# Review of Current Status of Safety Goals for Nuclear Power Plants in Korea

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## 1. Introduction

The nuclear industry began cautiously in the early 1960s and grew rapidly from the late 1960s to 1970s. At the beginning of the nuclear industry, it was considered that there was not undue risk to the public from the operation of the nuclear power plant with a reasonable assurance. Also, quantitative assessment methods for the safety of nuclear power plants were not available at that time. In the early 1970s, however, the nuclear industry started to question 'How safe is safe enough?' There were a lot of efforts to establish the objectives for the safety of nuclear power plants. Safety goals for a nuclear power plant define a level of safety that is considered to be safe enough. It also guides how much more effort should be required to improve safety.

As concerns are raised by the society on the construction of multiple units of nuclear power plants close to each other, discussions seems to start on the need for adopting the safety goals for multi-unit nuclear power plants. For such discussions, it would be first necessary to understand the philosophy and technical backgrounds on the establishment of safety goals for nuclear power plants.

## 2. Safety Goals in the United States

The safety goals of nuclear power plants define an acceptable level of risk from the normal operation or accident situation of nuclear power plants. By defining acceptable safety levels, public understanding on the regulation and public confidence in the safety of nuclear power plants can be improved. Safety goals also provide guidance on how to revise existing regulations and how to consider new regulations.

### *2.1 Establishment of the Safety Goals*

Okrent [1] briefly summarizes how safety goals were established in 1986. There have been many studies that suggests safety goals since 1970s in the Unites States. In 1973, United States Nuclear Regulatory Commission (USNRC) suggested that it is unacceptable that a frequency of the accident exceeding individual dose of 25 rem is greater than $10^{-6}/ry$. After the TMI accident in 1979, the Advisory Committee on Reactor Safeguards (ACRS) proposed a trial approach, quantitative safety objectives approach, requested from the Nuclear Regulatory Commission. The Atomic Industrial Forum (AIF) also proposed a system for using and establishing quantitative safety objectives to rationalize regulatory methods in 1981. Finally, in 1986, the USNRC established the safety goals of nuclear power plants in the Policy Statement [2].

There are two qualitative safety goals and two quantitative health objectives in the Policy Statement [2]. The quantitative health objectives are expressed as the individual risk of prompt fatalities and cancer fatalities. It is suggested that the health objective of prompt fatalities risk has more protection than that of cancer fatalities risk. That is, the risk of cancer fatalities can be considered sufficiently low if the health objective of prompt fatalities is met.

### *2.2 Safety goals for review of safety regulations*

In the Policy Statement [2], the commission approved the use of safety goals in regulatory decisions. These safety goals serve as a useful tool for judging appropriateness of regulations or change of regulatory decisions. In Regulatory Guide 1.174 [3], it is mentioned that the safety goals, published in the Policy Statement, are important factors in determining the regulation. SECY-93-138 [4] concluded that the large early release frequency (LERF) of $10^{-6}/ry$, stated in the Policy Statement, is more conservative than the health objectives. In this regard, SECY-97-077 [5] proposed the objective of LERF as $10^{-5}/ry$. It is also suggested that this numerical value ensures to meet the health objectives without conservatism. Subsequently, SECY-00-0077 [6] also suggested that this LERF objectives meet the Regulatory Guide 1.174 and the Regulatory Analysis Guidelines.

As stated in SECY-89-102 [7], the regulations should strive to keep consistent with the safety goals in developing or revising regulations. Therefore, safety goals, including current regulations, will provide consistent guidance in future regulations as far as they are reviewed with respect to the safety goals. However, it should be noted that the implementation of these safety goals or guidelines does not mean that it is a substitute for the Commission's rules nor mitigation of licenses or permission.

## 3. Safety Goals in Korea

### *3.1 Status of safety goals in Korea*

There were many discussions to establish safety goals in Korea since the early 1990s. In 1994, Nuclear Safety Policy Statement [8] suggested that the direction of safety criteria corresponds to the international standards and that the policy direction for nuclear power plants is to establish quantitative safety goals. Since 1998, there were a lot of discussions to

supplement it and the plan for Severe Accident was revised. As a result, the Nuclear Safety and Security Commission Notification [9] stipulated safety goals as law after the Policy for Severe Accident in Nuclear Power Plants [10].

The safety goals indicated in the Notification are as follows[9]:

The risk of prompt fatalities and cancer fatalities in the area near a nuclear power plant should not exceed 0.1% of the sum of prompt fatalities and cancer fatalities.

The sum of the frequency of accidents in which the emission amount of radionuclide Cs-137 exceeds 100 TBq should be less than $10^{-6}/ry$.

There are performance objectives for core damage frequency (CDF) and large early release frequency (LERF) that judge the compliance with the safety goals. The performance objective for CDF of the existing plants is $10^{-4}/ry$ and that of the future plants is $10^{-5}/ry$. The performance objective for LERF of existing and future plants are $10^{-5}/ry$ and $10^{-6}/ry$, respectively [11].

### *3.2 Research on safety goals in Korea*

Since 1991, a lot of studies have been conducted to establish probabilistic safety goals in Korea. The Policy for Severe Accident in Nuclear Power Plants [10] calculated rate of the prompt and cancer fatalities by the National Statistical Office data from 1997 and applied 0.1% criteria to estimate the health objectives. It is also confirmed that they are similar compared with the safety goals for the US nuclear power plants. Kim [12] proposed a method to derive the criteria and compared the results with safety goals. In this method, individual prompt fatalities risk and cancer fatalities risk were calculated by the data of the National Statistical Office from 1983 to 2006 and applied 0.1% criteria to set the health objectives. It was concluded that $5 \times 10^{-7}/ry$ and $10^{-6}/ry$ were the health objectives for prompt fatalities risk and cancer fatalities risk, respectively. It was also concluded that the allowable range of LERF is $7 \times 10^{-6} \sim 3 \times 10^{-4}/ry$ and that of CDF is $10^{-4}/ry$. Kim et al.[13] considered only prompt fatalities risk because the safety margin of prompt fatalities was less than that of cancer fatalities. When the conditional containment failure probability (CCDF) was assumed to be 0.1, the CDF and LERF criteria were calculated to be $2.6 \times 10^{-4}/ry$ and $1.8 \times 10^{-5}/ry$, respectively, which were considered to be compatible to the IAEA standards.

## 4. Conclusions

This paper provides a brief summary on how safety goals were established in the United States and examines the role of the safety goals. It is found that the establishment of safety goals is to define an acceptable level of the risk from nuclear power plants. The review of the appropriateness of current regulations and regulatory decisions with respect to the safety goals is found to be as important as the regulating the risk from nuclear power plants.

By examining the existing researches and current status on the establishment of the safety goals in Korea, it is found that the level of acceptable risk in Korea is similar to that in the US. It would be necessary to continuously update the data so that the level of acceptable risk in Korea can be kept evaluated and monitored.

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