Systems Integration

Presented to:
Nuclear Waste Technical Review Board

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Overview

- **Systems Integration**

- **Integration Activities**

- **Systems Integration Tools**

- **Total System Model Development/Future Activities**

- **Summary**

Systems Integration: Overall Objectives

- **International Council on Systems Engineering**

  - **…. an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem.**

Systems Integration:
An Integrated Solution to Waste Disposal

- **The Program has developed an integrated solution to accept, transport and dispose of spent nuclear fuel (SNF) and high-level radioactive waste (HLW)**

  - **Waste Acceptance based on 10 CFR 961 standard contracts**

  - **Transportation based on 10 CFR Part 71 for packaging and transportation of radioactive materials, 10 CFR 73 for physical protection, and 49 CFR 397.103 for transportation of radioactive materials**

  - **Repository receipt, handling and disposal based on 10 CFR Part 63 and will be in the License Application**

Systems Integration:
An Integrated Solution to Waste Disposal
(Continued)

- **The Program has complex cross-cutting issues in a dynamic environment**

  – **Regulatory, funding, and contractual**

  – **Industry capabilities, technology, design and lessons learned**

  – **Evolving scientific understanding**

  – **Logistics**

  – **Programmatic, policy and institutional changes**

- **This environment drives a continuing evaluation process to integrate solutions**

Systems Integration: Functional Roles, Responsibilities, Accountability & Authority

Systems Analysis and Integration

Waste Acceptance

- DOE SNF & HLW
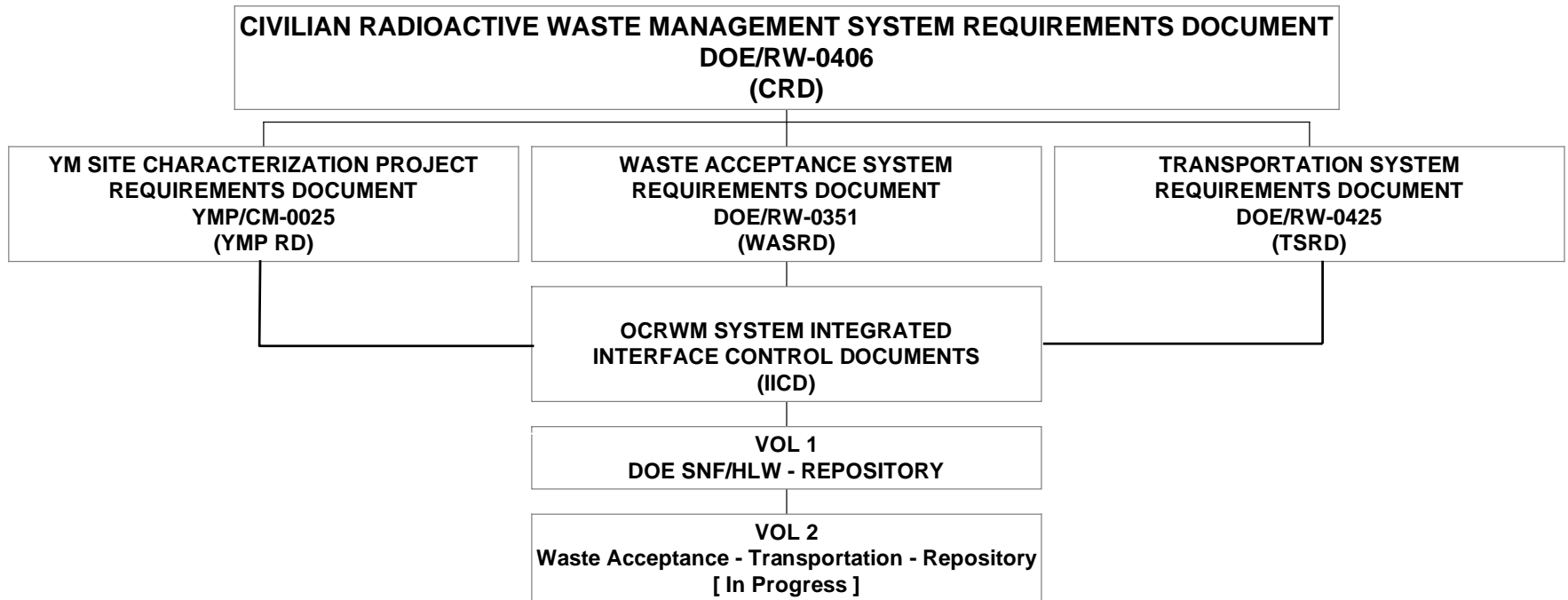- Commercial SNF
- Standard Contract Admin

Transportation

- Cask Design
- Fleet Acquisition
- Transportation Operations

Repository

- Repository Design
- Repository Operations
- Disposal and Post-Closure

SYSTEMS INTEGRATION: Requirements Hierarchy And Interface Control Documents

CIVILIAN RADIOACTIVE WASTE MANAGEMENT SYSTEM REQUIREMENTS DOCUMENT
DOE/RW-0406
(CRD)

| **YM SITE CHARACTERIZATION PROJECT REQUIREMENTS DOCUMENT YMP/CM-0025 (YMP RD)** | **WASTE ACCEPTANCE SYSTEM REQUIREMENTS DOCUMENT DOE/RW-0351 (WASRD)** | **TRANSPORTATION SYSTEM REQUIREMENTS DOCUMENT DOE/RW-0425 (TSRD)** |

OCRWM SYSTEM INTEGRATED INTERFACE CONTROL DOCUMENTS (IICD)

VOL 1
DOE SNF/HLW - REPOSITORY

VOL 2
Waste Acceptance - Transportation - Repository
**[In Progress]**

Integration Activities: Examples of Program Interfaces – Waste Stream Studies

- **Waste Stream Characteristics:**
  - **Repository Pre-closure and Post-closure Safety Analysis Basis**
  - **Facility physical interfaces**
  - **Queuing to meet contract considerations, handling, aging, and emplacement**

- **Transportation:**
  - **Delivery timetables**
  - **Cask and rail configurations**
  - **Regulatory issues at the transportation/repository interface**

- **Repository Design:**
  - **Surface and subsurface**

Integration Activities: Examples of Program Interfaces -Development of IICD Volume II
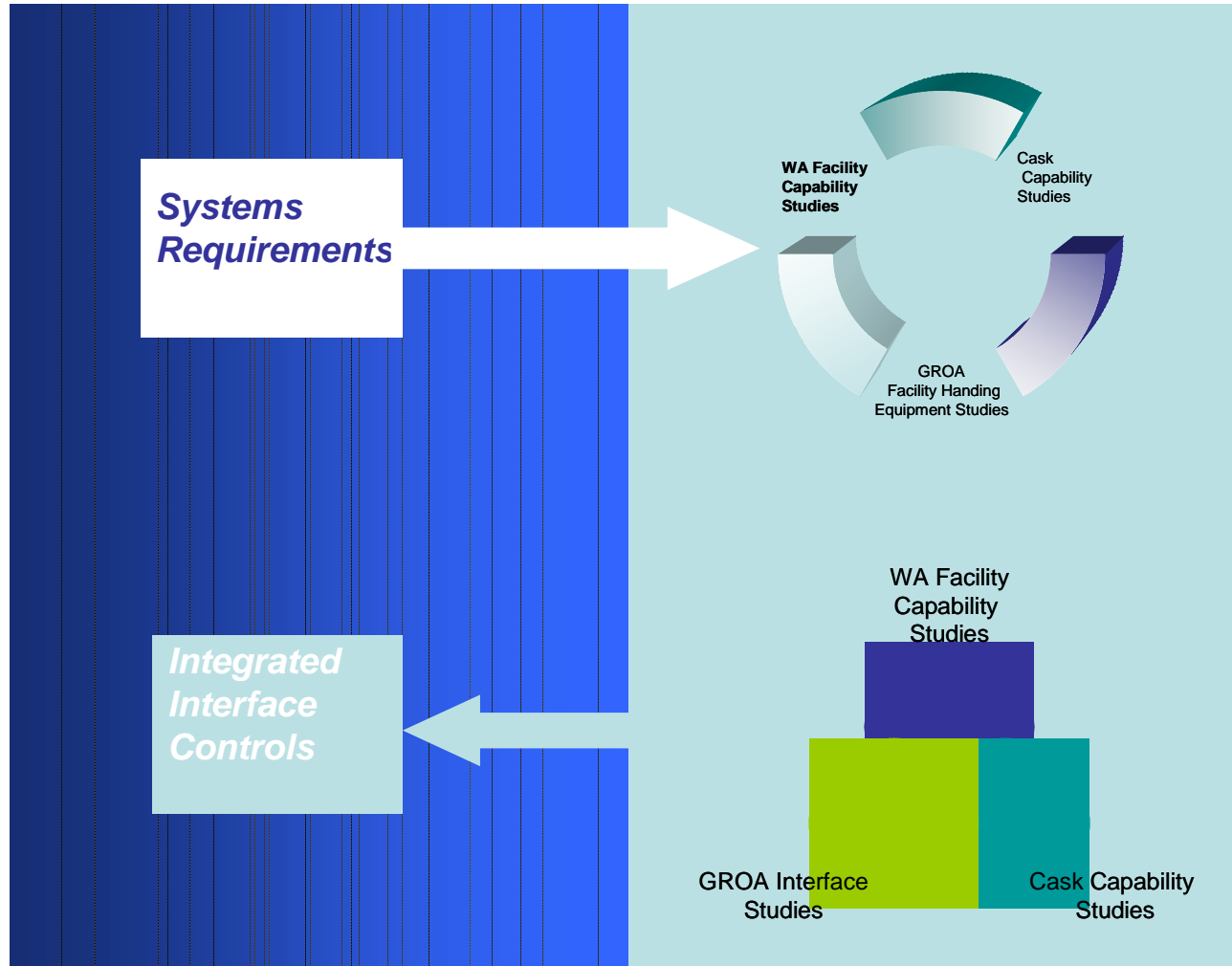
Integration Activities:
Examples of Program Interfaces - Utility Operator/Transportation Interface

- **Cask Loading Capabilities at Generator Facilities**

  - **Crane capabilities**

  - **Floor loading limits**

  - **Dimensional constraints**

  - **Potential impact on safety systems**

- **Transportation Capabilities**

  - **Mode (direct rail, heavy haul to rail, barge to rail)**

  - **Cask type and size**

- **GROA Design and Operational Capabilities**

Systems Integration Tools: Approach and Tools

- **The Program utilizes evaluation tools to conduct analyses to assess the impacts on the cost, schedule and technical baseline including the regulatory bases**

- **Evaluation tools include:**

  - **Total System Performance Assessment – post closure**

  - **Pre-closure Safety Analysis**

 - **Value Engineering Management – cost and schedule**

Systems Integration Tools:
Total System Model Overview

- **Total System Model (TSM) is under development as an integrated waste acceptance, transportation, and repository systems analysis tool**

- **With the Model, we will be able to analyze linkages, synergies to assess:**

    - **Baseline performance**

    - **Alternative analysis**

    - **System solutions**

    - **Program and Policy impacts**
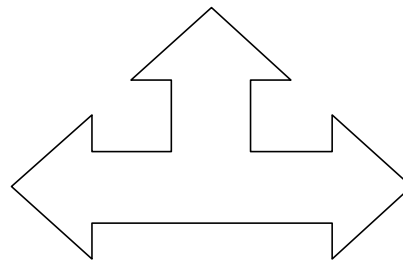
Systems Integration Tools: Total Systems Model

Waste Acceptance	→	Transportation	→	Repository

Requirements/Inputs   *Requirements/Inputs*   *Requirements/Inputs*

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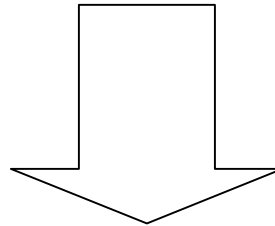
INTEGRATED WASTE ACCEPTANCE, TRANSPORTATION, AND REPOSITORY SYSTEMS ANALYSIS

SYSTEM ANALYSIS RESULTS

Transportation

Waste Acceptance   **Repository**

Systems Integration Tools: TSM Overview

- **The TSM is an event-driven real-time simulation, built on commercial software SimCAD™**

- **It is "object oriented" whereby discrete items (fuel assemblies, casks, work packages) progress through the processes as dictated by the process flow logic that we build into the model**

- **The Model is event-driven based on the availability of the next process step and/or response to set events or "triggers"**

- **The Model simulates real time activities, reporting the interactions and behavior of all objects and processes visualized in TSM Graphical User Interface and continuously written into data files**

- **Algorithms have been developed to simulate the decision processes and actions for filling waste packages to meet thermal constraints**

Systems Integration Tools: TSM Overview
(Continued)

- **Enables systems analysis approach to inform decisions**

  - **Analyzes alternative scenarios against the Program baseline**

  - **Provides insights into how systems components are impacted as different alternatives or inputs are considered**

  - **Challenges "existing" design and operating concepts and requirements**

  - **Provides implication of down stream impacts due to earlier Program decisions**

  - **Provides insights into areas requiring attention for improvements, optimization, or realignments**
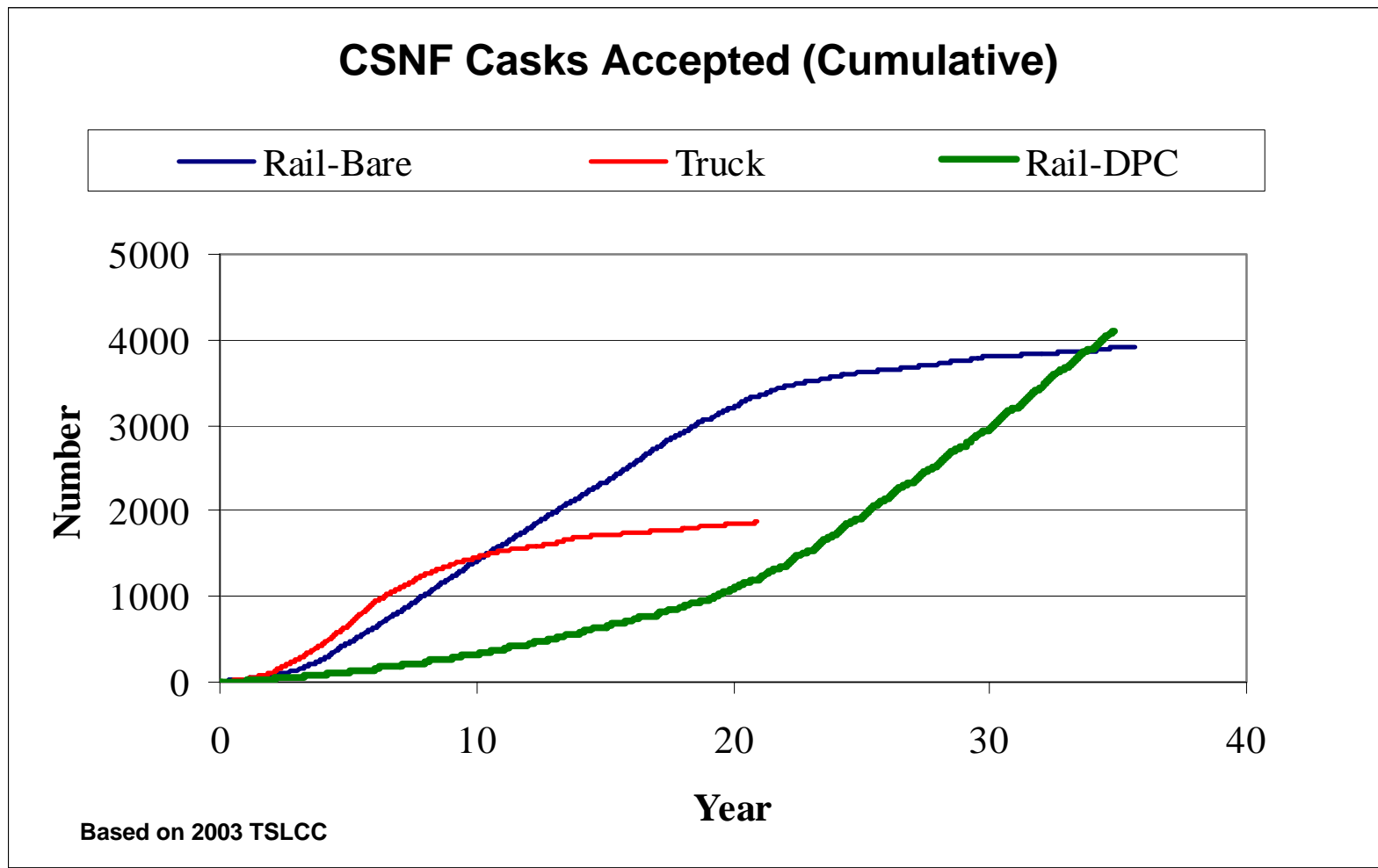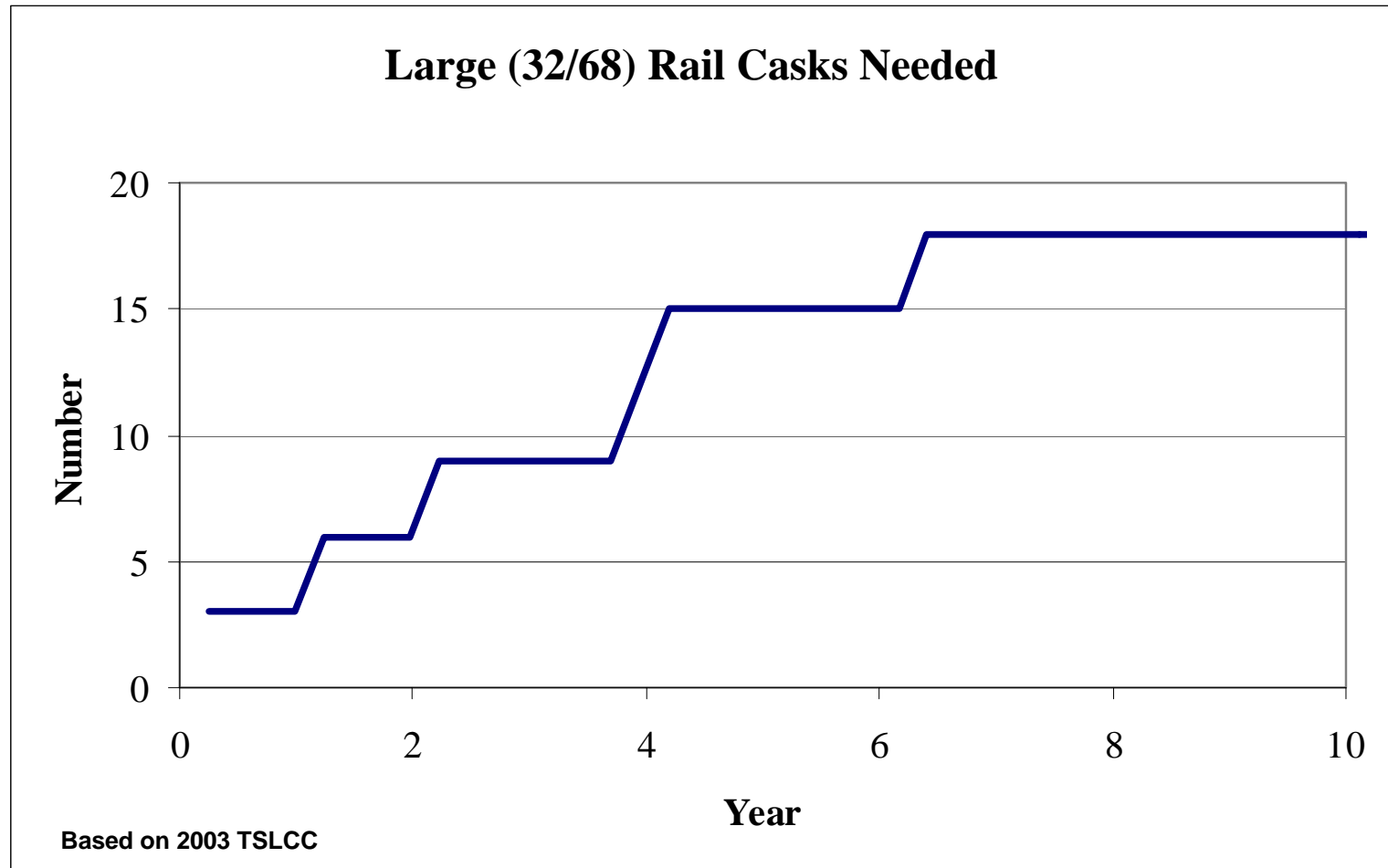
Systems Integration Tools: TSM Output

- **The TSM tracks the movement of every input item and object created through each process**

- **The TSM creates three data files that provides the systems analyst information to assess performance**

  – **Initial State Files: provides the SNF/HLW shipment loads base on producer site data**

  – **The Report Generator Files: provides object and process data**

  – **GROA Report Generator File: provides WP loading data**

- **From these data files, TSM tools or Excel can be used to analyze results, generate reports, or compare against other TSM simulations**

Systems Integration Tools: TSM Sample Results - Shipping Casks Received

CSNF Casks Accepted (Cumulative)

Legend: Rail-Bare, Truck, Rail-DPC

Y-axis: Number (0, 1000, 2000, 3000, 4000, 5000)
X-axis: Year (0, 10, 20, 30, 40)

Based on 2003 TSLCC

Systems Integration Tools: TSM Sample Results - Large Rail Cask Needs

Large (32/68) Rail Casks Needed

Based on 2003 TSLCC

Total System Model Development/Future Activities

- **The Total System Model is a developing systems tool to study the complex interactions among the Program elements**

- **The Model will challenge Program design assumptions, requirements, and operational assumptions**

- **RW will proceed through a systematic approach to support the major Program and policy issues ahead**

- **The Model will incorporate new data or inputs as they become available in a controlled and documented process**

Summary

- **DOE has developed a workable integrated solution to accept, transport, and dispose of spent nuclear fuel and high-level radioactive waste**

- **Integration continues across all functional elements**

- **Systems analysis tools will be refined as our designs mature**