

## FLINT: A Spatial Information Platform for Supporting External Event PSA

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### 1. Introduction

The accuracy and reliability of External Event Probabilistic Safety Assessment (PSA), including Fire PSA and Internal Flooding PSA, depend heavily on the accurate acquisition and interpretation of plant physical information, such as spatial relationships among plant areas and the locations of equipment, structures, and safety-related systems.

However, the plant physical information required for External Event PSA is typically dispersed across various engineering drawings, including Room Design Base Drawings (Room DBDs), architectural drawings, plumbing drawings, equipment layout drawings, electrical drawings, and other engineering drawings. Consequently, analysts must manually review a large volume of drawings to identify adjacent-area relationships, equipment locations, propagation pathways, and other spatial information necessary for the assessment. This process requires considerable time and effort, is prone to analyst-dependent inconsistencies, and results in reduced traceability of the analysis.

To address these challenges, this study developed FLINT (Fire & Flood Information Tool), a spatial information-based software platform for supporting External Event PSA. FLINT establishes and manages an integrated spatial information database based on Room DBDs and incorporates a Zone Mapping function that enables various engineering drawings to share a common room-based spatial information framework. The platform integrates plant spatial and physical information into this database and provides the information required for analysis, thereby improving analysis efficiency, consistency, and traceability.

### 2. Overview of FLINT

FLINT is a spatial information platform that establishes and manages an integrated spatial information database for supporting External Event PSA.

The database is established based on Room DBDs, which provide the fundamental spatial framework. Room information derived from Room DBDs serves as the fundamental spatial reference for the integrated database, while the Zone Mapping process spatially

aligns various engineering drawings with the Room DBD framework. This process enables the consistent sharing of room boundary and room identification information across different engineering drawings.

The resulting database combines room information with equipment, doors, drainage facilities, and other plant physical information, enabling efficient retrieval and visualization for analysis. To implement this functionality, FLINT was developed as a Windows-based, client-server application using C#, with Microsoft SQL Server employed as the underlying database management system.

### 3. Major Functions of FLINT

#### 3.1 Room Boundary Information Development

Room boundary information is derived from Room DBDs and stored in the database as polygon-based spatial information. Using an interactive drawing tool, room boundaries are delineated as closed polygons, and the corresponding boundary coordinates are automatically stored in the database.

In addition, textual information in the drawings, such as room numbers and descriptions, is automatically extracted and can be efficiently registered in the database through a single mouse click.

The resulting room boundary information constitutes the fundamental spatial reference for the database, providing the basis for subsequent PSA-related information management and analyses.

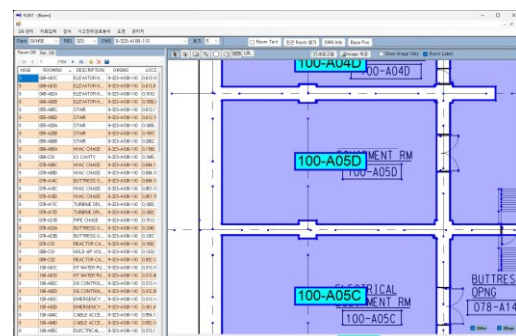


Figure 1. Room Boundary Information Development

### 3.2 Zone Mapping

Zone Mapping is a process that spatially aligns engineering drawings used for analysis with the Room DBD framework, enabling room boundary and room identification information defined in the Room DBD to be consistently shared across different engineering drawings. As a result, the corresponding room for equipment, plumbing, and structural components can be readily identified even when room information is not explicitly provided in the drawings. This process establishes a consistent room-based spatial framework for integrating and managing plant physical information in the database.

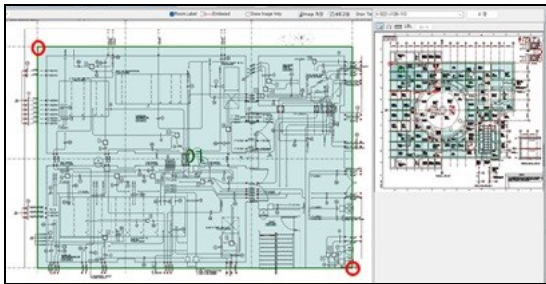


Figure 2. Zone Mapping

### 3.3 Equipment Information Management

Information on equipment, doors, and drainage facilities is derived from the drawings and stored in the database. Equipment, doors, and drainage facilities are delineated using the interactive drawing tool, and their associated textual information is extracted and linked to the corresponding room information.

Equipment information supports various PSA analyses, such as the identification of affected equipment and potential ignition source locations, while door and drainage information supports the identification of flood propagation paths.

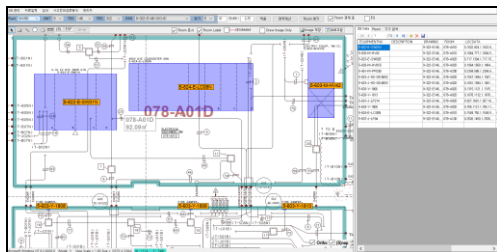


Figure 3. Registration of equipment information

### 3.4 Fire and Flood Propagation Assessment Support

Based on this database, FLINT provides analysis support functions for fire and flood assessments by

automatically generating and visualizing spatial analysis results.

For fire assessment, FLINT identifies rooms adjacent to a selected target room and presents their horizontal and vertical spatial relationships through tabular and graphical views, enabling analysts to efficiently identify potential fire propagation areas.

For flood assessment, FLINT traces flood propagation paths through doors and drainage facilities and visualizes the propagation sequence and affected areas using diagram-based and drawing-based representations.

These functions enable analysts to efficiently identify fire and flood propagation paths and affected areas without manually reviewing multiple engineering drawings, thereby improving the efficiency and consistency of the analysis.

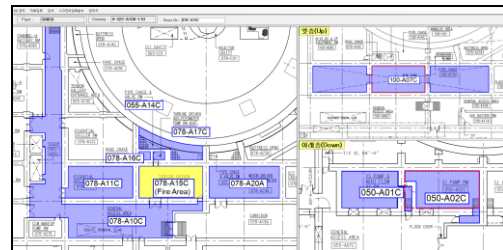


Figure 4. Adjacent Area Identification

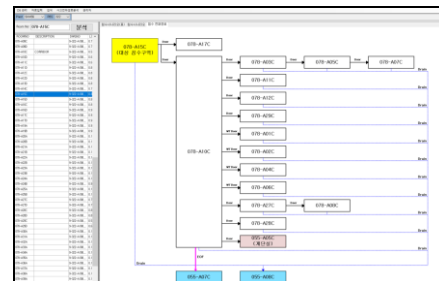


Figure 5. Flood Propagation Diagram

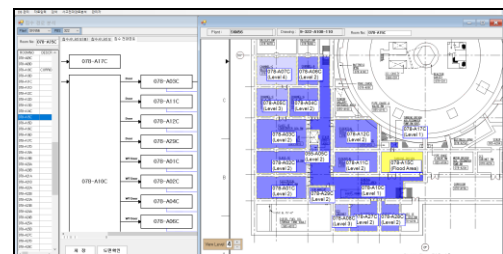


Figure 6. Flood Impact Area Visualization

### 3.5 Analysis Report Generation

FLINT provides analysis information required for PSA report preparation in tabular, drawing, and

spreadsheet formats. This functionality supports efficient report preparation while improving the traceability and reproducibility of PSA analyses.

#### **4. Conclusions**

This study developed FLINT, a spatial information platform that establishes and manages an integrated spatial information database to support External Event PSA. Using room information derived from Room DBDs and shared across engineering drawings through the Zone Mapping process, FLINT integrates plant spatial and physical information into a unified information environment for External Event PSA.

The integrated spatial information database supports efficient retrieval, visualization, and analysis of plant information, thereby improving the efficiency, consistency, and traceability of PSA analyses while reducing the manual effort associated with engineering drawing reviews.

Future work will focus on the practical application of FLINT to Fire PSA and Internal Flooding PSA, along with further evaluation of its effectiveness and usability.

#### **Acknowledgements**

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#### **REFERENCES**

- [1] EPRI and U.S. NRC, NUREG/CR-6850, Fire PRA methodology for nuclear power facilities, 2005.
- [2] EPRI and U.S. NRC, NUREG/CR-6850 and EPRI 1011989, Fire Probabilistic Risk Assessment Methods Enhancements: Supplement 1, 2010.
- [3] EPRI, EPRI 1019194, Internal Flooding PRA Guideline, 2009.
- [4] ASME/ANS, RA-S-1.1-2009, Addenda to ASME/ANS RA-S-2008 Standard for Level 1/Large Early Release Frequency PRA for NPP Applications, 2009..