NWMI

NORTHWEST MEDICAL ISOTOPES

U.S. Nuclear Regulatory Commission
Pre Construction Permit Application Meeting

April 29, 2014
9:00am – 4:00pm

Agenda

April 29, 2014 – Morning Session

Public Session		
9:00am	*Opening Remarks*	*NRC*
9:10am	*Safety Topic*	*NWMI*
9:15am	*NWMI Introductions and Update (10 min)*	*NWMI*
	Facility Siting (10 min)	
	Process Functions and Requirements and Facility Design Criteria (15 min)	
	Facility Layout and Description (15 min)	
	Process Description (15 min)	
	Applicability of 10 CFR 50 (15 min)	
	Regulatory Framework	
	2-Part Submission of Permit Construction Application	
	Public Question and Answer Period (30 min)	*NRC/NWMI*
Non-Public Session		
	NWMI Update (10 min)	*NWMI*
	Process Description (40 min)	
	SNM Processing & Storage (20 min)	

Agenda

April 29, 2014 – Afternoon Session

Public Session		
1:00pm	Opening Remarks	NRC
1:10pm	Accident/Hazards Analysis (30 min)	NWMI
	Environmental Report Overview (30 min)	
	Nonradiological Hazards (15 min)	
	Radiological Hazards (15 min)	
	Waste Management (15 min)	
	Transportation (15 min)	
	Instrumentation and Controls (10 min)	
	Safeguards & Security (10 min)	
	Public Question and Answer Period (30 min)	NRC
Non-Public Session		
	Close-Out (20 min)	NRC/NWMI

NWMI
NORTHWEST MEDICAL ISOTOPES

NWMI OVERVIEW AND STATUS

April 29, 2014

Organization

NWMI NORTHWEST MEDICAL ISOTOPES

Nick Fowler, President
Carolyn Haass, Vice President

Irradiation Services – University Reactors

MURR® Matters...
Ralph Butler

OSU Oregon State
Steve Reese, PhD

Radioisotope Production Facility Partners

Engineering Design

AEM Consulting
Gary Dunford (Process)

KURION
Isolating Waste from the Environment
Jim Kirskovich, PE (Chief Engineer)

MERRICK® & COMPANY
Michael Washer, PE (Process)

Licensing and Environmental Permitting

PORTAGE
Harry Fugate (Licensing)
John Beller (ER)

Technology Demonstration Partners

OAK RIDGE National Laboratory

OSU Oregon State

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

MURR® Matters...

NWMI Project Overview and Status

- Overview
  - NWMI created in 2009 to pursue a domestic, secure, reliable production of ^{99}Mo
  - NWMI and It's Team Members have extensive experience with nuclear and chemical processing, construction, commissioning and operations
  - ^{99}Mo will be produced using a fission method using LEU targets and will recover ^{99}Mo from targets through a dissolution/purification using standard chemical processes
- Status
  - Conceptual Design Complete, Preliminary Design Initiated
  - Nuclear Quality Assurance Plan implemented
  - Proof of concept tests have and are being performed in cooperation with MU, OSU and ORNL
  - Generated and exercised from other entities significant IP which is essential to the success of the project; Additional IP anticipated
  - Siting Decision Taken; Option formalized
  - Construction Permit Application
    - Received Exemption to Submit Construction Permit Application in 2 Parts (Oct 2013)
    - Environmental Report Complete; Part 1 submission in May 2014
    - Part 1 Submission to NRC in Early May 2014; Part 2 Submission in Early November 2014
  - Strategic Partnerships and Major Subcontractor development complete

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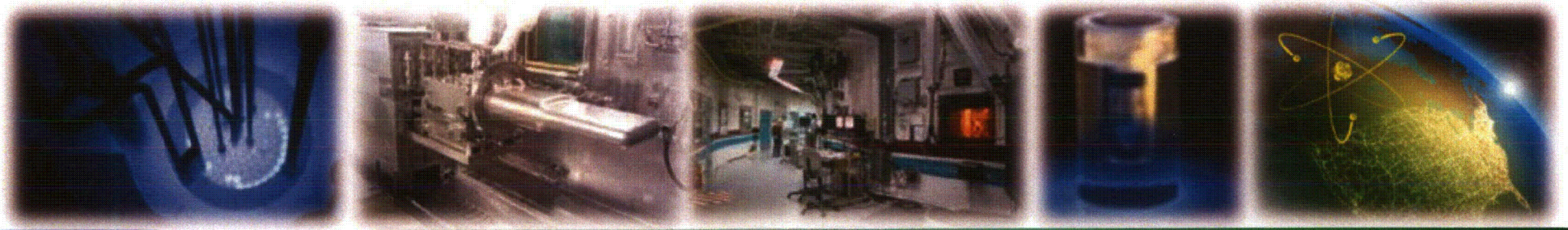
FACILITY LOCATION ALTERNATIVES AND SITING RECOMMENDATIONS

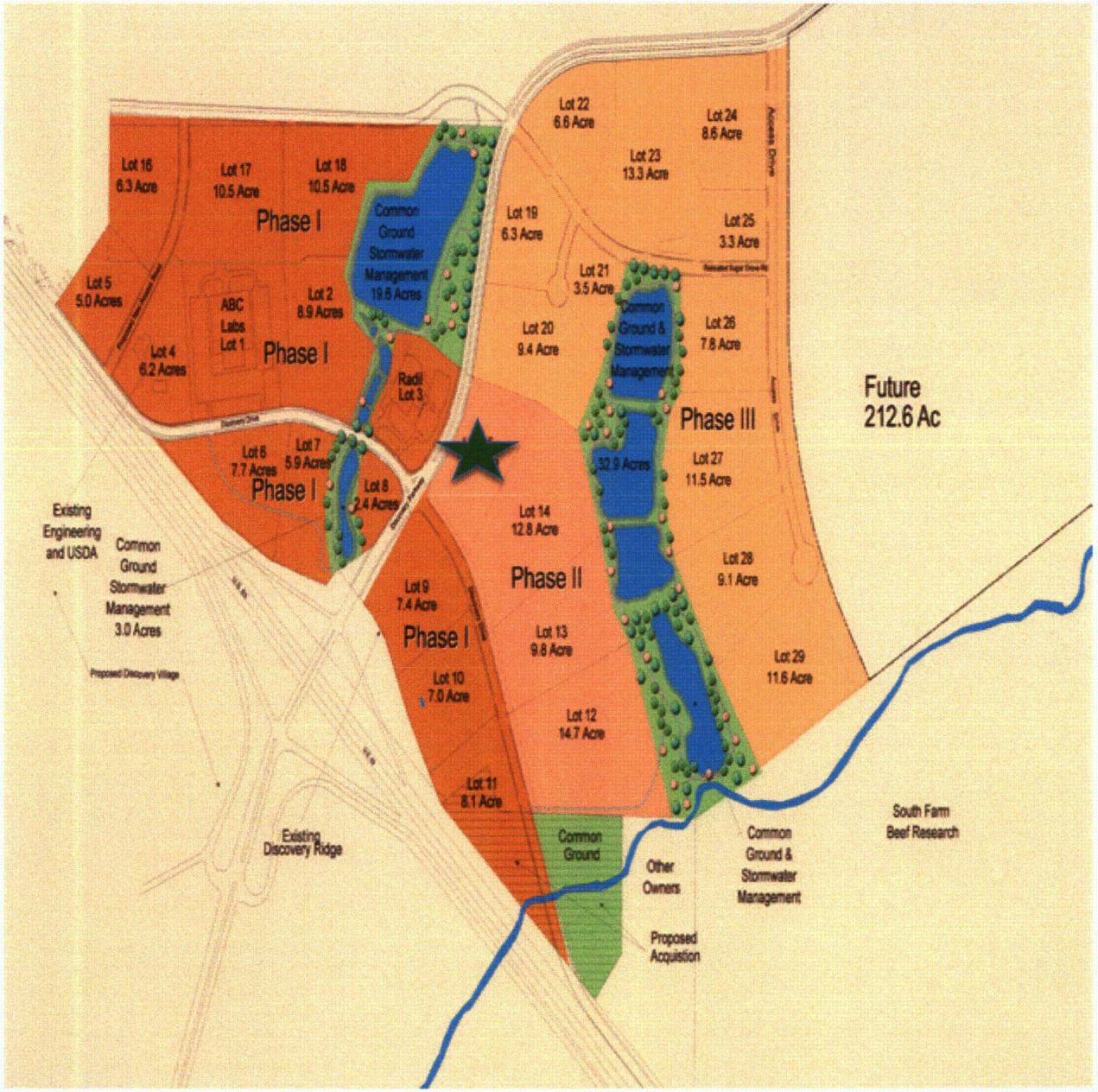
April 29, 2014



Siting – Proposed Locations Evaluated in ER

- Oregon State University (OSU), Radiation Center – Corvallis, OR
- McClellan Business Park (McClellan) – Davis, CA
  - Next to University of California at Davis (UC Davis) Research Reactor
- University of Missouri Research Reactor (MURR) – Columbia, MO
- Discovery Ridge Research Park (owned by MU) – Columbia, MO

RPF Siting Status

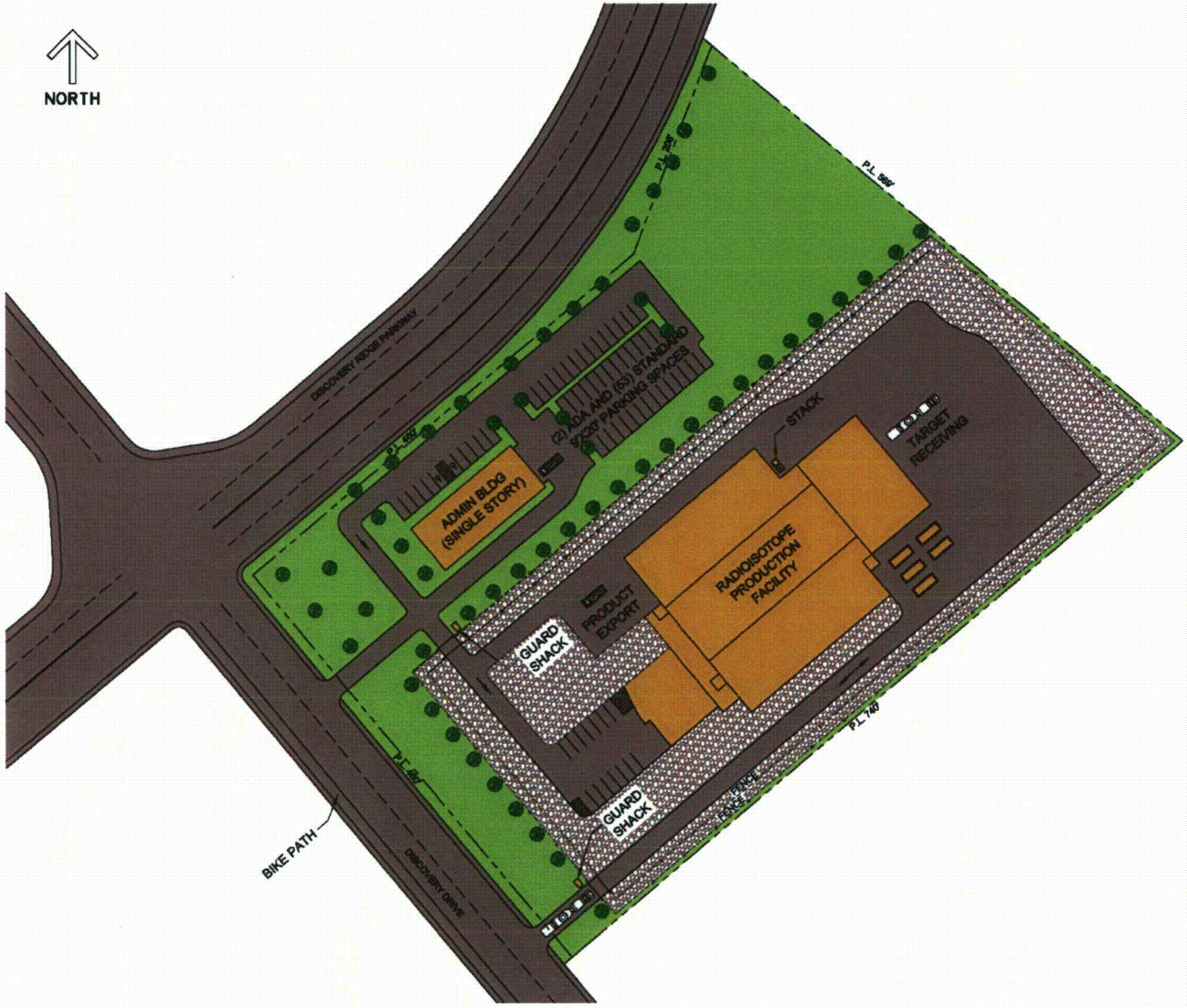


ASSUMPTIONS

- Completed Siting Recommendation for RPF; Discovery Ridge Research Park – Columbia, Mo (owned MU)
  - 7.4 Acre Parcel (Lot 15)
  - Primary Reactor (MURR) is ~6 Miles from RPF
- NWMI Optioned Site in November 2013
- Potential of MU/MURR Education/Research Building Co-Located with RPF

DISCOVERY RIDGE UNIVERSITY OF MISSOURI
Where Science Goes To Work

Facility Layout (7.4 Acres)



BUILDING SITE PLAN
SCALE: 1"=50'

-50 0 50 100
SCALE IN FEET

NOTE:
PROPERTY LINE DIMENSIONS ARE APPROXIMATE AND SHALL BE VERIFIED BY SURVEY OR LEGAL DESCRIPTION.

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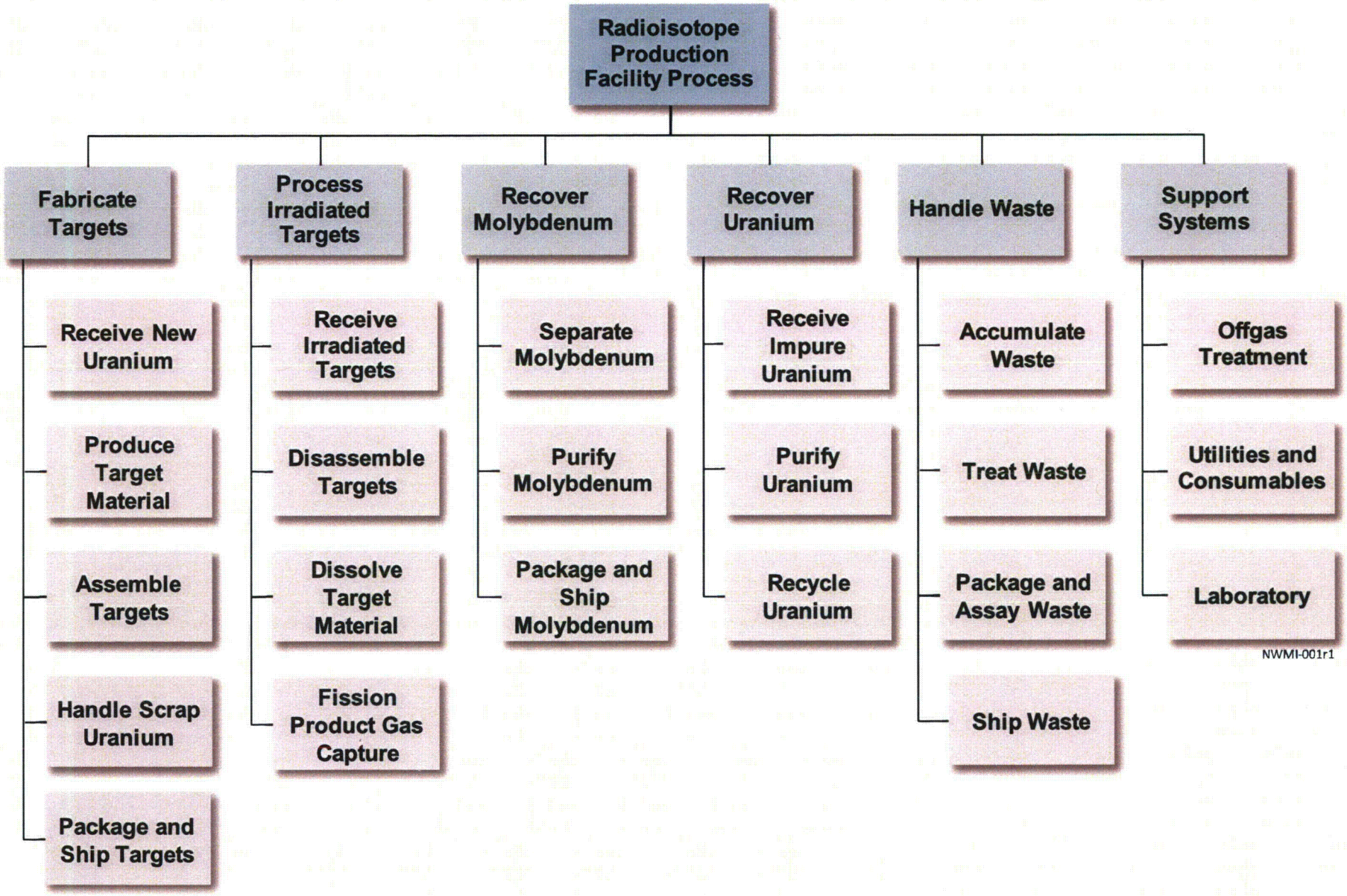
PROCESS FUNCTIONS & REQUIREMENTS AND DESIGN REQUIREMENTS

April 29, 2014

Primary Assumptions and Progress

- Primary Assumptions
  - Single RPF
  - Recover ^{99}Mo from irradiated targets generated by multiple reactors; All reactors will utilize same target design
  - Fission product releases will comply with environmental release criteria
  - Uranium processing and storage will meet all required Safeguards & Security Requirements
  - Each unit process/function and sub process/function requirements have been identified
- Progress
  - Developed and are implementing in preliminary design
    - Process Functions and Requirements Document
    - Facility Design Requirement Document

RPF Functions



Primary Design Criteria

Federal	State of Missouri	Local
CFR's 10 CFR 70.61 – Performance Requirements 10 CFR 70.64 – Baseline Design Criteria 10 CFR 50 Appendix A – General Design Criteria 10 CFR 50.55a – Codes and Standards ***NUREG*** NUREG-1537 NUREG-1520	***Title 10 Department of Natural Resources*** Division 10, Air Conservation Commission Division 20, Clean Water Commission Division 24, Hazardous Substance Emergency Response Office Division 25, Hazardous Waste Management Commission Division 26, Petroleum and Hazardous Substance Storage Tanks Division 30, Land Survey	***University of Missouri*** International Building Code City/County Codes ***Discovery Ridge*** Master Plan Covenants

Nationally Recognized Codes

- ICC Family
- IEEE
- ANSI N13.1
- ACI
- AISC
- NFPA
- ISA-84
- ISO 14644
- NFPA-801
- AISC N690
- ASME NAQ-1
- ASME AG-1
- ASME N509
- ASME N511
- ASME BPV Sec. VIII
- ASME B31.1
- ASME B31.3

Baseline Design Criteria

- Quality standards and records
  - ASME NQA-1 forms basis for quality assurance for design, construction and records management
- Natural phenomena hazards
  - Facility design will be per IBC and ASCE 7, with importance driven by hazards analysis
  - Design will ensure safe shutdown and the required post-accident operability
- Fire protection
  - Fire protection systems will be designed, installed, and maintained in accordance with
    - International Fire Code (IFC)
    - NFPA standards: NFPA 801 will be invoked for this radiological facility
- Environmental and dynamic effects
  - SSCs will withstand the natural environmental conditions, induced environments (e.g., vibration, elevated radiation, elevated temperature, electromagnetic fields, and elevated noise) and environments due to accident
- Criticality control
  - Criticality Safety Program will be implemented in accordance with ANSI ANS-8.1 and will have redundant safety systems including geometrically safe design
- Instrumentation and controls
  - Safety related controls will be designed in accordance with ANSI ISA-84

Baseline Design Criteria (con't)

- Chemical protection
  - RPF will provide safe and compliant confinement for hazardous materials including use of multiple layers of protection to prevent or mitigate hazardous/radioactive material releases
  - Confinement systems will protect against releases of hazardous materials due to natural phenomena hazards
- Emergency capability
  - Emergency lighting, power, fire protection, and communication systems will be provided in accordance with typical life-safety code requirements
  - Security systems and emergency planning will maintain control of licensed material under emergency conditions
- Utility services
  - Essential utility services will be defined in hazards analysis and appropriate standards applied (e.g., IEEE standards for Class 1E power)
- Inspection, testing and maintenance
  - Planning and design of RPF and its operating components and systems will take into account all aspects of operation and maintenance
    - e.g., personnel safety, equipment accessibility, dismantling, replacement, repair, frequency of preventive maintenance, inspection requirements, day-to-day operation, and decontamination and decommissioning

Defense in Depth

- Preference for engineered controls over administrative controls
  - Design will preferentially select engineered features over administrative controls
    - Minimizes employee exposure to radiation and chemical hazards
    - Prevents release of radioactive or toxic materials to the environment
  - System design will establish number, arrangement and characteristics of confinement barriers based upon consideration of the type, quantity, form, and conditions for dispersing radioactive and hazardous material
- Features that enhance safety by reducing challenges to IROFS
  - Failure of items that are not important to safety will not affect integrity and operability of items relied on for safety
  - Normal operation will not impart detrimental environmental conditions or excessive service requirements that will affect the reliability of items relied on for safety

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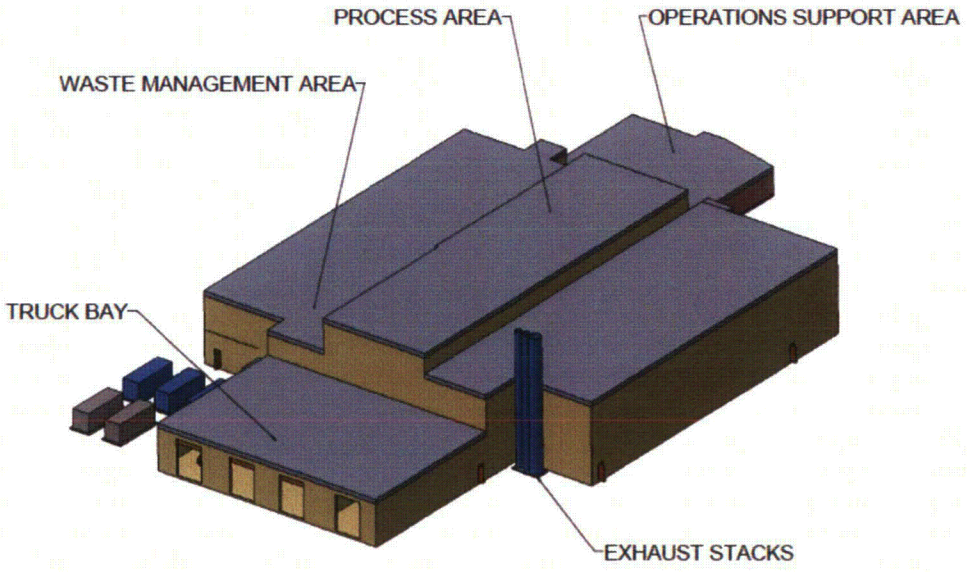
FACILITY DESCRIPTION AND LAYOUT

April 29, 2014

Facility Description

- Primary RPF Operations Include:
  - Receipt of LEU from DOE
  - Production of LEU microspheres and fabrication of targets
  - Delivery of LEU targets to University Reactor Network Participants
  - Return of irradiated LEU targets for dissolution, separations, and purification of ^{99}Mo
  - Reclaim/Recycle of LEU to minimize radioactive, mixed, and hazardous waste generation
- RPF estimated to contain ~48,000 ft^2 of floor space
  - Processing Areas Sized to Provide ~16 ft of Enclosure Height in Rooms Containing Process Equipment
  - Mezzanine Area Included in Portion of Process Area for Utility and Ventilation Equipment
- Administration Building (outside of secured RPF area) estimated to be ~10,000 ft^2

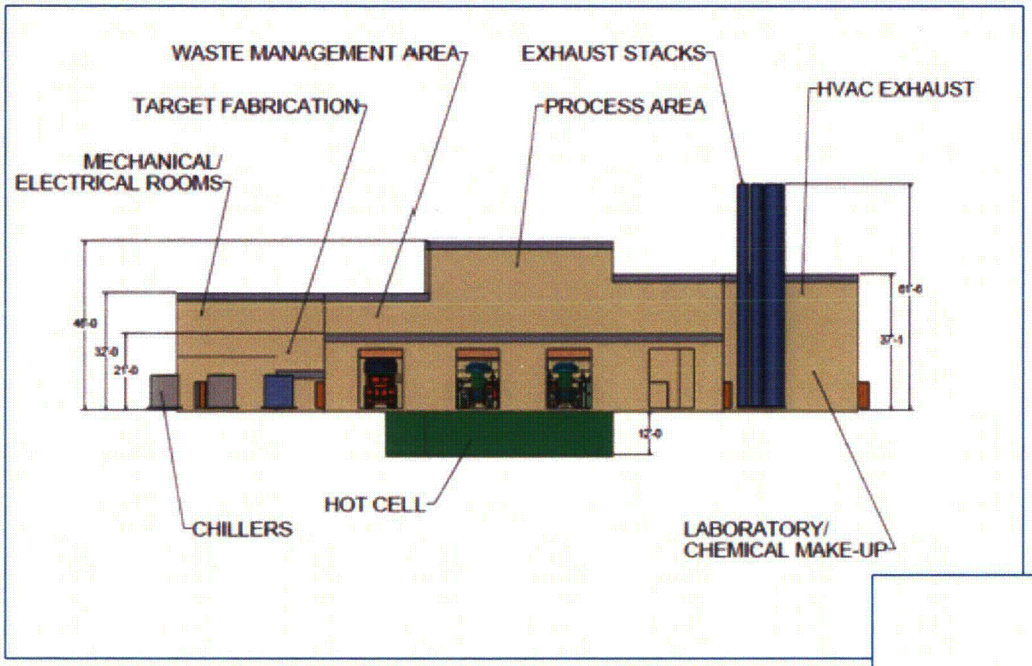


Ventilation

- Ventilation System would Maintain a Series of Cascading Pressure Zones to Draw Air from Cleanest Part of Facility to Most Contaminated Areas
  - Zone IV is a Clean Zone and is Independent of Other Ventilation Zones
  - Zone III is Cleanest of Potentially Contaminated Areas with Each Subsequent Zone having potential More Contaminated and Lower Pressures
  - A Common Supply Air System Would Provide 100% Outdoor Air to All Zone III Areas and Some Zone II Areas that Require Make-Up Air in Addition to that Cascaded from Zone III
  - 3 Separate Exhaust Systems Would Maintain Zone Pressure Differentials and Containment
  - Zone I Exhaust System Would Service Hot Cell, Waste Loading Areas, Target Fabrication Enclosures and Process Offgas Subsystems
  - Zone II/III Exhaust System Would Service Exhaust Flow Needs From Zone II and III in Excess of Flow Cascaded to Zone 1
  - Laboratory Exhaust System Would Service Fume Hoods in Laboratory Area

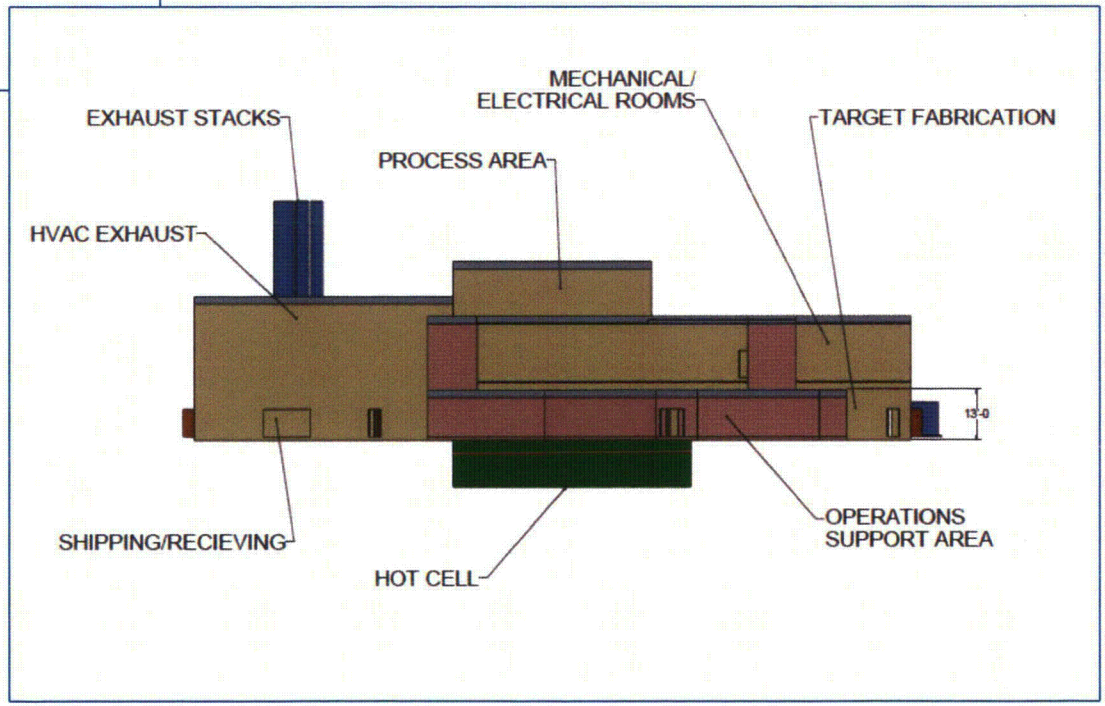
Area	Zone
Hot cell	I
High integrity container loading area	I
Solid waste loading area	I
Target fabrication enclosures	I
Laboratory	II
Target fabrication dry	II
Target fabrication wet	II
Uranium storage	II
Steam condensate pump room	II
Target truck bay	II
Waste truck bay	II
Waste management area	II
Operating gallery and corridor	II
Process offgas room	II
Truck bay	III
Mechanical/electrical room	III
Loading dock	III
Chemical supply room	III
Exhaust filter room	III
Corridors and air locks	III
Operation Support	IV

Facility Views



East Side of Building

West Side of Building



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PROCESS DESCRIPTION

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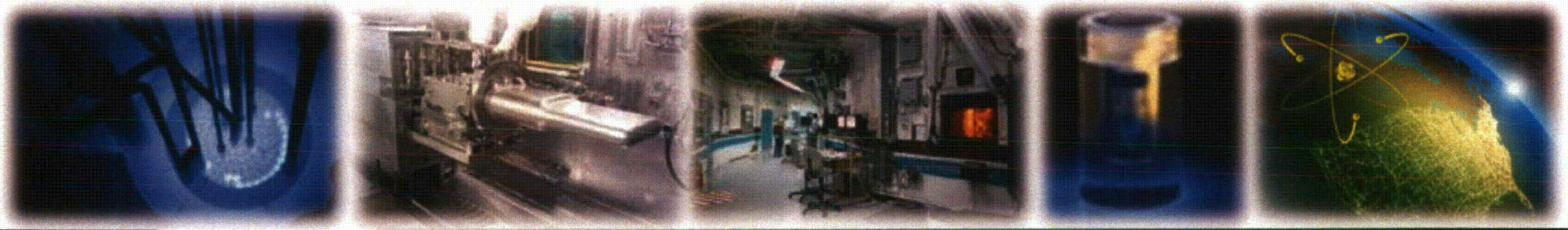
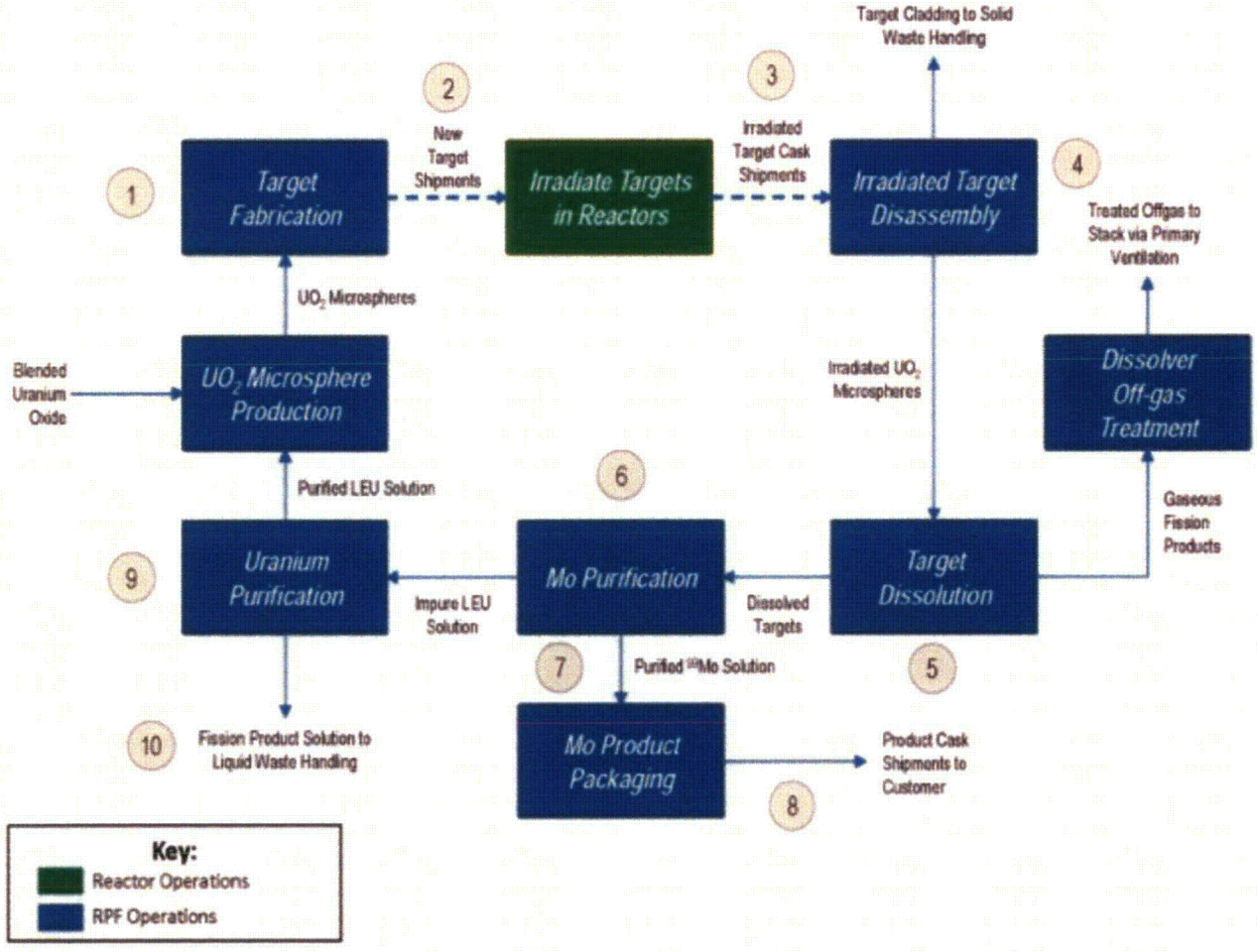


RPF Process Description

1. Targets are fabricated, tested and stored
   - Microspheres are produced from a combination of fresh LEU and recycled LEU
2. Fabricated targets are shipped to the reactors for irradiation
3. After irradiation, the targets are shipped back to RPF
4. Returned targets are disassembled
5. Irradiated LEU is dissolved
6. Separations of ^{99}Mo and LEU
7. ^{99}Mo is purified and sampled
8. Purified ^{99}Mo is packaged in shipping containers, inserted into casks, and transferred to the customer
9. LEU solution is purified and sent back to Step 1 for reuse
10. Wastes are converted to a disposal form by the waste handling system and placed in casks for disposal



RPF Annual Chemical Usage

Chemical	Quantity		Location	Physical Form
Nitric acid (HNO_3)	9,500 (L)	2500 (gal)	Chemical make-up room/laboratory	Liquid
Hydrogen peroxide (H_2O_2)	500 (L)	132 (gal)	Chemical make-up room/laboratory	Liquid
Ammonium Hydroxide (NH_4OH)	1000 (L)	26 (gal)	Chemical make-up room	Liquid
Oxygen	100 (kg)	220 (lb)	Chemical make-up room/laboratory	Gas
Nitrogen	1300 (kg)	2800 (lb)	Chemical make-up room/laboratory	Gas
Helium	500 (kg)	1100 (lb)	Chemical make-up room	
Sulfamic acid (HSO_3NH_2)	1 (L)	0.26 (gal)	Chemical make-up room	Liquid
Sodium hydroxide (NaOH)	3,800 (L)	1000 (gal)	Chemical make-up room	Liquid
Reductant ($Fe(SO_3NH_2)_2$/ HSO_3NH_2	Make up as needed		Chemical make-up room/waste management area	Liquid
Sodium hypochlorite (NaOCl)	1 (L)	0.26 (gal)	Chemical make-up room	Liquid
Sorbent	10,000(kg)	22,046 (lb)	Chemical make-up room/laboratory/waste management area	Solid
Trichloroethylene	40 (L)	5.3 (gal)	Chemical make-up room/laboratory	Liquid
Hexamethylenetetramine $(CH_2)_6N_4$	400 (kg)	882 (lb)	Chemical make-up room	Solid
Urea ($Co(NH_2)_2$)	162 (kg)	356 (lb)	chemical make-up room	Solid
Silicone oil	50 (kg)	110 (lb)	chemical make-up room	Liquid
General laboratory supplies	TBD	TBD	Laboratory	Solids/liquids/ gas
General custodial supplies	TBD	TBD	Janitor closet	Liquids/solids

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APPLICABILITY OF 10 CFR 50

(REGULATORY FRAMEWORK AND APPROACH TO 2-PART CONSTRUCTION PERMIT APPLICATION)

April 29, 2014

10 CFR 50 Requirements

Facility where the isotope separation process occurs may be considered a production facility subject to licensing under 10 CFR Part 50

NRC License Application Approach and Approval Requirements

Regulatory Authority	Required Approval	Activity Covered	Status
• Atomic Energy Act (i.e., Class 103 License) • 10 CFR 50.50	• Construction Permit • Operating License	• RPF Construction • RPF Operations	Addressed in Construction Permit Application
• 10 CFR 50.57	• Operating License	• RPF Operations	Addressed in Operating License Application
• 10 CFR 40 (through NUREG-1537 ISG)	• Source Material License	• Possession • Use and transfer of radioactive source material	Addressed in Operating License Application
• 10 CFR 30 (through NUREG-1537 ISG)	• By-Product Material License	• Production, possession, and transfer of radioactive by-product material	Addressed in Operating License Application
• 10 CFR 70 (through NUREG-1537 ISG)	• Special Nuclear Materials License	• Receipt, possession, use, and transfer of special nuclear material	Addressed in Operating License Application
• National Environmental Policy Act (42 U.S.C. § 4321 et seq.) • 10 CFR Part 51	• EA or EIS	• Site Approval for RPF Construction and operations	Addressed in Construction Permit Application

10 CFR 50 Requirements

- Facility where the isotope separation process occurs may be considered a production facility subject to licensing under 10 CFR Part 50
- NRC will review license application under the following:
  - NUREG-1537, October 2012, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non- Power Reactors: Format and Content, for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors*
    - Part 1, Format and Content
    - Part 2, Standard Review Plan and Acceptance Criteria
  - NUREG-1520, May 2010, (Rev.1), *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*

NRC Licensing Strategy

Strategy: Obtain Part 50 license for entire facility per NUREG 1537, enhanced by integrated safety assessment tools and concepts described in NUREG 1520 to thoroughly address worker and public safety related to criticality, radiation and chemical hazards, without adopting duplicative administrative processes of Parts other than 10 CFR 50.

- A single license will be prepared for RPF
  - Primarily licensed under 10 CFR 50, *Domestic Licensing of Production and Utilization Facilities,* with applications of other various parts of 10 CFR
  - Anticipate License to cover:
    - Fresh fuel (LEU) storage and handling
    - Isotope extract and purification
    - Other associated operations (i.e., product packaging and shipping, waste handling and storage)
    - Target Fabrication
    - LEU purification and recycle
- University Reactor will amend it's current operating license's to support production of ^{99}Mo
- Agreement State Responsibilities

Permit Approval Requirements (Non NRC) Summary

- U.S. Army Corps of Engineers (i.e., CWA)
- U.S. Environmental Protection Agency (i.e., RCRA, CWA)
- U.S. Department of Transportation (i.e., HMTA)
- MO Department of Natural Resources (i.e., RCRA, CAA, CWA)
- MO Depart of Health & Senior Services
- Boone County Resource Management Department (i.e., Storm Water, Land Disturbance, Commercial Building)
- Boone County Regional Sewer District (i.e., Sanitary)
- City of Columbia (i.e., CWA, Misc. Permits)

2-Part Submittal of Construction Permit Application

- NWMI received exemption for 2-Part Submittal of Construction Permit Application in Oct 2013
- Part One Submission:
  - Description and Safety Assessment of the safety assessment of the site required by 10 CFR 50.34(a)(1)
  - Environmental Report required by 10 CFR 50.30(f)
  - Filing fee information required by 10 CFR 50.30(e) and 10 CFR 170.21
  - General information required by 10 CFR 50.33
  - Agreement limiting access to classified information required by 10 CFR 50.37
- Part Two Submission
  - Remainder of PSAR required by 10 CFR 50.34(a)
  - Application will be submitted in accordance with requirements of 10 CFR 2.101(a)(5)
- Proprietary Information
  - Plan to withhold financial and trade secret information as confidential per 10 CFR 2.390(a)(4)
  - Will provide an affidavit with withholding request per 10 CFR 2.390(b)(1)(iii)
    - When application is submitted there will be two complete versions of application
      - One complete public version of application with confidential information redacted
      - One complete confidential version of the application with the confidential information included

License Application Structure

Part 1	General and Administrative Information and Environmental Report
Part 2	PSAR
Part 3	FSAR
Appendix A	Technical Specifications
Appendix B	Quality Assurance Program
Appendix C	Proprietary Information
Appendix D	Security Plans
Appendix E	Emergency Plans
Appendix F	Material Control & Accountability Plan
Appendix G	Other

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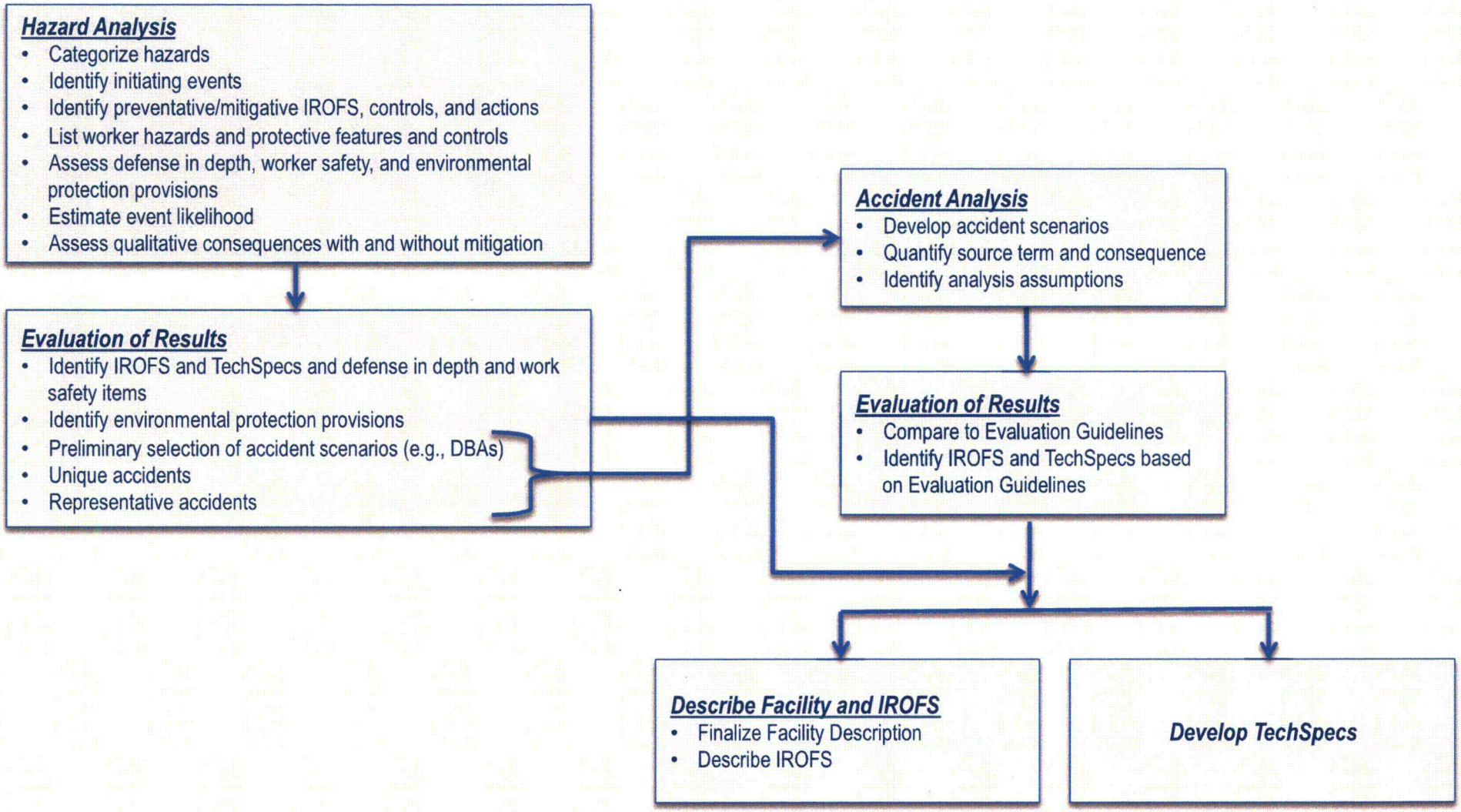
ACCIDENT ANALYSIS

April 29, 2014

Requirements

- 10 CFR 50.34(a) – Construction Permit Application content
- 10 CFR 70.61 – Performance Requirements
- NUREG Guides 1537 and Interim Staff Guidance (NUREG 1520)
- Intent
  - Preparation of an ISA, using the format and content guide in NUREG-1520
  - NUREG-1537/ISG Initiating Events and Maximum Hypothetical Accident (MHA)

Safety Analysis Methodology



ISG Approach

- Identification of Hazards
  - Operations with SNM
  - Radiochemical operations
  - Operations with hazardous chemicals
- Accident Initiating Events
  - Criticality
  - Loss of Electrical Power
  - External events (meteorological, seismic, fire, flood)
  - Critical equipment malfunction
  - Operator error
  - Facility fire
  - Other events
- Preliminary HAZOP assessment conducted during conceptual design

Preliminary HAZOPs

- Preliminary HAZOPS has been completed using conceptual design information
- Identified RPF Hazards
  - Criticality
  - Release of radioactive offgas or radioactive products
  - Radioactive waste
  - Explosion – resulting from production of hydrogen by radiolytic decomposition of irradiated fissile solution
  - Tank and equipment failure leading to a release of radiological or chemical materials
  - Release during receiving of hazardous chemicals outside RPF

ISA Approach

- ISA may be used to define IROFS to inform the PSAR
- ISA will integrated into RPF design and PSAR
  - Basic Assumptions
  - Methodology
  - Explicit Definitions for Terms Used (e.g., credible, unlikely, highly unlikely)
  - Uncertainties
  - Degrees of Conservatism
  - Margin of Safety
  - Intermediate and Ultimate Radiological Conditions
  - Controls, IROFS, and Administrative Measures
- Will only utilize acceptable computer codes that have been fully V&V by NRC

Modeling Tools

- Models that may be used (as appropriate) to evaluate consequences associated with operations or accidents associated with RPF
  - Radiological
    - RSAC - Consequences from release of radionuclides to the atmosphere (>100M).
    - RASCAL – Evaluates releases during emergencies from radioactive material handling facilities including power plants, storage pools, and casks
    - RADTRAN – Dose consequences during transportation
    - MCNP – Evaluation of neutron, photon, electron, or coupled neutron/photon/electron transport for radiation protection, dosimetry, criticality safety, and shielding analysis
    - HOTSPOT - Atmospheric dispersion models for near-surface releases, <10km, and durations <24 hrs.
    - RADTRAD – Calculates time dependent dose at specified locations for a given accident scenario (inside building and HVAC)
    - MicroShield - Photon/gamma ray shielding and dose assessment
    - RESRAD - Estimates radiation doses and risks during decommissioning
    - Others
  - Chemical
    - Aloha - Models chemical releases for emergency responders and planners.
    - Others

Maximum Hypothetical Accident

- Maximum Hypothetical Accident (MHA) is used to bound consequence values for all credible potential accidents
  - MHA is a "Non-Credible/Unmitigated Accident"
  - MHA will provide bounding consequence values for all credible potential accidents at RPF
  - MHA and ISA will serve to satisfy Accident Analysis Requirements of 10 CFR 50.34(a)
- Assumed:
  - Certain facility, process, and procedural quantities will not be fully developed
  - Conservatism will be used to ensure a broad safety envelope to be defined

Conclusions

- A very comprehensive ISA will be prepared for NWMI operations and facility, using standard acceptable hazard analysis methodologies
- Results of the ISA will be integrated into the design and PSAR
- NWMI will use recognized and acceptable NRC computer codes that will be V&V by NWMI to support accident analysis calculations
- RPF is expected to be an intermediate consequence facility

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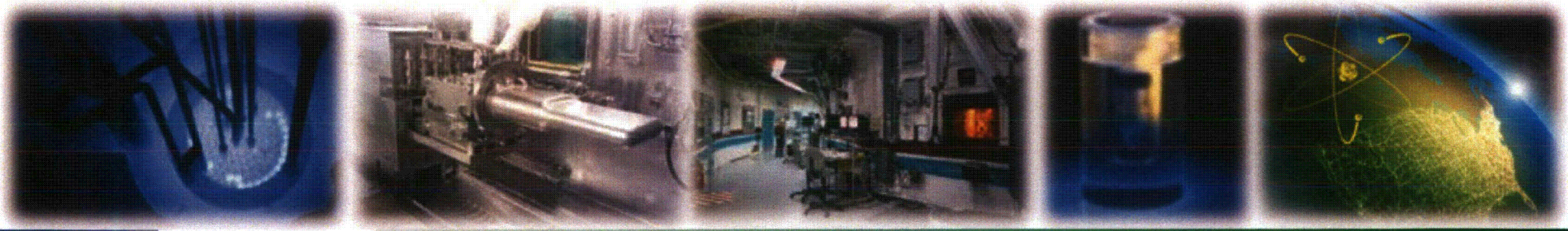
ENVIRONMENTAL REPORT OVERVIEW

April 29, 2014



Environmental Report Preparation

- Environmental report prepared to provide the NRC with the information needed to determine if an "finding of no significant impact" can be made or if an Environmental Impact Statement must be prepared
- Developed in accordance with provisions of 10 CFR 51 Attachment A "NEPA – Regulation Implementing Section 102 (2)."
- Follows Content and Organization of the "Final Interim Staff Guidance Augmenting NUREG 1537", Part 1, Chapter 19
- Affected Environment Prepared to Determine Baseline Conditions at Site of Proposed Action
    - Historical Data
    - Prior Studies
    - Geographic information system data
    - Field Surveys
    - Consultation

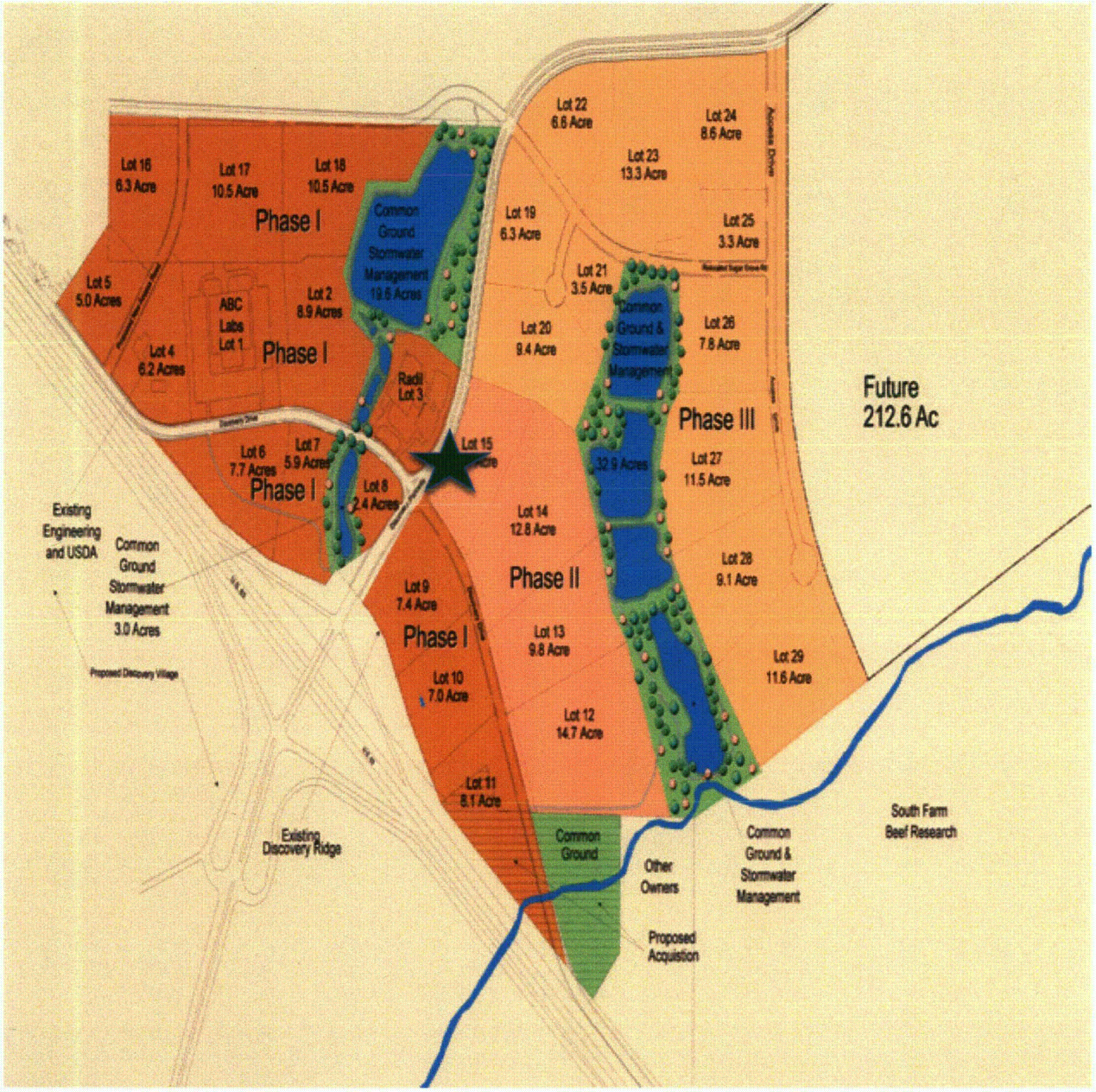
NWMI Proposed Action

- Given short half-lives of ^{99}Mo (66 hr) and ^{99m}Tc (6 hr)
  - ^{99}Mo cannot be efficiently stored over extended periods
  - Economics and medical utility of ^{99}Mo/^{99m}Tc are dependent upon minimizing decay losses
  - Logistical efficiency and just-in-time delivery are essential to realization of economic sustainability of global supply chain
- Proposed RPF activities
  - Receipt of LEU from DOE
  - Production of LEU microspheres and fabrication of targets
  - Delivery of LEU targets to University Reactor Network Participants
  - Return of irradiated LEU targets for dissolution, separations, and purification of ^{99}Mo
  - Reclaim/Recycle of LEU to minimize radioactive, mixed, and hazardous waste generation

Proposed Action

Issuance of an NRC license under 10 CFR Part 50 that would authorize NWMI to construct and operate an RPF for the production of ^{99}Mo at a site located in Columbia, MO

RPF Siting Status

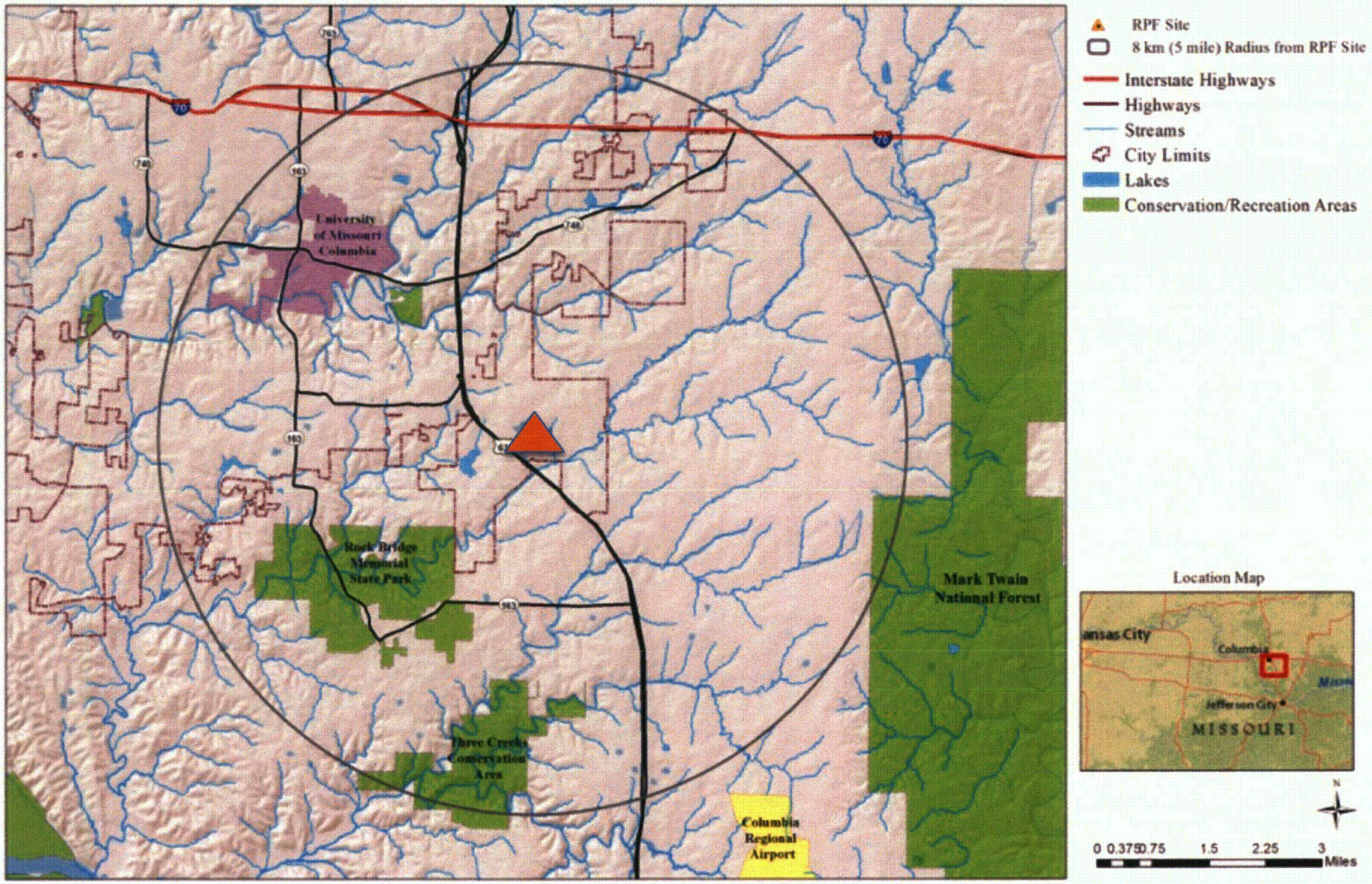


ASSUMPTIONS

- Completed Siting Recommendation for RPF; Discovery Ridge Research Park – Columbia, Mo (owned MU)
  - 7.4 Acre Parcel (Lot 15)
  - MURR is ~6 Miles from Site
- NWMI Optioned Site in November 2013
- Potential of MU/MURR Education/Research Building Co-Located with RPF

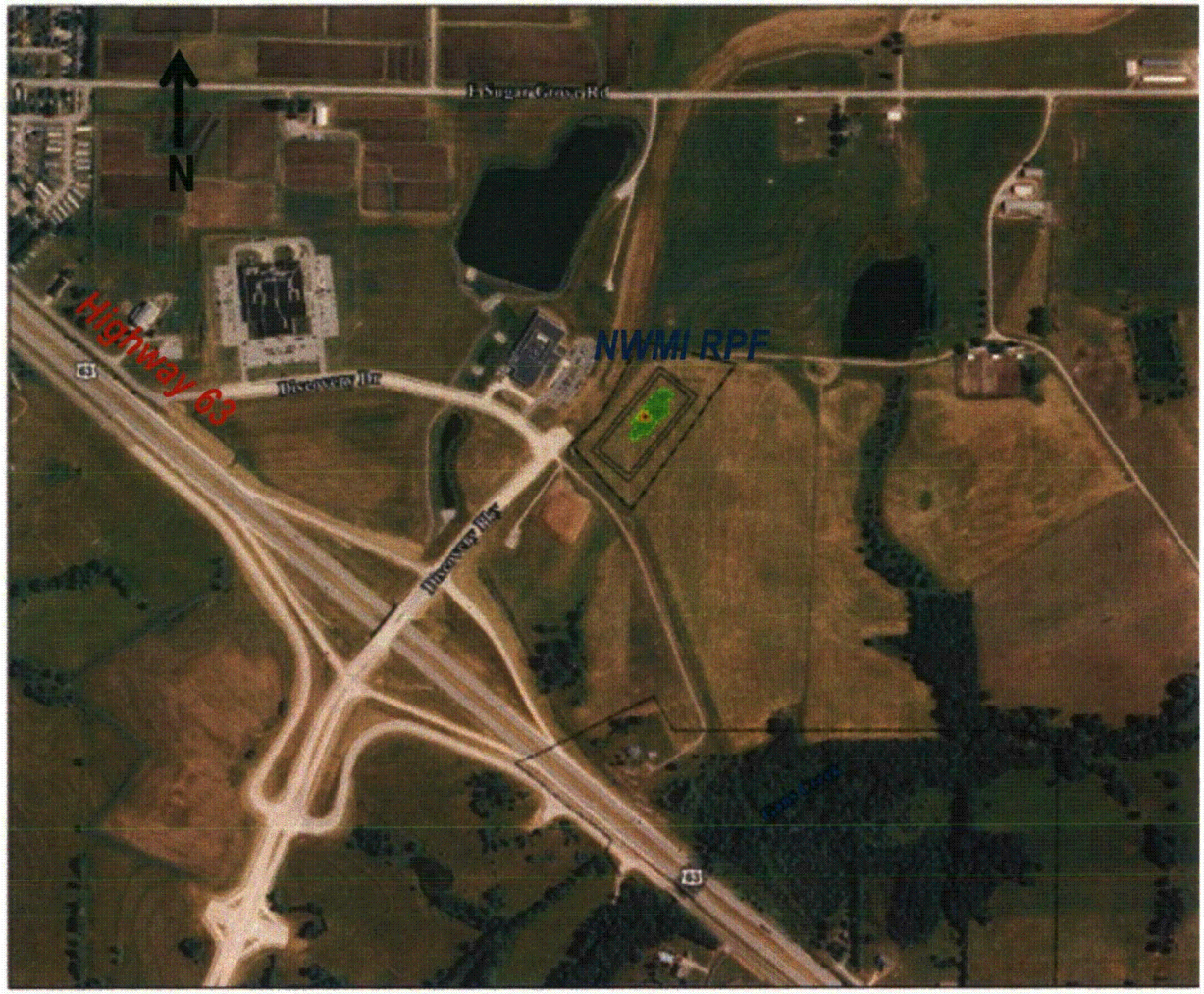
DISCOVERY RIDGE UNIVERSITY OF MISSOURI
Where Science Goes To Work

8 km (5 mi) radius from center of the facility

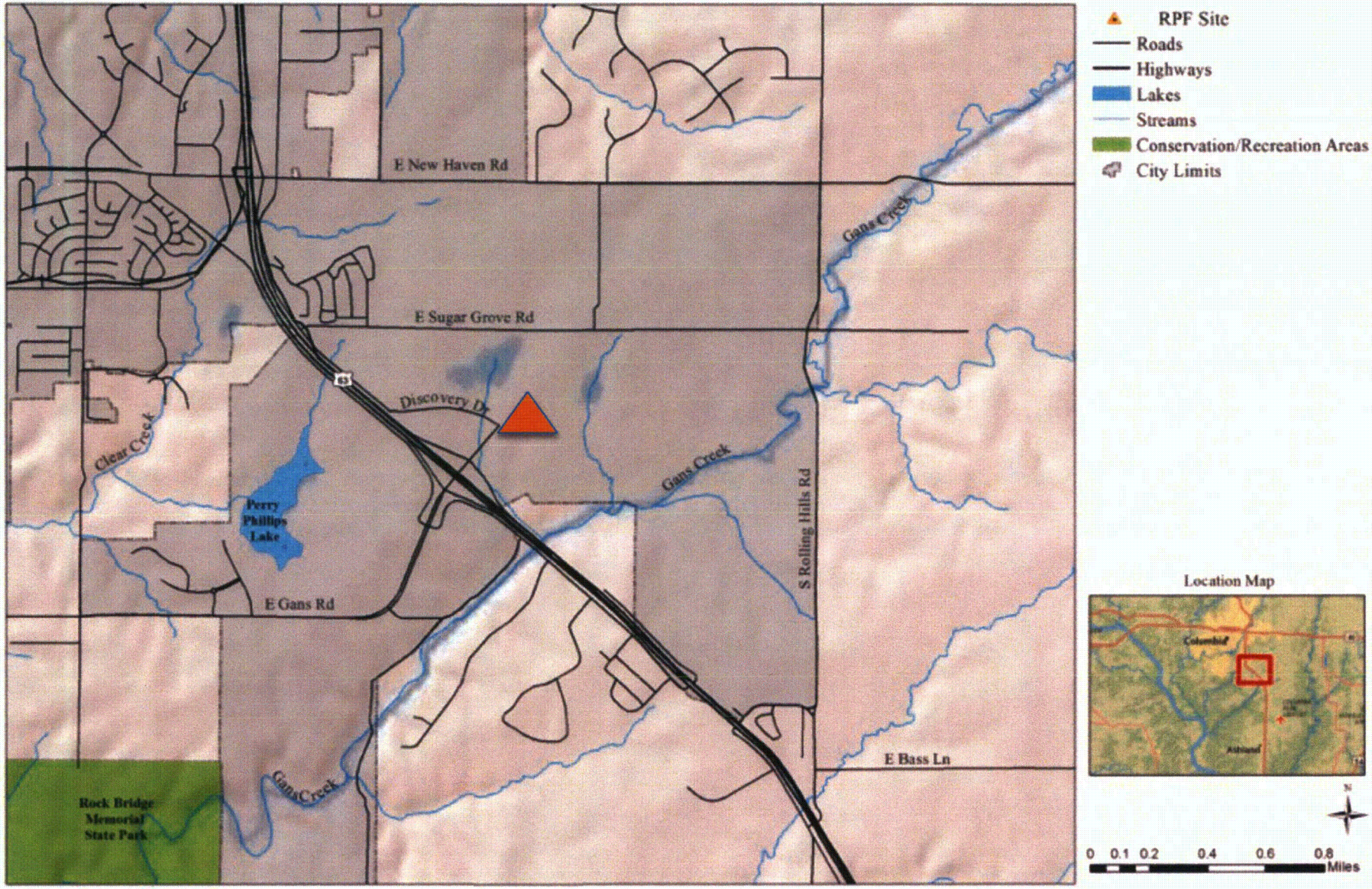


RPF Location and General Site Characteristics

- General Site Characteristics
  - Discovery Ridge Research Park in zoned as an industrial park
  - Agriculture land surrounding site
  - Clay loam till to depth of 12 feet over limestone
  - Groundwater at 12 to 18.5 feet
  - Static water level 650 feet Mississippian aquifer
  - Earthquake hazard area with peak accelerations of 2-3
  - New Madrid Seismic Zone 300 miles southeast of site
  - Gans Creek 0.25 miles southeast of the site
  - Nearest permanent resident 0.25 miles southeast



3.2 km (2 mi) radius from center of the facility



LAND USE AND VISUAL SETTING

Direct view of RPF Site from Discovery Parkway near Highway 63 overpass

Direct View of RPF Site from Discovery Drive looking south

Summary of Environmental Impacts

- ***Land Use and Visual Resources***
  - Land use set aside for a research park; similar to construction and operation of RPF
  - Loss of vegetation within RPF footprint
  - RPF would be designed to blend in with the current facilities
  - Impact: No degradation is anticipated associated with land use or visual resources
- ***Noise***
  - Construction: Visual, vibrational, and audible disturbance of Discovery Ridge tenants, employees, and nearby residents
    - Impact: Construction activities would result in a temporary increase in noise and limited to receptors close to site
  - Operations/Decommissioning: Increase in operational noise, generally, from process equipment, HVAC and generators
    - Impact: Operations/Decommissioning is anticipated to have noise levels well below noise limits

Summary of Environmental Impacts (con't)

- ***Air Quality***
  - Construction Impacts
    - Localized minor degradation of air quality from fugitive dust, combustion product emissions, volatile organic compound emissions from substances used during construction
    - Some emissions known to be greenhouse gases (GHGs) or contribute to secondary formation of GHGs and may persist in atmosphere
  - Operations/Decommissioning Impacts
    - Slight localized increases in vehicle and facility off-gas emissions, some known to be, or contribute to secondary formation of GHGs
      - Minor emissions of NOx and CO_2 along with levels of radionuclides below 10 CFR Part 20 levels
    - Releases of small amounts of fission products that are ≤ established allowable concentrations for residential receptors

Summary of Environmental Impacts (con't)

- ***Geologic Environment***
  - *Construction*
    - *Impact: Temporary, short-term increase in soil disturbance (e.g., minor compaction, erosion) and dust production during construction would be anticipated*
  - *Operations/Decommissioning*
    - *Impact: No degradation to the geologic environment would be anticipated during facility operations*
- ***Water Resources***
  - Nearest water body is 500 feet northwest of Lot 15 on Discovery Ridge Research Park
  - All surface water (e.g., stormwater runoff from building surfaces and paved areas) would be managed during construction with BMPs and not anticipated to impact surface or groundwater sources
  - No groundwater would be used during construction or operations
  - Impact: No degradation during construction or operations would be anticipated associated with water resources

Summary of Environmental Impacts (con't)

- ***Ecological Resources***
  - Discovery Ridge Research Park and Lot 15 is located on ground that has historically been used for agriculture purposes
  - No threatened or endangered species exist on or near Discovery Ridge Research Park
  - Potential for impact to fauna species near site due to noise levels at site during construction
    - Fauna would be expected to return to surrounding area after construction is complete
  - Potential impact to offsite aquatic environments would be mitigated with use of BMPs
  - Potential for bird strikes to elevated equipment during night construction
  - Impact: Temporary disturbance of transient wildlife and displacement of species residing within or near RPF footprint
- ***Historical and Cultural Resources***
  - Closest building on NRHP is 1.6 km (1 mi) to northwest of the Discovery Ridge Research Park
  - Construction and operation not anticipated to impact closest building to site
  - No historical or culturally important sites on or near Discovery Ridge Research Park
  - Impact: No degradation associated with historical and cultural resources at site is anticipated

Summary of Environmental Impacts (con't)

- ***Socioeconomics***
  - Construction and operation would result in a small increase in demand for housing, utilities, public schools, and other public services
  - Construction would result in increase amount of local traffic due to commuting construction workers and delivery of supplies and materials to site
  - Operations would result in increased local traffic from commuting employees and delivery of supplies and materials
  - Impacts:
    - Construction: Impact is anticipated to be small because majority of workers are anticipated to be obtained from local labor force
    - Operations: Slight increases in vehicle traffic, and minor traffic delays in immediate area of RPF

Summary of Environmental Impacts (con't)

- ***Human Health***
  - Workers
    - Potential hazards to workers during construction would be typical to those on a construction site
      - e.g., slips, trips, falls, heavy lifting, noise, sharp objects, and movement of heavy equipment
    - Impact: Public would have temporary and localized impacts due to fugitive dust, traffic, and air emissions
  - Chemicals
    - Chemicals used within RPF during operation would be contained within piping and tanks, limiting workforce and public exposure
    - Impacts:
      - Minor impacts to public would be experienced due to increased vehicle emissions from employee commuting and minor doses of radiation from transportations of radioactive materials
      - Radioactive gaseous emissions would be released which would be below regulatory limits

Summary of Environmental Impacts (con't)

- ***Waste Management***
  - All waste types will be managed in accordance with Federal State and local regulations
  - Waste types include Class A and C radioactive waste, hazardous waste, and solid waste
  - Result: Impacts are considered small
- ***Transportation***
  - Transportation required for fresh LEU, ^{99}Mo product, unirradiated targets, irradiated targets, waste disposal and commercial materials and chemicals
  - Results: Incident-free radiological dose
    - To workers – 2.42. person rem/year
    - To general public – 21.4 person rem-year
    - Maximum exposed individual during transport – 2.27E-04 rem
- ***Environmental Justice***
  - Construction and operation of RPF would not disproportionally impact minority and/or low income populations

Cumulative Impacts

- Evaluated incremental impacts of construction, operation, and decommissioning of RPF when combined with past present an reasonably foreseeable future project
- Identified 239 potential projects
  - City and county planning documents
  - Regional development agencies
- Reduced number of projects from 239 to 31 based on the following
  - Likelihood that project would occur
  - Likelihood that project would have short term/temporary impacts or long term impacts
  - Potential to contribute incremental impacts to during RFP's construction, operation, and decommissioning
- Impacts were evaluated for each resource area
  - Cumulative impacts were all determined to be small

Environmental Benefits and Report Conclusions

- *Other Costs*
  - No other environmental costs have been identified
- *Environmental Benefits*
  - Construction: Construction of RPF would result in 83 jobs at the peak of construction
  - Operations: Total of ~70 full-time jobs would be filled during operation at a salary higher than current Boone County average.
- *Expected Increase in Tax Payments*
  - Construction, operation and decommissioning of RPF would result in City of Columbia, Boone County, and Missouri additional tax revenue over 30 years
    - Construction → ~$1.7 million
    - Operation/Decommissioning → ~$73.6 million
- *Improvements to Infrastructure*
  - No improvements beyond those presently planned for Discovery Ridge infrastructure are expected for RPF construction or operation
- *Other Benefits*
  - Operation of RPF would benefit health of people who require diagnostic tests using ^{99m}Tc
  - RPF is anticipated to provide a reliable supply of ~50% of domestic need for ^{99m}Tc

Conclusions

- Impacts associated with construction, operation, and decommissioning of RPF on all resources evaluated in ER were found to be small or none.
- Mitigations (BMPs, etc.) will be implemented to minimize unavoidable impacts
- City of Columbia is accustom to similar type facilities that process isotopes and other nuclear activities
- Anticipated proposed action is considered to be non-controversial for surrounding community and State of Missouri
- Based on these results NWMI feels that an NRC Environmental Assessment would result in a Finding of No Significant Impact

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NORTHWEST MEDICAL ISOTOPES

NONRADIOLOGICAL HAZARDS

April 29, 2014

Environmental Effects Definitions

Classification	Definition*
Small	Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small as the term is used in the table.
Moderate	For the issue, environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
Large	For the issue, environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Notes *Definitions from 10 CFR 51, Appendix B, Subpart A, Footnote 3

Liquid Hazardous Chemicals Sources and Impacts

Process Chemicals

- Small Quantities (< 1000 lbs)
  - Acids
  - Bases
  - Oxidizers
  - Flammables
- > 1000 lbs
  - Nitric acid
  - Sodium Hydroxide
- Typical chemicals used in maintenance of an industrial facility

Impacts

- No point discharge to site
- No process wastes discharged to city sewer
- Other liquid wastes (e.g. sanitary) that are discharged to the city sewer system will meet Publicly Owned Treatment Works (POTW) requirements
  - Impact to the public will be SMALL
- Stormwater runoff will be managed by a Stormwater Management Plan approved by MO DNR during operation and construction
  - Impact to public will be SMALL

All Impacts to Public are Anticipated to be Small and Permitted by MO DNR or City POTW

Offgas Chemical Sources and Impacts

- Construction
  - Air emission sources generated during construction would be controlled by a Dust Management Plan
  - Nonradiological (vehicle combustion both on and off-highway)
    - CO < 3.1 tons
    - NO_2 < 0.9 tons
    - CO_2 < 710 tons
    - PM-10 < 60 lbs
    - PM-2.5 < 62 lbs
    - SO_x < 30 lbs
- Operations (5 stacks; Zone I, Zone II/III, laboratory, process boiler, HVAC boiler)
  - All RPF process effluents (Zone I) are vented to atmosphere through main stack
    - All radiological effluent below Table 2 10 CFR 20, Appendix B
    - Total stack discharge — Flow rate – < 1,150 in^3/min
  - Nonradiological contaminants (process boiler and HVAC boiler)
    - Total stack discharge — Flow rate 173 in^3/min
      Nitrogen oxides (NOx) < 5.32 tons/year
      SO_2 < 120 lbs/yr
      CO_2 ~12,780 tons/year
      Volatile organic carbons (VOC) < 1180 lbs/year

All Impacts to Public are Anticipated to be Small and Permitted by MO DNR

Solid Waste Sources and Impacts

- Construction
  - Mostly nonhazardous materials such as packing materials, paper, and scrap lumber shipped off site for disposal
  - Hazardous waste (paints solvents etc.) produced would be handled by approved methods and shipped offsite to approved disposal sites
  - BMPs to minimize the possibility of spills of hazardous substances
- Operation
  - Solid wastes encapsulated in cement
    - 5,900 L (13–120 gal drums)/year
  - High-dose solidified liquids
    - 72,000 L (19–130 ft3 HICs)/year
  - Low-dose solidified liquids
    - 370,000 L (100–130 ft3 containers)/year
  - Scrap metal, universal wastes, used oil and antifreeze would be collected, stored, and recycled or recovered at an offsite permitted recycling or recovery facility, as appropriate

All impacts of solid waste are Anticipated to be Small

Occupational Hazards and Exposure

- All Occupational Hazards to Workforce are Anticipated to be Small
- NWMI will be in Compliance with OSHA Regulations
  - Minimization of Physical Occupational Hazards To
  - No "Highly Hazardous Chemicals" will be in RPF During Operations Above Threshold Quantities (as defined in 29 CFR 1910.110, Appendix A)
    - Thus, Process Safety Management Requirements for Highly Hazardous Chemicals will not apply
- All Worker Exposure to Air Contaminants (e.g., NO_X, particulates, VOCs) in RPF will be Kept Below Threshold Limits in 29 CFR 1910.1000

All Occupational Hazards to Workforce are Anticipated to be Small

Nonradiological Hazards Mitigation

- Nonradiological impacts are controlled and mitigated by:
  - Construction
    - Implement Dust Control Plans
    - Implement Stormwater Management Plans
  - Operations
    - Zero Process Liquid Discharge Facility
    - Implement Stormwater Management Plans
    - Delivery of Other Wastewater to City of Columbia POTW
    - Gaseous Emission Controls, if needed
    - Waste Reduction Practices (e.g., recycling and minimization)

Public and Occupation Health Impacts form Nonradioactive Materials are Small

NWMI

NORTHWEST MEDICAL ISOTOPES

RADIOLOGICAL HAZARDS

April 29, 2014

Radiation Sources

- Gaseous Radiation Sources
  - Fission offgas from Dissolution System (e.g., Xe, Kr, I)
  - Process Vessel Vent System (PVVS)
- All Offgas (Zone I) released Through Single Vent Stack
  - Iodine is removed using silver zeolite or charcoal filters
  - Xe held up to allow for decay then release through activated carbon bed
- Liquid radioactive effluents
  - No Identified Effluent Pathways
  - All Liquid Wastes Recycled or Solidified and Disposed of as Solid Waste
- Fixed sources of radiation
  - None

Offsite Radiological Concentrations

- Airborne
  - Receptor locations
    - Maximally exposed individual (MEI) located on site boundary
    - Nearest full time resident
  - Calculation methodology
    - Releases based on generation rate with credit for holdup and iodine removal by silver zeolite or charcoal filters
    - Actual nuclide mix at time of release is used
- Water
  - No significant quantity of treated liquid wastes are generated at RPF, so there are no liquid effluent pathways
  - Annual average waterborne concentration is not expected to be greater than the baseline background concentration

Radiological Mitigations

- *Engineered Controls:* The facility would employ the following engineered controls to minimize radiation exposure to the public and workers
  - Radiation source identification
  - Shielding around radiation sources
  - Ventilation control
  - Access control to radiation areas
  - Contamination control
  - Remote operation
  - Waste minimization
  - Administrative controls
- *Administrative Controls:* To minimize radiation exposure to the public and workers, the facility would employ administrative controls, which would consist of written procedures, policies, and employee training in the following subject areas
  - General environmental activities; hazards regarding the facility
  - Waste minimization requirements and goals
  - Radiation safety; workforce protection
  - ALARA principles
  - Specific environmental issues and responsible environmental stewardship
  - Continual improvement
  - Regulation compliance

Radiological Effluent Monitoring

- Purpose
  - Purpose of the radiological effluent monitoring program is to identify and quantify principal radionuclides in effluents (RG 1.21, Regulatory Position C.1)
  - Effluent Monitoring is used to verify:
    - Doses to the public are within limits in 10 CFR 20.1301
    - Doses due to airborne emissions meet the ALARA requirement in 10 CFR 20.1101(d)
  - All pathways that could have significant radiological effluents would be monitored
- Liquid Effluent Monitoring
  - Zero process liquid discharge; extensive recycle/reuse of process wastewater
  - No defined liquid release pathways
    - Radiation monitoring for liquid effluents not required

Radiological Effluent Monitoring (con't)

- Gaseous Effluent Monitoring
  - Gaseous effluent sources
    - Process Vessel Vent System (VVS) exhaust
      - Subsystems: Dissolver, Iodine Based System, Non-I Based System
    - Target Fabrication VVS exhaust
    - Zone 1 Ventilation System Exhaust
  - Treatment of gaseous effluents
    - All pathways that could contain significant quantities of iodine are passed through silver impregnated zeolite or activated carbon filters
    - Xenon held up to allow for prior to release
    - All effluents pass through final HEPA filters before exhaust
  - RPF primary release point – vent stacks (~61Ft High)
  - Monitoring of vent stack exhaust
    - Continuous air monitoring of Gross Gamma
    - Periodic sampling of noble gasses, Iodine, particulates, etc.

Radiological Environmental Monitoring

- Purpose of the radiological environmental monitoring program is to verify effectiveness of measures to control radioactive effluents and pathway analysis used in dose estimates (10 CFR 20.1302)
- Guidance in RG 4.1 and NUREG 1301 considered in the development of the NWMI program
- Four radiation exposure pathways would be monitoring under the radiological environmental monitoring program
  - Waterborne exposure pathway
  - Direct radiation exposure pathway monitoring using thermoluminescent dosimeters (TLDs)
  - Airborne exposure pathway monitored using continuous are samples
  - Ingestion exposure pathway

Waterborne Exposure Pathway

- RPF designed to have zero liquid discharge from RPF's Radiological Controlled Area
  - Surface Water
    - No release of water from RPF to adjacent environment that would affect surface water
    - Similarly, aquatic life in rivers is not expected to accumulate detectable levels of radioactivity
    - Result: Sampling of surface water or fish or other aquatic creatures are not included in Radiological Environmental Monitoring Plan
  - Groundwater
    - Groundwater aquifer beneath RPF Site/Discovery Ridge Research Park is Mississippian aquifer
    - Since there are no defined liquid effluent release pathways; groundwater is not expected to become contaminated due to RPF operations
    - Result: Groundwater sampling is not Included in Radiological Environmental Monitoring Plan

Ingestion Exposure Pathway

- NUREG 1301 suggest sampling of various biological media (biota monitoring) as a means to indirectly assess doses due to particulate and iodine ingestion
  - e.g., Soils, Broad-Leafed Plants, Fish, Meat, or Milk
- Considering that particulates and ^{133}I are not normally expected to be present in measurable quantities within RPF airborne effluent releases, biota monitoring would not be performed
- If results of environmental airborne samples indicate the presence of particulates or ^{133}I in measurable quantities or they they exceeds 10% of dose constraint at property line (i.e., 1 mrem/yr), a Monitoring Program Would be Implemented
  - Since milk is an important food product that contributes to radiation dose to people (e.g., ^{133}I) and is a better indicator in environment rather than vegetation; vegetation sampling (e.g., broad leaf) would not be required
  - If monitoring would be required, cow and/or goat milk samples would be obtained from dairy production sites
    - Bi-Monthly when animals are on pasture
    - Monthly basis at all other times
    - I-131 analysis and a gamma isotopic analysis would be performed on the samples

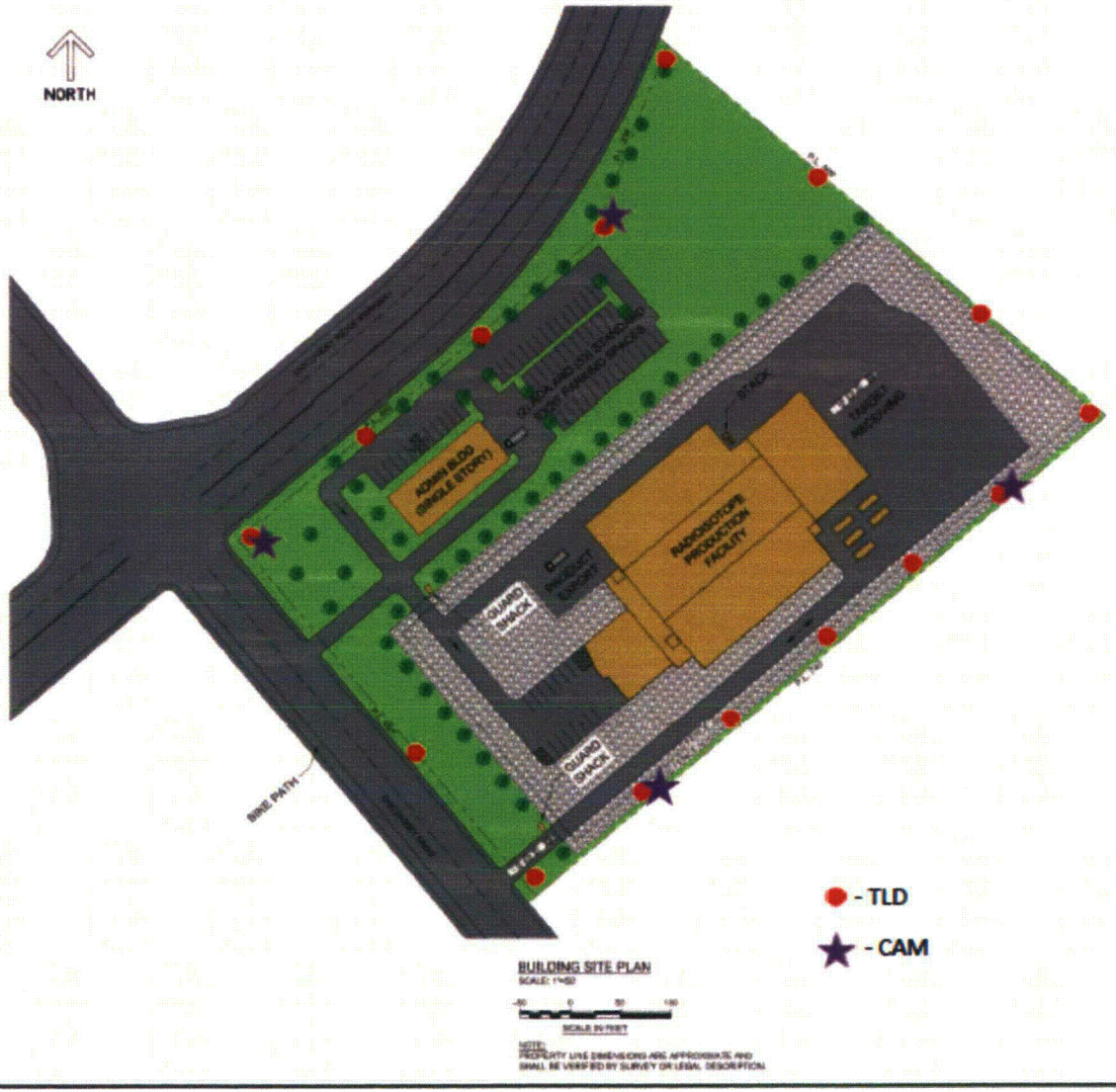
Direct Exposure Pathway

- Direct exposure is measured using thermoluminescent dosimeters (TLDs)
- Criteria for selecting TLD locations
  - Occupied areas within site boundary
  - Property line locations, including locations in the direction of significant offsite activities
  - Control (background radiation)
- Per NUREG-1301 and Our Evaluation – 40 TLD locations are recommended
  - 7 TLDs located on outside of RPF including entry points where personnel may congregate
  - 1 TLD located on outside wall near Target Fabrication Area of RPF to Measure Direct Radiation for Processing Area
  - 16 TLDs located on fence line around RPF (e.g., Place at All 4 Corners of Lot 15 and Remaining TLDs place at approximately equal distances from each other)
  - 1 TLD To serve as a control TLD; Located at a significant distance from RPF (e.g., background)
  - 1 TLD will be located with another TLD so that data reliability/quality can be evaluated

Airborne Exposure Pathway

- Airborne effluent releases from RPF (vent stacks) contribute to offsite doses
  - Expect measurable quantities of noble gas radioactivity (i.e., Xe and Kr) and other release include radioactivel, radioactive particulates, and tritium
- Environmental airborne sampling performed to identify/quantify airborne effluents
  - Regulatory Position C.3.b of Regulatory Guide 4.1 (NRC, 2009b) indicates airborne sampling should always be included in environmental monitoring programs
  - Since RPF includes radiological airborne effluent release and could result in measurable offsite doses, a Radiological Environmental Program will include airborne sampling
- Guidance provided in Table 3.12-1 of NUREG-1301 is used to establish locations for airborne sample acquisition, sampling frequency, and type of sample analysis
  - Continuous air monitors (CAM) include
  - Radioiodine canister for weekly Iodine analysis
  - Particulate sampler which is analyzed for gross beta activity and quarterly isotopic analysis
- Four CAM locations would be located near fence line
  - 1 CAM location in direction of prevailing wind (e.g., N-NW)
  - 2 CAM locations will be at remaining cardinal directions (e.g., 90°) from CAM-1 location
  - Additional CAM located at sufficient distance from RPF for background information

Location of Environmental Fence-Line TLDs and CAMs



Reporting

- Reports prepared on an annual basis for a 1 year period
  - Effluent Release Report: radioactivity effluent discharges
  - Environmental Operating Report: environmental surveillance report
- Environmental Operating Report will also include
  - Laboratory inter-comparison program to crosscheck sample analysis results
  - Land use census conducted during the growing season to determine the location of the nearest milk animal

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TRANSPORTATION

April 29, 2014

Materials to be Transported

- Nuclear materials
  - Fresh LEU from DOE
  - ^{99}Mo product produced at RPF
  - Unirradiated targets from RPF to University Network
  - Irradiated targets from University Network to RPF
  - Radioactive waste
    - All Waste types are expected to be Class C or Less
    - Spent LEU
- Non-nuclear materials
  - Hazardous waste
  - Non-hazardous waste

Transportation (con't)

- Fresh LEU
  - Shipment Origin: USDOE Y-12 Facility
  - Destination: Columbia, MO (Discovery Ridge) → ~590 Miles
  - Transportation Mode: Ground Using Certified Cask (e.g., ES-3100)
  - Annual Shipments – 1
- ^{99}Mo Product
  - Shipment Origin: Discovery Ridge (Columbia, MO)
  - Destination:
    - Lantheus Medical Imaging (Billerica, MA) → ~8 Miles to Columbia Region Airport via ground transport → Air transport to Logan International Airport → ~31 Miles to Lantheus Campus via ground transport
    - Mallinckrodt (St. Louis, MO) → ~112 Miles via ground transport
  - Transportation Mode: Air/Ground Using Certified Cask (e.g., Midas)
  - Weekly Shipments – 2 each with 4-5 casks

Transportation (con't)

- Unirradiated Targets
  - Shipment Origin: RPF in Columbia, MO
  - Destination:
    - MURR (Columbia, MO) → ~6 miles
    - OSU (Corvallis, OR) → ~2063 miles
    - 3rd Reactor → TBD
  - Transportation Mode: Ground using certified cask bi-weekly shipment
- Irradiated Targets
  - Shipment Origin: University Reactor
  - Destination: Columbia, MO
    - MURR (Columbia, MO) → ~6 miles
    - OSU (Corvallis, OR) → ~2063 miles
    - 3rd Reactor → TBD
  - Transportation Mode: ground using certified cask [e.g., BEA Research Reactor Cask (BRR Cask)]
  - Weekly Shipments – 2

Radioactive Waste

- Radioactive Waste (as described previously)
  - All shipments will originate from Columbia, MO
    - Waste Control Specialists (Andrews, TX) → 913 Miles
  - Transportation of radioactive waste will be by ground transport in appropriate certified casks
  - Solid waste/trash consolidated and shipped as LSA
  - Higher activity solid waste (resins/zeolite) and liquid waste is stored on site for decay, solidified and shipped as LLW
  - Expect 12 shipments per year
  - All shipments in packages that meet NRC/DOT requirements

Incident-Free Transportation Approach

- Incident-free radiological doses are determined for members of the public and workers that are involved in transportation of the LEU, irradiated and un-irradiated targets, ^{99}Mo product, and radioactive wastes (transportation workers and handling workers)
- Transport modeling code: RADCAT/RADTRAN
  - Calculates dose/shipment: members of public and transportation workers (drivers/ handlers)
  - Key inputs: package dose rates, transport route and population density
- Highway route and distance traveled determined by use of route data from MapQuest and applicable GIS data available from ArcGIS software
- Census data files were used to derive the population density along the route (USCB, 2010)

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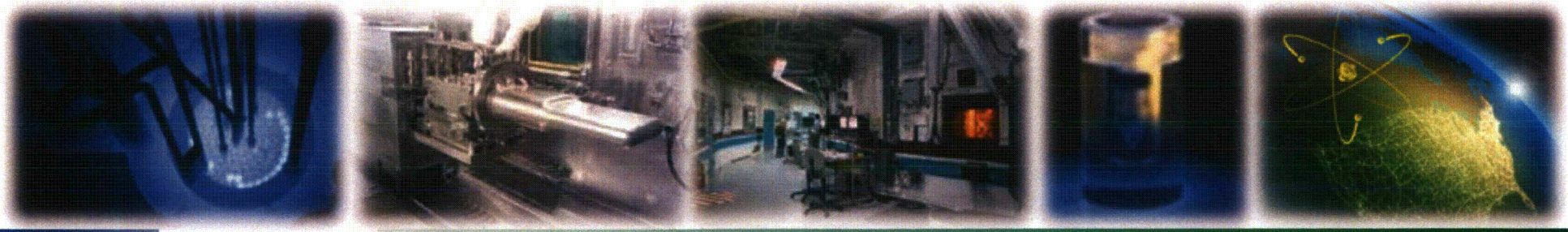
WASTE MANAGEMENT

April 29, 2014



Primary Assumptions

- RPF will not generate spent nuclear fuel or high-level waste per the Nuclear Waste Policy Act of 1982
  - Determination is based on 10 CFR 50.2 "Reactor Definition"
    - "Nuclear reactor means an apparatus, other than an atomic weapon, designed or used to sustain nuclear fission in a self-supporting chain reaction."
  - 10 CFR 50.2 definition specifies that the RPF does not meet this definition as it is not designed nor will it be used to sustain nuclear fission
- NUREG-1537, Final Interim Staff Guidance (2014) defines RPF as a non-reactor (e.g., RPF not designed nor will it be used to sustain nuclear fission)
- Any waste that does not have a disposal pathway will be disposed of by USDOE per S.99 (e.g., greater than Class C waste or spent LEU)

Process System Liquid Waste

- Where practicable, liquid wastes would be condensed and/or treated or recycled to reduce environmental impacts associated with disposal
- All of liquid waste streams generated during processing operations would be handled with a aqueous waste handling

Process	Annual Waste (gallons)
Target fabrication[a]	6,604
Target disassembly and dissolution[a]	13,209
^{99}Mo separation and purification system[a]	660.4
Uranium purification and recovery system[a]	245,812
Waste processes	[b]
Laboratory facilities	528.3
Facility support	TBD

[a] Annual waste transferred to waste processes for concentration and solidification
[b] Wastes processed do not produce liquid waste other than small quantities of specialty wastes.

Solid Waste Produced at RPF

- Where practicable, solid wastes would be condensed and/or packaged to reduce the environmental impacts associated with disposal

Process	Components	Annual waste
Target fabrication[a]	LEU heels	~13 kg (28.7 lb)
Target disassembly and dissolution[a]	Target cladding materials from disassembly	2,000 L (528.3 gal)
^{99}Mo separation and purification[a]	Exchange resins and other solid waste	Minimal L (Minimal gal)
Uranium purification and recovery[a]	Exchange resin and exchange media	~480 L (~127 gal)
Waste processes[b]	Solid wastes encapsulated in cement	5,900 L (13–120 gal drums)
	High-dose solidified liquids	72,000 L (19–130 ft^3 HICs)
	Low-dose solidified liquids	370,000 L (100–130 ft^3 containers)
Laboratory facilities	Municipal waste (e.g., chemicals)	4,000 L (1,056 gal)
	Potentially contaminated laboratory waste (e.g., sample vials and containers)	
Facility support	Municipal waste (e.g., paper)	26,000 L (6,868 gal)
	Potentially contaminated waste (e.g., decontamination materials, PPE)	40,000 L (10,566 gal)

[a] Transferred to waste processing system for final disposition.

[b] Waste quantities current bounding estimates. Optimization of waste processing should reduce the volume of liquid waste generation.

PPE = personal protective equipment.

Specialty Waste

- Specialty waste disposal system would address small quantities of unique wastes generated by other processes
- A reclamation process would be included to recycle trichloroethylene from waste liquid. Specialty wastes are assumed to be shipped offsite for treatment and disposal
  - Used silicone oil
  - Solvent waste
  - Facility maintenance fluids (e.g., paints, lubricants)
  - Spent batteries, spent fluorescent lighting tubes, and others
  - Personal protection equipment waste
  - Laboratory waste for expired chemicals and expired radioactive sources

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INSTRUMENTATION AND CONTROL

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Control System Requirements

- RPF will house a U-235 inventory greater than 700 grams
  - I&C system will include and Criticality Accident Alarm System (CAAS)
- RPF will have both CAMs and area radiation monitors (ARMs)
  - Will monitor continuously to detect high contamination and radiation respectively
- I&C for IROFS and Engineered Safety Features
  - System will include alarm on failure, redundancy, diversity and voting, where necessary, to ensure adequate reliability
- I&C systems will be matured in more detail during development of PSAR/FSAR and TechSpecs

NWMI

NORTHWEST MEDICAL ISOTOPES

SAFEGUARDS & SECURITY

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RPF Physical Security

- RFP is assumed to be a Category II facility
- Will incorporate applicable aspects of Regulatory Guide 5.59 [Rev. 1], "Standard Format and Content for a Licensee Physical Security Plan for the Protection of Special Nuclear Material of Moderate or Low Strategic Significance"
  - Physical Security Plan/Program
  - Safeguards Contingency Plan
  - Training and Qualification Plan
- NWMI is aware of recent changes/discussions
  - NUREG-2155, Implementation Guidance for 10 CFR Part 37, "Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material"
  - RPF safety/security interface
- Items for discussion
  - Obtaining additional information on fuel cycle facility orders
  - Details on vulnerability assessment process

Material Control and Accountability

- RFP is assumed to be a Category II facility
- Follow NUREG-1065 [Rev. 2] "Acceptable Standard Format and Content for the Fundamental Nuclear Material Control Plan Required for Low-Enriched Uranium Facilities"
- NWMI aware of recent changes to 10 CFR 74
  - Implementation of NUREG-2159 (DRAFT Report for Comment), Acceptable Standard Format and Content for the Material Control and Accounting Plan Required for Special Nuclear Material of Moderate Strategic Significance"
  - Assume RPF would follow subpart A (General Provisions) and B (General Reporting and Recordkeeping Requirements)
  - Waiting for clarification on applicability of other revisions to RFP licensed under 10 CFR 50 (i.e., a utilization facility but not a reactor nor ISFSI)

Cyber Security

- Will develop a cyber security plan for how requirements of 10 CFR 73.54, "Protection of digital computer and communication systems and networks" are implemented
  - Intent of the plan will be to protect the health and safety of the public from radiological sabotage as a result of a cyber attack.
  - Incorporate Regulatory Guide 5.71, "Cyber Security Programs for Nuclear Facilities"
  - Likely incorporate (as applicable) NEI 13-10 [Rev. 0] Cyber Security Control Assessments
  - Likely incorporate (as applicable) NEI 08-09 [Rev. 6] Cyber Security Plan for Nuclear Power Reactors
- Aware of cybersecurity executive order and Presidential Policy Directive (PPD)-21 on critical infrastructure and resilience
- Aware of most aspects of the draft order for fuel cycle facilities