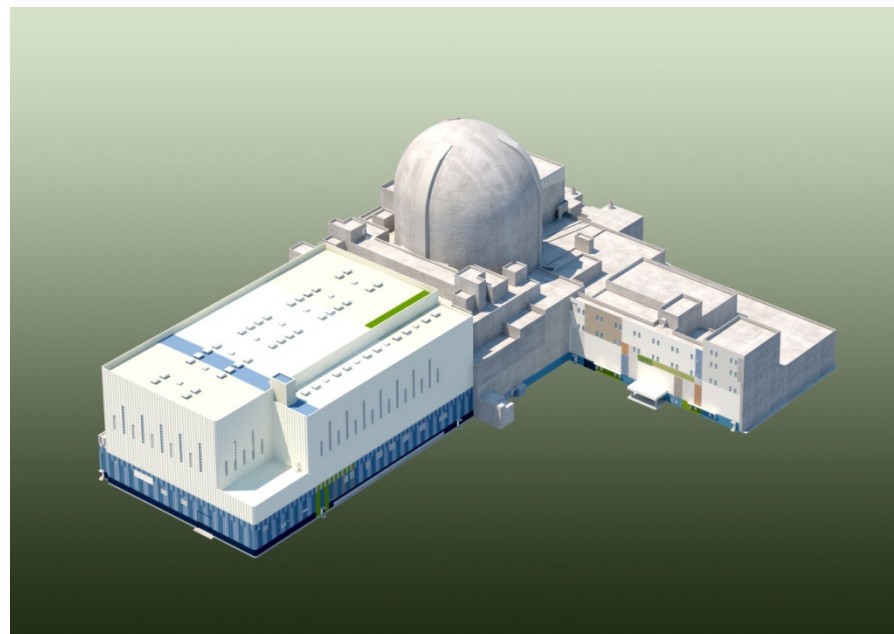


# Control Rod Depletion Evaluation



**KEPCO/KHNP**

**April 29, 2015**

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# Introduction

## Objective of the Meeting

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- **APR1400 introduces the concept of controlling power distribution using full strength or part strength control rods, which use B<sub>4</sub>C and Inconel as neutron absorber, respectively**
- **The NRC staff requests KHNP present their evaluation of the B<sub>4</sub>C depletion as a function of control rod exposure so that the control rod worth is conservatively estimated for various relevant AOOs and accidents**

## Background

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- **10 CFR Part 50 Appendix A, General Design Criterion (GDC) 11, “Reactor Inherent Protection”** requires that, in the power operating range, the prompt inherent nuclear feedback characteristics tend to compensate for a rapid increase in reactivity
- **GDC 28, “Reactivity Limits,”** requires that the effects of postulated reactivity accidents neither result in damage to the reactor coolant pressure boundary greater than limited local yielding nor cause sufficient damage to impair significantly the capability to cool the core

# Methodology

# Evaluation of Control Rod Depletion

- The evaluation of the control rod worth as a function of  $B_4C$  depletion has been performed for OPR1000 as reference calculation of APR1400
- The evaluation of System 80 as well as OPR1000 plants can also be referenced
- The loss in total control rod worth expected over CEA design lifetime (10 years) of operation due to the B-10 depletion is;  

[ ]<sup>TS</sup>
- The above results are believed to be valid for the other 16x16 lattice cores as well including APR1400

## Validity of Shutdown CEA Reactivity


- Although the loss in control rod worth due to the  $B_4C$  depletion is significantly small with respect to the total rod worth ( $\sim 17\% \Delta \rho$ ), the control rod worth should be conservatively estimated for various relevant safety analyses
- In the APR1400 case, those conservatism will be validated by comparing the measured total rod worth to the predicted value during the low power physics test (LPPT) before power operation
- If the difference is within the test acceptance criteria specified on FSAR 14.2, the shutdown CEA reactivity for various relevant safety analyses is validated
  - ✓ Acceptance criteria :  $\pm 10\%$



## Conclusions

## Conclusions

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- APR1400 introduces the concept of controlling power distribution using full strength, which use  $B_4C$  as neutron absorber. So the control rod worth should be conservatively estimated for various relevant safety analyses
-  TS
- The shutdown CEA reactivity for various relevant safety analyses is validated by verifying the difference between the measured total rod worth and the predicted value before power operation

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**Thank you for your attention.**