From: Christopher Bajwa
To: Harold Adkins
Date: Wed, Jul 14, 2004 4:29 PM
Subject: Please review 'PATRAM_2004_Bajwa-Rev1'

Harold,

Here's a first cut. I couldn't modify the colors on the TN-68 temperature plot beacuse it is a picture and not a "chart" like the plot from the HI-STAR100.

Anyway, that's about it...let me know if you have any Q's. Shouldn't take you long to comb through this. I received a reply from Garlock/Helicoflex (sort of)...it said that Kevin was out of toen and would get back to me next week with the information requested.

I'm not so sure the person whoresponded was really aware of what we were asking for. So we'll have to see what happens.

Peace out...

-Chris

A/7

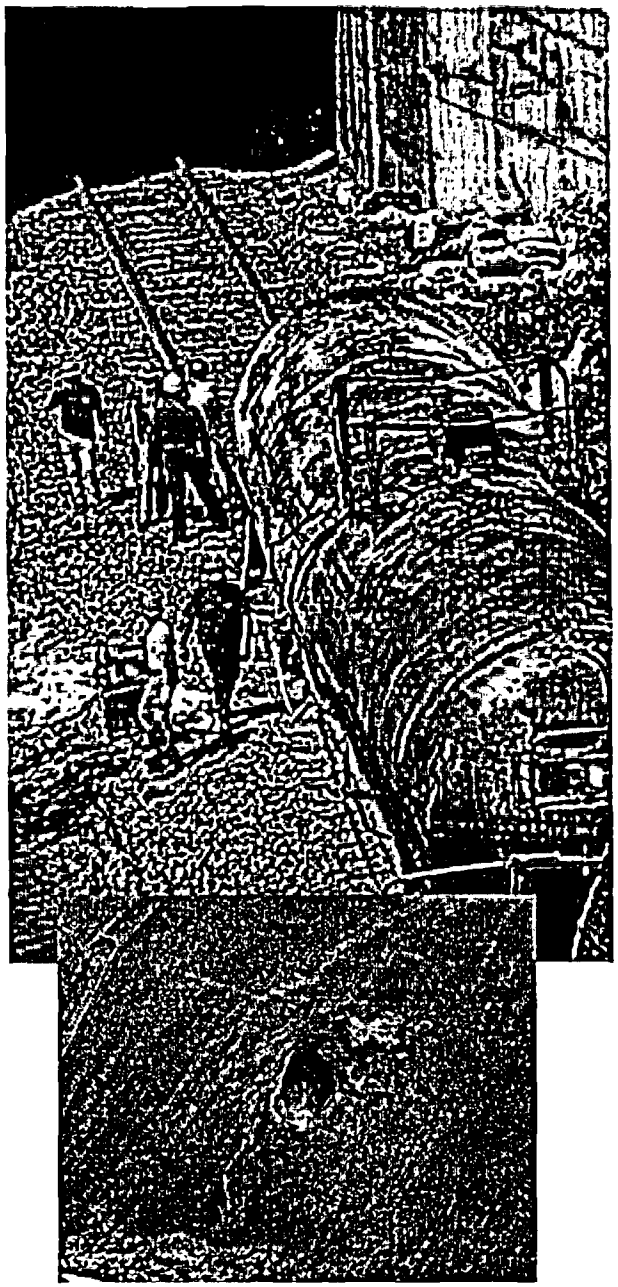
Spent Fuel Transportation Cask Response to a Tunnel Fire Environment

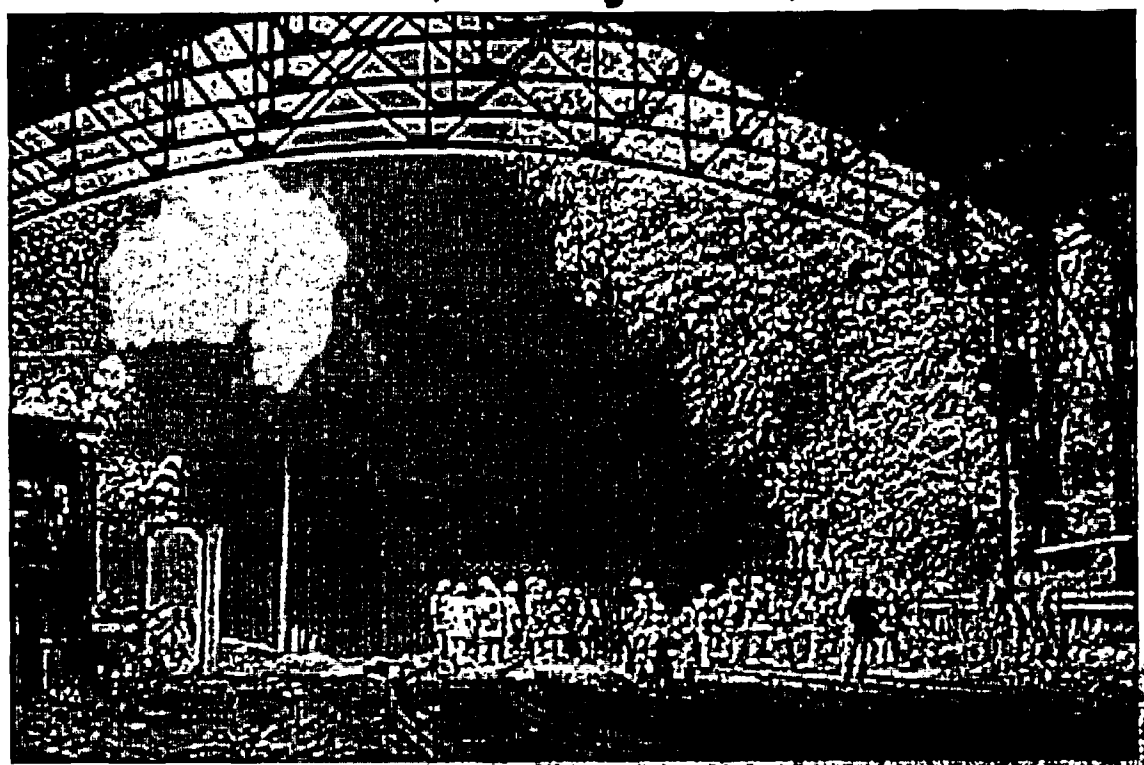
Christopher S. Bajwa, PE
Harold S. Adkins
Judith M. Cuta

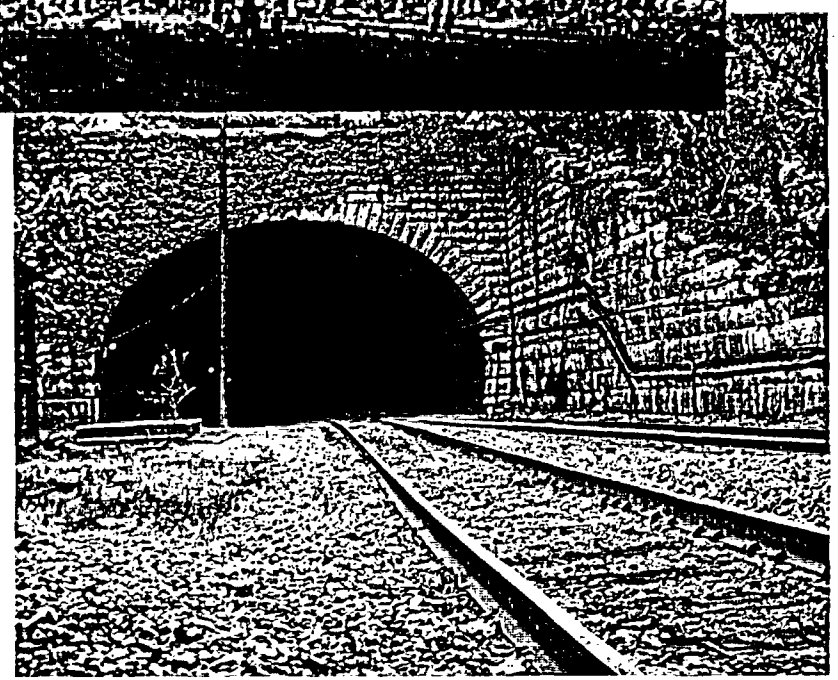
Introduction

- Baltimore Tunnel Fire Event
- Howard Street Tunnel Fire Model
- Spent Fuel Transportation Cask Analyses
- Results/Conclusions

Baltimore Tunnel Fire, July 18, 2001



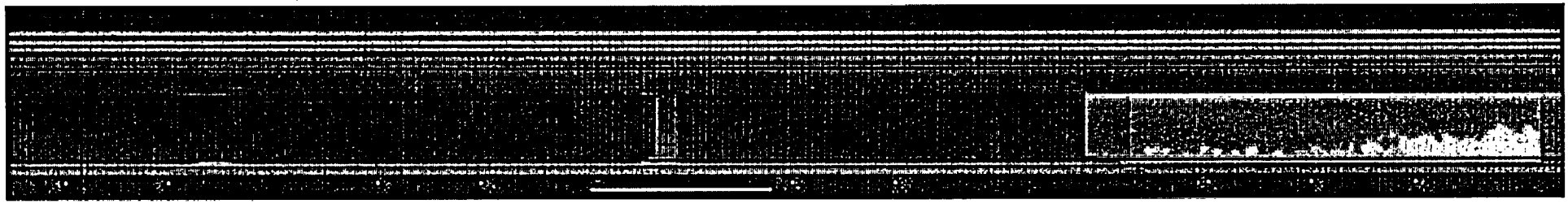




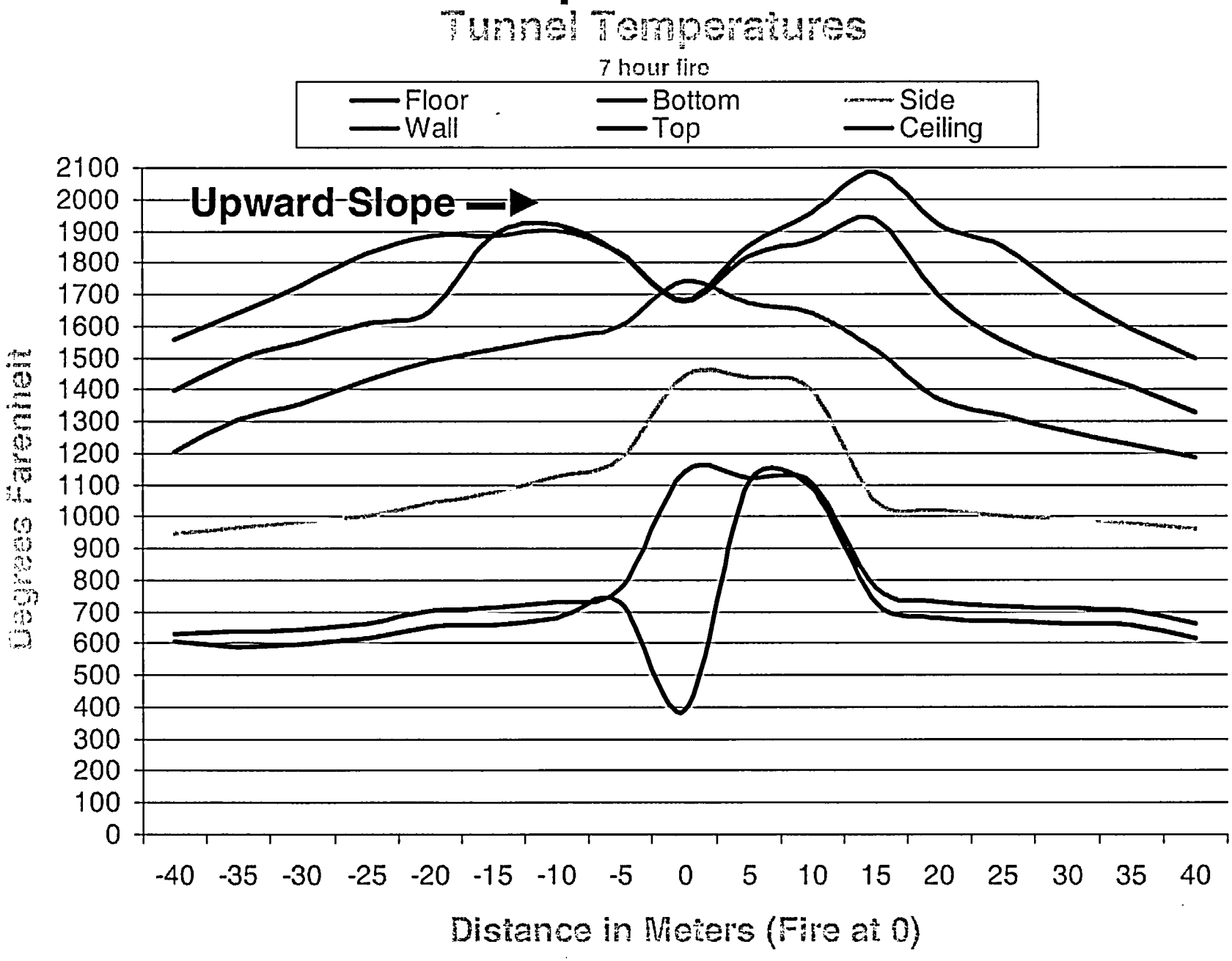
NIST Howard Street Tunnel Fire Model

- Fire Dynamics Simulator (FDS)
  - Computational Fluid Dynamics (CFD)
- Validated Against Test Data
  - Memorial Tunnel Fire Test Program
- Full 3D Tunnel Model
  - Included Railcars

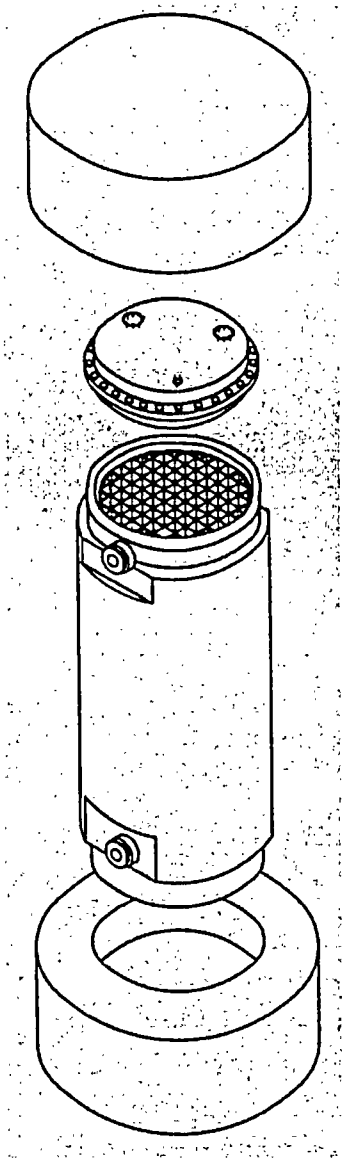
NIST Howard Street Tunnel Fire Model

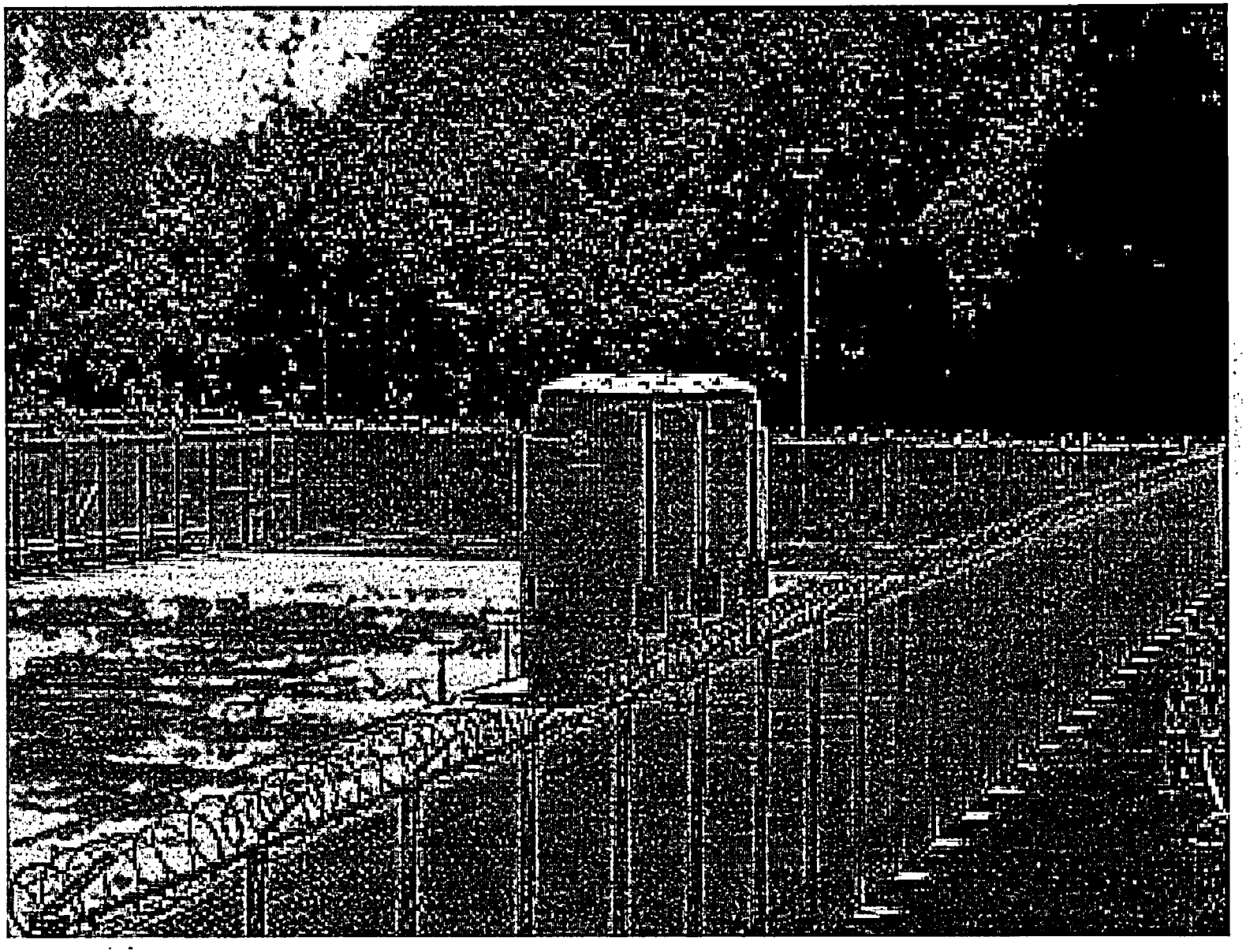


FDS Temperature Results

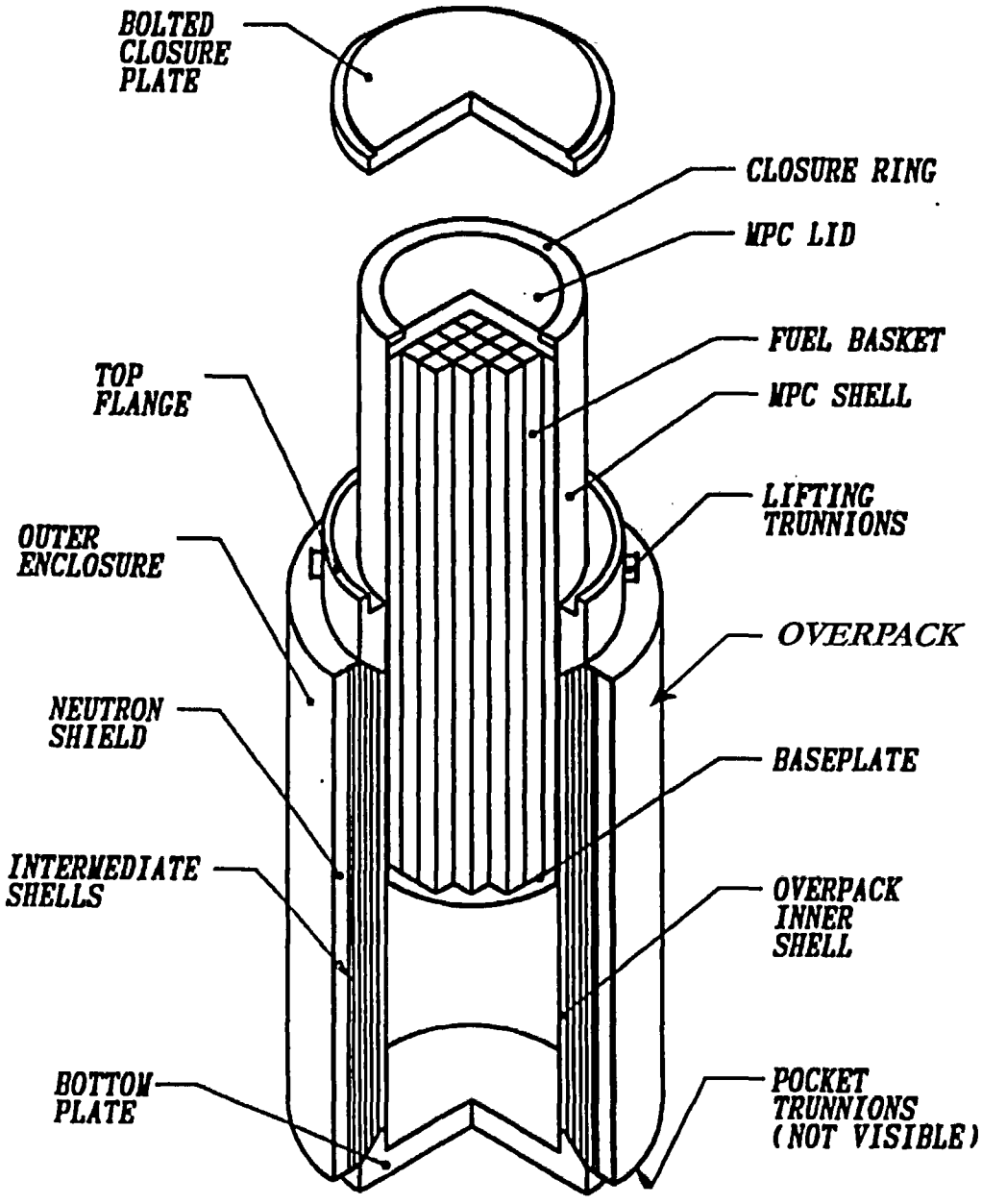


TN-68 Spent Fuel Cask

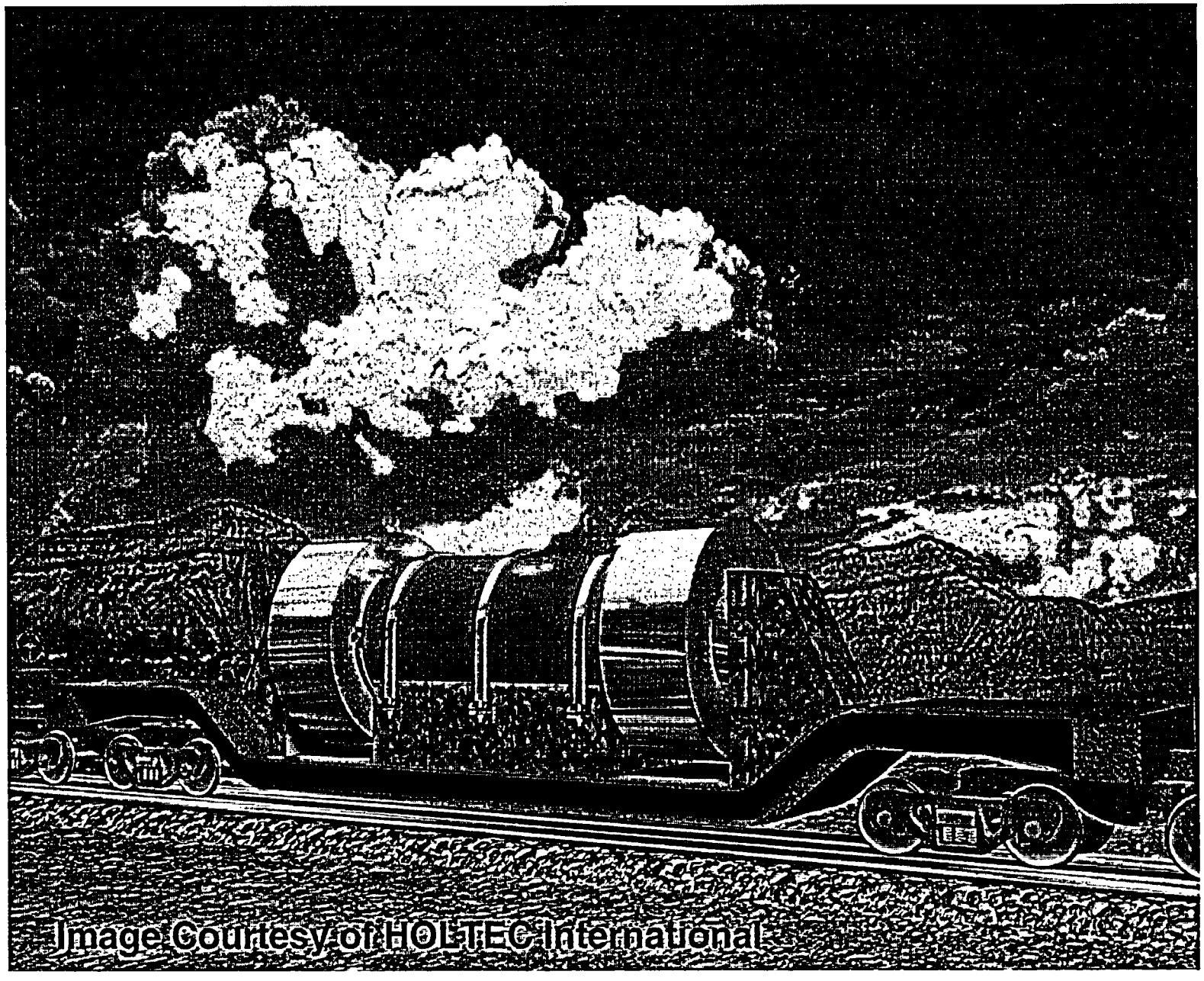




HOLTEC HI-STAR 100 Cask



HI-STAR 100 Rail Cask



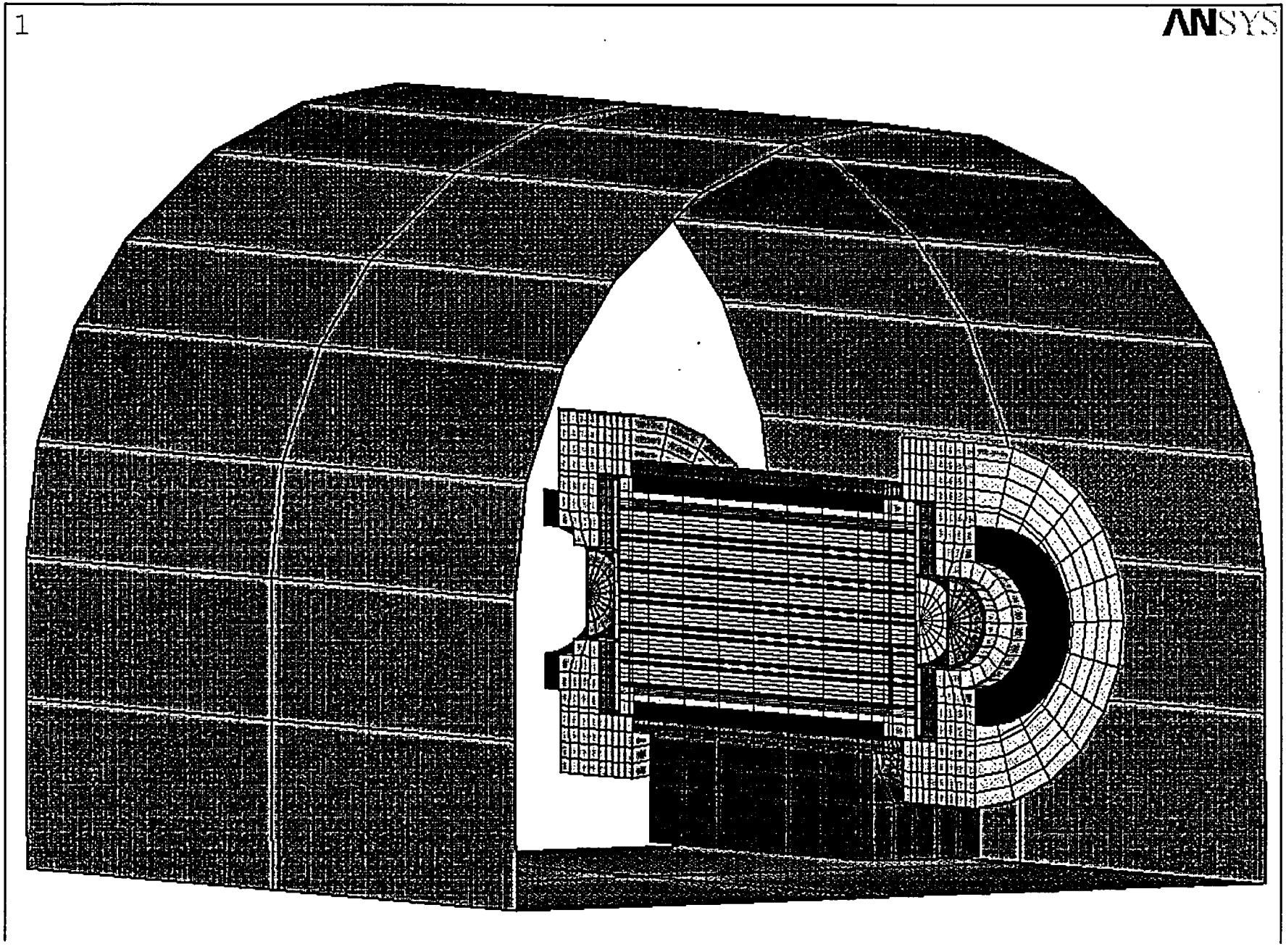
Cask Analysis Model Details

- HI-STAR 100 Spent Fuel Cask
  - Model Developed in ANSYS®
  - 3D half symmetry
  - Explicit geometry representation
  - Fuel assemblies homogenized
  - Conduction, convection, and radiation
  - Cask transport cradle included
  - Tunnel walls included
  - Model contains over 149,000 elements

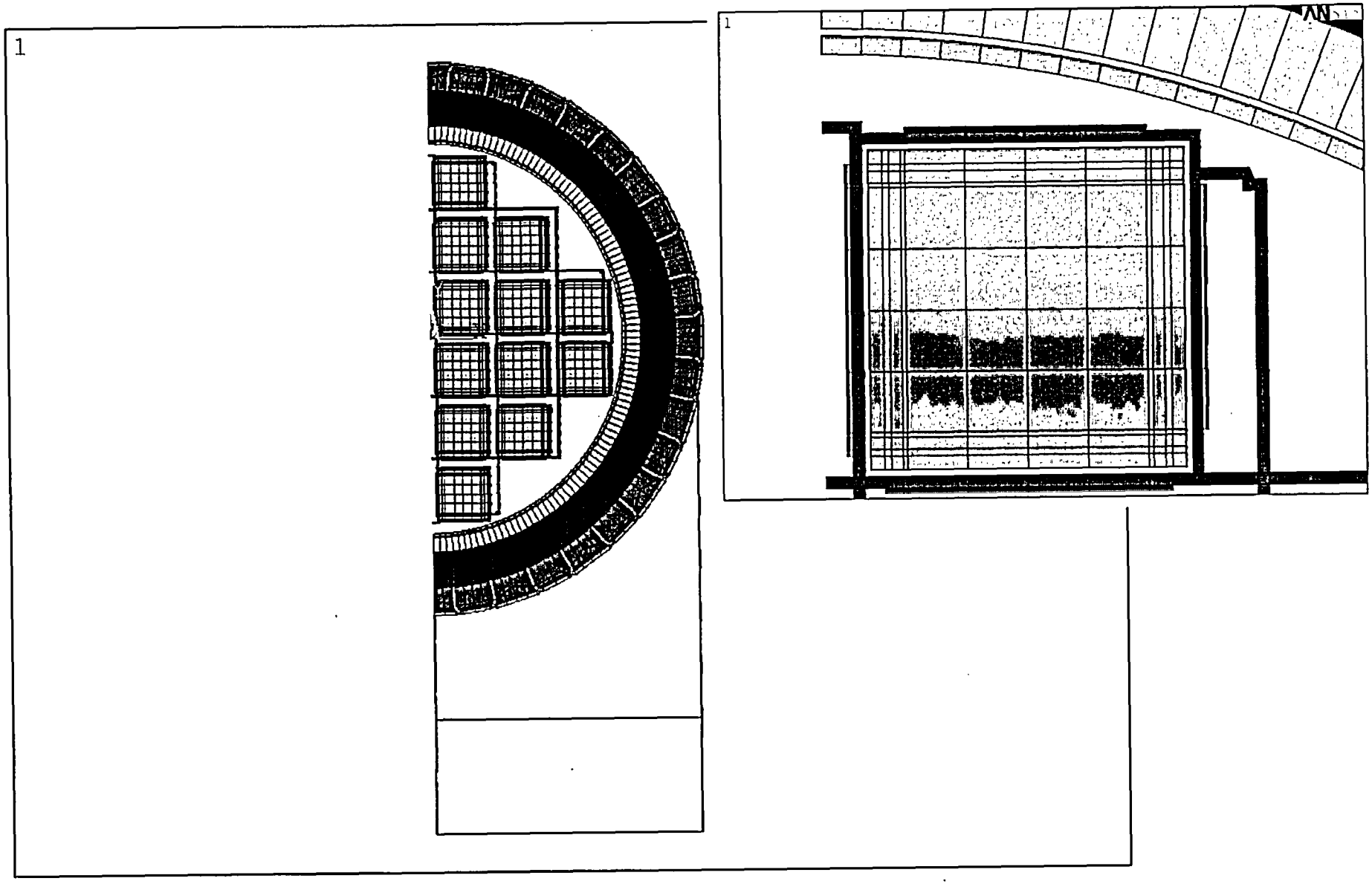
Cask Analysis Model Details, cont.

- TransNuclear (TN) 68 Spent Fuel Cask
  - Model Developed in COBRA-SFS
  - 3D half symmetry
  - Explicit geometry representation
  - Fuel assemblies explicitly modeled
  - Conduction, convection, and radiation
  - Tunnel walls included
  - Model contains approximately 139,000 nodes

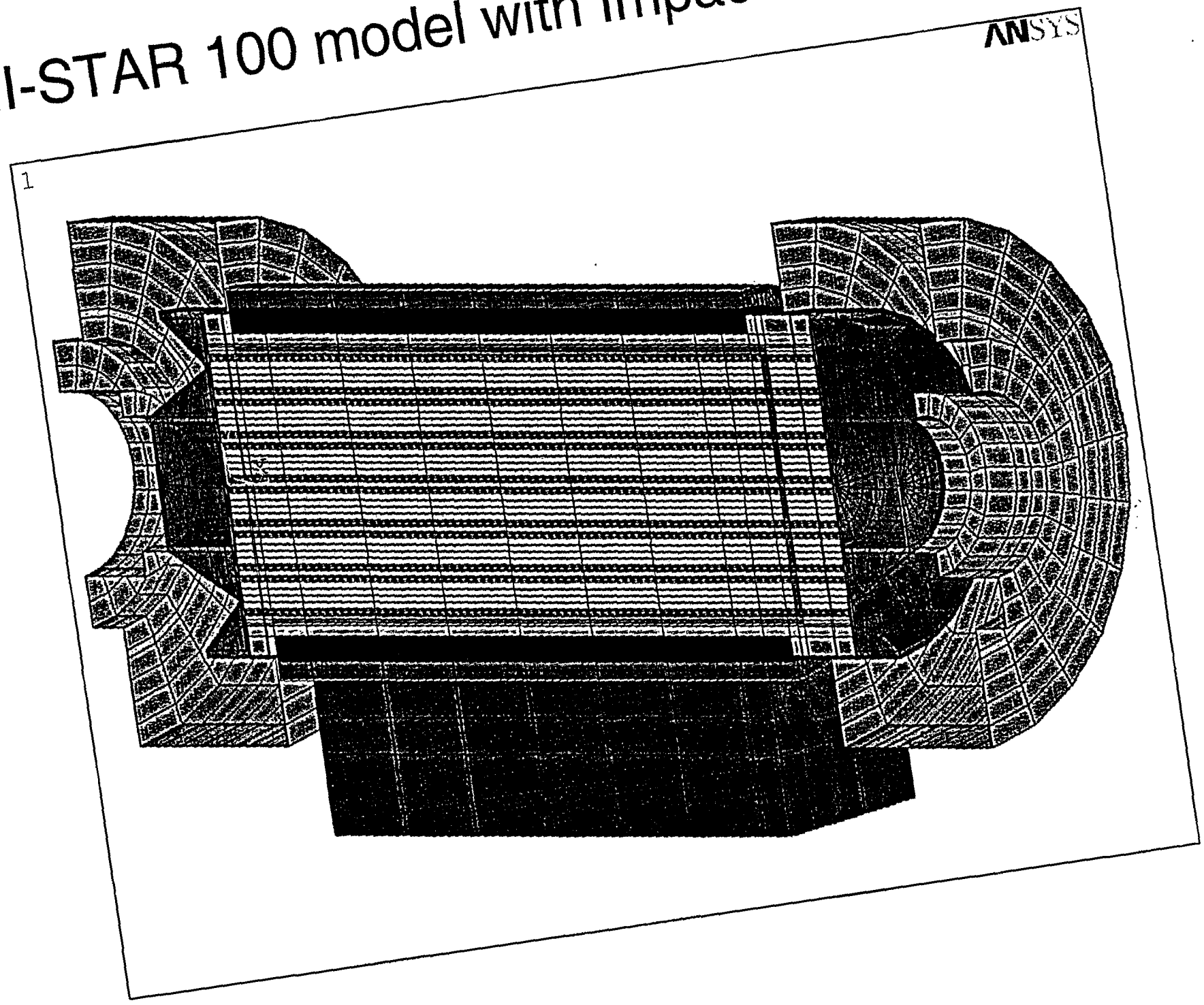
HI-STAR 100 Analysis Model (with Tunnel Walls)



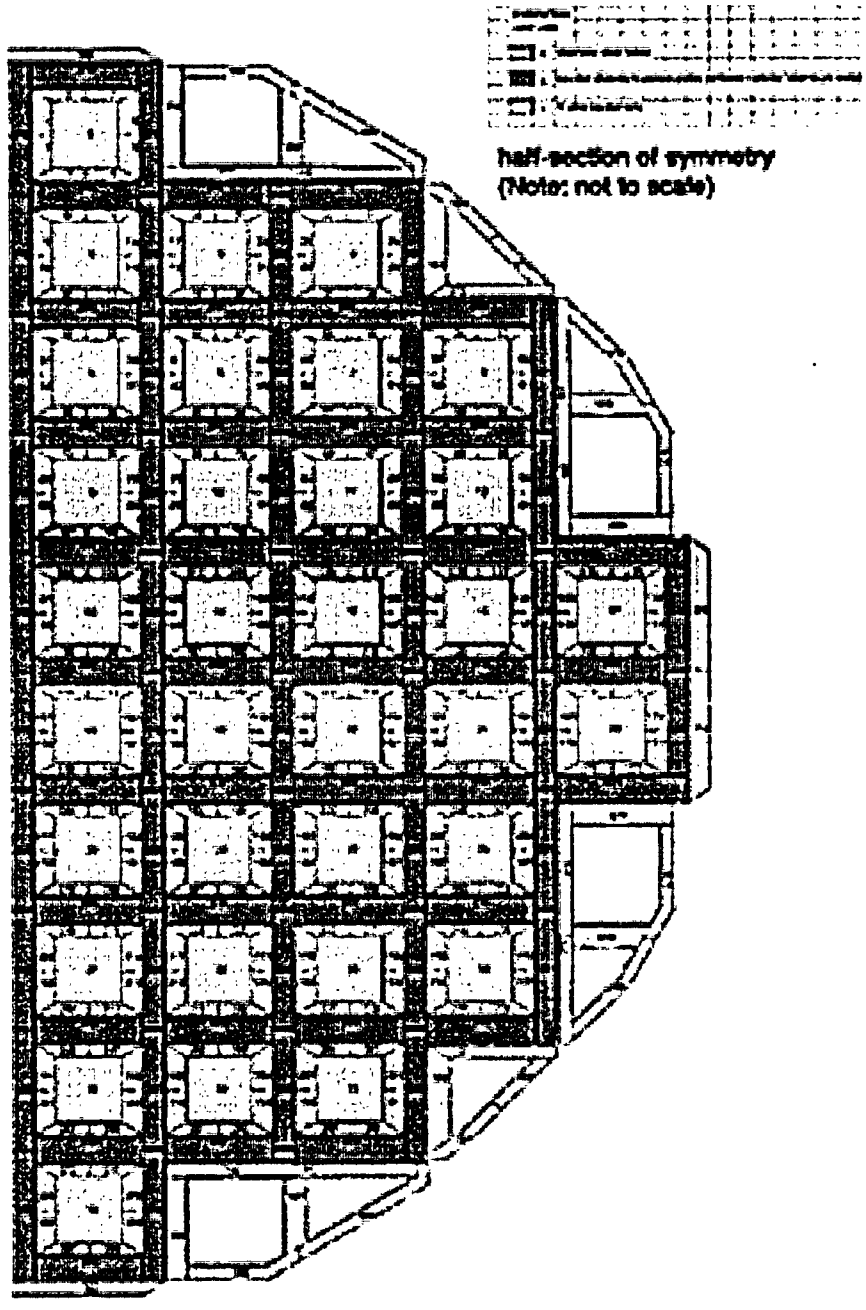
HI-STAR 100 Element Plot – (No Fill Gas)



HI-STAR 100 model with Impact Limiter Shells



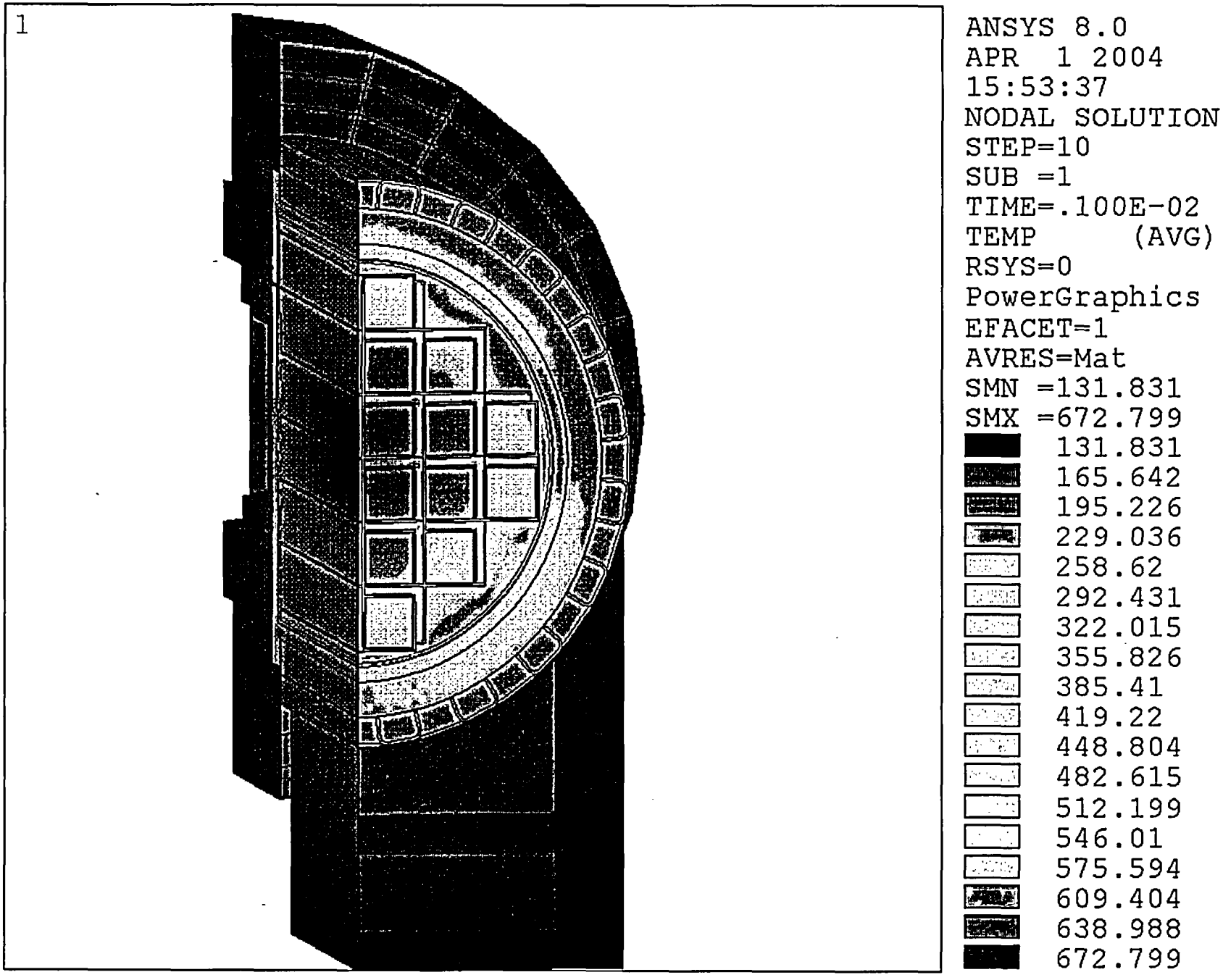
COBRA-SFS Node map for TN-68



Pre-Fire Analysis Conditions

- Equivalent to Normal Conditions of Transportation (NCT) in 10 CFR 71.71
  - Ambient Temperature 38°C (100°F)
  - Full Solar Insolation
  - Cask Surface Emmissivities: 0.3 for Stainless Steel, 0.85 for painted surfaces
- Maximum decay heat applied
  - TN-68 21.2 kW
  - HI-STAR 100 20 kW
- Steady state temperature solution obtained

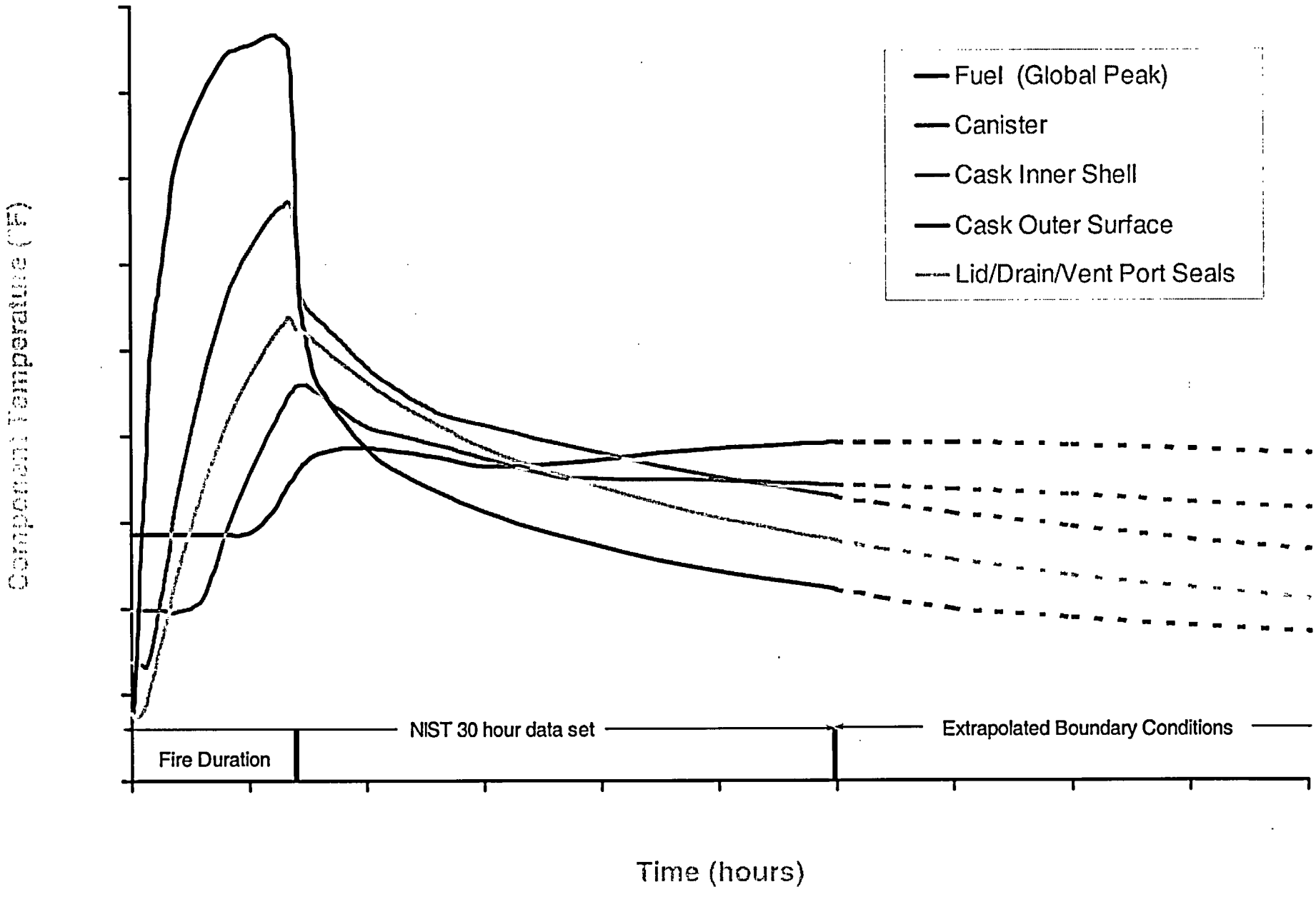
HI-STAR 100 Temperature Plot (Pre-Fire Conditions)



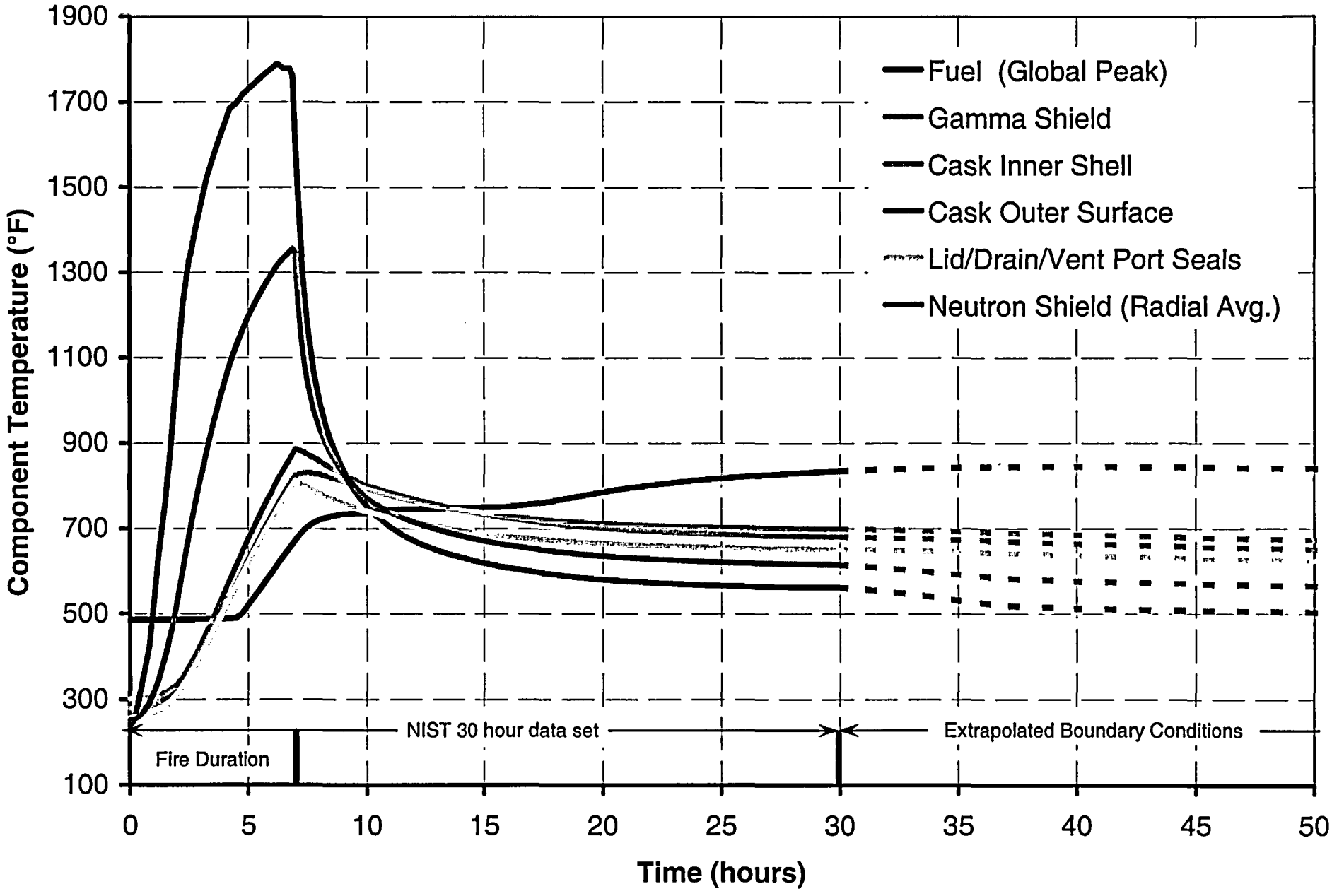
Fire Boundary Conditions

- Applied NIST Calculated Temperature and Flow Conditions
- Center of Cask Located 20 Meters from Fire Source
- 7 Hour Fire plus 23 Hour Cooldown
- Temperatures Extrapolated Using Power Function

HI-STAR 100 Cask Component Temperature Plot



TransNuclear-68 Cask Component Temperature Plot



Results from Cask Analysis

- Maximum Spent Fuel Cladding Temperatures:
  - HI-STAR 100: 887°F
  - TN-68: 845°F
- No Fuel Cladding Failure Expected
- No Failure of the Multi-Purpose Canister (MPC) Expected for HI-STAR 100
- No Seal Failure Expected for the TN-68 (Max seal Temperature 811°F)

Conclusions

- Robust Nature of Rail Casks is Evident
- Fire Exposure Results in No Release of Radioactive Material
- Health and Safety of the Public is Protected

Acknowledgements

- Mr. Harold E. Adkins, Jr. (PNNL)
- Ms. Judith M. Cuta (PNNL)
- Dr. Brian Koeppel (PNNL)
- Dr. Kevin McGrattan (NIST)
- Mr. Jay Kivowitz (NTSB)