



# The Status of Database Construction for RCAP Code Supporting Function

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# Introduction

- **Nuclear safety research**
  - Improving the safety
  - Reducing the risk
  - Based on simulation data and experimental data
- **Korea specific Level-3 PSA (Probabilistic Safety Assessment) code**
  - **developing**
- **With the simulation code**
  - **construct supporting database for the user**
- **Studied database related to the level-3 PSA**
- **Reviewed the status of the user supporting database**

# Level-3 PSA code (1/3)

- **Assessment for an off-site consequence analysis of a radiation release accident**
- **Execution of level 3 PSA**
  - Performed using a code
  - MACCS2 code : Most widely used code (developed by SNL in USA)
  - OSCAAR code (developed by JAEA in Japan)
  - COZYMA, CONDOR code also used
- **Lessons from Fukushima accident**
  - Increased necessity of Level-3 PSA execution
    - Regarding radiation release and the off-site consequence of radiation
  - Needed Korea specific Level-3 PSA
    - Due to the latest technology, social and legal requests

# Level-3 PSA code (2/3)

- MACCS2 code
  - : Practical code to execute the Level-3 PSA
- Limitations compared to domestic environmental characteristics → insufficiency
- Need to development for a Level-3 PSA
  - With domestic technology
  - Reflecting environmental characteristics
- After Fukushima accident, enormous progress
  - in the field of application technology in a Level-3 PSA
  - such as the atmospheric diffusion model and the radiation health effects model
- Need for the execution of a Level-3 PSA has arisen

# Level-3 PSA code (3/3)

- Reviewed international technical trends and the research status

- Classified major technical fields such as

Radiation source, NPP site information, Atmospheric diffusion module, Ocean diffusion module, Exposure dose model, Ecosystem model, Emergency response assessment, Health effects assessment, and economic impact assessment.

- 5 core models for the Level-3 PSA code, RCAP

the diffusion model, exposure dose model, exposure pathway model, emergency response model, and health effects model.

- Code development being processed

# Database of the Nuclear Field Research (1/4)

- **Severe accident fields (Level-2 PSA),**
  - Many requirements for the analysis of a severe accident
  - Various methods related to this analysis such as accident management, Level-2 experimental data analysis, code simulation data, and an optimized strategy.
- **Severe accident experiment**
  - Performed TROI experiment for a long time
    - Damage impact, Mitigation plan of the containment vessel
  - Experimental data arranged systematically, used for an easy and rapid data search
  - Constructed integrated database system for the TROI experimental data

# Database of the Nuclear Field Research (2/4)

- **For the optimum assessment of Level-2 risk (Severe Accidents)**

- Database Constructions of Uncertainty Analysis

Related to early containment failure and late containment failure

- **Uncertainty analysis data**

- For the containment pressure behavior in the case of a severe accident.
  - Obtained from MAAP code simulation (Developed by EPRI)

- **For the database system (severe accident)**

- Representative scenarios selected under different scenarios
  - Thermal hydraulic and source term analyses performed
  - Using the MAAP code

# Database of the Nuclear Field Research (3/4)

- Database system constructed for SFP(spent fuel pool)  
(severe accident risk assessment)

- After the Fukushima accident, safety of SFP important

Need data for the risk assessment of an SFP in various scenarios

- Selected assessment models

Based on SFP LOCA(Loss of Cooling Accident)

and LOPI(Loss of Pool Inventory)

# Database of the Nuclear Field Research (4/4)

- **HRA (Human Reliability Analysis) fields of a Level-1 PSA**
  - Reducing human error : critical issue
  - Database based on simulator training data
- **Sufficient and reliable human performance data collection for the safety**
- **Constructed HRA database of the operator's performance data**
- **HRA database**
  - Collected raw data
  - Stored the HRA analysis
  - Supported as a basis for the quantitative results
- **Database in the nuclear safety field as various data.**

# Database Construction (1/5)

- In Level-3 PSA, considered two kinds of database

## 1) Database of user supporting functions for document referenced in RCAP code

Used user supporting database for conjunction with the RCAP code during the run-time

## 2) Results of the Level-3 PSA code simulation

Utilized RCAP code simulation results

# Database Construction (2/5)

- **Scope of the supporting database : execution of the RCAP code**
- **Helps Users through 'HELP' function during code execution**
- **Supporting database consist of**
  - Keyword
  - Its descriptions (auxiliary description referenced by the 'HELP' function)
- **Obtained key documentation for the description**
- **Surveyed some documents for more trustful description.**
- **Selected keyword based on the frequently used**
- **Modification of keywords selected for future use**

# Database Construction (3/5)

- **HRA (Human Reliability Analysis) fields of a Level-1 PSA**
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# Database Construction (4/5)

- **For the technical aspects**
  - Checked the latest IT technologies related to the database
  - Considered HTML types and XTMIL types for document types
  - For the implementation tool, considered Visual Basic and Python
- **Implementation of a Level 3 PSA-supported database under construction**
- **Keyword selection in document file in progress**
- **Subsequent steps involving more diverse and larger numbers of keywords**

# Database Construction (4/5)

## Example of supporting database

The screenshot shows the RCAP Official Site with the following content:

- RCAP Official Site**
- Search-docs**
- 국내 고우 LEVEL3 PSA CODE (RCAP)**
- Home**
- RCAP**
  - 개발 배경
  - 개발 강과
  - 코드 구성
- 기술문서**
  - RCAP 사용자 매뉴얼
    - 요약문
    - 제1장 개요
    - 제2장 사용안내
    - 제3장 입력카드 풀조
    - 제4장 출력파일
    - 부록
  - RCAP 확인 및 검증 방법론
  - RCAP 예비 확장 및 검증 보고서
  - xRCAP 메뉴얼
- 해크숍**

**在国内露地LEVEL3 PSA CODE (RCAP) Description:**

RCAP을 실행하기 위해서는 RCAP 입력파일을 작성해야 한다. RCAP 입력 파일은 제3장 입력카드 참조의 RCAP 입력카드의 구성을 병행하는 형식으로 작성하여 RCAP 실행을 위한 필수 파일이다. 이외의 파일은 RCAP 입력파일 내에서 파일을 선택해야 한다. 추가 선택이 필요한 필수 파일은 다음과 같다.

- 가상데이터 파일
- 협동데이터 파일
- 선량변환인자 파일
- FCM 데이터 파일

**가상데이터 파일**  
가상데이터 파일은 RCAP에서 모사하고자 하는 가상데이터로 작성한다. 기본적으로 가상데이터는 1년간 (1월1일 0시부터 12월31 24시까지)의 데이터를 필요로 하지만 경우에 따라서는 변경 가능하다. 가상데이터는 기본적으로 물리시스 날짜, 시간, 품종, 풍속, 대기온정도, 강수량 등으로 구성된다. 자세한 데이터 내용 및 파일 작성 양식은 「부록 1」을 참조한다.

**협동데이터 파일**  
협동데이터 파일은 RCAP 계산에 필요한 ~~반사성핵증~~의 데이터를 수록한 라이브러리 파일이다. 기본적으로 협동데이터 파일은 RCAP 입력파일에서 제시한 방사성핵증을 모두 포함해야 한다.

**방사성핵증**  
방사성 불과를 하는 핵증, 방사능을 갖는 핵증, 핵증 중 방사성을 갖는 것

**선량변환인자 파일**  
선량변환인자 파일은 RCAP의 선량계산에 필요한 핵증별, 인체장기별, 피폭경로별 선량변환인자 데이터를 제공한다. 기본적으로 선량변환인자 파일은 RCAP에서 분석하는 핵증별, 인체장기별 선량변환인자를 포함해야 한다. 시스템별로는 원자로, 핵융합, 원자력기기류, etc.

# Conclusions

- According to data utilization

**Construction processes of the database are different case by case**

- Considering the diversity of database

**Needs to specify the database for Level-3 PSA**

- Previously constructed database systems reviewed and compared
- Supporting database focused on building a database for Level 3 PSA code users
- To construct an effective and useful database, keyword and descriptions reviewed and applied
- Level-3 PSA documents assembled in various methods
- Used to support the Level-3 PSA code user