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DEVELOPMENT OF QUALITY ASSUARANCE FOR HLW DISPOSAL R&D IN KAERI

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Abstract

To assure the credibility of R&D results and to systematically and effectively perform experiments and computations for the performance assessment of high-level radioactive disposal in Korea, the total quality assurance(QA) program is under development. To effectively manage the R&D' s and perform decision makings so called WEB based QA system is proposed based on the U.S. N.R.C. 10CFR50. The current proto-type QA system shall be extended to accommodate functionalities such as QA procedures, forms, and decision-making pathways. In parallel with the QA system, the technical data management (TDM) system is also applied to get probabilistic density functions (PDF' s) required for probabilistic safety assessment (PSA). So-called SNL-NRC protocol was applied to construct the PDF for solubility limits of two nuclides.

요약

현재 한국원자력연구소를 중심으로 활발하게 진행되고 있는 고준위 방사성폐기물 처분 성능 평가 관련 연구 결과물들의 신뢰성을 증진시키고 평가 입력 자료 생산 연구를 보다 체계적이며 효율적으로 수행하기 위해 품질보증체제 개발 연구가 수행되고 있다. 특히 효율적인 의사 결정 및 관리를 위해 웹을 기반으로 한 시스템이 제안되었다 미국 10CFR50 관련 규정을 근간으로 제정되고 있는 품질 보증 체제 개발 연구에서는 현재까지 proto-type의 품질보증체제를 개발하였으며 이를 바탕으로 근 시일 내에 국내 연구 실정에 적합한 품질 보증 체제를 개발할 예정이다. 이와 병행하여 생산된 입력 자료들을 종합 분석하거나 기존의 문헌 조사를 통해 수집된 입력 자료들을 확률 밀도 함수로 표시하기 위한 방안의 하나로 SNL-NRC 방법에 의한 기술적 자료 관리 체제에 관한 연구가 수행되어 최고 용해도 관련 확률 밀도 함수 산정에 적용되었다.

INTRODUCTION

Since 1954 when the Atomic Energy Act was set up various regulatory frames have been introduced for the quality assurance (QA) of the radioactive waste disposal projects in the United States. For the prospective Yucca Mountain Project (YMP) new 10 CFR Part 63 and ASME NQA-1 are backbones for QA. For the WIPP inaugurated in 1999, 40 CFR Part 194 and ASME NQA-1 are key components. QA requirements have been evolved as time spans. For example, during the site selection phase of the WIPP, Industrial drilling and geo-technical practices were the main QA requirements. However, currently, NQA-1, NQA-2a, NQA-3, and 10CFR830.120 are major QA regulations. As we can identify in the WIPP case, there is no everlasting QA system for the radioactive waste disposal. It changes as the Project progresses. However, the real demand of the QA, need for the documentation for the licensing decision making which inevitably requires the extensive and detailed review of the Compliance Certification Application(CCA), is always there from the beginning of the fundamental R&D to the closure of facilities. Korea Atomic Energy Research Institute(KAERI) has worked as a sole R&D institute in Korea in the field of high-level radioactive waste (HLW) disposal since 1997. During the annual R&D review meetings many outside experts have recommended to develop the proper QA and subsequent technical data management (TDM) system. QA and TDM are the key for the decision making, documentation, and record keeping over performance assessment (PA) calculations and input data generation. During the fiscal year 2000, KAERI in association with Sandia National Laboratory (SNL) in the United States developed the proto-type of the KAERI HLW QA system and subsequent TDM techniques. In parrarel, KAERI by herself developed the needed QA proceedures to cover all R&D activities on HLW disposal from the team structure to record keeping as well as the flow diagram over decision making pathways. In the fiscal year 2001, KAERI shall extend the proto-type to completely construct the Web Based QA so that all the KAERI participating R&D staffs and the outside contractors can use the system. In addition, KAERI shall open her HLW PA database system for the record keeping of all data collected from her own R&D as well as literature surveys.

KEY QUALITY ASSURANCE ELEMENTS AND IMPLEMENTATION

So called R^3T^2 , traceability, transparency, reviews, reproducibility, and retrievability, principles are adoted for the KAERI QA system. Traceability means that all registered document sources should be traceable for the CCA review and other internal R&D activities if required by internal and outside reviewers. Transparency implies that the logic and decision points to select and dis-select data should be understandable every stakeholders. Reviews indicates that it should be capable of independent reviews. For this all data and supplimentary papers such be documented by the proper QA procedures. Peproducibility means that all documented records should be re-constructable to produce the same results even though the operators of assessment and experiments change.

Retrievability implies that it should have the smart index system so that whenever required all documents should be ready in a proper time and manner.

In every R&D activities on HLW disposal, there are always five steps; 1) adequate planning, 2) controlled execution, 3) complete documentation, 4) thorough review, and 5) independent oversight. In these steps the principle of R^3T^2 is always implemented. Table 1 summarizes how actually the R^3T^2 principle is implemented in five steps.Then all those planned and systematic actions necessary to provide adequate confidence that a system and its component system elements will satisfy specified QA requirements and perform satisfactorily.

Table 1. QA Concepts and R^3T^2 Objectives

	Traceability	Transparency	Reviews	Reproducibility	Retrievability
Adequate Planning	◢	◢			
Controlled Execution	◢	◢	◢	◢	◢
Complete Documentation	◢			◢	◢
Thorough Review	◢	◢	◢	◢	
Independent Oversight	◢	◢	◢	◢	◢

In the United States, typically 18 QA criteria are applied for the nuclear industry by 10 CFR 50 Appendix B and NQA-1. Table 2 illustrates all 18 elements. However among 18 elements many of them are not practicable for radioactive waste disposal. SNL has modified it to set up the optimum QA procedures for the United States as summarized in Table 2.

As summarized in Table 2, many parts of the 10 CFR50 are merged and splitted into related sections in the procedures. For example, chapters 1 and, organization and QA program are merged to Organization and QA Planning which is compsed Planning and Qualification & Training to cover the applicability of QA, Implementation of Requirements, and Planning. For Criteria 8 Identification and Control of Materials, Criteria 12 Control of Measuring and Test Equipment, and 13 Handling, Storage, and Shipping, three criteria merged and then splitted into 1) M&TE Control, 2) Sample Control, 3) Software Control, 4) Scientific Investigation, and 5) Anslysis Control. The last three newly born criterias 3) Software Control, 4) Scientific Investigation, and 5) Anslysis Control, have similarity. They split into detailed sections such as 1) Software Baseline, 2) Software Change Control, 3) Data Management, 4) Model Development, and 5) Model Validation.

As described here the original 18 criteria are completely reformed to suite for the radioactive disposal related project.

Table 2. Eighteen Criteria in Nuclear Energy Related Activities

General Criteria	Applied or Not	New Criteria
1 Organization	Yes	Criteria for Radiactive Waste Disposal
2. QA Program	Yes	Criteria for Radiactive Waste Disposal
3. Design Control	Non	Deleted
4. Procurement Document Control	Yes	Procurement/ Procedures/ Document Control
5. Instruction, Procedures, Drawings	Yes	Procurement/ Procedures/ Document Control
6. Document Control	Yes	Procurement/ Procedures/ Document Control
7. Control of Purchased Materials, Equioment, and Services	Limited	Part of Procurement
8. Identification and Control of Materials, Parts, and Components	Limited for sample only	Part of Sample Control
9. Control of Special processes	Non	Deleted
10. Inspection	Non	Deleted
11. Test Control	Non	Deleted
12. Control of Measuring and Test Equipment (M&TE)	Yes	M&TE Control
13. Handlig, Storage, and Shipping	Limited for sample only	Sample Control/ Software Control/ Scientific Investigation/ Analysis Control
14. Inspection, Test, and Operating Status	Non	Deleted
15. Non-conforming Materials, Parts, or Components	Non	Deleted
16. Corrective Action	Yes	Corrective Action
17. QA Records	Yes	QA Records
18. Audits	Yes	Audits and Surveillance

DEVELOPMENT OF THE KAERI PROTO-TYPE QA SYSTEM

KAERI plans to develop her QA system step by step. In 2000, so called high-level QA system was constructed. The overall QA system and forms and the decision-making pathways in Figure 1 were developed. In 2001 the low level QA, specific project oriented procedures shall be developed along with the full Web based system.

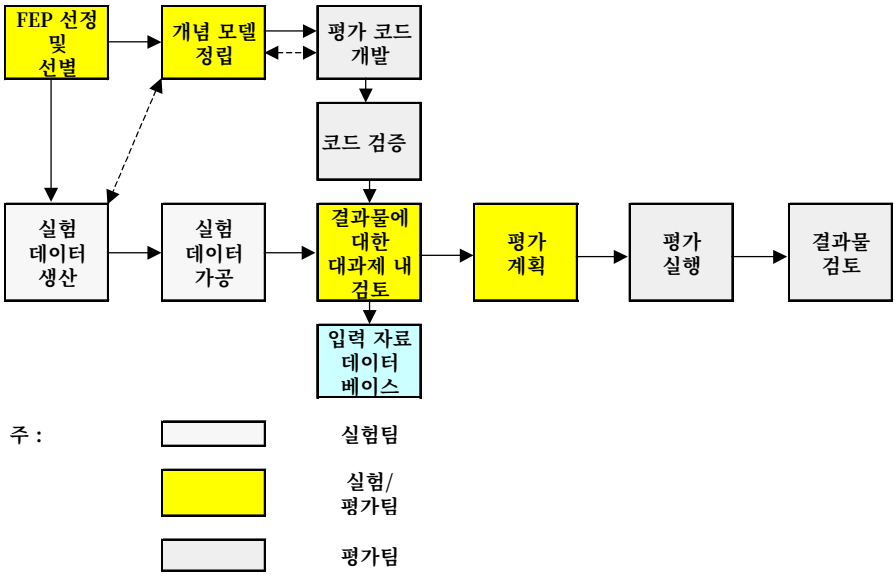

Figure 1. Decision-Making Pathways in KAERI HLW Disposal R&D

To develop the QA system all PA related R&D activities currently pursued in KAERI are classified into the following three categories;

1) Data Collection
2) Data Analysis
3) Compliance Support

Since the above three categories are the keys in PA R&D, the KAERI custom made QA system should describe the specific procedures on these in detail.
Traditionally all planning, qualification and training, record management, use of controlled documents, reviews, and oversight and corrective action are generally applicable to all activities to the QA program. And data collection activities involve the use of notebooks and or technical procedures. It also often requires measuring and test equipment. In addition it demands sample, procurement, and scientific controls. Data analysis control often involves software and document review. Finally, compliance support activities include administrative support in areas such as records and data management, procurement, personnel qualification and training, document control, and oversight and corrective action. These three areas are sometimes independent and sometimes overlap. To introduce the optimum QA system for the current PA R&D in KAERI whose participant numbers is less than 30, following principles are considered.

1) Processes and procedures should be simple, efficient, and directly traceable to requirements.
2) Base procedures on existing processes should be modified properly as necessary to ensure adequate compliance.
3) It is important to establish a system of “normalized procedures”.
4) It requires creating “assembly line” processes to minimize unnecessary looping, while ensuring adequate feedback.

5) It is required to minimize the presence of so called "audit bait."
6) It should clearly identify responsibilities such as control points and gatekeepers among concerned parties.
7) It should ensure easy maintenance and limit administrative overhead.

KAERI developed 18 procedures to cover PA R&D activities based on the principles described above. It can be classified into five categories;

1) PLAN
   (1) QAP 1-1 : Organization and QA
   (2) QAP 1-2 : Plan
   (3) QAP 6-1 : Document Control
2) CONTROL
   (1) QAP 2-1 : Qualification and Training
   (2) QAP 2-2 : Analysis
   (3) QAP 4-1 : Procurement
   (4) QAP 5-1 : Procedures
   (5) QAP 12-1 : M&TE
   (6) QAP 19-1 : Software
   (7) QAP 20-1 : Scientific Notebooks
   (8) QAP 20-2 : Sample Control
3) REVIEW
   (1) QAP 6-1 : Review
4) INDEPENDENT OVERSIGHT
   (1) QAP 16-1 : Corrective Action
   (2) QAP 18-1 : Audit/ Surveillance
5) DOCUMENT
   (1) QAP 17-1 : Records

As seen in Figure 2, all procedures and subsequent documents are coded in internet environment. And more detailed specific project oriented procedures shall be developed soon.

CONCLUSIONS

KAERI has developed her own QA system for HLW disposal PA R&D . Adopting the R^3T^2 principles and the 10CFR50, KAERI identified needed criteria and then develop the high QA system with her own QA procedures. This QA system shall be expanded in 2001 with specific project oriented QA procedures under WEB environment.

ACKNOWLEDGEMENT

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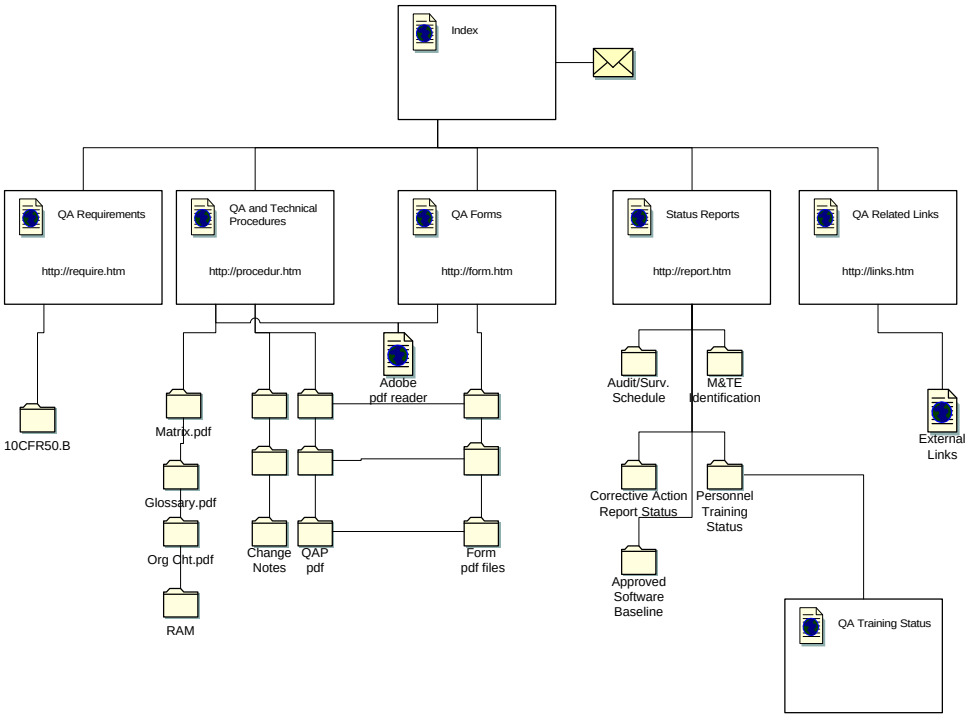

Figure 2. Proto-type KAERI Web Based QA system