Source Insert for Transport of Co-60 Sources in the 10-160B Cask

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Project Scope

Design/License/Build/Use a source insert in the 10-160B package to transport radioactive sources from SNL to NNSS

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Waste Characteristics

- Physical Form/Properties
  - Stainless Steel Encapsulated Co-60 Sources
  - No Liquids
  - < 125 lbs
  - No Transuranics
  - No fissile material

Radioactive Content

	Activity
Isotope	Ci
Co-60	10,000

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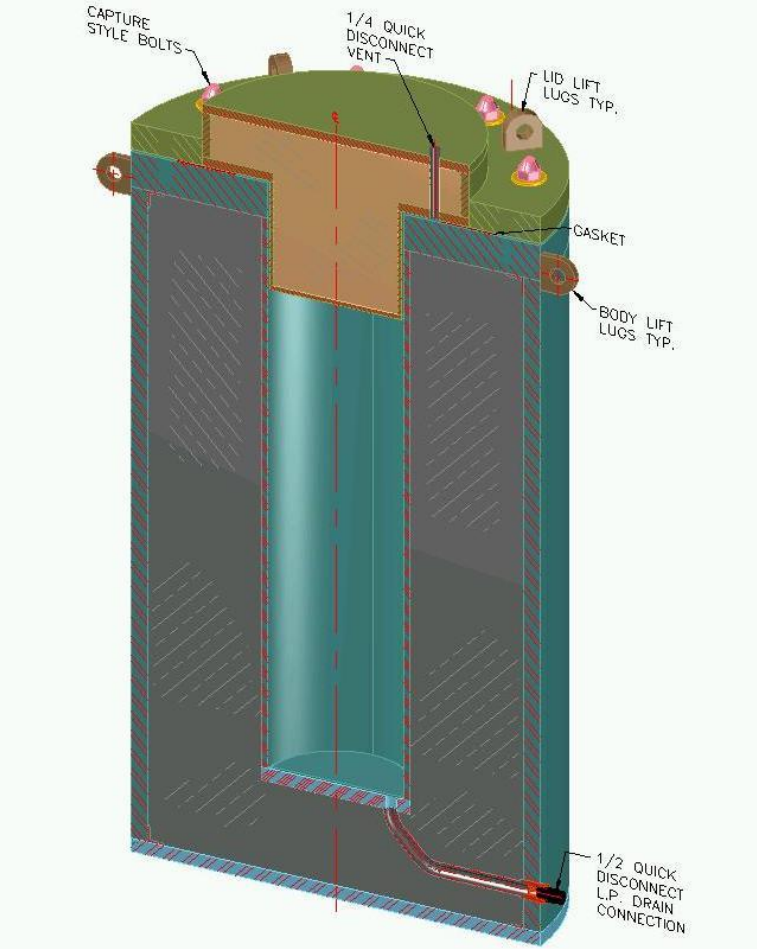
SNL Source Insert



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Approval Process

- Submit stand-alone addendum to the SAR with Co-60 sources in the source insert as contents
- Show structural, thermal, shielding, operations, and fabrication acceptance requirements are satisfied
- Refer to the base SAR for the containment, criticality, and maintenance requirements

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Project Schedule

- Submit SAR Addendum – September 2011
- Issue revised CoC – December 2011
- Start Fabrication – December 2011
- Deliver Insert to Sandia– March 2012
- Load Insert – March 2012
- Ship Loaded Insert to NNSS – March 2012

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Addendum Content

- Chapter 1 – Source Insert Description
- Chapter 2 – Structural Analysis of Source Insert
- Chapter 3 – Thermal Analysis and Gas Generation Analysis
- Chapter 4 – Containment : Bounded by SAR
- Chapter 5 – Shielding Analysis
- Chapter 6 – Criticality : Not Applicable
- Chapter 7 – Operations
- Chapter 8 – Acceptance Testing

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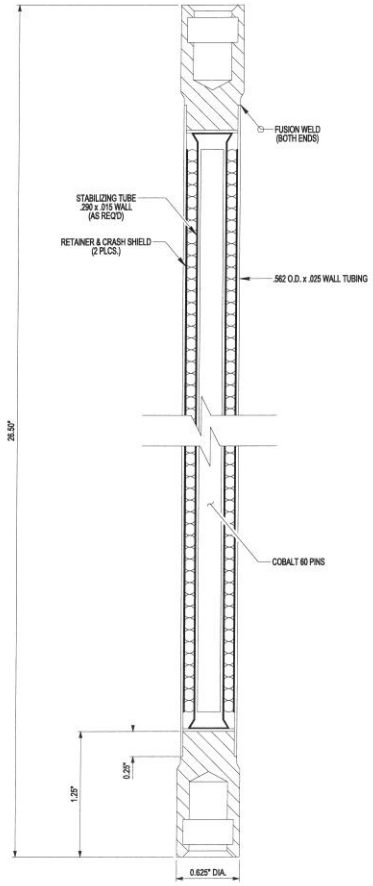
Description and Contents

For this Addendum,

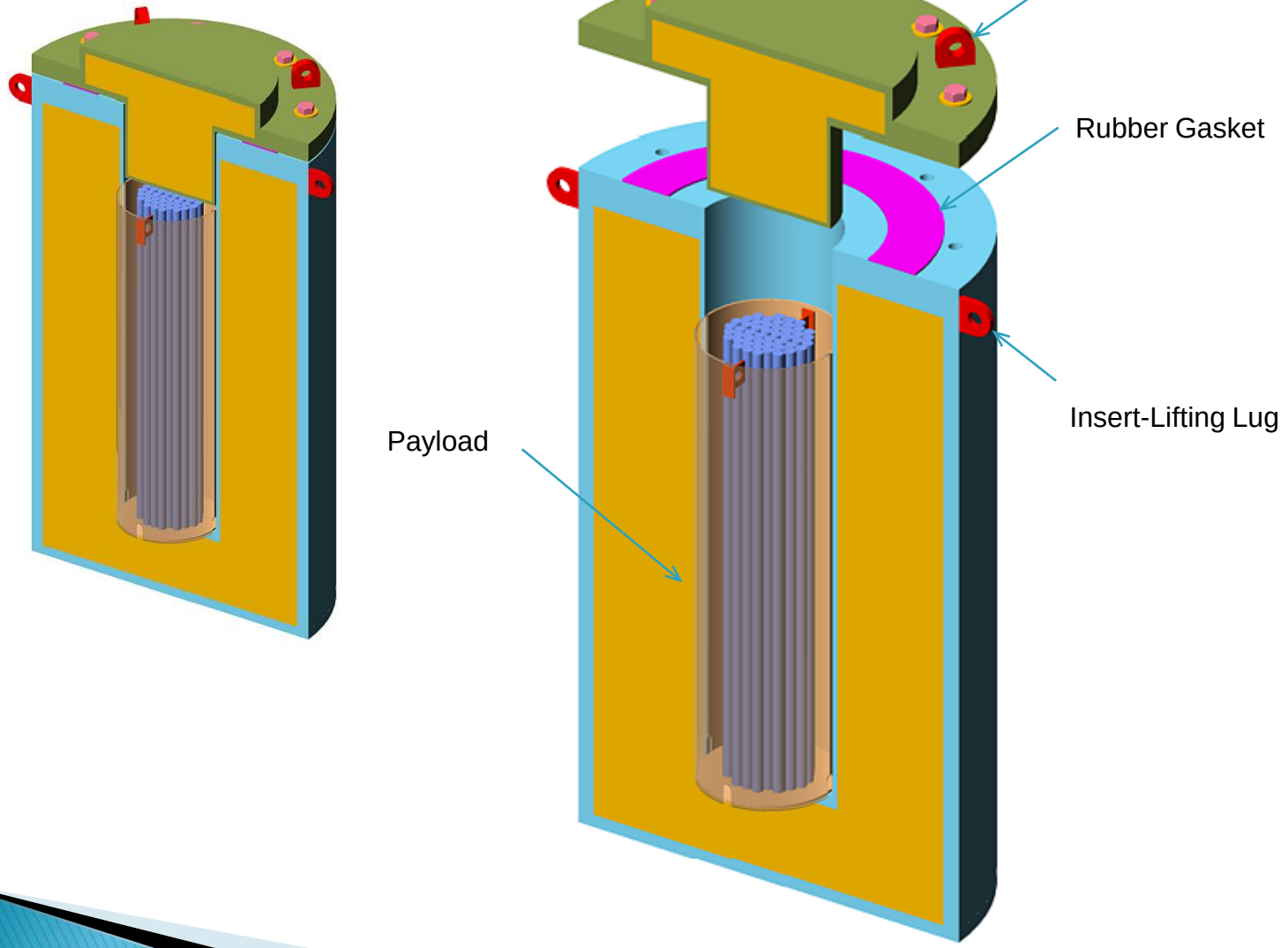
- The type and form of waste material will include:
  - 1) Co-60 as solid, irradiated metal
  - 2) RAM is contained in a source insert
  - 3) Source construction not included in analysis
- Maximum quantity material per package:
  - 1) 10,000 Ci of Co-60
- The source insert description will include:
  - 1) dimensions
  - 2) materials

Example of Typical Source

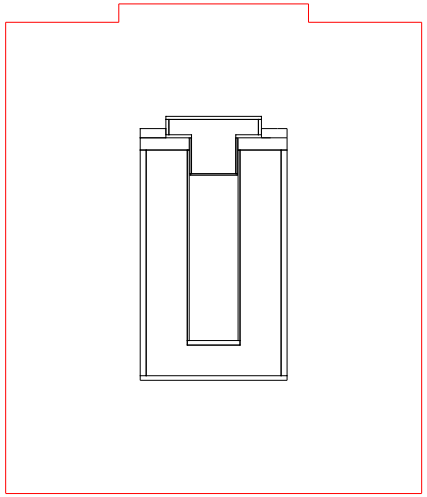


Structural Evaluation

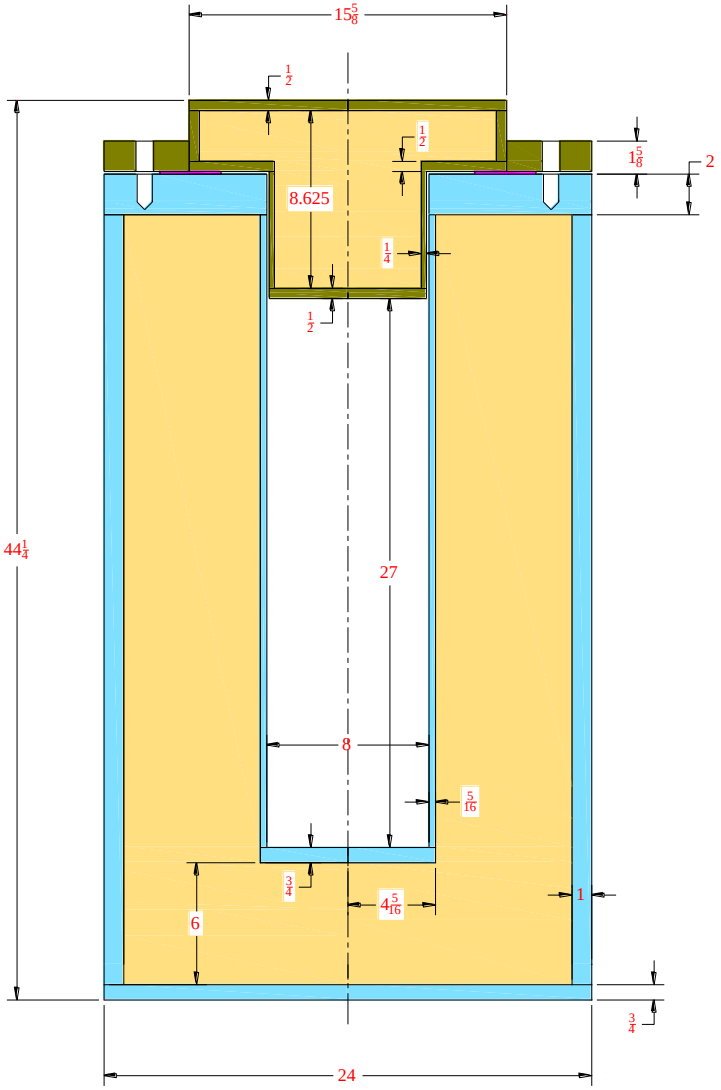
Source Insert - Features



Source Insert - Dimensions



10-160B Cavity Outline



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Source Insert - Estimated Weight

Source Insert		7,170 lb
Body	6,500 lb	
Lid	500 lb	
Payload	170 lb	
Design Weight		8,000 lb

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Structural Analysis – General Approach

- An addendum to the 10-160B SAR Section 2 will be provided to demonstrate the compliance of the package with the10CFR71 requirements.
- The addendum will follow the same format as the 10-160B SAR
- The detailed analyses will be documented in an EnergySolutions document (ST-663) that will be referenced in the addendum.
- The reference document ST-663 will be provided to the NRC for review.

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Structural Analysis – Major Assumptions

- The source insert is uniformly supported by the cribbing in both the axial and circumferential directions.
- Under the NCT and HAC drop tests the insert is subjected to the inertia loading corresponding to the maximum decelerations reported in the 10-160B SAR.

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Structural Analysis – Summary

- Section 2.5 will provide the analyses to show that the insert lifting lugs meet the requirements of 10CFR71.45(a).
- Section 2.6 will show that the NCT drop tests loadings (with the corresponding allowable stress values) are enveloped by the HAC drop test loadings.
- Section 2.7 will analyze the insert in three drop orientations – top end down, bottom end down, and on its side - with the assumption that the insert is uniformly supported on the cribbing. The loading in the corner drop orientation will be shown to be enveloped by the above test orientations.
- The structural components of the insert affected during each drop test will be analyzed to show that they meet the design criteria of the 10-160B cask.

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Structural Analysis – Summary (continued)

- The shell of the insert will be evaluated to show that the buckling is not a credible mode of failure of the shell during the HAC drop tests.
- The lid bolting will be analyzed under the combined axial loading (experienced under the end drop) and shear loading (experienced under the side drop) to show that the lid will remain attached to the insert body during the HAC drop tests.
- Lead slump analysis under the HAC end drop test will be provided.
- Loading from the cribbing members applied to the insert and the 10-160B cask under HAC drop tests will be shown to cause no damage to either structure.

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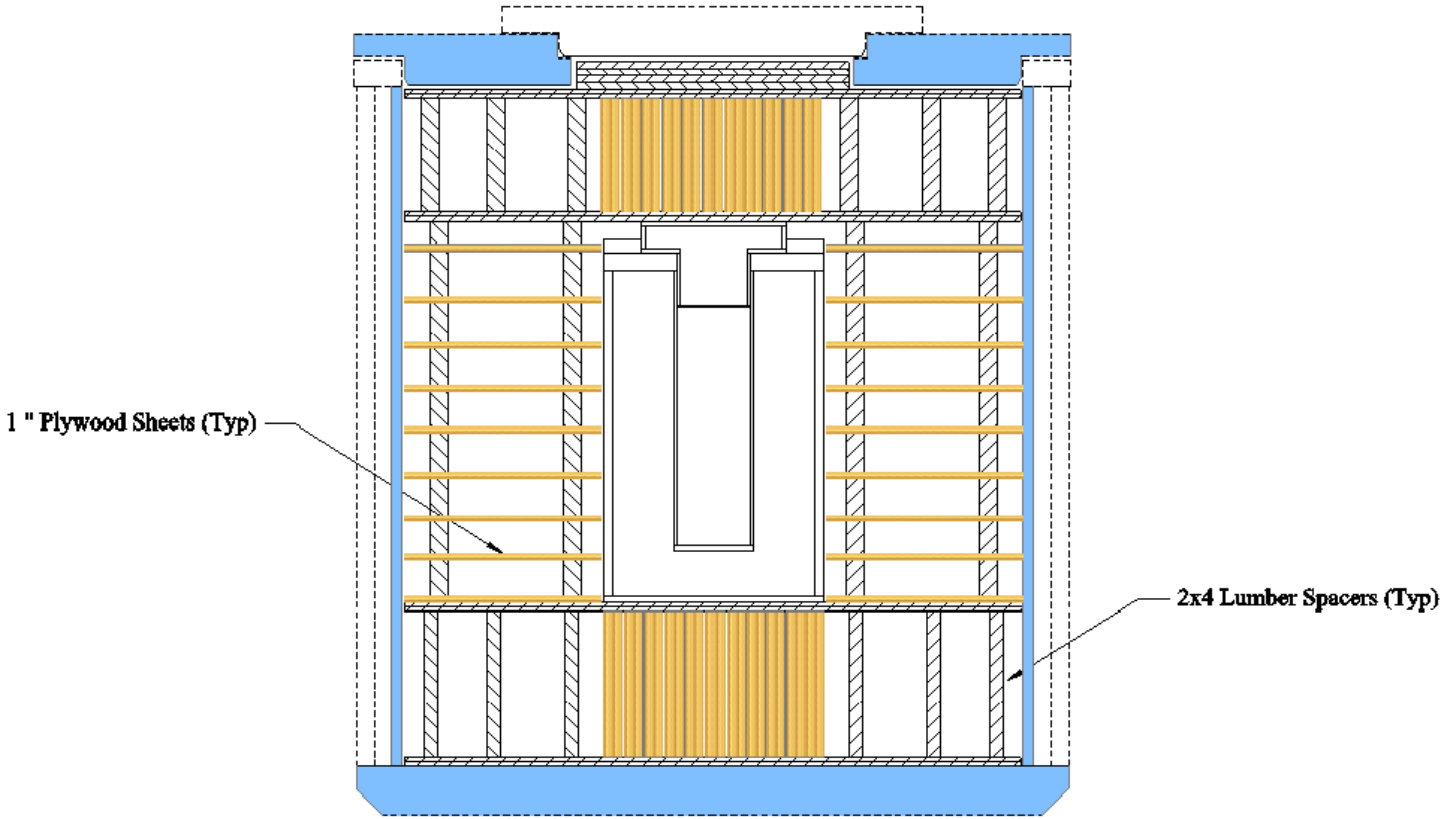
Structural Analysis – Cribbing Concept



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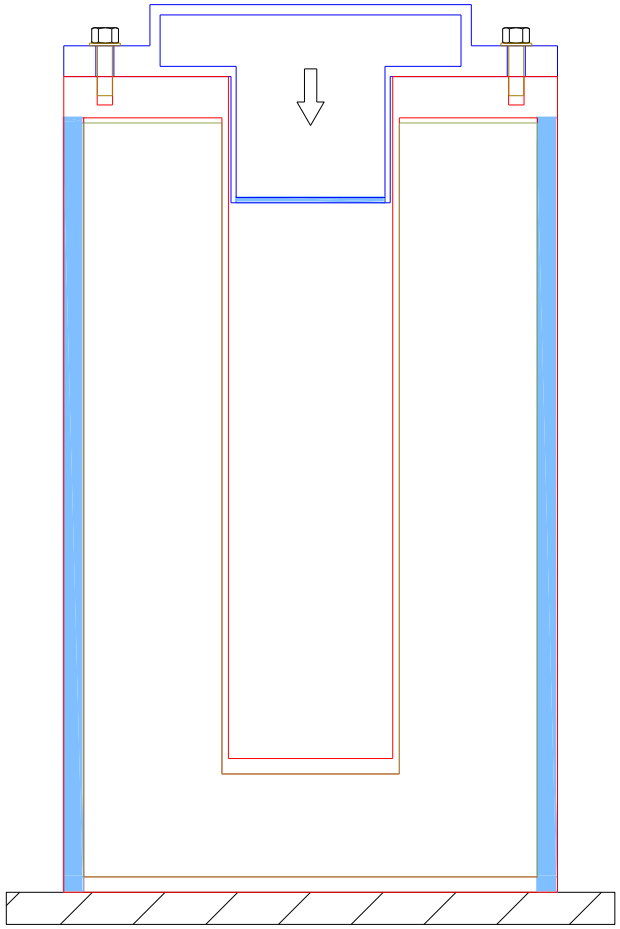
Structural Analysis – Example



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Structural Analysis – Conclusions

The 10-160B cask, with the source insert and its contents as the payload, meet the structural requirements of 10 CFR Part 71.

Thermal Evaluation

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Thermal Analysis – General Approach

- An addendum to the 10-160B SAR Section 3 will be provided to demonstrate the compliance of the package with the10CFR71 requirements.
- The addendum will follow the same format as the 10-160B SAR
- The detailed analyses will be documented in an EnergySolutions document (TH-031) that will be referenced in the addendum.
- The reference document TH-031 will be provided to the NRC for review.

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Thermal Analysis – Major Assumptions

- The source package (10-160B cask and the source insert) can be represented in a 2-dimensional finite element model.
- The boundary conditions applied to the 10-160B cask under NCT and HAC fire test are the same as those used in the SAR.
- The cribbing is made of low thermal conductivity material and has been neglected in the thermal analyses of the package.
- The means of heat transfer between the insert and the cask are (1) conduction through air and, (2) radiation between the outside surface of the insert and inside surface of the cask.
- An arbitrarily low value of emissivity (0.2) is used for the above radiation heat transfer. It has been shown that this assumption yields a conservative temperature results.

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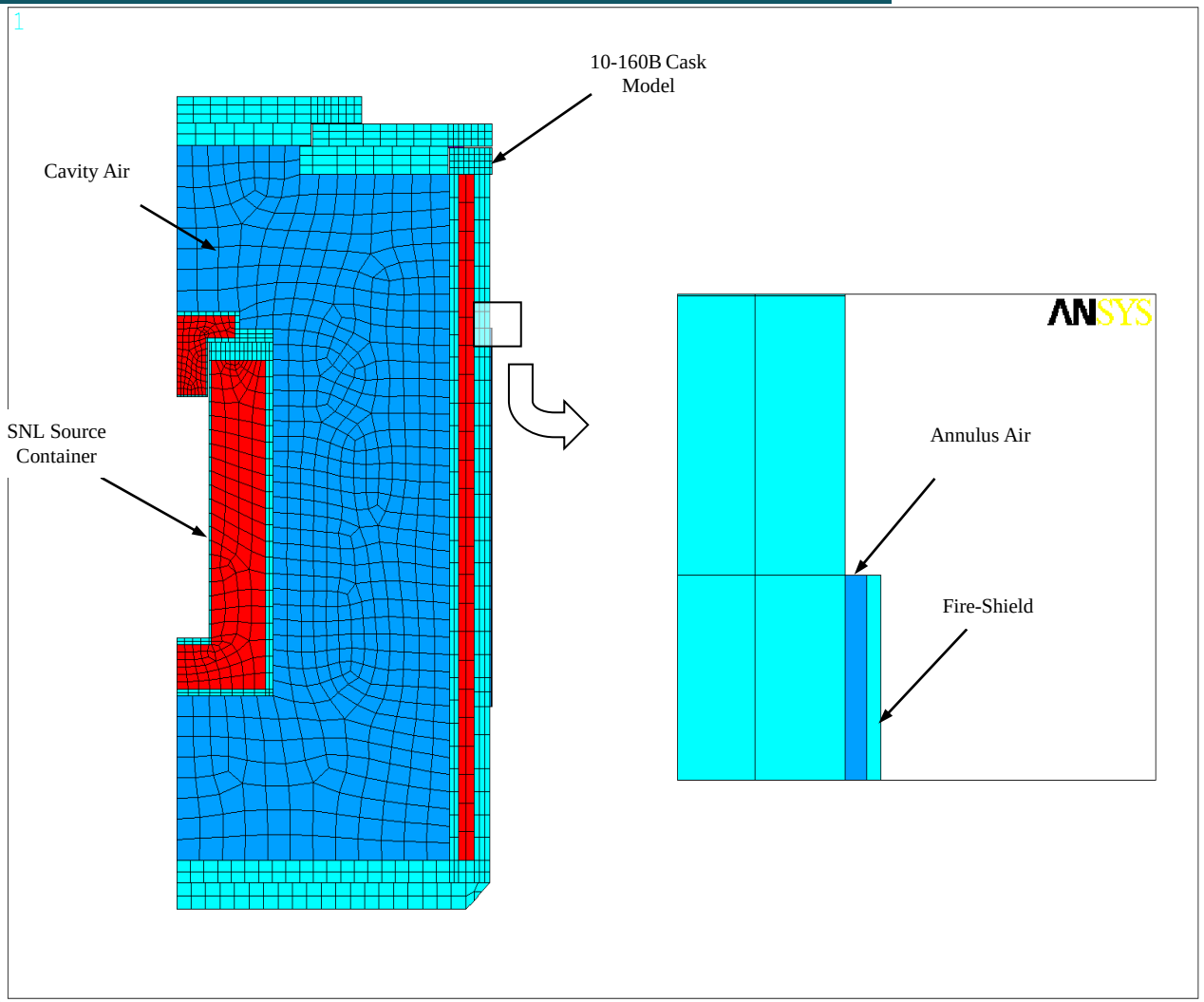
Thermal Analysis – Summary

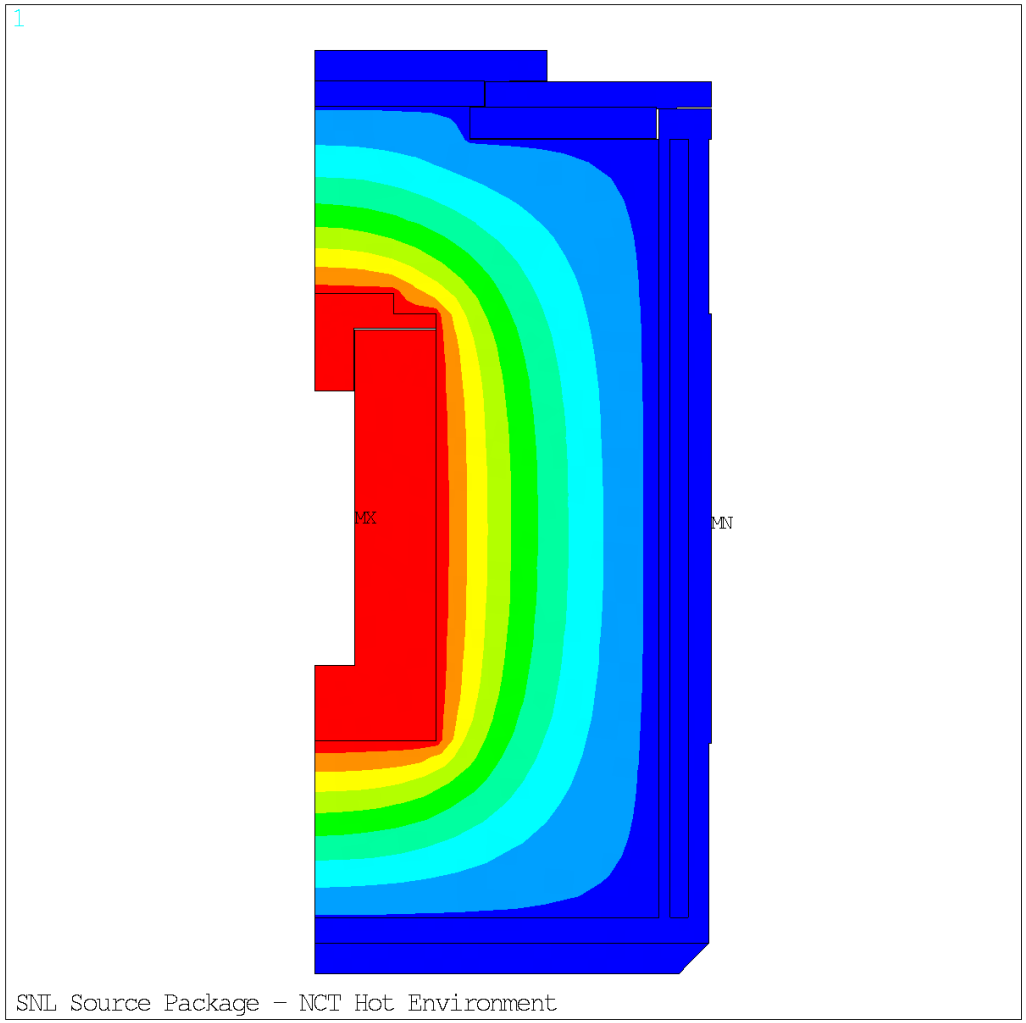
- Advanced finite element modeling techniques such as contact modeling, sub-structuring, and birth and death option of elements, have been employed in the FEM analyses.
- The source package analysis under NCT (Hot Environment) has been performed under steady-state conditions.
- HAC fire test analysis has been performed under transient loading conditions for 30 minute fire and 53 hours cool-down.
- The temperature distribution in the insert, cask, and the interstitial air has been obtained for the above loading conditions.

Thermal Analysis – Finite Element Model



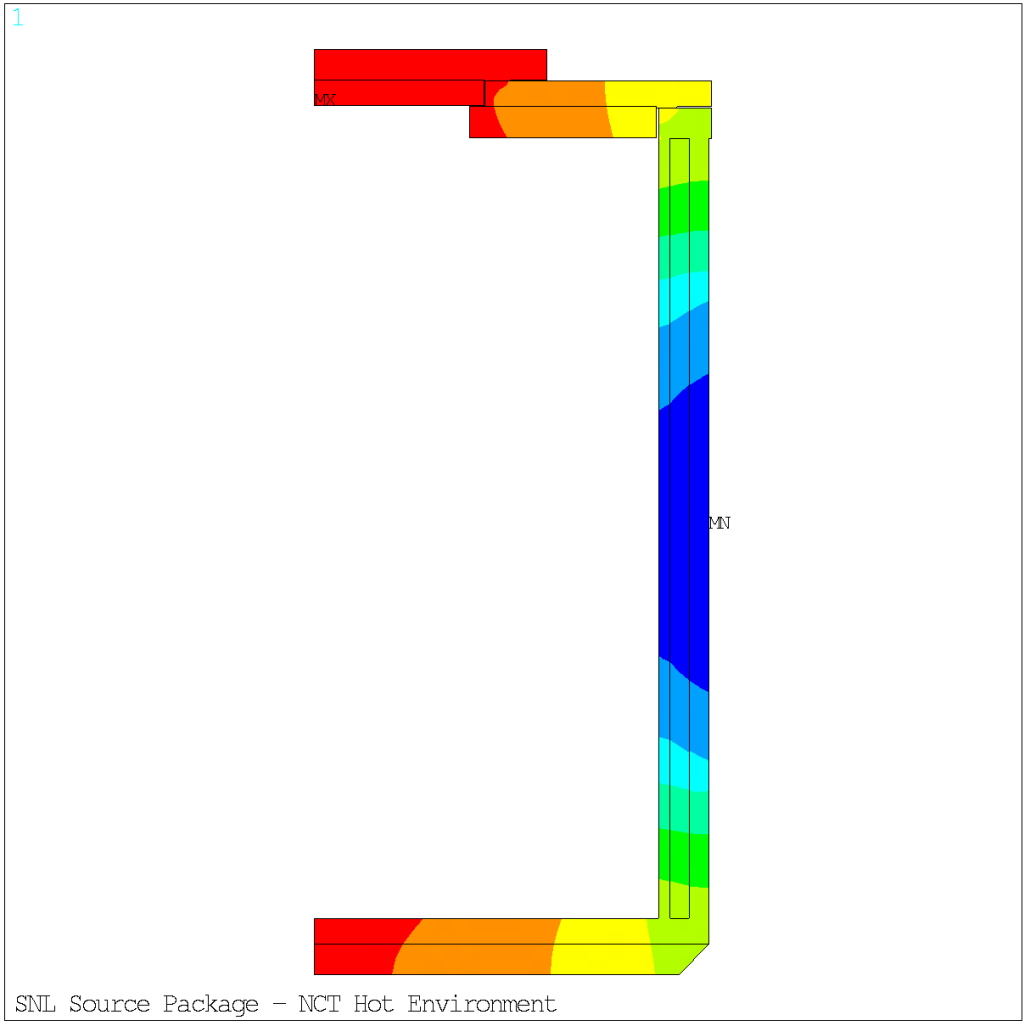
Thermal Analysis – Package under NCT

Version 11.0 will be used in the analysis.



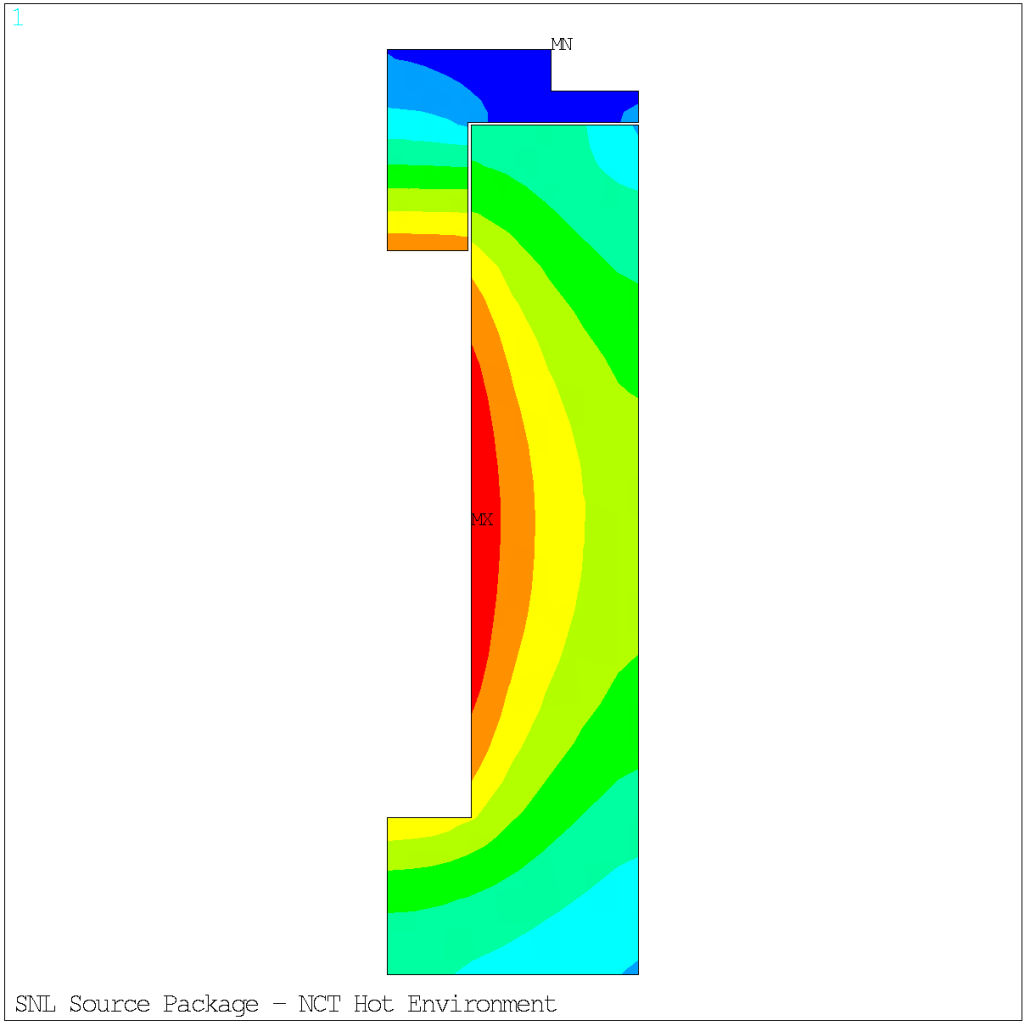
Sample

Thermal Analysis – Cask under NCT



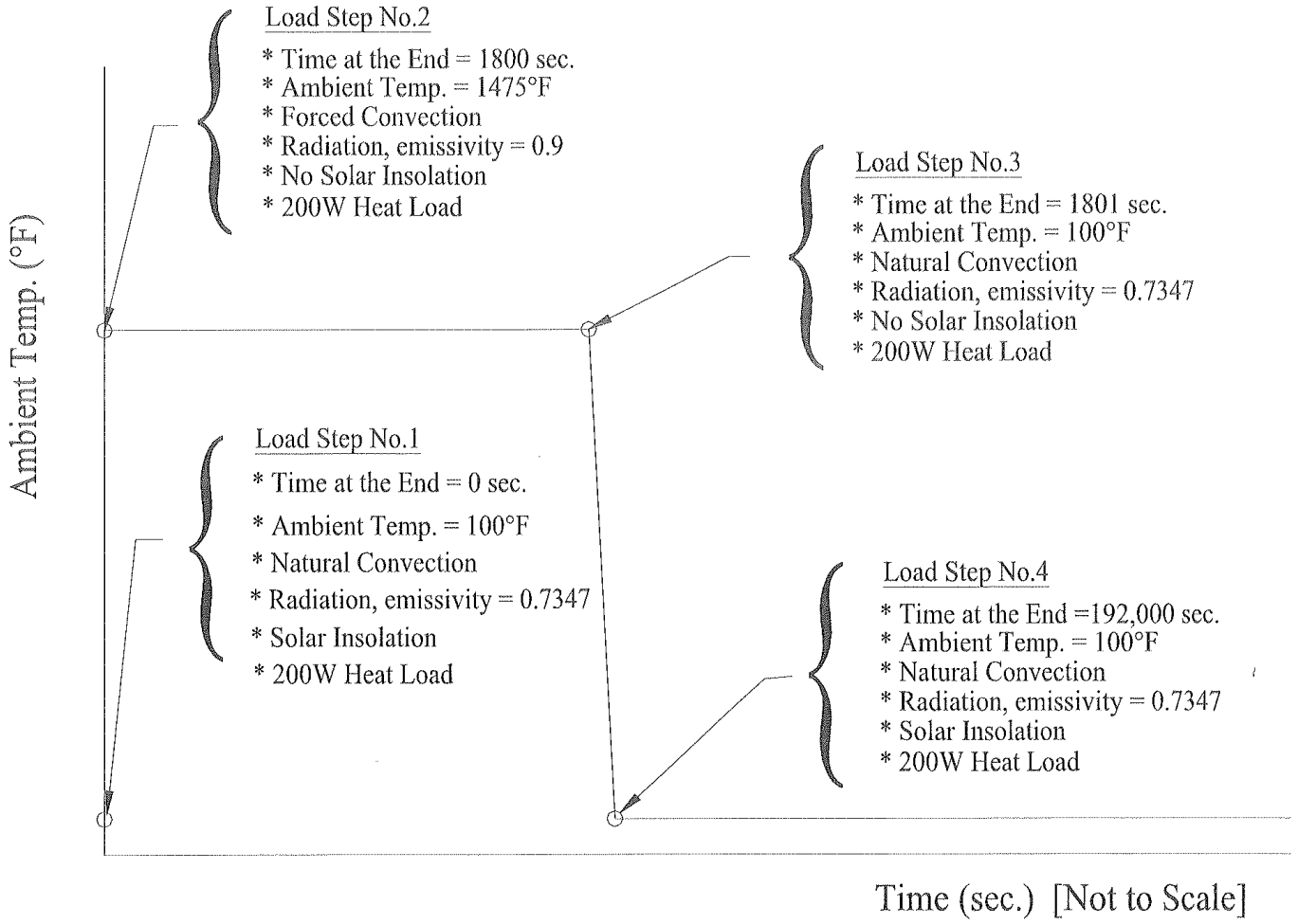
Sample

Thermal Analysis – Insert under NCT



Sample

Thermal Analysis – HAC Fire Test Load Steps



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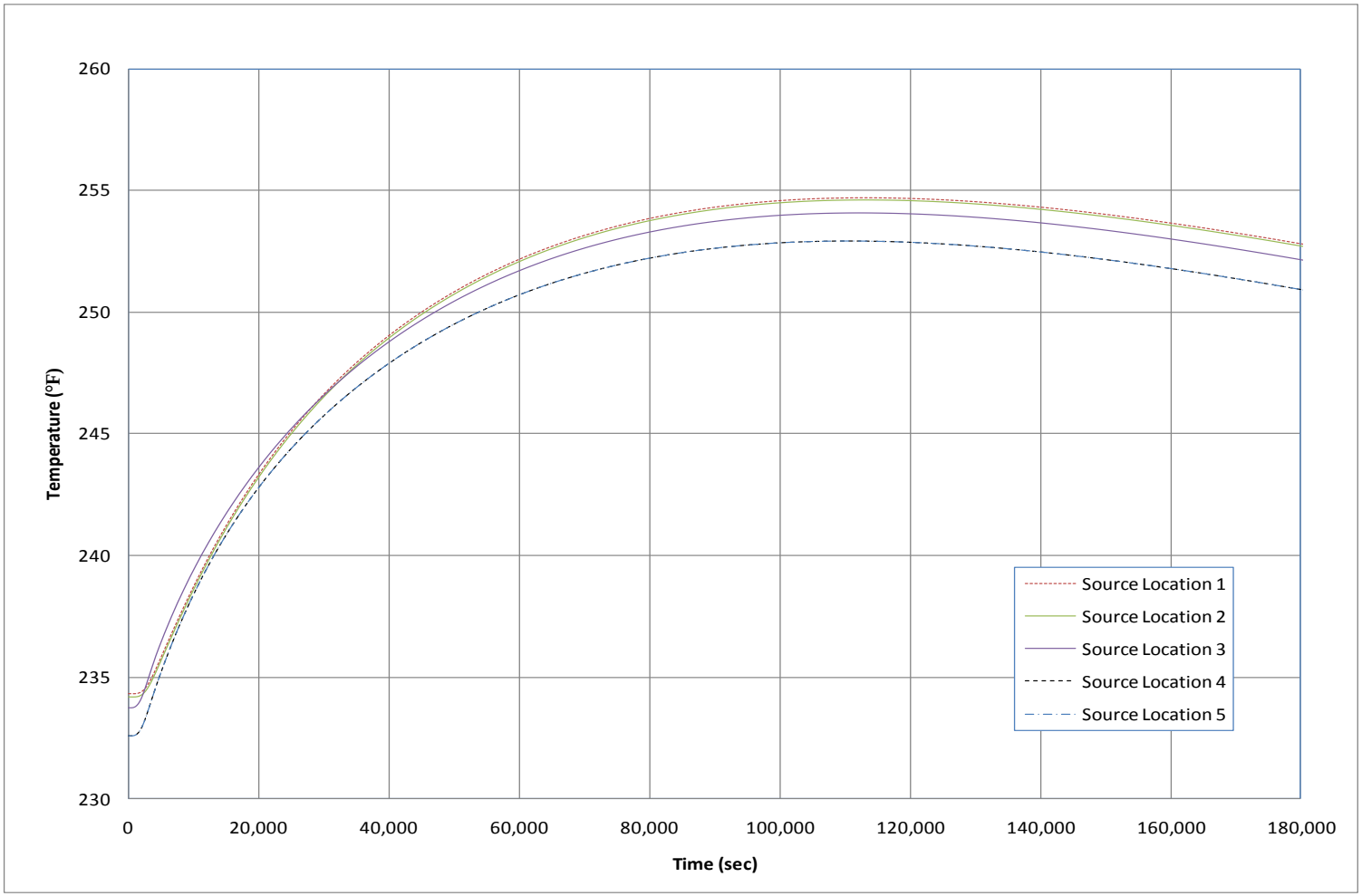
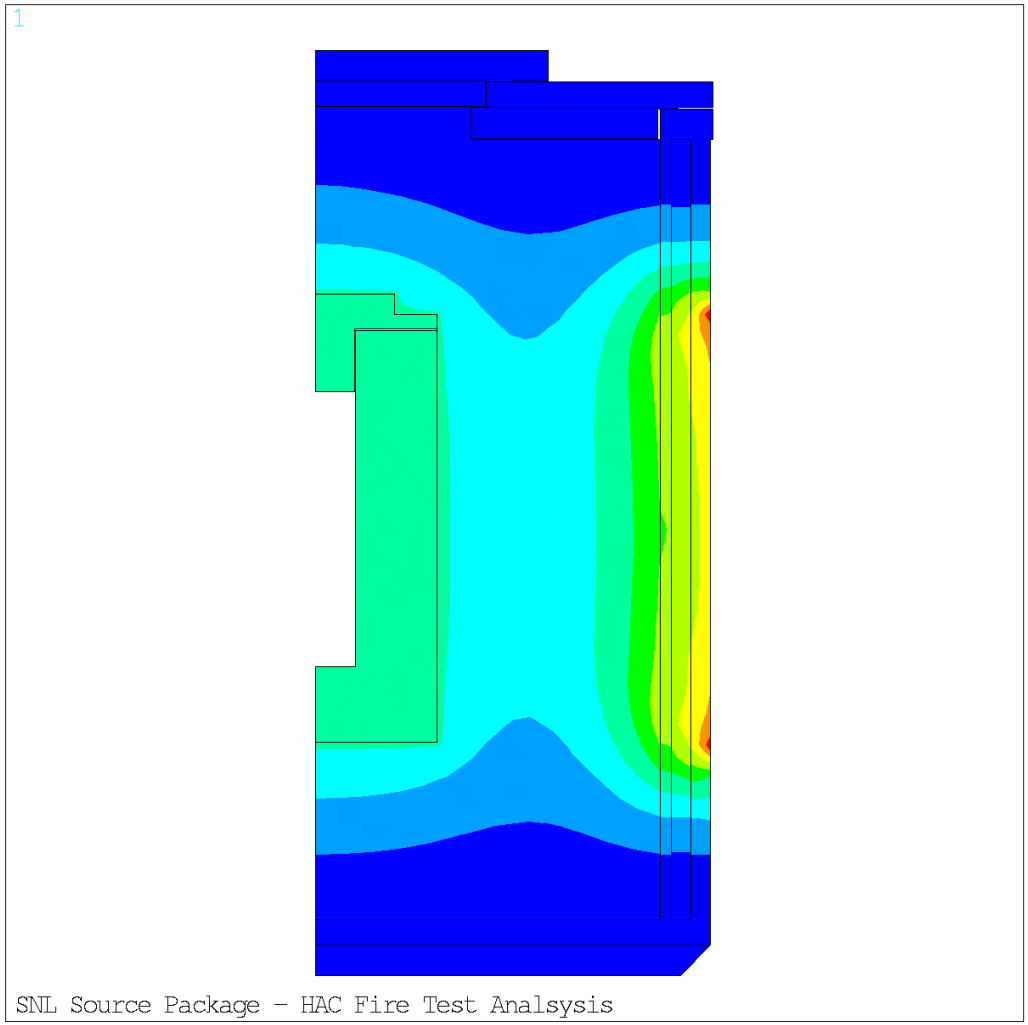
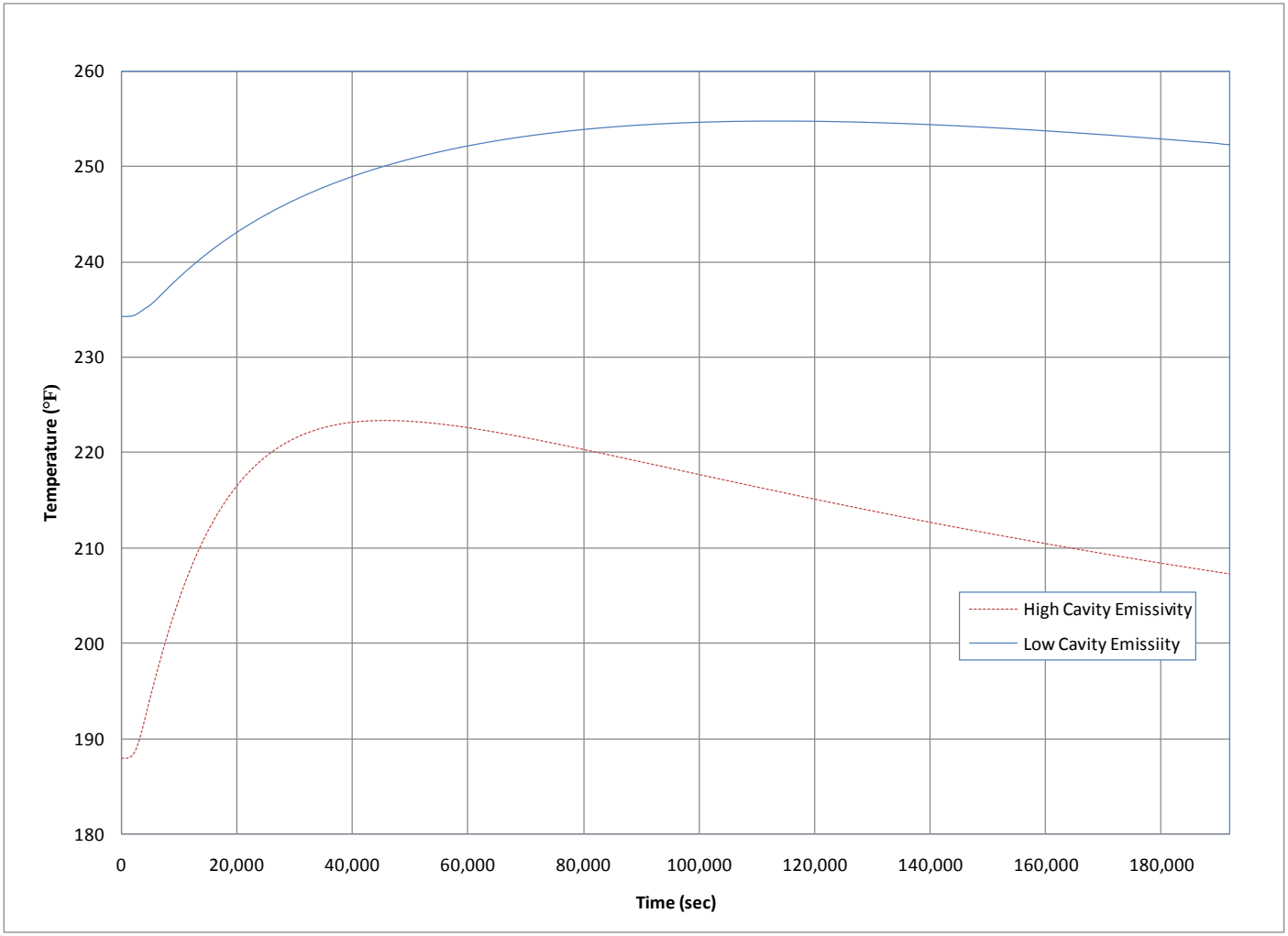
Thermal Analysis – HAC Fire Test Source Temperature



Thermal Analysis – HAC Fire Test Package Temperature



Thermal Analysis –Package Temperature Comparison



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SNL Source Insert– Gas Generation and Internal Pressure

- No gas generation from radiolysis
- Insert cavity will be vacuum dried
- Maximum Normal Operating Pressure will be evaluated for decay heat of sources
- Maximum HAC pressure will be calculated

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Thermal Analysis – Conclusions

The 10-160B cask, with the source insert and its contents as the payload, meet the thermal requirements of 10 CFR Part 71.

Containment Evaluation

- Co-60 $< 1000\ A_2$
- Bounded by current SAR ($3000\ A_2$)

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Shielding Evaluation

- Assumptions:
  - RAM distributed in cavity for NCT, as point source for HAC
  - ANSI-1977 flux-to-dose rate conversion factors used
  - Source insert moves under HAC
  - Ignore impact limiters for HAC

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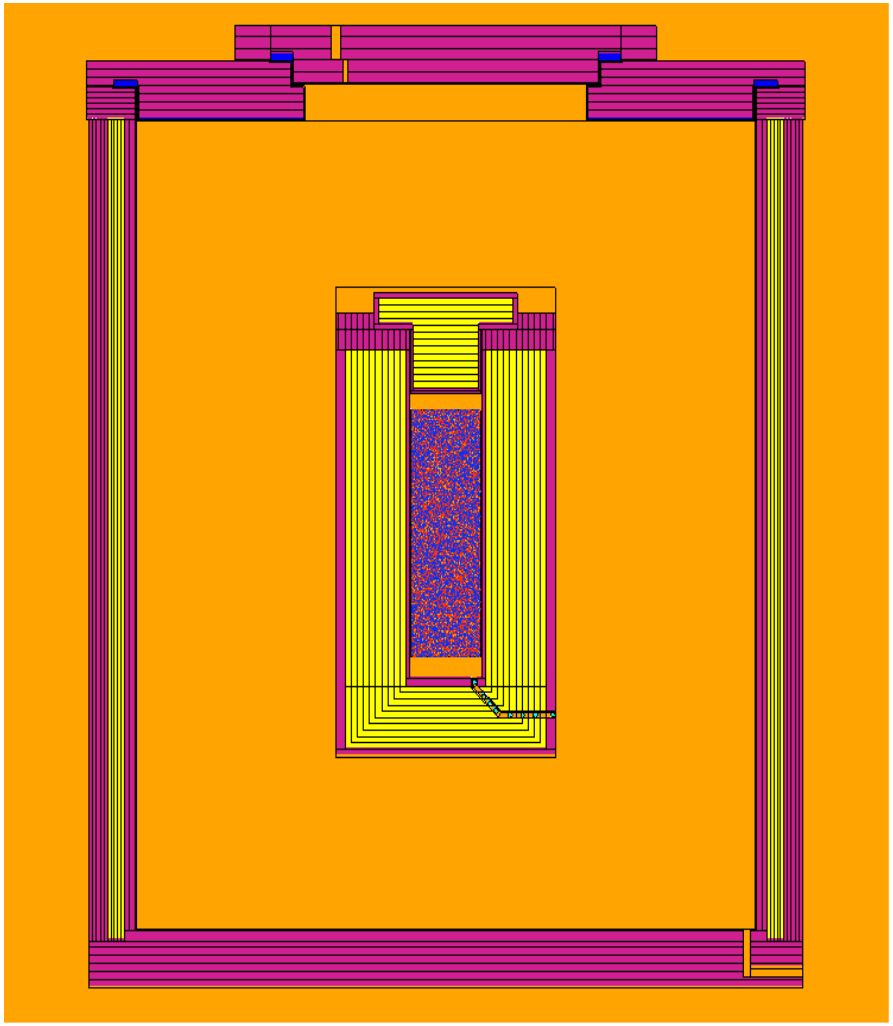
NCT Model (MCNP)



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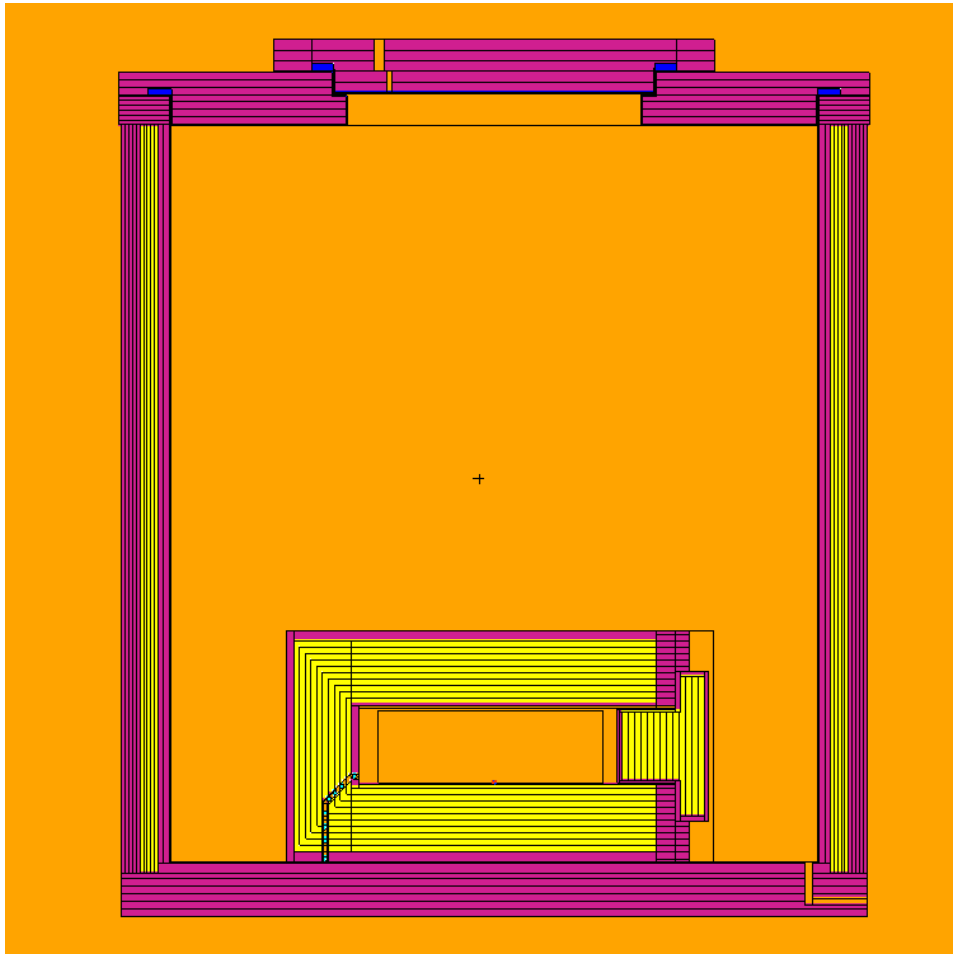
HAC Model (MCNP)



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Preliminary Shielding Results (MCNP)

	Cask Surface			1 m from Surface			2m from 8' trailer
Condition	Side	Top	Bottom	Side	Top	Bottom	
NCT							
Gamma Source	3.9	3.0	30.1	N.A.	N.A.	N.A.	0.4
Allowable	200	200	200	N.A.	N.A.	N.A.	10
HAC							
Gamma Source	N.A.	N.A.	N.A.	3.7	9.6	5.5	N.A.
Allowable	N.A.	N.A.	N.A.	1000	1000	1000	N.A.

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Shielding Analysis – Conclusions

The 10-160B cask, with the source insert and its contents as the payload, meet the shielding requirements of 10 CFR Part 71.

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Operations

- Place source insert in SNL pool
- Load sources into insert
- Install insert lid
- Drain insert cavity
- Vacuum dry insert cavity (1 torr for 30 minutes)
- Load insert into 10-160B
- Assemble cask
- Perform pre-shipment leak test
- Transport to NNSS

Fabrication and Acceptance

- Procurement Controls per Energy*Solutions* Quality Assurance Program
- Source Insert is Quality Level II (Category B) – following guidance of NUREG/CR-6407
- Shielding material (lead) will be procured as commercial items and will be upgraded to Quality Level II

Fabrication and Acceptance

- Gamma scan of completed Source Insert
- Welds inspected by MT – acceptance criteria per ASME Code Sec III, Div I, Subsection NF-5340
- Lift components load tested per ANSI N14.6
- No leak test of the Source Insert

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QA Program

- Energy*Solutions*, LLC has an established and fully implemented quality program for all aspects of design and fabrication. Our Quality Assurance (QA) Program meets the requirements of ASME NQA-1, 10 CFR Part 71, Subpart H and 10 CFR Part 50 Appendix B. Energy*Solutions* has extensive experience in managing, performing, and supporting projects in accordance with our QA Program and other quality consensus standards.
- The Quality Assurance Program has been evaluated and approved by the US Nuclear Regulatory Commission (USNRC). The implementation of Energy*Solutions* QA Program has been audited by the USNRC in 2009.