The Nonsense of Nuclear Fuel Reprocessing

Many readers will have seen the interesting Panorama programme on the poor safety record at Sellafield broadcast on BBC 1 on September 5 http://www.bbc.co.uk/iplayer/episode/b07v80s4/panorama-sellafields-nuclear-safety-failings

The BBC press release stated this was a "special investigation into the shocking state of Britain's most hazardous nuclear plant…" and it certainly was. Perhaps the most important of several whistleblower revelations was that the previous US managers had been shocked at the state of the plant when they took over its running in 2008.

Although the programme producers are to be congratulated for tackling the subject, it was only 30 minutes long and tells only a small part of the whole sorry story.

This article tries to give more background information, and importantly, more analysis and explanation. The full story would require several books and would be painful reading.

What is reprocessing?

Reprocessing is the name given to the physico-chemical treatment of spent nuclear fuel carried on at Sellafield in Cumbria since the 1950s. This involves the stripping of metal cladding from spent nuclear fuel assemblies, dissolving the inner uranium fuel in boiling concentrated nitric acid, chemically separating out the uranium and plutonium isotopes and storing the remaining dissolved fission products in large storage tanks.

It is a dirty, dangerous, unhealthy, polluting, expensive process which results high radiation doses to the ~9,000 workers employed at Sellafield.

Environmental consequences

The Sellafield plant is host to several hundred radioactive waste streams and processes which result in large discharges of radioactive liquids to sea and emissions of radioactive gases and aerosols to the atmosphere. Raised levels of childhood leukemias in some villages nearby are considered to be linked to the inhalation and ingestion of these radionuclides.

Sellafield, and a similar plant in La Hague France, continue to be, by some margin, the largest sources of radioactive pollution in the world. For example, the Irish Sea is the most radioactively polluted sea in the world with about half a tonne of plutonium sitting on its seabed from reprocessing.

The collective doses to the world's population from the long-lived gaseous nuclides C-14, and I-129, and from medium-lived Kr-85 and H-3 (tritium) emitted at Sellafield are huge and are estimated by radiation biologists to cause tens of thousands of early deaths throughout the world.

Another result is the 140 tonnes of unneeded, highly radiotoxic, plutonium (Pu) stored on site at a cost of £50 million a year. Pu is fissile and, in the wrong hands, this amount could be made into ~20,000 warheads, ie it is a serious nuclear proliferation danger.

The Liquid Waste Tanks

Not discussed in the BBC programme, but perhaps most serious of all, are the ~20 large holding tanks at Sellafield containing thousands of litres of extremely radiotoxic fission products, including long-lived Cs-137and Sr-90. Discussing these tanks, the previous management consortium Nuclear Management Partners stated in 2012 "there is a mass of very hazardous (nuclear) waste onsite in storage conditions that are extraordinarily vulnerable, and in facilities that are well past their designated life".

The National Audit Office (NAO) stated these tanks pose "significant risks to people and the environment". One official review concluded that, at worst, an explosive release from the tanks could kill two million Britons and require the evacuation of an area reaching from Glasgow to Liverpool. These dangerous tanks have also been the subject of complaints from Ireland and Norway who fear their countries could be contaminated if explosions or fires were to occur.

https://www.regjeringen.no/globalassets/upload/MD/2011/vedlegg/rapporter/sellafieldrapport_straalevernet_250111.pdf

http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(01)06620-X.pdf

The Sorry History of Reprocessing

The history of Sellafield (previously named Windscale) is littered with accidents and plant failures - some of which were very serious, as well as hundreds of leak and spillages. And there have been many scandals, cover-ups, secret reports, redactions, botched management contracts, allegations of corruption, and examples of gross financial mismanagement.

These have been discussed in scores of critical reports over the years by various Commons Committees, by the National Audit Office, by several independent consultant reports, and by environmental groups on many occasions. Also by reports from several European Governments, by the HSE, by RWMAC, and not least by several TV programmes in the 1990s alleging political dirty tricks and manipulation of Government Ministers.

Let's not mince words, the practice of reprocessing at Sellafield has been and remains a monumental national disgrace.

The final irony is that, if more intelligent spent fuel policies had been chosen, most nuclear reprocessing would have been quite unnecessary, as shown in the BOX below.

Why reprocess?

The initial rationale for reprocessing in the 1950s to the 1980s was the Cold War demand for fissile material to make nuclear weapons. Several studies during that time stated that reprocessing was a "dominating edifice of policy". All Government Departments had to operate within the "rigid framework imposed by the imperative of reprocessing." As a result, strategy-setting, regulatory functions, government reorganisations, and health and safety considerations always had to revolve around it. Reprocessing decisions were always made at Cabinet or Cabinet Committee levels.

The domination of reprocessing even extended to official inquiries. For example, in the late 1970s, the Windscale Inquiry was set up set up to determine a planning application to build the THORP plant. Inter alia, it had to assess the best way to handle spent nuclear fuel. Its 1978 Report strongly defended reprocessing. This was a nonsense even then (see BOX), but it held sway as nuclear defence considerations were considered paramount.

BOX
The Policy Horror of the Windscale Inquiry

How did the Windscale Inquiry conclude that nuclear reprocessing was a good way to deal with spent fuel? Largely by using unproved assertions, unsupported assumptions and unwise predictions. For example, it asserted impending uranium ore shortages and high uranium prices, despite evidence to the contrary even then. It asserted that the mooted glassification of HLW liquid wastes was the best way to proceed despite zero evidence that it would actually work, and despite testimony from Canadian scientists that untreated ceramic spent fuel was a much better waste form than glassified wastes.

Perhaps the most egregious assumption concerned the wisdom of storing spent fuel under water for relatively long periods. Such storage meant that spent fuel, especially Magnox fuel, had to be reprocessed, as the degradation of its cladding rendered it unfit for long term dry storage. Indeed, all or almost all, of the Report's recommendations on the rationale for reprocessing were later shown to be incorrect.

A major procedural flaw which probably explained much of the nonsense of the Inquiry's report was that Justice Parker, who knew next to nothing about nuclear technology, was advised by two senior advisors from UKAEA and MOD who sat on either side of him throughout the inquiry.

This Inquiry was perhaps an extreme example of policy-led "science". It is much preferable of course to have science-led policies. But when it comes to nuclear power or nuclear weapons, this rarely, if ever, occurs even today.

After the Windscale Inquiry's report, the policy of wet storage was maintained - in major part to ensure the continuation of reprocessing, as fissile material for weapons has not existed as a rationale at least since the early 1990s.

MOX Fuel

The next purported justification for reprocessing was the need to use plutonium as a reactor fuel in mixed oxide (MOX) fuels. However again this was and is a mirage as nuclear companies have repeatedly been unable to manufacture MOX fuel to the exacting standards required for Pu fuels. In addition, nuclear utilities in Europe and the US have generally refused to use it, unless forced to do so by Government agencies.

One reason is economics: MOX fuel costs about 4 to 5 times more than ordinary fuel per tonne and delivers 20% less energy output per tonne.

Another is that spent MOX fuel ex-reactor presents serious problems for nuclear utilities. It cannot be reprocessed as it is far too radioactive, and it has to be stored for 15 years rather than 5 years in cooling ponds as it is very hot when it exits reactors. This triples the cost of storing spent fuel. And it causes high radiation exposures to workers - even to managers in distant offices because of spent MOX's extremely penetrating radiation.

All in all, MOX fuel is a bad idea, but even in 2016, such is the dominance of nuclear thinking in Britain, that much evidence to the Parliament's recent POST report was still suggesting MOX fuel as a solution to deal with the UK's large unwanted plutonium stocks.

Are there other ways of dealing with spent nuclear fuel?

Yes. About 90% of nuclear fuel annual arisings around the world are NOT reprocessed but stored either in ponds or, increasingly, in dry storage facilities. Only the UK and France still carry out commercial reprocessing. This not to say that storage is problem-free or is a final solution but it does not suffer from the immediate dangers of reprocessing, nor from the huge number of waste streams nor from its massive pollution.

However the incoherence of reprocessing is gradually catching up with nuclear utilities and agencies, as the annual tonnages of reprocessed fuels are declining. Most European utilities (apart from those in France and the UK) stopped ordering their fuels to be reprocessed about a decade ago.

Where are we now with reprocessing?

The UK (and France) still carries out reprocessing, but its days are numbered at least in Britain.

Although all Magnox power stations are now closed, their spent fuels have not yet all been reprocessed. The latest NDA draft Business Plan https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/489358/Draft_Business_Plan_2016_to_2019.pdf shows its Post Operational Clean Out (POCO) plan lasting until 2023 with Magnox reprocessing ending in 2020.

With about 3,000 tonnes of Magnox fuel still to be reprocessed, the NDA could achieve the 2020 date, if the Magnox line managed to continue operating at the current rate. But the Magnox plant is 50 years old, and could break down at any time - as vividly shown in the

Panorama TV programme. So there is no guarantee of meeting the final Magnox closure date.

As for AGR fuel, the NDA stated in its draft Business Plan that the Thermal Oxide Reprocessing Plant (THORP) would close in November 2018, mainly because of the significant costs required to keep it going longer (including new HLW tanks costing £500 million) - costs that NDA said could not be justified.

The NDA stated its Post Operational Clean-Out plans (POCO) and timetable for THORP closure were now mapped out and firm, but whether these will be adhered to is a moot point. The problem is that the UK's 14 AGR reactors are expected to continue for another ~10 years on average (even although most are past their sell-by dates). This means at least another ~ 4,000 tonnes of AGR fuel will need to be catered for. The NDA has stated that this fuel will be stored at Pond 5 at Sellafield by chemically treating its pond water with strong alkali. Will this work? Again it's hard to say as no safety case for the long-term storage of AGR fuel in treated ponds has been published.

Of course, the NDA should really be building dry storage facilities like those at the Sizewell. nuclear station. (Sizewell, a PWR reactor, stores all its spent PWR fuel initially in ponds then in its dry stores.) However the latest NDA management plan omits any mention of dry storage.

This is despite the fact that, back in the early 1990s, the former company, Scottish Nuclear, had advanced technical plans and published safety cases for such dry stores for their AGR fuels. But BNFL, with Government connivance, ensured these plans were abandoned. It is instructive that none of the mooted new UK nuclear power stations contains plans for reprocessing their spent fuel.

Perhaps the most eye-watering revelations in the BBC programme were that, although reprocessing was going to cease, the waste containment functions of Sellafield would continue for another 110 years at an estimated cost of up to £162 billion. In other words, the mess of Sellafield will mainly be paid for by future generations. This is utterly unethical and an affront to any notion of sustainability.

Why did Britain reprocess for so long?

Mostly because of institutional mindsets, as the need to reprocess was deeply buried within the core beliefs of officials with nuclear responsibilities. Such institutional biases are powerful and long-lived as the NDA (formerly BNFL) is even now resistant to planning dry stores.

Another reason is that no one agency by itself seemed powerful enough to point out the folly of the matter and get the Government to stop reprocessing. When, in the past, environmental groups, Commons' Committees and audit agencies etc published report after report excoriating reprocessing, the Government fobbed them off with platitudes. For example, in 1993, during a public consultation over airborne radioactive releases from

THORP, when over 70,000 individuals called for a wider public inquiry, the Government simply ignored them.

What are the lessons for us today from this debacle?

- We must as a nation properly account for the environmental and other external costs of our policies.
- We must be wary of creating large permanent institutions over which Parliament has little or no control.
- We must learn to listen to people who have different views from the Government on nuclear issues. That includes appointing its critics as members to government committees and regulatory agencies.
- We must ensure that nuclear decisions are transparent and not hidden in secret documents or behind false "commercially confidential" labels in reports. No more cover-ups: no more redactions, and
- We must try to use science-led policies rather than fitting up false evidence around pre-conceived policies.

Most of all, we should recognize that, over the past 60 years, nuclear policies, whether in weapons or energy, have poorly served the nation.

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