Focus 07 The EPR, supposed improvements versus new vulnerabilities

"The design of EPR ensures the high level of safety that is required worldwide for the future nuclear power plants."

Areva, *EPR, un choix stratégique*, brochure,February 2004

Lessons from Three Mile Island and Chernobyl came too late to bring in-depth modification of the design of the 58 reactors currently operated by EDF. Although they consider them as safe as was required at the time of their conception, the operator as well as the authority have recognised for more than ten years that these reactors would fail to meet current safety standards applied to new reactors.

From the mid-1990s, the French nuclear industry developed, together with the German and then alone, the EPR design as a response. This reactor builds upon the designs of the latest French and German concepts, respectively N4 and Konvoi, and seeks to reinforce their safety by adding supplementary and redundant features instead of deeply reviewing the designs. This approach has been qualified as "evolutionary", as opposed to more "revolutionary" reactor concepts developed in other countries – and the EPR might be the less innovative amongst new "evolutionary" designs like the US reactor AP-1000, which has developed more passive safety features.

The reinforcements of the EPR design, as compared to its predecessor N4, mostly consist of an increased thickness of containment, a multiplication and improvement of the backup system, or the adding of water in the primary circuit, as well as improvements in the operational procedures and automation of control and command. All of these tend to reduce the probability of a scenario leading to a core fusion. The overall goal is to reduce such probability by a factor of ten, from a "guaranteed" level of one chance out of one million per reactor per year for existing plants to one chance out of ten million. Nevertheless, as if to acknowledge that even this reduction of the probability remains hazardous, the main innovation of the EPR is a "core catcher" designed to receive and let cool down the melted corium in case of a major accident, with the aim of preventing any large radioactive release outside the plant in such a scenario.

The EPR design is therefore based on the same principle that accidental events can be fully projected in probabilistic trees, an assumption even more problematic given the planned lifetime of 60 years for new-built EPRs.[56] Also, the complexity of the safety systems involved makes their assessment subject to high uncertainty, as they cannot be fully tested except in the unfortunate case of a real accident.[57] Some key elements of the EPR safety case, like the efficiency of the core catcher, the prevention of hydrogen explosions in case of a core fusion, or the behaviour of the automated system of control-command, remain prone to controversy. Also, the level of performance intended for the reactor raises some new safety issues. In particular, the behaviour of fuel elements that would reach the very high burn-ups targeted could not be fully guaranteed with existing technologies.

Finally, it should be noted that the safety of a reactor is also that of the whole fuel-chain that it needs, the overall level of safety being that of the weakest part of the system. The EPR brings no improvement as it will rely on the same front-end and back-end technologies as existing reactors. On the contrary, the higher fuel performances that it aims for will induce new safety and radiation protection problems at all stages of fuel management.

Altogether, the ten-fold reduction in probability of a major accident in the reactor appears neither sufficiently assessed given the uncertainty regarding key features, nor sufficiently comprehensive in view of the limits of the probabilistic approach on one hand, and the need to consider the safety of the full system on the other hand. As compared to the potential field of innovative safety systems, one can doubt that the EPR design fits the evolution of safety requirements in a century – the time scale that would separate the shutdown of an EPR started-up in 2020 from the 1980s conception of the N4 reactor which it is based upon.

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[56] The probabilistic approach also fails to cover the scope of malevolent acts that could reasonably, after 9/11, lead to thermal and/or mechanical loads superior to those arising from accidental situations.

[57] For instance, the resistance of the containment to the high pressure of an accident could be tested, but not coupled with the high temperature that would go with such pressure.