Outline for Criticality Safety Pre-application meeting

- Crit safety program overview
  - Overview
  - Nuclear Criticality Safety Policy
  - Nuclear Criticality Safety Evaluation Procedure
- ISA (Crit Safety Component)
  - ISA Methodology (flowchart, hazard categories, criteria for accident sequences, consequence category, likelihood tables, risk tables.
  - Pre-Hazard Analysis
  - Sample accident sequences and IROFS identification - criticality safety focus
- MCNP Code Validation
  - Procedure
  - Methodology
NUCLEAR CRITICALITY SAFETY PROGRAM
Summary of NCS and ISA

- Incorporate NCS with other health and safety programs into organization
- Establishing NCS program
  - Consultants, hiring, and on-the-job training to fill staffing roles
  - Begin validation of MCNP transport code for $k_{\text{eff}}$ calculations
- Design of UTA was mature enough so the ISA of this node and ancillary equipment has commenced. Emphasis on criticality safety.
  - Staff ISA teams (with consultants) and execute ISA methodology
- Draft ISA Procedure RP 24.0 completed.
Mo-99 Commercial System Overview

Accelerator Driven Neutron Source (x2)
- Electron Beam Power: 200 kW = 40 MeV x 5 mA
- Neutron Source Intensity: ~ 2.0 x 10^{14} n/s

Uranium Target Assembly
- \( k_{\text{effective}} \): \leq 0.95
- LEU Target Mass: XXX kgU
- NU Target Mass: 60 kgU
- LEU Fission Power: 138 kW
- NU Fission Power: 21 kW
- Mo-99 Activity Produced: 6 kCi/week EOB

Uranium Cycle & Isotope Pipeline
- NU processed: 60 kgU/week
- LEU processed: None
- Mo-99 Activity Extracted & Shipped: 0.8 kCi/week EOB (2% US Demand)
- Other Isotopes: Xe, I, Sr, Lanthanides
Layout of Building
Standards & Guides

- Niowave commits to following the guidance in the following regulations and standards as applicable:
  - NUREGs: 1513, 1520
  - Regulatory guide 3.71
  - ANSI/ANS-8 national standard
    - ANSI/ANS-8.3, (ANSI N-16.2), Criticality Accident Alarm System
    - ANSI/ANS-8.6, Safety in Conducting Subcritical Neutron-Multiplication Measurements In Situ.
    - ANSI/ANS-8.15, Nuclear Criticality Control of Special Actinide Elements.
    - ANSI/ANS-8.26, Criticality Safety Engineer Training and Qualification Program.
Nuclear Criticality Safety Program
RSP 10.0

- Responsibilities for NCS Program Management
- Operating Organization
- NCS Organization
- Configuration Management
- Procedures
- NCS Training
- Criticality Alarm Systems and Emergency Planning
- NCS Program Monitoring
Nuclear Criticality Safety Evaluations
RP 20.0

(ANSI/ANS-8.26)

3 LEVELS OF NCS ENGINEER

- Engineer in Training
- NCS Engineer
- Senior NCS Engineer

- Administration / Records Management

- CSE Development
  - Analyst
  - Peer reviewer (Senior Engineer)
  - Operations validates the CSEs
INTEGRATED SAFETY ANALYSIS
Preliminary Hazard Analysis #1

- Niowave Commercial Mo-99 Facility - Irradiation Processes
- Conducted on March 27-30, 2023 at the Niowave offices

Scope of analysis

- Node 1: Superconducting Electron LINACs
- Node 2: Lead-Bismuth Eutectic (LBE) Liquid Metal System
- Node 3: Uranium Target Assembly (UTA)
  - UTA
  - UTA tank & water pool
  - LEU rod movement & storage in facility
- Node 4: Auxiliary Cooling Systems
  - UTA primary & secondary cooling
  - LBE cooling
Preliminary Hazards Analysis Flow Diagram

Guidance
- NUREG – 1513 Integrated Safety Analysis Guidance Document
- Center for Chemical Process Safety, Guidelines for Hazard Evaluation Procedures
MCNP CODE VALIDATION
Validation of Neutron Transport

(ANSI/ANS-8.24)

- NCS Calculation Method Validation
  - MCNP 6.2 with point wise cross sections
  - Benchmark against available nuclear experimental data
  - Appropriate selection of benchmark experiments based upon range of applicability
  - Establishment of bias, bias uncertainty, and margins
  - Margin of subcriticality and its basis shall be documented
  - An upper subcritical limit and the methods documented
  - Configuration management of the server and the code itself
THANK YOU