# Evaluation on Accident Source Term based on the Regulations

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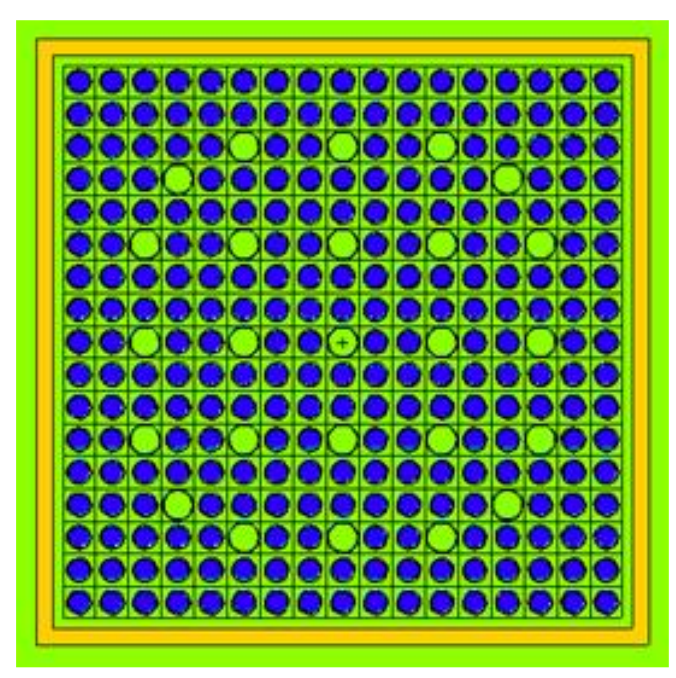
## Introduction

After Three Mile Island incident, accident source term had become great consideration. The accident source term is defined as radionuclides that could be released as form of mixture of gas, vapor, and aerosols produced from nuclear power plants (NPPs) severe accident sequences. The analyses and evaluations of accident source term required by 10 CFR 50.34 for an operating license are documented in the facility final safety analysis report (FSAR). Although accident source term under initial regulation, which is Technical Information Document (TID)-14844(RG 1.195) was used for the NPP site evaluation, it has been claimed that this evaluation was overly conservative. The updated understanding of the previous regulation resulted in the establishment of Alternative Source term (AST) (RG 1.183), alternative regulation for fission products (FPs) leakage and severe accident in LWR.

The model used for evaluating and comparing this accident source term is SMART (System-integrated Modular Advanced ReacTor), an integral type of small modular reactor (SMR) with 365 MWth which was developed by Korea Atomic Energy Research Institute (KAERI). In order to estimate the feasibility of applying the accident source term complied by NUREG-1465 to SMART, accident source term of SMART were analyzed by using ORIGEN module in SCALE code. The leakage of FPs over time was evaluated and compared using two regulations.

## Methodology and Model Specification

The SMART core is designed with 57 FAs and the initial core is designed with $UO_2$ fuel with 4.72wt% enrichment and 2-batch loading pattern. Averaged discharge burnup (EFPD) is about 870 days. The averaged fuel assembly burnup of equilibrium core is about 22 MWD/kgU and average discharge burnup of 2-batch fuel assembly is about 44 MWD/kgU. After 2-batch operation period, core inventory (radioactive nuclide concentration) was selected. As a first step, the FPs inventory were calculated using ORIGEN module in SCALE code using these core specifications. The listed information about FPs inventory was converted into binary file. After that, accident source term (LOCA source term and gas gap activity) was calculated.



### LOCA Source Term

The gamma source term were calculated by using ORIGEN. It was postulated that the all FPs are leaked out into containment by assuming LOCA is occurred after 2-batch operation period. By using FPs inventory, source terms were evaluated by time steps. The final source term was evaluated by taking into account for release fraction based on RG 1.195 and RG 1.183.

### Gas Gap Activity

The composition of FPs in gap were calculated by using ORIGEN. It was postulated that the all FPs are leaked out into containment by severe accident, and the activity of released FPs was evaluated. Gas gap activities at specified decay time were calculated from the FPs inventory at final burn-up. The decay time is assigned from after shutdown to 100 hours due to design criteria for passive safety system. Gas gap activities were evaluated by taking fraction of FPs inventory in gap based on RG 1.195 and RG 1.183.

| | TID (RG1.195) | AST (RG1.183) |
|---|---|---|
| **Core Inventory Fraction Released Into Containment** | Noble Gases -1.0<br>Iodines – 0.5 | Noble Gases – 1.0<br>Halogens – 0.4<br>Alkali Metals - 0.3<br>Tellurium Metals – 0.05<br>Ba, SR – 0.02<br>Noble Metals – 0.0025<br>Cerium Group – 0.0005<br>Lanthanides – 0.0002 |
| **Rate of Release** | Released Instantaneously | Released over 1.8 hrs Gap – 30s ~ 0.5h<br>Early In Vessel – 0.5~1.8 hrs |
| **Fraction of Fission Product Inventory in Gap** | I-131 – 0.08<br>Kr-85 – 0.1<br>Other Noble Gases, Other Iodines – 0.05 | I-131 – 0.08<br>Kr-85 – 0.1<br>Other Noble Gases, Other Halogens – 0.05<br>Alkali Metals – 0.12 |
| **Radionuclide Groups** | Noble Gases – Xe, Kr<br>Iodines - I | Noble Gases – Xe, Kr<br>Halogens – I, Br<br>Tellurium Group – Cs, Rb<br>Tellurium Group – Te, Sb, Se, Ba, Sr<br>Noble Metals – Ru, Rh, Pd, Mo, Tc, Co<br>Lanthanides – La, Zr, Nd, Eu, Nb, Pm, Pr, Sm, Y, Cm, Am<br>Cerium – Ce, Pu, Np |

## Results

The evaluated LOCA source term and gas gap activity of SMART based on TID and AST are shown in graphs, respectively. This evaluation showed that result of LOCA source term applying TID are more conservative than applying AST. The reason for the results is that the fraction applied in the TID is constant regardless of time but decreases over time in AST. This result will be used for future LWR and SMR design to evaluate accident source term.