Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 17-18, 2012

Recent Key Issues in New Reactors Licensing Program and APR1400 Design Upgrades

Kwang-Hong Kim*, Seong-Jong Oh, Moon-Ghu Park
KHNP-CRI, 1312 Gil, 70. Yuseongdaero Yuseong-gu, Daejeon 305-343, Korea
**Corresponding author: broader@khnp.co.kr*

1. Introduction

The new reactor licensing process consists of first a design certification rulemaking under the 10 CFR Part 52. Through the process the NRC would review and approve a complete nuclear power plant design. Utilities could also seek an Early Site Permit (ESP), which would resolve lots of site-related issues earlier. A utility could seek the Combined License (COL) in a single license both a construction permit and an operating license. A key feature of the combined license was its incorporation of specified Inspections, Tests, Analyses and Acceptance Criteria (ITAAC). The ITAAC would be the acceptance criteria which the licensee should demonstrated it would be sufficient to provide the reasonable assurance that the facility had been constructed and would be operated in conformity with the design certification. Westinghouse's Advanced Passive plant design AP1000 is the first design being built licensed under the 10 CFR Part 52.

NRC has done a great deal under the new rules. The Commission has issued many regulations incorporating recent experience of new findings by experiments and measurements particularly emphasizing the security issues since the events of 911. These rulemaking will require applicants for design certifications to submit a safety and security assessment addressing the relevant requirements that have been established 6 months before its submittal of Design Control Documents.

This paper describes the summary of recent rulemaking process and the gap between the key revised rules and current APR1400 design.

2. Regulatory Review

2.1 Standard Design Certifications (DC)

Standard DC allows an applicant to obtain a pre-approval of an essentially complete plant design and reduces licensing uncertainty by resolving all design issues. The DC application review process (Fig. 1) consists of six phases as follows:

- Phase1: Issue request for additional information(RAI)
- Phase2: Review RAI responses and develop Safety Evaluation Report (SER) with open items
- Phase3: ACRS review of SER with open items
- Phase4: Develop advanced SER with no open items
- Phase5: ACRS review of advanced SER
- Phase6: Develop final SER

After the chapter is issued, the Phase-4 chapter schedule will be rebase-lined. Factors considered in rebase-lining the chapter schedule include number of open items and resource availability. The schedule may be adjusted as necessary to consider ACRS (Advisory Committee for Reactor Safety) comments.

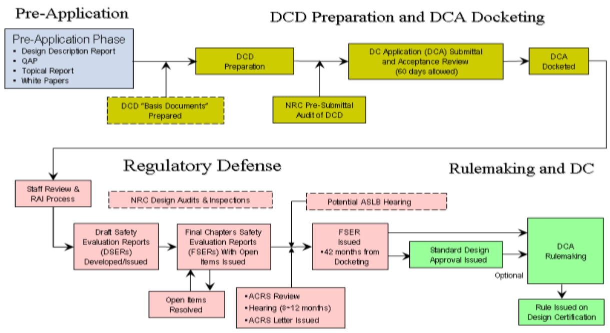

Fig. 1 Design Certification Review Process

Design control document (DCD) is partitioned into two tiers of information: the certified design material (CDM – tier 1) and the approved design material (ADM –tire 2). Tier 1 consists of material submitted for certification by rulemaking, including design description and Tier 2 consists of material submitted for approval as an acceptable means of implementation of Tier 1 criteria. It contains final safety analysis report (FSAR) and emergency operation guide (EOG). Table 1 summarizes DCDs for design certification application.

Table I Design Control Document

<table>
<tr><th colspan="2">Documents</th><th colspan="2">Contents</th><th>Remarks</th></tr>
<tr><td rowspan="7">DCD</td><td rowspan="5">CDM for DC Support</td><td colspan="2">1. Introduction</td><td rowspan="5">Tier-1</td></tr>
<tr><td rowspan="2">2. CDM</td><td>DD</td></tr>
<tr><td>DC/ITAAC</td></tr>
<tr><td colspan="2">3. Additional CDM</td></tr>
<tr><td colspan="2">4. Site Parameters</td></tr>
<tr><td rowspan="2">ADM for DC</td><td colspan="2">FSAR</td><td rowspan="2">Tier-2</td></tr>
<tr><td colspan="2">EOG</td></tr>
<tr><td colspan="2" rowspan="3">Supporting Information Documents</td><td colspan="2">ITTAC Basis Document</td><td></td></tr>
<tr><td colspan="2">Cross-reference Tables</td><td></td></tr>
<tr><td colspan="2">The safety significant design insights</td><td></td></tr>
</table>

2.2 Combined Licenses (COL) application

The COL review process includes three primary areas of review: the safety/technical review that results in a safety evaluation report; the environment review that results in an environmental impact statement; and the adjudicatory review that results in hearing findings/ orders. The scope and depth of review for a COL application are governed by the finality achieved under the design certification and early site permit provisions of 10 CFR Part 52.

3. Revised Regulations and Design Upgrades

3.1 Key regulations recently evolved

The first APR1400 nuclear power plants under the construction – Shin-Kori 3&4 - are designed under the regulatory rules cut-off dated in the end of 2001. This means the design upgrade or re-analyses of safety issues for compensating for ten years of the regulatory gap. The important regulation and provisions to be considered are as followings:

- 10CFR52, 10CFR50.150
- Standard Review Plan (2007)
- Regulatory Guides (82cases)
- DC/COL related Interim Staff Guidance (20cases)
- Digital I&C related Interim Staff Guidance (7cases)
- Generic Letters (10cases)
- SECY Reports
- EPRI URD Rev 10
- Revised IEEE, ASME Standards, etc.

3.2 Key design upgrades

The key design upgrade assessments for APR1400 for satisfying the revised regulations are as follows:

- Aircraft crash security assessment (10CFR50.150)

This requires each applicant for a new reactor design to assess how the design, to the extent practicable, can have greater built-in protections to avoid or mitigate the effects of a large commercial aircraft impact. ABWR is the first design certified (Nov. 2011) for aircraft impact by installing a remote control console for reactor cool-down.

- Seismic Safety Assessment

The application of new seismic hazard information became recently available and change of the seismic analysis methodology for safety-related structures from a "beam-stick model" approach to a finite element method. The incoherency SSI analysis for high frequency ground motion is also being considered. The assessment includes core seismic analysis considering plastic deformation of the fuel spacer grid.

- Evaluating fatigue analyses incorporating the life reduction of metal components due to the effects of the LWR environment

R.G 1.207 provides guidance for determining the acceptable fatigue life of Code Class 1 components, with consideration of the LWR environment. Current fatigue analysis methods provided in ASME Code do not fully account for the environmental effects of the reactor coolant on fatigue life.

- Reactivity Insertion Accident (RIA) Assessment

This assessment includes the fuel failure thresholds and core cool-ability focusing on behavior of fuel cladding with high burn-up or new material in RIA and LOCA conditions.

- Performance of PRA with conformance of new requirements

10 CFR 52.47(a) (27) states that a DC application must contain an FSAR that includes a description of the design-specific PRA and its results meeting the high level requirements as defined in the ASME PRA Standard (ASME-RA-Sb-2005).

- Guidance on Monitoring and Responding to Reactor Coolant System Leakage

RG 1.45, Rev. 1 requires to detect, monitor and quantify the leakage rates from unidentified sources equal to or greater than 0.05 gpm.

- Criteria for Digital Computers in Safety Systems of Nuclear Power Plants

The revised RG-1.152, Rev.2 endorsing IEEE Std. 7-4.3.2-2003 requirements has added requirements concerning fault detection and self-diagnostics, software quality metrics, including self-diagnosis criteria and V&V/cyber security requirements on software development tool and commercial software.

In addition to the above mentioned issues, the human factor engineering (NUREG-0711,Rev 2), habitability requirement of MCR, principles to develop ITAAC determination bases for closing ITAAC and follow-up of the post-Fukushima safety rules should be included as well.

4. Conclusions

The recent NRC's experience with new regulatory arrangements is revisited particularly emphasizing regulation-design gap of APR1400 design. To achieve success with the new reactor licensing process, the key design upgrade issues for APR1400 for satisfying the revised regulations are investigated. The in-depth insight into the evolution of regulations can make us capable to move forward to more predictive and safer designs.

REFERENCES

[1] US NRC, Regulatory Guide 1.206 Combined License Application for Nuclear Power Plant (LWR edition), 2007
[2] US NRC, 10 CFR 52 License Certification and Approvals for Nuclear Power Plant, 2009
[3] US NRC, Report of the Combined License Review Task Force, 2007
[4] NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants."