



## Supporting Severe Accident Management in Nuclear Power Plants

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## CONTEXT



### NARSIS:

New Approach to Reactor Safety Improvements

EU Horizon 2020 project, 2017-2021

<http://www.narsis.eu/>

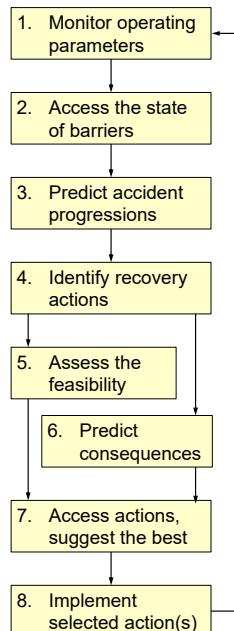
## OBJECTIVES

Improve systems, resources and training to enable effective responses to severe accidents in nuclear power plants.

Develop "Severa":

- a prototype demonstration-level decision support system,
- aimed at supporting the Technical Support Center
- while managing a severe accident
- and for training.

## STAGES



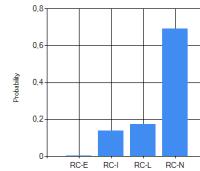
## SOME USER VIEWS

Line	CET/TC	S&A	RCS	RCS	RCS	Containment	Monitoring		Progress	
							8 parameters	Barrier states	Core State	Containment Progress
1	CET/TC	S&A	RCS	RCS	RCS	Containment	Level 91	HQ: 2	OK	OK
10	306	95.0	100.0	95.0	95.0	Containment	Level 91	OK: 0.5	OK	OK
20	306	94.0	100.0	94.0	94.0	Containment	Level 91	OK: 1.2	OK	OK
30	306	93.0	100.0	93.0	93.0	Containment	Level 91	OK: 1.2	OK	OK
40	310	92.0	100.0	92.0	92.0	Containment	Level 91	OK: 1.2	OK	OK
50	320	91.0	100.0	91.0	91.0	Containment	Level 91	OK: 1.2	OK	OK
60	320	90.0	100.0	90.0	90.0	Containment	Level 91	OK: 1.2	OK	OK
70	347	89.0	100.0	89.0	89.0	Containment	Level 91	OK: 1.2	OK	OK
80	362	88.0	100.0	88.0	88.0	Containment	Level 91	OK: 1.2	OK	OK
90	362	87.0	100.0	87.0	87.0	Containment	Level 91	OK: 1.2	OK	OK
100	387	86.0	100.0	86.0	86.0	Containment	Level 91	OK: 1.2	OK	OK
110	415	85.0	100.0	85.0	85.0	Containment	Level 91	OK: 1.2	OK	OK
120	415	84.0	100.0	84.0	84.0	Containment	Level 91	OK: 1.2	OK	OK
130	415	83.0	100.0	83.0	83.0	Containment	Level 91	OK: 1.2	OK	OK
140	415	82.0	100.0	82.0	82.0	Containment	Level 91	OK: 1.2	OK	OK
150	415	81.0	100.0	81.0	81.0	Containment	Level 91	OK: 1.2	OK	OK
160	415	80.0	100.0	80.0	80.0	Containment	Level 91	OK: 1.2	OK	OK
170	415	79.0	100.0	79.0	79.0	Containment	Level 91	OK: 1.2	OK	OK
180	415	78.0	100.0	78.0	78.0	Containment	Level 91	OK: 1.2	OK	OK
190	415	77.0	100.0	77.0	77.0	Containment	Level 91	OK: 1.2	OK	OK
200	415	76.0	100.0	76.0	76.0	Containment	Level 91	OK: 1.2	OK	OK
210	415	75.0	100.0	75.0	75.0	Containment	Level 91	OK: 1.2	OK	OK

### Possible actions

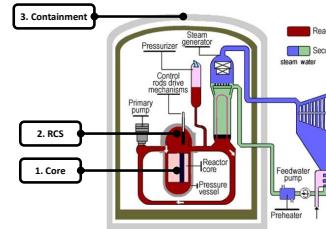
HLA1		Success Path		Description	Elements
SP11	High Level Action 1	Inject into Steam Gen.	SP11	Injection by Auxiliary Feedwater	AFW
SP12	Depressurize SG to DEC SG shutdown by SG.	SP12	SGPORV, DECG	Depressurize SG to DEC SG shutdown by SG.	SGPORV, DECG
SP13	Depressurize SG to DEC SG shutdown by DE.	SP13	DECG, SGINR	Depressurize SG to DEC SG shutdown by DE.	DECG, SGINR
SP14	Depressurize SG to FLEX SG shutdown by SG.	SP14	FLEXSG, SGINR	Depressurize SG to FLEX SG shutdown by SG.	FLEXSG, SGINR
SP15	Depressurize SG to FLEX SG shutdown by DE.	SP15	DECG, SGINR	Depressurize SG to FLEX SG shutdown by DE.	DECG, SGINR
HLA2	High Level Action 2: Depressurize RCS	SP21	SGPORV, SGINR	Depressurize RCS by SG PORV.	SGPORV, SGINR
		SP22	SGPORV, SGINR	Depressurize RCS from secondary side by PR.	SGPORV, SGINR
		SP23	SGINR	Depressurize RCS from primary side by PR.	SGINR
		SP24	SGINR	Depressurize RCS from primary side by DE.	DECPORV

### Assessment of radioactive releases



RC-E: Early release  
RC-I: Release expected in several days  
RC-L: Release not expected in several days  
RC-N: Long-term concern

## SEVERE ACCIDENTS AND MANAGEMENT



### Nuclear Power Plant

Type: Pressurized Water Reactor

#### Barriers:

1. Reactor Core
2. Reactor Cooling System (RCS)
3. Reactor Containment

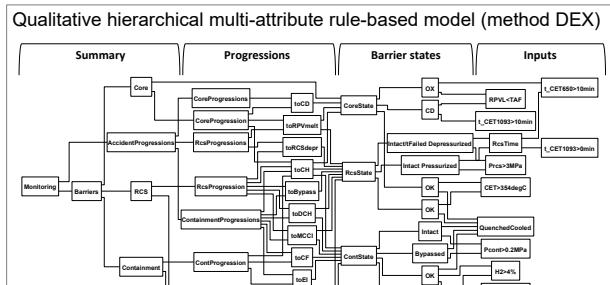
**Severe accident:** Rare circumstances that can cause:

- Severe core degradation
- Damage to the nuclear fuel, vessel and/or containment
- Release of radioactivity to the environment

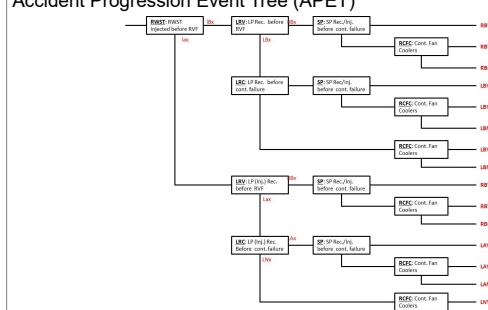
#### Severe Accident Management:

- by Technical Support Center
- according to Severe Accident Management Guidelines

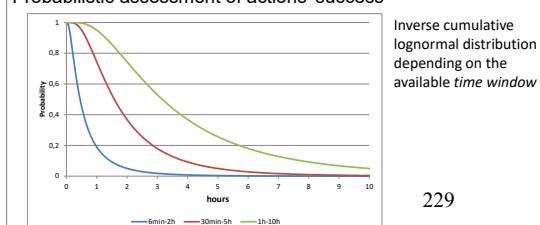
## MODELS



### Accident Progression Event Tree (APET)



### Probabilistic assessment of actions' success



## CONTRIBUTIONS

- Providing support in a difficult, time-critical and stressful situation
- Timely and useful information about the barriers and events
- Assessment: actions × systems → alternatives → consequences
- Operationalization of guidelines for a specific situation

Work in progress, to be completed in 2020 and validated in 2021.

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