Introduction and Looking Forward of IAEA Safeguards Technical Guide for Nuclear Material Bulk-handling Facilities (Focus on the Fuel Fabrication Facilities)

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1. Background

1.1 Projection of World Nuclear Electricity Capacity

U.S. EIA(Energy Information Administration)'s International Energy Outlook 2017 projects that global nuclear capacity will grow at an average annual rate of 1.6% from 2016 through 2040, led predominantly by countries outside of the Organization for Economic Cooperation and Development(OECD) [1].

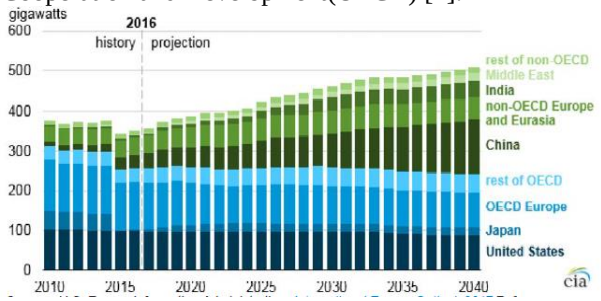

Fig. 1. Projected Nuclear Capacity in the IEO 2017 Reference case (2010-2040)

EIA expects China to continue leading world nuclear growth, followed by India. This growth is expected to offset declines in nuclear capacity in the United States, Japan, and countries in Europe.

1.2 Projection of World Uranium Production Requirements

In the report titled "Uranium 2016 : Resources, Production, and Demand" published NEA(Nuclear Energy Agency) and IAEA Jointly, World reactor-related uranium requirements by the year 2034 are projected to increase to a total of between 66,995 tU/yr in the low case and 104,740 tU/yr in the high case [2].

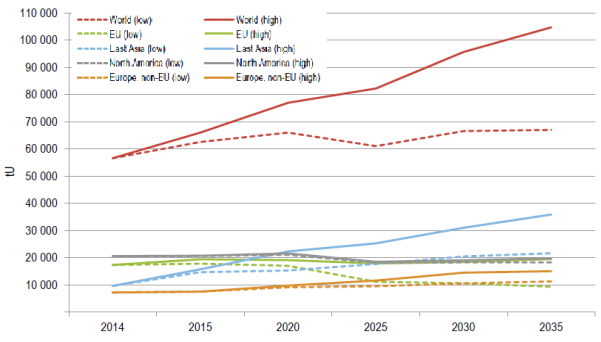

Fig. 2. Projected Uranium Requirements in the high case (2014-2035)

1.3 Overview of Domestic Nuclear Fuel Fabrication Facilities

Republic of Korea was started to operate the first and second facility in 1988 and 1997 in order to have reconversion and fabrication process of LWR as well as HWR fuel after commercial operation of Kori-1 in 1978.

KNF(KEPCO Nuclear Fuel Co.) has been stared to construct the third facility because future production demands including domestic and UAE's NPP fuels projected to exceed existing production capability.

Existing production capability in the first and second facility was 550tU per year, additional production capability in the third facility is planning to add 250tU per year.

Regulatory body conducted safety review for 35months regarding applications for construction license of fuel fabrication facility [3].

1.4 Needs of the Safeguards Criteria

Bulk Handling Facility is defined as a facility where nuclear material is held, processed or used in bulk form. Examples of bulk handling facilities are plants for conversion, enrichment, fuel fabrication and spent fuel reprocessing, and storage facility for bulk material [5].

According to the estimation to increase the number and throughput of bulk-handling facilities, IAEA has conducted continually to assure their human resources, budget as well as technical standard establishment to conduct their verification roles.

As one of these works, IAEA published "International Safeguards in the Design of Fuel Fabrication Plants" in 2017 as Nuclear Energy Series

This paper is to introduce this technical guide, explore domestic environments, and prepare when this guide should be applied at domestic facilities.

2. IAEA Technical Guidance [4,6,7,8]

2.1 General Elements

IAEA safeguards are designed to meet certain objectives that pertain to the diversion of nuclear material, the misuse of facilities or to undeclared

activities. In the early stage, possible misused and diversion scenarios developments are recommended with potential concealment methods and the safeguards measure to address each one.

Safeguardbility is a term that refers to the relative ease of applying safeguards to a nuclear facility [5]. Practical examples of design feature to increase the safeguardability of a fuel fabrication plant are included such as unique identifiers for nuclear material items, a minimum number of penetrations in the containment structures, seals and other TIDs, NRTA (Near-Real Time Accounting), mailbox declarations and SNRI (Short Notice Random Inspection) and so on.

2.2 Design Information Verification

During DIV at a fuel fabrication plant, a variety of activities which the IAEA may perform are included such as verification of process or containment design, preparation of an essential equipment list, examination of a subset of the essential equipment, etc.

2.3 Nuclear Material Accounting and Verification

In normal operations, the flow of nuclear material to and from the fabrication plant creates large additions to, and substractions from, the nuclear material inventory in the Material Balance Area (MBAs). It shows a simplified process flow diagram for producing uranium fuel as below

Fig. 3. Simplified fuel fabrication process flow

From lessons learned, practical examples of design features that may be considered in order to enhance nuclear material accounting verification for fuel fabrications plants are included such as dynamic nuclear material accounting, mailbox declarations, SNRIs and Near Real Time Monitoring systems for the production process, etc.

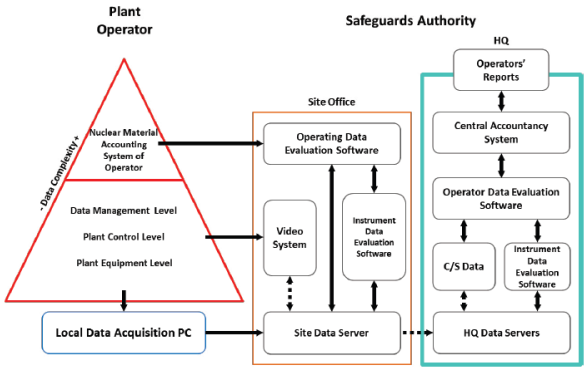

Fig. 4. Possible safeguards information flow for a modern fuel fabrication plant

3. Implications on the Future IAEA safeguards activities

First of all, IAEA has enhanced the importance of safeguards by design. Therefore, nuclear licensees have to prepare validation process of safeguardability including diversion scenarios.

Next is related to the designation of MBAs. In South Korea the only fuel fabrication facility operator, KNF had designated one MBA per a fuel fabrication facility. However, IAEA recommend 3 type of MBA in a facility which consist of feed storage, process area, and product storage.

Third is that there is possibility for IAEA to require dynamic nuclear material accounting system such as Near Real Time Monitoring. This guidance requires for licensees as well as regulatory body to prepare from the stage of early design for the facility.

Other things are to consider the extended containment, surveillance, and monitoring which are tends to be unattended.

4. Domestic Nuclear Material Safeguards related Regulations [9]

Domestic nuclear material safeguards related regulations prescribed in Nuclear Safety Act (NSA) are separated by types of nuclear licensee, but most of them are duplicated with the pre-defined regulation.

The first subject of NSA regulations related to safeguards is for approval of material accounting and control plans. According to this articles, nuclear licensees have to obtain the approval of the plans from the government. Then the regulation provides the form and the details to be filled within the plans, but not the criteria for the review and approval

Second is for inspections of material accounting and control. This regulation provides the inspection frequency, period, methods, and other inspection related matters. But it seems that there are no clear inspection criteria.

In summary, existing domestic regulations are focus on the writing and approval procedures of the plans, inspection procedures rather than the criteria for the reviewing the plans and inspecting the material accounting and control system.

5. Recommendations

Safegaurds is the matter of defining, documenting, conducting, and coordinating their roles among several stakeholders such as IAEA, Government of Member States, and Licensees.

Both IAEA's safeguards technical guide and domestic safeguards related regulations do not force licensees to comply with specific requirements in their safeguards system design.

However, IAEA's technical guide will be utilized for their inspection and verification activities as soon as possible. Finally, those guide will be the requirements to

apply related facilities. So, it is appropriate for the regulatory body to arrange those requirements in domestic regulations due to high possibility to require government and licensees as a post activity by that guide

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