CONUSAF

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PRESENTATION & FOUNDING MOTIVATIONS

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NUTHOS-12

12th International Topical Meeting on Nuclear Reactor Thermal-Hydraulics

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NUTHOS-2018 Advertisement

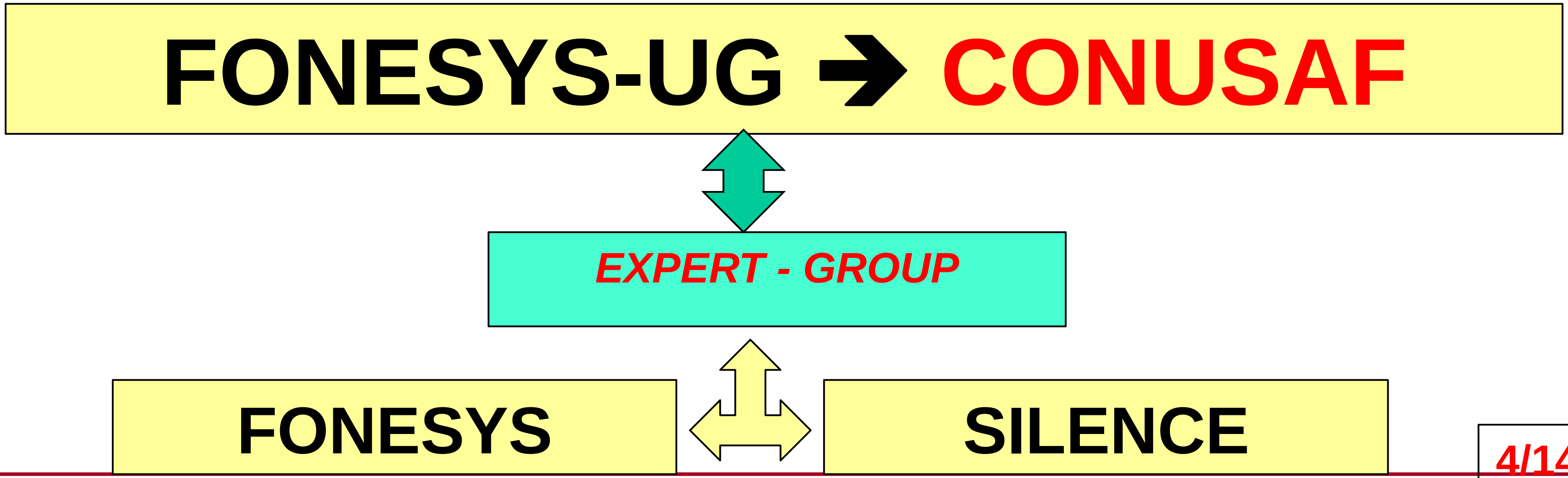
CONUSAF is an international network joining code applicants or users in the area of Nuclear Thermal-hydraulics. Following the launching and the successful operation of two previously proposed networks called FONESYS and SILENCE (respectively joining developers of thermal-hydraulic codes and experimentalists in nuclear thermal-hydraulics), CONUSAF aims at filling the gap in the area of code applications in nuclear reactor safety and design.

CONUSAF is going to be managed by Texas A&M University in United States with technical contribution provided by international Institutions including University of Pisa in Italy, KAERI in Korea and CEA in France. Typical topics addressed in CONUSAF will include (not an exhaustive list) Uncertainty, BEPU, licensing of NPP, Passive System (including related reliability), SMR operation, V&V (and newly proposed V&V&C), Scaling, Accident Analysis and Chapter 15 of FSAR. Issues proposed by participant organizations will be considered for CONUSAF activities. CONUSAF is expected to be formally established by October 31, 2018. All Institutions involved with code applications are invited to be members of CONUSAF.

LIST OF CONTENT

FOREWORD – 1 OF 2

The field of interest is nuclear thermal-hydraulics and whatever (as far as possible) in nuclear reactor technology has an interface with nuclear thermal-hydraulics. The focus is the application of nuclear thermal-hydraulics to nuclear reactor safety and design. The reactors of interest are water cooled nuclear reactors. *We* should attempt to predict and, as far as possible, to streamline and/or to direct the evolution of research in the concerned field.



FOREWORD – 2 OF 2

Huge amount of resources have been invested primarily in the past and those resources will never be available again in any forecast for the next foreseeable future.

Controversial situation as follows:

- **On the one hand, NPPs are in safe operation as designed**
- **On the other hand, insufficient knowledge characterizes fundamental elements like turbulence and complex transient 3D phenomena.**

We **recognize that we have to take note of the needs from participants, rather than proposing. … Nevertheless .. See below**

CLASSICAL RESEARCH

(including revisiting old issues with recent tools and knowledge)

UNCERTAINTY – BEPU – SCALING

1) Uncertainty methods (further) development and qualification.

- **More robust methods for physical model UQ**
- **(new) SET and IET to validate models and perform UQ**

2) BEPU and connection with licensing including licensing application

3) Scaling (this can be a part of V&V and uncertainty – or, vice versa: V&V and Uncertainty may need scaling), e.g.

- **Scalability of closure laws,**
- **Treatment of IET scale distortions,**
- **… .**

CLASSICAL RESEARCH 2 OF 3

(including revisiting old issues with recent tools and knowledge)

V&V – CFD-3D-SYS-CODES – PHENOMENA-MODELS

4) V&V: involving procedures for codes, input decks (or nodalization), and code-users.

5) CFD and 3D system codes: various specific application areas as needed, e.g.:

- **Porous 3D modules of system codes: improved modeling and validation,**
- **Coupling system-CFD codes in 1-phase flow,**
- **Coupling system-CFD codes in 2-phase flow.**

6) Model improvements and connection between models and phenomena (e.g. making reference to the internationally agreed updated-finalized 'new' list of phenomena). Basic phenomena and related basic experiments are included:

- **The list of thermal-hydraulic phenomena, recently updated (J NED paper 2018), shall be revisited/validated based on new approaches**

CLASSICAL RESEARCH 3 OF 3

(including revisiting old issues with recent tools and knowledge)

TPCF – NUMERICS – MULTI-EVERYTHING

7) Two-phase critical flow (TPCF) is just as an example of a model needing improvement, e.g. by using CMFD and improving 0D & 1D models

8) Numerical methods:

- **Prioritization of numerical methods.**

9) Multi-fluid, Multi-physics, Multi-scale, Multi-component, Multi-time-constant.

Sample key words or key aspects are: modeling of various non-condensable gases and interactions with steam-water, chemical interactions, aerosols, boron and solid particles, integrating (or modeling together in a consistent way) processes like: radioactivity decay, neutron life processes moderation, H2 production, vaporization and condensation of non-equilibrium phases (e.g. boiling and condensation due to de-pressurization and pressurization, respectively), boiling and condensation due to heat transfer, reflood, pump coast-down, turbine trip, propagation of pressure waves.

NEW FRONTIER RESEARCH 1 OF 5

(should be one of the key motivations for the FONESYS-UG)

FRAGMENTED CORE COOLING – FUEL MODELING

1) **Demonstrating the capability of cooling of a fragmented core including local fuel damage and overall core damage.** **[Latest experimental evidence (last 10-20 years) shows that the barrier constituted by fuel cladding is weak mainly (but not only) in the case of high burnup: so, one may expect a 'fragmented core' in the case of some DBA situations. Nuclear thermal-hydraulic specialists are expected to: a) contribute to demonstrating that the fragmented core can be cooled and will not affect the integrity of the subsequent barriers (i.e. the primary system and the containment), although significant radiation releases may occur inside the containment; b) contribute to reform (substantially) the acceptance criteria (e.g. for ECCS) providing demonstration that current ECCSs are suitable/consistent with the new evidence; c) contribute to demonstrate that radiation releases to environment comply with 'old' requirements].**

2) **Modeling of nuclear fuel performance.** **[Thermal-hydraulics can be the hinge connecting neutron physics, nuclear material science, burnup – corrosion – hydrating – spalling – crud formation, water chemistry, and nuclear fuel transient performance].**

NEW FRONTIER RESEARCH 2 OF 5

(should be one of the key motivations for the FONESYS-UG)

'V&V&C' – PRECISION TARGETS – PRIORITIZATION

3) **Moving from V&V to V&V&C (where 'C' is consistency and aims at enlarging the physical domain where a model is validated even without experimental data).** **This will make more effective the impact of the qualification process upon model predictive capabilities. Some activity already started within FONESYS and a paper has been prepared for the ASME V&V conference 2018 (the current draft of the paper - by F. D'Auria - for comments can be send to the members).**

4) **Introducing precision targets (D. Bestion is leading a related activity on CFD grade experiments: this can be extended to system codes) in combination or upstream the conduct of new research areas.** **For example, in case a research is proposed to characterize the mixing downstream a T-junction, one should fix (as far as possible) what is the precision limit requested to the models (and reasons, why?).**

5) **Introduce a method to prioritize research areas in nuclear thermal-hydraulics, showing connection between research and application needs (within DBA framework) in nuclear reactor safety** **(a paper has been presented in relation to prioritization by F. D´Auria at NURETH-17 – Xi'an, 2017 [now, J NED, 2018]).**

NEW FRONTIER RESEARCH 3 OF 5

(should be one of the key motivations for the FONESYS-UG)

BEPU/FSAR – PD AT GEOM DISCONTINUITIES

6) Expand BEPU and BEPU methods/elements, developed until today within the nuclear thermal-hydraulics framework, to any analytical step to demonstrate the NPP safety which is part of the FSAR (a PHD student is working on this subject under F. D`Auria´s tutoring, a couple of introductory papers is available).

7) Database of pressure drops at geometric discontinuities. It seems that in several new experiments (involving more or less sophisticated CFD and non-CFD two-phase models) the target of experimenters is fixed without having in mind the impact of pressure drops at geometric discontinuities upon any measured parameters. In other terms, model compliance with experiment is evaluated without considering possible large discrepancies between predicted and measured values of those pressure drops. Various initiatives can be undertaken in this connection including more sophisticated definition of pressure drops and design of more sophisticated methods for the measurements. **A comprehensive database of situations can be created where 'K-loss coefficients' (direct flow, and flow reversal conditions) are reported as a function of Re and void fraction.**

NEW FRONTIER RESEARCH

(should be one of the key motivations for the FONESYS-UG)

CHAIN-OF-RESEARCHES – NON FULLY DEVELOPED FLOW

8) Full chain of research areas in nuclear thermal-hydraulics. **Limitations and deficiencies of modeling (and model capabilities) are evident. Improvements of model capabilities (without having access to the huge resources available in 80's and 90's of previous 20th century) shall be planned having in mind a chain of situations including very basic experiments (e.g. emptying of a bottle) up to sophisticated experiment involving 'global multidimensional' phenomena in core region.**

9) Validity of current models in non-fully developed situations. Non-fully-developed flow situations are well known to constitute the most of the situations of interest in nuclear reactor accident analysis. However, current models are developed and qualified having in mind fully-developed flow conditions. **Research efforts are needed for developing models applicable (and validated) in non-fully-developed flow conditions. This includes transport of interfacial area and turbulence modeling in system codes.**

NEW FRONTIER RESEARCH

(should be one of the key motivations for the FONESYS-UG)

NEW NRS / SAFETY BARRIER NEEDED

10) New barrier to the release of fission products (partly connected with the item 1) in this list). One may feel the need for an additional barrier to cope with the 'recently-discovered' (not necessarily admitted) weakness of the barrier constituted by fuel cladding. An activity is in progress (first steps part of a J NED paper published Dec. 2017) to characterize an additional barrier.

… TH SPECIALISTS NEED TO CONTRIBUTE

FINAL REMARKS

CONUSAF: A R&D NETWORK
(NUCLEAR REACTOR THERMAL-HYDRAULICS)

ADVANCEMENTS ACCORDING TO NEEDS

CONSIDERING INTERNATIONAL FRAMEWORK (IAEA & OECD/NEA)

DETAILS IN NEXT MEETING FOLLOWING REQUESTS

SUPPORTING 'NEW' GROUPS

TRANSFERRING OF EXPERTISE / KNOWLEDGE MANAGEMENT

SUPPORTING NUCLEAR TECHNOLOGY FOR THE FUTURE