The calculation & assessment in Quality elements amount of Nuclear Research Projects.

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1. Introduction

Since Fukushima,accident, various activities in all of nuclear research fields and nuclear energy utilization divisions to acquire nuclear safety have been taken. Specially, the concept and affectiveness of quality assurance became a important suggestion in the various field of nuclear research related safety. In construction of nuclear power plant, quality assurance activities have been applied all design phases and construction phases by the laws. But in the case of the Republic of Korea, from operation phase, those activities including quality applications have been considered only as atomic law satisfaction and those are needed for obtaining the licences to construct NPP or pass the atomic safety laws. Actually, QA concept can be explain like below meanings; it should be well achieved by the pre-planned skeleton and the systematic control and the management actions should be assure the safety construction and operation of all the nuclear industry including R&D. Quality Assurance(QA) also should be applied all the phases of all nuclear activities and the QA concept should be applied not only nuclear industry but R&D projects. In the same manner, the QA system of R&D projects should be composed with the efficient quality assurance elements needed to excute the QA system effectively for the developments of the nuclear Research & Development fields. The purpose of these activities are to reduce the failure costs and prevent the repeated mistakes of various nuclear research projects.

2. QA application in nuclear R&D

In nuclear field, the role of QA is spreaded all the section and the range of the function is distributed from siting to decommissioning. All structures, systems and components are classified in accordance with their importance to nuclear safety and the possible radioactive release as Safety Class 1, 2, 3 or Quality Class Q,AQ,T,S in almost Korea Nuclear Power Plant. Equipment is assigned to a specific class recognizing that, within a system, parts may be of differing safety importance. However, The quality assurance (QA) requirements for research & development in Korea Atomic Energy Research Institute has to be simplified because the requirements of nuclear power plant and nuclear industry were described too rigorously in atomic laws and regulations. So the requirements for R&D project were established following 10 elements. The requirements derived from 10 CFR Part 50 Appendix B[1] ASME NQA-1[2], KEPIC QAP[3], DOE Order[4] and IAEA GS-R-3[5] so on.

These elements are Quality Program , Independent Assessment &Quality Improvement, Documents Control & records, Design Control, Software Control, Procurement Control, Controls of Items, Work process, Inspection and Acceptance Testing Elements, and Measurement /Equipment Control Elements. These are established as the methods in application of the world quality code&standards. So, firstly, in this paper, following questions as table 1. can be suggested to search the effective quality elements to apply various R&D projects.

• For how many R&D project are applicable? • For which R&D project is applicable? • For which phases of that R&D project is applicable? • For which safety class/quality class of that R&D project is applicable? • Are some other standards or requirements applicable for some of the phases in this R&D project (including quality class)?

Table 1. A suggestion to select R&D project element

From above suggested questions, a desirable solutions to set up the effective and efficient R&D QA elements and R&D QA systems can be guided by quality experts and project managers. Further, the amount of necessary elements for nuclear research projects can be decided also.

Secondly, These should be established on the basis the risk involved in R&D work (phase 1, 2, 3, 4 and 5) can be associated and evaluated with a below following table 2:

• The direct environmental, safety class & quality class impact. that is caused by the conduct of R&D projects. • The indirect impact on the above factors that is caused by the application of results from R&D, which can be approximated by the maturity of the R&D project. • The complexity of the project. • The importance of the data.

Table 2. Causes factors to select R&D project element

Besides, Risk is an another important fundamental consideration in determining to what extent the

requirements should be applied to the R&D project. For example, DOE Order 5700.6C states that "risk is the qualitative risk score can be obtained by analysis of hazards that could lead to undesirable events. Accordingly, a complex R&D projects should be needed an analysis by the procedures suggested above table 1 and the considerations features suggested above table 2.

Risk score	Description
1	No risk to health and safety and/or negligible inconvenience and cost
2	Limited risk to health and safety
3	Moderate risk to health and safety
4	Significant risk to health or safety of laboratory personnel or limited risk to the public
5	Significant risk to health and safety of both laboratory personnel and the public

Table 3. Risk Factor of the R&D project element

Above table 3 shows the graded risk control and degree. The risk conclude the concepts of human health, safety and environment. On the other words, risk is a function of probability of an undesirable event and consequences of an undesirable event from stable condition. Therefore, R&D elements adopted the method the risk control that all R&D work could be classified 5 categories (phase 1, 2, 3, 4 and 5) and could be associated and evaluated with the above table 3. Each project could be evaluated the effects and extent in accordance to these five progress types of project characters. Also, it could be evaluated by assigning a qualitative risk categories and requirements for each of the five areas (1)~(5).

Risk decision applied to the 5 devided R&D projects in several cases. Moreover it was based on limited risk to health and safety. For example, furnace will be operated within a hot cell environment and will contain only a limited amount of fuel at a time. Should problems occur and massive fuel failure result, the furnace will provide the first level of containment. Should the furnace fail, the hot cell will provide containment and shielding. Massive explosions or violent pressure increases that would cause breach of the hot cell are not credible with the small amount of materials and stored energy available. Primary concerns are personnel exposure and contamination. These will be controlled by the design of the experiment, the limited amount of fuel used, and administrative controls. To a large extent, the projects makes the results for the use of government's requests available to nuclear advance and development. And some results are to be put to the new technologies for the modification of nuclear power plants. Established new techniques were some supported to the other countries' construction of nuclear power plant. but these modifications do not require extensive engineering calculations or modeling. Only the results of some R&D projects and the completed hardware are delivered to the countries want the results to be provided. So the nuclear organizations want to know the results contain the validity,integrity and reliability. Recently, the complexity of R&D projects arises from the research laboratories of many different subjects at the same time, for long periods of time in a R&D environment, and the coordination of several groups cannot wait the R&D results. So the needs of QA activities are increased and applied broadly all the research field and nuclear divisions.

The primary concern of QA is the safety and reliability that assure a safe operation of system and prevent the malfunction may be occurred and may result in an incorrect results. So to make sure the above purpose, the QA elements and requirement were selected to strengthen and enhance safety and reliability.

3. Quality element assessment in nuclear industry

The QA standards applied to nuclear power plant in Korea derived from the code of ASME,NQA or CSA. The electrical power company are subject to the regulatory control from the design stage to the final stage in the licensing. All structures, systems and components of nuclear installations should be designed, fabricated, installed, erected, inspected and tested in accordance with the established the approved QA program. Especially, for pressure retaining items, the KEPIC Code rule shall apply and the QA requirements are specified. For the permission of construction and operation of a nuclear installation, the applicant should submit the approved QA program for the Government approval. During the construction and/or the operation, regulatory inspections or audits by the Government's representative (KINS, KINAC) should be performed. On the construction phase, the licensee shall be subject to the pre-operational inspection to prove that the construction and functional tests of the reactor facilities meet the safety requirements specified in the relevant technical standards. For example, on the operational phase, the licensee shall be subject to the regulatory periodical inspection, which is usually conducted on an annual basis. This inspection should confirm that the performance of the reactor facility ensure operations within the allowed service conditions in view of the pressure, radiation and other environments. Therefore,in the case of the QA inspection shall be performed as a part of the regulatory inspection, and the inspection are performed in accordance to the Korea Atomic Safety Laws or Acts. The laws or acts concerned to QA activities are described with ASME and CSA code & standard of QA in the technical aspect. It should be carried out annually to check the quality assurance activities of the licensee which should be performd with the QA program submitted. Also, in R&D projects, the

QA program contained approved quality elements should be submitted and approved by the Korean government laws and atomic laws in the future.

4. The Development of QA Element for R&D

To apply the nuclear industry QA code & standards in R&D projects and tasks and to improve their function, the element(criteria)'s efficiency and effectiveness are analyzed in their application with numerous manuals &procedures of R&D management. The results were introduced in the former paper, Establishment & Application of Management Concept in Nuclear QA [6]. Though the Quality assurance program requirements for an applicant of nuclear NPP installations in Korea are specified in Article 7 of the Enforcement Regulation of the Atomic Energy Act (AEA), which consists of 18 criteria, the QA code & standards for R&D projects and nuclear divisions are not specified anywhere in the AEA and the other Korean Atomic law yet.

These unique R&D nuclear circumstances results in the delay of nuclear R&D QA requirements application. Deming's PDCA Cycle is broadly introduced as the measurement of QA activity Performance. Especially R&D field of nuclear including the Demings Cycle can be used in the research methodology. Accordingly, To develop the desirable R&D QA elements in R&D field, The QA requirements for R&D criteria specified as in the industry elements on AEA also should be specified on the Korean Atomic Laws and AEA. Further, these R&D elements are specified in KEPIC codes divided to the Deming's 4 activity steps. The Deming's steps are plan,do,check and action. The plan activity area of Deming theory contains Design control, Quality Assurance Program, Procurement Document Control and Instruction & Drawing Control. The QA elements belong to the activity Do area of Deming Cycle can be classified to the Document Control, Special Process, Control of Purchased Items, Identification control element and Handling of items. The QA elements put into the Check activities of Deming's are Test Control,Inspection status,Control of Mesuring test equipment and Audit. The Action area contains QA Audit, Control of Nonconforming Items, Corrective Action and QA Records. Recently, it is revealed that the repetitive use of this cycle is very effective to promote a successful Results of Research & Development because quality improvement concept is in the Deming's cycle.

5. Conclusion

R&D QA element or requirement in nuclear is developed and promoted to apply from the basic research tasks to production step in R&D projects. So,the most useful elements for R&D QA activities can be suggested by 10 elements. These are the Organization, QA program, Design Control, Document Control, Procurement Control, Test Control, Control of Measuring Test& Equipment ,Inspection , QA Records and Quality audit. These R&D QA elements suggested above should be developed in the various quality documents and applied in the all quality activities to acquire nuclear safety in all nuclear R&D fields.

REFERENCE

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