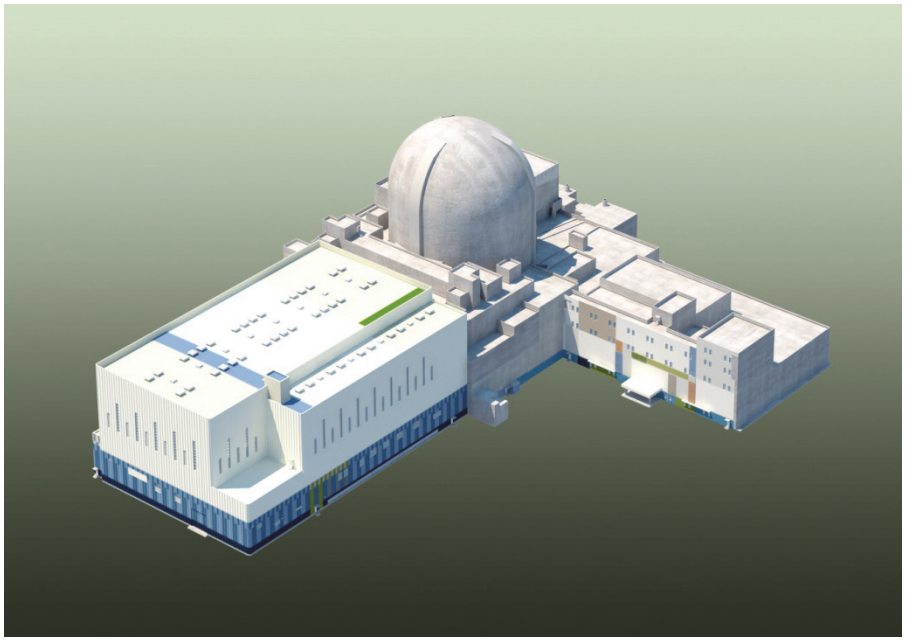
APR1400 Design Certification Application Pre-submittal Update



KEPCO/KHNP

October 29, 2014

18th Pre-application Meeting

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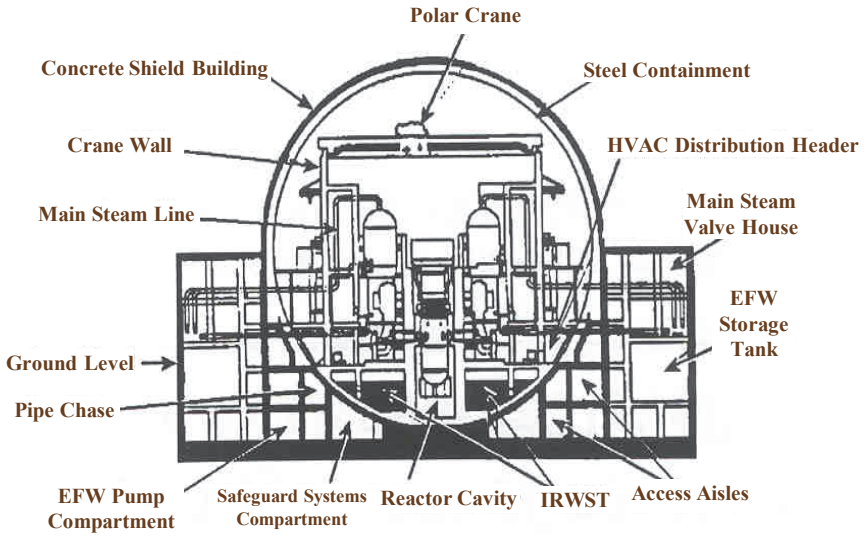
Purposes

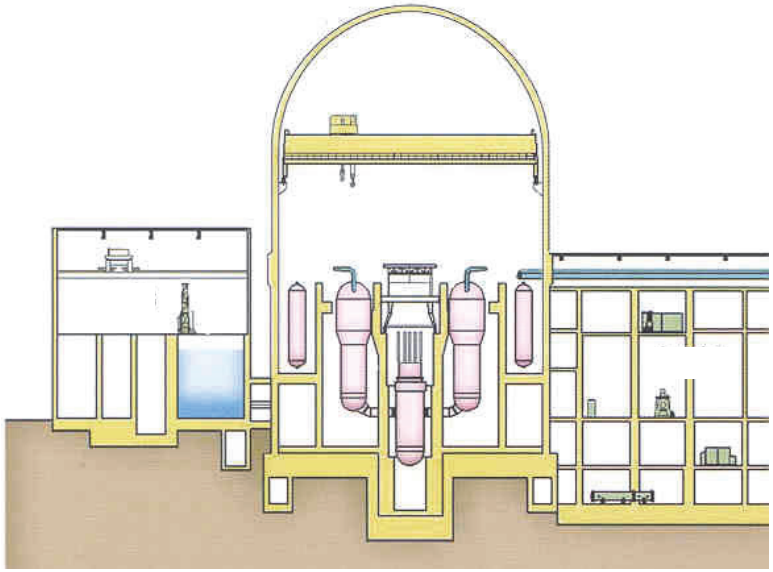
- **Present the status of the APR1400 submittal readiness**
- **Receive the NRC feedback**

Introduction

- **The APR1400 Design Concept and Features**
  - ✓ **Major design concept is identical to System 80+**



System80+



APR1400

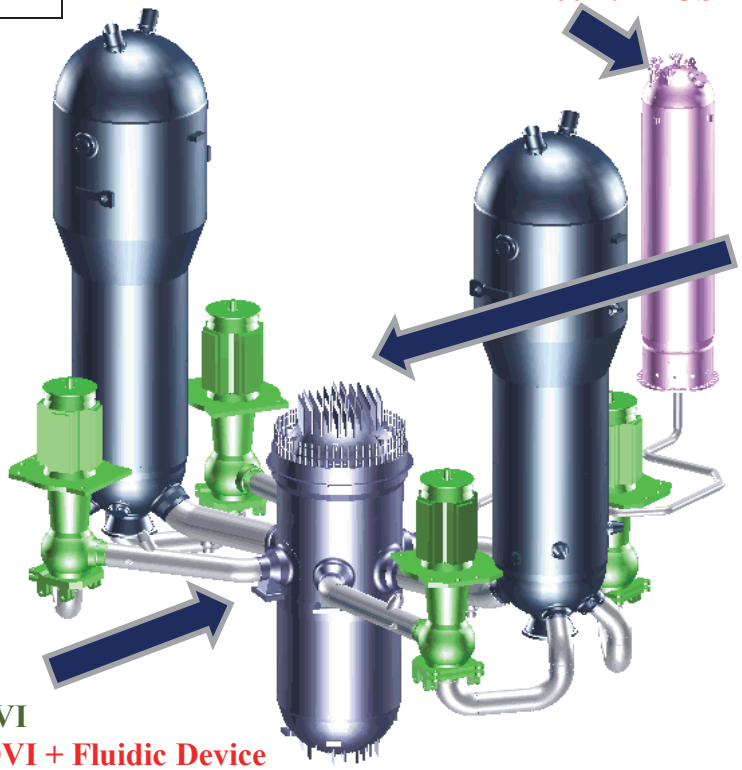
Introduction

- **The APR1400 Design Concept and Features**

  - ✓ **Additional safety features incorporated in the APR1400**

Thermal Power
- System80+ : 3,931 MWt
- APR1400 : 4,000 MWt

•**RCS Depressurization Equipment**
- System80+ : 3 spring loaded PSV + 2 SDS
- APR1400 : 4 POSRVs



RV Upper Structure
- System80+ : Conventional
- APR1400 : IHA

Safety Injection System
- System80+ : 4 train ECCS + DVI
- APR1400 : 4 train ECCS + DVI + Fluidic Device

Introduction

- **Shin-Kori Units 3 and 4**
  - ✓ **The reference plant for the DC application**
  - ✓ **Expected commercial operations: 2015 and 2016**
- **Future Projects**
  - ✓ **Shin-Hanul Units 1 and 2: Start-up 2017, 2018**
  - ✓ **Shin-Kori Units 5 and 6: Start-up 2021, 2022**
  - ✓ **Overseas Projects**

Introduction

- **APR1400 DC Application**
  - ✓ **Retain the reference plant design (Shin-Kori Units 3 and 4)**
    - **Some minor differences (e.g., turbine generator design to be selected by COL applicants, ultimate heat sink)**
    - **Address U.S. industry standards and expectations**
  - ✓ **Meet NRC expectations**
    - **Address December 2013 comments**
    - **Improve clarity**
    - **Include other changes resulting from NRC interactions this year**

APR1400 Design Certification Status

- **The letter of intent on the DC application submitted in March 2009.**
- **Numerous pre-application meetings held between 2010 ~ 2014.**
- **The initial APR1400 Design Certification Application submitted in September 2013.**
- **A summary of NRC review transmitted to KHNP in December 2013 (ML13351A417):**
  - ✓ **Twelve issues identified**
  - ✓ **Non-acceptance for docketing**

Twelve Issues

NRC Comments

ML13351A417

"…the application's deficiencies in the areas of instrumentation and controls (I&C), human factors engineering, probabilistic risk assessment, and in the environmental report. The two key I&C issues for which the application did not provide sufficient information are the software common cause failures of non-safety related control systems that can lead to spurious actuations of redundant safety and non-safety components; and the critical characteristics, such as deterministic performance and the software development process of the safety I&C system platform. Additionally, the NRC staff determined that the application did not provide a sufficient level of detail related to reactor coolant pump design; leak-before-break evaluation; effects of irradiation-assisted stress corrosion cracking on core supports and reactor internals; turbine missile probability; welds for reactor vessel integrity evaluations; radioactive waste management; and radiation protection. The NRC staff also notes that you have not yet submitted technical reports in the following areas: vibration assessment of reactor internals; flywheel integrity; fuel seismic response evaluation; and new and spent fuel criticality analysis."

NRC Comments

- **The deficiencies in the areas of:**
  - ✓ **instrumentation and controls (I&C);**
  - ✓ **human factors engineering;**
  - ✓ **probabilistic risk assessment; and**
  - ✓ **environmental report**

NRC Comments

- **Insufficient level of detail related to:**
  - ✓ **reactor coolant pump design;**
  - ✓ **leak-before-break evaluation;**
  - ✓ **effects of irradiation-assisted stress corrosion cracking on core supports and reactor internals;**
  - ✓ **turbine missile probability;**
  - ✓ **welds for reactor vessel integrity evaluations;**
  - ✓ **radioactive waste management; and**
  - ✓ **radiation protection**

NRC Comments

- **Technical reports needed in the following areas:**
  - ✓ **vibration assessment of reactor internals;**
  - ✓ **flywheel integrity;**
  - ✓ **fuel seismic response evaluation; and**
  - ✓ **new and spent fuel criticality analysis**

Resolutions

- **Instrumentation & Control (I&C)**
  - ✓ **Issues**
    - **Insufficient information on the software Common Cause Failures (CCFs) of non-safety related control systems**
    - **Lack of critical characteristics of the safety I&C platform**
  - ✓ **Resolutions**
    - **Evaluated safety of the system under software common cause failures of non-safety related control systems.**
    - **Adopted Westinghouse Common Q as the safety I&C platform. The critical characteristics of the platform are provided as a technical report.**

Resolutions

- **Human Factor Engineering (HFE)**
  - ✓ **Issues**
    - **Lack of clarity, conciseness and technical detail**
    - **HFE design approaches:**
      - **Detailed implementation plans (IPs) with supporting ITAAC or**
      - **General IPs with associated results summary reports**
  - ✓ **Resolutions**
    - **Improved document quality and supplemented technical details in Design Control Document (DCD) and the technical reports.**
    - **Will submit 9 detailed IPs and 3 Technical Reports.**

Resolutions

- **Probabilistic Risk Assessment (PRA)**
  - ✓ **Issues**
    - **Lack of quantitative development of the Low-Power Shutdown (LPSD) internal fire/flooding PRAs, and the LPSD level 2 PRAs**
    - **Lack of detailed risk insights**
  - ✓ **Resolutions**
    - **Performed quantitative assessments of LPSD PRAs**
    - **Updated the risk insights**
- **Environmental Report (ER)**
  - ✓ **Issues**
    - **Lack of design-specific Severe Accident Mitigation Design Alternative (SAMDA) list**
    - **Lack of detailed documentation**
  - ✓ **Resolutions**
    - **Clarified the design-specific SAMDA list**
    - **Prepared a technical report with the detailed information**

Resolutions

- **Reactor Coolant Pump (RCP)**
  - ✓ **Issues**
    - **Insufficient level of details**
    - **Proposed Design Acceptance Criteria (DAC) for the RCP design**
    - **RCP flywheel integrity was lacking**
  - ✓ **Resolutions**
    - **DCD enhanced with additional technical details**
    - **DAC will not be used for the RCP design, the Tier 1 revised**
    - **RCP flywheel integrity technical report will be submitted**

Resolutions

- **Leak-Before-Break (LBB)**
  - ✓ **Issues**
    - **Not addressed pre-service inspection for all welds in LBB-applied piping (i.e., surge line, SI/SC piping)**
  - ✓ **Resolutions**
    - **Will apply 100% pre-service inspection for the LBB applied piping welds.**
    - **A technical report will be submitted.**
- **Irradiation-Assisted Stress-Corrosion Cracking (IASCC)**
  - ✓ **Issues**
    - **No evaluation on the effects of IASCC and void swelling**
  - ✓ **Resolutions**
    - **Performed the evaluation for susceptibility to IASCC and void swelling.**
    - **The results are incorporated into the DCD.**

Resolutions

- **Turbine Missile Probability**
  - ✓ **Issue**
    - **Lack of turbine missile probability analysis**
  - ✓ **Resolution**
    - **Revised DCD to incorporate the Combined License (COL) action items and Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) with the detailed turbine missile probability analysis plan for the COL applicant.**

- **Reactor Vessel (RV) Weld Integrity**
  - ✓ **Issue**
    - **Not included RV integrity related evaluations for the RV welds**
  - ✓ **Resolutions**
    - **Performed RV integrity for RV weld and incorporated into DCD.**
    - **Revised the technical report.**

Resolutions

- **Radwaste Management (RW)**
  - ✓ **Issues**
    - **Compliance of Liquid Waste Management System (LWMS) and Gas Waste Management System (GWMS) with 10CFR20, App. B and 10CFR50, App. I**
    - **Initial loading and type of subsystem demineralizers and filters**
    - **Automatic isolation of effluent release**
  - ✓ **Resolutions**
    - **Added detailed description for processing the liquid/gaseous waste prior to release.**
    - **Added an ITAAC specifying the Decontamination Factor (DF) requirements and filter efficiency.**
    - **Added an ITAAC to confirm the automatic isolation of effluent release.**

Resolutions

- **Radiation Protection (RP)**
  - ✓ **Issues**
    - **Stay times in vital areas outside Main Control Room (MCR) and Technical Support Center (TSC) are not specified**
    - **Occupational Radiation Exposure (ORE) data consistency with RG 8.19**
    - **Justification of Environmental Qualification (EQ) total integrated dose (TID) margin**
    - **Radiation zones for Turbine Building and component cooling water (CCW) heat exchanger building**
  - ✓ **Resolutions**
    - **Vital area mission dose analyses have been completed with consideration of actual expected time and locations where the emergency operator actions are required.**
    - **Number of workers expected to be working on a given task and exposure time have been specified to be consistent with RG 8.19.**
    - **EQ margin justification and updates of the radiation zones drawings will be incorporated into the DCD.**

Resolutions

- **Technical Reports**
  - ✓ **Issues**
    - **Four Technical Reports needed:**
    - **vibration assessment of reactor internals;**
    - **flywheel integrity;**
    - **fuel seismic response evaluation; and**
    - **new and spent fuel criticality analysis**
  - ✓ **Resolution**
    - **The four technical reports are prepared and will be submitted with the DCD.**

Additional Efforts

- Four topical reports submitted are under review by the NRC.
- Over 50 technical reports are to be submitted with the DCD.
- The KHNP Quality Assurance Program Description (QAPD) for the APR1400 DC has been approved by the NRC in 2013.
- The Safeguards Information (SGI) order has been received, and the program approval is in process.

Conclusions

- All issues identified by the NRC staff have been addressed, and the staff's feedback received during several pre-application meetings were incorporated.
- The APR1400 DC application is being finalized, and the supporting technical reports will be submitted together with the DC application.
- KEPCO/KHNP plans to submit the APR1400 DC application in December 2014.

Conclusions

- **The KEPCO/KHNP management is in full support of the DCD submittal.**
- **The financial and technical resources are available to support the NRC staff's review of the DCD.**
- **KEPCO/KHNP looks forward to interact with NRC during the APR1400 DC application reviews, after its acceptance.**

Thank You!

Acronyms (1/2)

APR – Advanced Power Reactor
CCF – Common Cause Failure
CCW – Component Cooling Water
COL – Combined License
DAC – Design Acceptance Criteria
DC – Design Certification
DCD – Design Control Document
DF – Decontamination Factor
DVI – Direct Vessel Injection
ECCS – Emergency Core Cooling System
ER – Environmental Report
EQ – Environmental Qualification
ESF – Engineering Safety Feature
GWMS – Gaseous Waste Management System
HFE – Human Factors Engineering
HVAC – Heating, Ventilation, Air Conditioning
I&C – Instrumentation & Control
IASCC – Irradiation-Assisted Stress-Corrosion Cracking
IHA – Integrated Head Assembly
IP – Implementation Plan
IRWST – In-containment Refueling Water Storage Tank
ITAAC – Inspections, Tests, Analyses, and Acceptance Criteria
KEPCO – Korea Electric Power Corporation
KHNP – Korea Hydro & Nuclear Power Co. Ltd
LBB – Leak-Before-Break
LPSD – Low-Power and Shutdown
LWMS – Liquid Waste Management System
MCR – Main Control Room

Acronyms (2/2)

NRC – Nuclear Regulatory Commission

ORE – Occupational Radiation Exposure

POSRV – Pilot Operated Safety Relief Valve

PRA – Probabilistic Risk Assessment

PSV – Pressurizer Safety Valve

QAPD – Quality Assurance Program Description

PRA – Probabilistic Risk Assessment

RCP – Reactor Coolant Pump

RCS – Reactor Coolant System

RG – Regulatory Guide

RV – Reactor Vessel

RW – Radwaste Management

SAMDA – Severe Accident Mitigation Design Alternative

SDS – Safety Depressurization System

SGI – Safeguards Information

SI/SC – Safety Injection/Shutdown Cooling

TID – Total Integrated Dose

TSC – Technical Support Center