

**OECD NUCLEAR ENERGY AGENCY (NEA)**

**Joint Workshop  
on Analytical Activities related to  
OECD/NEA ATLAS3 and OECD/NEA ETHARINUS  
Projects**

**Universitat Politècnica de Catalunya  
Av. Diagonal 647, Barcelona, Spain  
07-09 November 2023**

***Final Programme***

DRAFT – version 22 September 2023

|                                     |                    |
|-------------------------------------|--------------------|
| Deadline for abstracts submittal    | September 15, 2023 |
| First draft program distribution:   | October 10, 2023   |
| Deadline for registration:          | October 26, 2023   |
| Final program distribution:         | October 31, 2023   |
| Deadline for sending presentations: | November 3, 2023   |

## ***1. ORGANISATION AND HOST***

The Programme Review Groups (PRG) and the Management Boards (MB) of the OECD/NEA Joint Projects ETHARINUS and ATLAS 3 organize the Joint ETHARINUS-ATLAS workshop on Analytical Activities (JAW) performed within the framework of their respective Projects. This workshop, promoted by the Committee on the Safety of Nuclear Installations (CSNI) of the OECD Nuclear Energy Agency (NEA), will be held in Barcelona (Spain) at the premises of the Technical University of Catalonia, located in Avenue Diagonal, 647, from 7 to 9 November 2023. This announcement is to inform you of this event and to call for abstracts to be submitted for presentation during the workshop.

## ***2. BACKGROUND AND PURPOSE OF THE WORKSHOP***

One of the major achievements of the NEA is the knowledge it has helped to generate through the organisation of joint international research projects. These projects, established under the auspices of the NEA, bring together the world's leading experts who contribute to maintaining and improving expertise and tools in participating countries, to enhancing technical exchange among specialists, and to promoting consensus building on approaches to resolve complex safety issues, see [https://www.oecd-nea.org/jcms/pl\\_72839](https://www.oecd-nea.org/jcms/pl_72839)

In the field of thermal-hydraulics, the NEA has since 2001, promoted the SETH/PKL, PKL, PKL2, PKL3, PKL4, and ETHARINUS collaborative projects to investigate thermal-hydraulic safety issues for current PWR and new PWR design concepts through experiments at the integral test facility PKL. The ETHARINUS Project started at the end of 2020 and covers tests carried out at the PKL facility of Framatome in Erlangen (Germany) with additional tests performed at the PWR PACTEL facility of Lappeenranta-Lahti University of Technology LUT (Finland). The Experimental Thermal Hydraulics for Analysis, Research and Innovations in Nuclear Safety (ETHARINUS) project focuses on studies related to loss of coolant accident (LOCA) addressing design extension conditions (DEC) for small break LOCA (SB-LOCA) scenarios and two-phase flow thermal-hydraulic phenomena for Intermediate break LOCA (IB-LOCA) scenarios, on studies related to core cooling performance under partial core blockage, on studies related to effectiveness of passive heat removal systems and on studies related to cool down procedures after a multiple steam generator tube rupture (M-SGTR) scenario, see [https://www.oecd-nea.org/jcms/pl\\_59465/](https://www.oecd-nea.org/jcms/pl_59465/)

Similarly, the NEA has, since 2014, promoted the Advanced Thermal-hydraulic Test Loop for Accident Simulation (ATLAS), ATLAS 2, and ATLAS 3 collaborative projects to address thermal-hydraulic safety and accident management issues relevant to water reactors, using experiments at the ATLAS Test Facility. The current ATLAS 3 Project, started in the first half of 2021, covers tests carried out at the ATLAS facility of KAERI in Daejeon (Korea). The set of ATLAS 3 experiments intends to investigate among others the so-called Design Extension Conditions (DEC) that are either more severe than Design Basis Accidents or that involve additional failures, such as Station Blackout (SBO) with SBLOCA or Total Loss of Heat Sink. The program additionally aims to provide further clarification in the analysis of passive systems performance and scaling issues by

performing Counterpart Tests (CTs) to previous Integral Effects Tests (IETs), see [https://www.oecd-nea.org/jcms/pl\\_24812/](https://www.oecd-nea.org/jcms/pl_24812/)

As in the previous phases of both projects, a comprehensive experimental database for model development and code validation is being established in the two projects. It is of particular relevance the fact that both experimental programs include CTs i.e., tests with a similar configuration, and corresponding initial and boundary conditions, to other previous tests performed in another IET. These CTs are considered especially valuable for addressing the issue of the effect of geometrical design differences that are always present between test facilities and, between facilities and actual plants.

In addition to that, analytical activities of thermal-hydraulic simulation code results have been established in OECD/NEA ETHARINUS and in OECD/NEA ATLAS3 to increase confidence in the validity and accuracy of tools which are used in assessing the safety of nuclear installations. These efforts are directed towards either helping in the definition and specification of the experiments (by means of pre-tests calculations), supporting the in-depth analyses of relevant phenomena and driving forward the application of experimental results to PWR dimensions by providing further insights, information and variables, available with the thermal-hydraulic simulation codes but not by the regular instrumentation of the experimental facilities. These analytical support activities were performed in the frame of similar previous projects under the auspices of the OECD/NEA (SETH, PKL, PKL2, PKL3, PKL4, ROSA, ROSA2, ATLAS, and ATLAS2), as well as the organization of technical seminars describing the analytical activities performed by the project participants, have proven to be very useful in the past, see e.g. <https://www.oecd-nea.org/nsd/docs/2020/csni-r2020-13.pdf> and [https://www.oecd-nea.org/jcms/pl\\_19796](https://www.oecd-nea.org/jcms/pl_19796)

During the 4th meeting of the PRG/MB of the OECD/NEA ETHARINUS project (Lappeenranta, Finland; 15-17 November 2022), and the 4th of PRG/MB of OECD/NEA ATLAS3 project (Daejeon, Korea; October 11-12, 2022) the organization of a JAW was approved to present and discuss in-depth analyses (pre and post-test) of different tests performed within the projects, as well as the discussion of the results and analyses of both benchmark exercises organized in the respective projects.

The main purpose of this workshop is then to fulfil these actions by presenting and discussing the results of the ATLAS, PKL, and PWR PACTEL analytical studies performed by participants in the ETHARINUS and ATLAS3 projects, as well as to present related plant applications.

In summary, the main objectives of the workshop are:

- Present and discuss in-depth analyses performed in the ATLAS3 and ETHARINUS benchmark exercises.
- Present and discuss in-depth test analyses of experiments carried out in the PKL and PWR PACTEL test facilities.

- Present and discuss in-depth test analyses of experiments carried out in the ATLAS/CUBE test facility.

### ***3. SCOPE, CONTENT AND OUTLINE OF THE WORKSHOP***

The intention of the workshop is to report on the major achievements of ETHARINUS and ATLAS 3 projects, on the progress of the technical capabilities and to discuss future perspectives. The workshop will also provide the opportunity to present new analyses and to identify key simulation challenges. In particular, analyses of the counterpart tests between facilities are aimed to be discussed. The progress in the area of thermal-hydraulic safety issues and DEC-A related accident management issues, as well as issues related to passive safety systems, will be highlighted. The applications to power plants of the results and their safety significance are also to be addressed. Relevant results of the complementary research carried out at various laboratories will also be presented.

The workshop is organized in three parts: Opening Session; Technical Sessions; and a Wrap-up Session. All the participants are expected to take part in the discussion at the end of each technical session and in the wrap-up session.

#### **Opening session**

The opening session of the workshop will introduce the organisation committee and organisational aspects, short introduction and objectives of the ETHARINUS and ATLAS3 projects and the involved institutions.

#### **Technical Sessions**

The workshop will consist of six technical sessions covering:

##### **a) Analyses of the benchmark exercise in the ATLAS facility**

The objective of this session is to present the main conclusions of the benchmark exercise related to the C2.3 test in ATLAS facility conducted within ATLAS 3 project. This experiment consisted of a SLB (Steam Line Break) with the use of the PAFS (Passive Auxiliary Feedwater System). On the other hand, the session would cover details of the different post-test analyses carried out by the different participants in the exercise. The session will cover presentations as well about the so-called Crosswalk Sensitivity Analysis, an independent and additional phase of this benchmark that has been organized within the project. Modelling issues and practices are also expected to be discussed, as well as indications about the approach and difficulties to scale conclusions to plant conditions.

##### **b) Analyses of the benchmark exercise in the PKL facility**

The objective of this session is to present the main conclusions of the benchmark exercise related to the J4.2 test in PKL facility conducted within ETHARINUS project. This experiment consisted of a SBO (Station Black Out) with the use of SACO (passive Safety COndenser) scenario. On the other hand, the session would cover details of the

different post-test analyses carried out by the different participants in the exercise. Modelling issues and practices are also expected to be discussed, as well as indications about the approach and difficulties to scale conclusions to plant conditions.

### **c) ETHARINUS experimental results, code calculations and validation**

This session will provide firstly an overview of the OECD/ETHARINUS project, and then will present related test calculations of ETHARINUS experimental series (PKL or PWR PACTEL) performed with CFD and/or Thermal-Hydraulic System codes. Modelling issues and practices are also expected to be discussed.

### **d) ATLAS3 experimental results, code calculations and validations**

This session will follow the same structure of the previous ETHARINUS related session, by providing a general overview of the ATLAS3 project, and presenting related test calculations of the ATLAS experiments, performed with CFD and/or Thermal-Hydraulic System and/or CFD codes. Modelling issues and practices are expected to be discussed.

### **e) Calculations on plant applications**

This session opens the possibility to present plant applications analyses related either to equivalent scenarios or to scenarios helpful to clarify the involved safety issues. In addition, this session will also contain information related with:

- the outcomes for safety analysis and reactor studies;
- the scaling approaches, techniques, and/or difficulties.

### **f) Future opportunities on experimental and analytical thermal-hydraulics activities**

This session discusses new proposals in the field of thermal-hydraulic activities such as the possibility to have new experimental and analytical activities such as International Standard Problems (ISPs) and might be useful to support the definition of the future needs and priorities of research on safety-related thermal-hydraulics.

### **Wrap-up Session**

The **Wrap-up session** of the workshop will:

- collect the summary conclusions of each technical session by session chairs; and
- discuss the needs for future experimental and analytical activities.

# Joint Workshop on Analytical Activities related to OECD/NEA ATLAS3 and OECD/NEA ETHARINUS Projects

**Tuesday 7<sup>th</sup> November 2023**

8.30-9.00                    **Registration**  
*(On the first day ID cards or Passport shall be presented at the entrance of the  
Conference room to get access badges)*

9.00-9.30                **Welcome, Opening remarks and Introduction**  
*Chair: M. Sanchez (CSN, Spain)*  
- H. Nakamura, WGAMA Chair (JAEA, Japan)  
- M. Adorni, NEA Secretariat  
- S. Schollenberger, ETHARINUS Operating Agent (FRAMATOME, Germany)  
- Kyoung-Ho Kang, ATLAS3 Operating Agent (KAERI, Korea)  
- Javier Dies, Consejo de Seguridad Nuclear (CSN, Spain)  
- Jan Rosell, Assistant Director of the Barcelona School of Industrial Engineering (UPC,  
Spain)

## 9.30 Session 1: General overview of ETHARINUS and ATLAS Programs

*Chairs: M. Sánchez (CSN, Spain), E. Virtanen (STUK, Finland)*

9.30-9.55,            (1.1),    Overview on OECD/NEA ATLAS-3 Project, K. Kang (KAERI,  
KOREA)

10.00-10.25,        (1.2),    Overview on Test Results from the PKL III testing program  
S. Schollenberger, L. Dennhardt, B. Schoen, (FRAMATOME,  
Germany)

## 10.25-11.00    **Coffee break**

11.00-11.25,        (1.2),    Overview on PWR-PACTEL testing program  
V. Riikonen, Virpi Kouhia , (LUT, Finland)

## 11.30 Session 2: Analyses of the benchmark exercise in the PKL facility

*Chairs: V. Martínez-Quiroga (UPC, Spain) and S. Schollenberger (Framatome,  
Germany)*

11.30-11.50,        (2.1),    FRAMATOME presentation on the results of the benchmark  
experiment OECD-ETHARINUS J4.2 3 S. Schollenberger, L.  
Dennhardt, B. Schoen, (FRAMATOME, Germany)

11.55 -12.15,        (2.2),    Benchmark activity on the ETHARINUS J4.2 experiment (V.  
Martínez-Quiroga, J. Freixa (UPC, Spain)

12.20-12.40,        (2.3),    Benchmark Analysis for PKL III J4.2 Test Using MARS-KS code, H.  
Byung-Gil (KAERI, Korea)

12.45-13.05, (2.4), Results on PKL J4.2 blind benchmark simulations with ATHLET, S. Buchholz (GRS, Germany)

**13.05-14.00 Lunch break**

14.00-14.20, (2.5), ETHARINUS J4.2 test benchmark - Cooldown under ELAP condition with SACO and heat losses, G. Mianne (EDF, France)

14.25-14.45, (2.6), OECD/NEA ETHARINUS blind benchmark activity: UPC pre-test calculation and sensitivity analysis, V. Martínez-Quiroga, J. Freixa (UPC, Spain)

14.50-15.10, (2.7), ETHARINUS – J42 SBO: CEA CATHARE3 blind calculations, M. Vernassiere (CEA)

**15.10-15.40 Coffee break**

15.40-16.00, (2.8), SPACE simulation on benchmark activity of OECD-ETHARINUS J4.2 test in PKL facility, Jong-Hyuk Lee (KAERI)

16.05-16.35, Session 2 General discussion

**16.40 Session 3: ETHARINUS experimental results, code calculations and validation**  
*Chairs: L. Dennhardt (Framatome, Germany) and J. Freixa (UPC, Spain)*

16.40-17.00, (3.1), Comparison of LSTF and PKL Tests on Upper Head Small-Break LOCA with SG Depressurization, T. Takeda (JAEA, Japan)

**17.00 First day adjourn**

**20.00 Joint dinner at “La Pomarada” Passeig de Gracia 78**

**Wednesday 8<sup>th</sup> November 2023**

9.00-9.20, (3.2), CATHARE simulation results of the PKL J1.1 & PKL J6.1 tests, A. Bousbia (BEL V, Belgium)

9.25-9.45, (3.3), SPACE simulation on IBLOCA scenarios of J2 tests in PKL facility, J. Lee (KAERI, Korea)

9.50-10.10 (3.4), Analysis of PKL III J2.2 Experiment with TRACE Code, J. Vihavainen (LUT, Finland)

**10.10-10.40 Coffee break**

- 10.40-11.00, (3.5), Aprosim simulations on PWR PACTEL LOCA experiments, V. Kouhia (LUT, Finland)
- 11.05-11.25, (3.6), RELAP5 code analysis of PKL-4 project test for MSGTR accident with recovery actions, M. Sekine (NRA, Japan)
- 11.30-11.50, Session 3 General discussion

**11.50 Session 4: Analyses of the benchmark exercise in the ATLAS facility**

*Chairs: Kyoung-Ho Kang (KAERI, Korea) and Anis Bousbia (BelV, Belgium)*

- 11.50-12.10, (4.1) KAERI presentation on the results of the benchmark experiment in ATLAS facility, Y. Park (KAERI, Korea)
- 12.15-12.35, (4.2) Sensitivity crosswalk for ATLAS Test C23, R. Harrington (USNRC, USA)
- 12.40-13.00, (4.3) EDF contribution to the C2.3 test benchmark exercise in the frame of the OECD/ATLAS3 Project, J. Vacher (EDF, France)

**13.00-14.00 Lunch break**

- 14.00-14.20, (4.4) Lessons learned from the ATLAS-3 benchmark for the simulation of passive systems involving cooling (...), N. Duenne, T. Hollands (GRS, Germany)
- 14.25-14.45, (4.5) Participation in C2.3 Benchmark activity: Blind-phase, Open-phase and Crosswalk Analysis, M. Lorduy, S. Gallardo (UPV, Spain)
- 14.50-15.10, (4.6) RELAP5 Simulation and Validation for ATLAS Test C2.3, H. Jung (Doosan Heavy Industries and Construction, Korea)

**15.10-15.40 Coffee break**

- 15.40-16.15, Session 4 General discussion

**16.15 Session 5: ATLAS experimental results, code calculations and validation**

*Chairs: Byoung-Uhn Bae (KAERI, Korea) and M. Sánchez-Perea (CSN, Spain)*

- 16.15-16.35, (5.1), Validation and Comparative Analysis of Containment Separate Effect Tests: A Study on OECD-ATLAS3 C5, J. Lee (KAERI, Korea)
- 16.40-17.00, (5.2), The scaling effect analysis of counterpart test between LSTF and ATLAS IET facilities on 1% top head, N. Alyammahi (FANR, UAE)

**17.00 Second day adjourn**

**20.00 Joint dinner at “TBD” Restaurant Address**



**Thursday 9<sup>th</sup> November 2023**

- 9.00-9.20, (5.3), MARS-KS Calculation Results of Natural Circulation Interruption phenomena in ATLAS, S. Cho (KAERI, KOREA)
- 9.25-9.45, (5.4), Validation of SPACE-CAP codes for coupling the RCS and containment systems with OECD-ATLAS3 C1 test, B. Bae (KAERI, Korea)
- 9.50-10.10, (5.5), MARS-KS code assessment with OECD-ATLAS3 C2.2 test result for the PECCS performance, B. Bae (KAERI, Korea)

10.10-10.40 **Coffee break**

- 10.40-11.10, (5.6), SPACE code Calculation Results of IBLOCA and SBLOCA in ATLAS, K. Lew (KEPCO Nuclear Fuel Co., Korea)
- 11.15-11.35, Session 5 General discussion

**11.35 Session 6: Plant applications and other topics**

*Chairs: Francesc Reventós (UPC, Spain), Rafael Mendizábal (CSN, Spain)*

- 11.35-11.55, (6.1), Scaling Analysis of Nuclear Power Plant (APR1400) Utilizing ATLAS Integral Effect Test Result, Y. Park (KAERI, Korea)
- 12.00-12.20, (6.2), Assessment of Scaling Effects in an IBLOCA scenario, J. Freixa, K. Martin, V. Martinez-Quiroga (UPC and CSN, Spain)
- 12.20-12.40, Session 6 General discussion

**12.40 Session 7: Future opportunities on experimental and analytical thermal-hydraulics activities**

*Chairs: Didier Jacquemain (NEA), Vesa Riikonen (LUT, Finland)*

- 12.40-13.00, (7.1), NEA activities in thermal-hydraulics and future perspectives, M. Adorni, D. Jacquemain (NEA)

13.00-14.00 **Lunch break**

- 14.00-14.20, (7.2), An International Standard Problem (ISP) proposal based on IRSN COAL experimental reflooding results, T. Glantz (IRSN, France)
- 14.25-14.45, (7.3), International Standard Problem on PKL experiment on Multiple SG U-tube rupture status update (ISP-52), A. Del Nevo (ENEA, Italy)

14.45-15.15, **Coffee break**

**15.15-16.30 Session 7 Wrap up and Concluding Remarks Session**  
**(15 mn + 50mn final discussion), *Panel by chairpersons of all the sessions***

- Summary of the seminar with the contribution of session chairs
- Final discussion: panel with all chairs

**16.30, CLOSURE OF THE WORKSHOP**

#### ***4. LOGISTICS AND PARTICIPATION IN THE WORKSHOP***

##### **Participants**

The test results of the OECD/ETHARINUS and OECD/ATLAS3 projects are confidential since the projects have been financed by the participating countries. Thus, the members of both projects decided to make the data within the presentations be made open to the participants in the workshop (i.e., for the sole purposes of the workshop).

##### **Location and accommodation**

The Workshop will be held in Barcelona, at the **Universitat Politècnica de Catalunya (UPC)** located in: Avenida Diagonal 647, Barcelona, Spain.

Detailed information on the Venue can be found in the attachment.

All costs incurred by participants for travel, stay and daily expenses are the responsibility of the participant and is not borne by the NEA or the organisation.

##### **Language**

All presentations and discussions will be in English.

##### **Workshop proceedings**

The proceedings of the Workshop will be published as a ETHARINUS-ATLAS3 report by the OECD/NEA in the form of a CD including presentations, papers and conclusions and recommendations of the sessions, and will be made available after the Workshop. The Organizing Committee will prepare a summary report for presentation to the CSNI.

#### ***5. ORGANIZING COMMITTEE (OC)***

An Organizing Committee has been nominated to prepare the technical content of the workshop on the basis of received abstracts, to organize the workshop and to prepare the summary report. The OC members are:

|                         |           |               |
|-------------------------|-----------|---------------|
| Miguel Sánchez          | CSN       | Spain (Chair) |
| Kyoung-Ho Kang          | KAERI     | Korea         |
| Simon Schollenberger    | FRAMATOME | Germany       |
| Vesa Riikonen           | LUT       | Finland       |
| Eero Virtanen           | STUK      | Finland       |
| Anis Bousbia            | Bel V     | Belgium       |
| Jordi Freixa            | UPC       | Spain         |
| Victor Martinez-Quiroga | UPC       | Spain         |
| Martina Adorni          | OECD/NEA  | France        |
| Didier Jacquemain       | OECD/NEA  | France        |

##### **Contact information**

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