International Workshop on Recent Advances in Seismic and Fault Displacement Hazards Assessment for Nuclear Installations
18-21 June 2024, IAEA Headquarters, Vienna, Austria

Keynote Lectures on Regulatory Challenges and Changes in the Practice after the 2011 Fukushima Nuclear Accident (Tuesday, 18 June 2024, IAEA, Vienna)

Recent Nuclear Regulations, Re-evaluations, and Backfits in Japan to Cope with Natural Hazards

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Nuclear Regulation Authority (NRA), Japan

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Nuclear Regulation Authority

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(3) Tsunamis coming without Warning

(4) Standard Spectra for 'Everywhere Earthquake'

Other improvements: (5) Slope Set-Back for Landslide

(6) Barrier for Tsunami Back Flow (retreating current)

Recent Topic (Noto Earthquake) / Conclusions 37/40

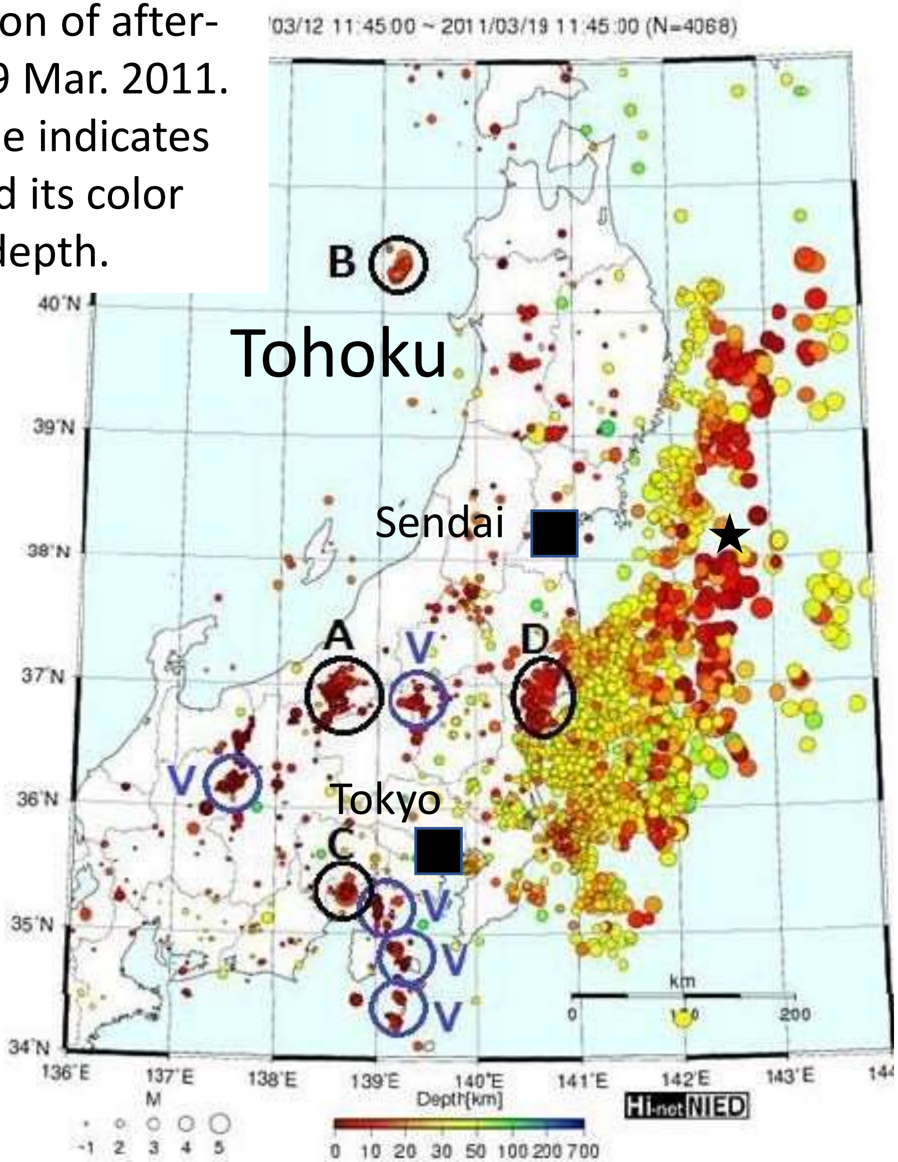
Introduction: Mar. 11, 2011 East Japan (Tohoku) Earthquake

Focal distribution of after-shocks in 12-19 Mar. 2011. Size of the circle indicates magnitude, and its color signifies focal depth.

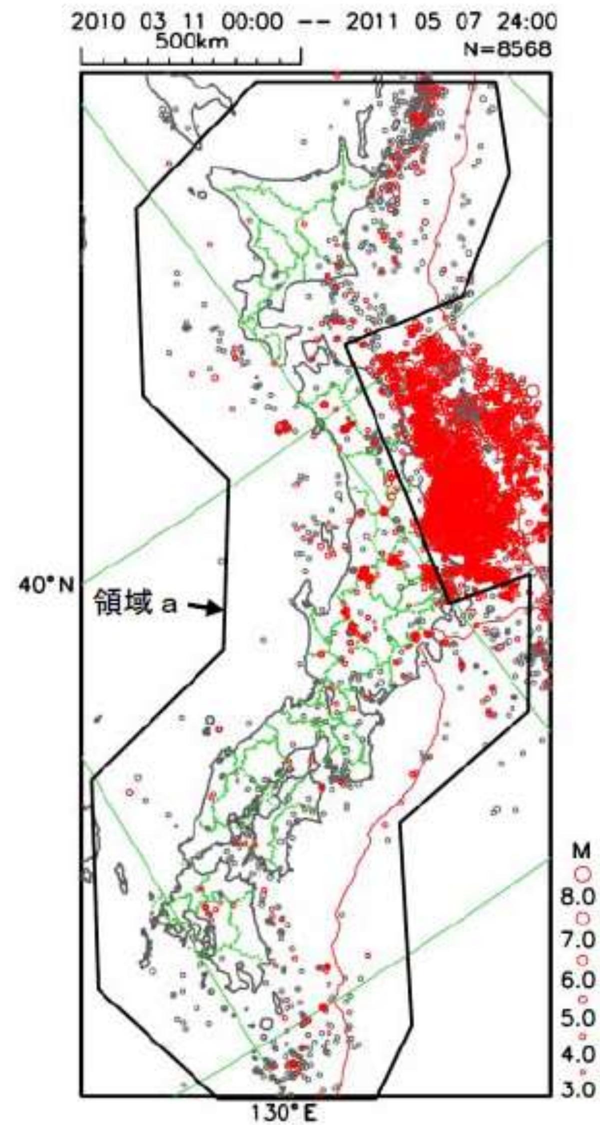
★ Main shock (M9.0)

A, B, C, D "Induced " earthquakes

V Volcanic earthquakes



Mar. 11 to May 7, 2011



Bosai.go.jp/info/saigai/2010/pdf/20110323_01.pdf
Japan Meteorological Agency:1104tohokuoki.pdf

Rice paddies inundated by March 11, 2011 tsunami in Sendai City, Tohoku, Japan (Photos taken on March 27, 2011 by Ishiwatari）.

[Below] Cemetery attacked by tsunami with drifted debris. Gravestones may have been fallen down either by earthquake or by crash with tsunami debris.

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Cemetery of Koganji Temple in Otsuchi Town attacked by tsunami fire (Photos taken on July 31, 2011 by Ishiwatari)

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Tsunami-devastated town


Tsunami-devastated cemetery


Destroyed steel-made building


No damage in the up-hill area

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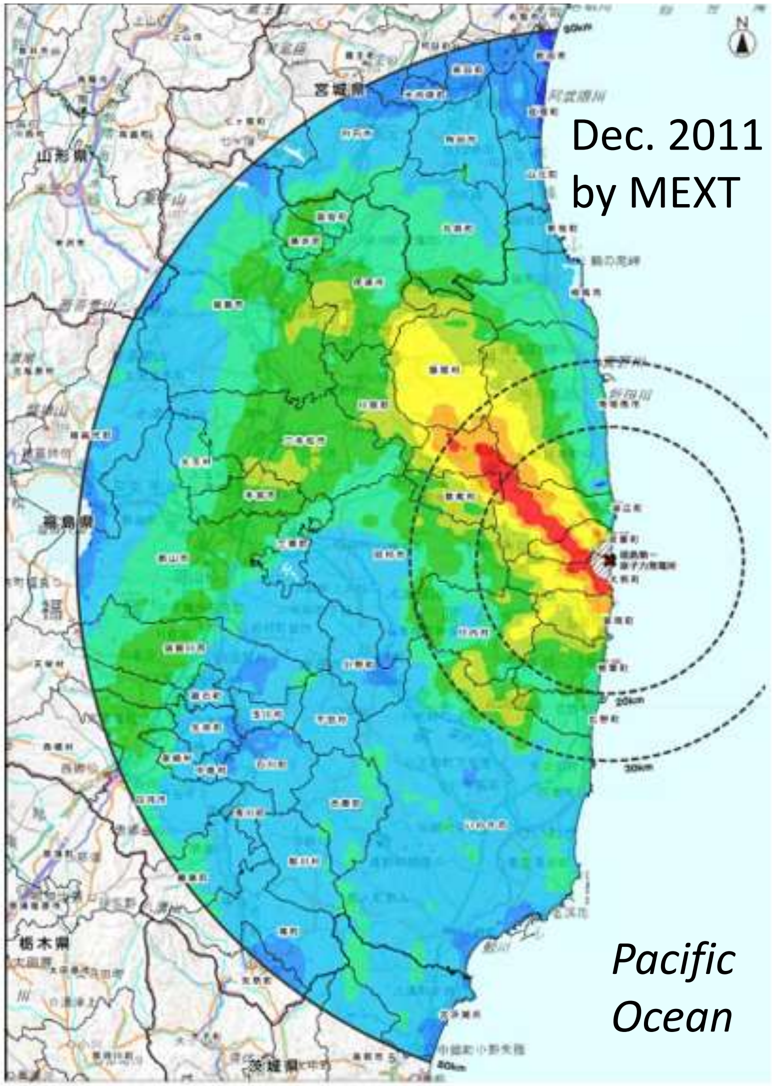
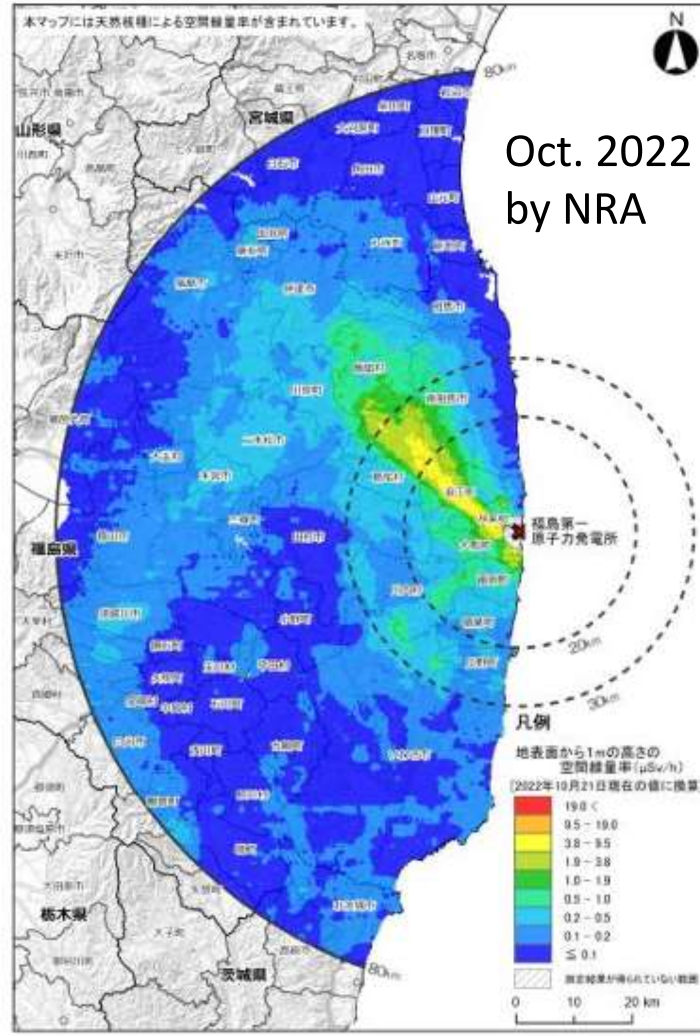
Kadonowaki Primary School of Ishinomaki City was burnt by tsunami fire. Gravestones in the adjacent Saikoji Temple were rounded by tsunami fire (Photos taken on Aug. 16, 2011)

Distribution of environmental radioactivity (μSv/h) within 80 km from the Fukushima Daiichi NPPs



文部科学省発表　2011年12月16日

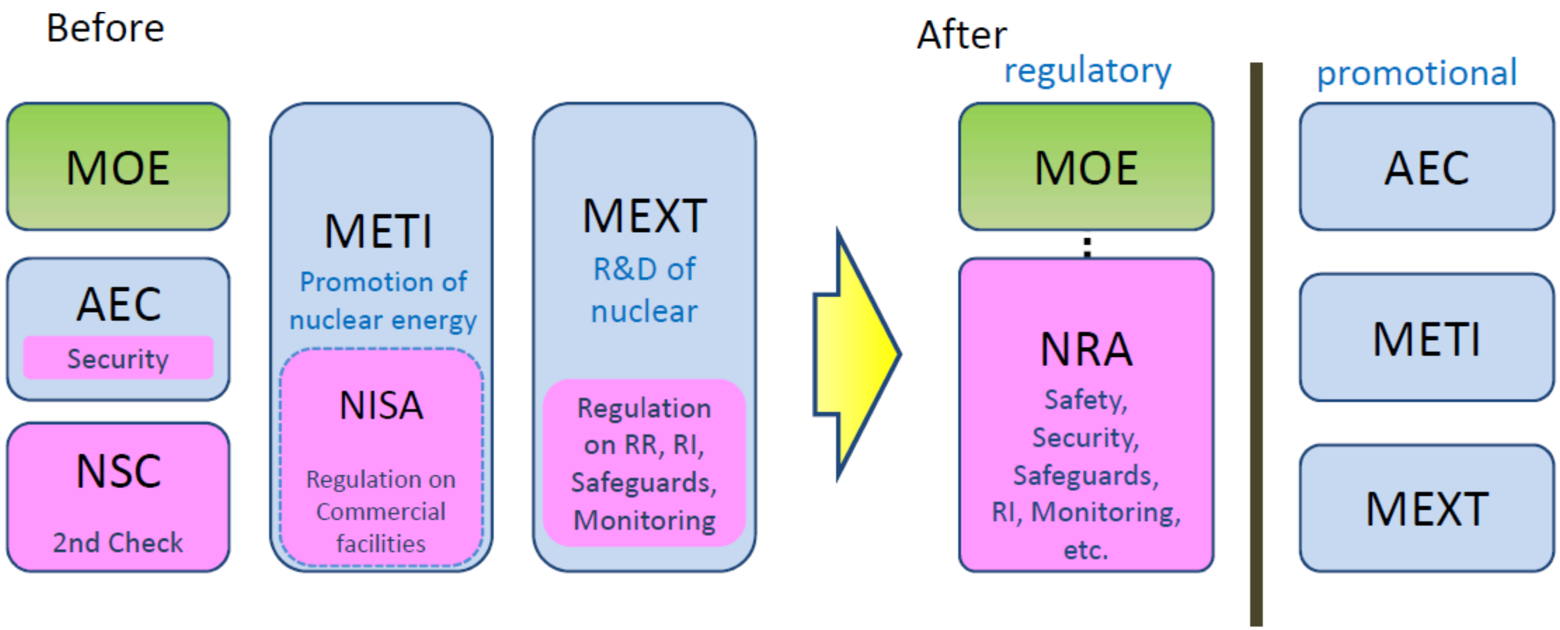


※2022年10月21日現在の値に換算

原子力規制委員会発表　2023年3月10日

NRA as an independent regulator

To reflect lessons learned from the TEPCO's Fukushima Daiichi NPS accident, relevant authorities were integrated as an independent commission (Nuclear Regulation Authority) in September of 2012.



AEC : Atomic Energy Commission
METI : Ministry of Economy, Trade and Industry
MEXT : Ministry of Education, Culture, Sports, Science and Technology
MOE : Ministry of the Environment
NISA : Nuclear and Industrial Safety Agency (abolished)
NSC : Nuclear Safety Commission (abolished)

Regulatory | Promotional

RR: Research Reactors
RI: Radioisotopes

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Outline of NRA's enhanced regulatory requirements

< Before the accident>

Design basis
(Based on single failure, etc.)

- Natural hazards
- Fire protection
- Reliability of power supply
- Performance of other SSCs
- Seismic/Tsunami resistance

< After the accident>

(SA Measures) NEW:
- Intentional aircraft crash
- Suppression of radioactive materials dispersion
- Prevention of CV failure
- Prevention of core damage

Reinforced and NEW:
- Internal flooding (NEW)
- Natural hazards (NEW: Volcano, Tornado, Forest fire, etc.)
- Fire protection
- Reliability of power supply
- Performance of other SSCs

Reinforced:
- Seismic/Tsunami resistance (New: Explicit regulation on tsunami)

According to the previous 2006 NSC standards, tsunami hazard was treated as events accompanied with earthquakes and considered as a part of seismic design.

NSC: Nuclear Safety Commission

Reference: NRA HP
The 13th NRA Commission Meeting (3 July 2013)
Reference materials (partially modified)
http://www.nsr.go.jp/committee/kisei/data/0013_08.pdf

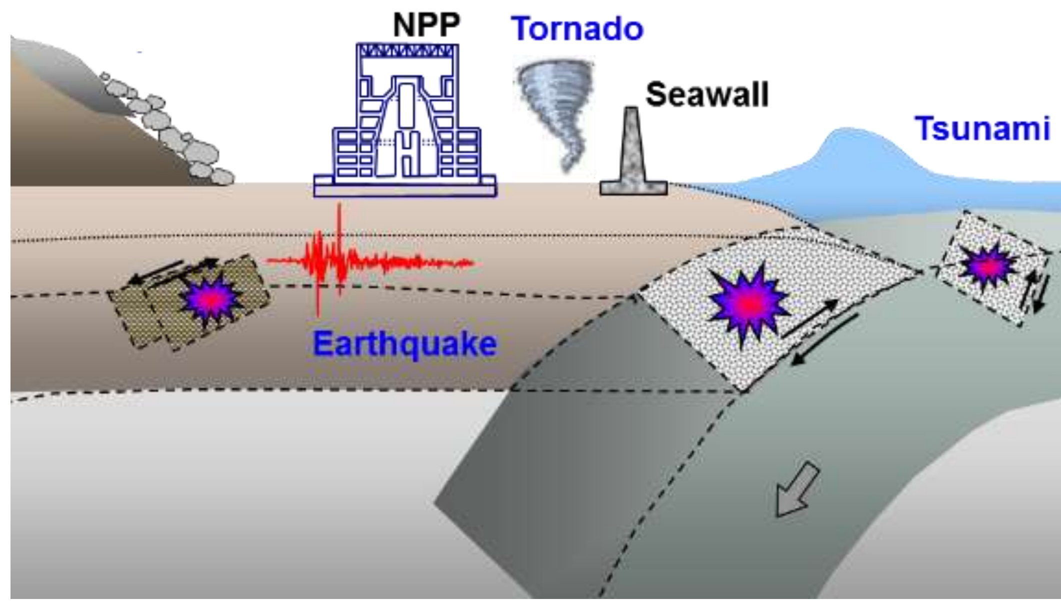
Regulatory requirements against natural hazards

NRA regulatory requirements, established after the TEPCO's Fukushima Daiichi Nuclear Power Station accident, require that safety-related SSCs maintain their function against the following external natural hazards:

- **Earthquakes**
- **Tsunamis**
- **Capable Faults**
- **Volcanoes**

Relevant topics of this presentation

- **Landslides**
- Tornadoes
- Wind (typhoons)
- Floods
- Precipitation
- Freezing
- Snow fall
- Lightning
- Biological phenomena
- Forest fires



(Underline: Hazards explicitly included in NRA's requirements but not addressed by the former regulator.)

Solar flares may also be a natural hazard for NPPs

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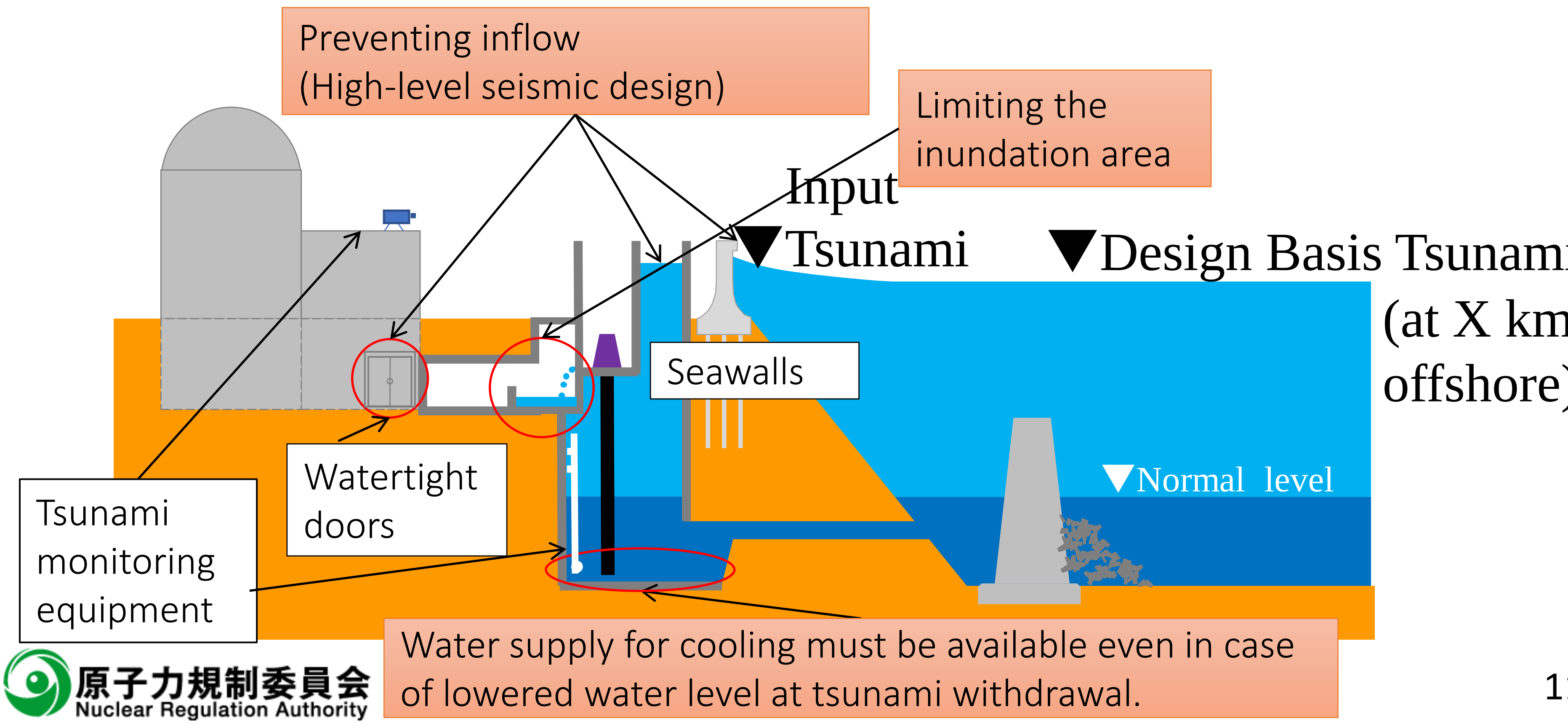
(1) Tsunamis

- Define "Design Basis Tsunami" that exceeds the largest in the historical and archeological records
- Requirements for multiple protective measures



Mar. 11 Tsunamis at NPPs of Japan

NPP	Tsunami Height (Mar. 11, 2011)	Input Tsunami (before Mar. 11)	Input Tsunami (after Mar. 11)
Higashidori	4 m [13 m]	6.5 m	11.7 m*
Onagawa*	13 m [15 m]*	9.1 m	23.1 m
Fukushima Daiichi**	15 m [10 m]	5.4 – 5.7 m	14.9 m** (22.6m)***
Fukushima Daini**	15 m [12 m]	5.1 – 5.2 m	(27.5 m)***
Tokai*	5 m [8 m]	5.7 m	17.1 m

Site caused severe accident
Site affected by tsunami
*Passed re-evaluation
**On decommissioning

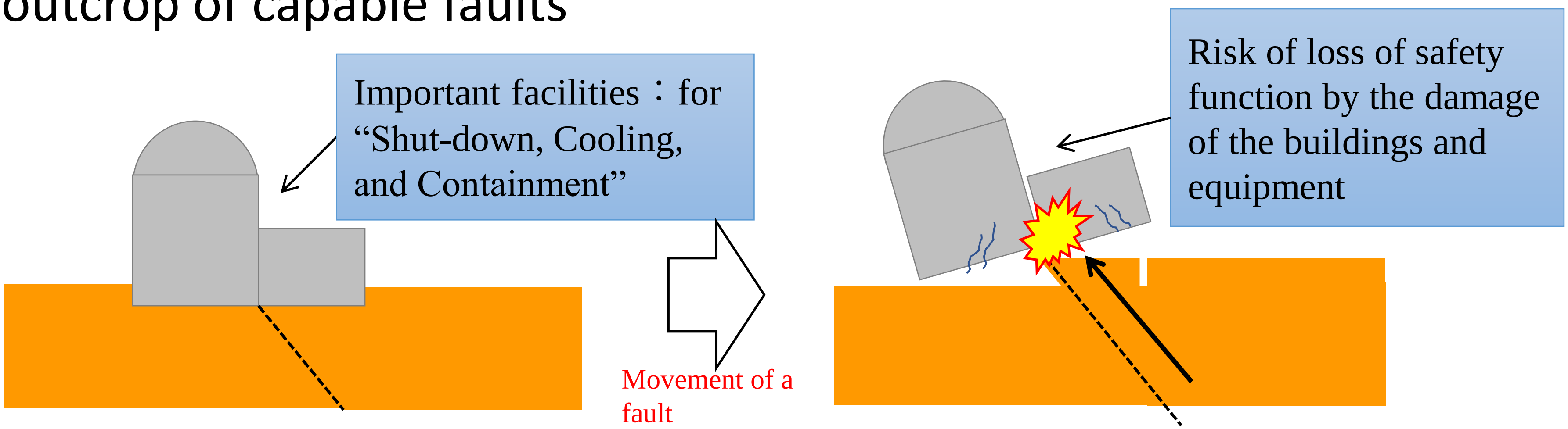
[ ] Site elevation
*Site subsided 1 m by the earthquake (Elevation was 14 m at tsunami input)

*Currently under re-evaluation
**Tsunami from Kuril Trench. Sea wall of 13.5 to 16 m high was already constructed by March 2024.
***Proposed by TEPCO as the highest tsunami for future consideration

Data from various sources (Credit: A. Ishiwatari)

(2) On-Site Capable Faults

- “Capable faults” need to be determined as those whose activities since the late Pleistocene (approx.120,000 to 130,000 years ago or later) cannot be denied
- Important facilities have to be constructed on the ground without outcrop of capable faults



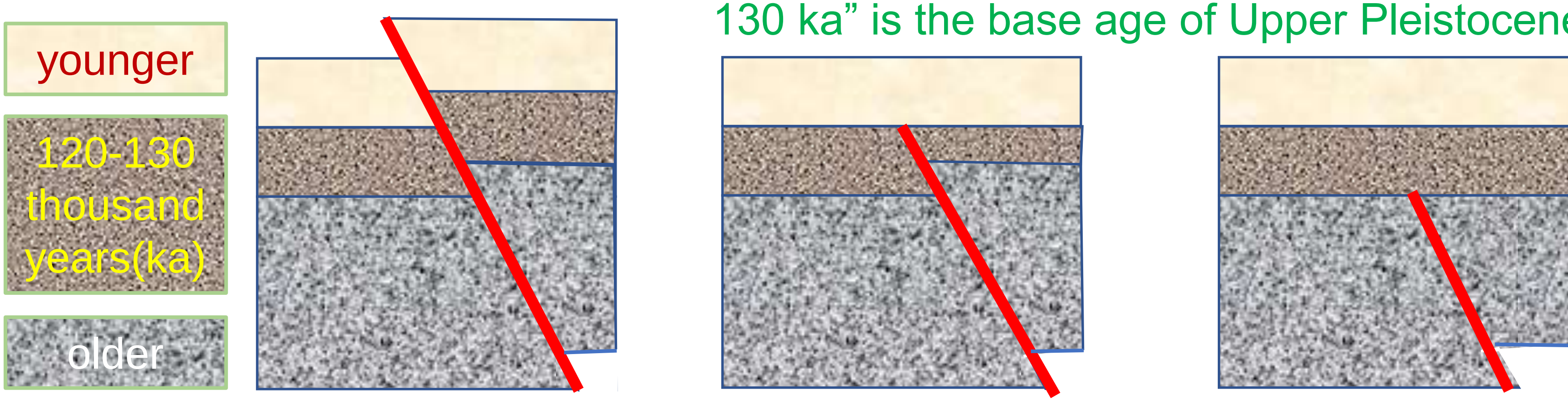
〇Movement of the fault under important facilities like Reactor Building may result in the concentration of deadweight onto the spot and cause damage of the building.
〇Even in case damage of the building is avoided, safety function can be lost due to the deformation of the facilities or damages of the internal equipment.

How to find a capable fault?

"Capable fault" is the official term for "active fault" that is defined in IAEA Safety Standards Series No. SSG-9 "Seismic hazards in site evaluation for nuclear installations". The "120-130 ka" is the base age of Upper Pleistocene.

1. Covering Bed Method

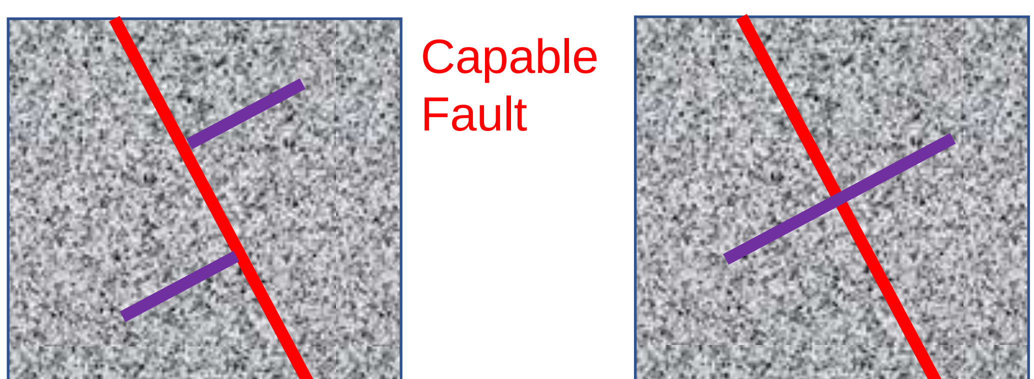
Geological age of bed



Judge:	Capable Fault	Capable Fault	Not Capable Fault

2. Mineral Vein Method

— 120-130 ka mineral vein or igneous dike



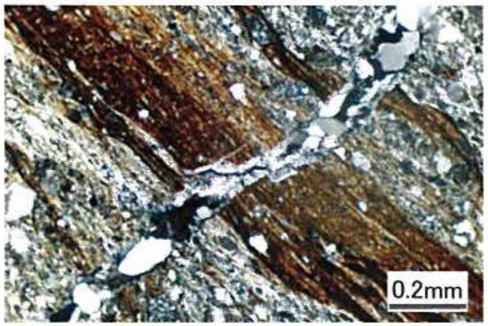
Capable Fault

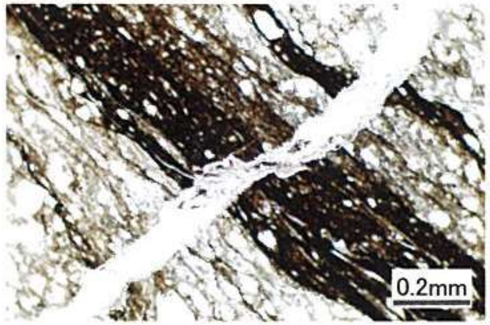
Not Capable Fault

Mineral veins cutting fault zones (Sendai NPPs)

Polarizing microscope views of about 1 mm width

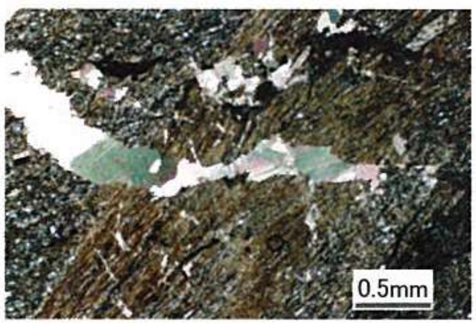
D-45 fault zone is cut by a quartz vein (p.109)

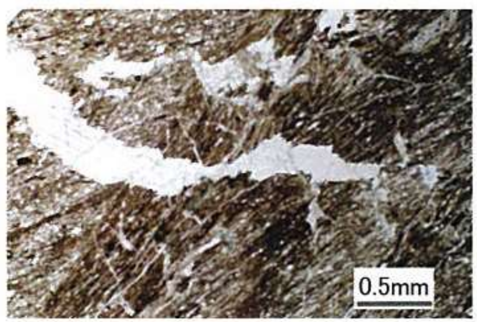


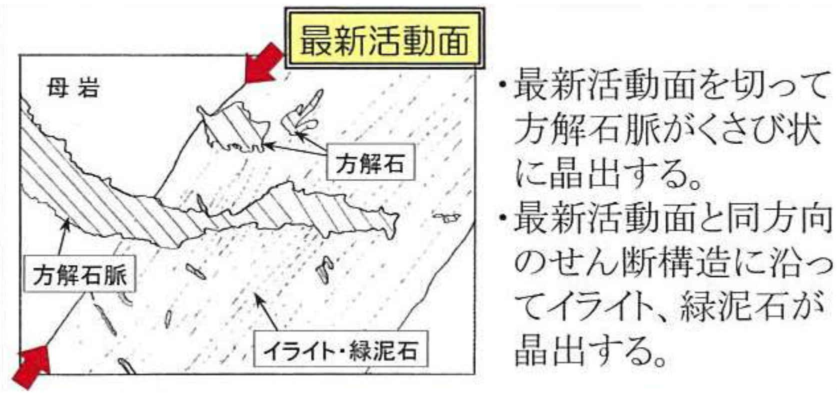


Mineral vein & Fault zone

D-48 fault zone is cut by a calcite vein (p. 117)







Crossed polarizers view

Single polarizer view

Sketch of the view

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Mar. 19, 2014, Assessment Meeting #95
Doc. 2-1, Sendai NPPs (Kyushu EPC)

Mineral veins are of 1 to 3 million years age.

On-Site Fault Evaluaion	Current Status	Capable Fault?
Tomari 1, 2 & 3 (PWR)	On Re-Evaluation	No (covering bed method)
Oma 1 (ABWR, on construction)	On Re-Evaluation	? (covering bed method)
Higashidori 1 (BWR)	On Re-Evaluation	No (mineral vein method)*
Rokkasho (Recycle Facilities)	Passed Re-Evaluation	No (covering bed method)
Onagawa 2 (BWR)	Passed Re-Evaluation	No (mineral vein method)
Tokai Daini 1 (BWR)	Passed Re-Evaluation	No (covering bed method)
Kashiwazaki 6 &7 (ABWR)	Passed Re-Evaluation	No (covering bed method)
Hamaoka 4 & 3 (BWR)	On Re-Evaluation	? (covering bed method)
Shika 2 (ABWR)	On Re-Evaluation	No (mineral vein method)*
Tsuruga 2 (PWR)	On Re-Evaluation	Yes (2015 assessment)**
Mihama 3 (PWR)	On Operation	No (mineral vein method)
Ohi 3 & 4 (PWR)	On Operation	No (covering bed method)
Takahama 1, 2, 3 & 4 (PWR)	On Operation	No (mineral vein method)
Shimane 2 (BWR) & 3 (ABWR, o.c.)	Passed Re-Evaluation	No (mineral vein method)
Ikata 3 (PWR)	On Operation	No (mineral vein method)
Genkai 3 & 4 (PWR)	On Operation	No (covering bed method)
Sendai 1 & 2 (PWR)	On Operation	No (mineral vein method)

*Evaluation changed by new data. **NRA's conclusion may be reached in July 2024.

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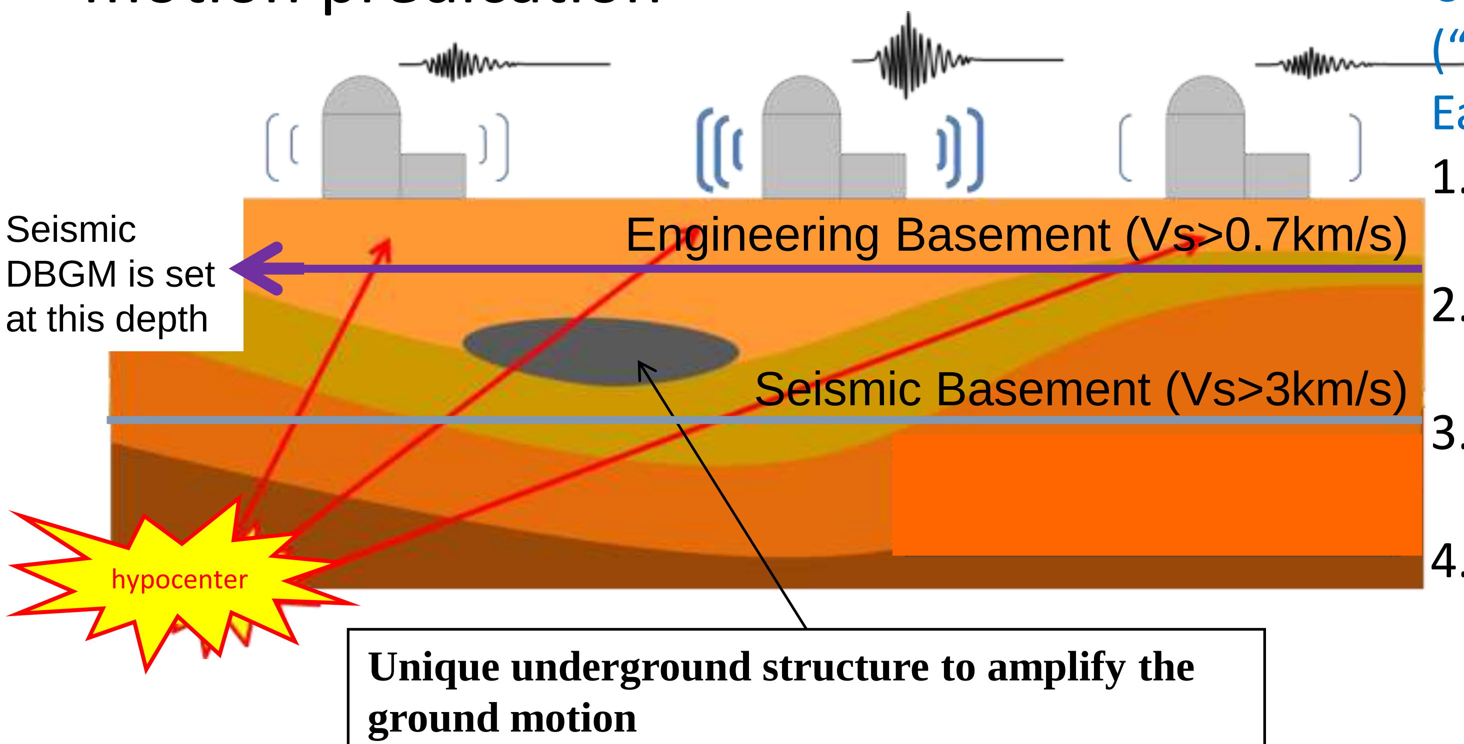
(3) Earthquakes
Realistic Design Basis Ground Motion (DBGM)

- Survey 3D geological structure of the site
- Take into consideration of seismic ground motion predication



NRA Categories of Earthquakes:

Specified Faults (Identified capable faults):
1. Plate Boundary
2. Intra-Plate
3. In-Land Crustal

Unspecified Faults ("Everywhere Earthquake"):
1. 2004 Rumoi Mw5.8
2. Standard Spectra Mw<6.5
3. 2000 Tottori W Mw6.7 (local)
4. 2008 Iwate-Miyagi Nairiku Mw6.9 (local)

Sites experiencing earthquakes with strong motions larger than the old DBGMs[3)]

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(gal = cm/s^2) Credit: NRA

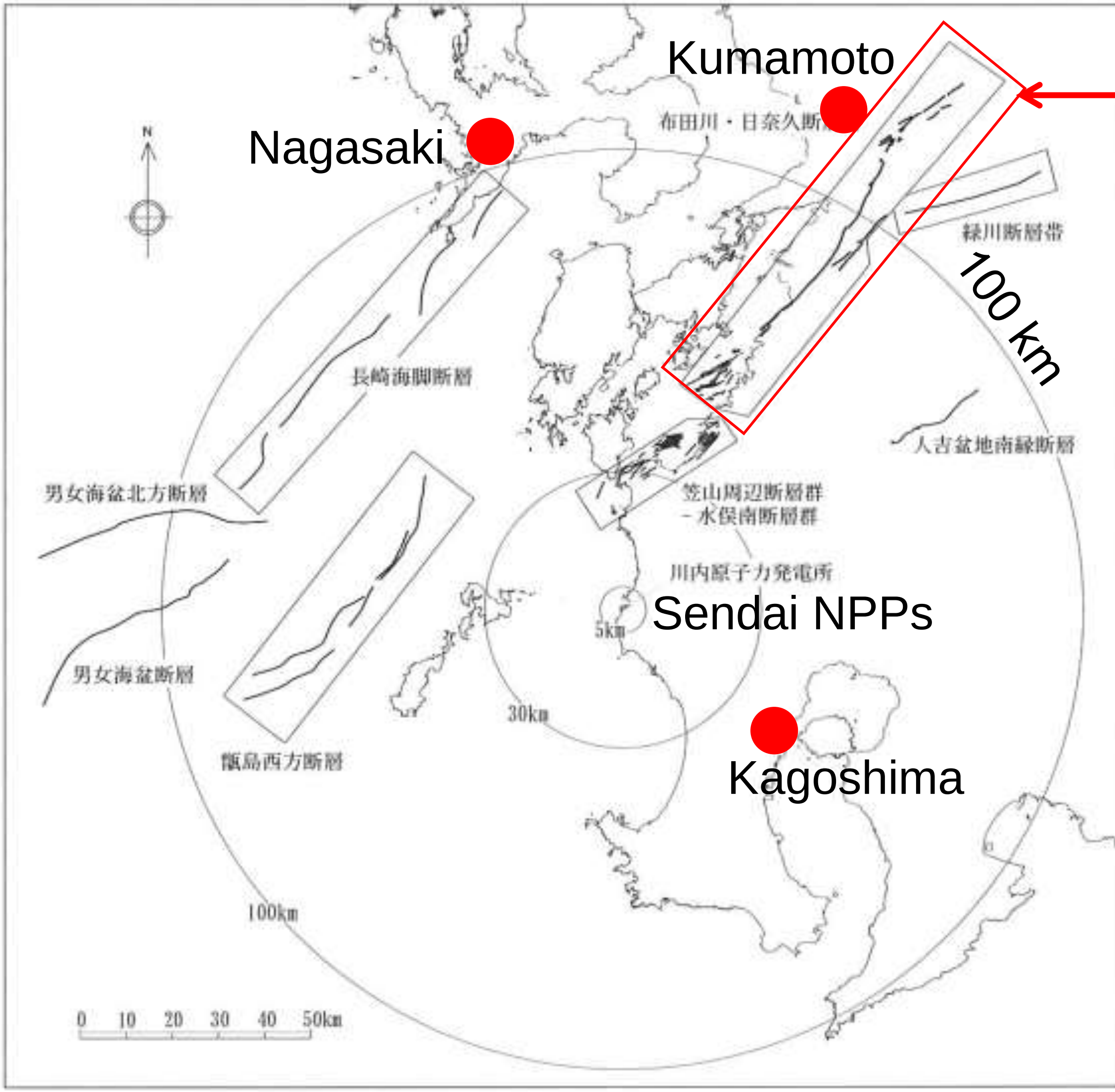
NPP site	Earthquake Name	Date	Magnitude M_w	PGA basemat	Distance to site	Operation Status
Onagawa	Miyagi-Oki earthquake	August 16, 2005	7.1	316 gal [1)]	84km	SCRAM at Units #1, 2, 3
Shika	Noto Peninsula earthquake	March 25, 2007	6.7	226 gal [1)]	18km	Under periodical inspection
Kashiwazaki -Kariwa	Chuetsu-Oki earthquake	July 16, 2007	6.6	680 gal [2)]	16km	SCRAM at Units #3, 4, 7. Others; under periodical inspection
Onagawa	Tohoku earthquake	March 11, 2011	9.0	607 gal [2)]	125km	SCRAM at Units #1 & 3. Unit 2 was under periodical inspection
Fukushima Daiichi	Tohoku earthquake	March 11, 2011	9.0	550 gal [2)]	180km	SCRAM at Units #1, 2, 3. Others: under periodical inspection
Onagawa	Miyagi-Oki earthquake	April 7, 2011	7.1	398 gal [1)]	78km	Under periodical inspection

1) Response spectra exceeded the design basis ground motion (DBGM, Ss or S_2) at some periods
2) Peak ground acceleration (PGA) and response spectra (at some periods) exceeded the DBGM (Ss or S_2)
3) Design basis ground motions (DBGMs) before and after the March 11, 2011 Tohoku Earthquake (at 50 Hz):

Site	Onagawa	Shika	Kashiwazaki-Kariwa	Fukushima-Daiichi
Before	580 gal	600 gal	450 gal*	600 gal (*Before back check)
After	1000 (intra-plate)	1000 (on evaluation)	1209-2300	900 (for consideration)

4) SCRAM threshold ground acceleration at Kashiwazaki-Kariwa: horizontal =120-185 gal, vertical = 100 gal

Near-Site Capable Faults and Earthquakes
Example of Sendai NPPs, Kyushu



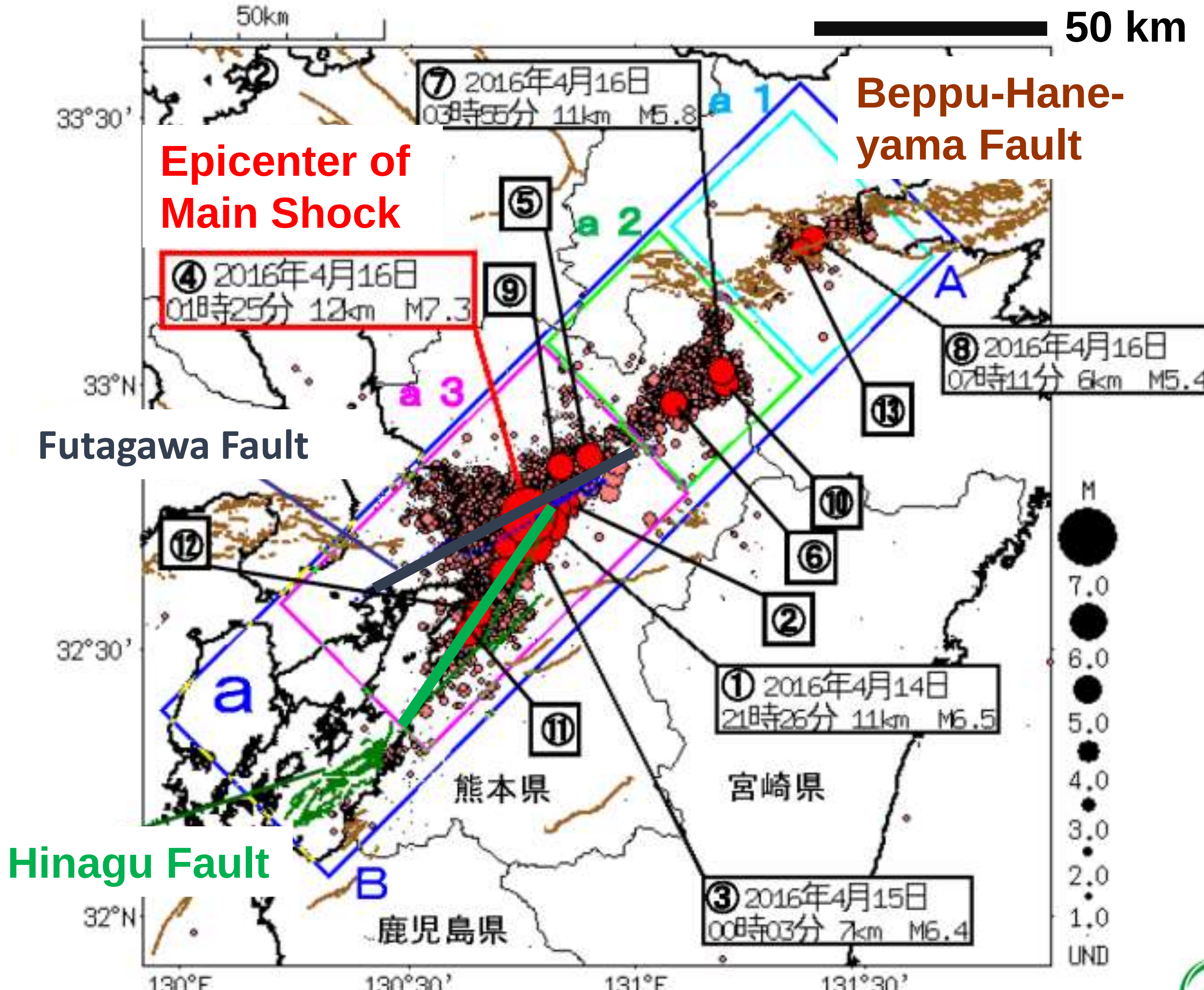
Kyushu EPC's evaluation of Futagawa-Hinagu Fault is 93 km long and M8.1, assuming a full-length rupture. Equivalent epicenter distance from Sendai NPPs is 104 km.

The Futagawa-Hinagu Fault caused M7.3 Kumamoto earthquake on Apr. 16, 2016 and associated numerous disastrous earthquakes.

(Mar. 12, 2014 Evaluation Meeting #92. Copyright: Kyushu EPC)

2016 Kumamoto Earthquake

Apr. 14, M6.5 and Apr. 16, M7.3; 50 deaths, >2,000 injuries and >180,000 evacuees.



Sendai NPP ●

Japan Meteorological Agency

Surface Fault Rupture:
Futagawa: 28 km
Hinagu: 6 km

Fault Length by Satellite-based Ground Movement:
Futagawa E: 5 km
Futagawa W: 20 km
Hinagu: 10 km
(Data from Japan Meteorological Agency)

Kyushu EPC's evaluation of the Futagawa-Hinagu Fault in the Sendai NPP Reassessment:
93 km, M8.1

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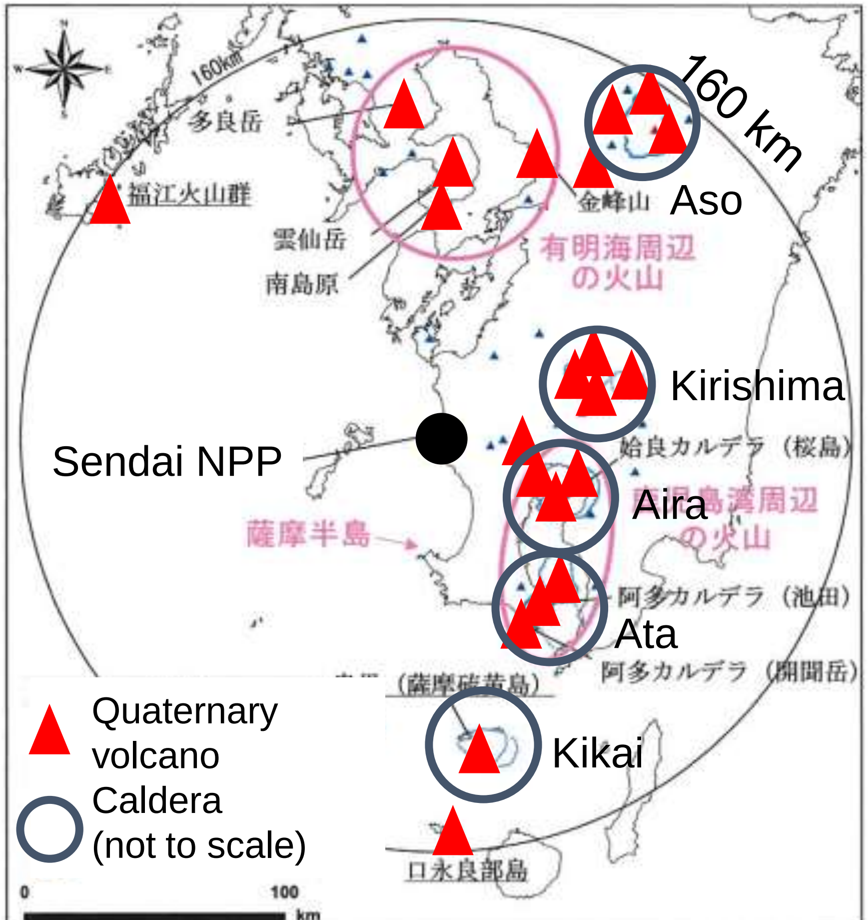
(4) Volcanoes

The licensee should survey Quaternary volcanoes within 160 km from the NPP, and assess their eruption histories, geothermal activities, distribution of lavas, pyroclastic flows and ash.

If a pyroclastic flow reached the NPP site in the geologic past, the licensee should give geophysical evidence for improbability of caldera eruption in decades and should conduct seismic and geodetic monitoring of the caldera volcano. This is the case for Sendai and Genkai NPPs and Rokkasho Recycle Facilities.



(Apr. 23, 2014 NRA Evaluation Meeting #107)

Evaluation of volcanic ash Thickness

NPP	Ash thickness
Sendai	15cm**
Ikata	15 cm
Takahama	10 cm*
Ohi	10 cm*
Mihama	10 cm*
Tokai Daini	50 cm
Shimane	56 cm

*see later backfit

**25 cm after 2020 Final Safety Analysis Report of Kyushu EPC

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Backfits/Improvements to cope with Natural Hazards:

2017 (1)Higher volcanic ash density in the air (for all sites)
Add a filter unit for aspirators of diesel generators.

2021 (2) Thicker volcanic ash fall (for 3 sites of KEPCO)
The facilities should keep their function to the ash thickness about 2 times of the previous value.

2017 (3) Sudden tsunami without warning (for 1 site of KEPCO)
Tsunamis caused by landslides or volcanoes may come without warning. Sensitive sea-level observation and tighter operation of water gates are required.

2019 (4) Application of the standard spectra of earthquake by unidentified fault (for all sites) applied in addition to previous “Rumoi Earthquake”.

Other improvements:

2023 (5) Slope set-back in the TEPCO Fukushima Daiichi site

2021 (6) Barrier for tsunami back flow in the JAEA Tokai site

Backfit (1): Higher volcanic ash density in the air

In 2013-14, during the first evaluation process to fit NRA's new regulation rule, the licensee (Kyshu Electric Co.) took the observed 3 mg/m^3 ash density in the air at 2010 eruption of Eyjafjallajokull Volcano, Iceland (VEI=4) to keep operation of their emergency diesel generators.

In 2016, another licensee (Kansai Electric Co.) took the 33 mg/m^3 ash density observed in 1980 at Yakima that is 135 km from the St. Helens Volcano, USA. (Baxter et al. 1983; *Archives of Environmental Health*, 38, 138-143)

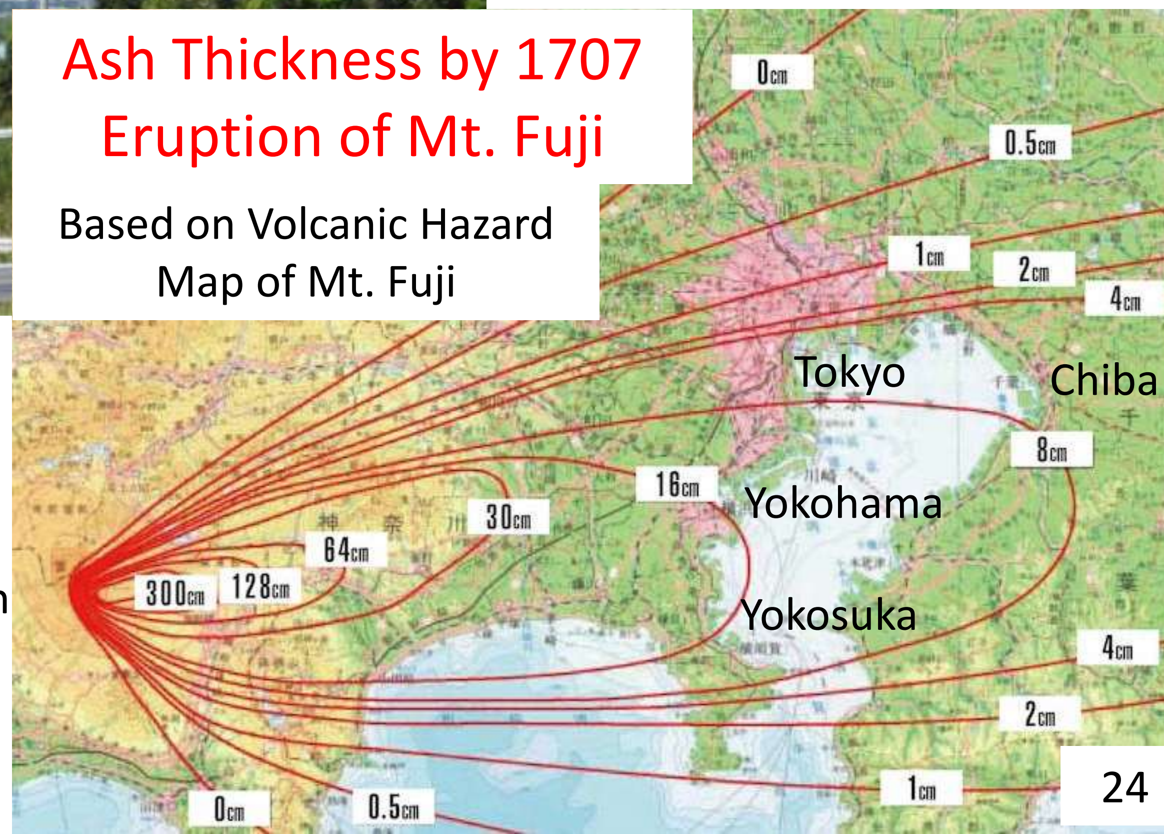
In 2016, Hattori et al. (*Central Research Institute of Electric Power Industry Report* 015004) calculated the ash density in the air in Tokyo by the 1707 Hoei eruption of Mt. Fuji as high as 1000 mg/m^3.

Backfit 1: Higher volcanic ash density in the air: example of Mt. Fuji in 1707

Photo taken by A. Ishiwatari

Ash Thickness by 1707 Eruption of Mt. Fuji

Based on Volcanic Hazard Map of Mt. Fuji



https://www.bousai.go.jp/kazan/fuji_map/pdf/fujihm_ir_hr.pdf

The 1707 Hoei volcanic ash layer (top >1 m) that covers eastern foothills of Mt. Fuji (Midono, Gotemba City)

Photo taken by A. Ishiwatari

In the 1707 eruption, white ash came first, and thick black ash followed. This suggests magmatic evolution in the deep magma chamber, and similar explosive eruption is expected for the next time.

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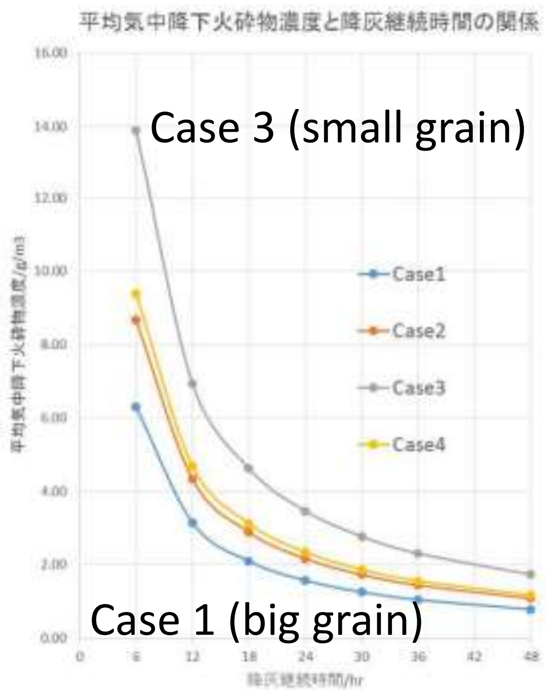
Calculation of volcanic ash density in the air: an example

<計算例>

- 堆積量：15cm
- 粒径分布（以下の4つのCase）
  Case1：0.070cm（100%）、Case2：0.050cm（100%）、Case3：0.025cm（100%）
  Case4：0.070cm（25%）,0.050cm（50%）,0.025cm（25%）
- 終端速度：1.1m/s（0.070cm）,0.8m/s（0.050cm）,0.5m/s（0.025cm）

Deposited volcanic ash thickness: 15 cm
Ash size distribution (4 cases):

Average ash density in the air (g/m^3)



0 12 24 26 48
Time span of ash fall (hours)

Report of the NRA examination team for assessment of volcanic ash fall (June 22, 2017).

※参考とした粒径分布
樽前山起源の火山噴出物（Ta-a）
火口から約100kmの地点（占冠付近）での中央粒径
（実測値）は、2～3φ（0.0250cm～0.0125cm）

降灰継続時間を12～24時間と考えると、
降灰継続時間が12時間の場合の平均濃度は、3～7g/m^3
降灰継続時間が24時間の場合の平均濃度は、2～4g/m^3

Notes on cloud and health:
Water particle density of a cloud (or thick fog) is about 100 mg/m^3. Volcanic ash denser than 150 mg/m^3 causes heavy damage for human respiratory system (Mckie et al. 2017 “Volcanic Ash”, Elsevier).

Note on international air traffic regulation:
>0.2mg/m^3: Caution notice issued, >2mg/m^3: Flights permitted for limited time and airplane types, >4mg/m^3: All flights prohibited.

Backfit (2): Thicker volcanic ash fall (for 3 sites of KEPCO)

Volcanic ash thickness evaluated for KEPCO’s Takahama, Ohi and Mihama NPPs was 10 cm when these NPPs passed re-evaluation in 2015-2017. NRA-funded study of AIST revealed that the Namatake ash bed of the Daisen Volcano is as thick as 30 cm in Koshihata to the west of Kyoto. The ash thickness to cope with is 27 cm for Takahama, 25cm for Ohi and 22 cm for Mihama as fixed in 2021.

Daisen Namatake Tephra (erupted 80 thousand years ago)

Jan. 24, 2020, NRA Evaluation Meeting #827, Book 1-1-1, p. 16, KEPCO

Backfit (3): Tsunami coming without warning

On Dec. 22, 2018, Anak Krakatau Volcano of Indonesia erupted and large tsunami attacked coastal areas, caused >400 deaths. This tsunami came without warning. Takahama NPP was not prepared for such tsunami coming without warning, and NRA ordered backfit in 2019.

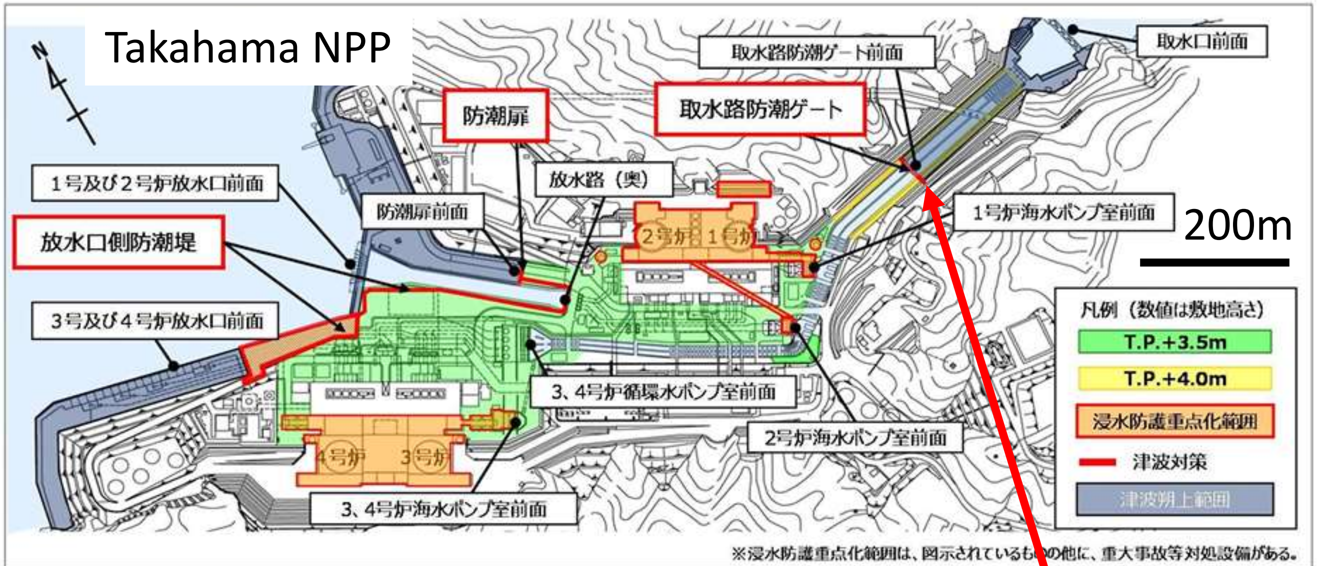
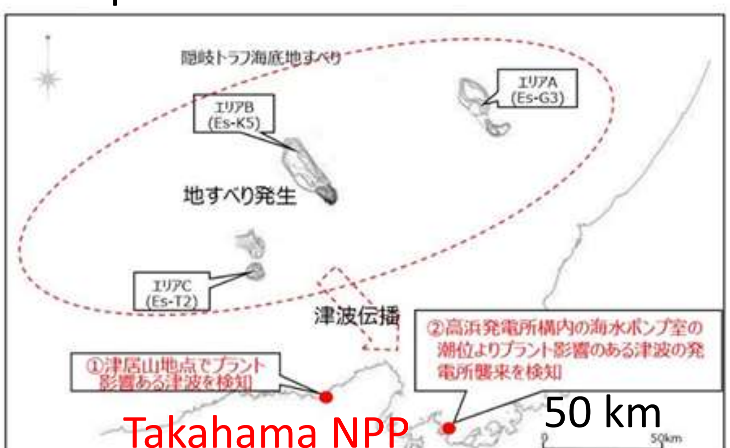


図１　高浜発電所における入力津波評価地点

Possible submarine landslides in Japan Sea to cause tsunamis



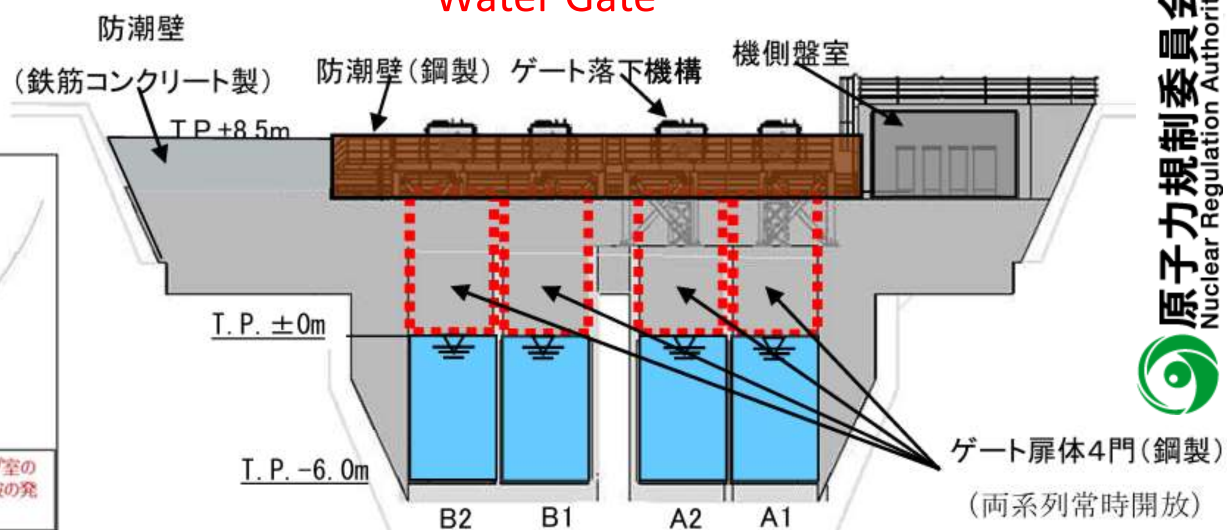


図７　４プラント運転時における取水路防潮ゲートの状況（正面図）

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Backfit (3): Tsunami coming without warning 2

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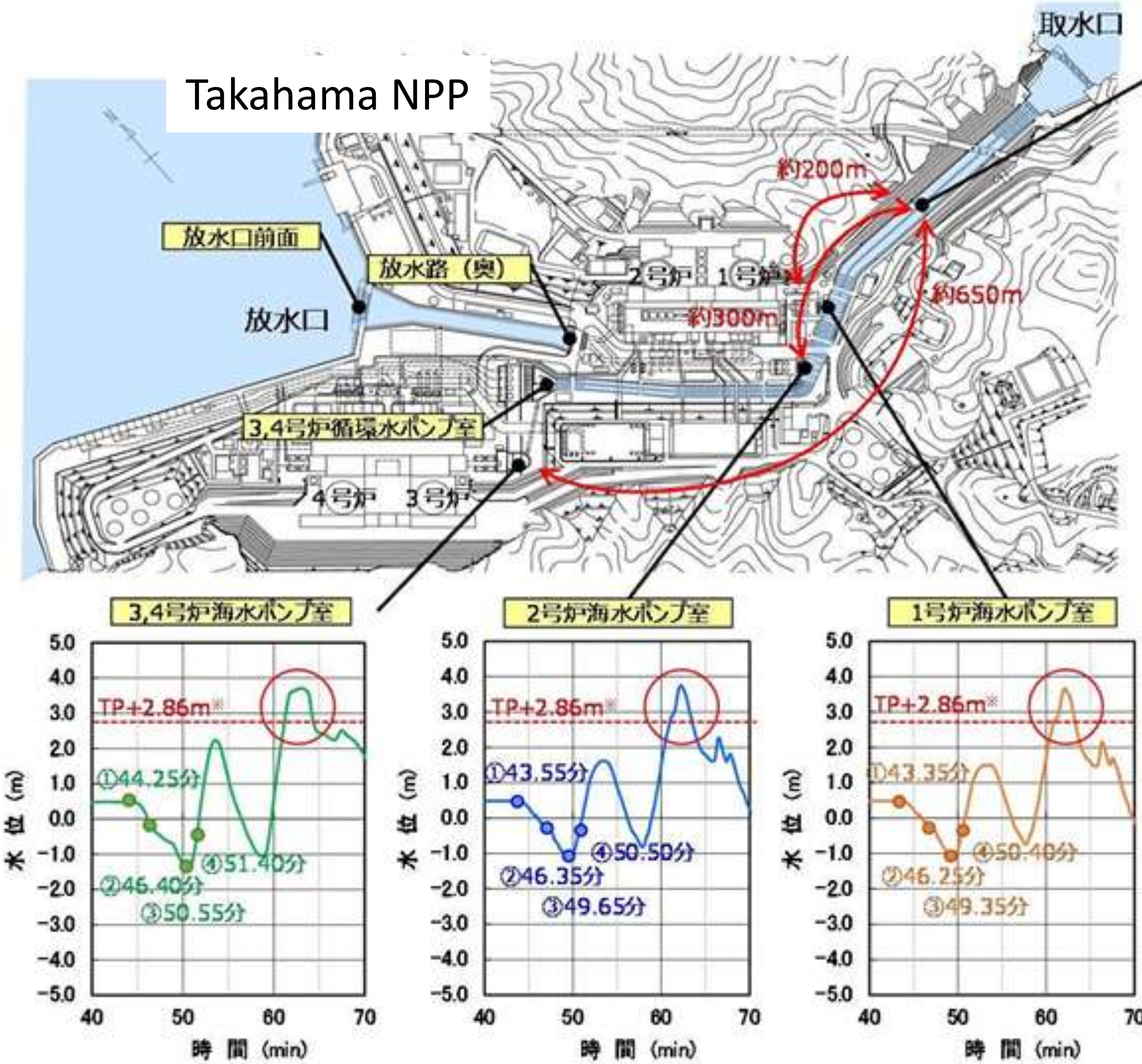
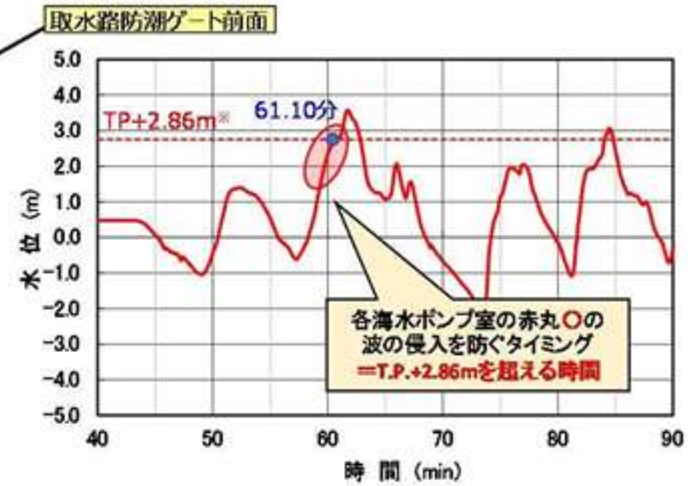




※：潮位のばらつきと高潮裕度を考慮した場合に敷地高さを超える高さ
T.P.+2.86m＝敷地レベルT.P.+3.5m－潮位のばらつき0.15m－高潮裕度0.49m

	1号炉 SWP	2号炉 SWP	3,4号炉 SWP	取水路防潮ゲート
①	43.35分	43.55分	44.25分	–
②	46.25分	46.35分	46.40分	–
③	49.35分	49.65分	50.55分	–
④	50.40分	50.50分	51.40分	–
取水路防潮ゲートの閉止（④＋1分）				52.40分
（余裕時間）				
取水路防潮ゲートでの水位がTP+2.86mを超える時間				61.10分

①：変動開始時間、②-0.6m水位変動、③：第1波目最低水位
④：+0.6m水位変動

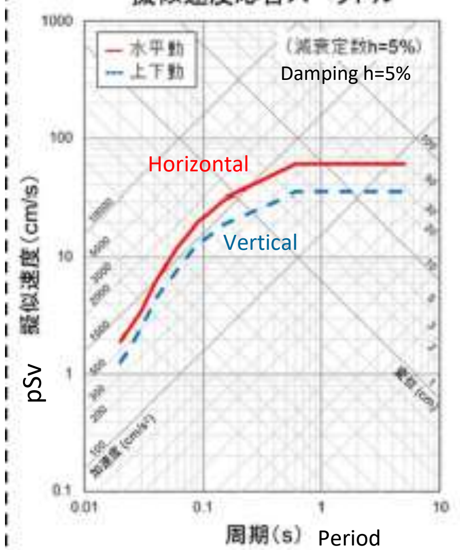
Sea level change of more than 50 cm within 10 minutes
is identified as tsunami arrival and the water gate should be immediately closed.

Backfit (4): Standard Spectra for Diffuse Seismicity
(Everywhere Earthquake)

- Design Basis Ground Motions (DBGMs) are developed from both the identified and unidentified seismic sources (the latter known as *diffuse seismicity* in IAEA's SSG-9).
- Licensees employed 2004 Rumoi Earthquake for the *diffuse seismicity* in 2013. NRA requested them to analyze 13 earthquakes (Mw5.0-6.2), but they did not give any result.
- In 2017, the NRA set up *the Study Team on Evaluation for Ground Motions without Identification of Seismic Sources*.
- After 11 meetings held in 2018 and 2019, *the Study Team* proposed the Standard Spectra for ground motions without identification of seismic sources (with Mw below 6.5).
- In April 2021, the NRA decided to include the Standard Spectra into its regulatory requirements. The utilities are requested to take into account the Standard Spectra and to update their DBGMs, if necessary, in addition to the previous Rumoi Earthquake of Hokkaido (Dec. 14, 2004; Mw5.8).

Standard Spectra are determined by statistically analysing strong motion records (a total of 614 horizontal records and 304 vertical records) from 89 inland earthquakes with moment magnitude ranging from 5.0 to 6.6.
For the detailed methodology, please refer to the following paper.

擬似速度応答スペクトル Pseudo-velocity (pSv) response spectra



Control points
コントロールポイント

Period 周期 (s)	水平動 擬似速度 (cm/s)	上下動 擬似速度 (cm/s)
0.02	1.910	1.273
0.03	3.500	2.500
0.04	6.300	4.400
0.06	12.000	7.800
0.09	20.000	13.000
0.15	31.000	19.000
0.30	43.000	26.000
0.60	60.000	35.000
5.00	60.000	35.000

Horizontal Vertical

Standard Spectra

Tajima, R., H. Tanaka, and C. Wu (2021). An Empirical Method for Estimating Source Vicinity Ground-Motion Levels on Hard Bedrock and Annual Exceedance Probabilities for Inland Crustal Earthquakes with Sources Difficult to Identify in Advance, *Bull. Seismol. Soc. Am.*, doi: 10.1785/0120210065

Improvement (5): Slope set-back in the TEPCO Fukushima Daiichi site: countermeasure for landslide

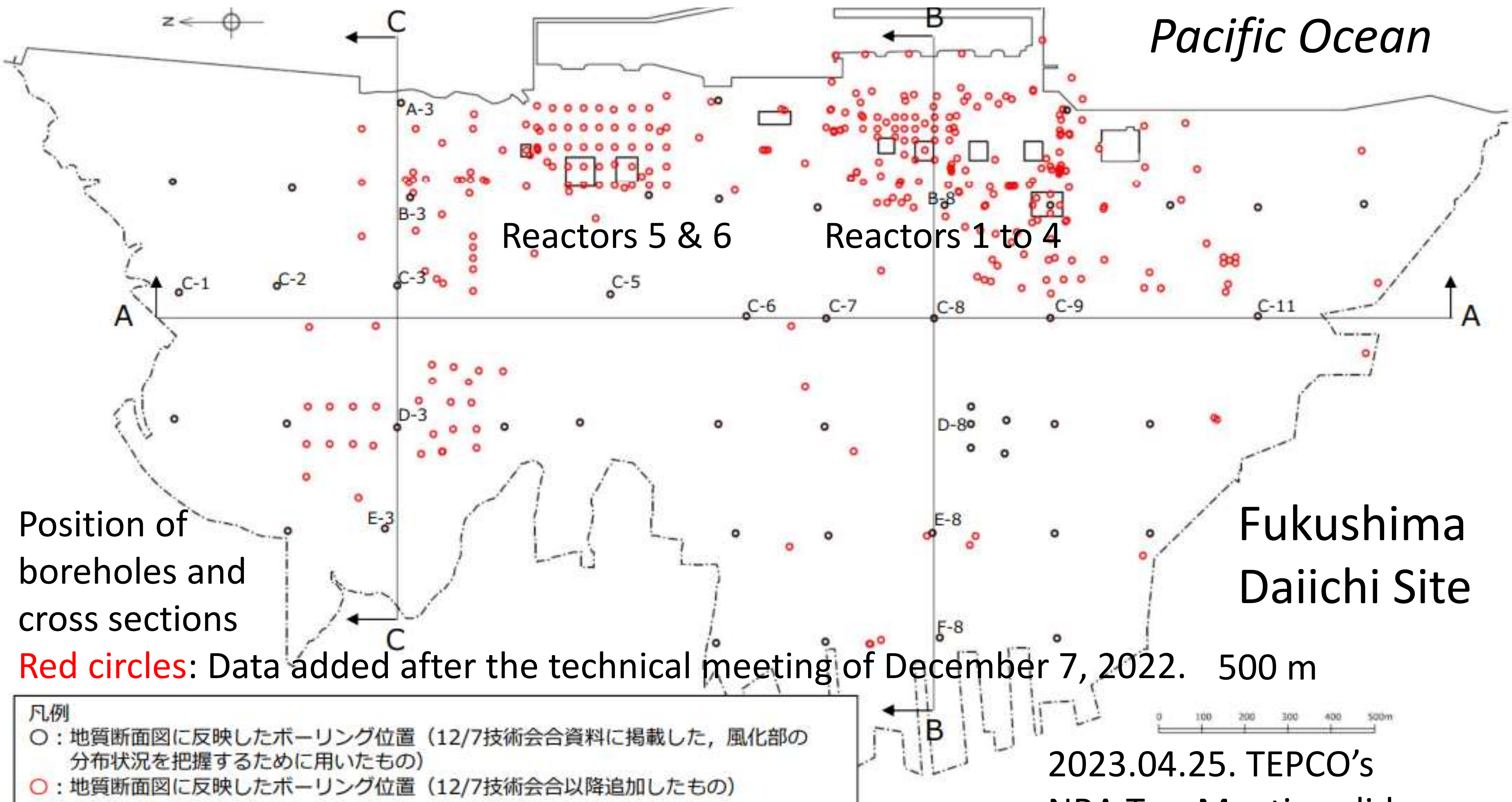


図　ボーリング位置図・地質断面位置図

Position of boreholes and cross sections

Red circles: Data added after the technical meeting of December 7, 2022.

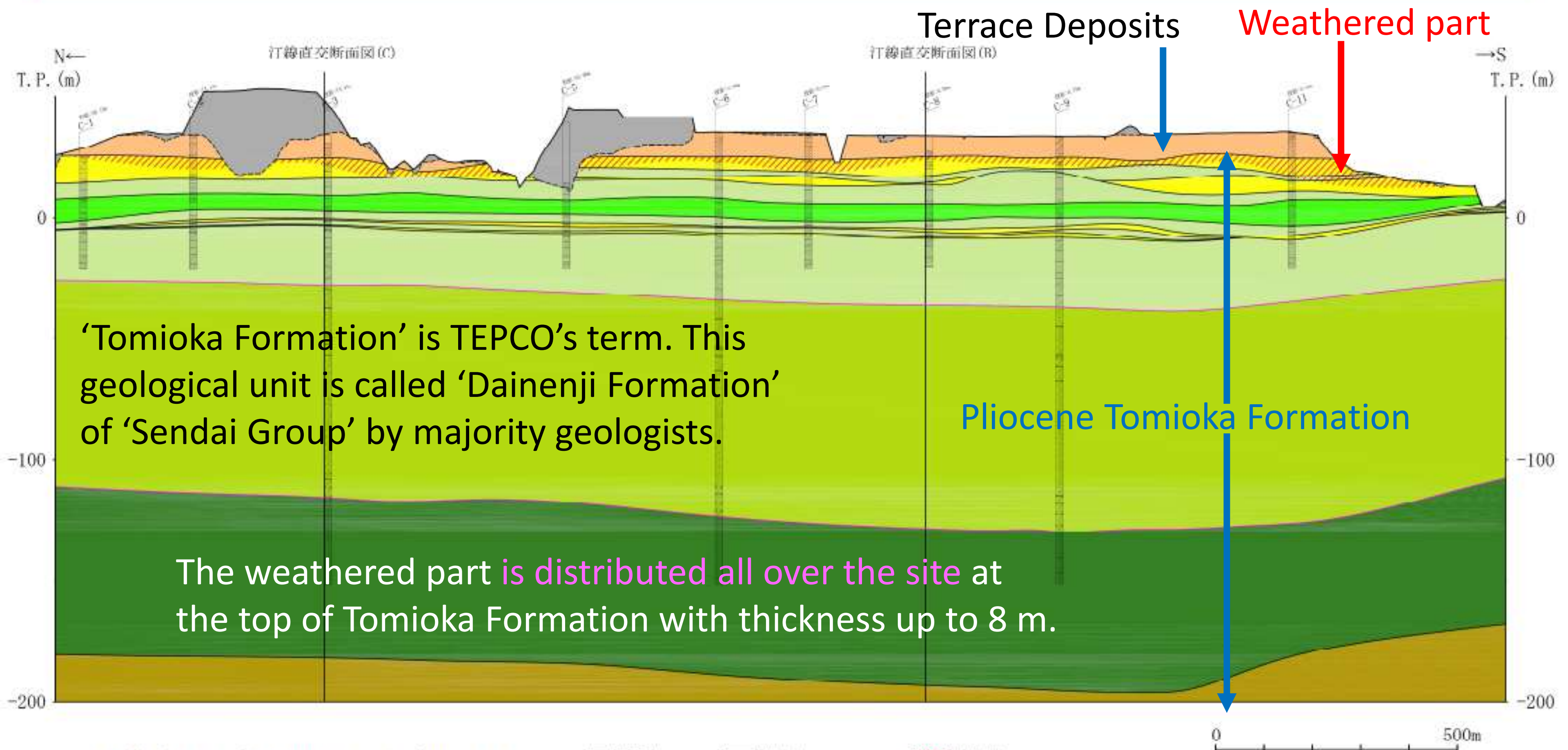
2023.04.25. TEPCO's NRA Tec. Meeting slide

原子力規制委員会
Nuclear Regulation Authority

Distribution of the weathered part of Tomioka Formation in the Fukushima Daiichi Site

敷地内の富岡層風化部の分布状況 (North-South Section)

TEPCO



- 風化部は富岡層の上部に8m以下の厚さで敷地全域に分布する。

埋戻土
粘土・シルト
砂
礫
泥岩
砂岩
凝灰岩
軽石

埋戻土
段丘堆積層
富岡層T3部層砂岩
富岡層T3部層泥質部
富岡層T3部層互層部
富岡層T2部層
富岡層T1部層
先富岡層
凝灰岩鍵層

風化部

※ 各ボーリング孔は断面線に投影

図 地質断面図（汀線平行方向A-A）

2023.04.25. TEPCO’s NRA Tec. Meeting slide

原子力規制委員会 Nuclear Regulation Authority

Distribution of the weathered part of Tomioka Formation in the Fukushima Daiichi Site

敷地内の富岡層風化部の分布状況 (East-West Sections)

TEPCO

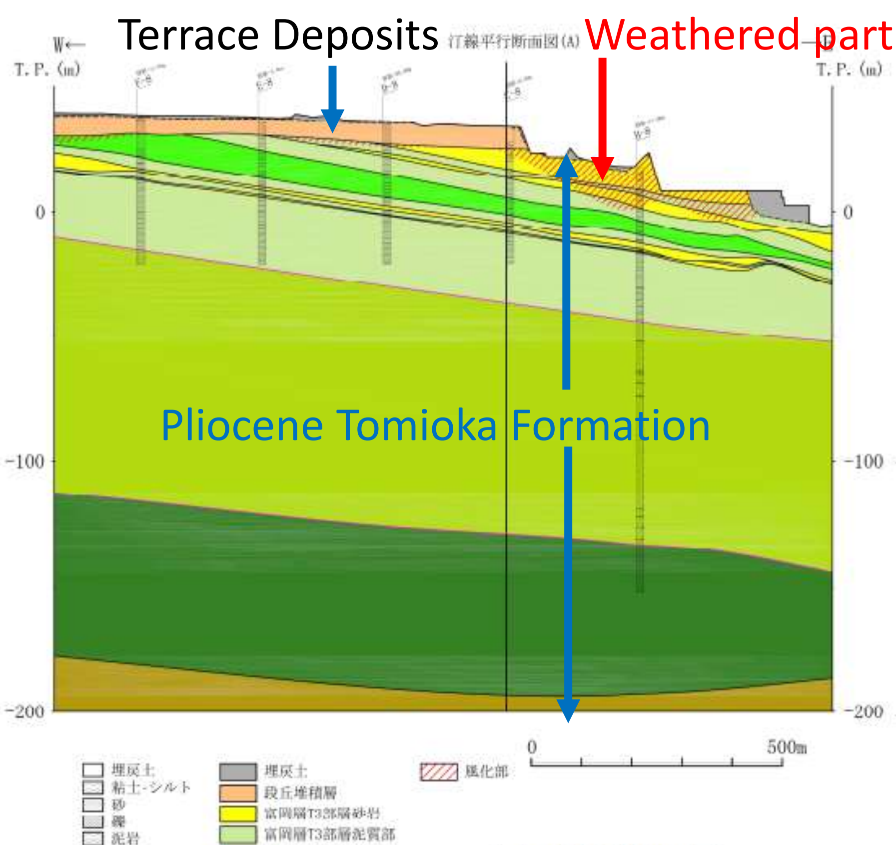


図　地質断面図
(汀線直交方向B-B)

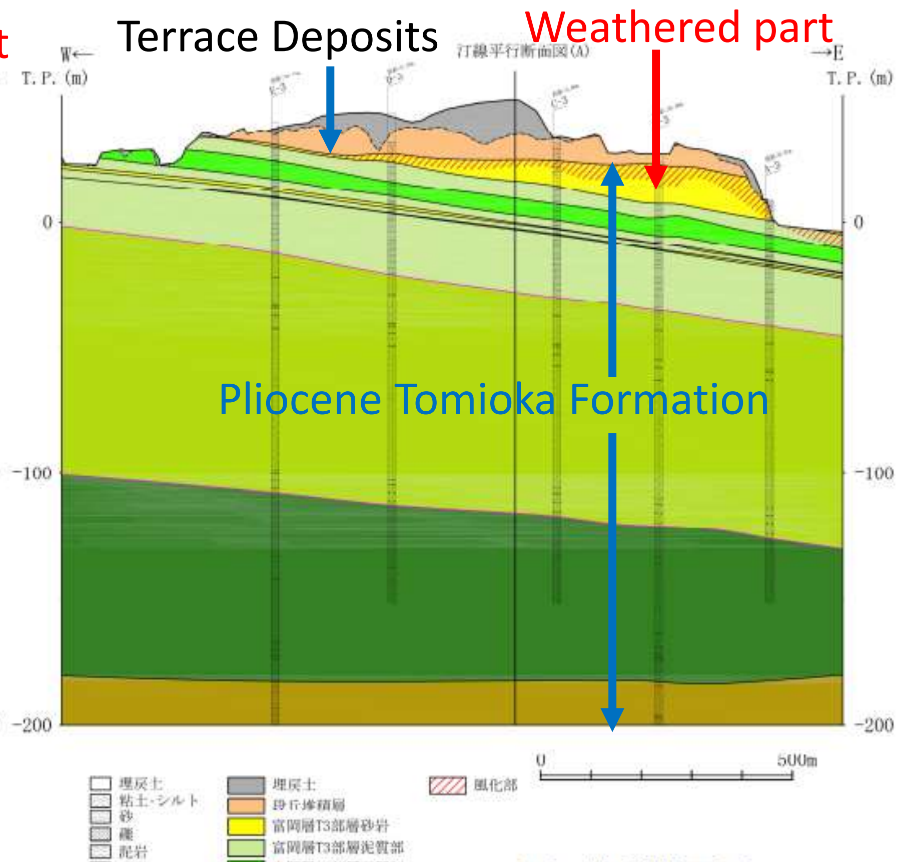


図　地質断面図
(汀線直交方向C-C)

2023.04.25. TEPCO's NRA Tec. Meeting slide

- 風化部は富岡層の上部に分布し，海側（東側）に向かい厚くなる傾向が認められる。

The weathered part (red dashed) is placed at the top of Tomioka Formation and is thickening toward the sea (east).

斜面対策工の検討　Set-back operation of the slope

TEPCO

斜面セットバック工事の概要

Used-fuel storage pool facility

Fukushima
Daiichi
Nuclear
Power
Plants

原子力規制委員会
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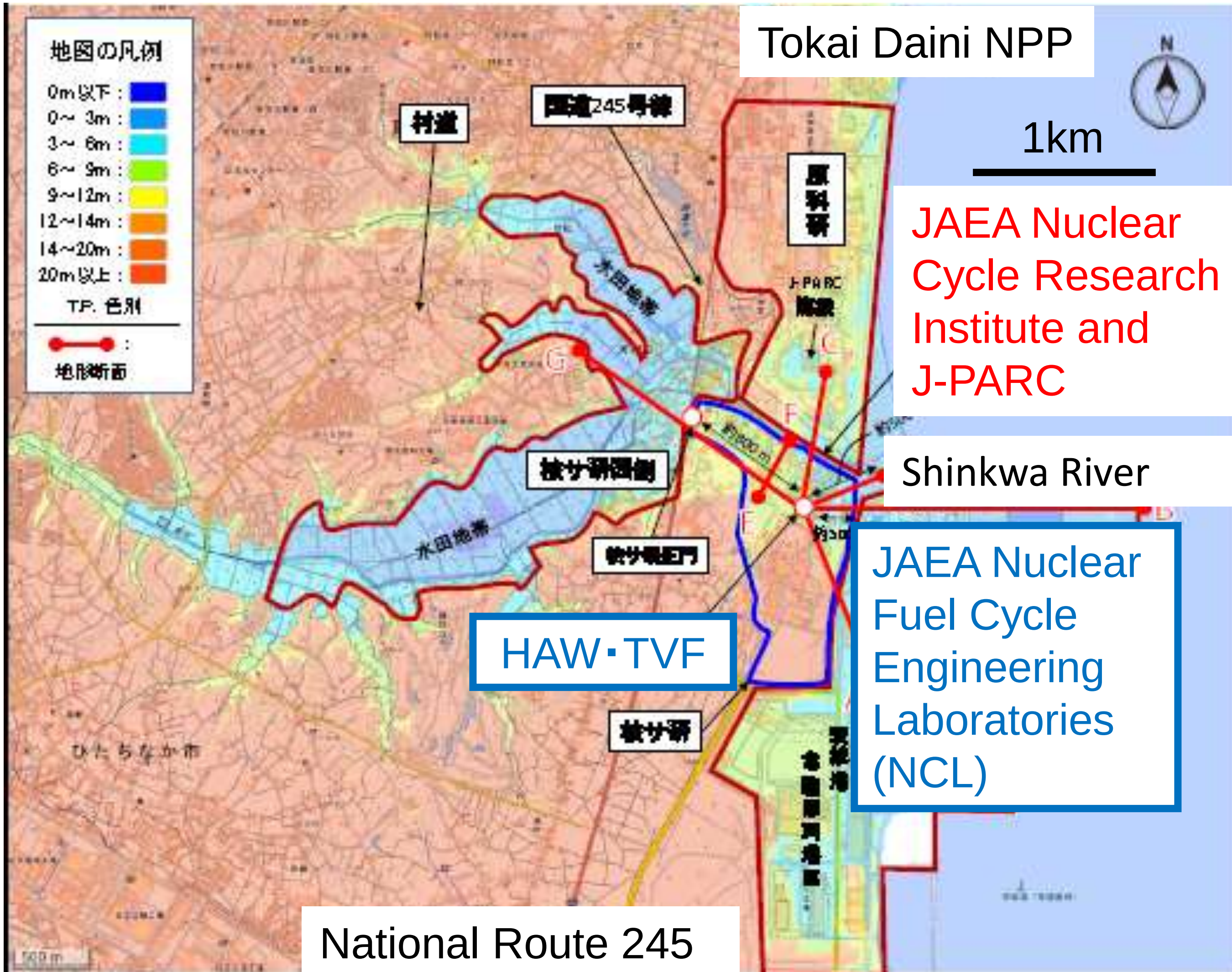
※工事の詳細は検討中であるため，本図から変更の可能性がある。

2023.12.26. TEPCO's NRA Meeting slide

Improvement (6): Barrier for tsunami back current In the JAEA Tokai site



The tsunami flows into Shinkawa River and spreads over the valleys. Then the tsunami water flows back to ocean with drifting debris.

原子力規制委員会東海再処理施設安全監視チーム第54回資料2「再処理施設における代表漂流物の妥当性の検証について」国立研究開発法人日本原子力研究開発機構（JAEA）p. 10.（2020年12月24日)

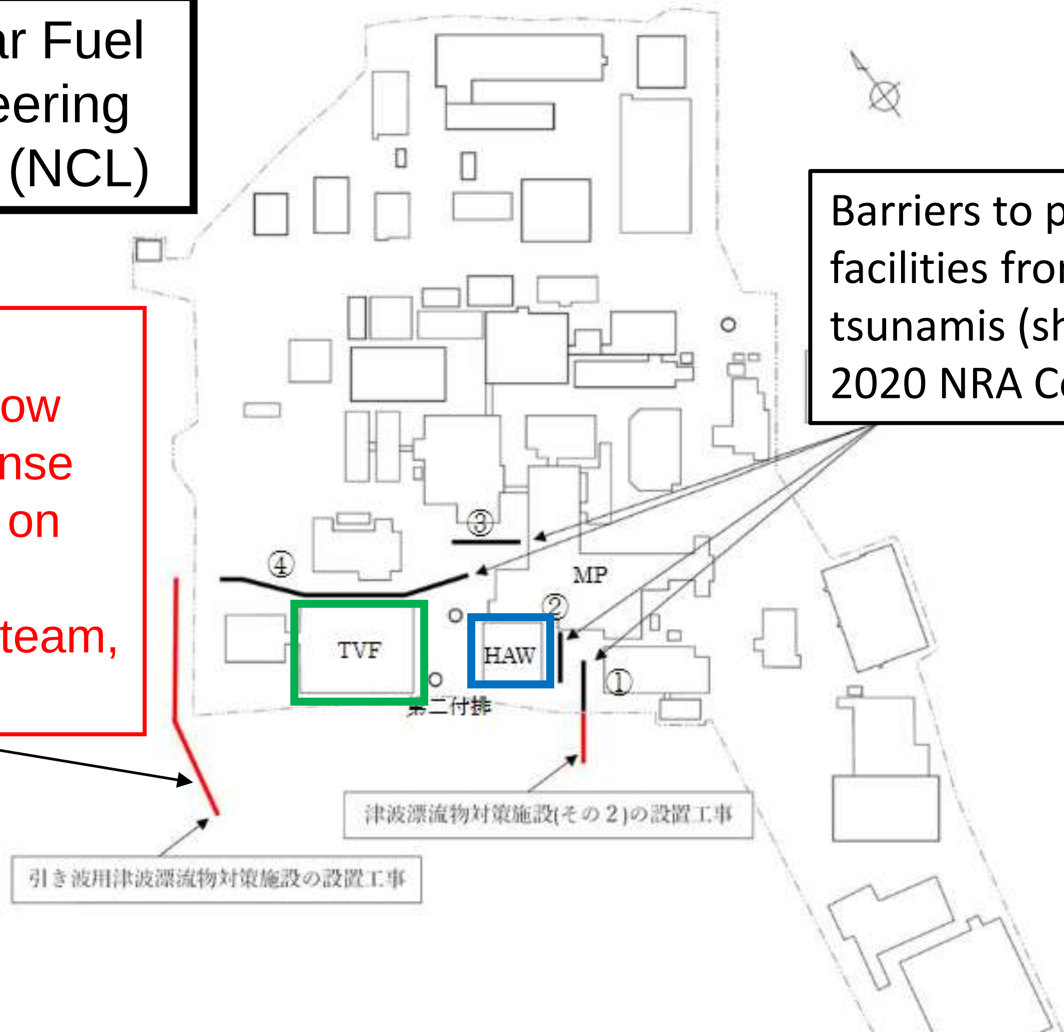
JAEA: Japan Atomic Energy Agency

Improvement (6): Barrier for tsunami back flow 2

Shinkawa River

Pacific Ocean

JAEA Nuclear Fuel Cycle Engineering Laboratories (NCL)



New barrier for tsunami back flow added in response to my proposal on June 17, 2020. （JAEA to NRA team, May 18, 2021)

Barriers to protect HAW and TVF facilities from drifting objects in tsunamis (shown on June 17, 2020 NRA Commission Meeting).

HAW: High Activity Wastes

TVF: Tokai Vitrification Facility

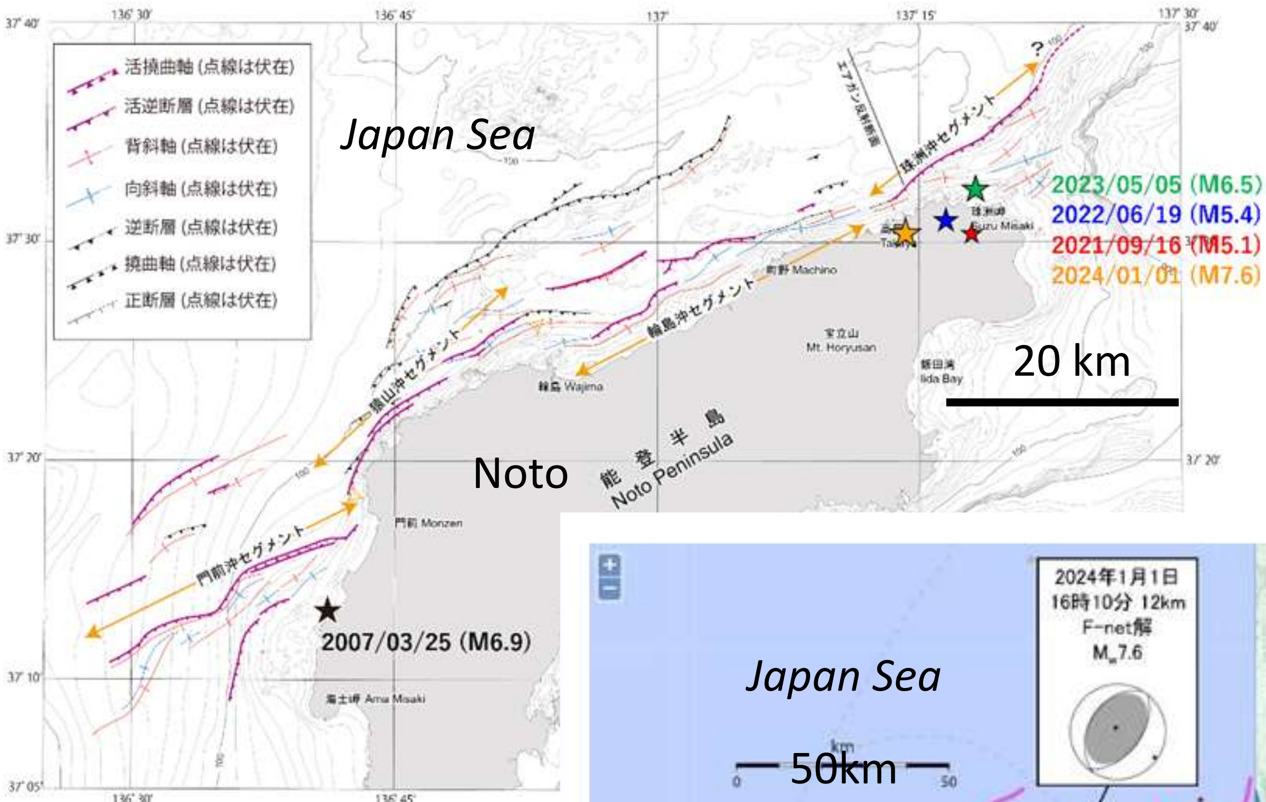
原子力規制委員会東海再処理施設安全監視チーム第58回資料7「漂流物の影響防止施設として設ける津波漂流物防護柵について」国立研究開発法人日本原子力研究開発機構（JAEA）p. 12.（2021年5月18日)

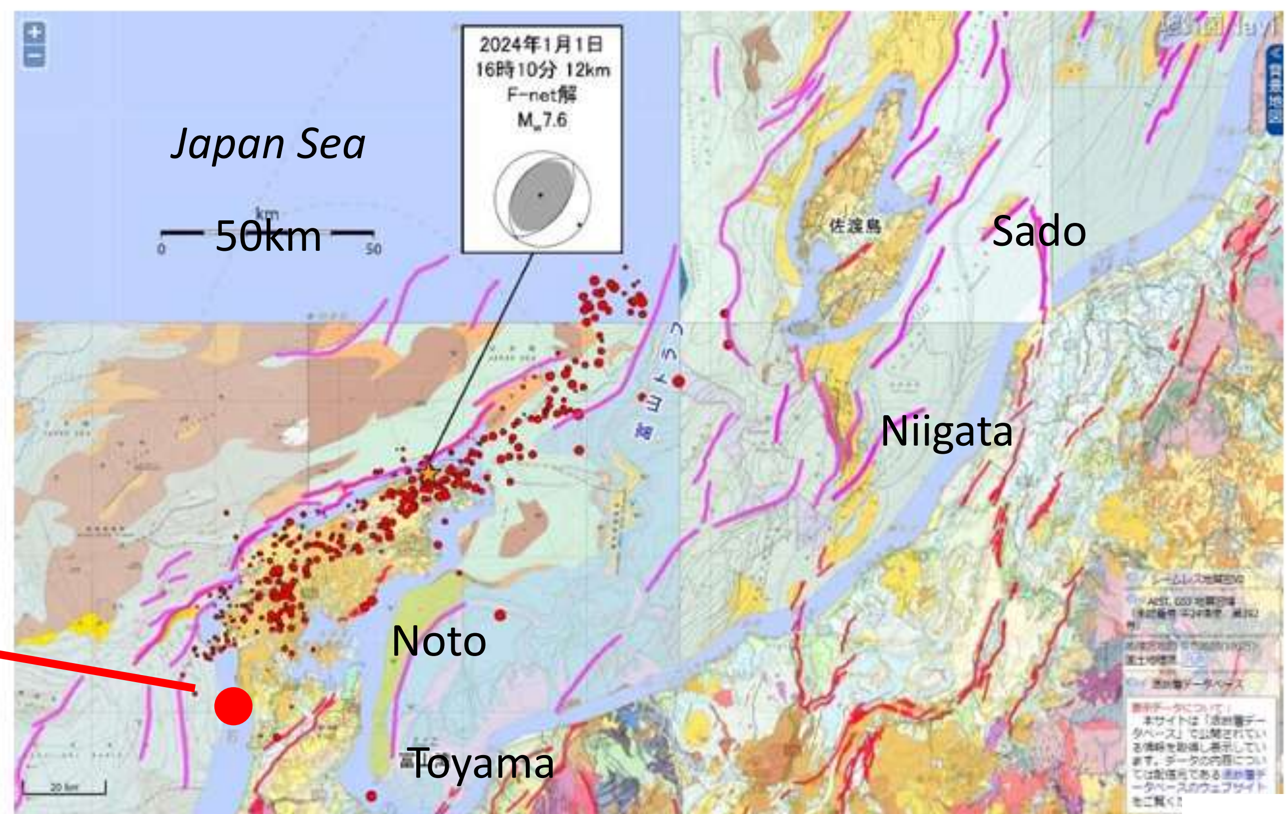
Recent Topic: Noto Peninsula Earthquake, Jan. 1, 2024

Magnitude: 7.6
Maximum Intensity: 7 (JMA scale, max. 399 gal in Shika NPP)
Aftershock area length: 150 km
Ground upheaval of >4 m in northern part of Noto Peninsula
Tsunamis of >5 m high along Noto and Niigata coasts
Intense liquefaction in Noto, Kaga, Toyama and Niigata plains
Deaths: 260, Injuries: 1316, Destroyed houses: 8424 (by June 4)
Troubles in Shika NPP (about 20 km from the active fault)
===Oil spilled from the transformers (24600 litters) and loss of 2 external power supply lines (other supply lines survived)
===Water spilled from used-fuel storage pools (#1: 95 litters, #2: 326 litters)
===Small steps and cracks on roads and slopes in the NPP site
===Tsunami height 3 m (site ground level: 11 m)

Jan. 1, 2024 Noto Peninsula Earthquake Epicenter (yellow star) and active faults

Mar. 27, 2024, NRA Tech. Inf. Meeting, Book 64-1-2, p. 2-3.





Shika NPP
(about 20 km
from the faults;
on re-evaluation)

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Miyashita, Y. et al. 2024 https://www.gsj.jp/hazards/earthquake/noto2024/index.html

Vertical and Horizontal Ground Displacement by 2024 Noto Peninsula Earthquake

Vertical Displacement (Upheaval) Horizontal Displacement (Westing)

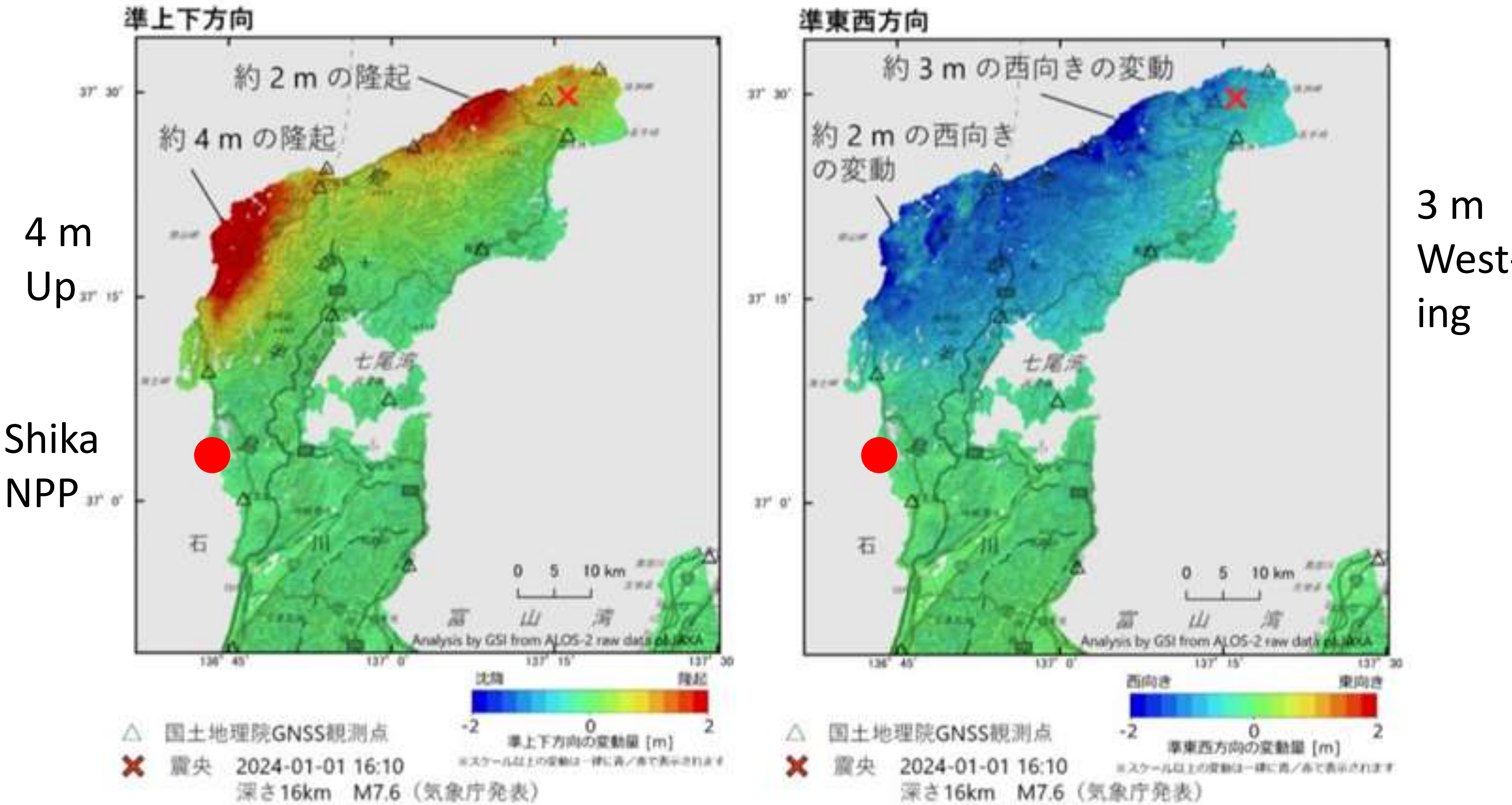

図 7　だいち 2 号により取得された観測データの 2.5 次元解析[5]による変動量[36]

値は暫定値であり、現地調査等により確認されたものではなく、今後の精査によって解析結果が変更されることがある。（解析：国土地理院　原初データ所有：JAXA）

https://www.gsi.go.jp/common/000254489.jpg
Mar. 27, 2024, NRA Tech. Inf. Meeting Book 64-1-2, p. 10.

Conclusions

- In 10 years of my term as NRA Commissioner, 17 NPPs were permitted and 12 are operating, but 10 are still on re-evaluation in the new regulatory requirements.
- In these 10 years, 4 backfits took place, some other improvements were indicated, and continuous efforts are practiced to cope with natural hazards.
- I thank IAEA for continuous help in improving NRA's regulation to keep nuclear safety, security and safeguards.
- Thank you for your kind attention!