

IAEA Coordinated Research Projects (CRP) in the area of Fuel Engineering and ATF plans

V. Inozemtsev

Fuel Engineering Team Leader

IAEA, Vienna, Austria

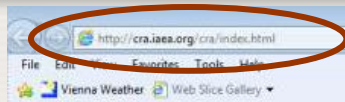


IAEA

International Atomic Energy Agency

CRPs on the IAEA web-site:

<http://cra.iaea.org/cra/index.html>



- Duration is about 4 years
- Members are organizations
- Joint work plan is based on the organizations' proposals, and agreed at the 1-st Research Coordination Meeting (RCM-1)
- CRP-2018 “Analysis of Options and Experimental Examination of Accident Tolerant Fuels for Water-Cooled Reactors”



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Coordinated Research Activities

Coordinated Research Activities

Stories

Nanoscale Radiation Engineering of Advanced Materials for Potential Biomedical Applications (F23028)
2013-07-31 – This CRP had a very strong impact on enhancing the research capabilities of the participating institutions in radiation engineering on the nanoscale, for the preparation/modification of new polymer materials intended for biomedical applications. Read more? Read More –

NEW CRP: Plasma-Wall Interaction for Irradiated Tungsten and Tungsten Alloys in Fusion Devices (F43021)
2013-07-31 – This CRP will enhance the knowledge base on effects of neutron and surrogate irradiation upon tungsten and tungsten alloy microstructure and thereby upon surface erosion and upon trapping and transport of tritium in tungsten-based plasma-facing materials. Read More –

Heavy Charged-particle Interaction Data for Radiotherapy (F43017)
2013-07-31 – This CRP has been successful in bringing together researchers from 12 different institutions for collaboration on experimental and theoretical aspects of atomic and nuclear data for the interaction of protons and carbon therapeutic beams on materials of relevance to radiotherapy. Read More –

NEW CRP: Identification of High Confidence Nuclear Forensics Signatures for the Development of a National Nuclear Forensics Library
2013-06-20 – New CRP J02003 on "Identification of High Confidence Nuclear Forensics Signatures for the Development of a National Nuclear Forensics Library". This CRP is now accepting proposals for agreements and contracts, and the interest from qualified institutes within the Member States are most appreciated. Read More –

Coordinated Research Activities

Explore CRPs

All CRPs open for proposals

All active CRPs

All completed CRPs (last 5 years)

Advanced Search

Proposal Forms

2013 CRP Listing

Coordinated Research Projects in 2005-2015

	DONE			APPROVED			PLANNED								
Coordinated Research Projects	05	06	07	08	09	10	11	12	13	14	15	16	17		
Delayed Hydride Cracking of Zr alloy fuel cladding, DHC-2 (TECDOC-1649, 2010)															
Optimization of water chemistry, FUWAC (TECDOC-1666, 2011)															
Modelling of transport of radioactive substances in the primary circuit (TECDOC-1672, 2012)															
Fuel behaviour modelling at extended burnup, FUMEX-2 (TECDOC-1687, 2012)															
Improvement of computer codes used for fuel behaviour simulation, FUMEX-3 (TECDOC-1697, 2013)															
Accelerator simulation and theoretical modelling of radiation effects, SMORE (draft NE Series Report)															
Evaluation of conditions for H-induced degradation of Zr alloys, K _{1H}															
Benchmarking of structural materials for advanced nuclear reactors, ODS															
Options for deployment of Th based nuclear energy															
Reliability of high power, extended burnup and advanced PHWR fuels (CRP-T12027, RCM-1 in Oct 2014)															
Management of severely damaged spent fuel and corium, B3 (CRP-T13015)															
Fuel modelling in accident conditions, FUMAC (CRP-T12028, RCM-1 in Nov 2014)															
Analysis of options and experimental examination of accident tolerant fuels for water-cooled reactors, ACTOF (CRP-2018)															

CRP series on fuel modelling (1982-2012)

Joint NEA-IAEA International Fuel Performance Experimental (IFPE) Database

Blind exercises

IAEA-TECDOC-415

DEVELOPMENT OF COMPUTER MODELS FOR FUEL ELEMENT BEHAVIOUR IN WATER REACTORS

SURVEY REPORT
OF A CO-ORDINATED RESEARCH PROGRAMME
ON THE DEVELOPMENT OF COMPUTER MODELS
FOR FUEL ELEMENT BEHAVIOUR IN WATER REACTORS
SPONSORED BY THE
INTERNATIONAL ATOMIC ENERGY AGENCY
AND PREPARED BY
J.H. GITTUS



A TECHNICAL DOCUMENT ISSUED BY THE
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1987

CRP D-COM
1982-1984
published in 1987



IAEA-TECDOC-998

Fuel modelling at extended burnup

Report of the Co-ordinated Research Programme on
Fuel Modelling at Extended Burnup — FUMEX
1993–1996



INTERNATIONAL ATOMIC ENERGY AGENCY IAEA

January 1998

CRP FUMEX
1993-1996
published in 1998

IAEA-TECDOC-1687

Fuel Modelling at Extended Burnup (FUMEX-II)

Report of a Coordinated Research Project 2002–2007



IAEA
International Atomic Energy Agency

CRP FUMEX-2
2002-2007
published in 2012

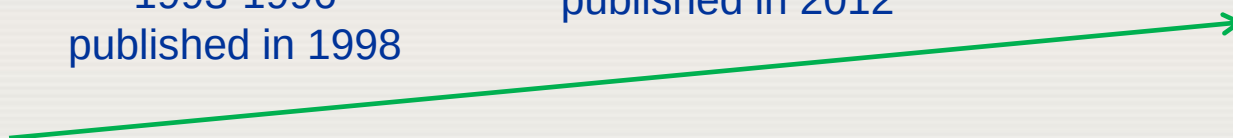
IAEA-TECDOC-1697

Improvement of Computer Codes Used for Fuel Behaviour Simulation (FUMEX-III)



IAEA
International Atomic Energy Agency

CRP FUMEX-3
2008-2012
published in 2013



FUMEX-3

34 members from 21 countries and ITU/JRC/EC

Argentina	2	India	1
Belgium	1	Italy	2
Brazil	2	Japan	3
Bulgaria	2	Korea	1
Canada	1	Romania	1
China	3	Russia	2
Czech Rep	1	Switzerland	1
Finland	1	UK	2
France	1	Ukraine	1
Germany	2	USA	2
Hungary	1	ITU/JRC/EC	1

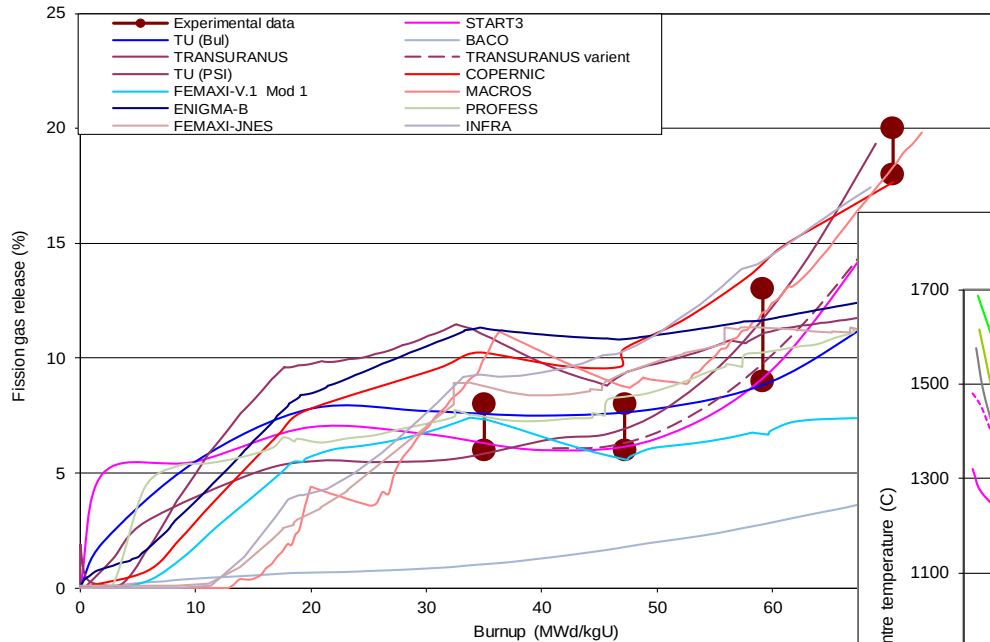
Data from the Halden Reactor Project (observer) and from CRP participants →

≈1500 datasets in the **NEA-IAEA Int'l Fuel Performance Experiments Database**

(<http://www.oecd-nea.org/science/wprs/fuel/ifpelst.html>)

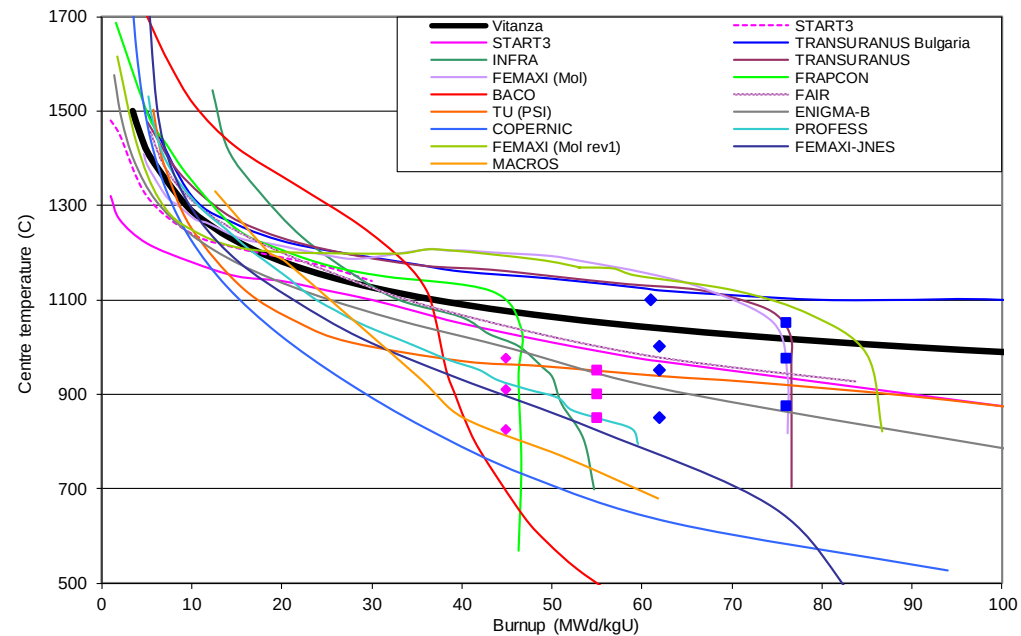
FUMEX: fission gas release prediction

Case 27(2d) FANP idealised



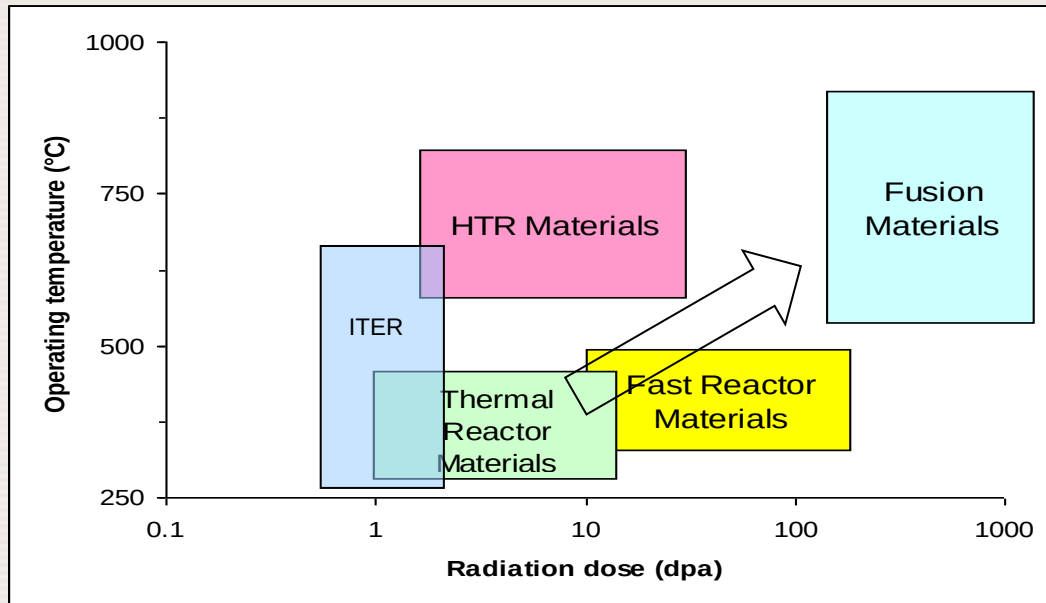
FUMEX-2, IAEA-TECDOC-1687, 2012

Case 27(1) Onset of FGR calculations



Vitanza threshold - the temperature of 1% FGR, experimentally derived up to around 40 MWd/kgU

SMoRE (Accelerator Simulation and Theoretical Modelling of Radiation Effects)



Reasons:

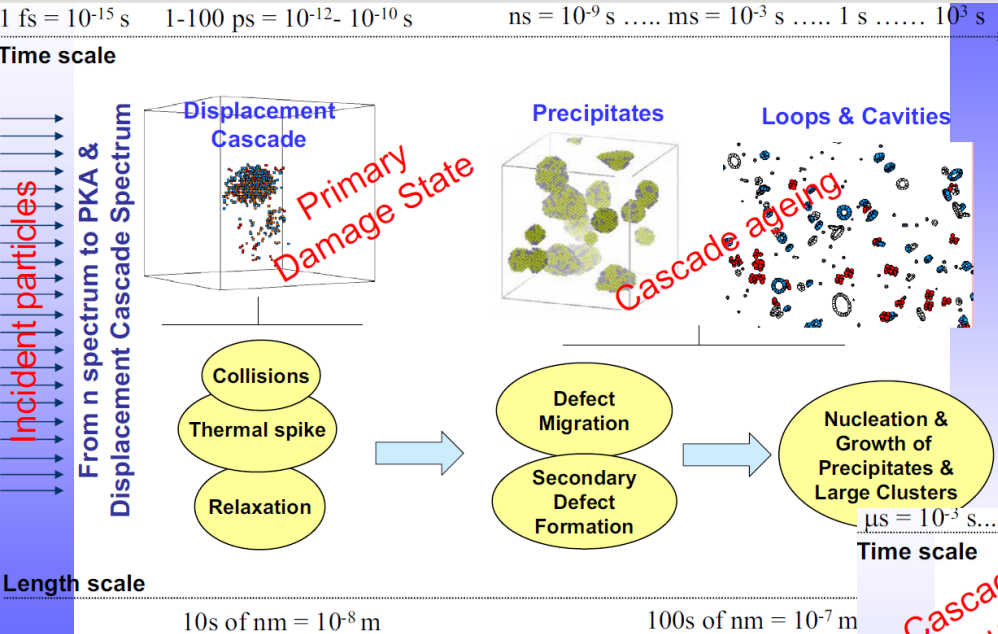
- Economically driven growth of conventional fuels burn-up
- Introduction of new fuels for innovative nuclear systems
- Insufficient basic understanding of radiation damage mechanisms

Nuclear Technology Review, IAEA, Vienna, 2007

SMoRE Objectives:

- enhancement of simulation capabilities of accelerators for materials testing
- contribution for better physical understanding of high-dose radiation effects

SMoRE: Multi-scale approach (NEA WPMM)



Radiation effects are inherently a multi-scale problem

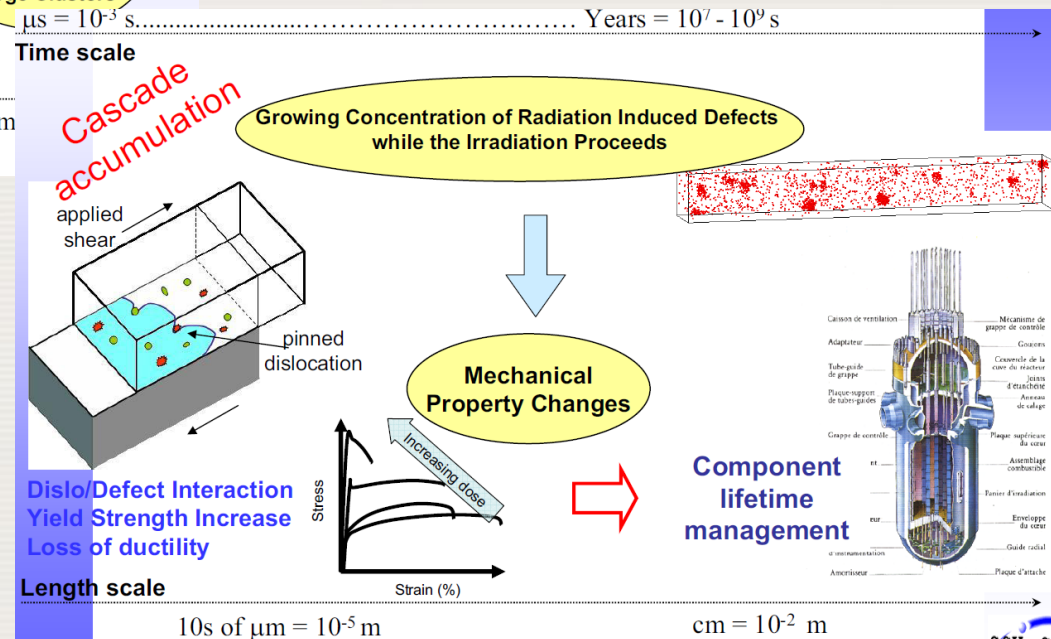
Quantum Mechanics →

Molecular Dynamics →

Kinetic Monte Carlo →

Dislocation Dynamics →

Elasticity / Plasticity



L. Malerba /SCK.CEN

Joint ICTP-IAEA Advanced Workshop on Multi-scale Modelling for Characterisation and Basic Understanding of Radiation Damage Mechanisms in Materials, Apr. 2010

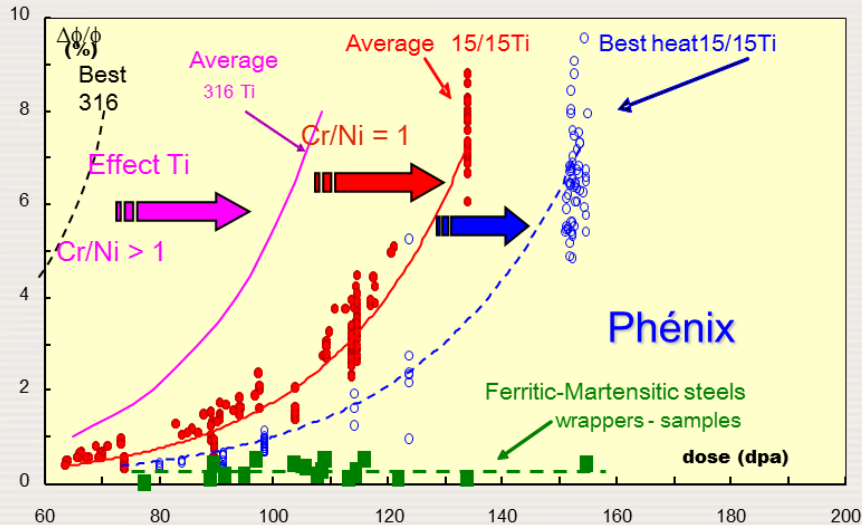
SMoRE (2008-2013): 19 members from 15 countries

1. Belgium: SCK.CEN (L. Malerba) – Fe-Cr potentials, their use in MD and MC, EPA experiments;
 2. China: CIAE (Sh. Zhu) – CLAM irradiation up to 85 dpa, temp. effects, tripple beam H/He synergy;
 3. France: CEA (F. Willaime), EdF (G. Monnet) – MSM in Fe, Fe-Cr, ODS, Jannus tripple beam, DD;
 4. India: BARC (P. V. Durgaprasad) – MD, DD in Fe, Fe-Cr, small-punch tests of T91;
 5. Japan: Kyoto University (A. Kimura) – Al-added-ODS, phase stability, He-trapping, dual beam;
 6. Kazakhstan: INP (O. Maksimkin) – F/M and AS, comparison with BN-350, martensite degradation;
 7. Korea, Rep: KAERI (J. Kwon) – MD, DD in F/M steels, TEM, atom probe, EPA, nano-indentation;
 8. Netherlands: JRC-Petten (L. Debarberis) – Fe-Cr ODSs (non-irradiated), EPA, SANS, TEP, TEM;
 9. Poland: IAE (W. Szteke) – small-punch testing of non-irradiated AS;
 10. Russia: IPPE (V. Pechenkin), Kurchatov Institute (A. Ryazanov) – F/M steels, neutrons, MSM, RIS;
 11. Slovakia: Bratislava University (V. Slugen) –ODS MA956, ODM751 and Eurofer comparisons, EPA;
 12. Spain: Madrid University, Institute of Fusion (J. Perlado) – Fe-Cr potentials, defect formation energies;
 13. Switzerland: PSI (M. Pouchon) – micro-pillar nano-indentation, analysis and modelling;
 14. Ukraine: KIPT (V. Voyevodin) – high-dose ion irradiation, comparisons with neutrons, MSM;
 15. USA: LLNL (M. Fluss), LANL/UCB (P. Hosemann) – ODS MA956, MA957 and K3; micro-studies;
- Rad. Effects Consulting (F. Garner) – chief consultant of the project;

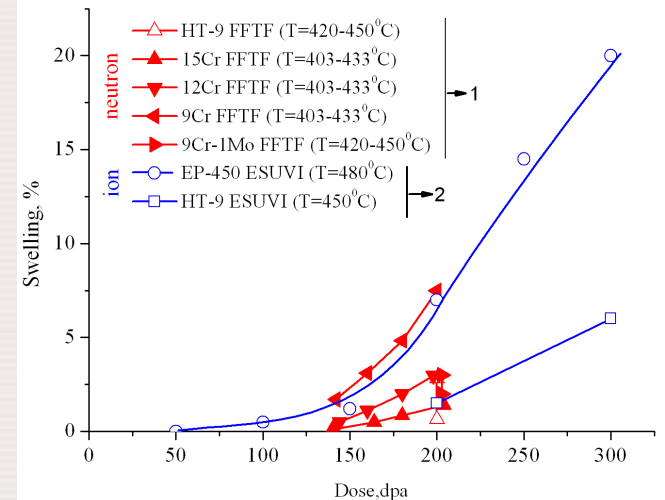
NEA / OECD – observer, many participating members and discussions at WPMM.

CRP SMoRE

Swelling under fast neutron irradiation:
IAEA TM on FR Fuels, IAEA-TECDOC-1689, 2013
PHÉNIX data, Ph. Dubuisson, CEA, France

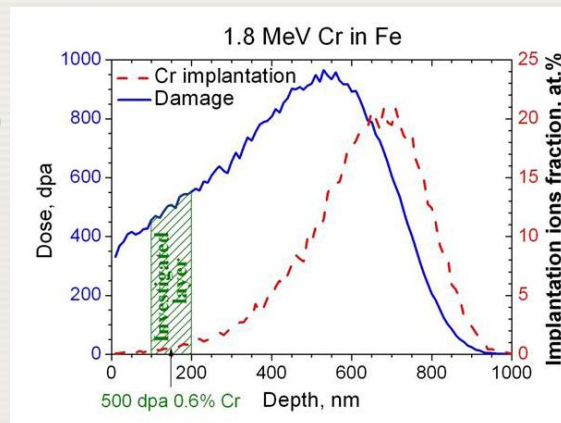


Accelerator simulations, SMoRE & ODS CRPs
V. Voyevodin et al, KIPT, Ukraine,

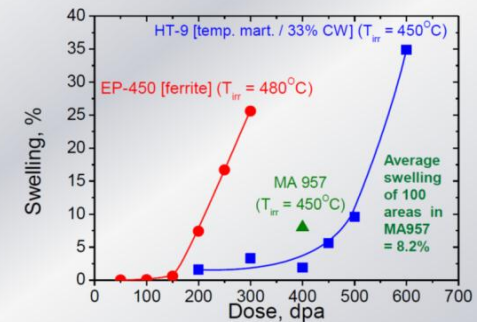


Ion induced void swelling of ODS ferritic alloys at 100-600 displacements per atom
O.V. Borodin, V.V. Bryk, S.V. Dnyk, A.S. Katchenko, N.P. Lazarev, V.V. Melnichenko, V.N. Voyevodin, F.A. Garner, M.B. Toloczko

DPA/NRT issue:
NEA/WPMM/EG-PRD
and IAEA/CRP PRD



Comparison of ion-induced swelling in three alloys



National Science Center
"Kharkov Institute of Physics and Technology"



IAEA Nuclear Safety Action Plan: FUMAC

CRP “FUEl Modelling in Accident Conditions” (FUMAC, 2014-2018)

is aimed at better understanding of fuel behaviour in accident situations through identification of best practices in the application of relevant physical models and computer codes, used in different Member States, and enhancement of their predictive capacities. Well checked results of accident simulation experiments will be selected, integrated into the joint **NEA-IAEA International Fuel Performance Experiments (IFPE) Database**, and used for codes verification and comparisons.

- TM “Fuel behaviour and modelling under severe transient and LOCA conditions”,
Mito, Japan, 2011
- TM “Modelling of water-cooled fuel including design basis and severe accidents”,
Chengdu, China, 2013
- Consultants Meeting on FUMAC outline and organization,
Vienna, 11-13 March 2014
- 1st Research Coordination Meeting of FUMAC,
Vienna or Karlsruhe, 10-14 November 2014

IAEA Nuclear Safety Action Plan: ACTOF

CRP “Analysis of Options and Experimental Examination of Fuels with Increased Accident Tolerance” (ACTOF, 2015-2019)

will examine approaches for development of water-cooled reactor fuel with improved tolerance to the severe accident conditions (ATF) that intensified after Fukushima accident, with the ultimate goal to replace the currently used Zr alloy fuel cladding, which is vulnerable to steam-zirconium reaction and hydrogen release when active cooling in the reactor core is lost. Technological, operational and economic aspects of ATF manufacturing and implementation are also to be considered.

- TM “Accident Tolerant Fuel concepts for Light Water Reactors”, Oak Ridge, USA, 13-17 October 2014
- Consultancy and RCM-1 in 2015

**IAEA TECHNICAL MEETING ON
ACCIDENT TOLERANT FUEL CONCEPTS FOR LIGHT WATER REACTORS
13 October – 17 October 2014, Oak Ridge National Laboratory, Oak Ridge, TN, USA
INFORMATION SHEET (extract)**

Topics:

- ✓ Materials, design, technology, and safety requirements for ATF with regard to possible reactor operation in normal, transient, and accident conditions;
- ✓ R&D on ATF, including:
 - Zr alloys modification and advancements
 - Alternative cladding concepts
 - Alternative fuel concepts
- ✓ Modelling ATF behaviour;
- ✓ Economic aspects of ATF implementation;
- ✓ ATF-relevant experience and lessons learned from Fukushima and other accidents;
- ✓ CRP ACTOF round-table discussion

Background, Objectives, Organization, Deadlines, Venue and Accommodation, Expenditures



***Thanks
for your attention, and
welcome to CRP ACTOF!***