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DEFENSE WASTE PROCESSING FACILITY PROCESS SIMULATION PACKAGE LIFE CYCLE (U)

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Defense Waste Processing Facility Process Simulation Package Life Cycle

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ABSTRACT:

The Defense Waste Processing Facility (DWPF) will be utilized to immobilize high level liquid radioactive waste into a safe, stable, and manageable solid form.

The complexity and classification of the facility requires that a performance based operator training program be instituted to satisfy Department of Energy orders and guidelines. A major portion of the training program will be the application and utilization of Process Simulation Packages to assist in training the Control Room Operators on the functionality of the process and the application of the Distributed Control System (DCS) in operating and managing the DWPF process.

The packages are being developed by the DWPF Computer and Information Systems Simulation Group.

This paper will describe the DWPF Process Simulation Package Life Cycle. The areas of package scope, development, validation, and configuration management will be reviewed and discussed in detail.

INTRODUCTION

Because of the magnitude, uniqueness, and complexity of the Defense Waste Processing Facility (DWPF), it was determined by the DWPF Training Organization that Process Simulation Packages would be required and applied as part of the DWPF Control Room Operator training program and certification process.

The DWPF will be used by the Department of Energy to process high level radioactive waste into a solid stable form (Fig. 1). The entire process is predominately controlled by a Distributed Control System (DCS) which employs the latest Process Control methodologies and concepts. Approximately, 6400 digital and analog input/output (I/O) points are processed by the DCS.

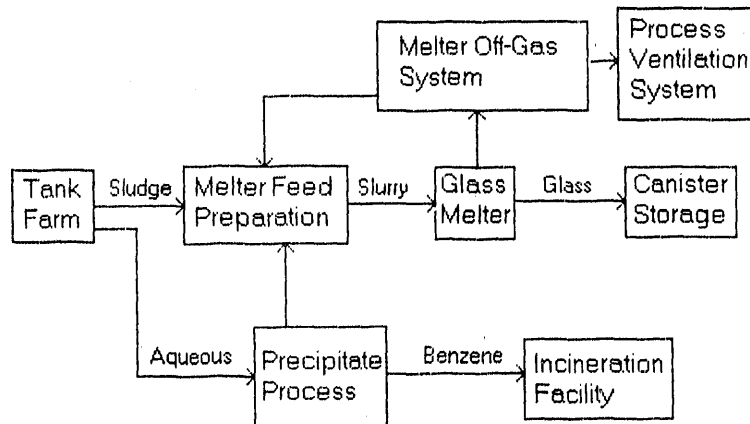


Figure 1: The sludge is fed from a storage tank to DWPF. The sludge is processed by the Melter Feed Preparation area into a glass frit slurry. The slurry is transformed into molten glass by the Melter and poured into Stainless Steel canisters that are welded shut. The vapor produced by the Melter is processed by the Off-Gas system. The Precipitate process removes organic material from the aqueous Melter feed.

The Process Simulation Packages are developed under the "Function Simulation" concept (Fig. 2) which utilizes the DCS as the model algorithm processing environment.

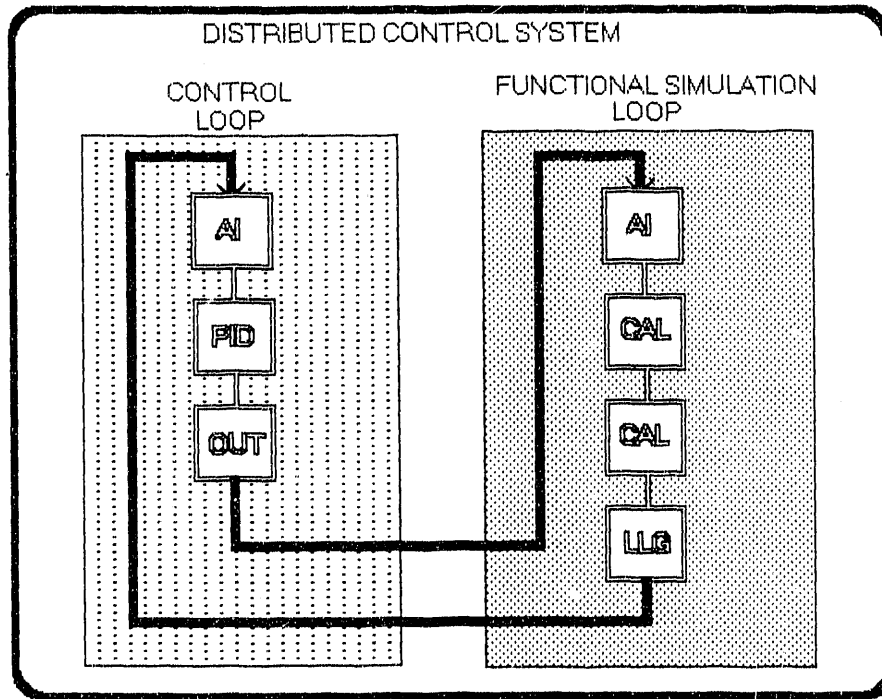


Figure 2: A Process Model and corresponding Control Loop represented in a "Functional Simulation" format on the Distributed Control System

The Process Simulation Packages follow a very rigorous and involved life cycle path that was established and based on Institute of Nuclear Power Operator (INPO) guidelines and Department of Energy Conduct of Operation and Training Orders.

ORGANIZATIONS

The roles assumed by each organization regarding the DWPF Simulation project are very well established and in line with standard quality assurance guidelines.

The major players that take part in the Process Simulation Package life cycle are:

DWPF TRAINING GROUP

This group is the official customer/sponsor for the DWPF Simulation Project and ultimately each individual simulation package. They are part of the Site Support/Services organization.

DWPF PROCESS SIMULATION GROUP

This group is responsible for the development and maintenance of the Process Simulation Packages. They are part of the Technical Departments Control and Information Systems organization.

DWPF PRODUCTION ORGANIZATION

This organization is the end user of the Process Simulation Packages and owner of the Simulator System.

Each organization and group has a very specific set of responsibilities that are key to the successful completion of the package life cycle.

PACKAGE SPECIFICATION AND DEFINITION

This step is the first area addressed in the Process Simulation Package Life Cycle.

SCOPE

The customer will initiate the development of a Process Simulation Package by submitting a scope of work for a specific Process Simulation Package. The scope will specify and address the following areas:

- o Package Title
- o Package Identification Number
- o Package Boundaries
- o Control Points to be Modeled
- o Control Configuration Items
 - Process Graphics
 - Face Plate Groups
 - Control Loops
 - Indication Loops
- o Initial Package Conditions
- o Assumptions
- o Simulation Task Listing

STRUCTURE

The DWPF Process Simulation Group will review the scope of work and determine the Process Simulation Package Structure (Fig. 3) and calculate the schedule milestones in the form of a Time Study.

RDS06: Primary Off - Gas System Simulation

Process Unit 6A: Film Cooler

Module 6A-S1: Film Cooler Process Steam

Module 6A-S2: Film Cooler Brush

Module 6A-S3: Film Cooler Temperature

Process Unit 6B: Spout Jet

Module 6B-S1: Spout Jet Condensate Pump

Module 6B-S2: Spout Jet Pressure

Process Unit 6C: Quencher

Module 6C-S1: Quencher Water Flow

Module 6C-S2: Quencher Water Pump

Process Unit 6D: OGCT

Module 6D-S1: OGCT Level

Module 6D-S2: OGCT - RCT Transfer Pump

Module 6D-S3: OGCT Temperature

Module 6D-S4: OGCT Pressure

Figure 3: An example of a Package Structure

This information will be used by the Process Simulation Group during the technical development stages of the life cycle to identify the layout of the package and organize documentation.

DEVELOPMENT

The development stages of the life cycle is comprised of three main sections

- o Model Development
- o Package Coding
- o Package Testing

The Simulation Engineer assigned to design and develop the Process Simulation Package will complete each one of these sections during the course of this stage of the life cycle.

MODEL DEVELOPMENT

This section primarily focuses on the application of approved concepts and procedures to develop the technical aspects of the Process Simulation Package.

The Simulation Engineer utilizes validated and approved Unit Operations and Control Loop Real Time methodologies and concepts to develop the process models in a format specific to the scoped package. This involves integrating into the concept package specific design information and data.

PACKAGE CODING

Within the DCS environment, pre-defined shells and libraries have been created and validated to assist in the configuration (coding) of DCS applications. The Engineering Work Station utilities are used by the Simulation Engineer to translate the technical equation based models into a format which is executable on the DCS.

The utilities provide a means for efficiently coding/configuring the Process Simulation Packages.

PACKAGE TESTING

The Process Simulation Package follows a very involved and detailed test path.

The test procedures and guidelines require the packages be tested in a phased format. Initially, each individual model is separately tested and evaluated to verify its accuracy and fidelity. The next step is the testing of specific groups of models as they pertain to the Simulation Module boundaries and the transfer of data between models.

The final test is a complete Integrated Package evaluation in real time against the Manual Operating procedures drafted to run the DWPF.

A detailed and thorough test journal is maintained to document the events of the test.

If at any point a test discrepancy is identified, the Simulation Engineer halts the test and resolves the problem. The affected package section or path is retested.

VALIDATION

The Simulation Package Owner (DWPF Training Group) is responsible for and manages the validation stage of the life cycle.

The Process Simulation Group is removed from this stage so that no issues regarding conflict of interest can be raised. The group assumes a maintenance role during this portion of the life cycle.

TURNOVER

Upon completion of the development stage, the Process Simulation Group turns the Simulation Package over to the Training Group for Acceptance Testing and ultimately validation.

CUSTOMER REVIEW AND EVALUATION

The Training Group performs a complete review and evaluation of the package in the form of an Acceptance Test. The Acceptance Test verifies that the Process Simulation Package has been developed in accordance with the scope of work.

A list of Acceptance Test Results (ATR) are compiled by the Training Group and transmitted to the Process Simulation Group for resolution and/or implementation.

ACCEPTANCE TEST RESULTS

Acceptance Test Results are test comments identified by the Training Group (Package Owner) during the validation stages of the life cycle.

The ATR list is indexed by item type:

- o Action Item - a discrepancy with the scope of work.
- o Modification Item - an addition to the scope of work.
- o Clarification Item - a question or concern regarding the package.

Based on the item type, the Simulation Engineer either resolves or implements the necessary package revisions.

CUSTOMER ACCEPTANCE

When all the ATR items have been closed out, the Training Group conducts a final review of the package and provided the items have been resolved to the groups satisfaction, the Process Simulation Package will be validated.

A validation form is signed by the Owner, User, and Developer of the package. At this point, the package can be utilized for operator training and other applications.

PACKAGE DUPLICATION

The validated Process Simulation Packages are duplicated from the Simulation Development environment to the Operator Training environment (Fig. 4).

Currently, three separate training stations exist and a package can be loaded to one, two, or all of the stations without a conflict.

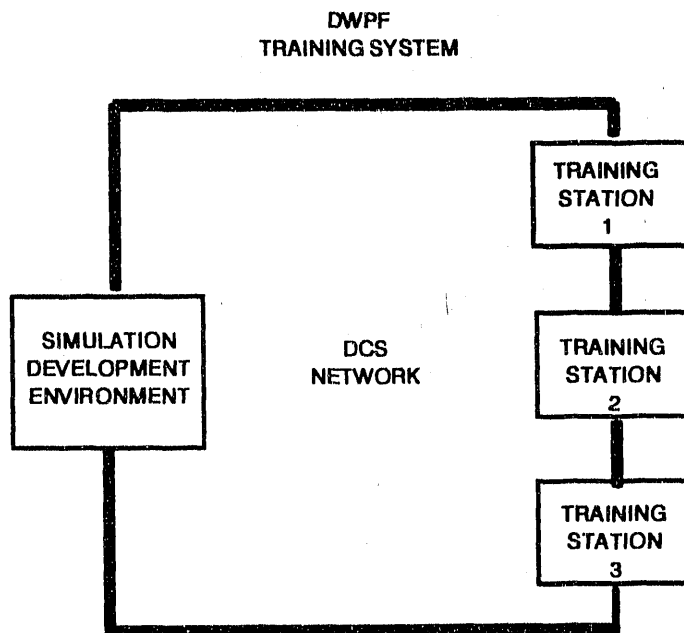


FIGURE 4: DWPF Training System Configuration

A software utility developed by the Process Simulation Group is used to automatically duplicate a Process Simulation Package to the Customer specified Training station.

CONFIGURATION MANAGEMENT

PACKAGE BASELINE

Immediately after a package is validated, a Simulation Engineer is assigned to baseline the package.

During the baselining process, the Process Simulation Package documentation is compared to the validated source code and updated to reflect the functionality of the code explicitly. Secondly, the overall structure of the package is verified against approved structuring requirements and guidelines .

Overall, the baselining effort prepares the entire package to be controlled and placed into the Configuration Management System.

CONFIGURATION MANAGEMENT SYSTEM

A Configuration Management System (CMS) is in place to maintain the Process Simulation Packages in an effective training state and up to date regarding actual process modifications.

The CMS is completely compatible with the systems used to control the DWPF plant configuration. As a result, changes approved in the plant environment are easily reviewed and integrated into the Simulation CMS environment.

All reference plant design modification requests are evaluated for Process Simulation Package impact and implementation by a Simulation Configuration Management Committee (Fig. 5). The Simulation Configuration Management Committee is chartered with reviewing package change initiators that effect validated packages and determining the impact on the effectiveness of the simulation. From the impact analysis, the initiator is categorized and transmitted to the Process Simulation Group for implementation.

SIMULATION CONFIGURATION MANAGEMENT COMMITTEE

Composition

- Process Simulation Engineer
- DCS/Simulation Trainer
- Process Simulation Application Specialist
- Production/Operations Engineer

Members

- DWPF Process Simulation Group
- DWPF Training Group
- DWPF Production Organization

Leader

CMC Chairperson - DCS/Simulation Trainer

Figure 5: DWPF Simulation Configuration Management Committee Structure

PACKAGE MODIFICATION

A programmatic means for handling CMC approved package modifications is utilized. The Simulation Engineer assigned the Initiator will review the modification for schedule, technical, documentation, and system impact.

The initiator is implemented per procedure and all corresponding documentation revised accordingly. If designated by the CMC, the Training Group will evaluate and approve the modification along with the Process Simulation Group before it is loaded to the Training environment.

Overall, the DWPF Simulation CMS provides a strict and secure but workable means for maintaining the validity and integrity of the validated Process Simulation Packages.

PROCESS DATA INTEGRATION

The models developed for the DWPF Process Simulation Packages are based on the concept of "Functional Simulation". This concept combines the attributes of Unit Operation and Control Loop Real Time modeling methodologies and techniques to form an analytical model from design data and boundary conditions.

All empirical and dynamic constants are obtained and/or calculated from design information and data.

However, as the process ages and fouls, the validity of the design based data and boundary conditions will change along with the empirical and dynamic constants. As a result, a system which provides a means for calculating new empirical and dynamic constants from actual process data will be utilized to maintain the fidelity of the Process Simulation Packages during the life cycle of the DWPF.

The Process Data Integration system will apply parameter estimation and lump parameter real time data evaluation concepts to calculate revised empirical and dynamic constants for the Process Simulation Packages.

The Process Data Integration system will interface to the Process Information and Management System that collects real time process data.

PACKAGE APPLICATION

Ultimately, the application of the Process Simulation Package is the goal of the complete life cycle.

As initially stated, the primary application of the Process Simulation Packages is Performance based Operator Training for Central Control Room Process Operators. However, during the life cycle, other users have and do apply the packages for Closed Loop Control Analysis, Advanced Control Configuration Evaluation Studies, Manual and Automatic Procedure Review, and Process Familiarization.

STATUS

Presently, twelve Process Simulation Packages have completed the entire life cycle. The packages are being utilized in different capacities and applications. Approximately 75 Process Operators have been trained and evaluated against the Process Simulation Packages.

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