Critical Review

of the

Joint Research Center policy report "Technical assessment of nuclear energy with respect to the 'do no significant harm' criteria of Regulation (EU) 2020/852" ('Taxonomy Regulation')

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The JRC report is very long, however, the key questions when it comes to nuclear energy use are:

- Final repository for spent fuel
- Nuclear safety and the risk of severe accidents

These are both unsolved and the Joint Research Center tries to hide this under admittedly very clever phrases and arguments.

A few examples from the JRC report's Key Conclusions and why they are wrong:

On nuclear safety and severe accident prevention:

1. **New safe reactor designs**

The JRC report stated: *After the Chernobyl accident, international and national efforts focused on developing Gen III nuclear power plants designed according to enhanced requirements related to severe accident prevention and mitigation. The deployment of* ***various Gen III plant designs started in the last 15 years worldwide and now practically only Gen III*** *reactors are constructed and commissioned. These latest technology 10-10 fatalities/GWh, see Figure 3.5-1 of Part A). The fatality rates characterizing state-of-the art Gen III NPPs are the lowest of all the electricity generation technologies.*

This is more disinformation than useful arguments: Even very old designs such as the VVER 440 / 213 second generation are intended for start-up (!) in line with the currently valid EU nuclear safety directive 2014/87/Euratom, because they were under construction when the directive was agreed upon. So this design from the 1970ies in the USSR might start operating in 2021 or later, others might follow (Belene/Bulgaria) in the EU. And: The mentioned Gen III NPP are not operating yet. The plant fleet which industry intends to keep is Gen II and between 30-40 years old. The key issues are not very different between the designs of Gen II and Gen III and will continue posing a risk. On top of this we need to see that e.g. the flag-ship GEN III reactor is in severe technical difficulty, e.g. the reactor lid of EPR Flamanville III was almost not licensed at all and now for only 10 years. No EPR or other Generation III reactor is operating in Europe yet, there seems to be one in China, but not enough information on the design is available.

2. **Higher legal safety requirement**

The JRC reports explains: *Although the WENRA safety objectives outlined in [5-6] are meant for new NPPs only, these objectives should also be used as a reference to help identify reasonably practicable safety improvements for existing plants during periodic safety reviews. (TSC).*

However, this is a very old attempt already made by WENRA years ago, when it tried to introduce this rule, but the other WENRA members refused to follow this up. Now this idea was presented by the French regulator ASN for the 900 MW-fleet. EDF did not manage to apply this rule to the old reactors and ASN now gave in and extended the life-time over 40 years anyway. The EU nuclear safety 2014/87/Euratom directive will not be amended to fulfill this suggestion, because most NPP in Europe cannot fulfill this standard and would veto any such proposal.

Also the JRC report continues: ***Operating nuclear power plants are subject to continuous improvement.*** *(...) The result of this continuous improvement is that the calculated frequency of severe accidents in the plant specific PSA reduces over time. Further reductions may be expected in future, although they may become more marginal as the most important safety improvements have probably been made already, including those following the EU nuclear stress tests.(p. 176)*

Continuous improvements do not necessarily lead to higher safety expressed or reduced severe accident frequency, since ageing of the plants continuously decreases safety. EU nuclear stress tests did deliver recommendation for safety improvements however, they were largely not implemented and very often declared not necessary by the national nuclear regulators and operators. A recently published study by a German nuclear expert showed that the EU nuclear safety stress test recommendations were not carried out, the Lessons from Fukushima not Learned[1]. The Fukushima disaster in 2011 shed light on serious deficits of the nuclear safety concepts and the plants' safety levels, also in Europe:

- Nuclear Power Plants' vulnerability against natural hazards is much higher than assumed before 2011

- Power supply for the plant and heat removal are not robust

1https://www.greenpeace.de/sites/www.greenpeace.de/files/publications/20210303-greenpeace-akw-europa-fukushima.pdf

- Possibilities to prevent radioactive releases during a severe accident with meltdown are actually very limited.

Not a single European NPP of 11 NPP in total which were assessed has implemented all the measures which the EU experts (of nuclear safety authorities) have recommended after the stress tests. For Krško an additional background paper is available in German: www.global2000.at/sites/global/files/2021-AtomStresstest.pdf. In many cases even key measure will never be implemented, only one example of many: The Czech NPP Temelin was advised to ensure another ultimate heat sink by the ENSREG stress test Peer Review Team for cooling during loss of power. But this recommendation was not taken up adequately.

*The protection of people and the environment in countries with nuclear installations relies on the existence of a solid regulatory framework that oversees the safety and environmental impacts of these installations. The achievement and maintenance of a **high level of safety** during the lifetime of nuclear facilities and the duration of related activities requires a sound governmental, legal and regulatory framework, which includes regular safety reviews and strict monitoring and reporting.* **However, nuclear regulators postponed the recommendations made by the EU stress tests: e. g., in France the "hardened core" was decided for all NPP in France. Not a single hardened core was implemented until today.**

JRC Report: *Related analyses demonstrate that **appropriate measures to prevent the occurrence of the potentially harmful impacts or mitigate their consequences** can be implemented using existing technology at reasonable costs.*

Reality: If this statement relates to safety measures and post-accident measures, it is worth pointing out that the costs and consequences of **Fukushima** are unbelievable and far from solved at reasonable costs. Only last week information was provided from Japan, that the decommissioning is still unclear, it will not be finalized before 2050 and costs are constantly increasing, decontamination is not progressing contrary to what the government is claiming. Allison M. Macfarlane, Professor and Director, School of Public Policy and Global Affairs, University of British Columbia said in the Bulletin in March 2021[2]:

"Nuclear poweradvocates claim that the Fukushimaaccident did not kill anyone directly, with the implication that the accident wasn't that bad. But it was. Many people lost property, land, jobs, and community. Over160,000 people evacuated, but fewer than 35 percent of them have returned. The fishing industry remains devastated. Agricultural industry is just beginning to come back. The cost for Fukushima decommissioning, decontamination, and compensation will be atleast $188 billionand up to$736 billion. And that doesn't count the loss of the 24 reactors permanently shut down, the updates to existing reactors, and the costs to replace the electricity lost."

2https://thebulletin.org/2021/03/the-fukushima-accident-do-we-have-the-wisdom-to-move-forward/

JRC on nuclear waste disposal – No facts, only words:

Here the Executive Summary is trying to pretend that nuclear waste is just an ordinary issue of management, admitting however at the same time that "*there is broad scientific and technical consensus that disposal of high-level, long-lived radioactive waste in deep geologic formations is at the state of today's knowledge, considered as an appropriate and safe means of isolating it from the biosphere for very long time scales.*" In other words: We don't have a final disposal and we don't even have evidence today that it might work eventually. The claim that "*Radioactive waste is therefore generated in practically every country*" is to gloss over the fact that non-nuclear countries need to find near-surface storages with a safety case of 300-1000 years, while spent fuel from reactors needs to be stored for one million years safely in repositories with unknown technology and unknown costs. Yes, that is the status after 60 years of commercial operation of nuclear power plants; therefore the attempt to compare those technologies by pointing out that "*there is currently no operational geological disposal for carbon dioxide or for radioactive waste"* is not a valid argument. Or: *Similarly, carbon capture and sequestration (CCS) technology is based on the long-term disposal of waste in geological facilities and it has been included in the taxonomy and received a positive assessment. The Taxonomy Expert Group therefore considers that the challenges of safe long-term disposal of CO2 in geological facilities, which are similar to the challenges facing disposal of high-level radioactive waste, can be adequately managed.* It is rather obvious, that in terms of long-term radiation and toxicity of spent fuel rods the comparison is only a new spin to disguise how very dangerous nuclear waste actually is.

With regard to the transition to a circular economy, the ***raw materials used to build the multiple engineered barriers of the disposal facilities (e.g. copper) cannot be recovered. The amounts needed are small,*** *in particular when compared with the world production and the long timeframes of the disposal. Some materials resulting from the construction of facilities, e.g. part of the rock excavated to construct the tunnels of a crystalline rock repository, can be commercialized.*

The material needed for final disposal is not known yet. However, materials used until now (steel) or researched as usable for storage containers such as copper, are very valuable and will be ever scarcer. On top it is necessary to understand that containers in which spent nuclear fuel is placed for now 50 years, have to replaced by new ones, because the material cannot cope with the high toxic and radioactive strain; to date nobody one can exclude that a regular exchange of containers with enormous material needed will be necessary for tens of thousands of years.

Measures to ensure that radioactive waste does not harm the public and the environment include a combination of technical solutions and an appropriate administrative, legal and regulatory framework. Although there remain contrasting views, it is generally acknowledged, that the necessary technologies for geological disposal are now available and can be deployed when public and political conditions are favourable. No long-term operational experience is presently available as technologies and solutions are still in demonstration and testing phase moving towards the first stage of operational implementation. Finland, Sweden and France are in an advanced stage of implementation of their national deep geological disposal facilities, which are expected to start operation within the present decade.

JRC claim: *Although the geological disposal concepts can vary, the environmental impacts are dominated by the activities related to excavating the tunnels and building the multiple engineered barriers. The environmental impact analysis of the disposal facilities includes a description of the measures implemented to mitigate specific effects. Mitigation measures are considered also in the mining of raw materials needed to construct a repository (e.g. metals and bentonite for the engineered barriers) to limit the environmental impact of the disposal phase. — The long-term potential impacts of radioactive waste relevant to the "do no significant harm" criteria, are of a radiological nature. Due to its potential to cause harm, radioactive waste and spent fuel must be managed aiming at radionuclide containment and isolation from the accessible biosphere for as long as 11 the waste remains hazardous. The maximum radioactive dose limits to humans and to the environment due to waste management activities and disposal facilities are set by the relevant regulations.*

For high-level radioactive waste and spent fuel, there is a broad consensus amongst the scientific, technological and regulatory communities that final disposal in deep geological repositories is the most effective and safest feasible solution which can ensure that no significant harm is caused to human life and the environment for the required timespan.

This sentence is around 15 years old, a pro-nuclear myth without any prove or progress made. It seems to be rather the contrary, new problems are coming up:

"We need to develop a new model for storing nuclear waste"[3]

This was the alarming message from a piece of the most recent corrosion research: Xiaolei Guo, a deputy director at Ohio State University continues by saying: *"Current planned methods for storing high-level nuclear wasteare 'severely' unsafe"*. Researchers at Ohio State University discovered that long-term plans to store radioactive waste from nuclear arms production are unsustainable and would result in radioactive materials being released

3Independent.co.uk on 20 01 27. Accessed on December 15 2020.

into the environment. The materials proposed to store the hazardous waste corrode far more quickly than previously thought, researchers write in a study published in scientific journal *Nature Materials* with details of their findings[4].The study is very clear on some important issues which obviously have been neglected until now: *"The complex corrosion behavior of materials over large time scale can be expected. The effects of corrosion products scale formation, radiation and bacteria etc. in the repository may all play a role in the corrosion process. Much work needs to be done to get a clearer scenario of corrosion development over geological time scale."* And continues: *"Corrosion is accelerated by the interface interaction between dissimilar materials could profoundly impact the service life of the nuclear waste packages (...). Once the container is damaged due to corrosion, surface waters and underground waters play a role in the transportation of radionuclides in water bodies, causing harm to humans. So the waste container serving as the first barrier to prevent HLRW from migrating into biosphere is of great importance. Corrosion effect of HLRW container is one of the most important problems needing to be solved in the HLRW disposal. Apart from corrosion effect, many problems influencing HLRW disposal are to be solved. For example, radiation damage of radioactive waste forms can result in changes in volume, leach rate, stored energy, structure/ microstructure and mechanical properties.*" (Nature 2018).

Corrosion is more and more becoming a serious problem also at the French repository site, Cigeo/Bure. The site with clay as a host rock poses an additional problem, because "*Radiation will break down water in the rock and cause corrosion of metal structures, leading to the release of explosive hydrogen gas, says biologist and engineer Bertrand Thuillier, an associate professor at the University of Lille. ANDRA plans to ventilate the tunnels, but that could exacerbate fires by providing oxygen, he says. A failure could be catastrophic, Thuillier warns: The area around Bure helps provide eastern Paris with water and is close to one of the world's most cherished wine regions, Champagne"[5].*

4https://www.osti.gov/pages/servlets/purl/1600995

5https://www.thefreelibrary.com/Reports+raise+concerns+about+France%27s+nuclear+waste+tomb.-a0506829286.