

Recent and Current Activities of the Working Group on Fuel Safety (NEA/CSNI)

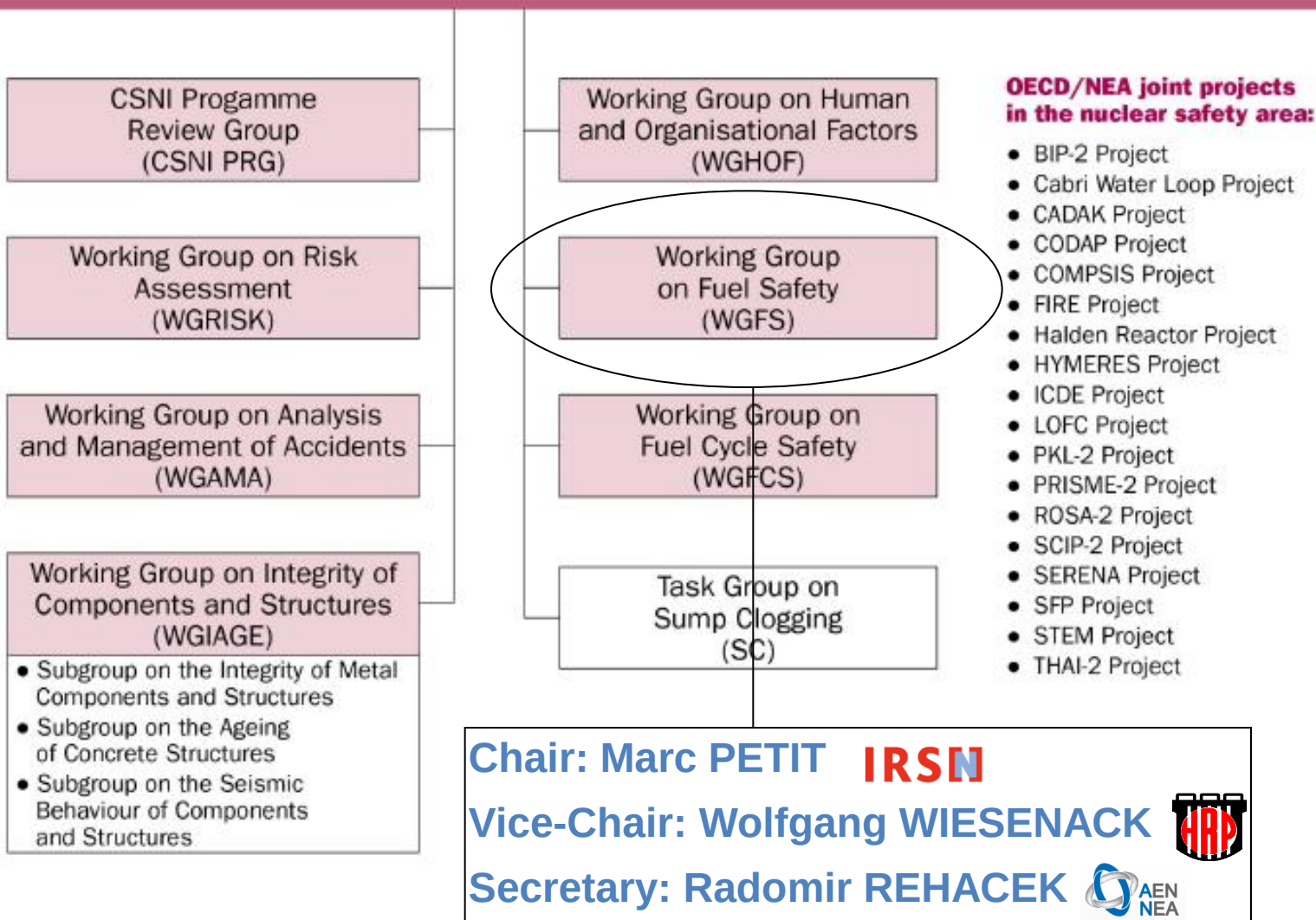
Marc PETIT
IRSN - France

OECD/NEA Workshop on Accident Tolerant Fuels of LWRs
10 -12 December, 2012
NEA Headquarters, Issy-les-Moulineaux

This presentation will cover

- ☐ The Working Group on Fuel Safety (WGFS)
- ☐ WGFS activities
- ☐ WGFS discussion of Fukushima
- ☐ Conclusions

Committee on the Safety of Nuclear Installations (CSNI)



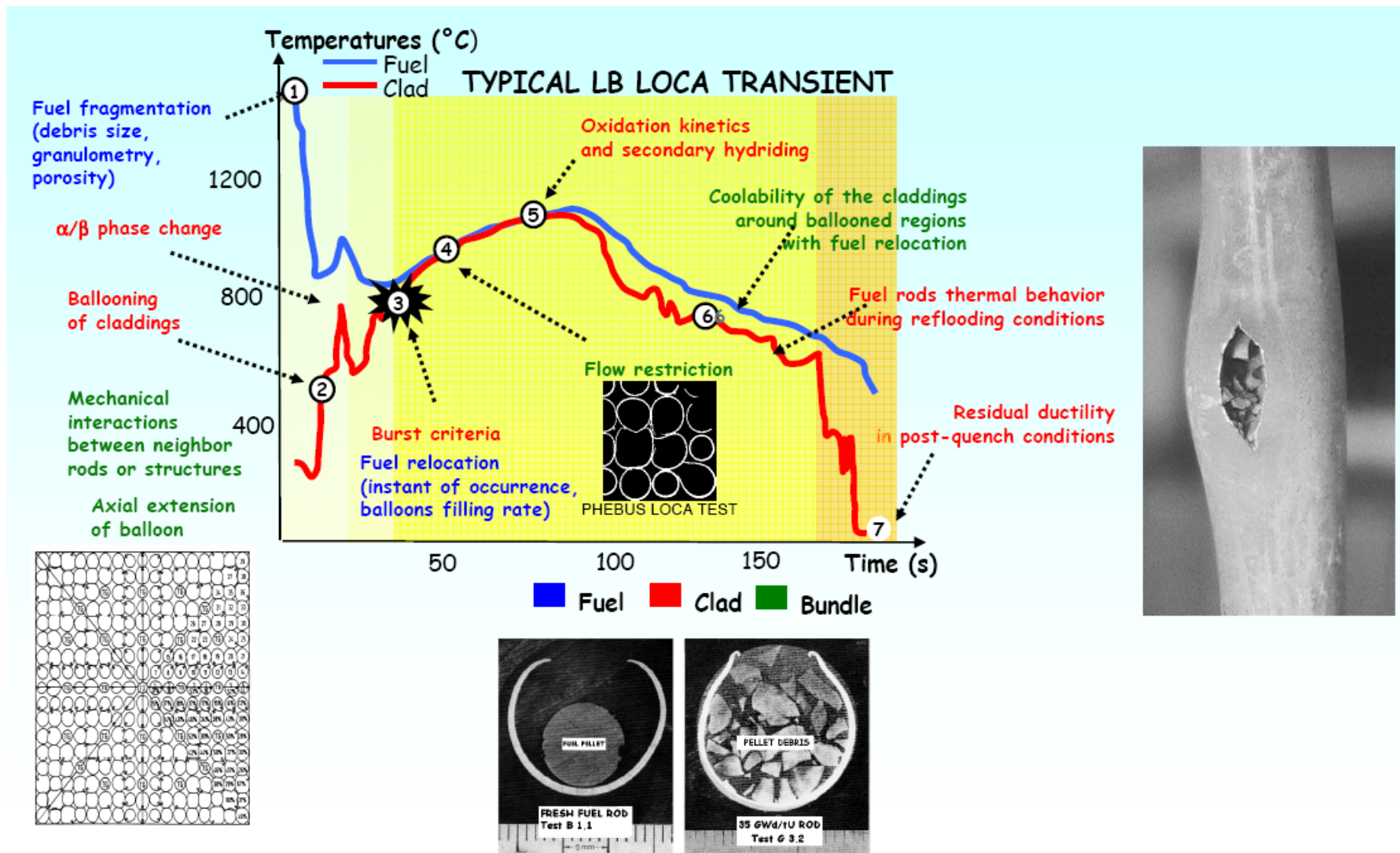
Excerpts from the mandate of the WGFS

- ▶ The main mission of the Working Group on Fuel Safety (WGFS) is to advance the current understanding and address safety issues related to fuel safety
 - ▶ Assess the technical basis for current safety criteria and their applicability to high burn-up (above 50 MWd/kg) and to new fuel designs and materials. ...
 - ▶ Determine needs and priorities for future research programmes in the area of fuel safety behaviour, with the aim of understanding and adequately modelling key phenomena and of quantifying safety margins.
 - ▶ Review from a safety point of view the adequacy of fuel codes and methodologies used for different core assessments as related to high burn-up fuel. ...
 - ▶ Provide a forum where safety-relevant fuel issues emerging from operating experience and research work can be addressed and resolved in an effective manner.

Recent and current activities of the WGFS

- ▶ Activities of the WGFS cover the following topics
 - ▶ Loss of Coolant Accidents (LOCA)
 - ▶ Reactivity Initiated Accidents (RIA)
 - ▶ Fuel Safety Criteria
 - ▶ Leaking fuel impacts and practices
 - ▶ Fukushima related topics

The LOCA transient



Nuclear Safety

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**Nuclear Fuel Behaviour in
Loss-of-coolant Accident
(LOCA) Conditions**

State-of-the-art Report

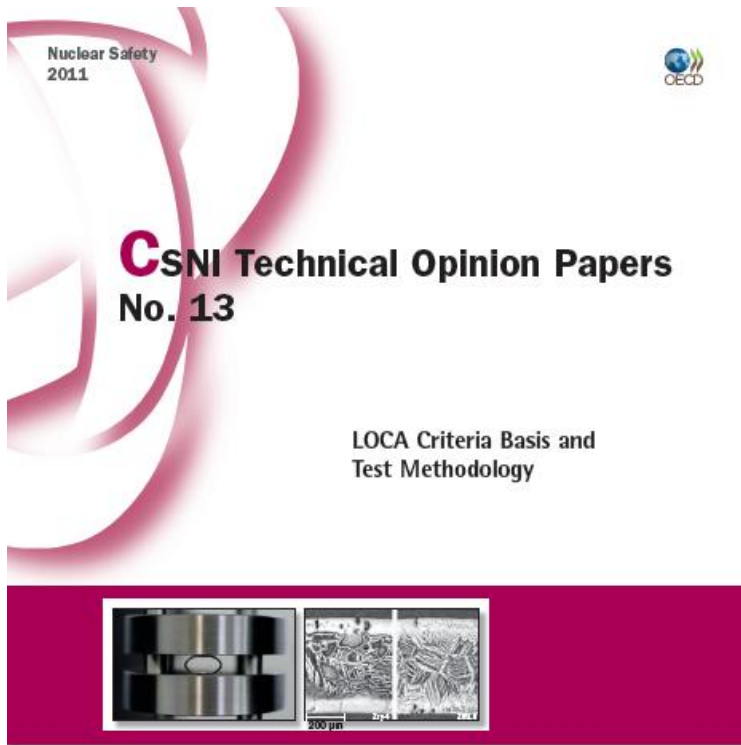
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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

LOCA State of the Art Report

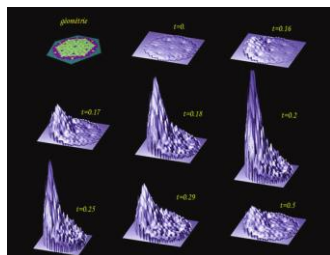
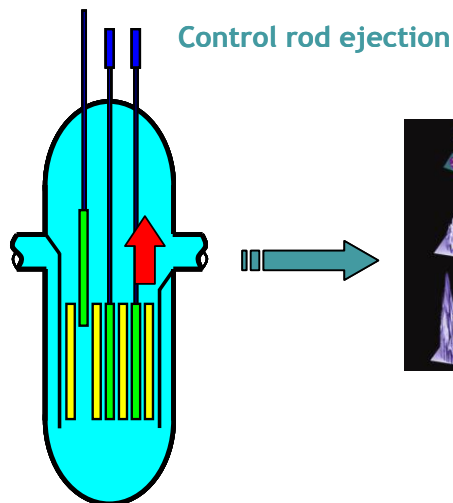
- ▶ Everything you need to know about LOCA (and even more)
- ▶ NEA/CSNI/R(2009)15

Other LOCA related documents

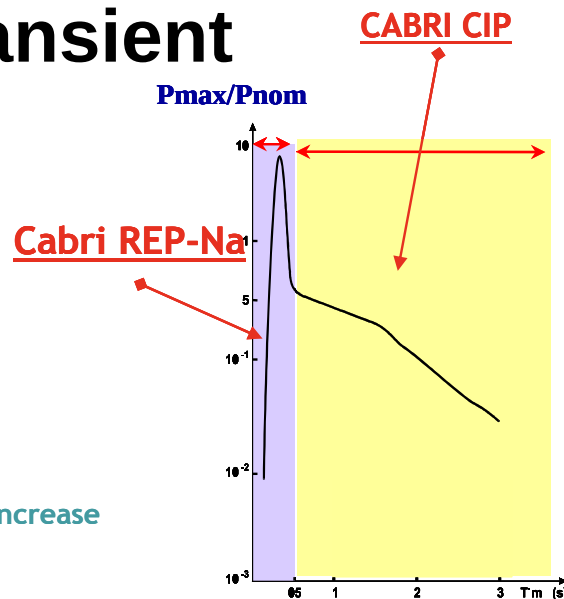


- ▶ LOCA Criteria Basis and Test Methodology
 - ▶ NEA/CSNI/R(2011)7
- ▶ Safety Significance of the Halden IFA-650 Test Results
 - ▶ NEA/CSNI/R(2010)5
 - ▶ The report discusses recent results on high burnup fuel showing fuel fragments dispersal out of the cladding under LOCA simulated conditions

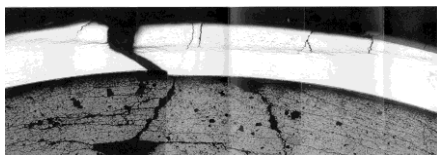
The RIA transient



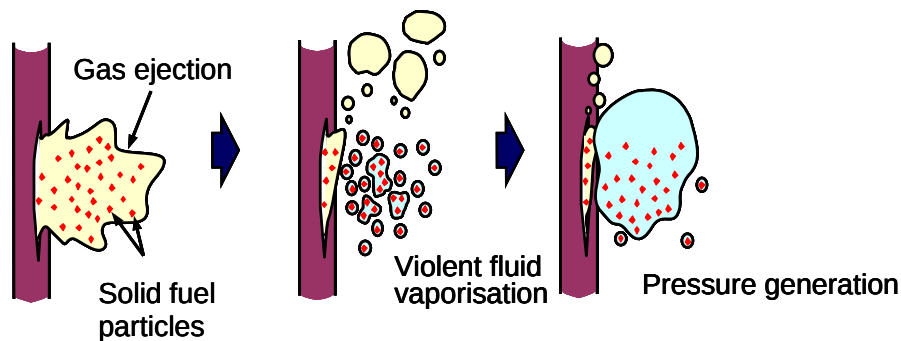
Reactivity injection / Power increase



1. Cladding rupture ?



2. Fuel / coolant interaction ? R.P.V. integrity ?



Nuclear Safety
NEA/CSNI/R(2010)7
November 2010
www.nea.fr



Nuclear Fuel Behaviour During Reactivity Initiated Accidents

Proceedings of a CSNI Workshop
Paris, France
9-11 September 2009



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RIA Workshop

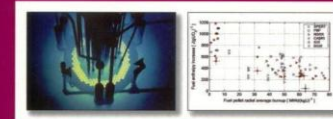
► NEA/CSNI/R(2010)7

Nuclear Safety
2010



Nuclear Fuel Behaviour under Reactivity-initiated Accident (RIA) Conditions

State-of-the-art Report



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RIA State of the Art

► NEA/CSNI/R(2010)1

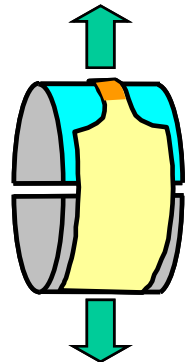
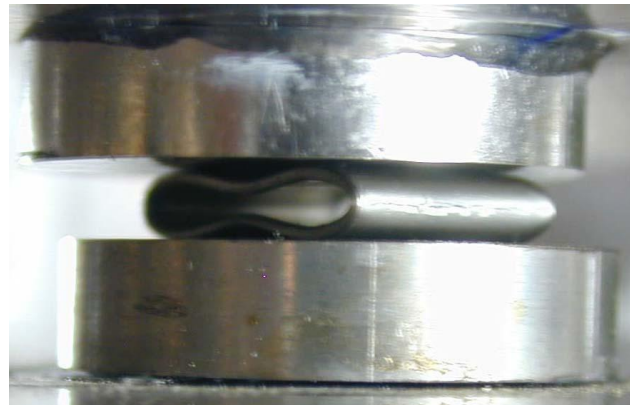
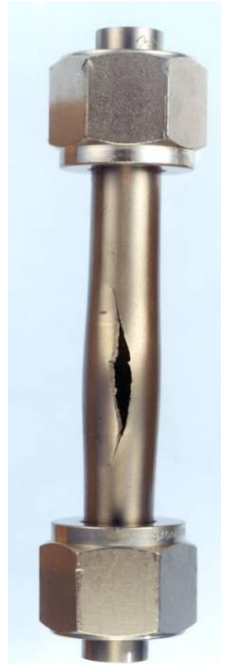
Other RIA related documents

► Mechanical testing for RIA applications (just approved)

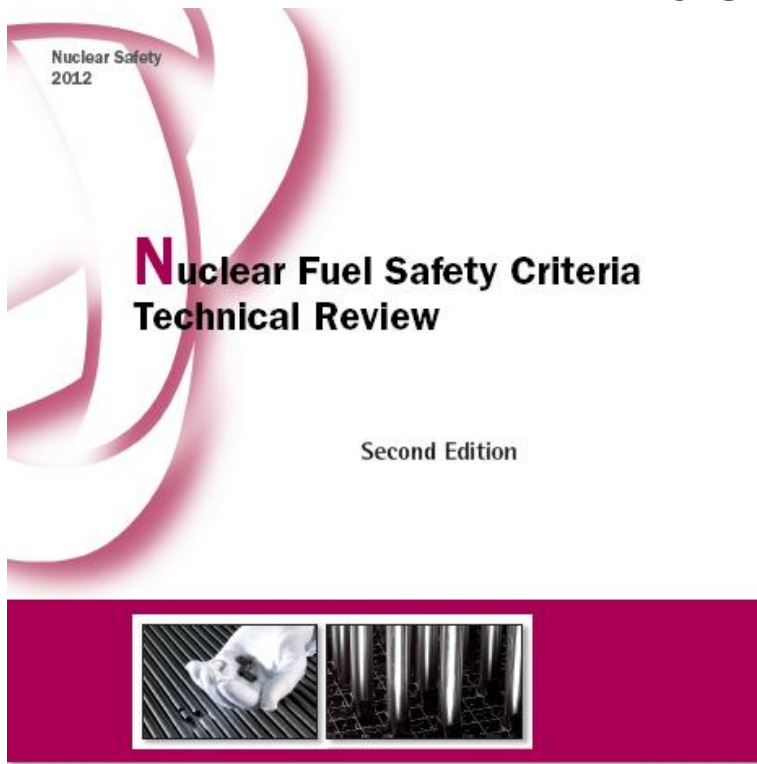
Executive summary

1. Background and introduction
2. Cladding mechanical loading during **RIA**
3. Description of existing methodologies
4. Discussion of the different methodologies
5. Recommendations regarding different methodologies
6. Conclusions

References



Fuel Safety Criteria



► Review of fuel safety criteria

► NEA/CSNI/R(2012)3

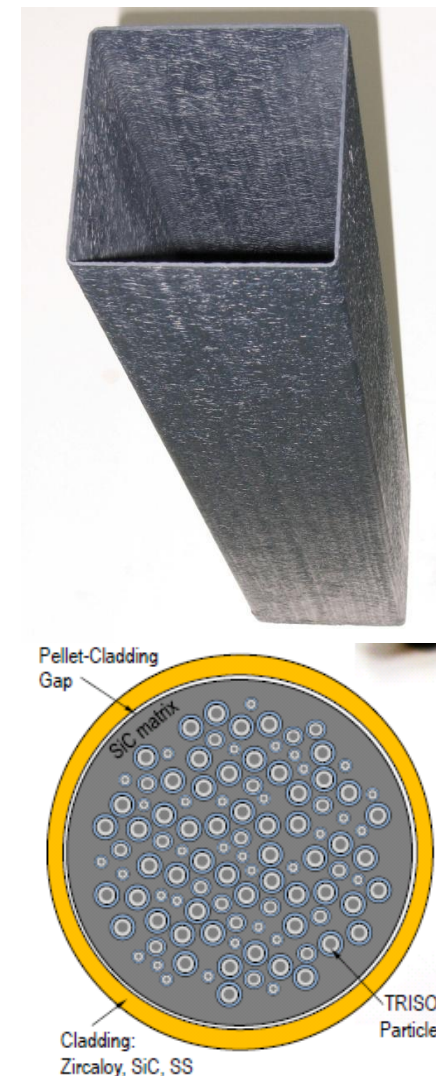
► Although the criteria discussed in this report may not be applicable to design different than the current ones for LWRs, this document is of interest because it compiles a list of phenomena to be addressed when assessing fuel safety

Leaking fuel impact and practices

- ▶ This task started recently
- ▶ Areas of interest identified
 1. Operation of NPP reactors with leaking fuel
 2. Identification of leaking fuel assemblies and fuel rods
 3. Consideration of leaking fuel in safety analyses on core behaviour during postulated accidents (LOCA, RIA and other transients)
 4. Storage of leaking fuel in the spent fuel pool (SFP)
 5. Activity release from leaking fuel during storage in the SFP
 6. Activity release from leaking fuel during manipulations in the SFP
 7. Transport and interim storage of leaking fuel assemblies
 8. Activity release from leaking fuel in interim storage facilities
 9. Hydrogen gas generation from leaking fuel in dry storage facilities and/or during transportation
 10. Reprocessing of leaking fuel rods
 11. Experimental investigations of leaking fuel

WGFS discussion on Fukushima topics

- ▶ Initial presentations and discussions during the last meetings
- ▶ New Fuel Material Development Activities
 - Fully Ceramic Microencapsulated fuels
 - MAX phase coating
 - SiC phase cladding/coating
 - Fe-Cr-Al alloys
 - Mo-alloys and Mo-Zr composite cladding
 - SiC BWR channel
 - SiC cladding
- ▶ Zr vs. alternative cladding materials with respect to hydrogen production in accident conditions
 - Presented at this workshop



Accident Tolerant Fuel?

- ▶ The concept of accident tolerant fuel needs to be precisely defined
 - *Design basis accidents / Beyond DBA*
- ▶ Following Fukushima accident, much emphasis has been put on hydrogen production
 - *Many other subjects deserve careful attention*
- ▶ Although some improvements are made, Zr-based alloys have been used continuously as the fuel cladding and structural material for LWRs
 - *Better solutions probably not straightforward*
- ▶ Qualification of new fuels for industrial use is a long process
 - *Still requires experiments in representative conditions, including accidents*

The present workshop will help clarifying these questions

Conclusions

- ▶ The WGFS is focused on safety aspects related to fuel, mostly for LWRs
- ▶ The WGFS is willing to interact more with other working groups of the NEA
- ▶ Innovative fuel concepts have been given more attention following the Fukushima accident
- ▶ Safety aspects have to be integrated early in the process of new fuel development because they induce important constraints
- ▶ This workshop is a good opportunity to strengthen the links between CSNI/WGFS and WPRS/EGRFP
- ▶ Depending on the outcome of this meeting, it may lead to a future joint activity