Abstracts of the cross check analysis on the evaluation of the cores of Unit 1, 2 and 3 of Fukkushima Dai-ichi NPP reported by TEPCO

１. Abstracts

On the accident of Fukushima Dai-ichi NPP, a lot of works to converge it and collecting essential information to determine the cause are in progress. Nuclear and Industry Safety Agency (NISA) issued to TEPCO to submit reports of accident records and others related to the Fukushima Dai-ichi NPP on April 25 pursuant to the Provisions of Article 67, Paragraph 1 of the Act on Regulation of Nuclear Source Materials, Nuclear Fuel Materials and Reactors and Article 106, Paragraph 3 of the Electricity Business Act, with the purpose of implementing adequate measures going forward. According to the report, NISA directed TEPCO on May 16 to submit reports of evaluation of safety on nuclear reactor facilities regarding to the analysis of records before and after the earthquake.

On the core damage unit 1 through 3 of Fukushima Dai-ichi NPP, TEPCO submitted evaluation reports, which were calculated by severe accident analysis code MAAP based on the operation records and observed parameters, to NISA on May 23

NISA examined the reports to confirm the validity of analysis and evaluation. The examination was carried out by using other severe accident analysis code, Methods for Estimation of Leakages and Consequences of Releases (MELCOR), supported by Japan Nuclear Energy Safety Organization (JNES). Abstract of analysis results by MELCOR is described below.

２. Analysis methods and conditions

Based on the observed data, chronology, etc. of Unit 1 through 3 of Fukushima Dai-ichi NPP which were reported by utility, computational analysis was calculated. A severe accident analysis code MELCOR, which is developed by US NRC in charge and is used widely by regulators and TSOs as JNES, was used in this work.

On the MELCOR analysis, transient of plant during 4 days from the accident, major events occurred, was calculated. We cared a lot about parameters which have great effect on the consequences or whose chronology is uncertain. According to the sensitivity analysis on them, uncertain chronology was confirmed and accident scenario was studied.

For example, analysis conditions conducted by TEPCO were confirmed and sensitivity analyses, shown in Tables 1-a, 2-a, and 3-a, were carried out.

３． Results and conclusions

Abstracts of MELCOR analysis are described below. Comparisons to the results of utility are shown in Table 1-1～3, Table 2-1～2, and Table 3-1～2.

Release ratio of fission products to the environment in each analysis is shown in Table 4. Preliminary calculation of fission products, regarding inventory of each unit, released to the environment during the term of the analysis is shown in Table 5. This work was calculated by using conditions (IC operation, PCV ventilation, alternative water injection, etc.) based on the operation record, alarms, and plant behavior at the transition which were reported by TEPCO on May 16. Total amount of fission products released to the environment was scrutinized and total amount of I-131 and Cs-137 (conversion to I-131) from unit 1, 2, and 3 is 840000 TBq. Compared to the reported value 370000 TBq (630000 TBq by NSC) for INES on April 12, it is in the same range.

Information about operation and behavior of equipment is still insufficient, however, further investigation is conducted to reveal the cause of accident.

Table 1-a Analysis conditions on Unit 1

Identifier	Analysis conditions	Remarks（results）
TEPCO	Correspond to utility's analysis	Table 1-1, Fig. 1-1-1～11
Case 1	Increasing of heat removal (restart IC-B with IC-A)	Table 1-2, Fig. 1-2-1～2
Case 2	①Amount of water injected through the fire protection line varies with RPV pressure. ②PCV leakage area at 50 hours is ca. 35 cm^2.	Table 1-3, Fig. 1-3-1～12

Table 2-a Analysis conditions on Unit 2

Identifier	Analysis conditions	Remarks（results）
TEPCO-1	Correspond to utility's analysis No.1	Table 2-1、Fig.2-1-1～13
TEPCO-2	Correspond to utility's analysis No.2 ①Amount of water injected through the fire protection line varies with RPV pressure. ②PCV leakage area is ca. 50 cm^2. ③S/C leakage area is ca. 300 cm^2	Table 2-2, Fig.2-2-1～12
Case-1	Based on the utility's analysis No.1, but ①PCV is intact	Fig.2-3-1～2
Case-2	Based on the utility's analysis No.1, but ①PCV leakage area is ca. 50 cm^2.	Fig.2-4-1
Case-3	Based on the utility's analysis No.1, but ①S/C leakage area is ca. 300 cm^2	Fig.2-5-1

Table 3-a Analysis conditions on Unit 3

Identifier	Analysis conditions	Remarks（results）
TEPCO-1	Correspond to utility's analysis No.1	Table 3-1, Fig.3-1-1～11
TEPCO-2	Correspond to utility's analysis No.2	Table 3-2, Fig.3-2-1～14

Table 1-1 Result of analysis on Unit 1 [TEPCO] and comparison to the utility's result

Event	Results (this work)		Utility's result
Core exposure	16：40, Mar. 11	2 hours (relative time)	3 hours (relative time)
Core damage	18：00, Mar. 11	3 hours (relative time)	4 hours (relative time)
RPV failure	20：00, Mar. 11	5 hours (relative time)	15 hours (relative time)

Table 1-2 Result of analysis on Unit 1 [case 1] and comparison to the utility's result

Event	Results (this work)		Utility's result
Core exposure	16：50, Mar. 11	2 hours (relative time)	3 hours (relative time)
Core damage	18：20, Mar. 11	4 hours (relative time)	4 hours (relative time)
RPV failure	2：50, Mar. 12	12 hours (relative time)	15 hours (relative time)

Table 1-3 Result of analysis on Unit 1 [case 2] and comparison to the utility's result

Event	Results (this work)		Utility's result
Core exposure	16：40, Mar. 11	2 hours (relative time)	3 hours (relative time)
Core damage	18：00, Mar. 11	3 hours (relative time)	4 hours (relative time)
RPV failure	20：00, Mar. 11	5 hours (relative time)	15 hours (relative time)

Table 2-1 Result of analysis on Unit 2 [TEPCO-1] and comparison to the utility's result

Event	Results (this work)		Utility's result (No.1)
Core exposure	18：00, Mar 14	75 hours (relative time)	75 hours (relative time)
Core damage	22：30, Mar 14	80 hours (relative time)	77 hours (relative time)
RPV failure	— (RPV doesn't fail)		— (RPV doesn't fail)

Table 2-2 Result of analysis on Unit 2 [TEPCO-2] and comparison to the utility's result

Event	Results (this work)		Utility's result (No.2)
Core exposure	18：00, Mar 14	75 hours (relative time)	75 hours (relative time)
Core damage	19：50, Mar 14	77 hours (relative time)	77 hours (relative time)
RPV failure	22：50, Mar 14	80 hours (relative time)	109 hours (relative time)

Table 3-1 Result of analysis on Unit 3 [TEPCO-1] and comparison to the utility's result

Event	Results (this work)		Utility's result (No. 1)
Core exposure	7：40, Mar 13	41 hours (relative time)	40 hours (relative time)
Core damage	10：20, Mar 13	44 hours (relative time)	42 hours (relative time)
RPV failure	— (RPV doesn't fail)		— (RPV doesn't fail)

Table 3-2 Result of analysis on Unit 3 [TEPCO-2] and comparison to the utility's result

Event	Results (this work)		Utility's result (No. 2)
Core exposure	7：40, Mar 13	41 hours (relative time)	40 hours (relative time)
Core damage	10：20, Mar 13	44 hours (relative time)	42 hours (relative time)
RPV failure	22：10, Mar 14	79 hours (relative time)	66 hours (relative time)

Table 4 FP release ratio

Unit	Identifier of analysis	Noble gas	CsI	Cs	Te	Ba	Ru	Ce	La
1	TEPCO	9.9E-01	1.9E-03	9.1E-04	2.4E-02	1.2E-04	6.4E-09	1.1E-06	1.1E-06
	Case 1	9.5E-01	1.2E-03	8.2E-04	1.1E-02	6.2E-05	2.1E-11	8.9E-07	6.9E-07
	Case 2	9.5E-01	6.6E-03	2.9E-03	1.1E-02	4.0E-05	9.0E-10	1.4E-07	1.2E-07
2	TEPCO-1	8.1E-01	3.8E-03	3.4E-03	4.2E-03	4.9E-04	7.6E-10	7.4E-11	6.5E-08
	TEPCO-2	9.6E-01	6.7E-02	5.8E-02	3.0E-02	2.6E-04	5.4E-10	4.0E-06	8.4E-07
	Case 1	9.7E-01	1.3E-03	4.6E-04	2.5E-04	3.3E-04	2.0E-11	1.5E-12	1.5E-09
	Case 2	9.7E-01	3.9E-02	3.8E-02	5.1E-02	2.9E-04	4.1E-11	8.2E-06	1.1E-06
	Case 3	9.7E-01	4.1E-02	3.9E-02	3.5E-02	4.0E-04	4.6E-11	1.3E-05	1.2E-06
3	TEPCO-1	6.5E-01	8.2E-03	5.9E-03	2.7E-03	6.1E-04	2.9E-10	2.5E-11	2.7E-08
	TEPCO-2	9.9E-01	3.0E-03	2.7E-03	2.4E-03	4.3E-04	8.6E-10	5.0E-08	1.3E-07

Table 5 Preliminary calculation of FP released to the environment
in the early stage of Fukushima Ddai-ichi accident（Bq）

			Unit 1	Unit 2	Unit 3	Total
Xe-133	5.2	d	3.4×10^{18}	3.5×10^{18}	4.4×10^{18}	1.1×10^{19}
Cs-134	2.1	y	7.1×10^{14}	1.6×10^{16}	8.2×10^{14}	1.8×10^{16}
Cs-137	30.0	y	5.9×10^{14}	1.4×10^{16}	7.1×10^{14}	1.5×10^{16}
Sr-89	50.5	d	8.2×10^{13}	6.8×10^{14}	1.2×10^{15}	2.0×10^{15}
Sr-90	29.1	y	6.1×10^{12}	4.8×10^{13}	8.5×10^{13}	1.4×10^{14}
Ba-140	12.7	d	1.3×10^{14}	1.1×10^{15}	1.9×10^{15}	3.2×10^{15}
Te-127m	109.0	d	2.5×10^{14}	7.7×10^{14}	6.9×10^{13}	1.1×10^{15}
Te-129m	33.6	d	7.2×10^{14}	2.4×10^{15}	2.1×10^{14}	3.3×10^{15}
Te-131m	30.0	h	9.5×10^{13}	5.4×10^{10}	1.8×10^{12}	9.7×10^{13}
Te-132	78.2	h	7.4×10^{14}	4.2×10^{11}	1.4×10^{13}	7.6×10^{14}
Ru-103	39.3	d	2.5×10^{09}	1.8×10^{09}	3.2×10^{09}	7.5×10^{09}
Ru-106	368.2	d	7.4×10^{08}	5.1×10^{08}	8.9×10^{08}	2.1×10^{09}
Zr-95	64.0	d	4.6×10^{11}	1.6×10^{13}	2.2×10^{11}	1.7×10^{13}
Ce-141	32.5	d	4.6×10^{11}	1.7×10^{13}	2.2×10^{11}	1.8×10^{13}
Ce-144	284.3	d	3.1×10^{11}	1.1×10^{13}	1.4×10^{11}	1.1×10^{13}
Np-239	2.4	d	3.7×10^{12}	7.1×10^{13}	1.4×10^{12}	7.6×10^{13}
Pu-238	87.7	y	5.8×10^{08}	1.8×10^{10}	2.5×10^{08}	1.9×10^{10}
Pu-239	24065	y	8.6×10^{07}	3.1×10^{09}	4.0×10^{07}	3.2×10^{09}
Pu-240	6537	y	8.8×10^{07}	3.0×10^{09}	4.0×10^{07}	3.2×10^{09}
Pu-241	14.4	y	3.5×10^{10}	1.2×10^{12}	1.6×10^{10}	1.2×10^{12}
Y-91	58.5	d	3.1×10^{11}	2.7×10^{12}	4.4×10^{11}	3.4×10^{12}
Pr-143	13.6	d	3.6×10^{11}	3.2×10^{12}	5.2×10^{11}	4.1×10^{12}
Nd-147	11.0	d	1.5×10^{11}	1.3×10^{12}	2.2×10^{11}	1.6×10^{12}
Cm-242	162.8	d	1.1×10^{10}	7.7×10^{10}	1.4×10^{10}	1.0×10^{11}
I-131	8.0	d	1.2×10^{16}	1.4×10^{17}	7.0×10^{15}	1.6×10^{17}
I-132	2.3	h	4.5×10^{14}	9.6×10^{11}	1.8×10^{13}	4.7×10^{14}
I-133	20.8	h	6.5×10^{14}	1.4×10^{12}	2.6×10^{13}	6.8×10^{14}
I-135	6.6	h	6.1×10^{14}	1.3×10^{12}	2.4×10^{13}	6.3×10^{14}
Sb-127	3.9	d	1.7×10^{15}	4.2×10^{15}	4.5×10^{14}	6.4×10^{15}
Sb-129	4.3	h	1.6×10^{14}	8.9×10^{10}	3.0×10^{12}	1.6×10^{14}
Mo-99	66.0	h	8.1×10^{07}	1.0×10^{04}	6.7×10^{06}	8.8×10^{07}

※：Evaluated by using the results of case2(unit 1), TEPCO-2(unit 2), TEPCO-2(unit3) in table 4

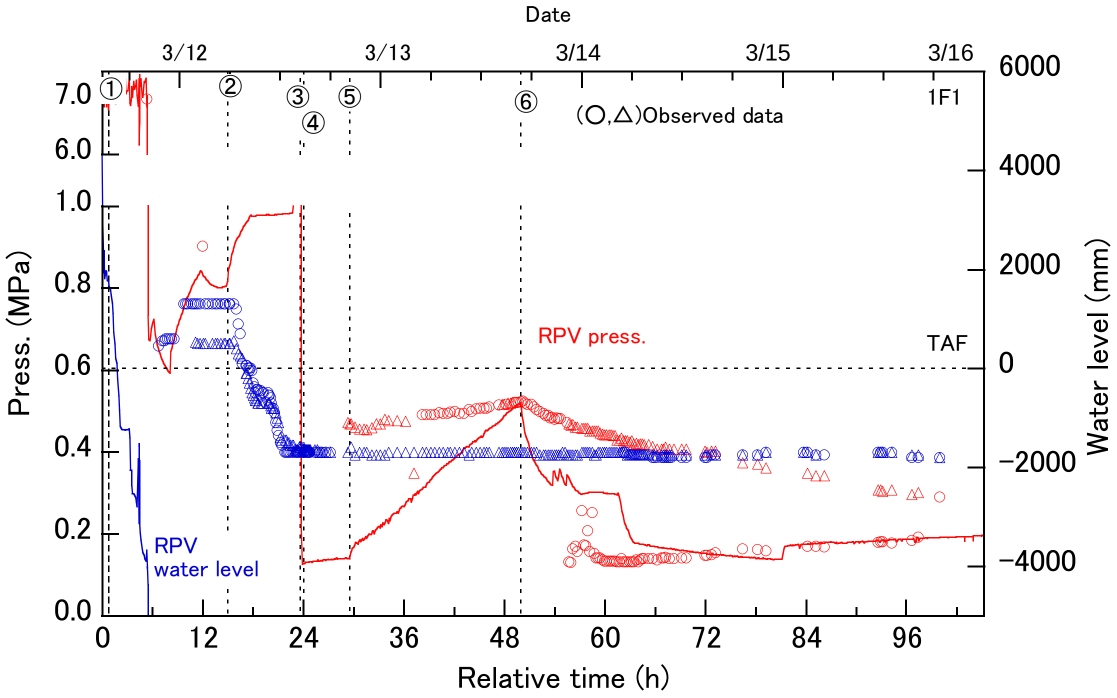


Fig. 1-1-1 RPV pressure and water level (unit 1) [TEPCO]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

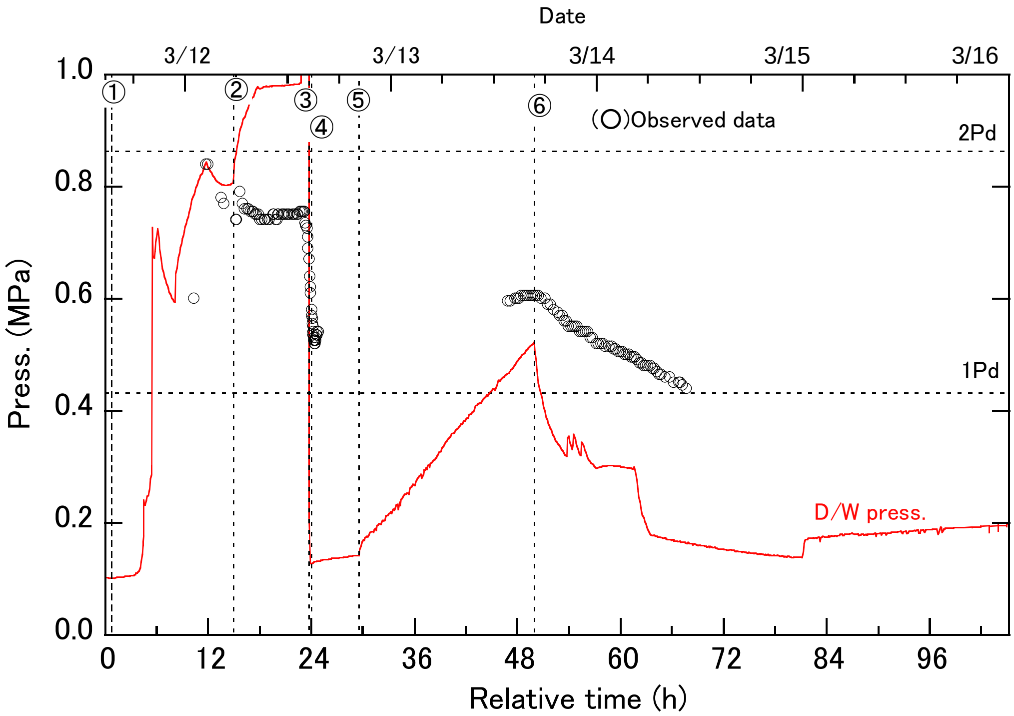


Fig. 1-1-2 D/W pressure (unit 1) [TEPCO]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

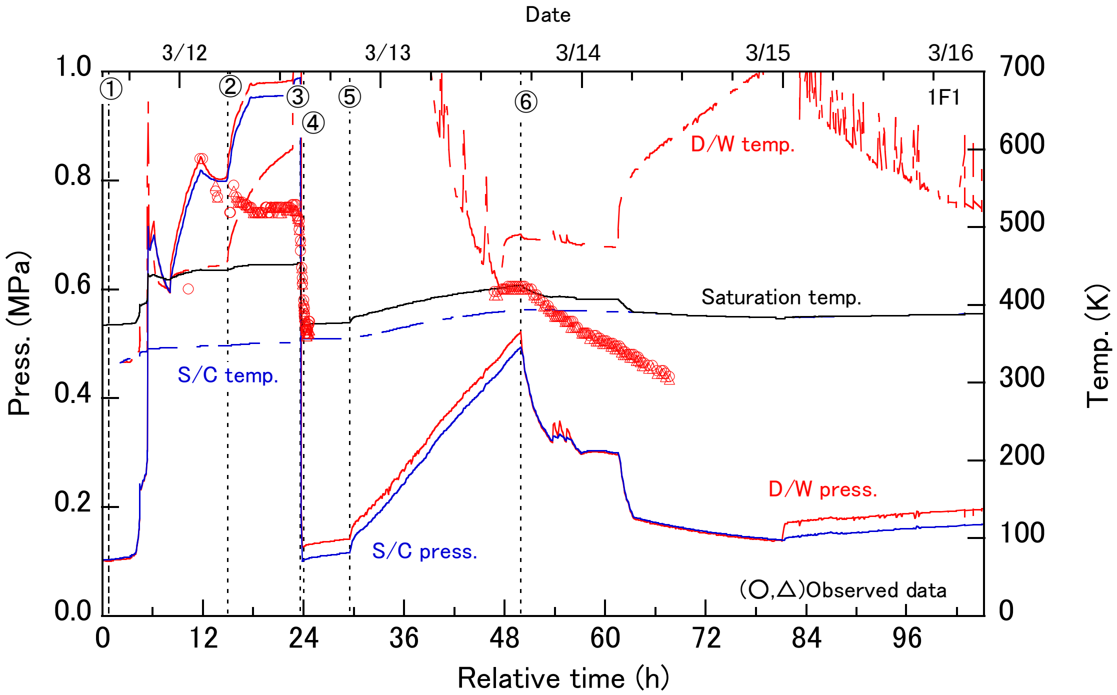


Fig. 1-1-3 PCV pressure and temperature (unit 1) [TEPCO]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

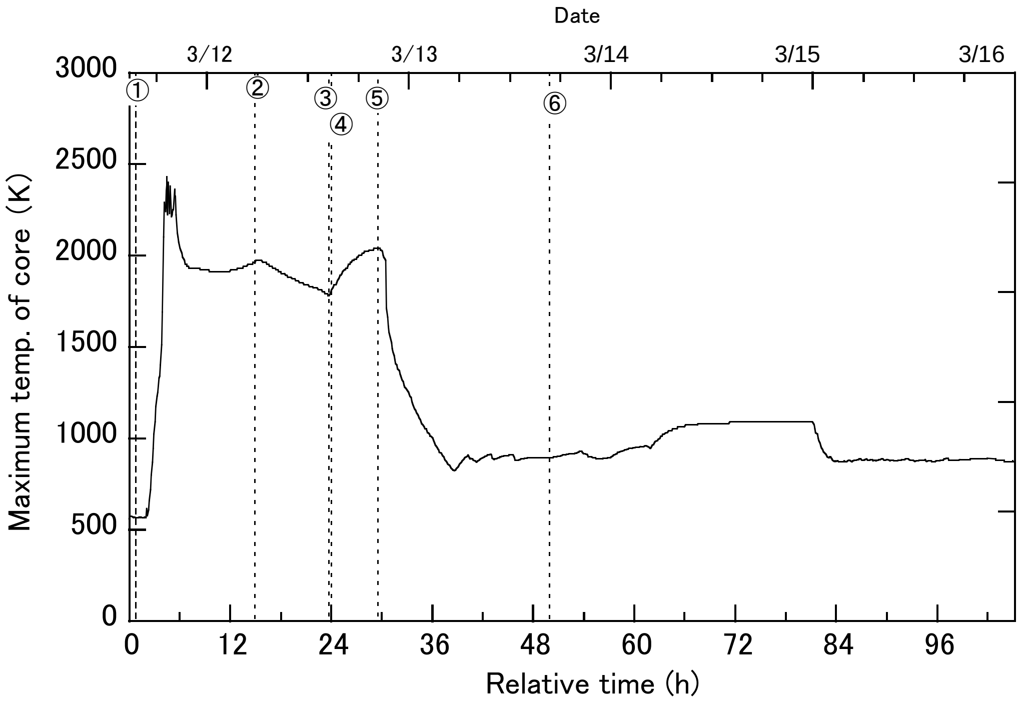


Fig. 1-1-4 Maximum temperature of the core (unit 1) [TEPCO]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

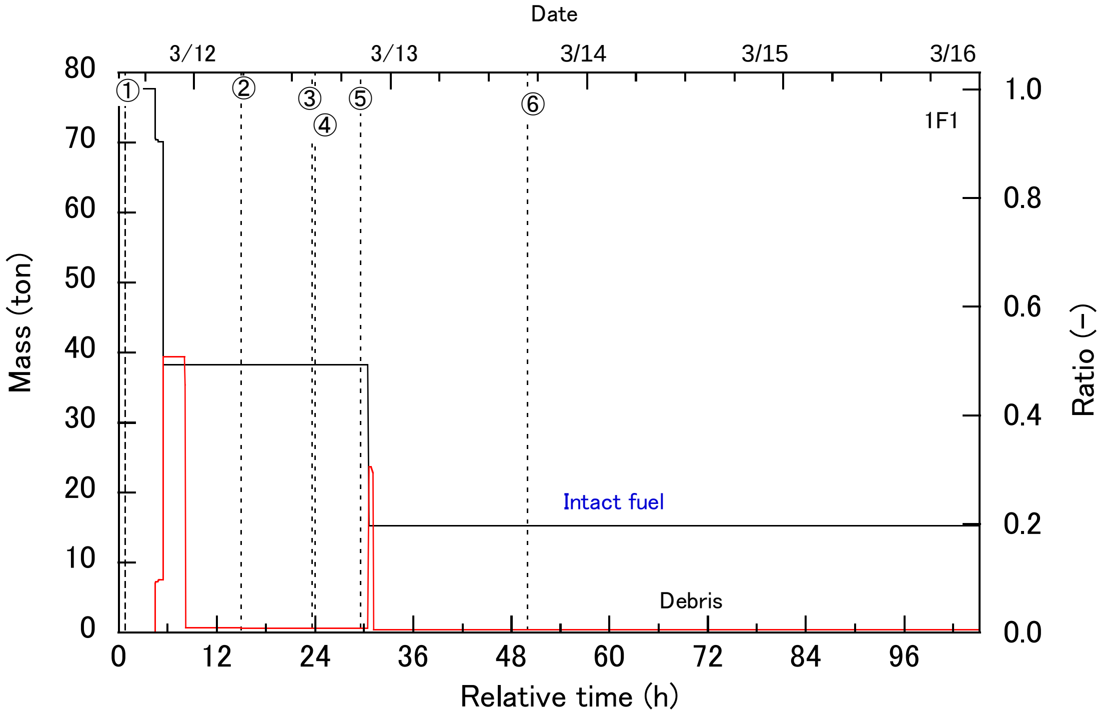


Fig. 1-1-5 Mass of the core (unit 1) [TEPCO]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

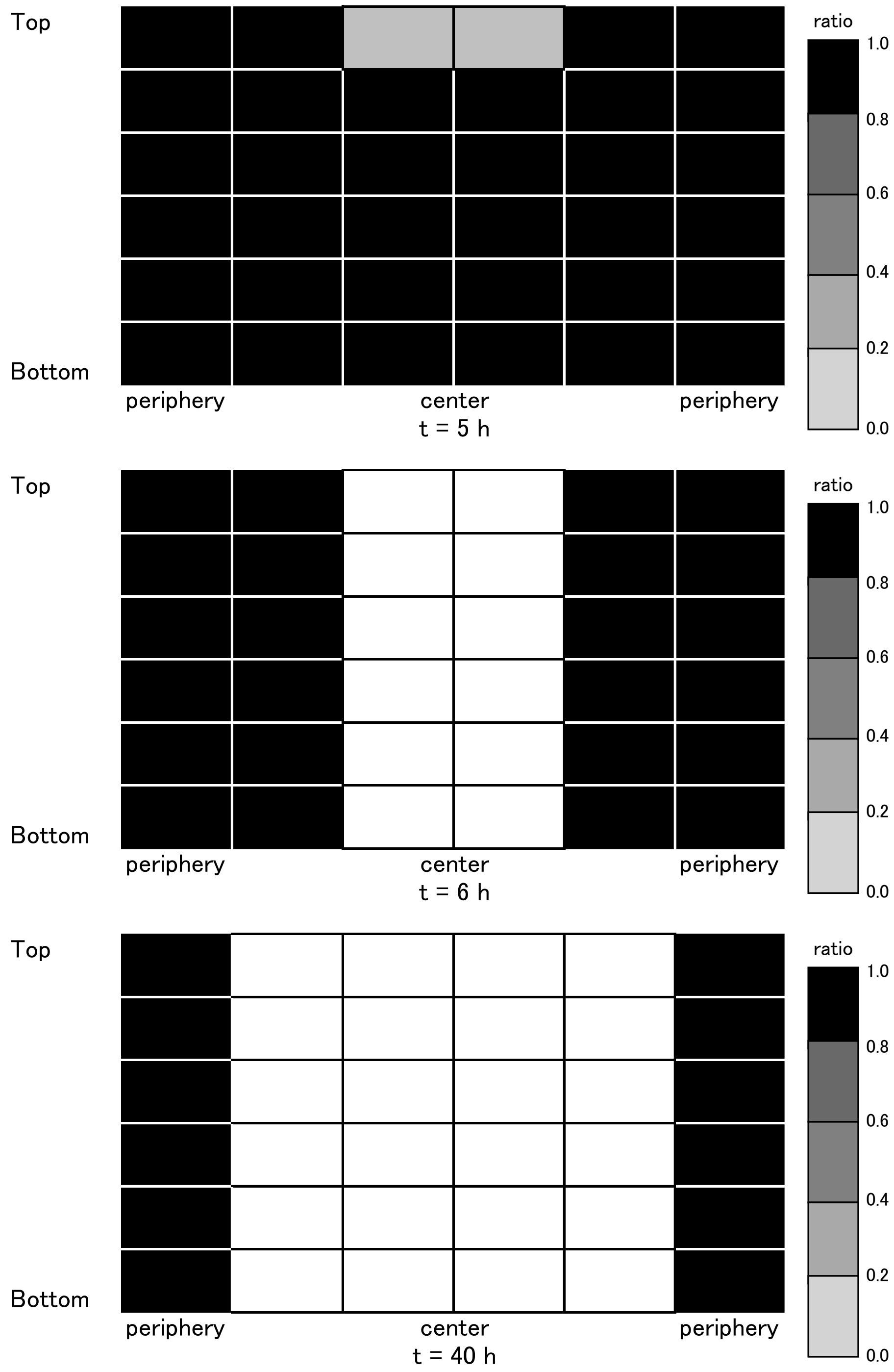


Fig. 1-1-6 Distribution of intact fuel (unit 1) [TEPCO]

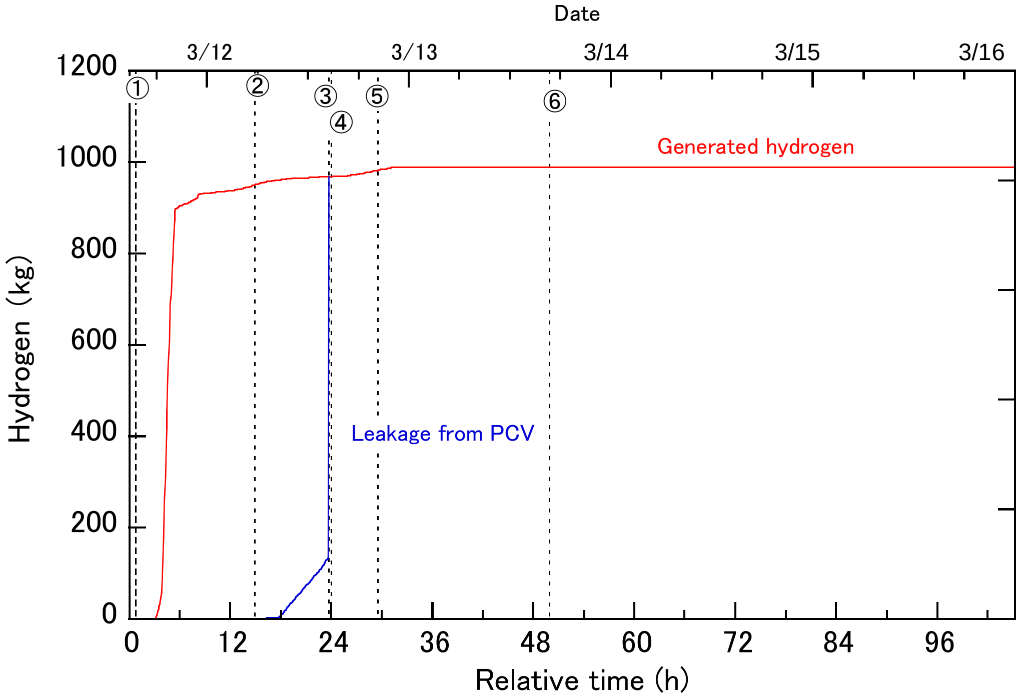


Fig. 1-1-7 Hydrogen generation (unit 1) [TEPCO]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

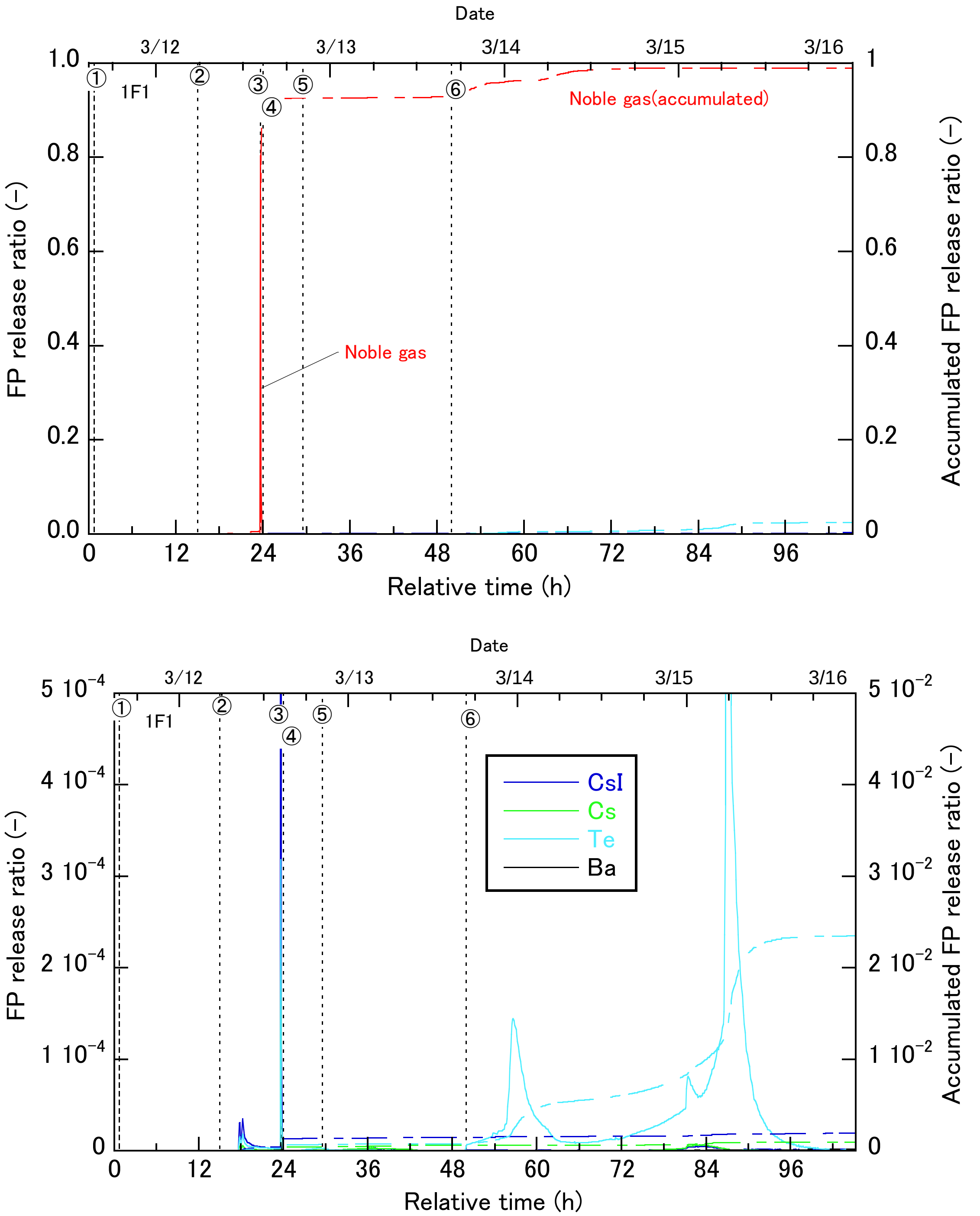


Fig. 1-1-8 FP release ratio to the environment (1/2) (unit 1) [TEPCO]
①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤ sea water inject., ⑥expansion of PCV failure (assumption)

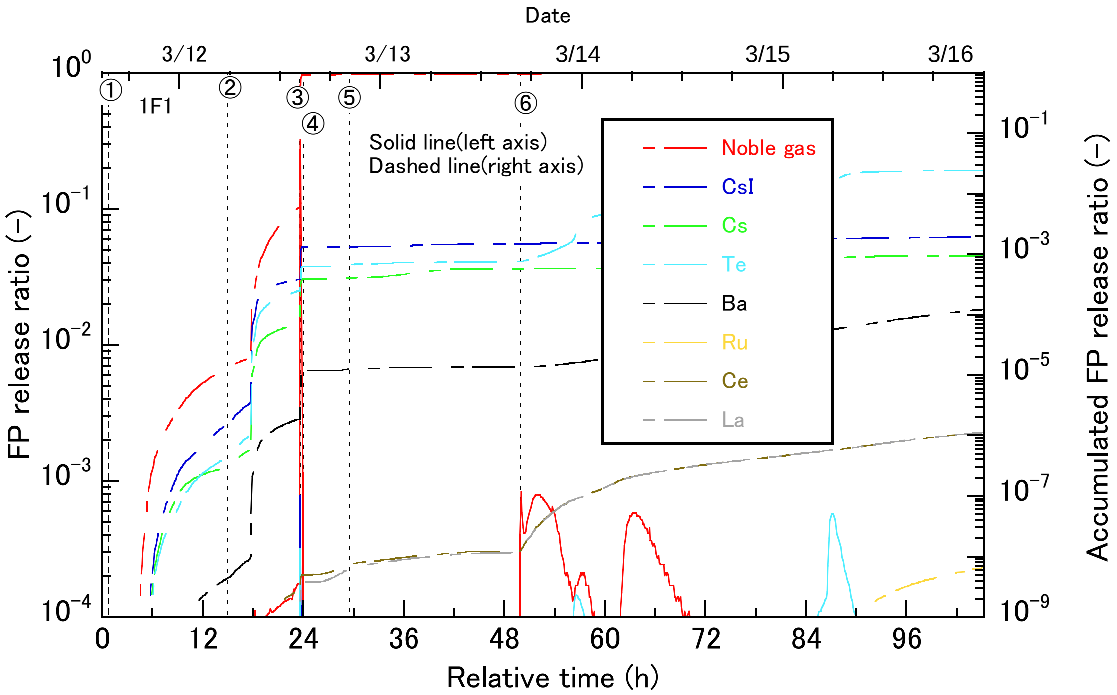


Fig. 1-1-9 FP release ratio to the environment (2/2) (unit 1) [TEPCO]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

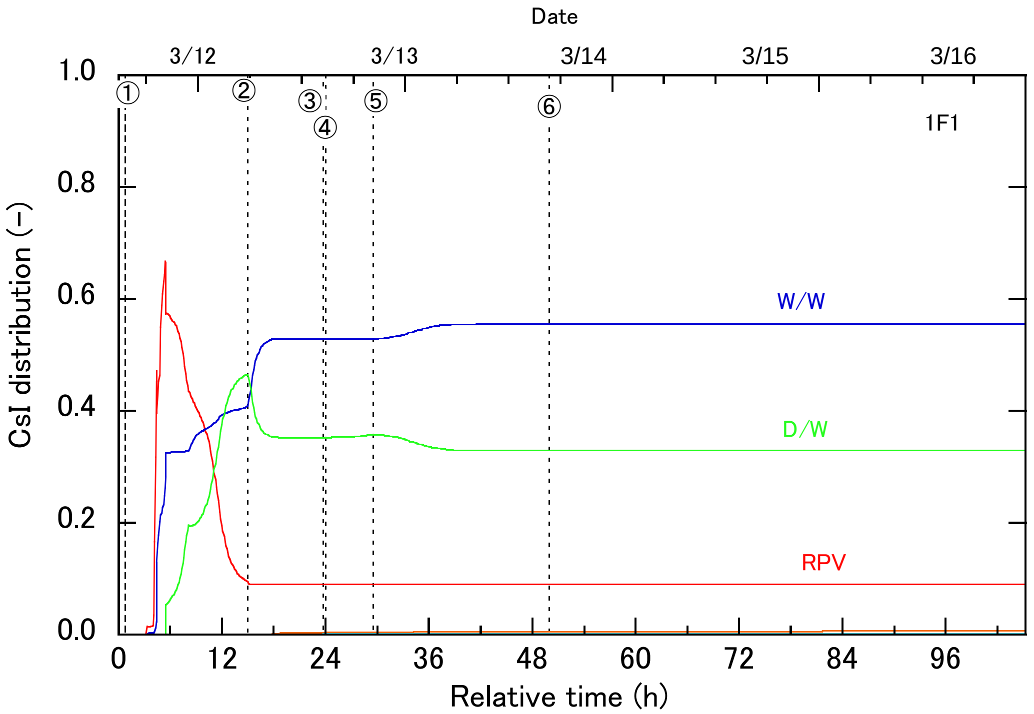


Fig. 1-1-10 Distribution of CsI (unit 1) [TEPCO]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

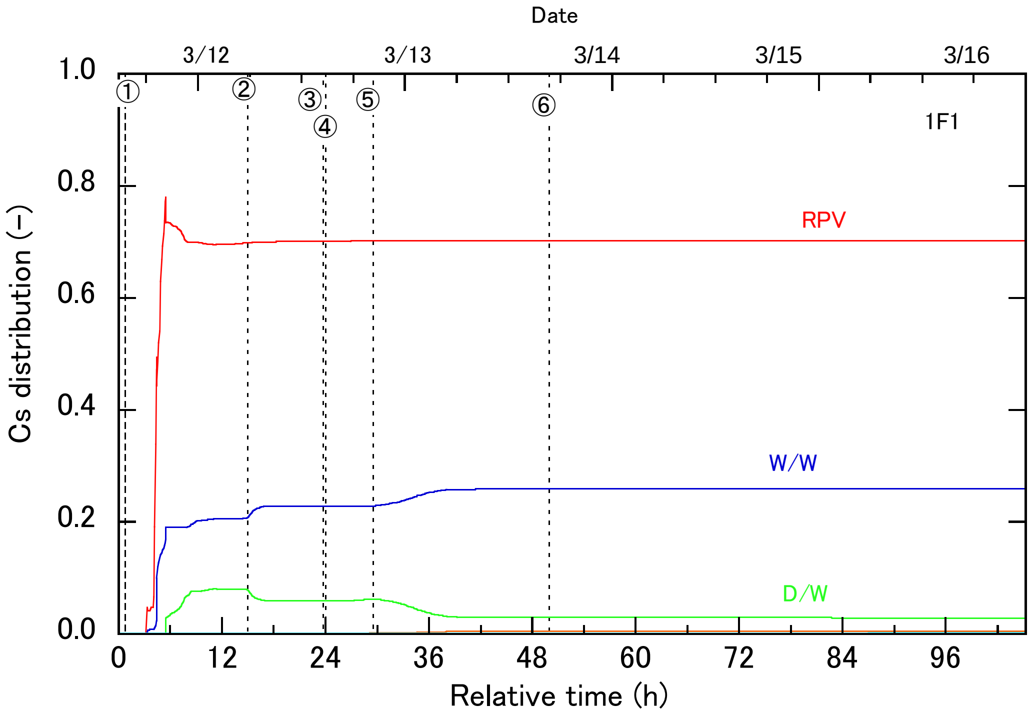


Fig. 1-1-11 Distribution of Cs (unit 1) [TEPCO]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

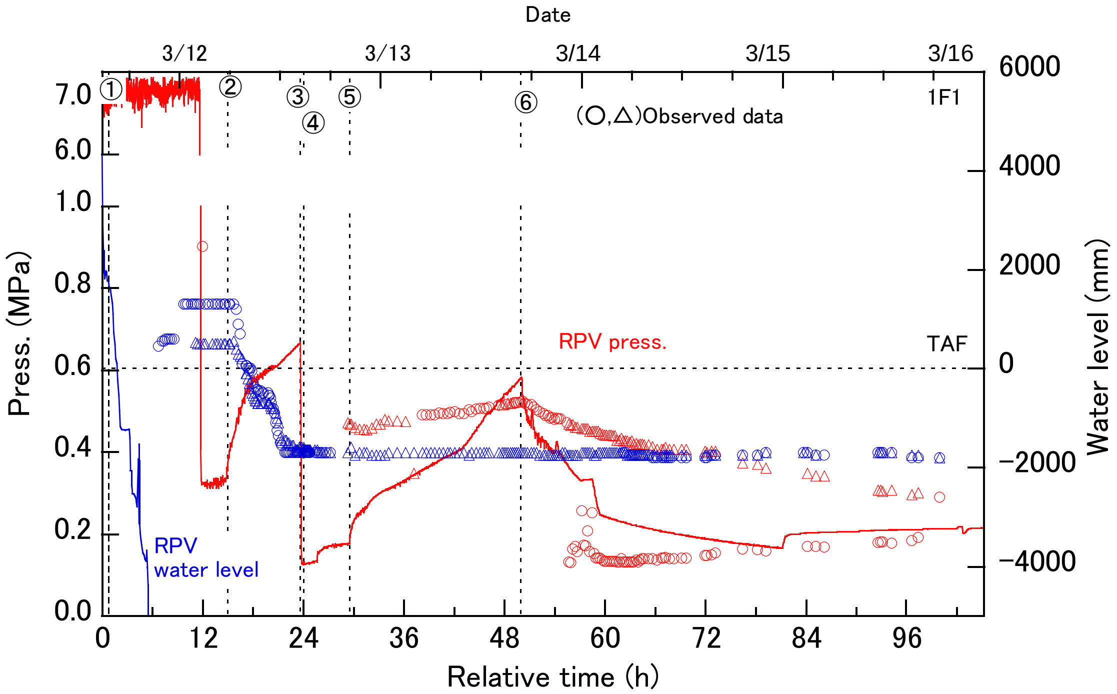


Fig. 1-2-1　RPV pressure and water level (unit 1) [case 1]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤ sea water inject., ⑥expansion of PCV failure (assumption)

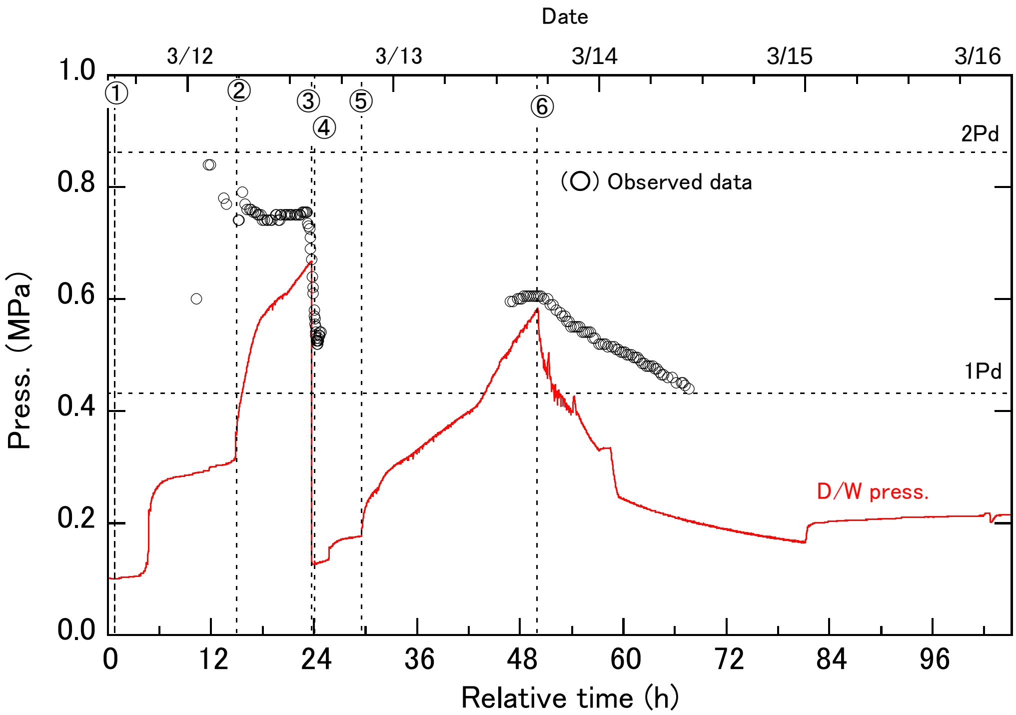


Fig. 1-2-2　D/W pressure (unit 1) [case 1]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤ sea water inject., ⑥expansion of PCV failure (assumption)

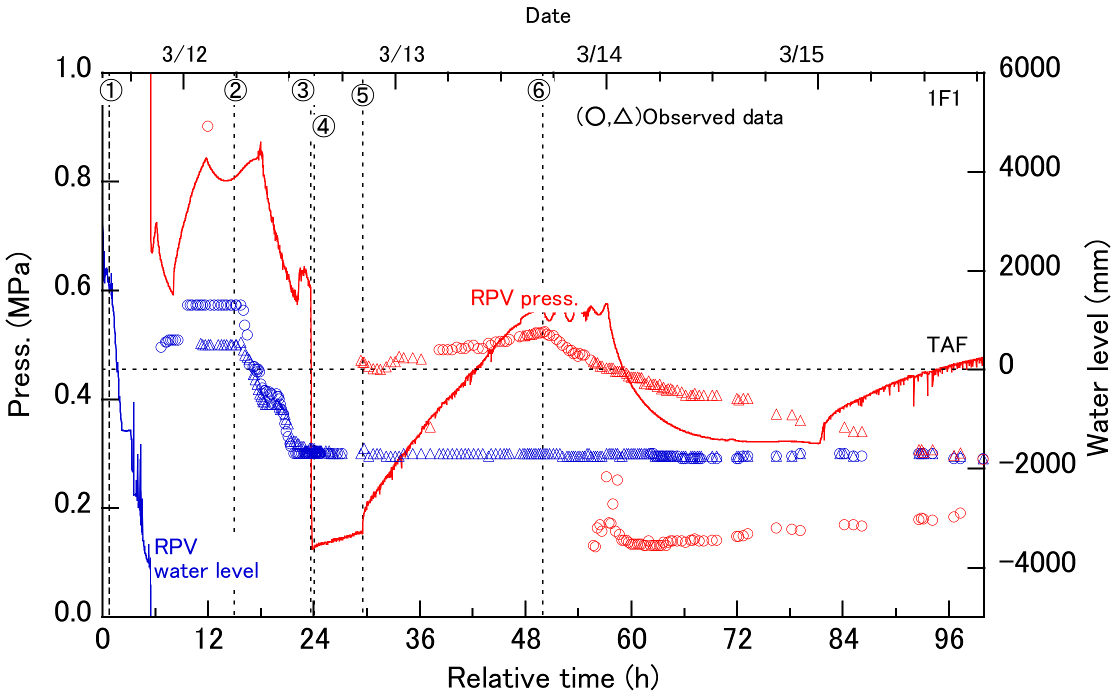


Fig. 1-3-1 RPV pressure and water level (unit 1) [case 2]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

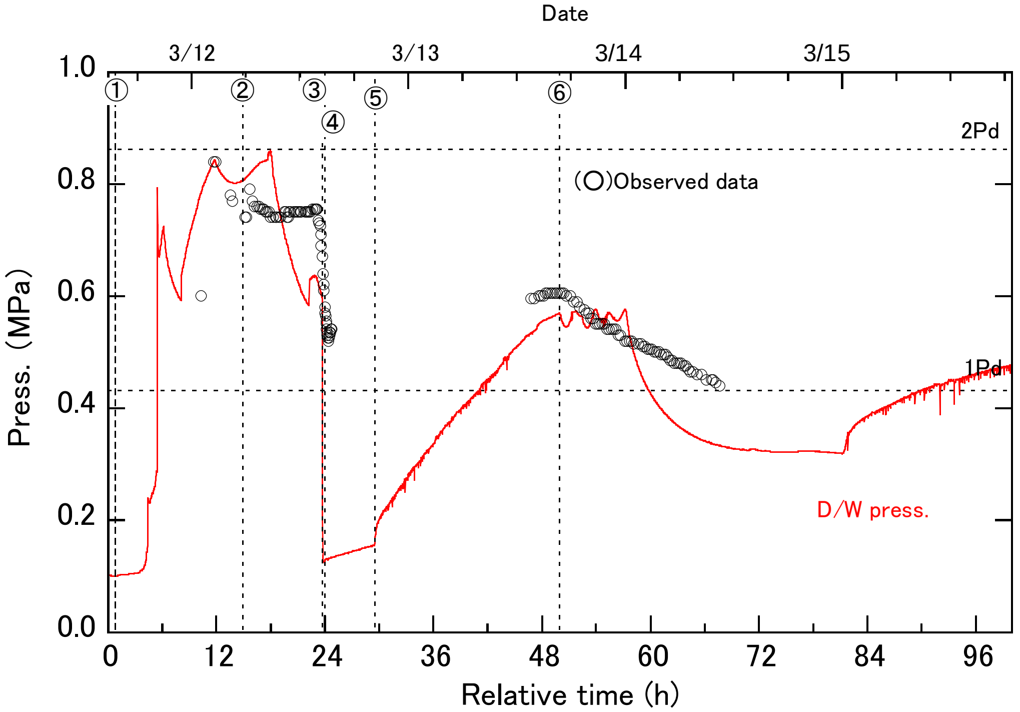


Fig. 1-3-2 D/W pressure (unit 1) [case 2]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

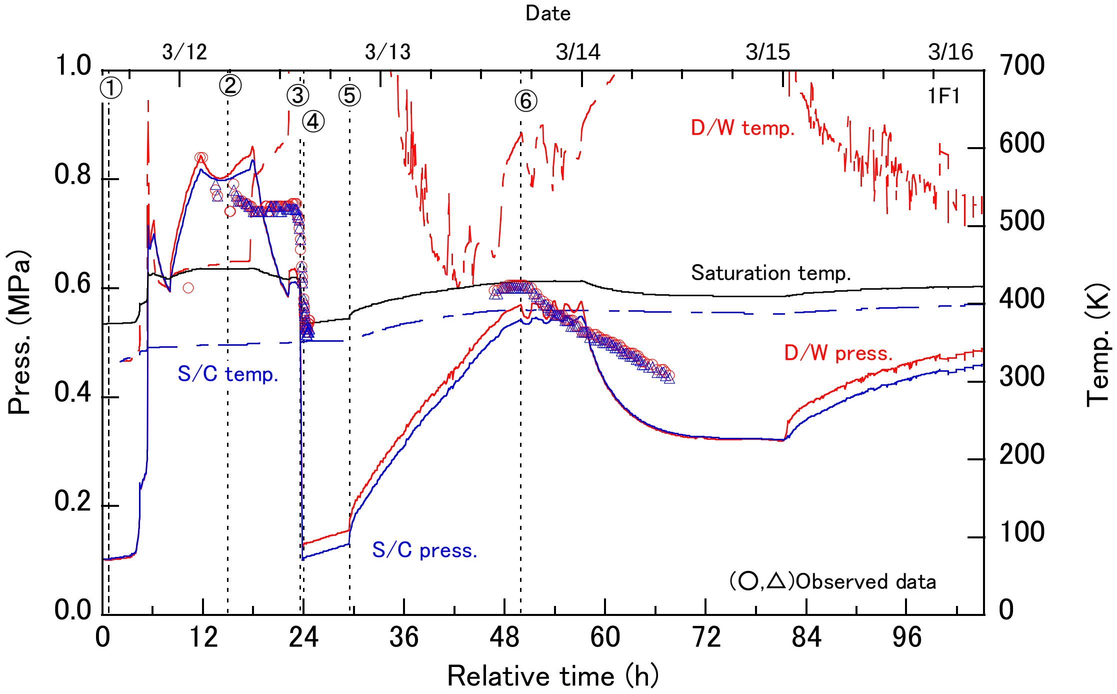


Fig. 1-3-3 PCV pressure and temperature (unit 1) [case 2]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

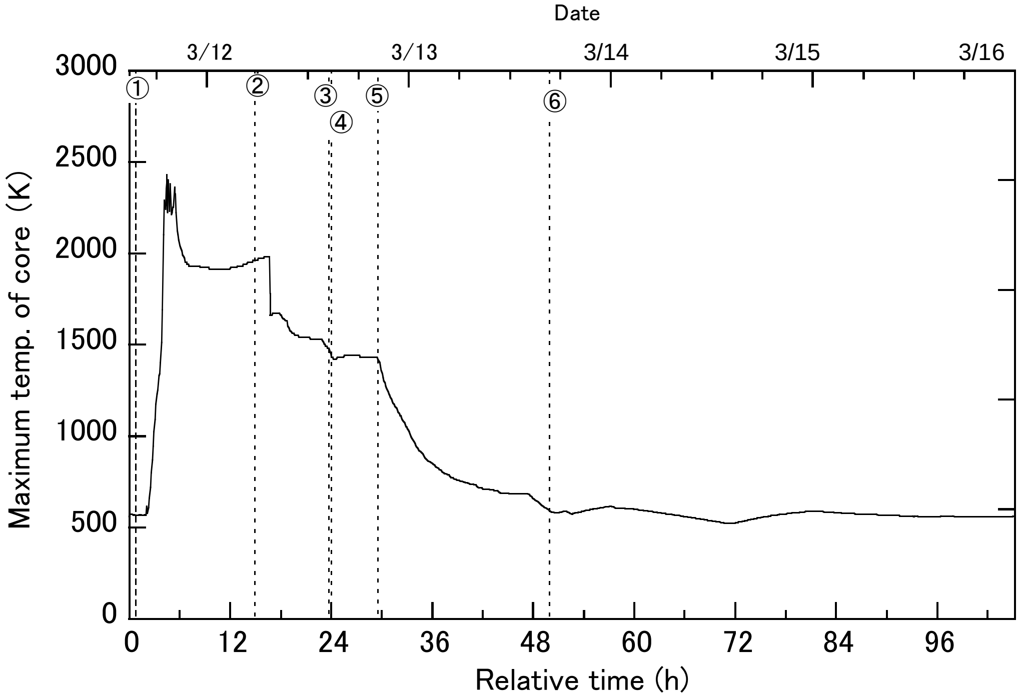


Fig. 1-3-4 Maximum temperature of the core (unit 1) [case 2]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

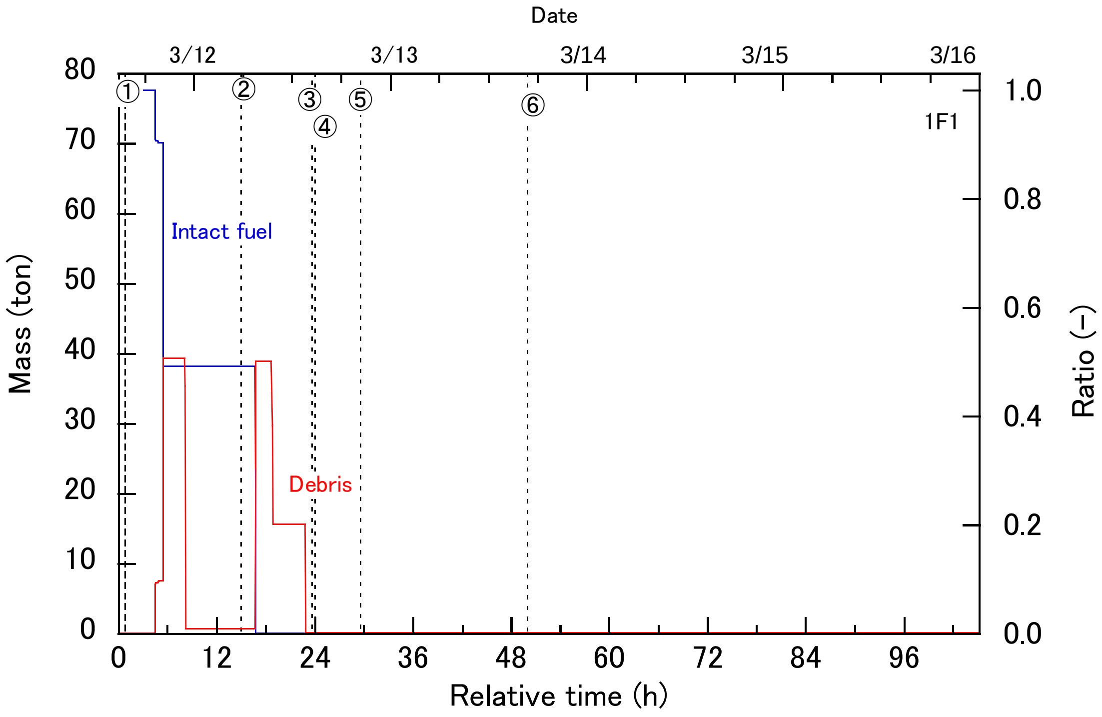


Fig. 1-3-5 Mass of the core (unit 1) [case 2]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤ sea water inject., ⑥expansion of PCV failure (assumption)

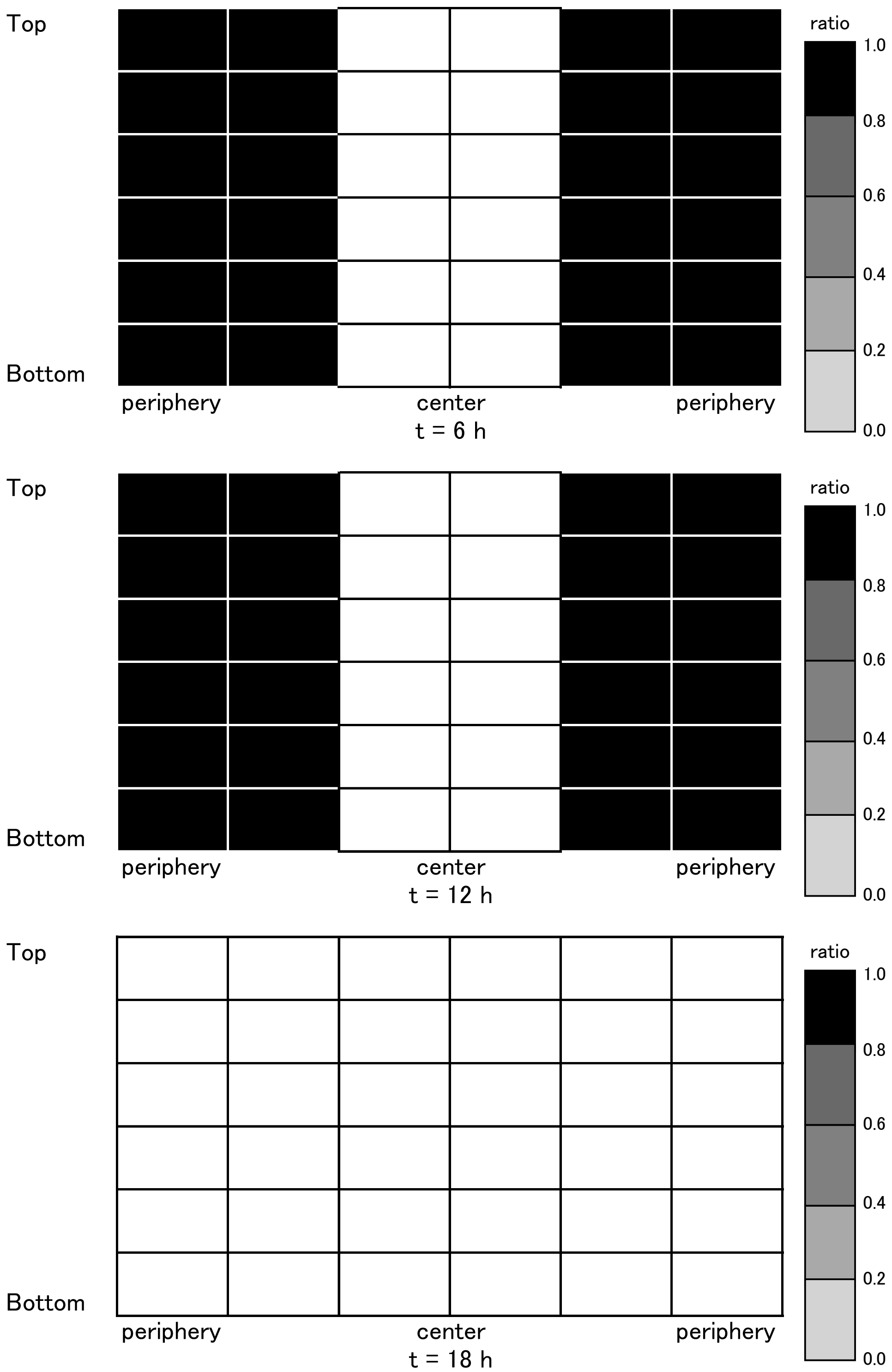


Fig. 1-3-6　Distribution of intact fuel (unit 1) [case 2]

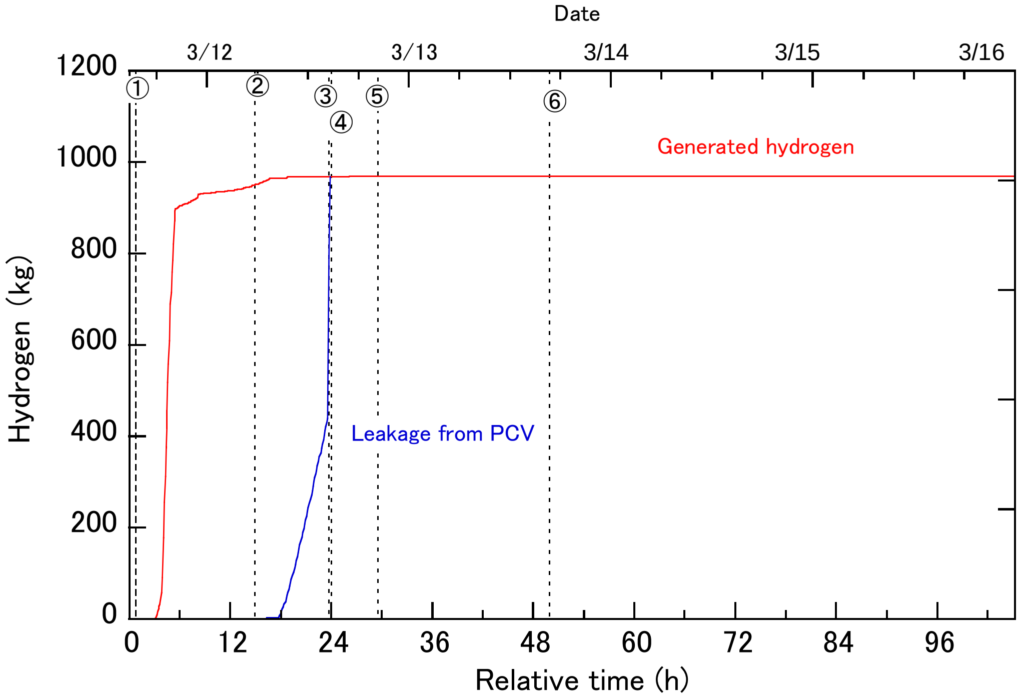


Fig. 1-3-7 Hydrogen generation (unit 1) [case 2]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

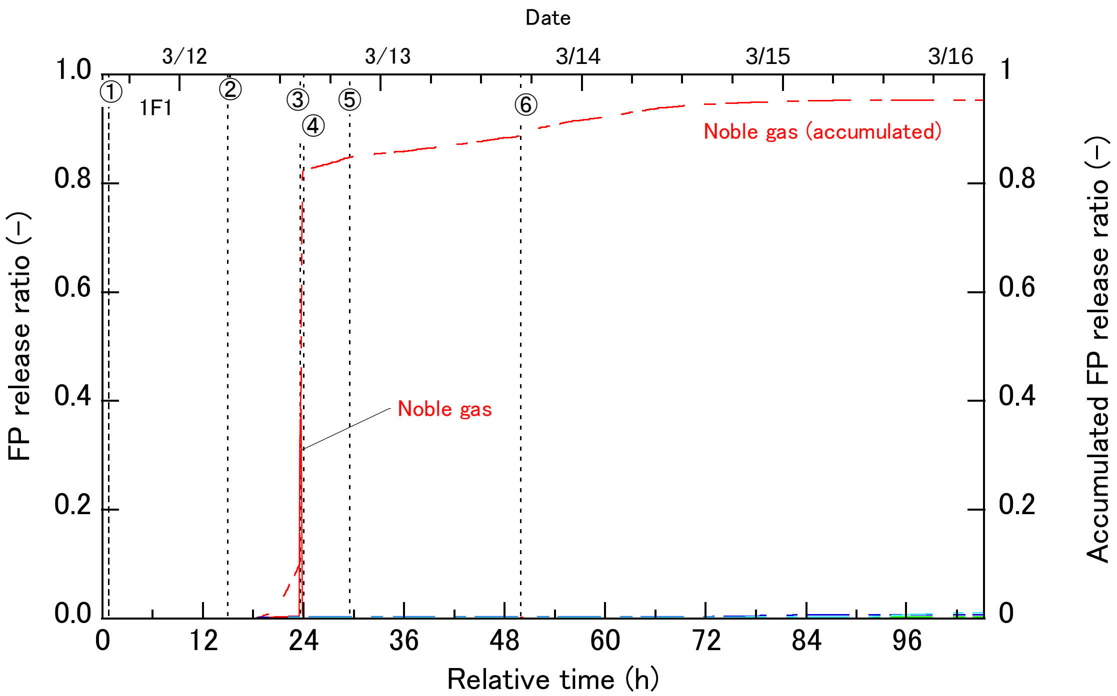


Fig. 1-3-8 FP release ratio to the environment (1/3) (unit 1) [case 2]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤sea water inject., ⑥expansion of PCV failure (assumption)

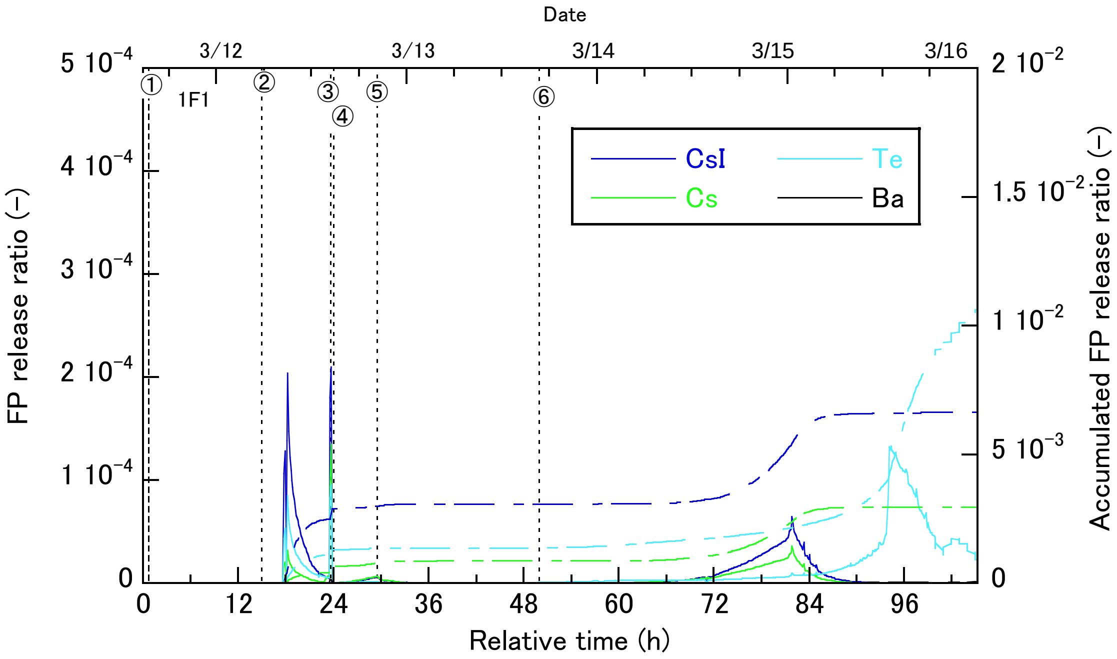


Fig. 1-3-9 FP release ratio to the environment (2/3) (unit 1) [case 2]
①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤ sea water inject., ⑥expansion of PCV failure (assumption)

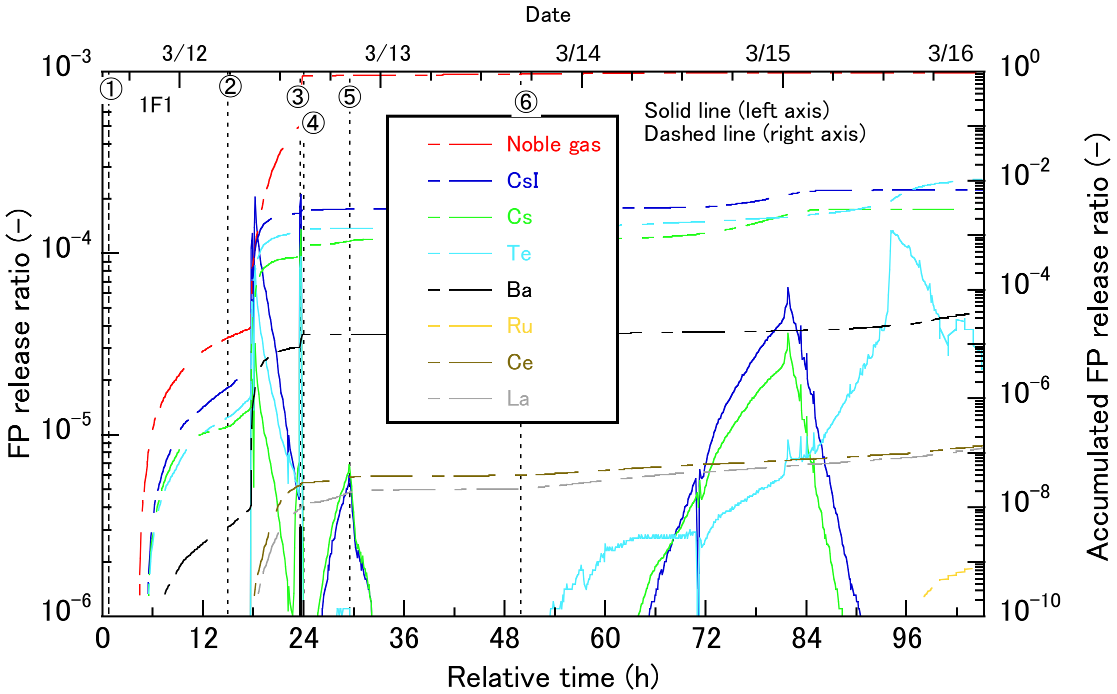


Fig. 1-3-10 FP release ratio to the environment (3/3) (unit 1) [case 2]
①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤ sea water inject., ⑥expansion of PCV failure (assumption)

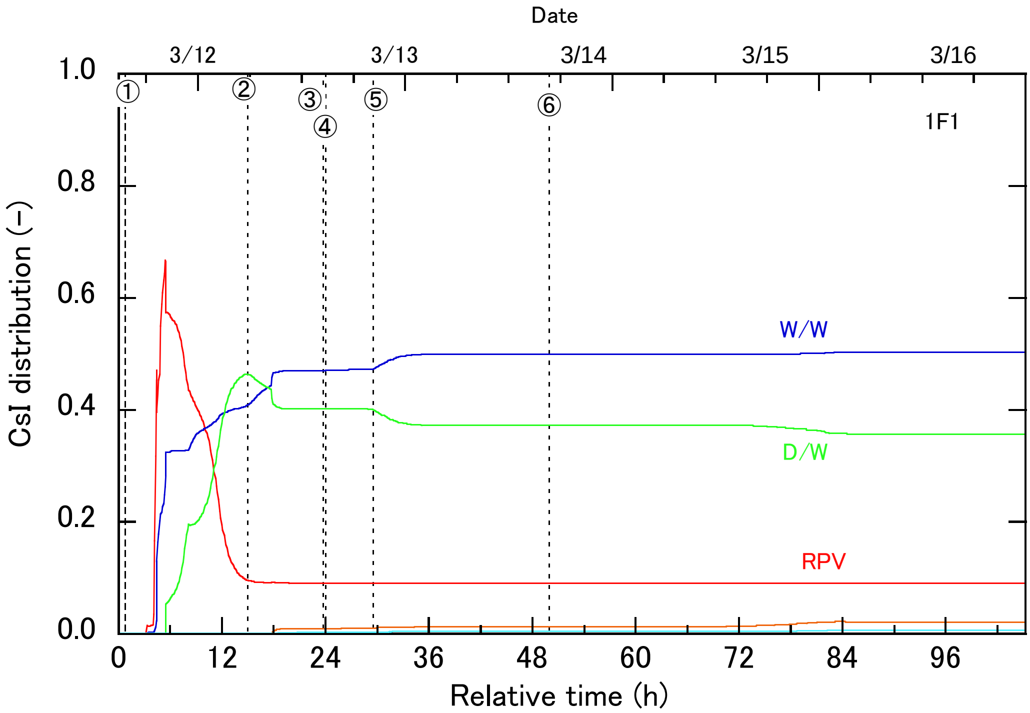


Fig. 1-3-11 Distribution of CsI (unit 1) [case 2]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤ sea water inject., ⑥expansion of PCV failure (assumption)

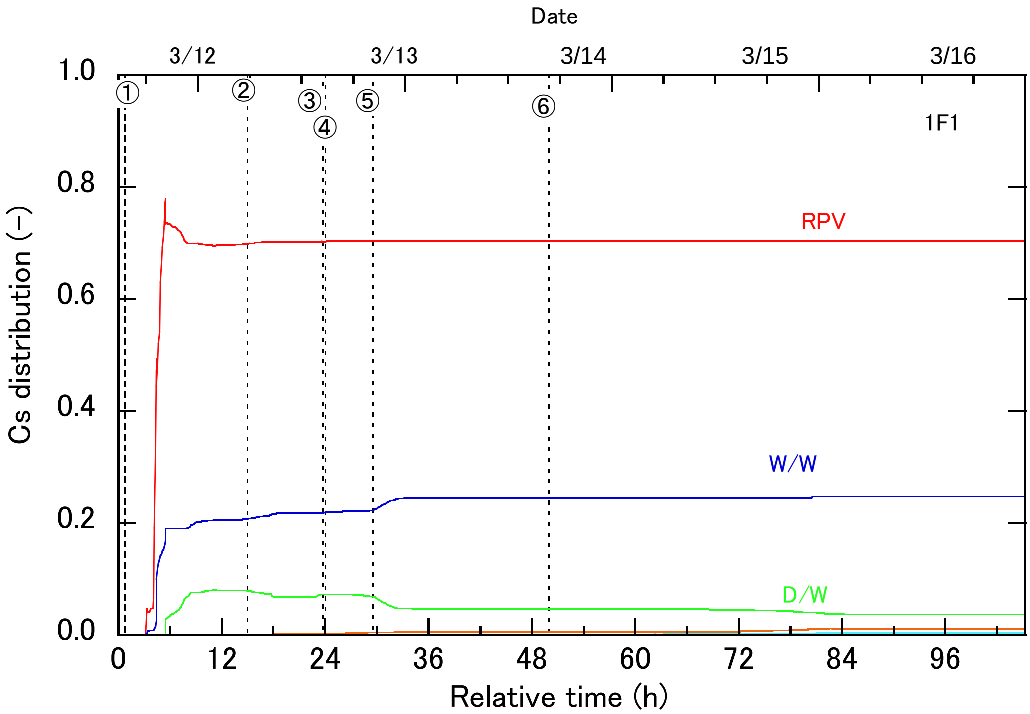


Fig. 1-3-12 Distribution of Cs (unit 1) [case 2]

①IC stop, ②PCV failure (assumption), ③W/W ventilation (open), ④W/W ventilation (close), ⑤ sea water inject., ⑥expansion of PCV failure (assumption)

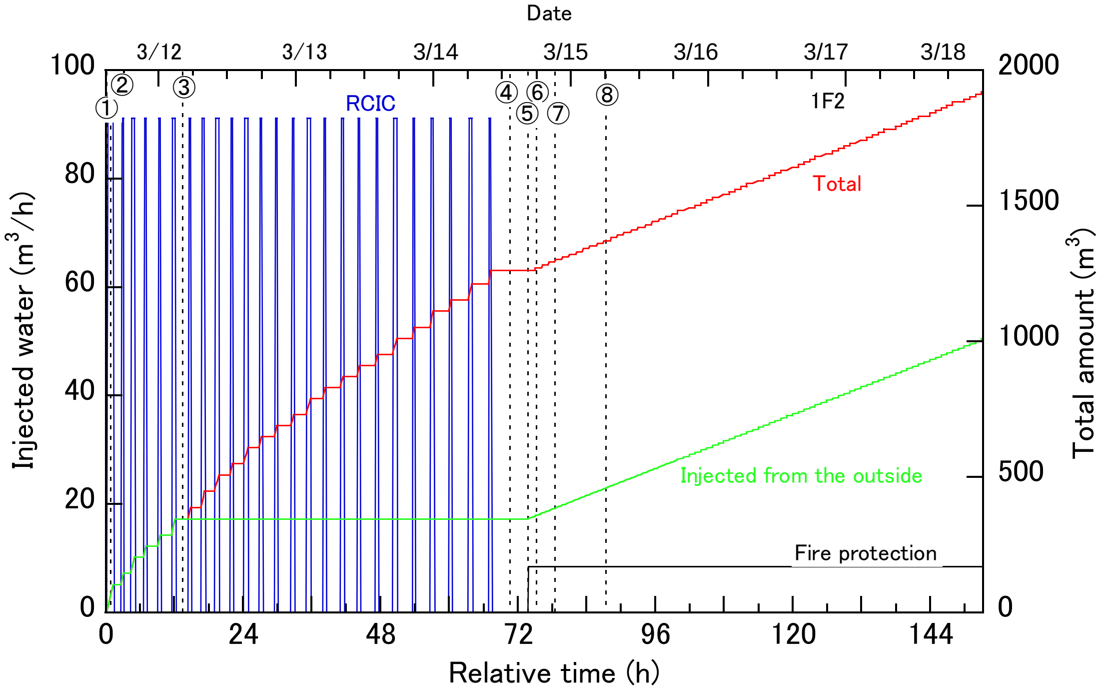


Fig. 2-1-1 Amount of water injection (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

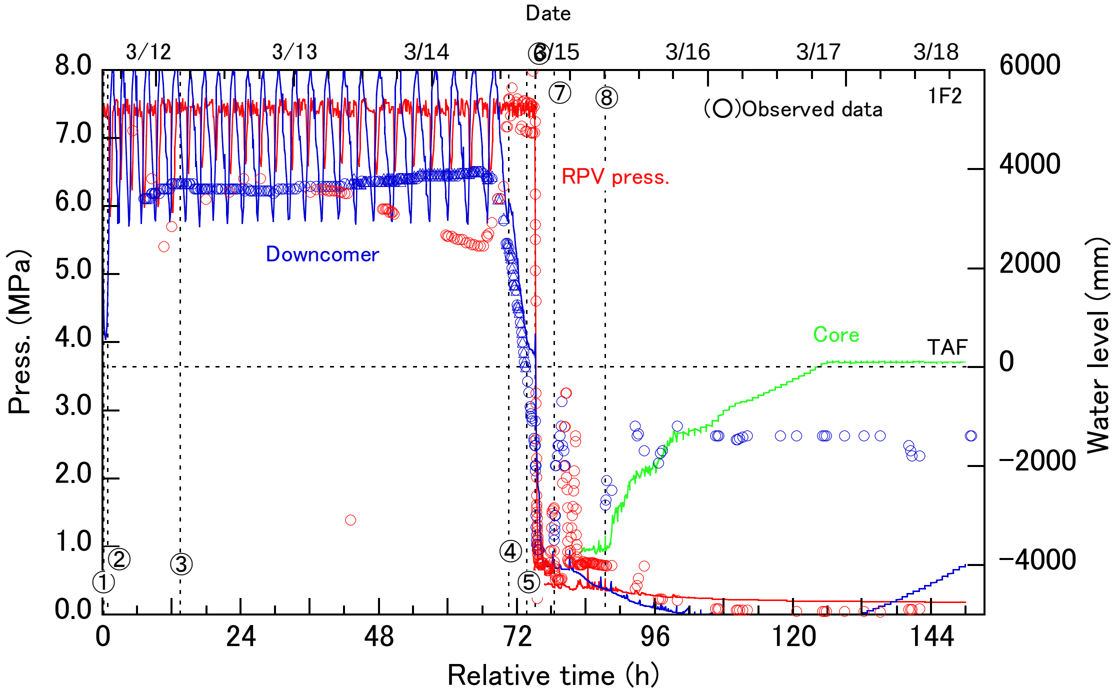


Fig. 2-1-2 RPV pressure and water level (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

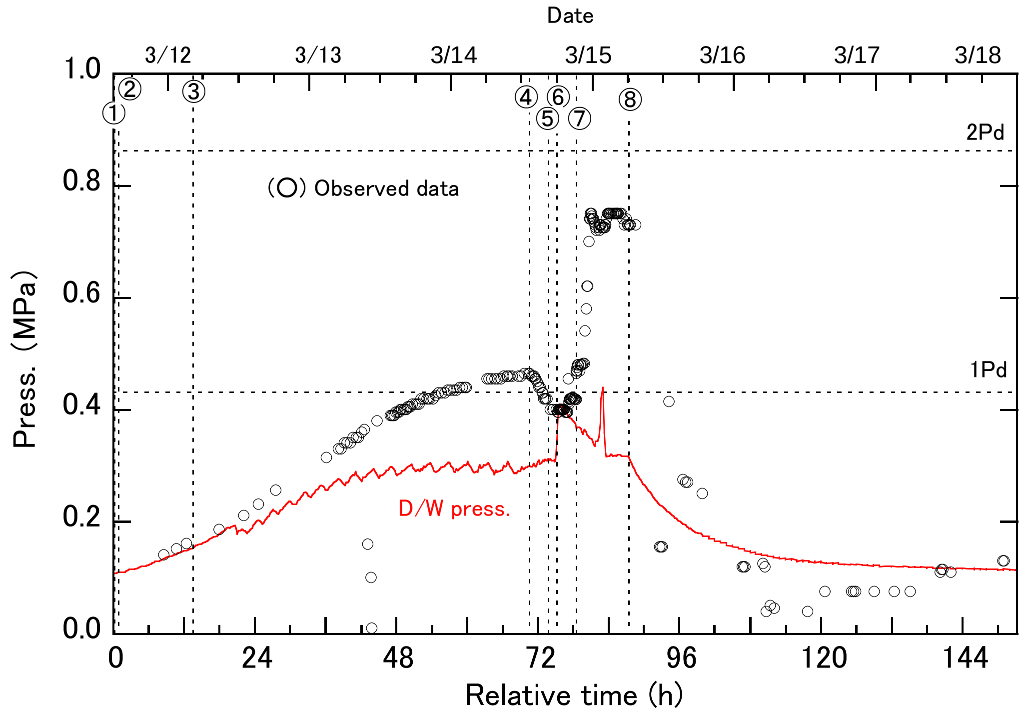


Fig. 2-1-3 D/W pressure (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

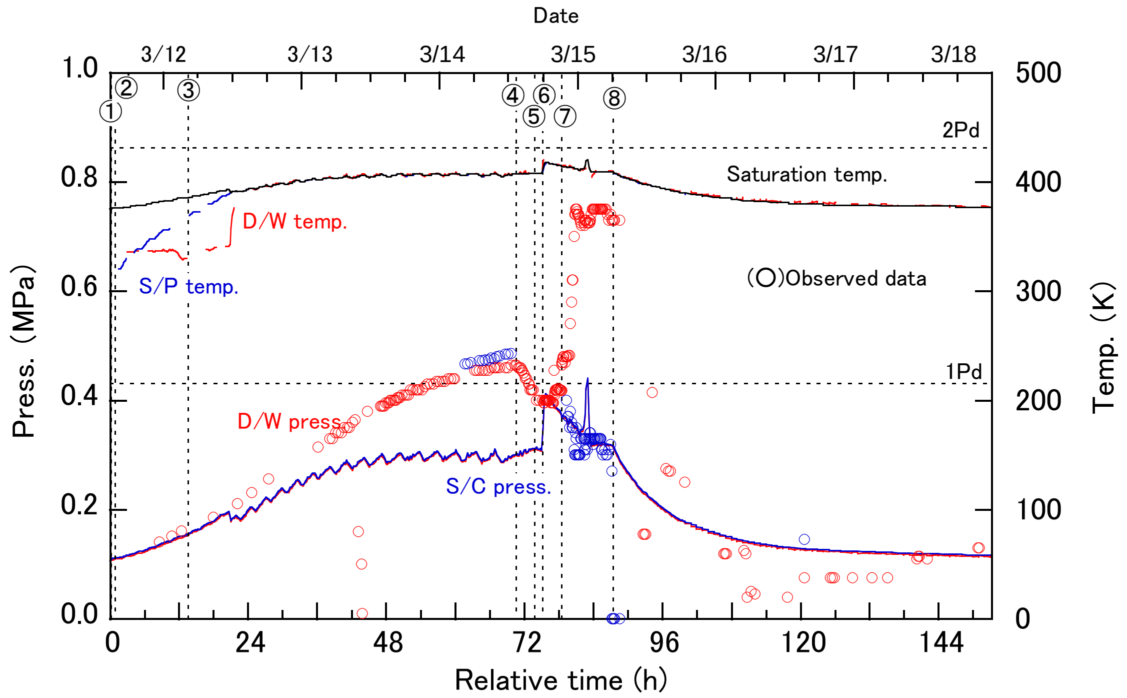


Fig. 2-1-4 PCV pressure and temperature (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

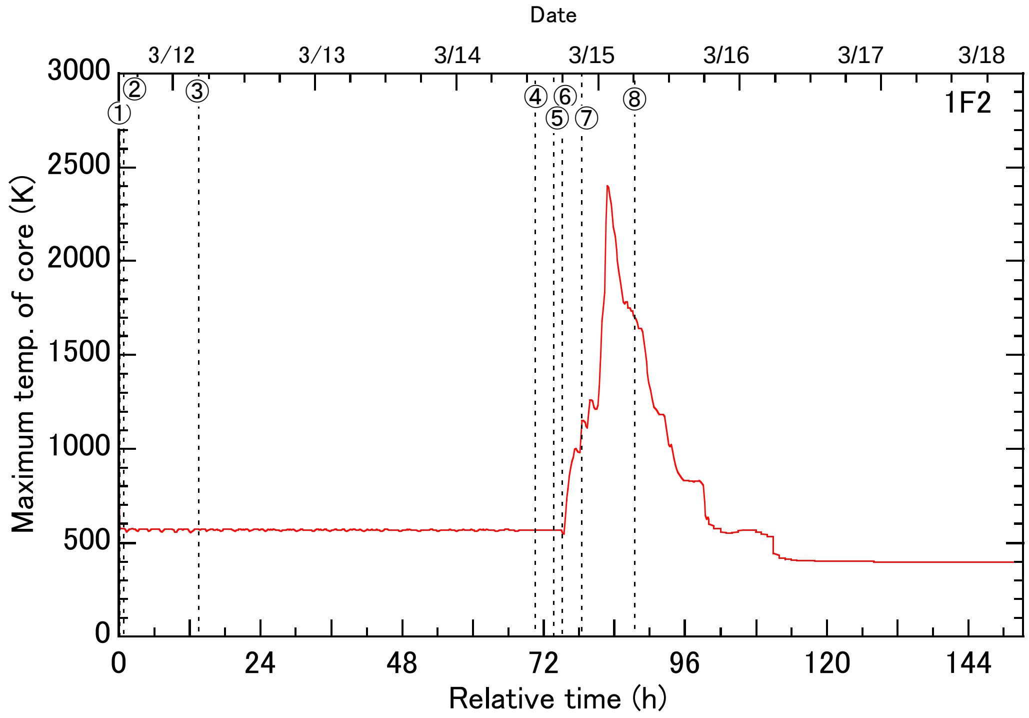


Fig. 2-1-5 Maximum temperature of the core (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

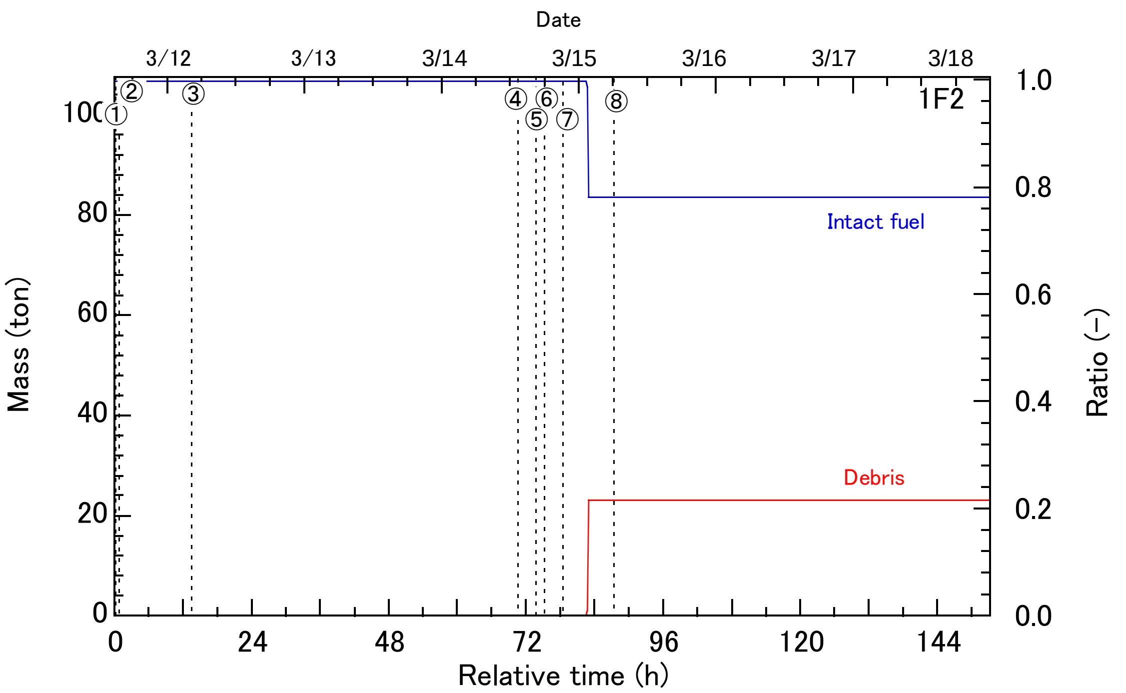


Fig. 2-1-6 Mass of the core (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

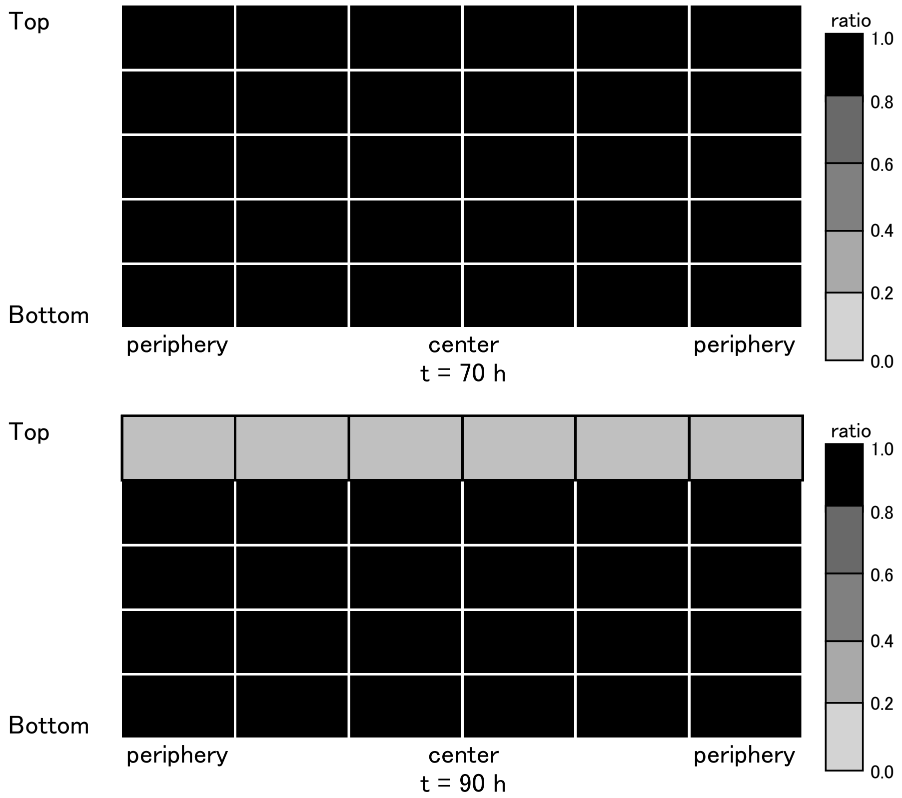


Fig. 2-1-7 Distribution of intact fuel (unit 2) [TEPCO-1]

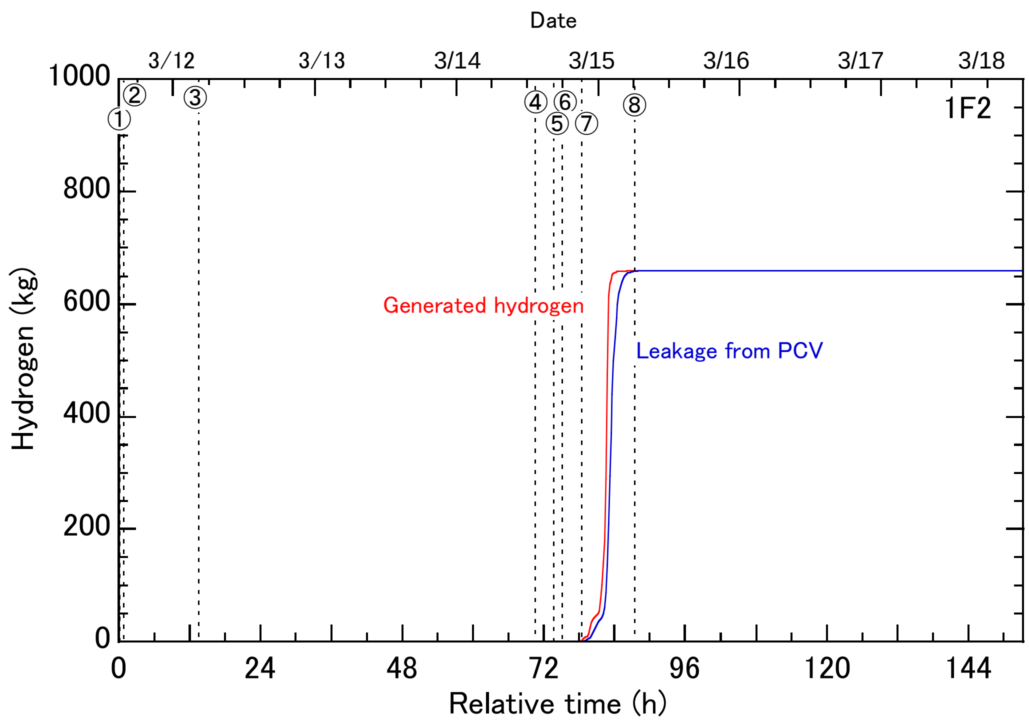


Fig. 2-1-8 Hydrogen generation (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

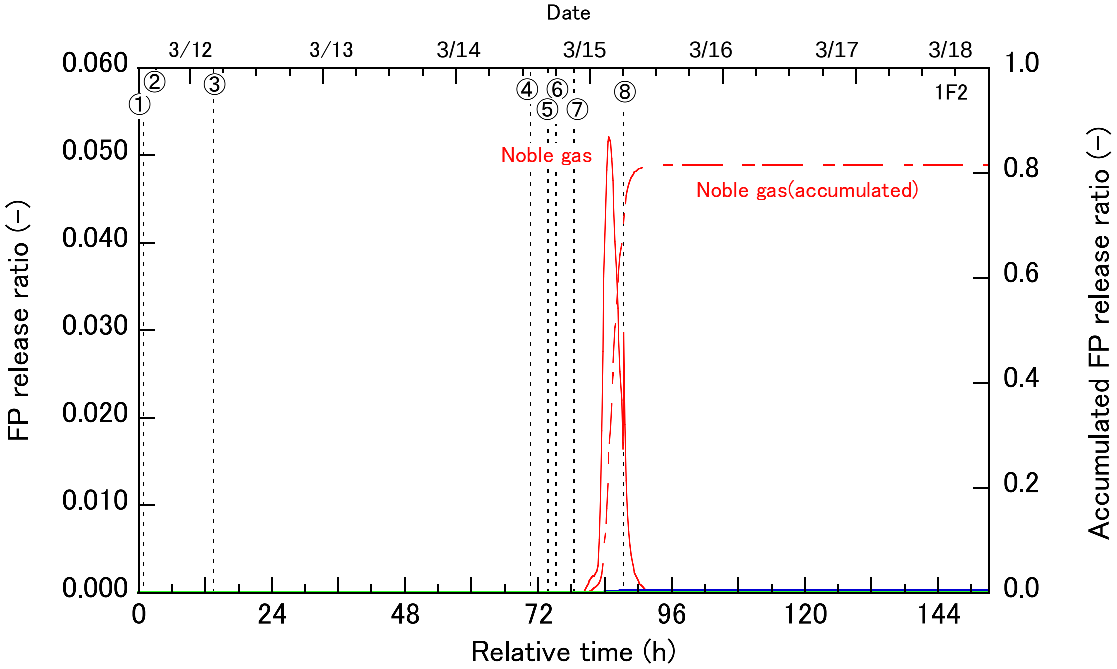


Fig. 2-1-9 FP release ratio to the environment (1/3) (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

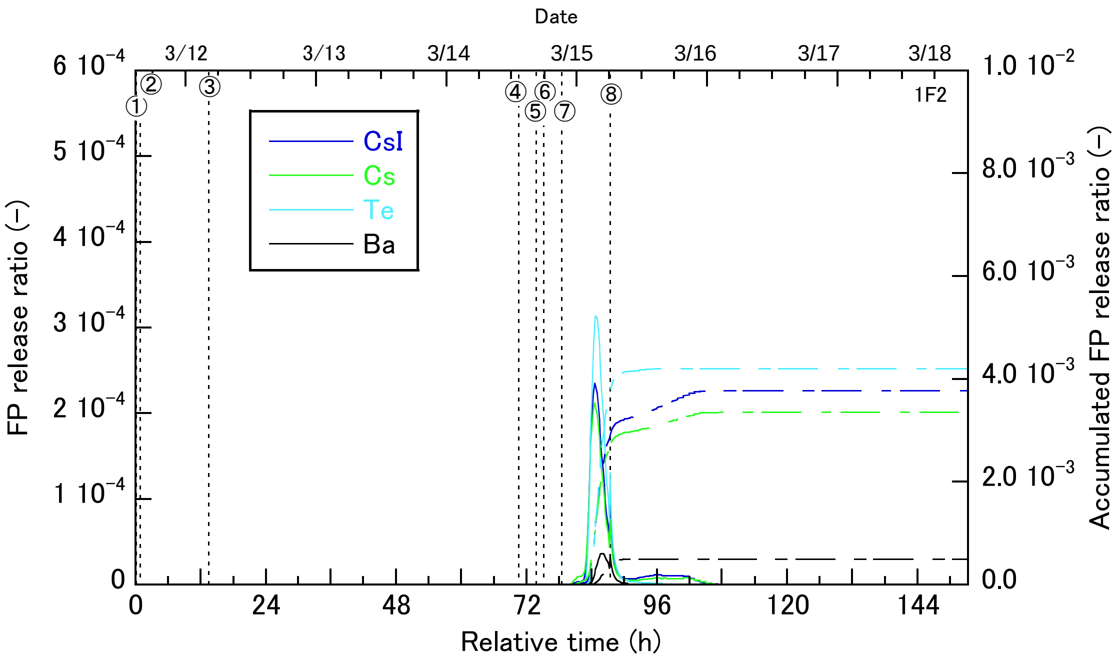


Fig. 2-1-10 FP release ratio to the environment (2/3) (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

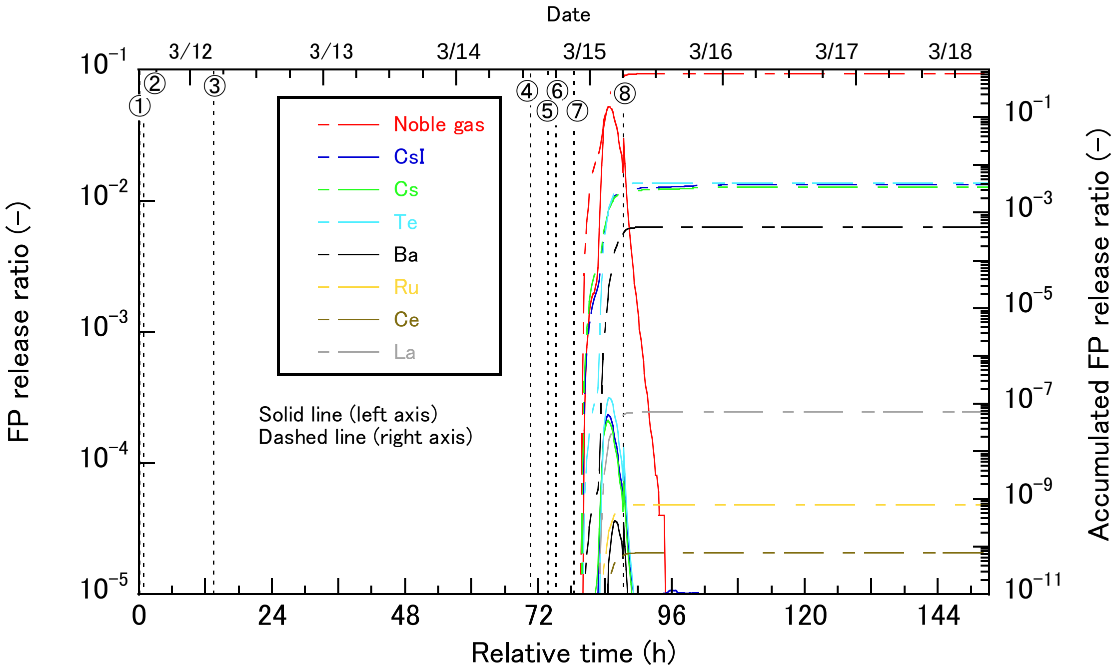


Fig. 2-1-11 FP release ratio to the environment (3/3) (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

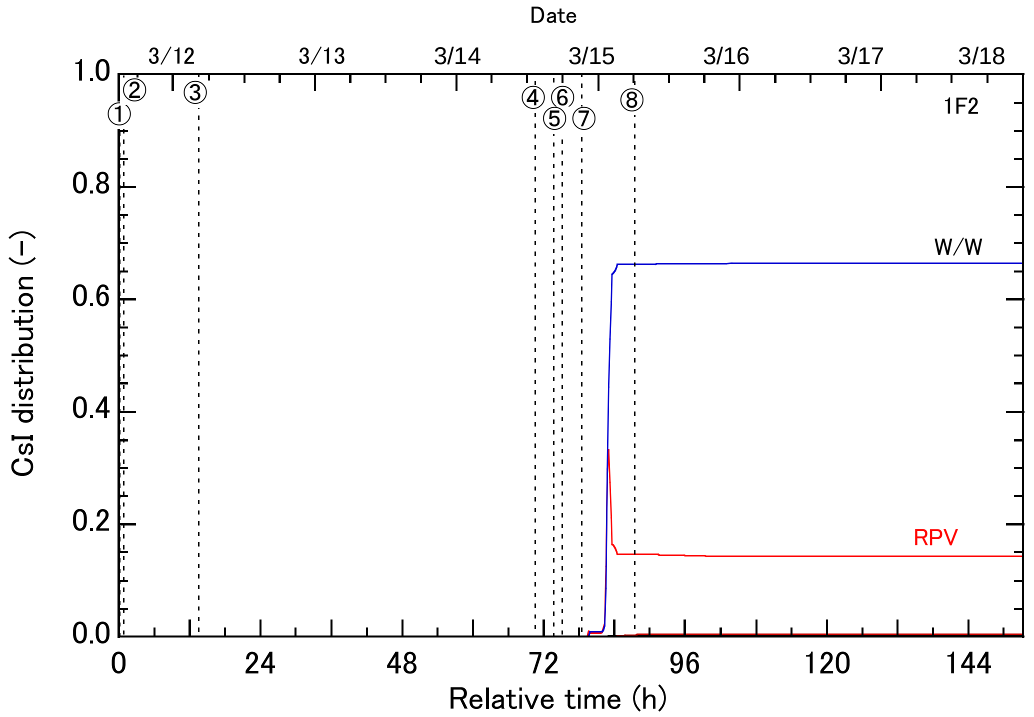


Fig. 2-1-12 Distribution of CsI (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

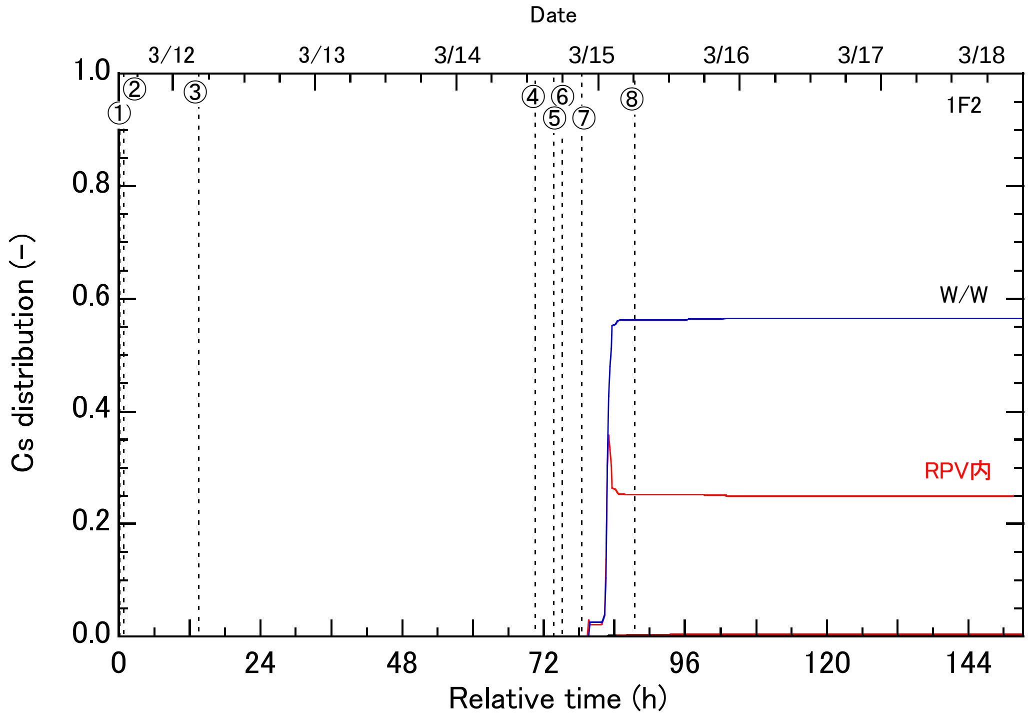


Fig. 2-1-13 Distribution of Cs (unit 2) [TEPCO-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

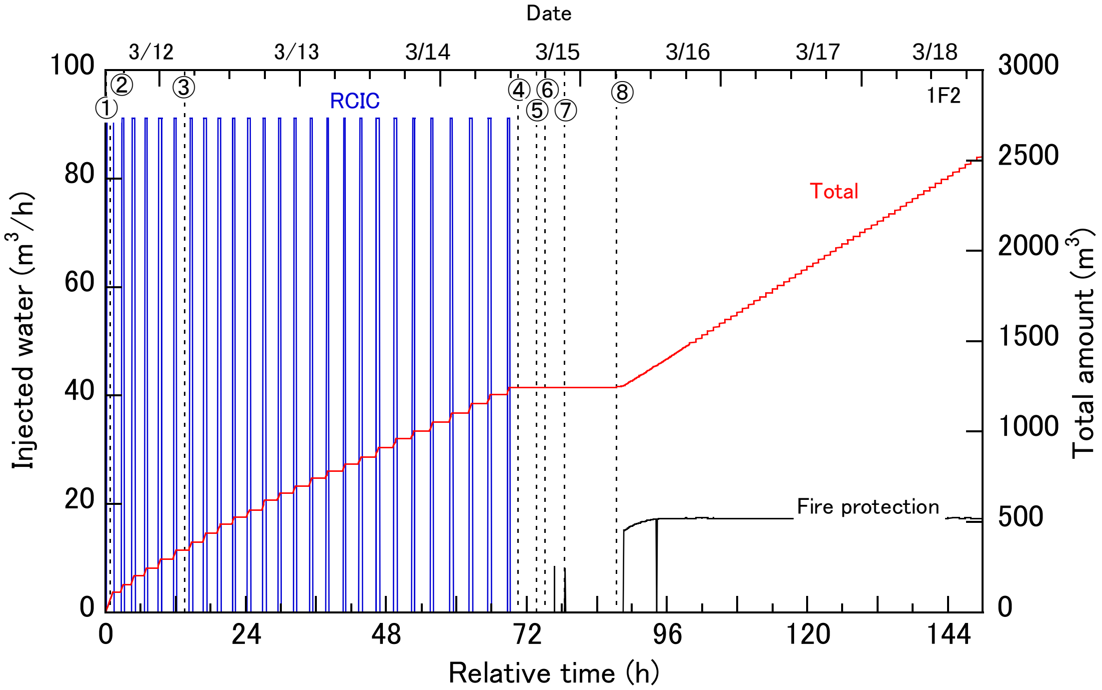


Fig. 2-2-1 Amount of water injection (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

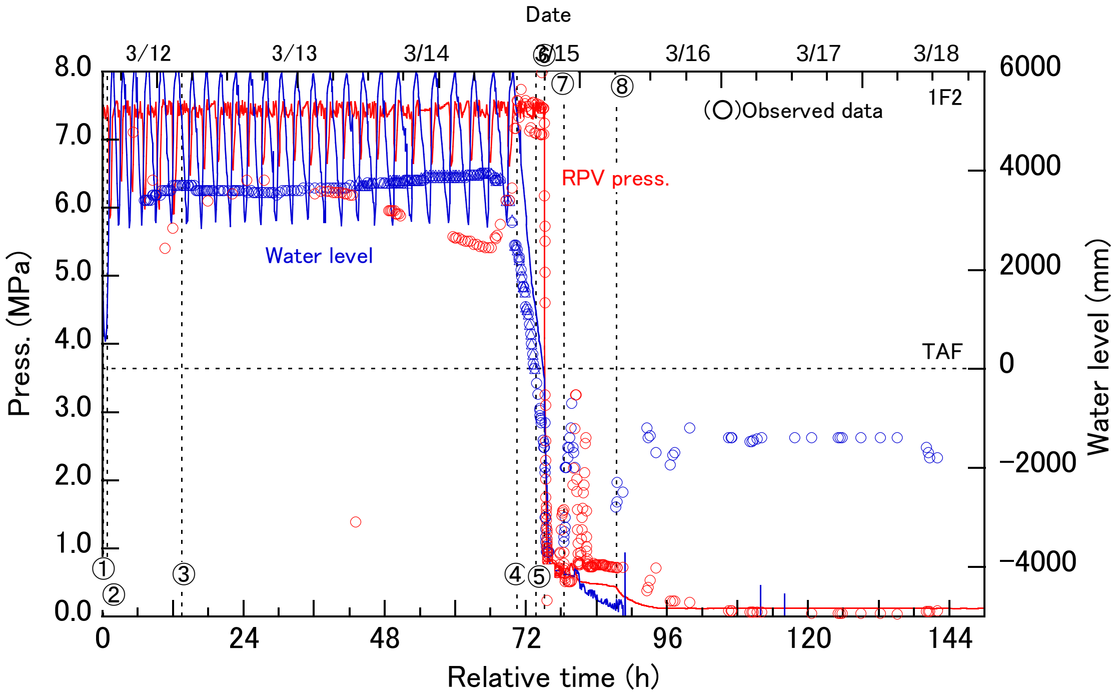


Fig. 2-2-2 RPV pressure and water level (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

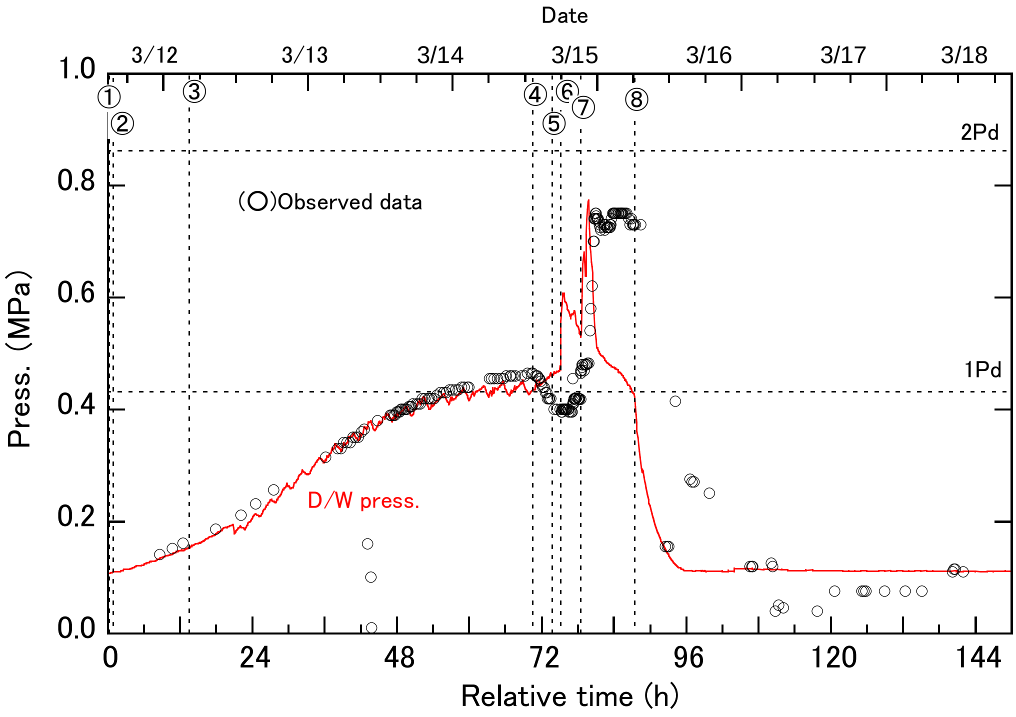


Fig. 2-2-3 D/W pressure (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

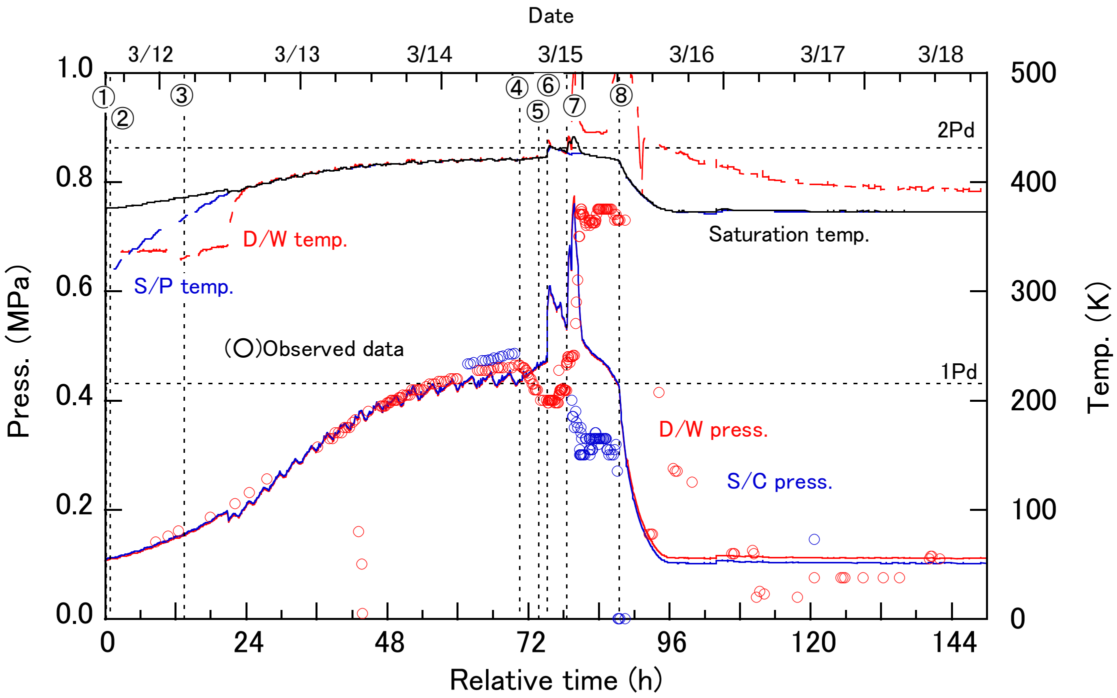


Fig. 2-2-4 PCV pressure and temperature (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

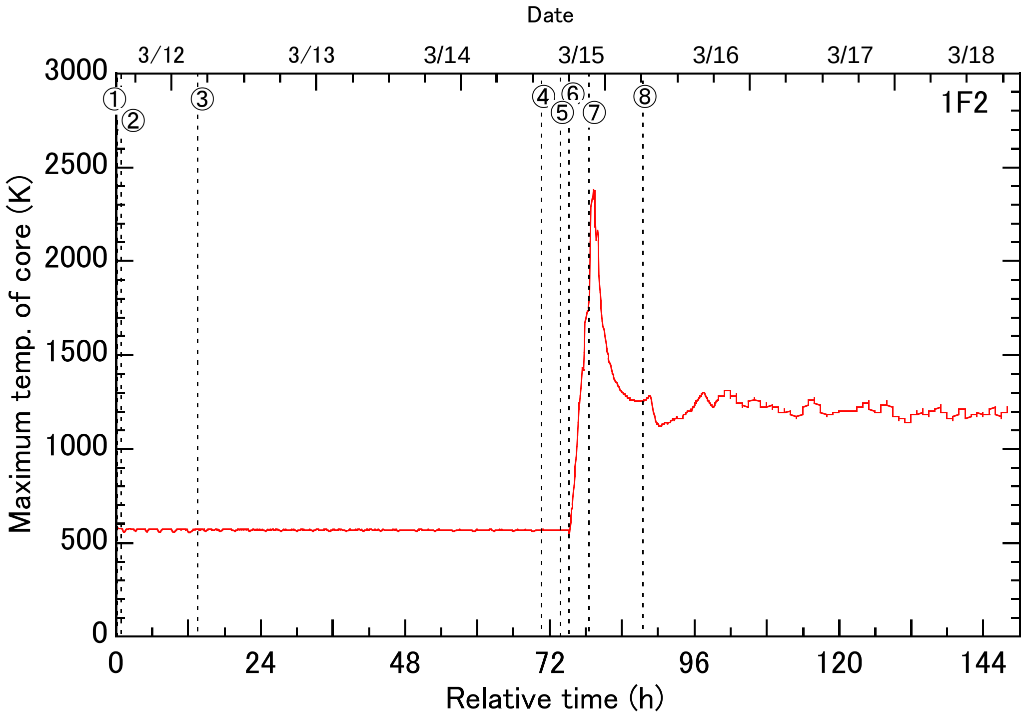


Fig. 2-2-5 Maximum temperature of the core (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

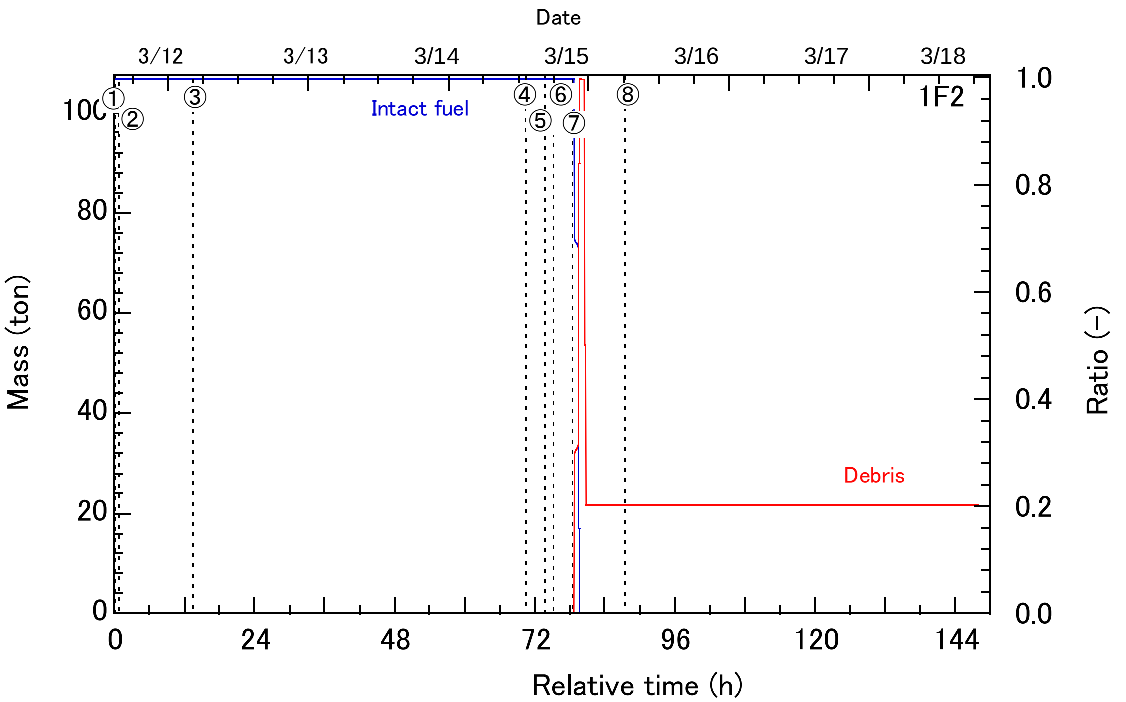


Fig. 2-2-6 Mass of the core (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

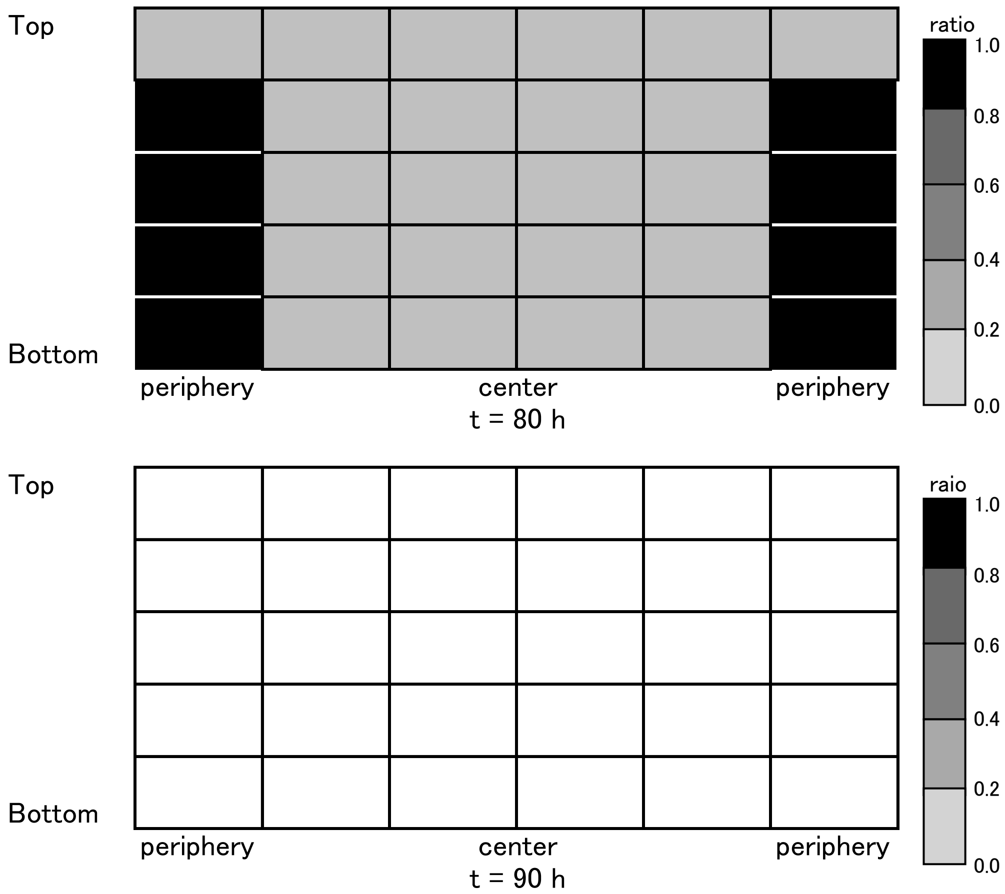


Fig. 2-2-7 Distribution of intact fuel (unit 2) [TEPCO-2]

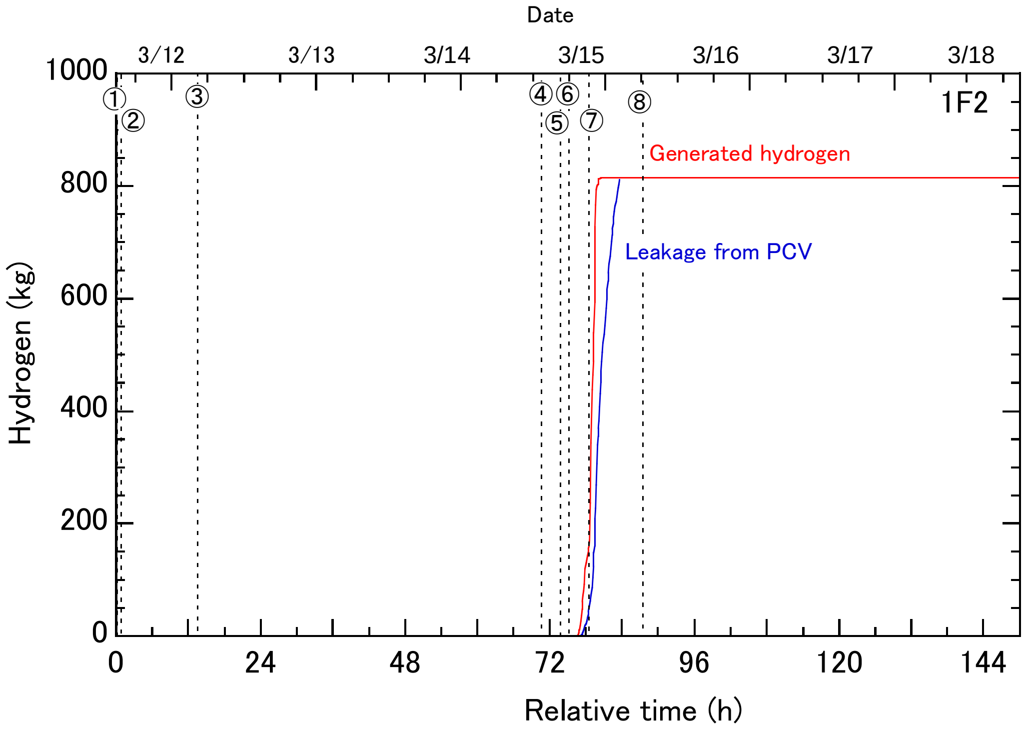


Fig. 2-2-8 Hydrogen generation (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

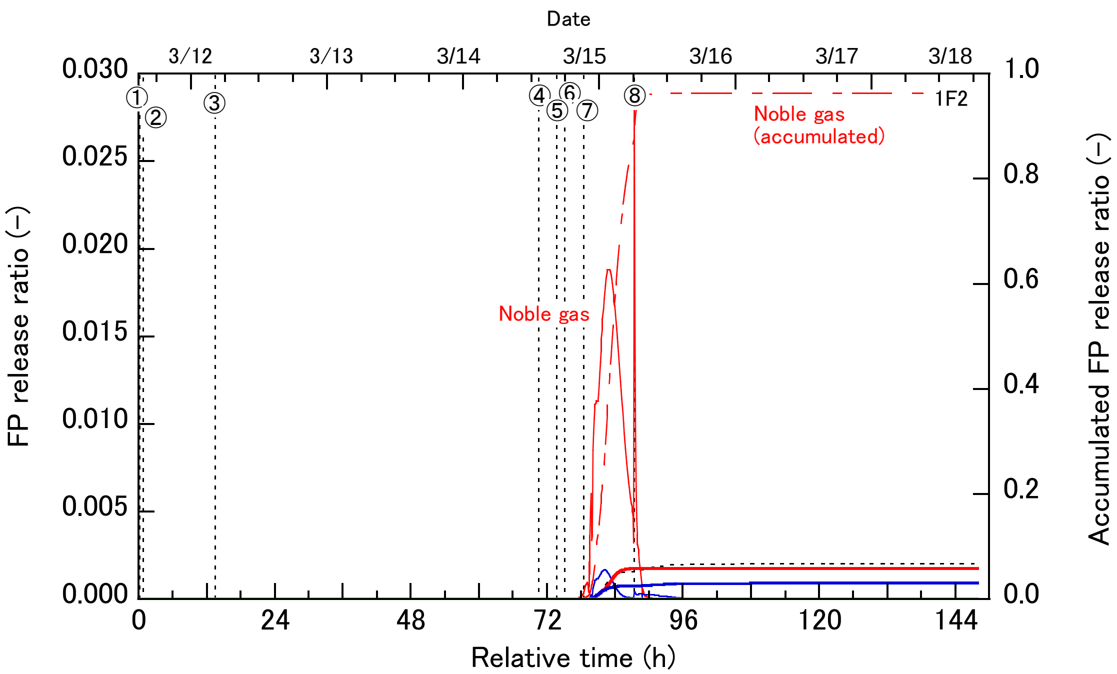


Fig. 2-2-9 FP release ratio to the environment (1/2) (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

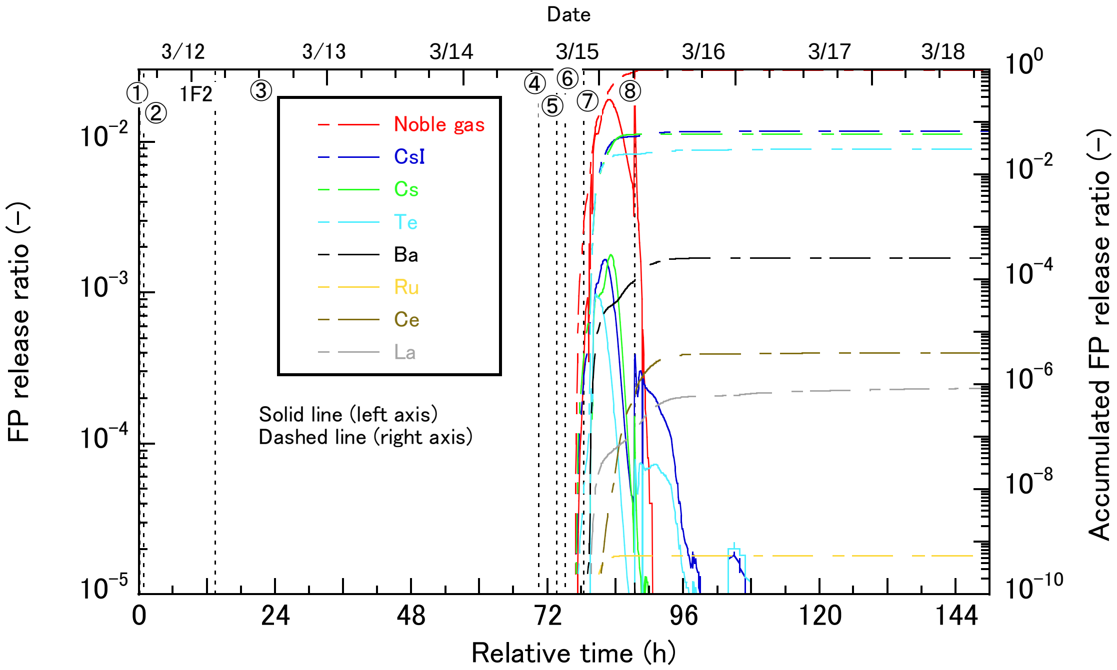


Fig. 2-2-10 FP release ratio to the environment (2/2) (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

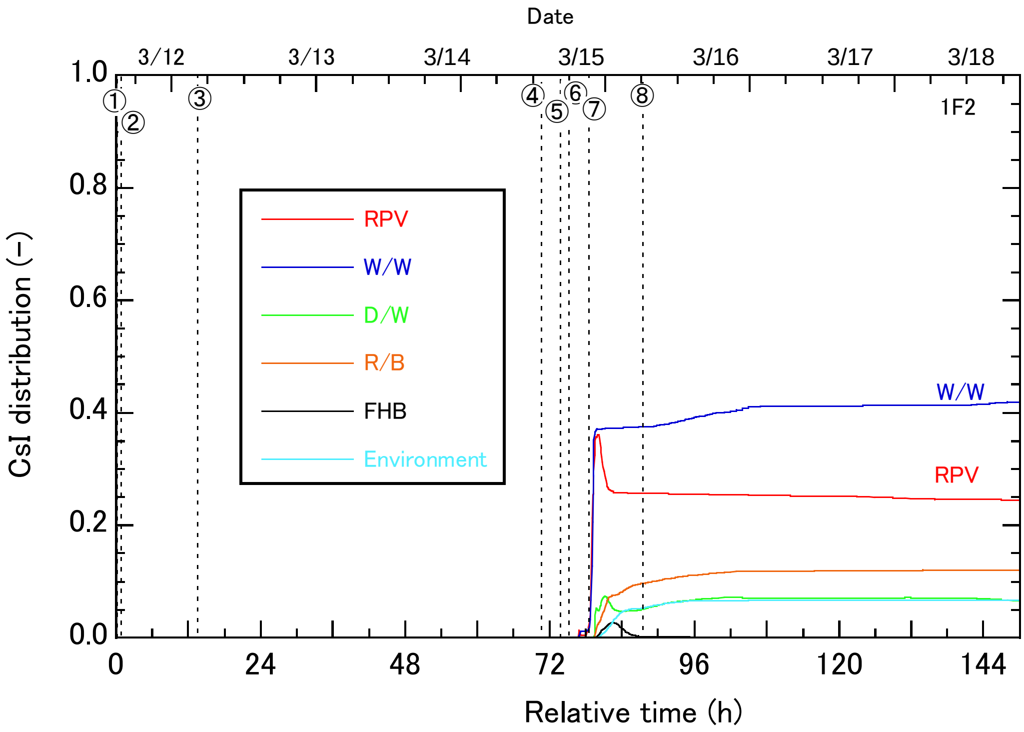


Fig. 2-2-11 Distribution of CsI (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

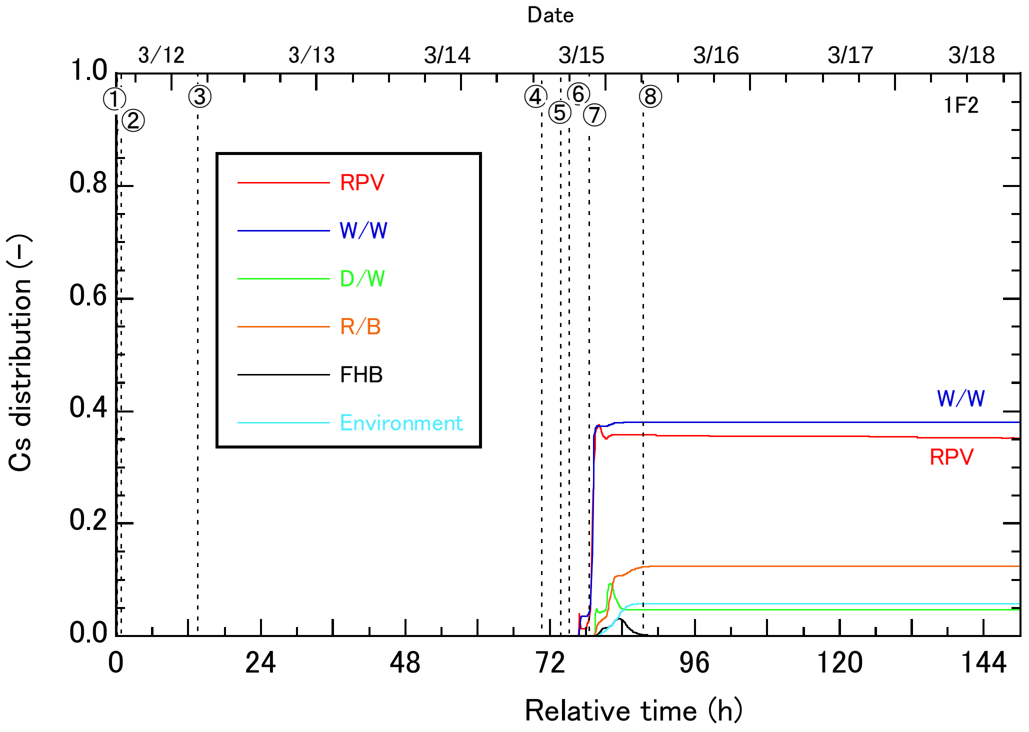


Fig. 2-2-12 Distribution of Cs (unit 2) [TEPCO-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

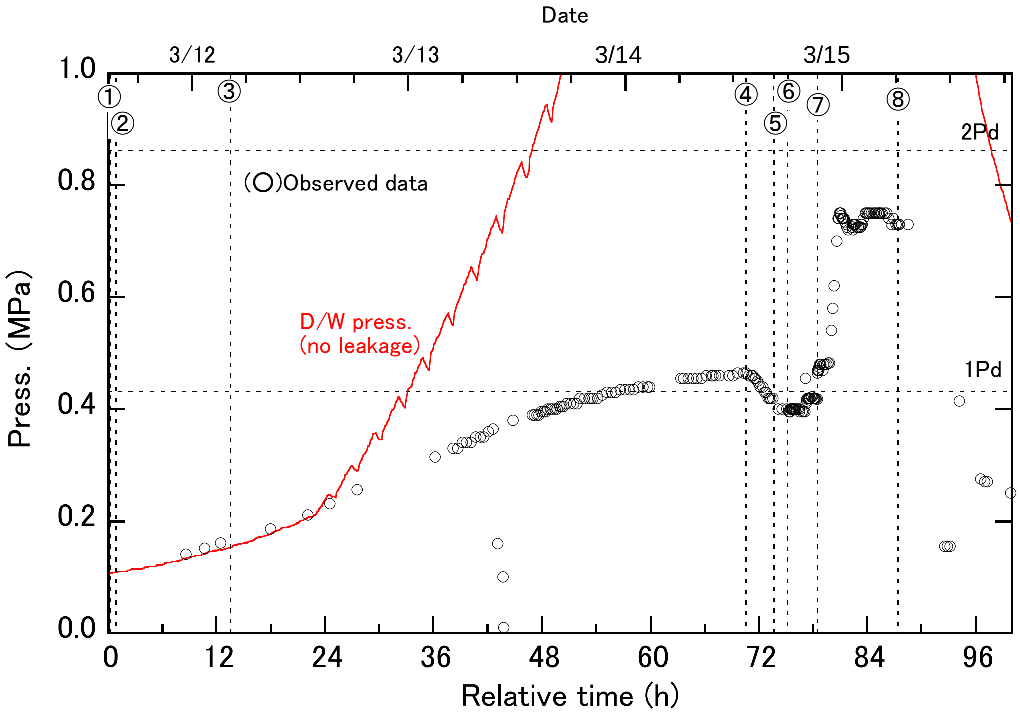


Fig. 2-3-1 D/W pressure (unit 2) [case-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

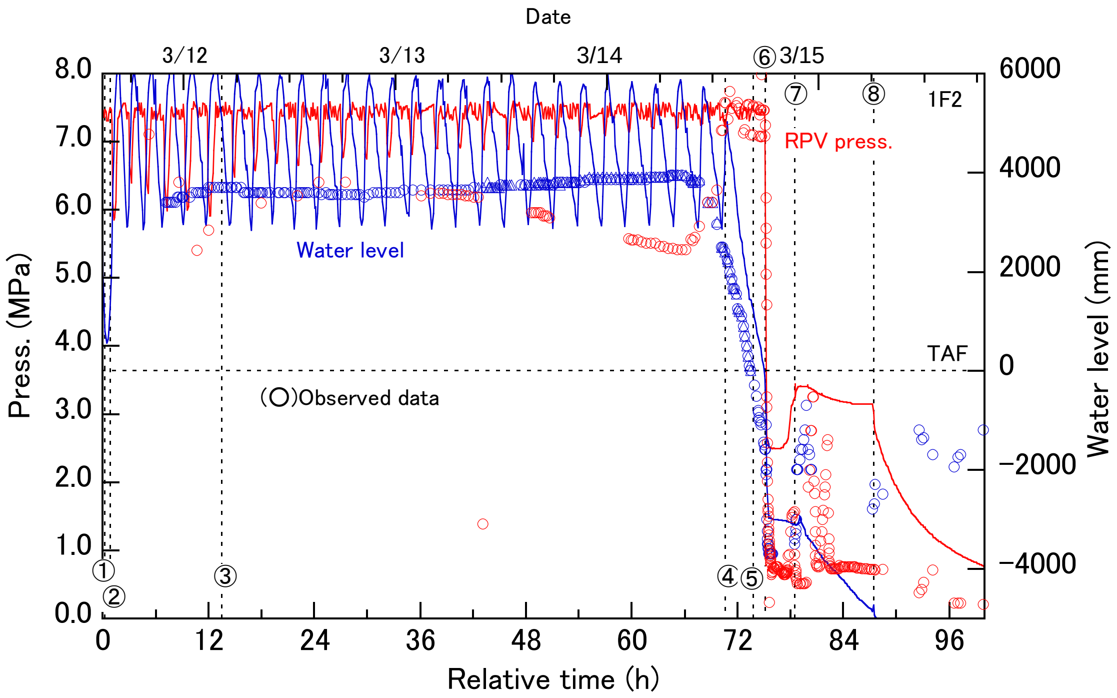


Fig. 2-3-2 RPV pressure and water level (unit 2) [case-1]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

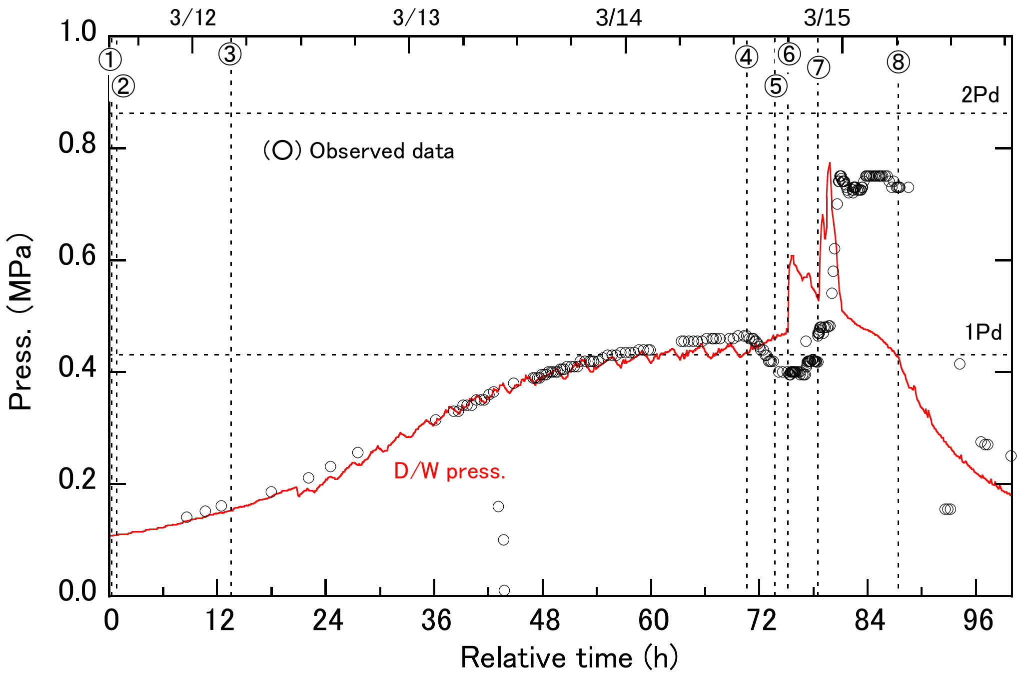


Fig. 2-4-1 D/W pressure (unit 2) [case-2]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

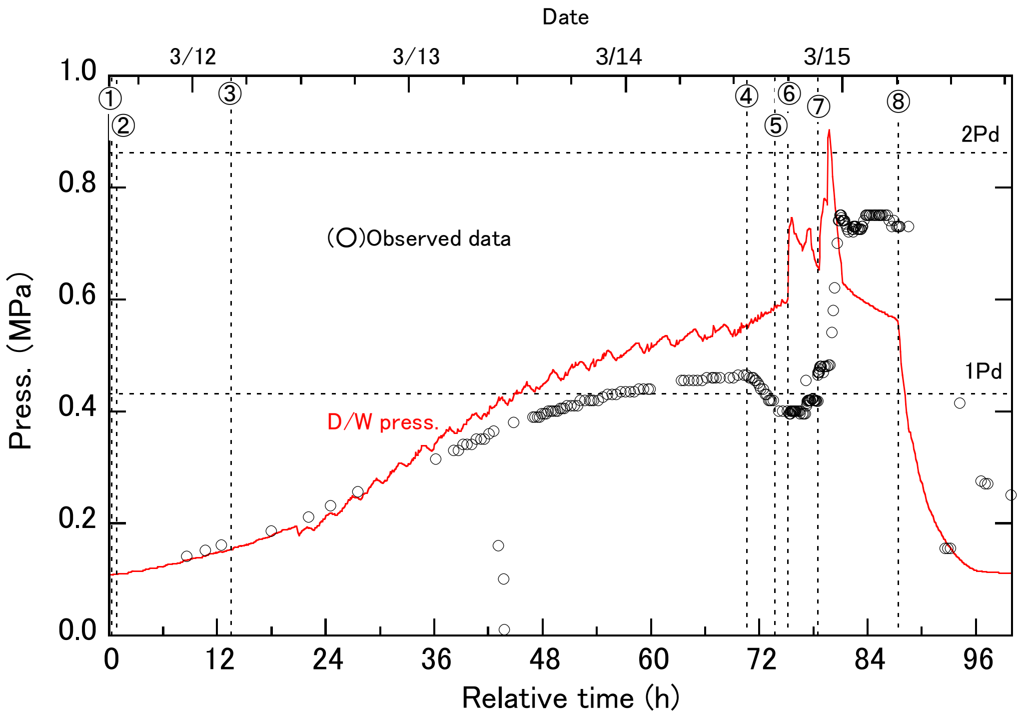


Fig. 2-5-1 D/W pressure (unit 2) [case-3]

①RCIC start manually, ②SBO, ③Water source change from CST to S/P, ④RCIC stop, ⑤Sea water inject., ⑥RPV depressurized, ⑦S/R valve-2 open, ⑧Impact sound

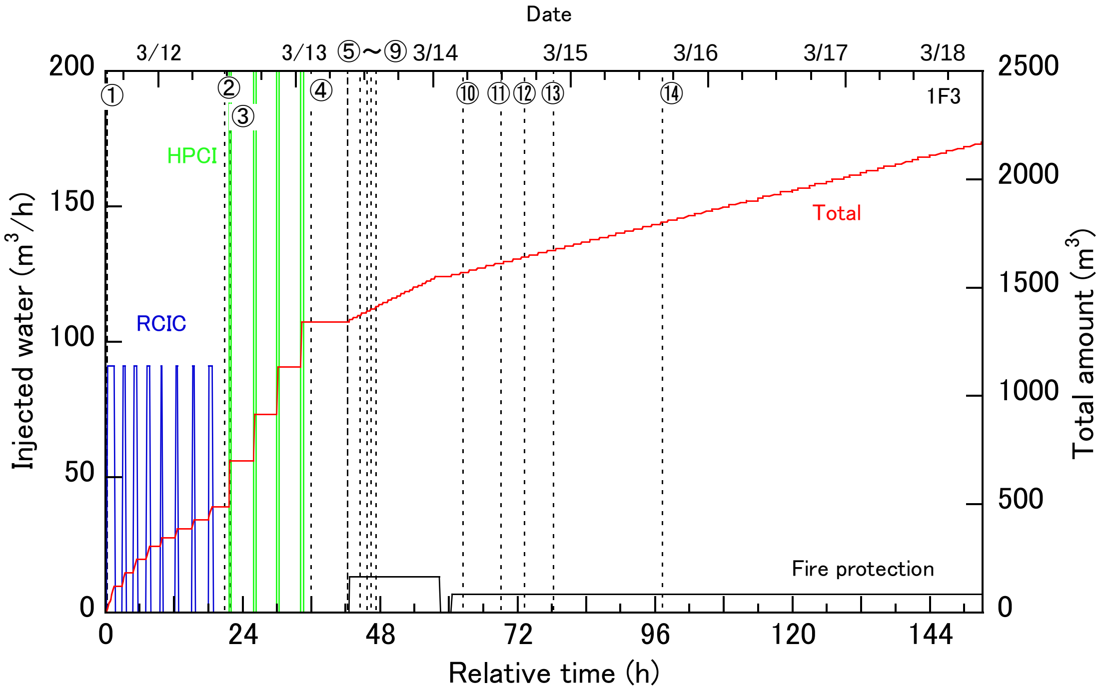


Fig.3-1-1 Amount of water injection (unit 3) [TEPCO-1]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

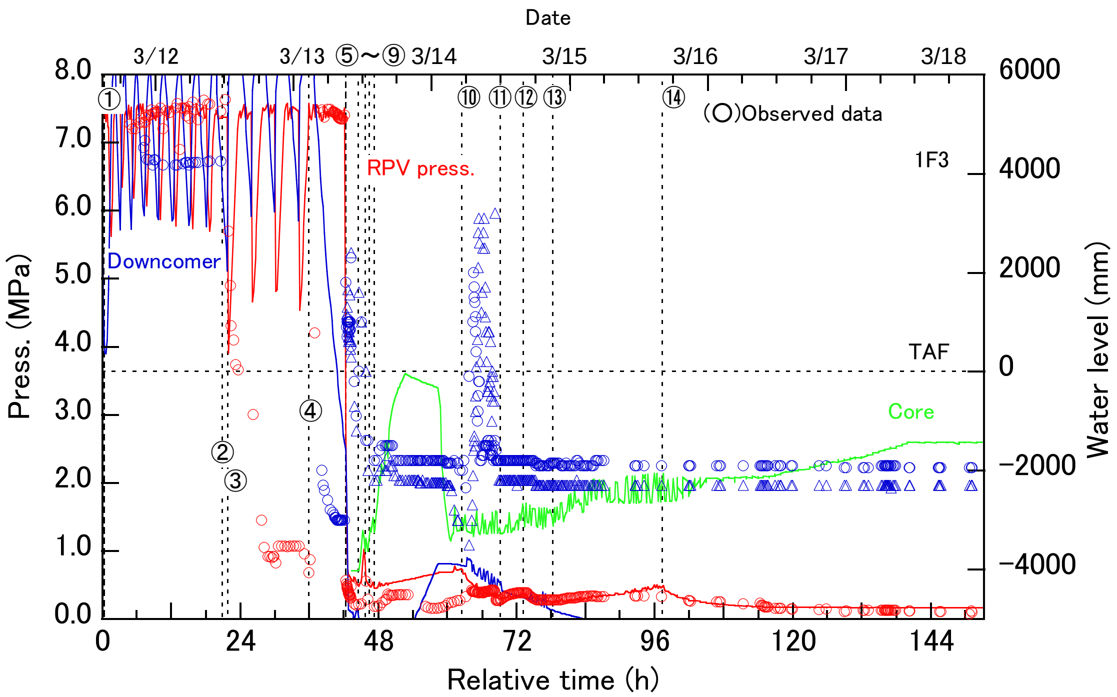


Fig.3-1-2 RPV pressure and water level (unit 3) [TEPCO-1]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

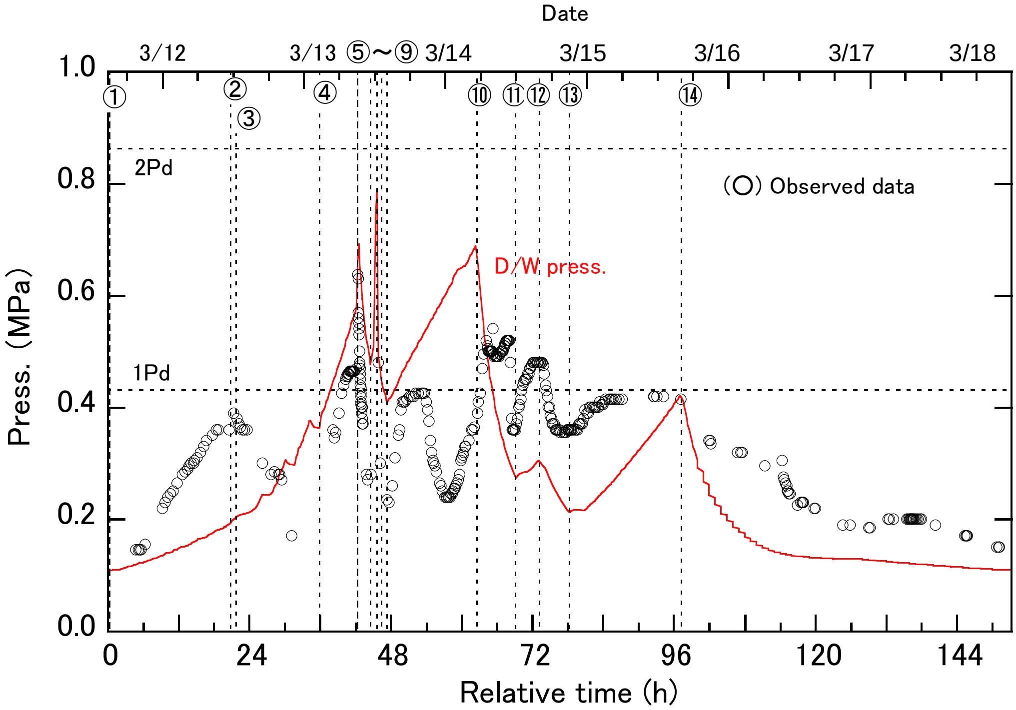


Fig.3-1-3 D/W pressure (unit 3) [TEPCO-1]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

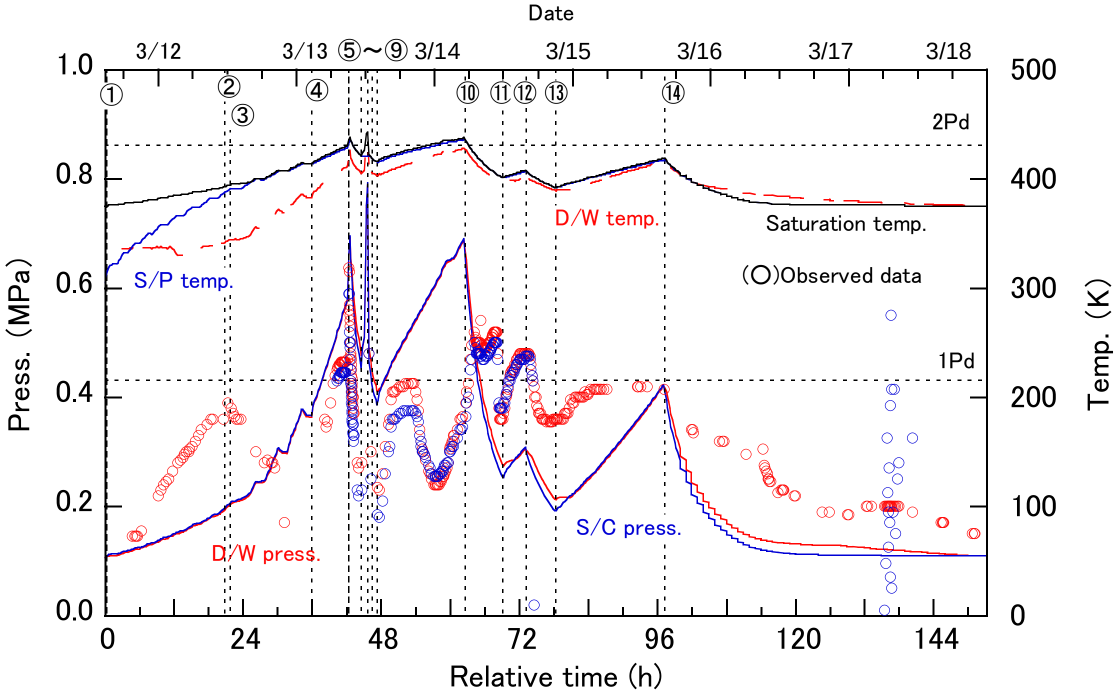


Fig.3-1-4 PCV pressure and temperature (unit 3) [TEPCO-1]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

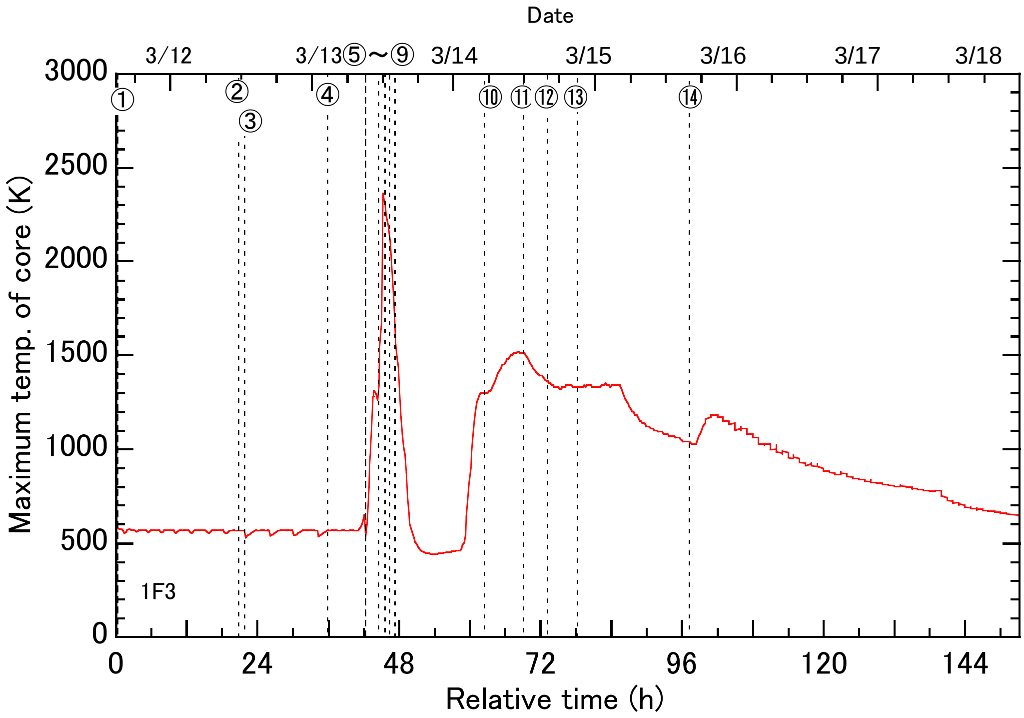


Fig.3-1-5 Maximum temperature of the core (unit 3) [TEPCO-1]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

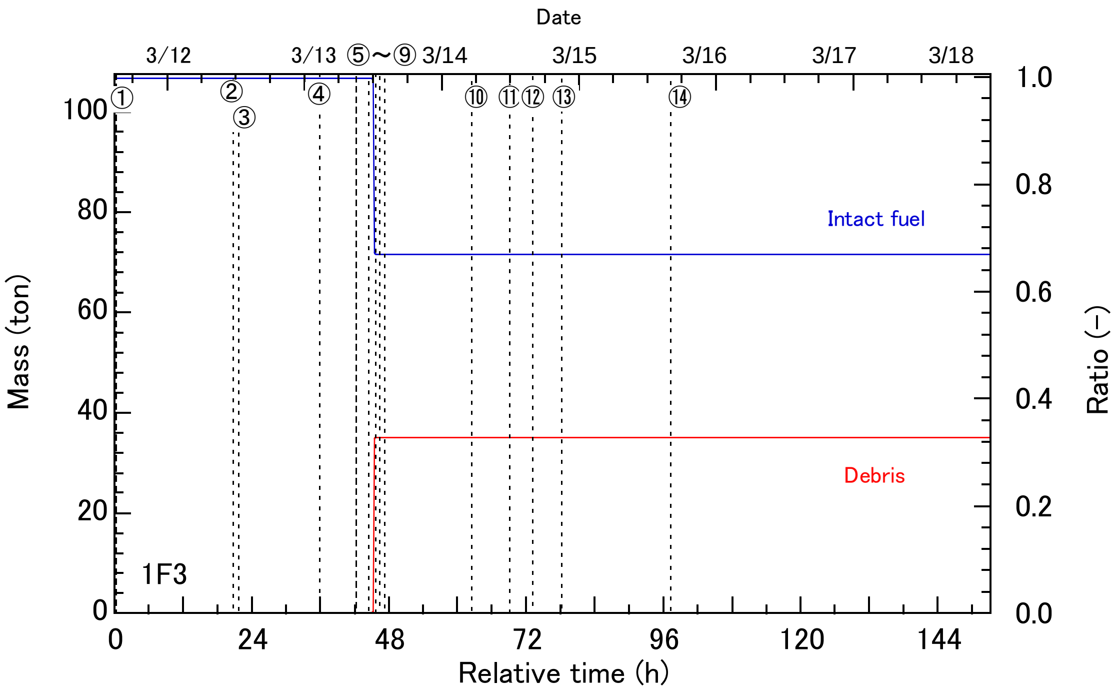


Fig.3-1-6 Mass of the core (unit 3) [TEPCO-1]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

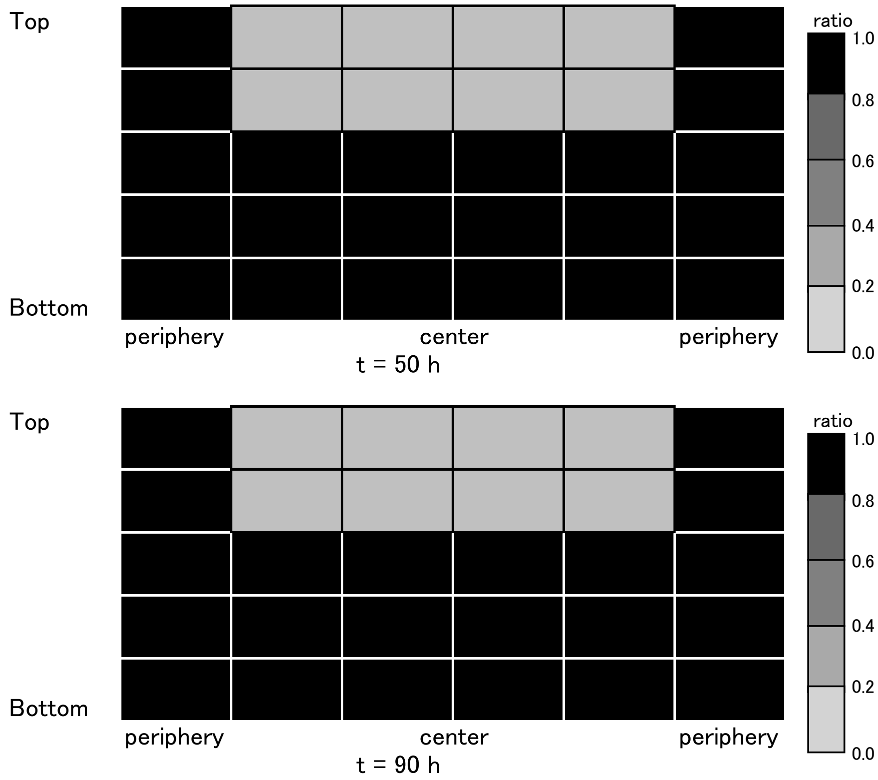


Fig.3-1-7 Distribution of intact fuel (unit 3) [TEPCO-1]

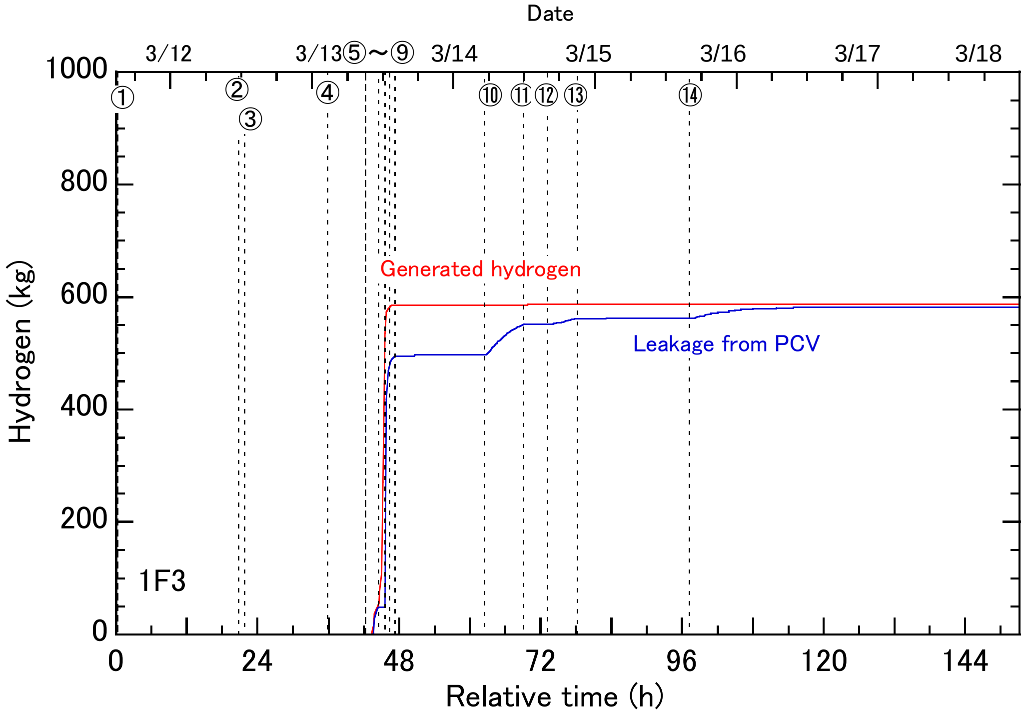


Fig.3-1-8 Hydrogen generation (unit 3) [TEPCO-1]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

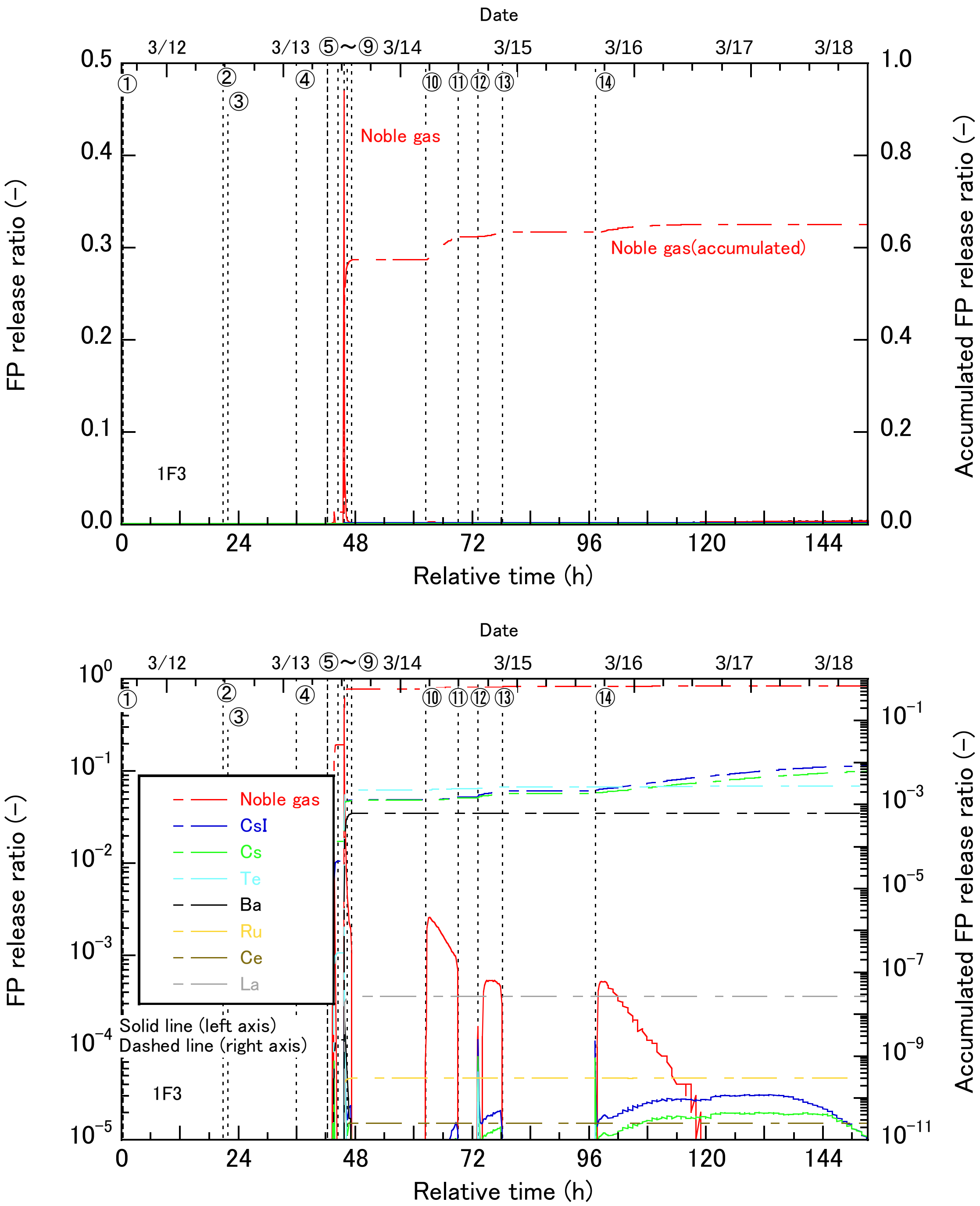


Fig.3-1-9 FP release ratio to the environment (unit 3) [TEPCO-1]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

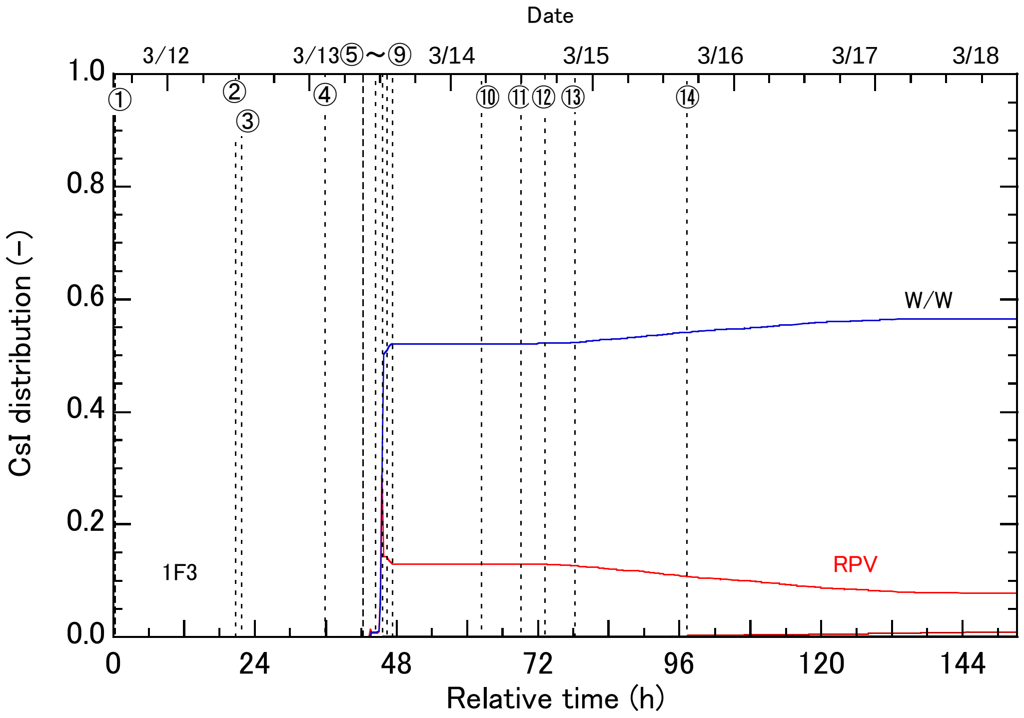


Fig.3-1-10 Distribution of CsI (unit 3) [TEPCO-1]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

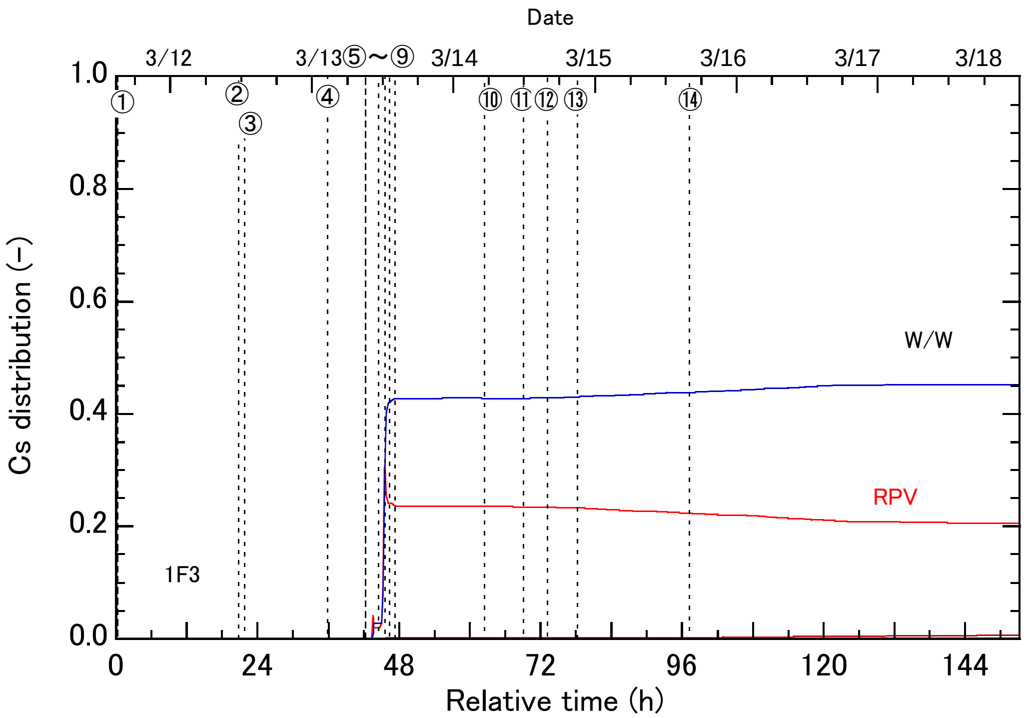


Fig.3-1-11 Distribution of Cs (unit 3) [TEPCO-1]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

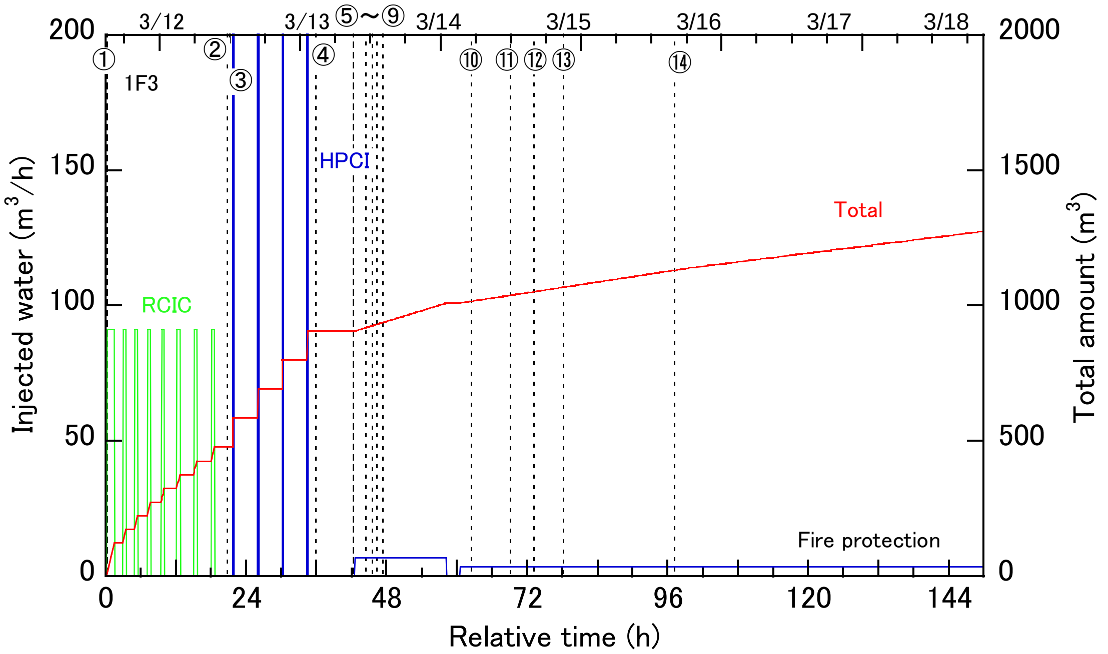


Fig.3-2-1 Amount of water injection (unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

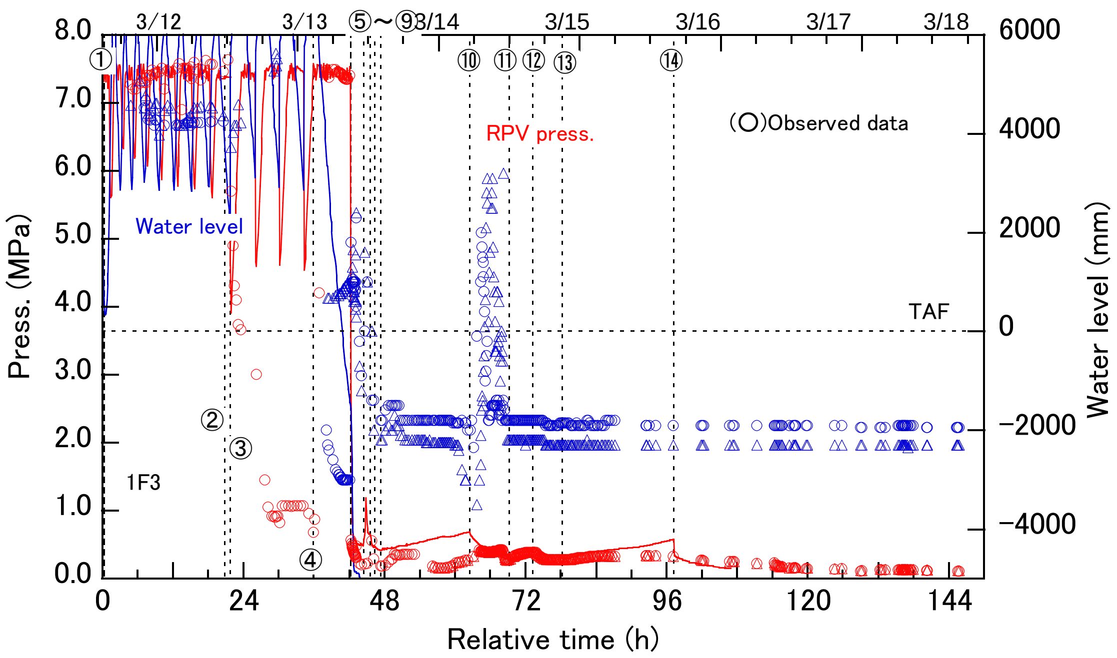


Fig.3-2-2 RPV pressure and water level (unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

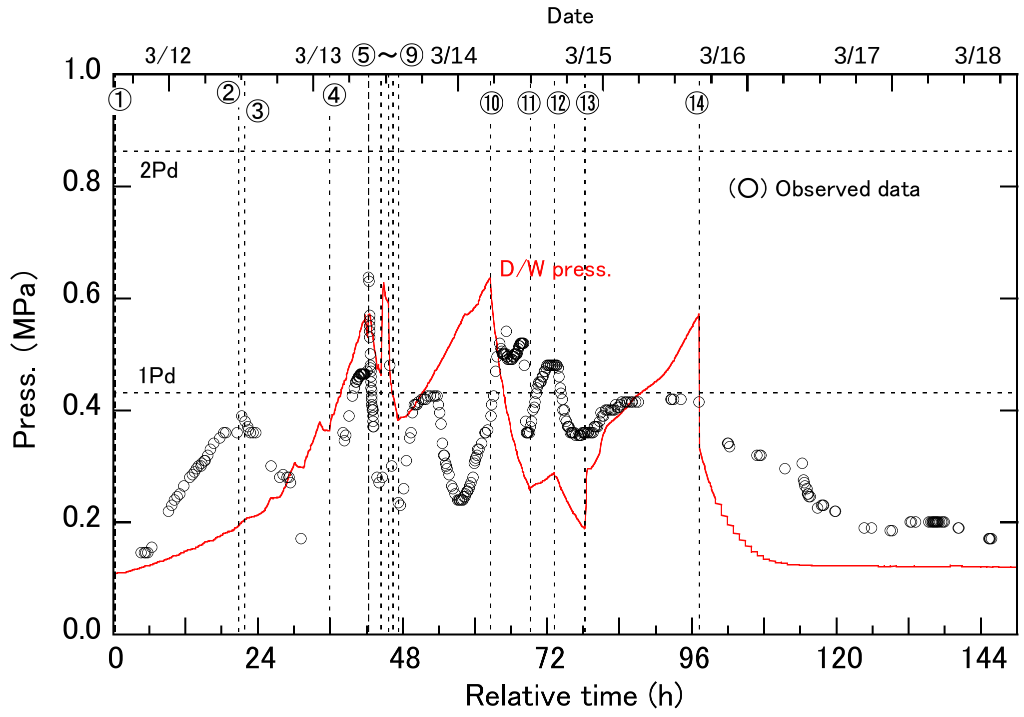


Fig.3-2-3 D/W pressure (unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

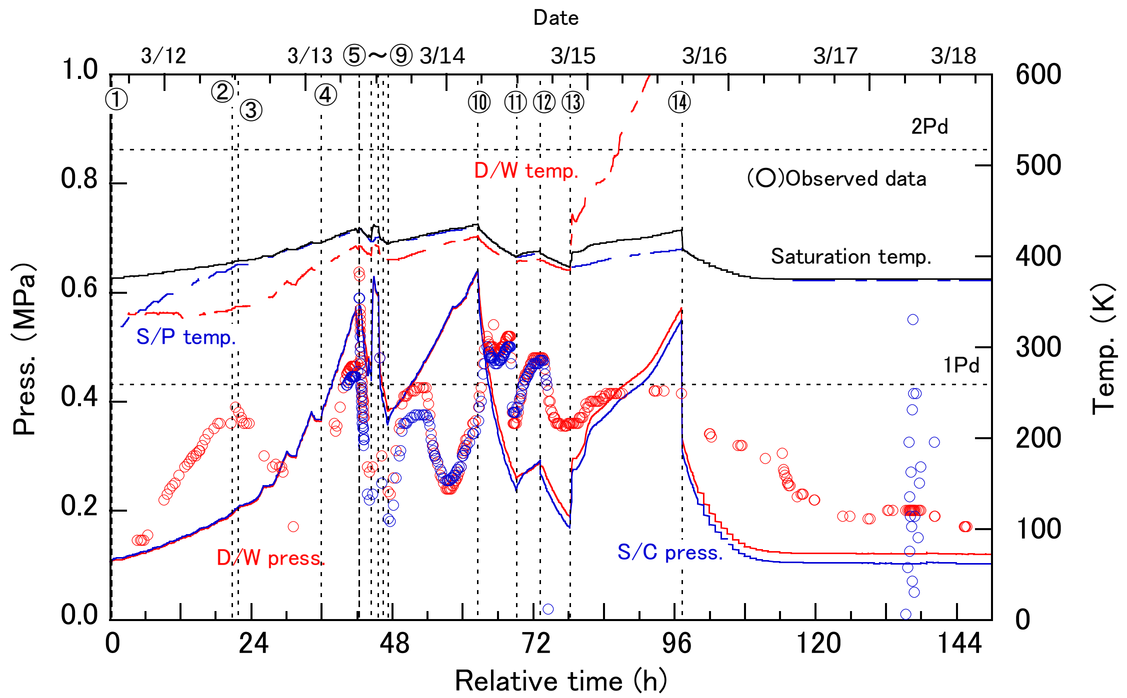


Fig.3-2-4 PCV pressure and temperature (unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

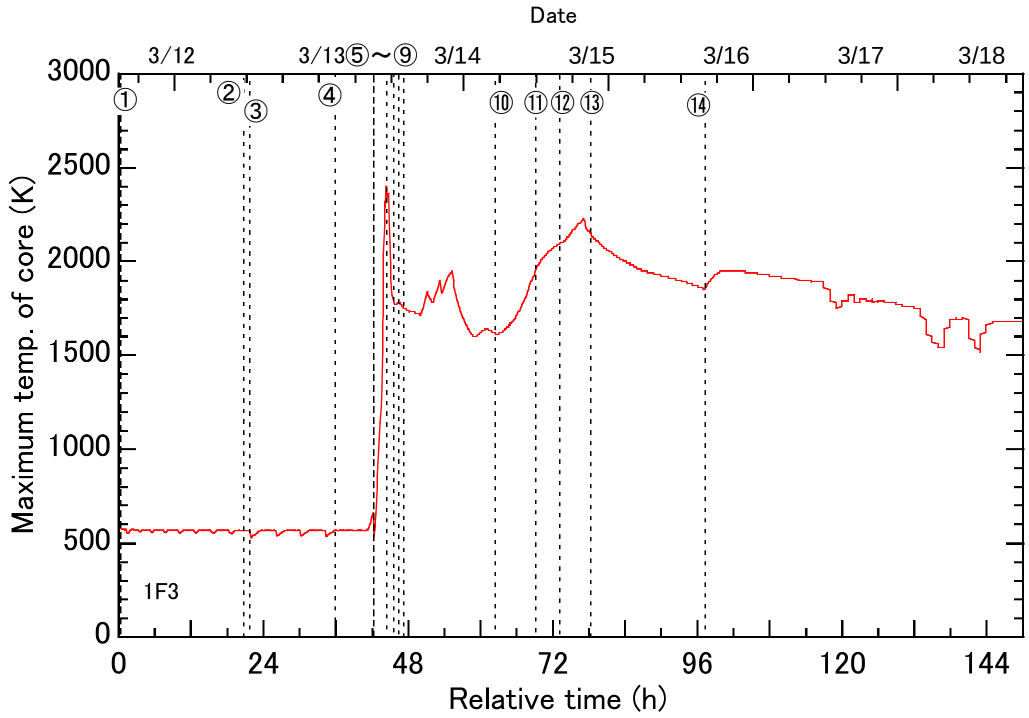


Fig.3-2-5 Maximum temperature of the core (unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩〜⑭PCV vent (open⇔close)

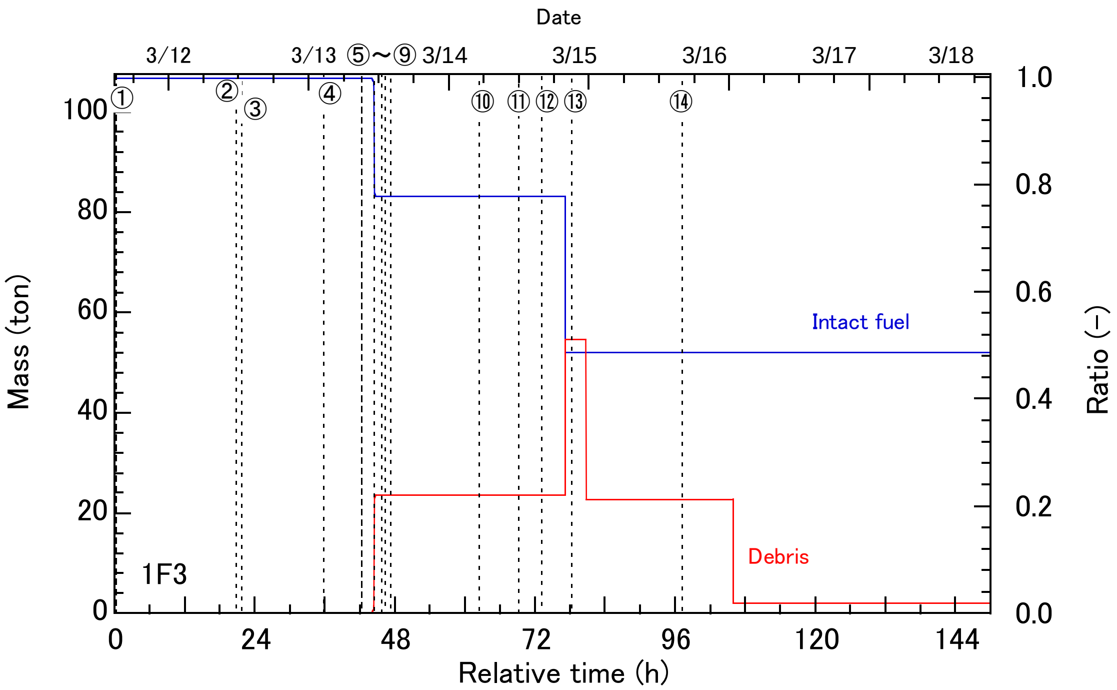


Fig.3-2-6 Mass of the core (unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩〜⑭PCV vent (open⇔close)

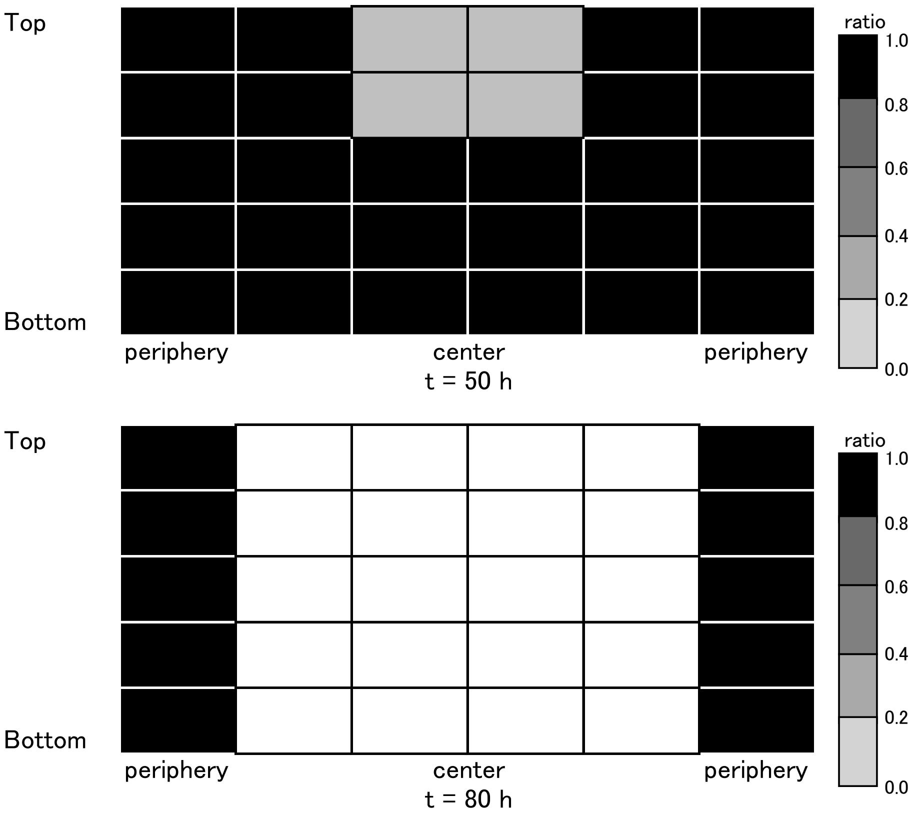


Fig.3-2-7 Distribution of intact fuel (unit 3) [TEPCO-2]

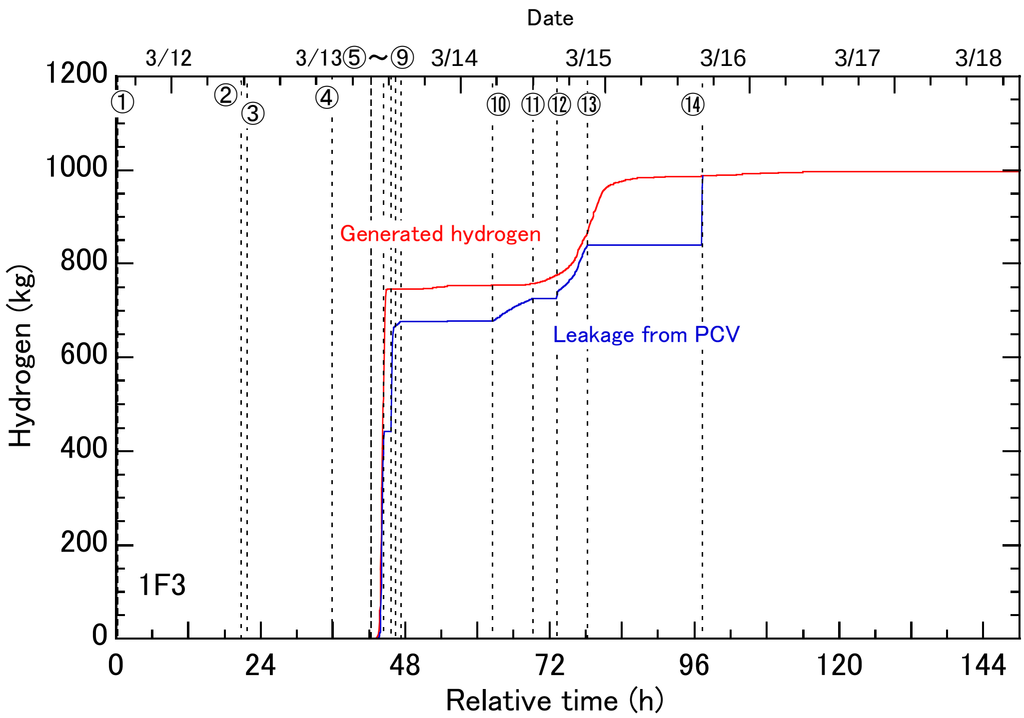
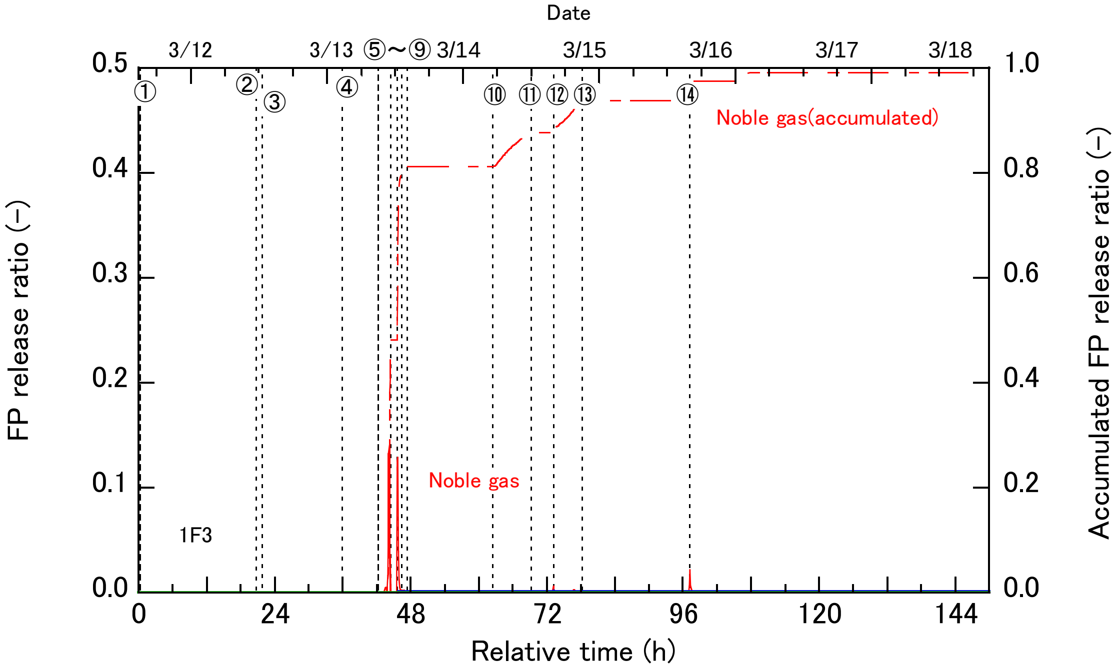


Fig.3-2-8 Hydrogen generation (unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)



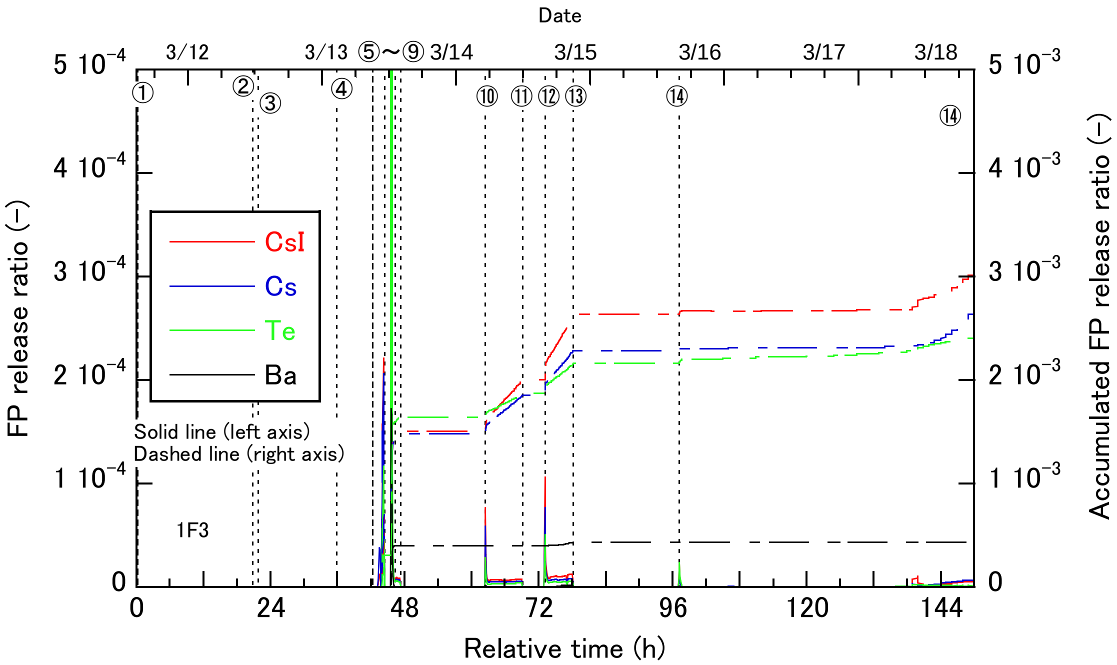


Fig.3-2-9 FP release ratio to the environment (1/2) (unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

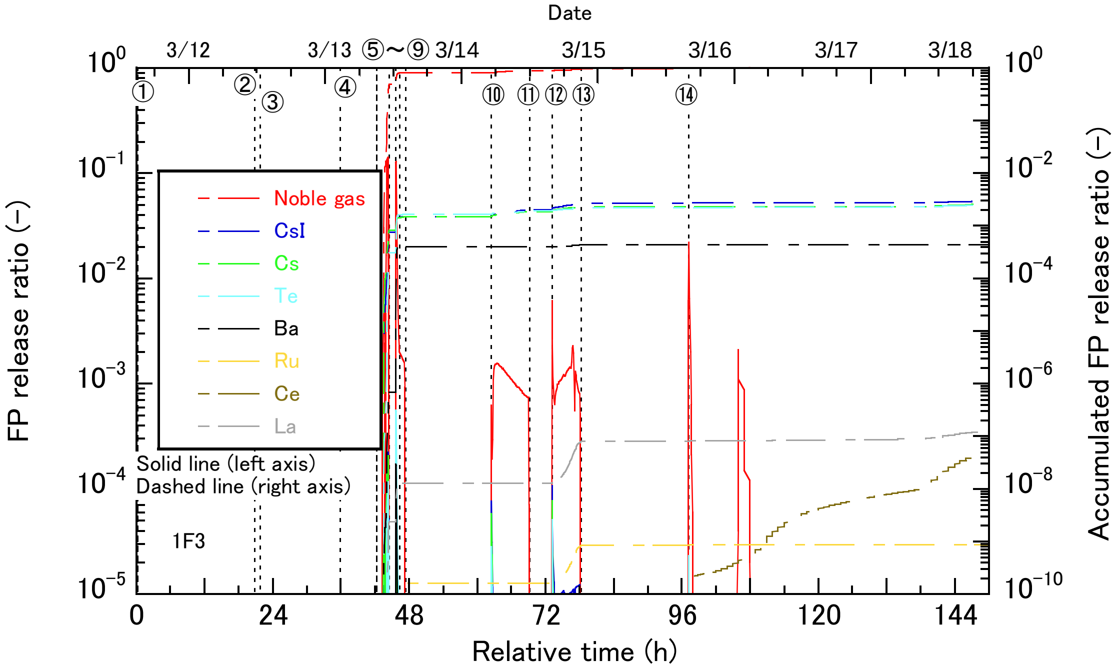


Fig.3-2-10 FP release ratio to the environment (2/2) (unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

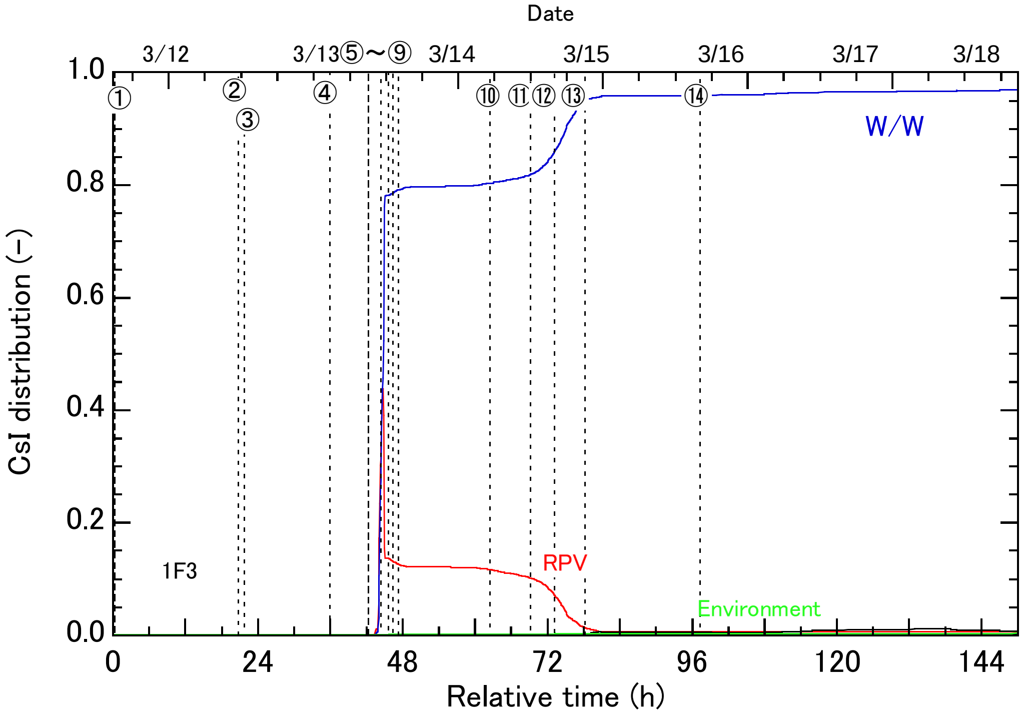


Fig.3-2-11 Distribution of CsI (1/2)(unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

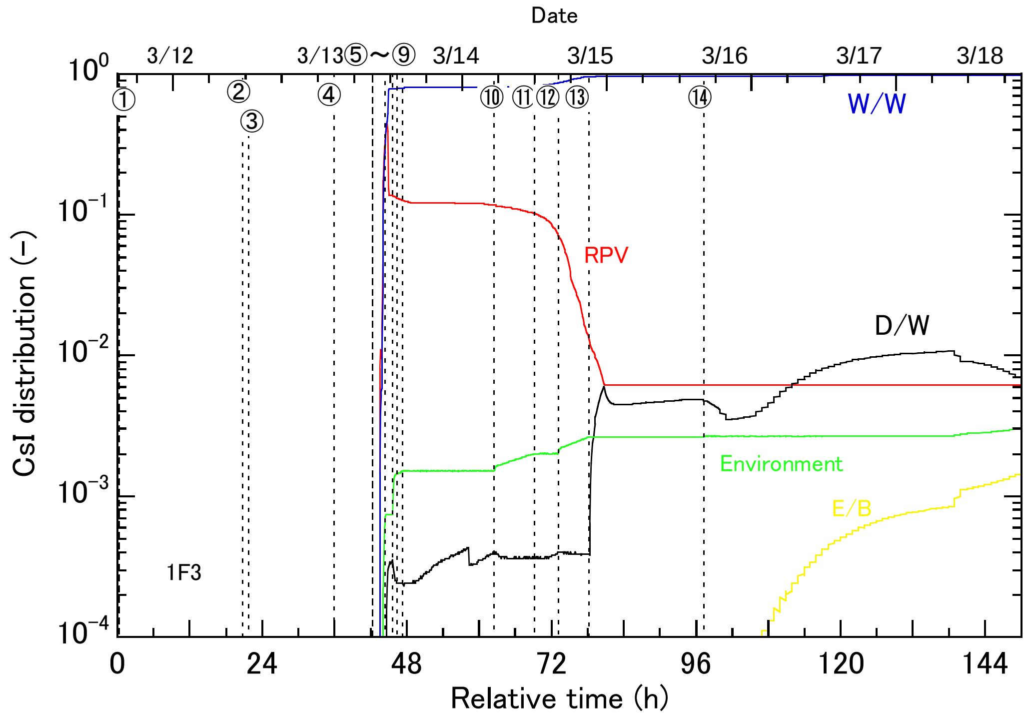


Fig.3-2-12 Distribution of CsI (2/2)(unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

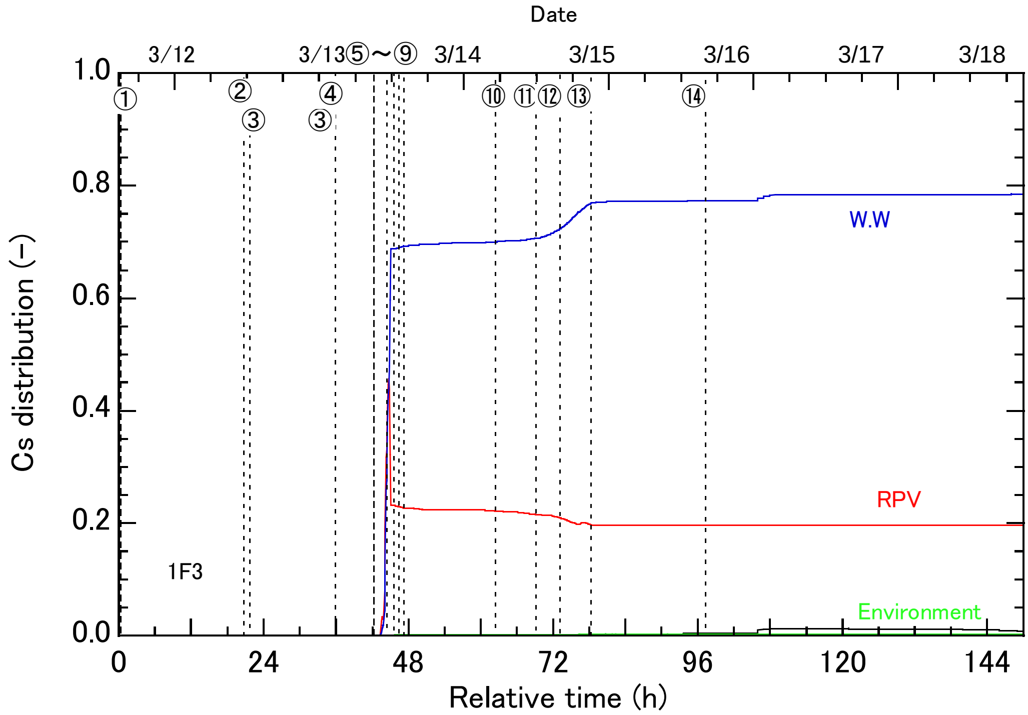


Fig.3-2-13 Distribution of Cs (1/2)(unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)

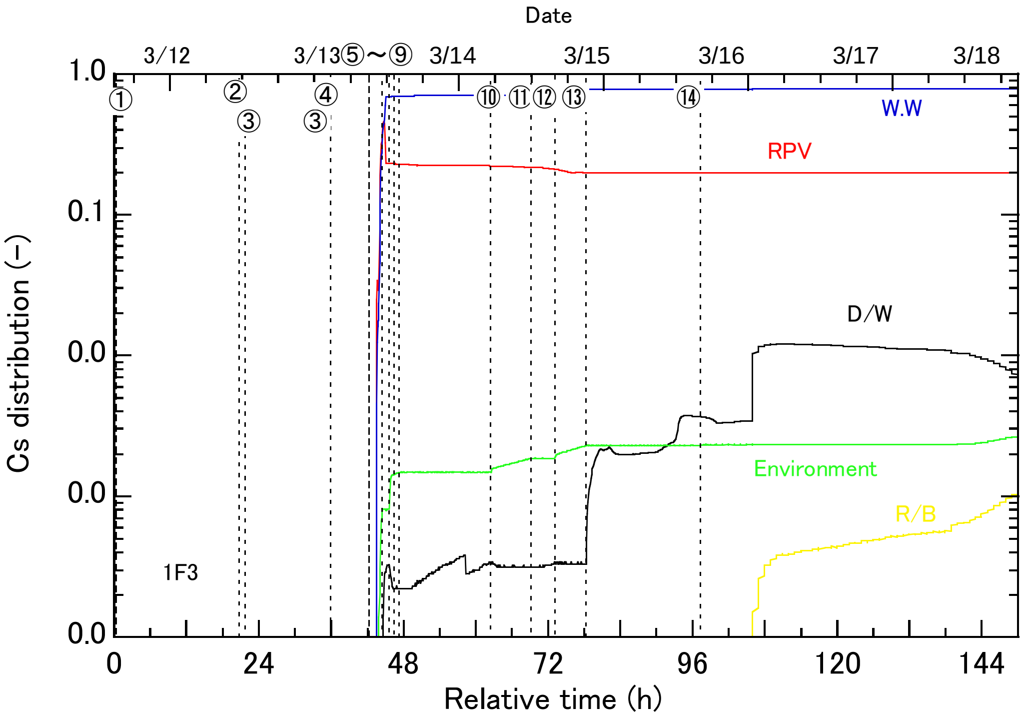


Fig.3-2-14 Distribution of Cs (2/2)(unit 3) [TEPCO-2]

①RCIC start manually, ②RCIC stop, ③HPCI start, ④HPCI stop, ⑤S/RV(open), ⑥PCV vent (open), ⑦Water inject., ⑧PCV vent (close), ⑨Sea water inject., ⑩～⑭PCV vent (open⇔close)