Bell Jar Application in FB-Line

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Agenda

- Background
- Discussion of Bell Jar Hardware
- Results
- Path Forward

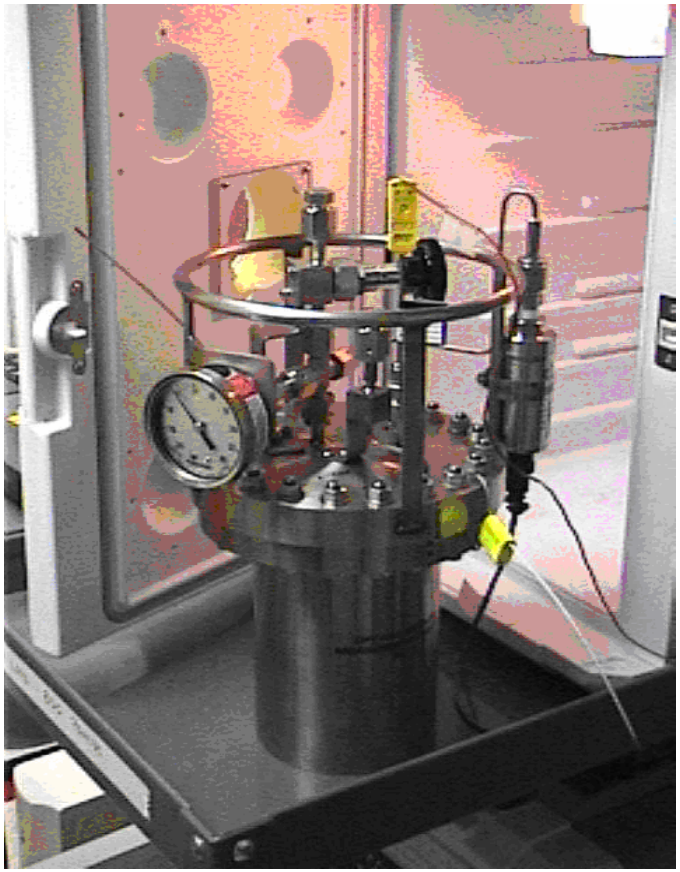
Background

- De-inventory / Disposition of FB-Line Materials
  - Frequent routine shipments to H-Area and SRTC
  - Primarily involves legacy materials and residues
- Gas generation in shipping containers is problematic
  - Radiolysis of absorbed moisture in radioactive materials
  - Need way to deal with gas generation of legacy materials / residues, whose constituents vary greatly
  - Bell Jar solution proposal

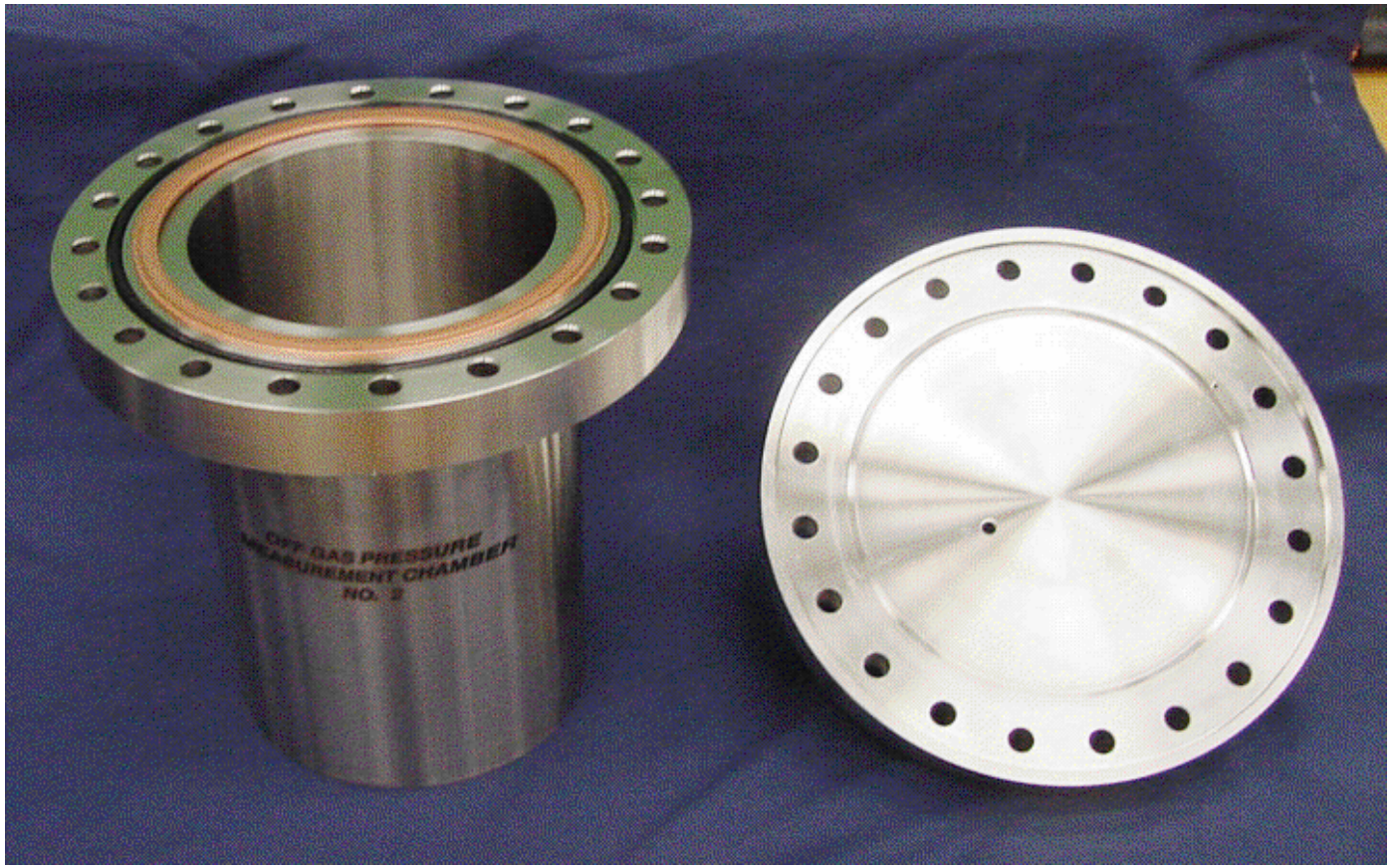
What is a Bell Jar?

- Meets business need for shipments to H-Area
  - Avoided expensive and timely accident analysis
  - Cost effective alternative
- Instrumented stainless steel pressure vessel
  - Data acquisition components
  - Testing chamber slightly larger than a 404X700 can
- Measures out-gassing from a can or container of fissile material
  - Placed in cooler / heater for isothermal testing

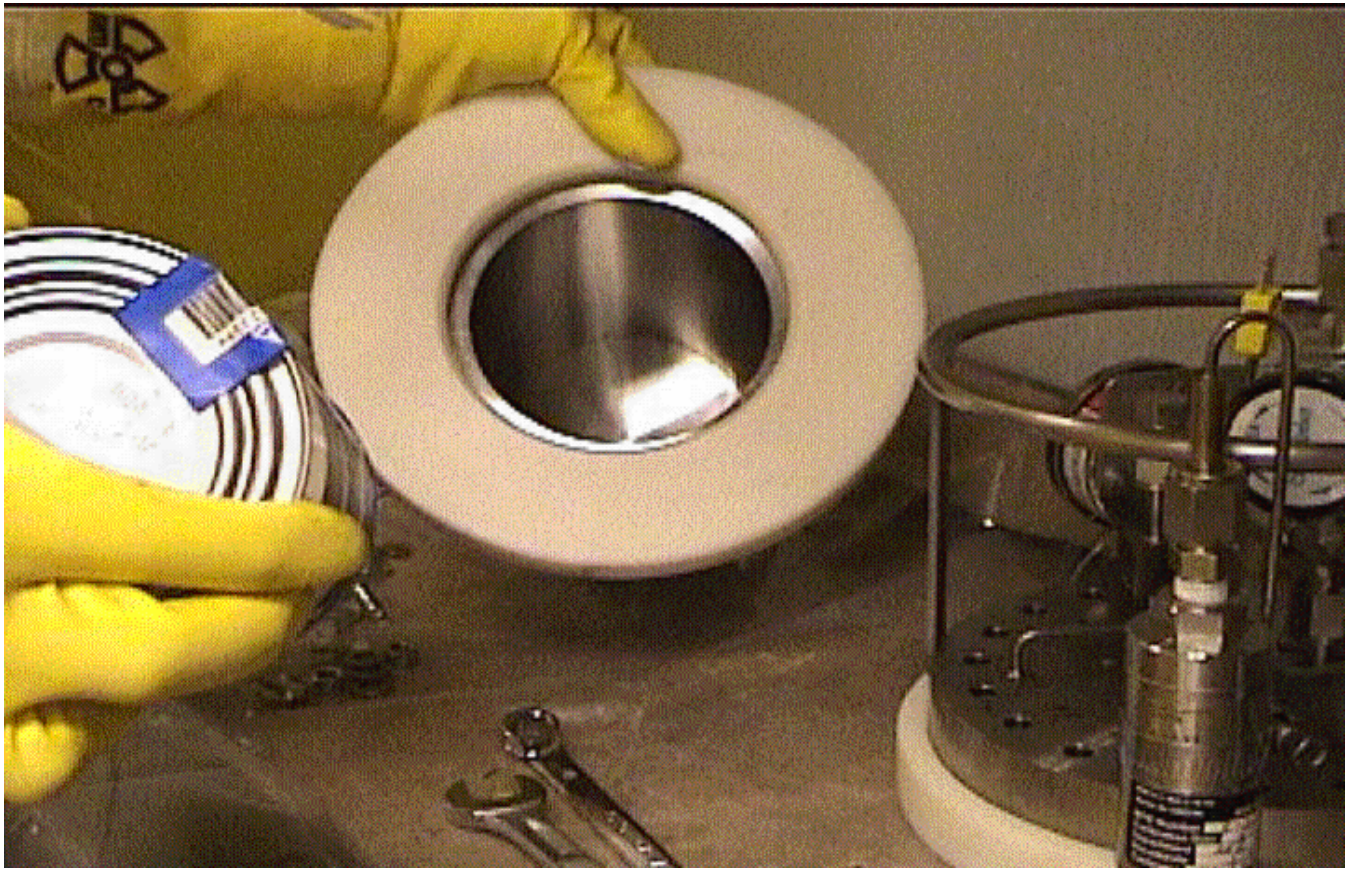
Integrated Bell Jar



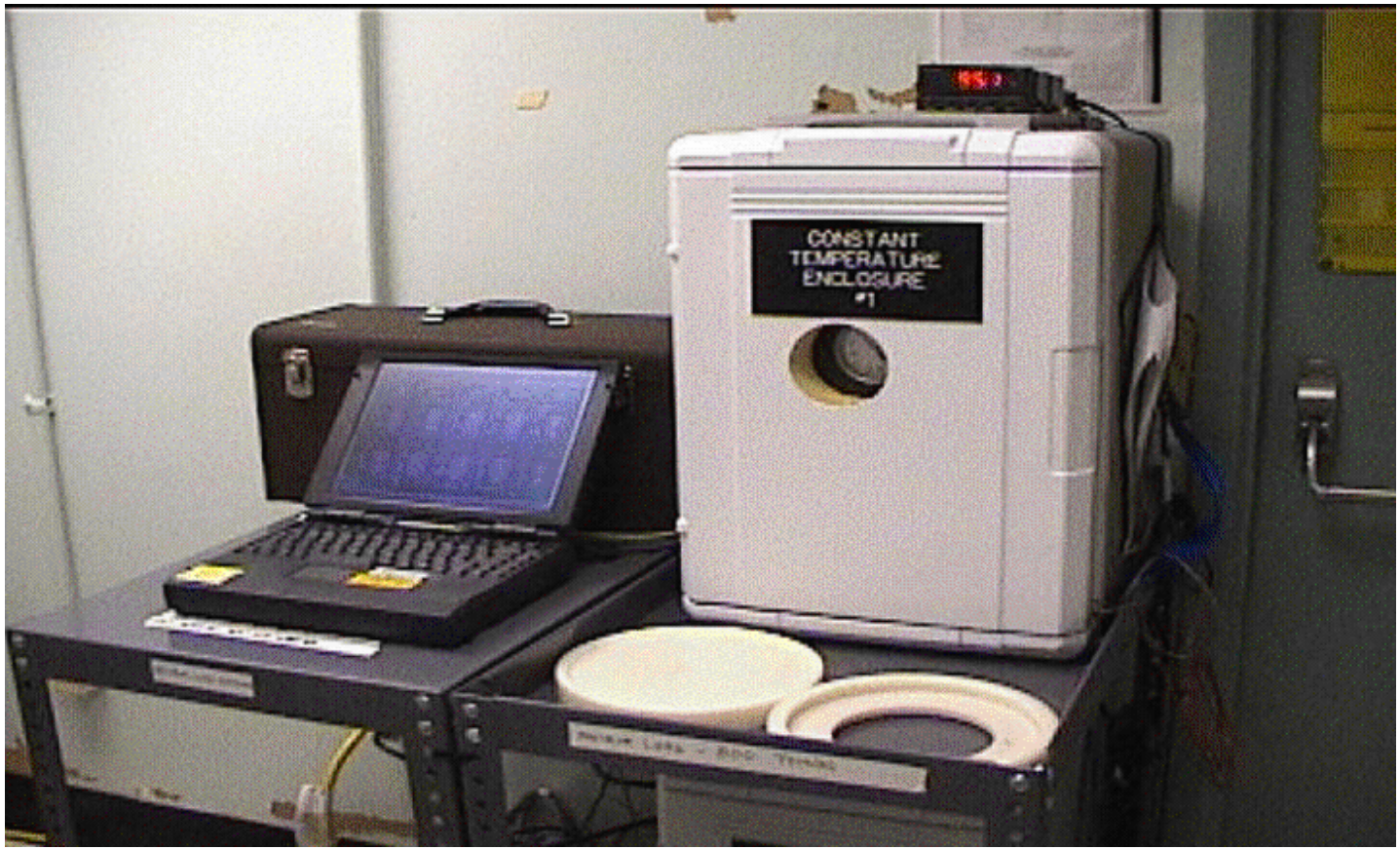
Disassembled Bell Jar



Bell Jar Loading



Bell Jar Set-up



Bell Jar Benefits

- Resolves gas generation issue for shipping Pu bearing materials
  - Raw data to verify onsite safe shipping compliance
  - Eliminates uncertainty with theoretical models
- Allows for statistical analysis of similar materials
  - Safely expedites release of larger inventories
- Short testing time of ~7days, Go or No-Go
  - Typically 6 cans per test

Bell Jar Benefits

- No need for repackaging or sampling material
  - Non-intrusive test

- Used in conjunction with current surveillance tools
  - Lid deflection measurement

Test Results

- Completed testing of 72 cans to date (six currently being tested)
- Bulged can, LLNL oxide packaged in plastic, sweepings, and Pu oxide mixed with magnesium oxide pressurized
- HB-Line oxide depressurized the most (BLO item also depressurized)
- The majority of cans had minimal change in pressure or depressurized slightly

Gas Sampling

- Utilization of gas chromatography to determine concentrations of constituents (H_2, O_2, N_2, CO_2, CH_4, CO, and N_xO_y)

- Determination of gas generation and/or consumption rates using change in pressure and GC results

Gas Sampling Data

- 5 cans gas sampled
  - HB9-06-02-019
    - HB-Line Phase II Oxide
    - 0.4% H_2, 10% O_2, 87% N_2, 2% CO_2
    - change in pressure: -1.67 psig
  - MC02-216
    - Pu/U Oxide Powder
    - 1% H_2, 0.4% O_2, 89% N_2, 8% CO_2
    - change in pressure: - 0.52 psig

Gas Sampling Data

- MC02-149 (bulged-can, CZA96-179)
  - Unirradiated developmental metal reactor fuel (ANL)
  - 6% H_2,13% O_2, 77% N_2, 2% CO_2
  - change in pressure: 0.73 psig
- CZA96-179A (sister-bulged can)
  - Unirradiated developmental metal reactor fuel (ANL)
  - 11% H_2, 7% O_2, 71% N_2, 7% CO_2
  - change in pressure: 1.10 psig
- MC02-150
  - Re-packaged CZA96-179A
  - 9% H_2, 10% O_2, 76% N_2, 3% CO_2
  - change in pressure: 0.94 psig

Gas Sampling Results

- Minimal hydrogen generated in HB-Line oxide
- Hydrogen and Oxygen found to co-exist in some cans
  - Oxygen partially consumed in all cans
- Hydrogen generation rates:
  - 1.1×10^{-6} moles/g(Pu)-day CZA96-179A
  - 0.49×10^{-6} moles/g(Pu)-day MC02-150
  - 0.61×10^{-6} moles/g(Pu)-day MC02-149
  - 0.07×10^{-6} moles/g(Pu)-day MC02-216
  - 0.01×10^{-6} moles/g(Pu)-day HB-019

Gas Sampling Results

- Oxygen consumption rates:
  - -1.19×10^{-6} moles/g(Pu)-day CZA96-179A
  - -0.67×10^{-6} moles/g(Pu)-day MC02-150
  - -0.62×10^{-6} moles/g(Pu)-day MC02-149
  - -1.34×10^{-6} moles/g(Pu)-day MC02-216
  - -0.27×10^{-6} moles/g(Pu)-day HB-019

Gas Sampling Results

- Carbon dioxide generation rates:
  - 0.68×10^{-6} moles/g(Pu)-day CZA96-179A
  - 0.22×10^{-6} moles/g(Pu)-day MC02-150
  - 0.15×10^{-6} moles/g(Pu)-day MC02-149
  - 0.51×10^{-6} moles/g(Pu)-day MC02-216
  - 0.04×10^{-6} moles/g(Pu)-day HB-019

Path Forward

- Continue testing items to expedite disposition of non-3013 materials (materials not represented in MIS)
- Publish test results in ASME papers
- May be used to support Np oxide shipments off-site
- Other off-site shipments of Pu bearing materials

Questions

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