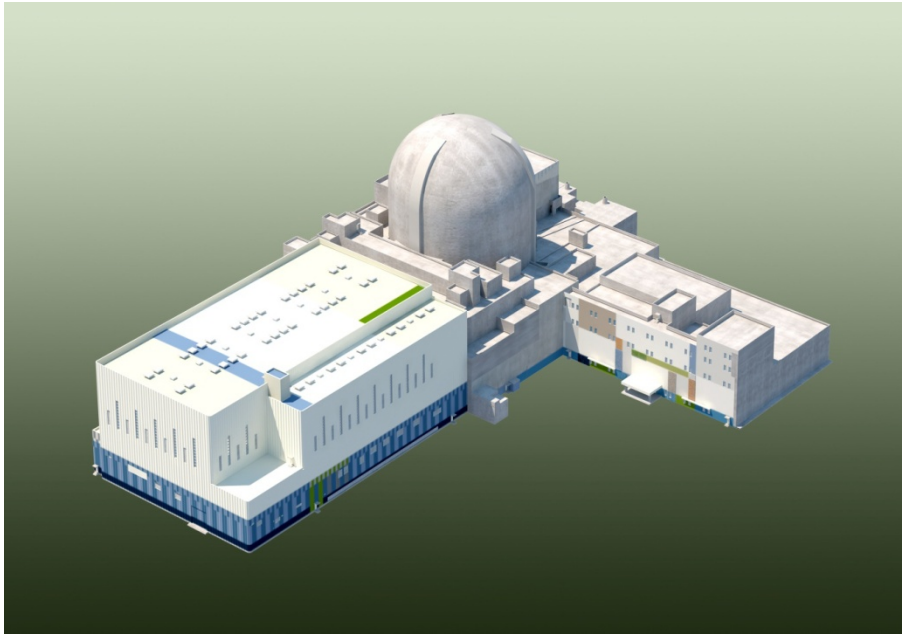
NON-PROPRIETARY

Cross-section Library



KEPCO/KHNP

April 28, 2015

Public Meeting

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Introduction

Introduction

- **DIT/ROCS**
  - ✓ **Topical Report: C-E. INC. , "The ROCS And DIT Computer Codes For Nuclear Design," April 1983, CENPD-266-P-A**
  - ✓ **DIT(for the generation of few-group neutron cross sections)**
    - ➢ **Verification Against 6 Critical Experiments**
  - ✓ **ROCS(for two- and three-dimensional neutronics analysis)**
    - ➢ **Benchmark comparison with various Plant Data**

      1) Normal Operation(Reactivity, Assembly Power Distribution, Inverse Boron Worth, ITC, Control Rod Bank Worth, Power Coefficient)

      2) Upset Condition(Dropped, Ejected and Net Rod Worths & Dropped, Ejected Rod Power Distribution)

Introduction

- **APR1400 Plant Design**
  - ✓ **Identical Lattice Configuration with OPR1000 Fuel Assembly(PLUS7)**
  - ✓ **Similar to Fuel Management of OPR1000 Core**
  - ✓ **Same Core Size with PVNGS Unit 1 & 2**
  - ✓ **Same Nuclear Design: SKN-3/4 & SHN-1/2**

Introduction

- **Cross-section Library for DIT Code**

  - ✓ **Cross Section Library is linked to DIT/ROCS Code System**
    - ➢ **The effects of biases and uncertainties associated with ENDF/B-IV cross section library are incorporated into the ROCS biases and uncertainties and are not treated separately for DIT/ROCS code system.**
  - ✓ **Usage of ENDF/B-IV cross section library can be compensated by Bias/Uncertainty update and cross-section adjustments**

CE Methodology

CE Methodology

- **Physics Bias/Uncertainty**
  - ✓ **For Plants Using the CE Safety Analysis Methodology**
  - ✓ **This methodology utilizes the standard three-dimensional ROCS models using universal cross section table sets generated by DIT**
  - ✓ **Bias/Uncertainty is generated from many data of "Measured" & "Calculated" for various operating plants by statistical treatment**
  - ✓ **Bias/Uncertainty associated with ENDF/B-IV library have been updated periodically in order to maintain the level of accuracy when sufficient evidence is accumulated to imply that these factors need to be revised, based on the measurement data of operating plants.**

Design Experience & Accuracy

Design Experience & Accuracy

- **Measurement Item for Physics Parameter Validation**
  - ✓ **Core K_{eff} : HZP CBC, HFP CBC Behavior**
  - ✓ **MTC : HZP & HFP ITC**
  - ✓ **Control Rod Worth : Individual Rod Worth & Total Rod Worth**
  - ✓ **Doppler Coefficient : Doppler Power Coefficient at 20, 50, 80, 95% & Difference between HZP CBC and HFP CBC**
- **Physics Uncertainty is occasionally used as Test Criteria for LPPT & PAT**
  - ✓ **MTC : 2.808 pcm/℃**
  - ✓ **Control Rod Worth : -6.52%△ρ**

Design Experience & Accuracy

- **OPR1000 Plant Design**

  ✓ **Over total 71 cycles of 12 plants**

PLANT	# of Total CYCLE (Designed by DIT/ROCS)
YGN3	13
YGN4	12
UCN3	10
UCN4	9
YGN5	7
YGN6	6
UCN5	5
UCN6	5
SKN1	1
SKN2	1
SWN1	1
SWN2	1
Total	**71**

Design Experience & Accuracy

- ROCS LPPT Results (CBC, IBW, ITC & Rod Worth of UCN-4 Cycle 1)

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Design Experience & Accuracy

- ROCS LPPT Results (CBC of YGN-3 Cy 10 ~ 12)

Design Experience & Accuracy

- ROCS LPPT Results (ITC of YGN-3 Cy 10 ~ 12)

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Design Experience & Accuracy

- ROCS LPPT Results (Bank Worth of YGN-3 Cy 10)

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Design Experience & Accuracy

- ROCS LPPT Results (Bank Worth of YGN-3 Cy 11)

Design Experience & Accuracy

- ROCS LPPT Results (Bank Worth of YGN-3 Cy 12)

Conclusions

Conclusions

- **Basis for using ENDF/B-IV instead of more recent B-VI or B-VII.**
  - ✓ **DIT/ROCS with ENDF/B-IV data library predict all nuclear parameters with sufficient accuracy at Core Physics Test (LPPT & PAT).**
  - ✓ **The effectiveness of current bias and uncertainty is confirmed by initial & every reload cycle LPPT & PAT measurement**
  - ✓ **The current ENDF/B-IV data library and its associated biases and uncertainties have been verified to be acceptable for numerous operating experiences of CE-type plants and OPR1000 plants.**

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Thank you for your attention.

Acronyms

LPPT – Lower Power Physics Test

PAT – Power Ascension Test