

Expectation to EGATFL from Japanese industry

TF members and Observers:

Toshiba, Hitachi-GE , MHI, MNF, GNF-J,
NFI, NFD

Presented by Toshiba at EGATFL 1st meeting
Sep. 23-25, 2014, OECD/NEA, Paris

Background and Focus on ATF development

- Current LWR fuel system had been optimized for in-reactor performance.
 - ✓ High burnup - reduced waste volume
 - ✓ Increased reliability - decreased fuel failures
 - ✓ Improved plant availability - more economical reactor operation
- Post Fukushima focus has been primarily on the safety issue such severe accident in Japan.
 - ✓ Redefine the severe accident scenario for LWRs
 - ✓ Demonstrate industry commitment to continuous improvement in safety and performance
- As the interest of nuclear fuel and plant vender in Japan,
 - ✓ Strength of "Defense in Depth for Safety"
 - ✓ Possibility for enlarged safety margin
 - ✓ Core and fuel materials and structure with potential to eliminate / mitigate hydrogen generation

Necessary R&D for utilization from viewpoints of industry

- In order to meet the desired development timeline, advanced fuel and/or cladding concepts with design under this initiative must be suitable for use in existing LWRs or reactor concepts with design certifications (GEN-III+).
- New ATF designs shall satisfy the LWR operations, safety and fuel cycle constraints
 - ✓ Backward Compatibility(qualified and quantified in an existing reactor)
 - ✓ Impact on Safety (for the entire spectrum of DBAs + SA)
 - ✓ Licensing and Economics
 - ✓ Impact on Operations, Fuel Cycle Impact
 - ✓ Roadmap, Metrics and TRL

Analytical Evaluations of ATF (1)

Analytical evaluation will be conducted in order to confirm the quantitative safety performance of the ATF when the ATF applies to the commercial plants such as BWR and PWR. The application of the ATF will have advantages that:

- The hydrogen combustion may be negligible.
- Increase of the containment pressure due to hydrogen generation is suppressed and the margin of the containment integrity may increase.

In order to conduct the analytical evaluation, we plan to perform the following items.

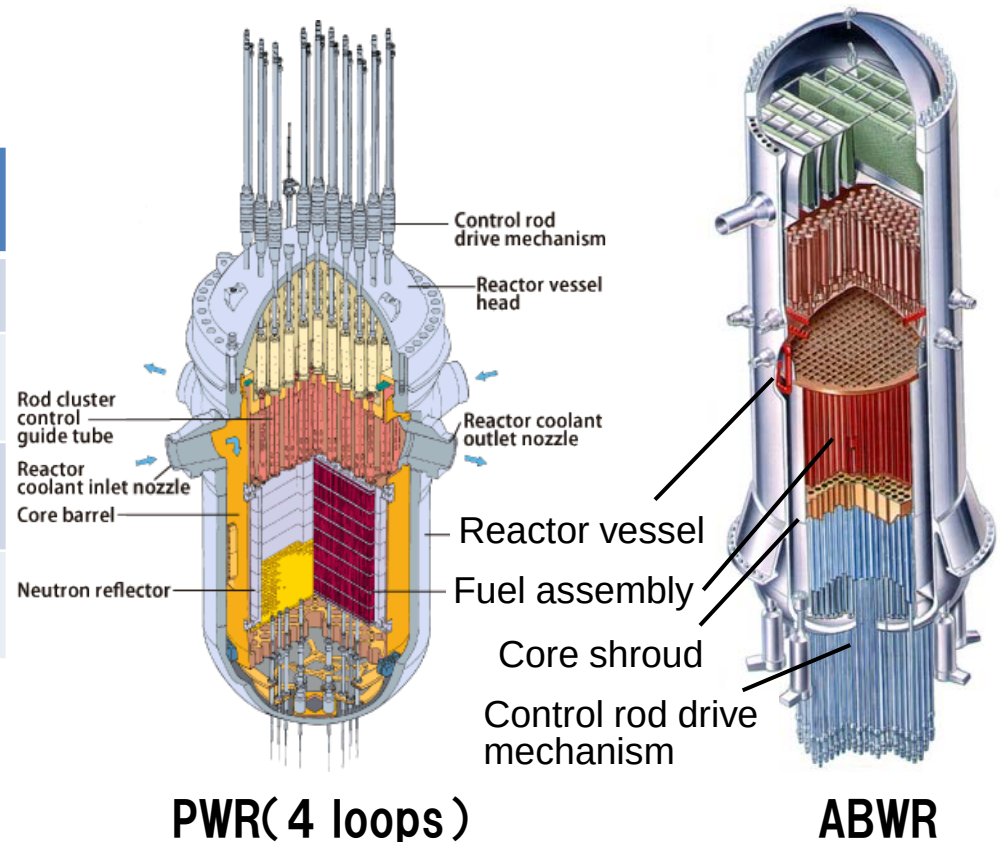
- ATF degradation model will be incorporated into an existing integrated severe accident analysis program.
- Key models are: cladding oxidation, material interaction (dissolution, eutectics), cladding failure criterion, melting, candlering, crust formation and breach criterion, etc.
- Metrics will be quantified through typical plant analysis and comparison to that of conventional fuel.

Analytical Evaluations of ATF (2)

We plan to conduct the analytical evaluations for typical type of the commercial reactors in Japan, which are 4 loops PWR and ABWR. Since PWR and BWR are different as shown in the table, PWR and BWR vendors will perform the evaluations separately.

Fuel conditions (tentative plan)

	PWR (4 loops)	ABWR
Fuel type	17x17	9x9
Fuel inventory	193 assemblies	872 assemblies
Control rod type	Cluster (Ag-In-Cd)	Cross shaped (B ₄ C)
ATF application for:	Fuel cladding	Fuel cladding, Channel box



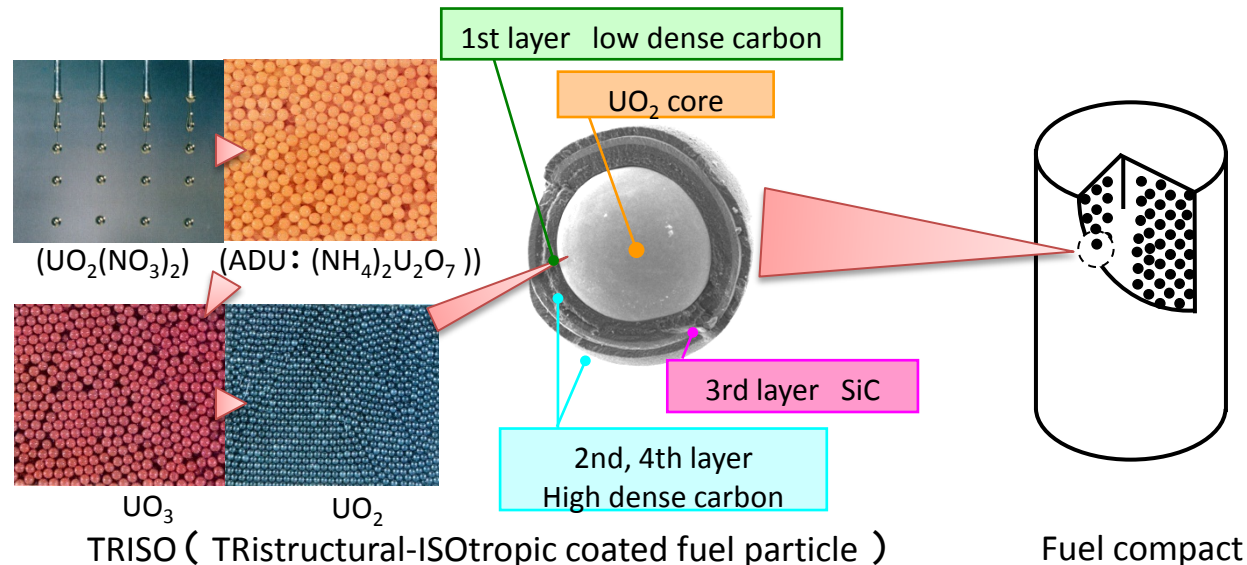
Application of TRISO to LWR

Fabrication technology of TRISO is already established for HTGR.

- Fuel Kernel : Fabrication technology for UO_2 is established.
- Coated Particle : Thickness of coated layer is well controlled for UO_2 Kernel.
- Fuel Compact : Filling rate of particles in graphite matrix based compact is ca.30% for HTGR fuel.

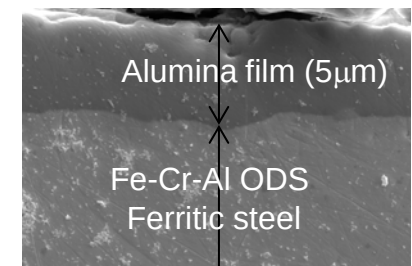
Subject for TRISO application to LWR

- Fabrication process for TRISO, comparable U-inventory to current LWR
- Core design for TRISO (start with conceptual design)



Application of Fe-Cr-Al ODS ferritic steel to LWR

- Concept
 - Protective alumina film → Extremely low reactivity to high temp. steam and chemical reactions
 - ODS → High strength at high temperature
 - Ferritic steel → Low sensitivity to IASCC
- Application
 - Fuel cladding of ATF (Feasibility study under the project supported by MEXT: 2013 – 2016)
 - Absorber tube and blade of ATCR (Planning)



In-pile testing (in case of SiC for example)

Current Project (Toshiba)

- Prototype fabrication of shorter channel boxes and claddings has been successfully done by Toshiba and IBIDEN.

Necessary future's plan (Toshiba, Hitachi-GE and Mitsubishi)

- Irradiation test using the SiC specimen of
 - channel box and cladding tube for BWR fuel (Toshiba, Hitachi-GE)
 - cladding tube for PWR fuel (Mitsubishi)in order to acquire the irradiation property data.



132.5mm × 800mmL
Channel Box ($\text{SiC}_f\text{-SiC}$)



Φ10mm × 280mmL
Cladding Tube ($\text{SiC}_f\text{-SiC}$)

TOSHIBA/IBIDEN, Trial fabrication

Approach to Economics evaluation

Economics evaluation

(ex)

- Fuel cycle cost
(neutronics performance analysis etc)
 - ✓ Front-end
 - ✓ Back-end
- Fabrication cost
- Economic benefit due to mitigation of O&M cost and operation flexibility
(High burnup, Long cycle, Power uprate)

Expectation to EGATFL

- In Japan, many organizations participate in EGATFL as representative and observer
- Information exchange and technical discussion on general issues of ATF

(ex)

- Candidate materials/designs
- Safety standard from normal operation to accident
- Required characteristics/performance metrics
- International joint program
- Management of EGATFL
 - Definition of representative and observer member
 - Obligation and right

Thank you for attention!