A Study on Establishment of Event Classification and Acceptance Criteria of Safety Analysis for new PWRs

Bub Dong Chung[a*], Chang Sup Lee[a], Kyun Tae Kim[b], Suk Koo Sim[c], Eun Kee Kim[d], Gyu Cheon Lee[d], Han Rim Choi[d], Jong Ryul Park[e], Song Kee Sung[e], Jae Don Choi[e], Si Hwan Kim[f]

[a] *Korea Atomic Energy Research Institute, 1045 Daeduk-Daero, Yuseong,Daejeon, 305-353,Korea.*
[b] *Korea Institute of Nuclear Safety, 34 Gwahak-ro, Yuseong, Daejeon, 305-338, Korea*
[c] *En2t Inc. , 100 Sinsung-dong, Yuseong, Daejeon, 305-804, Korea*
[d] *KEPCO Engineering & Construction Company, INC. , 1045 Daeduk-Daero, Yuseong,Daejeon, 305-353,Korea.*
[e] *Korea Nuclear Fuel Company, Ltd., 1047 Daeduk-Daero, Yuseong,Daejeon, 305-353,Korea.*
[f] *Ulsan National Institute of Science and Technology, Ulju-gun, Ulsan, 689-798, Korea*
[*]Corresponding author : bdchung@kaeri.re.kr,

1. Introduction

Classification of the events of the NPPs is a fundamental basis for the nuclear safety and thus it can be regarded as a starting point of the safety classification of systems, components or structures (SCSs) and safety analysis. The classification and acceptance criteria would be determined based on the defense-in-depth (DiD) concept for the plant safety architecture needed to assure the confinement of radioactive materials and, therefore, to meet the general safety objectives. Previous studies [1] indicate that a new consistent approach based on quantitative probabilistic criteria would be necessary for the systematic licensing with the global standard. This paper presents a new proposal of the safety classification and the global safety criteria which is applicable to the new PWRs with the current domestic regulatory environment.

2. Methods and Results

2.1 Review of Event Classification and Acceptance Criteria for PWRs of Foreign Countries

The event classification and acceptance criteria currently used by the USNRC for its review for PWRs as well as the DCDs(Design Certification Documents) submitted to the USNRC by ALWR vendors were studied. U.S. EPR and US-APWR DCDs [2,3] submitted to USNRC after 2007 used RG 1.206 [4] and NUREG-0800 SRP [5] event classification and acceptance criteria were also studied. IAEA classifies events into three categories such as AOO, DBA and BDBA according to expected frequence of occurrence and attempts to adopt extended concept of defense-in-depth in safety system design. IAEA uses expected frequency of occurrence of 1×10^{-2} events/year to divide between AOO and DBA for 60 year plant life, and the acceptance criteria are not consistent

with individual document [6]. IAEA propose qualitative requirements for acceptance criteria to integrate the regulatory requirements during the process of establishing regulatory requirements for each member country. European countries are making a continuous effort to meet required safety standard due to increasing demand of NPPs and thus developing technology to meet the strengthened requirements [7].

2.2 Review of Event Classification and Acceptance Criteria for Domestic PWRs

In order to establish the acceptable classification and criteria, the current regulations of the domestic PWRs were reviewed. The event classification and acceptance criteria of the Westinghouse type PWRs, OPR1000, and APR1400 PWRs were determined according to the domestic review guidelines which were written with reference to the US regulatory standards [8]. It is necessary to improve the inconsistency between the regulatory event classification of 2 group categories and safety review standard of 3 group categories. It is also necessary to unify the acceptance criteria when the event is not reactor system specific event. Even though most of the acceptance criteria of the events for the Westinghouse type NPPs and OPR1000 PWRs are similar, there are a few events which have different criteria, which should be also unified. It is also necessary to establish the systematic regulatory basis for the BDBAs.

2.3 Establishment of the Event Classification and Acceptance Criteria for new PWRs

The event classification has been established in 4 categories including AOO, DBA, BDBA, and severe accidents according to expected frequency of occurrence of initial event and it follows current regulatory system and global regulatory guides. The DBAs were divided

into two groups to establish the acceptance criteria according to frequency of occurrence. Global standard acceptance criteria were proposed for each event category to meet the regulatory requirements for adopting defense-in depth approach for safety design. Table 1 shows the proposed event classification and global acceptance criteria. Since the events were classified based on the initiating event frequency, the grade cannot be changed by the consequential assumptions of single failure or LOOP(Loss Of Offsite Power). However the accident at a special initial condition such as PIS(Pre-Iodine-Spike) can be classified by the probability of occurrence. Detailed acceptance criteria for individual event should be established in advance by the regulatory body and published as regulatory guides.

2.4 Evaluation of the Applicability of the Proposed Event Classification and Acceptance Criteria for Domestic PWRs

Each of the design base events was evaluated to identify any problems when the new criteria were applied to domestic PWRs. It is needed to additionally verify the adequacy of effective radiation dose of 1 mSv/yr proposed for AOO and detailed requirements for the methods of off-site dose calculation should be established in advance by the regulatory body and published as regulatory guides. If there is a consensus on the DBE event classification (Class1 and Class 2), the criteria will be applicable to the operating PWR plant.

3. Conclusion

The proposed results can be utilized to establish the regulatory bases and guides for domestic PWRs, enhancing public acceptance on nuclear energy. It will also promote the PSA utilization on determination of initiating event frequency and uncertainty analysis as well as the potential application for the next generation reactors.

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Table 1. Proposed Event Classification and Acceptance Criteria for new PWRs

PIE frequency (event/r-yr)	Event Classification*		Physical Barrier Criteria			Dose Acceptance Limit at EAB, LPZ (Whole-body)
			Fuel	NSSS/SG	Containment	
f ≥ 1	Normal operatin		No failure	ASME III Service level A	No Failure	Effective Dose 1mSv/yr
1 >f≥ 10⁻²	AOO (Anticipated Operational Occurance)			Service Level B		Effective Dose 1mSv/yr
10⁻² >f≥ 10⁻⁴	DBA (Design Basis Accident)	DBA1	Small fraction	Service Level C		10 % of 10CFR 100 Limit (25 mSv/event)
10⁻⁴ >f≥ 10⁻⁶		DBA2	Permissible Core Coolability			100% of 10CFR100 Limit (250mSv/event)
NA	BDBA (Beyond Design Basis Accident)		At least one barrier should be maintained			-
	Severe Accident		CDF goal	LERF goal		-