

Questioning nuclear waste substitution: a case study

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Abstract This article looks at the ethical quandaries, and their social and political context, which emerge as a result of international nuclear waste substitution. In particular it addresses the dilemmas inherent within the proposed return of nuclear waste owned by Japanese nuclear companies and currently stored in the United Kingdom. The UK company responsible for this waste, British Nuclear Fuels Limited (BNFL), wish to substitute this high volume intermediate-level Japanese-owned radioactive waste for a much lower volume of much more highly radioactive waste. Special focus is given to ethical problems that they, and the UK government, have not wished to address as they move forward with waste substitution. The conclusion is that waste substitution can only be considered an ethical practice if a set of moderating conditions are observed by all parties. These conditions are listed and, as of yet, they are not being observed.

Keywords Nuclear · Waste · UK · Japan · BNFL · Substitution

Introduction: what is waste substitution?

Back in the days of haughty nuclear optimism, the 1950s and 60s, the issue of nuclear waste was largely ignored. Meanwhile the nuclear cycle was becoming international. Uranium rich nations supplied nuclear operating nations with raw materials. Nuclear operating nations supplied nuclear ‘wanna-be’ nations

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with reactor technology, and would-be nuclear military nations were trying to beg, borrow and steel as much technology and materials as they could from anyone.

Another international nuclear trade, nuclear reprocessing is where the story begins with regards to waste substitution. Reprocessing is the technical and chemical process whereby spent fuel is separated from useful fuel, the latter of which can, if necessary, be used again in nuclear reactors. Originally, the reprocessing process was a military technology used to recover plutonium for use in nuclear weapons [16].

By agreement between the UK and Japan, the spent fuel to be reprocessed and the waste produced by reprocessing is still the property of the customer, i.e. the Japanese nuclear companies such as JNFL (Japan Nuclear Fuel Limited) and Tokyo Electric and Kansai Electric. However, many reprocessing customer nations, in agreement with the operator nations, have pushed for terms of operation whereby the latter will accept a certain specified substituted waste for the actual waste that they own. For example, in the case that this article addresses, Japan is a customer nation that has sent spent fuel to the UK to be reprocessed. Instead of sending back the intermediate level waste that reprocessing has produced, the UK, in cooperation with the Japanese nuclear authorities and companies, wants to send back smaller amounts of high level waste as a substitute. This waste substitution—BNFL and their Japanese customers suggest—would decrease waste transportation from about 600 ship transports to about 10; thus saving both BNFL and the UK a lot of money, and the world, a lot of unnecessary environmental risk. The waste substitution, says BNFL, would increase the overall amount of nuclear waste in the UK by an ‘insignificant’ amount (some 1.5 percent) and, in any case, the substitution will be radioactively neutral (i.e. it will not increase the overall radioactivity of waste materials in the UK).

In 2005, after years of deliberation, the government finally agreed to handle the substitution issue in the way that BNFL wanted, and they approved the concept of waste substitution. My arguments in this article suggest that the UK government were wrong to do so.

Should nuclear waste be traded?

There are two schools of thought which guide nuclear waste trading in the international sphere:

- (1) That each nation should be self-sufficient in all aspects of the nuclear ‘cycle’ including long-term waste management.
- (2) That since other parts of the nuclear cycle are not self-contained within most countries, why should long-term waste management be?

Those who lean toward the second school of thought might admit that self-sufficiency is a worthwhile principle but it should not bind a waste-producer

into a stringent pattern of relations if the various partners could benefit from waste trading without compromising overall safety.

Those who lean towards the first school of thought are likely to say that compromising safety is not the only ethical issue that affects substitution and they would state that nuclear materials and radioactive waste are such potentially damaging materials, can increase WMD proliferation and geopolitical instability, and are so incredibly long-lived—beyond the timeframe of any government—that each nation should manage the wastes by themselves and within their own territories.

There is a case to be made that substitution directly avoids rather than contributes to returning the obligated waste of another nation. It is, after all, not the same waste that was actually delivered for, or produced in, reprocessing. Acknowledging this, it is still the case that scientific categories are subject to social agreement and a looser definition of ‘waste return’ may be quite acceptable to all stakeholders if they are shown good cause. Despite this, a glaring inconsistency may be noticed by some stakeholders. In an industry that takes strict note of the precise physical nature of its raw materials (submitting different nuclear materials to different physical processes, with specialist rules for security, access, health and monitoring for each of these materials due to their inherently different physical properties), it seems rather inconsistent that they suddenly become so nonchalant at the end of the nuclear cycle and declare that there is an equivalence between high-level waste and intermediate-level waste. The exchange of different varieties of waste begs the question of whether we are comparing apples with oranges.

How equitable is the trading relationship?

As part of their push to proceed with waste substitution, BNFL produced a consultation paper in 2004 [5]. The consultation paper tried to suggest that substitution is a practical solution entered into by willing partners. Reading through the consultation paper there are a number of inconsistencies that seem throw suspicion on this suggestion. Firstly, BNFL advise that a substitution fee is payable by the customers, i.e. Japan’s nuclear companies. This would tend to imply that if it was a straight swap, purely a ‘substitution’ in the vernacular sense, waste for waste, then there is no need for money to change hands. However, when money changes hands (in the form of the ‘fee’) then the suggestion that waste substitution involves equitable or absolutely willing partners becomes less tenable because the substitution immediately becomes converted to one of compensation for taking on an increased safety or financial burden (i.e. it appears that Japan is happily paying the UK to take on the extra burden of dealing with the extra waste).

When money is involved there is also an obvious tendency for the transaction to be seen as a commercial endeavour. For those nuclear host communities in the UK such as Sellafield and Dounreay (who may be sensitive to their community being the future home of an anticipated final repository) the

fact that the BNFL or the UK Government will receive financial reward for taking on foreign waste is somewhat suspicious. If foreign customers are prepared to pay a 'substitution fee' then it is likely the British public will suspect that customer nations are getting more out of the arrangement (otherwise they wouldn't be paying a fee). Thus, substitution arrangements where money changes hands are likely to be interpreted as an unfair swap. In this case, BNFL's presentation of substitution as an equitable swap—economically and radiologically—is quite misleading.

Although both BNFL and the Government of the UK promise that financial revenue gained from substitution will be pumped back into paying for decommissioning old nuclear facilities, this is a scheme which provides for the future security of the nuclear industry not for the benefit of waste-burdened communities.

What is the role for stakeholder participation?

In democratic nations around the globe, the issue of nuclear waste management has been dragged kicking and screaming into the modern world of public participation and stakeholder involvement. In some nations, like the Scandinavian nations and the Low Countries, the national nuclear waste management programme tends to be heavily dependent on promoting successful stakeholder involvement. In others like the USA, stakeholder involvement tends to be patchy and superficial.

The UK has tried both approaches without much success so far. However, the UK Government and its nuclear waste authorities like the Environment Council, Nirex UK, and CoRWM (Committee on Radioactive Waste Management) speak of their commitment to public consultation [28]. When it comes to deciding whether substitution is an appropriate waste management strategy, however, the role of public participation is inadequate. For example, the 2005 nuclear waste substitution policy automatically (and unnecessarily) excluded an important set of stakeholders; those who will be living within the host community of a future repository containing the substituted waste. The obvious remedy to this situation is to let the decision on waste substitution be made as part of the UK's nuclear waste siting process. This would delay the decision until the siting process is formulated but it would allow prospective host communities to voice their opinions about the possibility of living near internationally substituted nuclear waste as well as domestic waste.

The obvious retort to the suggestion above is that the extra waste is 'insignificant' and the safety and environmental risks are negligible. However, the decision over whether it is really 'insignificant' should not be made by BNFL, or the UK Government, but by those who will be subjected to the burdens of the substituted waste; the future host community. From a public perception point of view, the 'insignificant increase' and 'radioactive neutrality' arguments might not wash with a host community intent on seeing themselves as 'custodians' of UK waste rather than as dumping grounds for

foreign fee-paying customers. Instead, waste substitution will be seen as profitable trade deal for both BNFL and the Government.

An anonymous reviewer of this article suggests that we should not worry too much about canvassing opinion from those who may end up living next to any substituted nuclear waste since such people should have confidence in the calculations and decisions of scientists, engineers and health and safety officials. The public, the reviewer suggests, has too many other urgent issues on their mind to bother about educating themselves on the technological details of nuclear waste. This would be fine if:

- (a) all members of the public were openly electing to defer all decisions about their future health and safety to the authority of scientists, engineers and Government officials (but they have made no such concession).
- (b) science, engineering and health and safety officials in the UK and Japan hadn't shown themselves to be incompetent and not entirely trustworthy in recent years (as shown through various public debacles [32] from nuclear safety [23] to mad cow disease [3]).

The alternative proposition is that many community members are very interested in the scientific issues of any new facility planned for their area since they are concerned about the economic, social and environmental well-being of their family and their community [24]. Many people are also very sceptical of any official who suggests that the easiest thing for everybody concerned is to just trust the authorities [6]. The more someone seeks to court trust purely on the basis of their technical authority, the more they tend to be distrusted.

Dumping foreign nuclear waste 'Through the Backdoor'?

Substitution might be criticized as a way of setting up an active trade in radioactive waste under a cover of 'pragmatic' waste management. This point of view is cognisant of the fact that if substitution was ever going to be discussed as a waste management option, it should have been discussed openly by BNFL and the UK Government when reprocessing was proposed. When reprocessing was formulated, discussed, opened up for public debate etc; did BNFL or the UK Government at that time openly state that substitution will play a major part in the future management of wastes arising from foreign reprocessing? The answer seems to be yes and no.

It is clear that waste substitution was presented as being within the realm of possibilities, along with waste return being 'optional', when BNFL discussed waste arrangements with potential reprocessing customers in the 1970s and 1980s (since such substitution means that customer countries would not be fettered by the possibility of having to repatriate large volumes of Intermediate Level Waste (ILW)). However, the UK Government position at this time was that any future substitution was subject to Government approval

from all involved countries before reprocessing was to commence. The UK government policy line at this time also stated that the exact specifications of waste return should be set out by all the involved parties prior to the commencement of reprocessing operations. For some reason, neither of these things happened [31]. From this point of view, it seems that BNFL were served well by such promises for they could press ahead with negotiating commercial reprocessing contracts unencumbered by the necessity to work strict waste return plans into the negotiations with customer nations and they could defuse angry rhetoric from media and activists about foreign waste dumping.

More than 10 years on from the latest start up of a reprocessing plant, THORP in Sellafield—and with 1000 tonnes of increased waste now residing nearby—it is rather late in the game for BNFL to set out the exact specifications of waste substitution. BNFL now hope that the UK public will see the pragmatic necessity for nuclear waste substitution, especially given the small (percentage-wise) increases in UK based waste that it gives rise to. However, it will not be the extra *volume* of waste (and supposedly negligible increase in health risk) which gives rise to ethical questions and public objections. It will, instead, be the following issues:

- the pattern whereby substitution is foisted upon the public as a way to help BNFL address its current economic and technological problems stemming from earlier decisions.
- the possibility of public/stakeholder exclusion from the decision-making process.
- and the idea that BNFL and the UK government is profiting by accepting overseas waste at the expense of burdening host communities.

Dealing with the discontent and immorality of the above issues should give rise to a number of new suggestions:

- (a) The financial benefits from waste substitution should not go to BNFL or the UK government (by, for instance, subsidising the decommissioning of old nuclear plants) but should be fed back into the host community.
- (b) Do not allow any future reprocessing contracts to be written out which approve substitution as a waste management strategy.

With regards to ‘a’, if it is thought ethical to reward those who take on risks, then all profits from substitution should flow into benefiting the actual host community that will be burdened with the waste. Those who are hesitant to give away rewards that flow to them from a risky activity tend to play down the risks, and we have to ask if BNFL and the UK Government are doing this with regards to their promises of ‘radioactive neutrality’ and ‘insignificant volumes’ in waste substitution.

Another vital question to ask at this point is this: ‘Does waste substitution create an undesirable precedent?’ The Waste Substitution consultation report states that:

“The current agreements in no way commit BNFL or the UK government to substitution in the event that additional reprocessing business was signed by BNFL” [5, p. 30].

This statement is disingenuous in that the single strongest entity seeking to forge substitution-connected reprocessing contracts will be BNFL. If they want substitution, BNFL should be obliged to state this upfront so that stakeholders can fully incorporate it into their decisions on waste management and waste facility siting. BNFL’s reticence in stating this desire ‘up front’ is understandable since, if they do so, then antagonistic stakeholders will likely feel that further substitution is possible, or in fact probable, and the nuclear waste trade will duly increase. The extra 1.5 percent nuclear waste volume may turn into an even higher percentage.

The emerging point is that substitution greases the wheels of reprocessing commerce for willing partners by putting it into a form that is acceptable, doable and legal. The worries of concerned Britons should be that because substitution is a money-earner (or money-saver) for BNFL and the UK government, a strengthened substitution policy will likely open the door to a regular nuclear waste trade (where money is exchanged for handling foreign wastes not just from reprocessing customers but from non-customer nations).

Looking at a parallel situation, when the Russian government approved the import of foreign waste into Russia for disposal, it was interpreted in both Britain and around the world as a key moment in making Russia the nuclear dump of the world [10]. The Russian atomic energy agency (which is to handle any contracted foreign waste) came under intense fire worldwide for selling out public and environmental safety but the answer it gave in response is that Russia has the technology to handle the waste and it needs the added income to operate its own nuclear waste facilities. The question we must put to BNFL and the UK government is whether or not the case whereby Britain takes on Japanese wastes via substitution is all that different? To save itself money, BNFL and the Government is, via the substitution program, actually importing wastes. So is it any different than Russia asking for money to store other countries’ waste? If it is not that different, then a backlash just as severe as the Russian one may be the least the UK government may expect when a UK waste repository is planned.

What do the public feel about substituted nuclear waste?

It was suggested above that any decision to go ahead with nuclear waste substitution should be made in consultation with affected communities. No one knows for sure who those affected communities are, or will be, because no decision has been made as to where or how to permanently store either intermediate level or high-level waste in the UK but we can learn a lot from several Government-sponsored studies such as the public consultation studies of the ‘Managing Radioactive Waste Safely’ programme.

In one report of this programme there was public ambivalence over whether substitution was a good or bad thing. There were also a number of individual expressions that a more open debate should be encouraged. In the Scottish Executive survey [26] of Scottish attitudes to radioactive waste, approximately 90 people out of 330 responded to the substitution issue, and of those, half were negatively predisposed to it. This may be interpreted in two ways: (1) that only a small proportion of interested people are opposed to substitution, (2) that substituted waste has not received any high-profile attention (because the final siting of it has not been discussed) but if it does receive attention and more people become interested in it then there will be a high percentage of people who will respond with marked concern.

It is notable that foreign-made nuclear waste is generally very unwelcome wherever it might be discussed. Candidate host communities can sometimes be persuaded to put up with their own national waste but they have a tough time putting up with other nations' waste. According to a poll undertaken by the European Commission [8] on nuclear waste disposal—of those questioned only 7 percent were willing to store waste from another country. This figure may be even lower if only members of prospective host communities, like Sellafeld or Dounreay, were polled.

With regards to those European communities that have selected themselves for possible repository siting, there are a number of examples that show that the communities are very sensitive to the idea of foreign waste. In Finland, for example, Kimma Tuikka, a representative of the Kively movement based near the once-proposed host community of Aankoski, stated that members of his movement were very negative to the idea that the proposed facility would end up receiving radioactive waste from other EU nations. Also in Finland, Altti Lucander, a member of the local authorities of the Eurojoki host community acknowledged that community confidence in the proposed facility strengthened after the import of spent fuel was prohibited by Finnish law 9 [25].

In Sweden, too, potential host communities have gone to great lengths to ensure that the repositories that are being proposed for their areas will only accommodate waste from their country [17]. An anonymous reviewer of this article suggested that Swedish communities are competing to offer themselves up to host nuclear waste so we shouldn't necessarily suggest nuclear waste as some universally despised spectre. However, it is not communities per se around the whole Swedish nation that want it, just members of the nuclear elite, including nuclear-industry friendly local authorities, within areas which are already highly nuclearised. And even there, they only want the waste from domestic sources, not international sources.

In Australia, a nation previously proposed as a host for a multinational repository [18], an independent survey commissioned by Greenpeace in 1999 [11] found that 85% of Australians were against the importing of radioactive waste.

In Russia, as introduced above, 2.6 million people signed a petition to halt the Russian Atomic Energy Agency from allowing the importation of nuclear

waste [30]. None of the above examples deal with waste substitution, in particular, but they certainly go some way to expose importation of nuclear waste as provoking negative reactions in the public mind.

Third party nations and transit issues

One affected group of stakeholders yet to be considered by BNFL and the UK Government are those people who populate the Pacific Islands surrounding the transport route to Japan. These nations have tried in vain to get BNFL and the UK involved in discussions about environmental safety assessments, liability and emergency procedures.

The Fiji based Pacific Concerns Resource Centre (PCRC), for example, declares:

“that Japan, France and Britain are refusing to discuss compensation in the event of an accident, and have failed to conduct detailed environmental risk assessments” [12].

Also, in July 2000, BNFL ignored the opposition from South Pacific island nations that waste shipments must not violate their 200 mile Exclusive Economic Zone.

South Pacific nations may feel particularly aggrieved on this issue since they have had to put up with what they consider ‘nuclear colonialism’ in the past with regards to French and American nuclear bomb testing. Now they have to put up with lack of consultation regarding ‘floating nuclear time bombs’ in their backyard.

Another socio-ethical problem is that the politics of anti-nuclear policies in the Pacific is affected by the politics of Aid. In the past, Pacific countries have had to abandon their anti-nuclear policies because countries like Australia, Japan, Britain and the USA have refused to sign aid packages. In the realm of nuclear transport there are strong suspicions that both Australia and Japan, which both provide significant aid to the region, have been lobbying behind the scenes to prevent more strident criticism of nuclear transports [13].

Reprocessing and waste substitution

In a number of statements BNFL has suggested that substitution decisions should be independent from the reprocessing issue. The division though is artificial in that the substitution issue comes about due to previous reprocessing contracts and the Japanese waste is in the UK in the first place due to reprocessing.

As is well documented, reprocessing has been subjected to intense criticism for economic, safety and environmental reasons. It has also been criticised for being a de facto waste management strategy. Obviously, waste substitution could be set upon by antagonists as a way to criticise the whole reprocessing

ethos. This will serve to re-ignite arguments within the public domain; arguments long hoped by the nuclear industry to have been put to rest. Reprocessing at THORP in the UK is now into its second decade of operation. It was not a smooth path getting this far, either politically or financially. THORP was, and is, derided by its critics as a messy, costly and undemocratic ‘white elephant’ [29]. Its future is all the more uncertain given a massive waste leak discovered recently.

One of the recurring criticisms against reprocessing is that it provided:

a pretence of a ‘solution’ to radioactive waste problems and is a significant driving force behind the growth of a civilian plutonium fuel cycle. The primary interest of nuclear power corporations, including those in Japan, is to dump spent reactor fuel somewhere else, on someone else, rather than managing it themselves. Reprocessing plants serve this purpose by serving as de facto storage sites” [13].

The benefits from reprocessing for the Japanese, then, seem to be its function as an expensive way to delay the waste crisis:

“So great was the Japanese enthusiasm for off-loading its waste on Britain, so significant was Japanese investment in THORP, that the facility was sometimes colloquially known as BNFL as ‘the Japan plant’” [22].

If we acknowledge such perspectives, it is easy to draw the conclusion that substitution encourages reprocessing by letting overseas customers know they can use reprocessing (coupled with substitution) to solve large volume nuclear waste problems. Given this, substitution is seen as the latest betrayal within the reprocessing quagmire whereby the stated promise to return the waste is finally given up for a little extra cash. And by bolstering reprocessing, waste substitution prolongs the financial efficacy of a process that creates more waste. If BNFL want to present substitution as part of an environmentally beneficial waste management process, it should state that substitution only increases safety and reduces risks from a process that inherently raises risks and increases wastes.

Security and proliferation implications of waste substitution

Although substitution will decrease the overall amount of transport of waste, it will not necessarily decrease the dangers associated with waste transportation. This is especially the case with regards to the terrorist-potential associated with high-level waste.

Any authorised transportation of nuclear materials could conceivably be subjected to terrorist attack and this attack could come in two forms; sabotage and theft.

Sabotage would aim at merely dispersing the nuclear materials on a nuclear-laden ship in order to create a pronounced international radiological

incident. Theft, on the other hand, would involve the collection of the material for some future sinister purpose, for example to make either a nuclear bomb or a radiological weapon. Nuclear bombs generally require 7–10 kg of plutonium whilst radiological weapons, or ‘dirty bombs’, involve the explosive dispersal of non-fissionable radioactive material. Both sabotage and theft of nuclear materials are acknowledged issues within the world of nuclear security and counter-terrorism [4]. For instance:

“Osama bin Laden described the acquisition of such weapons as a ‘religious duty’, when speaking to an ABC news interviewer three years ago’. The events of September 11th illustrate, and increase, the severity of this threat” [14].

And that:

“this threat from Rogue states, international terrorist networks and small fundamentalist groups alike is not a hypothetical one. There are already details of over 250 confirmed black-market incidents involving nuclear material or other radioactive sources in the International Atomic Energy Agency’s Illicit Trafficking Database” [14].

When it comes to nuclear waste substitution as planned by the UK and Japan, we should note that although the quantity of targets for terrorists to aim at are drastically reduced, the quality of terror-potential per target actually increases. This is to say that although any one of the 600 odd ship movements carrying intermediate level radioactive waste may serve to attract terrorist interest they will do so at a much lower level compared to the 10 or so high-level wastes. Given that high-level radioactive waste movement will also contain plutonium oxide (in a form mixed with uranium oxide), and given that such mixed oxide can be converted to plutonium via technology probably available to sub-state organizations, then, on the face of it, the high-level transport option will present a far greater physical danger of nuclear proliferation by sub-national terrorists. Also, given the greater degree of public terror potential that would come from attacking a plutonium laden vessel, it seems possible that the high-level waste option will present qualitatively more attractive targets.

To a large extent, though, nobody can really say which is the more attractive target. The real point here though is that BNFL and the UK government are confidently saying ‘the fewer movements there are, the fewer targets there are’, without judging either the qualitative difference in terror-potential or the increased intrinsic physical danger that ships carrying high-level waste may present. It is also inconsistent for BNFL to claim that high-level waste carried over the seas poses no greater risk of terrorism activity than intermediate-level waste yet they, themselves, station greater security for high-level waste at their own land-based facilities.

Some people [27] would suggest that the high-level waste terror potential is effectively countered by the security on board nuclear waste-laden ships.

Others however profess very strongly that such security is wholly inadequate. For instance,

“to spread plutonium across an entire region, terrorists need only send a missile or boat like the one Bin Laden used to attack the USS Cole, equipped with the right explosives, into the side of one of the freighters. The MOX fuel is stored in containers which can resist temperatures of 800c for 30 minutes. Fires on ships...can burn for 24 hours at 1,000C. Stealing the material is a matter of overwhelming the 26 British policemen on board and blowing the hatches off, a task well within the capabilities of several terrorist groups and all of the world’s aspirant nuclear states” [20].

Nuclear waste record keeping

The practice of accounting in the nuclear industry is plagued by discrepancies, both when that accounting deals with materials and with money. Since waste substitution is prefaced on good accounting of both, concern has to be expressed about past problems. BNFL, for example, has come under criticism with regard to past accounting practices which are directly relevant to their future planned work in waste substitution. For example, “*when BNFL built THORP, it predicted that it would eventually make profits of £500 million*” [19] but in August 2003, BNFL had announced that it had made a loss of more than £1 billion. Critics predicted this loss in the early 1990s [15] but their voices were drowned out by industry and government voices.

Questionable accounting practices have dogged the reprocessing industry [21] but perhaps more worrying is the penchant for mismanagement of materials accounting in the nuclear industry both in the UK and Japan. As one example of such mishandling, consider this news report:

“The disturbing revelation yesterday by the Japanese Government that plutonium recovered over 25 years of operations at the Tokai-Mura Reprocessing Plant is 206 kilograms short of the amount predicted demonstrates the inherent capacity of safeguards at facilities handling large quantities of bomb-usable nuclear material, according to the Nuclear Control Institute, a Washington DC-based non-proliferation research and advocacy center” [7].

This is enough to make 30 to 40 atomic bombs. It is noteworthy that:

“Japan has offered various explanations, including measurement and estimation errors, hold up in the plant’s process equipment and leaks into waste streams. Regardless of how it occurred, however, the Tokai ‘plutonium gap’ demonstrates that safeguards technology is incapable of fulfilling the objective of allowing timely detection of plutonium diversion. Japan and the International Atomic Energy Agency (IAEA) have

apparently been aware of this problem for many years, yet been unable to resolve it” [7].

While the International Atomic Energy Agency:

“says that it is satisfied with the Japanese government explanation that about half the missing material ended up in liquid waste, about 100 kilograms of plutonium still remain unaccounted for. Japan should immediately shut down the Tokai plant and undertake a full clean-out and accounting under IAEA supervision. To be credible this process must be transparent and open to scrutiny” [7].

Nuclear materials routinely go missing as they get moved around and one has to wonder if this will be the case in a waste substitution programme as volumes are handed from one caretaker to another. Accounting anomalies go on even within the UK. For example, there are discrepancies between British:

“recorded production histories, which may be incomplete, and current inventories, leading to a situation where significant quantities of fissile material cannot be accounted for” [2].

The lack of transparency in the industry may be a major contributor to this problem. And according to a report by ‘The Campaign for Freedom of Information’, BNFL were neither open or transparent about waste substitution when they were asked to disclose information in accordance with the 1992 Environmental Information Regulations. According to the report:

“BNFL failed to supply copies of clauses in the contracts between BNFL and one of its customers on the substitution of high level radioactive waste for intermediate and low level radioactive waste. These are a crucial part of the ‘waste substitution’ debate since they describe how much radioactive waste from overseas will ultimately be disposed of in the UK, and how much will be returned to the customer” [9].

As if losing records and materials, and the lack of transparency, isn’t bad enough, there is also a history of record falsification in British–Japanese nuclear trade relations [1]. From 1996 to 1999 BNFL transported mixed oxide nuclear materials to Japan that carried with it falsified safety data. The Japanese, once they had found out, refused to accept anymore transports until BNFL had launched all sorts of new safety checks, training programmes and not a little diplomatic appeasement of their Japanese customers.

The no transport option

To be sure, terrorist dangers, environmental risks and lost and falsified records can happen no matter whether the waste to be transported is 600 intermediate-level waste shipments or 10 high-level waste shipments. Given the problem with transporting wastes, one of the solutions might be to leave everything where it currently is, not to move anything. This would, of course,

prompt headlines about Britain being a waste dump, but surely it would also be poetic justice in that a country so vigorously pursuing reprocessing and international nuclear commerce would have to face up to the negative consequences of that trade.

Much has been made in the consultation report that the extra high-level waste will only add a small percentage to the inventory (and is radioactively and environmentally neutral) but, given BNFL's argument that the substitutable high-level waste that it wants to send back is radiologically equivalent to the intermediate-level waste, and that this intermediate-level waste is a tiny extra percentage of the national inventory of the UK's radioactive waste, then some of the arguments for the absolute necessity for even sending back high-level waste must be considered dented.

Summary

Under the regimes of waste substitution agreed by the UK government, BNFL and their Japanese trading partners, it is clear that BNFL will profit from a process that increases the amount of dangerous nuclear waste that one day will have to be sited near particular British communities. It is also clear that this practice will bolster BNFL's reprocessing business with all the environmental dangers and proliferation and terrorist problems that that presents. This does not mean waste substitution should not go ahead under any circumstances. Perhaps it can go ahead in an ethical manner if it fulfils the following conditions:

- Claims of radioactive equivalence and environmental neutrality have to be opened up for scrutiny by a wider audience.
- Any future waste substitute arrangements are made only between acknowledged equitable partners; wherein the partners are assumed to have the same political, economic and environmental standards. This would ensure that Britain and Japan are not taking advantage of the looser environmental or planning laws in each other's countries and it would ensure that waste substitution between Japan and the UK is not used as a precedent to justify the future trade between these countries and lesser developed countries.

All affected parties agree (including the future host communities and transit nations such as those en route in the Pacific).

To get these affected parties to agree means considering the following:

- arranging suitable emergency and liability plans (including taking seriously the option of paying up-front fees which are reimbursed by the country if nothing goes wrong).
- compensation of communities for becoming higher proliferation or higher terrorist-potential zones.
- delaying decision on substitution until this takes place.

- accepting no private profit for increasing public risks.
- giving consideration to the no transport of nuclear waste option.
- openly discussing who gets paid for what.
- debating whether the intractability of waste substitution is another reason to consider the cessation of reprocessing?

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