NWMI
NORTHWEST MEDICAL ISOTOPES

ATTACHMENT 3

Northwest Medical Isotopes, LLC

NWMI General Technical and Status Update
Public Meeting Presentation
November 10, , 2016

Public Version

Northwest Medical Isotopes, LLC
General Technical and Status Update
Public Meeting

November 10, 2016

Agenda

November 10, 2016
Public Session

TOPIC	*TIME*
Introductions	9:00am
Design of Structures, System and Components	9:15am
Quality Levels	9:35am
External Hazards (including seismic)	9:50am
Criticality	10:20am
Maximum Hypothetical Accident	10:40am
Accident Analysis Methodology	11:10am
Public Q&A	11:25am
Meeting Closeout	11:30am

NWMI Introductions

Commercial Irradiation Services
University Reactors

MURR®

Oregon State University

Radioisotope Production Facility

Engineering Design

MERRICK® & COMPANY

AEM Consulting

Criticality, Shielding, and Safety Analysis

ATKINS

Preconstruction/Construction

McCARTHY®

Environmental Assessments and Permitting

PORTAGE

Technology Demonstration

MURR®

Narodowe Centrum Badań Jądrowych
National Centre for Nuclear Research
Świerk

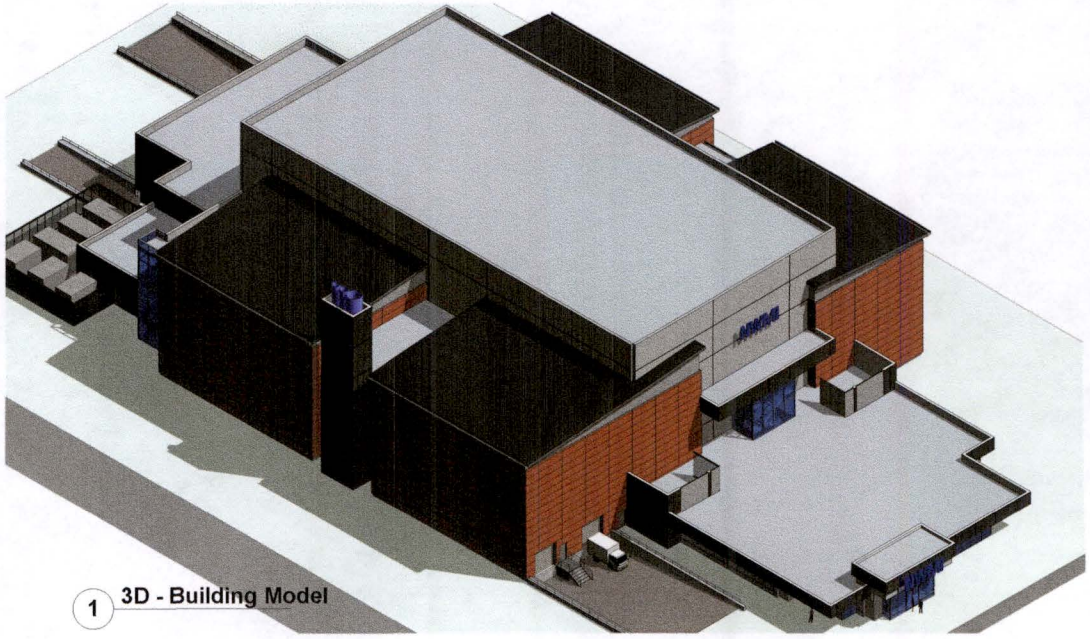
Oregon State University

MCL INC
Materials and Chemistry Laboratory, Inc
"Linking Technology to Solutions"

OAK RIDGE National Laboratory

NWMI RPF Status

- Site Selection – Discovery Ridge Research Park (Columbia, MO)
- Radioisotope Production Facility (RPF) preliminary design completed
- Construction Permit (CP) Application submitted and responded to all Request for Additional Information (RAI) to-date
- Initiated RPF final design and development of Operating License Application
- Selection of general contractor and initiated preconstruction activities
- Continuation of R&D Activities
  - 20 curie (Ci) generator test
  - Irradiation of prototypical target



1 3D - Building Model

Part 50 Construction Permit Application Revision Status

- Weekly calls between NWMI and NRC
- Completed RAI response for Environmental Report (Chapter 19); support, when asked, draft Environmental Impact Statement
- NWMI initiated respond to 2nd set of RAIs on PSAR
  - Completed review and segregation of RAIs (e.g., editorial, clarifications, technical)
  - Completed RAI clarification calls – Chapter specific
  - All RAI responses will be submitted to NRC within the requested 60-days
- All responses to RAIs will be incorporated into Construction Permit Application (e.g., Environmental Report, PSAR)
- Final Construction Permit Application will be updated and re-submitted formally prior to NRC approval

RPF Design Objectives

- NWMI's RPF design achieve the following objectives:
  1. Ensure that complete set of initiating events has been considered
  2. Categorize initiating events and accidents by type, and determines the limiting cases in each group to be quantitatively analyzed
  3. Meets 10 CFR Part 20 acceptance criteria (i.e., 5 roentgen equivalent man [rem] total effective dose equivalent [TEDE] to the worker and 100 millirem [mrem] TEDE to a member of the public off-site) for consequences of each postulated event
  4. Ensures necessary SSCs are included in the design to prevent criticality
  5. Ensures necessary SSCs are included in design to prevent undue risk to health and safety of workers and public from accidents involving chemicals produced from licensed materia

RPF Codes and Standards Development

- CP application will identify Identified applicable codes and standards for RPF and associated SSCs
- CP application will identify SSCs that have been determined to be IROFS and their associated safety functions
- Final design and construction drawings will be completed prior to start of construction including detailed design and specifications for each SSC
  - Design media will include specific codes/standard and design basis information
  - Construction and procurement packages will pass requirements on to fabricators and vendors
- QA/QC inspection packages will ensure necessary inspections, testing and verification
- Final specific codes/standard and design basis information will be included in Operation License Application

Design of Structures, Systems and Components

- Design criteria for RPF construction:
  - Will be specified for each SSC to perform an operational or safety function
  - Will include references to applicable up-to-date standards, guides, and codes
- Design criteria for SSCs will be designed for:
  - Complete range of normal facility operating conditions
  - Ability to cope with anticipated transients and potential accidents
- Design of SSCs:
  - Will be redundant to to protect against unsafe conditions in case of single failures of facility protective and safety systems
  - Will facilitate inspection, testing, and maintenance
  - Will limit the likelihood and consequences of fires, explosions, and other potential manmade conditions
  - Will have quality standards commensurate with the safety function and potential risks
  - Will have design bases to withstand or mitigate wind, water, and seismic damage to reactor systems and structures
  - Will include analysis of function, reliability, and maintainability of systems and components

Quality Levels

- NMWI has updated definitions for it QL to clarify ambiguity between QL-1 and QL-2
  - QA-1 shall be applied to Items relied on for Safety (IROFS). IROFS are QA Level 1 items in which failure or malfunction could directly result in a condition that adversely affects workers, the public, and/or environment, as described in 10 CFR 70.61, "Performance Requirements."
  - QA-2 will be applied to non-QA Level 1 safety SSCs. Some of the required characteristics may be examined less rigorously than for QA-1.
  - QA-3 items include those items that are not classified as QA Level 1 or QA Level 2. QA-3 items are controlled in accordance with standard commercial practices.
- Examples of QL Systems
  - QL-1 Systems
    - All IROFS
    - Preventive controls and measures to ensure that under normal and credible abnormal conditions, all nuclear processes are subcritical
    - Items credited to withstand credible design bases external events (e.g. seismic, wind)
  - QL-2 Systems
    - SSCs to meet 10 CFR 20 normal release or occupational exposure limits
    - Fire Protection Systems
    - Seismic Detection Systems
    - Safeguards and Security Systems

Quality Levels (con't)

- System and Components will be classified according to their importance to safety (e.g., nuclear, safety-related and non-safety related), quality levels (e.g., QL-1, QL-2, QL-3 and seismic class (e.g., Category C-I, C-II)
  - RAIs in Section 3.5 are primarily related to QLs
  - Safety related verses non-safety related
- NWMI will update Section 3.5 to align the content with updated QLs and associated performance characteristics
- NWMI will ensure that design basis information in all CPA chapters are aligned (e.g., Chapter 3, *Design of Structures, Systems, and Components*)
- Quality Assurance and associated procedures (part of Chapter 12) will be revised

Approach to External Hazards

Analysis	*Data Sources*
Wind, including tornado, & wind-borne missiles	• NUREG/CR-4461, Rev.2 (Feb 2007) • Regulatory Guide 1.76, Rev 1 (March 2007) • DOE-STD-1020-2002 • NOAA-NCDC • IBC-2012 • ASCE 7-10
Flood from internal & external sources for water intrusion into the building	• IBC-2012 • ASCE 7-10 • NWS Probable Maximum Precipitation • Statistics for random & seismic failure of piping
Response of the building structure to loading from earthquake, wind, snow & explosion	• IBC-2012 • ASCE 7-10 • Software tools SHAKE, SASSI, SAP2000
Seismic anchorage passive IROFS; demonstration of operability for active IROFS	• Building analysis floor spectra • ASME B-31.3 for piping • IEEE-344 for active equipment

Criticality

- Used "first principles" and guides as bases for equipment design and process area layouts
  - Geometry constraints (e.g., pencil tank diameters)
  - Tank array spacing (conservative)
  - Consideration of transition from "safe-geometry" process equipment to less-restricted waste staging and processing equipment
- Evaluations and analysis
  - Monte Carlo N-Particle (MCNP) code validation and upper subcritical limits for all areas of applicability with Continuous Energy ENDF/BVII.1 Cross Sections
  - 92 criticality safety experiments were selected that adequately match uranium enrichment, geometry, moderator, reflector, and neutron energy
  - Develop project-specific single-parameter criticality limits for U enrichment, forms, and basic geometries
- Areas of Applicability
  - ANECF
  - H/X
  - Moderating, reflective and adsorbent materials
  - Chemical forms
  - Comparison with RPF parameters
- Margin of Subcriticality

Criticality Safety Evaluation Documents
Irradiated Target Handling and Disassembly
Irradiated LEU Target Dissolution
Molybdenum Recovery and Purification
LEU Target Material Production
Target Fabrication Uranium Solution Processes (Wet)
Target Fabrication (Dry)
Target/Can Storage and Cart
Uranium Recovery and Recycle
Liquid Waste Processing
Solid Waste Collection, Encapsulation, and Staging
Offgas and Ventilation
Target Transport Cask and Drum Handling
Analytical Laboratory
Calculations • *Single Parameter Subcritical Limits for 20 wt% ^{235}U - Uranium Metal, Uranium Oxide, and Homogenous Water Mixtures* • *Irradiated Target LEU Material Dissolution* • *55-Gallon Drum Arrays* • *Single Parameter Subcritical Limits for 20 wt% ^{235}U - LEU Target Material* • *Target Fabrication Tanks, Wet Processes, and Storage* • *Hot Cell Tank Pit*

Maximum Hypothetical Accident

- RAIs provided additional NRC guidance on interpretation of NUREG 1537 expectations as it relates to an maximum hypothetical accident (MHA)

  "Demonstrate that the MHA in PSAR Section 13.2.1, including the items stated in the ISG Augmenting NUREG-1537, Part 2, Section 13b.1.1, such as appropriately functioning instruments, controls, automatic protective systems normally operating process systems and protective actions initiated by either the operating staff, control systems, or engineered safety features meets the generally accepted dose requirements of 10 CFR Part 20. Otherwise, provide an accident analysis that is either consistent with the requirements of 10 CFR 70.61 (e.g., application of items relied upon for safety to prevent or mitigate the event) or propose an alternate methodology."

- *NWMI is evaluating MHA based on this guidance to demonstrate meeting dose requirements of 10 CFR Part 20*

- Safety MHA
  - Loss of power event lasting more than 2 hours during target dissolution
  - Failure of primary IROFS
  - All iodine is evolved from dissolver
  - Resulting dose consequences maintained below 100 mrem

Accident Analysis Methodology

- NUREG 1537 Part 1
  - NRC staff has determined that use of Integrated Safety Analysis methodologies as described in 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," and NUREG-1520

    as well as
  - Application of radiological and chemical consequence and likelihood criteria contained in 10 CFR 70.61 – Performance Requirements
    - Designation of items relied on for safety
    - Establishment of management measures that are acceptable ways of demonstrating adequate safety
- NWMI performed an ISA for entire RPF using above referenced guidance
- Used both RSAC and RASCAL codes to determine accident dose consequences for Chapter 13, *Accident Analysis*
- NWMI plans to only use RSAC code re-evaluation analysis for Chapter 13 and in Operating Licensing Application development

Preliminary Hazard Analysis Summary

- Completed PHA on eight "systems"; 107 nodes evaluated
- PHA tables – 290 pages
- ~140 accident sequences identified for additional evaluation
- 75 accident sequences evaluated in QRAs

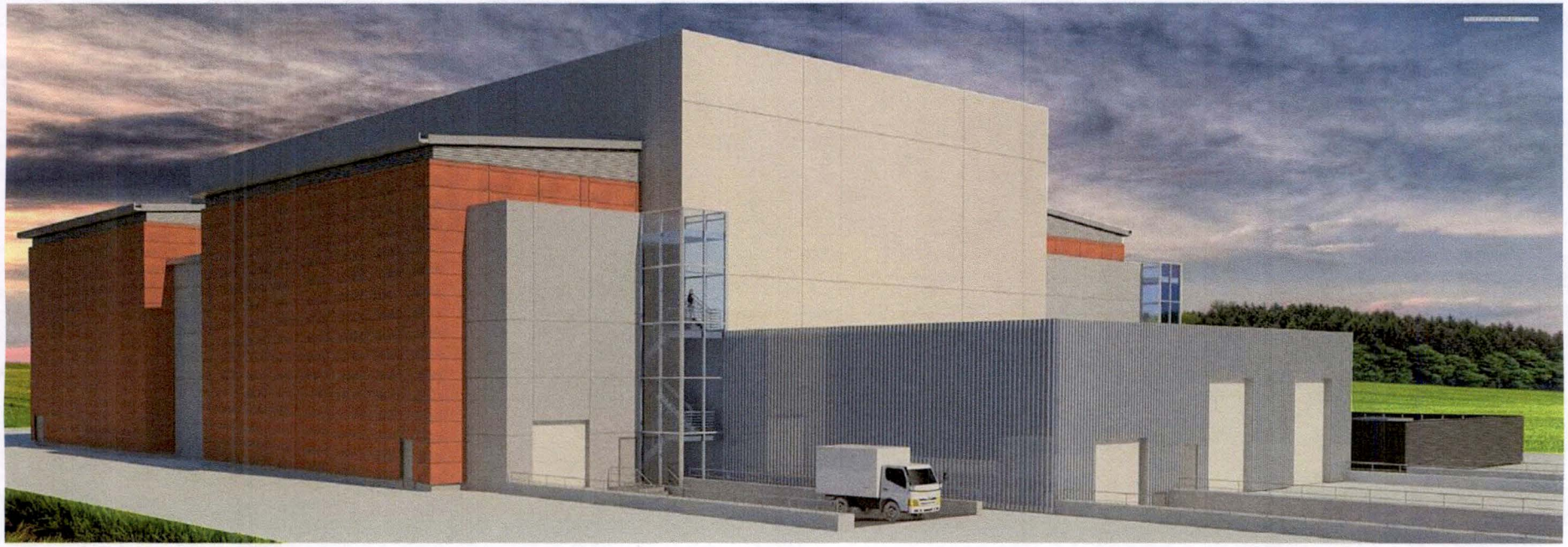
RPF PHA Accident Sequence Category Designator Definitions

PHA Top-Level Accident Sequence Category	Definition
S.C.	Criticality
S.F.	Fire/Explosion
S.R.	Radiological
S.M.	Man-Made
S.N.	Natural Phenomena
S.CS.	Chemical Safety

Preliminary Hazard Analysis Results (continued)

Crosswalk of NUREG-1537 Part 1 ISG Accident Initiating Events versus RPF PHA Top-Level Accident Sequence Categories

NUREG-1537 Part 1 ISG Accident Initiating Event Category	PHA Top-Level Accident Sequence Category					
	S.C.	S.F.	S.R.	S.M.	S.N.	S.CS.
Criticality accident	✓	✓			✓	
Loss of electrical power			✓		✓	
External events (meteorological, seismic, fire, flood)	✓	✓		✓	✓	✓
Critical equipment malfunction	✓	✓	✓	✓		✓
Operator error	✓		✓	✓		✓
Facility fire (explosion included in this category)		✓	✓			
Any other event potentially related to unique facility operations	✓		✓	✓		



Public Questions & Answer Period