ENERGY AND ENVIRONMENT DEPT. «DIPARTIMENTO DESTEC» – GRNSPG (San Piero a Grado)

UNIVERSITA' DI PISA
56100 PISA - ITALY

[1] Brief overview of past OECD/NEA/CSNI Specialists Meetings

Topics and selected Speakers

F. D'Auria

OECD/NEA/CSNI

SPECIALISTS MEETING ON TRANSIENT THERMAL-HYDRAULICS IN WATER COOLED NUCLEAR REACTORS (SM-TH)

1st TPC Meeting, CIEMAT, Madrid (Spain), Jan.30, 2020

CONTENTS

FOREWORD

CSNI has been leading the development of nuclear thermal-hydraulics since the 70's. A non-exhaustive list of cornerstone activities and related reports is:

- **ISP series: a couple of dozen in nuclear thermal-hydraulics including BWR, PWR and VVER simulators (e.g. [PWR]: LOFT, Semiscale, LOBI, LSTF, BETHSY, SPES, ATLAS; [BWR]: FIX-II, ROSA-III, PIPER-ONE; [VVER]: PACTEL).**

- **SOAR series: TPCF; T-ECC; PWR-cont.; BWR-PSP; BWR-S; Scaling; Passive Systems (*on-going*).**

- **"V" series of activity: ITF-CCVM; SETF-CCVM; VVER-CCVM, Cont.-CCVM + Accuracy quantification (FFTBM)**

- **VARIOUS: Uncertainty (UMS, BEMUSE, PREMIUM, etc.); CT; PTS; Advanced Reactors; CFD; Projects; Training (THICKET).**

- **SPEC. Meetings: TH, BEPU; coupled neutron physics / TH (*see below*).**

SPECIALISTS MEETINGS IN NUCLEAR TH

1. Toronto, 1976, Aug. 3-4, CSNI Specialists Meeting on Transient two-phase flow
2. Paris, 1978, June 12-14, 2nd CSNI Specialists Meeting on Transient Two-Phase Flow
3. Pasadena, 1981, March 23-25, 3rd CSNI Specialist Meeting on Transient Two-Phase
4. Aix-en-Provence, 1992, April 6-8, CSNI Specialist Meeting on Transient Two-Phase Flow - System Thermal-hydraulics
5. Annapolis, 1996, Nov. 5-8, OECD/CSNI Workshop on Transient Thermal-hydraulic & Neutronic Codes Requirements
6. Ankara, 1998, June 29 -July 1, OECD/CSNI Seminar on Best Estimate Methods in Thermal-Hydraulic Analyses - Ankara (Tr)
7. Barcelona, 2000, April 10-13, OECD/CSNI Workshop on Advanced Thermal-Hydraulic and Neutronic Codes: Current and Future Applications
8. Barcelona, 2011, Nov. 16-18, OECD/NEA/CSNI Workshop on Best Estimate Methods and Uncertainty Evaluations,

TORONTO 1976

SELECTED PAPERS:

J. L. Achard and J. M. Delhaye. On the averaging operators introduced in Two–phase flow modelling.

Ardron K. H., Furness F. A., Hall P. C., Experimental and theoretical studies of transient and two phase flow during the depressurization of a simple glass vessel.

Bauer E. G., Houdayer G. R. and Sureau H. M. A nonequilibrium axial flow model and application to loss-of-coolant accident analysis: the CLYSTERE system code

Bourè J. A., Mathematical modeling of two phase flow,

I. Brittain, F.J. Fayers, A review of UK developments in thermalhydraulic methods for loss of coolant accidents

Seynhaeve J. M., Giot M., Fritte A. A., Non equilibrium effects on critical flow rates at low qualities,

W.J. Turner, G.D. Trimble Calculation of transient two-phase flow,

Wolfert K. The simulation of blowdown processes with consideration of thermodynamic non equilibrium phenomena,

SELECTED AUTHORS :

K. H. Ardron, S. Banerjee, J. A. Bourè, J. M. Delhaye, M. Giot, W. T. Hancox, G. R. Houdayer, J. Reimann, I Tanaka

PARIS 1978

SESSION TITLES:

TWO PHASE FLOW MODELS (x 2)
NUMERICAL METHODS
EXPERIMENTS (x 2)
MEASUREMENT TECHNIQUES

Round Table 1: HOW DOES SCALE AFFECT THE CONSTITUTIVE RELATIONSHIPS AND GOVERNING EQUATIONS?

Round Table 2: EXPERIMENTAL TECHNIQUES FOR DEVELOPING LOCAL CONSTITUTIVE LAWS FOR ADVANCED TWO PHASE FLOW MODELS

SELECTED AUTHORS :

L. Agee, S. Banerjee, J. A. Bourè, I. Catton, D. Drew, A. E. Dukler, A. R. Edwards, R. B. Duffey, P. Raymond, G. Houdayer, R. T. Lahey, F. Mayinger, J. C. Rousseau, Y. Taitel, T. G. Theofanous, K. Wolfert, W. Wulff

PASADENA 1981 1 OF 2

SELECTED PAPERS:

Agee, L.J.; Paulsen, M.P.; Hughes, E.D. Equations of state for non-equilibrium two-phase flow models,

Burwell, M.J.; Ringer, F.J. The calculation of critical discharge rates with a one-dimensional finite difference model with consideration of discharge geometry,

Cheng, L.; Lahey, R.T.; Drew, D.A. The effect of virtual mass on the prediction of critical flow

Deruaz, R.; Freitas, R.L. Void fraction and pressure drop measurement in a reflooded single tube

Duffey, R.B.; Banerjee, S.; Tobin, R.; Stone, T. Wave propagation in idealized separated flow

Hsu, Y.Y.; Sullivan, L.H. Updating of best-estimate heat transfer recommendation for transient CHF and post-CHF heat transfer modes

Kolev, N.P.; Carver, M.B. Pseudo-characteristic method of lines solution of the two-phase conservation equations

Loftus, M.J.; Hochreiter, L.E.; Conway, C.E.; Rosal, E.R.; Wenzel, A.H. Non-equilibrium vapor temperature measurements in rod bundle and steam generator two-phase flows

Ransom, V.H.; Wagner, R.J.; Trapp, J.A., The RELAP5 two-phase fluid model and numerical scheme for economic LWR system simulation,

Reimann, J.; John, H.; Frank, R. Measurement of mass flow rate and quality with a venturi nozzle and a turbine meter in steam-water flow,

PASADENA 1981 2 OF 2

SELECTED PAPERS:

Richards, D.J.; McDonald, B.H. A dynamic grid point allocation scheme for the Characteristic Finite Difference Method

Rohatgi, U.S.; Neymotin, L.; Saha, P. Independent assessment of TRAC code with various blowdown experiments,

Spore, J.W.; Weaver, W.L.; Shumway, R.W.; Giles, M.M.; Phillips, R.E.; Mohr, C.M.; Singer, G.L.; Aguilar, F.; Fischer, S.R. TRAC-BD1-Transient Reactor Analysis Code for Boiling Water Systems,

Toman, W.I.; Duffey, R.B.; Catton, I. An experimental study of reflood in a scaled 1692 rod slab core,

Wallis, G.B.; Yeung, W.S.; Hossfeld, L.M. Transient one-dimensional flow of an evaporating mist flow,

Wulff W. The kinematics of moving flow regime interfaces in two-phase flow

SELECTED AUTHORS :

S. Banerjee, M. J. Burwell, I. Catton, R.B. Duffey, Y. Y. Hsu, E. D. Hughes, N. Kolev, R. T. Lahey, V. Ransom, J. Reimann, U. S., Rohatgi, D. Saha, Trapp J. A., G. B. Wallis, W. Wulff, N. Zuber

AIX-EN-PROVENCE 1992

SESSIONS

OUTSTANDING ISSUES OF TWO PHASE FLOW MODELING: chaired and introduced by G. Yadigaroglu and J-C. Micaelli

PROGRESSING IN THERMAL-HYDRAULIC EXPERIMENTS; LARGE SCALE PHENOMENA: chaired and introduced by M. Courtaud

ASSESSMENT OF UNCERTAINTIES IN CODE CALCULATIONS: chaired and introduced by O. Sandervag

APPLICATION OF COMUPTER CODES: chaired and introduced by G. Santarossa

SPECIAL AND PROSPECTIVE AREAS: chaired and introduced by E. Hicken (inherent boron dilution presented by J. Hyvarinen)

SELECTED AUTHORS :

N. Aksan, F. Barrè, D. Bestion, M. Corradini, H. Glaeser, J-M. Izquierdo, H. Karwat, J. Luxat, J. Mahaffy, K. Umminger, J. March-Leuba, J-C. Micaelli, Y. Murao, H. Staedtke, K. Tasaka, H.Tuomisto, G. Yadigaroglu

M. REOCREUX WROTE ON THE OCCASION OF THE AIX-EN-PROVENCE SM

The 4th. Specialists' Meeting on Transient Two Phase Flow was organized by the Safety Research Department of the French Nuclear Safety and Protection Institute at the request of the OECD Committee for the Safety of Nuclear Installations. **After Toronto in 1976, Paris in 1978 and Pasadena in 1981, the Aix-en-Provence** meeting was in keeping with the course of studies initiated by the Thermalhydraulic Systems Behavior Task Group of the Principal Working Group No.2 for discussing the achievements and defining the needs of safety research in accident thermal-hydraulics. **60 Specialists from 14 Countries** (Belgium, Canada, Finland, France, Germany, Italy, Japan, the Netherlands, the United Kingdom, the USA, Spain, Sweden, Switzerland, Taiwan) attended the meeting, representing a large spectrum of experts from National Safety Authorities, Research Laboratories, Universities, Vendors and Utilities. These specialists had to review the **15-year research** period which had elapsed since the last meetings. **This period had been characterized by the issuance of the large thermalhydraulic computer codes for LWR accidents, the performance of several hundreds of separate effect tests for the development and the qualification of the physical models**, the carrying-out of the large experimental programmes on system loops (up to scale 1) for verifying the computer codes. Although this research was mainly characterized by remarkable success, limitations still exist. In a safety approach, there need to be well identified and handled, and the specialists were asked to exchange their views in order to determine which solutions they expected to be affordable in the future. Safety applications have already started which use these latest research achievements. **They raise specific problems such as the use of validation matrices, the evaluation of uncertainties, the identification and the control of unavoidable users' effects.** The specialists were required to exchange their experience of applications and to define how to improve them in the future. **Finally, one cannot consider the future without a careful review of the new and important problems raised by the safety issues of existing plants in Eastern Countries, as well as the new concepts of future plants and the increasing requirements for more detailed evaluations of severe accidents.** These prospective areas were on the programme of the specialists in order that they define future needs and that they determine the research needed to satisfy them. **The papers upon which this Specialist meeting was based, all invited,** together with the exchanges of views and experiences which took place, undoubtedly succeeded in reaching the planned objectives. The present proceedings are the indication of how well this was accomplished

THE SM WAS LEADED BY USNRC – ONE MAIN TARGET FOR THE MEETING WAS THE LAUNCHING OF THE NEW CODE LATER-ON CALLED TRACE

OPENING PLENARY SESSION: CURRENT AND PROSPECTIVE PLANS OF THERMAL-HYDRAULIC CODES DEVELOPMENT: chaired and introduced by G. Yadigaroglu and L. Ybarrondo

SESSION 1: CURRENT AND ANTICIPATED USE OF THERMAL-HYDRAULIC CODES: chaired and introduced by G. Yadigaroglu and L. Ybarrondo

SESSION 2: ADVANCES IN MODELING OF THERMAL-HYDRAULIC PHENOMENA – ADDITIONAL EXPERIMENTAL NEEDS: chaired and introduced by M. Reocreux and J. Lillington

SESSION 3: NUMERICAL METHODS IN MULTIPHASE FLOWS: chaired and introduced by V. Teschendorff and J. Luxat

SESSION 4: PROGRAMMING LANGUAGE AND A CODE ARCHITECTURE'S AND USER INTERFACES: chaired and introduced by T. Vantolla and M. Naitoh

🡐 Three groups of participants were formed (I Advances and Needs related to thermal-hydraulic modeling; II Numerical Techniques and Coupling Interface Requirements; III User Needs and Interfaces)

BREAK-OUT SESSIONS TO DISCUSS AND SUMMARIZE FINDINGS

CLOSING PLENARY SESSION: CODE CAPABIILITIES AND DESIRED ATTRIBUTES

The unique, substantive results of this workshop are summarized in this report. The meeting clearly achieved remarkable success, as evidenced by the results presented in the proceedings. In particular, the reader is directed to Section 3.0 of this Summary for a consensus of the three breakout sessions. This material clarifies the needs identified by experts from the CSNI countries and other meeting participants in categories that are considered critical to the success of current and future computer code development and related experimental work.

SPECIFIC OBJECTIVES FOR THE MEETING:

- Understand the current and anticipated future needs of the user community in analyzing important reactor safety problems.
- Understand the current problems in the use and capability of the current generation of thermal-hydraulic and neutronic codes.
- Understand the practical solutions to these problems that are consistent with user needs.
- Derive recommendations that will lead to an efficient path forward for future code improvements, development, or consolidation through meeting the previous objectives.

In her opening remarks to the meeting, NRC Chairperson Dr. Shirley Jackson affirmed the purpose of the meeting and the above objectives. Specifically, Dr. Jackson summarized the evolution of transient thermal-hydraulic and neutronics codes from the 1960s to the 1980s and noted that new demands have been placed on best estimate codes as a result of advanced reactor development, severe accidents, and beyond design basis analysis. Because of these new demands, the NRC needs to develop a set of coupled thermal-hydraulic/neutronic codes to meet user needs into the 21st century. Dr. Jackson emphasized that this CSNI workshop would help determine the best way to advance code capabilities by focusing and prioritizing relevant issues so that, in a time of severe budget constraints, experts might proceed confidently within a framework of international cooperation whenever feasible.

3.0 DETAILED CONCLUSIONS AND RECOMMENDATIONS

3.1 Specific areas for improvement – 1 of 3

1. Multi-field models, specifically separate liquid fields for film and drops **Today of interest**

Codes with film and droplet fields already exist in the industry, so adding this type of model is possible within the present code structure and numerics. Multi-field models may be more physically based so that constitutive relations are simpler, even though a larger number are required. Additional experimental data are needed to validate such models.

2. Transport of interfacial area/dynamic flow regime definition **Still considered**

This area was identified as potentially having the greatest effect, since it may eliminate the use of flow regime maps based on steady-state and fully developed flows. Describing source terms is an area that may need additional work. Accurate modeling depends on getting properly scaled experimental data; there is a need for testing in three or four typical geometries such as small and large pipes, bundles, a direction change and an annulus.

3. Two- or three-dimensional hydrodynamics and their closure laws **Not yet achieved**

The need to define flow regimes under three-dimensional conditions was identified. Multidimensional models have been added to existing codes because they were found to be needed, but the present models are not satisfactory. Validation of these models against experimental data is required. The need may be partly met by coupling a system code to an existing computational fluid dynamics (CFD) code. Two-phase CFD modeling is a long-term item that is unlikely to be developed within the horizon established for this work. Alternative approaches such as Large Eddy Simulation (LES) should be studied.

3.0 DETAILED CONCLUSIONS AND RECOMMENDATIONS

3.1 Specific areas for improvement 2 of 3

4. Turbulent diffusion models **Some progress**

The inclusion of turbulent diffusion models needs to be addressed in the code development effort.

5. Operation at low pressure/low flow **Progress achieved**

Correlations need to be validated for these conditions and the model implemented accordingly.

6. Operation in the presence of noncondensables **Progress achieved**

A mass transfer model will need to be implemented. For a new code, noncondensables should be included in the basic structure. There are very little data on condensation of bubbles with noncondensables, so there will be some requirements for experimental data in this area. A model will be needed for heat transfer to volumes of noncondensable gas, e.g., nitrogen from accumulator injection. For containment analysis, at least two noncondensables need to be modeled.

Important progress achieved

7. Three-dimensional neutronics, consistent with the level of detail of thermal hydraulics

Three-dimensional models are available and should be added to handle, for example, BWR void feedback during normal operation, power oscillations, and anticipated transient without scram (ATWS). Two issues to be considered are (1) homogenization and de-homogenization of characteristic variables, which needs to be addressed for transients, and (2) consistency in the level of noding detail. Implementation is required, as well as some theoretical research on homogenization/de-homogenization for transients. Also, uncertainties in neutronic calculations need to be quantified.

3.0 DETAILED CONCLUSIONS AND RECOMMENDATIONS

3.1 Specific areas for improvement 3 of 3

8. Modeling of containment phenomena and situations beyond the design basis for primary systems **Progress achieved**

Containment models are available and need to be implemented. This could be done in a modular fashion. For example, containment capability coupled to the system code is required to handle BWR ATWS where containment pressure strongly influences core voiding and power.

Some phenomena, such as countercurrent flow (CCF) in the hot leg, quenching of a degraded core, core flow blockage, and radiation heat transfer, are required for beyond design basis accident (DBA) events.

3.0 DETAILED CONCLUSIONS AND RECOMMENDATIONS

3.2 Numerical Methods and Features

1. The integration of different numerical schemes for use in different phases of the same problem solution, based on their effectiveness, would clearly be of calculational benefit to the thermal-hydraulics user community.

2. Improvement of the multidimensional capability of codes and exploratory numerical work should be carried out in parallel to the ongoing physics research supporting thermal hydraulics and neutronics code improvements.

3. In addition to physics, numerical methods are frequently a major cause of code deficiency. To improve these methods, low diffusive schemes must be developed.

4. The following are some required numerical computing features:
   - Cases run to completion without user intervention
   - Reliable results (accurate and repeatable)
   - Capable of handling a wide range of operating conditions and states
   - Capable of handling a wide range of problem time scales (adaptive numerical scheme)
   - Real time is a practical target; however, achievement is dependent upon the nature of solutions, e.g., size of model, necessary time-step
   - Capable of tracking steep gradients
   - Maintain high level of modularity
   - Interface should permit but not require implicit coupling
   - Coupling should remain stable for separately stable solutions
   - Develop unified interface protocol to facilitate coupling—addresses analysis flexibility, portability and parallelization

Generic Progress achieved

ANNAPOLIS 1996

3.0 DETAILED CONCLUSIONS AND RECOMMENDATIONS

3.3 Modeling Methodology Issues 1 of 2

1. Implementation of the interfacial area transport equation in two-phase flow models should be initiated.
2. Small pilot/test codes must be written to test a new method, e.g., low diffusive schemes.
3. The establishment of common criteria for time-step selection must commence, noting that time-step size was usually adjusted by ad hoc methods and was not based on criteria from first principles. Time-step control is an integral part of numerical methods, and it can induce stability problems unless carefully designed.
4. Modularity is the desired goal and may be achieved through object-o[illegible] programming.
5. Prior to start of development, the new code must hav[illegible] for transients, time scales, and flow regimes.
6. Structuring the physics modeling portions o[illegible] into individual modules must be carefully considered to address code perform[illegible]ce and accuracy concerns.
7. New modeling research must concentrate on developing and benchmarking physical models.
8. The CFD codes, if coupled to system codes, must be tested with a comprehensive set of established and agreed-upon benchmark problems.
9. The interfacial area transport equation is already a part of the solution of the one-dimensional code models. These codes employ a semi-implicit solver, and time-step size is always limited by the Courant limit. It will be more difficult to implement an extra equation for the area transport in an implicit solver.

Progress difficult to monitor (for me)

3.0 DETAILED CONCLUSIONS AND RECOMMENDATIONS

3.3 Modeling Methodology Issues 2 of 2

10. Underlying physical models can be incorporated into the pre-conditioners in some of the advanced linear solvers.

11. New code development should consider the option for parallelization.

12. Higher spatial differencing schemes may be of benefit to achieving robust numerical schemes.

13. Table 3-1 describes the user interface needs that should be met.

Progress difficult to monitor (*for me*)

TABLE 3.1 FOLLOWS HERE WITH USER REQUIREMENTS AND RELATED RANKING

Progress achieved (*for topics not listed here*)

3.0 DETAILED CONCLUSIONS AND RECOMMENDATIONS

3.4 Modeling Approach Issues

1. Research on numerical methods should be carried out in parallel with work on the physical models.
2. In relation to benchmarking/testing, if a suite of benchmark problems were available, code developers could compare their numerical methods against objective tests. The OECD published a book with such problems in the mid-1980s. It was agreed that a document could be published periodically with results from developers so that the benchmarks would remain current.
3. Numerical benchmark problems should be carefully designed to test only the numerical method and should either constitute very simple physics, such as the oscillating U-tube manometer, or have well-defined boundary conditions and source terms.
4. An automatic means of converting input decks (including the potential for an expert system for automatic input conversion) could speed up the process and reduce errors, although manual intervention will still be required.
5. A standard for building plant models should be established.
6. A database should be established to facilitate the conversion of plant input decks for different codes.
7. Deficiencies in code performance may be attributed not only to the models, but also to the user.
8. A new code should be fully implicit. Wall and interfacial shear, heat transfer, and other closure relationships will be treated implicitly to enhance stability.

Generic Requirements: Generic Progress achieved

3.0 DETAILED CONCLUSIONS AND RECOMMENDATIONS

3.5 User Needs

Ranking	Code Feature
1	Robustness (i.e., no code aborts due to properties errors or other problems)
2	Documentation (users and developers [programmers] manual)
3	Graphical user interface
4	Internal assessment of uncertainty (automatically performed by the code)
5	Investment conservation by maximizing the use of previous model development efforts and user experience
6	Identification of the range of validity of code models and correlations (warnings would be generated if validity range is exceeded)
7	*Structure the code/input requirements to minimize the user effect* (examples are time-step control and automatic nodalization)
8	Near-real-time code performance
9	Training guidelines (also user guidelines based on previous experience)
10	Portability (easy installation across a variety of computer platforms/compilers)
11	Modularity (allows substitution of different models for three-dimensional thermal hydraulics, turbulence, etc.)
12	Capability for coupling to other models (possible models to be coupled include kinetics, containment, and those used for severe accident analysis)

… Achieved by CIAU

… THICKET (Suncop)

… Barcelona 2000

… Typical features of TRACE code

3.0 DETAILED CONCLUSIONS AND RECOMMENDATIONS

3.5 Data Needs

1. Developers must have access to data used for code validation and archival experimental data used in the code validation process.

2. Experimental data from unique tests such as LOFT may be lost. It is important to have the data stored with a stable organization in a retrievable manner.

Target pursued and achieved within BEMUSE

SELECTED AUTHORS & PARTICIPANTS:

H. Akimoto, N. Aksan, C. Allison, T. Baratta, F. Barrè, B. Boyack, D. Diamond, F. Eltawila, G. Johnsen, K. D. Kim, Y. Kukita, S. Langenbuch, J. Lillington, J. Luxat, J. Mahaffy, F. Pelayo, F. Reventos, V.Teschendorff, J-L. Vacher, G. Yadigaroglu

ANKARA 1998; BARCELONA 2000; BARCELONA 2011

ANKARA 1998: FOCUS ON UNCERTAINTY METHODS; UNCERTAINTY ORIGINS; UMS PROJECT

BARCELONA 2000: FOCUS ON COUPLED THREE-DIMENSIONAL NEUTRON PHYSICS – THERMAL-HYDRAULIC COUPLING. TECHNIQUES DEVELOPNED WITHIN NSC FRAMEWORK: TMI-1 BENCHMAK (MSLB – EXTREME CASES) – PEACH BOTTOM TEST (TT WITH AND W/O CONDENSER BYPASS, ETC.)

BARCELONA 2011: FOCUS ON BEPU APPROACH (MATURITY OF APPLICATION OF UNCERTAINTY METHODS). BEMUSE PROJECT AND FOLLOW-UP. AIM:TO PROMOTE, TO APPLY AND TO FURTHER QUALIFY UNCERTAINTY METHODS.

DISCUSSION

A) **TORONTO-1976; PARIS-1978; PASADENA-1981:** MOST OF DETAILED TOPICS ARE OF INTEREST TODAY

B) **AIX-EN-PROVENCE-1992:** MEETING SUMMARY VALID TODAY; OUTSTANDING ORGANIZATION AN PROCEEDINGS

C) **ANNAPOLIS-1996:** GUIDELINES AND STREAMLINE FOR FUTURE ACTIVITIES TO BE CONSIDERED IN THE ORGANIZATION OF MADRID-2020

D) **ANKARA-1998; BARCELONA-2000; BARCELONA-2011:** FOCUS ON APPLICATIONS OF TH. IMPORTANT TOPICS OF MARGINAL INTEREST FOR MADRID-2020

ACHIEVING A SIMILAR QUALITY AND SUCCESS AS PREVIOUS CSNI SM (NAMELY ANNAPOLIS AND AIX-EN-PROVENCE) IS AMBITIOUS AND, EVENTUALLY UN-ACHIEVABLE.

CONCLUSION

OUTCOMES (AND IMPLICATIONS) OF THE PERFORMED REVIEW (OF PREVIOUS CSNI SM)

1) MANY TH ISSUES DISCUSSED 30-40 YEARS AGO ARE **STILL CURRENT ISSUES** IN NUCLEAR TH (E.G. VIRTUAL MASS, TPCF, ETC.). THE M. REOCREUX SYNTHESIS IN 1992 IS VALID TODAY.

2) IT WAS ALREADY CLEAR (NOT ONLY TO ME) ALREADY IN 1996, ON THE OCCASION OF «THE ANNAPOLIS» MEETING, THAT A NEW CODE **CANNOT BE SUBSTANTIALLY BETTER THAN EXISTING ONES** (AT THE TIME), IF «BREAK-THROUGH PROGRESS» IN THE AREA OF PHYSICAL UNDERSTANDING / MODELLING IS NOT ACHIEVED.

3) **CAPABILITY** (OF MODELING PHYSICAL SCENARIO INCLUDING ADDRESSING THE SCALING ISSUE) BY TH CODES HAS REACHED, SINCE A COUPLE OF DECADES, A SORT OF **SATURATION**: ANY IMPROVEMENT IS DIFFICULT, TIME CONSUMING AND PROBLEMATIC TO BE DEMONSTRATED.

4) PERFORMING **VALID SENSITIVITY AND UNCERTAINTY ANALYSIS MAKES POSSIBLE «BOUNDING»** THE LACK OF UNDERSTANDING IN TH: SO THE SAFETY OF EXISTING REACTORS CAN BE ENSURED BY CURRENT (BEPU AND NOT ONLY) APPROACHES

SO, THE PROPOSAL FOR STREAMLINING THE PLANNING OF MADRID 2020 SM:

FOCUS ON TH (LIKE TORONTO-1976, PARIS-1978, PASADENA-1981, AIX-EN-PROVENCE-1992 AND ANNAPOLIS-1996) WITH THE (ADDITIONAL) TARGET **TO CONTRIBUTE TO A STRATEGY FOR IMPROVEMENTS** IN THE AREA, I.E. TO OVERPASS «THE SATURATION» IN PREDICTIVE CAPABIILITIES AND TO ARRIVE AT A «BREAK-THROUGH» MODELLING

ROUGH PLANNING MADRID 2020

CONSEQUENCE OF THE PREVIOUS SLIDE

	1° DAY	2° DAY	3° DAY	4° DAY
MORNING	TH1	TH3	TH5	CFD; UNC; BEPU; 3DNK-TH COUPLING
AFTERNOON	TH2	TH4	ROUND TABLE:TH-FUTURE CFD; UNC; BEPU; 3DNK-TH COUPLING	SUMMARY SESSION INVITED SPEAKERS/CHAIRS