Regulatory Analysis on the Safety Assessment of NPPs against Aircraft Crash

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1. Introduction

Following the 9/11 terror, a new regulation (10CFR 50.150) was enacted in June 2009 in the United States mandating the assessment of new nuclear power plants (NPPs) against intentional aircraft crashes, along with a regulation (10CFR 50.54 (h)(h)) in March 2009 that requires the establishment of accident mitigation measures for NPPs in operation. The UAE requested that the Korean NPP (APR 1400) design meet the U.S.'s new requirements related to the intentional aircraft crash. During the UAE NPP contract bidding process, France claimed that the Korean NPP is vulnerable to aircraft crashes comparing with the French NPP (EPR). Under these international and domestic environments, the necessity to establish a domestic regulation concerning the intentional aircraft crash was raised. This paper proposes a draft regulatory position on this issue through a comprehensive analysis of various influencing factors.

2. Analysis Method and Principle

The following analysis method and principle were applied for the research.

First, as a number of factors are difficult to quantify, a policy decision method based on a qualitative evaluation rather than a quantitative cost-benefit analysis was applied. Although USNRC performed a cost-benefit analysis, substantially, a quantitative comparison of the realistic cost effectiveness could not be performed since there were many factors need to be considered to carry out the qualitative evaluation properly.

Second, the following eight factors were selected for the analysis: 1) international regulatory trend, 2) domestic environment, 3) aircraft model to be considered, 4) expected additional cost, 5) assessment technology level, 6) countermeasures for operating NPPs, 7) domestic utility's activity, and 8) safety assessment method.

Third, as far as the domestic environment is concerned only in terms of aircraft crash risk, the investigation scope was limited to the identification of threat factors. An intentional aircraft crash into the NPP could be regarded as a terrorism, and a detailed analysis of the domestic environment at this point would be unnecessary or limited due to the following aspects: 1)for the determination of the level of protection against terrorist attacks, it is more rational to consider not only the anticipated risk but also other factors such as international trends, additional cost, and effects on NPP export environment; 2)it is very difficult to accurately predict the possibility of a terrorist attack due to the characteristics of itself; and 3)the environment of terror risk could be significantly different depending on the time of evaluation.

Fourth, since an intentional aircraft crash is a Beyond Design Basis Threat (BDBT) incident as one of terrors, the probability of occurrence cannot be calculated, rather it should be assumed when necessary through an analysis of relevant factors. For security concerns that are triggering factors of intentional aircraft crashes, it was assumed that the adequate protection system currently available is being operated by the responsible agencies.

3. Major Analysis Results

The following are the analysis results of major six factors out of eight.

- **International regulatory trend:** NPP suppliers, U.S., France, and Canada along with NPP importers, Finland and England, require evaluations of new NPPs against intentional aircraft crashes. Although Japan does not require an evaluation, the next-generation light water reactor projects adopt the aircraft impact assessment requirement of the U.S. as one of their performance goals. Russia holds the stance that this is classified as security-related issue and hence, it is desirable to respond to it properly according to the situation of each nation. The U.S. is requiring NPP operators to establish accident mitigation measures against intentional aircraft crashes, while most other nations do not require such activities. Meanwhile, the IAEA is developing a safety standard (DS-414) for the NPP design. This standard includes design parameters of safety, security, and control. A representative example is the protection against intentional aircraft crashes. Furthermore, the statement on safety objectives for new nuclear power plants drafted by the Western European Nuclear Regulator's Association (WENRA) specifies the protection design against a large civil aircraft crash as a core area that needs improvements in terms of a harmonized design approach in the safety and security area.
- **Domestic environment:** In order to investigate the domestic environment concerning aircraft crash risk to NPP, a review of the technical materials of the Korean Association for Terrorism Studies and expert consultations were performed. Various types of terrorist attack in Korea could be assumed but no materials were identified, which claim a high possibility of an intentional aircraft crash to NPPs.

- **Aircraft model to be considered:** The aircraft model for the evaluation was selected assuming that an aircraft impact assessment regulation for new NPPs is enacted. The objective of an aircraft impact assessment is to improve the safety of the new NPPs and the aircraft model for the evaluation was selected considering the flight frequencies in Korean peninsula and international practices.
- **Expected additional cost:** The additional cost imposed on the utilities and regulatory body in case of the enactment of regulation on the intentional aircraft impact assessment for new NPPs were calculated based on the KEPCO-E&C's solution for the NPP exported to the UAE. The cost by the utilities was calculated in two ways: (i) with only the design costs, and (ii) including the construction costs as well. It should be noted that USNRC considered only the design costs and not the construction costs because the regulation requiring an aircraft impact assessment is applied only to the designer.
- **Countermeasures for operating NPPs:** The U.S. is the only country officially identified, which has a specific countermeasure for operating NPPs against the intentional aircraft crash. The content of the accident mitigation measures required for operating NPPs by USNRC consists of two steps: 1) the development, implementation, and maintenance of procedures to maintain continuous communication with the threat alert sources when a potential aircraft threat is notified; and 2) the development and implementation of the strategies and guidelines for the maintenance and restoration of the function of the reactor core cooling, containment, and spent fuel cooling when there is damage in a large region of the power plant due to an explosion or fire.
- **Safety assessment method:** There are no problems applying the NEI 07-13 method considering the concreteness of the methods and the USNRC's positive position on them. However, in the case of the simplified method applied in the shock vibration assessment and others, the method is classified as safeguard information, thus necessitating the aid of specialized engineering consultants in the U.S. IAEA Nuclear Security Series No. 4 adopting PSA approach does not present a detailed evaluation method and acceptance criteria (i.e. conditional core damage probability, CCDP), which gives us some difficulties in its immediate application.

4. Overall Evaluation

Based on the major analysis results above, the advantages and disadvantages of the following four options were analyzed: 1) the adoption of both the regulation of aircraft impact assessment for new NPPs and the regulation of the establishment of an accident mitigation measure for operating NPPs, 2) the adoption of the regulation of aircraft impact assessment for new NPPs only, 3) the adoption of the regulation of the establishment of an accident mitigation measure for operating NPPs only, and 4) no application.

As a result of the overall evaluation, it is drawn that active regulatory framework preparations on the intentional aircraft crash are necessary in consideration of the necessity fulfilling international safety standards adopted by western countries and the Korea's special environment of confrontation of the North and the South. Therefore, selecting option 1, which calls for the adoption of both the regulation of aircraft impact assessment for new NPPs and the regulation of the establishment of an accident mitigation measure for operating NPPs, is required.

5. Conclusion

The establishment of a regulation on the safety assessment of NPPs against intentional aircraft crash in Korea is stimulated by the enactment of U.S. regulations related to this issue. This paper proposes a draft regulatory position on the safety assessment of NPPs against intentional aircraft crash based on the analysis results on eight factors related.

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