SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT

SASPAM-SA (Safety Analyses of SMR with Passive Mitigation strategies - Severe Accident) Horizon Euratom Project- CURRENT STATUS

International Conference on Small Modular Reactors and their Applications
21–25 October 2024, Vienna, Austria

Fulvio Mascari

ENEA, via Martiri di Monte Sole, 4, 40129, Bologna, ITALY

R&D GAPS ALONG SASPAM-SA PREPARATION

- iPWRs SA investigation is very limited and iPWRs safety assessment, with best estimate methods, is still not addressed.
- Novel topics of current high interests for TSOs, regulators, research centres, universities, industries and operators, are:
  - Systematic analyses of the applicability and transfer of the current available SA experimental database (developed for current large-LWR) for iPWR safety assessment studies, and
  - Analyses of current codes capabilities to simulate SA phenomena.
- Current on-going activities on iPWR, the SA investigation is very limited but DiD levels 1,2,3 are investigated.
- Project can contribute, going beyond the state-of-art, to investigate the key elements to create an European independent point of view on the safety of iPWR with respect to DiD levels 4/5.

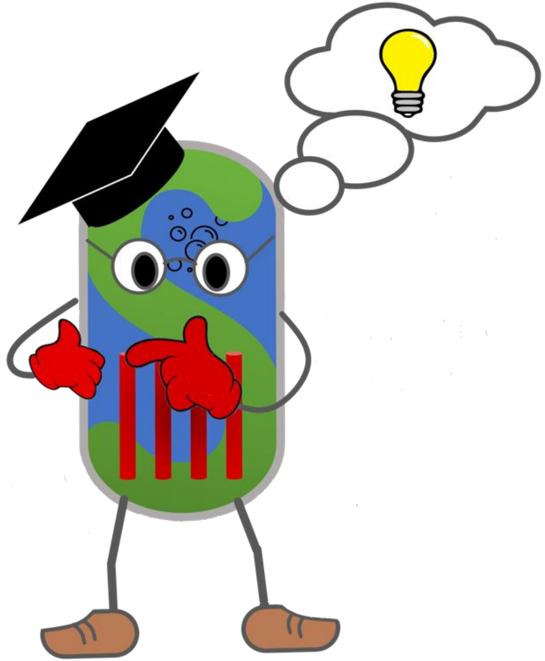
KEY OBJECTIVE AND KEY OUTCOME

- Key Objective of SASPAM-SA:

  investigate the applicability and transfer of the operating large-LWR reactor knowledge and know-how to the near-term deployment of integral PWR (iPWR), in the view of Severe Accident (SA) and Emergency Planning Zone (EPZ) European licensing analyses needs.

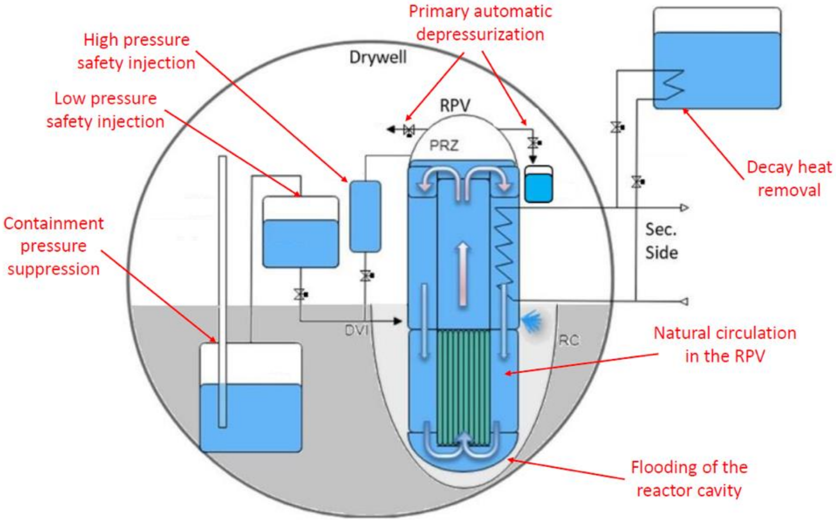
- Key Outcome of SASPAM-SA :
  - *To be supportive for the iPWR licensing process by bringing up key elements of the safety demonstration needed.*
  - *To speed up the licensing and siting process of iPWRs in Europe.*

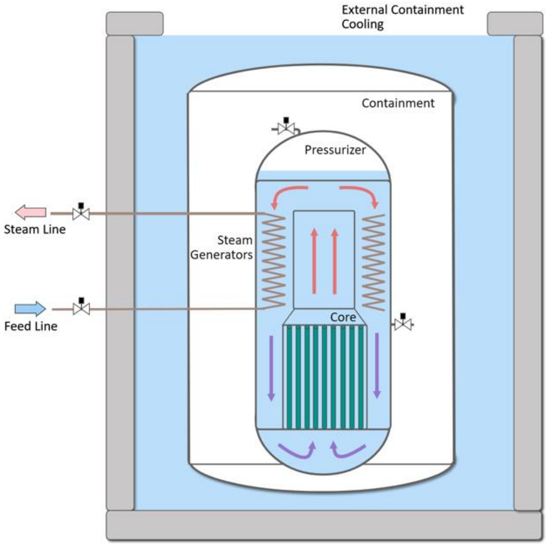
- Dedicated actions on:
  - Accident Tolerant Fuels (ATF)
  - In-Vessel Melt Retention (IVMR).



SPECIFIC NEEDS

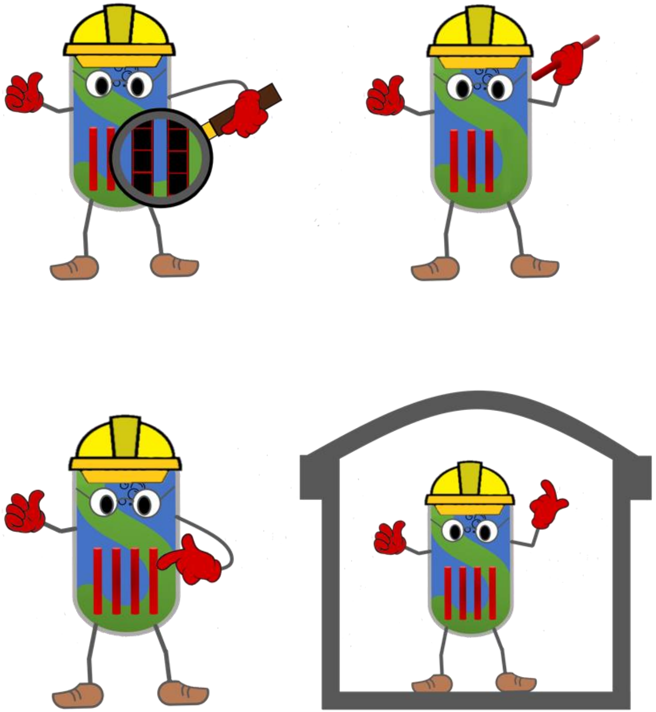
- Advanced designs, as iPWRs, are in general characterized by:
  - Common features with the current operating large-LWR;
  - Other specific features typical of their inherent evolutionary designs, providing safety advantages that reinforce the first three levels of the DiD principle.





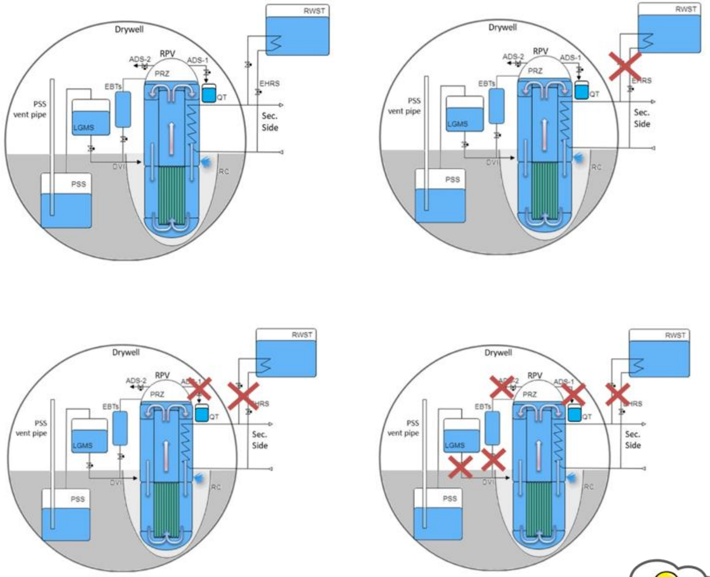
SPECIFIC NEEDS

- However, even if a plant is designed with advanced inherent features (through the reinforcement of the 1,2,3 DiD levels) allowing a reduction of the Core Damage Frequency (CDF),
  - Independent features for preventing and mitigating a severe accident sequence have to be included in its design (DiD level 4) together with the offsite emergency response (DiD level 5).
- Therefore, some scenarios that could lead to severe accidents need to be postulated and deterministically studied.
- Therefore, it is necessary to assess the capability of internationally recognized SA code to describe the behaviour of the most promising iPWR designs during SA scenarios and to predict the resulting radiological impact on- and off-site.

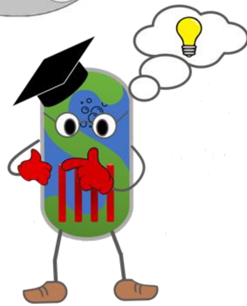


SPECIFIC NEEDS

- Passive systems:
    - Are an advanced solution to increase the inherent safety of the plant (e.g., there is no need of pumps);
    - Require extensive investigation for assessing the functional failure related to the thermal-hydraulic phenomena driving the operation of the systems and assess the related uncertainties;
    - May still need an active initiation;
    - Are characterized by very limited operational experience.



- The impact of the operation of passive systems on postulated severe accident progression is a novel topic and needs to be assessed.

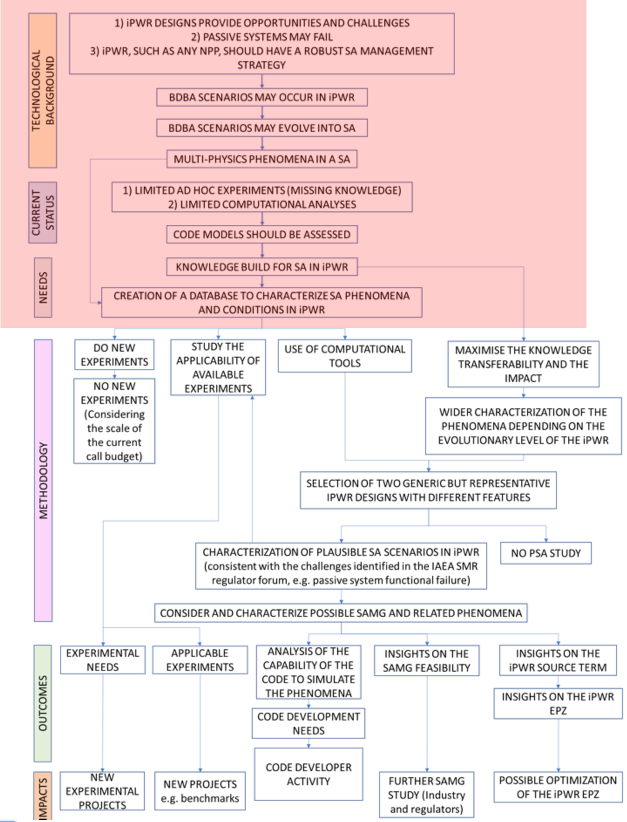


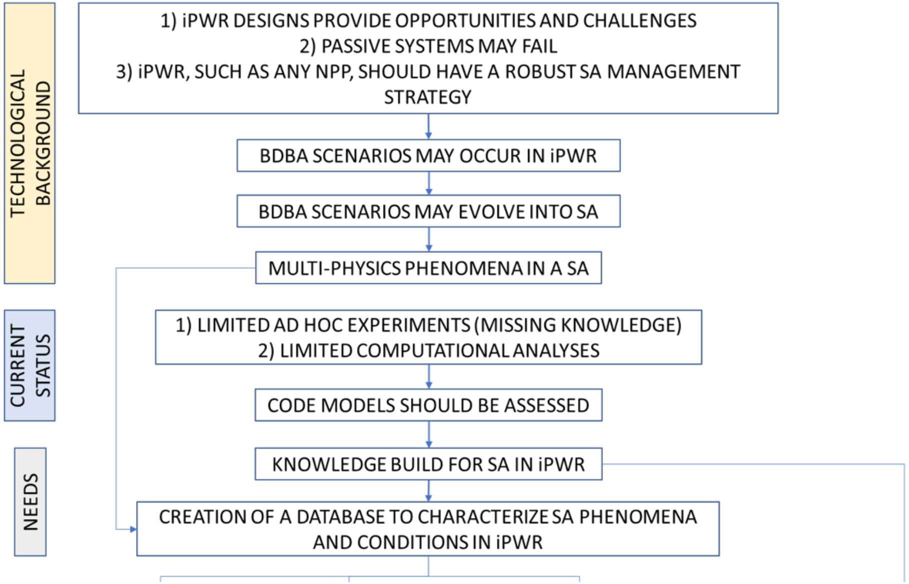
SPECIFIC NEEDS

- Identification of plausible SA scenarios for iPWR and address potential impact on the environment;
- Investigation of the applicability and transfer of the operating large-LWR reactor SA knowledge & know-how (codes, experiments, methodologies, etc.) to the near-term deployment iPWR;
- Identification of SA experimental and code development needs;
- Test the current best estimate safety analyses methodologies for iPWR SA analyses;
- Start to address challenges of SA mitigation measures in iPWR including EPZ assessment.

GENERAL OVERVIEW OF THE PROJECT

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT



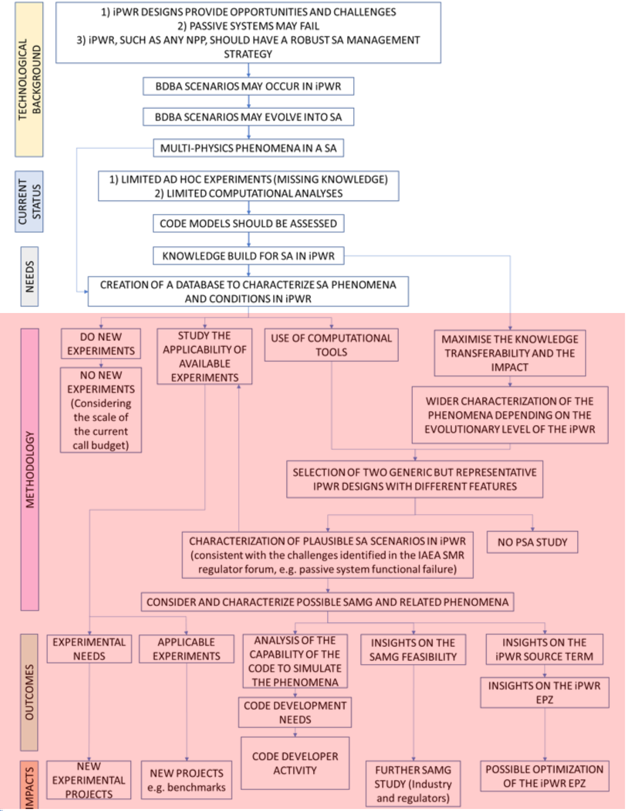


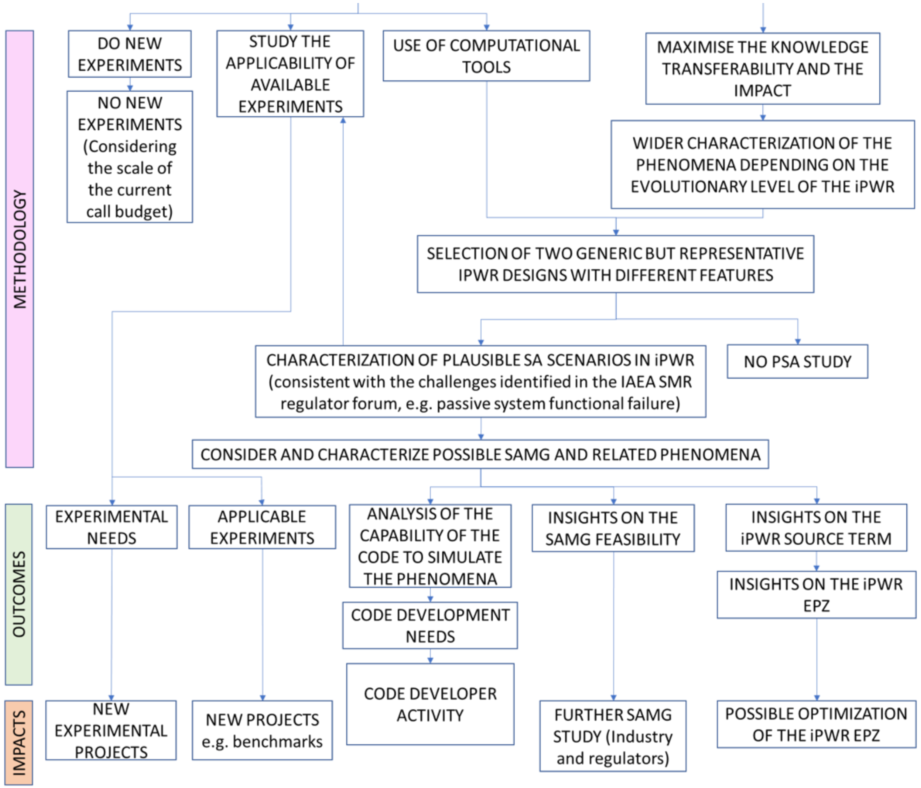
SPECIFIC OBJECTIVES

- Identification of plausible SA scenarios for iPWR designs;
- Identification of the conditions in the vessel and in the containment that characterize iPWR SA scenarios and differ significantly from those in large-LWRs;
- Study the applicability of the existing experimental database to iPWR and identify new experimental needs;
- Assess the capability of internationally recognized European and Non-European computational tools (largely used in Europe) to describe the behaviour of the most promising iPWR designs during SA scenarios and to predict the resulting radiological impact on- and off-site.

GENERAL OVERVIEW OF THE PROJECT

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT

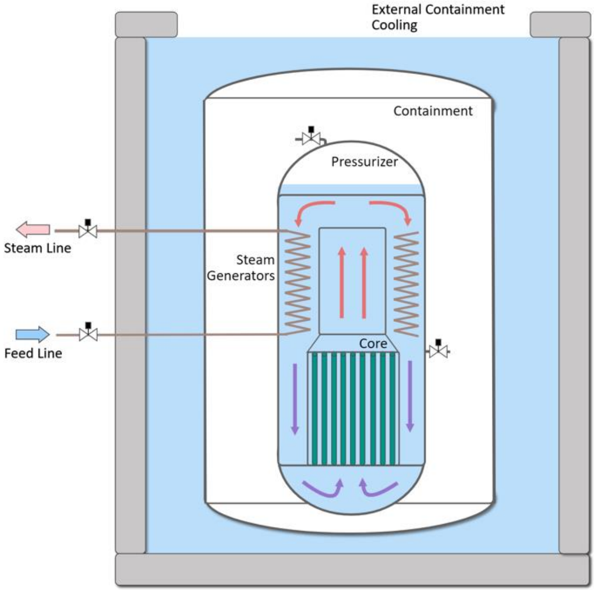




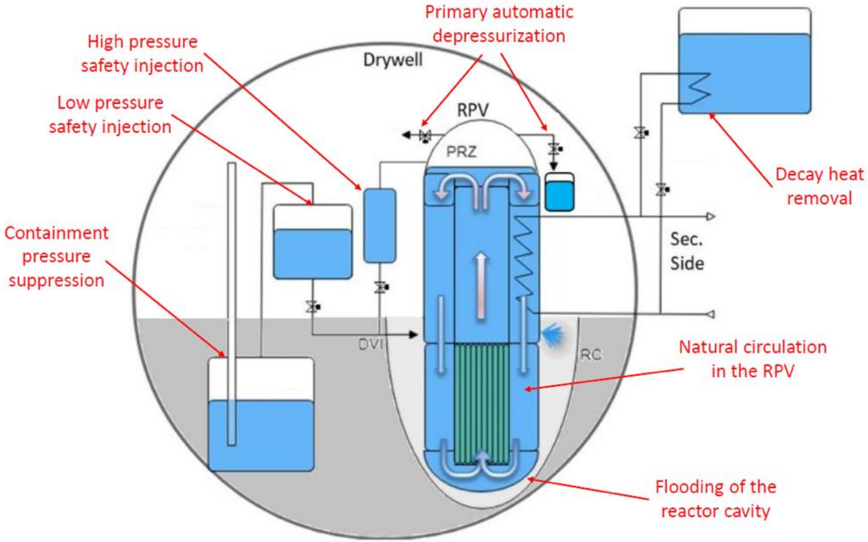
GENERIC DESIGNS CONSIDERED

- To maximize the knowledge transferability and impacts of the project:
  - Two generic design-concepts will be considered;
  - Characterized by Different evolutionary innovations in comparison with larger operating reactor.
- Despite generic, they resemble currently discussed designs and take benefit from available data in the open literature:
  - Design 1: iPWR characterized by a submerged containment and electric power of about 60 MWe;
  - Design 2: iPWR characterized by the use of several passive systems, a dry containment and an electric power of about 300 MWe.
- The two generic reactor concepts:
  - Include the main iPWR design features, considered in the most promising designs ready to go on the European market;
  - Allow to assess in a wider way the capability of codes (SA and CFD) to simulate the SA phenomena typical of iPWR.
- This will allow to characterize:
  - Feasibility and efficiency of the different SA mitigation features of the non-European designs, ready to be installed in Europe in the very near term;
  - Feasibility and efficiency of the different SA mitigation features of new European iPWR concepts, already in advanced design status, when the final designs become available.
- It is not the project's objective to assess the generic reactor designs selected; Based on the project findings, the target of the project is to allow a more general statement on the code's applicability to currently favored designs under postulated SA condition;
- No PSA considerations will be done in the project due to the generic nature of the reactor concept considered: Scenarios identified will be characterized in terms of severity but not in terms of probability.

GENERIC DESIGNS CONSIDERED



iPWR characterized by a submerged containment and electric power of about 60 Mwe



iPWR characterized by the use of several passive systems, a dry containment and an electric power of about 300 MWe

COMPUTATIONAL TOOLS USED IN THE PROJECT

- In SASPAM-SA several state-of-art computational tools will be adopted, both European and non-European largely used in Europe.

- For integral SA codes:
  - ASTEC (European code developed by IRSN);
  - AC2 (European code developed by GRS);
  - MAAP-EDF (non-European code developed by EPRI embedding EDF code changes);
  - MAAP (non-European code developedby EPRI);
  - MELCOR (non-European code developed by Sandia National Laboratories for the USNRC).

- For CFD codes:
  - ContainmentFOAM (European code developed by FZJ);
  - ANSYS CFX (non-European code developed by Ansys Inc.).

- For atmospheric dispersion codes:
  - ARANO (European code developed by VTT);
  - JRODOS (European code developed by KIT);
  - MACCS (non-European code developed by Sandia National Laboratories for the USNRC).

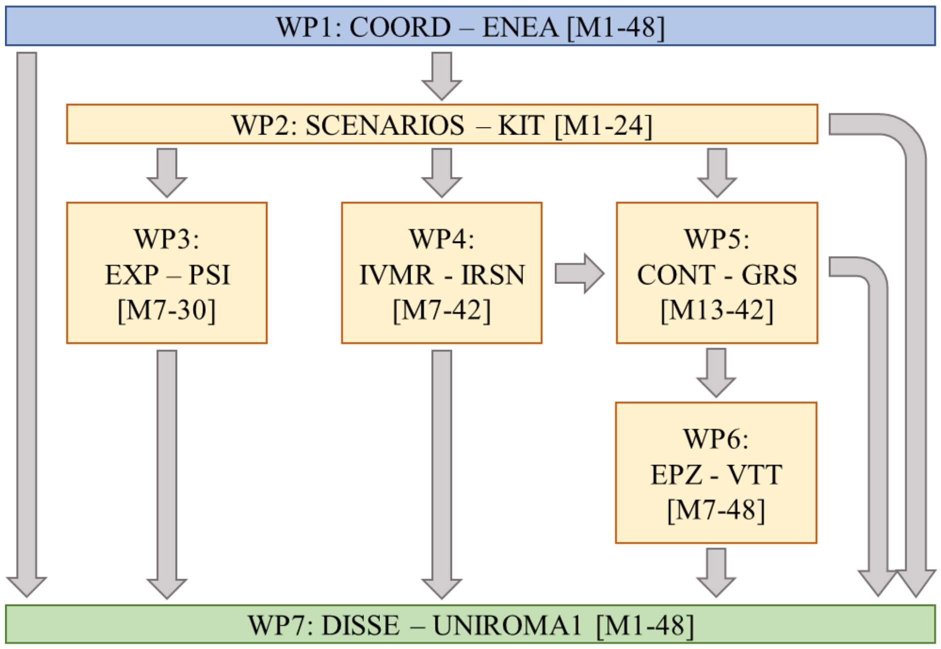
- For iodine chemistry:
  - IMPAIR (European code, developed as a European collaboration).

SPECIFIC OUTCOMES

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT

- Assessment and development of generic but representative iPWR SA codes input-decks:
  - Analyses of the iPWR behaviour under hypothetical postulated BDBA conditions;
  - Plausible SA scenarios in iPWR will be identified.
- Development of know-how in relation to the use of ATF in iPWR:
  - Enhances ATF application in iPWR;
  - Develop code capability to simulate it.
- Study the applicability of the existing experimental database to iPWR and identify new exp. needs.
- Study IVMR strategy in postulated SA scenarios in iPWR:
  - Assess the capability of the codes to simulate the main phenomena characterizing the IVMR in iPWR;
  - Characterize IVMR feasibility in iPWR.
- Study containment behaviour in postulated SA scenarios in iPWR:
  - Assess the capability of the codes to simulate the main phenomena characterizing the containment behaviour;
  - Characterize the efficiency of existing and innovative passive measures.
- Provide evaluations of size and extension of EPZ for postulated SA scenarios coupling the results of best estimate ST codes to radiological consequences tools.

SASPAM-SA PROJECT STRUCTURE AND SOME INSIGHTS



WP1 - Coordination

WP2 - Input deck development and hypothetical SA scenarios assessment (SCENARIOS)

WP3 - Applicability and Transfer of the Existing SA experimental database for iPWR Assessment (EXP)

WP4 - Assessment of code capabilities to simulate And evaluate corium retention in iPWRs (IVMR)

WP5 - Assessment of the code capabilities to simulate IPWR containment and characterize mitigation measures efficiency (CONT)

WP6 - Characterization of iPWR EPZ (EPZ)

WP7- Communication, dissemination and exploitation (DISSE)

WP2 - SCENARIOS

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT

- The objective of the WP2 is:
  - the development of generic but representative iPWR SA code input-decks and
  - the analysis of the iPWR behavior under hypothetical postulated SA-conditions.

- Two generic designs concepts, characterized by different evolutionary innovations, will be considered.

- In order to fulfil the goals, the following tasks will be addressed:

  - Development of plant models using different SA codes for iPWR Designs 1 and 2, including the estimation of the nuclide inventory for plausible radiological ST prediction;

  - Identification of plausible SA sequences for the iPWR Designs 1 and 2;

  - Simulation of selected SA-sequences for iPWR Designs 1 and 2 using different SA-codes, covering the in-vessel, the ex-vessel (if any), and the containment phenomena;

  - The capability of the codes to model ATFs will be investigated with the support of code developers.
    - The effect of the employment of the ATFs on the progress of the analyzed SA scenarios (RPV failure, hydrogen production, ST, etc.) in the iPWR designs will be investigated.
    - The data available from the QUENCH ATF-related experiments performed at KIT will be employed for the assessment of the results of the integral SA analysis codes

WP2 – INPUT-DECK STATUS – SA CODE

- In order to optimize the schedule of the project, the partners that have already available input-decks of the target codes (e.g. AC2, ASTEC, MELCOR, etc.) for the Design 1 or 2 will be involved in the development of iPWR SA scenarios since the beginning of the WP2.
- Results of a first survey suggest that a very limited number of iPWR SA code input- decks are already available in the European community. Therefore, the available input-deck will be shared through the Partners, and to have a complete set of input decks for the target codes, another group of partners will develop in parallel the missing input-decks for the Designs 1 and 2.

DESIGN	DESIGN	PARTNER	DBA	BDBA/SA	DTA	Sharing
DESIGN 1	MELCOR	PSI	✓	✓	✓	SURO
					✓	KTH
					✓	CIEMAT (NEW)
DESIGN 1	ASTEC	TRACTEBEL	✓	✓	✓	KIT
DESIGN1	AC2	RUB	✓	✓		SSTC
DESIGN 1	EDF-MAAP	EDF	✓	✓	NO SHARING PLANNED	
DESIGN 2	ASTEC	ENEA	✓	✓	✓	INRNE
					✓	RATEN
DESIGN 2	MELCOR	ENEA/UNIROMA1 /CIEMAT	✓	✓	✓	KTH
DESIGN 2	AC2	LEI	✓	✓	NO SHARING PLANNED	

WP2 - STATUS

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT

- Datasets of integral and CFD codes of the generic iPWR designs have been assessed (MILESTONE IS A LIVING DOCUMENTS);
- DBA and hypothetical SA scenarios have been postulated;
- A large calculation campaign has been performed and the results for the selected DBAs and hypothetical SA scenarios have been produced;
- The preliminary analysis of the results from the integral codes show that:
  - The codes are able to predict the key TH phenomena occurring in iPWRs
  - The codes produce results in a rather good qualitative agreement and quantitative agreement
- The collection of the results as well as the reporting phase are going on
- Thanks to the efficiency of the partners, discussions are going on to postulate additional SA scenarios, i.e., loss of containment isolation

WP3 - EXP

- The main objectives of the WP are to:
  - Study the relevance and applicability of the existing experimental database to iPWR,
  - Develop methods to extend the applicability of existing data,
  - Identify the need for new experiments.

- Based on the plant SA scenario identified and investigated in the WP2,
  - ➔the main boundary conditions of iPWR and the specific features will be determined.
    - ➔to identify the conditions in the RPV and in the containment during SA that characterize iPWR SA scenarios and that might differ considerably from large-LWRs.

- The relevant phenomena will be identified and the review of the current experimental database will be done considering the following phenomena:
  - a) In-vessel degradation and coolability;
  - b) Containment;
  - c) ST;
  - d) Ex-vessel coolability (If any ex-vessel phenomenology will be identified along the WP2).

WP3 EXP: Phenomena

	In-vessel	Ex-Vessel	Containment	Source term
CIEMAT			H_2 distribution in the containment	Pool scrubbing; ST
CNRS			Combustion and explosions risk; mitigation of the risk	
ENEA	Passive systems; natural circulation			
FZJ			H_2 mitigation with PAR	
IRSN			H_2 distribution	Iodine chemistry; mitigation
KTH	Debris formation; liquid melt spreading; steam explosion		pool T	
PSI			H_2 distribution	Aerosol transport
RATEN	Re-flooding; rod-like, debris	Corium cooling, MCCI		
SSTC	In-vessel degradation and coolability			
TUS	In-vessel melt pool	Ex-vessel coolability		
VTT				Aerosol properties

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT

WP3 EXP: Phenomena

Define phenomenon
- Main equations: which equations determine phenomenon
- Parameters: which are the main parameters defining the phenomenon
- Dimensionless numbers: which dimensionless numbers are most significant to the phenomenon

Define experiments / facilities
- Scaling factor of the facility
- Boundary conditions in the tests
- Measurements: which properties have been measured
- Values of the main parameters and dimensionless numbers in experiments

iPWR boundary conditions
- Boundary conditions in the iPWR during the times when the phenomenon is important
- Values of the main parameters and dimensionless numbers in iPWR

Comparison of iPWR and data
- Compare the boundary conditions, main parameters and dimensionless numbers in iPWR and experiments
- A good way to do this could be a table in which iPWR and experiments parameters are compared

Distribute the experimental data into categories
- 1: Data are applicable to iPWR
- 2: Data maybe applicable but methods need to be developed for adaptation
- 3. Data are not applicable

WP3 EXP: SUMMARY

Review of experimental data:

Identify the main phenomena:

- Natural circulation, In-vessel and ex-vessel core degradation, hydrogen risk, and source term covered
- Specific iPWR features from WP2: plant analysis
- The major differences in large-LWR and iPWR identified using dimensionless numbers
- Conditions during severe accidents dynamic → need to cover a wide range of values for parameters

Classification of data:

1. Applicable to iPWR
2. Applicable with extrapolation / other methods
3. Not applicable → need for further data

WP4 - IVMR

- Based on the Designs 1 and 2 input-decks and the postulated SA scenarios developed in WP2, the objective of this WP is to:
  - Investigate IVMR strategy in a postulated SA scenario in iPWR;
  - Assess the capability to simulate the main phenomena characterizing the IVMR in iPWR;
  - Characterize its feasibility by guided calculations.
- The main sources of uncertainty will be investigated together with a limited study of the effect of different claddings (e.g. ATF).
- The WP4 objectives will be addressed by:
  - Analysing the processes leading to the formation of a molten pool in the lower plenum and the possible oxide/metal stratification (impact of cladding material will be analysed at this stage);
  - Identifying/Implementing modifications to the models used for operating PWR in SA codes;
  - Evaluating the safety margin for a few iPWR designs and the degree of confidence. BEPU analysis for characterizing the different sources of uncertainty.

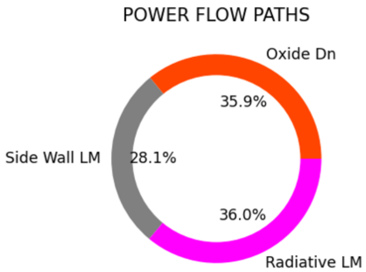
WP4.1: Preliminary conservative analyses [M7-M18]

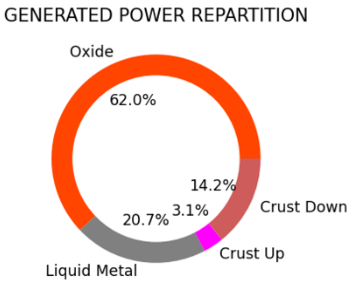
- A **0D Corium Model** was developed to preliminary investigate the **In-Vessel Melt Retention** (**IVMR**) phenomenon for **integral Pressurized Water Reactors** (**iPWR**).
- So far, the prepared model allows the calculation of **corium composition** and **heat transfer performances**.
- The main aim of the technical activity related to SASPAM-SA WP 4.1 task is setting up a **steady-state simplified model of IVMR** able to be used for:
  - ❖ Identify specificities of iPWRs in terms of IVMR parameters;
  - ❖ Provide the partners a fast-running tool giving the magnitude of expected results for a wide range of steady state configurations;
- The outcomes of this simplified model will provide a feedback on the most relevant parameters/phenomenologies to be investigated with 'complete' reactor calculations.

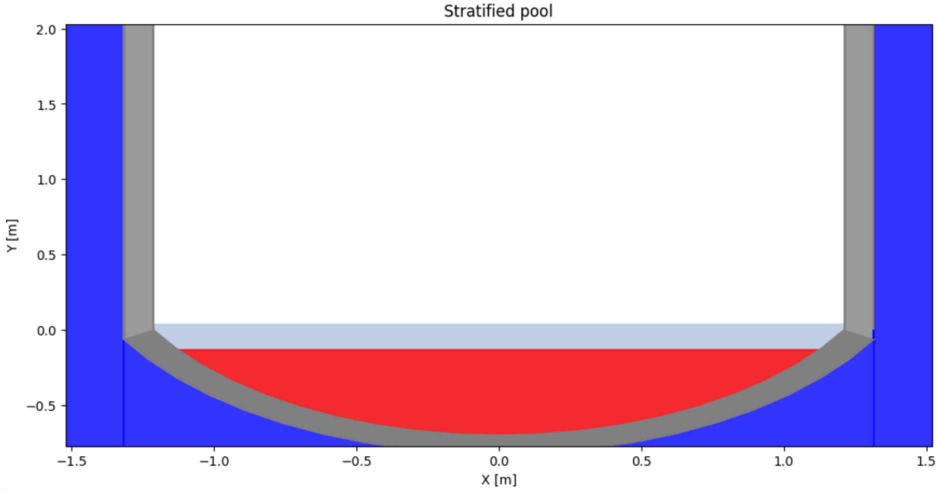
0D model: Example of results

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT

→ graphical interface + extension to other SMR designs
→ Convenient for quick evaluations
→ Useful for training







WP5 - CONT

- The objective of this WP is to:
  - Study the containment behaviour during a SA in an iPWR.
- The work will be based on the Design 1 and 2 input-decks and SA scenarios developed in WP2.
- Similarly to WP4:
  - Guided calculations will be carried out with SA code and
  - complementary analyses will be done by CFD codes for specific thermal-hydraulic phenomena.
- The work aims towards:
  - Assessment of the codes to simulate the main phenomena characterizing the containments behaviour (thermal hydraulics and fission product and aerosol behaviour)
  - Characterize the efficiency of existing and innovative passive measures in terms of accident mitigation and ST.
  - The Source Term (ST) estimation will be provided to WP6.

WP5 - CONT

- 5 codes applied by mostly 2 organisations each, broad spectrum of SA sequences
  - ⇒ Status of input decks allows to start WP5, thanks to WP2 work
  - ⇒ Aerosol/FP issues not tackeld in detail, which is left to WP5

- Scenarios in WP5 should cover a reasonable selection
  1. Choice of one reference SA scenario per design to be calculated by all codes
     ⇒ check the consistency of results, users effects, code effects
  2. Selected SA scenarios to get a bigger picture
  3. In addition: CFD analyses on selected issues (likely T/H, e.g. stratification)

⇒ FOM should allow assessment of calculations ⇒ incl. Source Term

⇒ From the spectrum of STs, selection to be provided to WP6

⇒ Identification of possible/necessary code improvements

⇒ Possibly giving hints for task 5.2 on what to assess in more detail

WP6 - EPZ

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT

- The objective of this WP is:
  - to provide evaluations of size and extension of EPZ for selected postulated SA scenarios coupling the results of best estimate Source Term (ST) codes to radiological consequences tools.

- One of the most important features of iPWRs is the possibility of their siting near densely populated areas thanks to the low impact and possibly reduced size of the affected region and the increased inherent safety.

- The need to demonstrate this feature using quantitative results is addressed by this WP which will provide scientifically sound basis for the assessment of EPZ.

- WP6 will produce recommendations on rigorous and justified methodology for iPWR EPZ right-sized determination.

WP6: TASK 6.1:Critical review of the existing methodology for EPZ determination

- Analyze the methods currently available for large LWR EPZ determination, to understand their applicability to iPWR.
- Prepare for Task 6.2, e.g. suitability of codes for the problem of near-range atmospheric dispersion and the effect of nearby buildings.
- Clarified terminology, reviewed (existence & contents, in variable detail) of EPZ-related regulations in Italy, Finland, Sweden, USA, Lithuania, Ukraine, Bulgaria, Spain, Germany
- Reviewed IAEA documents related to EPR (Emergency Preparedness & Response), Regulators' Forum WG EPZ specific approach flow chart, publicly available reports of IAEA CRPs
- Weighed pros and cons of EPZ approaches: generic vs, specific; deterministic, probabilistic, or hybrid (mixed, STs to PSA3); also risk-based vs. risk-informed (ENEA, JRC)
- SSTC NRS: Analysis of ground level release, building downwash, plume rise (with HotSpot)
- VTT (WP6 lead) summarizes the work done:
  - Country-specific regulations;
  - IAEA documents;
  - SMR Regulators' Forum;
  - SMR-specific considerations (e.g. initiating events, dispersion, dose projection);
  - available code tools for dispersion, dose projection & protective actions; high-level approaches (deterministic, probabilistic, etc.).

WP6 Task 6.2: Conservative assessments

- Task 2 is devoted to develop first estimates of source terms relying on publicly available data or conservative hypothesis based on initial inventory evaluated in WP2.
- Calculate EPZ required size using simplified and conservative methods.
- This will provide background technical results to be used as a comparison set for the BE (best estimate) tasks.
- Participants will start from preliminary / conservative / published source terms for iPWR design 1 (60 MWe submerged containment) and/or design 2 (300 MWe, passive systems, dry containment) and use their expertise, codes and criteria to calculate offsite doses and EPZ.
- Participants' subtasks will be defined to differ by choice of design, site & weather data, dispersion model, dose assessment code, protective actions criteria etc. to produce results as general as possible
- Codes used will include MACCS, JRODOS and ARANO.
- Task 6.2 serves as providing the conservative comparison case (upper bound) for 6.3, and also ensuring the readiness to calculate best-estimate results.

SASPAM-SA PARTNERS

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT

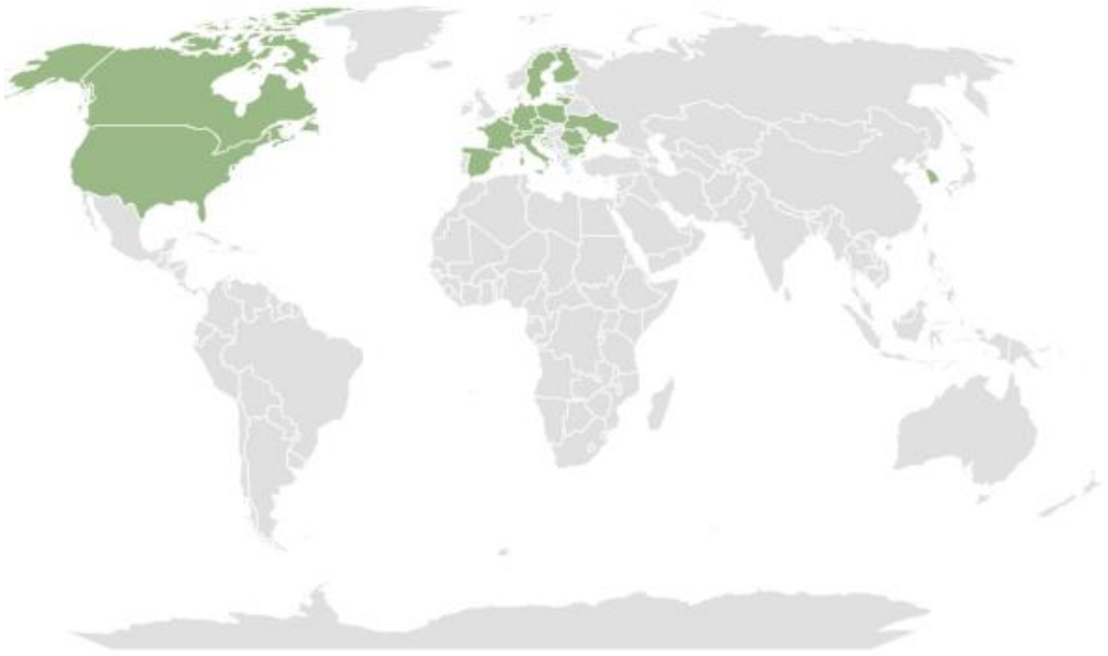
BELGIUM: EC-JRC, TRACTEBEL-ENGIE
BULGARIA: INRNE, TUS
CZECH REPUBLIC: SURO
FINLAND: VTT
FRANCE: CNRS, EDF, IRSN
GERMANY: KIT, FZJ, GRS, RUB
ITALY: ENEA, UNIROMA1, POLIMI, SINTEC
LITHUANIA: LEI
ROMANIA: RATEN
SWEDEN: KTH
SWIZERLAND: PSI
SPAIN: CIEMAT
UKRAINE: SSTC-NRS

23 PARTNERS FROM 13 EUROPEAN COUNTRIES, COMPOSED OF: UNIVERSITIES, RESEARCH INSTITUTES, TSO, INDUSTRIAL AND ENGINEERING ORGANIZATIONS

SUPPORTING GROUPS: EXTENDED SASPAM-SA NETWORK ON-GOING

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT

- In order to support the project, an AB (Advisory Board) and an EUG (End User Group) is currently under construction
  - AB Members from Becker Technology GmbH (GERMANY), CNSC (CANADA), IAEA (AUSTRIA), OECD/NEA (FRANCE), SUJB (CZECH REPUBLIC), SNL and USNRC (USA).
  - EUG Members from CEA and FRAMATOME (FRANCE), CNL (CANADA), EPRI (USA), FER (CROATIA), KAERI (SOUTH KOREA), POLITO (ITALY), VAB and SSM (SWEDEN), UPB (ROMANIA), WUT (POLAND), ENSO and UPM (SPAIN)



SNETP LABEL

CERTIFICATE
SNETP LABEL

SNETP
LABEL

Date of certificate issuance: *27/08/2021*
Certificate number: *2021NUG0085*

The SNETP Scientific Committee during its meeting held on *27 August 2021* awarded the SNETP Label to the project idea identified as **Safety Analysis of SMR with Passive Mitigation Strategy (SASPAM)- Severe Accident (SA)** with the technical content reviewed and published through SOIP on 19/07/2021.

Signed for and on behalf of the SNETP Scientific Committee.

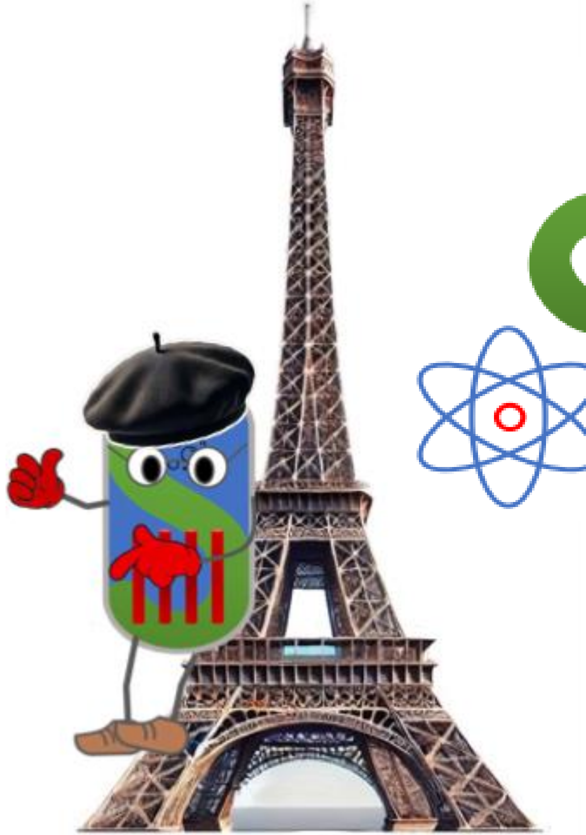
SNETP AISBL
Avenue des Arts, 53
1000 Brussels – Belgium
VAT N° : BE 0843 497 746
Company Registration: 0843 497 746
secretariat@snetp.eu

SNETP
Sustainable Nuclear Energy Technology Platform

- SASPAM-SA ideas born in the framework of the NUGENIA TA2, Severe Accident.
- SNETP Scientific Committee awarded the SNETP Label to the project idea

INTERACTION WITH OTHER PROJECTs

- Common presentation TANDEM/SASPAM-SA at the SNETP forum 2023
- PASTELS/SASPAM-SA joint meeting the 15/11/2023
- Interaction with the EASI-SMR project proposal for the design of the IVR experiments
- USNRC/ SASPAM-SA/TANDEN /Joint MEETING december 2023
- OPEN WORKSHOP, 17-18 October 2024, IRSN, Paris. ENEN2+ support 14 young researchers for the partecipation at the meeting



SASPAM-SA

INTERNATIONAL WORKSHOP ON SMR SAFETY FOR A SUSTAINABLE SHORT-TERM DEPLOYMENT

October 17th – 18th, 2024

IRSN Headquarter, 31 Av. de la Division Leclerc

Fontenay – Aux – Roses, Paris, France

Project funded by

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

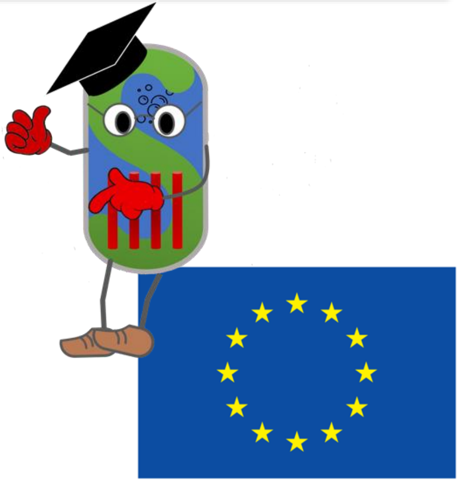
Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

ENEA IRSN

SAPIENZA UNIVERSITÀ DI ROMA

SASPAM-SA PROJECTS MEETINGS

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT



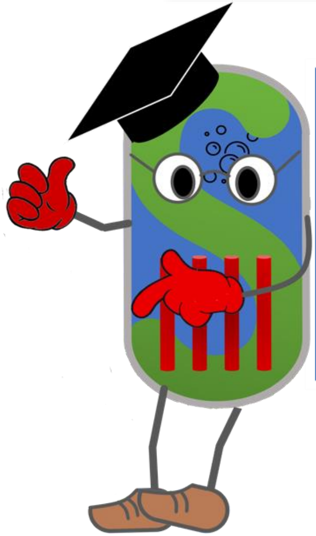
CONCLUSIONS

- The SASPAM-SA project has made significant progress in advancing the safety analysis practice for iPWRs.
- WP2 identified DBA and BDBA scenarios to evaluate the capability of state-of-the-art codes to simulate the main features of iPWRs.
  - The SA scenarios have been identified, and the code capability to predict degradation phenomena has been tested.
  - The conditions in the containment and in the vessel that characterize iPWR scenarios have been identified,
  - The results of the codes have been compared to evaluate potential differences.
- Dedicated database has been fully developed to be used in WP3 to assess the applicability of existing experimental data to iPWRs.
- Across all simulations of the postulated SA scenarios and using all SA codes, no lower head failure was observed in WP2 analyses;

CONCLUSIONS

- WP4 analyses support WP2 findings,
  - Maximum heat flux can be managed by pool boiling;
  - Residual vessel thickness ensures mechanical resistance;
  - IVR strategy appears feasible, with a good safety margin.
  - Build the know-how for the analysis of IVMR phenomena and to identify specific IVR features and near-term code development needs.
- WP6 is assessing the EPZ for iPWRs by analyzing SA scenarios and their radiological impacts.
  - Initial findings suggest iPWRs may have lower radiological impacts and require smaller EPZs compared to large NPPs, facilitating their siting near populated areas.
- Code applications enable, on one hand, the building of expertise among code users for SA in iPWRs and the training of new code users (e.g., younger generations), and on the other hand, the assessment of code guidelines and best practices for the simulation of iPWRs.
- These efforts highlight the project's contribution to advancing the understanding on safety of iPWRs, supporting the possible licensing review process in Europe.

Acknowledgement/Disclaimer



Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Commission-Euratom.
Neither the European Union nor the granting authority can be held responsible for them.

FOR PSI Project funded by

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs,
Education and Research EAER
State Secretariat for Education,
Research and Innovation SERI

TO HAVE MORE INFORMATION

Cordis

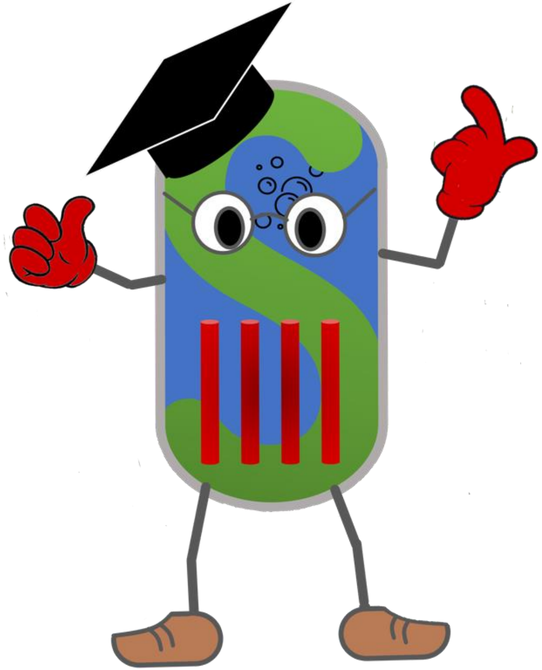
SNETP

ETSON

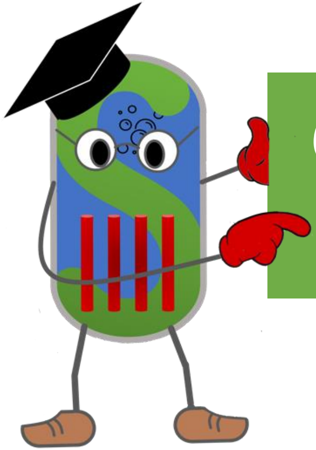
LINKEDIN

YOUTUBE

WEBSITE

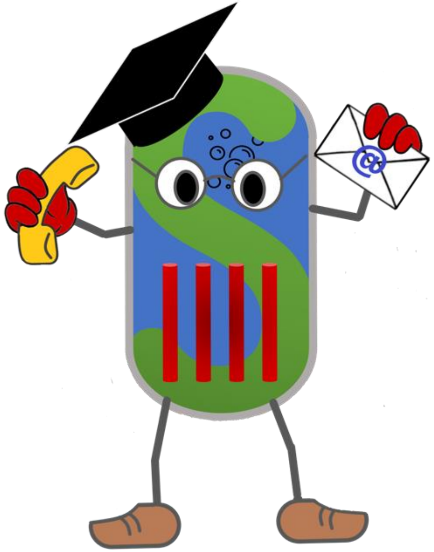


SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT



GRAZIE PER LA VOSTRA ATTENZIONE

SAFETY ANALYSIS OF SMR WITH PASSIVE MITIGATION STRATEGIES - SEVERE ACCIDENT



Fulvio Mascari

PhD Nuclear Engineer, Researcher
ENEA Research Center,
Via Martiri di Monte Sole n. 4,
40129, Bologna (BO), Italy
Tel: +39 0516098674
Mobile Phone: +39 3881135591

Email: fulvio.mascari@enea.it