Current Status of European Supply Chain for Commercial Grade Item Dedication in Nuclear Power Plants

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1. Introduction

Most nuclear power plant (NPP) operators in Europe are facing several problems, including difficulties in procuring replacement parts and increased maintenance costs due to the obsolescence of existing facilities. Currently, the number of suppliers providing safety-related equipment is steadily decreasing due to the growth limitations of the nuclear industry, which could eventually induce a potential hazard to the long-term safety operation of nuclear power plants [1].

To investigate possible solutions for supply chain challenges mentioned above, EC-JRC (Europe Commission-Joint Centre Research) launched a large-scale project called "Modernisation and Optimisation of the European Nuclear Supply Chain" in 2018 [2]. In this project, two meetings were held to assess the current status of European nuclear supply chain and a commercial grade item dedication (CGID) process was considered as one of the possible solutions.

In this paper, we introduce the current challenges of European nuclear supply chain with the background of these situations. In addition, the status of CGID utilization is presented by analyzing the policy direction of each European country.

2. Nuclear Supply Chain in Europe

The average age of the nuclear fleet in Europe is about 35 years [3]. Without the lifetime extension of nuclear power plants, 90% of current nuclear capacity will be shut down by 2035 and thus it will need to be replaced [4]. Thus, for new build projects and long-term operation (LTO), a strong and diversified supply chain is essential to ensuring the high levels of safety, quality and reliability and so on. Figure 1 shows the current challenges of European nuclear supply chain and background of these situation.

2.1 Current Challenges of European Nuclear Supply Chain

The European nuclear supply chain is now facing several challenge issues as shown in Figure 1 [2]. The greatest challenge is obsolescence of structures, systems, and components (SSCs) of NPP due to long-term operation over 35 years. For a like-for-like replacement of SSC, the original equipment manufacturers (OEMs) should provide these items continuously. However, some OEMs do not exist anymore or others have stopped producing the safety-related components or equipment. Second, finding new SSC suppliers is another challenge issue due to its low profitability. The potential suppliers consider as the market for nuclear industry is too small, thus the financial risk of supplying SSC is high. Moreover, existing suppliers lose interest to perform qualification due to the provision of SSC to their non-nuclear industry customers. Third, the formal strict QA (Quality Assurance) documentation requirement is also one of the challenging issues. It is considered that the efforts for issuing QA documentation for SSC are similarly the same regardless of its the safety class (SC) classified (i.e., SC1, 2, 3). This restricts the entry of nuclear industry market for the potential new supplier.

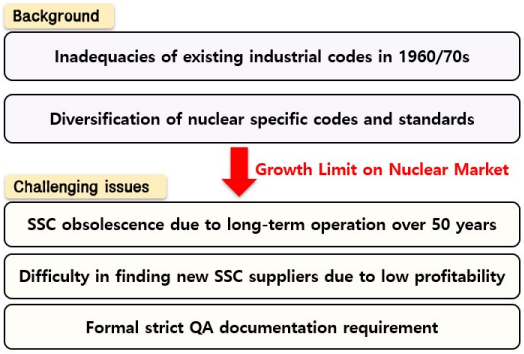

Fig. 1. Current challenges of European nuclear supply chain.

2.2 Background of Nuclear Supply Chain Challenges

The above challenges are coming from the time when the NPPs were designed to construct in 1960~1970s. At that time, the existing non-nuclear industry standards were not sufficient for safety-related SSC in a point view of design, manufacturing, quality control etc. This situation forced the nuclear industries to create their own nuclear specific codes/standards to address the inadequacies of existing industrial codes [2].

As a result, the diversification of nuclear specific codes/standards has evolved across different European countries, even in non-European countries. Currently, most of existing European reactors are following the codes/standards according to their adopted design such as ASME (USA), AFCEN (French), KTA (German) and so on. However, the available supply chain for high-quality equipment is limited to those supplying products designed and manufactured to one nuclear standard or the other due to nuclear regulation of each European country [1].

3. Categorizations of European Countries according to Policy Direction of Nuclear Supply Chain

As mentioned above, EC-JRC organized two meetings to evaluate the supply chain situation in European countries in June 2018 and March 2019, respectively [2]. In this meeting, the participants presented the supply chain situations of each European country. Based on this information, we classified the European countries into 3 groups according to their policy direction of nuclear supply chain as shown in Figure 2: (1) Elaborative Maintenance and Repair (2) Reinforcement of Supply Chain Connection (3) Utilization of CGID.

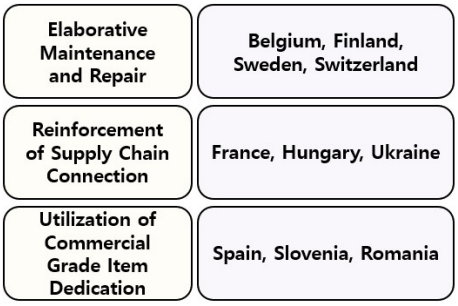

Fig. 2. Categorization of European countries according to policy direction of nuclear supply chain

3.1 Elaborative Maintenance and Repair

Most European countries prefer to "Elaborative Maintenance and Repair" which is focusing on the repair and maintenance of the SSCs for as long as it is possible instead of replacing the obsolete SSCs [2]. In these countries, there are Belgium, Finland, Sweden and Switzerland, etc.

- **Belgium**: Currently, SSC obsolescence starts to become an issue so that ENGIE Electrabel/Tractebel (nuclear operator) launched a project "Equipment Qualification and Obsolescence" with Bel V (technical branch of regulatory body FANC) to investigate all possible solutions [5]. Belgium applies a policy of both maintaining/repairing for installed SSCs and replacing with new state-of-the-art SSC according to an economic assessment such as timing, safety impact, and so on [2]. Belgium has experience in procuring commercial grade item with corresponding methodology. However, they think that there is no advantage of using commercial grade item from an economic point of view due to additional cost resulting from Belgian specific qualification rules [1, 2].
- **Finland**: Largely, the lifetime of installed SSCs is extended by elaborative maintenance in the Finnish nuclear power plant. In addition, the installed SSCs from decommissioned plants are reused to replace with the broken parts. In Finland, commercial grade item is used for non-safety classified SSC only. Currently, the Finnish utilities have launched a national project "KELPO" to handle the obsolescence issue with the support of regulatory body (STUK) [6]. This project aims at the establishment of CGID process for equipment in lower safety class of SC3.

3.2 Reinforcement of Supply Chain Connection

There are France and Hungry as European countries that focus on the reinforcement of nuclear supply chain connection.

- **France**: At present, 56 unit of nuclear power plants are operating with an average of more than 30 years [2]. The maintenance policy is based on periodic replacement of some component and equipment. For this, EDF S.A. (nuclear operator) has put in place contracts with OEMs for maintaining, repairing and replacing of SSCs. Moreover, there is still a sufficient number of potential suppliers due to current project of European Pressurized Water Reactor (EPR). However, commercial grade equipment is seldom used for safety-related SSCs.
- **Hungary**: In the early 90s, the OEMs of Hungarian NPP disappeared from the market. As a result, MVM-Paks (nuclear operator) faced a significant challenge to find potential nuclear suppliers [2]. Fortunately, the OEMs stored a considerable amount of spare parts, this made the supply of SSCs more plannable. MVM-Paks makes significant efforts to search and procure unutilized spare parts that were supplied by the OEMs to other companies. In addition, a close network between MVM-Paks and suppliers/manufacturers has been established for maintenance in NPP.

3.3 Utilization of Commercial Grade Dedication

There are Spain, Slovenia, Romania as European countries that utilizing CGID process.

- **Spain**: Spanish NPPs are facing increasing difficulties in replacing original SSCs and finding spare parts. For this, CGID process is allowed and supported by national regulatory guidance [7]. Currently, national project is ongoing for CGID in order to use commercial grade item for replacement of the safety-related SSCs, especially electrical I&C equipment such as relays and switches.
- **Slovenia**: To reduce the vulnerability resulting from obsolescence issue, NEK (nuclear operator) has been working on continuous investing program. As a result, most of the major components have been replaced. Most of the safety-related SSCs in Slovenia were originally manufactured according to 10 CFR 50 and U.S. codes and standards. consequently, a CGID process based on EPRI-5652 guidance has been established in 1995, and it became common practice

in Slovenia [1]. This enables cooperation with USA utilities and participation in joint efforts. Also, Slovenia has been running a proactive policy such as participation of joint industry program (Nuclear Utility Obsolescence Group) and contract with Rolls-Royce's Proactive Obsolescence Management System Group [2].

3.4 Approach for Reinforcement of Nuclear Supply Chain Environment

To reinforce of nuclear supply chain environment, EC-JRC presented the use of CGID process for the dedication of commercial grade item as one of solutions [2]. Dedication is an acceptance process undertaken to provide reasonable assurance that a commercial grade item accepted for use as a basic component will perform its intended safety function [8]. It can provide various advantages such as (1) increase of the availability of NPP by preventing delays in procurement of the obsolete SSCs, (2) Benefits to extend the lifetime extension of NPP and achieve goals for long-term operation effectively.

However, the utilization of CGID for safety-related SSCs should not impact on the safety operation of NPP. Thus, it is required well-stablished CGID process and it must comply with the concepts of diversity, redundancy, physical separation and functional independence throughout the lifetime of the NPP [2].

4. Conclusions

Most nuclear power plant operators in Europe are facing several problems such as difficulties in procuring replacement parts and increased maintenance costs due to the obsolescence of existing facilities.

EC-JRC launched a large-scale project in 2018 to solve the supply chain problem. In this project, the current status of nuclear supply chain was investigated for each European country. These European countries can be classified into 3 groups according to their policy direction: (1) Elaborative maintenance and repair (2) Reinforcement of supply chain connection (3) Utilization of CGID.

Then, as one of the solutions, the utilization of CGID process was proposed for safe-related SSCs in NPPs. CGID can provide many advantages, especially with the perspective of NPP availability. For example, Slovenia doesn't look like affected by SSC obsolescence due to the utilization of CGID process with a continuous investment program. Even though, the CGID process is effective in increasing the number of potential suppliers, it should not affect on the safety operation of NPP. This analysis result will be used as a background information to develop a regulatory guideline for the dedication of commercial digital equipment based on SIL certification in nuclear power plants.

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