Nuclear Waste – A global problem with only one answer: Stop producing it!

- Every stage of the nuclear fuel cycle produces radioactive waste. No country in the world has a solution for the highly radioactive waste produced in reactors which remains dangerous for hundreds of thousands of years.

- The nuclear industry claims it can 'dispose' of its nuclear waste by burying it deep underground. But even this can't isolate the waste from the environment forever. A deep dump only slows down the release of radioactivity into the environment.

- The industry tries to predict how fast a dump will leak so that it can claim that radiation doses to the public living nearby in the future will be "acceptably low". But scientific understanding is not sufficiently advanced to make predictions with any certainty.

- As part of its campaign to build new nuclear stations around the globe, the industry claims that problems associated with burying nuclear waste are to do with public acceptability rather than being technical in nature. The industry often points to nuclear dumping proposals in Finland, Sweden or the United States to underline its point.

- The least damaging option for waste already created at the current time is to be store it above ground, in dry storage at the site of origin, but this option also presents major challenges and threats. The only real solution is to stop producing this waste.

Nuclear Waste Inventories

From the moment uranium is mined the nuclear industry produces dangerous nuclear waste. Uranium mining generates radioactive tailings, which are collected in engineered tailings dams and covered with a layer of clay and rock to inhibit the leakage of radon gas.

Low-level Wastes (LLW) is generated in large volumes. It comprises paper, rags, tools, clothing, filters etc. It is often simply buried in shallow landfill sites, like the Drigg facility near Sellafield in the UK. Intermediate-level Wastes (ILW) includes things like resins, chemical sludges and the metal cladding stripped off waste fuel, as well as contaminated parts of reactors which have been decommissioned. Even this ILW, which contains higher amounts of radioactivity than LLW, is buried in shallow landfill sites in some countries.

In Normandy, France, the Centre Stockage de la Manche (CSM) was used from 1967 to 1994 to dispose of LLW and ILW. Radioactive contamination from this dump is leaking into groundwater, used by local farmers for their dairy cattle. (1) France now dumps waste at a new site in eastern France at Soulaine – the Centre Stockage l'Aube (CSA). CSA is in the Champagne region and has already begun to contaminate groundwater. (2)

Although not the most radioactive category of waste, ILW usually requires some form of shielding and needs careful management to protect the health of workers and the environment. In

the UK in 2002 it was revealed that over 80% of ILW is stored in a potentially dangerous condition - some in 40-50 year old buildings - because until recently it was thought best to delay treatment and packaging in case a particular form of treatment proved incompatible with the characteristics of a future underground dump. (3)
The most hazardous waste is the highly radioactive waste (or spent) fuel removed from nuclear reactors, which stays radioactive for hundreds of thousands of years. In some countries the situation is exacerbated by 'reprocessing' this spent fuel – which involves dissolving it in nitric acid to separate out weapons-useable plutonium. This process leaves behind a highly radioactive liquid waste. There are about 270,000 tonnes of spent nuclear waste fuel in storage, much of it at nuclear reactor sites. Spent fuel is accumulating at around 12,000 tonnes per year, with around a quarter of that going for reprocessing. (4) No country in the world has a solution for high-level waste.

Geological Disposal

Geological disposal is the emplacement of waste in geological formations. The industry says this is the preferred option for management of higher-level waste. It relies on the so-called multi-barrier concept to slow down the return of radioactivity back to the surface environment. The packaging the waste is placed in; the cement or other form of grout material placed around the waste packages; and the rock itself all help to contain the radioactivity in the dump.

Although the nuclear industry claims it can 'dispose' of its nuclear wastes by burying them deep underground, it does not claim to be able to isolate it from the environment forever as you might expect. It relies on diluting and dispersing the waste throughout the environment as it leaks from the dump. The International Atomic Energy Agency (IAEA) says the goal of radioactive waste disposal is to avoid "*undue exposure to radiation of humans or the environment*" and keeping any potential hazard to human health "*acceptably low*" over required periods of time. (5)

The industry relies on being able to predict the stability of the geological and hydro-geological conditions over very long time-scales – millions of years, in order to be able to prove that radiation doses to humans in the distant future will be kept acceptably low. But our scientific understanding is not sufficiently advanced to be able to predict the impact of underground nuclear waste dumping on human health or the environment that far into the future. For example, the Inspector's report into the application by the former (until 2006) UK Radioactive Waste Disposal body, Nirex, to build a Rock Characterisation Facility at Sellafield in England, talked about the "*profound novelty and complexity of the deep disposal, multi-barrier concept*." (6)

Nirex, said we should seek to minimise the further burdens imposed on future generations for the management of radioactive waste. It used the Sustainable Development Principle to argue that, since it is the present generation, which has benefited from nuclear power, we should be the ones to deal with the waste. (7) But it would be more responsible to bequeath future generations a well-managed, monitorable retrievable waste store than a waste dump from which radioactive materials will eventually leak. A nuclear waste dump with all its potential problems is not a way to protect future generations from problems arising with radioactive wastes. The most sensible way to reduce further burdens on present and future generations would be to stop creating more nuclear waste now by closing existing facilities as soon as possible.

International Safety Requirements

The IAEA has a Radioactive Waste Safety Standards (RADWASS) programme intended to provide an internationally agreed framework for setting national safety standards for the

management of nuclear waste: The 'Safety Requirements for the Geological Disposal of Radioactive Waste' (8) This proposes an estimated average dose to members of the public in the future from a dump of less than 0.3mSv per year or a risk of 10^{-5} per year ie a risk to a person of 1 in 100,000 per year of a serious health effect. (9) The IAEA does, however, say it recognizes that:

"…*radiation doses to individuals in the future can only be estimated and that the uncertainties associated with these estimates will increase for times farther into the future. Care needs to be exercised in using the criteria beyond the time where the uncertainties become so large that the criteria may no longer serve as a reasonable basis for decision making*".

In the UK the environment agencies have set requirements for radioactive waste disposal such that the assessed radiological risk to an individual should be less than one-in-a-million per year or 10^{-6}. This is equivalent to a dose of around 0.02mSv per year. (10) Yet in illustrative assessments of the performance of a generic dump, Nirex gives various scenarios which could result in doses 500 to 1000 times higher. (11) Another Nirex report - '*Potential Areas of Future Geosphere Research*' shows just how much uncertainty there is associated with key parameters which need to be quantified. (12) The Environment Agency in its November 2005 review of Nirex's phased geological disposal concept, lists 10 'key technical challenges' "...*where further work is needed before an acceptable repository safety case could be generated*." (13) Clearly we do not know enough to predict just how dangerous it would be to bury radioactive waste.

The nuclear waste problem is not solved

As part of its campaign to build new nuclear stations around the globe, the nuclear industry often claims that any problems associated with burying nuclear waste in a deep underground "repository" are to do with public acceptability rather than being technical in nature. The industry often points to nuclear dumping proposals in Finland, Sweden or the United States to underline its point. But the lack of a solution to the nuclear waste problem, and the absence of an operating HLW, spent fuel nuclear waste dump, acts as a barrier to the construction of new nuclear reactors.

Finland

The Finnish Parliament has **not** approved the construction of a HLW or spent fuel repository, as often claimed. It merely made a decision-in-principle, in May 2001, and gave permission to nuclear waste company, Posiva, to build a Rock Characterisation Facility (RCF), called ONKALO at the Olkiluoto nuclear power station site, to a depth of 500 meters. (14) Posiva began excavating the test facility in June 2004. Over 400 metres of access tunnel had been driven by end-April 2005.This may eventually be expanded to become a permanent nuclear waste dump for spent nuclear waste fuel, but only after approval has been given for the second stage of the project – construction of the actual dump. Posiva plans to submit an application to build the final disposal facility to the Finnish government by the end of 2012. It is planned to commence the final disposal of spent nuclear fuel at Olkiluoto in 2020.

Finland's relatively small volumes of low and intermediate-level waste (compared with countries with larger nuclear programmes or which carry out reprocessing) are buried in shallow (70-100 metres deep) underground silos at each of the two nuclear power station sites, Olkiluoto and Loviisa.

Sweden

The situation in Sweden is very similar to Finland, except that it does not yet have a site for HLW – only a concept. Short lived low-level and intermediate-level waste is disposed of at the SFR disposal facility at Forsmark in rock chambers at a depth of about 50 metres, beneath the bottom of the Baltic Sea.

After spent nuclear waste fuel has been discharged from the reactors, it is stored for at least one year in the nuclear power plants own pools. Then it is taken to the central interim storage facility for spent nuclear fuel, known as CLAB, located adjacent to the nuclear power plant in Oskarshamn.

The Swedish waste agency, SKB, is continuing to search for a site for the deep disposal of HLW. Several municipal areas have rejected proposals, and investigations are currently centred on Oskarshamn and Forsmark (Oesthammar). SKB wants to be able to suggest a site for deep repository around 2007. Sweden already has a hard rock laboratory at Aspo near the Oskarshamn nuclear power plant which carries out research tests under actual field conditions at a depth of 450 metres. This site is guaranteed never to become the final dumpsite. (15)

United States

At an estimated cost of $58bn, the American nuclear industry intends to bury 77,000 metric tonnes of HLW at Yucca Mountain in Nevada. (16) The Bush administration's original plan was to get a license application submitted to the Nuclear Regulatory Commission by the end of 2004, and to start burying waste in 2010. But after a string of problems, including a federal court ruling in 2004 that invalidated a repository safety standard and ongoing investigations of e-mails in which several workers discuss falsifying quality assurance documents, (17) the 2010 date has been abandoned. (18)

The proposed Yucca Mountain nuclear dump currently consists of a five-mile long tunnel dug into the side of the mountain. Drilling began in 1994 at a rate of about 185ft a day. But it will still be a long, long time, if ever, before construction is completed. If a licence is issued, there are seven more years of construction ahead, then another round of federal permits. (19) The US Department of Energy (DoE) says it will be another 11 years before there is a disposal facility. The DoE now hopes to open the 'repository' in 2017 – 19 years after the original target date of 1998. (20)

The new schedule sets 30th June 2008 as the date for DOE to submit a license application to the Nuclear Regulatory Commission, an important milestone that kicks off a formal review. But Nevada officials and politicians who have fought the repository were sceptical on the new timeline

In 2005 the U.S. Environmental Protection Agency's (EPA) proposed a new rule for radiation doses to future generations in response to the 2004 federal court ruling. This new proposal would still overturn all established principles of public health protection, according to the Institute for Energy and Environmental Research (IEER). It would be the worst standard in the Western world, by far. The proposal seems tailored to fit Yucca Mountain so that it can be licensed. (21) The proposed standard would allow a dose limit of 3.5 mSv per year beyond 10,000 years - three-and-a-half times the maximum limit allowed to the public from any human activity (other than medical radiation) according to current limits established in the United States and all western countries. The EPA now expects to release its finalised targets for Yucca Mountain in early 2007.

A new book on Yucca Mountain entitled "Uncertainty Underground", says despite a large knowledge base, substantial funding of over $7bn so far, and a large number of talented scientists engaged on every aspect of the problem, there continue to be delays. One important reason, say the authors, is that the scientific and engineering communities have underestimated the effort required to characterize the site and model the behaviour of the rocks and the waste over long periods of time, and the large uncertainties inherent in such analyses. (22)

The state of Nevada is also opposing the U.S. government's plan to store thousands of tons of nuclear waste temporarily above ground at Yucca Mountain. Because the underground dump is so far behind schedule the Government wants to place the nuclear waste temporarily above ground. (23) But Yucca is only being designed to hold 77,000 tons of waste, yet there are nearly 60,000 tonnes already piled up at U.S. nuclear plants and this is increasing by about 2,000 tonnes a year. So soon there won't be room for any more U.S. waste at Yucca. Nevada fears it will end up with a waste dump above and below ground. There are moves afoot, however, to expand the dumps capacity, but this would require Congress to pass a new Bill. (24)

United Kingdom

During the 1990s, Nirex, the UK's nuclear waste disposal company, sought permission to build a Rock Characterisation Facility (RCF) near Sellafield before building a 'Deep Repository' between 650 and 900 metres deep for nuclear waste. It was intended to accommodate both Low and Intermediate Level Waste (LLW & ILW), but not High Level waste (HLW). (25) After spending over £450 million (26) of public money, Nirex's plans were rejected by the Secretary of State for the Environment in March 1997, following a lengthy planning inquiry. (27)

In 2003 the UK Government set up the Committee on Radioactive Waste Management (CoRWM) to look at various options for the management of nuclear waste, including HLW. This Committee made recommendations to the Government in July 2006. (28) Although the Committee said geological disposal was its favoured option, it argued that the creation of suitable facilities "may take several decades" and robust interim stores must be built in the meantime. It said there may not be sufficient agreement to implement geological disposal at the present time, and there may be technical difficulties in siting or community concerns could make it difficult, or even impossible, to make progress at a suitable site. CoRWM was not asked to recommend a site for a nuclear waste facility. If the Government goes ahead with a deep dump there will need to be some sort of site selection process. (29)

CoRWM's chairman, Gordon MacKerron, stressed that its recommendations should not be seen as a green light for new stations. "We don't believe that anything we say is in any way endorsing new build," he says. "The public assessment that should apply to any future new build proposals should build on the CoRWM process, and will need to consider a range of issues including the social, political and ethical issues of a deliberate decision to create new nuclear wastes".

The UK's 2003 Energy White Paper noted that there are "important issues of nuclear waste to be resolved". An editorial in *New Scientist* magazine in May 2006 said that while advocates of nuclear power will argue that CoRWM has provided the solution to the nuclear waste problem, this is *"optimism gone mad. Deciding to put waste down a hole, with no idea what form the repository should take or where it should be, is no more of a plan than has existed for the past 30 years.*" (30) Yet the Government's 2006 Energy Review endorsed the idea of new nuclear power stations. It is remarkable that a report from a Committee can be considered to have solved the intractable problem of nuclear waste. (31)

In the Government's response to CoRWM it failed to capture the heavily qualified nature of CoRWM's recommendation about deep disposal. It disregards CoRWM's recommendation about wastes from a new nuclear programme, and it skipped a vital stage of consultation when it announced that the Nuclear Decommissioning Authority (NDA) would absorb Nirex. In fact, as Nirex itself highlighted, there is a potential conflict of interest because the NDA is a waste producer. CoRWM's recommendations about the need for an independent oversight of the policy implementation process were diluted. Rather than an oversight body, the Government has only committed to a reconstituted CoRWM as an advisory body. Members of CoRWM have "*substantial misgivings*" about these plans, which they fear could undermine public trust, because the Government has rejected the idea of establishing an independent oversight organisation to find a site. The appointment of the NDA is regarded as "*problematic*" by some because of its agenda to promote short-term efficiency. There were "*potential conflicts and loss of public confidence*" caused by its dual role as waste creator and waste disposer. (32)

France

A new Act was submitted to Parliament on 22nd March 2006, which proposed phased deep geological disposal as the preferred option for HLW, at a site to be selected by 2015. In the meantime research will continue in the underground laboratory at Bure, in north-eastern France. The Act was passed by the Senate in early June, with significant amendments. These gave oversight of the decision-making process to parliament, and require that any facility should incorporate 'reversibility' at every stage. (33)

Conclusion

Clearly the nuclear waste problem in Finland, Sweden, the US, UK and France has not been 'solved'. Despite apparent advances in these countries, our understanding of the deep geological environment is still in its infancy. Because of the multitude of complex and interacting factors which have to be taken into account when attempting to accurately predict the rate at which radioactivity will leak from a potential dump site, the nuclear waste problem may, in fact, never be 'solved'.

Above-ground storage

Environment groups believe the "*profound novelty and complexity*" of the deep disposal concept should now be fully recognised. Deep disposal is not a solution to the nuclear waste problem because leaking radioactive waste from a deep dump will inevitably contaminate the environment and pose a persistent, irreversible threat to future generations. The overwhelming weight of evidence is that this threat is poorly predictable, impossible to assess with current scientific understanding and likely to remain so for an indefinite period, despite many decades of expensive scientific research.

The first implication of the failure of deep disposal is that production of nuclear wastes must cease. Secondly, existing nuclear wastes must be stored above ground where they can be managed, monitored and retrieved if necessary, rather than dumped where environmental contamination is inevitable.

Existing nuclear wastes (including nuclear waste fuel) should be stored above ground in managed, monitored dry stores, built to resist terrorist attack. The waste should be retrievable so that problems can be dealt with or technologies improved. Storage is not a solution to the problem of nuclear waste, but at least it gives future generations a choice rather than an irrevocable

commitment to a leaking nuclear waste dump. It is more responsible to pass on to future generations the responsibility of managing existing wastes than it is to pass on an irreversible commitment to a contaminated environment.

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