The 4th Progress Report
on the Investigation and Examination of
Unconfirmed and Unresolved Issues
on the Development Mechanism
of the Fukushima Daiichi Nuclear Accident

December 17, 2015

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TEPCO 東京電力

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1. Overview of the Fukushima Nuclear Accident

To date, TEPCO has compiled the following documents to summarize the Fukushima Nuclear Accident:

Fukushima Nuclear Accident Investigation Report
(Provides details on the facts related to conditions before and after the Fukushima Nuclear Accident)

Nuclear Safety Reform Plan
(Analyzes organizational causes that served as a backdrop for the accident, as well technical causes of the accident)

- ✓ Elucidated the root causes of the Fukushima Nuclear Accident
  →Kashiwazai-Kariwa NPS: Implemented safety countermeasures to prevent the occurrence of a severe accident

- ✓ TEPCO compliance with new safety regulations
  →Nuclear Regulation Authority: Each measure discussed and confirmed at review meetings.

2. Positioning of this report

Accident root causes (clarified)

Accident investigations to date have made it clear that the accident occurred because of a widespread loss of safety function caused by the tsunami that occurred after all external power had been cut off by the earthquake, and that escalation of the accident thereafter was not able to be stopped due to the lack of advanced accident prevention preparation.

After reviewing the details of various accident investigations conducted by other agencies and organizations, including TEPCO, the Nuclear Regulatory Agency's accident analysis review committee determined that the primary causes of the accident are the same as those above determined by TEPCO.

⇒The Kashiwazaki-Kariwa NPS has implemented safety countermeasures based on these results.

Scope covered by the accident investigation report and the nuclear safety reform plan

Efforts to ensure that an accident like the Fukushima Daiichi Nuclear Accident never occurs again

Detailed accident development mechanism

Understanding the unsolved issues of details of how the incident developed after the initial accident is not only the responsibility of the parties involved in the accident but also important in order to:

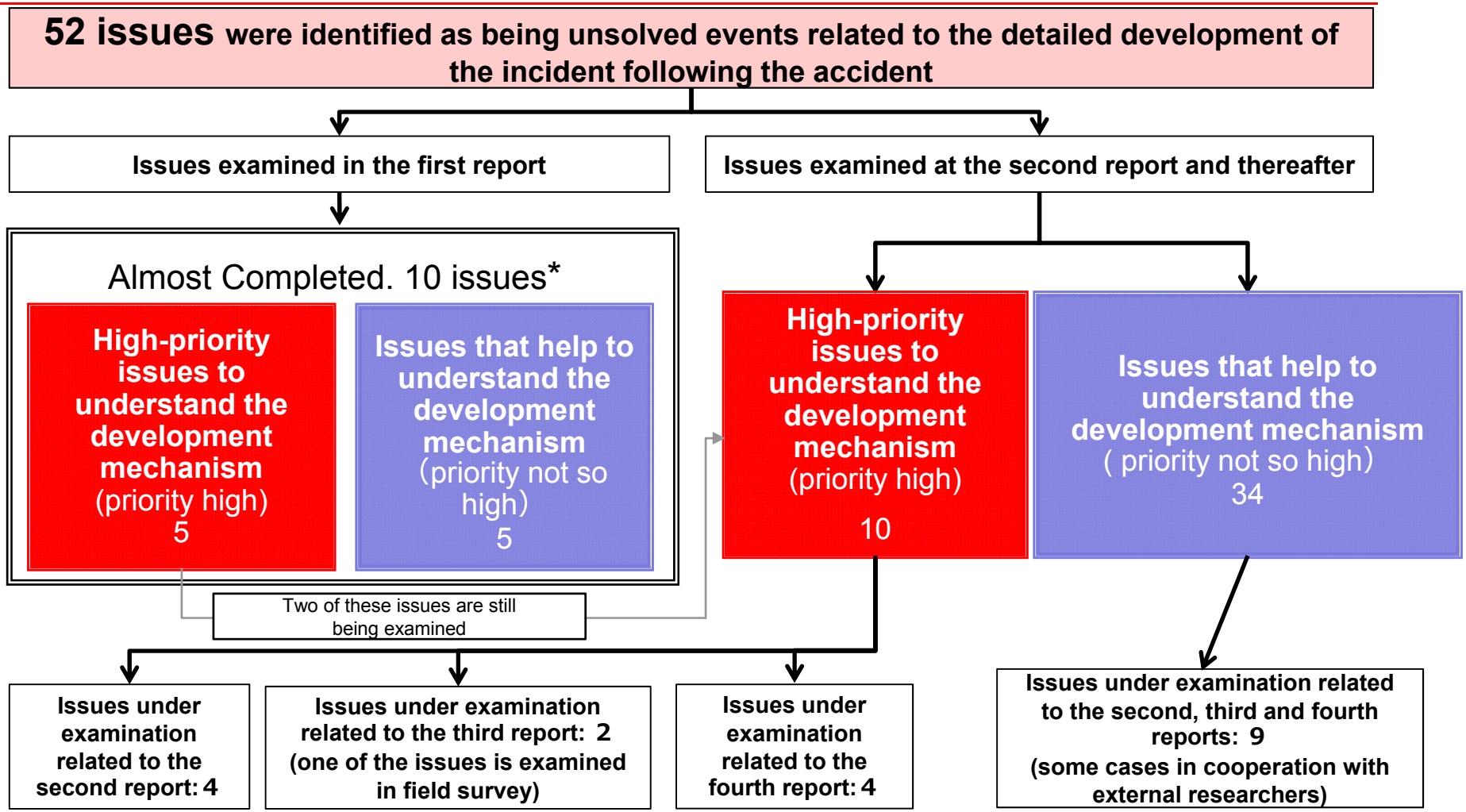
- **predict the state of field debris and accumulate knowledge required for decommissioning**
- **provide knowledge for contributing to the improvement of precision of accident simulation models used by countries all over the world.**
- **continually improve nuclear power station safety technology**

Scope covered by deliberations and investigations into unsolved issues

Continuous efforts to further improve safety

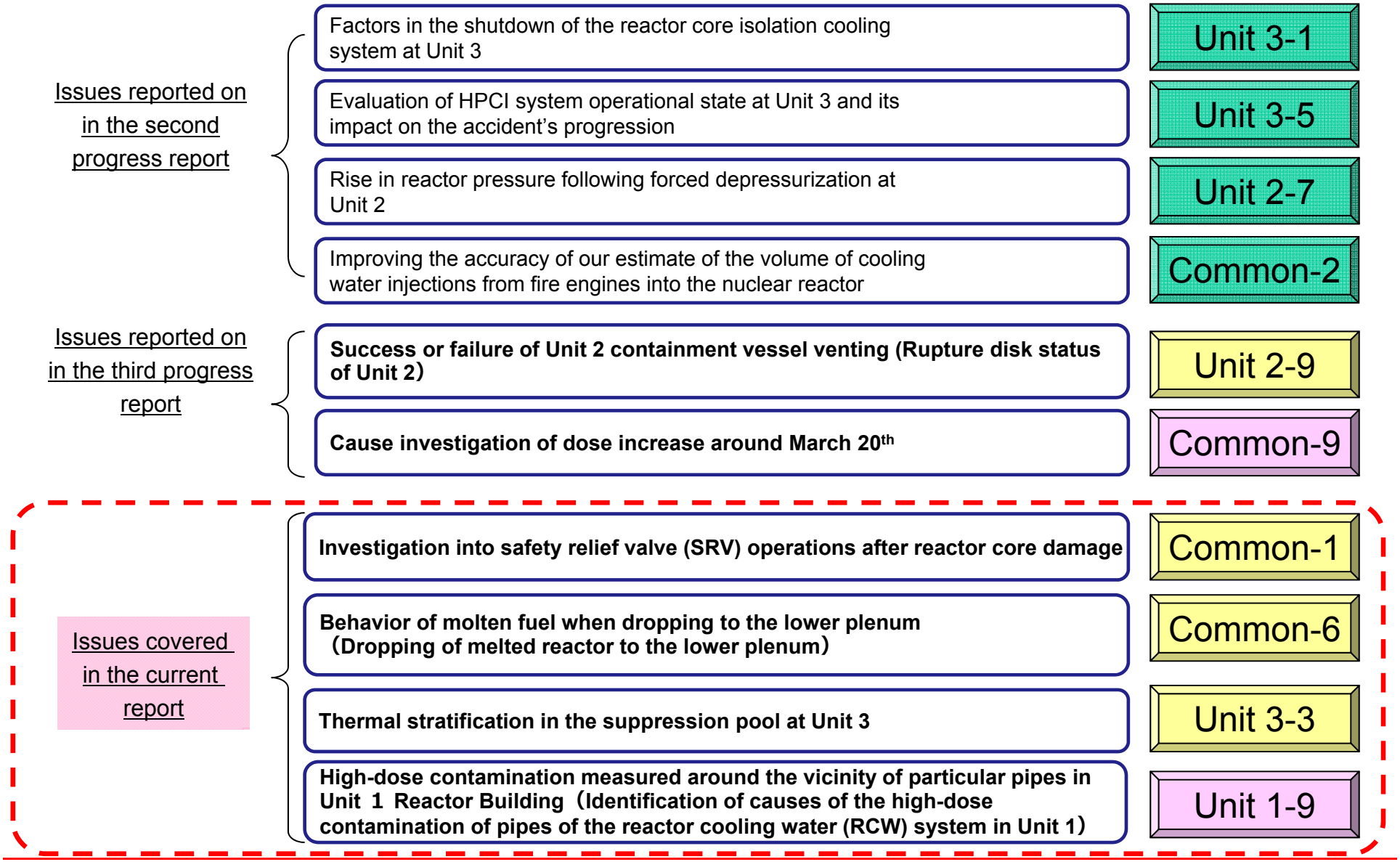
This report compiles the results of investigations and deliberations conducted from the viewpoints mentioned above. This is the forth progress report following those given in December 2013, August 2014 and May 2015.

3. Investigation/Deliberation History



*The ten issues Include the issues the causes of which have been reexamined through additional investigations. The second report and the reports thereafter examine the development mechanism.

4. Progress made in the examination of ten high-priority issues



5. Major Points of the Fourth Progress Report

High-priority issues to understand the development mechanism

1. Investigation into safety relief valve (SRV) operations after reactor core damage
The SRVs at Units 2 & 3 were opened to achieve and maintain the RPV pressure low. However, there were cases in which reduction in pressure was not confirmed. The investigation into the cause of it has revealed the importance of security of both power supply and nitrogen gas supply system.

2. Behavior of molten fuel relocation from the core region to the lower plenum
The behavior of molten fuel relocation from the reactor core to the lower plenum at the BWR plant has not been identified due to the structural complexity of lower region in the reactor core. Thus, by analyzing previous experiments and the results of the latest research for enhancement of the severe accident analysys code, the behavior has been examined.

3. Thermal stratification in the suppression chamber at Unit 3
The measurement results of the pressure in the PCV of Unit 3 on March 11 and 12, 2011 revealed that it elevated at a rate faster than that which could be estimated based on the decay heat. The analysis of the measurement data and related knowledge has reconfirmed the possibility that thermal stratification was developed in the suppression chamber.

4. High-dose contamination measured around particular pipes in the Reactor Building of Unit 1
High dose rates of radiation have been observed in the vicinity of the RCW system of Unit 1. The examination of the radiation dose levels inside the Reactor Building and the like, and of the RCW piping has supported the presumption that the high level of contamination was caused as a result of the molten fuel falling down to the PCV and damaging the pipes of the system inside the PCV.

Issues that help to understand the development mechanism

5. Leakage and release of a large amount of steam from the Unit 3 Reactor Building
The PCVs of Units 2 & 3 lost the airtightness in the end, which is confirmed by the fact that steam escaped from the Reactor Buildings. Analysis of the behavior of the pressure in the PCVs and the situation at the time of the accident has revealed that the environmental contamination from the night of March 14 to March 16 occurred by steam leakage together with radioactive materials directly from the PCVs not from the vent.

6. Presumption of behavior of radioactive materials based on measurement data of CAMS in Unit 2
In the 3rd progress report, how the Fukushima Daiichi accident unfolded was presumed based on the measurement data of the CAMS in Unit 2. The presumption has been supported by the results of the quantitative assessment of the behavior and distribution of radioactive materials in circumstances where the measurement data could be reproduced.

6. Sharing insights and engaging in discussion with researchers from Japan and overseas

The Atomic Energy Society of Japan meetings/International meetings

We have given presentations on study results at academic and international meetings. We have been fortunate to receive awards for these presentations. We will continue our examination while considering comments that have been made and other achievements gained through these activities.

＜Presentation＞
AESJ meeting: Spring and Fall meeting 2014-2015
International meeting:
NURETH (Nuclear Reactor Thermal Hydraulics) 15th meeting, 2013
NUTHOS (Nuclear Thermal Hydraulics, Operation and Safety) 9th meeting, 2012 and 10th meeting, 2014
International Workshop on Severe Accident Research, Tokyo Univ.

OECD/NEA　BSAF Project

We have shared our study results and accident information with BSAF project members. Comparing simulation results obtained from domestic and foreign researchers and exchanging opinions are helpful in our examination of unsolved issues.

OECD/NEA: The Organization for Economic Co-operation and Development/The Nuclear Energy Agency
BSAF: “Benchmark Study of the Accident at the Fukushima Daiichi Nuclear Power Station” has been established to improve severe accident codes and analyze accident progression and current core status in detail for presentation of fuel debris removal, as a part of the R&D projects for the mid-to-long term response for decommissioning of the Fukushima Daiichi. The first phase has been in completion in 2014 fiscal year, and the second phase has already begun.

Nuclear Regulation Authority, Japan The Committee on Accident Analysis

We explained our evaluation of the tsunami arrival time and the cause of the loss of all power sources, which is mentioned in the interim report made by the NRA. We will continue our examination using the results from field investigations and the analysis results from the Committee.

Niigata Prefecture Technical Committee

We have explained the issues regarding questions and points of interest from the governor and committee members during the discussion at the Niigata Prefecture technical committee meeting on the verification of the Fukushima Daiichi accident and safety measures at Kashiwazaki-Kariwa NPS.

We are continuing our investigation while considering discussions and opinions with and from various organizations and researchers.