
LUT
University
LAND
OF THE
CURIOUS

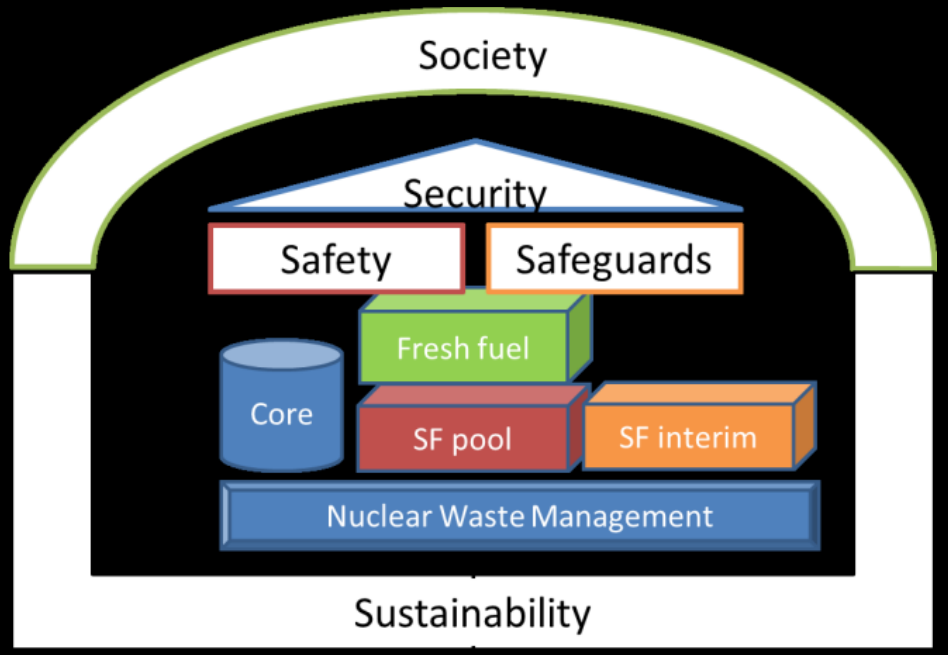
Final Seminar of the SAFIR2022

OSAFE PROJECT 2019-2022

DEVELOPMENT OF FRAMEWORK FOR JUSTIFICATION OF OVERALL SAFETY

JUHANI VIHAVAINEN

LUT UNIVERSITY



Final Seminar of the SAFIR2022

OSAFE - Development of Framework for Justification of Overall Safety

- OSAFE has been joint project with LUT University and VTT during 2019 - 2022
- Participants over the years:
  - Juhani Hyvärinen, Juhani Vihavainen, LUT
  - Mikko Turunen, Aleksi Valkeapää, Henri Rapeli, MSc students, LUT
  - Kim Björkman, Essi Immonen, VTT
  - Marja Ylönen, Janne Valkonen, VTT (during 2019 – 2021)

Final Seminar of the SAFIR2022

OSAFE

Safety significance:

The project identified key factors effecting to the holistic understanding of safety. The original ORSAC framework allows easy comparison of technical implementation of Defence-in-Depth in different reactor designs, and assessment of the adequacy thereof. Extensions of ORSAC framework using defence level analogies highlight the synergies and contradictions between safety, security and safeguards.

MAIN objectives:

- Overall Safety Conceptual Framework (ORSAC) development and related studies
- Semantic modelling and Graded Approach studies
- To provide MSc thesis opportunities on various subjects on overall safety
- Journal article on overall safety investigation
- Organize overall safety seminars annually

OSAFE

Main results:

- Slideset of overall safety (2019): Semantic modelling and ORSAC Framework
- Three MSc thesis prepared:
  - Turunen M., Overall safety of small modular reactors (2020)
  - Valkeapää A., Overall safety and the ‘3s’ of small modular reactors (2021)
  - Rapeli H., Comparison of societal risk acceptance criteria in different areas of society (2023)
- Overall safety seminars (8), organized by LUT annually 2015 – 2022
- Journal article: “An overall safety concept for nuclear power plants” published in Annals of Nuclear Energy, 2022 (Hyvärinen, J., Vihavainen, J., Ylönen M., Valkonen, J.)

Final Seminar of the SAFIR2022

OSAFE

Example of results (MSc thesis, M. Turunen)

The major operating systems as well as front-line safety systems implemented in NuScale reactor concept (SMR) placed on the functional **Defense-in-Depth** template (ORSAC).

Identifying dependencies of safety systems credited in different operational conditions.

	Operational States		Accident Conditions		
	Normal Operation	Anticipated Operational Occurrences	Design Basis Accidents	Design Extension Conditions	
				Without significant fuel damage	With core melting
Subcriticality	CVCS	CVCS			"N/A"
	CRA	CRA	CRA		
	Soluble boron				
	Gadolinia				
Heat removal	SG → Condenser → CWS → Atmosphere	SG → Condenser → CWS → Atmosphere			
	RCCWS → SCWS → Atmosphere	RCCWS → SCWS → Atmosphere			
		ECCS → CNV → UHS	ECCS → CNV → UHS	ECCS → CNV → UHS	
		SG → DHRS → UHS	SG → DHRS → UHS	SG → DHRS → UHS	
			RPV → CNV → UHS	RPV → CNV → UHS → Atmosphere	RPV → CNV → UHS → Atmosphere
				CFDS	
Containment	Closed piping (RCPB)	Closed piping (RCPB)	RPV	RPV	
	RSVs → CNV	RSVs → CNV			
		CIVs	CIVs	CIVs	
Power supply	TG				
		EDSS	EDSS		
			BPSS	BPSS	
HVAC	CRVS	CRVS	CRHS	CRHS	
	RBVS	RBVS			

Final Seminar of the SAFIR2022

OSAFE

Example of results

(MSc thesis, A. Valkeapää):

Proposed integration of

Safety-Security-Safeguards (3S)

for **Defense-in-Depth** template (ORSAC).