PAT-1
SAR Addendum
Update

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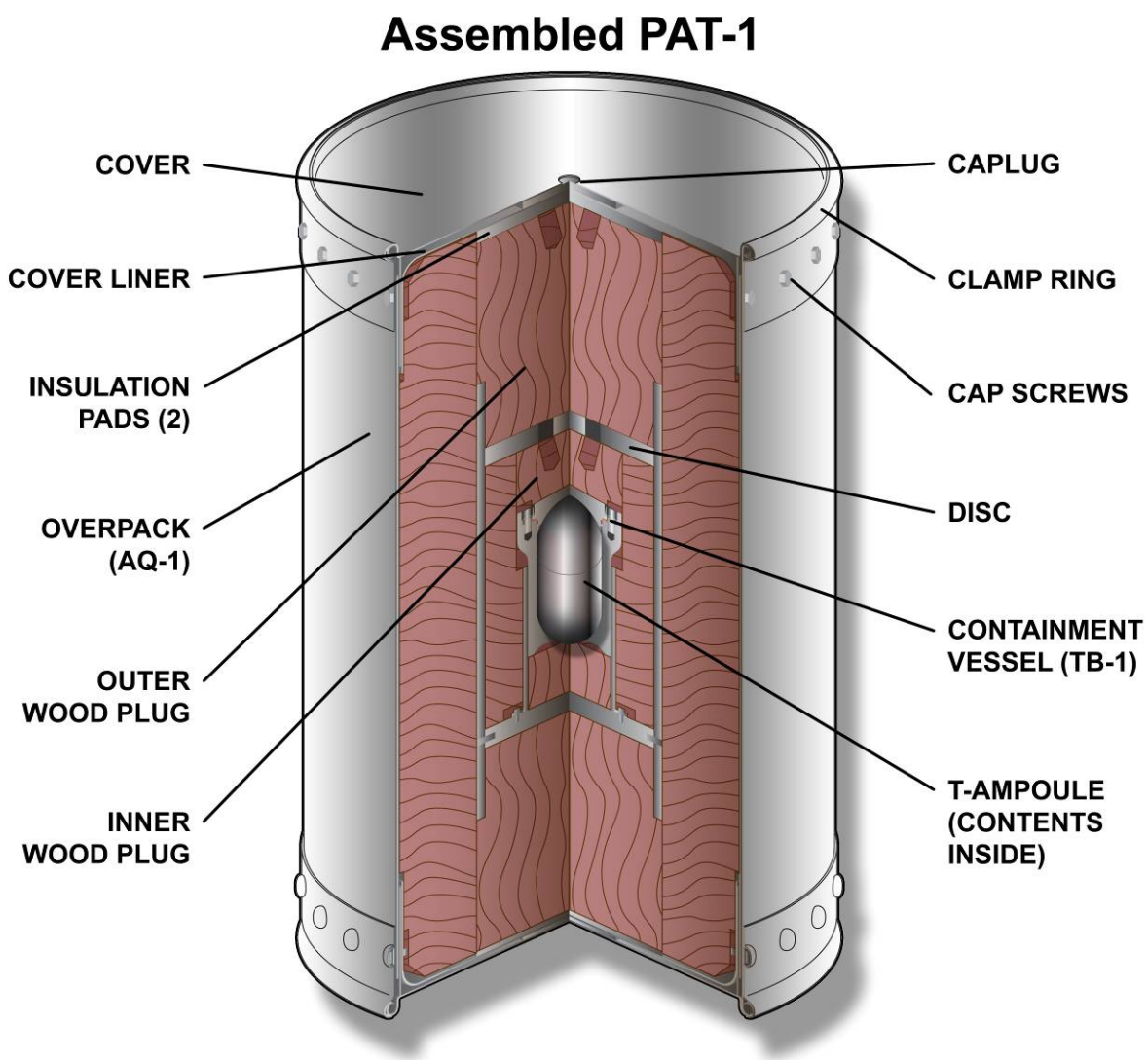
PAT-1


Assembled PAT-1
COVER
COVER LINER
INSULATION PADS (2)
OVERPACK (AQ-1)
OUTER WOOD PLUG
INNER WOOD PLUG
CAPLUG
CLAMP RING
CAP SCREWS
DISC
CONTAINMENT VESSEL (TB-1)
T-AMPOULE (CONTENTS INSIDE)

NNSA PAT-1 Certification Strategy

- Planned certification strategy
  - PAT-1 with new plutonium metal contents has one containment boundary (TB-1) under all transport conditions
  - TB-1 leakage rate test will be as per current SAR
- NRC input on NNSA certification strategy would be greatly appreciated

Proposed Contents

- Adding plutonium metal with <20 Ci Pu oxide as approved contents
- Various configurations
  - Hollow cylinders
  - Miscellaneous samples, coupons, etc. in titanium sample containers
  - 1.3 kg maximum plutonium mass

Containment System

- TB-1 is containment boundary
- Single containment under all conditions (NCT and accident)
  - Pu metal historically single containment
  - Similar to PAT-1 approved configuration w/o PC-1 for Pu oxide content ≤ 20 Ci
- TB-1 design remains unchanged
- TB-1 maintains containment under all conditions

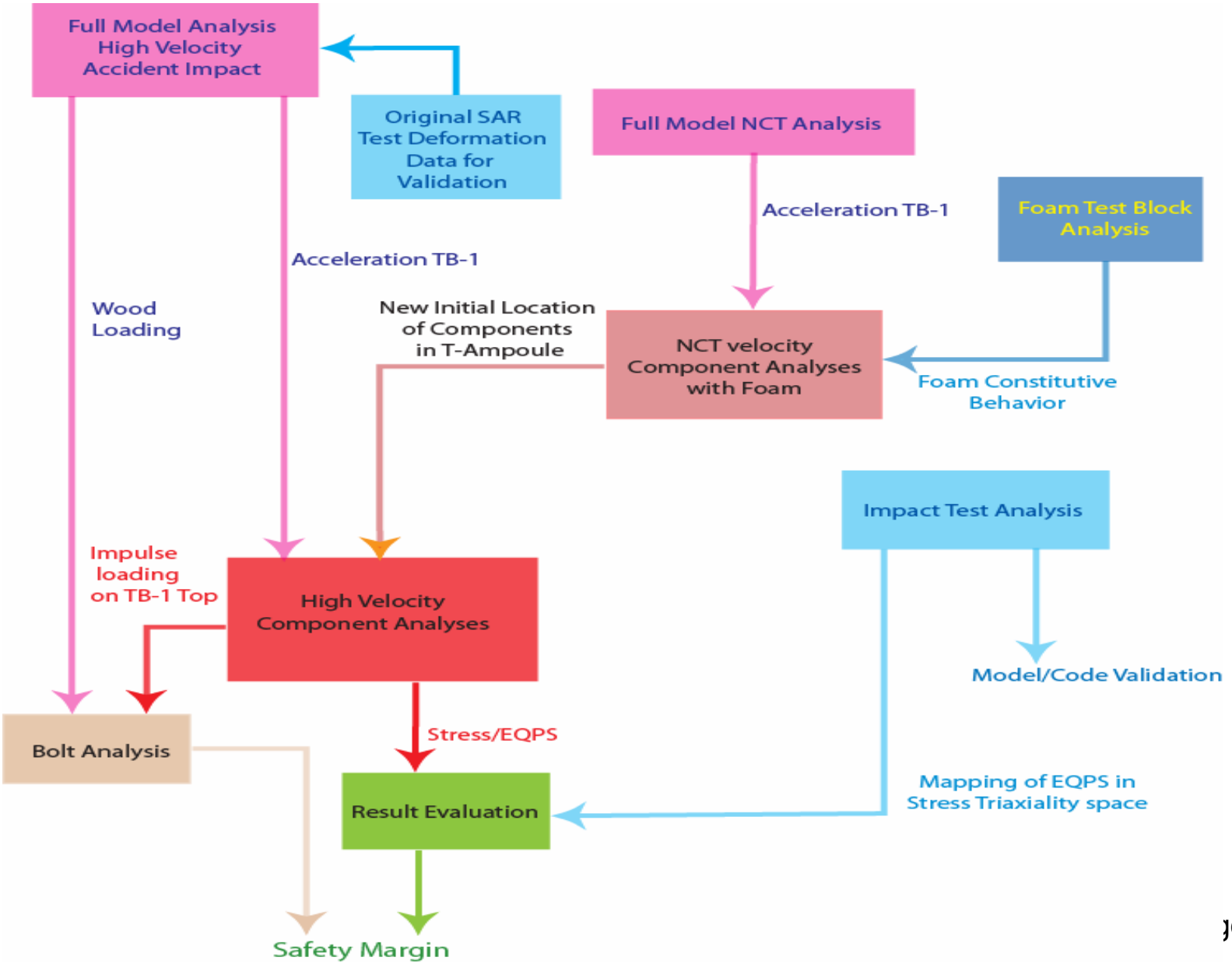
T-Ampoule

- T-Ampoule prevents Pu/Fe eutectic formation at high temperatures during air accident fire
  - Eutectic analysis demonstrates all metal contents stay in solid form
    - Lowest system melting point of 625ºC (1157ºF) is 43ºC (77ºF) higher than the maximum TB-1 temperature of 582ºC (1080ºF).
  - Maintains sample quality and provides contamination control for NCT (not a containment boundary in regulatory sense)

T-Ampoule

- Analysis demonstrates T-Ampoule not breached under any of the regulatory specified conditions/tests
  - Evaluation of metal content projectile impact under accident conditions
  - Structural analysis performed by SNL to ensure integrity
  - Physical testing to support structural modeling
  - Copper foam positioning to minimize strains

Flowchart of PAT-1 Structural Analyses



PAT-1 Structural Analyses

- Performed full package analyses to determine TB-1 loading (deformations compared favorably with certification test results)
- Conducted component impact tests to verify code and obtain strain failure data
- Analyzed all T-Ampoule components and demonstrated that T-Ampoule does not rupture
- TB-1 remains elastic from impacts of decelerating contents
- Conducted TB-1 bolt analysis and found loads much lower than bolt preload

Leak Rate Testing

- TB-1 leak rate testing unchanged under our approach
- Utilize approved SAR procedures
- Will test T-Ampoule to ensure atmosphere maintains sample quality
  - Pressure rise leak test
  - Not required for safety basis

Criticality and Shielding

- Criticality and shielding analysis done by ORNL (Cecil Parks)
- K_{eff} <0.72
- Calculated dose rates well below regulatory limits

PAT-1 Pu Metal Addendum

- Would appreciate NRC input regarding certification strategy
- SAR Addendum submittal to NRC January 2009 (seeking acceleration)

General Configuration of Metal Contents

Mike Caviness

Los Alamos National Laboratory

Contents Configuration

- Plutonium mass limits:
  - 1300 grams of electro-refined metal in T-Ampoule
  - 174 grams in Sample Container 1 (SC-1)
  - 338 grams in Sample Container 2 (SC-2)
- Packing configuration:
  - Copper foam for electro-refined metal
  - Tantalum foil and/or copper foam for small samples within sample containers
  - Sample containers are packed in T-Ampoule using copper foam

Safety Analysis Approach

Richard Yoshimura
Sandia National Laboratories

Topics

- Current PAT-1 Certification
- Oxide Formation
- Leak Testing

Single Containment Approach

- In 10 CFR 71.63 regulation prior to 2004,
  - Exempted material (metal and alloy, spent fuel, vitrified HLW, etc.) can be shipped in single containment package
  - Non exempt materials greater than 20 curies must be solid and required double containment
- For PAT-1 oxide contents certified in 1978, PC-1 (inner container) provided containment under 10 CFR 71.71 and 10 CFR 71.73
- PAT-1 CoC, Revision 8, Item 6, PC-1 product can need not be used when the content is 20 curies or less of plutonium oxide
- Single containment for Pu metal is consistent with the current CoC and past and current regulations

Oxide Formation Less than 20 Ci

- Conservative analysis yields maximum oxide of 3.5 grams, 4 Ci.
  - Total internal volume of TB-1 filled with ambient air (21% O_2).
  - All of the oxygen reacts completely to form plutonium oxide
  - Oxygen limited reaction

Leakage Rate Testing

Richard Yoshimura
Sandia National Laboratories

Proposed TB-1 Leak Testing

- For PAT-1 Pu metal addendum, TB-1 will use same leakage rate testing procedures in current SAR
- T-Ampoule leak test is to verify it contains an atmosphere which will maintain sample integrity and is not for demonstration of regulatory containment

Summary

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Summary

- SAR in combination with SAR Addendum will demonstrate PAT-1 with plutonium metal contents meets regulatory requirements
- We would appreciate NRC's input on NNSA's planned single containment and leakage rate strategy as soon as possible