

A Comparative Study on the Methodology of Quantitative Health Objectives

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1. Introduction

The government policy on severe accident of nuclear power plant was issued on Aug. of 2001. A QHO (quantitative health objective) was proposed as a safety goal in the policy but there wasn't much study on what it means quantitatively this QHO. The QHO which can be represented as 0.1% early fatality due to an accident was adopted from the NRC safety goal and the consequence of this 0.1% early fatality for Korean NPPs hasn't been evaluated yet. Thus the technical basis and quantification procedures for these quantitative health objectives for domestic nuclear power plants need to be evaluated. In this paper we have assessed an acceptable risks based on the mortality of Koreans to compare with the QHO of government policy. Also we have surveyed how the foreign QHOs were developed and compared the results with our domestic objective.

2. Methods and Results

2.1 Health objectives of the severe accident policy statement

The Korean government issued a policy on severe accident of nuclear power plant on August of 2001. According to the policy, utility should perform PSAs (probabilistic safety assessment), develop and implement accident management strategies for the operating plants. Also a safety goal was proposed for the additive risk of early fatalities and cancer fatalities not to exceed 0.1% of the sum of base early fatality risks resulting from other accidents and cancer fatalities, respectively. And it was recommended that a performance goal to achieve this safety goal to be developed.

2.2 Derivation on Korean quantitative health objectives

In order to assess the accident fatality risks and cancer fatality risks in accordance with the health objectives of severe accident policy, we have surveyed Korean statistics of mortality from 1983 to 2006 using Korean statistical information service (KOSIS) of national statistical office. The data on accident and cancer mortality, fatality risks by year using analysis results of the cause of death allows us to calculate the acceptable risks of safety goals based on these fatality risks. Fig. 1 shows the calculated acceptable risks of early and cancer fatality by year.

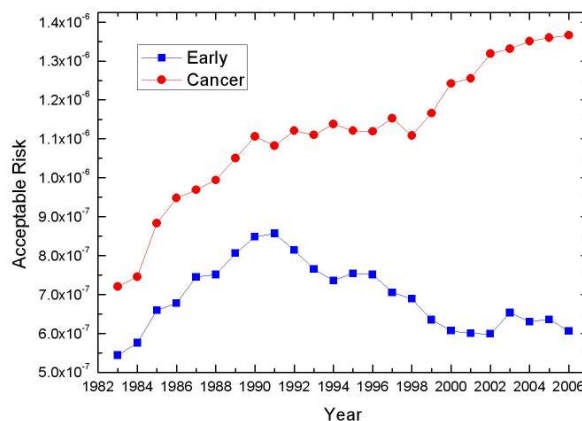


Fig. 1. Derived acceptable risks by year

Average acceptable risks of early and cancer fatalities during 24 years are 6.935×10^{-7} and 1.115×10^{-6} , respectively.

2.3 U.S. health objectives

Since United States nuclear regulatory commission (U.S. NRC) started making an effort to set safety goals in 1979, U.S. NRC issued the policy statement through 6 years evaluation period. Safety concept of U.S. had been basically kept by guarantee of sufficient safety margin with Defense-In-Depth principle. But this concept could not apply to the question of 'how safe is safe enough'. Also, there was no quantitative analysis methodology of light water reactor before WASH-1400 in 1975.

After the accident at Three Mile Island, Advisory Committee on Reactor Safeguards (ACRS) of U.S. NRC recommended that quantitative safety goals of nuclear power plants should be established. And the President's Commission on the Accident at Three Mile Island and the NRC's Special Inquiry Group recommended that safety goals and philosophy should be represented more clearly and announced to the public. Following that, U.S. NRC announced the plan for the development of safety goals and ACRS suggested trial approach for development of safety goals.

U.S. NRC held workshops on April and July in 1981 for the development of formal safety goals policy and issued safety goals policy statement for comment on February, 1982. Reflecting the opinions of ACRS, industry, and public U.S. NRC adopted safety policy statement that would be used during 2-year evaluation period on 14th March, 1983. After that policy statement on safety goals was announced on 4th August, 1986.

2.4 Japanese health objectives

In case of nuclear power plants, safety assurances by licensee and safety regulations by government are based on Defense-In-Depth principle, which considers 3-step safety measures as prevention of abnormal condition occurrence, prevention of abnormal condition extension and expansion to accident, and prevention of abnormal release of radioactive materials.

Japanese nuclear safety inspection guidelines and criteria don't mention the risk restriction level to the public quantitatively except radiation limits during the normal operation of nuclear power plant. Japanese nuclear safety commission decided that effective safety assurance could be possible if safety goals of probabilistic risk concept as risk restriction measures that could be achieved by nuclear safety regulatory activity are used to make a decision about safety regulatory activity. Accordingly, safety goals special group composed of expert advisers of various fields was founded on September in 2000.

Safety goals special group has investigated and reviewed the concept of safety goals and submitted an interim report to Japanese nuclear safety commission. Safety goals special group held panel forums to explain the meaning of safety goals and to collect citizen's views at Tokyo on July, 2002 and at Kyoto on October, 2002. Safety goals special group examined forum results and made progress on more deep inspection. And now, interim safety goals are determined, but it does not enforce any legal binding.

2.5 Comparison of quantitative health objectives

Quantitative safety goals of different countries are compared in Table 1. Quantitative safety goals of Korea and of U.S. were developed by similar method and Japanese quantitative safety goals has a different feature in that performance objectives supporting health objectives are set.

Table 1: Quantitative safety goals

		Korea	U.S.	Japan
Health Objectives	Early	< 0.1 %	< 0.1%	< 10 ⁻⁶
	Cancer	< 0.1 %	< 0.1%	< 10 ⁻⁶
Performance Objectives		N.A.	N.A.	CDF < 10 ⁻⁴ CFF < 10 ⁻⁵

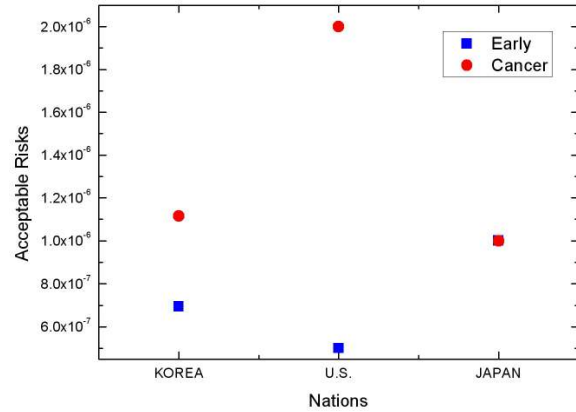


Fig. 2. Comparison of Korean, U.S. and Japanese health objectives

3. Conclusion

The establishing process of health objectives and evaluation methodology of foreign countries were surveyed and technical basis and criteria of setting health objectives were reviewed in order to assess the quantitative health objectives for the domestic nuclear power plants in the future.

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