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Data Quality Objectives Lessons Learned for Tank Waste Characterization

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Westinghouse
Hanford Company Richland, Washington

Management and Operations Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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DATA QUALITY OBJECTIVES LESSONS LEARNED FOR TANK WASTE CHARACTERIZATION

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ABSTRACT

The tank waste characterization process is an integral part of the overall effort to control the hazards associated with radioactive wastes stored in underground tanks at the Hanford Reservation. The programs involved in the characterization of the waste are employing the Data Quality Objective (DQO) process in all information and data collection activities. The DQO process is used by the programs to address an issue or problem rather than a specific sampling event. Practical limits (e.g., limited number and location of sampling points) do not always allow for precise characterization of a tank or the full implementation of the DQO process. Because of the flexibility of the DQO process, it can be used as a planning tool for sampling and analysis of the underground waste storage tanks. The iterative nature of the DQO process allows it to be used as additional information is obtained or "lessons are learned" concerning an issue or problem requiring sampling and analysis of tank waste. In addition, the application of the DQO process forces alternative actions to be considered when precise characterization of a tank or the full implementation of the DQO process is not practical.

I. INTRODUCTION

The Hanford Reservation system of underground storage tanks contains approximately 230 million liters of waste material distributed among 177 tanks. The waste in these tanks was produced as a part of the nuclear weapons materials processing mission that occupied the Hanford Site for the first 40 years of its existence. Waste tanks (149 single-shell and 28 double-shell tanks) contain a wide variety of waste compositions generated by three chemically diverse fuel and two tank waste reprocessing flowsheets.

The tank waste characterization process is an integral part of the overall effort to control the hazards associated with radioactive wastes stored in underground tanks at the Hanford Reservation. Knowledge of the physical, chemical and radiological properties of the wastes is prerequisite to operations to store, retrieve, process and dispose the wastes safely.

The programs in the Tank Waste Remediation System (TWRS) are employing the DQO process in all information and data collection activities. These activities include such issues as safety, process development and viability, regulatory, historical information, models, and scientific inquiry.

II. DATA QUALITY OBJECTIVE PROCESS FLEXIBILITY

The purpose of the DQO process is to provide a systematic planning tool for determining the type, quantity, and quality of data needed to support a decision. The process was initially developed by the U.S. Environmental Protection Agency (EPA) to characterize contamination at "Comprehensive Environmental Response, Compensation, and Liability

Act of 1980"[1] sites. The DQO process is an approach used to define data requirements and is scientific, logical, and defensible.

The DQO process is a flexible planning tool that can be used more or less intensively as a situation requires.[2] The effort required to complete the DQO process depends on the complexity of the problem and the consequence of making a wrong decision. If a problem is simple and the consequences are low, the DQO process can be completed in a simplified manner in a short period of time. If a problem is complex and the consequences of a wrong decision are high, deliberate, careful planning is required and may take an extended period of time.

The DQO process is an iterative process and can be used repeatedly throughout a project. Early decisions in a project may be preliminary in nature and only require limited planning and evaluation. As a study continues and making a decision error becomes more critical, the DQO process may require greater effort.

Not every step or all parts of every step in the seven step DQO process[2] is applicable to all data collection activities (e.g., studies that are exploratory in nature). One reason for this is that part of the DQO process includes formulating hypotheses.[2] If a statistical hypothesis is not linked to a clear decision in which the decision maker can identify potential consequences of making a decision error, some activities may not apply. In addition, the use of the DQO process will not always result in statistical/ probabilistic sampling methods for data collection. Although some problems cannot be evaluated using probabilistic techniques or result in a statistical data collection design, the DQO process still can be used as a planning tool.

III. TWRS EMPLOYMENT OF THE DQO PROCESS

Practical constraints, any hindrances or obstacles that interfere with full implementation of the data collection design, may be the main obstacle in TWRS data collection and implementation of the full DQO process. Specific TWRS obstacles include the heterogeneous (physical and chemical properties) nature of the tank waste, limitations on the number and location of sample points, sampler bias and incomplete sample recovery, incomplete or imprecise historical data, and the cost of obtaining and analyzing high-activity radioactive samples.

In general, the TWRS DQO process addresses an issue or problem rather than a specific sampling event. Therefore, tank sampling events may integrate sampling and analysis requirements from more than one DQO.

The TWRS applies the DQO process for the specification of information requirements. Programs requiring waste composition information document their issues and information needs in the DQO documents. In addition some DQO documents identify tanks which must be characterized to meet the needs. The Characterization Project integrates the information needs and tank priorities to define an overall plan for obtaining new information through sampling.[3,4]

The approach to characterization of each tank is to compile all available information about each tank to provide an estimate of the contents, then to generate a plan for acquiring additional information. Information sources include models of waste contents developed from historic records of processes and waste transfers, surveillance and monitoring data, previous sampling and analysis results, and models of chemical behavior. The estimate developed from these sources is improved by additional sampling or other measurement to provide additional data.

Based on the estimate of tank contents and the identified needs, a plan is developed to obtain additional data. The development of a defensible plan requires an understanding of the quality of existing data and the capabilities and limitations of the tools used to obtain new data. The quality of the data from newly acquired samples may be affected by the constrained access to the tanks, which limits the number of available samples and prevents sampling of large regions of the waste. Many tanks contain heterogeneous waste, which would require many random samples for very precise characterization. Random sampling is generally impossible, and interpretation of sampling results requires understanding of the impacts of non-random sampling.

The application of the DQO process to waste tank issues has necessarily been an iterative process. Each individual issue (associated with safe storage, waste retrieval or disposal) applies to many or all tanks. Likewise each tank has multiple issues requiring characterization information. Since the waste contained in each tank differs in physical and chemical properties, the plans designed to obtain new information must be specialized to the tank.

The first six steps of the DQO process (State the problem, Identify the decision, Identify the inputs to the decision, Define the study boundaries, Develop a decision rule, Specify acceptable limits on decision errors) have been developed for the general issues. The optimization step of the DQO process is applied to each specific tank after integrating all the data needs associated with all the applicable issues.

IV. LESSONS LEARNED IN TWRS

As the DQO process has been applied to issues in TWRS, the understanding of the data needs and the issues have evolved and matured. The efforts to devise a plan to obtain sufficiently precise data from tanks through sampling and analysis have often been unsuccessful. This has led the data requestors to review the data needs and consider alternative approaches to solving problems and making decisions.

A specific example of the evolution of the data requirements is demonstrated for the problem of ferrocyanide compounds in the Hanford tank wastes.[6] Nickel sulfate and sodium ferrocyanide were added to waste tanks to create sodium nickel ferrocyanide to precipitate cesium. Since the mixture of ferrocyanide with an oxidizer (such as the nitrate salts in the tanks) can support an exothermic reaction, a potential safety concern was identified.

Originally the ferrocyanide issue focused on the need to show that the ferrocyanide content in each tank could not sustain an exothermic reaction. If resolution of this issue were approached based only on analysis of waste samples, it might lead to the sampling of all 177 waste tanks regardless of process history. However, waste transfer records provide a strong justification that the ferrocyanide issue is limited to a set of 18 tanks designated the Ferrocyanide Watch List tanks.[6] Consideration of all available data early in the process allowed proper scoping of this problem, significantly reducing the boundaries.

The earlier approach to the sample analysis required core sampling of all the 18 ferrocyanide tanks to show that the fuel concentration was below 480 Joules/gram, or that the moisture content in the waste was sufficiently high to prevent a propagating reaction. However, process records predicted significant heterogeneity in the waste material and statistical review of the tank sample analysis results confirmed this prediction. Therefore, the degree of waste heterongenity and the limited number of sampling locations make it difficult to show absence of energetic material with a high degree of confidence. Thus, the major problem with the analytical approach stem from designing a sampling and analysis scheme based upon identifying the absence of chemical compounds rather than the presence of chemical compounds. As a result the initial DQO process led to data requirements that were nearly impossible to achieve with available capabilities.

Laboratory work and limited core sampling results indicate that ferrocyanide degrades (ages) to non-reactive components during interim storage in the waste tank environment. A revised approach to the resolution of the ferrocyanide issue focuses on proving that the ferrocyanide degrades.[6] Nickel found in the waste indicates that ferrocyanide was originally present in any given sample. (Sodium nickel ferrocyanide is the only significant source of nickel in most Hanford tank waste.) If nickel is found in waste that exhibits no exotherms, then the ferrocyanide is no longer reactive, and thus has degraded. This model may be confirmed by sampling only a few bounding tanks. The bounding tanks are those which received the greatest quantity of ferrocyanide and which provide an environment in which the ferrocyanide is least likely to have aged. (High pH and high radiation contribute to aging.) Because the nickel can be used as a marker, the approach no longer relies on showing absence of energetics, but on showing presence of the marker concurrent with low energetics. The statistical problem of interpreting the data becomes much more tractable.

The revised approach to resolution of the ferrocyanide issue incorporates the process history, results of modeling and experimental work, and limited sample analysis data. The additional data requirements are considerably less onerous than those associated with approaches that relied more heavily on sample analysis.

The evolution of thinking associated with the ferrocyanide issue illustrates how the application of the DQO process can provide results that change the way a problem is approached. The DQO process itself was not responsible for the evolution in thinking. However, the initial definition of data requirements acted as an indicator that alternative approaches needed to be considered. The iteration of the DQO process resulted in identifying more limited data requirements that could be met.

Most of the DQO processes applied to the Hanford waste tanks have undergone more than one iteration. It has been a universal discovery that the high precision, high accuracy data required to make decisions is nearly impossible to obtain. The programs requesting data have reviewed their approaches to determine if the decisions must rely solely or primarily on sample analysis data, if alternative sources of information can contribute, or if alternative approaches to the decisions can be identified.

Another example of evolution of approach involves safety screening of waste tanks. All 177 tanks must be screened to determine if possible safety issues are associated with the waste contents.[7] The most simplistic approach to this issue involves asking the general question "What is in the waste?" with a high level of precision. The contents can then be reviewed to determine if any safety hazards exist. Again, it is infeasible to obtain enough samples of the large volumes of heterogeneous solid materials to answer such a question defensibly.

The obvious next step is the examination of the process records to bound the type of hazards that might conceivably exist in the tanks. Then a much more limited set of questions addressing specific chemicals can be generated. This process was further improved by considering properties of the waste which would be generic indicators of potential problems (such as energetics) rather than the multiple specific analyses that would contribute to the problem (such as a variety of organic compounds or ferrocyanide).

Although the analytical requirements associated with this approach were considerably less than those associated with a non-directed search for any hazard, the problem of showing absence of a parameter (energetics) still remained. Additional theoretical and experimental work resulted in the hypothesis that an adequate level of water in the waste material could quench any potential exothermic reaction and prevent propagation. The details of this hypothesis have not yet been confirmed, but the potential implications for data requirements are significant. It may be considerably easier to show presence of moisture in the tank waste (for example, by observation of a liquid surface) than to show absence of energetics.

The iterations continue in the application of the DQO process to the Hanford tank wastes. Ongoing sampling and analysis is providing information on a tank by tank basis per the current DQOs. In some cases, the data quality requirements are still poorly defined or cannot be achieved. When current characterization methods cannot achieve the required quality, the issues must be reviewed with the requesting programs and stakeholders to identify other approaches to making decisions.

Because of the magnitude of the tank waste characterization problem, it is likely that iterations of the DQO process will continue. The data requirements will continue to be revised as more is learned about the waste materials and the associated issues.

REFERENCES

1. "Comprehensive Environmental Response, Compensation, and Liability Act of 1980," 42 U.S.C. 9601 et seq.

2. U.S. Environmental Protection Agency Quality Assurance Management Staff, "Guidance for the Data Quality Objectives Process," EPA QA/G-4, Environmental Protection Agency, Washington, D.C., (1994).

3. T. M. Brown, S. J. Eberlein, and T. J. Kunthara, "Tank Waste Characterization Basis," WHC-SD-WM-TA-164, Rev. 1, Westinghouse Hanford Company, Richland, Washington (1995).

4. C. S. Homi, "FY1996 Tank Waste Analysis Plan," WHC-SD-WM-PLN-101, Rev. 1, Westinghouse Hanford Company, Richland, Washington (1996).

5. G. L. Borsheim and B. C. Simpson, "An Assessment of the Inventories of Ferrocyanide Watch List Tanks," WHC-SD-WM-EP-133, Rev. 0, Westinghouse Hanford Company, Richland, Washington (1991).

6. J. E. Meacham, R. J. Cash, B. A. Pulsipher, and G. Chen, "Data Requirements for the Ferrocyanide Safety Issue Developed Through the Data Quality Objectives Process," WHC-SD-WM-DQO-007, Rev. 2, Westinghouse Hanford Company, Richland, Washington (1995).

7. G. T. Dukelow, J. W. Hunt, H. Babad, and J. E. Meacham, "Tank Safety Screening DQO," WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington (1995).