

**REGULATORY PROGRAM DATABASE VERSION 1.0
DEVELOPMENT STATUS FY93**

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1 INTRODUCTION

The Center for Nuclear Waste Regulatory Analyses (CNWRA) was initially tasked to support the Nuclear Regulatory Commission (NRC) High-Level Waste (HLW) regulatory program with the Program Architecture Support System/Program Architecture Database (PASS/PADB). The history of PASS/PADB has been one of a dynamic system meeting evolving programmatic requirements and conceptual models (DeWispelare et al., 1992). PASS/PADB was initially implemented in 1988 on a mainframe computer at Southwest Research Institute (SwRI), with data reflecting the concepts of the underlying steps 1-22 of the Program Architecture Process. Versions 1.0 and 2.0 of the system contained regulatory requirements, regulatory elements of proof, and regulatory and institutional uncertainty records, which were all derived through Systematic Regulatory Analysis (SRA) of 10 CFR Part 60. Version 1.0 of PASS/PADB supported the definition of the initial regulatory requirements and analysis of regulatory and institutional uncertainties, as well as major issues relating to them. Version 2.0 of PASS/PADB was designed and implemented in 1990 to reflect changes in the requirements and data relationships. Since that time, a number of fundamental changes have occurred in the data requirements and data structures that have necessitated further review and evolution of the system. Thus, Version 2.0 of PASS/PADB has become outdated. To reflect the evolving nature of the content and purpose of the database, the NRC has changed the name from PASS/PADB to the Regulatory Program Database (RPD). The current work is proceeding as implementation of RPD Version 1.0.

RPD Version 1.0 development is proceeding according to the requirements set forth in the associated development plan (DeWispelare et al., 1993). In general, the activity in FY93 and the beginning of FY94 included purchase and installation of hardware and software, code development, system integration and testing, and loading of compliance determination strategies (CDSs).

Section 2 of this report reviews the objectives and describes accomplishments to date, including configuration management procedures. Section 3 discusses the CDS data loading and update process and the current content of the database. Section 4 summarizes plans for the next phase of development. Section 5 delineates lessons learned in this initial effort.

2 OBJECTIVES AND ACCOMPLISHMENTS

In the Development Plan for PASS/PADB System Design Version 3.0 (DeWispelare et al., 1993), a number of system requirements and constraints were identified and discussed, resulting in proposed implementation plans and objectives for FY93 and FY94. During FY93, implementation of Phase I of RPD Version 1.0 met the primary objective of revising and updating the contents of the database. This activity included supporting CDS data loading and reporting, as well as providing data control listings. To accomplish these objectives, several activities were required:

- (i) procuring the RPD server
- (ii) procuring specific software products
- (iii) installing and interfacing products
- (iv) testing the system implementation at the CNWRA for standard connectivity and user interfaces

- (v) loading and checking of regulatory program records, the CDSs, and testing the maintenance process to update the RPD
- (vi) supporting CNWRA Waste Systems Engineering and Integration (WSE&I) staff in the initial loading and updating of the RPD

2.1 PROCURING THE REGULATORY PROGRAM DATABASE SERVER

Version 1.0 of RPD differs significantly from PASS/PADB in several respects. These differences contribute to increased functionality and usability, but they also require that a new system environment be established and tested.

- Network Based - RPD Version 1.0 is a network-based implementation, rather than a mainframe-based system. This means that data are stored on a server machine and are available to authorized users through a local area network (LAN) and, eventually, a wide-area network (WAN).
- Client Server Architecture - RPD Version 1.0 utilizes client server architecture, in which client functions are distributed among user workstations, and server functions are performed by a central server. This permits the system to take advantage of an efficient division of labor and to support multiple client hardware/software platforms, while permitting growth in capacity with minimal application impact.
- Graphical User Interface (GUI) - RPD Version 1.0 utilizes a GUI to enhance user effectiveness through the use of multiple windows and cut-and-paste facilities on a variety of platforms.

In order to support these capabilities and system approaches, a new system environment was established, and a SPARC-10 server hardware configuration was procured and installed. The SPARC-10 server is a Sun SPARCstation Model 512 with 128 megabytes of random access memory and 9 gigabytes of disk storage. This system has demonstrated its ability to perform the required functions rapidly and effectively, and it is anticipated to have sufficient computing and storage capacity to meet the needs of the RPD for the next several years.

The server configuration is connected to the CNWRA LAN and is running under a UNIX operating system. Connectivity is provided through the mechanism of Network File Sharing (NFS), one of the protocols of the Transmission Control Protocol/Internet Protocol (TCP/IP) suite. Users with appropriate authority and permissions are able to access the SPARC-10 server machine transparently and efficiently.

2.2 PROCURING SPECIFIC SOFTWARE PRODUCTS

The development and implementation of RPD Version 1.0 was predicated on the ability to acquire and integrate appropriate, commercially available, off-the-shelf software. This off-the-shelf software included two broad groups of products: strategic software products and system support software.

2.2.1 Strategic Software Products

Strategic software includes products to support (i) applications using relational databases, (ii) full-text search and retrieval of regulatory program records, and (iii) enhanced system usability through GUIs, as discussed below.

- **Relational Database Applications** - During the test and evaluation period in the spring of 1993, the ORACLE relational database software was selected. This software is fully compliant with the standard relational database language called Structured Query Language (SQL) and has superior performance and features that are directly applicable to RPD Version 1.0. ORACLE Version 6 was procured and installed on the SPARC-10. One member of the CNWRA Information Management Systems (IMS) development team attended training, and the database design required to support the Phase I implementation of RPD Version 1.0 was subsequently developed with programming support from an ORACLE experienced SwRI staff member.

In experience to date, ORACLE has met or exceeded functionality specified in DeWispelare et al., 1993. A new release (Version 7) of the ORACLE database, with additional features and enhancements, is scheduled for installation. The installation of this release was deferred until the completion of the RPD Phase I code, because this installation requires an evaluation and concurrent upgrade of the UNIX operating system on the server.

- **Full-text Search and Retrieval Facilities** - The Verity TOPIC full-text search and retrieval software was selected, procured, and installed. This software provides very powerful search and retrieval capabilities, coupled with the ability to cut and paste and utilize (launch) WordPerfect software with documents selected by the search facility. Two members of the IMS staff and one SwRI staff member attended training on TOPIC. After completion of the training, test documents were used for implementation. This testing verified proper TOPIC installation and confirmed approaches to using it in support of RPD Version 1.0. Performance to date has met or exceeded functionality specified in DeWispelare et al., 1993.
- **Graphical User Interface** - The Visix GALAXY software development tool was selected, procured, and installed to support implementation of applications using GUIs. GALAXY supports the development of applications that can run on multiple computers and operating systems such as Macintosh, Sun, IBM OS/2, and Microsoft Windows, while providing users with common interface displays. Two members of the IMS staff attended training, and the features and capabilities of the system were tested. An integrated GUI was implemented and tested for the Sun Open Look client workstation environments to verify intended functionality for Phase I of RPD Version 1.0. Additional client workstation environments, such as OS/2, Microsoft Windows and Macintosh will be implemented. Performance to date has met or exceeded functionality specified in DeWispelare et al., 1993.

2.2.2 System Support Software

The implementation of RPD also required that certain system support software be procured and installed.

- **C Programming Language** - The C programming language was selected for implementation of required interfacing and utility software for RPD Version 1.0. The appropriate C programming language compilers were procured, installed, and tested to support software interfacing for the SPARC-10 server, as well as the Sun, OS/2, Windows, and Macintosh client platforms. The C programming language is providing the intended functionality specified in DeWispelare et al., 1993.
- **Network Environment Software** - The SPARC-10 server was added to the existing CNWRA network, and access was provided for all client workstation environments. This involved procuring, installing, and testing TCP/IP software on workstations to support connectivity to the server. Performance to date has met or exceeded functionality specified in DeWispelare et al., 1993.
- **Client Server Architecture Software** - Most of the client server architecture was to be implemented through custom code and interfaces to strategic software. One general facility, Remote Procedure Call (RPC) was required to support the client server architecture. RPC permits processes running on the client and server machines to communicate with each other and exchange data and status information. RPC is part of the TCP/IP software procured for all the workstations. This facility has been used extensively in the development of the Phase I RPD Version 1.0 code, and its performance and functionality have met all requirements.
- **Electronic Mail Facilities** - New electronic mail software, implemented earlier, utilizing the CNWRA network rather than the previous mainframe environment, was evaluated during the test and evaluation period. cc:Mail was selected, procured, installed, and interfaced to the NRC WordPerfect Office system. This facility permits interchange of electronic mail and provides an effective vehicle for electronic transfer of data and word processing documents. The cc:Mail product has performed satisfactorily.

2.3 INSTALLING AND INTERFACING PRODUCTS

The hardware and software products were procured and installed with minimal technical difficulties. All products met functionality and performed satisfactorily.

It was anticipated that some technical difficulties might arise in interfacing the software. Therefore, it was decided to utilize two in-house development projects to prototype interfaces and test implementation approaches. The advantage of testing interfaces on these small in-house applications was that it permitted experience to be gained in a simple and easily constrained environment. A prototype GUI application was developed. This provided a convenient vehicle for developing and confirming approaches to be used in the implementation of RPD Version 1.0. It also permitted immediate application of knowledge gained in the GALAXY training and confirmed technical decisions that were important in the Phase I implementation of the RPD Version 1.0 code. Another prototype application was developed and used as a platform to perfect (i) interfaces to the ORACLE database, (ii) techniques for using RPC to

communicate between client and server processes, and (iii) interfaces to the TOPIC full-text search and retrieval software. These initial interfacing efforts were highly productive and contributed significantly to the successful and timely completion of the Phase I code for RPD Version 1.0.

2.4 TESTING THE SYSTEM IMPLEMENTATION AT THE CENTER NUCLEAR WASTE REGULATORY ANALYSES FOR STANDARD CONNECTIVITY AND USER INTERFACES

Connectivity was established between the SPARC-10 server and anticipated client platforms. Communication between client and server platforms was efficient and transparent to the user. Connectivity between the CNWRA and the NRC was established, tested, and put into routine use through the new network-based E-mail facilities.

As described in Section 2.5, an initial implementation of the RPD GUI and data management facilities was completed. This implementation included all of the strategic software and custom code. While the interfacing of commercially available, off-the-shelf software required that a few technical problems be solved, the resulting code performs the required functions effectively and efficiently. The user interface is essentially seamless and transparent.

2.5 LOADING AND TESTING OF REGULATORY PROGRAM RECORDS, THE COMPLIANCE DETERMINATION STRATEGIES, TO UPDATE THE REGULATORY PROGRAM DATABASE

An early requirement for the revised RPD was the loading of CDS records. This involved redefinition of approaches and database structures, as well as implementation of supporting code.

2.5.1 Updating the Database Using Unparsed Data

A decision was made jointly by the NRC and CNWRA to utilize unparsed regulatory program records in the Phase I implementation of RPD Version 1.0. These regulatory program records have been maintained as a set of WordPerfect documents since the redefinition of SRA procedures and data structures that occurred in 1991 and 1992. To achieve orderly and effective updating of the database, the system was designed to accommodate the existing WordPerfect files for CDS records, rather than immediately undertaking an approach that called for parsing the CDS records into lower-level units of storage. This design decision is reflected throughout the Phase I implementation of RPD Version 1.0.

The updating of the RPD required new database structures to be designed and implemented, along with appropriate program support for client and server processes. These activities included the following:

- Design and Implement a New Database Structure – New database structures to support configuration control of regulatory program records were designed and implemented as relational tables under the ORACLE database.

- Design and Implement Program Support for the Database – Custom code was designed, implemented, and tested to support insertion, deletion, and updating of regulatory program records through the relational database server facilities.
- Load Existing CDS Information into the Updated RPD – Support facilities were designed and implemented for both the client and server platforms to permit the existing CDS information to be processed and loaded into the new RPD database structures and full-text repositories.

2.5.2 Implementing the Check-in Procedure

A check-in procedure was needed to assure orderly and controlled update of the RPD. This process permits only authorized users to add or update information in the RPD, while permitting all users with userids and passwords to retrieve and view information. To facilitate positive identification of regulatory program records prior to updating, the system requires the operator to preload header information, such as the title and review plan number, for all records. The check-in operator then selects the record to be updated from a list of preloaded header information. The system verifies, from the submitted data file, that the input record matches the selection made by the operator, and the information is updated in the relational database and the full-text repository.

2.5.3 Implementing Full-Text Search and Retrieval

To facilitate identification and retrieval of desired information, full-text search and retrieval was implemented for all regulatory program records. Custom code was developed to access the facilities of the TOPIC full-text search and retrieval software. During the check-in process, a copy of the input document is indexed and stored in the full-text repository. At that time, selected data fields, such as the title and review plan number, are identified and stored along with the text. Thus, users are able to retrieve regulatory program records either (i) by searching for specific words and/or phrases in the text, or (ii) by searching for specific words and/or phrases in specified fields, such as the title. Access to search facilities is accomplished through a menu selection from the RPD Version 1.0 GUI.

2.6 SUPPORTING THE CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES WASTE SYSTEMS ENGINEERING AND INTEGRATION STAFF IN UPDATING THE REGULATORY PROGRAM DATABASE

The initial users of the RPD Version 1.0 system were the WSE&I staff. While access to the RPD system for retrieval and viewing is generally available to CNWRA staff, the WSE&I staff currently has responsibility for making any changes to the database. Therefore, only selected WSE&I staff are authorized to add, delete, or change regulatory program records, in conjunction with the configuration control and loading procedures¹ discussed in Section 2.6.1. After receiving concurrence from NRC/CNWRA management, the WSE&I Element Manager submits regulatory program records to the RPD custodian operator for loading, updating, or retiring in accordance with the procedure discussed in Section 2.6.1.

¹ TOP 001-15, RPD Loading Control, Version Control, and Change Control

Custom code was designed, implemented, and tested to support all of these functions. The custom code is fully integrated with the strategic relational database and full-text software and operates across computer platforms through a consistent and user-friendly GUI. Help facilities are available for all screens to assist the operator in using the system and responding to exception conditions.

2.6.1 Implementing Configuration Control and Loading Procedures

A Technical Operating Procedure was developed and implemented for RPD loading control, version control, and change control.² This procedure identifies responsibilities and procedures for assignment of version numbers, review of documents, determination of major versus minor changes, preparation of loading sheets, and loading of materials into the RPD.

2.6.2 Testing and Integrating Regulatory Program Database Software

The Phase I implementation of RPD Version 1.0 was completed, fully tested, and integrated on schedule. The testing took the form of initial functional evaluations, using specially prepared test data. This was followed by a full system test using actual regulatory program data. All known errors and omissions have been corrected, and the system is in operation. The user's guide for RPD Version 1.0 describes procedures for any user wishing access and will be available by November 30, 1993.

2.6.3 Reporting Functions

Initial reporting functions were designed, implemented, and tested to support configuration control and status monitoring. The availability of reports depends upon the authority and permissions of the individual user. Reports that are not authorized for a particular user will not appear on the report menu. Thus, the restriction of certain reports is transparent to those users not authorized to access them.

To run reports, the user simply selects the desired report from a menu in the GUI. The report is prepared and displayed on the screen, and the user may then choose to view and/or print the report. Two reporting functions were implemented to facilitate configuration control and monitoring of the status of the RPD:

- RPD Content Report – This report lists the review plan number, title, document type, version, and status for the current and all previous versions of all regulatory program records in the RPD.
- RPD Status Report – This report lists the review plan number, title, document type, version, and status for the current versions of all regulatory program records in the RPD.

2.6.4 Preparing the User's Guide

A user's guide was prepared for the Phase I implementation of RPD Version 1.0. This user's guide contains (i) background chapters that describe the general context and characteristics of the RPD system; (ii) a description of the regulatory program process; (iii) a general description of the database

² Ibid.

design and additional capabilities; (iv) specific instructions for obtaining a password and logging onto the system; (v) instructions on the basic usage of the system, including search and retrieval and reporting functions; and (vi) instructions for advanced use of the system, including regulatory program record preloading header information, check-in, and maintenance functions. The user's guide was prepared and used by WSE&I staff during the system testing and evaluation period. It will be available to all users by November 30, 1993.

3 LOADING OF COMPLIANCE DETERMINATION STRATEGY DATA INTO THE REGULATORY PROGRAM DATABASE

Following the development of the Phase I code for RPD Version 1.0, all of the CDSs developed during FY93 were preloaded and checked in. The loading process was integrated with the full system testing and operator training to assure that (i) all required system functionality was properly implemented, and (ii) the user interface and operator instructions were adequate and user-friendly. This activity served to establish RPD Version 1.0 and provided for configuration control of all CDSs.

3.1 INITIAL DEFINITION OF COMPLIANCE DETERMINATION STRATEGY RECORDS

The CDS records were initially preloaded using titles and review plan numbers from an ASCII file developed from an outdated copy of the License Application Review Plan (LARP) table of contents. This provided initial test data, some of which was outdated and required updating through the system's maintenance facilities. It was highly desirable that the initial record header information be somewhat outdated because subsequent check-in of the updated records fully tested the handling of mismatches and errors between the selected records and the submitted data files.

Once preloaded, the initial CDS header information was used to test the reporting functions.

3.2 INITIAL LOADING OF COMPLIANCE DETERMINATION STRATEGY TEXTUAL RECORDS

The initial copies of the currently approved CDSs loaded into the database were designated Version 0.0. Where the titles and review plan numbers of the submitted records did not match the preloaded CDS header information in the database, the system correctly identified the error and forced correction of the data. The maintenance facilities worked as designed, and the entire database was populated with Version 0.0 CDS data. The TOPIC full-text search and retrieval facilities were evaluated using the CDS data and performed very well. Users noted that the desired records could be found without difficulty, and the speed of retrieval exceeded functionality requirements [less than 5 seconds as compared to the requirement for 10 seconds (DeWispelare et al., 1993)]. The RPD status and content reports were visually compared with the Version 0.0 CDS information to confirm that all records had been properly loaded. While this initial evaluation of RPD performance is encouraging, several factors must be kept in mind. Only a very small percentage of the total amount of data expected to be incorporated into the system was available to test response time. The effects of any limitations on WAN transmittal speed were also not taken into account. Additionally, only one user was accessing the system, and system response time could be affected if several users are logged on. Consequently, more severe testing conditions will

be utilized as system development continues, and a conclusive evaluation of system performance cannot be provided now.

4 PLANNING FOR REGULATORY PROGRAM DATABASE VERSION 1.0 FY94 DEVELOPMENT

4.1 SOFTWARE UPGRADES

Software upgrades will be required for the strategic software and the UNIX operating system for the database server following NRC acceptance of the Phase I implementation of RPD Version 1.0. These software upgrades will make additional capabilities available that will be needed for the implementation of Phase II of RPD Version 1.0.

4.2 PARSING OF REGULATORY PROGRAM RECORDS INTO UNITS OF STORAGE

The Phase II implementation of RPD Version 1.0 will differ from the Phase I implementation in that the regulatory program records will be parsed into lower-level units of storage rather than being stored as complete documents. This means that, after modifying and adapting the database structures, the existing regulatory program records will be analyzed, parsed, and reloaded as units of storage. The units of storage will be stored in the database using an appropriate coding methodology, such as the Standard Generalized Markup Language (SGML), in order to preserve internal formatting such as underlining, italics, bold text, etc. Data selection and extraction code will be developed to permit various combinations of units of storage to be extracted and assembled into products and reports.

4.3 DEVELOPMENT OF THE REPORT WRITER

A generalized report writing capability will be procured and/or developed to permit units of storage that have been extracted from the RPD to be arranged, displayed, and/or printed in a variety of formats. The report writer facility will be controlled by report formatting specifications to facilitate rapid implementation of new reporting formats and changes to existing reports.

5 LESSONS LEARNED

The Phase I implementation of RPD Version 1.0 provided the first opportunity to assess the effectiveness of the new system architecture and the implementation methodologies. The predictions of functionality of the ORACLE and TOPIC software products were accurate in the previous design reports (DeWispelare et al., 1992, 1993). Likewise the technical challenges associated with implementing the RPD across numerous platforms with a GUI were also properly forecast in the design reports. The following narrative details lessons learned from this experience.

5.1 SYSTEM ARCHITECTURE

The system architecture for RPD Version 1.0 includes a network-based client server implementation and a GUI. This system architecture represents a significant departure from the mainframe-based, character interface approach used in earlier applications. Although there was some risk

involved in adopting this newer technology, the resulting system is superior in every respect. As expected during system design, performance is much faster than a comparable mainframe implementation, functionality is improved, and the ease of use is significantly enhanced. Although the new software technology required considerable reorientation of development approaches and techniques, the efficiency of development was at least equal to a mainframe implementation, validating the design approach. Therefore, the new system architecture is viewed as a major improvement.

5.2 DEVELOPMENT ENVIRONMENT

The development environment employs a new programming language (C versus REXX) and an entirely new suite of programming and development tools. These tools required rather extensive training and subsequent real world experience with utilization as was expected and planned for during system design. However, once the training was completed, the required functionality was implemented rapidly and effectively. While Phase I was a technical and programmatic success, there are some significant technical challenges which will be faced in Phase II, such as parsing of the regulatory program records and reporting in various formats.

5.3 INTEGRATION OF OFF-THE-SHELF SOFTWARE PRODUCTS

An important aspect of the design was maximized use of off-the-shelf software (DeWispelare et al., 1993). Although some expected difficulties were encountered in the integration of the strategic software with custom code developed by the IMS staff, these difficulties were quickly addressed and resolved. The basic integration of the software products has been accomplished. The difficulty of integration represented the major risk in using commercially available, off-the-shelf software products to achieve the functionality required for the system. Utilization and integration of these products is viewed by the CNWRA as a significant achievement.

6 REFERENCES

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