Schweizerische Eidgenossenschaft
Confédération suisse
Condederazione Svizzera
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Swiss Federal Nuclear Safety Inspectorate ENSI

Nuclear regulatory actions following the Fukushima accident

DRES Symposium, The Hague, 8 November 2019

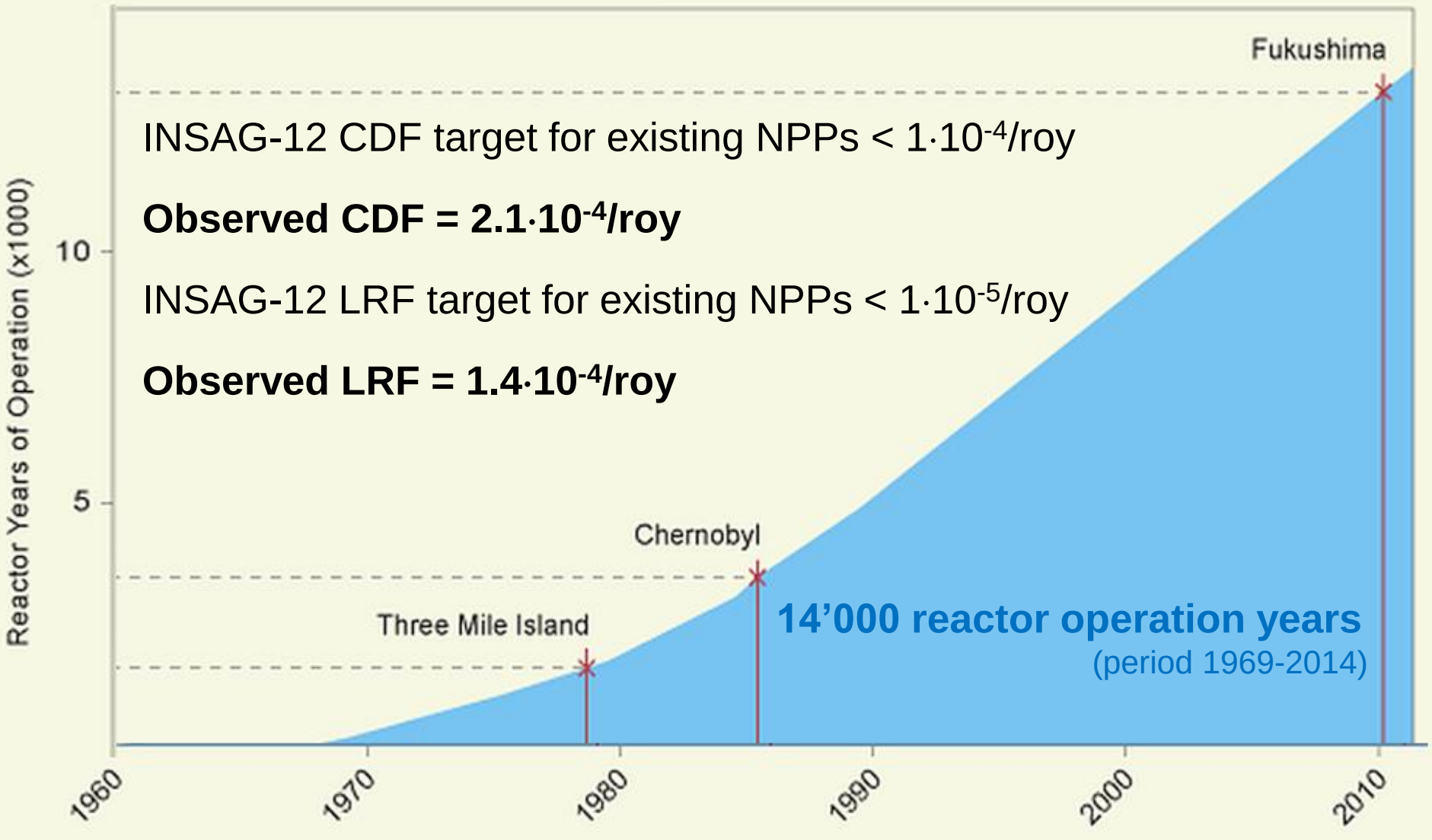
Georg Schwarz

Fukushima: An accident anywhere is an accident everywhere

Nuclear Advocate Merkel Flips: Says Germany to Quit Nukes by 2022

Swiss cabinet agrees to phase out nuclear power

Nuclear accidents of existing NPPs



Targets of INSAG-12 are not met

Core damage frequency

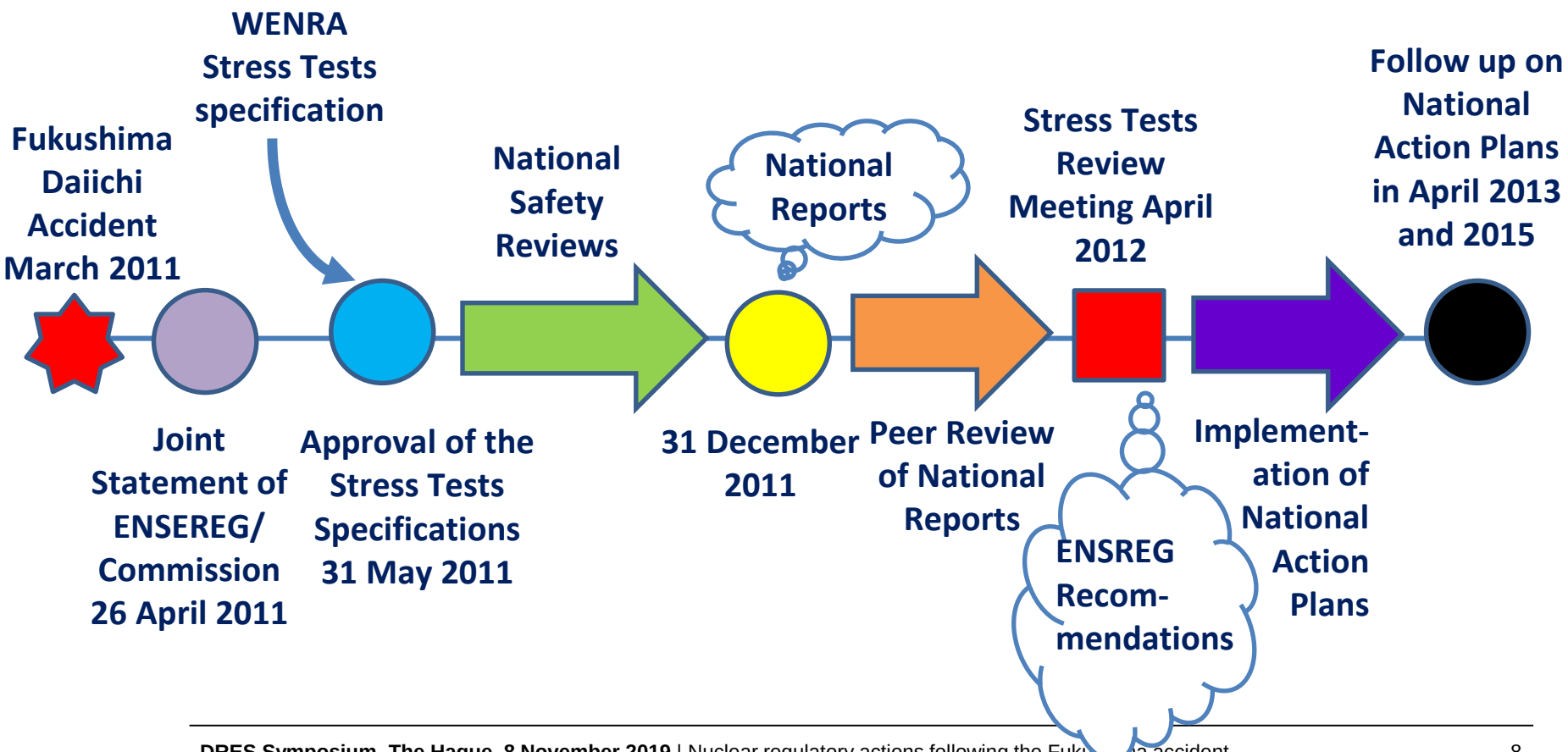
- The observed core damage frequency is 2 times higher than the target

Large release frequency

- The observed large release frequency is about 10 times higher than the target.
- There was one accident with a large release every 22.5 years instead of one every 225 years.

EU Stress Tests: Safety review of all European NPPs

EU Stress Tests: Overview



EU Stress Tests: Safety review of all European NPPs

Definition of the stress tests:

- a targeted reassessment of the safety margins of NPPs in the light of the events which occurred at Fukushima: extreme natural events challenging the plant safety functions and leading to a severe accident.

Technical scope

- **Initiating events:** Earthquake, flooding
- **Loss of safety functions:** Station blackout, loss of ultimate heat sink
- **Severe accident management**

Compilation of the EU stress test results: Issues

		I1a	I1b	I2	I3	I4	I5	I6	I7	I8	I9	I10
DE	BROKDORF			x		x			x			
	EMSLAND					x			x			
	GRAFENRHEINFELD			x					x			
	GROHNDE			x		x			x			
	GUNDREMMINGEN-B								x			
	GUNDREMMINGEN-C								x			
	ISAR-2			x					x			
	NECKARWESTHEIM-2								x			
	PHILIPPSBURG-2								x			
FR	BELLEVILLE-1	x	x		x				x			
	BELLEVILLE-2	x	x		x				x			
	BUGEY-2	x	x		x							
	BUGEY-3	x	x		x							
	BUGEY-4	x	x		x							
	BUGEY-5	x	x		x							
	CATTENOM-1	x	x		x				x			
	CATTENOM-2	x	x		x				x			
	CATTENOM-3	x	x		x				x			
	CATTENOM-4	x	x		x				x			
	CHOOZ-B-1	x	x		x				x			
	CHOOZ-B-2	x	x		x				x			
	CIVAUX-1		x									

- I1 External hazard safety cases corresponding to an exceedance probability of less than once in 10000 years should be used (I1a: for earthquakes; I1b: for flooding).
- I2 A DBE corresponding to a minimum peak ground acceleration of 0.1 g should be used.
- I3 Means needed to fight accidents should be stored in places adequately protected against external events.
- I4 On-site seismic instrumentation should be installed.
- I5 Time for restoration of the safety functions in case of loss of all electrical power and/or ultimate heat sink is less than 1 hour.
- I6 Emergency Operating Procedures not covering all plant states
- I7 Severe Accident Management Guidelines not covering all plant states
- I8 Passive measures to prevent hydrogen (or other combustible gasses) explosions in case of Severe Accident not in place
- I9 Filtered Venting Systems not in place
- I10 A backup Emergency Control Room not available, in case the Main Control Room becomes inhabitable.

		I1a	I1b	I2	I3	I4	I5	I6	I7	I8	I9	I10
CH	BEZNAU-1											
	BEZNAU-2											
	GOESGEN											
	LEIBSTADT									x		
	MUEHLEBERG											

Compilation of the EU stress test results: Good practices

		GP1	GP2	GP3	GP4	GP5
DE	BROKDORF		x	x		x
	EMSLAND	x	x	x		x
	GRAFENRHEINFELD		x	x		x
	GROHNDE		x	x		x
	GUNDREMMINGEN-B	x		x		x
	GUNDREMMINGEN-C	x		x		x
	ISAR-2		x	x		x
	NECKARWESTHEIM-2	x	x	x		x
	PHILIPPSBURG-2	x	x	x		x
FR	BELLEVILLE-1			x		
	BELLEVILLE-2			x		
	BUGEY-2			x		
	BUGEY-3			x		
	BUGEY-4			x		
	BUGEY-5			x		
	CATTENOM-1			x		
	CATTENOM-2			x		
	CATTENOM-3			x		
	FLAMANVILLE-1			x		
	FLAMANVILLE-2			x		
CH	BEZNAU-1	x	x	x	x	x
	BEZNAU-2	x	x	x	x	x
	GOESGEN	x	x	x	x	x
	LEIBSTADT	x	x	x	x	x
	MUEHLEBERG		x	x	x	x

- GP1 Existence of alternative and fully independent ultimate heat sink (good practice).
- GP2 Additional layer of safety systems fully independent from the normal safety systems, located in areas well protected against external events (for instance bunkered systems or hardened core of safety systems) (good practice).
- GP3 Additional Diesel Generators (or Combustion Turbines) physically separated from the normal diesel generators and devoted to cope with Station Black-Out, external events or severe Accident situations already installed (good practice)
- GP4 Mobile equipment especially Diesels Generators devoted to cope with Station Black-Out, external events or severe accident situations are already available (good practice)
- GP5 Additional on-site emergency control centre, from which the emergency response activities can be coordinated, should available and adequately protected against radiological and extreme natural hazards (good practice)

EU Stress Tests: Results

Outcome

- European NPPs have generally high safety standards but further improvements are needed in almost all of them

National Action Plans:

- Generic and Country specific recommendations have been established based on the results of the Peer Review
- These recommendations have been implemented in the framework of the national action plans of the participating countries

Revision of the European nuclear safety regulation

Content of the new Nuclear Safety Directive

- Introducing a high-level EU-wide safety objective
- Strengthen the role and effective independence of the national regulatory authorities
- Enhance transparency in nuclear safety and emergency preparedness and response
- Enhance accident management and on-site emergency response
- Highlighting the importance of the human factor by promoting an effective nuclear safety culture
- Set up an EU-wide system of topical peer reviews

IAEA Action Plan on Nuclear Safety

IAEA Action Plan on Nuclear Safety

Ministerial Conference on nuclear safety

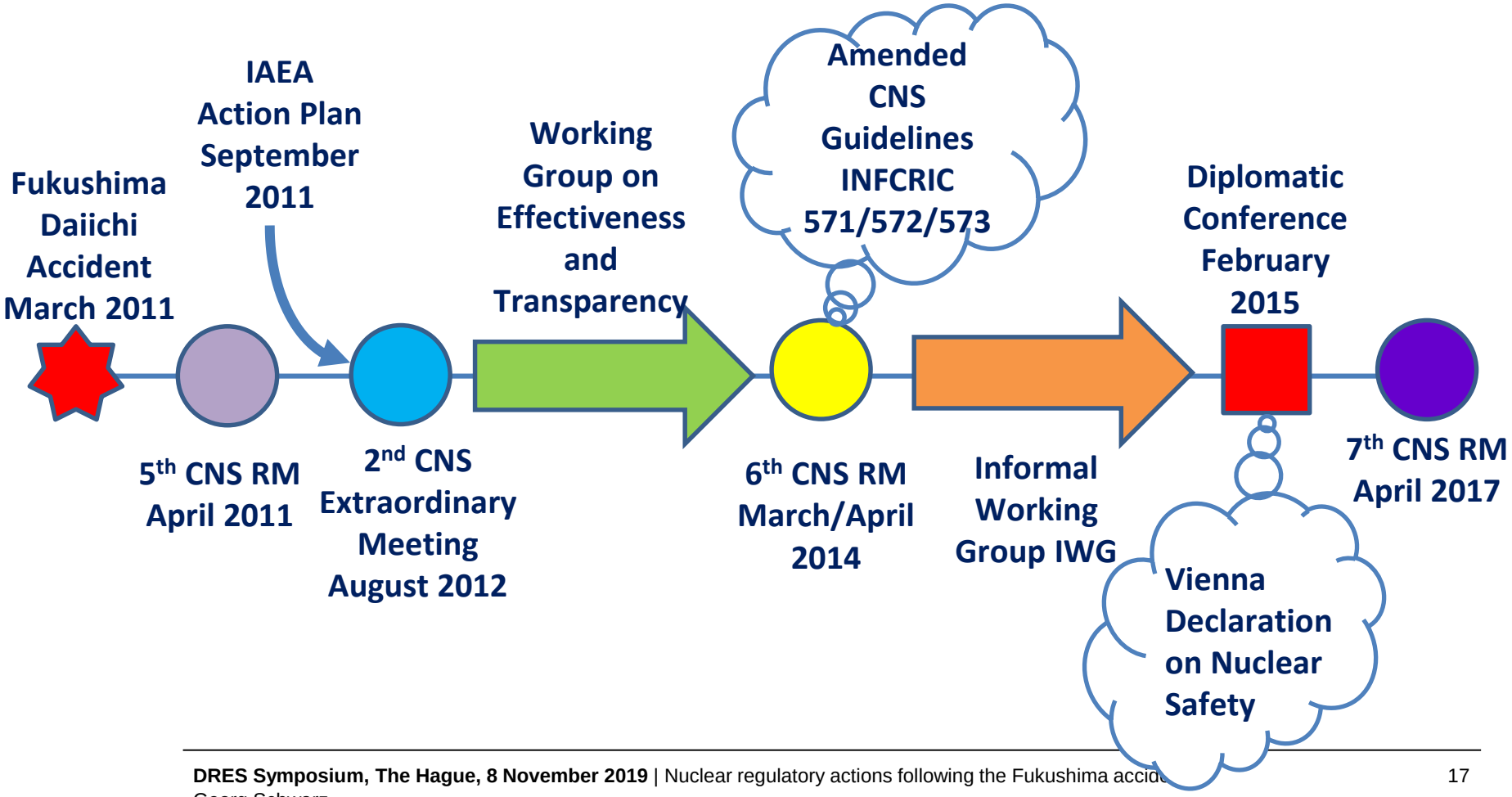
- Three months after the accident delegates from 83 States and 11 International Organizations meet in Paris
- The IAEA was requested to develop an Action Plan on Nuclear Safety

Actions of the IAEA

- Adoption of 12 measures and 39 sub-actions aiming at improving nuclear safety
- Review and revision of IAEA Safety standards
- Preparation of a comprehensive report about the Fukushima accident

Amend the CNS or improve its effective implementation?

Amend the CNS or improve its effective implementation



2nd Extraordinary CNS Meeting

Objective

- Share the lessons learnt from the accident
- Amendments proposals from Switzerland and the Russian Federation

Outcome

- No consensus on amendment proposals
- 15 action-oriented objectives for strengthening nuclear safety
- Establishment of the ‘effectiveness and transparency’ working group

6th CNS Review Meeting

Effectiveness and transparency of the CNS

- Agreement on the proposed amendments to the guidance documents.
- They provide clearer guidance on the preparation of National Reports, improvements to the review process, enhancement of international cooperation and more transparency towards the public

Diplomatic Conference

- The Contracting Parties decided by a two-thirds majority to submit the Swiss proposal to amend Article 18 to a Diplomatic Conference, for further consideration

Diplomatic Conference: Vienna Declaration on Nuclear Safety

Principle for New NPPs

- New NPPs are to be designed with the objective of preventing accidents and,
- should an accident occur, mitigating possible large releases of radionuclides

Principle for existing NPPs

- PSRs are to be carried out for existing NPPs in order to identify safety improvements that are oriented to meet the above objective.
- Reasonably practicable safety improvements are to be implemented in a timely manner

How much safer is the world today?

Main safety achievements after Fukushima

Improved safety of existing NPPs

- Comprehensive safety reassessments and back-fiitting programmes

Improved regulation

- Revision of the legally binding EU Nuclear Safety Directive
- Adoption of the non binding Vienna Declaration on Nuclear Safety

Improved transparency

- Strengthening of the International Peer Review Regime

Did we learn all lessons from Fukushima?

Draft of the updates of ICRP-109 and ICRP-111

DRAFT REPORT FOR CONSULTATION: DO NOT REFERENCE

ICRP ref: 4820-5028-4698
17 June 2019

Annals of the ICRP

ICRP PUBLICATION 1XX

Radiological Protection of People and the Environment in the Event of a Large Nuclear Accident

Update of ICRP *Publications 109* and *111*

Editor-in-Chief
C.H. CLEMENT

Reference levels for the population and responders

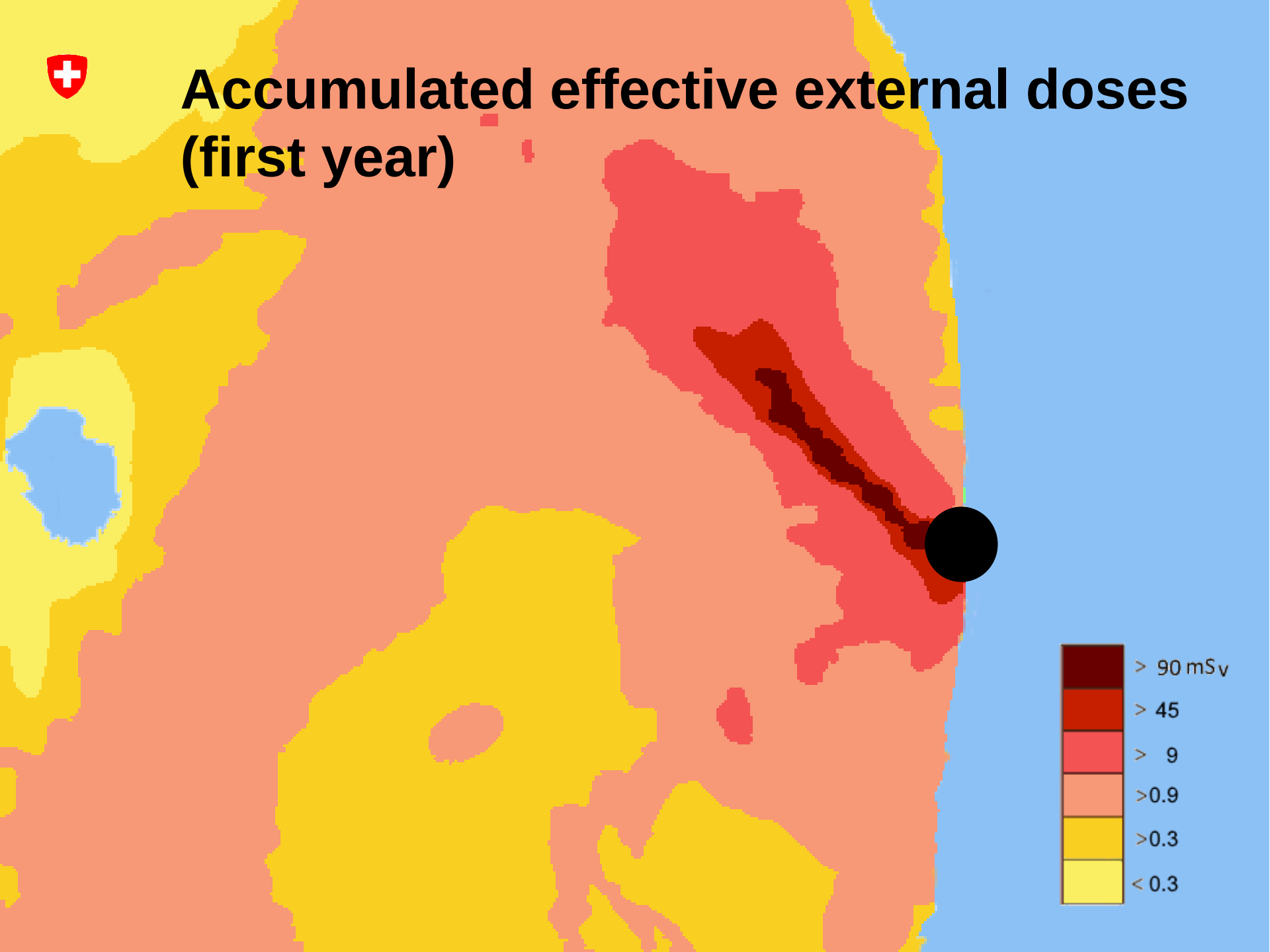
During emergency response phase

- The reference level should not generally exceed 100 mSv. It may be applicable for a short period, and should not generally exceed 1 year

After emergency response phase

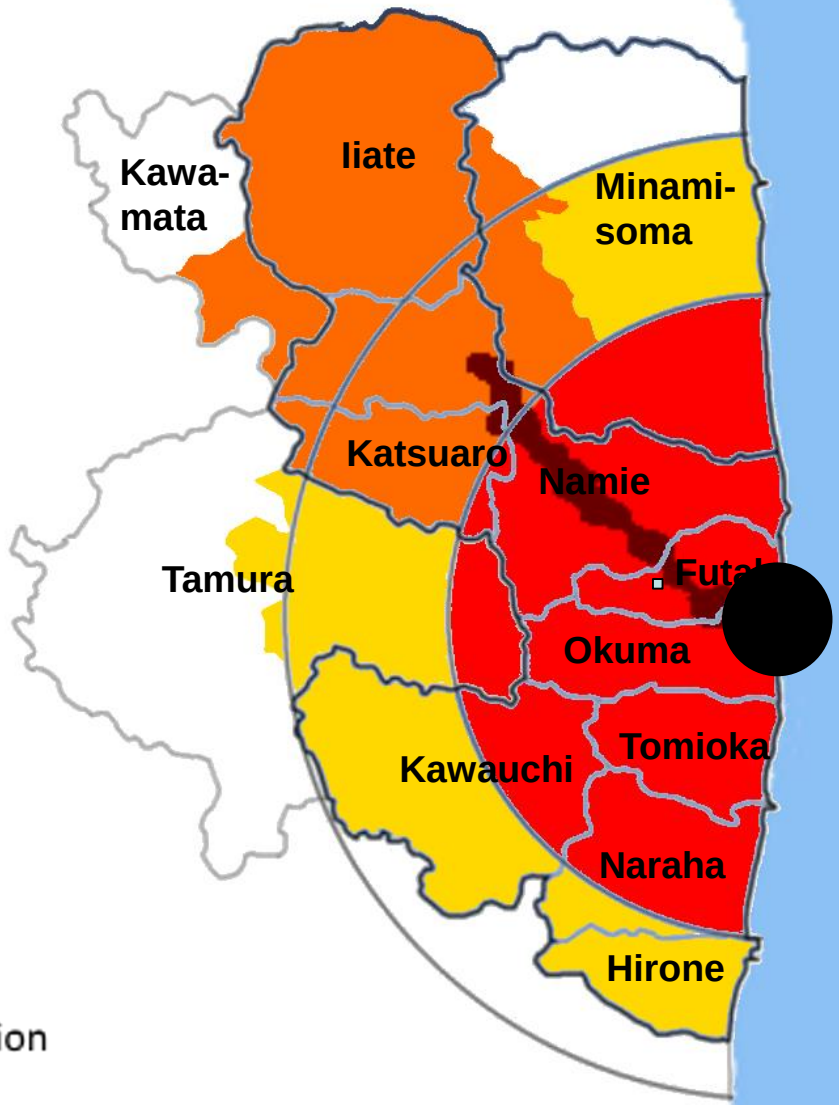
- Levels should be within or below the ICRP's recommended 1–20-mSv band, and would not generally need to exceed 10 mSv per year
- The objective of optimisation of protection is a progressive reduction in exposure to levels on the order of 1 mSv per year

Accumulated effective external doses (first year)



Evacuation zones as of 1 April 2011

Total number of evacuees: 146’520



Evacuation order zone

Planned evacuation zone

Emergency evacuation preparation zone

Evacuation of hospital patients and elderly people

Evacuation of hospital patients and elderly people

Evacuation order zone (20 km)

- Hospitals: 8 hospitals with 1240 patients
- Nursing care facilities: 17 with 980 elderly people

Evacuation

- 12 March: Evacuation order
- 13 March: Still 890 patients left in the zone
- March 14: Hurried transportation by busses to a screening point in Minamisoma

Victims

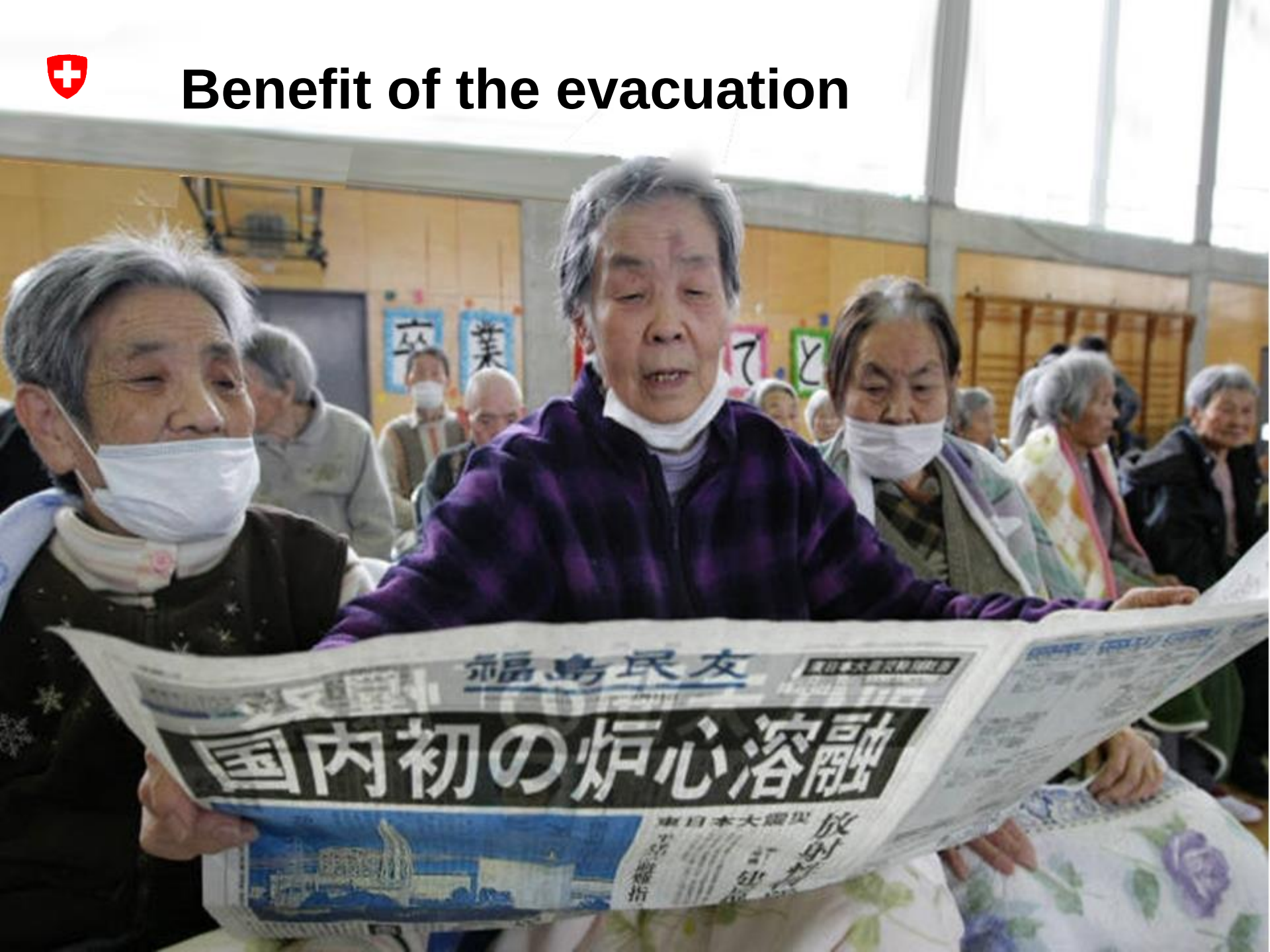
- 60 patients died during or soon after the evacuation (10 in the vehicles during transportation)

Damage of the evacuation

Indirect victims of the evacuation

Township	Inhabitants by 1 Oct. 2010	Victims by 13 March 2012	Victims by 7 Sept. 2018	Inhabitants by 1 Oct. 2018
Okuma Town	11’515	46	136	0
Futaba Town	6’932	56	171	0
Tomioka Town	16’001	94	453	0
Namie Town	20’905	184	607	0
Iitate Village	6’209	1	42	41
Katsurao Village	1’531	7	40	18
Kawauchi Village	2’820	27	99	1’981
Kawamata Town	15’569	0	29	13’398
Tamura City	40’422	1	14	36’716
Naraha Town	7’700	31	151	976
Hirono Town	5’418	3	48	3’971
Minamisoma City	70’878	638	1149	54’455
Total	**205’900**	**1’088**	**2939**	**111’556**

Benefit of the evacuation



Benefit of the evacuation

Township	Number of evacuees	Averted individual dose [mSv]	Averted collective dose [PersSv]	Detriment adjusted cancer cases
Tomioka Town	16’000	48.0	768	43.8
Okuma Town	11’500	45.0	518	29.5
Futaba Town	6’900	37.0	255	14.6
Naraha Town	7’710	3.5	27	1.5
Namie Town	20’900	19.0	397	22.6
Tamura City	4’600	-2.0	-9	-0.5
Minamisoma City	61’710	-1.3	-77	-4.4
Hirono Town	5’400	3.0	16	0.9
Kawauchi Village	2’800	-1.3	-4	-0.2
Katsurao Village	1’600	1.0	2	0.1
Iitate Village	6’200	3.0	19	1.1
Kawamata Town	1’200	-7.3	-9	-0.5
Total	**146’520**	**12.3**	**1’903**	**108.4**

UNSCEAR 2013 Report; SCIENTIFIC ANNEX A: Levels and effects of radiation exposure due to the nuclear accident after the 2011 great east-Japan earthquake and tsunami. P. 191

Justification of measures