

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

Marko Bohanec<sup>1</sup>, Adem Kikaj<sup>2</sup>, Ivan Vrbanic<sup>3</sup>, Ivica Bašic<sup>3</sup>, Klemen Debelak<sup>4</sup>, Luka Štrubelj<sup>4</sup>
1 Jožef Stefan Institute, Department of Knowledge Technologies, Jamova cesta 39, SI-1000 Ljubljana, Slovenia
2 International Postgraduate School Jožef Stefan, Jamova cesta 39, SI-1000 Ljubljana, Slovenia
3 APoSS, System Reliability and Safety Analyses, Repovec 23B, HR-49210 Zabok, Croatia
4 GEN energija, d.o.o, Vrbina 17, SI-8270 Krško, Slovenia
marko.bohanec@ijs.si, ademkikaj95@gmail.com, ivan.vrbanic@zg.t-com.hr, basic.ivica@kr.t-com.hr,
klemen.debelak@gen-energija.si, luka.strubelj@gen-energija.si

web-page: https://icdsst2022gr.wordpress.com/

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

#### CONTEXT



NARSIS: New Approach to Reactor Safety ImprovementS

EU Horizon 2020 project, 2017-2022 http://www.narsis.eu/

simulated, but realistic accident scenarios.

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.

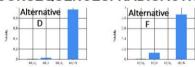
#### MONITORING, DIAGNOSIS AND PROGNOSIS

MONITORING and INTERPRETATION 8 System Parameters									DIAGNOSIS  Barrier States						PROGNOSIS  Progress
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#### **ALTERNATIVES: AVAILABILITY OF SYSTEMS**



#### **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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