Focus 10

## Pressure on performance and safety

*"The drop of the availability factor is an alarm signal for safety and is a wake-up call: are we paying sufficient attention to staff competence as well as to maintenance quality and material ageing?"*

**Pierre Wiroth, Inspector General for Nuclear Safety and Radiation Protection, EDF, January 2008**

The economic performance of nuclear facilities relies on such factors as their level of availability or the cost of maintenance. The need for profitability might therefore reduce the safety of the plants, for instance by delaying refurbishment or shortening technical controls. This particularly applies to French nuclear power plants, which already see their economics limited due to their huge overcapacity – and are subject to generic problems due to their high level of standardisation. For instance, in an internal note of 2001, EDF's financial department directorate estimated the loss of profitability at €76 million per percent point of productivity.[61]

EDF reactors have always shown a relative load factor. This combines the availability factor (the time when the plant is ready to produce) and the use factor (the actual production when available). EDF reactors have historically experienced a low use factor because of their excess capacity at large periods of insufficient demand. This, for instance, led to a worldwide unique pattern of reactor management where some units were shut down at weekends, particularly in summer. The constraints induced on the fuel assemblies were one of the potential causes of the unexpected failure of a highly unusual number of fuel rods at Cattenom in 1999-2000, which remains largely unexplained.[62]

Weekend shutdowns have supposedly ceased. However, over 40 units are still operated on load following mode, which could have unforeseen consequences on the fatigue of some components of the plants. Meanwhile, some problems have appeared that affect the technical availability of EDF reactors. Although it remains low, with 77.3 percent cumulated over the reactors' lifetime, the availability has been in constant progress during the last few years, with an increase from 80.4 percent in 2000 to 83.6 percent now, bridging some of the gap with the 90 percent availability or so that the reactor fleet achieves in some countries. But it dropped to 80.2 percent in 2007, clearly on technical grounds.

The main cause is a generic problem of plugging of the tube sheet penetrations of steam generators, that reduces the power output through cuts in the heat-exchange capacity, and could lead to tube cracking in huge numbers. EDF estimates that it will take until 2010 to solve this problem, which needs chemical cleaning. Only five to six units can be industrially treated each year, and 15 of the 900 MWe and 1,300 MWe have already been identified as affected, while some still wait for inspection. This would cost, according to EDF, another 2 percent of availability at least in 2008 and 2009. Yet another problem could further weight availability, as ASN ruled in February 2008 that an "anti-vibratory support default" has to be corrected in all affected reactors, the number of which has not been made public.

These are only the latest examples in a long series of generic problems that have affected the operation of EDF reactors. The negative side of standardisation is that it multiplies problems in large parts of the reactor fleet – and has associated high costs. An example of this link between safety and economy is the series of reinforcements of seismic withstanding after the ASN reassessed in 2003 the level of seismic hazard that had to be taken into account. This involved heavy refurbishments being required at specific points on some reactors, including anchoring points and metallic structures. EDF's reluctance led to the commissioning of a working group between the operator, ASN and IRSN to discuss in detail the exact level of reinforcements on each reactor involved.

[61] The figure must be higher now, following the increase of electricity prices in recent years.

[62] The problem had affected a total of 92 fuel rods in 28 different fuel assemblies (out of 193 assemblies with 264 rods each). This compares to an usual figure of a few rods failures at most in all French reactors in one year.

Another issue where economic pressure and safety can diverge is the search for fuel performance. The goal there is to improve the quantity of energy delivered by each fuel assembly, to allow a reduction in the number and intervals of outages for reloading of the core. EDF reactors were designed for nominal fuel burn-ups of 33 GW.d/t (gigawatt day per ton) which could be reached after a few years, then regularly improved up to 55 GW.d/t currently for uranium oxide fuel (UOX) – although not as quickly as EDF had wanted to. The operator plans to reach even higher burn-ups, both in currently operated reactors and in the future EPR reactor, for which the economic case is based on the hypothesis of a 70 GW.d/t burn-up.

The problem, on the safety side, is to keep control of the behaviour of fuel rods with increased burn-up. The concern with plutonium-uranium fuel (MOX) has for many years prevented ASN authorising a burn-up increase for that specific fuel from 42 to 47 GW.d/t. Fuel rod failures, among other problems, might be the start-up for some accidents. The zircalloy currently used for cladding is not resistant enough to reach the high burn-ups aimed for UOX fuel. The industry developed a new alloy, named M5. The first ever cycle of a full reactor reload cladded with the new M5, in 2002 in Nogent-2, had to be stopped because of primary fluid contamination following a record 39 rod failures on 23 assemblies. Although it remains unclear whether M5 cladding was a root or secondary cause, ASN suspended any extension of its use until full investigations.

Finally, cost-cutting impacts in many ways on operational safety. One recurring concern is the ever-growing use of external, underqualified and untrained workers for various maintenance tasks on nuclear power plants. The management of stocks recently arose as a new concern. EDF's inspector general for nuclear safety and radiation protection insisted in its report on the year 2007 on the problems raised by the massive reduction of costly replacement pieces.[63] He explained that it had become hard for sites to get those pieces when needed, reporting astounding cases where pieces had been unmounted to be replaced and were eventually put back in place due to the lack of spare parts.

[63] *Rapport de l'Inspecteur Général pour la Sûreté Nucléaire et la Radioprotection 2007*, EDF, January 2008.