Introduction

The Waste Isolation Pilot Plant (WIPP) in southeast New Mexico has been studied as a transuranic waste repository for the past 23 years. During this time, an extensive site characterization, design, construction, and experimental program was completed, which provided in-depth understanding of the dominant processes that are most likely to influence the containment of radionuclides for 10,000 years. Nearly 1500 parameters were developed using information gathered from this program; the parameters were input to numerical models for WIPP Compliance Certification Application (CCA)\(^1\) Performance Assessment (PA) calculations.

The CCA probabilistic codes frequently require input values that define a statistical distribution for each parameter. Developing parameter distributions begins with the assignment of an appropriate distribution type, which is dependent on the type, magnitude, and volume of data or information available. The development of the parameter distribution values may require interpretation or statistical analysis of raw data, combining raw data with literature values, scaling of lab or field data to fit code grid mesh sizes, or other transformation. Parameter development and documentation of the development process were very complicated, especially for those parameters based on empirical data; they required the integration of information from Sandia National Laboratories (SNL) code sponsors, parameter task leaders (PTLs), performance assessment analysts (PAAs), and experimental principal investigators (PIS). This paper, Part 1 of two parts, contains a discussion of the parameter development process, roles and responsibilities, and lessons learned. Part 2 will discuss parameter documentation, traceability and retrieveability, and lessons learned from related audits and reviews.
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DISCUSSION

Background

Between 1992 and 1995 the PA codes evolved in response to changes in conceptual models, and PIs collected new data and reanalyzed existing data. The process is illustrated in Figure 1. A significant amount of the informal background work related to parameter development (i.e., identification of conceptual and process models, parameters needed to run the codes, and data and other source information available from experimental programs and analysis) was initiated as part of the Systems Prioritization Methodology (SPM) process in 1994 and 1995.

The formal parameter development process began in late 1995 and continued through early 1996, concurrent with the phased CCA calculations. Following the submittal of the CCA in October 1996, the EPA and others reviewed the CCA document, codes, analysis, and input parameters. On 23 October 1997 the EPA announced its approval of the draft rule for the WIPP, proposing to certify that the WIPP will comply with the radioactive waste disposal regulations and criteria set forth in 40 CFR Part 191 and Part 194.
Parameter Development Process

For the WIPP PA CCA calculations, the processes of parameter development, documentation, and database entry are governed by two SNL QA Procedures: QAP 9-2, "Quality Assurance Requirements for the Selection and Documentation of Parameter Values Used in WIPP Performance Assessment" and QAP 9-4, "Quality Assurance Requirements for the Database Management of Parameter Values Used in WIPP Performance Assessment." The WIPP Parameter Data Entry Form, SNL WIPP Form 464, is used in conjunction with QAPs 9-2 and 9-4.

As illustrated in Figure 2, following QAP 9-2, requests from PAAAs for new parameters or modifications to parameters that existed in the 1992 PA calculations are sent to the PTL. After reviewing the request, the PTL contacts the PI or PAA for information to support the parameter, assigns a category to each parameter according to the source information available, and initiates Form 464. Form 464 and any attached supporting information comprise the Parameter Records Package (PRP).

Figure 2. Parameter development process.
Category 1 parameters are based on site-specific information, which is used as initial input to a WIPP PA numerical model that specifies the physical, chemical, or hydrologic properties of the rock formations, seals, backfills, and waste form, or any other natural or engineered feature of the WIPP. Category 2 parameters represent the inventory of the waste to be emplaced in the WIPP as defined in the WIPP Transuranic Waste Baseline Inventory Report (BIR).² Category 3 parameters represent precisely known, tabulated physical constants (e.g., half-life of a radionuclide, gravitational constant). Category 4a parameters are assigned based on a similarity of properties among materials or features of Category 1 parameters, and category 4b parameters are model configuration parameters not based on specific WIPP properties or features but nonetheless needed to make PA models run (e.g., time-step limits). Category 5 parameters were not used.

For most Category 1 and 4a parameters, the PI assembles a PI Parameter Package (PIPP) that links Form 464 to the technical data records packages, providing additional source information to support the parameter development documentation found in the PRP. After the PI assembles a PIPP, it is provided to the PTL and a copy is submitted to the Sandia WIPP Central Files (SWCF). The PTL then determines the appropriate parameter distribution from the information contained in the PIPP and completes Form 464. The PTL identifies the PIPP and any other relevant information as sources on Form 464. The PTL or designee then signs Form 464 and passes it to the PI and the PAA. If the PI and PAA concur with the distribution values selected, they also sign Form 464.

If more than one source of empirical data exists, each PI provides a PIPP to the PTL and reviews the distribution developed by the PTL. If the PI and PAA do not concur on the distribution values for Category 1 or 4a parameters, a dispute-resolution meeting is convened and the PI, PAA, and PTL establish mutually agreeable, justified parameter values. Documentation of dispute resolution meetings and results are contained in the PIPP.

For Category 2, 3 and 4b parameters, the PTL or PAA provide the source information to be attached to Form 464 or referenced in it. Concurrence of only the PAA and PTL are required for Category 2, 3, and 4b parameters.
After all required concurrence signatures are obtained, the PTL provides the completed PRP (including Form 464) to the Database Administrator (DBA) and the information is input to the CCA PA Parameter Database. Each PRP is then assigned a WIPP Project Office (WPO) number and submitted to the SWCF.

The CCA PA Parameter Database thus contains all the information recorded on a Form 464, including data values, associated models, all source information, category, and additional information documenting data entry (such as data entry staff and entry date). The CCA PA Parameter Database is a relational database implemented using Ingres software. Strict control of read and write access and audit trails ensures the security, integrity, and traceability of information in and out of the database.

**Parameter Development Team**

A focused team effort was required to develop parameters to meet the mandated CCA schedule. Well-defined roles and responsibilities of the four Parameter Development Team members were key to the success of the parameter development and documentation process, which is illustrated in Figure 3.

![Diagram](attachment:figure3.png)

Figure 3. Interrelationship of Parameter Development Team members.
At the core of the parameter development process is the PTL, who coordinates parameter development, classifies parameters according to category, and approves parameter entry requests. The PTL must have a broad technical understanding of the data and other available source information as well as the conceptual models and codes used. The PTL must also understand the parameters in terms of the reasonableness of the distribution values and the appropriateness of their use in the context of the models.

The PTL cooperates with the PIs, PAAs, and DBA. The PIs or scientific/experimental investigators are responsible for a particular experiment, design, or analysis. The PAAs are responsible for performing a numerical modeling exercise as part of the overall WIPP CCA PA and are sometimes referred to as code sponsors. The PTL helps mediate any conflicts between the PIs and PAAs. The DBA maintains the software and security of data entered into the CCA PA Parameter Database and ensures that all parameter documentation from the PTL is placed in the SWCF.

Lessons Learned

A focused team effort was required to develop and deliver nearly 1500 parameters to the WIPP CCA PA modelers within the mandated schedule. Although further improvements can be made in the areas of teamwork and breaking down of "ownership" barriers, the team worked effectively because procedures, roles, and responsibilities were well defined. In addition, by requiring concurrence from PIs and PAAs for parameter values that were based at least in part on empirical data, and by establishing a dispute resolution process, buy-in was obtained across program boundaries.

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References


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