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7. Abstract This document summarizes the mission analysis performed on the Integrated Dynamic Modeling and Management System (IDMMS). The IDMMS will be developed to provide the modeling and analysis capability required to understand the TWRS system behavior in terms of the identified TWRS performance measures. The IDMMS will be used to demonstrate in a verified and validated manner the satisfactory performance of the TWRS system configuration and assurance that the requirements have been satisfied.		
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INTEGRATED DYNAMIC MODELING AND MANAGEMENT SYSTEM (IDMMS) MISSION ANALYSIS

CONTENTS

1.0	INTRODUCTION	1
1.1	PURPOSE OF IDMMS	1
1.2	SCOPE AND APPLICABILITY OF IDMMS	1
1.3	BACKGROUND FOR IDMMS	2
2.0	SUMMARY OF RESULTS	2
3.0	MISSION ANALYSIS	2
3.1	PRELIMINARY ACTIONS	3
3.1.1	Mission Needs, Goals, and Objectives	3
3.1.2	Source Materials and Requirements Documentation	3
3.1.3	Required Tools	3
3.2	MISSION DEFINITION	4
3.2.1	Mission Initial Conditions	4
3.2.2	Mission Final Conditions	4
3.2.3	Mission Boundaries/Interfaces	5
3.2.4	Mission Resources	6
3.2.5	Establish Measures of Success	6
3.3	MISSION ANALYSIS EVALUATION	6
3.3.1	Unknown and Uncertain Information and Data	6
4.0	CONCLUSIONS/RECOMMENDATIONS	6
5.0	REFERENCES	7

LIST OF TABLES

1	List of Tools Currently Used to Perform Analyses	8
2	Relation of Types of Analysis to Program Function	9
3	Sources of Data Associated with the TWRS Program	10
4	Users of the Integrated Dynamic Modeling and Management System	12

INTEGRATED DYNAMIC MODELING & MANAGEMENT SYSTEM (IDMMS) MISSION ANALYSIS

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) has established the Tank Waste Remediation System (TWRS) Program to safely manage and dispose of the tank waste stored at the Hanford Site. The mission of the TWRS Program is "to store, treat, and immobilize highly radioactive Hanford waste in an environmentally sound, safe, and cost-effective manner." The scope includes project and program activities for receiving, safely storing, maintaining, treating, and disposing onsite, or packaging for offsite disposal, all tank waste. Tank waste includes the current contents of 149 single-shell tanks (SST), 28 double-shell tanks (DST), approximately 47 miscellaneous tanks, plus any new waste added to these facilities, and all encapsulated cesium and strontium stored onsite and returned from offsite users. As the TWRS program is developed and deployed, it is necessary for program decision makers to understand the cost, schedules, technical performance, environmental, and public and worker health and safety impacts of their decisions. Because of the size and complexity of the TWRS program, an integrated computer simulation and data management system is required.

1.1 PURPOSE OF IDMMS

This mission analysis will describe the Integrated Dynamic Modeling and Management System (IDMMS), which will be developed to provide the modeling and analysis capability required to understand the TWRS system behavior in terms of the identified TWRS performance measures. Because Systems Engineering has been adopted as the paradigm for development and management of the TWRS Program, a modeling system must be developed that will demonstrate in a verified and validated manner the satisfactory performance of the system configuration and assurance that the requirements have been satisfied.

The purpose of this document is to describe the computer tools, techniques, and means used to perform the analyses required to satisfy the requirements placed upon the TWRS system as defined by application of the Systems Engineering process.

1.2 SCOPE AND APPLICABILITY OF IDMMS

IDMMS will perform the analyses applicable to the definition of the TWRS technical baseline. The primary building blocks for the analyses required to satisfy the TWRS requirements and performance measures are simulation tools. These tools permit modeling of the tank waste through receipt, storage, characterization, retrieval, treatment, and final disposal. Simulation produces models that range from generic to very detailed. The complexity of the model is directly related to the desired output results and the capabilities of the simulation tool being used. The role of simulation is to evaluate practical alternatives either in support of major strategic

initiatives or in support of the continuous search for better performance at the operational level. Simulation provides the user with greater breadth and depth of information on which to base decisions. Additionally, simulation supports sensitivity analyses by allowing rapid changes to the model logic and data.

1.3 BACKGROUND FOR IDMMS

The existing methods for analyzing and modeling system cost, schedule, technical performance, environmental impact, and risk to public and worker health and safety are neither integrated nor adequate to support a large, complex program. The currently available analysis and modeling tools are comprised of both manual and automated data inputs, manipulations, and outputs. An assortment of unverified databases are currently in use, making these models, assumptions, input data, and results difficult to verify and validate. Because of this, the results produced by these models are not accepted by the customer (DOE) and other stakeholders (Westinghouse Hanford Company [WHC], Pacific Northwest Laboratories [PNL], Washington State Department of Ecology [Ecology], U.S. Environmental Protection Agency [EPA], etc.). Thus, building consensus, making decisions, and implementing the TWRS mission becomes very difficult.

2.0 SUMMARY OF RESULTS

Results from this mission analysis lead to the conclusion that an integrated computer simulation system is required to analyze and model TWRS cost, schedule, technical performance, environmental impact, and public and worker health and safety in an efficient, consistent, repeatable, verified, and validated manner.

3.0 MISSION ANALYSIS

As part of the Systems Engineering process, understanding the TWRS system behavior is essential in formulating TWRS decisions. This understanding is typically expressed in terms of technology performance, environmental impact, public and worker health and safety, cost, and schedule parameters. These parameters require systematic analyses. The objective of this document is to identify the tools, techniques, and means needed to perform these analyses. The need to manage, control, and ensure the quality of the data, information, and analytical results leads to the rationale for the development of an integrated set of computer-based tools.

3.1 PRELIMINARY ACTIONS

This section identifies those actions necessary to accomplish the mission of developing the IDMMMS, which will model and analyze TWRS system behavior in terms of the TWRS performance measures.

3.1.1 Mission Needs, Goals, and Objectives

TWRS has selected Systems Engineering as the process for defining the TWRS Program technical baseline. Implementation of Systems Engineering requires application of standard, recognized methods. TWRS Program participants require specialized tools to apply these methods. As a result, a need exists to provide systems engineers with a set of computer-based tools accessing verified and validated databases that can be used to produce efficient, consistent, verified, and validated analytical results in support of TWRS decisions. The goal and objective of this task is to develop and deploy an integrated computer simulation system that will provide a thorough understanding of the TWRS system behavior in terms of the TWRS performance measures. This simulation system will provide a clear understanding of internal and external interfaces, and allow integration and optimization of the system and its components, as well as determine subsystem and component performance, risks, and their interrelationships. A controlled database will be required to facilitate documentation and establish credibility and validity of the simulations.

3.1.2 Source Materials and Requirements Documentation

The TWRS Functions and Requirements document (Ref.1) provides a list of required analyses that need to be performed to support the enabling assumptions required for decomposition of the functions. The Tank Waste Remediation System Decisions and Risk Assessment document (Ref. 2) contains a list of the key decisions that must be made to effectively manage the TWRS Program. Additional analysis requirements will be derived through interaction with the programs and project organizations.

3.1.3 Required Tools

A variety of computer-based simulation tools will be required to accomplish the IDMMMS mission. Tools will be defined to assist in providing information required to make the key decisions itemized in the Tank Waste Remediation System Decisions and Risk Assessment document (Ref.2). A partial list of these tools currently in use is contained in Table 1. These tools consist of spreadsheets, mathematical subroutines, simulators, simulation languages, programming languages, specialized software applications, and custom software. As IDMMMS matures, tools with the capability of those indicated in Table 1 will be incorporated as well as other additional tools yet to be defined.

3.2 MISSION DEFINITION

This section outlines the initial conditions, final conditions, boundaries/interfaces, resources, and measures of success for the mission.

3.2.1 Mission Initial Conditions

Analyses are being performed using the tools listed in Table 1 to support many activities of the TWRS Program (Ref.1). Table 2 lists the types of analyses performed to support the different program activities. The activities are strategic decision making, alternative technology selection, design and licensing, and program management. The types of analyses are related to the Program activities with differing emphasis and levels of detail.

The analyses associated with strategic decision making involve the resolution of the socio-political and program direction, risk, safety, and compliance issues. The analyses associated with alternative technology selection seek to optimize performance that is in concert with resolving technology, safety, and compliance concerns. The analyses associated with program management are responses to programmatic concerns (i.e., cost and schedule) and their interactions with technical performance issues. The analyses associated with design and licensing focus on the physical aspects of the TWRS Program and associated impacts on safety and compliance issues.

Implementation of these analyses using the tools identified in Table 1 requires an extensive database. A partial list of the databases that may be relevant to the TWRS analyses effort are listed in Table 3. The sources of data range from hardcopy reports to individual and centralized databases. The initial condition of TWRS analysis consists of numerous standalone analyses and modeling efforts. These efforts produce results that are difficult to defend because the sources of data are difficult to locate and model results are difficult to trace back to the originating source. The use of standalone tools and data that are not managed, controlled, and validated produces seemingly inconsistent results. Timely responses to analysis requests are difficult to achieve because a segmented analysis approach results in duplicating efforts with the perception of not moving forward in understanding the TWRS behavior. As a result, building consensus, making decisions, and implementing the TWRS mission becomes nearly impossible to achieve.

3.2.2 Mission Final Conditions

The final condition desired for IDMMS would be a comprehensive integrated computer simulation system. This system would allow:

- 1) Models to be built such that traceability to TWRS requirements is clearly demonstrated. The models would be expressed in terms of technology performance, environmental impact, public and worker health and safety, cost, and schedule parameters, or other decision criteria as defined within TWRS.

- 2) Effective management of the sources of data, the assumptions associated with the analyses, and the model results.
- 3) Control of the sources of data, the assumptions, and the models in order to produce repeatable results.
- 4) Validation of the sources of data and models in order to produce repeatable results.
- 5) Use of a common set of databases and tools in order to produce consistent results.
- 6) Expedient responses to analysis requests and changes in the TWRS Program by building on existing models.

In addition to understanding the TWRS system behavior, the integrated analysis system needs to:

- 1) Provide information in support of physical system design specifications.
- 2) Aid in tracking the TWRS system behavior as it progresses through the lifecycle phases (i.e., requirements definition, conceptual design, design, construction, operational use, and decontamination and decommissioning).
- 3) Aid in testing and evaluating the TWRS system behavior as it progresses through the lifecycle phases.
- 4) Provide the tools necessary to develop the information required to make the key decisions itemized in the Tank Waste Remediation System Decisions and Risk Assessment document (Ref. 2).

3.2.3 Mission Boundaries/Interfaces

The mission boundaries and interfaces can be demonstrated by the wide range of potential users. The users can be categorized as system analysts, program managers, regulatory overseers and the general public. Table 4 lists the potential users and uses of IDMMS. To accommodate this wide range of users, the IDMMS requires a well-designed, high-quality, user interface that supports a seamless integration of the computer-based tools and provides visualization of the data and models. The user interface should provide user-defined access to all elements and components so that a meaningful, whole context is provided for the user. Equally important is selective presentation of relevant data, models, and tools for each type of user. The general public users would not need to be burdened with the data, models, and tools required by the system analysts. Hence, the user interface should provide means to differentiate user types so that appropriate information would be accessed.

3.2.4 Mission Resources

The resources necessary to accomplish the IDMMS mission will be provided by TWRS Systems Engineering personnel, TWRS Program and Project personnel, and contract consultants. The computer hardware and software tools will be acquired within the TWRS Systems Engineering organization on an as-needed basis. Multiple-user access to IDMMS will be accomplished through use of the WHC Hanford Local Area Network (HLAN).

3.2.5 Establish Measures of Success

Measures of success will be determined by how well and how timely the IDMMS satisfies the user needs identified in Table 4. All models will be subjected to verification and validation procedures and rigorous quality assurance practices to produce consistent, repeatable, and defensible results. A comprehensive and defensible database is critical to the success of the analysis and modeling simulations. All elements of the database will be traceable to a technology source and reviewed and documented by an acknowledged expert or team of experts.

3.3 MISSION ANALYSIS EVALUATION

This section on mission analysis evaluation identifies unknown or uncertain information and data and ensures that all mission analysis objectives have been satisfied.

3.3.1 Unknown and Uncertain Information and Data

The largest uncertainty in the analysis models is in the source and validity of the input data. Current analysis procedures utilize individual tools and data that are not managed, controlled, verified, and validated. The procedures produce inconsistent results unacceptable to the customer and other stakeholders.

Another major unknown is the computer hardware and software availability and applicability. Software developed for manufacturing applications is being applied to the TWRS Waste Management area and the validity of this application remains to be established. Further uncertainty exists in establishing the requirements on the IDMMS to satisfy the various level of users and uses identified in Table 4.

4.0 CONCLUSIONS/RECOMMENDATIONS

An integrated computer simulation system is required to analyze and model TWRS cost, schedule, technical performance, environmental impact, and public and worker health and safety in an efficient, consistent, repeatable, verified, and validated manner. These simulations will provide the capability

to quickly and thoroughly understand the TWRS system behavior in terms of the identified performance measures and satisfy the requirements developed through the Systems Engineering process.

5.0 REFERENCES

- 1) RL, 1994, "Tank Waste Remediation Systems Functions and Requirements", DOE\RL-92-60, Westinghouse Hanford Company, Richland, Washington, Draft, September, 1994.
- 2) Johnson, M.E., "Tank Waste Remediation System Decisions and Risk Assessment", WHC-EP-0786, Westinghouse Hanford Company, Richland, Washington, Draft, September, 1994.

Table 1. List of Tools Currently Used to Perform Analyses

Software Tools	Analysis Support	General Use Availability
Arena	<ul style="list-style-type: none"> Waste Retrieval, Transfer, Storage, and Processing Modeling 	No
Aspen	<ul style="list-style-type: none"> Chemical Flowsheet for Technical Performance Modeling (e.g., Case Beta Flowsheet; Sludge Washing Flowsheet) 	No
Excel Spreadsheet	<ul style="list-style-type: none"> Technical Performance Analysis Budget and Schedule Analysis 	No
Extend	<ul style="list-style-type: none"> Waste Pretreatment Analysis 	No
FastC	<ul style="list-style-type: none"> Cost Estimates 	No
Ithink	<ul style="list-style-type: none"> Waste Pretreatment Analysis Grout Analysis 	No
LINDO	<ul style="list-style-type: none"> Design Optimization 	No
Mathematica	<ul style="list-style-type: none"> Waste Pretreatment Analysis 	No
Prolog	<ul style="list-style-type: none"> Waste Transfer Modeling 	No
SLAM	<ul style="list-style-type: none"> Waste Pretreatment Analysis 	No
Supertree and Sensitivity	<ul style="list-style-type: none"> Decision Analysis 	No
TRAC	<ul style="list-style-type: none"> Tank Content and Inventory Assessment 	No

Table 2. Relation of Types of Analysis to Program Activities

Type of Analysis	Program Activities			
	Strategy Decision Making	Alternative Technology Selection	Design and Licensing	Program Management
Policy Analysis	X			
Decision Analysis	X			
Risk Assessment	X	X		X
Budget & Schedule Analysis	X			X
Performance, Cost, & Schedule Analysis		X		X
Environmental Impact Assessment	X	X	X	
Health & Safety Analysis	X	X	X	
Chemical Flowsheet		X	X	
Design Optimization		X	X	

Table 3. Sources of Data Associated with the TWRS Program

Database Acronym	Database Name
CASS	Computer Automated Surveillance System
CBRS	Component Based Recall System
CBRSEAST	Component Based Recall System - East
CBRSVCA	Component Based Recall System - VCA
CBRSWEST	Component Based Recall System - West
CMHD	Component Maintenance History Database
DACS	Data Acquisition and Control System
DSTOSR	Double-Shell Tank Operational Safety Requirements
DSTSA	Double-Shell Tank Sampling Analysis
FPMCS	Facility Process Monitoring and Control System
HDAT	Handheld Data Acquisition for Tank Farms
HTGEN	Heat Generation Rate Calculations
JDB	Jumper Database
PEDB	Pump & Equipment Database
PFPDT	PFD Drum Tracking
PNRA	Piping Network Routing Assistant
PU INVENTO	Plutonium Inventory
SACS	Surveillance Analysis Computer System
SS	Spears System
SSTDB	Single-Shell Tank Database
TCD	Tank Characterization Database
TCBD	Tank Calibration Data Acquisition
TFEE	Tank Farm Environmental Engineering Database
TIMPDB	TWR Issues Management Program Database
TMACS	Tank Monitor and Control System
TRAC	Track Radioactive Components
TRAC1990	Track Radioactive Components - 1990
TRIDB	Tank Regulatory Information Database

Table 3. Sources of Data Associated with the TWRS Program

Database Acronym	Database Name
TVDB	Transfer Volume Database
USNDB	US Nuclear Database
WSI	Waste Stream Identification Compliance
WTGI	Waste Tank General Information Database
WVP	Waste Volume Projection
WVPHDB	Waste Volume Projection Historical Database

Table 4. Users of the Integrated Dynamic Modeling and Management System

Users	Application
System Analysts	<ul style="list-style-type: none">• Technical Performance Modeling• Trade Studies• Parametric Analysis• Design Optimization• Process and Chemical Flowsheets• Environmental Impact Assessment• Health and Safety Assessment
Program Managers	<ul style="list-style-type: none">• Budget and Schedule Analysis• Programmatic Risk Assessment and Management• Decision Analysis• Planning• Marketing
Regulatory Oversight Individuals	<ul style="list-style-type: none">• Performance Assessment• Compliance Assurance• Permitting
General Public	<ul style="list-style-type: none">• Develop Understanding of the TWRS Program• Provide Information• Support Environmental Impact Statement Process• Support Value System