NTW
NUCLEAR TRANSPARENCY WATCH

Minutes of the Nuclear Transparency Watch Workshop

"Ageing of nuclear power plants in Europe: a threat to nuclear safety?"

March 19th 2014
European Parliament of Brussels

Brussels, April 9th 2014

Table of Contents

Context

Around one third of the European nuclear reactors are today over 30 years old. All European nuclear regulators and utilities are facing problems linked to this ageing of the fleet, which should be broadly understood as the physical degradation of structures, system and components (SSC) as well as the obsolescence of technologies, design, and losses in the transmission of human know-how.

Ageing directly impacts the possibilities of lifetime extension of nuclear facilities, one of the two key challenges (with nuclear waste) identified by the European Commission in its Strategic Energy Technology Plan. In this framework, the Commission proposed to add new Community safety objectives to the existing safety directive[1] so that plant life-time extension "does not expose the workers and the public to additional risks". The importance of ageing has also been directly acknowledged by the European Nuclear Energy Forum and more specifically by its Working Group on risks, which is drafting a proposal for a Commission recommendation on “harmonized conditions for the safe long-term operation of Nuclear Power Plants (LTO) in the European Union”[2]. This proposal defines among others the responsibilities of license holders as well as of regulatory authorities in charge of implementing harmonised safety LTO conditions.

For their part civil society organizations have taken the topic of ageing and its impacts on safety in hand but with few possibilities of expression. According to its engagement for the application of the Aarhus convention NTW is willing to organize an open discussion with MEPs, regulators and members of the civil society, in order to increase the transparency of the reflections already taking place.

[1] Directive 2009/71/Euratom establishing a Community framework for the nuclear safety, in revision. See (27) p17 of the Council proposal.
[2] On the basis of Directive 2009/71/EURATOM

Introduction by Michèle Rivasi, Chair of NTW

The aim of this workshop is to provide information to guarantee a high level of nuclear safety at the EU level. An increased participation of civil society means more questioning and a better safety. The absence of a European accident similar to the one in Fukushima depends on the attention put on safety issues.
In Europe, 46 of 151 reactors are now over their designed life time and the 25 oldest are over 35 year old.
These facts will impact the future European energy policy: electricity supply could be affected by the occurrence of an ageing problem on a highly standardized fleet; investments for safety directly threaten the economical profitability of a NPP; and last but not least, the decrease in safety margins involves a new risk that has to be taken into account.

Session I: Ageing processes

1. Technical characteristics of ageing processes and their impacts on nuclear safety

Speaker: Simone Mohr, Senior Researcher, Ökoinstitut

"Reactor lifetime extension and power uprating are leading to a progressive decrease in the safety level of the older reactors in Europe."

Presentation's aims: mapping out of the aspects of physical, technical and conceptual ageing.
Plant Lifetime extension means operation near or above design-limits.
Plant Life Management (PLiM) programs get essential.
Some European countries have PLiM program, some have none.

Overview of the situation in Europe:

- 29 years in average. In 2015, more than 50% of the European reactors will be over 40 years old. Beznau (Switzerland) is the oldest one with 45 years.
- The original life-time was between 30 and 40 years. Most of the EU's countries have planned a life-time extension up to 60 years.
- Age structure by country: some countries had to phase-out reactors after exceeding the design life time (Netherlands, Switzerland).

Problems linked to PLEX: physical ageing

- Vessel neutron irradiation causes increasing embrittlement of the steel and weld seams.
- Operating conditions induce thermal and mechanical stresses, leading to material fatigue. Existence of corrosion mechanisms, especially stress corrosion cracking.

- The replacement of the reactor pressure vessel and of the containment is nearly impossible for economic and practical reasons.

June 2012 in Belgium: discovery of flaws in the reactor pressure vessel of Doel 3 and Tihange 2. Continued operation of Doel 3 and Tihange 2 is permitted in spite of reduced safety margins concerning the integrity of the RPVs and uncertainties as to the further development of the flaws, initiated by manufacturing effects. Both reactors are nearly 30 year old and upgraded.

Other case of ageing: Switzerland: cracks at the core shroud welds at Mühleberg NPP. The original safety margins have been gradually decreased: The critical crack length was recalculated twice before the cracks had finally exceeded the initially calculated critical value. RPV-Internals like core shrouds have important safety functions.

Conceptual and technological ageing: concerns particularly the site specific basic design of all plants. "Comprehensive back fitting measures are not always conductible and sometimes impossible."

Some components are regarded as "non-conventional part" so "not safety essential", like the unit transformers. Nevertheless, this interface between the NPP and the grid often gives raise to accidents (example of Forsmark 1 and Forsmark 3 in Sweden).
Ageing means a propagating increase in the gap between the safety requirements according to the state of scientific and technological knowledge and the plant condition with or without retrofitting.

Ageing phenomena can be exacerbated by power uprating policies: Reactor lifetime extension and power uprating are leading to a progressive decrease in the safety level of the older reactors in Europe. That can initiate incidents and worsen the course of accidents.

2. Safety assessment of nuclear reactors ageing.

Speaker: Frédéric Ménage, Assistant to the safety expertise director, IRSN (French Institute for Radiological Protection and Nuclear Safety)

"These measures have a cost but they cost far less than an accident."

NPP are designed with a given lifetime in mind, no matter if there are regulatory limits or not (French case). In France, the design life-time is 40 years.

Two conditions are necessary for the prolongation of a reactor operation:

- The demonstration of the management of time dependent effects. Time dependant effects include plant modifications, obsolescence management, human resources, knowledge management, new threat or vulnerabilities through changes in industry and environment.

- A decrease in the safety gap between old and new NPP. The main tools to do so are the periodic safety reviews (PSR) that aim to prevent accidents and decrease their possible consequences.

Ageing management relies on the availability and effectiveness of all systems, structures and components important for safety: The replaceable one (electrical cables, valves…) and the non-replaceable (reactor pressure vessel, containment building…).
It includes: the knowledge of degradation mechanisms, the evaluation of the effectiveness of maintenance to detect ageing issues (and their effectiveness), the periodical check of components (+ repairing).

In case of life time extension, the safety demonstration should be extended too and operators should perform new tests to keep qualification for longer timespan.

Periodic safety reviews are the main tool to reduce the gap between the safety standards of old and new power plants. The objectives of these reviews are the new standards.
Enhancing the prevention of accidents goes with an enlargement of the scope of the "design" accidents by adding new scenarios to safety analysis report (for example, accidents specific to shutdown states) and by lengthening the time for operator actions from 20min to 30min.

3. Other ageing related issues: ageing of human know-how and technology, what can the JRC do in this field?

Speaker: Peter Hähner, head of Unit, Nuclear Reactor Integrity Assessment and Knowledge Management, Joint Research Center

"There is no clear correlation between the age of a NPP and its safety performances".

Presentation of the JRC, the "in house science service of the EC" to support EU policies.
Presentation of research fields concerning ageing mechanism:

- Corrosion and stress corrosion cracking of reactors internals and fuel cladding materials: classification of environmental factors (temperature, mechanical stress, water chemistry, neutron irradiation)
- Irradiation effect: embrittlement of the reactor pressure vessel
  Description of the "late blooming phase" which relies on the assumption that the embrittlement accelerates at high neutron fluences (so with the PLEX).
- Multimetalic welds: aim of investigations: assure the integrity of dissimilar metal welds components. Benchmark exercises were performed throughout Europe.
- Thermal fatigue: very complex phenomenon because of cyclic loading at various time scales. A methodology is proposed to monitor the behaviour of real components through laboratory testing.

The JRC and the German Gesellschaft für Reaktor Sicherheit are also developing a knowledge base for ageing mechanisms with two aims: consolidate and aggregate knowledge. This database is completed with a surveillance database: the date compiled by the AIEA on RPV embrittlement have been converted into a web enabled database. The technics are standardized to evaluate reactor embrittlement according to the master curve approach.
A new tool is available: the data citation thanks to the introduction of digital object identifiers. It aims to give visibility to some data and to avoid the duplication of tests because of a loss in knowledge on what has already been done.

Human resources: establishment of the human resources observatory in 2011, following a recommendation of a Council directive.
JRC is the operating agent of EHRO-N, a central information source for nuclear human resources, supported by different stakeholders like researcher, academic…

The main coming challenges are:

- A large scale retirement in nuclear workforce
- The absence of attractiveness of the nuclear field for new people
- A bad recognition of skills within the European network, which hinder the mobility of experts too.
  To cope with these issues, the JRC has implemented the ECVET (European Credit system for Vocational Education and Training)

Stress tests: the European Network on Operational Experience Feedback for nuclear power plants (known as the European Clearinghouse on Operating Experience Feedback for Nuclear Power Plants) has been involved in the post Fukushima stress tests.
“Although stress tests didn’t address ageing specifically, they have clearly revealed that there is no clear correlation between the age of nuclear power plants and their safety performances”. The stress tests helped to acknowledge that the design of NPP have evolved a lot.

Questions and answers:

Questions:

Jade Lindgaard, Mediapart:

There seems to be a contradiction between the statement “no clear correlation between ageing of NPP and safety performances” and the facts underlined during the 1st speech. Why?

Jan Haverkamp, Greenpeace:

Why are there differences in quality between what FANC (Belgian Federal Agency for Nuclear Control) ordered and what WENRA was proposing, after the discovery of cracks in the reactor pressure vessel of Doel 3 and Tihange 2? FANC ordered a full vessel check and suggested that this should be the case after a PLEX

decision; WENRA let the operators do an inspection “when they think they will find problems”.

Is it entirely true that the containment building is irreplaceable?

Some hidden things are dying out over years. Are there any solutions to the disappearance of unpleasant memory?

Philippe Jamet, ASN:

- EDF, the French operator, is considering operation of its plants between 40 years and 60 years. Today as a regulator, I am not sure at all that we will authorize plants to operate beyond 40 years. This is requested by the utility, this is certainly not authorized by the regulator.

Michel Raquet, adviser of the European green group:

- How can the JRC say that there is no correlation between ageing and safety performances?
- What about the costs? Are the cost for upgrading NPP after 10 years the same than after 20 or 30 years?
- JRC should put emphasis on training for decommissioning and nuclear safety. New people are needed for the coming decades.

Michèle Rivasi, chair of NTW:

- What is the state of the art regarding vessel check? What do we know about the impact of the MOX on ageing mechanisms?

Richard Ivens, Foratom:

- Comment: The technic to discover hydrogen flakes in Belgian reactor pressure vessel was fairly new.

Answers:

Simone Mohr, Okoinstitut:

- The techniques used in Germany to discover cracks are available on internet

Peter Hähner, JRC:

- There is no direct correlation between ageing and safety decrease, even if there might be a trend. However, there is no clear “best before date” for reactor pressure vessel. Until now, reactors are not retired because of their age but for political (Germany) and economic reasons. One should reiterate the importance of regulatory authorities and periodic safety reviews.

Frédéric Ménage, IRSN:

- The most reactive elements are put at the core of the reactor to avoid too high neutron fluence on the vessel.
- In France, the coming debate about the lifetime extension over 40 years will require new demonstration techniques from the operators. IRSN will probably be in charge of controlling and assessing the new methods proposed.

- In the USA, there have been some cases of unplanned opening of the containment building to change the steam generator. In France, this possibility is already planned during the very design of the plant.
- For the bath tub curve: one should distinguish the replaceable and non-replaceable components, which will limit the possibilities of PLEX. But repairing may be possible. In France some reparations have been done on the containment building. In Eastern Europe, thermal annealing has been applied to some reactor vessels to recover the fracture toughness of the material..
- Costs: in Japan, the expenses after the Fukushima accident to rapidly find other electricity supply sources have reached 1% of the GDP.
  Any cost-benefit approach in the field of safety should include an evaluation of the cost of accidents. A laboratory of the IRSN is dealing with these questions.

Session II: Measuring the risk

1. GDF SUEZ / Electrabel approach of the Long Term Operation (LTO) project in Belgium.

Speaker: Pierre Doumont, Group Senior Vice President, Nuclear Safety & Radiation Protection, GDF Suez.

"Ageing is not just physical, there is also non-physical ageing. We have to take into account the retirement of people."

Context in Belgium:
In Belgium there are 7 nuclear units on two sites. Three nuclear power plants are concerned by a possible lifetime extension.

The Belgian units are in constant evolution through the mandatory process of periodic safety reviews and Electrabel policy of continuous improvement. The plant itself has **no technical defined lifetime**. Some components have a limited lifetime, but most are replaceable.
In July 2012, the government announced its intention to extend the lifetime of the Tihange 1 reactor to 50 years, to assure electricity supply, while the closure of Doel 1 and 2 after 40 years was confirmed.
In March 2014, official authorisation to extend the lifetime of Tihange 1 has been given.

The nuclear fleet of GDF SUEZ

Units	Net capacity [MWe]	Date of 1st criticality	Design	Cumulative net load factor [%]	LTO relevant ?
Doel 1	433	1974	Westinghouse	85.1	**YES**
Doel 2	433	1975	Westinghouse	82.1	**YES**
Doel 3	1006	1982	Framatome	84.0	
Doel 4	985	1985	Westinghouse	83.6	
Tihange 1	962	1975	Framatome	79.0	**YES**
Tihange 2	1008	1982	Framatome	85.8	
Tihange 3	1015	1985	Westinghouse	86.6	

NTW Exploratory Workshop European Parliament Brussels March 19, 2014 4

Figure 1: The nuclear fleet of GDF Suez (Belgium)

But there are preconditions to extent NPPs lifetime, especially the analysis of ageing, design, knowledge and competences management.

A utility point of view on the justification for safe long term operation:
Long term operation is an opportunity for a complete and systematic approach of the physical ageing, based on international references.
Long term operation is an opportunity for reflections and for developing a clear strategy to tackle the t echnological obsolescence.

Increase the safety level: Three references are used to increase safety levels: the IAEA (International Atomic Emergency Agency), the American federal law and the Nuclear Regulatory Commission documents.

Speaking of ageing, one has to assess the material but also people. What about the team, the age of the workers, what should on do to compensate the loss of competences?

Electrabel made an ageing analysis of the initial design. The aim was to improve the design whereas the US include in their safety reviews that design is stable.
To improve the safety level, Electrabel used the operational experience feedback and then design documentation.
Lessons of Fukushima were integrated into safety measures and this work has been facilitated by the European stress tests.

Concerning knowledge management, peer reviews are carried out in Belgian plants every three years. Comments and recommendations are made and collected.

Permanents changes are set up. For example, new equipment has been built to avoid floods of the Tihange site in extreme conditions, after several years of rise of the water level in the Meuse River.

About costs: The price to increase safety level in order to extend lifetime of one reactor is 600 million euros.

2. Control methods across Europe and recent developments

Speaker: Noël Camarcat, Special Advisor for Nuclear R&D and International Issues, EDF

"That's true that there are non replacable equipments like the reactor vessels."

EDF fleet:
EDF has 58 units in operation and one reactor in construction in Flamanville.

Status of the french NPP's

	1st 10 ys Visit 10 yrs	2nd 10 ys Visit 20 yrs	3rd 10 ys Visit 30 yrs	4th 10 ys Visit 40 yrs
900MW (34)	completed	completed	2009 à 2020 (18 completed)	2019 à 2030
1300MW (20)	completed	Completed end of 2014	2015 à 2024	2025 à2034
1500MW (4)	completed	2019 à 2022	2029 à 2032	2039 à 2042

- End of 2013, 5 Units (900 MW series) formally authorized for 10 years beyond 30 years with special requirements to be performed (exemple basemat thickening at Fessenheim)
- In the US, 73 units out of 100 reactors in operations have been granted **a license extension up to 60 years.**

Figure 2: Status of the french NPP's

For the 1300 MW nuclear power plant, EDF is waiting for the position of the safety nuclear authority (ASN) in 2015 for beyond thirty years operations.
The Periodic Safety Visits take place every ten years since 1988 (Fessenheim 1 Unit).

The French 2006 law (TSN) and the regulatory context:

- General policy: continuous improvement of nuclear safety, with regard to the state of the art of scientific knowledge, to the worldwide operation feedback, and to the safety improvements of new reactors.
- Periodic safety review (PSR) every ten years for each unit
- No limited licensing life time but advice by the French Nuclear Safety Authority, on a case by case analysis for each unit, to operate for another ten year period. Generic approval for 900 MW units given in 2009 for operation beyond 30 years.
- Numerous modifications already implemented on the plants (after Three Mile Island, Chernobyl, Blayais site storm in 1999, summer heat wave in 2003, ...). Among them: sand filters on containment (1986), Hydrogen recombiners, new concept of emergency procedures, man-machine interface (N4 series).

EDF safety goals for long term operation, as far as reasonably practicable:

- For design basis accidents, mitigating their consequences and avoiding radioactive releases that would require off site emergency measures (iodine ingestion, evacuation).
- Continuing to reduce the risk of core melt, already divided by ten since the commissioning of the plants in case of internal events.
- Significantly enhancing plant resistance to hazards.
- Minimizing time and space-related countermeasures in the event of a severe accident, making use of the important modifications required by the regulator (ASN) as part of the post Fukushima EDF action plan.

Taking into account Fukushima's event:

- Following the Complementary Safety Assessments performed by EDF, the French Safety Authority (ASN) issued the following statement (January 2012) : "the ASN considers that the plants show a level of safety sufficient that enables her not to ask the immediate shutdown of any of them".
- At the same time, the ASN considers that it is necessary to increase, in a time as short as possible, beyond the safety margins already in place, the robustness of the plants to cope with extreme situations."

- Three steps to increase safety levels :
  - Step 1 (2012- 2015): Coping with situations of water and electricity losses more severe than today (several units of a site, long duration).
  - Step 2 (2015-2019) : Coping with situations of water and electricity losses more severe than today by design changes, anticipated vs. initially planned for life time extension programme.
  - Step 3 (from 2019) : Completion of the hardened safety core

Regulators considered that permanent improvement are needed to cope with extreme situation. According to M. Camarcat, the implementation of the three steps of the post-Fukushima action plan makes it possible to reach on the existing fleet in operation a **safety level as close as reasonably practicable to the safety level of**

Generation 3 reactors. This is a requirement of the French Safety Regulator (ASN) to extend the operating life of the plants beyond 40 years.

Questions and answers:

Questions:

Eloi Glorieux, Greenpeace Belgium:

Regarding the costs of this extension of Electrabel in Belgium, Electrabel referred to 600 million euros for one reactor. There is a study published by Wise Paris that make an assessment of the costs up to 4 billion to increase the safety level for a NPP in order to increase lifetime.

Michel Raquet, Energy Adviser in Greens group:

For the lifetime extension of Tihange 1, the decision has been taken without impact assessment. Civil society wasn't informed before this decision.

Michèle Rivasi, Chair of NTW:

Can you list all the generic failures in your reactors, or provide a list of these failures?

Can you explain what is the "Grand carénage" that will cost 90 billion and what was the 10 billion works made after Fukushima?

Answers:

Pierre Doumont, GDF Suez/ Electrabel

The € 600 million correspond to the minimum necessary required by the regulator. The works asked in France on what is called the core have already been made by Electrabel. With the ten years reviews, we have systematically and continuously improved the design.

These improvements are spread over time. Third element: the following improvements after Fukushima stress tests are part of a separate budget.

Generation 2 reactors like Tihange will not meet all requirements of generation 3 reactors.

Environmental impact assessment: I am not aware of any impact assessment or study.

Concerning the list of failures, we use the standards imposed by nuclear authorities. They set a number of benchmarks for visits, and safety authorities improved these already very strict standards.

Noël Camarcat, EDF

Until 2025, we will make a consequent investment of 55 billion euros regarding the "grand carénage", 20 billion for decennial visits and 10 billion is the cost of maintenance work after Fukushima. There is also 15 billion for replacement of major components such as Steam Generators and Transformers and 10 billion for special programs such as fire resistance, extreme heats or colds etc……

What happens after 2025? This is under investigation by a committee of the French Parliament. We will first give answers to our national parliament and then to the European one.

3. Regulation and supervision of aging management in Swedish NPP

Speaker: Lars Skånberg, head of the Section for Reactor Technology and Structural Integrity, Swedish radiation safety agency.

"Nearly all the degradations observed have been detected by service inspection before safety consequences."

Nuclear fleet in Sweden is composed of six PWR Nuclear Power Plants. Long term operation means a lifetime between 50 or 60 years.

"Ageing" manifests itself in various forms:

- physical ageing of components and structures
- Technological aging of equipment.

Besides the obsolescence of equipment but there is also an ageing of

- analytical methods and techniques
- regulations, guides and standards
- personnel and organizations

At the end of 1990s, there were reports of accidents and damages, especially in PWRs. It was a completely different picture to what was predicted. Measures have been taken, such as the replacement of affected components.
So experiences since the very beginning continuously improve safety.

Sweden is now in a process to revise and precise its regulation. Some aspects of ageing management and especially, time management of ageing is still to be clarified.
Coming to Long term Operation, this is a challenge, for both regulators and owners.

SSM has a strong legal basis and binding regulations with requirements for ageing management in general and for ISI/IST of pressurized components and other safety related structures and components. In particular SSM is now reviewing and clarifying both the regulations and general advice about ageing management in view of the licensee's planned long-term operation of the Swedish NPPs.

Research activities and operating experience worldwide have led to a situation where substantial knowledge has been accumulated about degradation mechanisms that can affect components and structures in NPPs.
However, degradation history shows clearly that our knowledge base must be continuously updated based on

- further research
- detailed damage analyses, which often reveal other circumstances than those expected

- Continued international cooperation will be important such as the IAEA IGALL, OECD-NEA O

Conclusion:
Experience shows that effective ageing management must continuously be taken into account from the design phase and throughout the planned period of operation. In regulatory evaluation of potential for LTO focus on ageing management is necessary but not sufficient
Other aspects that must be considered are:

- Implementation of and need for additional safety improvements
- application of lessons learned from operating experience
- adequate licensee staff resources and performance
- Security at the plant.

The aim is always to improve performance and security of the plants.

4. Control of "Time-Dependent Safety" The Role of ASN

Speaker: Philippe Jamet, Commissioner, French Nuclear Safety Agency

"The first responsibility of the regulator is to determine what should be achieved in order to be able to extend lifetime."

There are two aspects of ageing process: one is the ageing time dependent phenomena that can result into degradation of materials. The challenge for safety is to maintain compliance with current safety requirements;
The second challenge is safety revaluation: safety requirements are becoming stronger and stronger; it increases the differences between new installations and older installations.

- **Ageing**
  - Time dependent phenomena can result in degradation of materials and equipment.
  - Corrosion, cracking, wears, neutron embrittlement, relaxation of concrete pre-stressing…
  - Challenge: maintain compliance with current safety requirements

- **Safety Revaluation**
  - Safety requirements for new installations are becoming stronger and stronger, increasing the relative safety differences between old and new installations
  - Challenge: Enhancing as much as possible the safety of old installations compared to new ones.

Both challenges have to be fulfilled. You can't compensate one by the other. With ageing, implementation of continuous controls is necessary.

Formal introduction of "ageing" initiated by ASN in 2001 as a response to the «lifetime management project » of EDF:

- Need of an overall technical ageing diagnosis of each reactor at 30 years
- 30-year stage (3rd ten-year outages) has to be prepared specifically.

Safety revaluation is part of Periodic Safety Reviews required every 10 years by French law

Revaluate and improve safety of the installation with regards to:

- National and international operating experience
- Evolution of knowledge (e.g. development of Probabilistic Safety Analysis)
- Requirements for new installations (seismic hazards, severe accidents,…).

Responsibilities:

- Regulator: determination of new requirements for further operation of the installation
- Utility:
  - Decision whether cost of enhancement is economically acceptable, or shut down of the plant;
  - Proposal of enhancements to be accepted by the Regulator (in case continued operation is the chosen option).

About safety revaluation: it is mandatory to implement it every ten years. What is done is to revaluate and improved the safety of the installation with regards to the evolution of knowledge and also requirement for new installations.
EPR design has significant safety improvement compared to old reactors.
The first responsibility of the regulator is to determine what should be achieved in order to be able to extent lifetime. Then the operator has to determine the practical improvements which are necessary to comply with the requirements of the Regulator, whether these improvements are economically acceptable or whether he prefers to shut down the plant. If the operator decides that he wants to continue to operate the plant, he has to submit his proposals of improvements for assessment by the Regulator. If the detailed improvements are accepted by the Regulator, the operator can implement them and continue the operation of its plant.
Actually, EDF has to propose improvements in order to extent lifetime of NPPs beyond 40 years. ASN should issue a first position in 2015. But the final decision will not be made before 2018 or 2019.

The ASN underlines the importance of continuous control of ageing and the importance of Periodic Safety Reviews.

In conclusion, there are two independent objectives:

- Ageing management to maintain compliance with current safety requirements.
- Safety Revaluation: enhancement of safety by comparison with requirements applicable to new installations.

Questions and answers:

Questions:

Barnabé Binctin, Reporterre:

Is it possible to establish the new requirements in old designed nuclear power plants?

Gilles Heriard-Dubreuil, secretary of NTW:

The safety capital decreases with time. Some components cannot be changed like the reactor vessel…
How can we then consider that the safety level is reasonable? If you repair an old car, it will never be as efficient as a new one.
What is done for civil society and elected people to join this debate?

Eloi Glorieux, Greenpeace Belgium:

About safety levels in the 900 MW reactors in France which are subjects to lifetime extension: the 6 reactors in Gravelines have only a simple containment; is it possible to perform a lifetime extension without changing this point?

Answers:

Lars Skanberg, Swedish Radiation Safety Agency:

There is what we know now and what we do not know. We don't know everything. After Fukushima, all the reactors have been upgraded; the situation was, to some extent, unique. Of course it is not possible to upgrade an old reactor at the same level of a new reactor.
At any time SSM encourages to update safety levels. SSM's position is to evolve over time.

Philippe Jamet, French nuclear safety authority:

Upgrading the safety of all reactors at the same level of new reactors like EPR is not possible. At the end there is a gap, it is true. The question is: is the gap small enough to be authorized or not?
And finally, we are now thinking about the way we are we going to involve the stakeholders in the decision making process of allowing EDF to operate his plant, or not, beyond forty years.
According to the French law, the Regulator can stop any plant for safety reasons. If a safety problem is discovered some years after a safety revaluation, we can stop the plant immediately. We don't have to wait ten years, even if we agreed before that the following safety revaluation will be performed in 10 years.

Questions:

Jan Haverkamp, Greenpeace:

Comment: When you deal with safety, you speak about the stress test but you also look for the liability of regions, on-going evaluation on EP&R considerations. We could integrate emergency criteria with the experience we had from Fukushima because EP&R wasn't studied by the stress tests.

In Gravelines, there are six plants. It is a trans-boundary NPP. In the case of an emergency, it will be very difficult to organise an evacuation of the Belgium coast.

Several people spoke of the "Long Term Operation." I think it is a striking etymological change. Because we are going beyond the question of the lifetime extension, we do as if it was decided.

Jade Lindgaard, Mediapart

Is ageing a good criterion to shutdown nuclear plants?

Why regulators can't agree on an ageing limit to shutdown nuclear power plants?

Michèle Rivasi, chair of NTW:

It has to do with uprating. Through uprating (which is not done everywhere in Europe) it is possible to enhance energy productivity. It is a factor which contributes to the ageing of reactors in France.

About energy transition, 40 years later, citizens are still excluded from the decision process. The debate is confiscated by operators together with regulators, there is definitely something to do there.

Answers:

Lars Skanberg, Swedish Radiation Safety Agency

I am not aware that a reactor has been closed for ageing reasons. If there is serious degradation, of course it will be the case. It is important to continuously learn how to detect degradation ageing in an early phase.

On "power uprate" that occurred in Sweden, we did a risk assessment and analysis of all components to ensure that all safety requirements are maintained at a high level.

On the participation of civil society, as a regulator we are as open as possible.

Philippe Jamet, French nuclear safety authority

Concerning European harmonization, it takes a lot of energy and maybe it is the final stage we should reach.

The European Regulators are currently national Regulators. One can imagine that some day there will be a European Regulator. But what is not possible is to share the responsibility of regulatory control. If the Commission says "I am taking the responsibility of control", the ASN will say ok. But the ASN will also say that the European Regulator has to take the full responsibility of European control. Sharing regulatory responsibility can only lead to a catastrophe. This is one of the lessons learned from Fukushima. There was a regulatory Authority in Japan (NISA) and

another organization (NSC) which was controlling NISA. In fact, nobody knew which one was really responsible.
Our safety revaluation uses as a reference the WENRA objectives.
One difficult question you raise is the issue of population near NPP. Any accident in a European plant will cause problems in several, countries.. That's why we try to harmonize emergency preparedness and response. If there is the same accident than Fukushima in Europe, several countries will be affected. If different authorities prepare emergency with different measures, it will not work. We should harmonize across borders.

Stakeholders in our decision: for the possible decision to allow French plants beyond 40 years, we were thinking about some fundamental consultation.
We try to take into account all stakeholders in our decision making. Concerning the extension beyond 40 years we believe that the consultation is essential.

But if control on the safety is shared again it will not be effective. If you have independent regulator, you have to give him the power to control and decide of safety issues, if there are others actors, it can reduce the efficiency. The only thing the regulator has to say is, on a safety point of view.
The Regulator only provides the Government with safety assessments. On the other hand, the Regulator is independent from decisions related to the national energy mix.

Session III: Policy responses to NPP ageing

1. Policy responses to NPP ageing

Speaker: Pr. Stephen Thomas, University of Greenwich

"Historically most plants are retired on a combination of economic and technical issues."

Context: Normally, replacing all equipment that no longer meets safety standards is not a problem, because new equipment is cheaper to operate. But this is not the case with nuclear power since operating costs are a low proportion of all costs. For this reason plant life-time extension (PLEX) is very attractive.
In the EU, the only plants that have been forced to close are the old soviet designed plants in Eastern Europe. But even the majority of Chernobyl similar reactors are still in operation.

The USA is the only country with fixed license duration (40 years). According the NRC, this is not based on the expected physical life time of NPPs but on economic and antitrust considerations. In the rest of countries with NPPs, the most common practices are Periodic Safety Reviews (PSR). In France, they are legally required; in Britain, they are an "ad hoc process".

Until now, the reasons for NPP closure have been political (Germany, Italy) or economic-technical, when repairing would have cost more than the value of the plant (USA). In the USA, NPP have always been closed down before the dead-line imposed by their license duration.

PLEX issues are important in very concentrated areas, mostly in the USA and France. 2/3 of world's 105 old reactors (>35 years) are located in the USA (52), Japan (12), Russia (7) and France has 33 reactors between 30-37 years old. In France, if the regulator (ASN) decides not to allow PLEX, then reactors will go off-line very rapidly. By 2024, there should be a decrease of 50 % of the installed capacity. Given the actual failure of EPR projects, no new nuclear capacity is expected before 2030 (if EDF had enough money to finance it, which is doubtful).
So France and the USA are the countries to focus on because they will develop systematic and coherent policies.

In the USA:

- 14 of the 18 retired reactors have been shut-down for economic reasons (low gas prices in 1999 and 5 new retirements in 2013 because of shale gas development). None have been retired because of license expiration.
  Generating costs is the most serious reason to shut-down reactors.
- Planning for PLEX goes back to 1982. The first PLEX application was made on 1998, 17 years before the license expiration. And now, the NRC is expected to receive license extension proposal to 80 years from 2018 onwards. If the application for PLEX is made 5 years before the 40 years deadline, NPPs are allowed to run until the decision is taken, even if this occurs after 40 years of operation.

But since 2012, there is a moratorium on PLEX decisions imposed by the NRC because of waste issues.

Two other issues:

- Difficulties to obtain data on the costs of PLEX from the utilities.
- There is no evidence that PLEX implies significant equipment modifications

In France:

- PLEX should be simpler because France has a very standardized set of reactors.
- The PSR have led to significant inquiries (seismic protection, tests on withstanding low ambient temperature, tests on pressure vessel integrity).
- For the ASN (French regulator), post-Fukushima modifications have taken priority over PLEX. France has been more rigorous than other EU countries during the stress tests. For example, the investment of the UK for post-Fukushima safety measures is only 1/5 of the French investment.

Some questions arise:

- Is it defensible to give 20 years more life to a design that would have no chance of being licensed if new built?

- Is it premature to give life extensions 15 years before existing license expires? The US procedure seems to be premature.

There seems to be one main difference between the French and the US approaches: for the NRC, evaluation is different from enforcement, which means that a plant can go on producing even if it does not match current standards.

2. Public participation in PLEX discussions: Ecoclub experience

Speaker: Andriy Martynyuk, Chair of the Board of the Eco Club of Rivne

"According to the Committee for implementation of the Espoo convention, a plant life-time extension, even in the absence of any material change, has to be considered as a major change of activity."

Picture of the Ukrainian nuclear industry: 12 of the 15 existing reactors have to be closed before 2020. Nowadays, nuclear energy accounts for around 50% of the electricity in Ukraine that can fulfil 30% of its uranium consumption with its own national resources. Despite a recent reform of the energy market, the sell price of electricity is very low (0.02 €/kWh), a problem for the nuclear industry.

In 2011 the NGO Ecoclub has submitted a complaint to the secretariat of the Espoo convention regarding the PLEX of Rivne 1 and Rivne 2 in 2010.
The Espoo convention requires its parties to have a proper Environmental Impact Assessment (EIA) legislation (including for nuclear issues). The parties have to consult their neighbours in case they are taking a decision that could affect other parties of the convention. More precisely, they have to notify and consult their neighbours about decisions concerning dangerous activities.

The PLEX of Rivne 1 and 2 has been decided whereas no affected countries had been notified and no EIA had been carried out. Some public hearings have been organized with operators, regulators and ministries but there were no possibilities to influence (or stop) the process. This was merely public information.

During its 25th session, the Espoo Committee stated that:

- Ukraine had not applied the convention
- PLEX has to be considered as a major change in the activity of a NPP, even if there is no material change. So EIA should take place in any case.

The Committee asked 4 questions to Ukrainian government:

- Had the extension been subject to a trans-boundary EIA procedure?
- Had that report covering environmental impacts been submitted to the Ukrainian public for comments?
- Which Parties could potentially be affected?
- Would the Government implement the full trans-boundary EIA procedure?

Since that time, different consultations have taken place between the parties.

Local NGOs have led other activities such as information tours to local people that have afterwards submitted hundreds of complaints to the Ministry to require an Environmental Impact Assessment.
During the preparation of the second decision for PLEX (2013, for the NPP South Ukraine), a report was published stating that not even all necessary measures had been implemented to prepare the PLEX. The final decision was taken without waiting for a second report that was supposed to test the good implementation of all measures.

Since the operator Energoatom has not enough money to undertake the safety improvement measures, it contracted loans from different banks (Russia, Ukraine, EU). Recently, the ERBD and Euratom have granted a loan of 600 million euro for safety upgrades, that could not have been implemented otherwise. This is a direct support to PLEX, although there is no remark about the link between PLEX and safety upgrades in EBRD documents and although no information from Euratom is publicly available.

Nevertheless, to get a loan from Euratom, Ukraine has normally to comply with the Espoo and Aarhus convention.

Governance in the Ukraine and their position about PLEX:

- Ministry of environment: in charge of Espoo convention but no proper rights to guarantee its good implementation.
- Regulator (State nuclear inspectorate): is decision maker for PLEX. It recognized the Espoo convention.
- Ministry for Energy and Coal industry and the operators say that there is no need to meet Espoo requirements.

In the future:

- participation of the civil society in the development of a regulation for the application of the Espoo convention to nuclear related activities
- draft law in the Ukrainian parliament to adapt the national legislation to the Espoo requirements

In June 2014: meeting of the Espoo parties on Energy:

- final decision in Rivne's case
- Urgent need to find honest ways to compare the different policies: PLEX, energy savings, renewables energy. This could lead to the development of a Strategic Impact Assessment.

Conclusion: Espoo is really useful to draw attention on PLEX issues and increase the influence of civil society.

3. Legal ageing criteria for shutdown.

Speaker: Yves Marignac, Director of Wise Paris

"I will start with this sentence: "We all desire to reach an old age but we all refuse to acknowledge that we have actually succeeded". We know how it ends for each of us and we don't want it to happen for NPPs."

Age of reactors:

• First, there isn't any share and common basis to define the age of reactors. It means there is not a clear starting point. So what is the exact age of a reactor?
• About the French Nuclear fleet: French reactors have 29 years of operation on average;
• Concerning decennial reactor per reactor safety reassessment, it takes place more or less every ten years, but there is a significant gap through time and between reactors.
• A growing shift between technical and regulatory ages:
- 27 reactors over 30 years of operation;
- Only 5 have completed 3rd reassessment and obtained the authorization up to 40 years;
- These 5 had 34 years operation on average.
• No clear definition of a "40 years" limit:
- Neither calendar;
- Nor technical.

There are economic pressures on operators. They need to implement safety requirements but they still have to protect their margins for profitability reasons.
Until now, reactors have been closed because of economical reasons in order to save money that should be spent to maintain the safety level in an ageing reactor.

Problems arising from ageing:

A triple problematic:
• Need to compensate ageing by reinforcements;
• Introduction of new safety requirements after Fukushima-Daiichi;
• Managing a growing uncertainty between theoretical and real status.

The problem we have to face is the following: improve safety requirements and introduce reinforcement of requirements due to the return of experience of Fukushima. On the other hand, we have the effects of ageing, there can be a gap between theoretical and real statute of the plant. We have to manage both the uncertainty and the increase of requirements.

Safety issues:

• Intractable limits of the initial design:
- For 30 to 40 years of operation at most (big / not replaceable components);
- Severe accidents discarded (before Three Mile Island and Chernobyl).
• Unavoidable problems of ageing:
- concerning big and especially not replaceable components (vessel…);

- concerning diffuse equipment (piping, electric wires…).

• Major failures of "in-depth defence" approach as demonstrated by the return of experience after Fukushima:
- Design against external events;
- Reassessment of the risk of major accident on reactors;
- Evidence of the risk of severe accident arising from spent fuel storage.
• Some reinforcements have been introduced following the "stress tests" but it is still a long process with a lot of major question marks.
In France, among the over 55 detailed instructions after Fukushima, only 8 are directly implementable.

New requirements:
Within the different scenarios, the cost is from 400 000 million to 4 billion euro for one reactor, which means high stakes of industrial capacity to manage heavy works.
It is also a high profitability stake for the operator (and a stake on prices for consumers).

Decision making:
No formal process of public participation on requirements or individual decisions.
Ageing of nuclear reactors is a major safety stake that must be seriously managed in terms of public decision

Conclusion:
• There is an important risk that lifetime extension could be decided by defect or within an insufficient regulatory and political framework;
• Investments made by investors to prepare lifetime extension with no regulatory visibility bear strong industrial and financial risks;
• Lifetime extension of reactors goes beyond the actual design and therefore meeting new safety requirements is not granted;
• In order to maintain high safety level, it seems unavoidable to define a new and specific set of safety requirements applying to extension;
• This implies to introduce:
- A shared and objective reference to define the age of reactors;
- A definition of the time when a reactor reaches the end of its design lifetime;
- Criteria to assess and decide on the status of ageing reactors beyond that;
- An open and opposable decision making process based on those criteria.

Operators prepare lifetime extension but there are very strong industrial and financial risks.

4. Long-term operation of NPPs: what to do at EU level?

Speaker: Massimo Garribba, Director, Nuclear Safety & Fuel Cycle, European Commission DG ENER.

"Lifetime extensions are contingent on nuclear safety but also on public acceptance".

State of play

- **EU:**
  - **130 operating reactors, 125 GWe installed capacity**
  - **28% electricity consumed, 60% low carbon**
  - **Average reactor age: around 30**
- **Europe (excluding Russia):**
  - **Reactor age:**
    > 30: 67/151 (44%)
    > 35: 25/151 (17%)
    > 40: 7/151 (5%)
  - **Average reactor age: 29 (design lifespan: 30-40)**

Contingencies:
Lifetime extensions and new builds are contingent on nuclear safety and security but also on:

- Public acceptance;
- Member States' positions on nuclear (Member state decides on the energy mix. They decide if they want to extent their life or to build new nuclear power plants).
- Economics: financing, competitiveness;

Still, the objective of the European Union is decarbonisation:

- Attitude towards climate targets (2030) and the overhaul framework is to move to the 2020 objectives.
- Research and innovation.

Competences:
Member States:

- Energy mix
- New build & Lifetime extensions

EU:

- Provide a level playing field by putting in place and enforcing a common legal framework (safety, waste, radiological protection, safeguards);
- Stimulate an open debate and cooperation with stakeholders;
- Support third countries (cooperation with IAEA).

Some competences are shared between member states and European Commission including: nuclear safety, radioactive waste, radiological protection

Commission action:
EU fostered an open debate.
The commission action on the post Fukushima is articulated on numerous axes:

- Stress-tests and revision of the safety directive;
- Key-phase on the implementation of the directive on waste;
- Started to finance a study on off-site emergency preparedness and response;
- Recently, a public seminar on the issue of liability and assurances.

Associated to that, the Commission also proposed to the Council to have a European peer reviews system to monitor the implementation of the safety objectives. The Commission proposal includes a clear article on transparency and public involvement in decision making.
Once an operator or a state wants to extend lifetime of the nuclear power plants, it has to comply with the EU safety objectives. The Commission proposal includes compulsory safety reviews every ten years and in case of major licence modifications (e.g. life extension).
The Commission considers that decisions concerning individual installations should be taken at national level. The Commission will accompany the process as needed in close collaboration and dialogue with national authorities.

Conclusion of Michèle Rivasi, Chair of NTW

Europe is ageing: it is right for people but also for nuclear power plants. One should think about what is an acceptable level of risk.
The presentations showed that, in order to get a license prolonged, there are not just technical criteria but also humans one. Those issues (legal age, good practices…) should be discussed at the national but also at the European level.

The Espoo convention, unfortunately still not well-known, directly involves public participation and requires the implementation of trans-boundary environmental impact assessment in case of PLEX.
This meets the basic goal of NTW which is to promote citizen's participation and increase the available information in order to enhance the quality of the debate on nuclear issues.

Nuclear safety has a European dimension: we should work together and built little by little. We are going to have the election soon. The way people see Europe isn't very positive: we have to involve the citizens in societal choices, which also includes the choice to extend the life of nuclear power plants life or not.