MIDUS Transportation Package
NRC Pre-Submittal Meeting

Rockville, MD

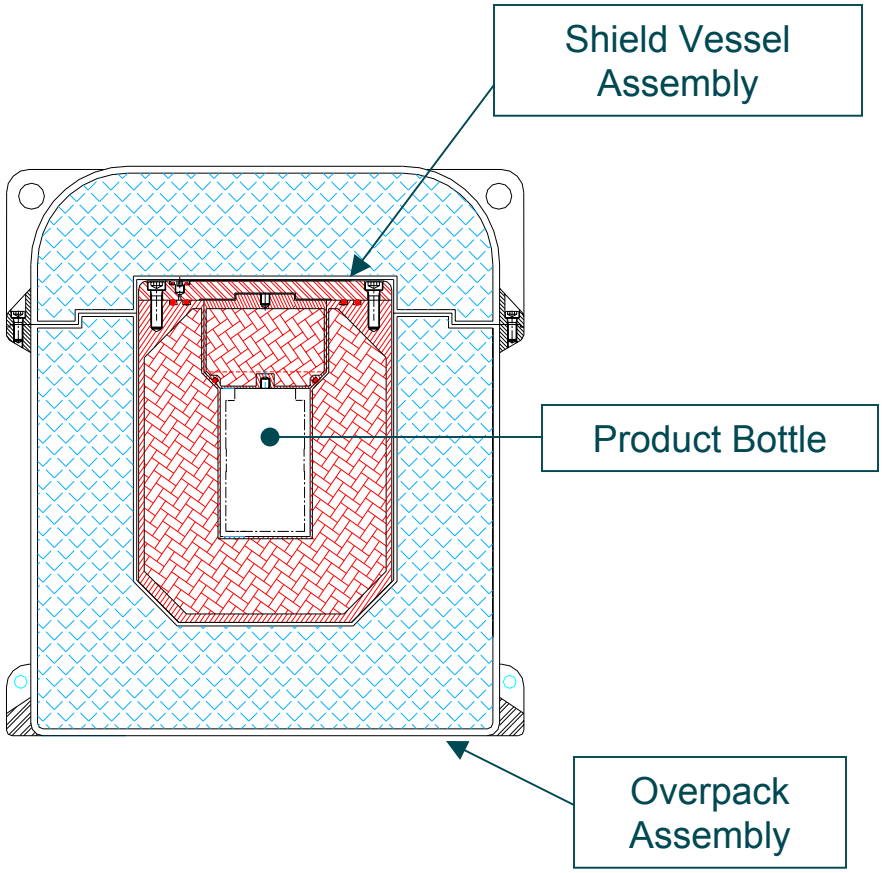
July 21, 2005

Package Overview

- Package ID: MIDUS
- Package Type: B(U)
- Contents: Molybdenum-99 (Mo99)
- Chemical Form: NaNO3/NaOH solution
- Maximum Activity: 4,500 Ci
- Maximum Height: ≤22 inches (560 mm)
- Maximum Weight: <550 lb. (250 kg)
- MNOP: ≤ 100 psig (700 kPa)
- Transport Mode: Air freight and truck
- Transport Index (TI): ≤ 10 per 10CFR71.47(a)
  - Airlines restriction: TI ≤ 3 (TI < 1 expected)

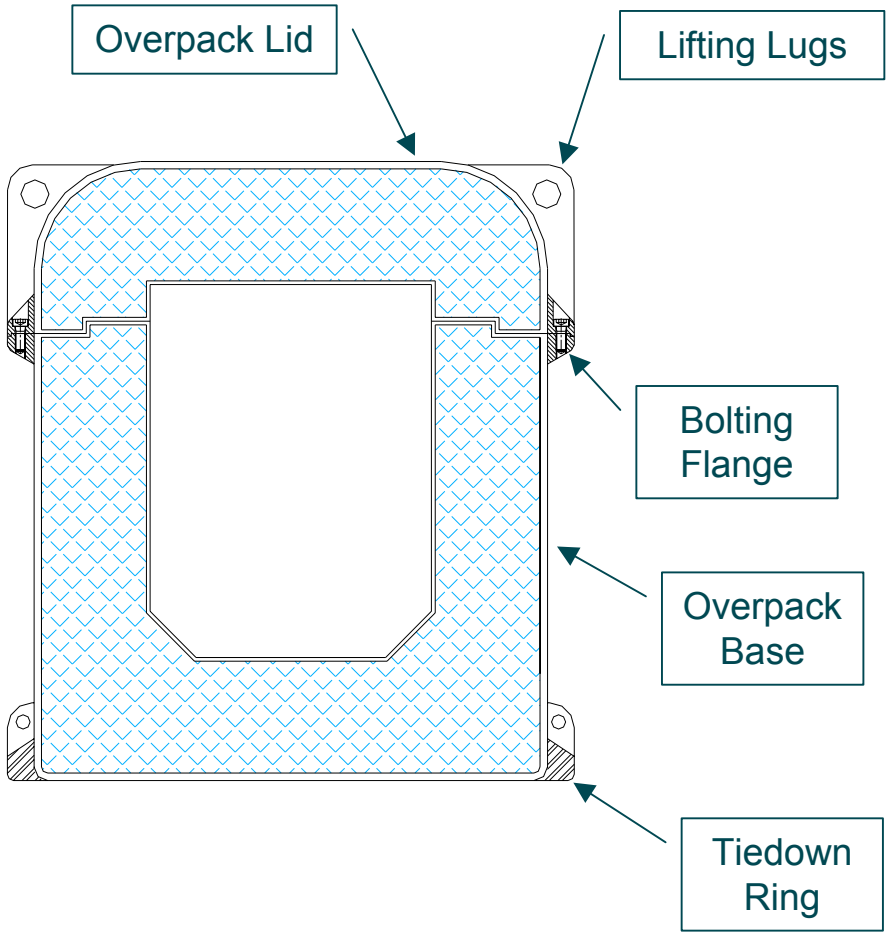
Transportation Package Concept

- Package Dimensions
  - Height: 20 in. (500 mm)
  - O.D.: 18 in. (460 mm)
- Materials of Construction
  - All exposed package surfaces are stainless steel
    - > Corrosion resistance
    - > Fracture toughness
  - DU shielding
  - Polyurethane foam overpack energy absorbing material



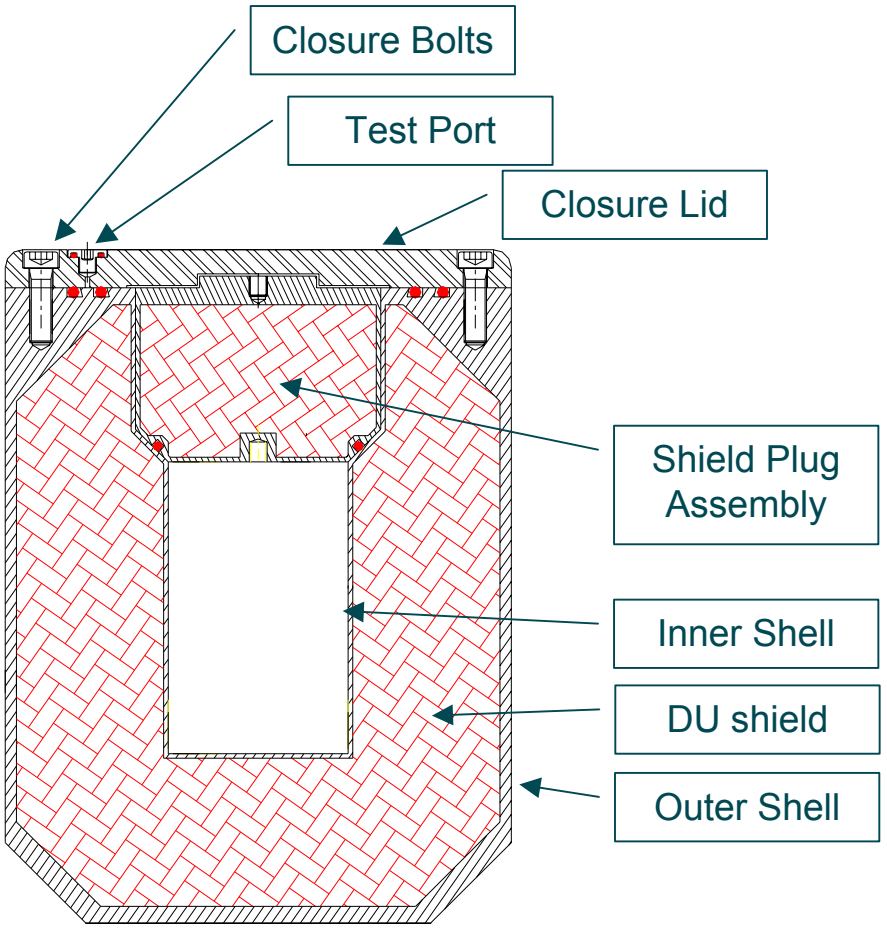
Overpack Assembly Concept

- Two-Piece Construction
  - Stainless steel external surfaces
  - Polyurethane foam or wood cores
- Mitigates Shield Vessel Impact Loading
- Insulates Shield Vessel during HAC Fire
- Lid bolted to base at flange
- Lifting lugs support entire package weight
- Tiedown ring adds stability



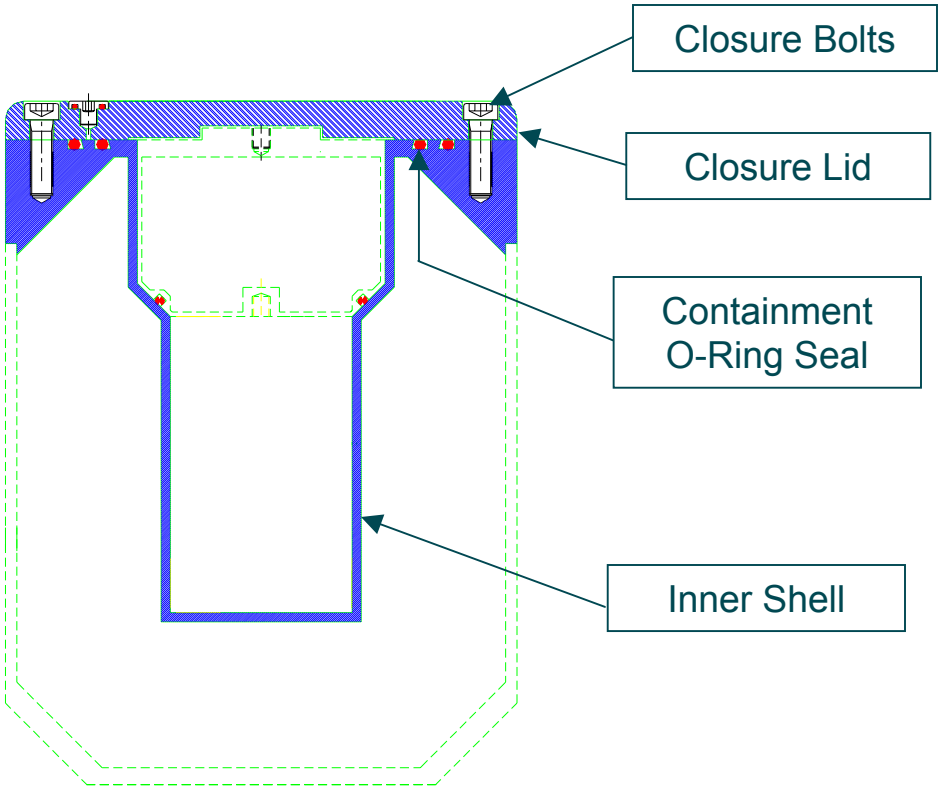
Shield Vessel Assembly Concept

- External Dimensions:
  - Height: 11.8 in. (300 mm)
  - O.D.: 8.9 in. (225 mm)
- Cavity Dimensions:
  - Length: 5.1 in. (130 mm)
  - Diameter: 3.1 in. (80 mm)
- Weight ≈ 400 lb. (180 kg)



Containment System Concept

- Containment System:
  - Inner vessel
  - Closure lid
  - Closure bolts
  - Containment O-ring seal
- No Welds on Containment Boundary
  - Shield vessel inner shell machined from single piece
- No Credit Taken for Containment Provided by Product Bottle



General Design Criteria

- Satisfy Requirements of 10 CFR 71, Subparts E and F
  - 71.43 – General Standards for all Packages
  - 71.45 – Lifting and Tiedown Standards
  - 71.47 – External Radiation Standards for all Packages
    - > Dose less than 2 mSv/h (200 mrem/h) on all external surfaces
    - > TI ≤ 10 (design provides TI < 1)
  - 71.51 – Additional Requirements for Type B Packages
    - > Permitted release limits per 71.51(a)
  - 71.61 – Special Requirements for Type B Packages Containing More Than $10^5 A_2$
    - > Not applicable for content activity (4,500 Ci < 1.6×10^6 Ci)

General Design Criteria

- 71.71 – Normal Conditions of Transport
  - Heat
  - Cold
  - Reduced External Pressure
  - Increased External Pressure
  - Vibration
  - Water Spray
  - Free Drop
    - > 4-feet (1.2m) onto unyielding horizontal surface in orientation expected to cause maximum damage…
  - Corner Drop (not applicable, 250 kg > 50 kg criterion)
  - Compression
  - Penetration

General Design Criteria

- 71.73 – Hypothetical Accident Conditions
  - Free drop
    - > 30-feet (9m) onto unyielding horizontal surface in orientation expected to cause maximum damage…
  - Crush (not applicable, 4,500 Ci < 16,000 Ci)
  - Puncture
  - Thermal
  - Immersion – Fissile Material (not applicable, no fissile material)
  - Immersion – All Packages
- 71.85(b) – Internal Pressure Test (150% MNOP)

General Design Criteria

- General Structural Design Criteria per RG 7.6
  - Design-by-Analysis (NUREG-1609)
  - Allowable stress design criteria
    - > Containment system: ASME Subsection WB
    - > Non-Containment components: ASME Subsection NF
  - Structural material properties per ASME, Section II, Part D
- Load Combinations per RG 7.8
- Closure Bolts Designed per NUREG/CR-6007
  - No plastic deformation of closure bolts or closure sealing surfaces due to all NCT and HAC tests
- Buckling
  - ASME Code Case N-284-1

Design/Licensing Plan

- Drop Loads Analysis
  - Upper and lower bound force-deflection curves will be determined for each impact orientation using ANSYS
    - > Developed based on the upper and lower bound stress-strain curves for overpack energy absorbing material considering:
      - Manufacturing tolerances
      - Temperature effects
      - Dynamic effects
    - > Including contribution from stiffness of overpack shells
  - Non-linear transient dynamic finite element analyses used to predict response of package
  - Confirmatory testing performed to demonstrate adequacy of analytical tools/methods

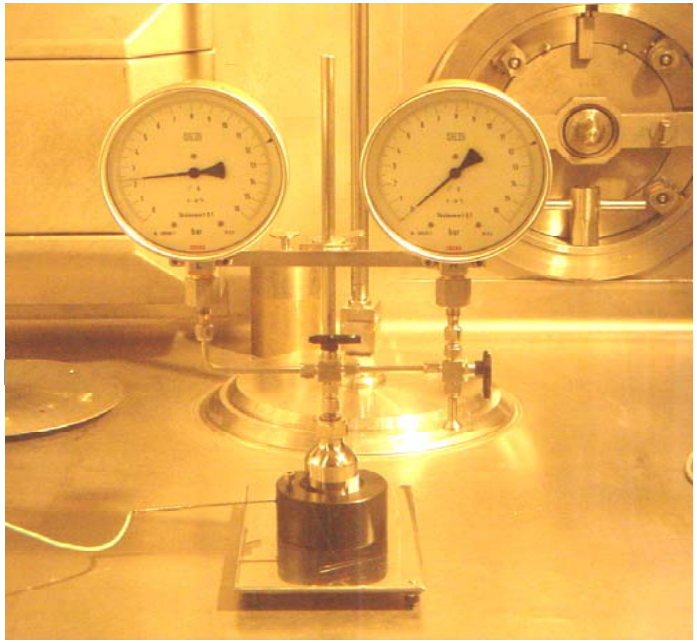
Design/Licensing Plan

- Thermal Analysis Using SINDA/FLUINT Code
  - Transient analysis for HAC fire event
  - Steady state analysis for NCT
- MCNP Used for Shielding Analysis
  - R-Z model used for NCT shielding evaluation
  - Target shielding design for TI < 1
  - Mo-99 payload for initial application

Gas Generation

- Limiting parameter for payload activity
- Radiolytic decomposition results in pressure buildup
- Mallinckrodt has completed extensive test program to characterize pressure buildup from Mo-99 solution
  - Tested range of activities, concentrations, chemical formulations
  - Analyzed H_2, N_2, and O_2 concentrations in gas
  - Developed empirical relationship between activity and resulting pressure buildup in a closed containme
  - MNOP based on test data, not on calculation estimates

    Limited MNOP to 100 psig (700 kPa)



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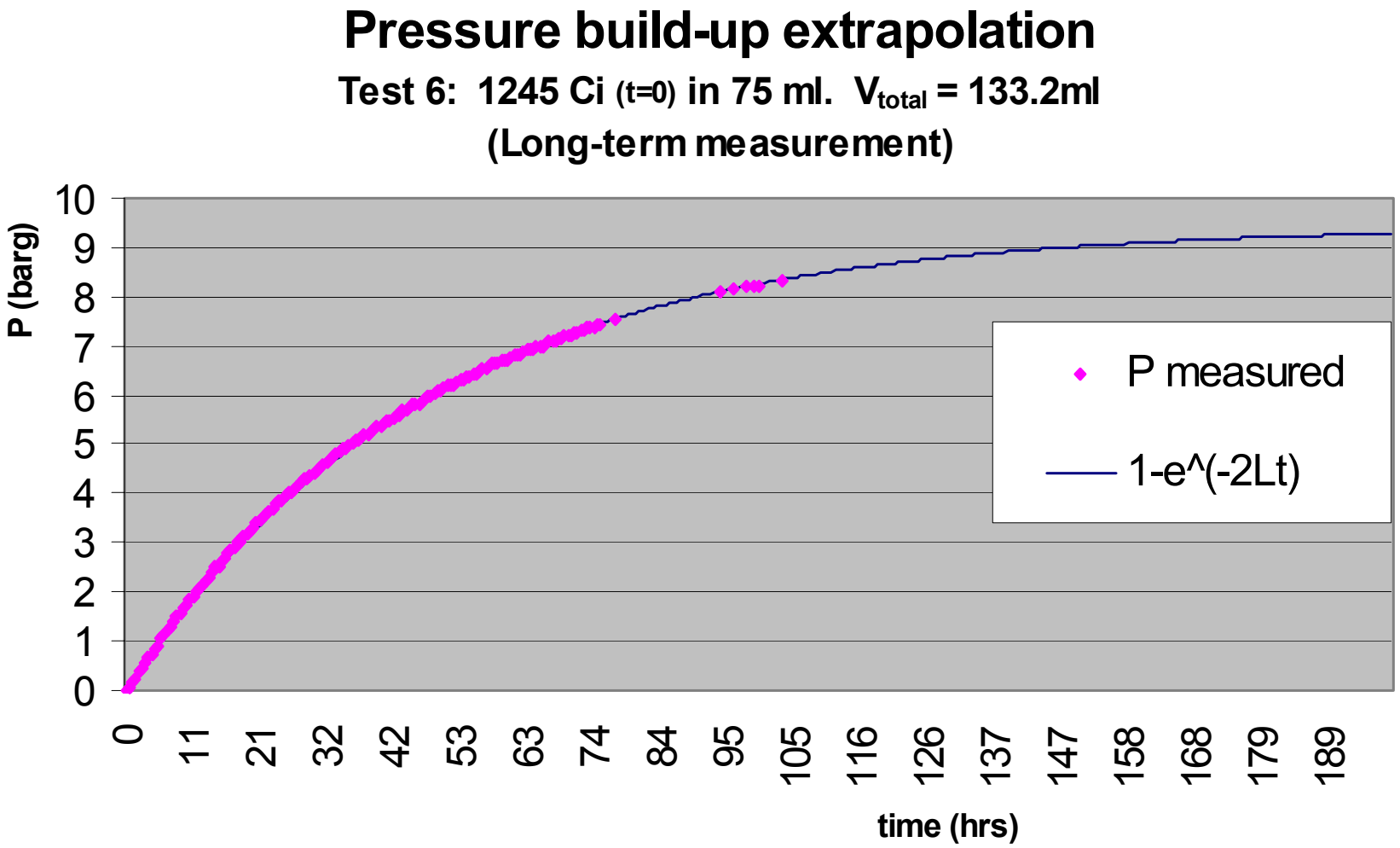

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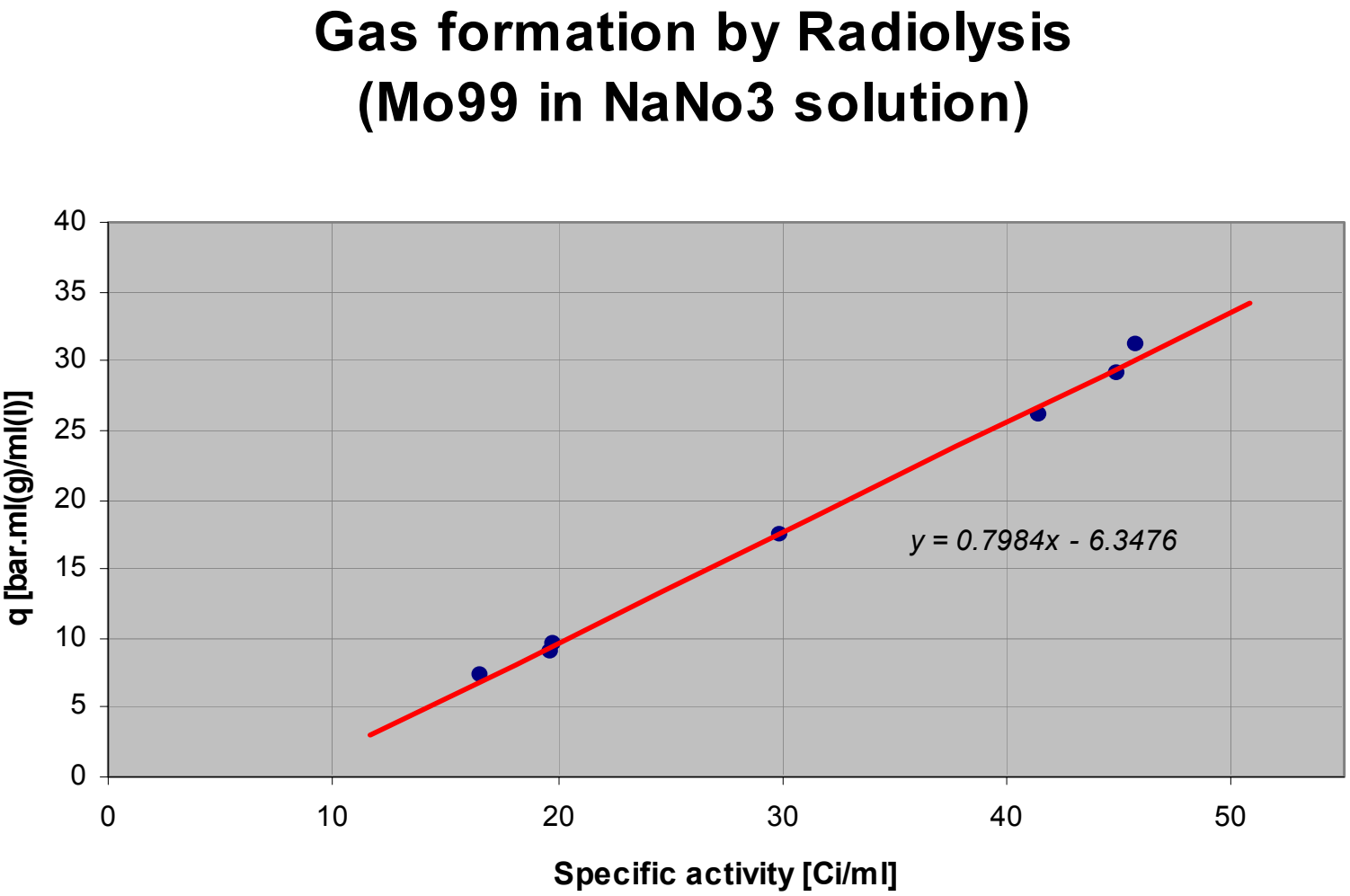

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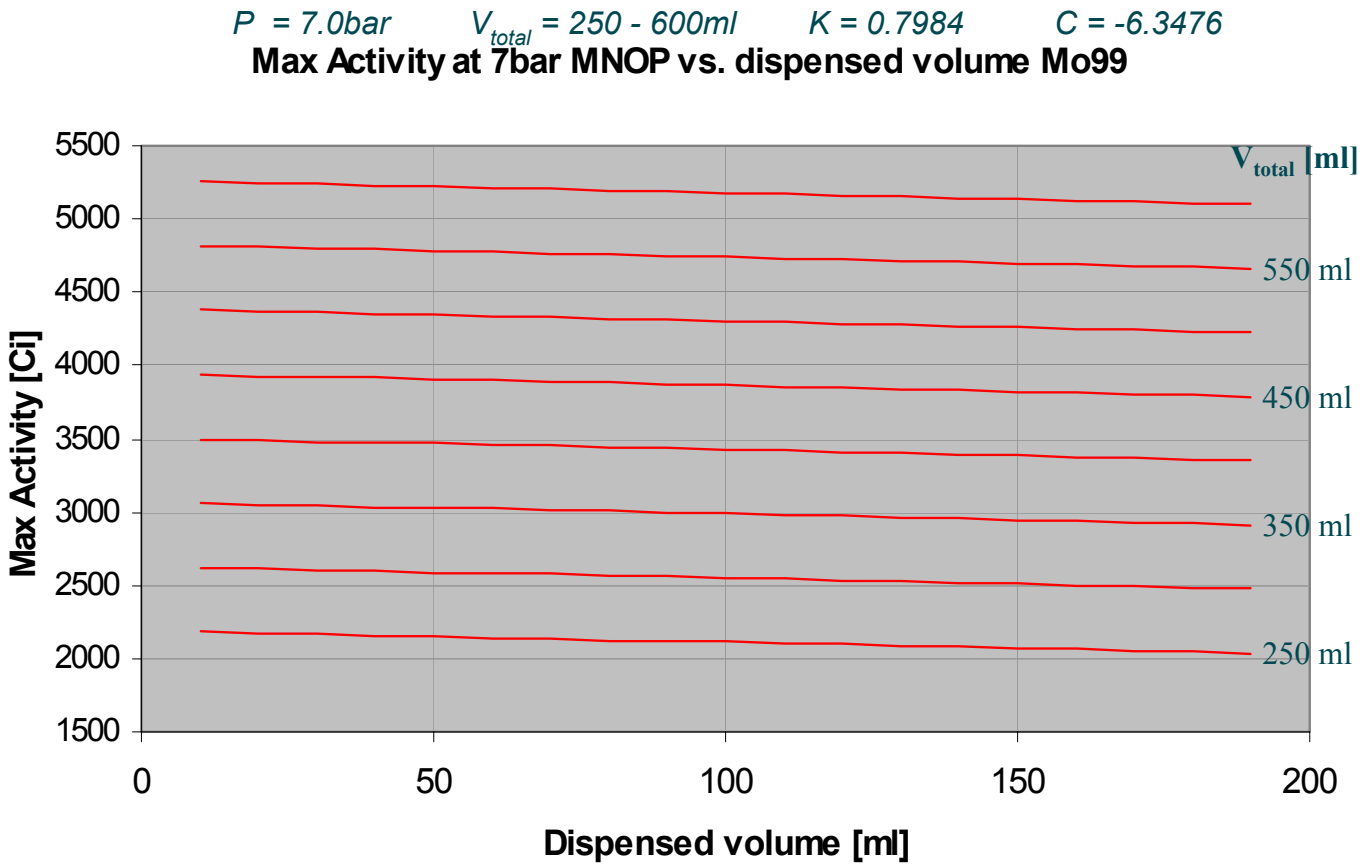

Project Schedule

ID	Task Name	2005		2006			
		Q3	Q4	Q1	Q2	Q3	Q4
1	Prepare License Application (LA)						
2	Confirmatory Testing		12/05				
3	Submit License Application to NRC			2/06			
4	**NRC Review (w/o RAI)**						
5	NRC Technical Review*						
6	NRC Prepare SES and CoC*						
7	NRC Issue CoC*					8/06	
8	European Licensing						
9	Current CoC Expires						10/06
10	Package Fabrication						

*Estimated NRC review schedule.

Summary

- Goal: Obtain CoC in August 2006
  - Accelerated NRC review schedule needed to ensure future continuity of Mo-99 shipments to U.S. (10/31)
- To Achieve This:
  - Provide simple, robust design with substantial safety margins
    - > Based upon best features of current cask fleet
    - > No welds in containment boundary
    - > Dose rates ~ 1/10th of regulatory limit
    - > Limit initial application to only Mo-99
  - Provide a high-quality license application
    - > Gas generation based on test results
    - > Compliant with SRP (NUREG-1609) and RG 7.9, R2
  - Perform confirmatory testing to confirm adequacy of analytical models
    - > HAC free drop and puncture tests
      - Detailed plans discussed at next NRC meeting
    - > Submit test results with initial application
  - Meet early and often with NRC staff
    - > 3 pre-submittal meetings planned