

WENRA

Updating the reference levels for existing reactors in the light of TEPCO Fukushima Dai-ichi accident lessons learned

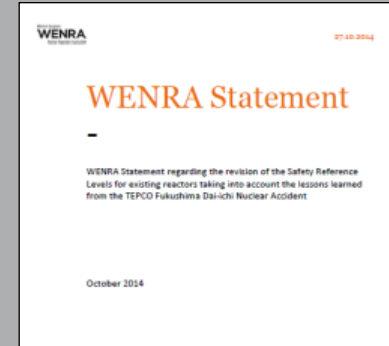
Fabien Féron
Reactor Harmonization Working Group chair

Agenda

- WENRA reference levels (RLs) for existing reactors
 - Overview of WENRA publications
 - 2006 – 2011
- WENRA and EU response to Fukushima Dai-ichi accident
- Updating the RLs in the light of Fukushima Dai-ichi accident
 - Process followed
 - New set of RLs
- Conclusion and outlook

WENRA Reference Levels for existing NPP

Overview of WENRA publications



WENRA Conclusions arising from the Consideration of the Lessons from the TEPCO Fukushima Dai-ichi Nuclear Accident (May 2012)



2006

2007

2008

2011

2012

2014

Harmonisation of Reactor Safety in WENRA Countries (Main Report, Jan 2006)

Update of RLs

Western European Nuclear Regulators' Association
REACTOR HARMONIZATION WORKING GROUP

WENRA Reactor Safety Reference Levels
January 2008

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A. Safety Policy	5
B. Operating Organisations	7
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E. Design Basis Review for Existing Reactors	10
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Q. Plant Modifications	36
R. Core in Emergency: Fuel Elements	38
S. Provisions against Internal Fires	41

RLs for Operating Reactors (Jan 2008)

Progress towards Harmonisation of Safety for Existing Reactors in WENRA Countries (Jan. 2011)

Report
WENRA
Safety Reference Levels for Existing Reactors

UPDATE IN RELATION TO THE TEPCO FUKUSHIMA DAICHI NUCLEAR ACCIDENT

24th September

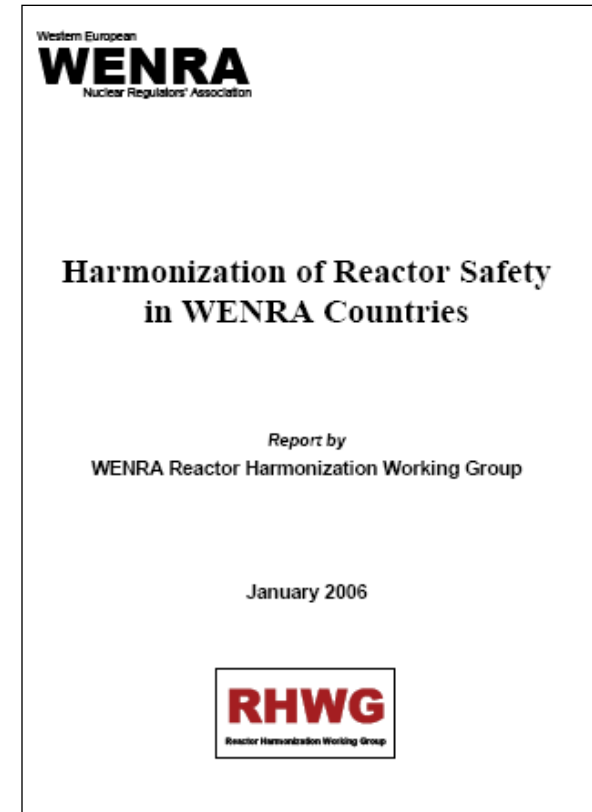
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WENRA
Safety Reference Levels for Existing Reactors

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WENRA Reference Levels for existing NPPs 2006-2011

- Established in 2006, updated in 2007 and 2008
- Set of **about 300 consensual reference levels (RLs)** throughout WENRA countries
 - Safety management
 - safety policy, operator's organization,
 - quality management, training and certification
 - Design
 - design check and improvement, safety classification, design envelope of light-water reactors
 - Operation
 - operating limits and conditions, ageing management
 - experience feedback, maintenance, accident procedures, accidents beyond the design basis
 - Safety verification
 - contents of the safety report, PSA, re-examinations, changes
 - Emergency situations
 - on-site emergency preparedness, internal fires
- Status report published by WENRA in March 2011



WENRA RLs for existing NPPs

2008 version

Safety area	Issue	Number of RLs
Safety Management	A – Safety Policy	8
	B – Operating organisation	15
	C – Management system	23
	D – Training and autorisation of NPP staff	15
Design	E - Design basis envelope for existing reactors	44
	F – Design extension of existing reactors	12
	G – Safety classification of structures, systems and components	7
Operation	H – Operational limits and conditions	19
	I – Ageing management	8
	J – System for investigation of events and operational experience feedback	16
	K – Maintenance, in-service inspection and functional tests	20
	LM – Emergency operating procedures and severe accident management guidelines	14
Safety verification	N – Contents and updating of safety analysis report	16
	O – Probabilistic safety analysis	16
	P – Periodic safety review	9
	Q – Plant modifications	15
Emergency preparedness	R – On-site emergency preparedness	18
	S – Protection against internal fire	20

**overall,
295 RLS**

WENRA response to Fukushima Dai-ichi accident

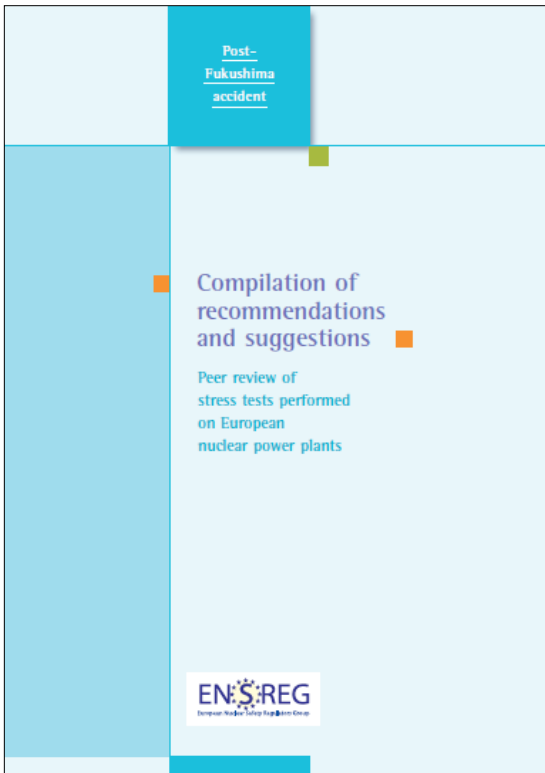
Learning from the accident

- **Spring 2011** : development of a specification for the EU Stress Tests
- **Spring 2012** : WENRA Conclusions arising from the Consideration of the Lessons from the TEPCO Fukushima Dai-ichi Nuclear Accident
 - WENRA is ready to tackle further issues as necessary on the basis of the lessons learned from the Fukushima accident. WENRA's commitment is to proceed along the path of **defining or revising existing RLs** as well as developing guidance documents for practical use by regulators.
 - Creation of new working groups in the RHWG:
 - **T1 Natural Hazards**
 - WENRA will produce updated harmonised guidance for the identification of natural hazards, their assessment and the corresponding assessment for “cliff-edge” (margins) effects. **RLs will be updated accordingly.**
 - **T2 Containment in Severe Accident**
 - WENRA will **review RLs** in light of the various measures identified to prevent containment overpressurisation, including those relevant for hydrogen mitigation and containment venting, **and modify them if necessary.**
 - **T3 Accident Management**
 - WENRA will **review RLs** in light of the various measures identified in relation to organisational and material arrangements for preventing or mitigating a significant radiological release, **and modify them if necessary.**
 - **I.4 Mutual assistance**
 - WENRA will put in place arrangements for mutual assistance amongst regulatory bodies in responding to nuclear accidents in one of its members' states.
 - The results from the stress tests and conclusions from the CNS 2012 will be incorporated as soon as they become available.

WENRA and EU response to Fukushima Dai-ichi accident

EU stress tests outcome

- 2012 EU stress test peer review
 - “The peer review Board recommends that WENRA, involving the best available expertise from Europe, develop guidance on natural hazards assessments, including earthquake, flooding and extreme weather conditions, as well as corresponding guidance on the assessment of margins beyond the design basis and cliff-edge effects”
 - The peer review Board recommends “The incorporation of the WENRA reference levels related to severe accident management (SAM) into their national legal frameworks, and ensure their implementation in the installations as soon as possible.”

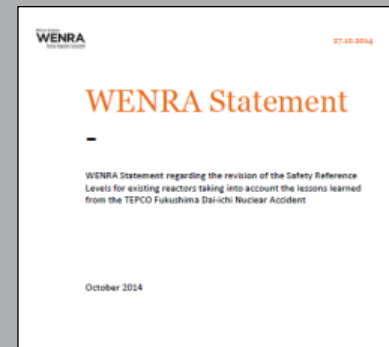


WENRA RLs for existing NPPs

Updating the RLs in the light of Fukushima Dai-ichi accident

The proposal by the WENRA Task Force about "Stress tests" specifications (April 2011)

WENRA Conclusions arising from the Consideration of the Lessons from the TEPCO Fukushima Dai-ichi Nuclear Accident (May 2012)



Western European
WENRA
Nuclear Regulators Association

2011

2012

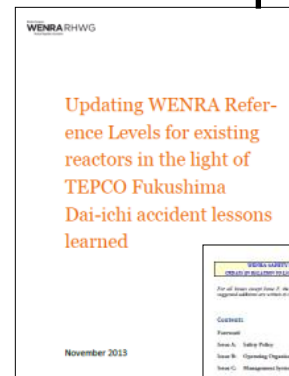
2013

2014

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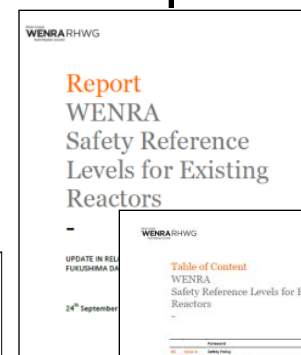


WENRA Position Paper on Periodic Safety Reviews (April 2013)



Public consultation on draft updated RLs (Nov. 2013)

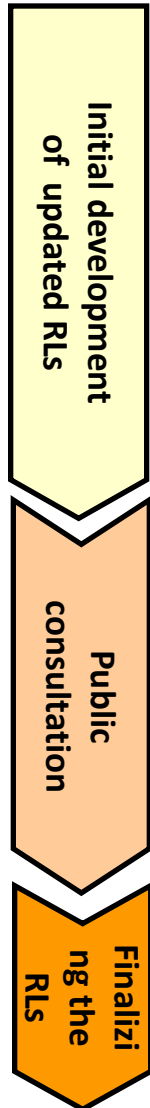
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WENRA RLs for existing NPPs

Update in the light of Fukushima Dai-ichi accident (1/7)



- Initial review of the RLs and decision to revise
 - Defining a methodology to perform the review and revision
 - Various Inputs (within WENRA or from other sources)
 - Drafting by T1, T2 and T3 working groups as well as some RHWG members
 - Collective review by RHWG : 4 meetings
 - (September 2012 ; January, May and September 2013)
- Public consultation on WENRA website (Nov 2013 – Feb 2014)
 - Draft updated RLs
 - RHWG report describing the process followed and main changes
- Finalizing the update
 - Disposition of comments submitted by stakeholders
 - Collective review by RHWG : 1 meeting (May 2014)
 - WENRA approval

WENRA RLs for existing NPPs

Update in the light of Fukushima Dai-ichi accident (2/7)

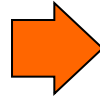
Extraordinary meeting of the CNS (August 2012)



Newly national published or under development regulation or regulatory guidance “generated” by Fukushima accident.

This would allow RHWG (and the WGs) to consider them as potential RLs.

Western European
WENRA
Nuclear Regulators' Association



Inputs for the review and revision of the RLS



ENSREG
European Nuclear Safety Regulators Group

WENRA WG T1

WENRA WG T2

WENRA WG T3

WENRA WG I3



IAEA review/revision of safety standards : DS462DO for revision of IAEA requirements

IAEA Gap analysis was performed against requirements published (or approved) mid-2011. RLs were established taking into account 2007 safety standards

EU stress tests
ENSREG peer review report + ENSREG compilation of (EU wide + national) recommendations

ENSREG peer review report covered quite well the topic. National reports could be considered as national gap analysis.

Booklet on new NPPs

Each WG work is focused on the topic it address, not on a specific issue (e.g. : issue LM for WG T-3 on accident management) of the RLS

WENRA RLs for existing NPP

Update in the light of Fukushima Dai-ichi accident (3/7)

Area where
most
changes
occurred

A	Safety Policy
B	Operating organisation
C	Management system
D	Training and autorisation of NPP staff
E	Design basis envelope for existing reactors
F	Design extension of existing reactors
G	Safety classification of structures, systems and components
H	Operational limits and conditions
I	Ageing management
J	System for investigation of events and operational experience feedback
K	Maintenance, in-service inspection and functional tests
LM	Emergency operating procedures and severe accident management guidelines
N	Contents and updating of safety analysis report
O	Probabilistic safety analysis
P	Periodic safety review
Q	Plant modifications
R	On-site emergency preparedness
S	Protection against internal fire
T	Natural hazards

New issue



23 April 2015

WENRA RLs for existing NPP

Update in the light of Fukushima Dai-ichi accident (4/7)

- For about half of the issues, there have been either no or only very limited changes.
- The issues where there have been the **most significant changes** are:
 - issue A (Safety Policy);
 - issue C (Management System). RLs relevant to safety culture have been introduced;
 - issue E (Design Basis Envelope for Existing Reactors);
 - issue F (Design Extension of Existing Reactors). Design extension conditions have in particular been introduced for consistency with IAEA SSR-2/1 safety standard, as well as the need for independent and diverse heat removal means, one being effective for natural hazards exceeding the design basis;
 - issue LM (Emergency Operating Procedures and Severe Accident Management Guidelines);
 - issue N (Contents and Updating of Safety Analysis Report);
 - issue O (Probabilistic Safety Analysis);
 - issue P (Periodic Safety Review);
 - issue R (On-site Emergency Preparedness);
- A new issue (**Issue T**), dedicated to natural hazards, has been established.
 - This issue has a strong interface with issues E and F.

WENRA RLs for existing NPP

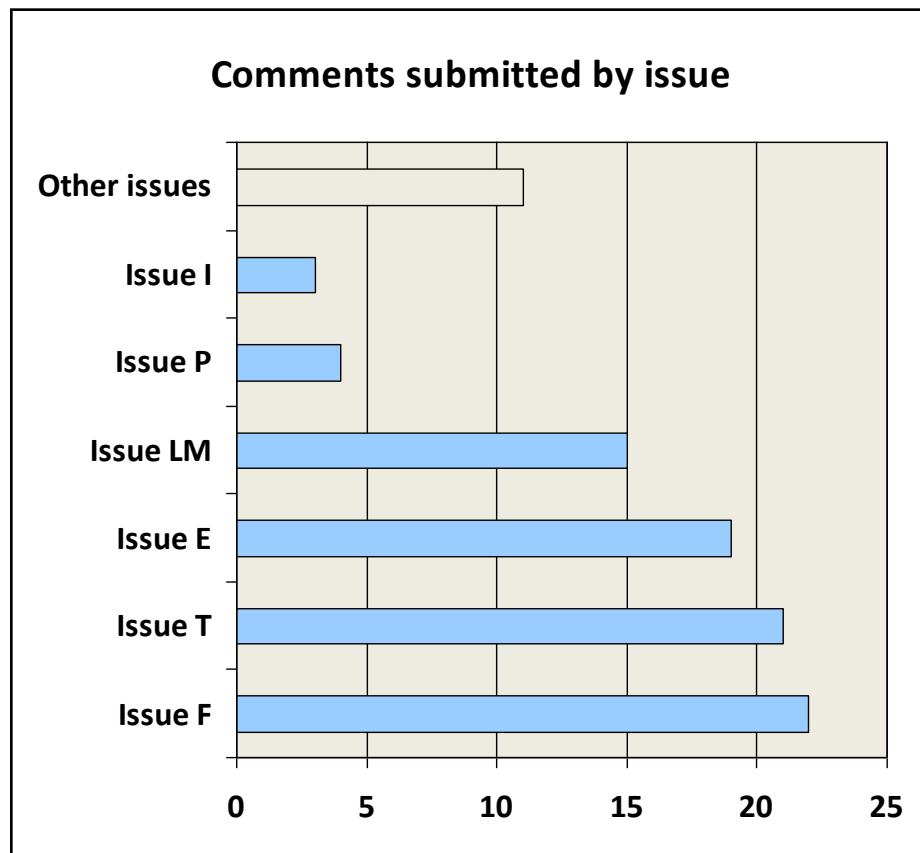
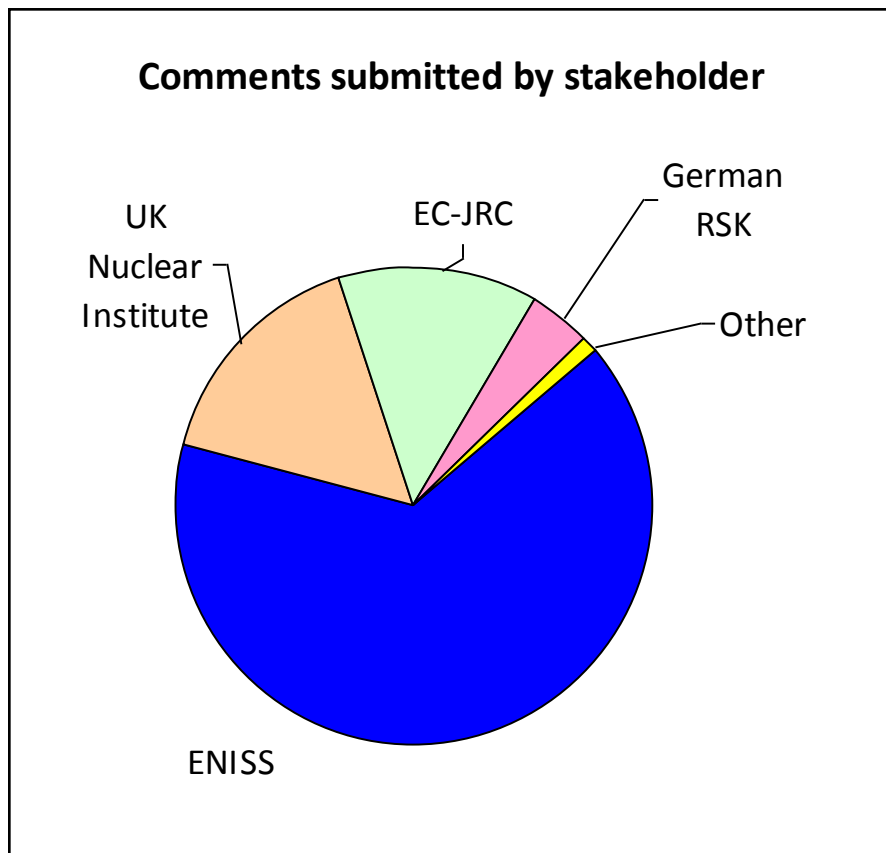
Update in the light of Fukushima Dai-ichi accident (5/7)

- In many cases, changes have been introduced to explicitly take into account
 - spent fuel storage,
 - sites with multiple reactors,
 - actual conditions at the site resulting from an accident (including those which may be caused by a natural hazard),
 - conditions more severe than the ones considered in the design basis of the plant, or
 - the need to ensure **relevant equipment or facilities will remain unaffected** so that foreseen actions to respond to an accident can be implemented.

WENRA RLs for existing NPPs

Update in the light of Fukushima Dai-ichi accident (6/7)

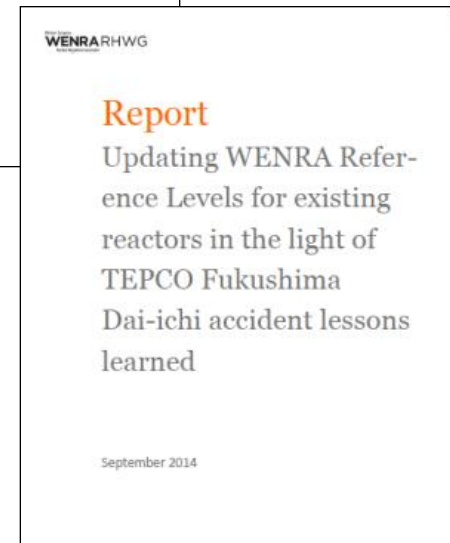
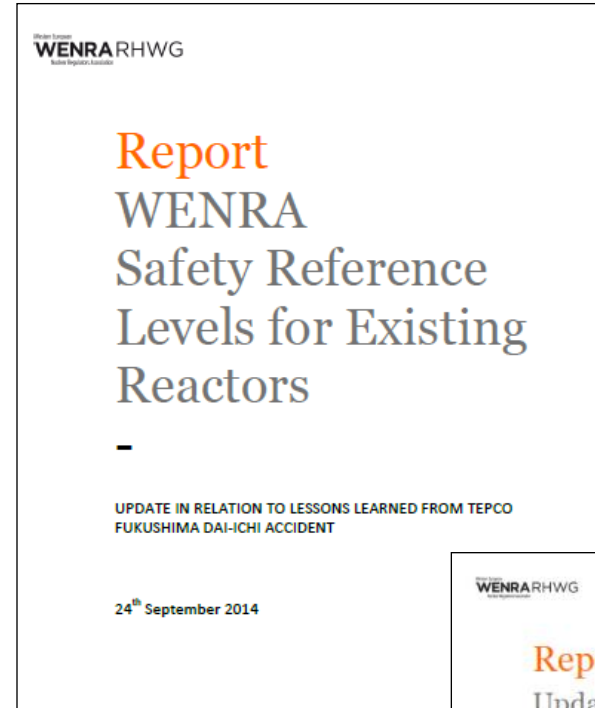
95 were received



WENRA RLs for existing NPPs

Update in the light of Fukushima Dai-ichi accident (7/7)

- Stakeholders comments were reviewed and, where appropriate, some changes were introduced into the draft RLs
- **The final version of the draft was submitted to WENRA and the final set of RLs was published in September 2014**
 - RHWG updated its report “Updating WENRA Reference Levels for existing reactors in the light of TEPCO Fukushima Dai-ichi accident lessons learned” to address the stakeholder comment disposition process and conclusion



WENRA RLs for existing NPP

2014 version

(1/3)

Safety area	Issue	Number of RLs
Safety Management	A – Safety Policy	9
	B – Operating organisation	15
	C – Management system	26
	D – Training and authorization of NPP staff	15
Design	E - Design basis envelope for existing reactors	46
	F – Design extension of existing reactors	25
	G – Safety classification of structures, systems and components	7
	T – Natural hazards	19
Operation	H – Operational limits and conditions	19
	I – Ageing management	8
	J – System for investigation of events and operational experience feedback	16
	K – Maintenance, in-service inspection and functional tests	20
	LM – Emergency operating procedures and severe accident management guidelines	20
Safety verification	N – Contents and updating of safety analysis report	17
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**overall,
342 RLS**

- **Natural Hazards**

- *T1.1 - Natural hazards shall be considered an integral part of the safety demonstration of the plant (including spent fuel storage). Threats from natural hazards shall be removed or minimised as far as reasonably practicable for all operational plant states. The safety demonstration in relation to natural hazards shall include assessments of the design basis and design extension conditions with the aim to identify needs and opportunities for improvement.*

- **Design Extension of existing Reactors**

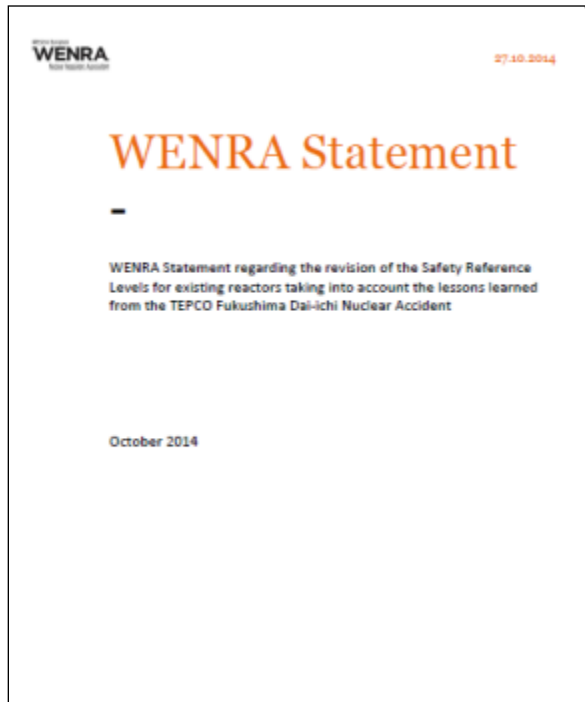
- *F1.1 As part of defence in depth, analysis of Design Extension Conditions (DEC) shall be undertaken with the purpose of further improving the safety of the nuclear power plant by*
 - *enhancing the plant's capability to withstand more challenging events or conditions than those considered in the design basis,*
 - *minimising radioactive releases harmful to the public and the environment as far as reasonably practicable, in such events or conditions.*

- Some key changes introduced in the RLs
 - Natural hazards (new issue T)
 - Safety culture
 - Safety of spent fuel pools
 - Sites with multiple reactors
 - Conditions at the site after an accident
 - Need for independent and diverse heat removal means
 - Beyond design basis conditions including margins

WENRA RLs for existing NPP

WENRA statement on 2014 version

WENRA Statement regarding the revision of the Safety Reference Levels (SRLs) for existing reactors taking into account the lessons learned from the TEPCO Fukushima Dai-ichi Nuclear Accident - October 2014



... WENRA members are committed to continuous improvement of nuclear safety in their countries. Within this spirit WENRA emphasizes identifying the insights from the Fukushima Dai-ichi accident in March 2011 and operators improving NPP safety accordingly. For this purpose, WENRA mandated its Reactor Harmonization Working Group (RHWG) to review and revise the SRLs for existing reactors with the aim to integrate the lessons learned from the 2011 Fukushima Dai-ichi accident.

The SRLs that have been developed represent, in addition to good practices in WENRA countries, objectives for safety improvements to take account of the lessons learned from the Fukushima accident.

The national regulators make a commitment to improve and harmonize their national regulatory systems, by implementing the new SRLs until 2017 as a target date.

....

RHWG work

Outlook

- Post Fukushima Daiichi actions :
 - Updating the RLs task was finalized in 2014
 - Developing guidance on issue F (design extension) was felt necessary and has been completed
 - Developing guidance on natural hazards (earthquake, floods, extreme weather) is still ongoing

- Future tasks
 - Overall review of the RLs, to take account of new IAEA publications and safety development
 - Initiate work on new topics, having safety implications both on existing and new reactors (passive systems,....)

Thank you

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- **Issue A (Safety Policy)**

- New RL on the timely implementation of reasonably practicable safety measures as well as continuous improvement of NPP safety.
 - This new RL widens the scope of application of continuous improvement which was contained within specific issues.
- Wording of A2.3 was improved and a sentence was added to express the idea that continuous improvement applies to all nuclear safety activities, thus avoiding repeating it in other issues (for example in E11.1 or F5.1). Timely implementation of reasonably practicable safety improvements is also stressed.

2014 RLs :

Changes introduced compared to the 2008 RLs

(2/9)

- **Issue C (Management System)**

- New section “7.” on safety culture.
- Three RLs (C7.1 to C7.3) have been developed to express the need for licensees and their contractors to develop and sustain a strong safety culture with emphasis on the role of the management in supporting and demonstrating safety culture.

- **Issue E (Design Basis Envelope for Existing Reactors)**
 - Changes to issue E are mainly clarifications, with the exception of changes introduced to high-light the need to consider spent fuel storage safety (E3.1, E9.8, E9.9, E10.1, E10.6) and to address the interface with the new issue T on natural hazards (E5.2).
 - New RLs on attributes
 - to support a sound safety analysis (E8.7) and
 - to take into account site-wide issues when several reactors are collocated (E9.5).
 - E11.1 (Review of the design basis) was reworded because the principle of “continuous improvement” is now only addressed in A2.3 but is valid for all issues.

• Issue F (Design Extension of Existing Reactors)

- The whole issue F was revisited and its structure was changed.
- Interfaces with issue E (Design Basis Envelope for Existing Reactors) and the new issue T (Natural Hazards) warranted specific attention, as well as the use of the concept of “Design Extension Conditions” (DEC) as established in IAEA SSR-2/1 safety standard (Safety of Nuclear Power Plants: Design – Safety Requirement 2012).
- New/modified RLs:
 - address safety of spent fuel storage;
 - clearly express whether they are applicable to DEC involving a severe accident (DEC-B) or to DEC not involving a severe accident (DEC-A);
 - clarify how DEC to be addressed in safety analysis will be identified (F2.1 to F2.3);
 - explicit goals of DEC analysis as well as attributes of the safety analysis of the selected DEC;
 - address adequate qualification and operability of (mobile) equipment used to manage DEC;
 - address sites where several reactors are collocated;
 - require independent and diverse heat removal means, one of them being effective for natural hazards more severe than the one used for design basis (F4.7);
 - address availability of I&C, electric power and control room to manage a DEC (F4.7, F4.16 to F4.18).
- The necessity to ensure sufficient margins to “cliff edge effects” is now only expressed in F3.1 as part of the DEC analysis.
- When needed, “core damage” was replaced by “fuel damage” to stress that not only the fuel in the core has to be considered but also the fuel in the spent fuel storage.
- Similar to E11.1 (Review of the design basis), F5.1 (Review of the design extension conditions) was reworded because the principle of “continuous improvement” is now only addressed in A2.3 but is valid for all issues.

2014 RLs :

Changes introduced compared to the 2008 RLs (5/9)

- Issue LM (Emergency Operating Procedures and Severe Accident Management Guidelines)
 - New/modified RLs:
 - address spent fuel storage safety as well as accidents compromising safety of fuel both in the reactor and in the spent fuel storage;
 - address sites with multiple reactors, both considering that all units may be challenged or that one unit may support another;
 - prioritise relying on adequately qualified equipment for the implementation of SAMG;
 - stress the need to carefully consider potential site conditions to ensure measures envisaged in EOP or SAMG can actually be implemented if needed;
 - extend training to all licensee emergency response personnel and expect drills to reflect realistic conditions as far as practicable.
 - Stakeholder comments resulted mostly in the possibility to use not only EOP and SAMGs but also other specific procedures and guidelines.

- **Issue N (Contents and Updating of Safety Analysis Report)**

- Improving consistency with issue F by referring to DEC, insisting on identification of safety margins (N2.7) and update of information related to site characteristics (N3.1).
- New RL (N2.14) to address safety of sites with multiple units.

- **Issue O (Probabilistic Safety Analysis)**

- Changes to O1.1 with respect to how natural hazards are (or not) included in level 1 PSA and to the need to include spent fuel storage in level 1 and 2 PSA.
- Need to consider:
 - appropriate mission time for equipment in PSA (O1.4);
 - all plant staff and not only control room operators in human reliability analysis (O1.5).
- As a result of stakeholder comments, O1.1 was reworded on the operational states and internal and external initiating events to consider in the PSA.

- **Issue P (Periodic Safety Review)**

- Changes to insist on:

- the determination of safety significance of each PSR findings (P3.2);
- the timely implementation of reasonably practicable safety improvements (P1.4);
- the need to identify safety issues which may limit the future safe operation of the plant and measures taken by the licensee to address them (P1.5).

- Clarification of the scope of PSR (P2.2) to increase consistency with IAEA SSG-25 safety standard (Periodic Safety Review for Nuclear Power Plants, Safety Guide 2013) and to clarify that interaction between reactors at the same site have to be considered.

- the listing of areas which have to be considered in the PSR (P2.2) was replaced by the 14 safety factors used in IAEA SSG-25.

- **Issue R (On-site Emergency Preparedness)**

- Changes to improve the consideration of accidents affecting several reactors at the same site (R1.1, R2.3, R5.4), long lasting accidents (R2.3, R3.2) or events where regional infrastructure might be severely disturbed (R3.6, R3.7).
- Emphasise the need for effective measures for emergency management. This covers the need for:
 - adequate emergency facilities, designed to ensure workers radiation safety and enable emergency management (R4.3);
 - appropriate procedures and (mobile) equipment to manage the emergency (R4.4);
 - sufficient staff (R3.2) who have been appropriately trained (R5.1, R5.3), including through drills and exercises (R5.4). Where contractors are expected to contribute to emergency management, training requirements are applicable (R5.3);
 - measures to accommodate long lasting situations (R2.3, R3.2) as well as the situation where site or regional infrastructure would be severely disrupted (R3.6, R3.7, R4.4).
- The potential use of mobile equipment, its associated storage and its use in drills/exercises are also explicitly covered (R4.4, R5.4).

- **New issue T and new associated RLs to address natural hazards**
 - After stating the objective of removing or minimizing the threats from natural hazards to the plant, the proposed RLs cover the screening and assessment of natural hazards which might challenge the safety of the reactor. The RLs within this issue address:
 - screening of hazards relevant to the site;
 - how design basis events shall be identified. A target of 10-4/y for event selection, as well as a 0.1g minimum PGA, are set;
 - the need to develop a protection concept to minimize threats to the plant, relying preferably on passive features;
 - the consideration of events that may exceed the design basis, to ensure that the design basis chosen is sound and that sufficient margins exist before cliff edge effects may occur.
 - As for earthquake resistance, T4.2 was discussed extensively in the commenting process because of the 0.1g horizontal peak ground acceleration value and the potential consequences for existing reactors. In a related footnote, it is now stated that “methods such as those mentioned in IAEA NS-G-2.13 may be used” to demonstrate the plant is protected against such an earthquake. More explanation will also be given in the guidance being developed on issue T.