
# Severa: Decision Support Software for Severe Accident Management in Nuclear Power Plants

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**Abstract:** *Severa* is a demonstration-level *decision support system* for *severe accident management* in *nuclear power plants* (NPP). It is aimed at aiding the expert team in the *Technical Support Center* (TSC) while managing a severe accident and for training. Severa provides three main functions: *diagnostic* (assessing the state of key NPP systems), *prognostic* (predicting possible further accident progressions), and assessment of *possible accident management actions* (*decision alternatives*) *and their consequences* (in terms of expected radioactive releases to the environment). Severa was implemented in the context of NARSIS (New Approach to Reactor Safety ImprovementS), an EU Horizon 2020 project (2017-2022). Severa has been already presented at ICDSST 2020 while it was still in the design and development stages. In 2022, it is a fully developed prototype system, thoroughly verified and validated on several hundreds of simulated, but realistic accident scenarios.

## CONTEXT

**NARSIS**: ***New Approach to Reactor Safety ImprovementS***
EU Horizon 2020 project, 2017-2022
http://www.narsis.eu/

**Severe accidents in NPPs**: Rare circumstances that can cause severe core degradation, damage to the nuclear fuel, vessel and/or containment, release of radioactivity to the environment.

## OBJECTIVES

- A prototype proof-of-concept demonstration-level Decision Support System for Severe Accident Management,
- aimed at supporting the TSC team while managing a severe accident ...
- ... and for training.

## FUNCTIONALITY

- **Monitoring**: Time series of 8 key system parameters (temperature, water level, pressure, ...)
- **Diagnosis**: What is the current state of NPP barriers?
- **Prognosis**: What can happen in the future?
- **Decision Making**: What can be done to resolve the situation?
- **Assessment of consequences**: What are the expected radioactive releases coming out from alternative actions?

## METHODS

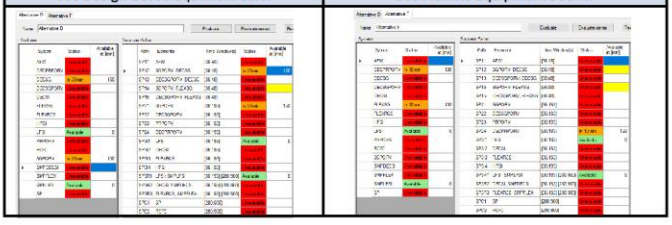
- **Success Trees** (inverse of Fault Trees) to define success paths of high-hevel management actions.
- **Probabilistic Safety Assessment (PSA)** to assess the probability of actions' success in a given time window.
- **Qualitative hierarchical multi-criteria rule-based models (DEX)** to assess barrier states and predict possible developments of the event.
- **Accident progression event trees (APET)** to determine NPP hazard damage states and consequently, combined with **DEX**, to assess expected radioactive releases.
- **Data Modeling** to represent static and dynamic elements of severe accident management.

## MONITORING, DIAGNOSIS AND PROGNOSIS

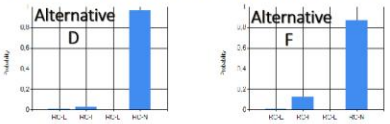
| MONITORING and INTERPRETATION | DIAGNOSIS | PROGNOSIS |
|---|---|---|
| 8 System Parameters | Barrier States | Progress |

## ALTERNATIVES: AVAILABILITY OF SYSTEMS

| Altrernative D | Alternative F |
|---|---|
| Use Design-Based Equiment Later | Use Flexible Equipment Sooner |



## CONSEQUENCES: RADIOACTIVE RELEASES




RC-E: Early release (hours)
RC-I: Intermediate (~ 1 day)
RC-L: Late (several days)
RC-N: Long-term concern

## RESULTS AND CONTRIBUTIONS

- Providing support in a difficult, time-critical and stressful situation
- Timely and useful information about the barriers and events
- A training tool for TSC team members
- Reducing the risk of inappropriate decisions
- Thoroughly tested on several hundreds of realistic accident scenarios.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