • Dosimetry requirement reductions • Nano-Dots for extremity estimation.
Technology Improvements • Real-time boundary monitoring • Radiation Area Monitor upgrades (ongoing) • Continuous Air Monitor upgrades • Electronic Dosimetry upgrades • Handheld Detector upgrades • Electronic Forms (several) • Electronic Radiation Work Permit approval • SENTINEL upgrades • Radiation Generating Device/Source Database.	**Training/Qualification Improvements** • Incorporated key radiological aspect courses into GDE-880, "Key Radiological Aspects for MFC Facilities" • Eliminated classroom trainings • Streamlined the qualification process • Created field office qualifications • Implemented RadWorker awareness campaign • Established MFC RadCon Continuing Training Plan.	**Radiological Control Improvements** • Increased contamination control device capabilities • Reduced RadCon coverage requirements • Reduced routine survey requirements • Streamlined radiation work permits • Defined and refined Soil Handling • Evaluated and implemented new gloves and gauntlets for Manipulator Repair Group gloveboxes.

Facility Characterization Improvements	Procedure/Process Improvements	Personnel Improvements
• Characterized and defined source term for nearly all facilities • Updated Underground Radioactive Material Area Map • Defined Underground Radioactive Material Area Controls • Updated Glovebox classifications.	• MCP-139, "Radiological Surveys" • MCP-9, "Radiological Control Log Keeping" canceled, information was combined with MCP-139 to streamline requirements • MCP-187, "Radiological Control Posting and Labeling" • LI-15002, "Radiological Control Activities and Norm Determination at MFC" • EPI-56, "MFC Facility Emergency Radiological Monitoring" • LWP-15017, "Radiological Release Surveys" • ALARA Goal Changes • MCP-3352, "Temporary Shielding" • GDE-906, "Good Radiological Work Practices."	• Key personnel development • Key strategic hires • Hiring strategy refined • Succession planning • Multiple certifications obtained • Multiple degrees obtained.

7.2 People

RadCon staff are engaged, knowledgeable, and service-oriented, as evidenced by the significant increase in RadWork over the last 5 years despite little increase in staff. RadWork at MFC has increased by more than 50% and RadCon staff has increased by 4%. In FY-21, RadCon hired a computer software engineer to support the current and planned technology upgrades in processes and equipment at MFC.

Although head count has not increased much, turnover has been, and will continue to be, an issue. 60% of Health Physics Technicians (HPTs) have worked at MFC 5 years or less. 40% of Radiological Engineers have worked at MFC 5 years or less. The RadCon management team is also young, having significantly changed in FY-20 and again in FY-22. While retention of employees has been an issue in the past, recent changes (FY-20) to pay grades and progression plans aim to change that trend. Attrition, due to retirement/age, will pose a significant challenge to RadCon over the next 5 years. A 5-year staffing plan has been developed to counter that challenge.

Over the last 5 years, RadCon and RadWorker training has been acceptable to maintain qualifications but significant improvement is needed to address upcoming work and to increase human performance. RadCon Training needs to improve proficiency in facility-specific areas, whereas RadWorker Training needs to improve in general proficiency and understanding. RadCon and RadWorker decision-making, with few notable exceptions, has been acceptable. However, events such as the Radiochemistry Laboratory contamination event in August of FY-19, 2 personnel contamination events at IMCL within weeks of each other, and multiple qualification lapses and boundary violations throughout FY-20 indicate

that increases in MFC personnel training, awareness, attitude, and proficiency are needed. RadCon proficiency and understanding, as well as RadWorker understanding and awareness, will increase as the RadCon organization continues to focus on continuous improvement throughout the program.

7.3 Process

RadCon processes and procedures are acceptable, however continued improvements are needed to make these processes and procedures strong. RadCon program managers diligently work to streamline procedures and processes. In FY-21 that included changes to several procedures and processes, including survey completion and documentation as well as an improved temporary shielding procedure. RadCon Management is committed to identifying additional areas in which improvements can be made.

To improve human performance in RadCon, streamlining of RadCon documentation is needed, technology improvements and innovation must continue, and the previously mentioned increase in training, awareness, attitude, and proficiency are all critical. To improve processes and procedures in RadCon, continued diligence and constant improvement in the program is needed.

One of the more significant RadCon organization initiatives is the programmatic addition of an irradiated and volumetrically contaminated materials release program. This process uses the Tier II release process methodology as described in DOE-STD-6004-2016, “Clearance and Release of Personal Property from Accelerator Facilities,” and the recently approved ANSI N13.12-2013 screening levels as the pre-approved Authorized Limits for Release and Clearance of Volumetric Radioactivity of Personal Property. This process has been under evaluation by the RadCon Home Organization for several years. With the recent authorization to implement a program using the above listed criteria, an amendment/revision to the INL’s Radiation Protection Program (RPP) is underway and MFC Radiological Engineering staff have been involved in all aspects of the process. A Technical Basis Document for implementing a Personal Property evaluation process has been drafted and is out for review, the establishment of appropriate detection methods using the Aegis HPGe detector system and the Inspector 1000 with LaBr probe are in progress and needed shielded enclosures to facilitate low background counting have been placed at TREAT and NRAD. The RadCon Home Organization is working concurrently with the DOE Field Element Manager to obtain required approval of the derived (INL specific) DOE O 458.1, “Radiation Protection of the Public and Environment,” compliant Tier II release process. Once completed, a subsequent revision to the INL RPP will be initiated and process changes, training, and procedure improvements to facilitate the new release program will be rolled out. This action was first added to the MFC RadCon Improvement Agenda for FY-21 and the level of support will continue through FY-22 with expected project completion and implementation scheduled for September 2022.

7.4 Equipment/Tools

Tools and equipment for RadCon are strong. With few exceptions across MFC, obsolete equipment has been replaced and technology improvements are ongoing. All MFC facilities have the radiological equipment and tools necessary to fulfill mission goals safely and successfully. However, some facilities are lacking upgraded instrumentation or are lacking instrument quantities to be truly efficient. Since facilities are lacking in radiological equipment and tools, the MFC RadCon Organization has worked with Facility Management to increase, and standardize, radiation detection equipment. Installation of new equipment that is on-site in the remaining facilities is necessary for completion. To increase HPI efficiency, RadCon equipment is being connected together via a network to be easily accessed from any networked computer. Networking RadCon equipment will allow faster recovery of facilities, greater reliability of detection and equipment, and an ability to efficiently view and evaluate radiological conditions in facilities. The cost estimates for implementation of Horizon in MFC facilities have been provided to the MFC divisions. Approval is needed from the divisions in order for Horizon to be installed for full implementation across MFC.

Further equipment and tools that will increase efficiency and human performance include upgraded stack counters in the RadCon count room as well as completion, and full implementation of the

HORIZON network, gamma and alpha spectroscopy capability additions, liquid scintillation counting equipment upgrades, and computer and IM upgrades for RadCon.

7.5 Actions FY-22

- Streamline RadCon documentation
  - Continue support of the RadCon Home Organization in finalizing development of the new RadCon Log Survey Application including procedure changes, training, and development of a user's guide. (Alan Carvo, September 30, 2022)
  - Train MFC RadCon personnel and implement RadCon Log Survey Application. (Alan Carvo, September 30, 2022)
- Improve MFC personnel proficiency, awareness, attitudes, and training regarding RadCon
  - Implement the continuing training plans for HPTs and Supervisors developed in FY-21. The training plans cover a 2 year training cycle and have been developed for calendar years 2021 and 2022. (Alan Carvo, September 30, 2022)
  - Implement recommended improvements to the oral board qualification process to include an oral walkthrough in the facility. (Alan Carvo, June 30, 2022)
  - Enhance distribution of specific details related to radiological incidents at MFC facilities to all RadCon staff through the use of Microsoft Teams channels and in routine staff meetings. (Alan Carvo, September 30, 2022)
  - Identify one HPT in each field office to be cross-qualified in another field office. (Alan Carvo, September 30, 2022)
  - Evaluate training and staffing options for a special Field Monitoring Team to respond to abnormal radiological events. Based on evaluation, develop white paper to discuss pros and cons and path forward for FY-23. (Alan Carvo, September 30, 2022)
- Improve RadCon's processes and procedures
  - Convert at least three radiological instrumentation forms to electronic forms (eForms). Automating these forms will improve efficiencies for the RCTs/HPTs to perform instrument checks and reduce human performance errors. (Alan Carvo, September 30, 2022):
    1. Form 441.14, "Instrument Performance Check Sheet & Reference Value Determination"
    2. Form 441.82, "Benchtop Sample Counter Performance Record"
    3. Form 441.91, "Hand and Foot Monitor/Personnel Contamination Monitor Instrument Check Data Sheet."
- Implement process for uploading paper records into EDMS for records storage as an alternative to hard copy storage off-site. (Alan Carvo, June 30, 2022)
- In the RWP approval process, the changes in RWPs from one revision to the next are not marked to show changes. The ability to it would be a process improvement to show tracked changes which would speed up the review process. RadCon IM will need to evaluate if it is possible to update the application to show tracked changes. Based on the evaluation, determine cost and timeframe to complete and provide information to RadCon Management to determine path forward. (Alan Carvo, September 30, 2022)
- Identify and implement the use of OSL holders for security personnel and other staff. (Alan Carvo, September 30, 2022)
- Develop a system to track calibration dates for portable RadCon instruments maintained by HPIL. (Alan Carvo, September 30, 2022)
- Improve MFC Radiation Detection Capabilities

- Implement Horizon in one additional facility in FY-22 and develop an implementation plan (IP) for installing and using Horizon in remaining MFC facilities. (Alan Carvo, September 30, 2022)
- Complete installation of Series 6 stack counters, procedure development and training of appropriate staff. (Alan Carvo, September 30, 2022)

7.6 Looking Forward (FY-23 and Beyond)

- Continue improving MFC personnel proficiency, awareness, attitudes, and training regarding RadCon
  - Develop additional facility-specific training for HPTs and update continuing training plan.
  - Annually evaluate the impact the plans are having and adjust the plans as necessary for continued improvement.
  - Develop and implement awareness and education topics for facility management personnel and their responsibilities in implementing Radiological Control Program requirements.
- Continue improving RadCon's processes and procedures
  - Develop and implement electronic forms to replace dosimetry forms, RWP request form, RWP peer review form, RadCon evaluation form, Source check out sheets, source inventory, and remaining instrument check sheets for Continuous Air Monitors and Radiation Area Monitors.
  - Develop and implement a barcode system for instrument checks that ties into the RadCon Documentation System.
  - Develop a "dashboard" for RadCon staff that includes information at a glance from RadCon applications that can be accessed from one place. This would include actions needs for the air sample application, new Log Survey application, Horizon viewing, RadCon status board for instrumentation, RWP review application, and Area Monitors on televiewer. This could feasibly include RadCon metrics for management. The information would be based on the user role and the information needing to be seen.

8. ENVIRONMENTAL

8.1 A Look Back

MFC Environmental has had a strong performance record over the past 5 years. MFC has not received an environmental notice of violation during the 5-year period. The MFC Environmental internal and external assessment program ensures it is continually evaluating program element effectiveness and identifying areas for improvement. Stakeholder engagement has been a high priority with particular focus on regular communication with Idaho Department of Environmental Quality (IDEQ) permit writers and DOE counterparts and building relationships with other environmental personnel across the DOE complex. The group is actively looking for improvements in technology to maintain environmental compliance, improve efficiency, and simplify processes (e.g., light detection and ranging [LIDAR] imaging for cultural resources documentation, electronic inspection forms, tracking environmental requirements database, and radio-frequency identification [RFID] to fulfill inventory tracking). The design for the upgraded industrial wastewater system monitoring station was completed and is being submitted to Department of Environmental Quality (DEQ) for approval; construction will be initiated as funding allows. Stack monitor upgrades and improved methods for calculating air effluent source terms have improved MFC's compliance posture related to Clean Air Act (CAA) requirements. For the past 5 years, performance has generally been strong, and issues have been relatively minor and quickly resolved, with mitigations put in place to prevent recurrence. Areas of weakness were recently discovered in the Waste Management Program. Aggressive actions have been taken to correct these deficiencies, including tracking/trending and revamping waste management training and procedures. The documentation and approval obtained through the environmental group is crucial for performing research at MFC and maintaining compliance with environmental regulations. MFC Environmental strives to continually support Operations and other support organizations in the success of INL and MFC missions.

Since FY-17 many improvements have been made in the MFC Environmental organization. The most significant improvements are shown in Table 6.

Table 6. MFC Environmental Improvements.

MFC Environmental Organization Improvements		
Technology • Completed project to use RFID for the management of mixed waste inventory. • Used LIDAR for the documentation of cultural resources. • Developed electronic RCRA inspection forms. • Developed web-based requirements tracking database. • Used new electronic spill notification tool. • Identified remote monitoring needs for stored waste.	**Waste Management** • Documented total amount of waste shipped off-site in cubic feet and total number of shipments sent off-site per year: FY-17 18,647 ft^3 55 FY-18 34,100 ft^3 50 FY-19 17,867 ft^3 58 FY-20 34,428 ft^3 66 FY-21 19,022 ft^3 68 • Performed baseline monitoring of stored waste in Sodium Storage Building. • Eliminated decades-old liability with the disposition of the remaining ~35,000 individual, highly-engineered, sodium-filled ZPPR plates utilizing alternate off-site technology. • Completed disposition of excavated soil from CERCLA sites to the Idaho CERCLA Disposal Facility and off-site. • Wrote an HLW Program IP, HLW Determination Process document, and Quality Assurance Program Plan as part of the HLW Program development.	**RCRA** • Implemented the Hazardous Waste Generator Improvements rule. • Completed and implemented multiple permit modifications for the continual improvement of RCRA permitted TSDF. • Developed and implemented Accountable Nuclear Materials program for the management and tracking of accountable nuclear material that will become mixed waste. • Implemented the electronic inspection system for RCRA inspection of hazardous/mixed waste.

Wastewater and Potable Water

- Closed old sanitary sewage lagoons under State and CERCLA regulations.
- Renewed reuse permit for longer duration (10 years vs. initial 5 years) and reduced the number of monitored contaminants and implemented new requirements.
- Completed the connection of the two industrial wastewater system pipelines with one monitoring location as part of the WCUC project, implemented new O&M procedures, and revised the corresponding plan of operation.
- Closed Industrial Waste Ditch reuse unit.
- Implemented remote monitoring/recording of industrial wastewater flow.

Training/Qualification

- Developed Environmental Qualification process; staff completed general and media-specific qualifications.
- Attended vendor provided sodium/sodium potassium alloy handling training.

Other Regulatory Areas

- Participated in (and founding member of) DOE's Migratory Bird Treaty Act (MBTA) working group.

CAA/NESHAPs

- Obtained approval from the EPA to allow the use of modified emission factors for calculating radioactive emissions.
- Implemented ODS tracking database to ensure compliance with reporting and maintenance regulations for refrigerant equipment.
- Revised refrigeration appliance service/repair documentation to conform to new regulations.
- Used regulatory analysis and computational fluid dynamics study to bring the HFEF stack into compliance with NESHAPs.
- Prioritized and completed stack upgrades.
- Developed dose calculator tool for new projects.
- Developed/revised INL PTC facility IPs.
- Completed INL PTC MFC record management surveillance and corrective actions.
- Completed APADs to provide a baseline for operations/processes at ZPPR, SCMS, MFC-753, Analytical Laboratory, and Water Chemistry Laboratory as a best management practice.

NEPA	CERCLA	Personnel Improvements/ Key Personnel Development
• New NEPA/Environmental Review Process is the method used to evaluate a new project, proposal, procurement, decision, or activity for potential environmental impacts.	• Completed CERCLA improvement activities, including a "CERCLA Coach's Playbook" that summarizes steps to take for various scenarios (based on those encountered at MFC). • Closed old sanitary sewer lagoons as a CERCLA site. • Added a CERCLA lead position to the home organization. • Completed a HASP that covers work in MFC CERCLA institutional control sites.	• Cross-trained back-ups for various environmental media. • Planned for succession. • Presented at conferences including the International Waste Management Symposia. • Hired and mentored summer interns annually (started in FY-15). • Hired entry-level MFC Environmental staff member. • The new ESH FACT Environmental Subgroup was reestablished in May of 2021. Like the ESH FACT, the primary objectives of this group are broadening the environmental network within Amentum projects.

8.2 People

The Environmental staff at MFC possesses a wealth of knowledge with most staff having 20-30 years of experience in the environmental arena. However, attrition due to retirements or advancement will pose a significant challenge to the environmental group in the coming 1-7 years. A 10-year resource management plan has been developed to counter that challenge. Environmental staff established and is now improving an MFC environmental qualification program. Back-ups have been identified for each environmental media and functional leads strive to cross-train their back-ups to provide depth of knowledge. Most MFC Environmental staff also serve as INL Technical Points of Contact or Program Environmental Leads in various environmental disciplines. Staff development in recent years includes presenting at conferences, including the International Waste Management Symposia. This and other venues provide positive exposure to INL and the environmental group from MFC. Environmental staff also participates in a DOE complex-wide environmental community of practice with other DOE contractors to communicate common interests, discuss issues, and share lessons learned.

MFC Environmental staff present several training classes on topics including Chain of Custody, General Waste Generator, Radioactive Waste Inventory Sheet for Low-Level Waste, Treatment, Storage, and Disposal (TSD) Resource Conservation and Recovery Act (RCRA) Inspector, Waste Generator Services (WGS) Temporary Accumulation Areas, RCRA Contingency Plan for MFC Emergency Action Managers (EAMs), and new ozone depleting substances (ODS) Regulations.

8.3 Process

The Environmental group at MFC provides instructions for performing environmental planning, compliance, and protection during the course of conducting work. These instructions are used in conjunction with other appropriate procedures (e.g., operating, maintenance, construction, safety, and health) and environmental permits. Environmental staff are involved in facility morning meetings, design reviews, work order approvals, assessments, and work planning walk downs.

The MFC Environmental group implemented several INL programs at MFC and developed, or helped develop, many facility procedures. RCRA Permit requirements have been implemented into facility-specific procedures in accordance with the TSD Environmental Compliance procedure. Permit implementation matrices were developed for all regulatory permits at MFC to ensure requirements are appropriately flowed down into operating documents. The Accountable Nuclear Material Plan for mixed waste has been implemented into facility-specific procedures for the Fuel Conditioning Facility (FCF), Fuel Manufacturing Facility (FMF), Fuels and Applied Science Building (FASB), Hot Fuel Examination Facility (HFEF), and Analytical Lab. The industrial wastewater plan of operation was revised as required by the new reuse permit. MFC Environmental staff ensured facility procedures, forms, and manuals were revised to implement operation and maintenance (O&M) of the new industrial wastewater and sanitary sewer lift stations, and changes resulting from the new industrial wastewater pipeline connection (all installed per the West Campus Utility Corridor [WCUC] project). MFC Environmental staff developed or revised INL Permit to Construct (PTC) Implementation Plans for FCF, FMF, Irradiated Materials Characterization Laboratory (IMCL), and U&IS Support. Environmental staff revised the INL Form 435.50, "HVAC/Refrigeration Appliance Service/Repair Form" to align with ODS regulation revisions and the ODS tracking database.

As a result of large-scale construction projects at MFC over the past couple years, a weakness related to knowledge and documentation of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements has been identified. Efforts to strengthen the CERCLA program in collaboration with project, Facilities and Site Services (F&SS), MFC operations, and environmental home organization personnel are ongoing and must continue over the new few years to rebuild internal expertise in this area.

8.4 Equipment/Tools

Tools and equipment for environmental compliance are being improved with upgraded stack monitoring, National Environmental Policy Act (NEPA) compliance with new Environmental Compliance Permit (ECP) process, RFID, and electronic RCRA inspection forms. In addition, permit-required equipment, such as flow meters and stack monitoring instrumentation, is maintained as part of the MFC calibration and preventive maintenance process.

The industrial wastewater system was upgraded to combine discharge lines to eliminate a regulated unit, and flow meter equipment was upgraded to record and remotely monitor flow data. Additional upgrades to the industrial wastewater system are planned to optimize performance.

8.5 Actions FY-22

- Support preparation of PE-certified design documents for a modified industrial wastewater monitoring station that includes a new flow meter flume, sampler, and heated building and submit an approval request to DEQ by December by 2021. Work with MFC projects to initiate construction project as funding allows. (Alan Carvo, September 30, 2022)
- Initiate planning and develop process flows for implementing RFID technology for chemical management. (Alan Carvo, September 30, 2022)
- Prepare a request for Environmental Protection Agency (EPA)/Department of Environmental Quality (DEQ) to remove a portion of the CERCLA site ANL-74 area from institutional control (IC),

eliminating the need for CERCLA controls while disturbing soil in the non-IC area. (Alan Carvo, September 30, 2022)

- Develop electronic forms for satellite accumulation areas and temporary accumulation areas. (Alan Carvo, September 30, 2022)
- Develop a policy for retaining contaminant history of abandoned-in-place underground piping. (Alan Carvo, September 30, 2022)
- Develop and present PCB waste characterization and storage training for WGS personnel. (Alan Carvo, September 30, 2022)
- Complete required 10-yr evaporative sewage lagoons seepage test. (Alan Carvo, September 30, 2022)
- Collaborate with the home organization to align NEPA and cultural resource requirements to streamline the overall approval process for ECPs and cultural resource reviews. (Alan Carvo, September 30, 2022)
- Evaluate current MFC waste management training contents, audience, and frequency and implement changes to improve worker understanding. (Alan Carvo, September 30, 2022)
- Review MFC waste management procedures and revise to clarify employee actions related to waste management activities. (Alan Carvo, September 30, 2022)
- Assess operations and research knowledge of waste management requirements including proper recognition and characterization of waste items, packaging and storage requirements, regulatory time commitments, and appropriate contacts for waste management issues and concerns to determine effectiveness of improvement actions taken to date. (Alan Carvo, September 30, 2022)
- Compile MFC water and equipment fuel use monthly and report to the INL Sustainability Group to establish baselines for future Net-Zero goals. (Alan Carvo, September 30, 2022)

8.6 Looking Forward (FY-23 and Beyond)

- Increase environmental awareness through regular communication, particularly related to the NEPA process and ISO 14001.
- Continued evaluation and improvement of the MFC and INL waste management program.
- Improve and develop CERCLA Program internal subject matter expertise.
- Improve Air Permitting Applicability Determination (APAD) coverage for MFC facilities by developing APADs for MFC buildings with no coverage or combining multiple APADs for one facility into one combined APAD to ease interpretation and compliance.
- Technology:
  - Develop RFID for chemical management.

9. SAFETY & HEALTH

9.1 A Look Back

The MFC Occupational Safety and Health Group continues to experience and adapt to change in recent years. While there has been moderate improvement in safety and health performance at MFC since FY-17, injury rates have been stagnant in recent years. The COVID-19 pandemic, and all associated impacts, has dominated the evolution of safety and health performance across MFC, and service posture of the MFC Safety and Health organization. From a safety and health performance perspective, a significant portion of serious occupational illnesses at MFC have been COVID-19 exposures, with a total of eight OSHA recordable cases in FY-21, all incurring days lost. However, most recordable injuries have been associated with Musculo-skeletal disorders, totaling 12 OSHA recordable cases in FY-21. Many of the cases, from overexertion, awkward movement, and body position, are often caused in part by distraction or fitness for duty. These causal factors can also be attributed, to a great extent, to the unique circumstances associated with the pandemic—interruption of routine and selflessly doing more in a climate of less clarity. The direct impacts of the pandemic are being addressed on many levels, but the indirect impacts—distraction, breaks in routine, overexertion—remind us that positively influencing individual behavior is key to preventing many injuries and illnesses. The primary objective of the MFC Safety and Health organization must be to educate and empower the workforce to understand behaviors that heighten risk and the behaviors and tools available to help protect from mishaps.

In recent years, several improvements have been made to MFC's Safety and Health Program and organization. Some of the more significant improvements include:

- Hazard Control Program Improvements:
  - Completion of fire barrier remediation throughout non-nuclear facilities
  - Machine guarding improvements
  - Direct workforce engagement in situational awareness familiarization
  - Fall protection assessment and inventory
  - Remote manipulator ergonomics assessment
  - CERCLA health and safety plan (HASP) improvements
  - Fire and emergency communications network improvements
  - Confined space evaluations and inventory
  - Crane descender training
  - Asbestos abatement, inventory, and data management improvements
  - Specialized ventilation system assessments
  - Foot protection assessment
  - Walking/Working surface assessment.
- Resource Management Improvements
  - Organizational communication improvements and lessons learned sharing
  - Advancement of dual-discipline qualifications
  - OSH team dynamics assessment
  - University outreach to support diversity and inclusion.

9.2 People

In this past year, FY-21, MFC Safety and Health personnel assignments have been stable, allowing for continued development of established staff. The professionals who make up the MFC Safety and Health organization are a valued strength within the MFC community and have been sought throughout INL for their expertise. The diversity of skills is exceptional. All personnel are degreed in either occupational safety and health, health science, fire protection, engineering, or IH. Additionally, 45% of MFC Safety and Health employees have earned graduate degrees in one or more of those fields. In addition, the majority of personnel in the organization have achieved one or more professional certifications in chosen disciplines.

Throughout the MFC Safety and Health organization, the experience range across industries is impressive. Many employees come from other nuclear industry sectors, while others have had successful prior careers in chemical and materials processing, aerospace, and construction, each offering valuable insights into MFC's unique research pursuits. Reflecting the organization's experience and credibility, many MFC Safety and Health personnel have been delegated authority for several INL programs as Technical Points of Contact. This includes disciplines such as Respiratory Protection, Laser Safety, Asbestos Abatement, and Hazardous Waste Operations.

Some organizational attrition is anticipated in the coming years. For instance, one veteran fire protection engineer has recently accepted a new role. Other late-career staff will need to be replaced in the coming years. Capability expansion and skilled worker succession must be stressed. This may prompt a flexible approach to expedite new employee development, and innovative methods to expand in-house discipline qualifications. Capability and planning will need to be developed to anticipate skill and capacity demands. Similarly, qualification processes will need to be honed to efficiently on-board and activate new employees to apply their unique skills as soon as possible to the MFC mission. The incumbent personnel will be challenged to expand their capabilities, pursuing, and attaining dual qualification beyond their primary discipline, to provide greater organizational flexibility in meeting broad mission challenges across MFC.

9.3 Process

MFC Safety and Health has demonstrated an ability to address the unique needs of the MFC mission. This has been substantially due to the core technical excellence of services provided by veteran safety and health professionals in applying hazard control programs. The growing technical credibility of the organization is earning the respect of MFC operational counterparts, who are relying increasingly on safety and health SMEs to help resolve unique hazardous conditions, such as toxic and unhealthful environments, complex fire protection systems, fall hazards, and hazardous material controls. The MFC Safety and Health organization must be mindful of not only the safest means of performing work, but also the most efficient means of safely achieving objectives. Long-term hazard control and mitigation efforts must continue to be sponsored through completion with a focus on the most efficient and practical approach to protecting personnel and MFC assets. This approach necessitates a close and respected relationship with Environment, Safety, Health, and Quality (ESH&Q) Home Organization to assure risk trades, regulatory interpretations, and decisions are meeting professional expectations for injury and illness prevention.

With the variety of technical challenges, the volume of process controls and associated documentation can be overwhelming. Entrusting process discipline alone cannot assure personnel safety. More pervasive methods of engaging employees are necessary to leverage the attention of the entire workforce. The MFC Safety and Health organization must be prepared to contribute to communication and engagement strategies that encourage greater leadership and employee integration with injury prevention efforts at MFC.

Improvements are also necessary to assure ESH&Q Home Organization and MFC-deployed safety, health, and fire protection resources are effectively and seamlessly integrated to meet the MFC mission. This must be a feature consideration in goals for improving hazard control and injury prevention efforts. Similarly, it must be a priority for MFC-deployed staff to assure MFC objectives are considered in process development of improvement efforts undertaken by the ESH&Q Home Organization that may be beneficial to MFC operations.

9.4 Equipment/Tools

Tools and equipment for Safety and Health programs are strong. With few exceptions, IH monitoring equipment, fall protection equipment, and other personal protective equipment is well suited to the potential hazards associated with the MFC mission. Improvements in equipment monitoring and maintenance, such as inventory and configuration management tools, are integrated into overall process improvement strategies.

One recent equipment acquisition, the Noraxon® Portable Motion Analysis Laboratory, will be leveraged to assist in identifying manual labor vulnerabilities, including manipulator operations and material handling tasks. The laboratory will also be key in determining less intensive manual interface options to reduce potentially harmful body motions.

Work venues are anticipated to continue to diversify. Telecommuting technology will continue to be called upon to ensure greater engagement through a variety of circumstances.

9.5 Actions FY-22

Improving Workplace Safety and Health Assessment Processes

- Implement a process of periodic Independent Safety and Health observations to identify opportunities for risk reductions, reinforce positive safety and health conditions and behaviors, and promote and assist organizational accountability in controlling and mitigating hazards. This process should consider existing mechanisms, such as the Integrated Observation Tool. (Alan Carvo, September 30, 2022)
- Implement a process or tool for monitoring fire hazard analysis/assessment and IH exposure characterization, scheduling, and completion. (Alan Carvo, September 30, 2022)
- Integrate HPI tools into injury investigation practices. (Alan Carvo, September 30, 2022)
- Complete risk assessment of MFC high pressure systems to ensure hazards are identified and mitigated and appropriate response actions to potential releases/failures are addressed. (Alan Carvo, September 30, 2022)

Continuing Fire Protection System Improvements

- Complete fire extinguisher and suppression head inventories – develop and implement a process and necessary tools to inventory this fire protection equipment. Identify opportunities for potential efficiencies in reducing equipment maintenance within compliance with applicable code. (Alan Carvo, September 30, 2022)
- Support MFC Projects with previously identified upgrades to nuclear facility fire barriers. (Alan Carvo, September 30, 2022)

Improving Occupational Ergonomic Hazard Awareness

- Analyze common tasks that have resulted in past Musculo Skeletal Disorders (MSD) injuries and distribute improvement recommendations to organizations most vulnerable to these hazards. (Alan Carvo, September 30, 2022)
- Complete assessment of ergonomic vulnerabilities associated with MFC manipulator operations. (Alan Carvo, September 30, 2022)

Improving Hand Protection Awareness

- Identify appropriate cut and puncture resistant gloves for common tasks at MFC that are at greater risk of hand injury. Provide awareness information and guidance in workplaces which typically host personnel supporting tasks at risk of hand injury. (Alan Carvo, September 30, 2022)
- Provide hand and power tool selection and hazard mitigation techniques to users of this equipment at MFC. (Alan Carvo, September 30, 2022)

Sustaining Maturation of OSH Team Dynamics

- Complete consensus building for behavioral norms and collaboration based on Culture Wizard Results completed in FY-21. Issue organizational norms and consider methods for positive reinforcement. This action may be facilitated by INL Learning and Organizational Development. (Alan Carvo, September 30, 2022)

9.6 Looking Forward (FY-23 and Beyond)

Completing Long-Term Hazard Control Program Improvements

- It is anticipated that some of the long-term hazard control program improvements, such as fire barrier remediation, fire equipment inventory and efficiency implementation, workplace exposure monitoring, asbestos database population, and occupational ergonomic hazard mitigation strategies will likely require sustained effort beyond FY-22 to resolve.

Improving Resource Planning

- Explore and formulate processes to forecast resource needs, establish succession development programs, and determine the needs of operational counterparts. This will include further expansion of dual qualification among incumbent staff, bolstering of recruitment pools with broadened relationships with diverse universities educating students in safety and health programs, and greater alignment of ESH&Q Home Organization efforts and initiatives with deployed MFC Safety and Health objectives. In addition, overlap of newly hired staff with exiting staff is desired to allow for better turnover prior to the loss of staff due to attrition or other opportunities.

10. CONTRACTOR ASSURANCE

10.1 A Look Back

Prior to 2016, the performance analyst (PA) function was carried out by staff specialists embedded in each division as an ancillary duty. The PA staff were organized under a single work organization manager with the intent to bring consistency to the function. The PAs initially reported directly to the Business Division director for approximately one year until a department manager was put in place with contractor assurance (CAS) expertise. The new manager's strong technical experience was immediately beneficial to the MFC organization and contributed to good development of the PA staff. The PAs improved understanding of CAS along with increased experience contributed to further improvements in PA performance. PAs were ultimately assigned two divisions each and provided those divisions with CAS support. PAs were also assigned to lead functional areas (management observations, assessments, lessons learned, corrective action review board [CARB], etc.) to support the MFC organization and to become more knowledgeable in all areas of CAS. In addition, the manager rotated PAs through different assignments, which led to further knowledge, proficiency and efficiency gains, and better overall implementation of CAS processes.

The current department manager was rotated into the position in January 2021. The new manager's goal is to foster a robust performance improvement culture in which managers and employees' value self-critical, candid, and objective evaluation of performance against standards of excellence and effectively resolve noted gaps, commensurate with the risk. The new manager will work closely with the MFC Chief Operating Officer (COO), and the Business and Operations division directors to improve MFC performance analysis.

MFC's Performance Assurance program continues to mature. In 2021 the following were achieved:

- The CARB has increased focus on the quality and timeliness of corrective actions. Action owners are working with their PAs to provide substantive updates, which reinforces management ownership of performance and promotes quality discussions in the CARB beyond timeliness alone. The year's focus on NTS and greater than 180 days actions has resulted in more timely closure and reinforced the expectation for rigorous action management.
- To maximize the learning opportunity from events, ILLs are crisply written and distributed throughout MFC within days of the event. Over 40 have been issued and are being converted for distribution beyond MFC via OPEXShare. In a few instances, managers encouraged those involved in the events to share their learnings directly with their co-workers, making the lesson more compelling. Two Significant Lessons Learned were also issued to promote reflection and action on negative performance trends, i.e., pyrophoric materials handling and occupational safety.
- Two working groups were established to promote consistent and effective improvement actions in two broad performance areas: pyrophoric and reactive materials management, and hazardous and mixed hazardous waste management. The pyrophoric materials working group facilitated implementation of a technical guide to manage such materials and deployment of interim and formal qualification training. The hazardous and mixed hazardous waste group has just begun strategizing improvement efforts.
- A Performance Improvement Working Group was established to conduct cognitive trending and align efforts and standards to reverse noted trends. The group has begun taking meaningful actions to improve the quality of pre-job briefings and to then execute the work per the briefings.
- The MOP continues to mature. The FY-21 emphasis on performing and documenting in field, interactive observations resulted in sustained high-level participation rates and improved observation quality. Observations can, and in some cases are already being evaluated for performance trends. Observations have identified weak performance in pre-job briefings, procedure use and adherence, and work preparation and coordination.

10.2 People

Contractor Assurance staff are engaged and service-oriented. Staffing levels remain at five employees. There is a need for more operational and analytical expertise to conduct critical, objective, and timely assessments of events and emerging trends.

10.3 Process

MFC management uses assessments to review, evaluate, inspect, test, check, survey, or audit, to determine and document whether items, processes, systems, or services effectively meet specified requirements. Assessments also identify operational strengths, deficiencies, and opportunities for improvement. Assessments required by regulation are performed to verify compliance and determine effectiveness of program requirement implementation. Risk-based assessments are conducted at management discretion if further information is needed to understand adverse conditions, trends, or performance-related issues to develop appropriate corrective actions. Understanding which assessments are necessary and developing risk-based assessments is an area that needs focus and improvement. An individual with significant operational experience, the ability to accurately and objectively assess events, trends, and performance, and to clearly document discoveries in a timely manner is necessary.

Issues management is BEA's process for documenting and resolving a broad range of workplace conditions and issues, including identifying and reporting issues, categorizing issue significance, analyzing causes, tracking the timely completion of corrective actions, and analyzing and communicating trends to management.

A causal analysis is performed on events and trends when necessary. This is an analysis of facts and conditions surrounding an issue, trend, or event to identify causes. A causal analysis provides a basis for understanding the complex factors involved in an event or trend, and for development of appropriate corrective actions to prevent recurrence of the issue. A causal analysis can identify when it is appropriate to perform an extent of conditions across MFC.

Fact findings and critiques are conducted to identify, document, preserve, and report the facts surrounding an event—or other area of concern—to understand the event, determine causes, and recommend corrective actions. Fact findings and critiques are opportunities for workers and managers to come together to fully understand the environment, decision-making, tools, and procedures that were involved in an event.

Lessons learned are used to communicate issues, events, and best practices between BEA and industry partners to maintain high awareness of behaviors or circumstances that resulted in or contributed to events. There is also the opportunity to recognize and promote best practice behaviors. Operational excellence requires use of internal and external operating experience to minimize the likelihood of undesirable behaviors and promote noteworthy practices. BEA embraces the philosophy that lessons learned are lessons applied.

Management observations promote engagement between managers and employees. Observations enhance management's understanding of employee functions, skills, and abilities. Management observations provide the opportunity to build positive relationships, and to address employees' concerns. These observations build trust between the employee and the manager. Consistent and well-executed management observations reinforce INL Values and the MFC Trust Model.

10.4 Equipment/Tools

Multiple tools are used by CAS staff. These tools are designed to understand an organization from an individual's performance, to programs, processes, and organizational culture. The proactive tools are management observations, assessments, lessons learned, and MRMs. The reactive tools are cause analysis, event investigations, and HPI investigations.

LabWay is the software tool provided by DevonWay that facilitates CAS with implementation of issues management, assessments, improvement agendas, and management observations.

OPEXSHARE is the software tool that facilitates sharing the lessons learned beyond MFC and even INL.

10.5 Actions FY-22

- Improve the Performance Improvement Working Group's ability to identify and respond to negative trends. (Dave Coates, September 30,2022)
- Develop metrics and goals to monitor and improve MFC Issues Management Performance. (Dave Coates, September 30, 2022)
- Develop and begin implementation of a strategy to respond to the finalized DOE EA-31, "BEA/MFC Issues Management Assessment Report." (Dave Coates, March 31, 2022)
- Improve Performance Assurance capacity and bench strength for assessments, cause analyses, effectiveness reviews and trending by hiring two additional full time Senior Assessors. (Tiffany Leavitt, May 31, 2022)

10.6 Looking Forward (FY-23 and Beyond)

- Develop directors and managers to take clear ownership for performance improvement:
  - Strike a healthy balance between using CAS tool "experts," such as CAS staff, and deepening management ownership for performance improvement
  - Provide regular coaching and mentoring at all levels.
- Assist MFC managers with applying CAS tools to achieve the following:
  - The picture of excellence is well known
  - Problems are prevented and mistakes avoided
  - Performance gaps are analyzed, prioritized, and efficiently, effectively solved
  - Performance improvement is ingrained as a core business practice
  - Performance monitoring drives continuous improvement.

11. PERSONNEL DEVELOPMENT

11.1 Personnel Selection

11.1.1 A Look Back

Personnel selection encompasses all actions associated with selecting personnel for a specific position through the first year of service. This includes selecting a new hire from outside of the laboratory, new assignments, and internal transfers to MFC.

The function of staffing is outlined in the "Materials and Fuels Complex Management Plan" (pages 35-42) and defines the processes used over the last 5-years. MFC has been consistent in using the criteria outlined in the "Materials and Fuels Complex Management Plan" handbook. The criteria considered are key attributes such as integrity, service attitude, work ethic, and the right technical skill set for every new hire or transferring employee.

Group interviews have been conducted, and prior to travel restrictions associated with COVID-19, all interviews had been conducted at MFC. These on-site interviews included meeting with a broad group of employees and a tour of MFC. Directors, or their delegates, have participated in second interviews confirming management selection. These additional interviews provide an opportunity for directors to lead and develop their management team in the interview process, especially for those who hire infrequently. This additional interview ensures a questioning attitude to guard against an unconscious bias from entering the decision-making process. In the past directors have rejected candidates that were presented to them as they did not meet their expectations. Another best practice, that has been adopted for many roles, is the inclusion of customers or stakeholders from outside of MFC in the interview process. Behavior based questions are used and a diverse interview team is selected. For positions that are a direct report to a division director, it is expected that an interview with the ALD, or delegate will be conducted.

Recently, several internal employees have applied to postings and when selected, the employees home organization makes a counteroffer for them to stay in their current role. This is an area for improvement. While MFC cannot dictate what other organizations do, MFC can ensure management is engaging with employees to determine their career aspirations and provide solid development plans that help employees see their contribution to the mission.

11.1.2 People

Hiring managers, interviewers, and HR are the key people involved in the personnel selection process. Each have specific roles and responsibilities.

Hiring Managers

If recruiting efforts are successful, there will be a strong diverse candidate pool where managers can seek to hire the best talent qualified for the position. Managers conduct a thorough resume review against a set of criteria, while being mindful of any unintentional bias that might influence interviewing decisions.

Interviewers

When selected to participate in the interview process, interviewers have a responsibility to be prepared for a meaningful conversation. Interviewers should be provided with the resumes, job posting, and any other information relevant to the position. A pre-interview conversation with the interview team should take place to discuss the flow of the interview. During interviews, candidates are also interviewing the team and develop a first impression of the way business is conducted. During the interview the candidates will also decide if they want to be part of the department's team.

Human Resources

Human resources balances providing support to the hiring manager, with providing a great experience for candidates. There are system and workflow challenges throughout the entire hiring process. The hiring process takes the HR business partner, recruiter, staffing consultant, compensation analyst, HR administrative assistant, medical, and security roles all working collaboratively to improve processes. It is requested that each partner engage in open-minded discussions so improvements can be made.

11.1.3 Process

During the selection process, there are many hand-offs that not only create an error likely situation but are difficult to track and follow progress. Feedback and recommendations for process improvements which affect experience in the field and in selecting candidates include some of the following areas:

- Managers need a matrix indicating how each applicant answered screening questions and whether the candidate met the minimum qualifications.
- Managers need to complete resume reviews in a timely manner. Failing to review resumes does not present the right impression to potential candidates and is not fair to the manager's current employees who are waiting for additional resources to support the work scope.
- Coordinating schedules for the interview team is cumbersome. It is suggested HR does the initial security screen once candidates are identified to be interviewed and then the hiring manager's administrative assistant can work directly with the candidate to schedule interview. Once travel resumes, this would streamline that portion of the process as well.

In the MFC management model the process for personnel selected to fill matrixed positions within MFC has been documented. These efforts should continue. Additionally, it has been requested that positions assigned to support work at MFC without being matrixed shall also be interviewed by the assigned manager. This is an area where management is not included on the front side of the decision-making process but informed after the fact and is an area for improvement.

Currently, job offers are reviewed by managers and in some cases, by the directors to ensure salary recommendation is competitive with the market. To hire the best talent, INL's salary recommendations need to be competitive, which will be at or above the current market, in order to lead the market for talent supporting nuclear energy. Frequent and regular engagement with the compensation and benefits department is critical to ensure INL is staying relevant in the market.

Post-Offer Acceptance

After the offer is accepted there is an opportunity for improved communication between HR, hiring managers, and the candidate. Once the candidate has accepted the position, every interaction the selected candidate experience contributes to how they view their INL career. If HR or the hiring managers fail during this time, all the recruiting efforts put into finding the right candidate and the managers put into interviewing, will be difficult to recover from. Challenges in the process include the following:

- Offer contingencies are taking about 6-8 weeks to complete.
- On-boarding classes fill up fast which could push a start date out further.
- There is a need for an improved method of communication between all parties as selected candidates move through the process.
- Managers need to be more engaged with the candidate during this time.
- Improvement can be made in the actual new employee on-boarding experience. There is a need for better communication as candidates prepare for the new employee on-boarding. During COVID-19, there are several ways employees may on-board and managers are not sure which method is being used.

- MFC should consider how to conduct MFC New Employee On-boarding with the increase in teleworking arrangements. Content for future classes should be reviewed annually to ensure continued relevance.

First-Year Onboarding

Managers have a responsibility to work diligently to create an inclusive work environment and for those who relocated to the area, to help them feel included in the local community. Suggesting new employees get involved with the INL Newcomers group could be a good avenue to support their transition into the area. Managers, group leads, and mentors need to have frequent conversations with employees, talking about the mission, their work scope, and career aspirations. These suggestions are outlined in the "Materials and Fuels Complex Management Plan" handbook, pages 37-38.

Completing the new employee checklist is one of the first tasks managers are required to complete. A simple action to assign the position description to the employee is another area for improvement. Assigning the position description to the employee does not happen automatically; and involves emails or requests. Therefore, a better method for completing this step needs to be identified.

11.1.4 Equipment/Tools

The applicant tracking system INL uses is Taleo. The system is cumbersome, processes slowly, and user experience is less than adequate. There is an opportunity to continue to provide recommendations to improve manager and, possibly, candidate experience.

MFC would like to explore the development of a dashboard to track where candidates are throughout the entire process.

11.1.5 Actions FY-22

- Begin gaining access to the information needed to develop a dashboard so managers can follow candidates from selection to the onboarding process. (Janice Cook, September 30, 2022)
- Finalize memorandums of understanding that define expectations and involvement of MFC management in the selection and placement of personnel supporting MFC. (Janice Cook, April 30, 2022)

11.1.6 Looking Forward (FY-23 and Beyond)

- Benchmark best practices and tools for personnel selection from other Laboratory organizations and collect recent hire input regarding experiences.

11.2 Professional Development

11.2.1 A Look Back

For the last 10-years, MFC has been proactive in providing development opportunities to employees. In 2013, the operations staff specialist role was established. Employees with the right skill sets and aptitude for leadership were selected to participate in a rotational assignment. The intent of this assignment was to provide employees with a wide variety of experiences, covering all aspects of operations, to better prepare them to take the next leadership role in within 18-24 months. Staff jumped right into the new role and became very busy in the newly assigned duties. Staff enjoyed the role and became critical to the day-to-day operations in the facility. However, many of the employees serving in the staff specialist roles were not as interested in moving to the more stressful leadership positions and instead were content remaining in the staff specialist position.

For years, feedback gathered during Employee Engagement Surveys consistently identified professional development and feedback from managers as an area of opportunity. Since FY-15, the MFC leadership team has taken a more proactive and strategic approach to professional development. Division directors were allocated indirect funds within their division to support employees with development opportunities. In FY-20 alone, MFC invested approximately $1,700,000 in professional and workforce development funds. These funds covered newly hired technicians during training in BOQ school, initial training for newly hired crafts, year-long craft helper program, and short-term funding for scientists and engineers while they completed initial INL training before they can charge to direct programs. This number does not include laboratory funded employee education, courses that are available for free, or activities that are developmental and included in day-to-day work.

In FY-19, the Leadership and Organizational Development (L&OD) group within HR developed a series of tools to support these efforts. A professional development program titled, “My Development Journey” was developed and presented across INL. The program walked employees and managers through all steps of the development journey. MFC quickly adopted the process and required that all managers would include a development conversation with each employee during a mid-year review. Workbooks were printed and provided to every employee and manager in the MFC Work Organization. Employees were encouraged to dive into the content and be prepared for conversations with their manager. In FY-19, a metric was established to measure progress. While the content and quality of each conversation is difficult to measure, 80% of MFC employees participated in a mid-year conversation with their manager.

Across the MFC leadership team, division directors have prioritized employee attendance in laboratory sponsored training, such as INL Way and Leadership Immersion, and have been proactive in recommending key leaders to participate in the newly formed Assessment Center. This prioritization allows MFC to ensure the experiences are provided to those leaders that need to be ready for the next assignment.

MFC has always been proactive in using rotational assignments as a means of development. This process should be continued to build leaders for the future.

11.2.2 People

MFC has always been mindful of roles and skill sets that have the greatest risk of attrition. MFC needs to use professional development opportunities to design great workforce experience.

While progress has been made, there is still an opportunity to help employees make the connection between activities they are participating in and development. There is still an illusion that unless an employee attends a conference, they are not receiving professional development. Meanwhile, some employees equate development with a promotion. Employees have been provided a laundry list of development opportunities that could be done virtually during this year of COVID-19. Virtual conferences and free webinars in a variety of subjects are now being provided by numerous vendors which are free, or at a reduced cost, which allows MFC to provide additional opportunities to more employees.

Part of MFC’s strategic professional development plan needs to include increased focus on future attrition. Approximately 30% of home organization employees are age 55 and over. As future roles are considered, MFC needs to take a strategic approach to review and identify the skill sets needed for the future. Development of a way to visually see skill gaps, potential attrition, and staffing forecasts would be beneficial in identifying areas needing improvements.

A Leadership Bootcamp, like the monthly NFM seminar, is needed to provide all leadership with real-time training and discussion on a variety of topics to continue to build leadership and management skills. A yearly schedule will be developed with the seminar.

A balanced approach to the staff role is essential. Currently, processes are cumbersome and time consuming. Until processes become more streamlined, it will take additional staff to support work. It is

suggested that divisions ensure one person performing the staff role is being provided opportunities to be prepared for the next leadership role. Additional funding is not necessary as they would charge time as any other staff support would charge time. This employee should gain experiences in conduct of operations, CAS, training, HR, risk management, employee safety, etc. Time to complete training and have actual experiences in each area will provide a stronger leader for the future.

Currently MFC has 60 employees participating in degree seeking education programs, with 40 seeking degrees through the University Partnership Program. As a laboratory, INL does not track employees who may be seeking degrees which could be funded through sources outside of INL, such as the GI Bill. A possible option for the future would be to work with university partners and develop a degree program that encompasses all aspects of operations management. The above topics are not just INL related topics, but topics that are relevant to every section of industry. Topics could include financial accounting, risk management, industrial safety, business ethics, etc. Courses provided by ISU or University of Idaho (U of I) would then fall under laboratory level funding. Consideration for work experience should be factored into coursework credits, like the Human Resources and Diversity (HR&D) Bachelors program at ISU.

Leveraging university connections could be broadened into developing a program which could provide educational opportunities in the crafts disciplines. Opportunities structured like apprenticeships should be explored, where an employee gains experience along with their education program.

Employees nearing retirement might not be as interested in participating in the professional development journey. For those employees, a knowledge transfer goal and/or mentoring goal should be established as part of their annual performance goal. L&OD has a defined process for knowledge transfer and for single points of failure. These goals could be tied to variable pay recognition.

MFC needs to leverage SMEs and provide brown bag sessions that cross the full spectrum of each work discipline, from administrative programs to senior scientists. On the scientific and engineering side, presentations are already being held. It is essential to ensure these presentations continue and are broadcast for all workers to expand their knowledge. Organizing these types of technical seminars would be a great development opportunity.

11.2.3 Process

MFC has always been challenged with determining a way to track development without it becoming another burdensome process. A step within the My Development Journey process is to implement the People Planning Process (PPP). Prior to COVID-19 changing the way meetings are held, the personnel development team had begun to meet with each division to collect data for use with the PPP. At this point the PPP is an excel spreadsheet which contains the training each person completed, as well as the experiences they may want to have. This activity is also tied into Succession Planning. A method of continuing to collect this data needs to be revisited so the process can continue until it is possible to return to meeting in groups.

The capability to upload documents, professional development plans, or areas of recognition in the Annual Review Tool is needed. Having this data as part of the employee conversation is valuable for continuing the conversation around development. DOE requires contractors complete one annual review conversation. The tool should support ongoing conversations and not be closed until the end of the calendar year.

11.2.4 Equipment/Tools

L&OD is rolling out Mind Tools, available online and as an app, which contains a variety of development topics employees can easily access and complete. The tool is available on Nucleus, and at the following link: https://www.mindtools.com/community/welcome. These activities can be done independently or can be completed within a workgroup. Employees can structure their own plan with options for a 15-minute read, a weeklong course, or any of the other thousands of topics which are available. Managers can also assign topics to an employee development plan. These activities can take place during a commute, on a 15-minute break, or even when on lunch. Employees own their development, so management can encourage employees to choose to use Mind Tools for opportunities to grow. Activities completed in this app will earn points which tie into the Virgin Pulse program adding to points gained during other health and wellness activities.

The Assessment Center has been established where employees can experience real-life work simulations. Observations from this experience, coupled with feedback from a variety of other sources, such as 360 review, and Hogan Assessments, are assimilated together and provided to the employee and manager for a deeper dive into their development. Leveraging these insights provides a whole picture to the employee and indicates where employees need to focus their professional development. MFC Division Directors will continue to prioritize attendance in this program.

INL courses such as INL Way for new managers, Leadership Immersion, Outward Mindset, and a variety of other INL courses are also avenues for promoting development.

There is a need for a simplified method to track succession planning, development, knowledge transfer. MFC will explore how our business intelligence analyst can take the data in the PPP spreadsheet, information from TRAIN, and other sources and display it in a manner that is meaningful and actionable.

11.2.5 Actions FY-22

- Complete succession planning to include SS, NFM, Department Managers, and key research PIs. (Janice Cook, July 31, 2022)
- Implement management checklist and/or qualification programs for manager and supervisor positions. (Janice Cook, September 30, 2022)
- Work with L&OD Knowledge Transfer Specialist to develop MFC's approach to a knowledge transfer program. (Janice Cook, September 30, 2022)

11.2.6 Looking Forward (FY-23 and Beyond)

- Develop Leadership Bootcamp monthly topics
- Organize monthly brown bag development topics, identify the target audience, and send out reoccurring invites
- Explore opportunities for a manager in training program, including funding, curriculum, and Work discipline codes (WDCs)
- Explore how to visually display and connect succession planning with attrition with professional development for managers and individual employees
- Explore educational opportunities for under-represented
- Explore ways to display the data captured in the PPP
- Work to establish a cross-organizational weeklong immersion leadership development program similar to the "Thinking Expeditions" conducted in the past.

11.3 Inclusion and Diversity

11.3.1 A Look Back

Inclusion and diversity (I&D) are critical to laboratory outcomes and are now represented in the INL values. MFC expects the leadership team to embrace and drive an inclusive environment through diversity of thought, ideas, perspectives, talents, and experiences. MFC wants everyone to bring their best selves to work because they are valued as unique individuals. MFC is passionate about efforts to remove barriers and is dedicated to building an environment where inclusive diversity fuels growth and drives innovation.

It is important for everyone to feel like their contributions matter and MFC is continuously looking for an increase in diversity of thought. In FY-19, MFC took a proactive approach to expand the dialogue around creating a more inclusive environment. MFC established the following goals:

- Analyze specific WDCs to identify key skill sets to focus on during recruiting efforts and establish goals for top areas of opportunity
- Increase recruiting efforts and presence in HBCUs and target specific skill sets
- Division directors leverage their university partnerships to seek a broader and more diverse candidate pool
- Include diversity candidates in succession planning
- Ensure interview teams have a diverse panel of participants
- Increase university R&D engagement using the under-represented metrics
- Start recruiting interns earlier in the academic year.

Improvements have been made in some areas; however, in other areas, more work is still needed. The number of diversity candidates identified in succession planning has been expanded, managers have worked to ensure diverse interview teams where possible, and the leadership team has met with the I&D team to review the MFC metrics over the last 5 years. Those results indicated that MFC trends were positive, and progress has made in many areas related to I&D and, in some cases, advanced beyond a few other organizations in the laboratory, particularly as they relate to learning. The MFC management team, and a majority of the staff, have also participated in a series of courses focused on I&D from Mind Gym. The goal of these courses was to create an open atmosphere where everyone felt psychologically safe, a sense of belonging was created, and everyone felt free to ask questions.

Collecting the data to analyze specific WDCs has been difficult. National and market data provided by a vendor to HR is not easily manipulated, is unclear, and has not provided the right information for accurate analysis. As indicated by the I&D review, strides in hiring and promoting within MFC have been made, however, there is still room for progress. Additional information needs to be gathered to determine which universities will provide the skill sets needed for MFC mission work.

Continued focus on the items above along with those items discussed in the recruiting portion of the OMI will help attain goals of attracting an inclusive, diverse, and talented workforce that will help MFC accomplish its mission of securing our nuclear energy future.

11.3.2 People

MFC will continue to partner with HR in obtaining data useful in making decisions. Subsection 11.4 explores opportunities to increase presence during the advertisement posting process. Additionally, the recruiting team has been asked to continue to post positions in areas that attract a more diverse population. By increasing the viable populations that read and see postings, MFC will attract a more diverse candidate pool to be considered for each position. In turn, this will increase opportunities for hiring the best and brightest in the industry.

Once MFC has a more diverse population, the efforts to create a more inclusive environment should guide decisions and efforts. An inclusive environment is an engaged workforce that knows their ideas and opinions matter to everyone in the organization. These efforts include ensuring all employees are provided development opportunities, open and honest performance feedback, and are rewarded for their efforts.

MFC leadership engagement and representation on I&D councils internal and external to INL continues to be an important commitment from the leadership team. Currently, MFC leadership is represented on four of the five INL leadership councils. This helps model to the MFC workforce the importance of inclusion topics and MFC's commitment to improving work performance through I&D. MFC must also actively and appropriately identify, recognize, and reward worker participation and championing of inclusion, including identifying personnel for award nominations as appropriate.

11.3.3 Process

The process for obtaining MFC labor statistics as they pertain to I&D has been very difficult. MFC will need to continue to request the information to support decisions.

One area that can change the diversity in the workforce is a change to the relocation policy. Since 55% of the workforce at the site facilities are non-exempt, different options for relocation need to be considered. If the diversity of the laboratory is going to change, then hiring will need to expand beyond the local market which is already saturated and does not reflect the diversity of the National Laboratory system. Currently, managers will often overlook candidates due to the challenges in seeking a relocation exception. Non-exempt workers can often bring a skill set that is as unique as those of exempt employees which is needed at the laboratory. However, while it is standard practice for the Laboratory to reimburse exempt employees for relocation expenses, non-exempt employees are generally not reimbursed for relocation expenses, unless burdensome justifications and paperwork are provided. Even in those circumstances, the relocation reimbursement may be rejected. The current relocation policy offers non-exempt relocations as exceptions only with a typical package of $5,000. The laboratory needs to provide this benefit to this critical workforce, just as they do an exempt worker. The local labor market is saturated and not equipped to adequately supply the skill set currently needed in general, making it especially challenging to attract and hire an increasingly diverse group.

While there are two options for training in the area, ESTEC and CEI, competition for these unique skill sets is quite high. Once students have graduated, their skill sets are in demand and they are often hired by other companies, both local and out-of-area. One local vendor shared that if they could hire every graduating welder across the entire state of Idaho, they would still not have enough employees to perform the work they have been contracted to do at the laboratory. INL must leverage hiring non-exempt employees from outside of the area which will provide an opportunity to increase diversity in a multitude of ways—thought, experiences, and background to name a few. Failing to acknowledge that non-exempt employees possess a critical skill set deserving of this benefit is not acceptable. This is a huge opportunity to change the diversity within the workforce.

In preparation for the future development of advanced fuels and construction of new reactors, it is vital that MFC expands the market area search to ensure the workforce is ready to meet the mission. The laboratory must also use a relocation benefit as one tool to attract key employees to the Laboratory.

11.3.4 Equipment/Tools

HR has provided some tools to support managers as they work to increase their I&D strategies. The INL Culture Wizard Tool is available at the following web address: https://inl.culturewizard.com/app/onboarding?._T=~A9IYY. This tool is an interactive online learning resource designed to enhance managements cultural acumen. This tool helps avoid faux pas, build cultural agility, and maximize effective communication. Efforts should be made to ensure managers are aware of this tool and use it as a resource for improvement.

Building on MFC's proactive approach in bringing various content from Mind Gym to the MFC workforce, it is important to continue efforts to raise awareness around conscious and unconscious bias for continued improvement. Continuing training on hiring a diverse workforce and creating an inclusive workplace should be conducted. Listed in Table 7 are a few of the workshops and other tools used to train teams on the MFC I&D goals which can help accelerate cultural change:

Table 7. Workshops for training teams on MFC I&D Goals to accelerate cultural change.

MFC I&D Goal Workshops	
Breaking Bias	Respect Me
One of Us	Did You Hear
Building Bridges	Knowing Me, Knowing You
Your Impact on Others	Leading Inclusively
Respect Me	Micro messages

MFC expects the entire team to embrace and drive inclusive leadership by fostering a culture of inclusion through integrated technology solutions, diversity of thought, ideas, perspectives, talents, and experiences. All these inclusion workshops are designed to move participants from rudimentary awareness to inclusive leadership actions.

MFC should explore opportunities to increase integrated employment or volunteer opportunities with organizations such as BestBuddies.com or local Development Workshop for the skill sets that could work in the MFC environment. MFC will continue to take steps in training managers the benefit of being inclusive.

11.3.5 Actions FY-22

- Hold the Mind Gym session, "Ignite Inclusion" with extended leadership and other key personnel to continue inclusion awareness and conversations. (Janice Cook, March 31, 2022)
- Provide and encourage employees an opportunity to participate in an online 15-minute quarterly inclusion module. Topic to be determined by their division from the five provided by HR. (Janice Cook, September 30, 2022)
- Establish a relationship with at least one HBCU or MSI, chosen for strategic impact for INL and the university, evidenced by a meeting of selected MFC and university leaders and at least one professor/MFC PI relationship to collaborate on a research proposal. (Abdul Dulloo, September 30, 2022)
- Actively solicit applications from HBCUs/MSIs for three entry-level MFC positions. (Abdul Dulloo, September 30, 2022)

11.3.6 Looking Forward (FY-23 and Beyond)

- Evaluate additions of skill development, hiring, and cultural awareness initiatives supporting individuals with disabilities at MFC and in the broader community. Examples could include engagement with existing local organizations and others like Best Buddies.
- Continued engagement with HR&D staff to develop meaningful training and development for leadership and the workforce and ensuring participation by MFC staff when courses are offered.

11.4 Recruiting

11.4.1 A Look Back

For the last 5 years, MFC has relied on traditional INL recruiting practices, such as attendance at job/career fairs, technical conferences, postings on the INL website and job clearinghouses, and some

technical sourcing of candidates for specific jobs. A reach into a broader pool of applicants was needed. After budget reductions eliminated all recruiting staff, progress was made in rebuilding a strong recruiting staff with the right talent to recruit and source candidates. The recruiting staff have begun to find new and innovative ways to reach a broader segment of the market and a more diverse audience.

In FY-19, it was determined that INL needed to have a stronger presence in the American Nuclear Society, so a marketing campaign was funded by NS&T, Advanced Test Reactor (ATR), and MFC for monthly ads in *Nuclear News*. Recruiters provided input on the content, but a more strategic approach with a compelling and consistent message in the ad campaign is needed if this type of branding campaign for broader media is to continue.

Several years ago, MFC changed the structure of all MFC postings and developed an introductory paragraph to be used. This change influenced other organizations to begin to advertise their postings in a new way.

MFC envisions a world where recruiting is a seamless process, where recruiters know and understand the skill sets needed in MFC facilities and staff roles. In partnership with managers, recruiters can develop a strong network to source candidates in advance and develop pipelines for positions in the future. To support those efforts, MFC will maintain the Integrated Nuclear Staffing Plan, which is discussed in Chapter 11.8, "MFC Staffing Plan." This will assist HR in understanding the hiring needs across the nuclear platform to source talent in advance of openings.

11.4.2 People

Internships are a great opportunity to bring talent into the organization and build a pipeline for the future. As indicated by the figures below, MFC has incrementally increased intern and post-doc numbers.

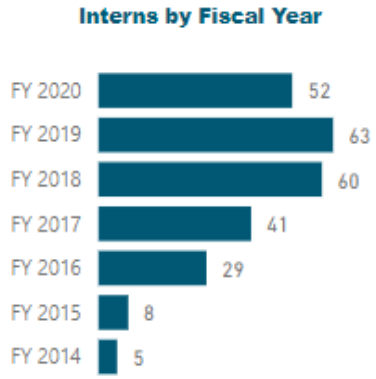

Figure 2. Number of Interns by fiscal year.

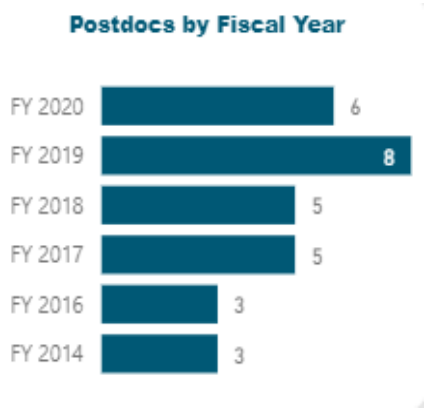

Figure 3. Number of Post-docs by fiscal year.

Recently University Partnerships conducted an assessment matching the skill sets needed at the laboratory with the best universities with needed MFC skills. This information should be provided to managers as a foundation of where to focus their attention. To attract and hire the best interns, managers are expected to post and offer intern opportunities early. Because most of MFC's interns are hired during the spring and summer months, managers will be expected to post and offer spring and summer interns by the end of September of the prior year. Each division should establish an annual internship goal.

Managers should also be more methodical in terms of using the Seaborg and Russ Heath fellowship programs. There is a need to reach out to university contacts, identify their best students, hire these students as interns, if possible, establish relationships, and then mentor these students during the fellowship application process. It is suggested that indirect funding is provided at the laboratory level to support this professional endeavor.

Post-docs are an important part of the nuclear pipeline strategy. It is generally expected that post-docs will remain in a post-doc role for at least 1-year before being converted to regular staff. In the event there

is not an open position within the division the post-doc was hired, there should be a mechanism for retention, such as transfer to another relevant organization in order to maintain the human capital investment.

11.4.3 Process

The overall hiring process is cumbersome. Recruiting support is not needed for all positions; however, given the administrative burden and an inefficient work structure that does not streamline the flow of work, recruiters are unable to expand their current recruiting volume. Nevertheless, efforts are underway to improve the process. A change that has been very well received is the skills intake call. Managers share the skill sets they are seeking and describe a day in the life of that position. Tweaking the process slightly will add additional benefit. Additional changes that would benefit the overall process include the following:

- The WDC is not established by the recruiter, but by a staffing consultant who might not look at the position description until after that call. The staffing consultant should join the call or review the position description in advance so the level and WDC can be discussed during the intake call.
- A discussion on the availability of finding that skill set in the market should be included in this call.
- Managers need to be briefed on how the recruiting team is supporting the "entire" recruiting process for any given position.
- Recruiters should discuss the best marketing method for that position including social media, print, or other outlets.
- Managers need to know all the places their positions are getting posted, how the job scraping works, especially managers who only post occasionally.
- Job posting verbiage should be reviewed using the Textio program which instantly shows recruiters the effectiveness and quality of the job posting to an external audience. This would be helpful in ensuring the verbiage is reaching the broadest and most inclusive audience.

Job postings differ from position descriptions in that they are crafted from a marketing perspective, with the intent to reach a broad and diverse audience via job boards, social media, and networking. Continued efforts to edit verbiage to increase impact is necessary.

Managers need to know about the suite of resources used to support recruiting efforts. Currently the following is a list of the additional resources used:

- **LinkedIn.com**: Unlimited search and a job post package
- **LinkedIn.com Diversity Groups**: Including Women in Energy, Blacks in Energy, INROADS, Hispanics in Energy, etc.
- **Entelo.com**: Ten sourcing seats and three automated sourcing seats; the Envoy tool within Entelo can source candidates based on requirements input by the recruitment team, can send "blind" resumes to managers, and can contact any professional in its database
- **AmericasJobExchange.com**: Local and nationwide posting, Talent Cast, and Office of Federal Contract Compliance Programs fulfillment
- **ClearanceJobs.com**: Unlimited search and unlimited daily scrape job posting
- **ClearedJobs.com**: Unlimited search and a job post package
- **Dice.com:** Unlimited search and a job post package
- **EnergyCentralJobs.com:** Unlimited search and unlimited daily scrape job posting
- **NuclearStreet.com:** Unlimited search and a job post package

- **AmericanNuclearSociety.com:** Unlimited search and a job post package
- **Indeed.com:** 30 professional contracts per month and unlimited daily scrape job posting
- **DiversityJobs.com:** Unlimited search and unlimited daily scrape job posting
- **VetJobs.com:** Unlimited daily scrape job posting
- **AfricanAmericanHires.com:** Unlimited daily scrape job posting
- **DisabilityJobs.net**: Unlimited daily scrape job posting
- **AllHispanicJobs.com**: Unlimited daily scrape job posting
- **LatinoJobs.org**: Unlimited daily scrape job posting
- **AllLGBTjobs.com**: Unlimited daily scrape job posting
- **AsianHires.com**: Unlimited daily scrape job posting
- **WeHireWomen.com**: Unlimited daily scrape job posting.

For some positions that are going to be left open for a longer timeframe, or when managers have contacts at universities or organizations, a flyer needs to be created to support that effort. Recruiters should encourage the same level of urgency and request the flyers be available the same day the job posting goes live. Working with the MFC communication partner would speed up the process as they understand the Complex and have the relevant pictures for the flyer. A base template could be developed that would shorten the time needed to publish the flyer.

The laboratory has developed a "Dual Career" program to assist employees who have a spouse, or partner who needs to find career resources. In the event a candidate has a spouse, or partner seeking employment, managers should engage the Dual Career center through their recruiter.

MFC also needs to explore options to bring candidates' significant others to the area to determine if relocation to Idaho will meet family desires.

When a candidate visits Idaho for a job interview, a standard recruiting package should be provided by the recruiting team that contains relevant community and INL information. This welcome package will provide insights to the area and answers questions. Additional media marketing needs to be readily supplied for managers to share with candidates.

11.4.4 Equipment/Tools

Since the recruitment process is cumbersome, the biggest opportunity MFC has is to leverage the data that is available and display it in a more meaningful manner to support recruiting efforts, such as a dashboard. This dashboard could contain the information which should be provided to managers during the process. Information as to where the candidate pool reached and attracted candidates would also be valuable.

Recruiters established a uniquely specific email alias nucjobs@inl.gov as a main point of contact for interested individuals who may not find a current suitable position posted to INL's careers page. This address has accompanied many job postings and advertisements. MFC managers should consider including it on documents or business cards to be shared at a conference or job fair.

11.4.5 Actions FY-22

- Conduct a review of the recruiting and hiring function to ensure recruiting is proactively and inclusively identifying and attracting targeted talent for current and future mission needs. Ensure the processes and tools are efficient, agile, and responsive to candidate and market needs. (Janice Cook, June 30, 2022)

- Ensure qualified candidates are moved forward in the hiring process and the diversity matrix accurately reflects the qualified candidate pool. (Janice Cook, September 30, 2022)
- Explore funding travel for significant other when interviewing top candidates. (Janice Cook, September 30, 2022)

11.4.6 Looking Forward (FY-23 and Beyond)

- Develop a variety of recruitment-focused media to communicate benefits of working at MFC facilities.

11.5 Personnel Training and Qualification

11.5.1 A Look Back

The MFC Training organization implements 91 nuclear qualification programs that support 11 nuclear facilities and the five types of positions associated with each facility—management, supervisor, operators, technicians, and technical staff. Within the past 5-years the organization has seen three different training managers, and an 80% turnover of employees. These staffing issues have led to challenges in delivering training services. Despite this, operator and craft qualifications have been maintained and new or modified facilities have been brought online with a competent work force. In February 2020, a large-scale training assessment was completed at MFC using DOE training objectives and criteria and a team of 16 professionals to determine the quality of all nuclear qualification programs associated with MFC. The assessment looked at evidence from the past 3-years. Out of the 11 nuclear facility training programs and their five nuclear positions reviewed, one facility (SSPSF) received an overall rating of "Highly Effective," four (NRAD, Zero Power Physics Reactor [ZPPR], HPTs, and Technical Staff) received an overall rating of "Effective," and the remaining programs received an overall rating of "Marginally Effective." Some of the issues found in the assessment included a weak Support Manager qualification program, inconsistent supervisor training, a weak Continuing Training Program, a weak Training Program Evaluation program, inadequate classrooms and labs for conducting training, and weaknesses in the administration of formal On the Job Training (OJT).

Since FY-15 a few improvements have been made to the MFC Training organization. The more significant improvements include the following:

- The development of HPI Dynamic learning activities (DLAs), where operators and technicians receive hands-on practice applying HPI principals and tools.
- The startup of RHLLW, with associated Management Self Assessments (MSAs) and RHs, which found no training issues—all newly qualified operations personnel were ready and qualified to operate the facility.
- For the first time in years, the MFC training department is fully staffed.
- In early FY-20 it was determined by MFC training management to conduct a full DOE-STD-1070, "Guidelines for Evaluation of Nuclear Facility Training Programs," training assessment for all MFC nuclear qualification programs to baseline current training practices and standards to enable a more focused corrective action strategy.

11.5.2 People

Refer to Subsection 11.6.5.

11.5.3 Process

MFC Training follows the Systematic Approach to Training (SAT) process. The SAT process is a methodology for managing training programs and is required by DOE O 426, "Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities." INL Laboratory-wide Manual 12, "Training and Qualification," includes procedures and processes for how the SAT

process is to be implemented. Overall, these lab-wide procedures and processes are acceptable for MFC except in the area of "Continuing Training" and "Training Program Evaluation." MFC's training staff needs more guidance on how to implement consistent and effective continuing training programs for each nuclear facility and how to implement a consistent and effective training evaluation program that identifies training strengths and weaknesses.

11.5.4 Equipment/Tools

MFC has access to two acceptable classrooms in building MFC-1727 for conducting training. Classrooms and labs for conducting site-wide ES&H courses including Rad Worker training, LO/TO training, Respirator training, First Aid, and others needs improvement. Training facilities for these topics are located on the top floor of the old Experimental Breeder Reactor II (EBR-II) power plant where it is difficult to control noise and other distractions, and difficult to control temperature extremes.

The off-the-shelf examination software tool, LXR, is difficult to use and is no longer supported by the developer. Thousands of exam bank questions are at risk if this software malfunctions.

Also, the availability of hoisting and rigging (H&R) equipment to support regular practical exams needs improvement. Practical H&R exams are consistently being canceled because the equipment is not available.

11.5.5 Actions FY-22

- Improve the quantity and quality of operational drills to better prepare facility staff to respond to upsets, abnormalities, and emergencies. This would include the recruitment and hiring of a drill coordinator. (Tiffany Leavitt, August 31, 2022)
- Develop a process to conduct MFC New Employee On-boarding both in-person and virtually to align with the increase in teleworking arrangements. Content for future classes should be reviewed annually to ensure continued relevance. (Tiffany Leavitt, August 31, 2022)
- Develop cost estimate to convert the former MFC Dispensary building to the MFC Training Center. This classroom space will be used for Rad Worker training, LO/TO training, Respirator training, First Aid training, and other ES&H hands-on courses. (Tiffany Leavitt, July 31, 2022)
- Continue updates to Facility Operator/SS exam banks to increase the number of higher-level thinking questions. (Tiffany Leavitt, September 30, 2022 [ongoing])
- Review all CY-22 continuing training plans to ensure compliance with PDD-147, "MFC Nuclear and Radiological Facility Training Program." (Tiffany Leavitt, March 30, 2022)
- Revise PDD-147 to ensure compliance with DOE O 426.2 and consider reformatting. (Tiffany Leavitt, September 30, 2022)

11.5.6 Looking Forward (FY-23 and Beyond)

- Improve the quality of formal OJT at MFC by involving line managers in the occasional observation and feedback of checkouts.
- Improve the shift supervisor (SS) qualification program to strengthen the technical, problem solving, and managerial skills of Facility Supervisors and to allow for technically competent outsiders to qualify as Facility Shift Supervisors without having first qualified as Facility Operators.
- Develop and deliver additional facility systems training to strengthen operations knowledge. Develop this training for use in classrooms and/or self-study and include, where applicable, technology such as "Augmented/Virtual Reality" to strengthen delivery.
- Identify H&R equipment frequently used at MFC including selected types of aerial lifts, forks lifts, and cranes that can be dedicated and maintained for the purpose of training, including practical exams.

- Identify and procure an exam administration software that can automatically create qualification exams for operators and supervisors per DOE requirements. Then begin the process of converting the existing exam bank and exam profiles to the new software. This conversion will take several years to complete.
- Develop an NFM "Book of Knowledge" to assist NFM candidates through the qualification process.
- Continue identifying and dedicating H&R equipment frequently used at MFC for the purpose of training, including practical exams.
- Continue the development and delivery of DLAs to support the mastery of HPI and Conduct of Operations Skills.
- Improve the training of researchers working at MFC to strengthen their knowledge of and application of Nuclear Safety Culture, HPI Culture and Conduct of Operations Culture.
- Coordinate all NFMs and Shift Supervisors attendance at the INPO First Line Supervisor Academy.

11.6 Continuing Training

11.6.1 A Look Back

Continuing training programs are established to maintain and enhance the knowledge and skills of personnel who perform functions associated with engineered safety features and safety-related systems as identified in facility documented safety analyses (DSAs).

For positions identified in PDD-147, continuing training programs must be structured commensurate with specific position needs and be administered on a cycle not to exceed 2-years.

Continuing training at MFC consists of completing training on a significant facility system and component changes, applicable procedure changes, applicable industry operating experience, selected fundamentals with emphasis on seldom-used knowledge and skills necessary to assure safety, and other training as needed to correct identified performance problems.

MFC-specific continuing training is training that is being formally planned, developed, delivered, and tracked to ensure key topics are included. In addition to this formal continuing training, it is recognized that all MFC employees, including nuclear qualified personnel, receive unplanned and sometimes less formal training in the form of management discussions, safety meetings, design meetings, critique meetings, DSA discussions, required readings for revised procedures, vendor training, facility modification discussions, and other just-in-time facility training that maintains and improves worker knowledge and skills.

11.6.2 People

Continuing training is required for MFC nuclear operators and their supervisors, MFC nuclear maintenance personnel, and other nuclear technicians supporting MFC including Laboratory Technicians, Laboratory Researchers, HPTs, Quality Inspectors, Qualified Fissionable Material Handlers (FMHs), and Waste Examination Operators (WEOs). Continuing training is also required for MFC nuclear technical staff.

11.6.3 Process

Continuing training required for MFC nuclear operators and their supervisors is documented on a "2-year Continuing Training Plan" using INL Form 361.72, "Continuing Training Plan," and within discipline-specific job codes included within each worker's electronic training plan. It is expected that the 2-year plans will contain at least 40 hours/year of facility-specific continuing training for most MFC facilities and 20 hours/year for facilities with fewer systems and procedures.

Continuing training required for MFC nuclear maintenance personnel is documented on a "2-year Continuing Training Plan" using INL Form 361.72 and within discipline-specific job codes included

within each worker's electronic training plan. It is expected that the 2-year plans for Electricians, Instrument and Control Technicians, HVAC Technicians, Mechanics, heavy-equipment operators (HEOs), Manipulator Repair Technicians, and Carpenters will contain at least 20 hours/year of craft-specific, MFC-wide, and facility-specific continuing training.

Other nuclear technicians supporting MFC, including Laboratory Technicians, Laboratory Researchers, HPTs, Quality Inspectors, Qualified FMHs, and WEOs, will be required to complete MFC-wide, and nuclear facility-specific continuing training in addition to training already included on their discipline-specific job codes. Training for these other technicians is not required to be documented in a "2-year Continuing Training Plan."

Continuing training for MFC nuclear technical staff is documented within discipline-specific job codes already included within each worker's training plan. In addition to this training, the MFC System Engineer, Cognizant System Engineer, Rad Engineer, Fire Protection Engineer, MAR Coordinator, and Facility Disposition Specialist (FDS) will be required to attend MFC-wide and nuclear facility-specific continuing training. Training for these technical staff personnel is not required to be documented in a "2-year Continuing Training Plan."

Other nuclear technical staff supporting MFC, including Quality Engineers, Criticality Safety Engineers, Safety Analysts, Industrial Safety Engineer, and Industrial Hygienist, receive continuing training from their discipline-specific support organizations. MFC-specific continuing training for these positions is considered and provided when needed, as part of the change management processes associated with facility modifications (EJs), procedure revisions (DCRs), and DSA upgrade checklists.

11.6.4 Equipment/Tools

The Training Records and Information Network (TRAIN) supports the management and conduct of employee training necessary to ensure assigned tasks are completed in a safe and competent manner for the protection of workers, facilities, and the environment at INL. TRAIN provides all INL employees with online, real-time access to reports, including training plans, schedules, status, and history. This enables the employee to monitor and maintain their training, facilitates the administration of training, and supports a timely and informed decision by management in making job assignments.

11.6.5 Actions FY-22

- Develop and implement an MFC NFM Continuing Training Program. (Tiffany Leavitt, September 30, 2022)
- Develop continuing training for SSs. (Tiffany Leavitt, September 30, 2022)
- Develop and implement an NFM requalification program. (Tiffany Leavitt, September 30, 2022)
  - Conduct oral boards every 2 years.

11.6.6 Looking Forward (FY-23 and Beyond)

No additional actions identified at this time.

11.7 Training Staff

11.7.1 A Look Back

Since 2005 the MFC Training department has been organized with one trainer supporting multiple facilities and taking on the workload by themselves. This model worked when the MFC personnel count was at much lower levels and the trainers had fewer facilities. Under this model, as the organizations grew, trainers became overworked and unable to keep up with the constant changes. This led to training material updates lagging far behind the facilities and issues of training material being constantly out of date. Over the last 2-years, the MFC Training department has had a shift in how workload is distributed and how instructors are tasked to keep up with the constant state of change and growth that MFC has seen. Instructors and training coordinators are teamed together to support each other and customers.

Teams were built around the knowledge level of the current staff to encourage mentoring and sharing of talents.

11.7.2 People

Training staff consists of a training manager, 10 instructional analysts/developers, and three training coordinators. This staff supports MFC organizations involved in operating nuclear and radiological facilities by:

- Assuring that operations, maintenance, technical staff, technicians, supervisors, and managers receive the necessary training to perform their job assignments in a safe and efficient manner.
- Maintaining and improving operations and maintenance, personnel and technical staff, technicians, supervisors, and manager performance through structured continuing training programs.

Although head count has slightly increased, turnover has been, and will continue to be, an issue. Currently 70% of the instructional staff have worked at MFC two years or less and 100% of the training coordinators have been in the position for fewer than 2-years. Attrition, due to retirement, will pose a significant challenge to MFC Training over the next 5 years. While most training staff are new to MFC, and to training, they are engaged, service-oriented, and eager to learn.

The goals of the MFC Training program are to:

- Assure that personnel operating nuclear facilities are properly trained to perform their assignments in a safe and efficient manner
- Maintain and improve operating proficiency through structured requalification and recertification plans
- Conduct training programs that meet DOE and laboratory-specific requirements
- Ensure all personnel are trained and maintain qualifications specific to their area of assignment which fosters a safe and productive work environment.

11.7.3 Process

MFC Training follows the SAT process. The SAT process is a methodology for managing training programs. It is an orderly, logical approach to determining what people must know and do for a particular job. The SAT process ensures that people are prepared for their work by having the necessary knowledge, skills, abilities, and attitudes to do their job.

MFC instructional analysts/developers are qualified in accordance with INL Manual 12 implementing procedures which includes instruction on subjects such as TSRs, facility operating characteristics and principles, operating limits and their bases, and facility-specific knowledge for the material the instructors will present.

Instructional analysts/developers are responsible for the analysis, design, development, and evaluation of initial and continuing training programs for the qualification and certification of MFC personnel. Training staff are responsible for implementing initial and continuing training programs for qualifications and certifications identified within PDD-147. Instructional staff provide facility line management with the support necessary to ensure that personnel in the operating organization are qualified to perform their job functions.

11.7.4 Equipment/Tools

TRAIN supports the management and conduct of employee training necessary to ensure assigned tasks are completed in a safe and competent manner for the protection of workers, facilities, and the environment at INL. TRAIN provides all INL employees with online, real-time access to reports, including training plans, schedules, status, and history. This enables the employee to monitor and maintain their training, facilitates the administration of training, and supports a timely and informed

decision by management in making job assignments.

11.7.5 Actions FY-22

- Review MFC Training Processes to find efficiencies (Tiffany Leavitt, September 30, 2022)
  - Design/develop and implement a more effective MFC-specific training request/needs analysis form
  - Design/develop and implement a more effective MFC-specific training job analysis task listing form
- Develop and implement an "MFC Training Effectiveness Evaluation Program" that establishes site-specific guidance for the systematic evaluation of training programs that meets the intent of Objective 8 of DOE-STD-1070. (Tiffany Leavitt, June 30, 2022)

11.7.6 Looking Forward (FY23 and Beyond)

- Incorporate Augmented Reality in Training Modules
  - Develop and pilot augmented reality training for operators or maintenance personnel.

11.8 MFC Staffing Plan

11.8.1 A Look Back

Every year, HR requests a staffing plan be developed. MFC has completed the activity but has not turned the plan into a strategic plan with associated key actions. For a staffing plan to be effective MFC will need to continually review, refine, and then determine how to fund hiring decisions that are in advance of attrition or program arrival. There have been recent successes (see list below), but MFC looks forward to the advances that are planned for the next 5-years.

- Following the workforce reductions in 2012, to prepare for future work, the laboratory funded a workforce development pool to hire and train nuclear facility technicians in preparation for the return of direct work
- In MFC's organization management funding pool, line items have been added for specific skill sets that have been difficult to find
- When possible, hiring is done in advance of attrition
- MFC realized in 2020 the need to fund an increase of three Full Time Equivalents (FTEs) in FY-21 for the operations area to support more direct work and build a pipeline of leaders.

Developing a staffing strategy goes beyond determining the number of people that will be hired. The strategy must include maintaining and retaining a competent and satisfied workforce, skilled for the right roles at the right time to meet mission goals now and in the future. Reinvention includes considering the changing business landscape and skills needed to continually meet the needs of the future. MFC should consider the challenges that the historic FY-20 presented. Computer technologies such as robotics or new computer programs should be considered. Similarly, consideration should be given to which processes should be eliminated; then steps should be taken to change the way work has always been performed. All areas will be considered from a strategic point of view and routine discussions will be held.

11.8.2 People

Collaborating across the nuclear platform can be a very positive endeavor for MFC employees because opportunities for professional development will increase. Employees will gain a stronger understanding of the INL mission and naturally become more engaged as they see themselves as an integral part of that vision, and a stronger pipeline will be developed. The following efforts will also support an integrated staffing plan:

- Recruiting efforts with a focus on diversity will be critical to meeting the needs of the entire nuclear platform.
- Increased efforts in university engagement to influence curriculum needs.
- Succession planning has been conducted at the leadership team level and has been completed for management positions in some areas. A more planful approach of critical resources, across the entire organization, including single points of failure will be completed.
- Cross directorate professional development discussions need to be facilitated by HR to better understand what options are available for employees across the entire complex.
- The use of subcontractors and staff augmentation can be a key component to a staffing plan. Determining which work should be completed by a subcontractor and monitoring how long they perform the work is key to the successful use of this type of resource.

11.8.3 Process

Integrated Nuclear Staffing Plan

In FY-19, MFC provided data for an Integrated Nuclear Staffing Plan. Meetings were held with each division to discuss potential future projects in the next 5 years along with resources needed if that work came to fruition. Layered into this plan included potential attrition. HR complied the information into one staffing plan with the intent to share with outside stakeholders to prepare for the future workforce needs.

With the structure of the INL's Integrated Nuclear 5-year Staffing Plan developed, it is expected the staffing plan will be reviewed annually and finalized by May of each year. This annual planning process provides consistent planning and is a snapshot in time that serves as a baseline for talent acquisition and hiring execution. Funding shifts, mission needs, and staff movement (and attrition) dictate evolving staffing needs. As such, staffing planning requires ongoing conversations between management, program managers, customers, and stakeholders. These conversations will enable real-time updates to budgets in the IRPT which will result in increased agility in responding to staffing needs in concert with the annual staffing plan.

INL Nuclear Staffing Executive Board

The ALDs of ATR, MFC, and NS&T met in early FY-20 and agreed to set up an "INL Nuclear Staffing Executive Board." The board would be formally chartered, and accountable for the enterprise-wide strategic nuclear staffing and development. A foundational document for the board will be the "INL Integrated Staffing Plan." The plan was suggested to begin with operational and planned new nuclear facilities as the focus of this effort. This board is not responsible to make day-to-day hiring decisions, but responsible for determining the strategic approach.

- Included in the scope of this committee would be:
  - Accountability for executing nuclear facility strategic and tactical staffing including long-term plans and short-term actions for hiring and retention.
  - Authority, as required, for establishment of nuclear enterprise-wide processes, such as approval authority for nuclear operations, scientists, and applied engineering promotion criteria.
  - Authoring and maintaining the INL Nuclear Staffing Plan.
- The board will address cross organization development, establishing staff development plans that may involve directed transfers to grow the nuclear staff, supervisors, and leaders of the future. Having cross-qualified personnel will give greater assurance that critical positions will be adequately staffed.
- Recruiting efforts will typically be coordinated, with cross-organizational interviews and decision input utilized on appropriate positions.

During the regularly scheduled meetings of the executive board, decisions around progress and acceptance of work, as well as decisions on funding positions in advance of attrition or arrival of

programmatic work will be made. This executive board will provide transparency across the nuclear platform and ensure the nuclear messaging is clear, consistent, and united in a strategic plan.

Hiring efforts must include staffing for new nuclear projects such as NRIC initiatives, GAIN, and the Versatile Test Reactor (VTR). Inclusion of this work in the decision-making process must be strategically mitigated to avoid undesirable impacts in current organizations. The staffing of new nuclear organizations must also be strategically aligned with INL objectives, and alignment will involve using the operating facilities for pools of trained personnel to support current and newly emerging work.

Establishing the INL Nuclear Staffing Executive Board will be the next step in building the collaborative environment across the nuclear platform. The board will:

- Establish the lead and future chairman
- Write a charter and submit to INL Laboratory Directory for approval
- Review the Integrated Nuclear Staffing Plan with regular data updates to include potential new programmatic work and attrition
- Establish routine meetings of all stakeholders which include to:
  - Conduct discussions on potential future work
  - Review and status of accepted work
  - Operational status of facilities and ability to complete work
  - Dashboard review of all relevant human capital data
  - Conduct discussions of critical skill gap areas and staffing needs from the balance of the Laboratory
  - Make decisions on hiring for future work and determine how those positions can be funded.

Skills Gap Analysis

Developing a staffing strategy goes beyond determining the number of people to hire. The strategy must include maintaining and retaining a competent and satisfied workforce, skilled for the right roles at the right time to meet mission goals now and in the future.

To better position MFC for the workforce of the future, the framework for a skills gap analysis needs to be developed. It is important to consider the changing business landscape and skills needed to continually meet the needs of the future. MFC should consider computer technologies, such as robotics or new computer programs. To perform work in a different way, MFC will need to consider what skill sets are needed to accomplish that change. To accomplish this all areas will be considered from a strategic point of view and routine discussions will be held to determine ways to change how work is performed. As MFC proactively evolves for the future, consideration should be given on what can be eliminated, what can be started, and what needs to stay the same.

11.8.4 Equipment/Tools

MFC needs to explore the best method of compiling the information contained in the Integrated Nuclear Staffing plan, forecasted attrition, and resources planned in the IRPT. MFC's business intelligence analyst is to develop a dashboard which would visually display the above information and allow it to be reviewed at the INL Nuclear Staffing Executive Board quarterly meeting.

11.8.5 Actions FY-22

Establishing the INL Nuclear Staffing Executive Board will be the next step in building the collaborative environment across the nuclear platform.

- Continue close coordination with NRIC to establish future staffing needs. (Janice Cook, September 30, 2022 [ongoing])

11.8.6 **Looking Forward (FY-23 and Beyond)**

- Establish cross directorate meetings to understand future programmatic needs to ensure data in staffing plan represents similar timing and captures program depth.
- The INL Nuclear Staffing Executive Board will:
  - Establish the lead and future chairman
  - Write a charter and submit to INL Laboratory Directory for approval
  - Maintain the Integrated Nuclear Staffing Plan with regular data to include potential new programmatic work and attrition
  - Establish routine meetings of all stakeholders
  - Develop dashboard with staffing plan, attrition, and current planned resources
  - Develop succession plans deeper into the organization (PPP actions are included in the Professional Development section [Subsection 11.1] of this publication)
  - Establish cross directorate meetings to understand future programmatic needs to ensure data in staffing plan represents similar timing and captures program depth
  - Establish a process for entering the staffing plan into the IRPT.
- Quarterly Executive Board meetings should include:
  - Information on potential future work
  - Review of work already accepted
  - Operational status of facilities and ability to complete work
  - Dashboard review of all relevant human capital data
  - Discussion of critical skill gap areas and staffing needs from the balance of the Laboratory
  - Decisions on hiring for future work and how those positions can be funded.
- Continued refinement of dashboard.
- Annual INL staffing plan exercise.
- Continue to build relationships with key leaders across nuclear platform.
- Begin to build the framework for an employee skills gap analysis. Skills needed now, skills needed for future, skills of current employees, and how to identify those deltas.

12. FUNDING/BUDGET CONTROLS

12.1 Integrated Resource Planning Tool

12.1.1 A Look Back

For years, INL senior leadership has asked for a total cost to operate each facility at MFC and why it costs what it does. Despite working to a specific budget amount, it has been difficult to clearly communicate a cost. MFC managers and programmatic managers used a variety of methods to budget; spreadsheets and the web-based INL Cost Estimating Tool are two of the methods that were used. During this process, the resources needed to perform direct work was vague. There has always been a disconnect between the number of MFC personnel NS&T has planned to perform work within their work packages, and the number of personnel who charged those work packages. Additionally, there is not an easy method to determine where the discrepancies were.

Over the past 5 years, MFC has made great strides in the development and implementation of the IRPT. This tool was developed to create the integrated work plan (IWP). By planning specific activities, the IWP more accurately addresses the full scope of work required to operate and maintain facilities and achieve the mission at MFC. The IWP is a bottoms-up, resource-loaded plan that incorporates research activities, operations, maintenance, and other requirements in an integrated fashion, by fiscal year, allowing for prioritization and risk management. The fundamental purpose of the tool is to align budget with mission outcomes. In addition, the IWP provides:

- Full budgetary transparency both internally and externally
- Managers the flexibility to manage at tailored levels that make sense for each situation
- Divisional integration to make necessary budget adjustments
- Surety that the organization is right sized to meet the mission
- Surety that MFC priorities align to mission commitments
- Better understanding of resources needed to perform work
- Better understanding of what it costs to operate and maintain each facility and ultimately, MFC as a whole
- Ability to plan work into the out-years. A large advantage of the tool is the ability to plan into the out-years. The typical INL business systems look at the next fiscal year, with reporting always in a backwards-looking view. The IRPT has the ability to plan work in the out-years in preparation for future staffing needs.

MFC began developing the tool in FY-16. Every year, additional capability and features were added to make it easier to input, export, and analyze data. The scope of work planned in the tool has incrementally increased each year. Hiring decisions are now determined based on resource planning.

In FY-20, the tool gained some use outside MFC. Several divisions within N&HS began using the tool to understand the demands on their workforce.

For FY-21, NS&T has agreed to let MFC enter some of their programmatic work into the tool as a pilot. This will allow NS&T to determine whether use of the data from the tool would add value to their work planning process.

12.1.2 People

Management and division Control Account Managers have grown in understanding and ultimately use of the tool. Users at all levels need to see the value in the data analysis and forecasting the tool can provide. MFC hired a business intelligence analyst who has the skills and ability to use a suite of business intelligence tools to develop a dashboard which can display the data in a visually meaningful manner.

The MFC Business Manager has fully embraced the use of the tool and has led the organization into being an advocate with their divisional customers. The FY-21 MFC work packages were entered into the tool prior to October 1, 2020, even though there is not an approved budget. This data was exported from the tool to the business systems. This was done with the support of the Planning and Financial Controls Specialists (PFCs) working side by side with the division contacts.

One intent of the tool is to facilitate communication between support organizations and division work at MFC. In previous years, meetings were held between Engineering, RadCon, Maintenance, and division directors to understand what activities were missed in planning and what could be expected in the upcoming year. This communication was valuable to all organizations. These same types of meetings should be conducted every year to ensure open dialogue between all MFC parties. As more BEA directorates use the tool, these discussions will expand from within MFC to outside MFC.

Currently, the only way to increase headcount to be ready to support programs, is to financially carry resources above those needed to support base operations. This can be done in the short-term using indirect funding from an organization management rate increase that supports general training and qualification of new hires. Longer-term there needs to be a collaborative strategic investment plan by research programs and MFC to support hiring and development of research qualified support staff. This should be a financially shared responsibility across the directorates.

Continual improvement in communication between division directors and programs is necessary to understand the scope of potential out-year research baselines. In many cases training and qualification can take up to one year to provide a nuclear facility operator that can support R&D.

12.1.3 Process

The IRPT manages the day-to-day resource planning. With the addition of dashboards, it will become a simple and easy way to review work and will become even more valuable. The IRPT planning process is simple and is improving each year. The vision for using the tool is to review budget performance, employee resource needs, milestones, and performance against programmatic work each month. There are gaps between the current state of the IRPT and the end goal of where the system should be. Examples include:

- The data in the tool is used to make hiring decisions and continued development to better demonstrate those gaps are ongoing.
- Disciplined structured monthly review meetings are key, reviewing base O&M funding as well as program spending plans.
- Visualization of progress against programmatic work is key to understanding and prioritizing work.
- As more INL directorates begin using the tool, a strategic approach to future development should take place. A strategic advisory group should be formed so changes to the tool that benefit all BEA directorates can be approved. Looking at the tool from a strategic approach will require communication across all directorates as to what information is beneficial.
- Integrating other tools, such as P6, is also needed for full planning perspective (import/export as needed).
- Integrating the IPL into the tool will help to understand resources needed to perform work if funding is awarded.
- Integrating the Nuclear Staffing Plan into the tool.

12.1.4 Equipment/Tools

The tool has developed significantly since is its conception

- A lab-level decision will need to be made about the web-based cost estimating tool. There are good features in the CET. Decisions regarding merging the two will need to be made.

- Integration with P6 will be necessary for a smooth transition in the planning life cycle, from planning to scheduling to importing into the INL budgetary systems.

12.1.5 Actions FY-22

- Continue to develop IRPT capabilities to support broader end user needs. (Janice Cook, September 30, 2022)
- Continue development and refinement of dashboards so end users can perform analysis for meaningful decision making. (Janice Cook, September 30, 2022)
- Use Priorities 1, 2, and 3 in a meaningful way. (Janice Cook, September 30, 2022)
- Use the tool as the parking lot of IPL items. (Janice Cook, September 30, 2022)

12.1.6 Looking Forward (FY-23 and Beyond)

- Explore how to identify and track milestones in the tool for visibility and reporting purposes.

13. WORK PLANNING AND CONTROL

13.1 MFC Maintenance Planning Improvement Strategy

13.1.1 A Look Back

The MFC Planning Department has made progress in improving consistency in the last year by hiring a Work Control Manager that restructured Planning and Work Control. Restructuring of the Work Control process has resulted in implementing the iQ – Work Smart process, ensuring all planners are Procedure Professionals Association (PPA) certified, and instituting a Continuous Document Improvement (CDI) group. Planners holding the PPA Certification has led to an increased focus on writing packages with human factored writing in mind. The planners are now better trained on how to correct common inconsistencies when addressing the 18 PPA error traps.

The Planning Department has been collaborating with engineering to implement a return to service standard for work packages. This new standard will aid engineering in the EJ process. The department has been working diligently in introducing and improving the Engineering Change (EC) module. The EC module will result in a streamlined process to ensure planned maintenance is kept up to date and relevant.

In FY-21 the Planning Department created a metrics page to track and evaluate Hold for Approval (H/APPR) times, the number of packages processed, and backlog. The department is in the process of establishing a baseline using data from the metrics page to set standard times for items to be in H/APPR. Data and information will be shared with the other facilities to ensure expectations are clear.

The Scheduling Department made changes to work processes, including instituting schedule adherence meetings, and moving when the plan of the week (POW) meeting is held. Rescheduling of POW week meetings increased the amount of time the foreman has to set up work for the start of the POW week, with the goal being 93% POW adherence. A schedule adherence meeting was implemented where scheduled work not performed during the POW is evaluated to determine the reasons work was not performed. The data collected at these schedule adherence meetings is used to address issues across MFC divisions.

Implementation of the Maintenance Work Management in iQ – Work Smart has improved flow of work through Work Control. Specifically, the approval process for a low-risk job dropped from an average of 15 days to 1 hour. Multiple facilities have noted the significant increase in efficiency due to implementing iQ – Work Smart. All work packages now flow through Work Control Administration Center (WCAC), which allows for improved work package tracking from start to finish and captures feedback. The Planning Department designed, tested, and implemented a feedback process loop to aide in tracking and providing data to the crafts when feedback resolution is complete. Integration of HPI and PPA methods will be improved by implementing MFC-ADM-2026, “MFC Maintenance Work Control Guide,” which fills the gaps with iQ – Work Smart and will supersede SP-20.2.6, “MFC Supplement to LWP-6200 and GDE-6200.”

13.1.2 People

Currently, Work Control has PPA certified personnel but does not have a HPI Practitioner. To ensure focus on HPI implementation, Work Control plans to select one person to obtain the HPI Practitioner qualification.

The MFC Planning Department continues to emphasize standards when writing work orders. As has been shown in the newly implemented CDI meetings, work order still contain drift in the technical details. The planning department has also identified that a refresher course is not currently provided for these standards. To that end, a regular professional development set of tailgate sessions will be instituted on the technical details of MFC-ADM-2026.

Amongst the crafts, there is a gap in knowledge with respect to HPI principles, and how Human Factored Writing should be formatted. To close the knowledge gap, a Human Factored Writing Overview will be presented to the entire maintenance department. This will ensure all personnel understand not only

know why HPI is important, but why packages are built in a way that improves human performance.

13.1.3 Process

The MFC Planning Department will continue to teach and help others learn the Work Management process in iQ – Work Smart. The Planning Department will promote utilizing the PPA standards throughout MFC, continue focusing on the INPO standards throughout MFC, TREAT, and INL, and will develop and execute an improved process for place keeping.

There is currently no method to plan resource loading for the upcoming weeks leading to facilities being required to re-schedule work. Scheduling is working with facilities to develop a long-range schedule to proactively plan for upcoming work. A long-range schedule will provide more accurate resource loading for upcoming weeks and allow for a more accurate snapshot of the resource workload.

Work packages have needed improvement with regards to being up to date with equipment and configuration changes, and steps being laid out in an inefficient manner. In FY-21 the Planning Department implemented a process for crafts to provide feedback to planners and ensure corrections are made in a timely manner. To ensure 100% of the feedback is captured, all completed work packages are returned to WCAC and tracked in a database.

Schedule adherence at MFC continues to hover at approximately 80%. Best-in-class organizations maintain adherence of greater than 93%. A bi-weekly schedule adherence meeting is held to discuss issues that resulted in scheduled work not being completed as required. Participation across MFC is mediocre and must increase in order to ensure continuous improvement. The Work Control Manager and the Work Execution Manager will track and trend results of the meeting. Work Control will continue to monitor schedule adherence and take future action if warranted.

13.1.4 Equipment and Tools

The previous personal leave (PL) calendar was not efficient, and many requests were missed or placed in the wrong calendar. An automated PL calendar was designed, tested, and implemented. The new PL calendar has been established for Work Control to help capture and plan for time off. Employees now request time off per an online request form that is emailed directly to their supervisor/manager. Once the manager approves the request it is automatically added to a calendar that can be filtered. Due to the new calendar's effectiveness in the Work Control Department, this system will start to be used throughout the maintenance department. In addition, planner computer monitors, computers, and workspaces have been upgraded to improve efficiency.

Integration between Primavera P6 (P6) and AS communication continues to be an issue. However, the scheduling department does a great job of catching inconsistencies with this program. The P6 group is currently rebuilding the database to improve communication.

13.1.5 Actions FY-22

Actions for Work Control Manager in FY-22

- Qualify at least one Work Control person as an HPI Practitioner. (Eric Papaioannou, September 30, 2022)
- Institute quarterly professional development tailgate sessions. (Eric Papaioannou, September 30, 2022)
- Present Human Factored Writing Overview to entire maintenance department. (Eric Papaioannou, June 30, 2022)
- Develop a long-range work schedule with the facilities. (Eric Papaioannou, September 30, 2022)
- Ensure 100% of craft feedback on work orders is addressed through use of the feedback tracking process. (Eric Papaioannou, September 30, 2022)

- Implement the new PL calendar for the maintenance department. (Eric Papaioannou, February 28, 2022)

13.1.6 Looking Forward (FY-23 and Beyond)

- In accordance with the maintenance department's strategic plan, work control intends to continue to model Human Performance, qualify an addition PPA certified instructor, develop an expected timeline for package processing and continuously look for ways to improve schedule adherence.

13.2 Work Execution

13.2.1 A Look Back

MFC maintenance made significant improvements in work execution and performance in FY-21. Despite working under highly restrictive COVID-19 regulations, the maintenance department implemented INPO 18-002, "Conduct of Maintenance" as a guiding standard. In the years prior to implementation of INPO 18-002 there were four DOE Findings, eight Deviations of Minor (DOM) Significance, and several dozens of LabWay issues. Since implementation of INPO 18-002, a marked improvement has been observed as a result of a new set of standards and expectations, and a change in culture throughout the maintenance department. Since implementation of INPO 18-002, there have been zero DOE Findings, zero DOMs, and 19 LabWay issues.

Leading from the front, MFC Maintenance was the first to implement INL's Work Management process in iQ – Work Smart. The team worked through the expected and unexpected issues and demonstrated the benefits of the software. The new work management process identified Low-Risk Simple Activity (LRSA) to take the place of Tool pouch and Minor Maintenance activities performed as skill of the craft. To improve the tracking of man hours and charge numbers associated with LRSA, MFC Maintenance has implemented and started using the LRSA database. The team also created M-MP-1000, "MFC Maintenance Low-Risk Simple Activities," an instruction that directs how a LRSA is completed. Implementing the LRSA form increased the monthly average number of low-risk jobs completed from 25 to 110. The LRSA form has also been valuable for providing feedback on how many hours a given job takes, to improve future planning. LRSA simplicity in execution has allowed the maintenance department to respond quickly to simple tasks that make a big difference to maintenance personnel. Examples include; quickly responding to safety concerns regarding the parking lot walking path, allowing maintenance to remove old trees and paint a building prior to a visit from the Deputy Secretary of Energy, quickly hanging a whiteboard, fixing a leaking faucet, and troubleshooting an instrumentation and control issue to assist in developing a planned corrective maintenance work order.

Implementation of the Expedited Minor template has improved the scope of work that can be covered when compared to the previous Documented Minor template. This has resulted in reduced administrative burden while increasing efficiency and maintaining safety.

The MFC work execution group felt the strain from retirement and promotions during FY-21. Multiple personnel transitioned into the planning group, one was promoted to a foreman position, one terminated employment, and one retired. Some of these key personnel have been replaced, and the group continues the search for the best candidates to replace the others. To be better prepared for upcoming retirements in the future, four additional instrumentation and control (I&C) technicians were hired.

For each shop, new lead personnel were selected, trained, and qualified who now have a thorough knowledge of the foreman's responsibilities. Lead personnel are prepared to effectively lead the crew when the foreman is unavailable. The lead training and qualification program now includes a qualification card, oral boards, aptitude, and judgement capability verification, as well as behavior, safety attitude, and HPI knowledge training.

Implementation of INPO's Conduct of Maintenance has enhanced overall efficiency and helped to adopt best practices. Tools such as the written turnover checklist, documented pre– and post–job briefs, and place keeping standards help achieve best-in-class performance. To ensure a continual focus on

improvement, the principles in the INPO's document are discussed at the weekly meetings with the foremen and leads.

Continuing from FY-21, all Foremen will be qualified as HPI Practitioners to ensure certain maintenance personnel are held to the best-in-class practices presented in INPO 18-002 and 18-003. MFC Maintenance developed and implemented a more efficient pre-job briefing form (FRM-2923, "MFC Maintenance Pre-Job Briefing Checklist"), with focus on the key elements applicable to most tasks.

MFC Maintenance invested in new and upgraded tools to prioritize safety for personnel and meet or exceed industry standards. Some of the notable purchases include:

- Scaffolding to replace existing old and outdated style
- Portable pipe threader for the plumber to take to the facilities for on-site work
- Tablets to support the Mobile Work Package (MWP) process
- Updated HVAC equipment to aide diagnosis and repair
- Sliding table saw for improved safety
- Heavy duty benches with cabinets for increased work surface stability and storage
- CNC waterjet for expanded in-house manufacturing capability
- 5 gallon pail lifter and dumper for reducing potential for ergonomic injury and spills
- Belt/disc sander to replace the non-compliant one
- Broadcast spreader for the small tractor for winter snow preparation
- Multiple smaller tools for all the shops to replace worn tools and minimize handing tools in and out of controlled areas.

Maintenance continued the effort to address, repair or replace of all the Edison Circuits at MFC. In FY-21, conversions for approximately 75% of the Edison Circuits were completed. The rest of the Edison Circuits are intended to be completed or addressed by the end of FY-22.

13.2.2 People

MFC foremen have historically been weak in applying HPI principles, this is evident in the number of issues identified in LabWay. To improve knowledge and performance Maintenance has started qualifying all foremen as HPI Practitioners. All foremen are expected to become qualified by March of 2022.

The current craft qualifications training does not cover specific skills that are valuable to individual trades. To provide more detailed training, in addition to the basic qualifications training that is required, a two-year Continuing Training Plan will be implemented. The training plan will include multiple training sessions for various crafts. Human Performance and the Conduct of Maintenance will be stressed throughout the training plan. Implementation of the Continuing Training Plan will lead to improved safety, compliance, and efficiency.

The Maintenance department will continue developing the department towards being a best-in-class organization. Maintenance will continue to evaluate staffing needs throughout the year to be prepared to replace personnel as they leave, and as workload increases. The foremen will have an ever-increasing presence in the field to coach, develop, and assist with issue resolution more efficiently. Making progress towards best-in-class will be evident by managers and employees understanding their roles, committed to the success of the team, and have the skills and capabilities to execute the maintenance strategic plan.

13.2.3 Process

Place keeping is inconsistently taught and utilized at MFC. To ensure proper procedure use and adherence, as well as consistent practices across MFC, a standard will be implemented and used by the

MFC maintenance department. The maintenance team is in collaboration with other departments across MFC in hopes the new standard will be adopted by all departments. This will ensure all facilities are consistent with each other to allow improved peer check and effective communication practices.

13.2.4 Equipment/Tools

Previously, manufacturing of glovebox windows, gaskets, and fan transitions was outsourced. To improve lead times and ensure critical items can be manufactured in-house, a CNC water jet was purchased. In order to properly use the waterjet to its full capability, four personnel will be trained in both operating the waterjet and the CNC waterjet software. Two personnel have already completed the training, the other two will complete training in FY-22. The CNC waterjet is expected to be completely operational by March of 2022.

13.2.5 Actions FY-22

Actions for Work Execution Manager in FY-22

- Qualify all maintenance foreman as HPI Practitioners. (Eric Papaioannou, April 30, 2022)
- Create a procedure and conduct training to ensure consistent place keeping across the Maintenance Department. (Eric Papaioannou, June 30, 2022)
- Complete CNC water jet training plan. (Eric Papaioannou, March 30, 2022)

13.2.6 Looking Forward (FY-23 and Beyond)

In accordance with the maintenance department's strategic plan, the following future actions are planned for the upcoming years:

- Implement a very straightforward form for simple activities that do not meet the threshold for LRSAs.
- Begin utilizing the MWP process.
- Continue to evaluate the need for new equipment to ensure a safe and efficient workplace.

13.3 Preventive Maintenance

13.3.1 A Look Back

The MFC Preventative Maintenance (PM) program has seen significant progress in improving adherence to SP-20.2.5, "MFC Preventive/Predictive Maintenance Program – Supplement to MCP-6201." Operations management assisted with the transfer of ownership for facility maintenance to NFM/OM/Facility Manager (FM) which resulted in backlog reduction. Improved operations accountability has also contributed to timely maintenance performance and schedule adherence. The Preventative Maintenance Coordinator (PMC) saw increased attendance at the end of month incomplete PM status meetings, indicating a growing culture of continuous improvement.

The Engineering Change (EC) module of AS was introduced late FY-21. The interface for affected Model Work Orders (MWOs) from the Affected Equipment List (AEL) within the EC module has been identified. This allows for a Preventative Maintenance Change Request (PMCR) to now be initiated early in the modification process to retire, suspend, or change the scope of affected MWOs. This is expected to reduce delays and unnecessary resource allocation caused by modification of equipment not known prior to scheduling.

The PMC collaborated with RadCon Engineering in the transfer of accountability to maintain radiological instruments throughout MFC facilities. Tailgate Training was conducted, and the RadCon division is prepared to ensure radiological equipment is properly maintained. The transfer of this equipment to RadCon has lightened the load on system engineering and allowed for increased focus on other equipment at MFC.

The PMC collaborated with INL SMEs to develop of iQ – Work Smart process flow. The iQ – Work Smart process flow is used for initiating and processing a PMCR for justification approval(s) and changing maintenance strategies.

Tracking and trending the execution of preventive and predictive maintenance, with incomplete PM reports and developed metrics has provided a method to identify when, where, and what improvements are needed. One example of continual improvements was the identification of more effective PM balancing opportunities, which enhanced resource allocation and efficiency. Increased PM balancing opportunities have contributed to effective monthly scheduling, which will continue to aid in backlog reduction. Additionally, the MFC Monthly Incomplete PM Status Meeting aided in identifying barriers to finish month to month maintenance on time and addressed any at risk to finish PM items. A new bi-monthly report was created, with division focus on operations, to address monthly facility maintenance for the current month and backlog.

The PMC rebalanced the PM load throughout FY-21 and coordinated with various divisions to support facility outages. This resulted in an increase in maintenance accomplished during an outage, and a decrease in the growth of the backlog and the negative impacts for facilities.

The PMC increased use of A/S by tying MWOs to ECs. The SharePoint dashboard and metrics pages continue to evolve and become a tool for maintenance to monitor the overall performance. The dashboard is used for identifying PM finished percentages, trend analysis, and process improvements.

13.3.2 People

MFC has only one PMC with knowledge of MFC equipment, maintenance processes, A/S Database functionality, facilities, mission, and personnel. The PMC will develop an OJT plan for qualifying a backup PMC. A backup PMC will be trained to perform data base manipulations and use HPI tools, in support of existing and new Preventive Maintenance Justifications (PMJ) and PMCR. The training of the backup PMC will be complete by the end of September 2022.

Currently the PMC has limited knowledge in the EC module. With gained knowledge in the EC module, time spent processing an effective PMCR can be minimized. By taking a 40 hour EC module training, the PMC will be better prepared to assist Engineering in identifying affected PMs due to modifications early in the modification process.

MFC continues to see an increase in workload from new facilities, changes to maintenance strategies in support of Preventative Maintenance Optimization (PMO), new equipment, and modifications. A business case will be created to hire one additional PMC to handle the increased workload.

13.3.3 Process

Currently, the PMC is driving the MFC organization to accomplish monthly PMs. To draw awareness to the PMs that are at risk of not being finished on time and current backlog, the PMC will initiate a bi-monthly report to ensure individual divisions take ownership of the maintenance scheduled for their facilities. The bi-monthly report will be sent out mid-month, and before the end of month incomplete PM status meeting. This will aid operations in addressing backlog and any PM that is at risk to not be finished by the due date. The bi-monthly report will be sent to the NFM/OM/FMs and mission directors.

The current version of SP-20.2.5 contains some misleading verbiage and document references that are no longer in use. Additionally, there are gaps that are not addressed in the iQ – Work Smart process. Generating an updated version of SP-20.2.5 will fill the gaps within the iQ – Work Smart process and clarify misleading language. The revision to this SP will provide consistency with roles and responsibilities to finish preventive/predictive maintenance by the due date. The procedure will provide a consistent method to move PMs from schedule to finish. This procedure will directly contribute to achieving the goal of a 93% PM completion rate by defining roles, responsibilities, and expectations for the PM program.

13.3.4 Equipment/Tools

There are currently MFC active MWOs that do not have an approved PMJ. These MWOs make it challenging to accurately implement a grace period or determine whether or not a PM is critical. Additionally, without a PMJ for an Active MWO, there is no way to determine the appropriate quality requirements for procurement of materials for conducting maintenance. Maintenance will establish and update a report that highlights which active MWOs do not have an approved PMJ. This report will then be sent to engineering.

Combined frequencies within MWOs creates differing requirements for resources and needed materials depending on which maintenance will be performed. This contributes to misappropriating resources at scheduling. Separating out the frequency scope will allow scheduling to assign resources more accurately. A quarterly report will be used to identify combined frequencies needing to be split out until no combined frequencies exist within MWOs.

13.3.5 Actions FY-22

Actions for PM Coordinator in FY-22

- Qualify a backup PMC. (Eric Papaioannou, September 30, 2022)
- Establish bi-monthly division specific PM Status Reports. (Eric Papaioannou, September 30, 2022)
- Revise SP-20.2.5 to clarify Roles, Responsibilities, Accountabilities, and Authorities in addition to incorporating the new PMCR process. (Eric Papaioannou, July 31, 2022)
- Provide the engineering manager a report which shows all active MWOs that do not have a PMJ (update quarterly). (Eric Papaioannou, January 31, 2022)
- Provide the engineering manager with a report that shows all of the MWOs that combine frequencies (update quarterly). (Eric Papaioannou, January 31, 2022)

13.3.6 Looking Forward (FY-23 and Beyond)

In accordance with the maintenance department's strategic plan, preventative maintenance plans to accomplish the following future actions in the upcoming years:

- Create a business case for one additional fully functioning PMC.
- Implement a plan to split out combined PM frequencies to improve labor hour estimates.
- Develop a work smart flow that to associate materials to PMs prior to scheduling.
- Mentor PMC operate with user rights to the AS database.

14. SECURITY

14.1 Emergency Preparedness

14.1.1 A Look Back

Improvement of the Emergency Response Organization (ERO) team stability and the quality of drills was facilitated by the encouragement of MFC directors to consider ERO service an enhancement of professional development plans and ensuring ERO personnel commitment to participation in a drill or exercise was announced to the respective management ahead of time. As a result, ERO recruitment has improved and there were no last-minute operations tasking that precluded personnel from drill participation.

The Emergency Management organization continued its laboratory level Incident Command System (ICS) implementation by continuing the design and development/revision of training courses in preparation for eventual delivery to various laboratory audiences. This is the first innovation of its kind in the DOE complex.

Specific actions were taken to ensure continuous improvement for the MFC ERO in the following areas:

- A 20% increase in the number of Area Wardens to provide additional redundancy in several buildings to provide for gaps caused by COVID-19 telecommuting policies
- A 30% increase in the number of Shift Supervisors qualified as Building Emergency Directors (BEDs).

Reliable communications capability was kept current with the issuance of 17 new model handheld radios to ERO personnel.

A much improved video linkage system based on Microsoft Teams facilitation was recently installed in the MFC emergency control center (ECC). This will enable simplified conferencing capability in support of ERO activations and connectivity between ECCs.

14.1.2 People

The Emergency Management organizations continues to show a level of dedication throughout MFC to the all-volunteer organizations as evidenced by:

- The increase in numbers of trained personnel mentioned above
- A noticeable increase in people actively inquiring about service on an ERO team

Going forward the focus will be on a persistent pursuit to keep the ERO teams staffed, especially with Area Wardens, Area Warden Coordinators, and Personnel Accountability Leaders. Those roles have been and will continue to be significantly impacted by the telecommuting posture.

14.1.3 Equipment and Tools

ECC equipment and decision-making tools are state of the art. A dedicated EM-specific IT FTE ensures it is up to date and integrates well with all laboratory assets.

Moving forward there will be focus on improved access to incident locations and ECCs. Emergency Management is investigating ways of credentialing ERO members (i.e., a separate card or other identification issued by the proper Laboratory authorities) in a physical way to alleviate periodic scene access control issues. Credentialing equipment has been purchased to facilitate this project.

14.1.4 Actions FY-22

- Staff the ERO watch bill by adding 20 Area Wardens, two Area Warden Coordinators, and two Personnel Accountability Leaders to better compensate for the telecommuting population of those

positions, and boost ERO's ability to man the rotating on-shift teams. (Eric Papaioannou, September 30, 2022)

14.1.5 Looking Forward (FY-23 and Beyond)

- Implement credentialing of ERO personnel. This is an Emergency Management lab-wide initiative that is still being researched.
- Complete implementation of the ICS concept at MFC to function seamlessly with Emergency Management, Security, Fire Department, RadCon, and the rest of the laboratory. This will greatly enhance communication, recognized incident management authority, and the ability to integrate response with the rest of the laboratory's EROs. MFC application of new training will follow briefings to all levels of INL management.

The Emergency Management organization will constantly monitor ERO positions, strength, and telecommuting impact, and add actions in the FY-23 version of the OMI if adjustment is needed.

14.2 Personnel Security

14.2.1 A Look Back

The Laboratory Protection Division at INL is one of the broadest divisions in terms of the number of staff and the variety of programs maintained. Security Programs and Services at INL encompasses, and is responsible for, a wide range of security interests including: the classification office, physical security, safeguards, security investigations, personnel security (PERSEC), Human Reliability Program (HRP), and Foreign Visitors and Appointments.

PERSEC is an element in the overall protection strategy of the Laboratory Protection Division at INL. This organization encompasses DOE Access Authorization (clearances), Employment Processing, Badging, and HRP.

PERSEC ensures that anyone visiting or working at INL, whether a prime contractor employee, subcontractor, or visitor, is authorized and that all individuals needing access to classified matter and/or special nuclear materials (SNM) have the required access authorization. PERSEC is responsible for properly and efficiently processing INL employees for DOE security clearances, and to ensure that all employees, contractors, subcontractors, and visitors meet DOE badging requirements.

PERSEC requirements are outlined in DOE O 473.3, "Protection Programs Operations" and DOE O 472.2, "Personnel Security." INL implements these requirements through several LWPs and MCPs:

- LWP-11100, "Personnel Security"
- LWP-11101, "Pre-Employment/Suitability Investigations for Determining Employment/Access Eligibility"
- LWP-11102, "Unclassified Foreign Visits and Assignments"
- LWP-11104, "Human Reliability Program"
- LWP-11105, "Classified Visits Involving Foreign Nationals"
- MCP-11100, "INL Personnel Security Functions for DOE Access Authorization"
- MCP-11101, "INL Personnel Security Badging Functions"
- MCP-11102, "INL Personnel Security Employment Processing Functions."

Within the past several years the Safeguards and Security Directorate has undergone a significant reorganization and hired many new personnel. Some positive outcomes have resulted from the reorganization and growth of this directorate. These include an improved website and access to procedures and required documents, a new visitor request process, and a badging office located at MFC.

However, very little has been done to improve the Foreign Visitors and Appointments process, and the process for determining access to documents that personnel need to perform their job functions is difficult and cumbersome. Paperwork, such as the SF-86, for initial clearance, and required for re-certification, is difficult to navigate and error likely. Access to staff with the experience and knowledge to navigate these forms is lacking. Consistency in hiring and disciplinary actions related to reporting for clearance seekers and holders is also lacking. There are several situations that employees and their managers have encountered that are not explicitly discussed within implementing procedures. This has led to inconsistent management of this program and its requirements. History, process, challenges, and suggestions for HRP are described in a separate chapter.

14.2.2 Process

The process of hiring for any position within a national laboratory is lengthy first requiring a basic background check. This process is made more difficult for any position requiring a DOE “L” or “Q” clearance which requires submittal of an SF-86 and active investigation and interviews. Often newly hired employees wait many months to obtain the appropriate clearance to perform their intended job functions. This can be frustrating for many new hires especially those that have been hired from private industry or academia. While not as widespread, there have been some instances of potential employees disclosing previous drug use from states that have legalized recreational and/or medicinal drug use. Typically, this ends up with them not advancing through the security screen and unable to be offered a position with INL/MFC.

Additional challenges are encountered when hiring a foreign national employee. Hiring of foreign nationals has grown at MFC particularly for highly specialized scientific and instrumentation roles. While they are not eligible for clearances they are working with peers and within facilities where certain programmatic work requires specific clearance levels. Because of this, foreign nationals end up being restricted from certain areas of otherwise common workspace. The security plans of foreign nationals often limit these individuals to specific buildings, during certain hours of the day, and days of the week. Making matters worse they are unable to access many documents or work applications to perform the job they were hired to do.

For existing employees, the requirements to renew a clearance can be confusing, difficult, and take several days to weeks to complete cumbersome questionnaires, such as the SF-86. Access to individuals that are well versed in these activities is difficult as there are not many POCs lab-wide, and none identified at MFC. Furthermore, employees that hold current clearances remain unsure and unclear on what types of activities must be reported to their manager or to security personnel. Often incidents and occurrences that should have been reported are discovered by investigators during the clearance renewal. On the other hand, some staff are quick to report things such as misdemeanor traffic citations to management that are not required to be reported.

There are numerous challenges that both potential and existing employees encounter that relate to PERSEC. The result of these challenges is an increased difficulty to attract and retain some highly qualified individuals. The requirements and rules for reporting security related activities for both the clearance holder and their management is difficult to navigate and know. For most clearance holders and hosts of foreign national employees the only training required is an annual web-based refresher course.

14.2.3 Actions FY-22

- Evaluate and determine whether the required training for clearance holders is adequate or should be adjusted. (Tim Hyde, March 31, 2022)
- Evaluate and determine whether the required training for hosts of foreign national employees is adequate or should be adjusted. (Tim Hyde, March 31, 2022)
- Determine how security Lessons Learned could be more openly shared and discussed with staff. (Tim Hyde, March 31, 2022)

- Provide direct feedback/comments to the document owner(s) of implementing security procedures for improvements based on MFC experience/lessons learned. (Tim Hyde, September 30, 2022)

14.2.4 Looking Forward (FY-23 and Beyond)

- Provide a point of contact (POC) for clearance paperwork and related concerns at MFC to help staff with this process.
- Provide a POC for PERSEC much like our POC for physical security.
- Improve accessibility to documents for foreign national employees.
- Streamline the clearance paperwork process.
- Streamline Foreign Visitors and Appointments process.

14.3 Human Reliability Program

14.3.1 A Look Back

The Human Reliability Program (HRP) is a security and safety reliability program designed to ensure that individuals who occupy positions affording access to certain materials, nuclear explosive devices, facilities, and programs meet the highest standards of reliability as well as physical and mental suitability. This is done through increased evaluation of an individual's financial condition, mental wellbeing, and physical health. These evaluations are also accompanied by increased random drug and alcohol testing (The HRP program implements requirements of 10 CFR part 712 the criteria of which is described in LWP-11104 INL specific details are described in PLN-11101, "Human Reliability Program Implementation Plan."). Currently there are several hundred employees at MFC who are actively monitored and evaluated in the HRP. While the majority of these employees are security police officers (SPO) who report to safeguards and security management, there are a number of MFC employees within this program that report directly to MFC management. Currently the Security Programs and Services Division of the Safeguards and Security Directorate manages the HRP at INL.

Within the past several years the Safeguards and Security Directorate has undergone a significant reorganization and hired many new personnel. Despite the reorganization and growth of this directorate, very little has been done to improve HRP documents to provide clear and concise requirements for participants and for supervisors and managers of HRP personnel. Furthermore, there are several situations that HRP employees and their managers have encountered which are not explicitly discussed within implementing procedures. This has led to what appears to be inconsistent implementation of this program and its requirements.

14.3.2 People

Individuals under HRP have several requirements they are personally responsible for. Additionally, there are several key positions (described in PLN-11101) to ensure compliance with HRP requirements.

- HRP employees are responsible for the following actions:
  - Completing a life change index each year and reporting of any life change issues to the psychologist
  - Ensure that after 40 or more hours of missed work due to sickness or injury they are evaluated by designated medical professional for an HRP return to work evaluation
  - Reporting all medical conditions (physical and mental) that require medication or treatment
  - Must report **all** prescription medicine and any over the counter (OTC) medications that may impair judgement or ability to perform HRP functions
  - Reporting for drug and alcohol testing after being notified by HRP supervisor
  - Monitoring personal and coworker's behaviors for changes.

- HRP supervisors are responsible for the following actions:
  - Completing initial and annual HRP Supervisor's Report to aid psychologist in their decisions
  - Update job task analysis form each year for HRP employees
  - Receive and issue requests for drug and alcohol testing of HRP employees
  - Removes HRP employees from HRP duties if HRP management official temporarily removes HRP employee from HRP, there is reasonable belief an HRP employee is not reliable, or employee displays questionable behaviors or conditions
  - Reports the removal of an HRP employee from HRP duties to the HRP management official.
- HRP certifying officials are responsible for the following actions:
  - Receives notice from the HRP management official if an HRP employee is temporarily removed from HRP
  - Maintains authority to approve employee reinstatement to HRP
  - Ensures DOE PERSEC office reviews certification documents.
- HRP management official is responsible for the following actions:

NOTE: *It is important to note here that the final authority for HRP certification resides with DOE. BEA performs the administration and execution and turns over recommendations to DOE for acceptance or rejection.*

  - Receives written communications from the Site Occupational Medical Director (SOMD) and psychologist including work restrictions, temporary removal from HRP, reinstatement recommendations, and positive drug/alcohol testing results
  - Notifies HRP supervisor of temporary removal of an HRP employee from HRP
  - Notifies the HRP certifying official of removal or reinstatement of HRP employees
  - Evaluates all individuals for initial or recertification to HRP communicates concerns to HRP certifying official and DOE-ID PERSEC
  - Provides initial training for HRP participants and HRP supervisors
  - Provide written notification to HRP employee within five business days of their temporary removal from HRP.
- The SOMD, or designee, is responsible for the following actions:
  - Perform annual medical assessment of HRP employees
  - Recommend temporary removal of HRP employees from the program
  - Impose restrictions on HRP employees
  - Approve the use of regulated medications including narcotics (This is noted in the employee medical file and not HRP file)
  - Provide written return to work recommendations for HRP employees to the HRP management official
  - Conducts rehabilitation evaluations and subsequent recommendation to HRP management official
  - Determines frequency of drug/alcohol testing for HRP employees that are reinstated to HRP
  - Ensures training of medical staff to fulfill HRP duties
  - Makes medical based decisions and recommendations based on testing results.
- The INL designated psychologist is responsible for the following actions:
  - All psychological assessments of HRP candidates and HRP employees including return to work evaluations

- Requests information from INL Employee Assistance Program (EAP) counselors related to HRP employees
- Conducts rehabilitation evaluations
- Determines frequency of drug/alcohol testing for HRP employees that are reinstated to HRP.

14.3.3 Process

Initial training for HRP involves required reads, a required training course, and an "Initial Briefing" for HRP participants and HRP supervisor by the HRP management official. HRP participants are required to complete an annual refresher training. The SOMD ensures initial and annual refresher training is complete for medical personnel related to HRP duties.

If an HRP candidate tests positive for alcohol or illegal drugs they are disqualified as an HRP candidate. If an HRP participant tests positive for alcohol or illegal drugs they are temporarily removed from HRP. Randomized drug and alcohol testing are described as an hourglass sampling method with randomized testing days, but at least one test per year is required. HRP employees may be tested for drugs or alcohol following an incident, unsafe practice, or due to reasonable suspicion. If the employee's position description specifies maintaining the HRP certification then disciplinary action, likely leading to termination, will be the result of not maintaining the requirements.

Issues outside of work like a DUI, that indicate a potential judgement and reliability problem will likely result in removal from HRP. There is then a process for increased monitoring that allows an individual to potentially stay in the program. The agreement set up through EAP and medical, generally result in abstinence commitments and increased monitoring. This agreement is referred to as a Stipulation of Understanding (SOU). Self-disclosures also result in a path that likely results in program removal and an SOU.

Several situations are described in the HRP guidance documents; however, many situations involving other scenarios have been encountered at MFC. Determinations made by designated medical professionals are conveyed per procedure to the "HRP management official" whom is not the employees line management. This makes accurate and timely information unavailable to the employee's manager. There are numerous inconsistencies in how the requirements of HRP have been interpreted and implemented. Many of the decisions that HRP supervisors are required to make end up being subjective due to a lack of access to pertinent medical information.

14.3.4 Equipment/Tools

Medical facilities and staffing on-site at MFC are required to implement the HRP effectively.

14.3.5 Actions FY-22

- Provide direct feedback/comments to LWP-11104 and PLN-11101 document owner for improvements based on MFC experience/lessons learned (Tim Hyde, September 30, 2022)
  - Including better defined guidance for positive breathalyzer and prescription drug testing.
- Address HRP surveillance and escort requirements for upgrades and facility modifications, current operational staff cannot maintain the current workload. (Tim Hyde, September 30, 2022)

14.3.6 Looking Forward (FY-23 and Beyond)

- Evaluate and determine if the required training for HRP is adequate or should be adjusted based on position/decision authority. If additional training is deemed necessary, creation of a training video is suggested using current HRP Program leadership.
- Develop a User Guide to help HRP employees with decisions. (Improve HRP webpage/interface.)
- Develop a Decision Tree to help HRP supervisors with decisions. (Improve HRP webpage/interface.)

- Evaluate and review/update HRP Supervisor's Report, Form 472.07, “Human Reliability Program (HRP) Supervisor’s Report.”
- Develop a mechanism for HRP supervisors to have access to individuals HRP files in the event of personnel actions.
- Evaluate pay differential for HRP employees.
- Improve MFC Medical Facility and incorporate EAP for increased availability.
- Develop a more timely and accurate way for HRP supervisors to be informed of decisions made by others about their HRP employees.
- Consider a master list of OTC drugs that are permitted under HRP. (Determine whether this exists for those in the program already; this would greatly benefit HRP employees and HRP supervisors.)
- Continue to improve the reference material and decision trees.

15. SUBCONTRACTOR WORK MANAGEMENT

15.1 Subcontracted Construction and Modification Performance

15.1.1 A Look Back

In the last five years, construction work and subcontracted MFC plant modifications has significantly increased year-over-year. In FY-21 work on the SPL, East Gate, Administrative Building, parking lot, and numerous infrastructure piping repairs dominated this area. Multiple small projects and modifications were also completed. Overall performance was outstanding. The few events and issues that occurred were handled without any significant issues in timely notification, investigation, and corrective action.

The OMI actions taken in FY-21 were instrumental in solving problems with field execution. Monthly collaboration meetings between MFC Projects Division, Construction Services, and U&IS Management ensured all groups were informed of current issues and priority shifts. Additionally, all affected are both aware of and prepared to handle upcoming fiscal year scheduled projects.

In fiscal year 2021 there were numerous failures in infrastructure support systems (e.g., fire and potable water, cooling water, sanitary waste, compressed air, and electrical distribution). The integration of communication between F&SS, MFC PMO, and MFC U&IS divisions allowed rapid response to these failures, many of which have been repaired and placed fully back in service, with the remainder to be finished early in FY-22.

15.1.2 People

The U&IS Department increased staff in FY-21 to five Building Facility Managers (BFMs). BFMs perform the daily work release for all subcontracted work occurring outside nuclear and radiological facilities, which comprise most of the subcontracted construction and modification projects being executed across MFC. Typically, each BFM is responsible for one major construction project as well as the day-to-day maintenance for their assigned buildings. These construction projects add significant scope to the BFM workload in addition to the daily landlord responsibilities for numerous support buildings and tenants. To better manage workload, as many ancillary duties as possible have been reassigned to the U&IS Department Move Coordinator. Examples of these ancillary duties include move coordination, maintenance outage coordination, and building/system health tracking. One of the major issued BFMs face is competition from the Research and Education Campus (REC), where BFMs can work in town for similar pay and have a significant reduction in scope. This issue was analyzed and has been largely solved by changing the base pay for this role. However, the job family scope issue still exists.

F&SS has hired several new Construction Field Representatives (CFRs) and project managers to replace those lost to attrition. Hiring of new CFRs and project managers ensures pre-planning and field oversight is provided for critical activities associated with F&SS managed projects. Despite adding staff, it is not possible for CFRs to be present for every critical activity that may be occurring on any given day.

15.1.3 Process

Construction processes, subcontracted modification processes, and project management processes have yet to be revised by the Process Architecture for Continuous Excellence (PACE), formerly Management Systems Transformation Initiative (MSTI). These processes have the same common gaps and issues associated with all INL management systems and are navigated via a network by knowing who to call for help. Until these processes are streamlined, and the gaps are removed, planning, preparation, and execution of major construction projects and subcontracted services will continue to be less than optimal.

Differences in the details for project turnover and engineering modification turnover for subcontracted projects has caused confusion in the BFM group. To resolve this a turnover checklist that incorporates the Engineering Change turnover and project turnover processes will be developed to assist in tracking of punch list items and a disciplined turnover to operations.

15.1.4 Actions FY-22

- Develop a project turnover checklist for U&IS staff that incorporates the key elements of both project turnover and the Engineering Change process to facilitate project turnover to U&IS.
  (Eric Papaioannou, September 30, 2022)

15.1.5 Looking Forward (FY-23 and Beyond)

- Continue to monitor performance in the subcontracted work execution area and respond accordingly in out-years.

16. EQUIPMENT RELIABILITY

16.1 A Look Back

Prior to 2016, MFC had no specific equipment reliability program (ERP) or processes beyond standard preventative maintenance (PM). In 2016, MFC contracted Nuclear Services Group Inc. (NSGI) to perform an ERP assessment and develop a plan for implementing a reliability program at MFC. The program has grown and developed since 2016, with the primary focus on the workstreams shown in Table 8.

The Reliability group vision is to develop, implement, and sustain a world class predictive program where current equipment is monitored and maintained to minimize equipment downtime, and to establish a culture within MFC that incorporates equipment reliability (ER) into the design of new equipment for future installation(s) – ensuring that ER supports MFC and INL in completing their mission and vision.

Table 8. Equipment Reliability Program's workstreams of primary focus.

<table>
<tr><th colspan="3">Equipment Reliability Program Improvements</th></tr>
<tr>
<td>Predictive Maintenance Improvements
Vibration Analysis
As of November 2021 – Monitored 64 pieces of rotating equipment.
Used motion amplification for in-depth diagnoses.
Thermography Analysis
As of November 2021 – Monitored 901 pieces of electrical and rotating equipment.
Tribology Analysis
As of November 2021 – Monitored 89 pieces of rotating and electrical equipment.
Used Ultrasonics for bearing lubrication.</td>
<td>Preventative Maintenance Optimization
Developed process to review facility equipment and current PM strategies.
Reviewed and updated maintenance strategies for top 20% of equipment within Analytical Labs.
Utilized PMO for MFC's top 20% systems.
Reviewed and optimized over 118 systems and 220 PMs
Worked with engineering, maintenance, and operations groups to optimize maintenance strategies
Created templates for MFC-specific equipment.</td>
<td>SERP
Performed SVRs of 586 systems at MFC according to established criteria.
Performed CVRs on over 6,000 pieces of equipment in IMCL, UIS, SSPSF, FMF, and Analytical Lab.
Developed streamlined methodology for determining equipment criticality using feedback and lessons learned from SERP process
Used results to feed PMO process.</td>
</tr>
<tr>
<td>RCA Process
Developed a working procedure for performance of equipment-based RCAs at MFC.
Performed RCA on the following equipment:
STL cam follower in FCF in 2019
RPZ backflow preventer in RCL in 2020
MFC -768 Facility Air Compressors PA-CP-001, PA-CP-002.</td>
<td>ER Suite
Completed Training of ER suite package with System Engineers.
Loaded current system health reports into SystemIQ.
Loaded PdM equipment into PlantIQ for predictive tracking moving forward.
Loaded LTAM training and issues into system.
Developed MFC-ADM-0005, "MFC System Health Monitoring," MFC-ADM-0006, "Materials and Fuels Complex (MFC) Facilities and Complex Health Reporting Process," and updated PRD-394, "MFC Predictive Maintenance (PdM) Program."</td>
<td>Personnel Development
PdM Vibration/Tribology Analyst – Level 1&2 Vibration, Level 1 Thermography, Level 1 Lubrication, Level 1 Motion Amplification, Level 1 Ultrasound.
PdM Thermography Analyst – Level 1 Thermography, Level 1 Vibration, Transformer analysis, Ultrasound level 1, System Engineer Qual.
Reliability Lead – Certified Reliability Leader, Level 1 Vibration, Level 1 Thermography, System Engineer Qual.</td>
</tr>
</table>

16.2 **People**

The MFC ER Team consists of two Reliability Engineers (one Mechanical, and one Electrical), and two Predictive Maintenance Improvement (PdM) Analysts (one Thermography, one Vibration/Tribology). The PdM analysts possess highly specialized skillsets for in-depth analysis of equipment health using PdM technologies. The team, shown in Figure 4, is cross-trained to be able to support each other, while each team member has become an SME in their own respective areas.

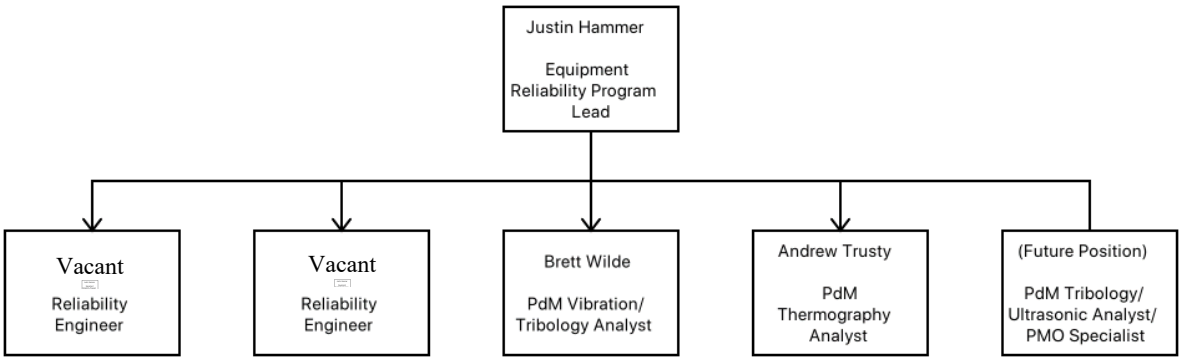

Figure 4. The MFC ER Team.

As the PdM program is relatively new at MFC, the personnel retention rate had been high until the fall of 2021 when the group lost both Reliability Engineers. Initially, the program struggled to acquire a dedicated Lead; however, the position was filled in February 2020. As the program continues to grow, a goal of MFC ER leadership is to incorporate PdM positions into a career path for personnel continuing to seek professional development. The group will look to fill vacant positions and add a position that will own Tribology/lubrication and Ultrasonic testing for MFC facilities. This position will also be responsible for supporting the Preventative Maintenance Optimization (PMO) process. This position will fill the gap identified in a 2019 assessment of the MFC lubrication program, which called out a need for improvements in procurement, quality control, storage, handling, application, sampling, training, and analysis.

Each of the PdM analysts will obtain at least a level 3 certification in their primary technologies (as applicable), and the Reliability Engineers will obtain at least a level 2 in the technologies associated with their engineering disciplines. A 5-year ERP training plan has been developed to ensure the organization remains current with changes in technologies and processes associated with ER. As the PMO process continues to strengthen, the primary responsibility and ownership of the work stream will shift from ERP personnel to System/Facility Engineers. However, ERP personnel will still support and provide subject matter recommendations. Another responsibility of the ERP will be to track equipment failures and ensure correct engineering resources are identified to correct these equipment failures.

16.3 **Process**

Currently, within the ER group, there are several processes that will help to complete the MFC/INL vision and support other work groups. The PdM work management process has been significantly streamlined in most MFC facilities. Previously, existing legacy PdM tasks lacked consistency and rigor—and were often part of packages for other preventative activities with little thought given to optimal monitoring frequency or task alignment. In 2018, PdM personnel worked closely with MFC Planning to update and improve these tasks and packages, as necessary. Today, data acquisition packages are easy and safe to perform by Maintenance personnel with a high-level of consistency. PdM will continue to enable MFC to replace time-based PMs with condition based PdMs, which will be more effective at preventing failures and reduce the hours facilities spend in maintenance and repair. Equipment Reliability continues to support other work groups by performing equipment RCA, which

helps to proliferate understanding of failure modes and ways to prevent failures from reoccurring. RCAs are currently performed by the Reliability Engineers at the request of MFC Management with assistance from various SMEs, as required. Findings and technical recommendations from RCAs are reported to System/Facility Engineers and Managers using Technical Evaluations (TEVs) and Engineering Calculation and Analysis Reports (ECARs). The group has also been heavily involved in the implementation of ER Suites—which tracks system health reports (SystemIQ), condition monitoring (PlantIQ), and facility Long-Term Asset Manager (LTAM).

There are still processes that need to be developed and implemented within the organization. One of these processes is how to incorporate the "Reliability, Availability, and Maintainability (RAM) Standard" (MFC-ADM-3007, "Reliability, Availability, and Maintainability RAM Standard") into new equipment and modifications. The criteria and processes for RAM has been integrated into the Engineering Change (EC) process through the discipline reviews. The discipline review process for facility modification and subcontracted design is intended to specify and capture reliability-focused elements upfront—including design recommendations, PM/PdM recommendations, and acceptance criteria. Another process pending development and implementation is evaluation of equipment lifecycle management. This would include an obsolescence review of current equipment to determine which equipment needs to be added into long-term planning. This review will be informed by national standards, such as ANS 3.14, "Aging for Non-Reactor Nuclear Facilities." This will also require System Engineers to determine mitigation strategies for critical equipment. This information will be tracked within the ER suites LTAM module.

Reliability will be an integral part of the lifecycle of new and existing equipment and systems. Criticality will be defined and documented upfront. Engineering, Maintenance, and Operations personnel will work together to identify how existing and new equipment should be designed, maintained, and operated. As part of the RAM process, design recommendations will be implemented to ensure that critical equipment and systems can perform reliably, consistently, and can be maintained with minimum complexity. PMs and PdMs will be specified to attack specific failure modes and will force functions at frequencies that will maximize system availability at optimal cost, while eliminating non-value PM activities. The goal is to move the MFC ERP from a dependent model to an independent model—and to permeate reliability principles and practices throughout the organization until the principles and practices become "business as usual."

16.4 Equipment/Tools

MFC PdM program currently utilizes the following suite of different tools and software to track and trend equipment health:

- Vibration – MFC utilizes vibration analysis to monitor rotating equipment such as pumps and fans using the SKF Vibration tool (CMXA 80), and SKF @ptitude analysis software.
- Thermography – MFC utilizes thermography analysis to monitor mechanical equipment and electrical equipment such as panels and breakers using FLIR infrared imaging hardware (E8, E85, T620 Cameras), and FLIR software for analysis.
- Tribology – MFC utilizes Bureau Veritas for mechanical oil analysis and SDMyers for transformer oil analysis.
- Ultrasonic – MFC utilizes a Ludeca SDT270, SDT 340, and Fluke ii900 ultrasonic tools to diagnosis rotating equipment, leak detection, electrical faults and to perform proper bearing lubrication.
- Motion Amplification – MFC utilizes RDI motion amplification hardware and software for in-depth vibration fault diagnosis.
- PdM Database – The MFC PdM team has developed an in-house database that stores PdM monitoring activities. With the implementation of ER suites, the PdM group will be using PlantIQ to continue to track the equipment.

- Motor Current Analysis – MFC purchased the motor current tester in 2021. One focus for FY-22 is to train MFC personnel on proper use of this tester.

The various PdM technologies will continue to monitor equipment health and report to System/Facility Engineers, as well as Facility Managers as anomalies arise. Currently, tech exams are updated into PlantIQ in ERSuites and sent to System/Facility Engineers and Managers as anomalies are found. System/Facility Engineers are expected to work with Facility Managers and PdM personnel to determine corrective actions as required. Health for all equipment is also reported monthly to Facility Management. With the implementation of ER Suite, all reports are available to view real-time for System/Facility Engineers and operations personnel. Vibration monitoring will continue for existing rotating equipment and will also be incorporated into new equipment as an element of the MFC RAM process. Thermography and Tribology monitoring will continue to be streamlined as equipment criticality is evaluated. Ultrasonics will continue to be incorporated into new and existing bearing lubrication PMs and will be deployed for airborne and electrical survey applications as required. Proper execution of the PdM program will minimize unplanned facility/system downtime and move the maintenance culture from a Reactive/Preventative model to a Preventative/Predictive model and, ultimately, towards a Predictive/Proactive model.

16.5 Actions FY-22

- Fill open position in ERP group. (Stuart Jensen, March 30, 2022)
- Support transition of PMO process to System Engineers. (Stuart Jensen, July 30, 2022)
- Support PMCR for new PMs and PM updates. (Stuart Jensen, September 30, 2022)
- Implement the FY-22 training plan for PdM group: (Stuart Jensen, September 30, 2022)
  - Develop training plan for new ERP team members once hired.
  - Train and certify (at least) two Mechanics to Ultrasonics Level 1.
  - Train and certify PdM Thermography Analyst to Thermography Level 2, and Motor Current Analysis.
  - Train and certify the Vibration/Tribology Analyst to Vibration Level 3, and Motor Current Analysis.
  - Train and certify the ERP Lead to Ultrasound Level 1, and Motor Current Analysis.
  - Continue to utilize ER Suites.
  - Continue to develop and grow System Health reporting through SystemIQ
    - Promote System Engineering ownership add additional systems into program.
  - Continue to utilize PlantIQ to report PdM equipment monitoring.
  - Continue to utilize LTAM for long-term planning
    - Serve as CHC facilitator/coordinator.

16.6 Looking Forward (FY-23 and Beyond)

- FY-23 and beyond training plan for the PdM group:
  - Continue to train MFC Maintenance personnel in Vibration, Thermography, Tribology, Motion Amplification, and Ultrasonics
  - Continue to cross-train and certify ERP group members in all PdM technologies
  - Continue training dedicated Tribology Analyst (Lubrication Champion) for MFC.
- Continue to grow PdM program at MFC and other INL facilities to ensure reliable equipment supports mission needs.
  - Continue to develop lubrication improvement strategies at MFC

    - Grow and develop Ultrasonic Predictive technology application across MFC.
- Continue to utilize ERSuites
    - Continue to grow system health reporting by adding more systems in SystemIQ
    - Continue to utilize LTAM to track facility and complex long-term plan.
- Develop and Implement Spare Part Process and Program.
- Develop life cycle management process and procedure
    - Develop a Long-Term planning process and procedure
        - Migrate forward-looking equipment issues into LTAM
        - Train in and implement the use of LTAM risk ranking to support the Facility and Complex Health committees.
    - Create obsolescence review standard.

17. ENGINEERING/CONFIGURATION MANAGEMENT

17.1 Design Standards

17.1.1 A Look Back

MFC has had several issues with code implementation in terms of determining what constitutes adequate electrical guarding for electrical conductors. Two significant process changes were made to improve this situation. The MFC Facility Modification Process has been changed to require the authority having jurisdiction (AHJ) to review electrical equipment prior to acceptance testing rather than prior to placing into service (as the code requires). In addition to this new requirement, a standard for electrical guarding was created for MFC in 2020. The standard for electrical guarding will aid the design engineer by giving clear guidance for the needs of MFC, such as in gloveboxes and hot cells, with examples to better understand the standard for electrical guarding of conductor at MFC.

Another major improvement in the use of standards was to introduce an evaluation section to the EJ form. The evaluation section can be used for many purposes, but typically is used to explain or document design decisions that were made for the design. In this regard, the use of codes and code interpretation can be documented on how the design met codes or standards. This section of the process requires signatures of a technical checker, as well as approval by the engineering manager or technical integrator. After full implementation and training of engineering personnel, the evaluations section has proven valuable to document the correct interpretation of national codes and standards, as well as standards imposed by procedure by the INL.

MFC has been creating a standard specification for glovebox procurement. Gloveboxes are a common engineered item that have a standard set of criteria to meet the American Glovebox Society (AGS) guidelines for glovebox design. This standard provides the contractors with a clear set of standards and test criteria which apply to a wide range of radiation containment enclosures. The results have saved time and resources for engineering, procurement, and inspection activities. These standards need to become a documented standard for use by the rest of the INL.

17.1.2 People

MFC is continuing to strengthen the discipline-centric element of the current organization by expanding it deeper and aligning personnel into discipline-specific work groups while maintaining assignment to facility systems. Strengthening the role of each engineering discipline is accomplished by delegating engineering work approval authority to discipline leads and supporting professional development through growth assignments and formal training. MFC Engineering wants to perform most of the design work involving core MFC competencies such as nuclear ventilation, remote handling, etc., in-house rather than subcontracting or sending work to other engineering groups. MFC Engineering will continue to prioritize technical capabilities when adding staff and focus on professional development for training junior engineers and external engagement for senior engineers.

Only the correct mix of disciplines will make it possible to cover all of the codes and standards with a resident engineer that can act as an expert in the vast variety of design work conducted at a national laboratory with nuclear experiments. The unique talents for experimental equipment such as furnaces, gloveboxes, and remote hot cell design must be created from within the directorate. These disciplines are in addition to the required disciplines of electrical, mechanical piping, and structural engineering, generally required for facility modifications. MFC is targeting expertise through hiring in code areas such as nuclear ventilation and structural engineering.

17.1.3 Process

Currently the engineering process requires the responsible engineer to list all the codes and standards that are applicable for a modification. With limited existing design basis documentation, the engineer relies on their expertise, the review of technical checkers, and the technical integrator (engineering manager) to capture the codes and standards that apply. Additional standards are listed in STD-139, "INL Engineering Standards" and STD-142, "INL Nuclear Engineering Standards." These standards identify standards and practices that are followed by the INL and the codes and standards that are more rigorous than commercial industry. These standards are continually updated to remain in compliance with changing national and DOE standards. In the future the code of record, system design description, and applicable codes and standards will be information that will be attached to each system or piece of equipment in the AS Master Equipment List (MEL). This will create efficiency in not only the conduct of engineering process but in engineering excellence at the INL.

17.1.4 Equipment Tools

All the codes and standards for engineering work will need be electronically captured within AS. The use of AS will allow engineering to track the code of record and standards used at the MFC to enable quality engineering work. A monumental effort by all system engineers will be needed to get the codes and standards data entered into the AS database. The process will take many years to complete and will start with the active safety and defense in-depth systems. All other systems will follow as system design descriptions are written and the facility configuration information is loaded.

AS will also allow engineers to identify approved models for specific equipment items, such as HEPA vacuums, and attach engineering and quality standards to the procurement catalog ID. This will simplify and standardize selection and procurement of equipment subject to specific standards.

17.1.5 Actions FY-22

- Create a standard guide for changing incorrect drawings used for LO/TO. A standard guide will be written to address corrections identified during LO/TO walkdowns. This guide will explain how to make corrections in AS while allowing work to commence. (Stuart Jensen, March 30, 2022)
- Create a standard for electrical cable maintenance at MFC. This standard will provide guidance on the testing and/or replacement of electrical cables due to obsolescence or end of life. (Stuart Jensen, July 30, 2022)
- Create a standard guide to identify and provide the location of older electrical drawings for MFC. This guide will assist engineers in finding drawings that are not located in EDMS but contain vital information on electrical systems. (Stuart Jensen, September 30, 2022)
- Write a standard guide for panel schedules at MFC. This guide will assist engineers by describing a standard methodology for the information that should be included on a panel schedule. (Stuart Jensen, April 30, 2022)

17.1.6 Looking Forward (FY-23 and Beyond)

The design standards for INL and MFC continue to change and be updated. As the codes change, MFC will need to update the list of codes and standards followed and keep trained personnel updated on changes. This will need to be accomplished in two ways: processes, and personnel. The current list of codes and standards will need to be updated to remain current with industry and with DOE updates. MFC personnel will need to be trained and kept current through use of planned professional development.

- Update or create Code of Record for MFC facilities.
- Many design standards that are specific to MFC or the INL will need to be created. Writing standards that will clarify the general national standards and the of the best standard design practices for the INL will provide efficiency for design engineers and procurement of fabricated engineered items.

17.2 Configuration Management

17.2.1 A Look Back

MFC has worked under PLN-4656, "MFC Configuration Management Program Implementation Plan," for several years to update or create (where none existed) essential drawings for the various facilities. Most facilities have completed this first stage of configuration management (CM) recovery.

17.2.2 People

Staffing has continued to be a challenge as demand for engineering services has increased due to the number of facility modifications, new facilities, and new equipment has increased. Filling those positions with the best system engineers with the correct disciplines has been a constant challenge. Additionally, subcontracting has needed support and has had limited success in relieving the burden on engineering staff. Positions are targeted based on expertise, which has created a challenge to fill positions.

MFC has a CM engineer responsible for assigning all the equipment/component ID numbers for all new equipment at MFC, in addition to, tracking all of the facility modifications for the modification process. In addition, MFC hired an equipment coordinator to assist in the task of equipment numbering and tracking equipment. The addition of an equipment coordination will resolve one of the major issues of tracking portable equipment. A program is being developed to better track portable equipment with an AS tool crib so that maintenance can be tracked, and the location of equipment is known. The equipment coordinator is working through the MEL to verify its data against the reality in the facilities.

The MEL will need a large amount of additional data added to each piece of equipment at the MFC to make the data base more usable and support processes updated around AS. Processes such as quality level designation will no longer depend on additional databases but will be unified under AS. MFC will also build a bill of materials linking equipment to the catalog data.

17.2.3 Process

The AS data base is the current and future data base for CM. With the implementation of version 9 of Asset Suite (AS9), EDMS will be linked to equipment and all configuration documentation will be linked in AS. Asset Suite will fundamentally change the way modifications are performed at MFC. With the implementation of AS9, all facility modifications will be tracked and controlled in the confines of a single data base. Changing of all documentation including drawings, operating procedures, changes to permits, hazard evaluations, analysis, and all documents relating to the modification will be tracked and modified through the AS data base. The process will have drivers to ensure all related documents that need to be modified during a modification will be identified and changed. This change will ensure all the proper authorizations and approvals are documented in one place and will be packaged into one organized comprehensive place that can be tracked during the modification and retrieved after the modification is complete.

With the full implementation of the MEL database in AS, all equipment information will be located in one area with a foundation of equipment. This means looking up a piece of equipment in AS you will be able to see the maintenance history and all associated documentation for that piece of equipment. The availability of this information will aide in LO/TO. When preparing LO/TO, operations will have access to the drawings and information to prepare the LO/TO, therefore eliminating not only the time it takes to find drawings but also providing help to get the correct drawing, eliminating possible errors. Having the documents tied to equipment will also assist the engineer performing facility modifications, as the engineer will be able to identify what documents will need to be revised in the EC. However, building these links will take time and attention from system engineers.

A major process improvement that will be implemented with the use of AS9 is how quality levels will be identified for equipment. With the implementation, quality level will be identified with each piece of equipment, eliminating the need to search another data base for the quality level. Not only will this create the ease of seeing the quality level with the equipment in AS, but it will also eliminate the process for the creation of quality levels in a separate data base. This will create efficiency for both quality level identification and using a separate process to justify and approve the quality level for equipment. Since the existing process is onerous it is often applied at a high-level, leaving some ambiguity about the quality levels of components. The AS process will remedy this.

17.2.4 Equipment Tools

The use of a single engineering tool to standardize and organize the engineering, maintenance and operational information is essential for the success of CM. Asset Suite is a powerful data base that has multi-functional use for integrating all three of these functional areas. AS9 will need the effort of all three functional areas to be successful. It will take years to enter and integrate all the information that will be necessary to make the data standardized and organized to make MFC fully proficient in configuration management.

17.2.5 Actions FY-22

- Continue updating essential drawings for the facilities identified in PLN-4656. (Stuart Jensen, September 30, 2022)
- Add the information for quality level, seismic category, safety class, and environmental qualified equipment to the AS database for all equipment at MFC. These fields in AS are considered revision tracked and will require a formal engineering change to modify them in the future. Once quality level determinations (QLDs) have been made for all equipment at MFC it will allow the elimination of the current QLD process. (Stuart Jensen, September 30, 2022)
- Write a standard guide describing where information will need to be placed in AS for each piece of equipment. This guide will provide consistency on where information will be located for each piece of equipment in the MEL. (Stuart Jensen, September 30, 2022)
- Develop and implement a data loader tool to assist loading information into AS. This new tool will assist the system engineers in loading information by system, this will eliminate having to enter data individually for each piece of equipment. (Stuart Jensen, April 30, 2022)
- Upon implementation and training on the guide and data loader the system engineers will begin entering data into AS for each piece of equipment. Each engineer will create a plan with dates to complete entering equipment information for all systems assigned to the engineer. (Stuart Jensen, September 30, 2022)

17.2.6 Looking forward (FY-23 and Beyond)

- Continue with updating essential drawings for the facilities identified in accordance with PLN-4656.
- Create system design descriptions (SDDs) for systems; at present in general these only exist for active safety systems, as required by DOE O 420.1C, “Facility Safety.”
    - SDDs will be developed for all systems that are classified as Type “MOD” in the Engineering Change process prior to EC closeout.
    - Assigned system engineers will write SDDs and include lists of safety-related and defense in-depth equipment/components.
    - The new AS has built CM into its workflows and data structures and will continue to populate CM documentation as it is developed.

- Once an assessment is completed for equipment labeling, conduct a recovery program to ensure all MFC is correctly labeled with the correct equipment IDs.
  - Several facilities do not have the correct labels or alternate labels that can be error precursors for both operations and maintenance.
  - This has been a legacy issue that will need to be corrected for excellence in operations.
- Looking forward a fully integrated approach to CM will have a single data base to organize all the engineering and operational information for equipment at MFC. Areas of improvement are found below:
  - Updated essential facility drawings with a process to verify every 5-years
  - Changed the facility modification process to account for MFC-specific CM requirements
  - Updated unique equipment/component identification numbers and facility tags
  - Identified defense in-depth systems and evaluate to provide justifiable level of system engineering rigor.

17.3 Modification Process

17.3.1 A Look Back

Several years ago, MFC had issues with the lab-wide engineering modification process. The process lacked rigor, was vague, and there were systemic issues with the turnover from engineering to the facility. MFC developed its own facility modification process to fix these problems and to create a robust engineering change process that was clear and compliant with the host of DOE regulations for nuclear facility changes and configuration management. Creating a process that was clear and enabled a broad range of modifications was challenging. The creation of this process necessitated a procedure that covered all phases of change from initiation, design, turnover, and closeout. Since this time, the process has worked and been more effective. Several audits and reviews have looked at the process and confirmed that it is much improved.

The notable inherent problems resulted from the procedure being too long and the form to document the modification process was not electronic. The process still involves a host of required signatures for each phase of the process. The current process requires expert knowledge through checking, that requires the entire package to be physically routed to each approver systemically creating a less efficient process. Having a fully electronic process will allow significant increases in efficiency and a process to capture all the documentation and information involved for facility modifications.

Understanding the manpower limitations and the facility needs for engineering support; an evaluation was undertaken in 2018 to determine the weaknesses and threats within the engineering division. There was an identified need to make improvements in CM, as well as support the modifications and new upgrades of equipment and systems within facilities. Facility Management was also asking for additional engineering support for upcoming projects due to their anticipated need over the next 5 years. Part of this evaluation included a bottom-up estimate of the system engineering needs to staff MFC. The following Table 9 identifies new hires to date.

Table 9. MFC Engineering Directorate new hires.

Department	Full Time Position Hire	Hired
U710 System Engineering	FCF Process Engineer	1
	System Engineer	3
	Equipment Reliability Lead	1
	SPL System Engineer	1
	Hoisting & Rigging and Manual Material Handling	1

Department	Full Time Position Hire	Hired
	Mech Design Engineer	5
	HVAC Sys Engineer	2
	Equipment Reliability Support	1
	Mech Design Engineer	5
U720 Mechanical and Electrical Engineering	Electrical Engineer	3
	Equipment Coordinator (Configuration Management)	2
	Mechanical Engineer	5
U780 MFC Drafting	Drafter	3

17.3.2 People

Engineering provides the technical basis for safe, useful, and reliable SSCs to further the MFC mission. All necessary functions including design, nuclear safety, procurement, construction oversight, fabrication, quality assurance, specification of maintenance, and modification are integral to the engineering scope and responsibility.

Currently the Engineering Division has less staff than is needed to keep up with the pace of work at MFC. This is largely due to growth in base funding not keeping pace with escalation, plus growth in facility buildouts, combined with a lack of program planning for long-term needs. Many programs fail to recognize, and therefore, fail to plan and communicate the need for MFC system engineering to support their work. For basic support to the anticipated design and system engineering needs in FY-22 MFC Engineering is short of staffing in the following positions:

- 1 Cask/Container Engineer
- 4 Mechanical System Engineers
- 3 Mechanical Design Engineers
- 3 Electrical Engineers
- 1 I&C Engineer
- 3 Drafters
- 1 Equipment Reliability Electrical Engineer
- 1 Equipment Reliability Analyst
- 1 Structural Engineer.

17.3.3 Process

The modification process performed by engineering is currently well defined at MFC. A major process improvement is the implementation of Engineering Change within AS. With this new change to the facility modification process, MFC has a managed system that will allow an outside organization to request an engineering effort in a straightforward process to allow the engineering organization to assign the correct system engineers and will help the requestor get the correct disciplines involved for the success of the design, implementation, and eventual installation, turnover, and closeout of the necessary documents, and CM information.

With the implementation of AS9, MFC Engineering will be in the lead for defining engineering processes. Engineering is counting on this change to remove longstanding roadblocks to improved CM, such as the inability to access EDMS documents from AS, the lack of a usable equipment tree, and the difficulty of creating efficient process flows. MFC Engineering has investing time and attention to defining and refining the AS engineering process workflow implemented for AS9.

Keeping track of the location of EJs by the responsible engineer has always been time consuming. In addition, engineers have numerous responsibilities while implementing a facility modification, which includes providing EJ status to the Configuration Management Engineer. With the AS upgrade and use of Engineering Change (EC), the status of ECs can be easily determined by running reports on each building, responsible engineer, Technical Integrator, etc. In addition, engineers will no longer have to keep track of paper EJs, as the ECs will be electronically stored within AS. Approvals at various stages of the EC life cycle can be electronically routed for review and approval and Engineering Management can easily determine what progress is being accomplished by viewing the EC in AS. The AS to EDMS interface capability allows the engineer to load documents, drawings, and records against the proper equipment and/or Master Equipment and Activities List (MEAAL) system. Facility documentation can be loaded against the equipment and/or MEAAL system, the engineer no longer has to spend days determining what documentation will require revisions because prior to initiation of a facility modification, the documentation will be readily available in AS.

17.3.4 Equipment/Tools

The use of a single engineering tool to request engineering and drafting support at MFC will help outside organizations obtain the critical support they need for facility modifications and installation of future scientific capabilities. The organization requesting engineering services will only have to fill out the scope of work, need dates, and basic information on an easy user interface. The request will then route to an engineering board that will categorize the request to determine the level of engineering rigor and assign the work to the appropriate engineering for execution. All the engineering work will be electronically captured within AS. The use of AS will allow engineering to track the status of the work through all phases of the facility modification process.

The new AS9 provides engineers with a user friendly process flow and data repository for defining engineering specifications, procurement, inventory, CM condition monitoring, and maintenance throughout the lifecycle of systems and facilities.

The engineering change module of AS has dramatically changed the facility modification process at MFC. AS will not only be a tool used for both controlling and tracking the change but can also be relied upon to ensure the correct documents and facility configuration information are modified to reflect the change.

A data loading tool, i.e., a dashboard, will be made available to allow engineers to mass load documents, drawings, records, technical notes, action requests, etc., against the selected MEL hierarchy. The data loading tool will improve the efficiency of loading various information as it can be mass loaded into AS, instead of individually loading the documentation against equipment one step at a time. The engineer's efficiency while performing a facility modification will drastically increase once documentation has been loaded against the appropriate MEL hierarchy, as they will be able to easily review what documents require a revision. These documents will be added to the Affected Documents List within the EC and will be revised accordingly during the EC lifecycle.

17.3.5 Actions FY-22

- Continue to address staffing needs to broaden existing disciplines and fill needed discipline in the areas of HVAC, Cask Handling, Gloveboxes and Enclosures, and Civil/Structural. (Stuart Jensen, September 30, 2022)
- Implement the CM process to ensure all facility configuration information is placed in a consistent place in AS and easy to retrieve based on equipment numbers. (Stuart Jensen, September 30, 2022)

17.3.6 Looking Forward (FY-23 and Beyond)

- The new facility modification based in AS has solved several systemic issues with the current facility modification process. The modifications will allow outside organizations a simple process to get engineering services, allow for a process that is rigorous and is electronic eliminating the time necessary to route paper packages for individual approval.
- The new EC process, which has been fully integrated with CM, will provide correct facility information for future modifications.
    - It will take several years to build the databases of information around the MEL structure and to mature the AS engineering change process.

17.4 Quality Assurance (Design)

17.4.1 A Look Back

In 2016, MFC Engineering started the process of integrating the functional organizations within the engineering directorate. Quality, procurement, subcontracting, warehousing, and receipt inspection were combined into the engineering organization. This change has facilitated collaboration in the design process and has created a culture where quality and how to verify the quality is considered early in the design process.

Engineering has established functional groups that leverage areas of expertise to create efficiency and consistency throughout the facilities in design and configuration. An example is the Glovebox group that works to provide a consistent approach in glovebox design and facility integration. Other areas of improvement are found below:

- Altered the EJ process to account for MFC-specific requirements.
- Created nuclear specification and commercial specification for fabrication work.
- Integrated quality into the engineering organization, which has allowed for participation and feedback in the design process.
- Integrated procurement engineering to assist in specification development while also establishing procurement strategies early in the process.
- Ensured drawings have been through a do/check/approve process.
- Conducted a rewrite of LWP-10109, “Commercial Grade Dedication” to be a clear and efficient process which also included comprehensive classroom training given by the SME. MFC Engineering has taken program ownership of this process.

17.4.2 People

The number of items being procured and the total value is continually increasing. Improvements such as a standard practice for quality clauses and competent staff has allowed MFC to be successful at maintaining the quality of products. However, with the implementation of engineering change and procurement engineering, more quality engineers are needed for the creation of Bills of Materials (BOMs), and in performing procurement engineering evaluations to document design basis information. Two additional quality engineers have been hired. Staff such as engineering and planning will need to be trained on BOMs to ensure an efficient and accurate process.

17.4.3 Process

New processes for engineering in AS were deployed early in FY-21. The new processes are engineering change and procurement engineering. With the engineering process completely housed in AS, engineering decisions are documented and attached to the equipment in AS. This will allow easy retrieval of design basis information and create greater efficiencies when performing modification or maintenance.

BOMs will be created that contain the information necessary to properly procure and accept items. The BOM links the procurement catalog ID to the facility equipment, a process which has been lacking. Design basis information such as drawings, specifications, safety analysis, Commercial Grade Dedication (CGD) plans will be a part of the category ID and the acceptance activities will be verified for the items end use. For the first time a clear connection to the items end use, design information, requirements, and acceptance activities will be available in one place.

17.4.4 Equipment Tools

The AS implementation of engineering change and procurement engineering modules will improve the quality of engineering deliverables by containing the design information as well as the history of design changes in one location. AS will drive quality assurance by being able to link important documents such as drawings, specifications, and others to the equipment. A clear link between requirements and outputs will be established within AS.

17.4.5 Actions FY-22

- Mature the process for creating BOMs within AS. (Stuart Jensen, June 30, 2022)
  - A process will be established for building BOMs in their various use cases.
  - Involvement of Cognizant Safety Engineer (CSE) in the review and approval of BOMs and Catalog IDs.
- Re-design Laboratory processes for QLD to utilize AS capabilities and implement these at MFC. (Stuart Jensen, September 30, 2022)
- Continue creating standard specifications for items like containers, lead crucibles, RadCon equipment, anchors, and others as appropriate. (Stuart Jensen, September 30, 2022)

17.4.6 Looking Forward (FY-23 and Beyond)

As MFC Engineering moves forward, facility modifications will continue as MFC becomes the leader in reactor and fuel demonstration and testing. This will require an agile team that must be able to incorporate customer requirements into the needed facility configuration changes, either through construction or maintenance activities. Being flexible, creative, and precise in MFC's design approach is key. Additionally, the quality of these outputs will be a necessity to innovate and accommodate customer demands without failure or delays due to design errors.

Looking forward a fully integrated approach to quality in design will be implemented which will have early involvement of all stake holders and a well-developed acquisition strategy well ahead of procurement/construction. Leveraging lessons learned from projects such as SPL, Uranium silicide, and the MARVEL project will aid MFC Engineering in becoming efficient in design quality.

- Reconcile INL drawings with fabricated red-line drawings combining abilities of ProCore and AS software.
- Create CAT-IDs and common procurement strategies that span multiple facilities that aligns with the Code of Record (e.g., anchors, valves, PLCs, and other identified items).
- Establish reviews of design and look at improvements that can be made based on fabricator/construction feedback and change requests to original design.
- Broaden the use of MFC Engineering's standard for model-based design definition and fabrication.

18. MATERIALS AND SERVICES

18.1 Procurement

18.1.1 A Look Back

In mid-2015 the Nuclear Material Acquisition Group was formed at MFC and has seen tremendous growth in recent years. The group was able to manage the business volume increase by incorporating process improvements and implementing a customer focused strategy that included more engagement with facilities and project individuals. The acquisition group was integrated within engineering and includes procurement (contracts and materials), material coordinators, commercial grade dedication, quality, warehousing, and receipt inspection.

NOTE: *This is not added headcount but rather assembling connected functions into one department with many positions being matrixed from home organizations, such as quality, to optimize teamwork.*

The current acquisition group focuses on customer service and being the path of least resistance for the programs at MFC. The group has embraced this culture and has gained the trust of MFC organizations. The acquisition group is now involved early and often in procurement strategies and problem-solving discussions. The group also realizes the need for continuous improvement and is looking for ways to provide tools to customers, so the procurement process is transparent.

The acquisition group completed implementation of the procurement engineering module and transitioned LWP-10109 using the MSTI process into the procurement engineering module. Training was completed on the new module and processes and has been adopted by all affected organizations.

MFC has increased capabilities for receipt inspection to include improved dimensioning capabilities as well as XRF (X-ray fluorescence) which allows MFC to perform dedication activities in-house.

Improvements have been made to informal processes for tracking and staging of material, which has decreased the time to process as well as decreased errors. The acquisition group continues to hold meetings with facilities to provide up to date status on procurements and work to resolve issues. These meetings have been beneficial to Analytical Lab, HFEF, and specific projects such as MARVEL and the NRIC program.

18.1.2 People

To create an effective cradle-to-grave procurement support organization at MFC it was imperative to identify key organizational positions and collating these existing functions within the organization was necessary. An effective method is matrixing individuals from functional organizations such as Quality Assurance (QA) into the Organization. The QA organization is fully matrixed within the Organization and consists of quality engineering and receipt inspection. Matrixing these individuals created a team environment where the team works together to solve problems that arise daily. Currently, procurement, including buyers and subcontract administrators, are co-located at MFC but are not directly matrixed to the organization.

To take the next step, matrixing these procurement individuals to MFC will be necessary. This effort will not only include matrixing buyers and subcontract administrators but will include construction contract administrators as well. All matrixed procurement individuals will be required to have a strong understanding of nuclear procurements. A nuclear buyer/contract specialist qualification will be implemented. This qualification will ensure adherence to key nuclear facility quality and safety requirements and could provide a financial incentive to those who are chosen to be part of the MFC Team. In the long-term, BEA Acquisition and Contracts Management will assign a management level individual to lead the MFC team, and who in turn will assign lead roles to competent and trustworthy individuals for materials purchasing, service contract management, and construction contract management.

The need also exists to transition MFC buyers from commodity-based purchasers (current BEA procurement structure) to facility-based buyers who will support only MFC-specific needs. Additional dedicated procurement professionals will be needed to support all MFC facilities future purchasing and contracting needs.

18.1.3 Process

The overall procurement process is mature and well known by the individuals who use it on a frequent basis. Room for improvement exists in some of the formal and informal processes for procurement. Informal processes have been improved using Jira for material coordinators to track assignments. A MFC online material request form has been implemented and has been effective at improving the quality of the requests, as well as the time it takes to process the request. The procurement engineering module within AS provides efficiencies as items will contain all the needed information to facilitate efficient procurements. The improvements allow for inclusion of design basis documentation in the catalog id, reduced reviews for procurement of items and reduction in the number of hours engineers and planners spend looking for information and identifying the appropriate material or equipment to order.

18.1.4 Equipment Tools

The staging area is near capacity and often material must be sent to West One for storage until the work begins. To facilitate current and future MFC growth larger staging area is necessary. Currently the staging is located on a mezzanine upstairs in MFC-781. Ideally, staging would be on the ground floor as these items are high turnover and generally are allocated to work orders within 6-months. Additional helpful tools would be scanners and tracking equipment that would make it easier to stage, locate, and manage stored material.

18.1.5 Actions FY-22

- Add a Project Quality Engineer supporting MFC projects such as SPL and Microreactor projects. (Stuart Jensen, September 30, 2022)
- Add a Procurement engineer supporting MFC facilities and projects. (Stuart Jensen, September 30, 2022)
- Complete BOMs process in PACE and training for Engineering and Planning. (Stuart Jensen, September 30, 2022)
- Develop or improve staging database for quick assessment of material for disposition. (Stuart Jensen, September 30, 2022)

18.1.6 Looking Forward (FY-23 and Beyond)

The demand for procurements at MFC is expected to grow in both volume and complexity. Efficient and transparent purchasing processes, paired with on demand acquisition status, will be vital to accomplish the needed modifications and improvements at MFC. The Nuclear Material Acquisitions Group at MFC is off to a great start but improvement must continue. The groups' goal is to have an organization that is fully capable of assisting with all needs in the MFC procurement process, however, this can only happen if customer oriented, and technically competent individuals are in key procurement positions.

A summary of the recommended process improvements includes the following:

- Have a standard process for requesting engineered items that does not incorporate redundancies (e.g., Fab request, and material request)
- Nuclear Buyer and Nuclear Contract Specialist qualification/Designation and associated compensation incentives

- Enough buyers and contract specialists within the organization to handle all MFC acquisitions (change to commodity buying and centralized purchasing)
- Fully matrixed organization with a designated MFC Acquisitions Manager and procurement leads in key areas
- New warehouse for staging and storage of spares
- Staging improvement – scan and stage to location and implement a process to easily see location of staged items.

18.2 Commercial Grade Dedication

18.2.1 A Look Back

Five years ago, MFC embarked on a path to become "best-in-class" in CGD and procurement engineering. These changes included a new organization structure, new people, new procedures, and new training. These changes were brought about from a realization by MFC senior leadership of the need for improvement to attain excellence in the area of CGD. An improved CGD program is aligned with the projected growth at MFC which will require improved procurement effectiveness.

MFC has made significant investments in CGD that have paid dividends in the past 2-years. MFC Engineering took ownership of LWP-10109 in 2019 and completely re-wrote the procedure in collaboration with senior engineering, quality, and procurement lab-wide leadership (CGD Improvement Team [CGDIT]). Additionally, the CGDIT redesigned the CGD training program aimed at raising awareness of CGD across effected functions as well as provide focused practitioner training to those authoring CGD plans.

The CGD program has been designed to react quickly to emergent operation's needs, as well as being the primary procurement strategy for the SPL. MFCs program has enabled across the board improvements in nuclear use procurements and has proven effective when deployed for small procurements, as well as significant construction procurements such as SPL.

18.2.2 People

The CGDIT has implemented a focused strategy to ensure those assigned as SE/CSE of safety SSCs receive CGD and AS training and support necessary to complete efficient, effective procurements. The team's strategy to ensure effective procurement engineering execution is through procedures, training, regular communication, and mentoring from a CGD SME.

Since rolling out the new CGD program in 2019, engineering has trained over 40 engineers to be originators of CGD plans. Of those trained, approximately half have been actively involved in the dedication process. The training strategy is focused on ensuring each HAZ-CAT 1, 2, or 3 facility has at least two trained engineers capable of originating/checking CGD plans. Employment of this strategy will focus on training and mentoring by the CGD SME, thereby expanding the knowledge and capability of MFC to sustain a best-in-class CGD program.

Additional Salient Items

- The program is currently SME based
- Additional time and mentoring are required to raise the skill level of those needing this skill set.

18.2.3 Process

Commercial Grade Dedication

Commercial Grade Dedication process improvements have significantly improved CGD performance across the laboratory. When the process was introduced in 2019, it aligned with the existing execution model of documenting processes in LWPs, completing work on standard templates and qualification to do that work via classroom training. The process of transitioning CGD to AS is complete. CGD plan creation is performed within AS in variable templates, while the procedure requirements will be housed in the MSTI process maps. Training will remain the same. This transition offers opportunities for efficiency gains that align with overall engineering configuration management improvements. Much of the data currently populated in CGD plans will exist within the AS panels, therefore, allowing for shortening of the CGD template.

Currently, CGD plans are created on an "as needed" basis and are very specific to the item and installed location. Going forward, the creation of bounding CGD plans for general commodities, that would be attached to the CAT-ID, will allow for items to be procured quickly and efficiently.

Asset Suite

The rollout of AS9 offers opportunities for engineering and procurement engineering to become more efficient and effective. In addition to incorporating CGD into AS, the process for creating CAT-IDs will be improved while the BOM module will be employed for the first time. Better integration of the above noted items is part of broader engineering process integration into AS. From a procurement engineering perspective, AS9 will ultimately result in more efficient, consistent procurement of QL-1, QL-2, and QL-3 items. The primary drivers for this improvement will be the housing of technical and quality requirements within the item CAT-ID in addition to associating the item to the system via the BOM module.

18.2.4 Equipment/Tools

Completing the commercial grade dedication process can require special equipment. MFC inspection and test capability include XRF (material chemistry), metal hardness/strength testing, soft/good durometer testing, as well as a variety of dimensional inspection instruments. MFC testing capability can be augmented via qualified testing suppliers. Additional testing and inspection capabilities would reduce reliance on third party dedicators as well as lower procurement costs and material lead times.

18.2.5 Actions FY-22

- Revise definition of "like-for-like" as it applies to nuclear use items. (Stuart Jensen, July 30, 2022)
- Create standard QA/Engineer guidance for reactor developers who intend to use the INL test bed. (Stuart Jensen, July 30, 2022)
- Create template for AS for nuclear use items procured from NQA-1 suppliers. (Stuart Jensen, September 30, 2022)
- Improve MFC Personnel Proficiency, Awareness, Attitudes, and Training Regarding CGD. (Stuart Jensen, September 30, 2022)
- Complete CGD practitioner training at MFC. (Stuart Jensen, September 30, 2022)
    - Issue regular Procurement Engineering bulletins to communicate lessons learned and best practices.

18.2.6 Looking Forward (FY-23 and Beyond)

- The CGD program at INL has been strengthened and is now clearly understood by practitioners and SMEs at INL. Going forward the CGD program at MFC needs to add a procurement engineer to enable MFC to support the growing need for CGD. The growth for CGD will come mainly from micro reactor projects and demonstration. Facilities need to be modified to accommodate the reactors and those facility modifications include many safety systems. In order to maintain the quality of the process it is necessary to add an additional Procurement Engineer.
- BOMs will become an essential part of the process. Clear ties between the item and its end use will be clearly identified in the BOM. This improvement will reduce evaluation time, shorten the procurement process, and reduce engineering reviews on items needed for work orders.

18.3 Quality Assurance (Procurement)

18.3.1 A Look Back

In the last 5-years, MFC has driven significant organizational paradigm changes in procurement quality assurance. MFC stood up the Nuclear Acquisitions organization aimed at co-locating functions that had previously been siloed with improved efficiency as the primary objective. In addition to the organizational change, MFC began a cultural change effort. In the previous paradigm, engineering relied solely on quality assurance (QA) to determine procurement acceptance requirements and procurement strategy. This paradigm resulted in procurement acceptance strategies not always in alignment with the design basis. Cultural and paradigm shift in process at MFC requires engineering to determine procurement acceptance requirements and strategy. Engineering is best positioned to do this, being most familiar with the design. QA has been integrated into the engineering process by aiding engineering in identifying and determining appropriate quality acceptance requirements. In that, QA assists engineering in selecting procurement acceptance requirements and executes that acceptance plan.

The primary source of MFC's success and improvement has been a cross-functional organization coupled with the right people. In addition to the organizational improvements, program changes have improved quality. Some of these improvements include:

- A standardized online request form designed to eliminate duplicate procurement requests.
- An online material coordinator workload management tool.
- General build to print fabrication specifications for both QL-3 and QL-1 orders.
- Collaborating with senior leaders across the lab to provide consistent quality execution of the procurement acceptance process (CGDIT).
- Implementation of the AS Procurement Engineering Module.

Outcomes of improvements made have been quality focused, incremental progress. SPL is a prime example of matching the procurement acceptance strategy to the scope of work. SPL is a first of a kind in the DOE complex in that CGD is the primary procurement acceptance method for a safety-significant construction project.

MFC has been the laboratory trail blazer in this regard resulting in the MFC Nuclear Acquisition team being asked to lead complex-wide efforts to improve procurement quality assurance. MFC intends to continue this improvement trajectory and retain the complex-wide leadership role.

18.3.2 People

Developing and executing a right sized quality acceptance plan requires a unique understanding of engineering, quality assurance, and procurement. Previous organizational structure has siloed these functions as part of a serial process where procurements were passed from one organization to another with minimal integration as the procurement progressed. Given the unique blend of skills required to develop and execute a right sized quality acceptance plan, organization, process, training, and Roles, Responsibilities, Authorities, Accountabilities (R2A2s) must be aligned to ensure an integrated process.

Organization

With support from senior management, a Nuclear Acquisition organization with procurement/contract specialists and quality engineers co-located with engineering is required.

Process

Process control can be achieved via a combination of written direction (i.e., procedures, guides, and templates) and SMEs guiding the process. These are proportional in that where minimal written direction is available, the primary process control is a SME. Conversely, where detailed written direction is documented, the process is less reliant on SMEs. The process is currently heavily dependent on SMEs.

Training

There is no training specific to specification of procurement quality requirements. A training on specifying technical and quality requirements for acceptance of quality and safety effecting items should be considered moving forward.

R2A2s

Clear definition of roles and responsibilities with regards to the procurement acceptance process that align with the above defined organizational structure is required for successful execution of the procurement acceptance process. Those roles are as follows:

- Engineering:
  - Define technical and quality requirements.
- Quality Engineering:
  - Consult Engineering on possible acceptance strategies and methods. Execute selected acceptance strategy.
- Procurement/Contracts administrator:
  - Manage scopes of work defined by engineering. Consult with engineering on procurement acceptance strategies.

18.3.3 Equipment/Tools

Procurement quality is an administrative process that does not require capital equipment. Tools employed by procurement are software and administrative tools. Examples are AS, Jira, and a variety of process controls designed to ensure consistent/quality procurement execution.

18.3.4 Actions FY-22

The vision for FY-22 in terms of procurement quality improvement is focused on increased transparency, integration, and collaboration between engineering, procurement, quality, and the supply chain. This effort will drive for greater collective ownership of end item quality. As the nuclear supply chain continues to diminish, responsibility for end item quality and nuclear safety falls to the purchaser. To this end, MFC plans develop processes that acknowledge the supply chains unfamiliarity with nuclear safety terminology and develop procurement specifications that specify procurement acceptance activities in a manner that is understandable to commercial fabricators, constructors, and suppliers. Below is a list of improvements to be integrated into the MFC procurement acceptance process:

- Draft MFC guidance on best practices for developing large CAPEX procurement acceptance strategies. (Stuart Jensen, September 30, 2022 [ongoing])
- Facilitate the retirement of LWP-13014, "Determining Quality Levels" by incorporating the quality level determination process into the AS Procurement Engineering and other modules. (Stuart Jensen, September 30, 2022)
- Develop process to define quality levels for procured services including construction. (Stuart Jensen, September 30, 2022)
- Improve MFC Personnel Proficiency, Awareness, Attitudes, and Training Regarding Procurement Quality. (Stuart Jensen, September 30, 2022)
    - Issue regular Procurement Engineering bulletins to communicate lessons learned and best practices
    - Ensure proper training and awareness of SP-20.6.5, "MFC Procurement Clause Requirements," by the MFC Engineering group.
- Evaluate receipt inspection for use within Asset Suite to simplify processes. (Stuart Jensen, September 30, 2022)

18.3.5 Looking Forward (FY-23 and Beyond)

FY-23 and beyond will see MFC continuing to lead the way in procurement quality. The following are planned areas of improvement from FY-23 and beyond:

- Identify supply chain issues to help establish risk reduction approaches (e.g., welding, consistency of requirements for items such as ASME B31.3, "Process Piping").
- Establish a regular vendor forum to facility MFC/INL vendor improvements as well as allow vendors to offer suggestions on where MFC/INL can improve their procurement procurement/acceptance processes (e.g., meeting with key suppliers on common performance health issues and needs, what issues vendors see with MFC/INL technical and quality specifications, etc.).
- Cross site-collaboration of resources for efficiencies (e.g., one DOE contractor audits a local vendor for a DOE contractor in another state to address travel restriction issues).
- Identify spare equipment/spare parts and equipment obsolescence issues.
- Create a training module for specification of technical and quality requirements for acceptance of quality affecting items for engineering.

19. NUCLEAR SAFETY

19.1 A Look Back

The MFC Nuclear Safety Engineering department has maintained quality nuclear safety support for existing nuclear facilities while gaining valuable experience during the beginning of operations of the two new facilities within the department: RHLLW, and IMCL. Additionally, the department developed the preliminary documented safety analysis (PDSA) for the new SPL. The SPL PDSA was the first and precedent setting DSA following the newest revision of DOE-STD-3009.

The department has made improvements in the application of the USQ process and procedure, LWP-10801, "INL Unreviewed Safety Questions." MFC Nuclear Safety worked with the program office to define an additional Categorical Exclusion (CX) for the USQ process as outlined in LWP-10801. The new CX allows the exemption of procedures being suspended or canceled when they meet the requirements outlined by the CX. Additionally, MFC Nuclear Safety developed a streamlined process of including controlled drawings within the Engineering Process by allowing the drawings to forgo the normal USQ process and be included in the review of the associated EJ. This helped reduce additional reviews for the same EJ while providing for an overall, comprehensive review of modifications to a nuclear facility.

Over the past year, the MFC Nuclear Safety department has been working to identify and document a safety related equipment list (for all Safety Class and Safety Significant SSCs). This effort will identify all Safety Related systems for all facilities at MFC, as well as define the Critical Safety Functions of each. This is a specific request from the ALD for MFC. The goal of this list is to provide a quick and accurate reference to Operations and Engineering for use when abnormal conditions arise, and timely decision-making is paramount.

The MFC Nuclear Safety department has supported the development and implementation of the new radioactive and nuclear material tracking system, NUTRON. NUTRON is currently being deployed at all Radiological Facilities at INL. MFC Nuclear Safety will continue to support the development of this program for future adoption by Hazard Category 2 and 3 facilities at MFC.

19.2 People

MFC Nuclear Safety staff present a broad range of experience, education, and diversity; all benefiting the ability of the department to fulfill its mission. The department staff education range incudes; Chemical Engineers, Nuclear Engineers, Structural/Civil Engineers, and a Health Physicist. The experience range for the staff also spans several generations, from young professionals in the workforce to seasoned veterans in the field of Nuclear Safety Analysis, with over 30 years' experience. This culminates in a department focused on mentoring younger staff while also being fully engaged in new developments and capable to meet the challenges at MFC. The department reached full staffing in FY-21 but experienced two retirements and a staff member's death resulting in staffing needs that will be filled in FY-22. The intention is to fill two positions with junior staff members and one position with a senior experienced staff member. All three staff members will be qualified, contributing members of the department by the end of FY-22.

MFC is seeing a growth in work projection over the next 5-10 years. This will present unique challenges to the MFC Nuclear Safety department. Namely, an increased scope of activities to be analyzed considering new reactor technology is one of the primary emphases of the new work. MFC is also planning to add new nuclear facilities to MFC which will add an increased demand for nuclear safety support. The need for additional staff members in the department to accommodate this growth will be realized by FY-23. The initial goal is to increase staffing of the department by plus one by the end of FY-22.

19.3 Process

Nuclear Safety processes and procedures are outlined in Laboratory-wide Manual Chapter 18, "Nuclear Safety." They are acceptable but undergoing continuous improvement to make them stronger. MFC Nuclear Safety diligently works with the Program Lead to streamline procedures and processes for the laboratory-wide. In FY-21 that included several changes to procedures and processes, including the implementation of a local MFC procedure to further provide needed guidance on annual and triannual updates to facility safety bases. While efficiency has been gained, there is more work to be done.

19.4 Equipment/Tools

Tools and equipment for MFC Nuclear Safety are strong. Nuclear Safety tools include validated software and computers, and the knowledge and experience of the staff members. Even though MFC Nuclear Safety is strong related to existing software packages associated with analysis needs, the new staff may not have the breadth of knowledge for the spectrum of computer codes used by the department. This requires emphasis be placed on increasing the analytical knowledge of the nuclear safety staff, concentrating on the newer staff members. Along with dose consequence, shielding calculations, and air dispersal analyses, the department has also chosen to increase the structural analysis capabilities of the group with a strategic addition to the group.

Fiscal years 2020 and 2021 have highlighted another tool for the MFC Nuclear Safety department, the ability to effectively perform work via telecommuting. Telecommuting will be a useful tool in the coming years to increase the flexibility of the group to not only attract highly qualified members to fill vacancies made by retirements, but retain these members as well, reducing the cost of attrition.

19.5 Actions FY-22

- Safety Basis Development (Stuart Jensen, September 30, 2022)
  - Roll into all safety bases the developed lower threshold for when Safety Significant shielding is required and complete the revision of program documents to include this guidance for future safety bases revisions.
  - MSTEC and BEARTOOTH are Major Modifications to FCF. This results in a need to bring SAR/TSR-403, "Technical Safety Requirements for the Fuel Conditioning Facility" in line with the requirements of the revised DOE-STD-3009 by rewriting the safety basis and controls. In FY-22, addendums to SAR-403, "Safety Analysis Report for the Fuel Conditioning Facility" will be written for each project.
  - MFC Nuclear Safety Engineering will work with IMCL management to revise the facility protection strategy to increase efficiency of operations within IMCL. This will be a rewrite of the IMCL safety basis and controls.
- Safety Analysis (Stuart Jensen, September 30, 2022)
  - The developed Critical Safety Function (CSF) list for each Nuclear Facility at MFC will be rolled into the MEL for MFC and Nuclear Safety will work with Engineering Management and Operations (M&O) to roll the information into easily referenced documents for each division's needs.
  - Professional development will be a concentrated area to improve the department's analysis capabilities. This is a long-needed improvement within the department that has been forced to be delayed due to COVID-19 restrictions. The department has received adequate funds to ensure each staff member of the department may participate in a professional development opportunity to this end in FY-22.

- Continue to work with NFMs to appropriately annotate when the PISA process is required to be entered. Part of this task will be to educate the NFMs on recent lessons learned across the DOE complex, the rest will be identifying on ramps to the PISA process from normal and abnormal occurrences within the facility. (Stuart Jensen, September 30, 2022)
- Gain experience using the newly developed MFC-ADM-0012 procedure and its guidance for triannual safety basis updates to continuously improve the TSRs at all MFC Nuclear Facilities on a 3-year rotating schedule. This new procedure and its use will continue to be reviewed and revised to increase its effectiveness and efficiency. (Stuart Jensen, September 30, 2022)
- The department will concentrate on removing SACs by replacing them with Engineered Controls and LCO/SR for all MFC Nuclear Facilities in FY-22. (Stuart Jensen, September 30, 2022)
- Develop strategy to reduce the TSR reliance on Contractor-approved lists. (Stuart Jensen, September 30, 2022)
- Align the Nuclear Safety organization to support MFC Projects, Engineering, and Operations. (Stuart Jensen, September 30, 2022)

19.6 Looking Forward (FY-23 and Beyond)

- The previously identified 5-year goals remain a focus of the department. Implement the approach toward defining the lower threshold quantity for material to be tracked by facility Radioactive Material Acceptance Coordinators (RMACs). This will facilitate improvements in the procedures associated with transport activities of radioactive and nuclear material, as well as reduce the uncertainty associated with material tracking at each facility when material is transferred from one to the other.
- Personnel Development:
  - Increased need to hire staff and allow the newly hired staff opportunities to shadow Operations staff, in order to instill an understanding and appreciation for operational challenges to benefit the department in developing safety bases and controls that fit well within each nuclear facility at MFC.
  - Improve the analytical capabilities of the operations group to deepen expertise in technical issues related to nuclear safety. (This effort was limited by COVID-19 in FY-20 but will remain a focus moving forward into FY-23 and beyond.)
- Process and procedure improvements for the next 5-years will concentrate on the following five areas:
  - Safety Basis development
  - Safety Analysis
  - PISA/USQ process implementation
  - TSR implementation
  - Critical Safety Function definition and usage.
- Safety Basis Development
  - Continue to work with Operations within each facility to effectively communicate the importance of Plutonium Equivalent Gram in DSA and determine if an alternate representation is needed for day-to-day operations for the facility staff.
  - Continue to improve documentation of safety bases and supporting analyses.
  - Support the development of nuanced criteria within NUTRON to support its release to each Hazard Category 2 and 3 facility at MFC.
  - Complete rewrite of SAR-403 to be completed by end of FY-23.

- Safety Analysis
  - Continue to build analytical skills within the department to alleviate the need for outside support for nuclear safety analyses. Specifically, increase the departments proficiency in RSAC, ORIGEN, MCMP, and other currently used codes. A specific area of development will be the ability of the department to independently perform shielding calculations and structural analyses.
  - Work with Radiological Control to produce a paradigm to be included into Material at Risk (MAR) calculations for each MFC nuclear facility to allow for the exemption of low-level sources that are equivalent to commercially available material that is already exempted from MAR calculations.
  - Review the use of Contractor Approved Lists and develop consistency in controls for SSCs used in multiple facilities.
- PISA/USQ Process Implementation
  - Work with the Laboratory program office for nuclear safety to continue to develop CX criteria for occasions that should not be within the USQ process.
  - Continue to work with NFMs to appropriately annotate when the PISA process is required to be entered normal and abnormal occurrences within the facility.
- TSR Implementation
  - Develop a consistent format of control types across the MFC facilities to facilitate reduced human error for Operations staff qualified in multiple facilities or transfer to new work locations.
  - Continue to review and revise TSR controls to better conform to the guidelines of DOE G 423.1-1B, “Implementation Guide for use in Developing Technical Safety Requirements.”
- Critical Safety Functions
  - Build upon the system level CSFs to further define the system components, their functions, and better define the boundaries of Safety Related systems at all nuclear facilities at MFC.
  - Define CSF for equipment in the MEL database.

20. NUCLEAR MATERIAL MANAGEMENT

20.1 A Look Back

MFC manages a substantial inventory of contact-handled and remote-handled (primarily spent nuclear fuel [SNF]) accountable nuclear material. The major quantities of contact-handled nuclear material are associated with ZPPR fuel, unirradiated fast reactor fuel and associated fabrication scrap, and feedstock materials. These materials are typically managed by the Fuel Fabrication and Nuclear Material Management (FFNMM) Division. The remote-handled inventory is primarily associated with sodium-bonded spent SNF associated with the EBR-II reactor and is typically managed by the MFC Production Facilities Division.

The overarching strategic nuclear material management goal is to maintain and enhance the capability to efficiently support excess material disposition and programmatic missions while minimizing the number of facilities and locations that are required to manage significant quantities of special nuclear material. To this end, MFC continues to advance its efforts to ensure needed nuclear material is readily available to meet anticipated programmatic needs (including feedstock for advanced fuel development and qualification activities), while minimizing the inventory of excess nuclear material stored at MFC.

On a need to know basis, additional details regarding INL's accountable nuclear materials and associated management strategies can be found in PLN-4585, "Idaho National Laboratory Nuclear Material Management Plan."

In the last 5 years, more than 800 kg of contact-handled excess special nuclear material (plutonium and enriched uranium) and more than 115,000 kg of source nuclear material (depleted uranium, natural uranium, and thorium) has been successfully processed and shipped off-site. Multiple new equipment capabilities were developed and activated to enable these accomplishments.

The special nuclear material shipments primarily consisted of transfers of legacy highly enriched uranium (HEU) and excess ZPPR plutonium fuel. The HEU was primarily in the form of legacy unirradiated sodium-bonded EBR-II/FFTF fuel. A custom vacuum distillation furnace system was developed and successfully used to separate the reactive sodium metal from between the cladding and the fuel slugs. the fuel slugs were then sheared and repackaged for shipment. The HEU was subsequently shipped to a BWX Technologies, Inc. (BWXT) Facility for recovery and subsequent reuse as feedstock for new nuclear fuel fabrication under an NNSA down-blend contract. The ZPPR plutonium fuel was inspected, repackaged, and shipped to a new programmatic owner. Shipment of these SNMs had many impacts: freed up significant vault storage space in FMF and ZPPR, transitioned these valuable materials for beneficial reuse, and demonstrated continued progress towards removal of excess nuclear material from the state of Idaho.

Removal of the large quantities of source nuclear material (primarily depleted uranium), along with large quantities of non-nuclear materials, that were stored in MFC-784 was key in freeing up this area to support new missions. MFC-784 was subsequently renamed the Advanced Fuels Facility (AFF), transitioned from a nuclear facility to a radiological facility to facilitate more efficient operations, and multiple new advanced fuel manufacturing systems installed. These new systems have already proven to be key to supporting rapid manufacture of many unique test articles for TREAT and ATR irradiation.

The receipt of EBR-II SNF from Idaho Nuclear Technology and Engineering Center (INTEC) wet storage to MFC continues to be a top priority to ensure the Idaho Settlement Agreement (ISA) commitment for the complete removal of all spent fuel from wet storage is met. Shipments are received at both FCF and RSWF. The treatment of EBR-II driver fuel in FCF has resulted in recast of more than 1,000 kg of the recovered enriched uranium product into new low-dose 'Regulus' ingots to make the high-assay low-enriched uranium (HALEU) material more conducive for efficient reuse by advanced reactor programs. Production of the regulus shape has been facilitated through development of a drip cast crucible method. This arrangement allows for the recast of the traditional 30-40 kg HALEU through a stacked set of crucibles with the lower portion having interconnected cascading pockets enabling the

molten uranium to flow into them. The result has been the production of a smaller and lower radiation level uranium ingot, known as regulas, intended to support glovebox-based fuel fabrication needs associated with advanced reactor concepts.

20.2 People

The division staff working on the various nuclear material management efforts are highly trained and many require Q clearances and HRP certification. Several years of training and on-the-job experience are typically needed before a new fissile material handler is considered to be fully qualified and efficient. Various operations staff personnel are also key in planning, equipment development, and processing support functions in order to maintain efficient operations and develop enhanced capabilities. Sufficient associated RadCon, Safeguards, Engineering, and Crafts support personnel are also routinely relied on outside of directly assigned Division staff.

Over the last decade, the FFNMM Division has taken a load-leveled staffing approach to contact-handled nuclear material management by maintaining a core staff of roughly 10 FTEs focused on routine excess material processing and shipments. This allows for a consistent funding level (currently about $5 M, plus yearly escalation) and minimum perturbation of the staffing level. The current and out-year nuclear material management work scope priorities are planned around this consistent resource base. The majority of associated staff supporting the nuclear material management efforts are relatively young. Personnel attrition hires are made as needed, but there is little to no backup personnel capacity, so nuclear material management impacts can be expected if out-year staffing projections do not prove to be accurate, or if significant additional programmatic scope is added to the Division workload. The FFNMM staffing and succession planning efforts attempt to minimize the impact of such potential personnel shortfalls. However, FFNMM historically runs relatively ‘lean,’ and so mentoring and hiring of additional personnel is recommended to the extent funding permits, especially regarding positions associated with Nuclear Facility Management, Operations Support Professionals, and Fissile Material Handlers.

Production Facilities necessary staffing is more directly dictated by regulatory and legal commitment drivers associated with the Idaho Settlement Agreement, and by staffing levels necessary to meet the HALEU demand requirements communicated by DOE. These commitments have recently required significant additional staffing actions, as funding has allowed. FCF transitioned to a 12-hour work shift in 2019 and is anticipated to expand to 24 hour per day operations in 2024 as described in the baseline plan in PLN-6098, “Treatment Plan for Irradiated Sodium-Bonded Driver Fuel and the Production of High-Assay Low-Enriched Uranium.” The additional staff have included operational technicians, radiological control technicians, engineers, manipulator repair specialists, and a host of other administrative personnel necessary to support the fuel treatment and HALEU production requirements.

20.3 Process

FFNMM strives to identify and implement enhancements to nuclear material processing approaches. For contact-handled material processing, such enhancements typically focus on developing more efficient processing approaches; incorporating HPI factors; identifying and eliminating unnecessary analyses; leveraging existing equipment and experience where practical; and negotiating efficient material transfer requirements with material recovery and disposal sites. Evaluation of processes for disposition of excess legacy plutonium material has been initiated, but the approach will be dependent on whether near-term plutonium fuel fabrication efforts for the VTR or the Molten Chloride Reactor Experiment (MCRE) will occur.

FFNMM will continue to evaluate existing INL nuclear material inventories to determine what material is likely excess and to develop disposition pathways for such material to the extent practical. Identification of potential nuclear material feedstock gaps for pending programmatic missions will also continue. FFNMM will characterize and evaluate whether existing INL material could meet those needs, attempt to identify, and obtain desired material within the DOE complex to the extent practical, and develop capabilities to supply general-purpose R&D quantities of metal feedstock material. This includes installing a new casting furnace capability in FMF that can produce kilogram quantities of good, enriched uranium metal feedstock from legacy degraded metal pieces.

Production Facilities has continued to utilize the pyrometallurgical equipment originally deployed in FCF during the mid-90s as part of the Integral Fast Reactor (IFR) experiment. Upon cancelation of the IFR project, the majority of the equipment was repurposed for the electrometallurgical treatment (EMT) of the sodium-bonded irradiated driver fuel and blanket elements produced during EBR-II's 30 years of operation. The process was identified in the Environmental Impact Statement (EIS) and corresponding Record of Decision (ROD) issued in September 2000 as the preferred method for treating the irradiated material and has been in operation since that time. The process has undergone several changes recently to accommodate revisions in the safeguards and security policy at the facility as well as integrating the HALEU production process into the traditional treatment system. Additionally, DOE and the State of Idaho agreed to an acceleration of the timeline identified for treatment of the irradiated EBR-II driver fuel inventory to complete prior to December 31, 2028, as opposed to the original deadline of January 1, 2035. This has necessitated a renewed focus on increasing facility and process availability as well as process efficiency.

20.4 Equipment/Tools

FFNMM has developed, installed, and successfully operated multiple custom systems to process the various forms of excess contact-handled nuclear material to meet disposition requirements. This has included the following:

- New HEU processing glovebox
- Multiple systems for dismantlement of legacy fuel assembly configurations
- New thermal vacuum distillation furnace system for separation of metallic sodium from various fuel forms
- New/modified nuclear material containers
- New oxidation furnace system.

Significant legacy equipment was also removed from multiple contact-handled nuclear material facilities to free up valuable floor space to support advanced fuel manufacturing and other programmatic efforts. The primary equipment yet to be developed is associated with disposition of excess legacy plutonium materials. As a minimum, this will include new process equipment for casting scrap oxidation, mechanical disassembly, size reduction, blending, characterization, packaging, and disposal. If VTR or MCRE fuel fabrication do not occur in the near-term, then the new indirect-funded general-purpose plutonium gloveboxes that are currently in development could house this processing equipment. If VTR or MCRE fuel fabrication does occur in the near-term then another new glovebox may need to be developed to house this equipment, assuming new VTR or MCRE gloveboxes do not sufficiently incorporate usable legacy plutonium scrap disposition capabilities. If new plutonium fuel missions effectively fill up space in FMF to the point of displacing the current HEU processing glovebox capabilities, a new smaller HEU breakout glovebox will still need to be installed in FMF, along with a larger glovebox system in ZPPR to maintain the capabilities currently provided in the existing FMF SNM Glovebox.

As mentioned in the Subsection 20.3, Production Facilities continues to operate much of the equipment originally installed in conjunction with the IFR program in the mid-90s. Primary amongst this

equipment are two molten salt electrorefiners used to electrochemically separate the uranium from the bond sodium and fission products generated during irradiation. The remainder of the original equipment includes chopping mechanisms used to size reduce the elements prior to placement in the electrorefiner, as well as high temperature vacuum atmosphere induction furnaces used to distill salt away from the recovered uranium and cast the metallic uranium into ingots of various size. DOE has provided additional funding through the 2018 Plant Health Investment Initiative to support acquisition of a new multi-function furnace to enhance the distillation and uranium casting capabilities. This new remotely operated furnace will increase the process reliability by alleviating the current single point failure associated with the heavily subscribed cathode processor, which is currently used for all salt distillation activities, as well as HALEU production for recasting into the regulus shape. The Plant Health Investments have also funded the establishment of an expanded fuel inspection workstation that will eliminate redundant element handling and has also supported development of a new style electrode assembly intended to increase the operating efficiency of the electrorefiners. DOE is also supporting investments in FCF's material handling equipment to refurbish or replace the aging through wall tele-manipulators, as well as the overhead electro-mechanical manipulators.

20.5 Actions FY-22

- FFNMM contact-handled material management targets for FY-22 include the following:
  - Meet defined program goals. (Tim Hyde, September 30, 2022)
  - Develop conceptual excess Pu scrap disposition process requirements and equipment to begin planning for those future efforts. (Tim Hyde, September 30, 2022)
  - Implement SNM program leadership succession plan. (Tim Hyde, September 30, 2022)
  - Complete the low-level waste (LLW) disposal of the greater than 50 kg of impure UO2 recovered from the Sandia sodium debris bed experiments, freeing up storage space for RD&D customers and retiring this longstanding DOE liability. (This is a full cost recovery effort for the NNSA material owner.) (Tim Hyde, September 30, 2022)
  - Utilize the new casting furnace in the SNM Glovebox to fabricate kilogram quantities of HEU/HALEU feedstock/products for RD&D customers. (Tim Hyde, September 30, 2022)
  - Using research from the MEDE process treatment of sodium-bonded blanket elements, develop a scale-up strategy for NE and EM funding consideration. (Robert Miklos, September 30, 2022)

20.6 Looking Forward (FY-23 and Beyond)

- FFNMM contact-handled material management actions for several years beyond FY-22 include the following primary targets.
  - Evaluate keeping NE owned HEU. Complete processing and packaging of legacy EBR-II/FFTF HEU fuel casting scrap.
  - Negotiate and perform multiple high-mass excess HEU shipments to BWXT facilities for recovery under the DBOT (Down-Blend Offering for Tritium) contract, facilitating reuse of this enriched uranium and freeing up vault storage space for RD&D missions.
  - After completing EBR-II/FFTF casting scrap processing, restart decladding, stabilizing, and repackaging the remaining degraded ZPPR HEU fuel plates to make the metal fuel coupons available for reuse.
  - Negotiate and perform multiple high-mass excess ZPPR HEU metal shipments to Y-12 to make this uranium available as feedstock for new research reactor fuel.
  - Develop the glovebox and processing equipment capabilities necessary to process and package legacy Pu scrap for disposal or potential reuse.
  - Mentor and hire staff as needed (or to the extent funding allows) to ensure sufficient experienced staff remain available to accomplish the remaining equipment development and excess material disposition activities.

- Continue to work with the NNSA Office of Nuclear Material Integration and other DOE programs/sites to evaluate and develop potential end state requirements, disposition paths, equipment capabilities, and regulatory actions needed to ultimately deal with all of MFC's remaining excess nuclear material.

- Production Facilities material management actions for several years beyond FY-22 include the following primary targets.
  - Continue with receipt and treatment of the EBR-II Driver Fuel.
  - Prepare FCF for the transition to 24-hour per day operations.
  - Continue with integrated HALEU production in FCF as well as HFEF.
  - Configure the MK-V electrorefiner for treatment of EBR-II driver fuel.
  - Continue with the refinement of strategies and subsequent disposition of cladding hulls resulting from the electrochemical treatment process.
  - Implement a treatment method to address the inventory of non-candidate material.
  - Support scale-up research into innovative pyrochemical separations concepts and development of related waste form associated with advanced fuel cycle concepts.
  - Installation and operation of a Multi-Function Furnace.
  - Installation and operation of an integrated bottle inspection station.

21. RADIOLOGICAL WASTE MANAGEMENT

21.1 Legacy Waste Management

21.1.1 A Look Back

DOE-NE is responsible for the storage, management, and disposition of a number of legacy waste and SNF inventories including irradiated sodium-bonded uranium-based material from the EBR-II reactor, sodium-contaminated contact-handled and remote-handled mixed transuranic waste (MTRU), remote-handled mixed low-level waste (MLLW), CH-MLLW, EBR-II driver SNF and blanket material, and ATR SNF. Collectively these items are all managed under the INL Site Treatment Plan (STP) as directed by the consent order between DOE and the IDEQ, or under the 1995 Idaho Settlement Agreement and subsequent associated agreements. All legacy liabilities and associated disposition costs are detailed in LST-1149, "INL Other Legacy Environmental Liabilities Register," current revision.

Additional legacy waste management regulatory drivers include DOE O 435.1, "Radioactive Waste Manual," which addresses management and disposition of LLW, transuranic (TRU) waste, and high-level waste (HLW) and RCRA which establishes requirements for managing mixed waste (waste that is both hazardous and radioactive) and non-rad. hazardous waste.

MFC Operations has refined its legacy waste management strategy since 2015 to establish pathways for off-site treatment and disposition; develop a multi-year, sustainable funding strategy; and maintain core on-site capabilities for current compliance (STP) and future needs.

Reducing MFC legacy waste liabilities over the last 5 years has seen an increase in visibility and funding priority as compared to prior years. This is critical as the MFC mission continues to expand and shows our commitment to INL stakeholders that the Laboratory is committed to reducing its environmental liabilities and legacy waste inventories.

Legacy waste is defined as waste that was existing at INL contract transition in 2005 and has no responsible program for disposition. Legacy waste is further defined as waste generated during BEA contract and prior to the established waste generator service center recovery model that has no existing program responsible for funding disposition.

Table 10 below details a summary of legacy waste reduction progress since 2015.

Table 10. Summary of legacy waste reduction progress since 2015 (not including SNF).

Waste Stream	Facility Location	Updated Inventory Reference	Regulatory Driver
RH-LLW	RSWF, HFEF, and FCF	LST-1149	DOE O 435.1
RH Mixed LLW	RSWF and SSB (RWDP Backlog)	LST-1149 and INL Site Treatment Plan	INL STP
CH Mixed LLW	SSB (SCMS Backlog)	LST-1149 and INL Site Treatment Plan	INL STP
RH-TRU Waste[a]	RSWF, HFEF, FCF, and AL	LST-1149	DOE O 435.1
CH-TRU Waste[b]	FMF and AL	LST-1149	DOE O 435.1
ZPPR Na Plates	Disposition of this inventory occurred in FY-21 and the liability has been eliminated	Inventory Eliminated	DOE O 435.1
Lithium Hydride (Na-cont.)	Disposition of this inventory occurred in FY-19 and the liability has been eliminated	Inventory Eliminated	INL STP
ZPPR Calandria Tubes (Na-cont.)	Disposition of this inventory occurred in FY-19 and the liability has been eliminated	Inventory Eliminated	DOE O 435.1

Waste Stream	Facility Location	Updated Inventory Reference	Regulatory Driver
Fermi Drums	Disposition of this inventory occurred in FY-18 and the liability has been eliminated	Inventory Eliminated	DOE O 435.1
Tin Bismuth (Na-cont.)	Disposition of this inventory occurred in FY-18 and the liability has been eliminated	Inventory Eliminated	INL STP
a. Ship to EM Contractor - INTEC for RH-TRU WIPP Certification. Ongoing waste stream. b. Ship to EM Contractor - AMWTP for CH-TRU WIPP Certification. Ongoing waste stream.			

21.1.2 People

Performance of this waste management area is strong, however, the level of expertise in waste management and in particular treatment of reactive waste streams needs improvement. Attrition has reduced the number of personnel with previous experience. Hiring activities in this area has been focused on previous experience and educational backgrounds.

Legacy waste is actively managed by the residing facility with disposition support provided by the Production Facilities Division Waste Management Integration group, Treatment, Storage, and Disposal Facilities (TSDF) operations, dedicated Project Management staff, and WGS. Each of these organizations maintain qualified personnel to support waste management needs as applicable.

Since 2017 there have been new areas of training development that support MFCs TRU program and RHLLW Facility. Specifically, the WEO qualification which was created to be a “like-for-like” visual examination expert (VEE) qualification as required in TRU waste certified programs under the Central Characterization Project (CCP). This WEO qualification must be carried by anyone who characterizes or packages TRU waste. The qualification ensures individuals are knowledgeable of the Waste Isolation Pilot Plant (WIPP) waste acceptance criteria (WAC), and WEOs are provided quarterly refresher training where lessons learned are also shared. As part of startup of the RHLLW Disposal Facility, an FDS was hired and new training/qualification was developed that ensures the FDS is knowledgeable in DOE O 435.1 LLW requirements, facility WAC, and facility performance assessment requirements.

Training and qualifications related to Sodium (Na) and Sodium Potassium (NaK) treatment capabilities are maintained by TSDF operations personnel. Since 2018, Production Facilities Division has hired six operators to cross-qualify at TSDF, Radioactive Scrap and Waste Facility (RSWF), and the RHLLW Disposal Facility. This cross-qualification provides operational flexibility where resources can be shifted to support operations as needed, however Na and NaK treatment experience and expertise has been significantly reduced. TSDF has lost much of this expertise due to personnel attrition. Production Facilities management utilizes off-site Na and NaK specific training for new staff to bridge the gap in expertise and experience as part of its training program. Maintaining qualified and experienced staff is critical to supporting not only STP activities but also treatment of Na and NaK waste generated by current and future MFC R&D activities. Future programs are currently evaluating the use of Na and NaK and research activities in FCF and TREAT will be generating new quantities of Na and NaK.

21.1.3 Process

Legacy Waste Management processes are strong. This is due to a number of factors which include the following:

- Strong coordination between MFC waste generating facilities (Bi-weekly waste management meetings)
- Implementation and reinforcement of HPI tools—in particular, a *questioning attitude* which is essential when dealing with “unknowns” related to legacy waste streams

- Current MFC capabilities; and partnerships with off-site entities.

With sustained, dedicated investment funding, MFC will continue to make progress in reducing its legacy waste liabilities. MFC has established a waste management program that ensures current waste generating activities have a path for future disposition which also avoids adding to the INL STP. All newly generated reactive waste must be treated within 1-year to avoid adding to the STP.

The preferred treatment approach for some of the more challenging waste streams is identifying off-site treatment capabilities from commercial vendors whenever possible. PLN-4588, "Disposition Plan for Current and Future Reactives and Other Environmental Liabilities," has been revised to reflect the strategy for establishing a path for off-site treatment capabilities for the identified inventories, with the potential for application against future reactive waste or materials on a case-by-case basis. Identifying off-site treatment as the preferred approach considered several factors, including how quickly the respective inventories could be dispositioned, realizing efficiencies by focusing on more than one off-site treatment provider, total life-cycle cost savings, and INL capabilities associated with disposition that should be retained, expanded, or retired with respect to the enduring mission of the INL. This plan also provides the key activities, preliminary cost estimates, and high-level schedule that are required to implement the preferred approach. The MFC FYS reflects this approach and funding profile to support.

MFC has recently partnered with Veolia to demonstrate a new treatment approach to deactivate elemental sodium using its GeoMelt In-Container Vitrification (ICV) process. This has been successfully applied to the treatment of the Fermi Drum inventory, ZPPR Na Plates, and Calandria Tubes. In addition, BEA, using EM funding, is executing a proof-of-concept demonstration with the objective of developing and demonstrating a prototype system to improve the Remote Waste Disposition Project (RWDP) liner retrieval process at RSWF. This system has been designed to provide a size-reduced liner, thereby, improving the efficiency of downstream waste handling and processing/disposition. The proof-of concept demonstration successfully occurred in FY-21 and included a coupled demonstration of the advanced liner retrieval system and GeoMelt treatment. It is anticipated that this alternative RWDP liner disposition approach will significantly reduce cost and schedule associated with the INL STP.

Incorporating innovation where possible is critical. Thus, engagement with outside entities such as active participation with Energy Facilities Contractors Group (EFCOG) Waste Management Groups, DOE National TRU Program Users Group (NTP), as well as engagement with international consortia and institutions such as the European Commission funded THERAMIN and PREDIS is vital to this legacy waste management strategy to leverage and understand industry technology advances in managing challenging waste streams.

One area that will require sustained investment is establishing a future CCP TRU Waste Certification Program. MFC will continue to utilize the EM contractor at Advanced Mixed Waste Treatment Project (AMWTP) until the mission can no longer support receipt of BEA contact-handled transuranic waste (CH-TRU) due to downsizing operations to support plant closure. This is anticipated to occur in the 2026 timeframe.

MFC will need to continue to support development of an HLW program for management of cladding hulls and metal waste forms associated with past and current EMT of EBR-II driver SNF and blanket materials which have historically been managed as in-process materials. Included in this evaluation is continued analysis of the revised DOE interpretation of the statutory term of HLW which could provide alternative disposal pathways for candidate materials (i.e., cladding hulls and/or MWF). Engagement with NE-ID counterparts and appropriate EM-HQs program leadership will be necessary to continue to explore applicability of these candidate materials against the revised statutory interpretation.

21.1.4 Equipment/Tools

Equipment and tools supporting legacy waste management are acceptable with areas of needed improvement. Inventory tracking of legacy waste has seen significant improvement due to new databases being utilized at MFC. Those include the Waste Item Characterization Database (WICD) which is primarily used for tracking TRU waste items and is currently being expanded to track LLW items as well.

In addition, Searchable Liner Online (SEALION) was created to track the physical configuration, radiological data (e.g., source term, transuranic content, fissile content, and direct gamma radiation reading), RCRA characterization data, contents descriptions, and a variety of other legacy waste management data for RSWF. This database has seen expanded use in other MFC waste storage facilities for tracking legacy waste inventories.

Other areas of unique waste management capabilities at MFC include SCMS which provides capabilities that are critical to this legacy waste management strategy. There are two distinct programmatic and regulatory-compliance functions. The first is a radiological control work tent that provides MFC the capability to open containers of radioactive waste for inspection and, usually, subsequent waste management activities such as sizing or repackaging. SCMS also provides permitted mixed waste treatment. The SCMS employs a water-wash (reaction) vessel, caustic-carbonation system, neutralization, and stabilization unit. Treatment technologies permitted at SCMS include deactivation, water-reaction, neutralization, open/melt/drain, repackaging, and stabilization capabilities. MFC will need to retain these on-site waste characterization and treatment capabilities to ensure support for future reactor programs and R&D activities.

As reactor programs and nuclear R&D activities continue to expand at MFC, MFC will need a dedicated Waste Management Facility. This has been captured in the 5-year investment strategy as the Waste and Materials Management Facility. Required capabilities include:

- Sorting and segregation
- Advanced characterization systems
- Na and NaK treatment capabilities
- Headspace gas sampling for TRU waste containers
- Storage of contact-handled and remote-handled wastes pending off-site disposition
- TRUPACT-II loading capability for shipping TRU waste to the WIPP.

Benefits of a dedicated Waste Management Facility will provide safe and secure storage of radioactive wastes, cost reduction opportunities by efficiently handling and packaging waste, and risk reduction of unnecessary waste handling which also aligns with MFC's as low as reasonably achievable (ALARA) principles.

21.1.5 Actions FY-22

RWDP Backlog – Advanced Retrieval Project

- Complete Phase II Advanced Retrieval Project prototype optimization to support future RSWF RH-MLLW liner retrieval operations. (Robert Miklos, September 30, 2022)
- Continue RWDP backlog reduction activities (retrieve, package, ship) for GeoMelt. (Robert Miklos, September 30, 2022)

Legacy Cargo Containers

- Continue progress preparing waste from cargos and ship off-site for disposition. (Robert Miklos, September 30, 2022)

Transuranic Waste

- Continue leveraging EM contractor TRU certification capabilities. (Robert Miklos, September 30, 2022)
- Continue efforts to characterize and package legacy RH-TRU waste from HFEF and FCF Hot Cells. (Robert Miklos, September 30, 2022)

Remote-Handled Low-Level Waste

- Retrieve and ship 14 RH-LLW liners from RSWF to the RHLLW Disposal Facility in FY-22. (Robert Miklos, September 30, 2022)

High-Level Waste

- Support applicability and implementation of an HLW Program. (Robert Miklos, September 30, 2022)

21.1.6 Looking Forward (FY-23 and Beyond)

High-Level Waste

- Support HLW program maturity.

Transuranic Waste

- Continue leveraging EM contractor TRU certification capabilities
- Continue efforts to characterize and package legacy RH-TRU waste from HFEF and FCF Hot Cells.

SCMS Backlog – Site Treatment Plan Milestone

- Support treatment activities for the $6m^3$ milestone. To be completed by the end of FY-24.

RWDP Backlog – Advanced Retrieval Project

- Continue RWDP backlog reduction activities (retrieve, package, ship) for GeoMelt.

Remote-Handled Low-Level Waste

- Continue to retrieve and ship RH-LLW liners from RSWF to the RHLLW Disposal Facility and work off the RH-LLW backlog at RSWF.

21.2 Newly Generated Waste

21.2.1 A Look Back

MFC manages various newly generated radioactive waste streams as part of its nuclear energy research and development (R&D) mission. MFC waste management processes and requirements ensure environmental stewardship responsibility and compliance with DOE O 435.1 requirements, which address management and disposition of LLW, TRU waste, and HLW, and in compliance with the RCRA which establishes requirements for managing mixed waste (waste that is both hazardous and radioactive) and non-radioactive hazardous waste. The MFC Production Facilities Division in partnership with the INL Waste Management Program (WMP) and WGS, has developed a mature waste management program that provides treatment and disposal paths for MFCs diverse waste streams, and evaluates alternative paths for the more challenging radioactive wastes associated with MFCs mission.

Since 2015, MFC waste programs have incorporated several improvements, specifically in the areas of cost recovery models, TRU program development which aligns with establishing a future MFC WIPP certified program, and enhanced waste generator training. In addition, waste programs have managed the newly generated waste streams to ensure expedient off-site treatment and disposal pathways. This avoids adding to the INL STP as directed by the consent order between DOE and the IDEQ or creating new legacy waste environmental liabilities.

21.2.2 People

Performance in this area is considered acceptable with some areas needing improvement. Since 2017, new areas of training have been developed to enhance the performance of MFC's TRU waste program, RHLLW Disposal Facility operations, and waste transfer activities. Specifically, the WEO qualification was created and implemented as a comparable VEE qualification for certified TRU waste programs under the national CCP standard. This WEO qualification must be held by anyone who characterizes or

packages TRU waste to ensure the waste will be acceptable for disposal at the WIPP. The qualification ensures individuals are knowledgeable of the WIPP WAC, and WEOs are provided quarterly refresher training where lessons learned are also shared. As part of startup of the RHLLW Disposal Facility, an FDS was hired, and a new training/qualification program was developed that ensures the FDS is knowledgeable in DOE O 435.1 LLW requirements, facility WAC, and facility performance assessment requirements.

Training and qualifications related to Na and NaK waste treatment capabilities are maintained by TSDF operations personnel. Since 2018, the Production Facilities Division has hired 6-operators to cross-qualify at TSDF, RSWF, and the RHLLW Disposal Facility. This cross-qualification provides operational flexibility where resources can be shifted to support operations as needed. However, Na and NaK waste treatment experience and expertise has been significantly reduced due to personnel attrition. Production Facilities management utilizes off-site Na and NaK specific training for new staff to bridge the gap in expertise and experience as part of its training program. Maintaining qualified and experienced staff is critical to supporting treatment of Na and NaK waste generated by current and future MFC R&D activities. While off-site treatment may be the preferred option for applicable reactive waste streams, MFC will need to maintain the capability/resources of treating reactive wastes on-site.

The INL WMP subcontracts with Atkins Nuclear Secured, LLC to provide waste management services and support to INL facilities. This INL support group is known as WGS. Atkins along with the INL WMP have an established training and qualification program for their WGS representatives which ensures individuals are qualified and proficient to provide guidance on the proper characterization and compliant packaging and shipping requirements of waste containers from LLW, MLLW, and TRU waste streams for disposal.

In FY-21, The INL Office of Nuclear Assurance (ONA) conducted a Waste Management assessment with a focus on radioactive waste handling and storage, waste characterization and classification, problem identification and resolution, and training. Areas of needed improvement identified by the assessment team included the following:

- Remedy the training gaps amongst work groups and lack of training in LLW and MLLW
- Improve facility procedure (lack of defined waste management R2A2s, discrepancies, etc.)
- Improve Conduct of Operations performance
- Improve issues management reporting.

In response to these findings, a Waste Management Improvement working group was formed and tasked to take the assessment and its findings and learn from the assessment ways to improve MFC waste management processes and performance, and to ensure MFC waste generators have the knowledge and tools necessary to be successful and reduce/eliminate errors. This working group will continue to support this improvement strategy throughout FY-22.

21.2.3 Process

Newly Generated Waste Management processes are strong. This is due to a number of factors which include the following:

- Strong coordination between MFC waste generating facilities that include holding bi-weekly waste planning meetings
- Implementation and reinforcement of HPI tools—in particular, actively employing a *questioning attitude,* which is essential when dealing with “unknowns” related to newly generated waste streams
- Current MFC capabilities, and partnerships with off-site entities.

MFC in conjunction with the INL WMP and WGS has established a waste management program that ensures current waste generating activities have a path for future disposition which also avoids adding to the INL STP and INLs environmental liabilities.

Historically, funding of waste management characterization and disposition activities was provided by the generating facility, project, or program. This became problematic when newly generated wastes were not dispositioned within the year they were generated, and projects/programs no longer had the funding required to proceed with managing their wastes from cradle-to-grave. This led to an accumulation of legacy wastes in MFC R&D facilities that is still being managed to this day. To remedy this, the INL WMP created a cost recovery model for MFC. This waste cost recovery program provides a funding mechanism for disposition of all newly generated hazardous, radioactive, and mixed waste. Specifically, the WMP administers two service centers that collect revenue from MFC programs and projects to pay waste disposition costs and programmatic elements. The INL WGS service center collects revenue and pays disposition costs for waste with a readily available disposition path and establishes disposition paths for new waste streams prior to generation. The INL RH Waste Service Center collects revenue for newly generated RH waste that are dispositioned at the INL RHLLW Disposal Facility or will be dispositioned when the backlog at WIPP is eliminated.

MFC has recently partnered with Veolia to demonstrate a new treatment approach to deactivate problematic elemental sodium and other reactive waste using its GeoMelt ICV process. This process has been successfully applied to several legacy waste streams and will be added to the suite of on-site and off-site capabilities for treating newly generated reactive wastes. This process not only deactivates sodium and other reactives using an innovative approach but can accept much more complex physical configurations as feedstock than traditional treatment technologies. The robust nature of the process requires much less head end processing, resulting in lower worker risk associated with chemical hazards and radiological exposure. The process provides a strong addition to the suite portfolio of waste treatment technologies that will allow current and future R&D projects more flexibility in planning and implementing more innovative R&D approaches. Establishing a wide spectrum of treatment technologies provides principal investigators with one of the major tools needed to get research concepts through NEPA and other approval processes. Meeting stakeholder expectations in treating waste is one of the key factors in moving research from conceptual and bench scale processes into larger scale applications such as test beds and production facilities.

Incorporating innovation, where possible, is critical. Thus, engagement with outside entities such as active participation with EFCOG Waste Management Groups, DOE NTP, as well as engagement with international consortia and institutions such as the European Commission funded THERAMIN and PREDIS is vital to the MFC waste management strategy to leverage and understand emerging industry technology advances in managing challenging waste streams. Innovative technologies will also support newly generated waste disposition paths and a wider spectrum of research activities.

One area that will require continued investment, is establishing a future CCP TRU Waste Certification Program. MFC will continue to utilize the EM contractor at AMWTP until the mission can no longer support receipt of BEA CH-TRU waste due to downsizing operations to support plant closure. This is anticipated to occur in the 2026 timeframe.

Looking at FY-22 and beyond, MFC will also need to continue to support development of a HLW program for management of cladding hulls and metal waste forms associated with past and current EMT of EBR-II driver SNF and blanket materials which have historically been managed as in-process materials. Included in this evaluation is continued analysis of the revised DOE interpretation of the statutory term of HLW which could provide alternative disposal pathways for candidate materials (i.e., cladding hulls and/or MWF). Other initiatives, such as HALEU, include fuel reprocessing that will generate HLW as the processes emerge from bench scale to full scale operations. Engagement with NE-ID counterparts and appropriate EM-HQs program leadership will be necessary as waste management continues to explore the applicability of these candidate materials against the revised statutory interpretation.

21.2.4 Equipment/Tools

Equipment and tools supporting newly generated waste management are acceptable, with areas of needed improvement. Inventory tracking of radioactive wastes utilizes the Integrated Waste Tracking System (IWTS). The system is used to track the life cycle of all containerized waste through generation, storage, treatment, processing, and ultimate disposition. IWTS is an NQA-1 Quality Level 2 system and is used for a variety of waste tracking activities in addition to waste characterization, waste stream profiling, waste disposition, compliance with WAC for on and off-site TSDFs, annual and environmental reporting, RCRA management units, and other activities. IWTS provides all information necessary for facilities to properly manage and demonstrate inventory compliance with RCRA regulations, DOE O 435.1, state permits, and facility-specific requirements. An improvement MFC has incorporated for tracking TRU wastes is the WICD. This software captures the pertinent RCRA characterization data and cost charging data for individual waste items or packages as they are generated; after which, this data can be reported and summarized to the final waste container for certification and uploading to IWTS. WICD was initially developed for TRU waste generating facilities and has since been expanded to include LLW.

Other areas of unique waste management capabilities at MFC include SCMS which provides capabilities that are critical to this waste management strategy. There are two distinct programmatic and regulatory-compliance functions. The first is a radiological control work tent that provides MFC the capability to open containers of radioactive waste for inspection and, usually, subsequent waste management activities such as sizing or repackaging. SCMS also provides permitted mixed waste treatment. The SCMS employs a water-wash (reaction) vessel, caustic-carbonation system, neutralization, and stabilization unit. Treatment technologies permitted at SCMS include deactivation, water-reaction, neutralization, open/melt/drain, repackaging, and stabilization capabilities. MFC will need to retain these on-site waste characterization and treatment portfolio capabilities to support future reactor programs and R&D activities.

The preferred treatment approach for some of the more challenging waste streams is identifying off-site treatment capabilities from commercial vendors whenever possible. In some cases, the limiting factors effecting this strategy are sustained funding to maintain off-site capability and shipping constraints. Several factors are considered, including how quickly the respective inventories could be dispositioned, realizing efficiencies by focusing on more than one off-site treatment provider, total lifecycle cost savings, and current INL capabilities.

As reactor programs and nuclear R&D activities continue to expand at MFC, MFC will need a dedicated Waste Management Facility. This has been captured in the 5-year investment strategy as the Waste and Materials Management Facility. Required capabilities include:

- Sorting and segregation
- Advanced characterization systems
- Na and NaK treatment capabilities
- Headspace gas sampling for TRU waste containers
- Storage of contact-handled and remote-handled wastes pending off-site disposition
- TRUPACT-II loading capability for shipping TRU waste to the WIPP.

Benefits of a dedicated Waste Management Facility will provide safe and secure storage of radioactive wastes, cost reduction opportunities by efficiently handling and packaging waste, and risk reduction of unnecessary waste handling which also aligns with MFCs ALARA principles.

MFC is currently evaluating a new thermal treatment pyrolysis system which will remove certain hazardous characteristics in CH-TRU wastes including destruction of Oxidizers, neutralization, or conversion of corrosives (acids and bases) into non-corrosive compounds, and conversion of Reactive materials to non-reactive forms. This would ensure any hazardous constituents are ultimately removed from the waste thereby mitigating any potential unknown risks associated with R&D and TRU waste packaging activities.

21.2.5 Actions FY-22

- Develop a documented strategy to perform routine inspections at the MFC-793C facility of random LLW bags generated by MFC nuclear facilities. This strategy shall outline waste bag selection criteria, and inspection criteria that would ensure no prohibitive items are in the waste and waste constituents align with waste documentation. (Robert Miklos, May 31, 2022)

R&D Equipment within Facilities

- Implement the developed pilot method to ensure sufficient funding for equipment disposition is retained in the event of program termination. (Robert Miklos, June 30, 2022)

Transuranic Waste

- Establish TRU Waste Certification support for CH-TRU and RH-TRU waste streams with the new ICP contractor. (Robert Miklos, June 30, 2022)
- Complete Universal Drum Assay Scanning System (UDASS) system installation develop training and operational procedures and commence screening. (Robert Miklos, September 30, 2022)
- Complete Pyrolysis Lab Scale Testing to evaluate technology feasibility for CH-TRU waste streams. (Robert Miklos, June 30, 2022)

High-Level Waste

- Support implementation of the HLW Program. (Robert Miklos, September 30, 2022)

Consolidated Waste Management and Cask Management Facility

- Develop implementation plan in MFC FYS. (Robert Miklos, February 28, 2022)

21.2.6 Looking Forward (FY-23 and Beyond)

Consolidated Waste Management and Cask Management Facility

- Upgrade SCMS to a Hazard Category 2 Nuclear Facility.
- D&D legacy EBR-II support equipment.
- PDSA and SAR development, readiness activities, etc.

22. PROJECT MANAGEMENT

22.1 Project Planning

22.1.1 A Look Back

MFC Project Management has experienced significant growth over the past several years with an increase in demand for projects requiring coverage. The increase is a result from an influx in funding for major Plant Health projects, expanding RD&D Capability Sustainment efforts, core investments in supporting infrastructure, and a concerted effort to improve the management of projects at MFC. Construction procurement volume increased nearly 325% between 2016 and 2021. Similarly, RD&D activities at MFC have also increased significantly over the past 5 years adding additional demand to MFC's research infrastructure, facility operations, and research staffing. The MFC Project Management division was established in FY-18 with a focus on improving project management oversight, improving project delivery, and providing transparency for project reporting at MFC. In order to establish core principles and process in the new division, the initial division focus was placed on construction projects. To that end, a monthly project reporting and review process was established for major plant health projects, additional project management resources were obtained, and improvements have been made for the MFC Project Management division structure and integration with construction management.

22.1.2 People

INL and MFC continue to have a need for new project manager resources and personnel as demand increases and normal attrition occurs. However, with new hires and new project managers to INL the need for improved training, increased mentoring, and efforts to address attrition will continue to be a challenge to ensure personnel resources are in place to support the expanding demand. An understanding of the complexities of appropriate application of project management principles to MFC work scope is critical, particularly considering the wide breadth of facilities, support systems, research programs, and requirements.

22.1.3 Process

The INL Project Management Office has established the high-level management system/processes for capital asset project management, as required by DOE O 413.3B, "Program and Project Management for the Acquisition of Capital Assets." Project development and management is guided by INL procedures and guidelines that align with industry standards and best practices. Tailoring project requirements to smaller projects exists; however, the tailoring process is still unclear for many project managers. Appropriate tailoring of requirements for small capital asset projects, operating-funded projects/activities, and RD&D activities is critical to effectively manage these projects/activities while ensuring execution is cost-effective and expeditious. Project planning can be very dynamic for each set of circumstances depending on the scope, size, location, and complexity of the project or activity. This requires a project manager who is actively engaged and has a good base understanding of the requirements necessary to ensure all aspects of a project are covered during the planning phase and carried through execution.

22.1.4 Equipment/Tools/Training

While there is a suite of tools available to project managers during the planning phase there is still a need for improvement in this area. New tools and training have been identified as an area for improvement needed for project management staff to better aid the project planning process, provide clarity on requirements, and improve the current systems/tools that are utilized. A project planning checklist aid is currently being utilized that, if formalized, could help the planning process. Additional areas for improved training relevant to MFC have also been identified by the MFC project management division. Additionally, new project managers have also expressed a need for improved training/mentoring and clear understanding of R2A2s, which can vary significantly depending upon the type of project/activity being supported.

An integrated project team (IPT) is a crucial tool that enables project execution success and should be established very early in the planning process. Appropriately trained support staff such as facility and engineering professionals, construction management, project controls analysts (PCAs), procurement specialists, and cost estimators are critical members of the IPT. The IPT ensures project requirements are identified early in order to establish realistic baseline scope, schedules, and estimated costs.

22.1.5 Actions FY-22

- Formalize the MFC Project Manager Subcontractor Work Checklist to ensure all necessary prerequisites are complete prior to starting a new subcontract requisition, to support incorporation of lessons learned/corrective actions into the planning process, and to aid in understanding of high-level requirements. (Brady Orchard, March 31, 2022)
- Establish monthly project review meeting for INL indirect-funded investments at MFC. (Brady Orchard, June 30, 2022)
- Support formal establishment of line-item capital project for the NRIC Laboratory for Operations and Testing in the United States (LOTUS). (Brady Orchard, March 31, 2022)
- Provide project management support to the Molten Chloride Reactor Experiment (MCRE) project, with a senior-level program manager to aid in ensuring coordination of MFC resources, reporting, and execution of work scope. (Brady Orchard, March 31, 2022)
- Support incorporation of MFC supporting infrastructure investment needs into the "MFC Five-Year Strategic Investment Plan." (Brady Orchard, March 31, 2022)
- Re-assess home organization-work organization relationship of project managers assigned to the MFC Projects Division. (Brady Orchard, June 30, 2022)

22.1.6 Looking Forward (FY-23 and Beyond)

- Continue to expand monthly project reviews to those beyond plant health-funded projects to expand learning opportunities and provide performance feedback on a broader group of projects/activities at MFC.
- Establish active Project Manager engagement in advanced planning of critical work scope to ensure realistic scope, budget, and schedule expectations are established upfront and that facility/program requirements are met.
- Develop expectations and process to ensure RD&D estimates appropriately reflect resources (personnel and infrastructure) required to support the work scope, the facility(ies) can support the work scope, and that assumptions and strategies are appropriately vetted by all Stakeholders.
- Replace the vendor data system with a new management system that is integrated with AS/iBuy, EDMS, and others
    - The current vendor data system is awkward, outdated, and not user friendly. This antiquated system is only mastered by a few people, is difficult to access and navigate, and is extremely outdated.
- Develop targeted training for MFC project management staff to address specific nuances of nuclear facilities, org structure, POCs, improving competency and certification of staff.
- Coordinate with training department to formalize required reads, lessons learned, etc.
- Implement project forecasting for MFC
    - Increase the early visibility of projects in the pipeline to provide time for pre-award planning and staffing.

22.2 Project Execution

22.2.1 A Look Back

Implementation of project management principles at MFC has consistently evolved in a positive direction over the last several years. This positive trend is reflected in successful completion of INL's first line-item capital construction project, the RHLLW Disposal Project, start of SPL construction, and execution of plant health investments and other infrastructure improvement projects at MFC. Projects are executed at MFC in accordance with applicable project management system procedures/processes, which have continued to improve and evolve at the Laboratory and field level. With the establishment of the MFC Projects Division, additional structure has been established for plant health projects, line-item capital construction projects, and key supporting infrastructure investments. Improvement and growth opportunities remain to ensure ongoing investments, regardless of funding source/type, are aggregated, consistently managed, and incorporated/prioritized as part of a risk-based set of projects in the MFC portfolio.

22.2.2 People

The project management staff at MFC comprises people with strong work ethic and integrity. Project Manager experience ranges from newly hired to very seasoned individuals with diverse experience. Each contributes significantly to project success across the MFC and INL. Project managers work as a team to provide lessons learned and new ways to approach problems. Project managers also work in close coordination with numerous work groups including engineering, environmental, safety, quality, researchers, management, crafts, and construction personnel. The relationship between the Project Manager, the CFR, and the FM in the project execution phase is critical to success.

22.2.3 Process

A clearly defined scope is not always obvious for all projects/activities based on the nature of the activity/system, the various R&D capabilities that exist, and the age of MFC's facilities. A consistent approach for defining the scope of a project is needed to ensure projects are appropriately defined and to prevent scope creep. In recognition of the uncertainties that exist with certain scopes of work, these uncertainties need to be documented during initial project planning and accounted for when considering funding requirements/profiles. Additionally, the use of a Project Execution Plan (PEP) is not consistent or often utilized beyond formal capital asset projects. Another area for improvement includes estimates and advertising of rough-order-of-magnitude (ROM) estimates before the scope is well defined. Pre-planning to define scope, develop appropriate cost estimates, and ensure requirements are well understood could help better manage a budget, as opposed to managing to a funding amount. Development of a portfolio of appropriately planned MFC projects, including projects not "owned" by MFC, would enable leadership to balance resources across all activities, identify "peaks and valleys," aid in prioritizing activities, and support more effective internal (project staffing, engineering resources, support personnel, etc.) and external (union and subcontractor) communication of needs increasing the overall probability of successful execution.

22.2.4 Equipment/Tools/Training

The IRPT tool was established at MFC in recent years and while it helps to better understand overall resource needs at MFC, it is not well integrated with the other project management and Earned Value Management System (EVMS) processes required by the laboratory. Additional tools for traditional project execution could greatly improve the project management organization at MFC. There are several new resources and tools being explored which are discussed in other chapters.

22.2.5 Actions FY-22

- Establish quarterly meetings to forecast upcoming MFC projects including resource forecasting and potential conflict/issues resolution. Consider use of procurement portal for upcoming projects

resulting from these meetings. (Brady Orchard, June 30, 2022)

- Establish formal Work Organization relationship between Construction Management and MFC Projects Division. (Brady Orchard, June 30, 2022)

22.2.6 Looking Forward (FY-23 and Beyond)

- Continue to improve integration of Project Management, Construction, Engineering, and Facility staff.
  - Co-locate Construction Management and Project Management Staff
  - Expand use of Project Engineer role beyond large capital projects
  - Review construction and project management processes to ensure consistency in R2A2s and hand-off/interaction with facility management
  - Improve R2A2s and expectations for the Project Manager and CFR roles to improve communication lines/expectations, improve Project Manager field oversight, and improve construction work oversight
  - All personnel at MFC performing a Project Manager function have formal line management relationship with MFC Projects Division to ensure consistency in application of processes and communication and improvement.
- Evaluate improving various tools used by project managers
  - The interface between IRPT and other EVMS reporting tools (P6, Cobra, etc.)
  - iBuy material tracking process
  - iBuy requisition status updates
  - Replacement of the Vendor Data System
  - Define requirements for use of formal PEP.
- Improve new hire and continuing education process
  - OJT checklist
  - List of important contacts
  - Mentoring
  - Recurring learning meetings for MFC-specific training, lessons learned, information sharing.
- Improve the establishment of and adherence to budgets vs monitoring of funding to support effective use of EVMS principles.
- Evaluate changes to the procurement process to address more contracts as best value and not just low bid by integrating contract specialist (CS), Project Manager, and CFR.
- Improve subcontractors short range schedule reporting – consider use of a standardized format.
- All key resources needed to successfully enable the MFC project portfolio are aligned and coordinated through the MFC Projects Division. Clear R2A2s established with support organizations and interfaces documented.
- External assessment of MFC Projects Division structure, processes, and performance.

22.3 Project Controls & Reporting

22.3.1 A Look Back

Improvements on reporting methodology to demonstrate work accomplishment, development of baselines that support effective resource management, allocation of funding, compliance with established requirements, and the ability to support various reporting requests have been important objectives at MFC

over the past several years. The MFC Projects Division was established in part to place a greater focus on Plant Health investments, and to establish a more consistent and standardized process for reporting. Over the past several years, project reporting has been better aligned to provide visibility into individual project performance. This alignment has considered INL's EVMS guidelines and principles, as well as INL policies, procedures, and customer needs, with requirements tailored based on the size and complexity of the project. The demand for application of sound project management principles, including project controls, in the execution of work scope at MFC has increased dramatically over the years commensurate with increased direct and indirect investments in MFC's unique nuclear RD&D infrastructure.

22.3.2 People

Project controls support includes PFCs and PCAs. While Control Account Managers and Project Managers are not part of the project controls group, they are integral to the overall project management process. Project controls personnel support implementation of work scope to ensure compliance with applicable EVMS standards and principles, contractual requirements, lab procedures, DOE orders, and other driving regulations. Responsibilities include:

- Support of scope definition, development of the work breakdown structure (WBS), identification and mitigation of risks, support submittal of cost estimates and funding determinations, implementation of the following: scope, schedule, and budget for baselines
- Maintain proper change control through the formal Baseline Change Proposal (BCP) process, monitor performance, record status, monitor the following: variances, trends, forecasts, and identify corrective actions as necessary
- Collect and perform comprehensive analysis of project performance, variances, cost, and schedule, and provide the analysis to management and stakeholders
- Provide analysis and guidance to Project Managers and Control Account Managers regarding subcontracts, schedule of values, change orders, and other contracting provisions.

Based on the significant increase in workload and project complexity over the past 5 years, the project controls workforce is strained. The increased workload has been largely absorbed with minimal changes in staffing. However, the additional projected volume of new work on the horizon will require additional project controls personnel to meet the growing demands in support of the MFC mission.

There are numerous procedures and guides for performing the responsibilities of a PCA/PFCs. These documents provide expectations, regulations, requirements, and guidance for processing and implementing required actions; however, expansion of OJT training and qualification represents an opportunity for improvement due to the magnitude of applicable requirements and the current/forecast work volume and staffing levels.

22.3.3 Processes

Sound application of project controls, particularly for capital asset projects, is required to maintain compliance with specific DOE orders, standards, procedures, and guides to ensure the lab maintains its EVMS certification. Processes and procedures have been developed to help ensure compliance to the specific orders and standards. The overall process is effective and efficient. Heightened awareness continues to expand regarding applicability of requirements and options, particularly associated with implementation of a tailored approach.

With several different requirements for different project sizes/types, Project Controls personnel, working closely with Control Account Managers and Project Managers, can tailor project requirements to meet the needs and desires of the customer. For example, smaller projects are not required to provide the same level of rigor as larger capital asset projects. Accordingly, non-value added, and unnecessary work can be eliminated. While this is a benefit, there is room for improvement in consistent application. Most importantly, it is critical to ensure any tailored requirement is approved and appropriately documented.

Due to the large array of responsibilities and methods within Project Controls, there are several different ways of performing the same task. This can prove difficult or result in confusion for Control Account Managers and Project Managers who have several projects supported by different project controls personnel. Consistency and unified processes would be beneficial for some functions. A prime example and great opportunity for improvement would be associated with project folder setup and location as each PCA/PFCs has a different idea of saving project files. The project files then end up in several different locations, under several different file names. This creates difficulty when turning a project over to another PCA/PFCs, or during an audit as project files are requested. Along these same lines, another opportunity for improvement would be associated with development of the WBS. A consistent WBS for specific types of projects would result in an improved ability to utilize historical data in estimating new work scope.

The Project Controls group does an excellent job meeting the demands and requirements of large visible projects. There are well-defined implementation and execution requirements, administrative and reporting requirements, regularly scheduled internal review meetings, DOE/customer status meetings, and high management scrutiny and expectation. Smaller projects, however, require less rigor, yet the volume is high. As a result, these smaller projects require significant effort, but follow a less standardized process. While compliant, efficiency could be improved by implementing a unified business system approach for data collection in lieu of the labor intensive, manual collection process. Systematic data collection would also reduce errors associated with manual data collection.

22.3.4 Equipment and Tools

Project controls equipment and tools are sufficient and align with current industry standards. The primary tools used are Primavera P6 scheduling software, Deltek's Cobra pricing software, AS, the IRPT, Splash BI, the Business Decision Support Information System (BDSIS) Data Warehouse, Power BI, and SharePoint Dashboards. Development of the new Financial Model has been very successful in its testing stage and will significantly streamline the data collection, validation, and reporting process.

During FY-21, the MFC Projects Division successfully implemented the Empower Analytics Software for the MFC Plant Health Portfolio, reducing data collection time and allowing for value-added analysis. Expansion to all MFC projects would be another valuable opportunity for improvement as it would significantly streamline the monthly analysis and reporting process.

22.3.5 Actions FY-22

- Obtain/hire Project Controls and PFC support as necessary to meet the demands of scope increase for MFC projects and O&M support. (Brady Orchard, September 30, 2022)
    - Beneficial to maintain adequate support of projects, O&M, and other organizational needs. Stretched workforces struggle to maintain all requirements and expectations as the workload increases.
- Expand duration of OJT/mentoring for new hires or Project Controls personnel with minimal experience. (Brady Orchard, September 30, 2022)
    - Beneficial to properly prepare new employees or less experienced employees (job function change) and familiarize them with BEA processes, resources, points of contact, routine day-to-day operations, and risk/error avoidance.
- Create a standard file location, naming convention, and project folder setup for MFC projects. (Brady Orchard, June 30, 2022)
    - Necessary to standardize and appropriately house required documents for ease of access by project controls, project managers, control account managers, audits, and for day-to-day operations. This would also reduce transition time as projects are moved or assumed by new project managers or PCA/PFCSs.

- Expand use of Empower Analytics Software reporting tool to support indirect-funded investment reporting and incorporate INL indirect-funded investments into monthly MFC review meetings. (Brady Orchard, June 30, 2022)

22.3.6 Looking Forward (FY-23 and Beyond)

- Improve/standardize the process for documenting a tailored project management approach
  - Necessary to ensure projects are properly documented and compliant.
- Standardized WBS Structure on capital asset construction projects and other project types
  - Necessary to create consistency and efficiency. This will assist cost estimating, project controls, and project management to have more efficient upfront planning, standardization, categorized historical actuals to glean from, provide better alignment with capitalization of an asset post closeout of a project, and aligns with commercial standards.
- Establish consistent reporting requirements/thresholds for MFC projects
  - To be accomplished over a phased implementation
  - Necessary to streamline the reporting process and provide visibility.

22.4 Construction Process

22.4.1 A Look Back

The value of awarded construction subcontracts at MFC continues to steadily increase nearly, reflecting the increased investment in RD&D and supporting infrastructure. In FY-21, a record 156,000 craft labor hours were recorded in support of projects at MFC, representing nearly 45% of the total INL construction volume. This growth is reflecting the increased demand for RD&D capabilities which is putting pressure on the capacity of the current program, and a predicted increase in longer-term demand because of new capital construction programs targeted for MFC (e.g., continued plant health investment, continued investment in supporting infrastructure, and expanding RD&D programs such as NRIC). Therefore, it is imperative MFC looks for ways to support and improve the current construction management team, and to provide the personnel and tools that will be needed to be successful.

22.4.2 People

Construction Management staff are engaged, knowledgeable, and service-oriented, as evidenced by the significant increase in construction work over the last 5 years with minimal increase in staffing. Although head count has not increased, turnover has been, and will continue to be, an issue. Well over 80% of the construction staff (construction management, construction safety, construction quality) have worked at MFC 5-years or less. While retention of employees has been an issue in the past, it will remain a significant issue in the future due to other demands at INL. Attrition, due to retirement/age, will also pose a significant challenge to construction management over the next 5 years. A 5-year staffing plan will need to be developed to counter said challenges. Understaffing of construction support (e.g., industrial hygiene, and safety) is a current issue which results in a demanding workload for the few individuals supporting multiple projects. This work/stress load will no doubt contribute to turnover issues at facilities across INL.

22.4.3 Process

Construction processes and procedures are acceptable but can improve with the implementation of industry best practices. Due to staffing shortages and increasing construction demands, construction oversight personnel are responsible for far more projects than they can reasonably be expected to manage. Essential tasks, such as daily reports, are not always completed the day of, or in some instances are not completed at all, thus limiting the usefulness of said reports. Far too much time is spent in the office reviewing plans, writing reports or correspondence, or approving Subcontractor Field Problems/Changes. This limits the time that can be spent in the field overseeing active construction work. Construction

program managers are working diligently to streamline procedures and processes to allow personnel to work more efficiently and enable them to have a greater presence in the field.

BEA construction processes and procedures are acceptable but are considered archaic and should be brought up to current industry best practices. As the INL continues bringing in new subcontractors from outside the area to compete with local subcontractors, more standard methods/processes would be beneficial. Part of the reason local subcontractors have a head start is because they know the INL's processes, whereas new contractors' struggle. A more standardized process would allow more competition and perhaps a better value to projects and the laboratory.

22.4.4 Equipment/Tools/Training

New tools, equipment, and training need to be provided to the field construction staff to better define, provide access to, and/or in support of the following:

- Developing clear and concise R2A2s for project managers and CFRs to support improved project execution
- Understanding the project depth; project team members need to understand and be able to complete others' tasks to keep work flowing (e.g., key personnel take PL, CFR covering too many jobs to process Subcontractor Field Problems [SFPs])
- Writing daily logs in the field
- Viewing specifications and drawings in the field via mobile devices (i.e., phones, tablets, iPads)
- Implementing a Request for Information (RFI) process distinguishable from that of the SFPs, eliminating duplicative paperwork
- Streamlining the SFP process to minimize the number of reviews, approvals, and signatures required
- Training to industry proven software for construction support
- Trending in order to establish trends of project metrics to evaluate what is driving changes, delays, etc. (e.g., is it the design, working to specific MFC requirements and other facility programmatic milestones taking precedence over construction, and/or subcontractor specific [the subcontractor underbid and expect to make up costs via change orders])
- Mentoring is a key item, currently MFC is mentoring new CFRs by having them shadow other CFRs for 6 months. The MFC construction management team is also developing a CFR checklist which will be a living document to be revised as needed.

22.4.5 Actions FY-22

- Review existing project execution metrics (e.g., construction change codes, risk realization) metrics and define improvements in process/reporting. (Brady Orchard, September 30, 2022)
- Implement Best Value Contract Award (PM/CFR/SA) methodology versus the standard use of low-price, technically acceptable methodology to ensure awarded construction subcontracts truly represent the best value to the government when considering technical capability, cost, and past performance. (Brady Orchard, September 30, 2022)
- Formally adopt and implement Procore™ construction management software for use in more effectively supporting construction execution at MFC. (Brady Orchard, March 31, 2022)

22.4.6 Looking Forward (FY-23 and Beyond)

- Trend project execution metrics and identify additional areas to improve processes and systems.
- Formally establish reporting relationships for PMs supporting all work within MFC to the MFC Projects Division, regardless of fund source.

- Strengthen support for field leadership and teams by better defining R2A2s and processes and improving tools for subcontractor performance management
  - Ensure all project staff understand:
    - Their roles, responsibilities, accountabilities, and authorities
    - All project expectations
    - INL processes, tools, and procedure sets that are applicable to the work
  - Ensure all projects are considering the use of common industry tools used at INL to effectively measure and manage subcontractor performance. The following examples are some of the available tools for consideration:
    - Procore
    - P6
    - EMPOWER
    - Commodity use reports.
- Identify means of holding the subcontractors accountable for schedule and cost (need to look at the subcontractor's schedule and identify if they will or will not meet the schedule).
- Evaluate development of a standard 2-week look-a-head template for Subcontractors to use so all construction projects are consistent, making it easier for CFRs and project managers to cover for others when needed.
- Improve pre-award shaping (e.g., the pre-bid process of developing the scope of the project starting with the client request and engineering and continuing with review and refinement by other key contributors [e.g., safety, environmental, construction, quality] to detail the specifications and address constructability issues).
- Implement early communication and planning of designs and bid packages to decrease downstream inefficiency and cost.
- Strengthen the project management program and function changes in the organization structure, increase training and competency building of key staff, and certification of the project managers.
- Increase the early visibility of MFC projects in the pipeline to provide time for pre-award planning and staffing.

23. REFERENCES

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