

1-18 An Exploration of the Reason for Iodine-131 Release after Core Cool Down

— Release of Iodine-131 from Contaminated Water in the Basement of Reactor Buildings —

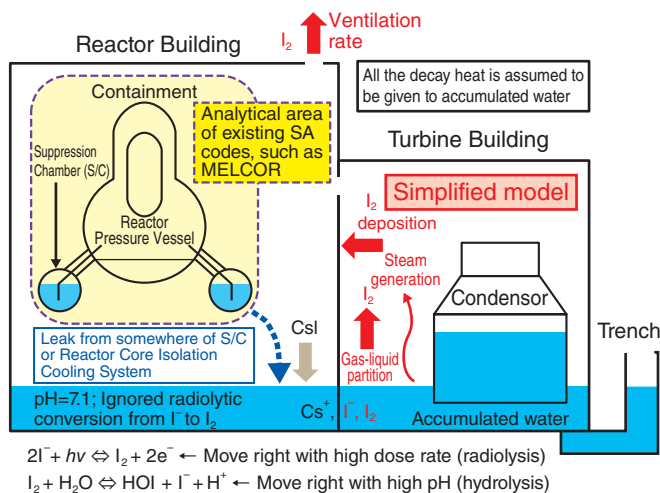


Fig.1-37 Schematic of contaminated water accumulation in the basements of reactor building and turbine building and the release from the accumulated water considered in present simplified model

During the 1F accident, somewhere of the reactor coolant system failed and contaminated water accumulated in the basements of the reactor building. Since the release of ^{131}I from the contaminated water due to gas-liquid partition is not considered to be negligible, a simplified model of the release from the contaminated water was prepared, as indicated in red.

During the process of core cooling in the accident at the TEPCO's Fukushima Daiichi NPS (1F), large amounts of contaminated water accumulated in the basements of the reactor buildings (Fig.1-37). The present study estimated the quantity of I-131 (^{131}I) in the water as of late March in 2011 based on the data made available to the press. The estimation showed that a significant fraction of the ^{131}I inventory was dissolved in water (Table 1-3).

Most of ^{131}I released from the fuel would be dissolved as I^- in water, while some of the I^- could become I_2 and be released as a gas phase due to the gas-liquid partition in the case of acidity. This and the ventilation of the reactor buildings result in an increase in the release of ^{131}I into the environment.

Many analyses of ^{131}I release have been attempted, mainly using the two methods. One is reverse estimation using the atmospheric dispersion code SPEEDI combined with the environmental monitoring data. The other is estimation using severe accident analysis codes, such as MELCOR. No large difference was found in the cumulative release to environment between the two methods. However, SPEEDI predicted continuous release for longer than one month, whereas MELCOR predicted that it would stop after March 17 due to the decrease in release from the cooled core (Fig.1-38).

Table 1-3 Estimated fractions of ^{131}I in accumulated water to each core inventory in late March

Unit	^{131}I (%)
1	0.51
2	74
3	26

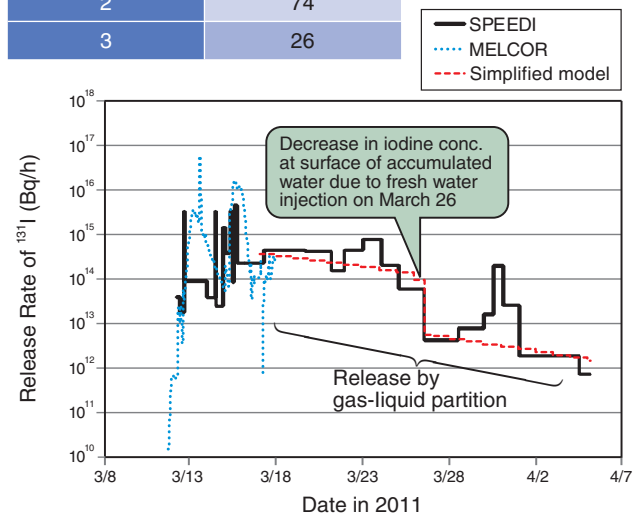


Fig.1-38 A comparison of the ^{131}I release rate between our simplified model and SPEEDI reverse estimation

Although our simplified model did not predict an increase in the release rate on March 23 and 30 due to shortages of cooling water and re-melt, the model mostly reproduced the continuous release from the accumulated water after March 17 and the decrease in the release rate due to fresh water injection on March 26.

In the present study, we prepared a simplified model of ^{131}I release from the accumulated water, and tried to simulate the continuous ^{131}I release predicted by SPEEDI after March 17.

The pH in the water after March 17 was assumed to be constant at the value of 7.1 measured on March 27. The ventilation rate of the reactor building was determined from the steam generation rate, assuming that all the heat from the decay is given to the water. The decrease in the I_2 release at the time of fresh water injection for core cooling on March 26 was simulated by the stratification of water, due to difference in specific gravity between fresh and sea waters. The simplified model well-reproduced the release baseline predicted by SPEEDI (Fig.1-38).

The present study showed that the ^{131}I release from the accumulated water may explain the release between March 17 and 26. This strongly suggests a need for improvement of the current MELCOR approach, which treats the release only from containment breaks.

We plan to further improve the present simplified model through detailed investigation of the effect of revaporization or resuspension of ^{131}I once-deposited on the wall surface, as well as the stratification of accumulated water at the time of fresh water injection.

Reference

Hidaka, A. et al., Quantities of I-131 and Cs-137 in Accumulated Water in the Basements of Reactor Buildings in Process of Core Cooling at Fukushima Daiichi Nuclear Power Plants Accident and Its Influence on Late Phase Source Terms, Journal of Nuclear Science and Technology, vol.51, issue 4, 2014, p.413-424.