An Application Example Analysis of Quality Assurance Program for STELLA(Sodium Integral Effect Test Loop for Safety Simulation and Assessment) Project

Minhwan Jung*, Dayoung Gam, Jae-Hyuk Eoh, Ji-Young Jeong
Korea Atomic Energy Research Institute, 989-111 Daedeok-daero, Yuseong-gu, Daejeon, 305-353, Republic of Korea
**Corresponding author: minhwan@kaeri.re.kr*

1. Introduction

The nuclear industry has a tremendous socioeconomic impact on the entire country and a high level of safety standard and a large investment. Thus, a Quality Assurance (QA) program that ensures the reliability of a nuclear facility has been mainly applied for nuclear power plant areas. In recent years, the necessity of a QA program for the nuclear R&D area, not only inside the country but also internationally, has been emphasized for safer and more reliable R&D activities.

KAERI has been conducting various basic R&D activities in the field of nuclear technology. In addition, KAERI is now participating in the Generation IV International Forum (GIF), preparing for the development of key technologies for Generation IV nuclear energy system, including Sodium cooled Fast Reactor (SFR) development. All of the key technologies for SFR development need an appropriate level of QA activities to achieve the GIF safety and performance objectives. Therefore, QA activities have been conducted as an essential part of the national SFR project. As a result, QAM (Quality Assurance Manual) and QAP (Quality Assurance Procedures) have been developed for the SFR project, which are based on ASME NQA-1, KEPIC QAP and the GIF Quality Management System Guidelines.

The objective of this study is to analyze the application examples of the QA program for KAERI'S SFR project; STELLA and to propose the necessity of a more appropriate QA program for the ongoing SFR project.

2. QAM & QAP

The QAM and QAP cover all items or activities for the development of key technologies for an SFR system including those important to the safety, reliability and performance of R&D activities.

The QAM gives a general description of the outline of the policy and a way to fulfill the QA requirements presented by the manager of the organization. The QAM consists of a total of 18 parts as presented in Table. 1.

The QAP contains the detailed procedures of the QA in accordance with requirements of the Quality Assurance Manual. Table 2 shows 22 parts of the Quality Assurance Procedure.

Table. 1 Quality Assurance Manual

No	Subject
1	Organization
2	Quality Assurance Program
3	Design Control
4	Procurement Document Control
5	Instructions, Procedures, and Drawings
6	Document Control
7	Control of Purchased Items
8	Identification and Control of Items
9	Control of Special Processes
10	Inspection
11	Test Control
12	Control of Measuring and Test Equipment
13	Handling, Storage, and Shipping
14	Inspection, Test, and Operating Status
15	Control of Nonconforming Items
16	Corrective Action
17	Quality Assurance Records
18	Audits

Table. 2 Quality Assurance Procedures

No	Subject
QAP-SFR-2.1	Control of Quality Assurance Manual and Procedure
QAP-SFR-2.2	Personnel Indoctrination and Training
QAP-SFR-2.3	Conformity assessment of Quality Assurance Plan
QAP-SFR-3.1	Design Control
QAP-SFR-3.2	Design Verification
QAP-SFR-3.3	Software Control
QAP-SFR-3.4	Control of Design Drawing
QAP-SFR-4.1	Procurement Document Control
QAP-SFR-6.1	Document Control
QAP-SFR-7.1	Control of Purchased Items and Services
QAP-SFR-7.2	Assessment and Selection of Supplier
QAP-SFR-10.1	Quality Inspection
QAP-SFR-10.2	Qualification of Quality Inspector
QAP-SFR-11.1	Test Control
QAP-SFR-11.2	Software Test Control
QAP-SFR-11.3	Qualification Control of Tester
QAP-SFR-12.1	Measurement and Control of Test Equipment
QAP-SFR-15.1	Control of Nonconformance
QAP-SFR-16.1	Corrective Action
QAP-SFR-17.1	Control of Quality Assurance Record
QAP-SFR-18.1	Audits
QAP-SFR-18.2	Qualification of Auditor

3. Application QA for STELLA project

In regard to the long-term SFR development plan, a large-scale sodium thermal-hydraulic test project is being progressed by KAERI. This project is called STELLA (Sodium Integral Effect Test Loop for Safety Simulation and Assessment), and it finally aims at the construction of an integral effect test facility subject to the prototype SFR. In the first step of the STELLA project, the first sodium test facility called STELLA-1 is in operation at the KAERI site. The general arrangement of the STELLA-1 facility is shown in Fig 1.

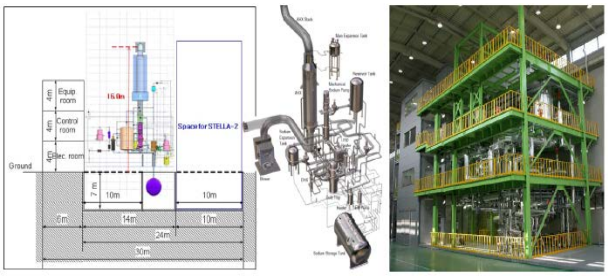

Fig. 1. General arrangement of STELLA-1 facility with images of the structures

The above mentioned QAM & QAP have been applied for the STELLA project in consideration of the specificity of an experiment using sodium(Na) categorized as Class 3(pyrophoric material & water-prohibiting substance) by the Safety Control of Dangerous Substances Act. Typical examples of the application are presented in the next three paragraphs.

• Personnel Indoctrination and Training

This procedure describes the implementation methods of the indoctrination and training of the personnel performing activities affecting quality. In the case of the STELLA project, the indoctrination and training courses have been planned and executed by an appointed training officer. The contents of the course consist of essential knowledge to help a trainee conduct a Na-experiment, which contains the unique physical and chemical properties of Na, precautions while conducting the Na-experiment, the characteristics of a Na-fire, facilities for Na-fire prevention, etc.

• Measurement and Control of Test Equipment

This procedure describes methods for ensuring that the test equipment used for activities affecting the quality shall be controlled, calibrated at specific periods, adjusted, and maintained at the required accuracy limits. In the case of the STELLA-1 facility, the validity periods of the calibration of 5 flowmeters (FT-101, 102, 103, 104, 121) were already expired because it was impossible to test them for use in a Na-experiment before completing the overall sodium experimental loop, and there was no qualified institution that plays a role in calibrating the flowmeters for the measurement of the Na-flow rate. Therefore, the equipment manager appointed by the subject responsible person made a self-calibrating procedure including the application scope, recording form, environmental condition, and detailed calibration procedure through consultation with the Quality Management division that generalize related tasks in KAERI. The self-calibrating procedure approved by the people in charge will be performed by May 29 of this year.

• Control of Nonconformance

This chapter describes the QA requirements to ensure that items that do not conform to the specified requirements shall be controlled to prevent an inadvertent installation or use. Non-conformance means the characteristics, documents and procedural defect that make the quality of the work uncertain. Non-conformance should be documented as an NCR (Non-Conformance Report), which includes the processing plan, method, and authentication result. As mentioned above, the validity periods of the calibration of the 5 flowmeters of the STELLA-1 facility were expired before testing them for the Na-experiment. Therefore, the NCR which contains the essential details was made by the equipment manager and published after obtaining the signatures of the subject responsible person of the STELLA project and the manager of the Quality Management division.

5. Conclusion

In this work, the introduction background and application examples of the QA program for the STELLA project were investigated. Application of the QA for the STELLA project has great significance because the QA has been mainly applied for the nuclear power plant area in operation, which helps ensure the reliability of the test data and completeness of the research performance. Nevertheless, developing more appropriate QA procedures remains a major task because some parts of them are not applicable to the Na-experiment. A meaningful discussion and close cooperation between on-site researchers and a QA specialist, especially in respect of calibration of test equipment, should be carried out as soon as possible for the ongoing project.

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