Transactions of the Korean Nuclear Society Autumn Meeting
Jeju, Korea, October 21-22, 2010

A Perspective into Regulatory Requirements for Intentional Aircraft Crash

Sang Yun Kim[a], Inn Seock Kim[b], Seong-Soo Choi[c], Jong Seuk Park[a], Yun Suk Chung[a],and Jong Hyun Kim[c]
[a]*Korea Institute of Nuclear Safety, 19 Kusong-dong, Yuseong, Daejeon 305-338, Republic of Korea*
[b]*ISSA Technology, Inc., 21318 Seneca Crossing Drive, Germantown, Maryland 20876,USA*
[c]*ACT Co., Ltd., 705 Gwanpyeong-dong, Yuseong, Daejeon 305-509, Republic of Korea*
E-mail: k125ksy@kins.re.kr

1. Introduction

In the aftermath of the 9/11 terrorist attacks on the United States, there was heightened interest worldwide in protecting nuclear power plants against intentional aircraft attack by terrorists. This paper presents our perspective into regulatory requirements for intentional aircraft crash that were set forth in foreign countries, including the latest rulemaking by the U.S. Nuclear Regulatory Commission (NRC), i.e., 10 CFR 50.54(hh) and 10 CFR 50.150 that have been made effective in May and July of 2009, respectively. In light of these international efforts to further enhance safety of NPPs, a study is also underway at the Korea Institute of Nuclear Safety (KINS) to establish an effective and efficient regulatory approach in consideration of the state of the art in this area.

2. International State of the Art

The evolution of requirements to protect against aircraft crash in Europe and the USA is shown in Fig. 1. The evolution in Europe and the USA is separately described below following the timeline of this figure.

2.1. Evolution of Requirements in Europe

The activities in Europe regarding aircraft crash on NPPs are briefly addressed focusing on the items indicated in Fig. 1:

- Mid-1970s: After a series of crashes in the mid-1970s, when more than 150 F-104G ("Starfighter") military aircraft went down over densely populated NATO countries in Europe, it was demanded, especially by German agencies, that new nuclear power plants should also be designed to withstand aircraft strikes. The Swiss authorities were also among the first, still in the mid-70s, to prescribe design requirements regarding an aircraft crash for the buildings and systems of future nuclear power plants [1].
- Late-1970s: At the time of planning the Gösgen and Leibstadt nuclear power stations (commissioned between 1979 and 1984), because the sites are relatively near Zurich Airport the HSK (now ENSI) stipulated that the new plants be designed to withstand a Boeing 707-320 travelling at 370 km/h on its approach to land [1]. For the first time, specific crash conditions were defined for type of aircraft (including weight and fuel load), speed and approach conditions, in order to take account in a realistic manner of the loads and stresses (shock-load/time behavior) incurred by such an accident. Although these regulatory requirements were established in Germany and Switzerland without consideration of "intentional" aircraft crash, they are similar to the 10 CFR 50.150 rule discussed below in the sense that aircraft impact was required to be considered in the NPP design stage.
- 2002: Early in 2002 following the 9/11 terrorist attacks, the OECD took the initiative and organized a meeting of specialists to which most nuclear safety authorities were invited. The purpose of the meeting was to weigh up the current state of knowledge and technology, particularly regarding responses to impact and subsequent fire [1]. As well as recording a complete inventory of the models and data, a stimulus was given for international cooperation in numerous secondary areas. The principal shortcomings of the earlier models and data were identified, and major points for further development defined. Following this OECD meeting, there was an intensive and regular exchange of experience among the authorities in the USA (NRC), Switzerland (HSK, now ENSI), Germany (BMU and the bodies of the Länder), Sweden (SKI), Finland (STUK) and Belgium (AVN).
- Early-2000s: The safety requirements for protection against aircraft crash was included in the European Utility Requirements (EUR) document published by the European electricity producers around late 1990s or early 2000s timeframe [2]. The EUR document states the following with respect to the protection against aircraft crash among others: (1) protection against aircraft crash shall be based on probabilistic approach unless the authorities require a deterministic approach, i.e., against a regulatory loading function and associated criteria; (2) in a standard design with aircraft crash protection, this will be provided by extra thickness of the walls exposed to the impact and/or by physical separation of sensitive equipment from those walls; (3) in a standard design which does not include aircraft crash protection, the design shall be such that it would allow the incorporation of protection against light and military aircraft crash for all the sensitive parts of the plant, without jeopardizing the layout and the functional specifications of the plant.

2.2. Evolution of Requirements in the USA

The evolution of regulatory requirements for aircraft crash in the USA is discussed below along with a notable study performed almost three decades ago (Fig. 1):

- Mid-1970s: The risk of aircraft crash on NPPs used to be investigated focusing on a crash caused accidentally, not deliberately. In particular, the WASH-1400 study (i.e., the first PSA) evaluated the risk of aircraft crash along with other external or natural phenomena events such as fires, high winds, or earthquakes. This risk was found to make insignificant contribution to the overall plant risk primarily because of a very low likelihood of an aircraft accidentally hitting the structures of a nuclear power plant.
- 2002-2003: Following the 9/11 event, the NRC issued four interim security orders in 2002 and 2003, as mentioned in the Federal Register notice for the final Design Basis Threat (DBT) rule, 10 CFR 73 [3]. In particular, mitigating requirements for intentional aircraft crash were imposed on all operating power reactor licensees through the EA-02-026 Interim Compensatory Measure (ICM) [4]. The detailed requirements were specified in Attachment 2 of this order, but was not released to the public since it contained safeguards information.
- 2009.3: The mitigative strategies of the ICM order of 2002 were further developed and refined through extensive interactions with licensees and industry. These strategies were originally supposed to be included in the security requirements of 10 CFR 73 but relocated to 10 CFR 50.54(hh) [5] as conditions of license because they are not specific to the licensee's security organization. The NRC recognizes that these mitigative strategies are beneficial for the mitigation of all beyond-design basis events that result in the loss of large areas of the plant due to explosions or fires. New reactor licensees are required to employ the same strategies as current reactor licensees to address core cooling, spent fuel pool cooling, containment integrity, and spent fuel pool integrity with reduced use of operator actions.
- 2009.7: In parallel with the effort on developing security requirements [3], the NRC also embarked on rulemaking to require the applicants for new NPPs to perform a rigorous assessment of the design to identify design features and functional capabilities that could provide additional inherent protection to avoid or mitigate the effects of an aircraft impact. The aircraft impact requirements were initially planned to be included in 10 CFR 52.500 but relocated to 10 CFR 50.150 [6] because the rule is also applicable to new construction permits and operating licenses under 10 CFR Part 50.

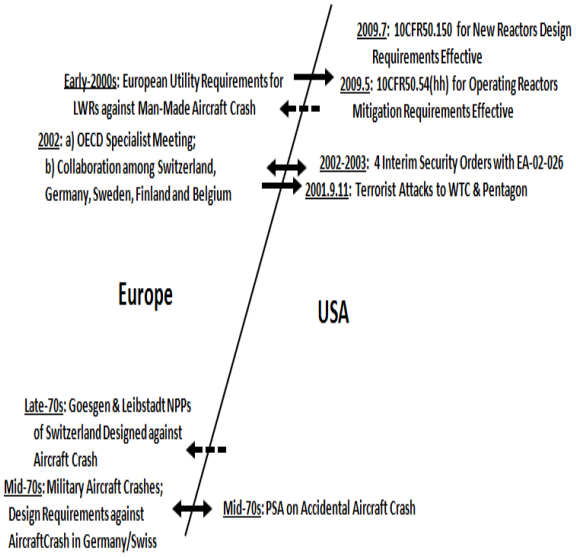

Fig.1. Evolution of requirements for aircraft crash

3. Conclusions

Especially in the aftermath of the 9/11 terror attacks, considerable efforts have been made worldwide to protect NPPs against intentional aircraft crash. In particular, the NRC recently completed rulemaking for aircraft crash, i.e., 10 CFR 50.54(hh) and 10 CFR 50.150, based on several years of intensive research on security regulatory framework.

In light of these international efforts to further enhance nuclear plant safety, an effective and efficient regulatory position with respect to intentional aircraft crash will also be established in Korea.

ACKNOWLEDGMENT

This work has been carried out under the Nuclear R&D program supported by the Ministry of Education, Science and Technology, Republic of Korea.

REFERENCES

[1] HSK, Position of the Swiss Federal Nuclear Safety Inspectorate regarding the Safety of the Swiss Nuclear Power Plants in the Event of an Intentional Aircraft Crash, HSK-AN-4626, March 2003.
[2] http://www.europeanutilityrequirements.org/eur.htm
[3] Federal Register, Power Reactor Security Requirements, 74FR13926, March 27, 2009.
[4] Federal Register, All Operating Power Reactor Licensees: Order Modifying Licenses (Effective Immediately), EA-02-026, 67FR9792, March 4, 2002.
[5] Federal Register, Power Reactor Security Requirements: Supplemental Proposed Rule, 73FR19443, April 10, 2008.
[6] Federal Register, Consideration of Aircraft Impacts for New Nuclear power Reactors, 74FR28112, June 12, 2009.