Fifth COBRA-TF (CTF) User's Group Meeting - CTF-5

Lucca, Italy
May 14-15, 2018

in conjunction with BEPU-2018 conference on multi-physics and multi-scale simulations with uncertainty

Hosted by NINE S.r.l.
Italy

Announcement and Proposed Program

Background and Purpose of 5ᵗʰ CTF User's Group Meeting

The fifth COBRA-TF (CTF) User's Group (UG) Meeting (CTF-5) will be held on May 14-15, 2018 in in Lucca, Italy, and is a follow-up of the previous CTF UG meetings. The CTF-5 meeting will be held in conjunction with other meetings/workshops and the BEPU-2018 conference, in order to facilitate co-ordination and sharing of work. Seven other meetings are being held in Lucca, Italy during the same week in order to combine efforts in common areas such as neutronics, thermal-hydraulics, and multi-physics modelling and uncertainty analysis and to make the participation more efficient. The meetings/workshops concerned are:

- *May 14 – May 15, 2018* – Fourth OECD/NEA Sodium Fast Reactor (SFR) Uncertainty Analysis in Modelling (UAM) benchmark meeting (SFR-UAM-4);

- *May 15 (afternoon), 2018* - Kick-off meeting on Blind benchmark on CANDU THermal-hydraulics (CANDU T-H);

- *May 15 – May 16, 2018* - Competence Building Program for Embarking Countries workshop (CBPEC);

- *May 16 – May 17, 2018* - Twelfth OECD/NEA Light Water Reactor (LWR) Uncertainty Analysis in Modelling (UAM) benchmark meeting (UAM-12);

- *May 16 - May 17 (afternoon), 2018* – Kick-off meeting on Multi-Physics Pellet Clad Mechanical Interaction Validation benchmark (MPCMIV);

- *May 17 (afternoon) – May 18, 2018* - Third OECD/NEA Time-Dependent Neutron Transport (C5G7-TD) benchmark meeting (C5G7-TD-3);

- *May 18, 2018* - Kick-off meeting on Rostov-2 VVER-1000 Multi-Physics benchmark (Rostov-2).

COBRA-TF is a thermal-hydraulic simulation code designed for LWR vessel analysis. It uses a two-fluid (hence the "TF" designation), three-field modeling approach. The original COBRA-TF code was developed as a thermal-hydraulic rod-bundle analysis code in 1980 by Pacific Northwest Laboratory under sponsorship of the Nuclear Regulatory Commission (NRC). It was subsequently implemented in the COBRA-TRAC code system and further validated and refined as part of the FLECHT-SEASET 163-Rod Blocked Bundle Test and analysis program. Over the past several decades, the COBRA series of codes has been used extensively throughout the nuclear industry, resulting in many variants of the code being created and validated.

CTF is the shortened name given to the version of COBRA-TF being developed and improved by the Reactor Dynamics and Fuel Modeling Group (RDFMG) initially at the Pennsylvania State University (PSU), and currently at the North Carolina State University (NCSU). In the last decade, CTF has been extensively validated for Pressurized Water Reactor (PWR), Boiling Water Reactor (BWR), VVER, Small Modular Reactor (SMR), and research reactor applications. Improvements have included development of models, enhancing computational efficiency, as well as improving software quality and associated Quality Assurance (Q&A) procedures and documentation of CTF. Modifications and validation of CTF to analyze advanced fast reactors as well as spent fuel pools and dry storages is underway. As a result, CTF has become state-of-the-art sub-channel code for reactor thermal-hydraulics bundle and core analysis.

CTF have been distributed under code and collaboration agreements to different organizations, which resulted in further improvements, modifications, verification & validation activities and applications. The CTF has been included in two large projects – U.S. Department of Energy (DOE) Consortium for Advanced LWR Simulation (CASL) (as the basic thermal-hydraulic core feedback model) and European Commission (EC) NUclear REactor SAFEty simulation platform (NURESAFE) (as a BWR, PWR and VVER core thermal-hydraulic transient analysis tool). As part of the CASL program CTF is being jointly developed by Oak Ridge National Laboratory and NCSU. CASL mission is to provide leading edge modeling and simulation capabilities to improve the performance of currently operating LWRs. Within CASL, CTF has become an important component of VERA, a "Virtual Environment for Reactor Applications", Core Simulator (CS) – VERA-CS.

In order to leverage and combine all non-proprietary developments, improvements, modifications and error fixes as well as the available verification and validation database and application experience of CTF from different organizations and activities, it was decided to establish a CTF User Group (UG) under the leadership of Prof. M. Avramova, RDFMG/NCSU in order to provide and maintain the so-called "gold-standard" of CTF. RDFMG/NCSU is the keeper of the gold-standard CTF and taking on the responsibility of maintaining and merging all developments and modifications. RDFMG/NCSU works to bridge the gap between the CASL program, the NURESAFE program and other activities (from other organizations) related to CTF. Such unified and up-to-date code version, supplemented with extended verification and validation suite and application guidelines based on previous documented experience, will be useful to all CTF users in the future. RDFMG works to implement non-proprietary features developed in different projects in a single, gold-standard, and state-of-the-art version of CTF for the entire nuclear industry to benefit. The gold-standard version of CTF uses GIT source control and is hosted on GITHUB to be accessible by all members of CTF UG. The code can be run in serial or parallel modes and is being distributed via a code agreement/license to interesting parties. The information for CTF UG is provided at:

https://www.ne.ncsu.edu/rdfmg/cobra-tf/

The CTF-5 meeting will involve all interested users with objective to discuss on the progress in achieving a common version and to review the contributions from different organizations to the common version (including code development, improvement, verification and validation, uncertainty quantifications, and applications). The meeting will be conducted following the agreements reached at the CTF-1 meeting to have one annual meeting of the CTF UG to present, discuss and coordinate activities related to CTF.

Scope and Technical Content of the Meeting

The topics to be addressed at the workshop include:

- Review of the CTF UG activities after the CTF-4 meeting;
- Discussion of status and recent additions to the CTF UG – activities, coordination, etc.;
- Discussion on updates of the common CTF version, GITHUB access, source control, maintenance, testing, etc.;
- Discussion on updates of coding guidelines and Software Quality Assurance Requirements for CTF;

- Discussion of updates of Verification and Validation (V&V) matrix as well as coverage matrix of CTF. Proposals for further expansion of V&V matrix and coverage matrix;
- Discussion of recent uncertainty quantification studies of CTF;
- Discussions of CTF model improvements/additions;
- Discussions of using high-fidelity models to inform low-fidelity models in CTF;
- Overview of CASL activities with CTF;
- Overview of EC activities with CTF;
- CTF modifications and applications to PWRs;
- CTF modifications and applications to BWRs;
- CTF modifications and applications to VVERs;
- CTF modifications and applications to SMRs;
- CTF modifications and applications to research reactors;
- CTF modifications and applications to FBRs and MSRs;
- Discussion of multi-physics and multi-scale activities involving CTF;
- Discussions of transient applications of CTF;
- Presentations on other activities with CTF as well as experience and expertise of different organizations in CTF model developments, efficiency improvements, verification and validation efforts and applications;
- Defining a work plan and schedule for CTF UG activities.

The proposed meeting program is attached as Annex 1.

Organization of the Meeting

The meeting is organized around the discussion of CTF UG and its activities. The participants are requested to present their expertise and experience in CTF developments, improvements, verification and validation, uncertainty quantification and applications.

Participation in the Meeting

The participation in the meeting is open to all former, current and future developers and users of COBRA-TF (CTF) for different applications.

Organization and Program Committee of the Meeting

An Organization and Program Committee has been nominated to make the necessary arrangements for the CTF-5 meeting and to draw up the final program, etc. The members of the Program Committee are:

Maria Avramova – *Co-Chair and Coordinator of CTF UG*
North Carolina State University, USA

Alessandro Petruzzi - *Co-Chair and Local Host*
NINE S.r.l., Italy

Robert Salko – *Coordinator of CASL CTF activities*

Oak Ridge National Laboratory, USA

Yann Perin - *Coordinator of EC CTF activities*
Gesellschaft fuer Anlagen und Reaktorsicherheit (GRS) mbH, Germany

Proposed Program of the Meeting

The proposed program was drawn up by the Program Committee and is enclosed as Annex 1.

Language of the Benchmark Workshop

The official language of the CTF-5 meeting is English.

Proceedings of the Meeting

A summary of the CTF-5 meeting will be published by the RDFMG/NCSU after the meeting. The summary will be distributed free of charge to the participants in the meeting. The presentations will be available free of charge to the participants to download from participants' restricted area after the CTF-5 meeting.

Contacts and Registrations

The eight meetings/workshops to be held in conjunction with the BEPU-2018 conference are named WPRS Workshops and include: SFR-UAM-4, CTF-5, CANDU T-H, CBPEC, LWR-UAM-12, MPCMIV, C5G7-TD-3, and Rostov-2. There is an established process by which those wishing to attend only the WPRS workshops/meetings (i.e. not participating in or presenting at the concurrent BEPU conference) should register to this event.

These instructions should be followed, in order to register without a conference package.

Please be aware and respect the following regarding this format of registration:

- o **Dinners and lunches are not included**, and must be bought separately as desired by the individual. Coffee breaks however, will kindly be made available to all;
- o This option **precludes access to any of the BEPU conference rooms**;
- o For those attendees to the WPRS workshops who have also **submitted a paper to the BEPU conference, attendance of the conference, and hence purchase of a conference package is necessary**. This is in order to publish the paper, to have access to the conference rooms and furthermore to be provided with the final conference proceedings.

At the initial sign-up page http://www.nineeng.com/bepu/index.php/register

1. Answer "Yes" to the question "Do you want to attend ONLY WPRS Workshops?"

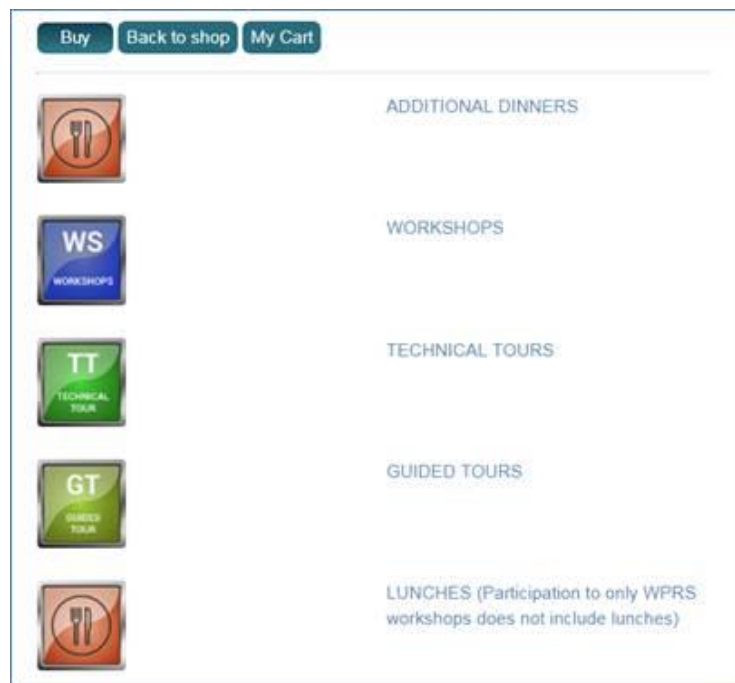2. Type as the 'WPRS code' the following: "wprs2018lucca" (all lower case)

3. Once logged in, use the registration system to add the intended workshops to your cart. At this time you may also purchase, additional dinners, lunches and technical / guided tours.

Should you have any question, please do not hesitate to contact the NEA wprs@oecd-nea.org or the Organizing Committee http://www.nineeng.com/bepu/index.php/contact.

Please send titles and authors of your presentations for CTF-5 UG Meeting to Maria Avramova at mnavramo@ncsu.edu

<u>Workshops' Location</u>

The meeting place for the eight workshops during the week of May 14-18, 2018 is the same as for the BEPU-2018 conference – the Real Collegio, which is located inside the city walls of Lucca: http://www.nineeng.com/bepu/index.php/venue/the-real-collegio

The information for transportation and hotels are provided at the links below:

http://www.nineeng.com/bepu/index.php/conference-info/transportation
http://www.nineeng.com/bepu/index.php/conference-info/hotel-reservations

The programme and schedule of the meetings is shown below:

	Morning 08:30 - 12:30 (1 coffee break)	LUNCH	Afternoon 14:00 - 18:00 (1 coffee break)
MONDAY	SFR-UAM-4 / CTF-5		SFR-UAM-4 / CTF-5
TUESDAY	SFR-UAM-4 / CTF-5 / CBPEC		SFR-UAM-4 / CANDU T-H / CBPEC
WEDNESDAY	LWR-UAM-12 / MPCMIV / CBPEC		LWR-UAM-12 / MPCMIV / CBPEC
THURSDAY	LWR-UAM-12 / MPCMIV		LWR-UAM-12 / C5G7-TD-3
FRIDAY	ROSTOV-2 / C5G7-TD-3		ROSTOV-2 / C5G7-TD-3

ANNEX 1

Fifth COBRA-TF User's Group Meeting (CTF-5)

Host Organization
NINE S.r.l.
Lucca, Italy

May 14-15, 2018

PROPOSED PROGRAM

CT01-23: Session code

Day 1: May 14, 2018

CT01. Introduction and opening remarks

CT02. Review of the CTF User's Group activities after the CTF-4 meeting – M. Avramova, NCSU

CT03. Discussion of status and recent additions to the CTF User's Group – activities, coordination, etc. – K. Ivanov, NCSU

CT04. Updates on CTF Infrastructure and SQA – R. Salko

CT05. Development activities in support of extending VERA-CS to MSR modeling applications – R. Salko

CT06. Implementation of a Grid Heat Transfer Hi2Lo Reconstruction Capability in CTF – R. Salko

CT07. Updates on residual formulation implementation in CTF and associated verification studies.

CT08. Presentations on recent uncertainty quantification studies of CTF.

CT09. Presentations on CTF model developments and improvements/additions.

CT10. Presentations on coupling CTF with system thermal-hydraulics models.

CT11. Presentations on CFD informed models for CTF.

CT12. Presentations on improved fuel rod modeling in CTF – CTFFuel

CT13. Summary of GRS activities with CTF – Y. Perin, GRS

CT14. CTF modifications and applications to PWRs.

CT15. CTF modifications and applications to BWRs.

CT16. CTF modifications and applications to VVERs.

CT17. CTF modifications and applications to SMRs.

Day 2: May 15, 2018

CT18. CTF modifications and applications to research reactors.

CT19. CTF modifications and applications to FBRs and MSRs.

CT20. Presentations on CTF applications to solving industry challenge problems.

CT21. Presentations on multi-physics and multi-scale activities involving CTF.

CT22. Presentations on CTF efficiency improvements and parallelization.

CT23. Presentations on other activities with CTF as well as experience and expertise of different organizations in CTF model developments, efficiency improvements, verification and validation efforts as well as design and safety applications.

CT24. Defining a work plan and schedule for CTF UG activities.