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Masaki Kurata, Marc Barrachin, Tim Haste, Martin Steinbrueck

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Masaki KURATA
Japan Atomic Energy Agency,
Shirakata 2-4, Tokai-mura, Naka-gun, Ibaraki-ken, 319-1195, JAPAN

Marc Barrachin
Institut de Radioprotection et Sûreté Nucléaire,
Bat. 702, St. Paul-lez-Durance, Cadarache, F-13108, France

Tim Haste
Institut de Radioprotection et Sûreté Nucléaire,
Bat. 702, St. Paul-lez-Durance, Cadarache, F-13108, France

Martin Steinbrueck
Karlsruhe Institute of Technology, Institute for Applied Materials
Hermann-von-Helmholtz-Platz 1; 76344 Eggenstein-Leopoldshafen, Germany

Corresponding author: Masaki Kurata
e-mail address: kurata.masaki@jaea.go.jp

ABSTRACT

Severe accidents occurred at the Fukushima-Daiichi Nuclear Power Station (FDNPS) required an immediate re-examination of fuel degradation phenomenology. The present paper reviews the updated knowledge on the phenomenology of the fuel degradation, focusing mainly on the BWR fuel assembly degradation at the macroscopic scale and that of the individual interactions at the meso-scale. Oxidation of boron carbide (B_4C) control rods potentially generate far larger amounts of heat and hydrogen under BWR accident conditions. All integral tests with B_4C control rods or control blades have shown early failure, liquefaction, relocation and oxidation of B_4C starting at temperatures around 1250°C, well below the significant interaction temperatures of UO_2-Zry. These interactions or reactions potentially influence the progress of fuel degradation in the early phase. The steam-starved conditions, which are being discussed as a likely scenario at the FDNPS accident, highly influence the individual interactions and potentially lead the fuel degradation in non-prototypical directions. The detailed phenomenology of individual interactions and their influence on the transient and on the late phase of the severe accidents are also discussed.

Highlights

- Phenomenology mainly focusing on BWR fuel degradation is reviewed using previously accumulated and recently updated knowledge.