



**IAEA**

International Atomic Energy Agency

*Atoms for Peace and Development*

# Arrangements for the Termination of a Nuclear or Radiological Emergency

**Case Study Part 2:**

**The Fukushima Daiichi Nuclear Power Plant Accident**

# Purpose

- To present and discuss the emergency response to the Fukushima Daiichi NPP accident in Japan in 2011.
- To analyse the nuclear accident in the context of the guidance given in IAEA Safety Standards Series No. GSG-11 for the transition to an existing exposure situation.

*The Case Study is not an assessment of the emergency response to this nuclear accident but an opportunity to illustrate fulfillment of the prerequisites given in the IAEA Safety Standards Series No. GSG-11 for transition to an existing exposure situation.*

# Learning objectives

- To analyse the emergency response to this nuclear accident against the guidance given in IAEA Safety Standards Series No. GSG-11;
- To identify different stages of response to the nuclear accident;
- To analyse when the prerequisites for transition to an existing exposure situation were fulfilled and when the emergency could have been terminated.

# Contents



- Overview of the emergency response to the Fukushima Daiichi Nuclear Power Plant accident in 2011
- Discussion and feedback session

# Expectations from participants



- Following the presentation, participants are expected to discuss the emergency response to this accident within their Working Group and to answer the questions provided in *Case Study Part 2 and Part 3: Analysis of the Fukushima Daiichi NPP accident and the radiological incident in Hueypoxtlá, Mexico.*

*Case Study Part 2 and Part 3:  
Analysis of the Fukushima Daiichi NPP accident and the radiological  
incident in Hueypoxtlá, Mexico*

QUESTIONS	Fukushima Daiichi NPP accident	Radiological incident in Hueypoxtlá, Mexico
1. What urgent protective actions were implemented and when their implementation was completed?		
2. What early protective actions were implemented and when their implementation was completed?		
3. What activities were implemented to characterize the situation and to support resumption of normal social and economic activity and when preparations for this resumption were completed?		
4. When conditions were ensured that allow for the emergency to be terminated?		

# References



Published : August 2015

Vol. 1 : Description and Context of the Accident

Vol. 2 : Safety Assessment

Vol. 3 : Emergency Preparedness And  
Response

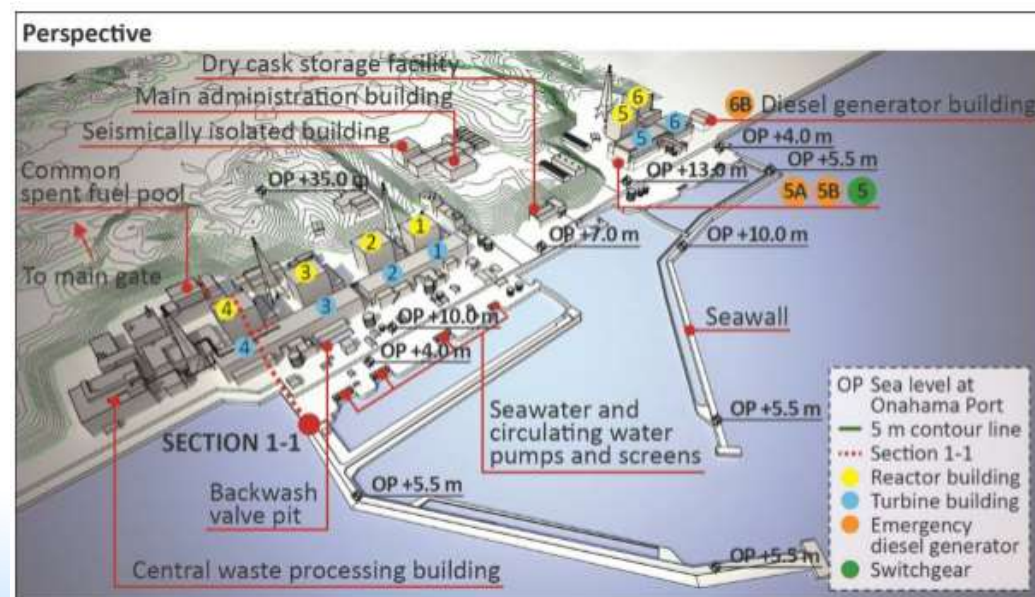
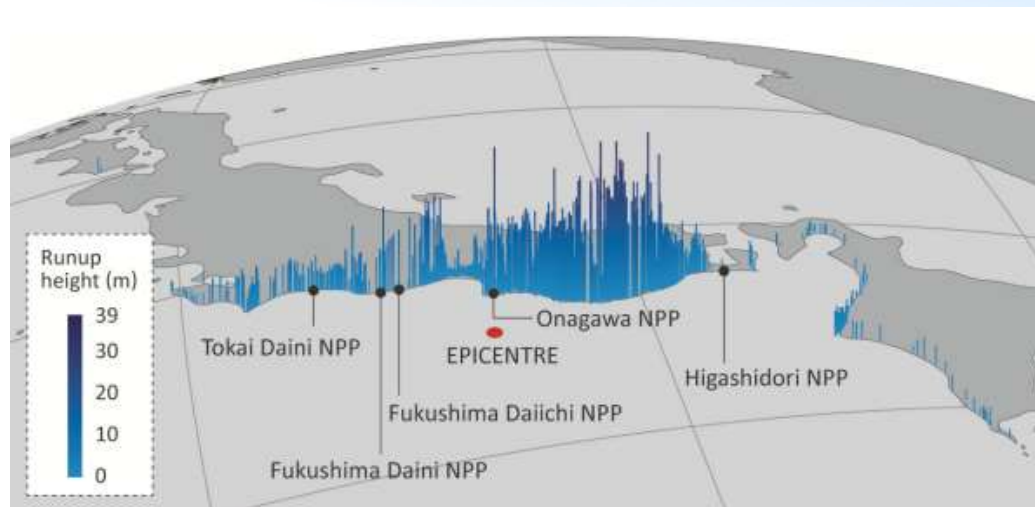
Vol. 4 : Radiological Consequences

Vol. 5 : Post-accident Recovery



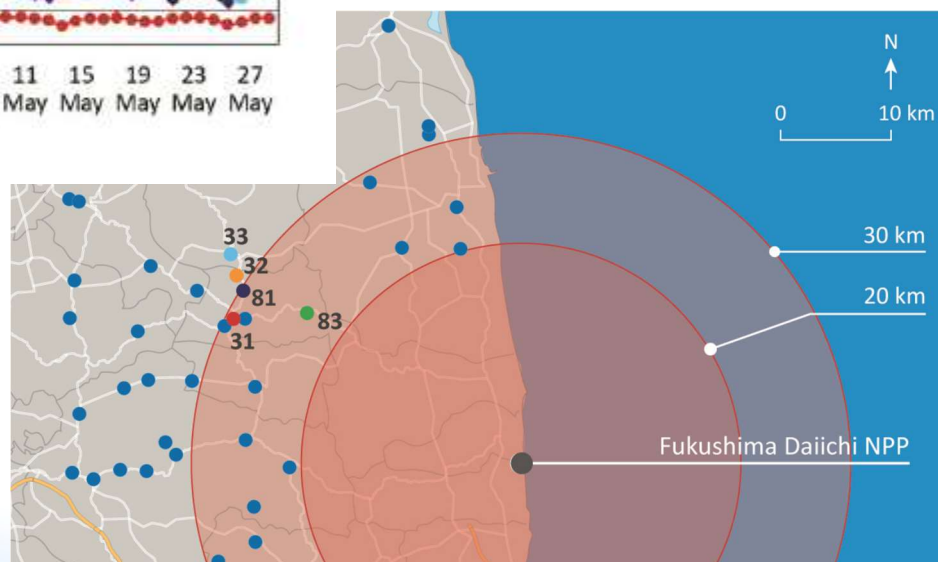
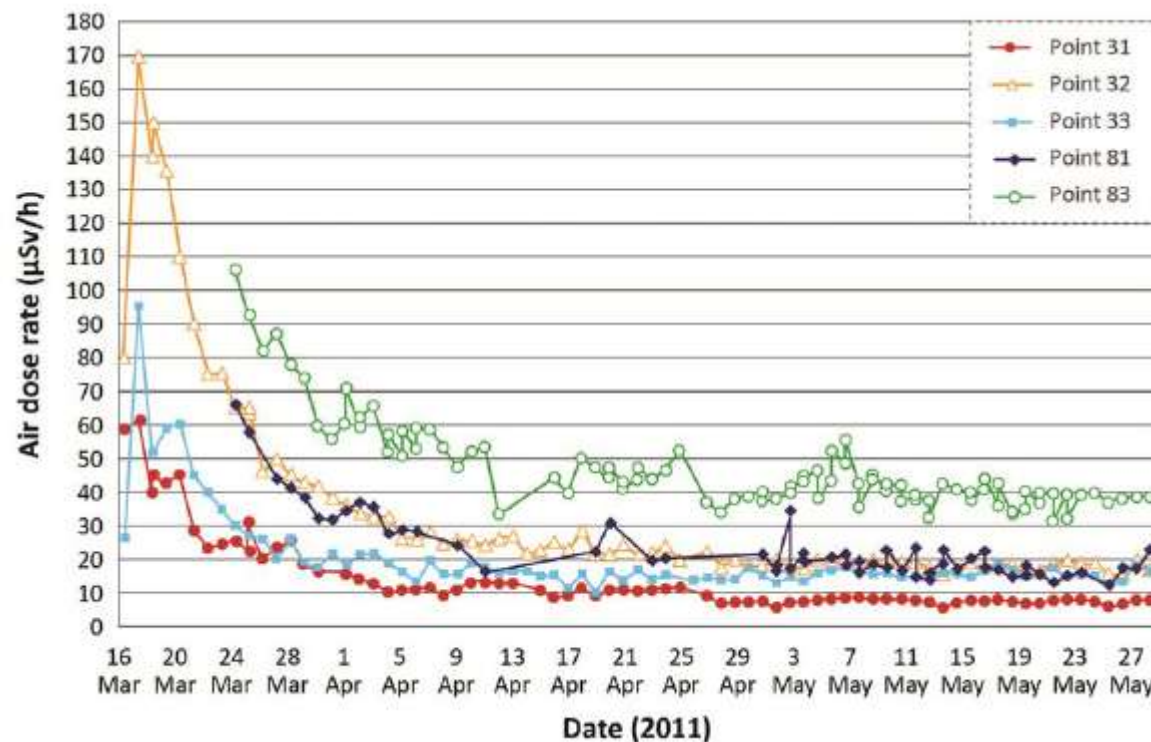
# Multi-hazards

The accident occurred following a severe natural event – a tsunami (caused by a large earthquake) flooded the NPP site leading to loss of electricity in multiple units.



Images reproduced from 'The Fukushima Daiichi Accident', IAEA, Vienna (2015)

# Radiological situation arising from prolonged releases from multiple units



Images reproduced from 'The Fukushima Daiichi Accident', IAEA, Vienna (2015)



# 11 March 2011



Time	Events or actions
14: 46	Great East Japan <b>earthquake</b> (Magnitude 9.0) <b>Loss of off-site power</b> , automatic reactor shutdown Emergency Response Centre established
15:36	<b>Tsunami</b> wave flooded site (inundation height +15 m)
15:42	Fukushima Daiichi reported <b>station blackout</b> to national and local governments
16:45	Fukushima Daiichi <b>reported nuclear emergency</b> (failure of core cooling in Units 1 and 2)
19:03	<b>Declaration</b> of nuclear emergency by national government and establishment of Nuclear Emergency Response HQ (NERHQ)
20:50	Fukushima Prefecture issued <b>evacuation</b> order for <b>2 km</b> around site
21:23	National government issued <b>evacuation</b> order for <b>3 km</b> around the site and <b>sheltering</b> in area of <b>3 – 10 km</b> around the site

# 12 March 2011



Time	Events or actions
05:44	National government issued <b>evacuation</b> order for <b>10 km</b> around the Fukushima Daiichi site
15:36	Hydrogen <b>explosion in Unit 1</b> , destruction of water and power provisions, degraded on-site conditions
18:25	National government issued <b>evacuation</b> order for <b>20 km</b> around the Fukushima Daiichi site  Fukushima Prefecture began <b>monitoring evacuees</b> (decontamination criterion 13,000 counts/min applied)

# 13 – 14 March 2011



Time	Events or actions
05:58 13 March	<p>Fukushima Daiichi <b>reported nuclear emergency</b> (loss of cooling in <b>Unit 3</b>)</p> <p>Iodine Thyroid Blocking (<b>ITB</b>) implemented for on-site workers</p>
11:01 14 March	<p><b>Explosion in Unit 3</b> and destruction of alternative water cooling for Units 1 and 3</p>
13:38	<p>Fukushima Daiichi <b>reported nuclear emergency</b> (loss of cooling in <b>Unit 2</b>)</p> <p>Monitoring <b>criterion</b> for decontamination of the public increased from 13,000 to 100,000 counts/min</p>

# 15 – 16 March 2011



Time	Events or actions
05:30 15 March	National government – TEPCO Integrated Response Office established
06:14	Sound in Unit 2 primary containment vessel, <b>explosion</b> in Unit 4 reactor building
09:00	<b>Maximum radiation level measured</b> at main gate (around 12 mSv/h)
11:00	National government issued order to <b>shelter</b> within <b>20 – 30 km</b> of site
20:50	Dose rates of <b>few hundred microSv/h</b> measured in locations beyond 20 km evacuation zone
	<b>Dose criterion for emergency workers increased</b> from 100 to 250 mSv
16 March	<b>Evacuation</b> of 20 km zone around Fukushima Daiichi NPP <b>completed</b>

# 17 March – 17 April 2011



Date	Events or actions
17 March	Provisional Regulation <b>Values</b> established to <b>restrict food</b> and drinking water
20 March	National government received <b>aerial monitoring</b> data from USA <b>Characterization of exposure</b> situation began
21 March	National government began to issue <b>restrictions</b> on the distribution of <b>specific foods</b>
22 March	Residents advised not to allow <b>infants to drink tap water</b> at specified locations
25 March	National government recommended <b>voluntary evacuation</b> of residents within <b>20 – 30 km</b> of the site
11 April	National government announced <b>20 mSv criterion for relocation</b> from areas beyond 20 km zone
17 April	TEPCO issued <b>Roadmap for on-site recovery</b>

# 19 April – 30 June 2011



Date	Events or actions
19 April	National government established 20 mSv/year criterion for reopening schools (subsequently reduced to 1 mSv/year)
22 April	Deliberate Evacuation Area, Evacuation Prepared Area in Case of Emergency and Restricted Area established
15 May	Relocation from the Deliberate Evacuation Area began
17 May	National government established Roadmap for Immediate Actions for Assistance of Nuclear Sufferers
13 June	Plans for detailed monitoring announced
30 June	National government began to designate locations for relocation



# Accumulated deposition of Cs-137

By July 2011, a detailed understanding of the distribution of radionuclides deposited in the areas around the site had been established.

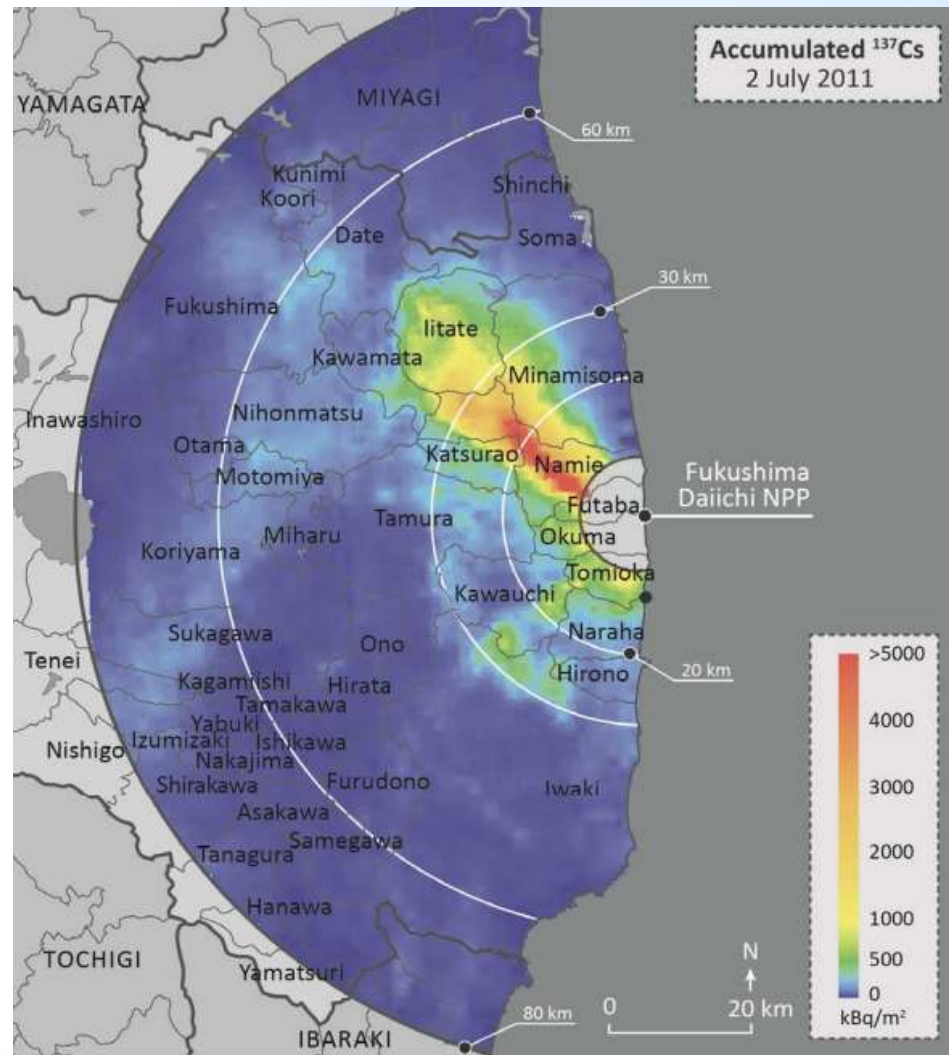


Image reproduced from 'The Fukushima Daiichi Accident', IAEA, Vienna (2015)

# 1 July – 30 September 2011



Date	Events or actions
July	Comprehensive <b>medical check ups</b> began
19 July	Basic <b>Policy</b> on Radiation Protection for <b>Termination of Evacuation</b> and <b>Reconstruction</b> issued
25 July	Radiation <b>Monitoring Action Plan</b> for Homecoming regarding the Evacuation Prepared Area established
4 Aug.	Nuclear Safety Commission issued views on <b>termination</b> of urgent protective actions
26 Aug.	Enactment of <b>Act on Special Measures</b> Concerning the Handling of Environmental Pollution <b>Policies for decontamination</b> works issued by NERHQ Guidelines for <b>protection of emergency workers</b> issued
19 Sept.	Disaster <b>recovery programmes</b> prepared for Evacuation Prepared Areas
30 Sept.	Evacuation Prepared <b>Area lifted</b>

# Protective actions in place to 30 September 2011

11 – 12 March  
Evacuation &  
sheltering orders

12 – 25 March  
Adjusted evacuation  
& sheltering orders

22 April – 30 Sept.  
Relocation and  
delineation of areas

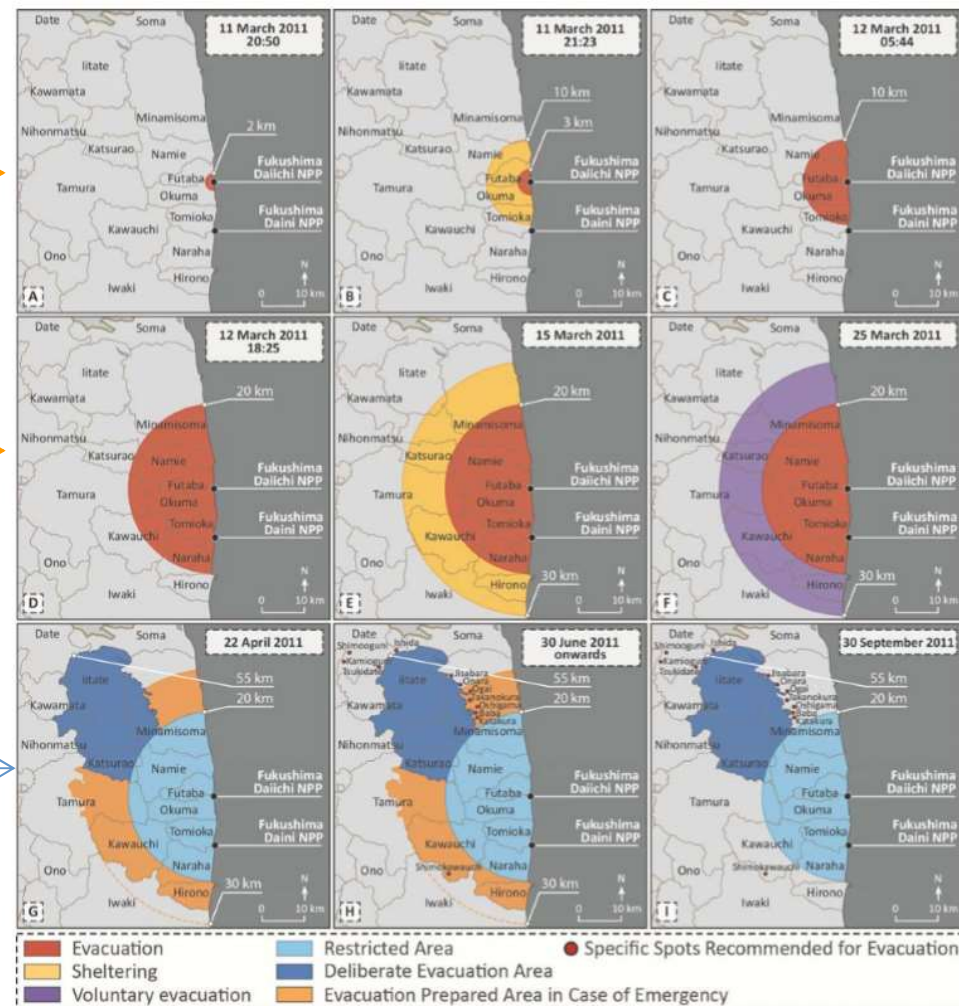


Image reproduced from 'The Fukushima Daiichi Accident', IAEA, Vienna (2015)

# September – December 2011



Date	Events or actions
1 Nov.	100 mSv effective dose <b>criterion re-established</b> for new emergency workers
16 Dec.	<b>Conditions for cold shutdown</b> achieved in Units 1 – 3 100 mSv effective dose criterion re-established for majority of emergency workers NERHQ judged that overall <b>safety of the NPP secured</b>
26 Dec.	Basic <b>concept for rearranging areas</b> adopted by NERHQ

# January – April 2012

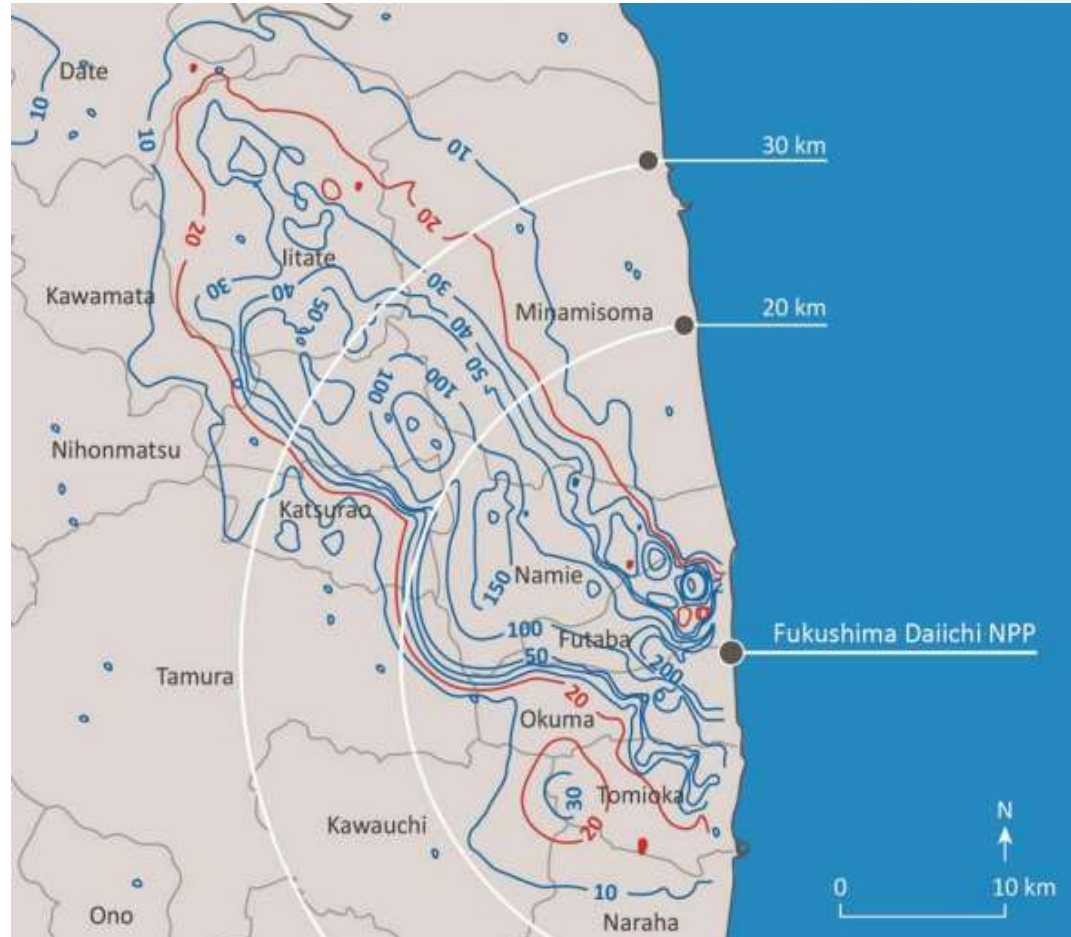


Date	Events or actions
1 Jan	Act on Special Measures came into force
1 April	Standard <b>limits for</b> activity concentrations in <b>food and drinking water</b> established based on dose criterion of 1 mSv/year
30 April	100 mSv effective dose <b>criterion re-established</b> for remaining group of workers
	...



# Estimated integrated dose (mSv) received in first year (up to 11 March 2012)

After 1 year, detailed assessment of doses received in areas around the site established



*Image reproduced from 'The Fukushima Daiichi Accident', IAEA, Vienna (2015)*



# Measured aerial ambient dose equivalent rate from deposits (April 2011 – Nov. 2014)

Continued monitoring demonstrates the change in the radiological situation as a function of time

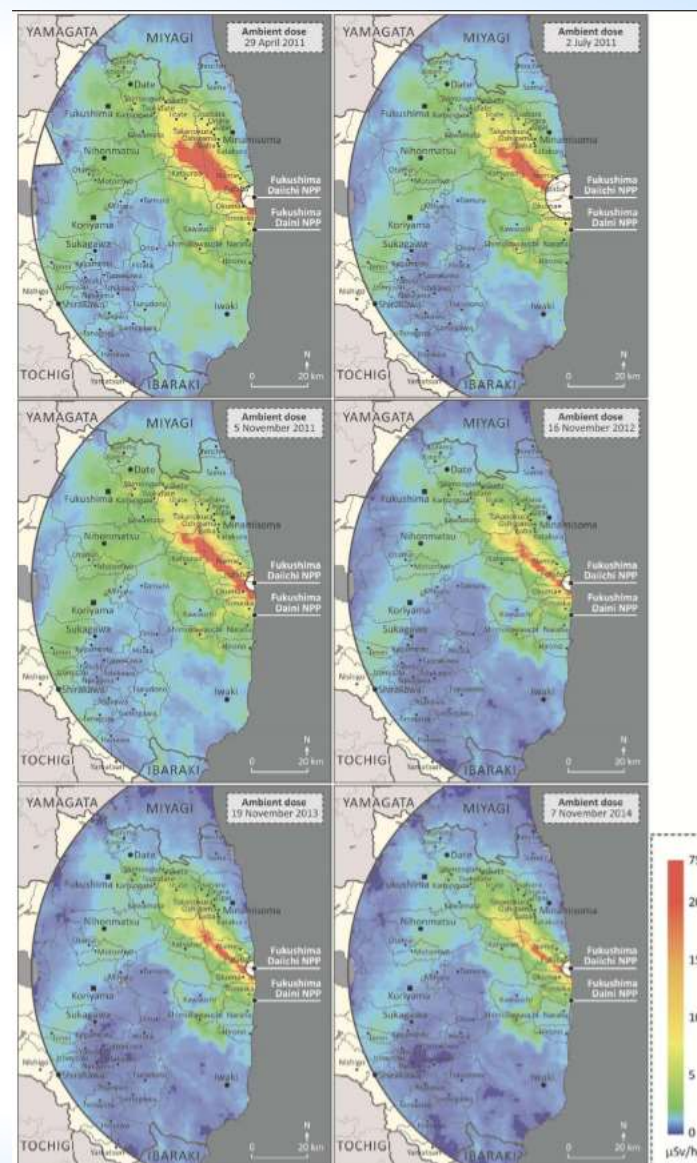


Image reproduced from 'The Fukushima Daiichi Accident', IAEA, Vienna (2015)

# Designation of areas

Areas designated to identify those where return is possible as an input to establishing priorities and responsibilities for undertaking activities to facilitate return

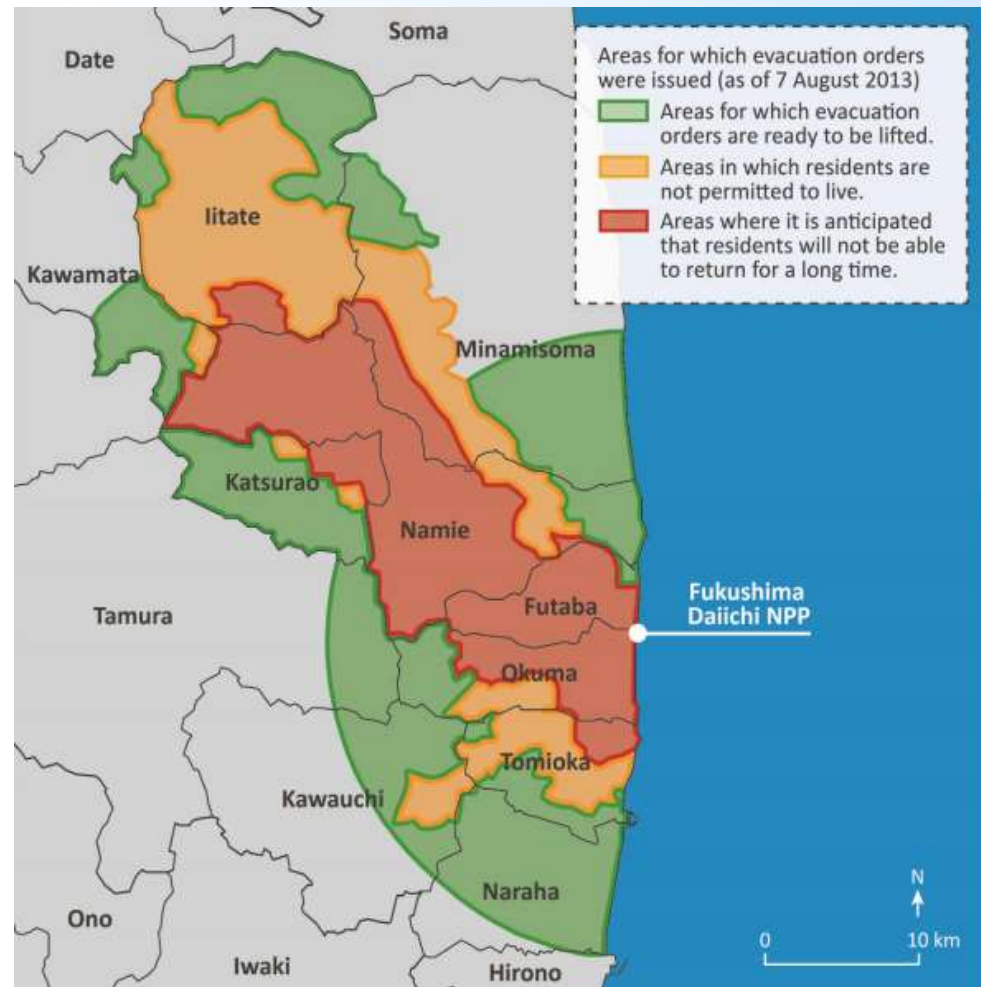
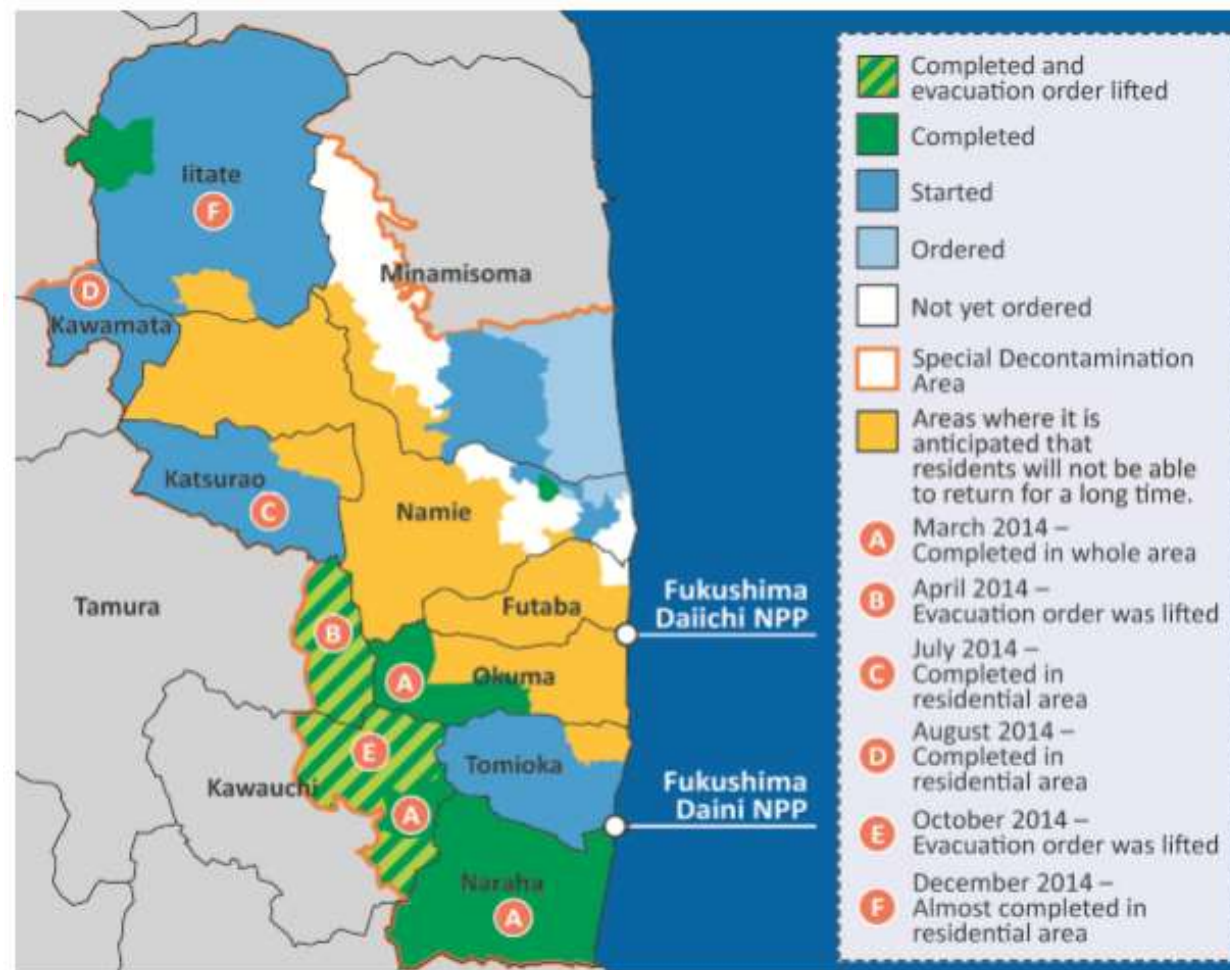


Image reproduced from 'The Fukushima Daiichi Accident', IAEA, Vienna (2015)

# Status of areas in SDA, December 2014

The status of remediation and evacuation orders in the 'Special Decontamination Area'



*Image reproduced from 'The Fukushima Daiichi Accident', IAEA, Vienna (2015)*

# Discussion



- Based on this information, please discuss and answer the questions distributed for this Case Study (*Case Study Part 2 and Part 3: Analysis of the Fukushima Daiichi NPP accident and the radiological incident in Hueypoxtla, Mexico*) within your working group.

– Time allocated: **15 min**

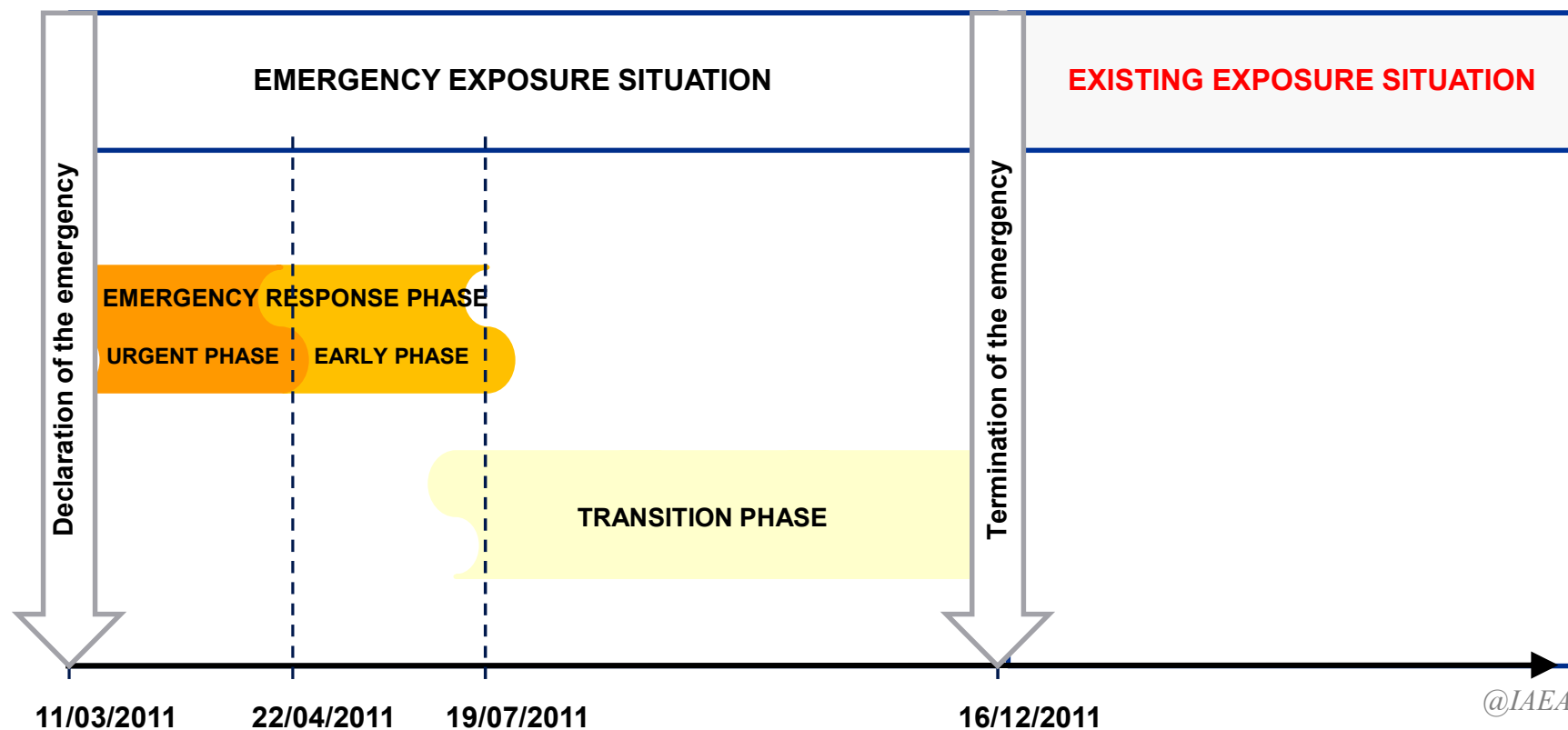


# Let's discuss:



- What urgent protective actions were implemented and when was their implementation completed?
- What early protective actions were implemented and when was their implementation completed?
- What activities were implemented to characterize the situation and to support resumption of normal social and economic activity and when were preparations for this resumption completed?
- When were conditions ensured that allowed for the emergency to be terminated?
  - Time allocated: **20 mins**

# Retrospective sequencing and milestones of the Fukushima Daiichi NPP accident





# Basis for the milestones

- Urgent protective actions, such as the evacuation and sheltering of people in the vicinity of the site were implemented after the emergency declaration (**11 March 2011**), and restrictions on the distribution and consumption of food and drinking water were implemented during the following days.
- Early protective actions, such as the relocation of people outside the evacuation areas and the relocation of people from locations at which hot spots of activity had been identified, were taken on the basis of detailed monitoring primarily during the first few months. Still, a few hot spots were detected as late as November 2011.
- Steady decline of radiation doses achieved during **emergency response phase** that lasted to about **19 July 2011**.
- The following months (**July – December**) can be considered as the **transition phase**, during which policies and arrangements for the recovery phase were established.
- Conditions for cold shutdown / stable condition of the NPP were confirmed on **16 December 2011**.

# Case studies

- Detailed in Annex I of IAEA Safety Standards Series No. GSG-11 for further information



**IAEA**

International Atomic Energy Agency

*Atoms for Peace and Development*

*Thank you!*