

# Development of AtomCARE Training Module Using NPP Simulator Information

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# Table of Contents



## 1 Korea's Nuclear Emergency Response System

Nuclear Facilities Status

Legal Framework & Organization

Emergency Response Procedures

## 2 AtomCARE

System Overview

System Features

Module Workflow

## 3 Radiological Emergency Preparedness Training Satus

Training Overview

Communication & Simulator

Limitations & Requirements

Data Acquisition

## 4 Training Mode Development Plan

System Architecture

System Dashboard

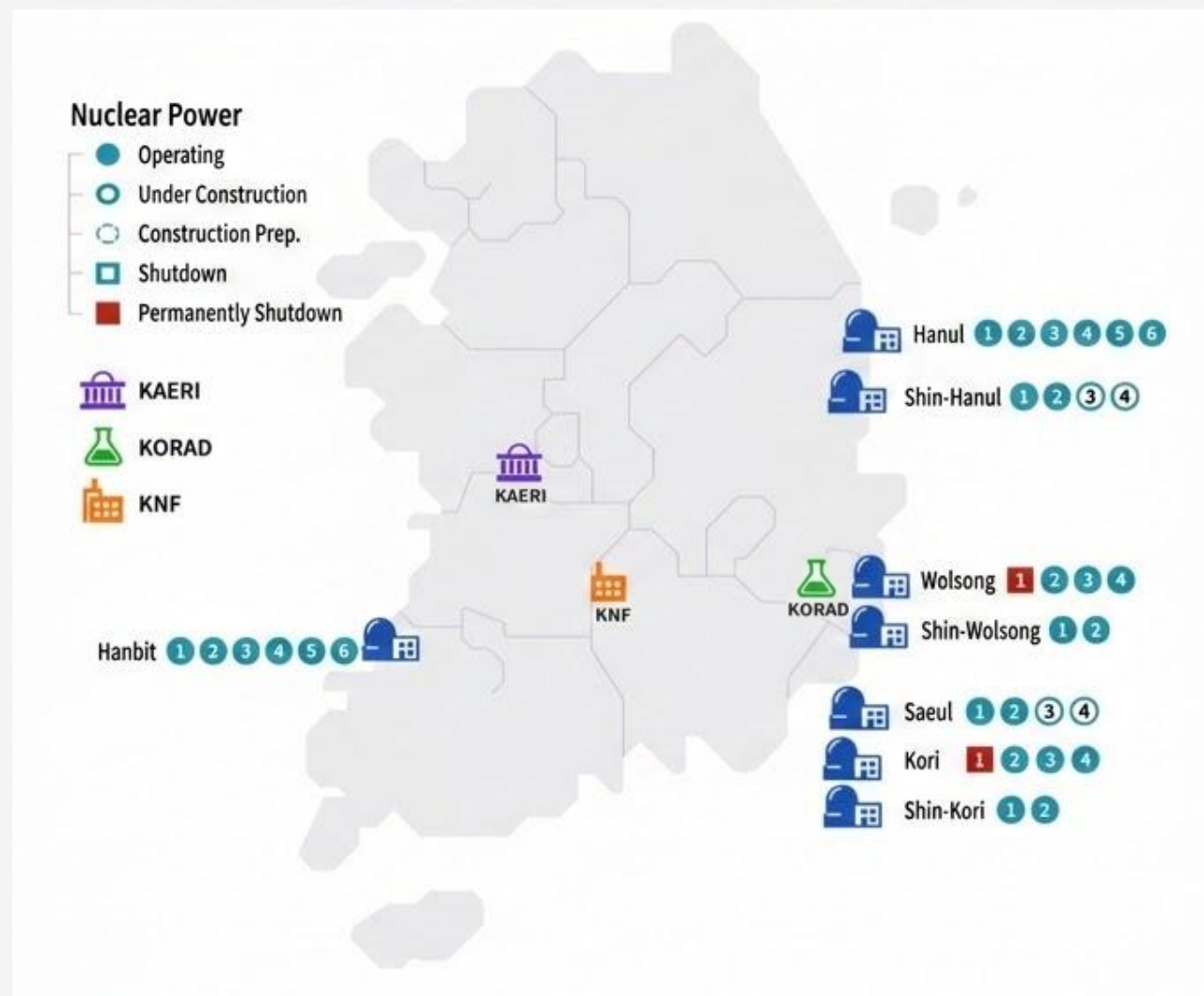
Validation and Implementation Roadmap

Expected Benefits

Enhancement of AI-Enabled Functions

Minimum Viable Product

- **Operating Reactors**
  - 26 units (6 reactor types)
- **Other Facilities**
  - 3 sites (research reactor / radioactive waste disposal facility / nuclear fuel company)
- **Major Sites**
  - Kori, Hanbit, Hanul, Wolsong (4 sites)
- **Nuclear Power Plant Density**
  - One of the highest in the world
- **Characteristics**
  - Continuous management of nuclear power dependency and generation share





## Nuclear Safety Act

- Safety regulation
- Safe operation of nuclear facilities
- Accident prevention
- Legal framework
- Emergency preparedness planning



## Act on Radiological Emergency Preparedness

- Public protection
- Roles by agency
- Response manual



## Framework Act on Disaster and Safety Management

- National disaster response system
- Central Disaster and Safety Countermeasure Headquarters



원자력안전위원회

## Nuclear Safety and Security Commission

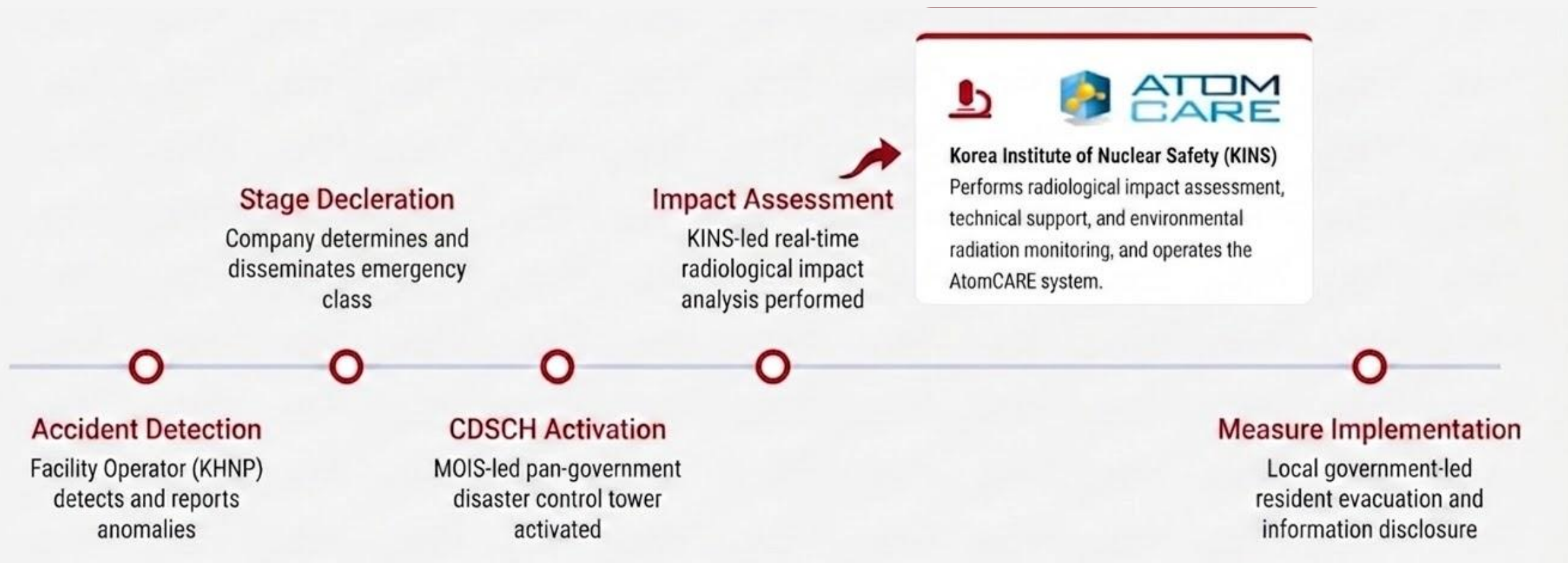
- Overall emergency coordination
- Emergency classification (White / Blue / Red)
- Protective action recommendations

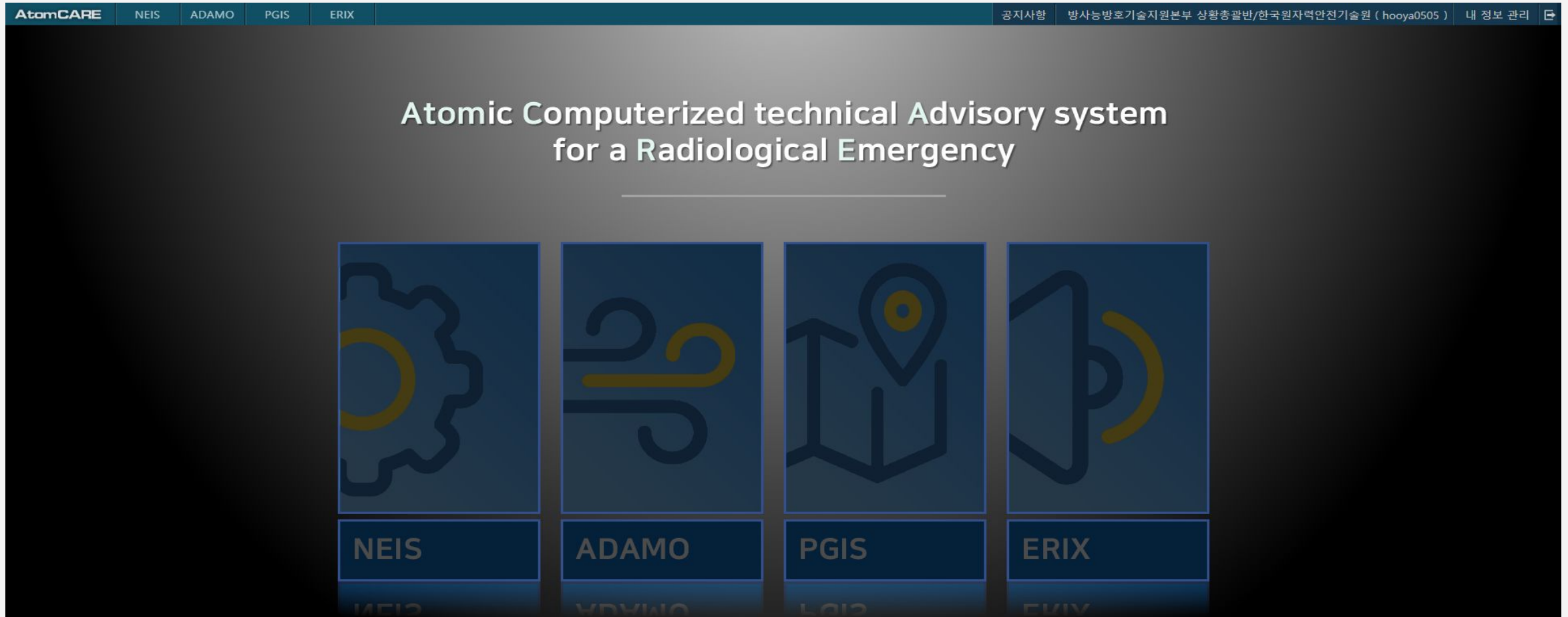


행정안전부

## Ministry of the Interior and Safety

- Inter-agency coordination
- Central Disaster Safety Countermeasure Headquarters operation
- Resource mobilization





## legally mandated system

### **Act on Physical Protection and Radiological Emergency**

Article 32 (Technical Support, etc. for Prevention of Radiological Disasters)

(3) The President of the Korea Institute of Nuclear Safety under paragraph (1) shall build and operate an information system necessary for radiological impact assessment in order to prepare against any possible radiological disasters. <Newly Inserted by Act No. 15280, Dec. 19, 2017>

### **Enforcement Regulation of the Act on Physical Protection and Radiological Emergency**

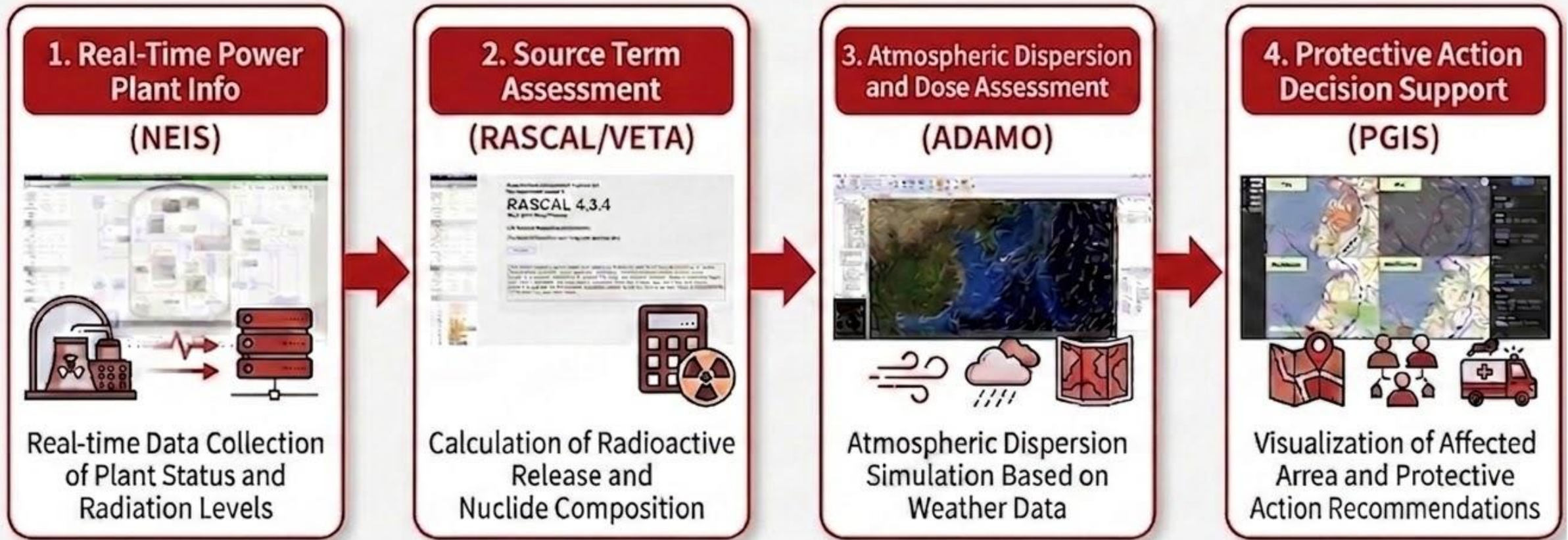
Article 17-2 (Construction and Operation of the Radiological Impact Assessment Information System)

(1) The head of the Korea Institute of Nuclear Safety shall collect and analyze the following information for efficient construction and operation of the information system (hereinafter referred to as the "Radiological Impact Assessment Information System") required for the assessment of radioactivity under Article 32 (3) of the Act <Enforcement Date: Jun. 28, 2018>

1. Meteorological information (i.e., meteorological obs./prediction and dispersion prediction)
2. Social geographical information (i.e., population, geographical maps, etc)
3. Information on the status of the nuclear facility (i.e., Rx temp., containment pressure, etc)
4. Information on environmental radiation monitoring and radioactivity analysis result

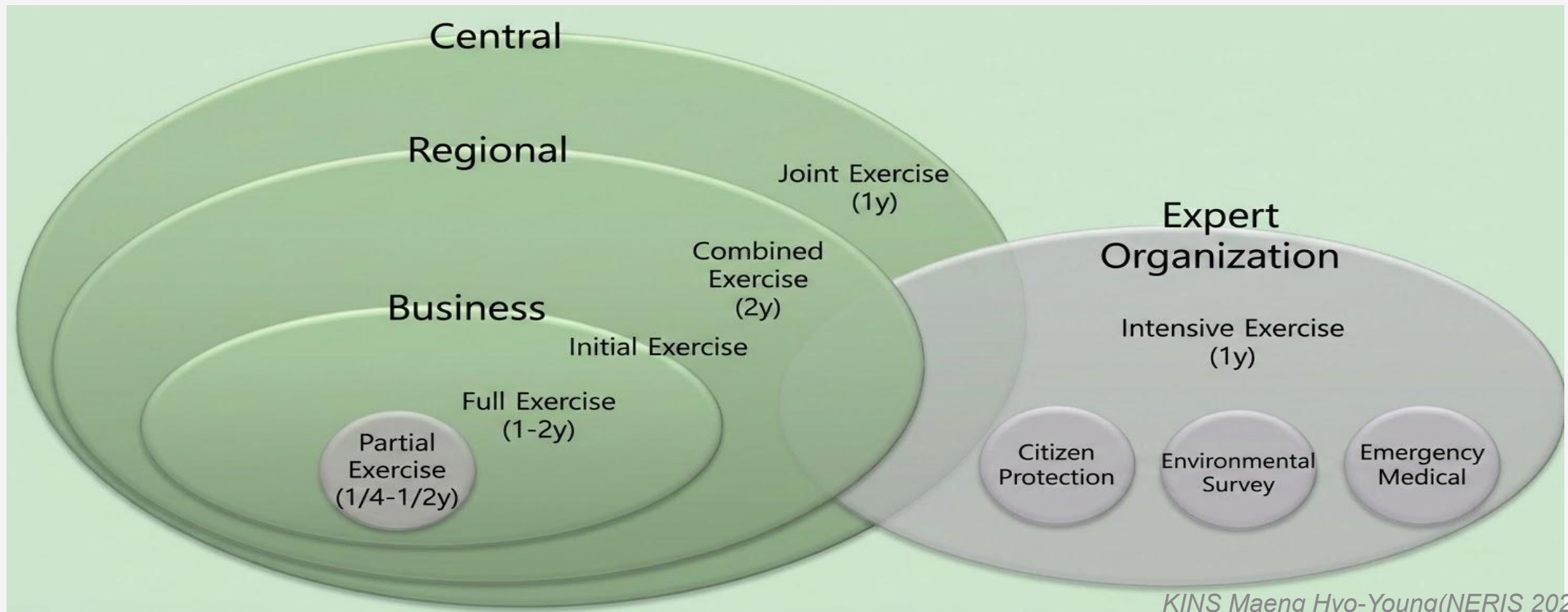
## Real-time NPP Data Acquisition

- 30 Nuclear Related facilities(NPP/R&D NPP/ NPP Simulators/ Radioactive Waste Disposal Facility)
- ~600 plant parameters per unit/ Signal monitoring and Alarming System with SMS
- 5-second intervals via a cybersecurity-hardened, redundant dedicated network between organizations



*RASCAL/VETA : Source Term Evaluation & Accident Analysis Tool (NRC/CNSC)*

- Objectives and Rationale for Radiological Emergency Preparedness Training
  - Establishing an effective radiological emergency management system** to ensure regulatory compliance and protect public safety in both domestic and international scenarios.
- Training Types, Frequency, and Involved Agencies



[illegible]

## Information Sharing and Communication System

- **Plant data provided in documents based on training scenarios**
- **Manually updated parameters distributed according to timeline (H+00:00)**



## NPP Simulator

- **Full-scope simulator capable of normal and accident scenario simulation**
- **Acquisition of real plant-equivalent parameter data**

## Differences between Training and Actual Situations

|                              | Training                                           | Actual                                                        | Results                                                   |
|------------------------------|----------------------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------|
| Information Delivery methods | Written Documents                                  | AtomCARE NEIS Real-time Data                                  | Lack of Interface Usage Experience                        |
| Time Flow                    | Training snapshot data at fixed points             | Continuous real-time Data                                     | Reduced Agility to Grasp Accident Progression             |
| Decision-Making Processes    | Relaxed review & Discussion                        | Rapid judgement under Time Pressure and Uncertain Information | Limitations in Verifying Real-World Response Capabilities |
| Using Module                 | Training Module<br><b>(NEIS Training Module X)</b> | AtomCARE                                                      |                                                           |

## Necessity of Establishing a Realistic Training Environment

- Implement Training Environments Identical to Actual Emergency Response Conditions
- NPP Simulators
- Improve Decision-Making Proficiency

***"Train as you fight, Fight as you train"***

KINS Maeng Hyo-Young(NERIS 2026)

## OPR1000 partial Exercice Simulator Data Acquisition

- **Target Parameters:** NEIS module received variables of the target nuclear power plant's SPDS (111 items)
- **Acquisition Time:** Total training scenario duration (307 hours 14 minutes 23 seconds, approximately 12.8 days)
- **Training Mode MVP Development Baseline Data**

[illegible]

## Objectives

- Integration of simulator data with training mode based on the AtomCARE NEIS module
- Establishment of an environment providing the same user experience as the operational system  
(all reactor types in operation)
- Provision of repeated training and evaluation functions

## Phased Development Plan

### Phase 1: Acquisition and analysis of simulator data for all reactor types

Acquisition of simulator data for in-plant accident analysis during the training scenario period (AtomCARE NEIS display parameters)

OPR1000 / APR1400 / WH / FRAMATOME

### Phase 2: Development of a Data Integration Interface

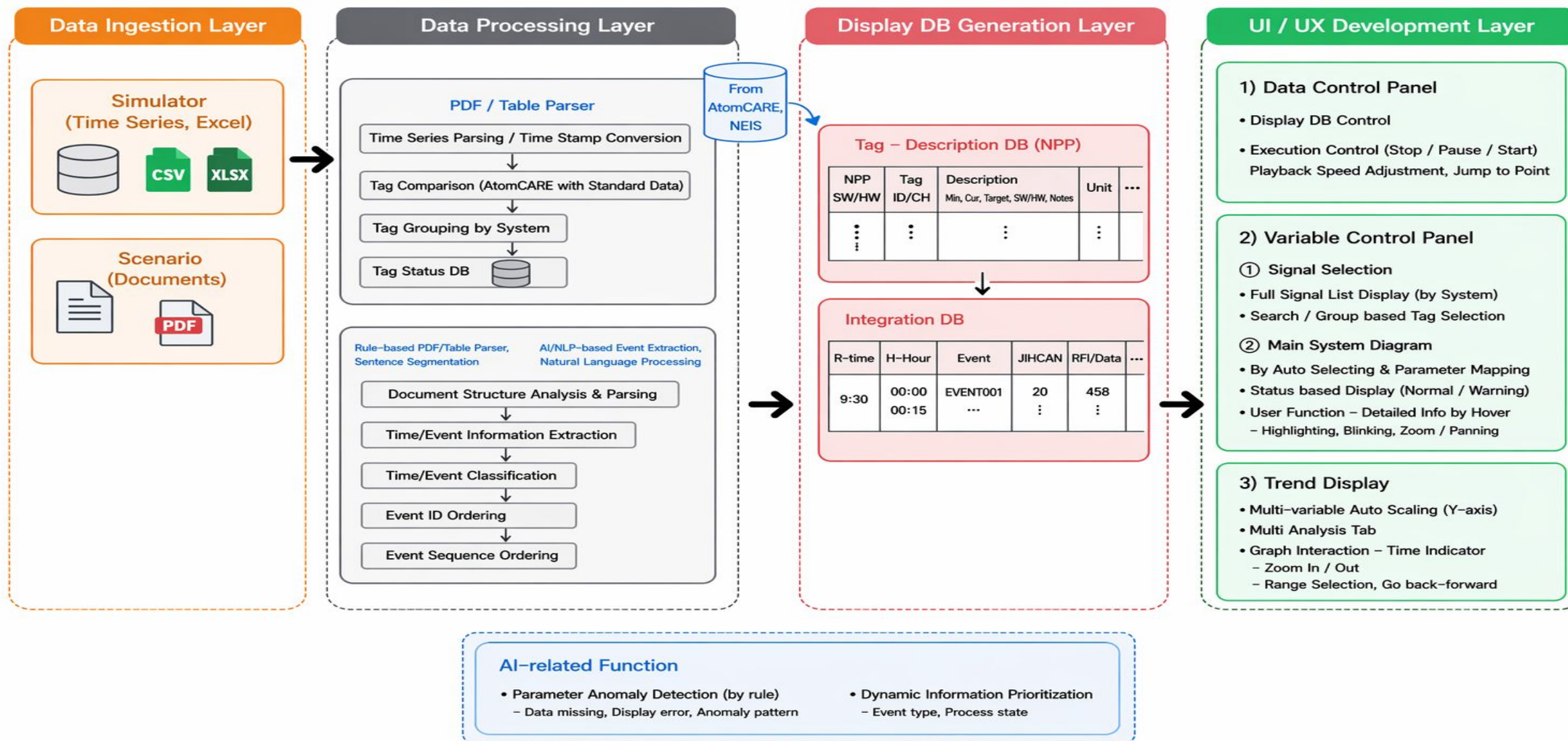
Provision of a layout 100% identical to the actual NEIS interface, enabling immediate real-world response without additional training

### Phase 3: User Interface Development

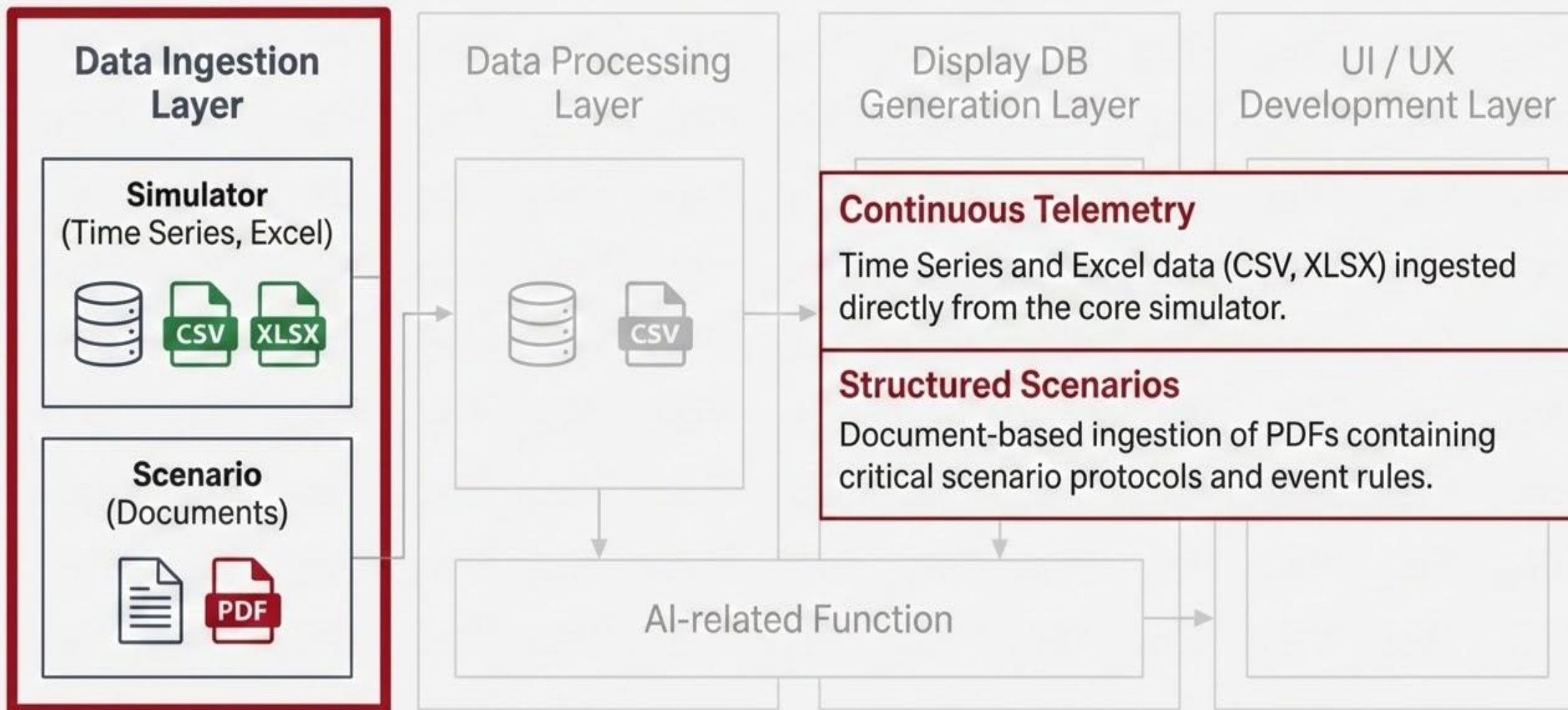
**1st:** Internal experts (1 LOCA scenario) → **2nd:** Usability evaluation by emergency response personnel → **3rd:** Application in actual joint exercises

### Phase 4: Development of Scenario Management and Evaluation Functions

**1st:** Internal experts (1 LOCA scenario) → **2nd:** Usability evaluation by emergency response personnel → **3rd:** Application in actual joint exercises\*\*



## I Layer 1 | Ingestion : Capturing Every Variable



## I Layer 2 | Processing : Structuring the Unstructured

### Top Path: Quantitative



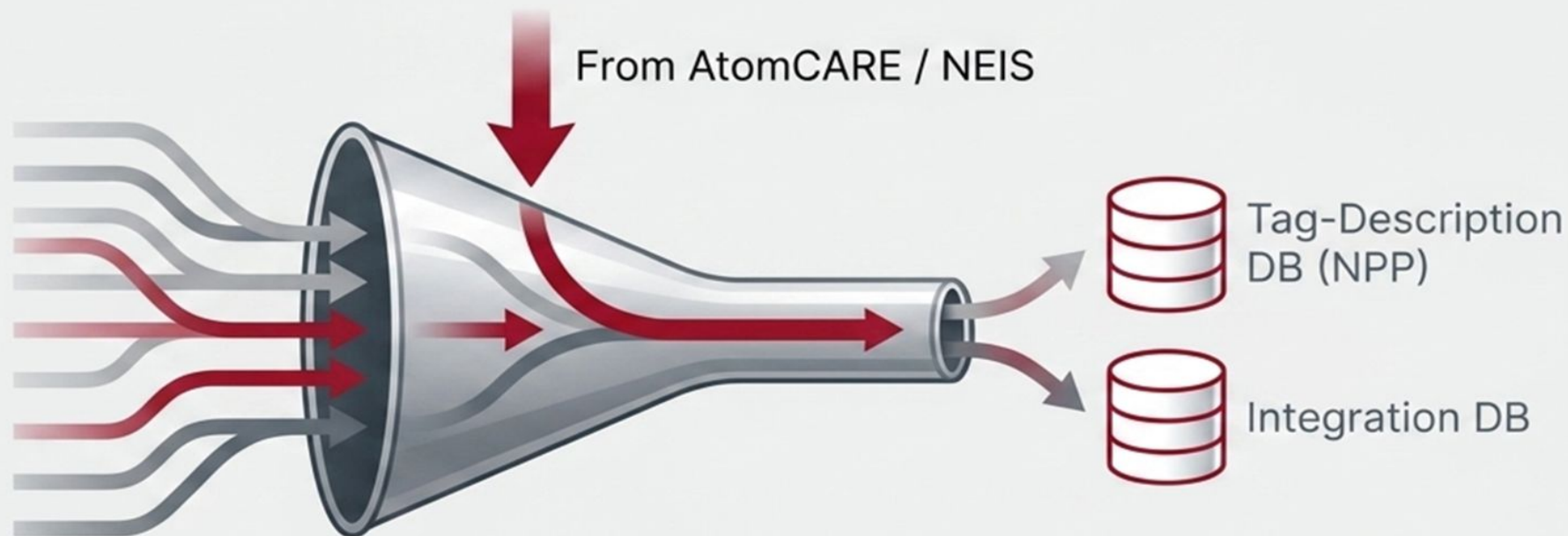
**Time Series Engine:** Parses raw timestamps and strictly standardizes tags against AtomCARE data to build a unified Tag Status Database.

### Bottom Path: Qualitative



**AI/NLP Event Extraction:** Uses sentence segmentation and natural language processing to transform static PDFs into an ordered, chronological event sequence.

## I Layer 3 | DB Generation : The Single Source to plot



### Tag-Description DB (NPP):

Consolidates hardware/software tags, exact IDs, descriptions, targets, and units into one lookup table.

### Integration DB:

The synchronized engine. Perfectly aligns Real-Time (R-time), H-Hour, and Event triggers down to the millisecond to ensure UI fidelity.

## Layer 4 | Interface : Data brought to life

### Data Control Panel:

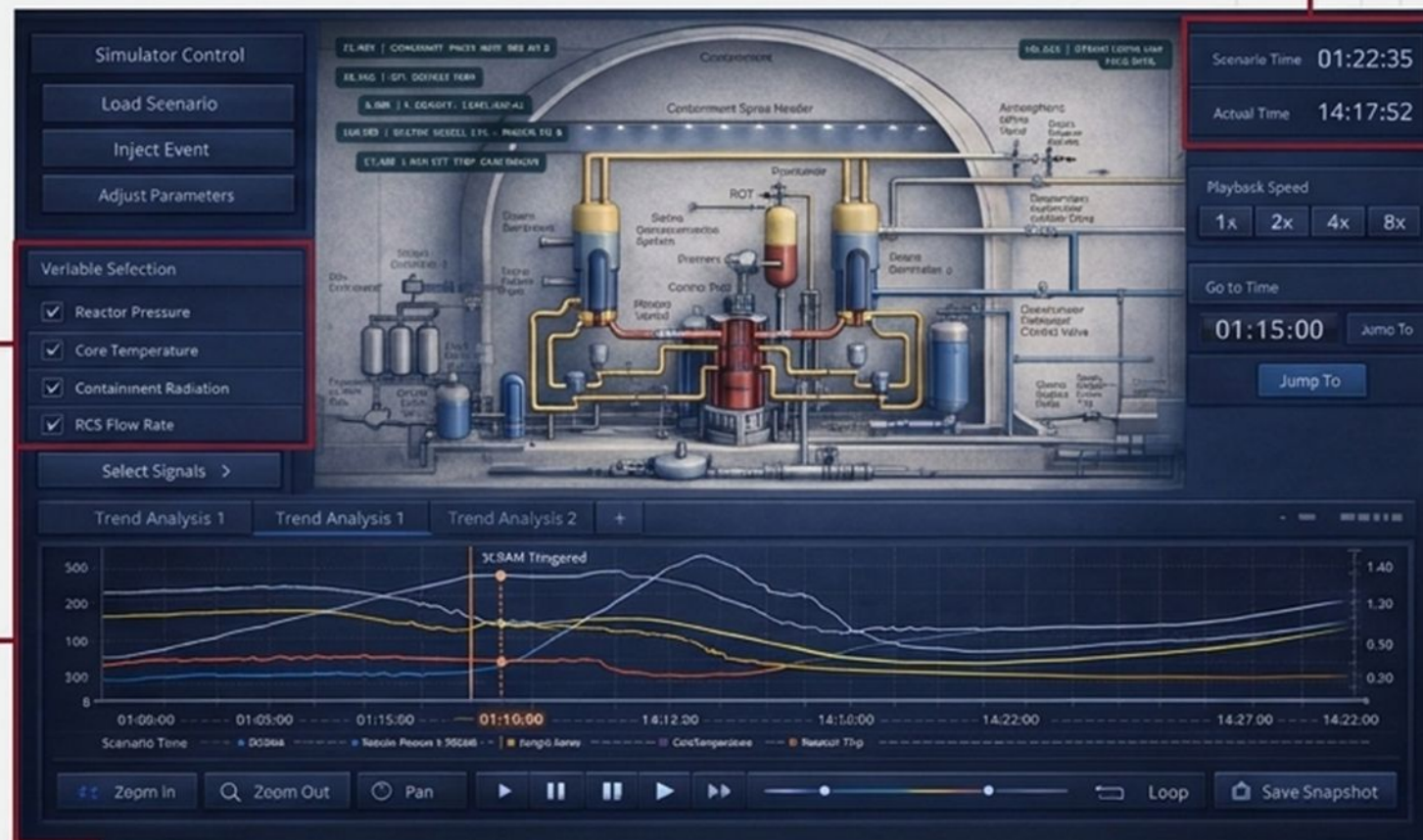
Execution and playback routing.

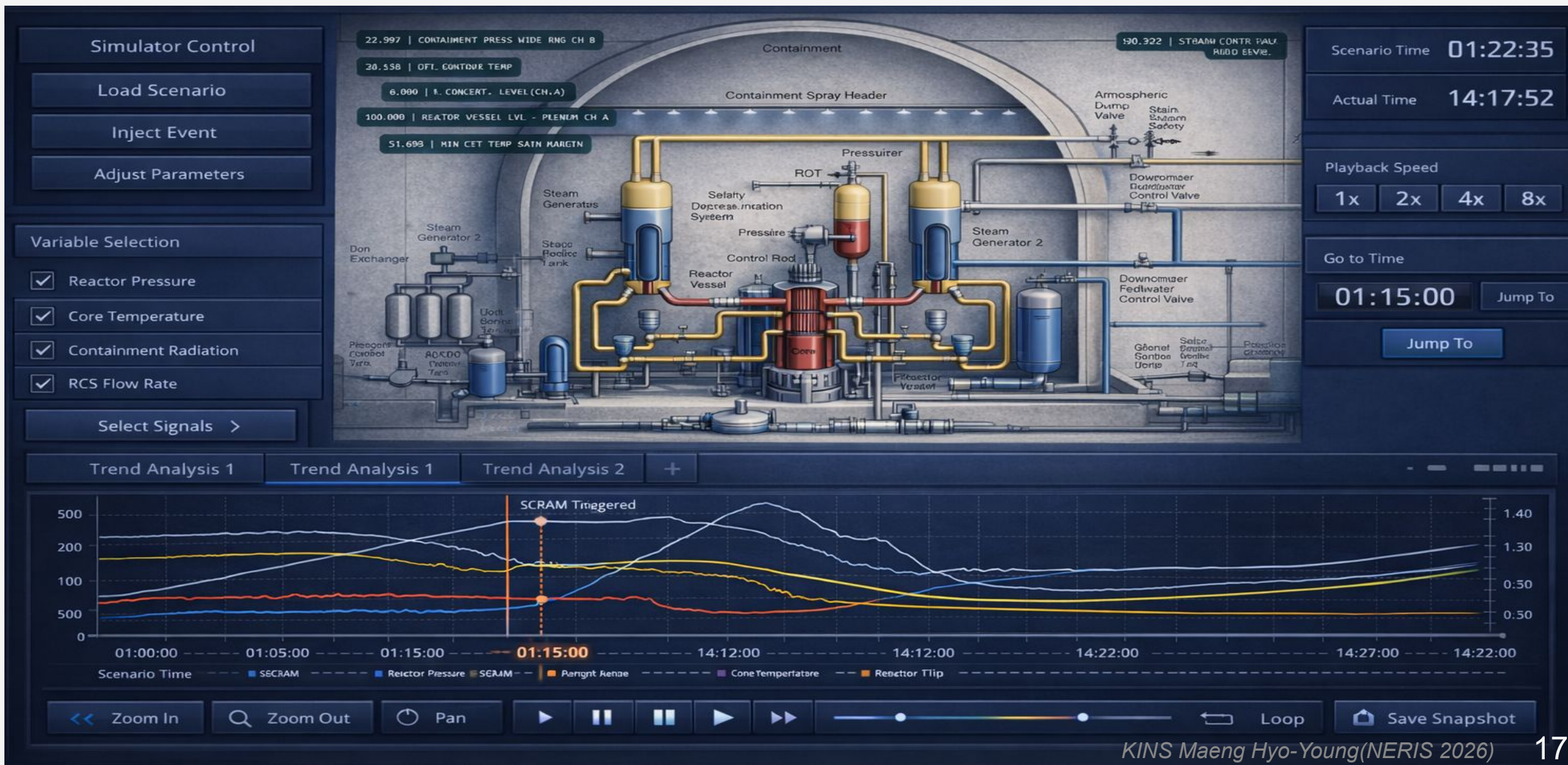
### Variable Control Panel:

Signal selection and Main System mapping.

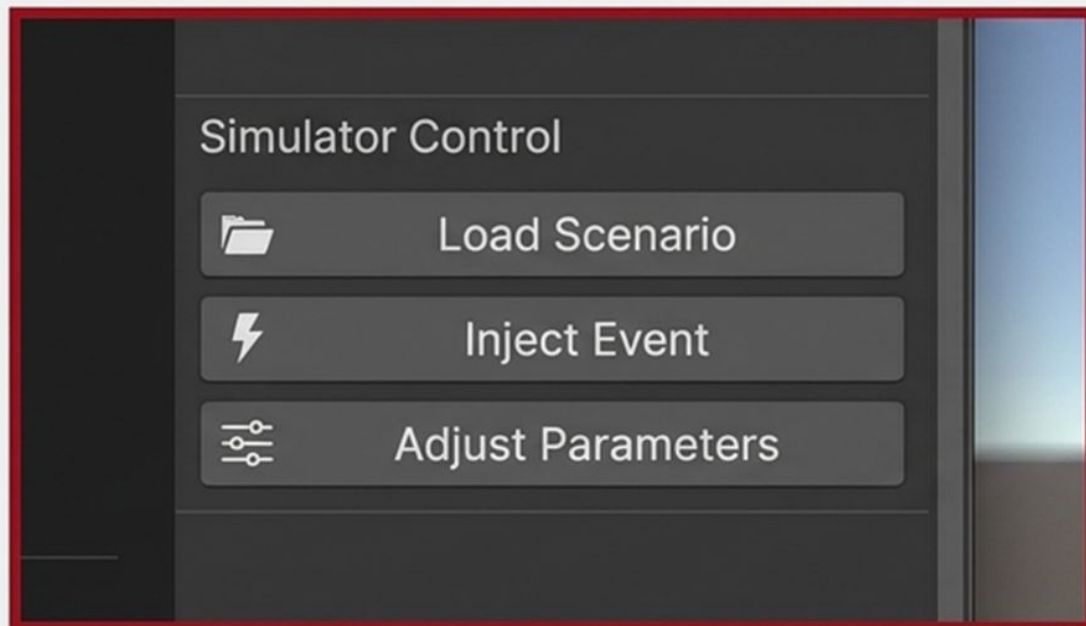
### Trend Display:

Multi-variable analysis and temporal alignment.

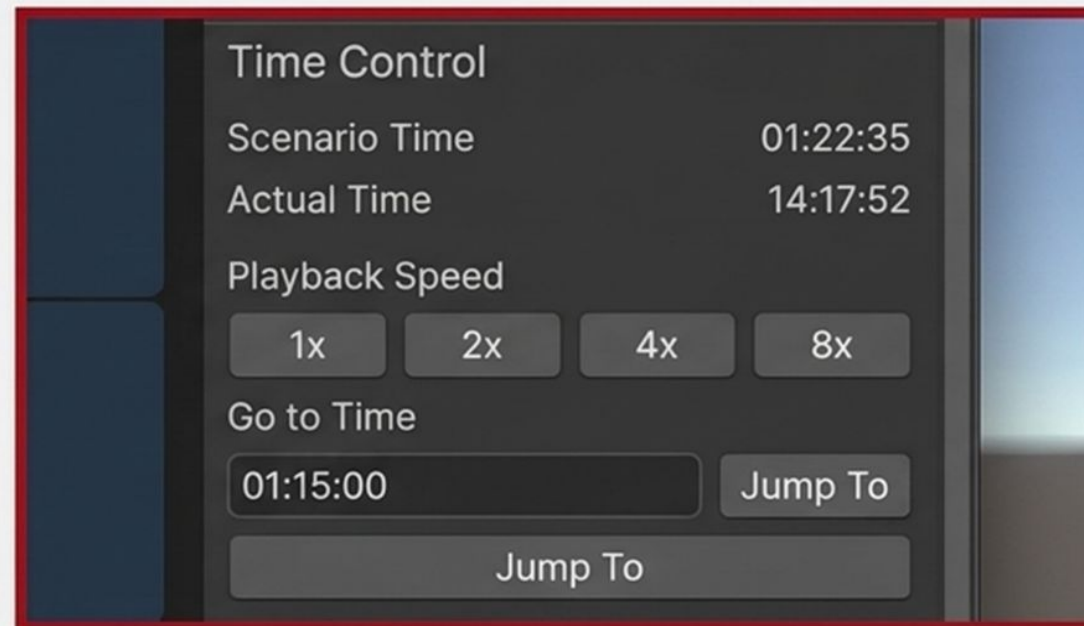




## Function 1 | Command Center : Execution Control



**Scenario Management:** Instantly load new conditions, manually inject critical events, and adjust underlying parameters on the fly.



**Temporal Precision:** Total control over execution states. Sync scenario time to actual time, accelerate playback up to 8x, or utilize precise "Jump To" temporal markers for instant reviews.

## I Function 2 | Customizing : Key Variable Selection



The image shows a 'Variable Selection' interface with a dark blue background. It features a title bar 'Variable Selection' at the top. Below it are four rows, each with a red checkmark icon in a square box and a text label: 'Reactor Pressure', 'Core Temperature', 'Containment Radiation', and 'RCS Flow Rate'. At the bottom is a button labeled 'Select Signals >'.

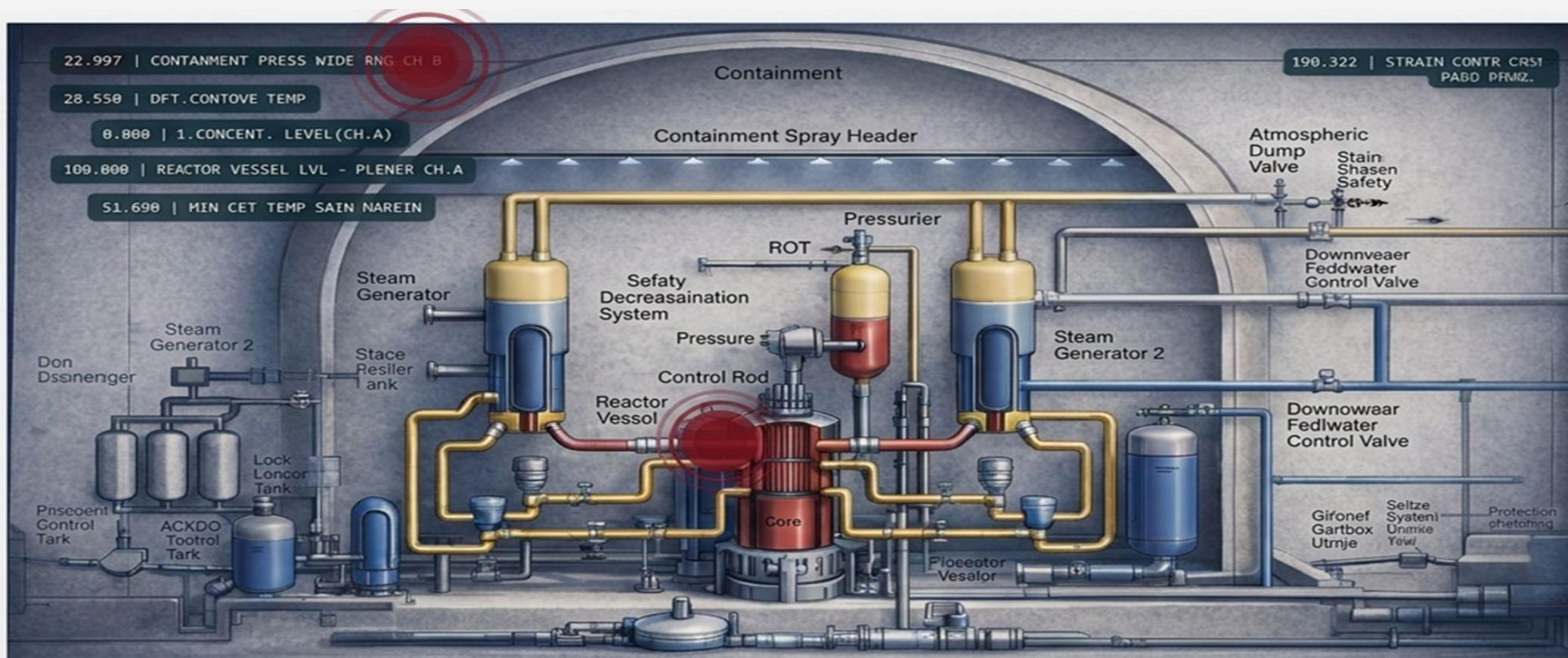
### Targeted Monitoring

Isolate exact plant systems with a single click—Reactor Pressure, Core Temperature, Containment Radiation, and RCS Flow Rate.

### Group-Based Logic

Switch between full signal lists by system, or utilize search/group-based tag selection to instantly declutter the operator's view during high-stress anomaly events.

## Function 3 | Situational Awareness : System Diagram



**Parameter Mapping:** Real-time integration database values are superimposed directly onto the physical plant schematics.

**Status-Based Display:** Instant visual cues differentiate Normal operations from active Warnings (Highlighting, Blinking).

**Granular Inspection:** Unprecedented zoom, panning, and detailed hover-state functions for micro-level system diagnostics.

## Function 4 | Diagnostic Depth : Multi-Variable Trend Display



### Auto-Scaling Fidelity

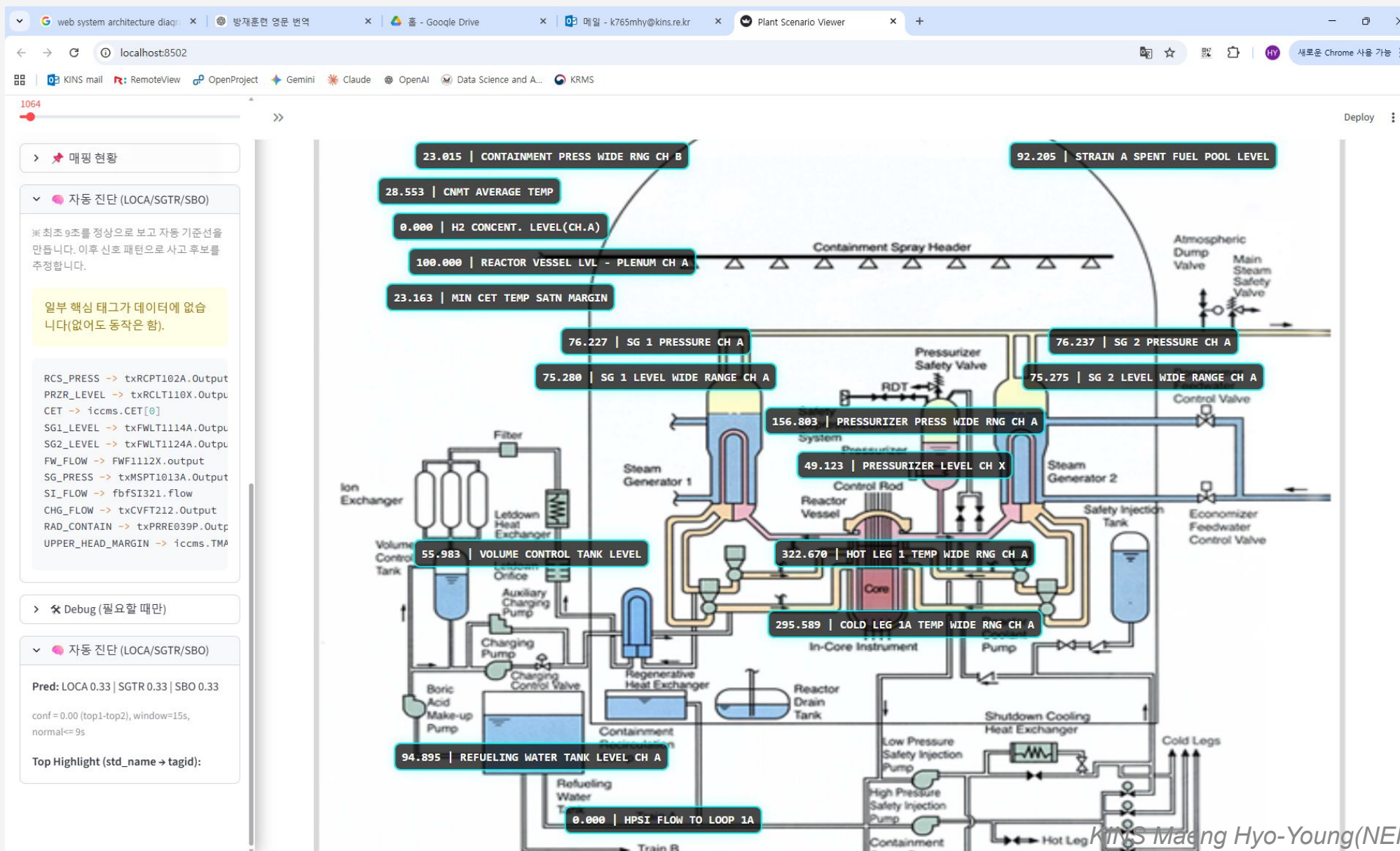
The Y-axis automatically adjusts to accommodate multiple overlapping variables (Pressure, Temperature, Level) without visual distortion.

### Event Contextualization

Critical timeline events (e.g., SCRAM triggers) are graphically overlaid on the data stream for instant causality mapping.

### Rich Interaction

Complete timeline authority—zoom, pan, loop specific ranges, and save analytical snapshots for post-action review.





# Validation and Implementation Roadmap



■ Minimizing the Gap Between Training and Actual Operations

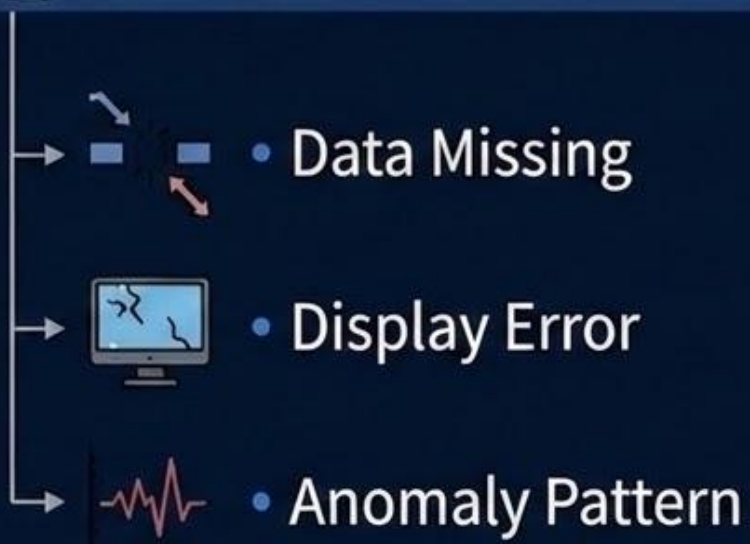
|                              | Training                                                    | Actual                                                        | Results                                                   |
|------------------------------|-------------------------------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------|
| Information Delivery methods | <b>NEIS Training Module</b>                                 | AtomCARE NEIS Real-time Data                                  | Lack of Interface Usage Experience                        |
| Time Flow                    | <b>Continuous time-series data over the training period</b> | Continuous real-time Data                                     | Reduced Agility to Grasp Accident Progression             |
| Decision-Making Processes    | <b>Urgent &amp; Complex (Enhance realism)</b>               | Rapid judgement under Time Pressure and Uncertain Information | Limitations in Verifying Real-World Response Capabilities |
| Using Module                 | <b>All 5 Training Module (Including NEIS)</b>               | AtomCARE                                                      |                                                           |

■ Expected Benefits

- Strengthen KINS emergency response capabilities through enhanced realism and data-driven analysis
- Enhance overall preparedness and enable more accurate, timely decision-making in radiological emergencies



## Parameter Anomaly Detection Algorithm (Rule-Based)



## Dynamic Information Prioritization



# Thank You

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