Focus 16 Alongside waste, the problem of dismantlement

The legacy of nuclear activity does not consist solely of waste: it also entails the management of installations and their sites at the end of their useful life. For the time being, such activity involves only a relatively small number of installations, all old and very different from one another. The nuclear industry sees the carrying out of these various dismantling operations as preparation for the major phase of decommissioning which will be needed when the huge plants currently being operated have to be dismantled – plants such as UP2 and UP3 at La Hague (reprocessing) and Eurodif at Tricastin (enrichment), and above all EDF's whole complement of 58 reactors currently operating.

The difficulties encountered during the dismantling operations so far carried out or ongoing give little grounds for optimism. There is no existing example of a dismantling operation that has been carried through to the "green field" stage which is the theoretical goal of all operations of this type – in other words the disappearance of every trace of the installation, and the return of the land concerned to unrestricted use. The most successful decommissioning operations involve installations that have been cleared out, cleaned up and transformed into visitor attractions or monuments to the history of the nuclear industry – such as the building that housed France's first atomic pile, Zoé, at Fontenay-aux Roses, or that of the Chinon A1 "ball" reactor, a 70MWe reactor which entered service in 1963 and was turned into a museum in 1986. But these are exceptions.

As far as reactors are concerned, current experience relates essentially to models of the natural uranium-graphite gas line, for which the trial site is Bugey-1. This has been partially dismantled, as have the UNGG reactors at Marcoule and Chinon; dismantling is being completed at Saint-Laurent. In the course of this process, these plants have been turned into storage sites for their own waste. In the case of the CEA's reactors at Marcoule, treatment of steel and, above all, graphite waste was carried out in a fusion oven specially installed for the purpose. It has not been possible to apply this solution more widely. The process of dismantling EDF's UNGG reactors, involving the opening of the reactor vessels, is currently impeded by the lack of a management procedure for graphite waste, for which a definitive storage solution has still to be established in compliance with the 2006 legislation.

The dismantling of the Brennilis reactor, an industrial prototype heavy water reactor which entered service in 1963 and was shut down in 1985, should have been a model of its kind. The industry had presented it as a showcase for the progress from a "research and development" phase on the first deconstruction sites to an "industrial" phase of dismantling, which would demonstrate a process whose technical, economic and regulatory aspects had been mastered. In practice, difficulties proliferated at the site. The first phase, which consisted of removing all accessible radioactive material from the installation, began after authorisation in December 1994. The first demolition operations had to be halted, and the process revised, when it was discovered that the concrete was harder than anticipated. The Autorité de Sûreté Nucléaire (the French Nuclear Safety Authority) then interrupted work on the site for a complete revision of the zoning plan which categorised waste from different parts of the building (very low-level waste, low-level waste etc). Inspections regularly highlighted problems with specifications, non-conformities, the presence of highly corroded waste, and even, in 2004–05, a "complete incoherence" in the waste accounting data as presented by the operator, EDF. Recent developments in this story also illustrate the regulatory risks to which a badly managed dismantlement operation is exposed. At the end of 2007, the Council of State cancelled the decree authorising the final shutdown of the reactor (decree of 9 February 2006), including all the provisions relating to its dismantlement, on the grounds of an inadequate impact assessment.

The process of dismantlement is made all the more complex by the fact that the obligation to include a demonstration of the safety of the dismantlement operation at the design stage, which is now a requirement for the authorisation of an *installation nucléaire de base* (INB – regulated nuclear installation), did not apply when most of the existing installations were built. The example of Superphénix illustrates this difficulty. When the decision to shut down the reactor definitively was finally taken in 1997, after many years of technical and legal problems, it became clear that the

technical conditions for its dismantlement had not been foreseen, or insufficiently so, when it was designed. This dismantling process is now throwing up numerous technical difficulties. First it was necessary to produce inert rods to replace one by one the fuel rods extracted from the core, in order to maintain its geometry so as to avoid the danger of a collapse. But the most delicate stage is being carried out at present, with the emptying of the approximately 4,000 tonnes of liquid sodium contained in the cooling circuit and 1,500 tonnes in the back-up reservoirs. Highly inflammable and explosive on contact with air and water respectively, this product is "neutralised" by means of a procedure developed by the CEA which is supposed to be capable of emptying five tonnes a day over two treatment lines. This level does not seem to be reached at present. The emptying of 100kg from the Rapsodie breeder reactor prototype, when this was being dismantled, caused an explosion which lifted in the air a concrete slab weighing several tens of tonnes and resulted in the death of an operator. The rest of the dismantling operation, which will essentially consist of deconstructing the reactor building, is still to come. The work is currently planned to be finished in 2027.

Leaving aside the troublesome dismantlement of mostly elderly CEA installations with a combined R&D and industrial status, France has little experience of dismantling fuel cycle plants. The only large-scale example is the first fuel reprocessing plant, UP1 at Marcoule, which was used by the military programme but also by EDF. An economic interest group comprising the CEA, EDF and Cogema (now Areva) was formed in 1996 to oversee the programme to clean up and dismantle the plant. Little information exists on the progress of work in an installation which retains its secret status, but the technical difficulties of waste retrieval and decontamination appear significant. The dismantling process is not foreseen to finish before 2040.

Taken as a whole, these operations of course raise the question of cost. They invariably entail an increase in projected costs as the beginning of the work approaches, and in actual costs as compared to projected costs once the work has begun. In 2006 the Court of Auditors (Cour des Comptes) assessed the cost of dismantling Brennilis at €482 million, or 20 times more than the sum envisaged by the reactor's developers in the 1960s. In 2003 the Cour des Comptes assessed the cost of dismantling Superphénix and managing its waste at €2.081 billion. The dismantlement of UP1 had already cost €1 billion by the end of 2004, out of a total estimated in 2003 at €6 billion.

At the end of 2004, the Cour des Comptes estimated the overall long-term costs related to dismantlement for the three main operators, EDF, the CEA and Areva, at €65 billion (undiscounted costs). Nevertheless, numerous uncertainties remain regarding the cost of ongoing and (even more so) future dismantlement operations, and it was only in 2006 that France, in the context of the law on nuclear waste management, committed itself to setting up a dedicated mechanism intended to build up and safeguard the necessary provisions for this finance. Part of the uncertainty around costs also lies, more fundamentally, in uncertainty as to the industry's strategy for dismantlement: a number of factors play a major role, such as the timescale of dismantlement (immediate or deferred), the existence (or not) of exemption thresholds for very low-level waste which the dismantlement process produces in large quantities (rubble, scrap metal), and the level of 'return to normality' aimed at. In the first half of this year the ASN conducted a consultation on a framework document setting out a broad outline for the safety of dismantlement –among all the regulatory texts, such a document does not at present exist. While dismantlement is becoming increasingly important, with the difficulties being encountered by the ongoing operations and the planned shutdown of further installations, France's policy on the issue is still not fixed, and the real problems may just be beginning.